for Preparation Click here

CAUTION:

When using the intelligent tester, observe the following items for safety reasons:

- **Read its instruction books before using the tester.**
- **Prevent the tester cable from being caught on the pedals, shift lever and steering wheel when driving with the tester connected to the vehicle.**
- **When driving the vehicle for testing purposes using the tester, 2 persons are required. One person drives the vehicle, and the other operates the tester.**

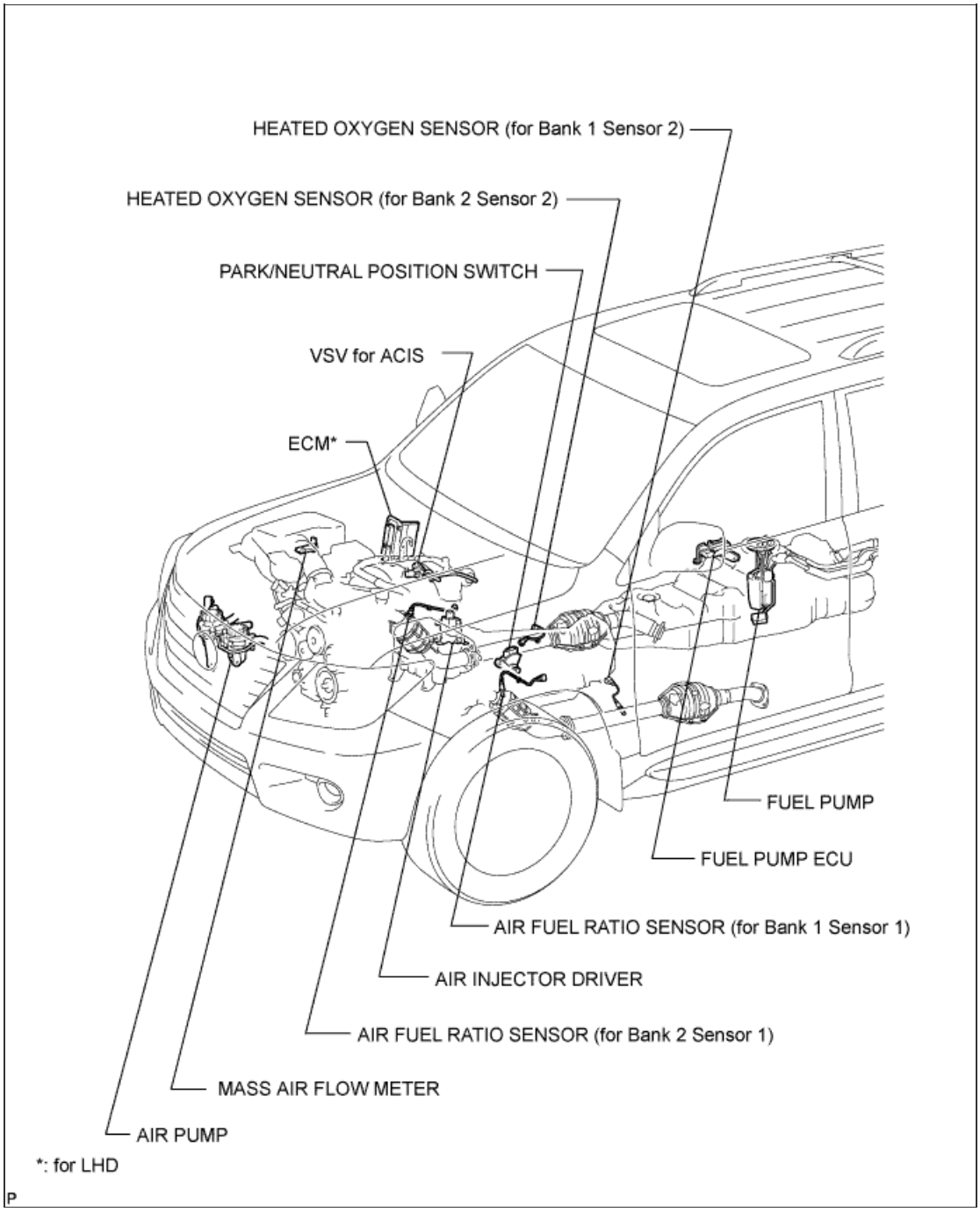
NOTICE:

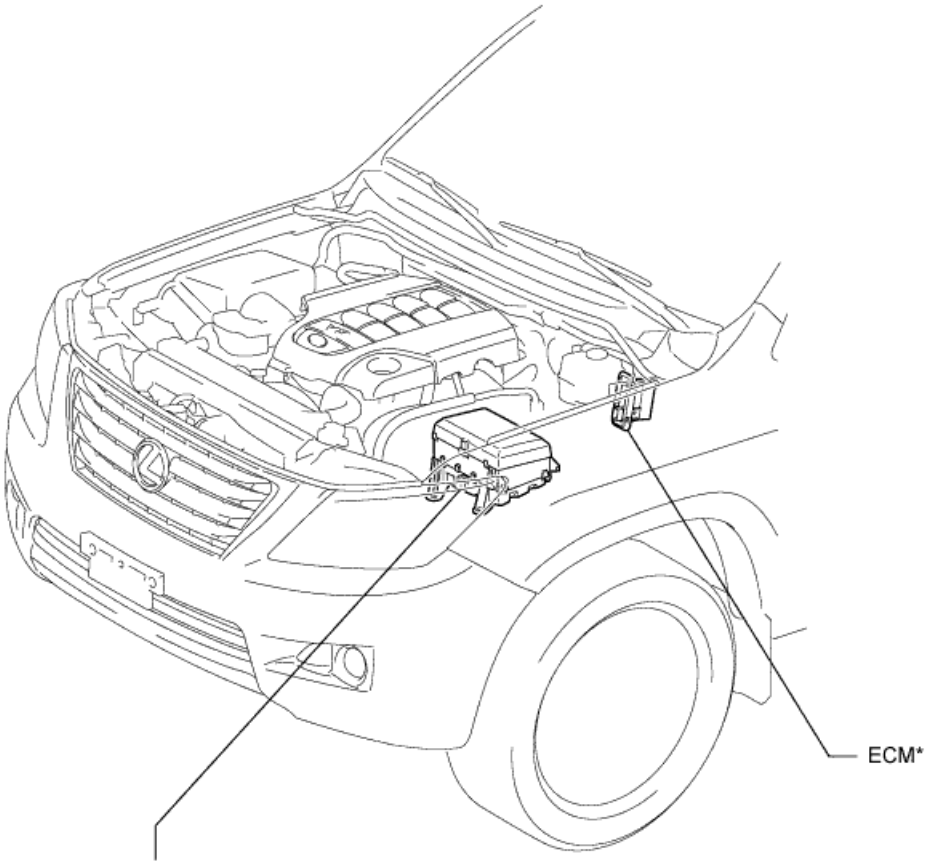
Perform Reset Memory (AT initialization) for 4WD when replacing the automatic transmission assembly, engine assembly or ECM (Click here).

HINT:

Reset Memory cannot be completed by only removing the battery.

for Preparation Click here



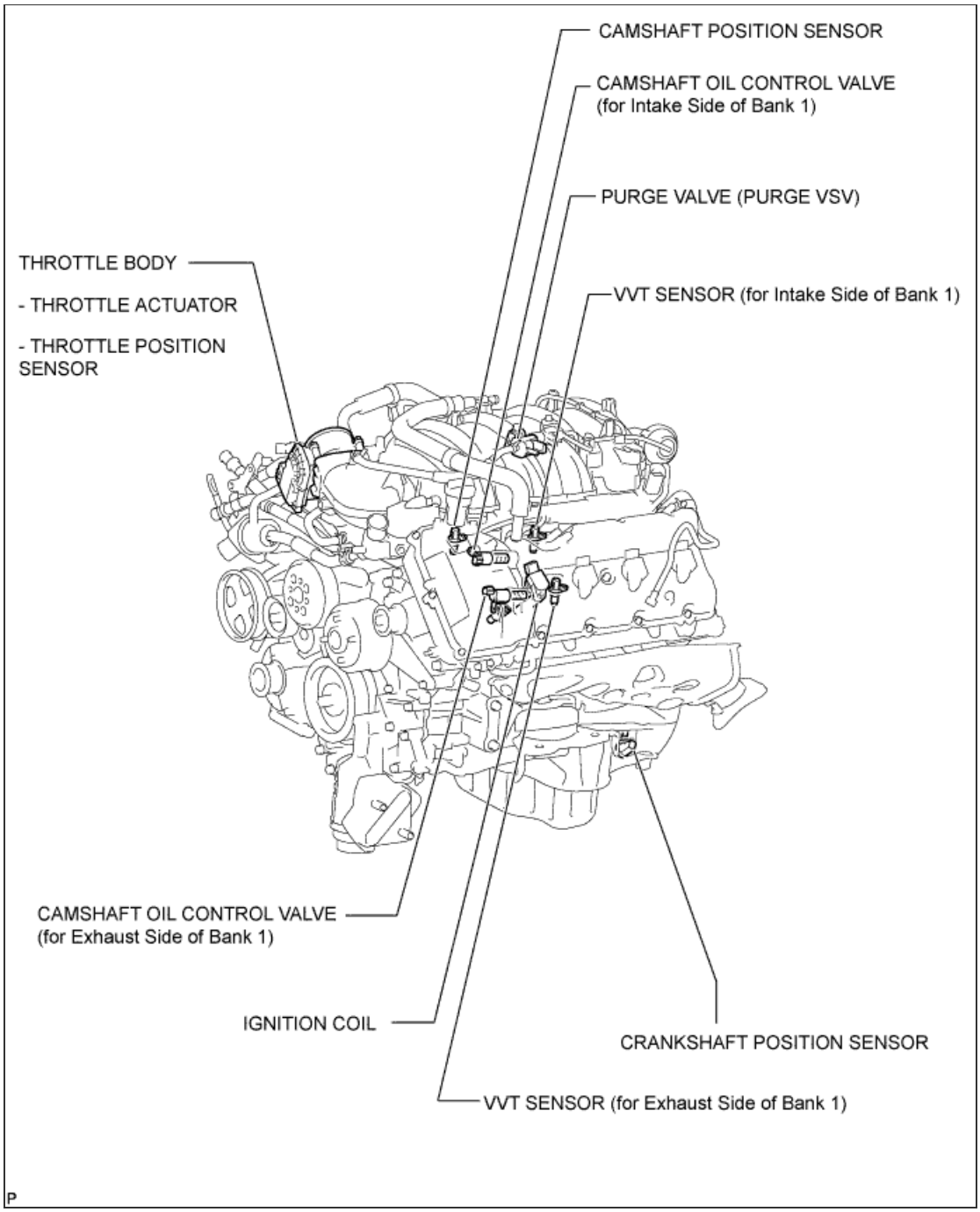


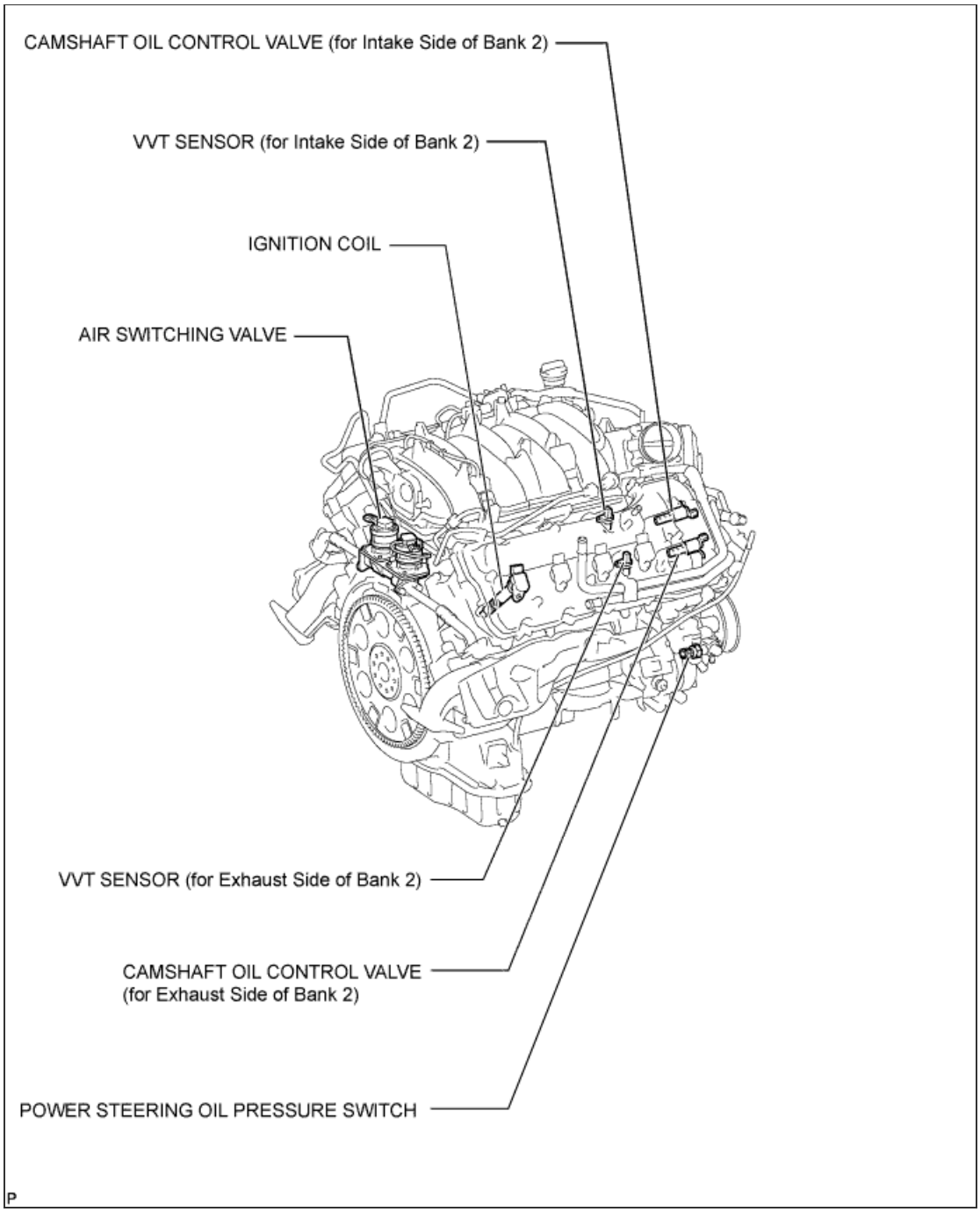
ENGINE ROOM RELAY BLOCK

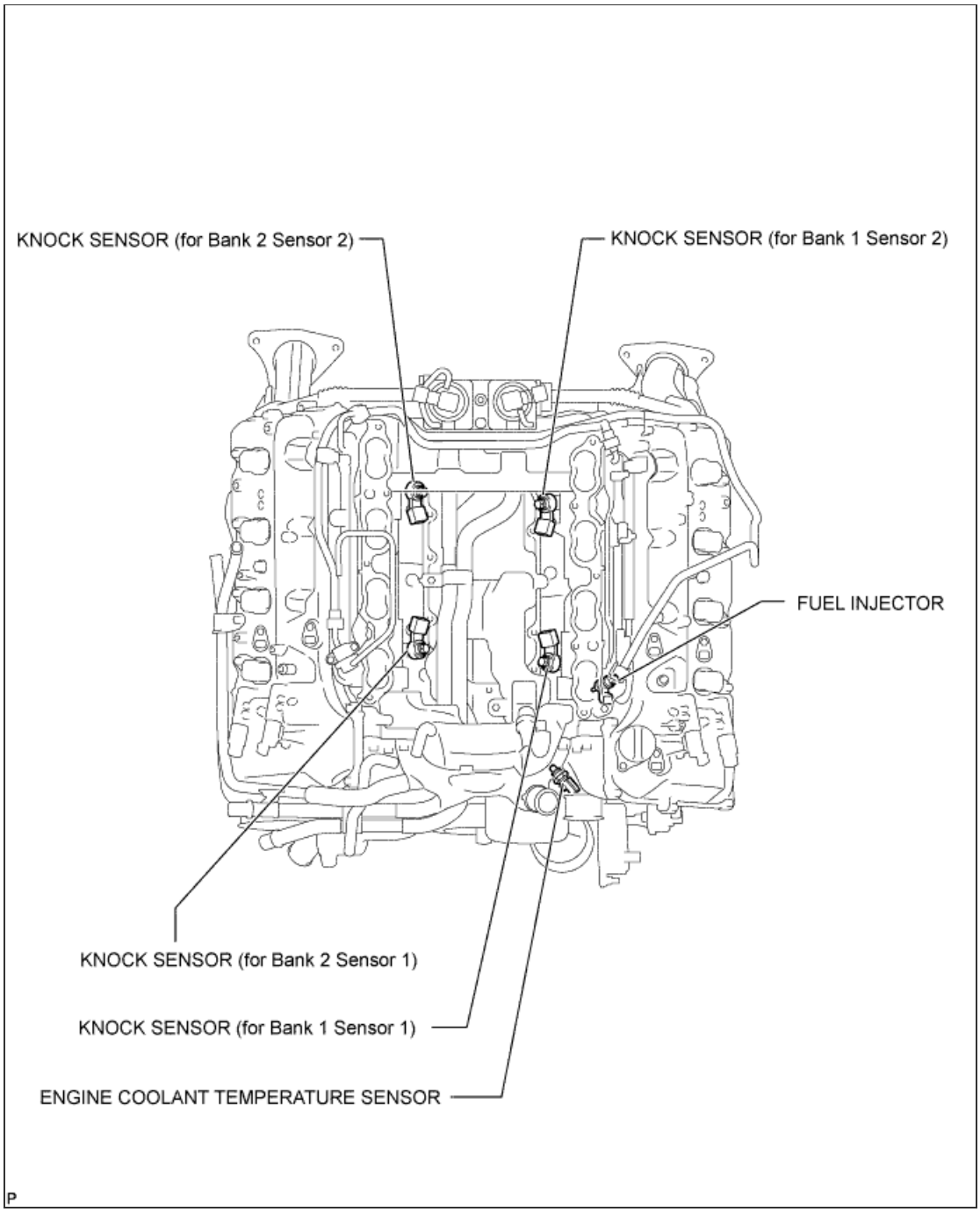
- CIRCUIT OPENING RELAY (C/OPN)
- IGNITION RELAY NO. 2 (IG2)
- EFI RELAY
- EFI NO. 2 RELAY
- A/F SENSOR HEATER RELAY (A/F)
- STARTER RELAY (ST)
- STARTER CUT RELAY (ST CUT)
- ETCS FUSE
- EFI MAIN 2 FUSE
- EFI NO. 2 FUSE
- A/F FUSE
- EFI MAIN FUSE
- STOP FUSE
- IG2 MAIN FUSE
- INJ FUSE
- IGN FUSE

*: for RHD

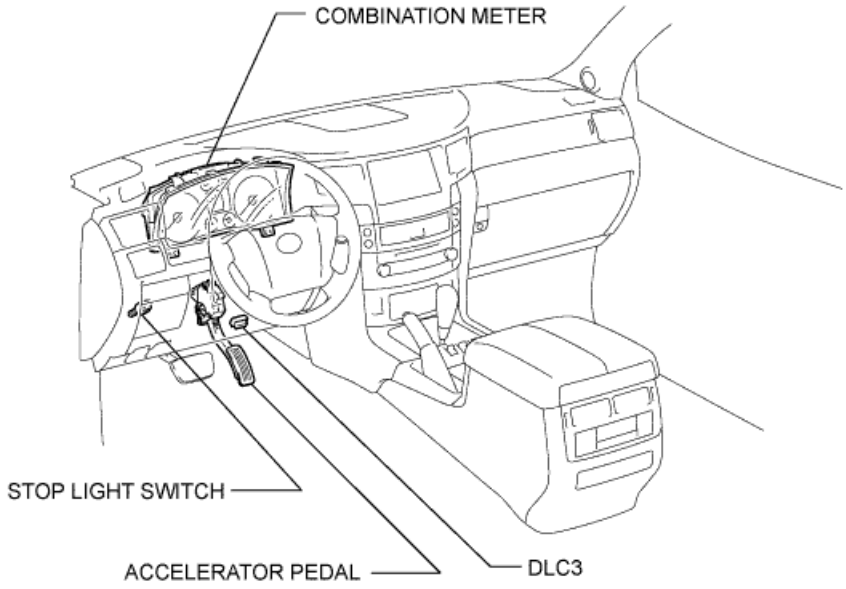
P


CAMSHAFT POSITION SENSOR
CAMSHAFT OIL CONTROL VALVE
(for Intake Side of Bank 1)
PURGE VALVE (PURGE VSV)
THROTTLE BODY
- THROTTLE ACTUATOR
- THROTTLE POSITION SENSOR
VVT SENSOR (for Intake Side of Bank 1)
CAMSHAFT OIL CONTROL VALVE
(for Exhaust Side of Bank 1)
IGNITION COIL
CRANKSHAFT POSITION SENSOR
VVT SENSOR (for Exhaust Side of Bank 1)
P

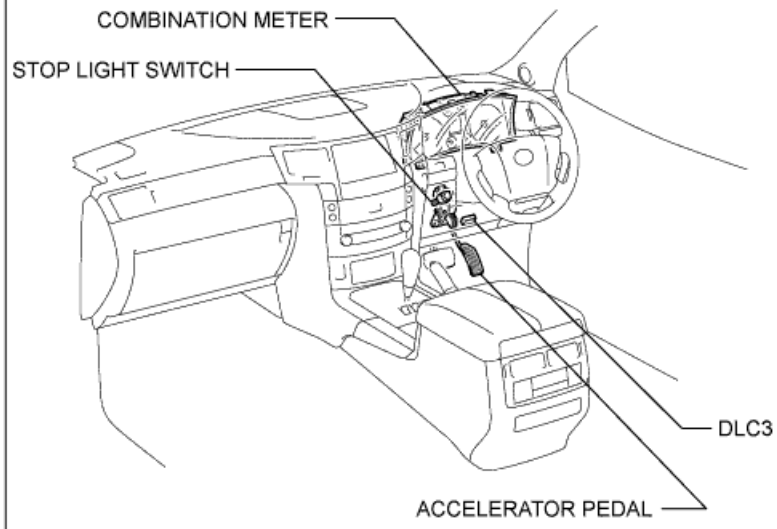

CAMSHAFT OIL CONTROL VALVE (for Intake Side of Bank 2)
VVT SENSOR (for Intake Side of Bank 2)
IGNITION COIL
AIR SWITCHING VALVE
VVT SENSOR (for Exhaust Side of Bank 2)
CAMSHAFT OIL CONTROL VALVE
(for Exhaust Side of Bank 2)
POWER STEERING OIL PRESSURE SWITCH
P


KNOCK SENSOR (for Bank 2 Sensor 2)
KNOCK SENSOR (for Bank 1 Sensor 2)
FUEL INJECTOR
KNOCK SENSOR (for Bank 2 Sensor 1)
KNOCK SENSOR (for Bank 1 Sensor 1)
ENGINE COOLANT TEMPERATURE SENSOR
P

for LHD:

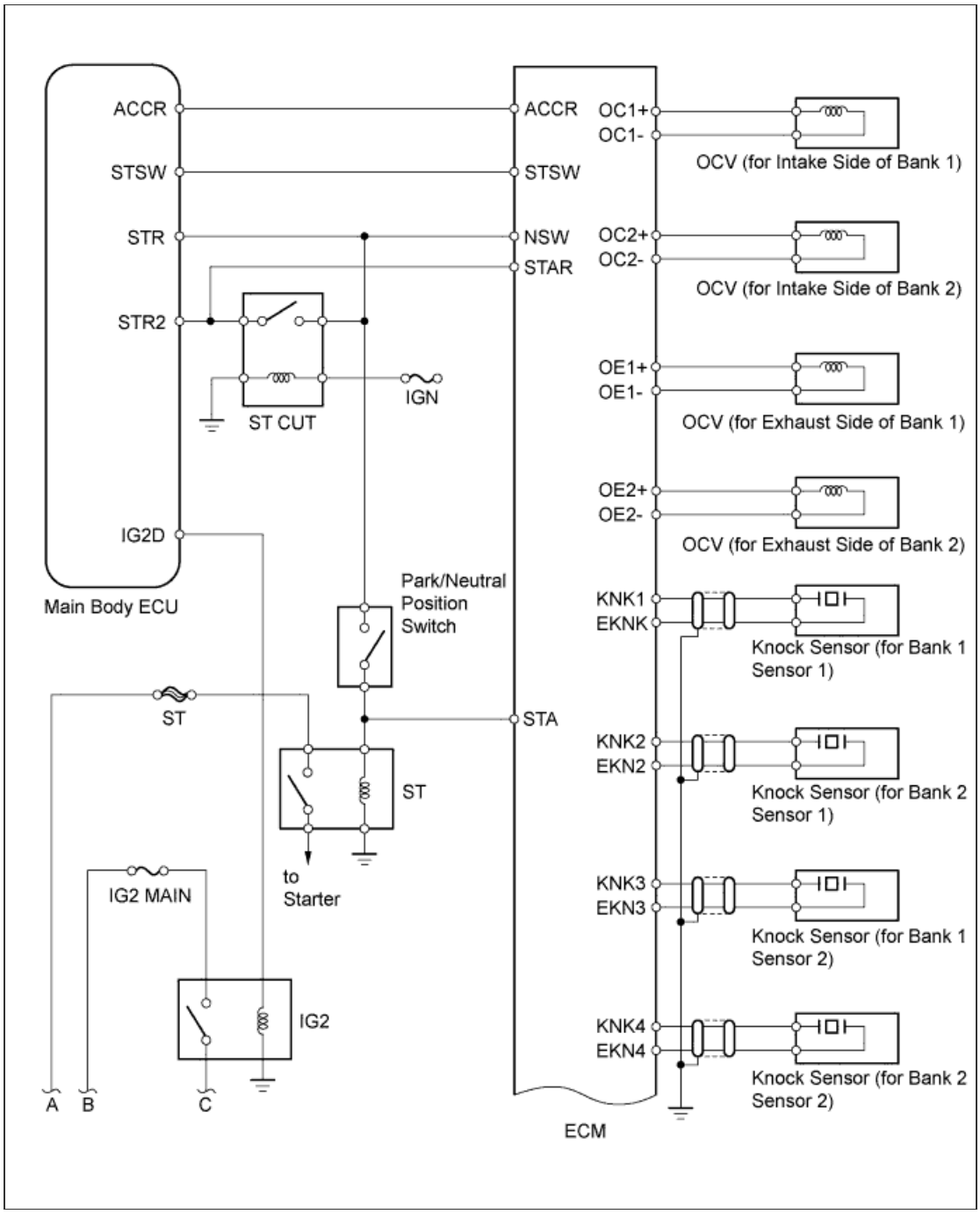


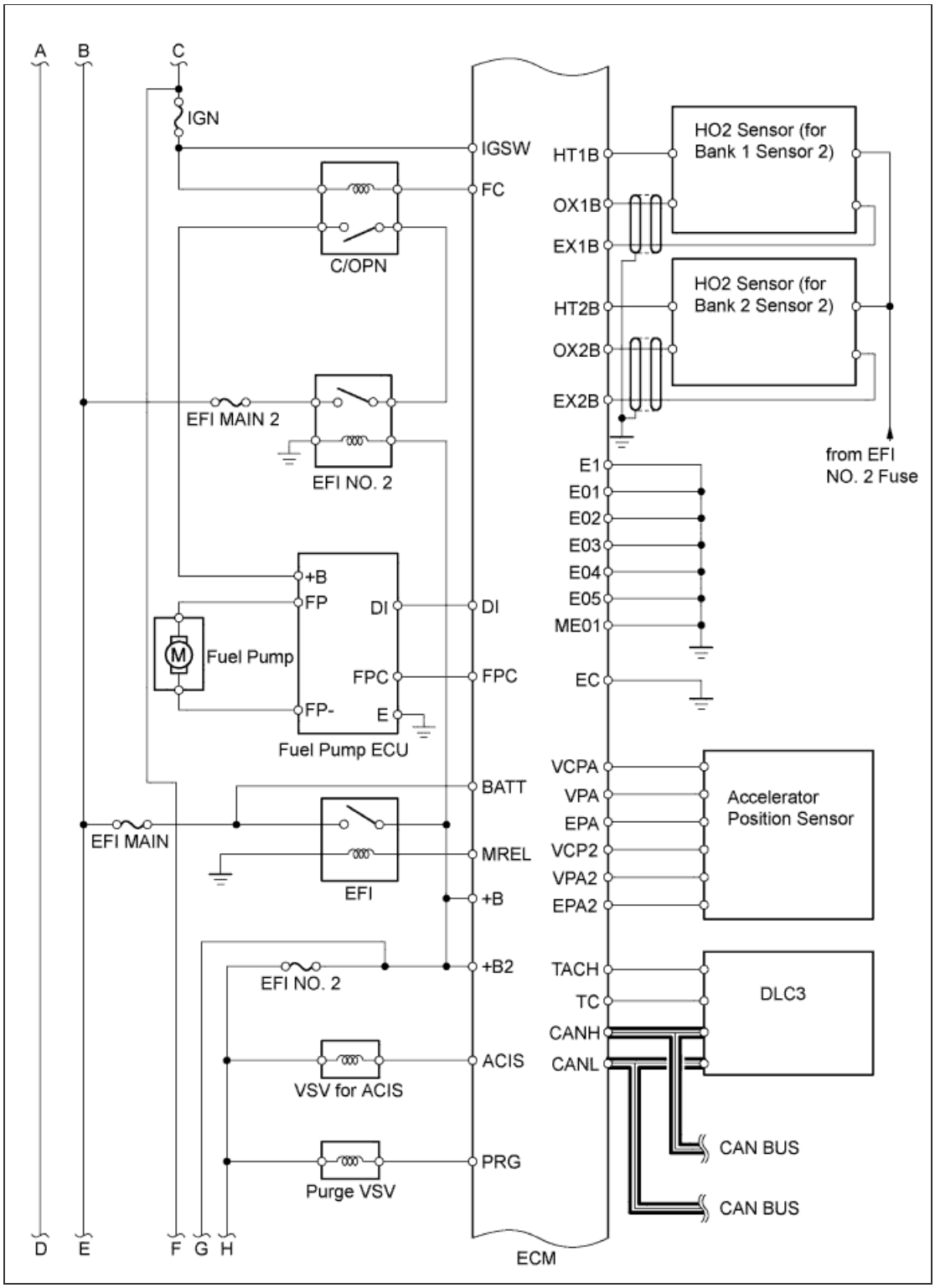
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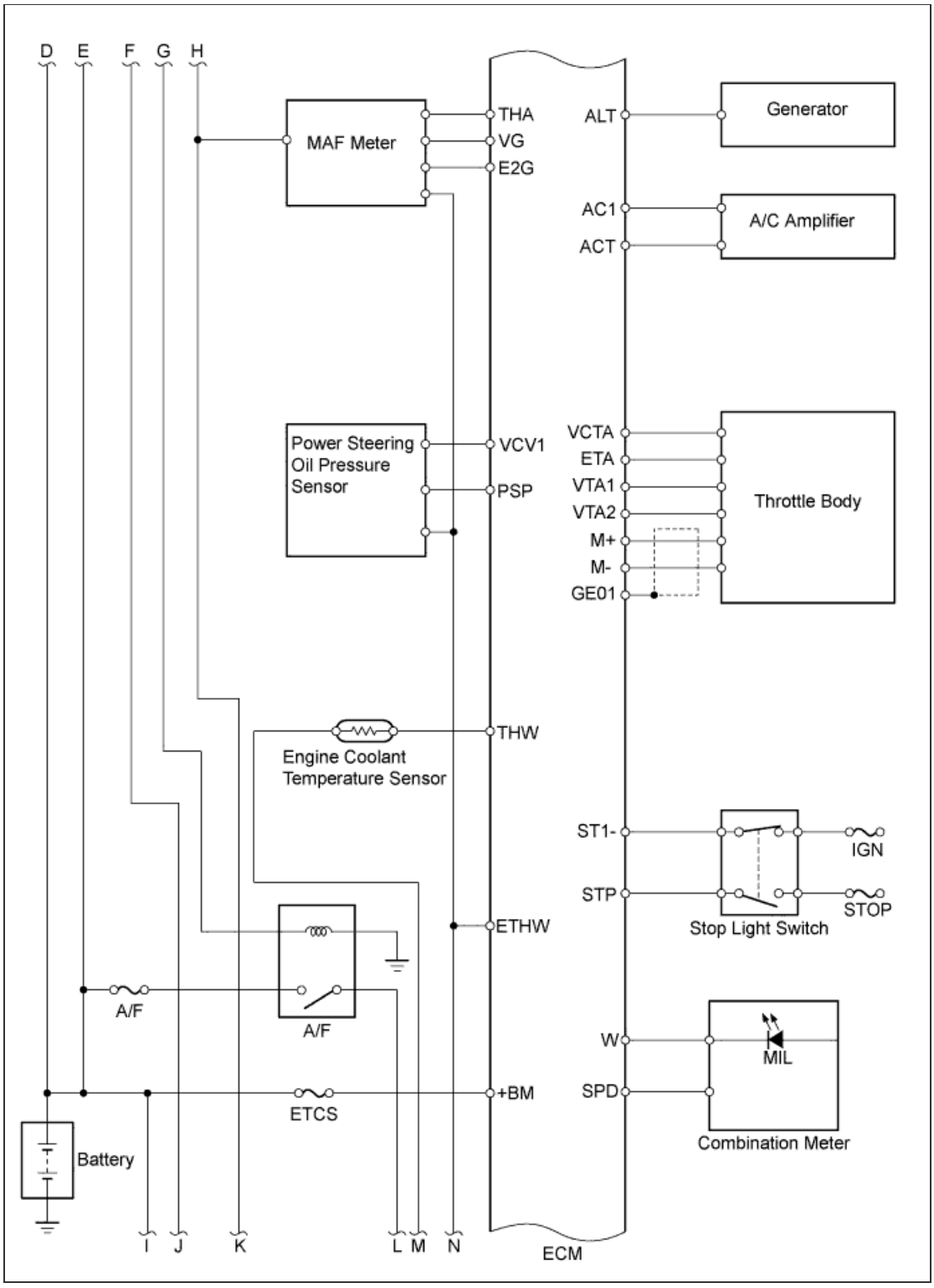


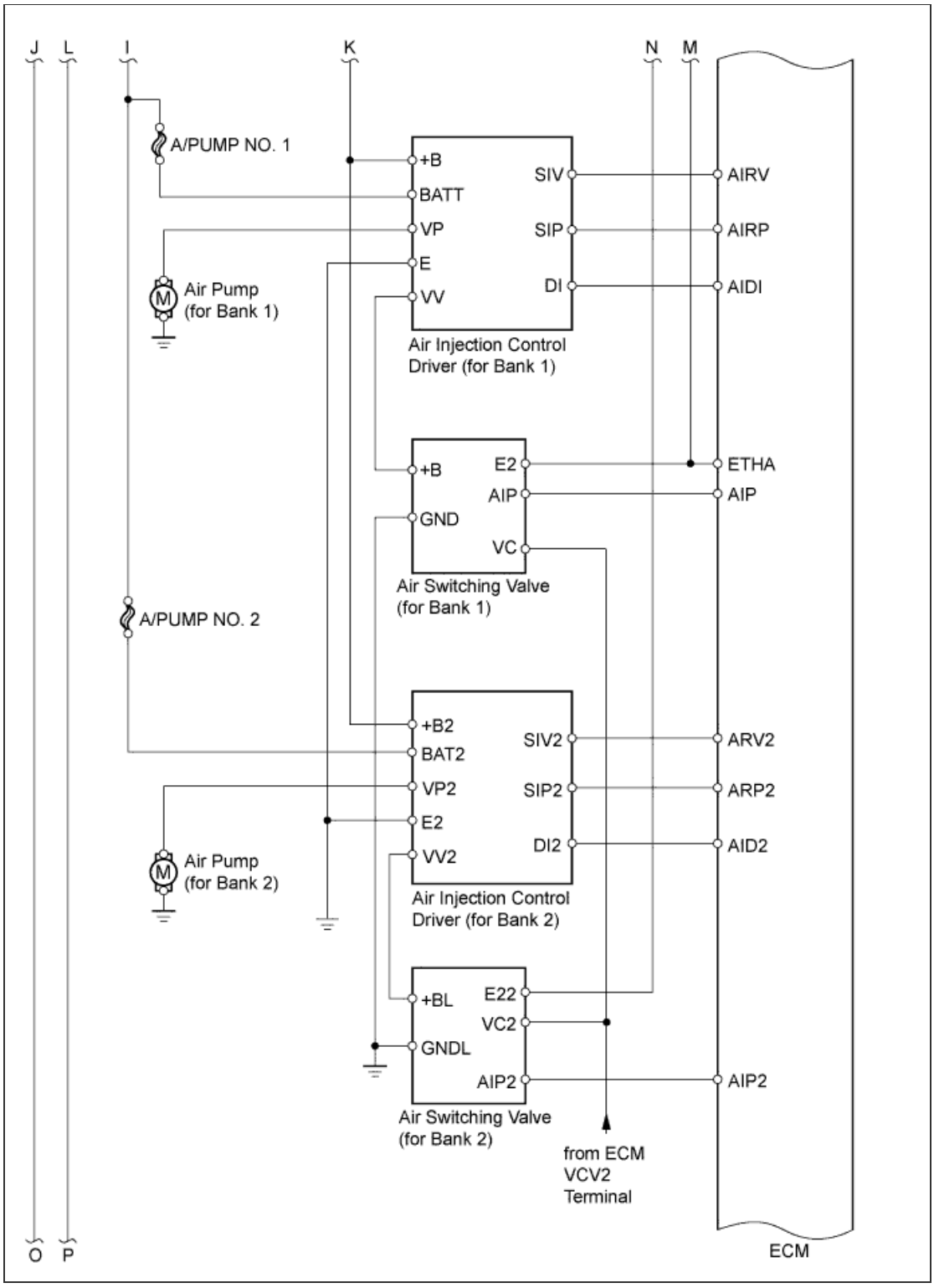
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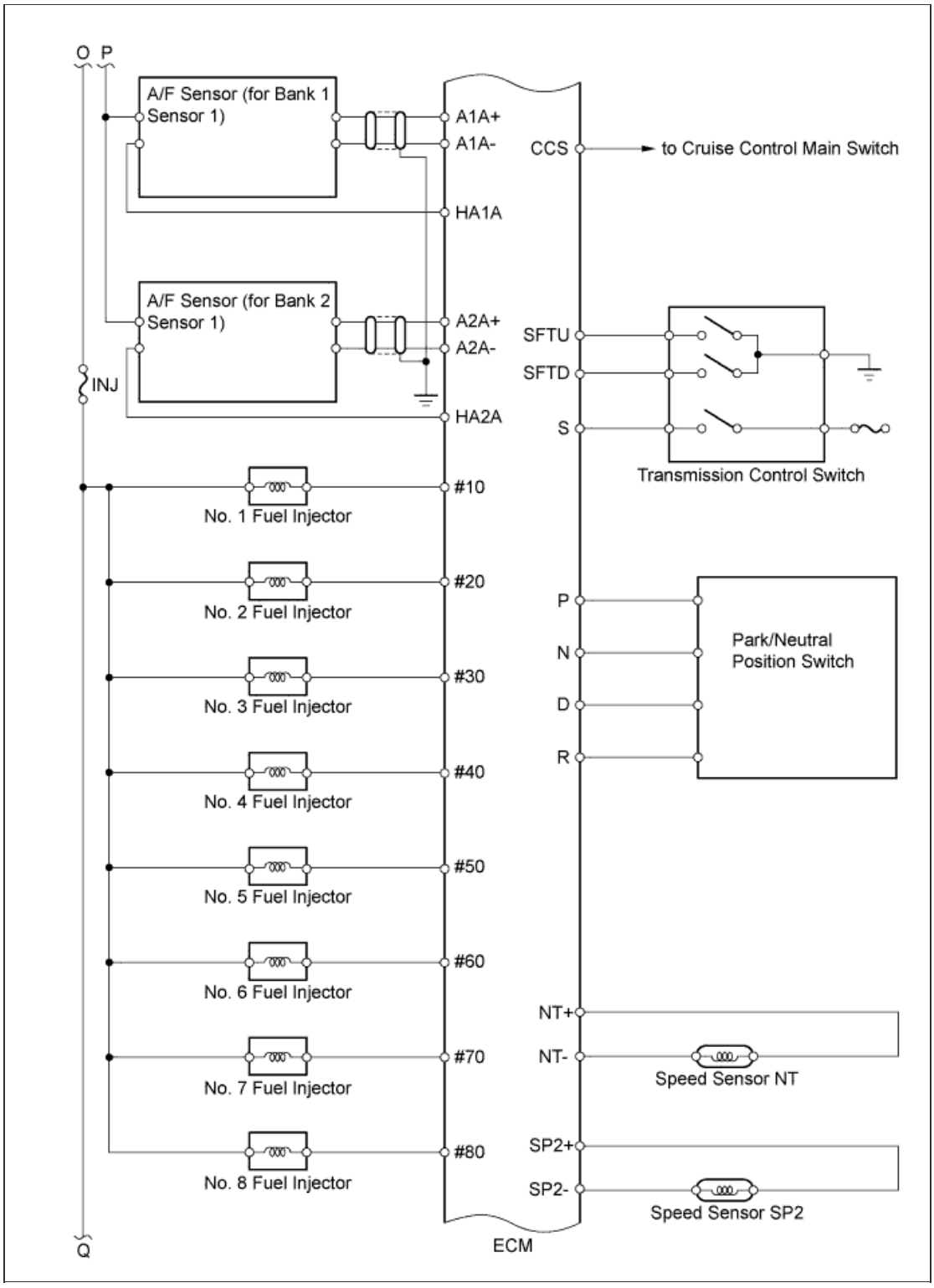
for Preparation Click here

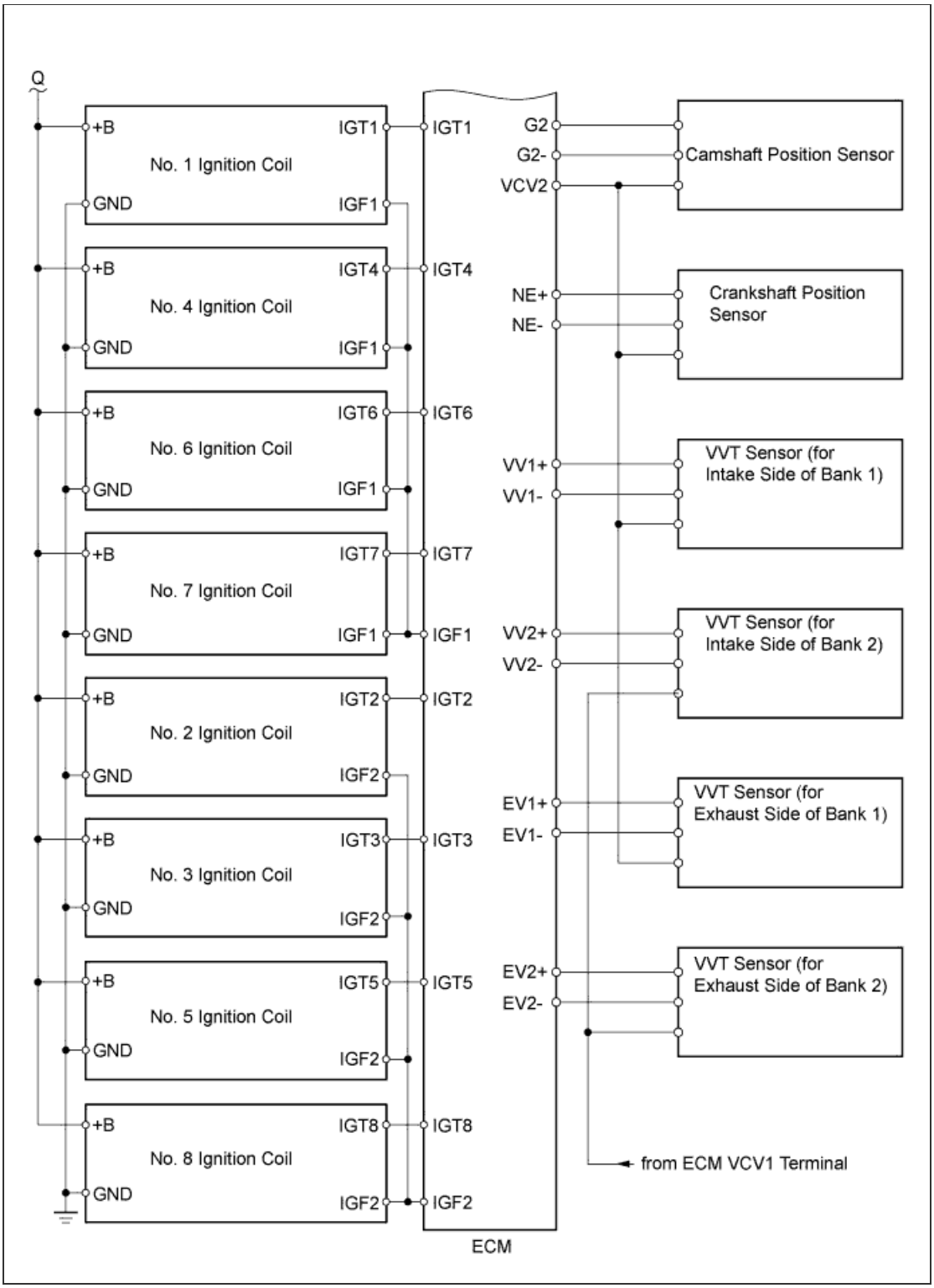



A
B
C
IGN
IGSW
FC
C/OPN
EFI MAIN 2
EFI NO. 2
+B
FP
DI
DI
Fuel Pump
FPC
FPC
FP-
E
Fuel Pump ECU
BATT
EFI MAIN
MREL
EFI
+B
+B2
EFI NO. 2
ACIS
VSV for ACIS
PRG
Purge VSV
D
E
F
G
H
ECM
HT1B
OX1B
EX1B
HO2 Sensor (for Bank 1 Sensor 2)
HT2B
OX2B
EX2B
HO2 Sensor (for Bank 2 Sensor 2)
from EFI NO. 2 Fuse
E1
E01
E02
E03
E04
E05
ME01
EC
VCPA
VPA
EPA
VCP2
VPA2
EPA2
Accelerator Position Sensor
TACH
TC
CANH
CANL
DLC3
CAN BUS
CAN BUS


D
E
F
G
H
MAF Meter
THA
VG
E2G
ALT
Generator
AC1
A/C Amplifier
ACT
Power Steering
Oil Pressure
Sensor
VCV1
PSP
VCTA
ETA
VTA1
VTA2
M+
M-
GE01
Throttle Body
THW
Engine Coolant
Temperature Sensor
ST1-
IGN
STP
STOP
Stop Light Switch
ETHW
A/F
A/F
W
MIL
SPD
+BM
ETCS
Battery
Combination Meter
I
J
K
L
M
N
ECM


J
L
I
K
N
M
A/PUMP NO. 1
+B
BATT
VP
E
VV
SIV
SIP
DI
AIRV
AIRP
AIDI
Air Pump
(for Bank 1)
Air Injection Control
Driver (for Bank 1)
+B
GND
E2
AIP
VC
ETHA
AIP
Air Switching Valve
(for Bank 1)
A/PUMP NO. 2
+B2
BAT2
VP2
E2
VV2
SIV2
SIP2
DI2
ARV2
ARP2
AID2
Air Pump
(for Bank 2)
Air Injection Control
Driver (for Bank 2)
+BL
GNDL
E22
VC2
AIP2
AIP2
Air Switching Valve
(for Bank 2)
from ECM
VCV2
Terminal
ECM
O
P


O
P
A/F Sensor (for Bank 1 Sensor 1)
A1A+
A1A-
HA1A
A/F Sensor (for Bank 2 Sensor 1)
A2A+
A2A-
HA2A
INJ
Q
No. 1 Fuel Injector
#10
No. 2 Fuel Injector
#20
No. 3 Fuel Injector
#30
No. 4 Fuel Injector
#40
No. 5 Fuel Injector
#50
No. 6 Fuel Injector
#60
No. 7 Fuel Injector
#70
No. 8 Fuel Injector
#80
ECM
CCS
to Cruise Control Main Switch
SFTU
SFTD
S
Transmission Control Switch
P
N
D
R
Park/Neutral Position Switch
NT+
NT-
Speed Sensor NT
SP2+
SP2-
Speed Sensor SP2


Q
+B
GND
IGT1
IGF1
No. 1 Ignition Coil
+B
GND
IGT4
IGF1
No. 4 Ignition Coil
+B
GND
IGT6
IGF1
No. 6 Ignition Coil
+B
GND
IGT7
IGF1
No. 7 Ignition Coil
+B
GND
IGT2
IGF2
No. 2 Ignition Coil
+B
GND
IGT3
IGF2
No. 3 Ignition Coil
+B
GND
IGT5
IGF2
No. 5 Ignition Coil
+B
GND
IGT8
IGF2
No. 8 Ignition Coil
IGT1
IGT4
IGT6
IGT7
IGF1
IGT2
IGT3
IGT5
IGT8
IGF2
ECM
G2
G2-
VCV2
Camshaft Position Sensor
NE+
NE-
Crankshaft Position Sensor
VV1+
VV1-
VVT Sensor (for Intake Side of Bank 1)
VV2+
VV2-
VVT Sensor (for Intake Side of Bank 2)
EV1+
EV1-
VVT Sensor (for Exhaust Side of Bank 1)
EV2+
EV2-
VVT Sensor (for Exhaust Side of Bank 2)
from ECM VCV1 Terminal

for Preparation Click here

HINT:

*: Use the intelligent tester.

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.CUSTOMER PROBLEM ANALYSIS

NEXT

3.CONNECT INTELLIGENT TESTER TO DLC3

HINT:

If the display indicates a communication fault in the intelligent tester, inspect the DLC3.

NEXT

4.CHECK DTC AND FREEZE FRAME DATA*

HINT:

Record or print DTCs and freeze frame data, if necessary.

NEXT

5.CLEAR DTC AND FREEZE FRAME DATA*

NEXT

6.CONDUCT VISUAL INSPECTION

NEXT

7.SET CHECK MODE DIAGNOSIS*

NEXT

8.CONFIRM PROBLEM SYMPTOMS

HINT:

If the engine does not start, first perform the "Check DTC" procedures and "Conduct Basic Inspection" procedures below.

Result

Result	Proceed to
Malfunction does not occur	A
Malfunction occurs	B

B. Go to step 10

A

9.SIMULATE SYMPTOMS

NEXT

10.CHECK DTC*

Result

Result	Proceed to
Trouble code	A
No code	B

B. Go to step 12

A

11.REFER TO DTC CHART

NEXT

Go to step 14

12.CONDUCT BASIC INSPECTION

Result

Result	Proceed to
Malfunctioning parts not confirmed	A
Malfunctioning parts confirmed	B

B. Go to step 17

A

13.REFER TO PROBLEM SYMPTOMS TABLE

Result

Result	Proceed to
Malfunctioning circuit confirmed	A
Malfunctioning parts confirmed	B

B. Go to step 17

A

14.CHECK ECM POWER SOURCE CIRCUIT

NEXT

15.CONDUCT CIRCUIT INSPECTION

Result

Result	Proceed to
Malfunction not confirmed	A
Malfunction confirmed	B

B. Go to step 18

A

16.CHECK FOR INTERMITTENT PROBLEMS

NEXT

Go to step 18

17.CONDUCT PARTS INSPECTION

NEXT

18.IDENTIFY PROBLEM

NEXT

19.ADJUST AND/OR REPAIR

NEXT

20.CONDUCT CONFIRMATION TEST

NEXT

END

for Preparation Click here

HINT:

Inspect the vehicle ECM using check mode. Intermittent problems are easier to detect with the intelligent tester when the ECM is in check mode. In check mode, the ECM uses 1 trip detection logic, which is more sensitive to malfunctions than normal mode (default), which uses 2 trip detection logic.

1. **Clear the DTCs (Click here).**
2. **Switch the ECM from normal mode to check mode using the tester (Click here).**
3. **Perform a simulation test.**
4. **Check and wiggle the harness(es), connector(s) and terminal(s).**

for Preparation Click here

HINT:

Inspect the vehicle ECM using check mode. Intermittent problems are easier to detect with the intelligent tester when the ECM is in check mode. In check mode, the ECM uses 1 trip detection logic, which is more sensitive to malfunctions than normal mode (default), which uses 2 trip detection logic.

1. **Clear the DTCs (Click here).**
2. **Switch the ECM from normal mode to check mode using the tester (Click here).**
3. **Perform a simulation test.**
4. **Check and wiggle the harness(es), connector(s) and terminal(s).**

for Preparation Click here

When a malfunction is not confirmed by the DTC check, troubleshooting should be carried out in all circuits considered to be possible causes of the problem. In many cases, by carrying out the basic engine check shown in the following flowchart, the location of the problem can be found quickly and efficiently. Therefore, using this check is essential when performing engine troubleshooting.

1.CHECK BATTERY VOLTAGE

NOTICE:

Conduct this check with the engine stopped and engine switch off.

Result

Result	Proceed to
11 V or higher	OK
Below 11 V	NG

NG. → CHARGE OR REPLACE BATTERY

OK ↓

2.CHECK WHETHER ENGINE WILL CRANK

NG. → PROCEED TO PROBLEM SYMPTOMS TABLE

OK ↓

3.CHECK WHETHER ENGINE STARTS

NG. → Go to step 6

OK ↓

4.CHECK AIR FILTER

a. Visually check that the air filter is not excessively contaminated with dirt or oil.

NG. → REPLACE AIR FILTER

OK ↓

5.CHECK IDLING SPEED

NG. → TROUBLESHOOT IDLING SPEED AND PROCEED TO NEXT STEP

OK ↓

6.CHECK FUEL PRESSURE

NG. → TROUBLESHOOT FUEL PRESSURE AND PROCEED TO NEXT STEP

OK

7.CHECK FOR SPARK

NG. → TROUBLESHOOT SPARK AND PROCEED TO NEXT STEP

OK

PROCEED TO PROBLEM SYMPTOMS TABLE

for Preparation Click here

HINT:

Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.

SFI System

Symptom	Suspected Area	See page
Engine does not crank (Does not start)	Battery	Click here
	Starter	Click here
	Starter relay	Click here
	Park/neutral position switch	Click here
	Immobiliser system	Click here
	Entry and start system	Click here
No initial combustion (Does not start)	ECM power source circuit	Click here
	Crankshaft position sensor	Click here
	Camshaft position sensor	Click here
	Ignition system	Click here
	Fuel pump control circuit	Click here
	ECM	Click here
	VC output circuit	Click here
Engine cranks normally but difficult to start	Fuel pump control circuit	Click here
	Compression	Click here
Difficult to start with cold engine	Ignition system	Click here
	Spark plug	Click here
	Fuel pump control circuit	Click here
	Fuel injector	Click here
	Cranking holding function circuit	Click here
Difficult to start with warm engine	Fuel injector	Click here
	Ignition system	Click here
	Spark plug	Click here
	Fuel pump control circuit	Click here
	Cranking holding function circuit	Click here
High engine idle speed	Electronic throttle control system	Click here
	A/C signal circuit	Click here
	ECM power source circuit	Click here
	Acoustic Control Induction System (ACIS)	Click here
Low engine idle speed (Poor idling)	Electronic throttle control system	Click here
	A/C signal circuit	Click here
	Fuel pump control circuit	Click here
	Air induction system	Click here
	Acoustic Control Induction System (ACIS)	Click here
	PCV hose	Click here
Rough idling	Compression	Click here
	Spark plug	Click here
	Fuel injector	Click here
	Ignition system	Click here
	Fuel pump control circuit	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	Acoustic Control Induction System (ACIS)	Click here
	PCV hose	Click here

	Mass air flow meter	Click here
Idle hunting	Electronic throttle control system	Click here
	Air induction system	Click here
	ECM power source circuit	Click here
	Acoustic Control Induction System (ACIS)	Click here
Hesitation/Poor acceleration	A/T faulty	Click here
	Fuel pump control circuit	Click here
	Spark plug	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Mass air flow meter	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	Compression	Click here
Surging (Poor driveability)	Spark plug	Click here
	Fuel pump control circuit	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Mass air flow meter	Click here
	Variable valve timing system	Click here
	Compression	Click here
Engine stalls soon after starting	Fuel pump control circuit	Click here
	Spark plug	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Variable valve timing system	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	PCV hose	Click here
	Compression	Click here
Engine stalls only during A/C operation	A/C signal circuit	Click here
	ECM	Click here

for Preparation Click here

HINT:

Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.

SFI System

Symptom	Suspected Area	See page
Engine does not crank (Does not start)	Battery	Click here
	Starter	Click here
	Starter relay	Click here
	Park/neutral position switch	Click here
	Immobiliser system	Click here
	Entry and start system	Click here
No initial combustion (Does not start)	ECM power source circuit	Click here
	Crankshaft position sensor	Click here
	Camshaft position sensor	Click here
	Ignition system	Click here
	Fuel pump control circuit	Click here
	ECM	Click here
	VC output circuit	Click here
Engine cranks normally but difficult to start	Fuel pump control circuit	Click here
	Compression	Click here
Difficult to start with cold engine	Ignition system	Click here
	Spark plug	Click here
	Fuel pump control circuit	Click here
	Fuel injector	Click here
	Cranking holding function circuit	Click here
Difficult to start with warm engine	Fuel injector	Click here
	Ignition system	Click here
	Spark plug	Click here
	Fuel pump control circuit	Click here
	Cranking holding function circuit	Click here
High engine idle speed	Electronic throttle control system	Click here
	A/C signal circuit	Click here
	ECM power source circuit	Click here
	Acoustic Control Induction System (ACIS)	Click here
Low engine idle speed (Poor idling)	Electronic throttle control system	Click here
	A/C signal circuit	Click here
	Fuel pump control circuit	Click here
	Air induction system	Click here
	Acoustic Control Induction System (ACIS)	Click here
	PCV hose	Click here
Rough idling	Compression	Click here
	Spark plug	Click here
	Fuel injector	Click here
	Ignition system	Click here
	Fuel pump control circuit	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	Acoustic Control Induction System (ACIS)	Click here
	PCV hose	Click here

	Mass air flow meter	Click here
Idle hunting	Electronic throttle control system	Click here
	Air induction system	Click here
	ECM power source circuit	Click here
	Acoustic Control Induction System (ACIS)	Click here
Hesitation/Poor acceleration	A/T faulty	Click here
	Fuel pump control circuit	Click here
	Spark plug	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Mass air flow meter	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	Compression	Click here
Surging (Poor driveability)	Spark plug	Click here
	Fuel pump control circuit	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Mass air flow meter	Click here
	Variable valve timing system	Click here
	Compression	Click here
Engine stalls soon after starting	Fuel pump control circuit	Click here
	Spark plug	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Variable valve timing system	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	PCV hose	Click here
	Compression	Click here
Engine stalls only during A/C operation	A/C signal circuit	Click here
	ECM	Click here

for Preparation Click here

HINT:

Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.

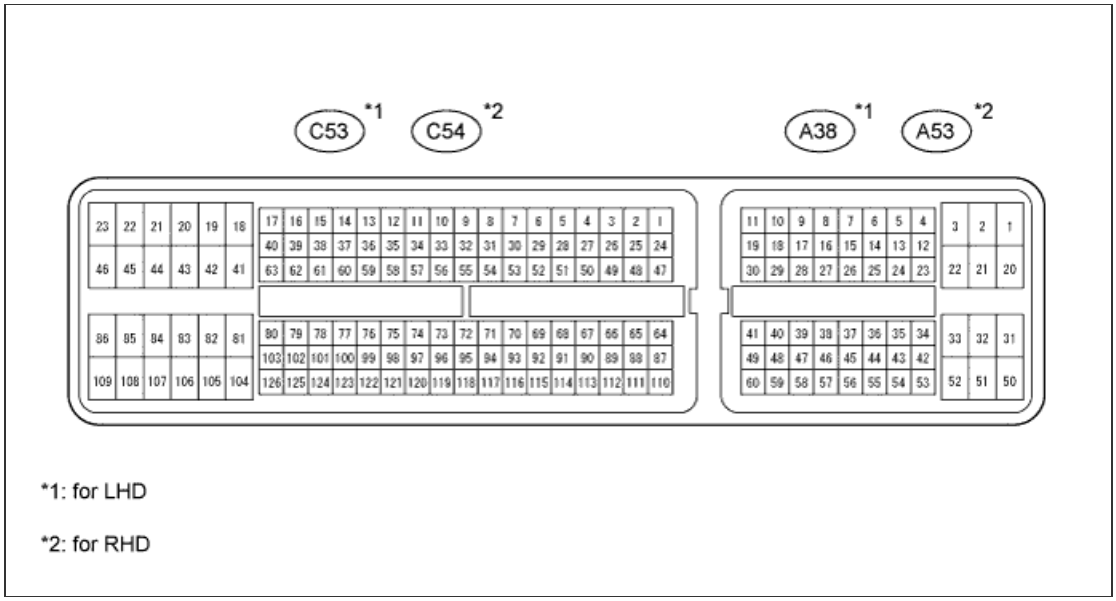
SFI System

Symptom	Suspected Area	See page
Engine does not crank (Does not start)	Battery	Click here
	Starter	Click here
	Starter relay	Click here
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No initial combustion (Does not start)	ECM power source circuit	Click here
	Crankshaft position sensor	Click here
	Camshaft position sensor	Click here
	Ignition system	Click here
	Fuel pump control circuit	Click here
	ECM	Click here
	VC output circuit	Click here
Engine cranks normally but difficult to start	Fuel pump control circuit	Click here
	Compression	Click here
Difficult to start with cold engine	Ignition system	Click here
	Spark plug	Click here
	Fuel pump control circuit	Click here
	Fuel injector	Click here
	Cranking holding function circuit	Click here
Difficult to start with warm engine	Fuel injector	Click here
	Ignition system	Click here
	Spark plug	Click here
	Fuel pump control circuit	Click here
	Cranking holding function circuit	Click here
High engine idle speed	Electronic throttle control system	Click here
	A/C signal circuit	Click here
	ECM power source circuit	Click here
	Acoustic Control Induction System (ACIS)	Click here
Low engine idle speed (Poor idling)	Electronic throttle control system	Click here
	A/C signal circuit	Click here
	Fuel pump control circuit	Click here
	Air induction system	Click here
	Acoustic Control Induction System (ACIS)	Click here
	PCV hose	Click here
Rough idling	Compression	Click here
	Spark plug	Click here
	Fuel injector	Click here
	Ignition system	Click here
	Fuel pump control circuit	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	Acoustic Control Induction System (ACIS)	Click here
	PCV hose	Click here

	Mass air flow meter	Click here
Idle hunting	Electronic throttle control system	Click here
	Air induction system	Click here
	ECM power source circuit	Click here
	Acoustic Control Induction System (ACIS)	Click here
Hesitation/Poor acceleration	A/T faulty	Click here
	Fuel pump control circuit	Click here
	Spark plug	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Mass air flow meter	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	Compression	Click here
	Brake override system	Click here
Surging (Poor driveability)	Spark plug	Click here
	Fuel pump control circuit	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Mass air flow meter	Click here
	Variable valve timing system	Click here
	Compression	Click here
Engine stalls soon after starting	Fuel pump control circuit	Click here
	Spark plug	Click here
	Ignition system	Click here
	Fuel injector	Click here
	Variable valve timing system	Click here
	Electronic throttle control system	Click here
	Air induction system	Click here
	PCV hose	Click here
	Compression	Click here
Engine stalls only during A/C operation	A/C signal circuit	Click here
	ECM	Click here

for Preparation Click here

CHECK ECM



a. Measure the voltage according to the value(s) in the table below.

HINT:

The standard normal voltage between each pair of ECM terminals is shown in the table below. The appropriate conditions for checking each pair of terminals are also indicated. The result of checks should be compared with the standard normal voltage for that pair of terminals, displayed in the Specified Condition column. The illustration above can be used as a reference to identify the ECM terminal locations.

Terminal No. (Symbols)	Wiring Color	Terminal Description	Condition	Specified Condition
A38-1 (BATT) - C53-81 (E1)*1 A53-1 (BATT) - C54-81 (E1)*2	L - W-B	Battery (for measuring battery voltage and for ECM memory)	Always	11 to 14 V
C53-41 (+BM) - C53-81 (E1)*1 C54-41 (+BM) - C54-81 (E1)*2	P - W-B	Power source of throttle actuator	Always	11 to 14 V
A38-28 (IGSW) - C53-81 (E1)*1 A53-28 (IGSW) - C54-81 (E1)*2	B - W-B	Engine switch	Engine switch on (IG)	11 to 14 V
A38-3 (+B) - C53-81 (E1)*1 A53-3 (+B) - C54-81 (E1)*2	B - W-B	Power source of ECM	Engine switch on (IG)	11 to 14 V
A38-2 (+B2) - C53-81 (E1)*1 A53-2 (+B2) - C54-81 (E1)*2	B - W-B	Power source of ECM	Engine switch on (IG)	11 to 14 V
C53-58 (OC1+) - C53-57 (OC1-)*1 C54-58 (OC1+) - C54-57 (OC1-)*2	B - B-L	Camshaft oil control valve (OCV) (for Intake Side of Bank 1)	Idling	Pulse generation (See waveform 1)
C53-52 (OC2+) - C53-51 (OC2-)*1 C54-52 (OC2+) - C54-51 (OC2-)*2	L-B - R-B	Camshaft oil control valve (OCV) (for Intake Side of Bank 2)	Idling	Pulse generation (See waveform 1)
C53-56 (OE1+) - C53-55 (OE1-)*1		Camshaft oil control valve (OCV) (for		Pulse generation

C54-56 (OE1+) - C54-55 (OE1-)*2	L-W - L-B	Exhaust Side of Bank 1)	Idling	(See waveform 1)
C53-50 (OE2+) - C53-49 (OE2-)*1 C54-50 (OE2+) - C54-49 (OE2-)*2	L-R - L-B	Camshaft oil control valve (OCV) (for Exhaust Side of Bank 2)	Idling	Pulse generation (See waveform 1)
A38-34 (MREL) - C53-81 (E1)*1 A53-34 (MREL) - C54-81 (E1)*2	W-R - W-B	EFI relay	Engine switch on (IG)	11 to 14 V
C53-74 (VG) - C53-75 (E2G)*1 C54-74 (VG) - C54-75 (E2G)*2	L-Y - G-W	Mass air flow meter	Idling, Shift lever in P or N, A/C switch off	0.5 to 3.0 V
C53-73 (THA) - C53-97 (ETHW)*1 C54-73 (THA) - C54-97 (ETHW)*2	Y-B - BR	Intake air temperature sensor	Idling, Intake air temperature 20°C (68°F)	0.5 to 3.4 V
C53-76 (THW) - C53-98 (ETHA)*1 C54-76 (THW) - C54-98 (ETHA)*2	G-B - BR	Engine coolant temperature sensor	Idling, Engine coolant temperature 80°C (176°F)	0.2 to 1.0 V
C53-80 (VCTA) - C53-79 (ETA)*1 C54-80 (VCTA) - C54-79 (ETA)*2	Y - L	Power source of throttle position sensor (specific voltage)	Engine switch on (IG)	4.5 to 5.5 V
C53-78 (VTA1) - C53-79 (ETA)*1 C54-78 (VTA1) - C54-79 (ETA)*2	R-Y - L	Throttle position sensor (for engine control)	Engine switch on (IG), Throttle valve fully closed	0.5 to 1.2 V
			Engine switch on (IG), Throttle valve fully open	3.2 to 4.8 V
C53-77 (VTA2) - C53-79 (ETA)*1 C54-77 (VTA2) - C54-79 (ETA)*2	Y-B - L	Throttle position sensor (for sensor malfunction detection)	Engine switch on (IG), Throttle valve fully closed	2.1 to 3.1 V
			Engine switch on (IG), Throttle valve fully open	4.5 to 5.5 V
A38-55 (VPA) - A38-58 (EPA)*1 A53-55 (VPA) - A53-58 (EPA)*2	R - W-L	Accelerator pedal position sensor (for engine control)	Engine switch on (IG), Accelerator pedal released	0.5 to 1.1 V
			Engine switch on (IG), Accelerator pedal fully depressed	2.6 to 4.5 V
A38-56 (VPA2) - A38-60 (EPA2)*1 A53-56 (VPA2) - A53-60 (EPA2)*2	GR-G - BR	Accelerator pedal position sensor (for sensor malfunctioning detection)	Engine switch on (IG), Accelerator pedal released	1.2 to 2.0 V
			Engine switch on (IG), Accelerator pedal fully depressed	3.4 to 5.3 V
A38-57 (VCPA) - A38-58 (EPA)*1 A53-57 (VCPA) - A53-58 (EPA)*2	L-W - W-L	Power source of accelerator pedal position sensor (for VPA)	Engine switch on (IG)	4.5 to 5.5 V
A38-59 (VCP2) - A38-60 (EPA2)*1 A53-59 (VCP2) - A53-60 (EPA2)*2	V - BR	Power source of accelerator pedal position sensor (for VPA2)	Engine switch on (IG)	4.5 to 5.5 V
C53-22 (HA1A) - C53-23 (E04)*1 C54-22 (HA1A) - C54-23 (E04)*2	L - W-B	Air Fuel ratio (A/F) sensor heater	Idling	Below 3.0 V
			Engine switch on (IG)	11 to 14 V
C53-20 (HA2A) - C53-21 (E05)*1 C54-20 (HA2A) - C54-21 (E05)*2	G - W-B	A/F sensor heater	Idling	Below 3.0 V
			Engine switch on (IG)	11 to 14 V
C53-126 (A1A+) - C53-81 (E1)*1 C54-126 (A1A+) - C54-81 (E1)*2	G - W-B	A/F sensor	Engine switch on (IG)	3.3 V*3
C53-125 (A1A-) - C53-81 (E1)*1 C54-125 (A1A-) - C54-81 (E1)*2	R - W-B	A/F sensor	Engine switch on (IG)	2.9 V*3
C53-103 (A2A+) - C53-81				

(E1)*1 C54-103 (A2A+) - C54-81 (E1)*2	P - W-B	A/F sensor	Engine switch on (IG)	3.3 V*3
C53-102 (A2A-) - C53-81 (E1)*1 C54-102 (A2A-) - C54-81 (E1)*2	L - W-B	A/F sensor	Engine switch on (IG)	2.9 V*3
C53-45 (HT1B) - C53-46 (E03)*1 C54-45 (HT1B) - C54-46 (E03)*2	G-B - W-B	Heated oxygen sensor heater	Idling	Below 3.0 V
			Engine switch on (IG)	11 to 14 V
C53-44 (HT2B) - C53-46 (E03)*1 C54-44 (HT2B) - C54-46 (E03)*2	B - W-B	Heated oxygen sensor heater	Idling	Below 3.0 V
			Engine switch on (IG)	11 to 14 V
C53-114 (OX1B) - C53-115 (EX1B)*1 C54-114 (OX1B) - C54-115 (EX1B)*2	G - L	Heated oxygen sensor	Engine speed maintained at 2500 rpm for 2 minutes after warming up sensor	Pulse generation (See waveform 2)
C53-112 (OX2B) - C53-113 (EX2B)*1 C54-112 (OX2B) - C54-113 (EX2B)*2	R - W	Heated oxygen sensor	Engine speed maintained at 2500 rpm for 2 minutes after warming up sensor	Pulse generation (See waveform 2)
C53-86 (#10) - C53-43 (E01)*1 C54-86 (#10) - C54-43 (E01)*2	R-L - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-109 (#20) - C53-43 (E01)*1 C54-109 (#20) - C54-43 (E01)*2	L - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-85 (#30) - C53-43 (E01)*1 C54-85 (#30) - C54-43 (E01)*2	R-B - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-108 (#40) - C53-43 (E01)*1 C54-108 (#40) - C54-43 (E01)*2	Y - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-84 (#50) - C53-43 (E01)*1 C54-84 (#50) - C54-43 (E01)*2	G - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-107 (#60) - C53-43 (E01)*1 C54-107 (#60) - C54-43 (E01)*2	R - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-83 (#70) - C53-43 (E01)*1 C54-83 (#70) - C54-43 (E01)*2	W - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-106 (#80) - C53-43 (E01)*1 C54-106 (#80) - C54-43 (E01)*2	R-B - W-B	Fuel injector	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 3)
C53-94 (KNK1) - C53-93 (EKNK)*1 C54-94 (KNK1) - C54-93 (EKNK)*2	R - G	Knock sensor	Engine speed maintained at 4000 rpm after warming up engine	Pulse generation (See waveform 4)
C53-117 (KNK2) - C53-116 (EKN2)*1 C54-117 (KNK2) - C54-116 (EKN2)*2	W - B	Knock sensor	Engine speed maintained at 4000 rpm after warming up engine	Pulse generation (See waveform 4)
C53-96 (KNK3) - C53-95 (EKN3)*1 C54-96 (KNK3) - C54-95 (EKN3)*2	W - B	Knock sensor	Engine speed maintained at 4000 rpm after warming up engine	Pulse generation (See waveform 4)
C53-119 (KNK4) - C53-118 (EKN4)*1 C54-119 (KNK4) - C54-	R - G	Knock sensor	Engine speed maintained at 4000 rpm after warming up engine	Pulse generation (See waveform 4)

118 (EKN4)*2				
C53-92 (VV1+) - C53-91 (VV1-)*1 C54-92 (VV1+) - C54-91 (VV1-)*2	R - Y	Variable valve timing (VVT) sensor (for Intake Side of Bank 1)	Idling	Pulse generation (See waveform 5)
C53-87 (VV2+) - C53-88 (VV2-)*1 C54-87 (VV2+) - C54-88 (VV2-)*2	R - Y	Variable valve timing (VVT) sensor (for Intake Side for Bank 2)	Idling	Pulse generation (See waveform 5)
C53-69 (EV1+) - C53-68 (EV1-)*1 C54-69 (EV1+) - C54-68 (EV1-)*2	R-L - Y	Variable valve timing (VVT) sensor (for Exhaust Side of Bank 1)	Idling	Pulse generation (See waveform 16)
C53-64 (EV2+) - C53-65 (EV2-)*1 C54-64 (EV2+) - C54-65 (EV2-)*2	R-L - Y	Variable valve timing (VVT) sensor (for Exhaust Side of Bank 2)	Idling	Pulse generation (See waveform 16)
C53-110 (NE+) - C53-111 (NE-)*1 C54-110 (NE+) - C54-111 (NE-)*2	W - G-W	Crankshaft position sensor	Idling	Pulse generation (See waveform 5)
C53-40 (IGT1) - C53-81 (E1)*1 C54-40 (IGT1) - C54-81 (E1)*2	B-Y - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-33 (IGT2) - C53-81 (E1)*1 C54-33 (IGT2) - C54-81 (E1)*2	L-B - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-37 (IGT3) - C53-81 (E1)*1 C54-37 (IGT3) - C54-81 (E1)*2	B - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-34 (IGT4) - C53-81 (E1)*1 C54-34 (IGT4) - C54-81 (E1)*2	L-B - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-35 (IGT5) - C53-81 (E1)*1 C54-35 (IGT5) - C54-81 (E1)*2	G-R - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-36 (IGT6) - C53-81 (E1)*1 C54-36 (IGT6) - C54-81 (E1)*2	G - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-38 (IGT7) - C53-81 (E1)*1 C54-38 (IGT7) - C54-81 (E1)*2	G-W - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-39 (IGT8) - C53-81 (E1)*1 C54-39 (IGT8) - C54-81 (E1)*2	G-B - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
C53-104 (IGF1) - C53-81 (E1)*1 C54-104 (IGF1) - C54-81 (E1)*2	G-B - W-B	Ignition coil (ignition confirmation signal)	Engine switch on (IG)	4.5 to 5.5 V
			Idling	Pulse generation (See waveform 6)
C53-105 (IGF2) - C53-81 (E1)*1 C54-105 (IGF2) - C54-81 (E1)*2	R - W-B	Ignition coil (ignition confirmation signal)	Engine switch on (IG)	4.5 to 5.5 V
			Idling	Pulse generation (See waveform 6)
C53-63 (PRG) - C53-81 (E1)*1 C54-63 (PRG) - C54-81 (E1)*2	L-B - W-B	Purge VSV	Engine switch on (IG)	11 to 14 V
			Idling	Pulse generation (See waveform 7)
A38-13 (SPD) - C53-81 (E1)*1 A53-13 (SPD) - C54-81 (E1)*2	V-R - W-B	Speed signal from combination meter	Driving at 20 km/h (12 mph)	Pulse generation (See waveform 8)
A38-46 (STA) - C53-81 (E1)*1				

A53-46 (STA) - C54-81 (E1)*2	R-B - W-B	Starter signal	Cranking	5.5 V or more
C53-120 (NSW) - C53-81 (E1)*1 C54-120 (NSW) - C54-81 (E1)*2	L - W-B	Park/neutral position switch	Engine switch on (IG), Shift lever in other than P and N	11 to 14 V
			Engine switch on (IG), Shift lever in P or N	Below 3.0 V
A38-36 (STP) - C53-81 (E1)*1 A53-36 (STP) - C54-81 (E1)*2	R - W-B	Stop light switch	Brake pedal depressed	7.5 to 14 V
			Brake pedal released	Below 1.5 V
A38-35 (ST1-) - C53-81 (E1)*1 A53-35 (ST1-) - C54-81 (E1)*2	R-W - W-B	Stop light switch (opposite to STP terminal)	Engine switch on (IG), Brake pedal depressed	Below 1.5 V
			Engine switch on (IG), Brake pedal released	7.5 to 14 V
C53-19 (M+) - C53-82 (ME01)*1 C54-19 (M+) - C54-82 (ME01)*2	R - W-B	Throttle actuator	Idling with warm engine	Pulse generation (See waveform 9)
C53-18 (M-) - C53-82 (ME01)*1 C54-18 (M-) - C54-82 (ME01)*2	G - W-B	Throttle actuator	Idling with warm engine	Pulse generation (See waveform 10)
A38-48 (FC) - C53-81 (E1)*1 A53-48 (FC) - C54-81 (E1)*2	L-R - W-B	Fuel pump control	Engine switch on (IG)	11 to 14 V
A38-52 (FPC) - C53-81 (E1)*1 A53-52 (FPC) - C54-81 (E1)*2	W - W-B	Fuel pump control	Engine switch on (IG)	Below 1.5 V
A38-24 (W) - C53-81 (E1)*1 A53-24 (W) - C54-81 (E1)*2	R-Y - W-B	MIL	Engine switch on (IG)	Below 3.0 V
			Idling	11 to 14 V
A38-16 (TC) - C53-81 (E1)*1 A53-16 (TC) - C54-81 (E1)*2	V-W - W-B	Terminal TC of DLC3	Engine switch on (IG)	11 to 14 V
A38-15 (TACH) - C53-81 (E1)*1 A53-15 (TACH) - C54-81 (E1)*2	W-G - W-B	Engine speed	Idling	Pulse generation (See waveform 11)
C53-67 (VCV1) - C53-97 (ETHW)*1 C54-67 (VCV1) - C54-97 (ETHW)*2	L - BR	Power source for sensor (specific voltage)	Engine switch on (IG)	4.5 to 5.5 V
C53-66 (VCV2) - C53-97 (ETHW)*1 C54-66 (VCV2) - C54-97 (ETHW)*2	L - BR	Power source for sensor (specific voltage)	Engine switch on (IG)	4.5 to 5.5 V
C53-32 (ALT) - C53-81 (E1)*1 C54-32 (ALT) - C54-81 (E1)*2	R - W-B	Generator	Engine switch on (IG)	11 to 14 V
A38-10 (CANH) - C53-81 (E1)*1 A53-10 (CANH) - C54-81 (E1)*2	P - W-B	CAN communication line	Engine switch on (IG)	Pulse generation (See waveform 12)
A38-11 (CANL) - C53-81 (E1)*1 A53-11 (CANL) - C54-81 (E1)*2	B - W-B	CAN communication line	Engine switch on (IG)	Pulse generation (See waveform 13)
C53-62 (ACIS) - C53-81 (E1)*1 C54-62 (ACIS) - C54-81 (E1)*2	L-Y - W-B	VSV for ACIS (Acoustic Control Induction System) operation signal	Engine switch on (IG)	11 to 14 V
C53-28 (AIRV) - C53-81 (E1)*1 C54-28 (AIRV) - C54-81 (E1)*2	BR - W-B	Air switching valve for secondary air injection system	Engine switch on (IG)	11 to 14 V

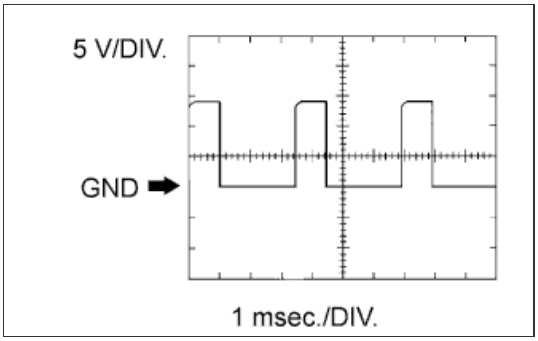
C53-54 (AIRP) - C53-81 (E1)*1 C54-54 (AIRP) - C54-81 (E1)*2	P - W-B	Air pump control	Engine switch on (IG)	11 to 14 V
C53-30 (AIDI) - C53-81 (E1)*1 C54-30 (AIDI) - C54-81 (E1)*2	G - W-B	Diagnostic information signal for secondary air injection system	Secondary air injection system operates	Pulse generation (See waveform 15)
A38-54 (AIP) - C53-98 (ETHA)*1 A53-54 (AIP) - C54-98 (ETHA)*2	P-L - BR	Secondary air injection system pressure signal	Engine switch on (IG)	3.0 to 3.6 V
A38-43 (ARV2) - C53-81 (E1)*1 A53-43 (ARV2) - C54-81 (E1)*2	R-L - W-B	Air switching valve for secondary air injection system	Engine switch on (IG)	11 to 14 V
C53-53 (ARP2) - C53-81 (E1)*1 C54-53 (ARP2) - C54-81 (E1)*2	P-L - W-B	Air pump control	Engine switch on (IG)	11 to 14 V
C53-29 (AID2) - C53-81 (E1)*1 C54-29 (AID2) - C54-81 (E1)*2	G-Y - W-B	Diagnostic information signal for secondary air injection system	Secondary air injection system operates	Pulse generation (See waveform 15)
A38-53 (AIP2) - C53-97 (ETHW)*1 A53-53 (AIP2) - C54-97 (ETHW)*2	LG-B - BR	Secondary air injection system pressure signal	Engine switch on (IG)	3.0 to 3.6 V
C53-90 (G2) - C53- 89 (G2-)*1 C54-90 (G2) - C54- 89 (G2-)*2	G - Y	Camshaft position sensor	Idling	Pulse generation (See waveform 14)
A38-18 (DI) - C53-81 (E1)*1 A53-18 (DI) - C54-81 (E1)*2	G-Y - W-B	Fuel pump control	Engine switch on (IG)	0 to 3.0 V
A38-14 (STSW) - C53-81 (E1)*1 A53-14 (STSW) - C54-81 (E1)*2	R - W-B	Starter switch	Shift lever in P or N, Cranking	6.0 V or more
A38-41 (ACCR) - C53-81 (E1)*1 A53-41 (ACCR) - C54-81 (E1)*2	L-Y - W-B	ACC relay control signal	Engine switch on (IG) → Cranking	11 to 14 V → Below 1 V
C53-16 (STAR) - C53-81 (E1)*1 C54-16 (STAR) - C54-81 (E1)*2	L - W-B	Starter relay control	Engine switch on (IG)	Below 1.5 V
			Cranking	5.5 V or higher
C53-72 (PSP) - C53-81 (E1)*1 C54-72 (PSP) - C54-81 (E1)*2	G - W-B	Power steering oil pressure sensor	Engine switch on (IG)	0.5 to 4.5 V

- *1: for LHD
- *2: for RHD
- *3: The ECM terminal voltage is constant regardless of the output voltage from the sensor.

b. WAVEFORM 1:

Camshaft Oil Control Valve (OCV) (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
C53-58 (OC1+) - C53-57 (OC1-)	5 V/DIV., 1 msec./DIV.	Idling
C53-52 (OC2+) - C53-51 (OC2-)	5 V/DIV., 1 msec./DIV.	Idling
C53-56 (OE1+) - C53-55 (OE1-)	5 V/DIV., 1 msec./DIV.	Idling
C53-50 (OE2+) - C53-49	5 V/DIV., 1	Idling

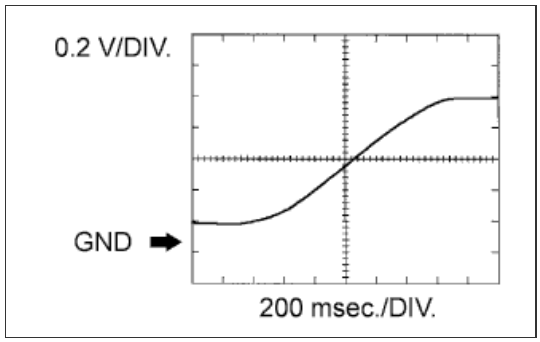


(OE2-)	msec./DIV.	

Camshaft Oil Control Valve (OCV) (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-58 (OC1+) - C54-57 (OC1-)	5 V/DIV., 1 msec./DIV.	Idling
C54-52 (OC2+) - C54-51 (OC2-)	5 V/DIV., 1 msec./DIV.	Idling
C54-56 (OE1+) - C54-55 (OE1-)	5 V/DIV., 1 msec./DIV.	Idling
C54-50 (OE2+) - C54-49 (OE2-)	5 V/DIV., 1 msec./DIV.	Idling

c. WAVEFORM 2:



Heated Oxygen Sensor (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
C53-114 (OX1B) - C53-115 (EX1B)	0.2 V/DIV., 200 msec./DIV.	Engine speed maintained at 2500 rpm for 2 minutes after warming up sensor
C53-112 (OX2B) - C53-113 (EX2B)	0.2 V/DIV., 200 msec./DIV.	Engine speed maintained at 2500 rpm for 2 minutes after warming up sensor

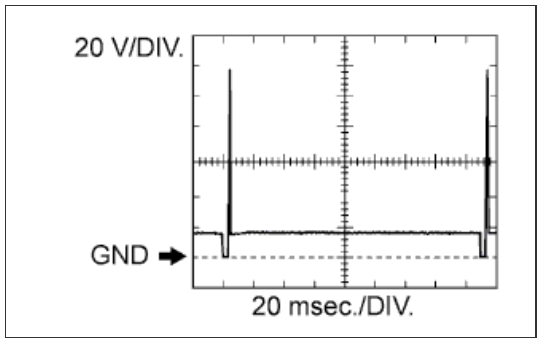
Heated Oxygen Sensor (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-114 (OX1B) - C54-115 (EX1B)	0.2 V/DIV., 200 msec./DIV.	Engine speed maintained at 2500 rpm for 2 minutes after warming up sensor
C54-112 (OX2B) - C54-113 (EX2B)	0.2 V/DIV., 200 msec./DIV.	Engine speed maintained at 2500 rpm for 2 minutes after warming up sensor

HINT:

In the Data List, item O2S B1 S2 or O2S B2 S2 shows the ECM input values from the heated oxygen sensor.

d. WAVEFORM 3:



Injector No. 1 (to No. 8) Injection Signal (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
C53-86 (#10) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-109 (#20) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-85 (#30) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-108 (#40) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-84 (#50) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-107 (#60) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-83 (#70) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C53-106 (#80) - C53-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling

Injector No. 1 (to No. 8) Injection Signal (for RHD)

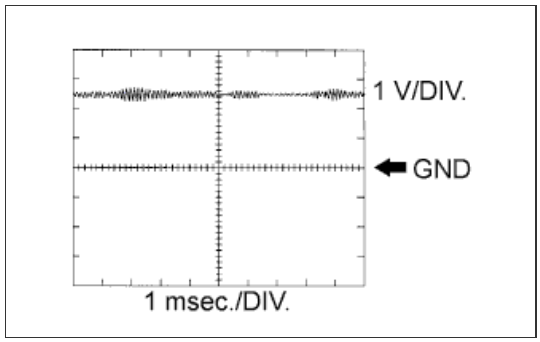
Terminal No. (Symbols)	Tool Setting	Condition
C54-86 (#10) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C54-109 (#20) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling

C54-85 (#30) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C54-108 (#40) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C54-84 (#50) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C54-107 (#60) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C54-83 (#70) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling
C54-106 (#80) - C54-43 (E01)	20 V/DIV., 20 msec./DIV.	Idling

HINT:

The wavelength becomes shorter as the engine speed increases.

e. WAVEFORM 4:



Knock Sensor (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
C53-94 (KNK1) - C53-93 (EKNK)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine
C53-117 (KNK2) - C53-116 (EKN2)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine
C53-96 (KNK3) - C53-95 (EKN3)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine
C53-119 (KNK4) - C53-118 (EKN4)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine

Knock Sensor (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-94 (KNK1) - C54-93 (EKNK)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine
C54-117 (KNK2) - C54-116 (EKN2)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine
C54-96 (KNK3) - C54-95 (EKN3)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine
C54-119 (KNK4) - C54-118 (EKN4)	1 V/DIV., 1 msec./DIV.	Engine speed maintained at 4000 rpm after warming up engine

HINT:

- **The wavelength becomes shorter as the engine speed increases.**
- **The waveforms and amplitudes displayed differ slightly depending on the vehicle.**

f. WAVEFORM 5:

Crankshaft Position Sensor and VVT Sensor for Intake Side (for LHD)

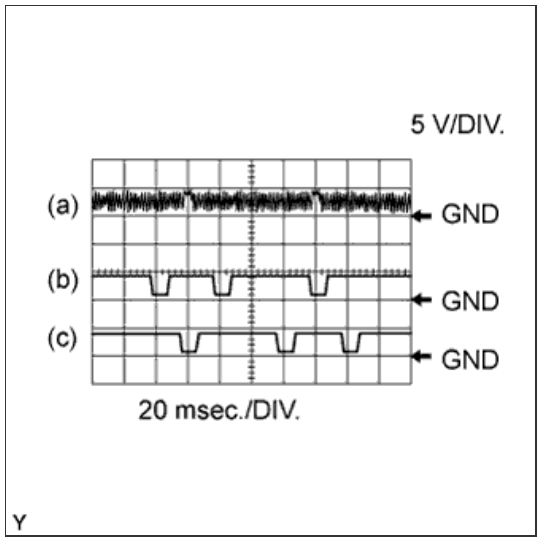
Terminal No. (Symbols)	Tool Setting	Condition
(a) C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(b) C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(c) C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up

Crankshaft Position Sensor and VVT Sensor for Intake Side (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
(a) C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(b) C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(c) C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up

HINT:

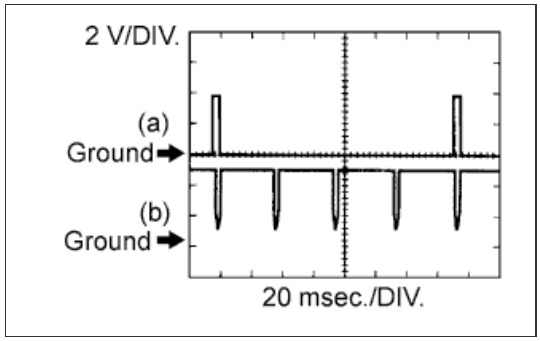
The wavelength becomes shorter as engine speed increases.



g. WAVEFORM 6:

Igniter IGT Signal (from ECM to Igniter) and Igniter IGF Signal (from Igniter to ECM) (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
(a) C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(b) C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(b) C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling



Igniter IGT Signal (from ECM to Igniter) and Igniter IGF Signal (from Igniter to ECM) (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
(a) C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(a) C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(b) C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling
(b) C54-105 (IGF2) - C54-81	2 V/DIV., 20	

(E1)	msec./DIV.	Idling

HINT:

The wavelength becomes shorter as engine speed increases.

h. WAVEFORM 7:

Purge VSV (for LHD)

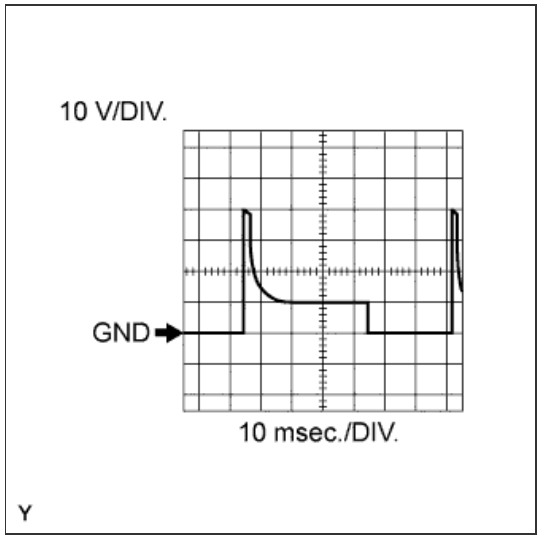
Terminal No. (Symbols)	Tool Setting	Condition
C53-63 (PRG) - C53-81 (E1)	10 V/DIV., 10 to 100 msec./DIV.	Idling

Purge VSV (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-63 (PRG) - C54-81 (E1)	10 V/DIV., 10 to 100 msec./DIV.	Idling

HINT:

If the waveform is not similar to the illustration, check the waveform again after idling for 10 minutes or more.



i. WAVEFORM 8:

Vehicle Speed Signal (for LHD)

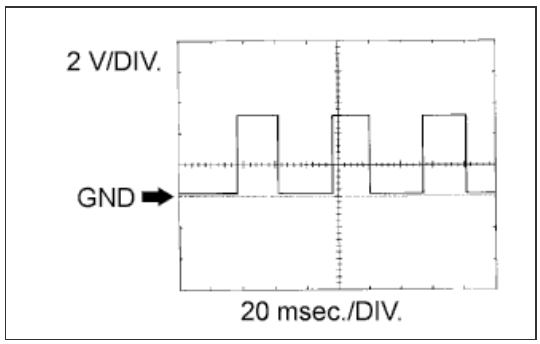
Terminal No. (Symbols)	Tool Setting	Condition
A38-13 (SPD) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Driving at 20 km/h (12 mph)

Vehicle Speed Signal (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
A53-13 (SPD) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Driving at 20 km/h (12 mph)

HINT:

The wavelength becomes shorter as the vehicle speed increases.



j. WAVEFORM 9:

Throttle Actuator Positive Terminal (for LHD)

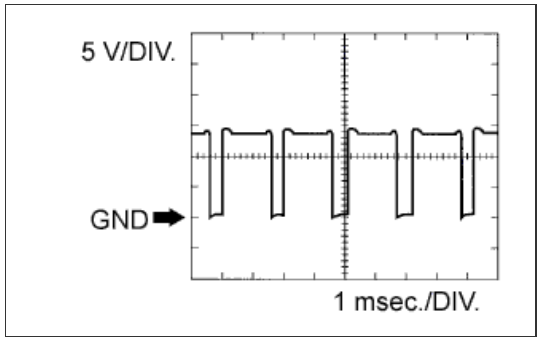
Terminal No. (Symbols)	Tool Setting	Condition
C53-19 (M+) - C53-82 (ME01)	5 V/DIV., 1 msec./DIV.	Idling with warm engine

Throttle Actuator Positive Terminal (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-19 (M+) - C54-82 (ME01)	5 V/DIV., 1 msec./DIV.	Idling with warm engine

HINT:

The duty ratio varies depending on the throttle actuator operation.



k. WAVEFORM 10:

Throttle Actuator Negative Terminal (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition

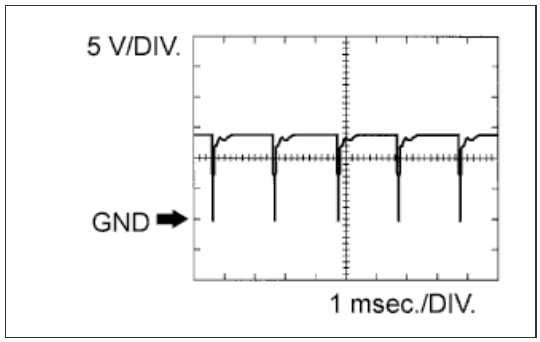
C53-18 (M-) - C53-82 (ME01)	5 V/DIV., 1 msec./DIV.	Idling with warm engine

Throttle Actuator Negative Terminal (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-18 (M-) - C54-82 (ME01)	5 V/DIV., 1 msec./DIV.	Idling with warm engine

HINT:

The duty ratio varies depending on the throttle actuator operation.



l. WAVEFORM 11:

Engine Speed Signal (for LHD)

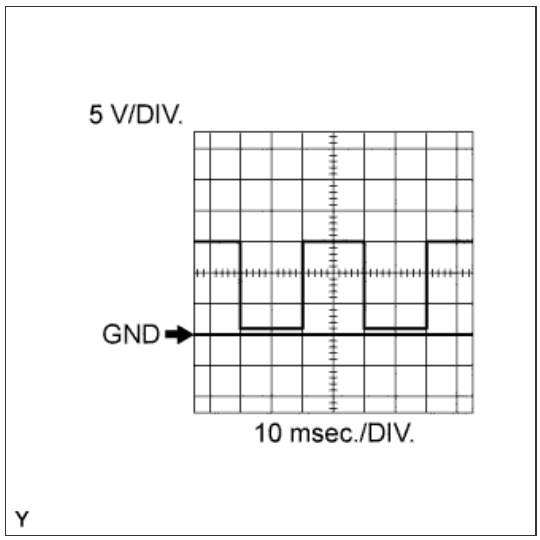
Terminal No. (Symbols)	Tool Setting	Condition
A38-15 (TACH) - C53-81 (E1)	5 V/DIV., 10 msec./DIV.	Idling

Engine Speed Signal (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
A53-15 (TACH) - C54-81 (E1)	5 V/DIV., 10 msec./DIV.	Idling

HINT:

The wavelength becomes shorter as the engine speed increases.



m. WAVEFORM 12:

CAN Communication Signal (for LHD)

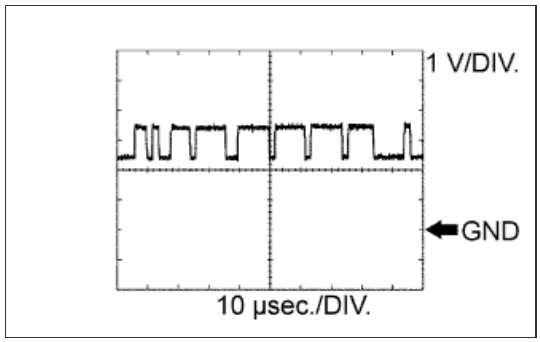
Terminal No. (Symbols)	Tool Setting	Condition
A38-10 (CANH) - C53-81 (E1)	1 V/DIV., 10 µsec./DIV.	Engine stops and engine switch on (IG)

CAN Communication Signal (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
A53-10 (CANH) - C54-81 (E1)	1 V/DIV., 10 µsec./DIV.	Engine stops and engine switch on (IG)

HINT:

The waveform varies depending on the CAN communication signal.



n. WAVEFORM 13:

CAN Communication Signal (for LHD)

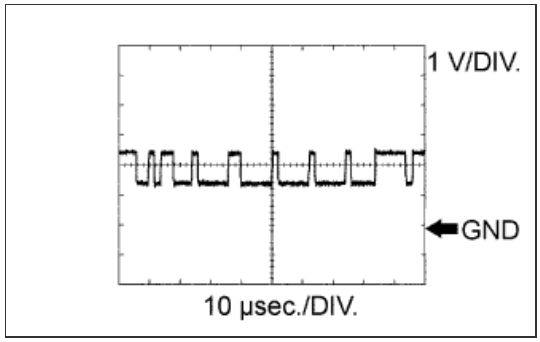
Terminal No. (Symbols)	Tool Setting	Condition
A38-11 (CANL) - C53-81 (E1)	1 V/DIV., 10 µsec./DIV.	Engine stops and engine switch on (IG)

CAN Communication Signal (for RHD)

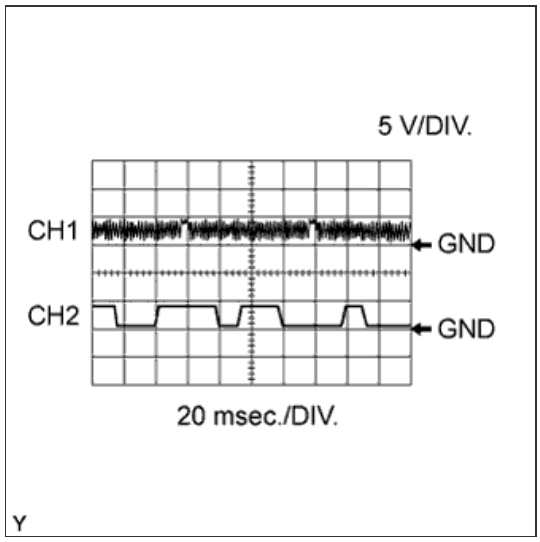
Terminal No. (Symbols)	Tool Setting	Condition
A53-11 (CANL) - C54-81 (E1)	1 V/DIV., 10 µsec./DIV.	Engine stops and engine switch on (IG)

HINT:

The waveform varies depending on the CAN communication signal.



o. WAVEFORM 14:



Crankshaft Position Sensor and Camshaft Position Sensor (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
CH1: C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
CH2: C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up

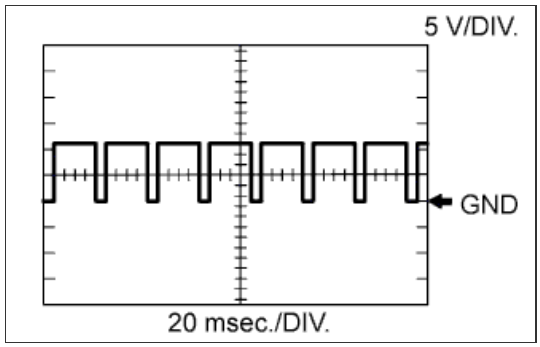
Crankshaft Position Sensor and Camshaft Position Sensor (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
CH1: C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
CH2: C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up

HINT:

The wavelength becomes shorter as the engine speed increases.

p. WAVEFORM 15:



Terminal DI of Air Injection Control Driver (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
C53-30 (AIDI) - C53-81 (E1)	5 V/DIV., 20 to 40 msec./DIV.	Performing utility using intelligent tester (secondary air injection check)
C53-29 (AID2) - C53-81 (E1)	5 V/DIV., 20 to 40 msec./DIV.	Performing utility using intelligent tester (secondary air injection check)

Terminal DI of Air Injection Control Driver (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
C54-30 (AIDI) - C54-81 (E1)	5 V/DIV., 20 to 40 msec./DIV.	Performing utility using intelligent tester (secondary air injection check)
C54-29 (AID2) - C54-81 (E1)	5 V/DIV., 20 to 40 msec./DIV.	Performing utility using intelligent tester (secondary air injection check)

HINT:

The wavelength changes when the air injection control driver detects malfunctions in the secondary air injection system (Click here).

q. WAVEFORM 16:

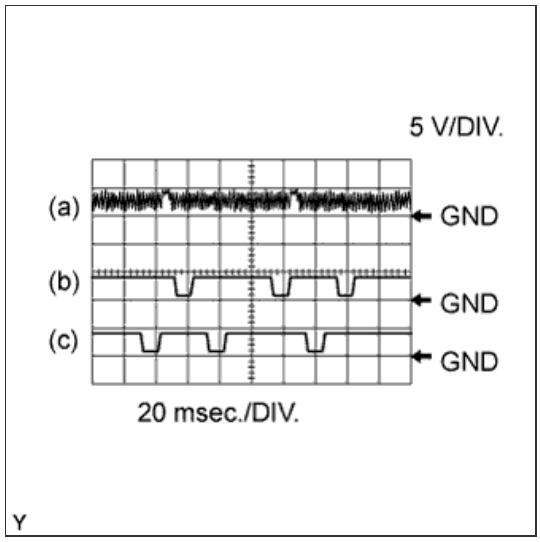
Crankshaft Position Sensor and VVT Sensor for Exhaust Side (for LHD)

Terminal No. (Symbols)	Tool Setting	Condition
(a) C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(b) C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(c) C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up

Crankshaft Position Sensor and VVT Sensor for Exhaust Side (for RHD)

Terminal No. (Symbols)	Tool Setting	Condition
(a) C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up

(b) C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up
(c) C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV., 20 msec./DIV.	Idle after engine warmed up



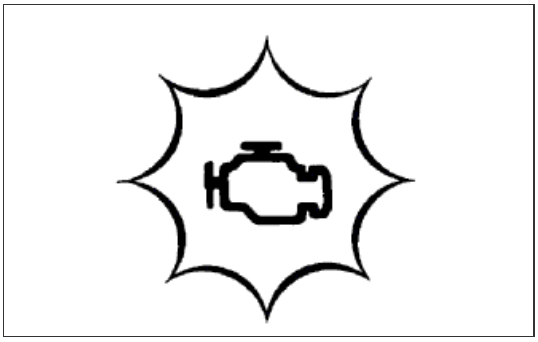
HINT:

The wavelength becomes shorter as engine speed increases.

for Preparation Click here

EURO-OBD (EUROPE)

When troubleshooting Europe On-Board Diagnostic (Euro-OBD) vehicles, the vehicle must be connected to an OBD scan tool (complying with ISO 15765-4). Various data output from the vehicle ECM can then be read.



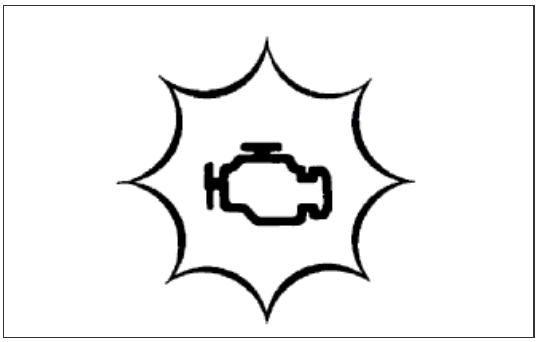
Euro-OBD regulations require that the on-board computer of the vehicle illuminate the Malfunction Indicator Lamp (MIL) on the instrument panel when the computer detects a malfunction in:

1. The emission control system components
2. The powertrain control components (which affect vehicle emissions)
3. The computer itself

In addition, the applicable Diagnostic Trouble Codes (DTCs) prescribed by ISO 15765-4 are stored in the ECM memory. If the malfunction does not reoccur in 3 consecutive trips, the MIL turns off automatically but the DTCs remain stored in the ECM memory.

To check the DTCs, connect the intelligent tester to the Data Link Connector 3 (DLC3) of the vehicle. The scan tool displays DTCs, the freeze frame data and a variety of the engine data. The DTCs and freeze frame data can be cleared with the scan tool.

M-OBD (EXCEPT EUROPEAN SPEC.)



When troubleshooting Multiplex On-Board Diagnostic (M-OBD) vehicle, the vehicle must be connected to the intelligent tester. Various data output from the ECM can then be read.
OBD regulations require that the on-board computer of the vehicle illuminate the MIL on the instrument panel when the computer detects a malfunction in:

1. The emission control system components
2. The powertrain control components (which affect vehicle emissions)
3. The computer

In addition, the applicable DTCs are stored in the ECM memory. If the malfunction does not recur in 3 consecutive trips, the MIL turns off automatically but the DTCs remain stored in the ECM memory.

NORMAL MODE AND CHECK MODE

The diagnosis system operates in normal mode during normal vehicle use. In normal mode, 2 trip detection logic is used to ensure accurate detection of malfunctions. Check mode is also available as an option for technicians. In check mode, 1 trip detection logic is used for simulating malfunction symptoms and increasing the ability of the system to detect malfunctions, including intermittent problems (intelligent tester only).

2 TRIP DETECTION LOGIC

When a malfunction is first detected, the malfunction is temporarily stored in the ECM memory (1st trip). If the same malfunction is detected during the next subsequent driving cycle, the MIL is illuminated (2nd trip).

FREEZE FRAME DATA

The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.

BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If voltage is below 11 V, replace or recharge the battery before proceeding.

MIL (Malfunction Indicator Lamp)

a. The MIL is illuminated when the engine switch is first turned on (IG) (the engine is not running).

b. The MIL should turn off when the engine is started. If the MIL remains illuminated, the diagnosis system has detected a malfunction or abnormality in the system.

HINT:

If the MIL is not illuminated when the engine switch is first turned on (IG), check the MIL circuit (Click here).

ALL READINESS

HINT:

- **With "All Readiness" it is possible to check whether or not the DTC judgment has been completed by using the intelligent tester.**
- **Check "All Readiness" after simulating malfunction symptoms or for validation after finishing repairs.**

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear the DTCs (Click here).

e. Perform the DTC judgment driving pattern to run the DTC judgment.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input the DTCs to be confirmed.

h. Check the DTC judgment result.

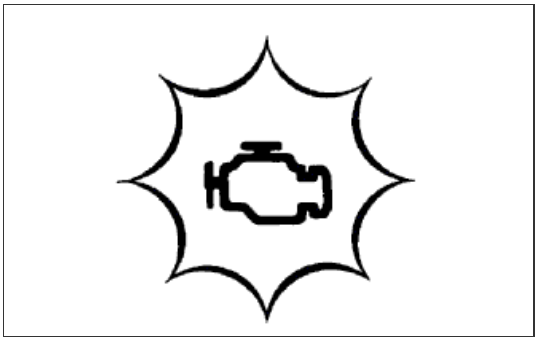
Result

Tester Display	Description
NORMAL	• DTC judgment completed • System normal
ABNORMAL	• DTC judgment completed • System abnormal
INCOMPLETE	• DTC judgment not completed • Perform driving pattern after confirming DTC enabling conditions
UNKNOWN	• Unable to perform DTC judgment • Number of DTCs which do not fulfill DTC preconditions has reached ECU memory limit

for Preparation Click here

EURO-OBD (EUROPE)

When troubleshooting Europe On-Board Diagnostic (Euro-OBD) vehicles, the vehicle must be connected to an OBD scan tool (complying with ISO 15765-4). Various data output from the vehicle ECM can then be read.



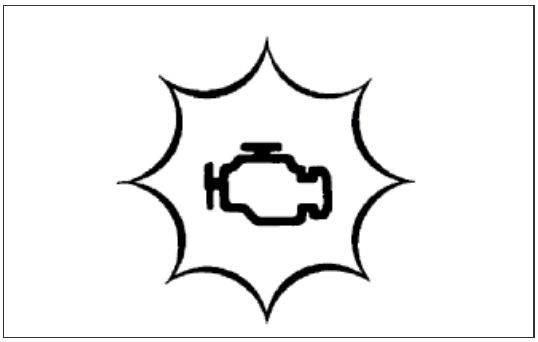
Euro-OBD regulations require that the on-board computer of the vehicle illuminate the Malfunction Indicator Lamp (MIL) on the instrument panel when the computer detects a malfunction in:

1. The emission control system components
2. The powertrain control components (which affect vehicle emissions)
3. The computer itself

In addition, the applicable Diagnostic Trouble Codes (DTCs) prescribed by ISO 15765-4 are stored in the ECM memory. If the malfunction does not reoccur in 3 consecutive trips, the MIL turns off automatically but the DTCs remain stored in the ECM memory.

To check the DTCs, connect the intelligent tester to the Data Link Connector 3 (DLC3) of the vehicle. The scan tool displays DTCs, the freeze frame data and a variety of the engine data. The DTCs and freeze frame data can be cleared with the scan tool.

M-OBD (EXCEPT EUROPEAN SPEC.)



When troubleshooting Multiplex On-Board Diagnostic (M-OBD) vehicle, the vehicle must be connected to the intelligent tester. Various data output from the ECM can then be read.
OBD regulations require that the on-board computer of the vehicle illuminate the MIL on the instrument panel when the computer detects a malfunction in:

1. The emission control system components
2. The powertrain control components (which affect vehicle emissions)
3. The computer

In addition, the applicable DTCs are stored in the ECM memory. If the malfunction does not recur in 3 consecutive trips, the MIL turns off automatically but the DTCs remain stored in the ECM memory.

NORMAL MODE AND CHECK MODE

The diagnosis system operates in normal mode during normal vehicle use. In normal mode, 2 trip detection logic is used to ensure accurate detection of malfunctions. Check mode is also available as an option for technicians. In check mode, 1 trip detection logic is used for simulating malfunction symptoms and increasing the ability of the system to detect malfunctions, including intermittent problems (intelligent tester only).

2 TRIP DETECTION LOGIC

When a malfunction is first detected, the malfunction is temporarily stored in the ECM memory (1st trip). If the same malfunction is detected during the next subsequent driving cycle, the MIL is illuminated (2nd trip).

FREEZE FRAME DATA

The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.

BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If voltage is below 11 V, replace or recharge the battery before proceeding.

MIL (Malfunction Indicator Lamp)

a. The MIL is illuminated when the engine switch is first turned on (IG) (the engine is not running).

b. The MIL should turn off when the engine is started. If the MIL remains illuminated, the diagnosis system has detected a malfunction or abnormality in the system.

HINT:

If the MIL is not illuminated when the engine switch is first turned on (IG), check the MIL circuit (Click here).

ALL READINESS

HINT:

- **With "All Readiness" it is possible to check whether or not the DTC judgment has been completed by using the intelligent tester.**
- **Check "All Readiness" after simulating malfunction symptoms or for validation after finishing repairs.**

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear the DTCs (Click here).

e. Perform the DTC judgment driving pattern to run the DTC judgment.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input the DTCs to be confirmed.

h. Check the DTC judgment result.

Result

Tester Display	Description
NORMAL	• DTC judgment completed • System normal
ABNORMAL	• DTC judgment completed • System abnormal
INCOMPLETE	• DTC judgment not completed • Perform driving pattern after confirming DTC enabling conditions
UNKNOWN	• Unable to perform DTC judgment • Number of DTCs which do not fulfill DTC preconditions has reached ECU memory limit

for Preparation Click here

NOTICE:

When the diagnosis system is changed from the normal mode to check mode or vice versa, all DTCs and freeze frame data recorded in normal mode are cleared. Before changing modes, always check and make a note of DTCs and freeze frame data.

HINT:

- **DTCs which are stored in the ECM can be output to the intelligent tester. The tester can display the current and pending output DTCs.**
- **Same DTCs are not set if the ECM does not detect the same malfunction again during a second consecutive driving cycle. However, such malfunctions, detected on only one occasion, are stored as pending DTCs.**

CHECK DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Check the DTC(s) and freeze frame data, and then write them down.

f. Check the details of the DTC(s) (Click here).

CLEAR DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Clear the DTCs.

CLEAR DTC (Without using the intelligent tester)

a. Perform either of the following operations:

i. Disconnect the cable from the negative (-) battery terminal for more than 1 minute.

ii. Remove the EFI MAIN fuse from the engine room relay block located inside the engine compartment for more than 1 minute.

for Preparation Click here

NOTICE:

When the diagnosis system is changed from the normal mode to check mode or vice versa, all DTCs and freeze frame data recorded in normal mode are cleared. Before changing modes, always check and make a note of DTCs and freeze frame data.

HINT:

- **DTCs which are stored in the ECM can be output to the intelligent tester. The tester can display the current and pending output DTCs.**
- **Same DTCs are not set if the ECM does not detect the same malfunction again during a second consecutive driving cycle. However, such malfunctions, detected on only one occasion, are stored as pending DTCs.**

CHECK DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Check the DTC(s) and freeze frame data, and then write them down.

f. Check the details of the DTC(s) (Click here).

CLEAR DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Clear the DTCs.

CLEAR DTC (Without using the intelligent tester)

a. Perform either of the following operations:

i. Disconnect the cable from the negative (-) battery terminal for more than 1 minute.

ii. Remove the EFI MAIN fuse from the engine room relay block located inside the engine compartment for more than 1 minute.

for Preparation Click here

DESCRIPTION

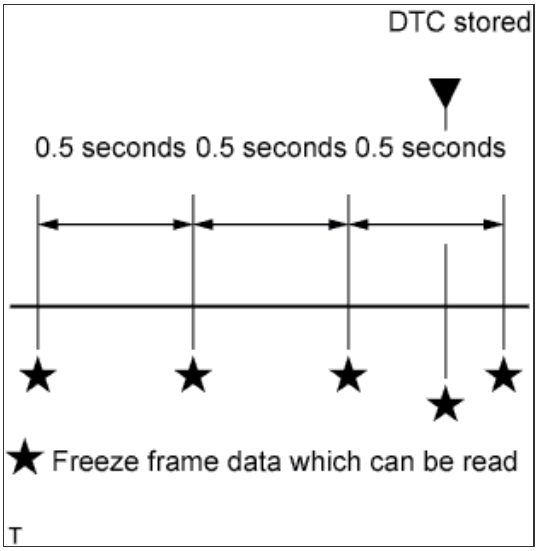
Freeze frame data records the engine conditions (fuel system, calculated load, engine coolant temperature, fuel trim, engine speed, vehicle speed, etc.) when a malfunction is detected. When troubleshooting, it can help determine if the vehicle was running or stopped, the engine was warmed up or not, the air-fuel ratio was Lean or Rich, and other data from the time the malfunction occurred.

HINT:

If it is impossible to duplicate the problem even though a DTC is output, confirm the freeze frame data.

The ECM records engine conditions in the form of freeze frame data every 0.5 seconds. Using the intelligent tester, 5 separate sets of freeze frame data can be checked.

- 3 data sets before the DTC was stored.
- 1 data set when the DTC was stored.
- 1 data set after the DTC was stored.
  These data sets can be used to simulate the condition of the vehicle around the time of the occurrence of the malfunction. The data may assist in identifying the cause of the malfunction, and in judging whether it was temporary or not.



LIST OF FREEZE FRAME DATA

Display Item	Measurement Item	Diagnostic Note
Injector (Port)	Injection period of No. 1 cylinder	-
IGN Advance	Ignition advance	-
Calculate Load	Calculated load	Calculated load by the ECM.
Vehicle Load	Vehicle load	-
MAF	Mass air flow volume	If the mass air flow volume is approximately 0.0 g/sec.: • The mass air flow meter power source circuit is open or shorted. • The VG circuit is open or shorted. If the mass air flow volume is 160.0 g/sec. or more: • The E2G circuit is open.
Engine Speed	Engine speed	-
Vehicle Speed	Vehicle speed	Speed indicated on the speedometer.
Coolant Temp	Engine coolant temperature	If the value is -40°C (-40°F), the sensor circuit is open. If the value is 140°C (284°F) or higher, the sensor circuit is shorted.
Intake Air	Intake air temperature	If the value is -40°C (-40°F), the sensor circuit is open. If the value is 140°C (284°F) or higher, the sensor circuit is shorted.
2nd Air System Status	Second air system status	-
Air-Fuel Ratio	Ratio compared to stoichiometric level	-
Purge Density Learn Value	Learning value of purge density	-

Evap Purge Flow	Ratio of evaporative purge flow to intake air volume	-
EVAP (Purge) VSV	Purge VSV duty ratio	-
Knock Correct Learn Value	Correction learning value of knocking	-
Knock Feedback Value	Feedback value of knocking	-
Accelerator Position No. 1	Absolute Accelerator Pedal Position (APP) No. 1	-
Accelerator Position No. 2	Absolute APP No. 2	-
Throttle Pos. Sensor Output	Throttle Position Sensor Output	-
Throttle Sensor Position	Throttle sensor positioning	-
Throttle Sensor Position #2	Throttle sensor positioning #2	-
Throttle Motor DUTY	Throttle actuator duty	-
O2S B1 S2 O2S B2 S2	Heated oxygen sensor output	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the output voltage of the sensor.
AFS B1 S1 AFS B2 S1	A/F sensor output	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the output voltage of the sensor.
AFS B2 S1	A/F sensor current	-
Total FT #1 Total FT #2	Total fuel trim	-
Short FT #1	Short-term fuel trim	Short-term fuel compensation is used to maintain the air-fuel ratio at the stoichiometric air-fuel ratio.
Long FT #1	Long-term fuel trim	Overall fuel compensation is carried out in the long-term to compensate for a continual deviation of the short-term fuel trim from the central valve.
Short FT #2	Short-term fuel trim	Short-term fuel compensation is used to maintain the air-fuel ratio at the stoichiometric air-fuel ratio.
Long FT #2	Long-term fuel trim	Overall fuel compensation is carried out in the long-term to compensate for a continual deviation of the short-term fuel trim from the central valve.
Fuel System Status (Bank 1)	Fuel system status (for Bank 1)	• OL (Open Loop): Has not yet satisfied the conditions to go to closed loop. • CL (Closed Loop): Using the air fuel ratio sensor as feedback for fuel control. • OLDrive: Open loop due to driving conditions (fuel enrichment). • OLFault: Open loop due to a detected system fault. • CLFault: Closed loop but the air fuel ratio sensor, which is used for fuel control, is malfunctioning.
Fuel System Status (Bank 2)	Fuel system status (for Bank 2)	• OL (Open Loop): Has not yet satisfied the conditions to go to closed loop. • CL (Closed Loop): Using the air fuel ratio sensor as feedback for fuel control. • OLDrive: Open loop due to driving conditions (fuel enrichment). • OLFault: Open loop due to a detected system fault. • CLFault: Closed loop but the air fuel ratio sensor, which is used for fuel control, is malfunctioning.
AF FT B1 S1	Fuel trim at A/F sensor	-
AFS B1 S1	A/F sensor current	-

AF FT B2 S1	Fuel trim at A/F sensor	-
Catalyst Temp (B1 S1) Catalyst Temp (B2 S1)	Estimated catalyst temperature (for Sensor 1)	-
Catalyst Temp (B1 S2) Catalyst Temp (B2 S2)	Estimated catalyst temperature (for Sensor 2)	-
Initial Engine Coolant Temp	Engine coolant temperature at engine start	-
Initial Intake Air Temp	Intake air temperature at engine start	-
Injection Volum (Cylinder 1)	Injection volume	-
Air pump pressure (absolute)	Air pump pressure	-
Air Pump Pulsation Pressure	Air pump pulsation pressure	-
Air Pump2 Pressure (Absolute)	Air pump pressure	-
Air Pump2 Pulsation Pressure	Air pump pulsation pressure	-
Power Steering Pressure	Power steering pressure sensor	-
ACC Relay	ACC relay status	-
Starter Relay	Starter relay status	-
Starter Signal	Starter switch (STSW) signal	-
Starter Control	Starter switch status	-
Power Steering Switch	Power steering switch status	-
Power Steering Signal	Power steering signal (history)	This signal status is usually ON until the cables are disconnected from the battery terminals.
Closed Throttle Position SW	Closed throttle position switch	-
A/C Signal	A/C signal	-
Neutral Position SW Signal	Park/Neutral position (PNP) switch signal	-
Electrical Load Signal	Electrical load signal	-
Stop Light Switch	Stop light switch	-
Immobiliser Communication	Immobiliser communication	-
Fuel Cut Condition	Fuel cut condition	-
Battery Voltage	Battery voltage	-
Atmosphere Pressure	Atmosphere pressure	-
Secondary Air Control VSV	Secondary air injection system status	-
ACIS VSV	VSV for Acoustic Control Induction System (ACIS)	-
ACT VSV	A/C cut status for Active Test	-
VVT Control Status (Bank 2)	VVT control status	-
EVAP Purge VSV	Purge VSV	-
Fuel Pump/Speed Status	Fuel pump/speed status	-
VVT Control Status (Bank 1)	VVT control status	-
TC and TE1	TC and CG (TE1) terminals of DLC3	-
AI Test	Secondary air injection system operation prohibit	-
Engine Speed of Cyl #1	Engine speed for cylinder 1	-
Engine Speed of Cyl #2	Engine speed for cylinder 2	-
Engine Speed of Cyl #3	Engine speed for cylinder 3	-
Engine Speed of Cyl #4	Engine speed for cylinder 4	-
Engine Speed of Cyl #5	Engine speed for cylinder 5	-
Engine Speed of Cyl #6	Engine speed for cylinder 6	-
Engine Speed of Cyl #7	Engine speed for cylinder 7	-
Engine Speed of Cyl #8	Engine speed for cylinder 8	-
Av Engine Speed of All Cyl	Engine speed for all cylinders	-
VVT Aim Angle (Bank 1)	VVT aim angle	-
VVT Change Angle (Bank 1)	VVT change angle	-
VVT OCV Duty (Bank 1)	VVT OCV operation duty	-
VVT Ex Hold Lrn Val (Bank 1)	VVT exhaust hold duty ratio learning value (Bank 1)	-
VVT Ex Chg Angle (Bank 1)	VVT exhaust change angle (Bank 1)	-
VVT Ex OCV Duty (Bank 1)	VVT exhaust OCV duty (Bank 1)	-
VVT Aim Angle (Bank 2)	VVT aim angle	-
VVT Change Angle (Bank 2)	VVT change angle	-

VVT OCV Duty (Bank 2)	VVT OCV operation duty	-
VVT Ex Hold Lrn Val (Bank 2)	VVT exhaust hold duty ratio learning value (Bank 2)	-
VVT Ex Chg Angle (Bank 2)	VVT exhaust change angle (Bank 2)	-
VVT Ex OCV Duty (Bank 2)	VVT exhaust OCV duty (Bank 2)	-
Idle Fuel Cut	Fuel cut idle	ON: when the throttle valve is fully closed and the engine speed is more than 3500 rpm.
FC TAU	Fuel cut during very light load	Fuel cut being performed under a very light load to prevent the engine combustion from becoming incomplete.
Ignition	Ignition counter	-
Cylinder #1 Misfire Count	Cylinder #1 misfire	Only displayed during idling.
Cylinder #2 Misfire Count	Cylinder #2 misfire	Only displayed during idling.
Cylinder #3 Misfire Count	Cylinder #3 misfire	Only displayed during idling.
Cylinder #4 Misfire Count	Cylinder #4 misfire	Only displayed during idling.
Cylinder #5 Misfire Count	Cylinder #5 misfire	Only displayed during idling.
Cylinder #6 Misfire Count	Cylinder #6 misfire	Only displayed during idling.
Cylinder #7 Misfire Count	Cylinder #7 misfire	Only displayed during idling.
Cylinder #8 Misfire Count	Cylinder #8 misfire	Only displayed during idling.
All Cylinders Misfire Count	All cylinders misfire	Only displayed during idling.
Multi Cylinders Misfire Count	Multiple cylinder misfire	-
Misfire RPM	Engine speed when misfire occurred	-
Misfire Load	Engine load when misfire occurred	-
Misfire Margin	Margin to detect engine misfire	-
Catalyst OT MF F/C	Catalyst over temperature misfire prevention F/C	-
Cat OT MF F/C History	Catalyst over temperature misfire prevention F/C history	-
Cat OT MF F/C Cylinder#1	Display of fuel cut operation in No. 1 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#2	Display of fuel cut operation in No. 2 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#3	Display of fuel cut operation in No. 3 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#4	Display of fuel cut operation in No. 4 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#5	Display of fuel cut operation in No. 5 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#6	Display of fuel cut operation in No. 6 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#7	Display of fuel cut operation in No. 7 cylinder (if certain level of misfire malfunction is detected)	-
Cat OT MF F/C Cylinder#8	Display of fuel cut operation in No. 8 cylinder (if certain level of misfire malfunction is detected)	-
Engine Run Time	Accumulated engine running time	-
Time after DTC Cleared	Cumulative time after DTC cleared	-
Distance from DTC Cleared	Accumulated distance from DTC cleared	-
Warmup Cycle Cleared DTC	Warm-up cycle after DTC cleared	-

for Preparation Click here

DESCRIPTION

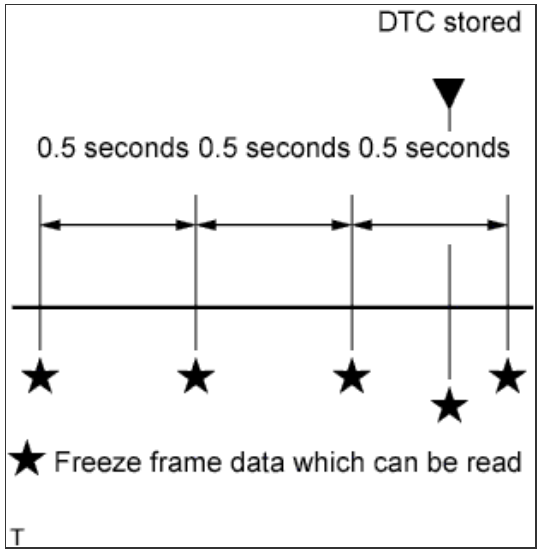
Freeze frame data records the engine conditions (fuel system, calculated load, engine coolant temperature, fuel trim, engine speed, vehicle speed, etc.) when a malfunction is detected. When troubleshooting, it can help determine if the vehicle was running or stopped, the engine was warmed up or not, the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

HINT:

If it is impossible to duplicate the problem even though a DTC is stored, confirm the freeze frame data.

The ECM records engine conditions in the form of freeze frame data every 0.5 seconds. Using the intelligent tester, 5 separate sets of freeze frame data can be checked.

- 3 data sets before the DTC was stored.
- 1 data set when the DTC was stored.
- 1 data set after the DTC was stored.
  These data sets can be used to simulate the condition of the vehicle around the time of the occurrence of the malfunction. The data may assist in identifying the cause of the malfunction, and in judging whether it was temporary or not.



LIST OF FREEZE FRAME DATA

LABEL (Tester Display)	Measurement Item	Diagnostic Note
Trouble Code	Trouble code	-
Injector (port)	Injection period of No. 1 cylinder	-
IGN Advance	Ignition advance	-
Calculate Load	Calculated load	The load calculated by the ECM.
Vehicle Load	Vehicle load	-
MAF	Mass air flow volume	If the value is approximately 0.0 g/sec.: • The mass air flow meter power source circuit is open or shorted. • The VG circuit is open or shorted. If the value is 160.0 g/sec. or more: • The E2G circuit is open.
Engine Speed	Engine speed	-
Vehicle Speed	Vehicle speed	The speed indicated on the speedometer.
Coolant Temp	Engine coolant temperature	If the value is -40°C (-40°F), the sensor circuit is open. If the value is 140°C (284°F) or higher, the sensor circuit is shorted.
Intake Air	Intake air temperature	If the value is -40°C (-40°F), the sensor circuit is open. If the value is 140°C (284°F) or higher, the sensor circuit is shorted.
2nd Air System Status	Second air system status	-
Air-Fuel Ratio	Ratio compared to stoichiometric level	-
Purge Density Learn Value	Learning value of purge density	-

Evap Purge Flow	Ratio of evaporative purge flow to intake air volume	-
EVAP (Purge) VSV	EVAP purge VSV duty ratio	-
Knock Correct Learn Value	Correction learning value of knocking	-
Knock Feedback Value	Feedback value of knocking	-
Accelerator Position No.1	Absolute Accelerator Pedal Position (APP) No. 1	-
Accelerator Position No.2	Absolute APP No. 2	-
Throttle Position	Throttle position	-
Throttle Sensor Position	Throttle sensor positioning	-
Throttle Sensor Position #2	Throttle sensor positioning #2	-
Throttle Motor	Throttle motor	-
O2S B1 S2 O2S B2 S2	Heated oxygen sensor output	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the output voltage of the sensor.
AFS B1 S1 AFS B2 S1	A/F sensor output	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the output voltage of the sensor.
AFS B2 S1	A/F sensor current	-
Total FT #1 Total FT #2	Total fuel trim	-
Short FT #1	Short-term fuel trim	Short-term fuel compensation is used to maintain the air-fuel ratio at the stoichiometric air-fuel ratio.
Long FT #1	Long-term fuel trim	Overall fuel compensation is carried out in the long-term to compensate for a continual deviation of the short-term fuel trim from the central value.
Short FT #2	Short-term fuel trim	Short-term fuel compensation is used to maintain the air-fuel ratio at the stoichiometric air-fuel ratio.
Long FT #2	Long-term fuel trim	Overall fuel compensation is carried out in the long-term to compensate for a continual deviation of the short-term fuel trim from the central value.
Fuel System Status (Bank1)	Fuel system status (for Bank 1)	• OL (Open Loop): Has not yet satisfied the conditions to go to closed loop. • CL (Closed Loop): Using the heated oxygen sensor as feedback for fuel control. • OLDrive: Open loop due to driving conditions (fuel enrichment). • OLFault: Open loop due to a detected system fault. • CLFault: Closed loop but the heated oxygen sensor, which is used for fuel control, is malfunctioning.
Fuel System Status (Bank2)	Fuel system status (for Bank 2)	• OL (Open Loop): Has not yet satisfied the conditions to go to closed loop. • CL (Closed Loop): Using the heated oxygen sensor as feedback for fuel control. • OLDrive: Open loop due to driving conditions (fuel enrichment). • OLFault: Open loop due to a detected system fault. • CLFault: Closed loop but the heated oxygen sensor, which is used for fuel control, is malfunctioning.
O2FT B1 S2 O2FT B2 S2	Fuel trim at heated oxygen sensor	-
AF FT B1 S1	Fuel trim at A/F sensor	-

AFS B1 S1	A/F sensor current	-
AF FT B2 S1	Fuel trim at A/F sensor	-
Catalyst Temp (B1 S1) Catalyst Temp (B2 S1)	Estimated catalyst temperature (for Sensor 1)	-
Catalyst Temp (B1 S2) Catalyst Temp (B2 S2)	Estimated catalyst temperature (for Sensor 2)	-
Initial Engine Coolant Temp	Engine coolant temperature at engine start	-
Initial Intake Air Temp	Intake air temperature at engine start	-
Injection Volum (Cylinder1)	Injection volume	-
Air pump pressure (absolute)	Air pump pressure	-
Air Pump Pulsation Pressure	Air pump pulsation pressure	-
Power Steering Pressure	Power steering pressure sensor	-
ACC Relay	ACC relay status	-
Starter Relay	Starter relay status	-
Starter Signal	Starter switch (STSW) signal	-
Starter Control	Starter switch status	-
Power Steering Switch	Power steering switch status	-
Power Steering Signal	Power steering signal status	-
Closed Throttle Position SW	Closed throttle position switch	-
A/C Signal	A/C signal	-
Neutral Position SW Signal	Park/Neutral Position (PNP) switch signal	-
Electrical Load Signal	Electrical load signal	-
Stop Light Switch	Stop light switch	-
Immobiliser Communication	Immobiliser communication	-
Fuel Cut Condition	Fuel cut condition	-
Battery Voltage	Battery voltage	-
Atmosphere Pressure	Atmospheric pressure	-
Secondary Air Control VSV	Secondary air injection system status	-
ACIS VSV	VSV for Acoustic Control Induction System (ACIS)	-
ACT VSV	A/C cut status for Active Test	-
VVT Control Status (Bank2)	VVT control status	-
EVAP Purge VSV	EVAP purge VSV	-
Fuel Pump/Speed Status	Fuel pump/speed status	-
VVT Control Status (Bank1)	VVT control status	-
TC and TE1	TC and CG (TE1) terminals of DLC3	-
AI Test	AI test status	-
Engine Speed of Cyl #1	Engine speed during No. 1 cylinder fuel cut	-
Engine Speed of Cyl #2	Engine speed during No. 2 cylinder fuel cut	-
Engine Speed of Cyl #3	Engine speed during No. 3 cylinder fuel cut	-
Engine Speed of Cyl #4	Engine speed during No. 4 cylinder fuel cut	-
Engine Speed of Cyl #5	Engine speed during No. 5 cylinder fuel cut	-
Engine Speed of Cyl #6	Engine speed during No. 6 cylinder fuel cut	-
Engine Speed of Cyl #7	Engine speed during No. 7 cylinder fuel cut	-
Engine Speed of Cyl #8	Engine speed during No. 8 cylinder fuel cut	-
VVT Aim Angle (Bank1)	VVT aim angle	-
VVT Change Angle (Bank1)	VVT change angle	-
VVT OCV Duty (Bank1)	VVT OCV operation duty	-
VVT Aim Angle (Bank2)	VVT aim angle	-
VVT Change Angle (Bank2)	VVT change angle	-
VVT OCV Duty (Bank2)	VVT OCV operation duty	-
Idle Fuel Cut	Fuel cut idle	ON: when the throttle valve is fully closed and the engine speed is more than 3500 rpm.
FC TAU	Fuel cut during very light load	Fuel cut is being performed under a very light load to prevent the engine combustion from becoming incomplete.
Ignition	Ignition counter	-
Cylinder #1 Misfire Count	Cylinder #1 misfire	Only displayed during idling.

Cylinder #2 Misfire Count	Cylinder #2 misfire	Only displayed during idling.
Cylinder #3 Misfire Count	Cylinder #3 misfire	Only displayed during idling.
Cylinder #4 Misfire Count	Cylinder #4 misfire	Only displayed during idling.
Cylinder #5 Misfire Count	Cylinder #5 misfire	Only displayed during idling.
Cylinder #6 Misfire Count	Cylinder #6 misfire	Only displayed during idling.
Cylinder #7 Misfire Count	Cylinder #7 misfire	Only displayed during idling.
Cylinder #8 Misfire Count	Cylinder #8 misfire	Only displayed during idling.
All Cylinders Misfire Count	All cylinders misfire	Only displayed during idling.
Multi Cylinders Misfire Count	Multiple cylinder misfire	-
Misfire RPM	Engine speed when misfire occurred	-
Misfire Load	Engine load when misfire occurred	-
Misfire Margin	Margin to detect engine misfire	-
Engine Run Time	Accumulated engine running time	-
Time after DTC Cleared	Cumulative time after DTC cleared	-
Distance from DTC Cleared	Accumulated distance from DTC cleared	-
Warmup Cycle Cleared DTC	Warm-up cycle after DTC cleared	-

for Preparation Click here

HINT:

Intelligent tester:

Compared to the normal mode, check mode is more sensitive to malfunctions. Therefore, check mode can detect the malfunctions that cannot be detected in normal mode.

NOTICE:

All the stored DTCs and freeze frame data are cleared if: 1) the ECM is changed from normal mode to check mode or vice versa; or 2) the engine switch is turned from on (IG) to on (ACC) or off while in check mode. Before changing modes, always check and note any DTCs and freeze frame data.

CHECK MODE PROCEDURE

a. Check and ensure the following conditions:

   i. Battery positive voltage 11 V or higher.

   ii. Throttle valve fully closed.

   iii. Transmission in the P or N position.

   iv. A/C switch off.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Check Mode.

g. Switch the ECM from normal mode to check mode.

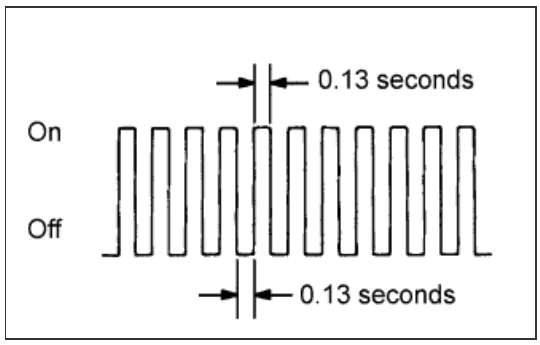
h. Make sure the MIL flashes as shown in the illustration.

i. Start the engine.

j. Make sure the MIL turns off.

k. Simulate the conditions of the malfunction described by the customer.

l. Check the DTCs and freeze frame data using the tester.



for Preparation Click here

If any of the following DTCs are stored, the ECM enters fail-safe mode to allow the vehicle to be driven temporarily.

DTC	Component	Fail-Safe Operation	Fail-Safe Deactivation Condition
P0011, P0021, P0015 and P0025*3	Camshaft oil control valve (OCV)	When a misfire occurs, fuel cut is performed for catalyst overheat malfunction prevention. • With a normal load and normal engine speed (MIL is blinking): - Fuel cut is performed on the malfunctioning cylinder. • With a high load and high engine speed driving (MIL is blinking): - Throttle valve opening angle control is performed. - Fuel cut is performed on all cylinders or the malfunction cylinder.	Pass condition detected and then engine switch turned off
P0031, P0032, P0051 and P0052	Air Fuel ratio (A/F) Sensor Heater	The ECM turns off the A/F sensor heater.	Engine switch off
P0037, P0038, P0057 and P0058	Heated Oxygen (HO2) Sensor Heater	The ECM turns off the HO2 sensor heater.	Engine switch off
P0102 and P0103	Mass Air Flow (MAF) Meter	The ECM calculates ignition timing according to the engine speed and throttle valve position.	Pass condition detected
P0110, P0112 and P0113	Intake Air Temperature (IAT) Sensor	The ECM estimates the IAT to be 20°C (68°F).	Pass condition detected
P0115, P0117 and P0118	Engine Coolant Temperature (ECT) Sensor	The ECM estimates the ECT to be 80°C (176°F).	Pass condition detected
P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0604, P0606, P060A, P060B, P060D, P060E, P0657, P2102, P2103, P2111, P2112, P2118, P2119 and P2135	Electronic Throttle Control System (ETCS)	The ECM cuts off throttle actuator current and the throttle valve is returned to a 7° throttle position by the return spring. The ECM then adjusts the engine output by controlling fuel injection (intermittent fuel cut) and ignition timing in accordance with the accelerator pedal opening angle to allow the vehicle to continue at minimal speed*1.	Pass condition detected and then engine switch turned off
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308*2	• Fuel injector • Electronic Throttle Control System (ETCS)	When a misfire occurs, fuel cut is performed for catalyst overheat malfunction prevention. • With a normal load and normal engine speed (MIL is blinking): - Fuel cut is performed on the malfunctioning cylinder. • With a high load and high engine speed driving (MIL is blinking): - Throttle valve opening angle control is performed. - Fuel cut is performed on all cylinders or the malfunction cylinder.	Pass condition detected and then engine switch turned off
P0327, P0328, P032C, P032D, P0332, P0333, P033C and P033D	Knock Sensor	The ECM sets the ignition timing to maximum retard.	Engine switch off

P0351 to P0358	Ignition Coil	The ECM cuts fuel.	Pass condition detected
P0504	Stop Light Switch	The accelerator pedal angle is fixed.	Accelerator pedal angle is fixed
P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138	Accelerator Pedal Position (APP) Sensor	The APP sensor has 2 sensor circuits: Main and Sub. If either circuit malfunctions, the ECM controls the engine using the other circuit. If both circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.	Pass condition detected and then engine switch turned off
P2432, P2433, P2437 and P2438	Secondary Air Injection System	Throttle valve opening angle control is performed.	Pass condition detected
P2440 and P2442	Secondary Air Injection System	Throttle valve opening angle control is performed.	Pass condition detected
P2445 and P2447	Secondary Air Injection System	Throttle valve opening angle control is performed.	Pass condition detected

HINT:

- ***1: The vehicle can be driven slowly when the accelerator pedal is depressed firmly and slowly. If the accelerator pedal is depressed quickly, the vehicle may speed up and slow down erratically.**
- ***2: Misfire related fail-safe operations occur when catalyst overheat malfunctions occur.**
- ***3: Only for M-OBD.**

for Preparation Click here

DATA LIST

HINT:

Using the intelligent tester to read the Data List allows the values or states of switches, sensors, actuators and other items to be read without removing any parts. This non-intrusive inspection can be very useful because intermittent conditions or signals may be discovered before parts or wiring is disturbed. Reading the Data List information early in troubleshooting is one way to save diagnostic time.

NOTICE:

In the table below, the values listed under "Normal Condition" are reference values. Do not depend solely on these reference values when deciding whether a part is faulty or not.

a. Warm up the engine.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data.

g. According to the display on the tester, read the Data List.

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
Injector (Port)	Injection period of the No. 1 cylinder/ Min.: 0 ms, Max.: 32.64 ms	2.0 to 4.0 ms: idling	-
IGN Advance	Ignition timing advance for No. 1 cylinder/ Min.: -64 deg., Max.: 63.5 deg.	BTDC 5 to 15°: Idling	-
Calculate Load	Calculated load by ECM/ Min.: 0%, Max.: 100%	• 11 to 25%: Idling • 12 to 26%: Running without load (2500 rpm)	-
Vehicle Load	Vehicle load/ Min.: 0%, Max.: 25700%	Actual vehicle load	-
MAF	Air flow rate from Mass Air Flow (MAF) meter/ Min.: 0 g/sec., Max.: 655 g/sec.	4.0 to 8.0 g/sec.: Idling	If the mass air flow volume is approximately 0.0 g/sec.: • The mass air flow meter power source circuit is open or shorted. • The VG circuit is open or shorted. If the mass air flow volume is 160.0 g/sec. or more: • The E2G circuit is open.
Engine Speed	Engine speed/ Min.: 0 rpm, Max.: 16383 rpm	650 to 750 rpm: Idling	-
Vehicle Speed	Vehicle speed/ Min.: 0 km/h, Max.: 255 km/h	Actual vehicle speed	The speed is indicated on the speedometer.
Coolant Temp	Engine coolant temperature/ Min.: -40°C, Max.: 140°C	80 to 100°C (176 to 212°F): After warming up	If the value is -40°C (-40°F): the sensor circuit is open. If the value is 140°C (284°F): the sensor circuit is shorted.
Intake Air	Intake air temperature/ Min.: -40°C, Max.: 140°C	Equivalent to ambient air temperature	If the value is -40°C (-40°F): the sensor circuit is open. If the value is 140°C (284°F): the sensor circuit is shorted.
2nd Air System Status	Secondary air system status/ ON or OFF	ON: Secondary air system operation	-

Air-Fuel Ratio	Air-fuel ratio: Min.: 0, Max.: 1.999	0.8 to 1.2: During idling	-
Purge Density Learn Value	Learning value of purge density/ Min.: -50, Max.: 350	Idling: -40 to 0%	The service data.
Evap Purge Flow	Purge flow/ Min.: 0%, Max.: 102.4%	0 to 100%: Idling	-
EVAP (Purge) VSV	Purge VSV control duty/ Min.: 0%, Max.: 100%	0 to 100%: During idling	The order signal from the ECM.
Knock Correct Learn Value	Correction learning value of knocking/ Min.: -64 CA, Max.: 1984 CA	0 to 22° CA: Driving, 70 km/h (44 mph)	The service data.
Knock Feedback Value	Feedback value of knocking/ Min.: -64 CA, Max.: 1984 CA	-22 to 0° CA: Driving, 70 km/h (44 mph)	The service data.
Clutch Current	Clutch current/ Min.: 0 A, Max.: 2.49 A	-	-
Accelerator Position No. 1	Absolute Accelerator Pedal Position (APP) No. 1/ Min.: 0%, Max.: 100%	10 to 22%: accelerator pedal released 54 to 86%: accelerator pedal fully depressed	-
Accelerator Position No. 2	Absolute APP No. 2/ Min.: 0%, Max.: 100%	12 to 42%: accelerator pedal released 66 to 98%: accelerator pedal fully depressed	-
Accelerator Position No. 1	APP sensor No. 1 voltage/ Min.: 0 V, Max.: 4.98 V	-	The ETCS freeze data.
Accelerator Position No. 2	APP sensor No. 2 voltage/ Min.: 0 V, Max.: 4.98 V	-	The ETCS freeze data.
Accelerator Position No. 1	APP sensor No. 1 voltage/ Min.: 0 V, Max.: 5 V	0.5 to 1.1 V: accelerator pedal released 2.6 to 4.5 V: accelerator pedal fully depressed	-
Accelerator Position No. 2	APP sensor No. 2 voltage/ Min.: 0 V, Max.: 5 V	1.2 to 2.0 V: accelerator pedal released 3.4 to 5.3 V: accelerator pedal fully depressed	-
Accelerator Idle Position	Whether or not accelerator pedal position sensor detecting idle/ ON or OFF	ON: Idling	-
Throttle Fully Close Learn	Throttle valve fully closed (learned value) Min.: 0 V, Max.: 5 V	0.4 to 0.8 V	-
Accel Fully Close #1 (AD)	Accelerator fully closed value No. 1 (AD)/ Min.: 0, Max.: 4.98 V	-	The ETCS service data.
Accel Fully Close Learn #1	Accelerator fully closed learning value No. 1/ Min.: 0, Max.: 124.512	-	The ETCS service data.
Accel Fully Close Learn #2	Accelerator fully closed learning value No. 2/ Min.: 0, Max.: 124.512	-	The ETCS service data.
Fail Safe Drive	Whether or not fail-safe function executed/ ON or OFF	ON: ETCS has failed	-
Fail Safe Drive (Main CPU)	Whether or not fail-safe function executed/ ON or OFF	ON: ETCS has failed	-
ST1	Brake pedal signal/ ON or OFF	ON: Brake pedal depressed	-
System Guard	System guard/ ON or OFF	-	The ETCS service data.
Open Side Malfunction	Open side malfunction/ ON or OFF	-	The ETCS service data.
Throttle Pos. Sensor Output	Absolute throttle position sensor/ Min.: 0%, Max.: 100%	• 10 to 24%: Throttle fully closed • 64 to 96%: Throttle fully open	Read the value with intrusive operation (Active Test).
Throttle Idle Position	Whether or not throttle position sensor detecting idle/	ON: Idling	-

	ON or OFF		
Throttle Require Position	Throttle requirement position/ Min.: 0 V, Max.: 5 V	0.5 to 1.0 V: Idling	-
Throttle Sensor Position	Throttle sensor positioning/ Min.: 0%, Max.: 100%	10 to 18%: Idling	The calculated value based on VTA1.
Throttle Sensor Position #2	Throttle sensor positioning #2/ Min.: 0%, Max.: 100%	-	The calculated value based on VTA2.
Throttle Position No. 1	Throttle position sensor No. 1 output voltage/ Min.: 0 V, Max.: 4.9 V	-	The ETCS freeze data.
Throttle Position No. 2	Throttle position sensor No. 2 output voltage/ Min.: 0 V, Max.: 4.9 V	-	The ETCS freeze data.
Throttle Position No. 1	Throttle position No. 1/ Min.: 0 V, Max.: 5 V	• 0.5 to 1.2 V: Throttle fully closed • 3.2 to 4.8 V: Throttle fully open	-
Throttle Position No. 2	Throttle position No. 2/ Min.: 0 V, Max.: 5 V	• 2.0 to 2.9 V: Throttle fully closed • 4.6 to 5.5 V: Throttle fully open	Read the value with intrusive operation (Active Test).
Throttle Position Command	Throttle position command value/ Min.: 0 V, Max.: 4.98 V	0.5 to 4.8 V	The ETCS service data.
Throttle Sens Open Pos #1	Throttle sensor opener position No. 1/ Min.: 0 V, Max.: 4.98 V	0.6 to 0.9 V	The ETCS service data.
Throttle Sens Open Pos #2	Throttle sensor opener position No. 2/ Min.: 0 V, Max.: 4.98 V	2.2 to 2.6 V	The ETCS service data.
Throttle Sens Open #1(AD)	Throttle sensor opener position No. 1 (AD)/ Min.: 0 V, Max.: 4.98 V	0.6 to 0.9 V	The ETCS service data.
Throttle Motor	Whether or not throttle actuator control permitted/ ON or OFF	ON: Idling	Read the value with the engine switch on (IG) (do not start the engine).
Throttle Motor Current	Throttle actuator current/ Min.: 0 A, Max.: 20 A	0 to 3.0 A: Idling	-
Throttle Motor DUTY	Throttle actuator duty/ Min.: 0%, Max.: 100%	0.5 to 40%: Idling	-
Throttle Motor Current	Throttle actuator current/ Min.: 0 A, Max.: 19.92 A	0 to 3.0 A: Idling	-
Throttle Motor Open Duty	Throttle actuator opening duty ratio/ Min.: 0%, Max.: 100%	0 to 40%: During idling	When the accelerator pedal is depressed, the duty ratio increased.
Throttle Motor Close Duty	Throttle actuator closed duty ratio/ Min.: 0%, Max.: 100%	0 to 40%: During idling	When the accelerator pedal is released quickly, the duty ratio increased.
Throttle Motor Duty (Open)	Throttle actuator duty ratio (open)/ Min.: 0%, Max.: 100%	-	The ETCS service data.
Throttle Motor Duty (Close)	Throttle actuator duty ratio (close)/ Min.: 0%, Max.: 100%	-	The ETCS service data.
O2S B1 S2	Heated oxygen sensor output voltage (for Bank 1 Sensor 2)/ Min.: 0 V, Max.: 1.275 V	0.1 to 0.9 V: Driving 70 km/h (44 mph)	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the voltage output of the sensor.
O2S B2 S2	Heated oxygen sensor output voltage (for Bank 2 Sensor 2)/ Min.: 0 V, Max.: 1.275 V	0.1 to 0.9 V: Driving 70 km/h (44 mph)	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the voltage output of the sensor.
AFS B1 S1	Air fuel ratio sensor output voltage (for Bank 1 Sensor 1)/ Min.: 0 V, Max.: 7.999 V	2.8 to 3.8 V: Idling	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the voltage output of the sensor.

AFS B2 S1	Air fuel ratio sensor output voltage (for Bank 2 Sensor 1)/ Min.: 0 V, Max.: 7.999 V	2.8 to 3.8 V: Idling	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the voltage output of the sensor.
AFS B2 S1	Air fuel ratio sensor current (for Bank 2 Sensor 1)/ Min.: -128 mA, Max.: 127.99 mA	-0.5 to 0.5 mA: Idling	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the output current of the sensor.
Total FT #1	Total fuel trim of bank 1 Average value for fuel trim system of Bank 1/ Min.: -0.5, Max.: 0.496	-0.2 to 0.2: Idling	-
Total FT #2	Total fuel trim of bank 2 Average value for fuel trim system of Bank 2/ Min.: -0.5, Max.: 0.496	-0.2 to 0.2: Idling	-
Short FT #1	Short-term fuel trim of Bank 1/ Min.: -100%, Max.: 99.2%	-20 to +20%	This item refers to the short-term fuel compensation used to maintain the air-fuel ratio at the stoichiometric air-fuel ratio.
Long FT #1	Long-term fuel trim of Bank 1/ Min.: -100%, Max.: 99.2%	-20 to +20%	This item refers to the overall fuel compensation carried out in the long-term to compensate for a continual deviation of the short-term fuel trim from the central value.
Short FT #2	Short-term fuel trim of Bank 2/ Min.: -100%, Max.: 99.2%	-20 to +20%	This item refers to the short-term fuel compensation used to maintain the air-fuel ratio at the stoichiometric air-fuel ratio.
Long FT #2	Long-term fuel trim of Bank 2/ Min.: -100%, Max.: 99.2%	-20 to +20%	This item refers to the overall fuel compensation carried out in the long-term to compensate for a continual deviation of the short-term fuel trim from the central value.
Fuel System Status (Bank 1)	Fuel system status (Bank 1)/ OL, CL, OLDrive, OLFault or CLFault	CL: Idling after warming up	• OL (Open Loop): Has not yet satisfied the conditions to go to closed loop. • CL (Closed Loop): Using the heated oxygen sensor as feedback for fuel control. • OLDrive: Open loop due to driving conditions (fuel enrichment). • OLFault: Open loop due to a detected system fault. • CLFault: Closed loop but the heated oxygen sensor, which is used for fuel control, is malfunctioning.
Fuel System Status (Bank 2)	Fuel system status (Bank 2)/ OL, CL, OLDrive, OLFault or CLFault	CL: Idling after warming up	• OL (Open Loop): Has not yet satisfied the conditions to go to closed loop. • CL (Closed Loop): Using the heated oxygen sensor as feedback for fuel control. • OLDrive: Open loop due to driving conditions (fuel

			enrichment). • OLFault: Open loop due to a detected system fault. • CLFault: Closed loop but the heated oxygen sensor, which is used for fuel control, is malfunctioning.
AF FT B1 S1	Short-term fuel trim associated with the Bank 1 Sensor 1/ Min.: 0, Max.: 1.999	• Value less than 1 (0.000 to 0.999) = Rich • Stoichiometric air-fuel ratio = 1 • Value more than 1 (1.001 to 1.999) = Lean	-
AFS B1 S1	Air fuel ratio sensor current Bank 1 Sensor 1/ Min.: -128 mA, Max.: 127.99 mA	-0.5 to 0.5 mA: Idling	Performing the Control the Injection Volume or Control the Injection Volume for A/F Sensor function of the Active Test enables the technician to check the output current of the sensor.
AF FT B2 S1	Short-term fuel trim associated with the Bank 2 Sensor 1/ Min.: 0, Max.: 1.999	• Value less than 1 (0.000 to 0.999) = Rich • Stoichiometric air-fuel ratio = 1 • Value more than 1 (1.001 to 1.999) = Lean	-
Catalyst Temp (B1 S1)	Catalyst temperature (Bank 1, Sensor 1)/ Min.: -40°C, Max.: 6513.5°C	-	-
Catalyst Temp (B2 S1)	Catalyst temperature (Bank 2, Sensor 1)/ Min.: -40°C, Max.: 6513.5°C	-	-
Catalyst Temp (B1 S2)	Catalyst temperature (Bank 1, Sensor 2)/ Min.: -40°C, Max.: 6513.5°C	-	-
Catalyst Temp (B2 S2)	Catalyst temperature (Bank 2, Sensor 2)/ Min.: -40°C, Max.: 6513.5°C	-	-
Initial Engine Coolant Temp	Initial engine coolant temperature/ Min.: -40°C, Max.: 120°C	Close to ambient air temperature	The service data.
Initial Intake Air Temp	Initial intake air temperature/ Min.: -40°C, Max.: 120°C	Close to ambient air temperature	The service data.
Injection Volum (Cylinder 1)	Injection volume (cylinder 1)/ Min.: 0 ml, Max.: 2.048 ml	0 to 0.5 ml	The quantity of fuel injection volume for 10 times.
Air pump pressure (absolute)	Air pump pressure (absolute)/ Min.: 0 kPa, Max.: 320 kPa	Atmospheric pressure +1 kPa or more: Air pump ON, Air switching valve open Close to atmospheric pressure: Air pump OFF, Air switching valve closed	Refer to DTC P2431 (Click here).
Air Pump Pulsation Pressure	Air pump pulsation pressure/ Min.: 0 kPa, Max.: 639.9 kPa	-	The cumulative pulsation pressure calculated by the ECM. (Click here).
Air Pump2 Pressure (Absolute)	Air pump pressure (absolute)/ Min.: 0 kPa, Max.: 320 kPa	Atmospheric pressure +1 kPa or more: Air pump ON, Air switching valve open Close to atmospheric pressure: Air pump OFF, Air switching valve closed	Refer to DTC P2431 (Click here).
Air Pump2 Pulsation Pressure	Air pump pulsation pressure/ Min.: 0 kPa, Max.: 639.9 kPa	-	The cumulative pulsation pressure calculated by the ECM. (Click here).
Power Steering Pressure	Power steering oil pressure/ Min.: -1.897 MPa, Max.: 12.799 MPa	-	-
	Acc relay status/		

ACC Relay	ON or OFF	ON: Cranking	-
Starter Relay	Starter relay status/ ON or OFF	ON: Cranking	-
Starter Signal	Starter signal/ ON or OFF	ON: Cranking	-
Starter Control	Starter switch status/ ON or OFF	ON: Cranking	-
Power Steering Switch	Power steering switch signal/ ON or OFF	ON: Power steering operation	-
Power Steering Signal	Power steering signal (history)/ ON or OFF	ON: When steering wheel first turned after battery terminals connected	This signal status is usually ON until the cables are disconnected from the battery terminals.
Closed Throttle Position SW	Closed throttle position switch/ ON or OFF	• ON: Throttle fully closed • OFF: Throttle open	-
A/C Signal	A/C switch status/ ON or OFF	ON: A/C ON	-
Neutral Position SW Signal	PNP switch status/ ON or OFF	ON: Shift lever in P or N	-
Electrical Load Signal	Electrical load signal/ ON or OFF	ON: Headlights or defogger turned on	-
Stop Light Switch	Stop light switch/ ON or OFF	ON: Brake pedal depressed	-
Immobiliser Communication	Immobiliser communication/ ON or OFF	ON: Normal	-
Fuel Cut Condition	Fuel cut condition/ ON or OFF	ON: Fuel cut operating	-
ETCS Actuator Power	Whether or not electric throttle control system power inputted/ ON or OFF	ON: Idling	-
+BM Voltage	+BM voltage/ Min.: 0, Max.: 19.92	10 to 15 V: Idling	The ETCS service data.
Battery Voltage	Battery voltage/ Min.: 0 V, Max.: 65.535 V	11 to 14 V: Idling	-
Actuator Power Supply	Actuator power supply/ ON or OFF	ON: Idling	The ETCS service data.
Atmosphere Pressure	Atmospheric pressure/ Min.: 0 kPa, Max.: 150 kPa	Equivalent to atmospheric pressure (absolute pressure)	-
Secondary Air Control VSV	Secondary air injection system status	ON: Secondary air injection system operation	-
ACIS VSV	VSV status for ACIS control/ ON or OFF	-	The Active Test support data.
ACT VSV	A/C cut status for Active Test/ ON or OFF	-	The Active Test support data.
VVT Control Status (Bank 2)	VVT control status (Bank 2)/ ON or OFF	-	The Active Test support data.
EVAP Purge VSV	VSV status for EVAP control/ ON or OFF	-	The Active Test support data.
Fuel Pump/Speed Status	Fuel pump/speed status/ ON or OFF	-	The Active Test support data.
VVT Control Status (Bank 1)	Variable valve timing (VVT) control status (Bank 1)/ ON or OFF	-	The Active Test support data.
TC and TE1	TC and TE1 terminal of DLC3/ ON or OFF	-	-
AI Test	AI operation prohibition/ OK or NG	OK	-
Engine Speed of Cyl #1	Engine speed for cylinder 1/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Engine Speed of Cyl #2	Engine speed for cylinder 2/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Engine Speed of Cyl #3	Engine speed for cylinder 3/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.

Engine Speed of Cyl #4	Engine speed for cylinder 4/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Engine Speed of Cyl #5	Engine speed for cylinder 5/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Engine Speed of Cyl #6	Engine speed for cylinder 6/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Engine Speed of Cyl #7	Engine speed for cylinder 7/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Engine Speed of Cyl #8	Engine speed for cylinder 8/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
Av Engine Speed of All Cyl	Engine speed for all cylinders/ Min.: 0 rpm, Max.: 25600 rpm	-	Output only when Check the Cylinder Compression is performed using the Active Test.
VVT Aim Angle (Bank 1)*	VVT aim angle (Bank 1)/ Min.: 0%, Max.: 100%	0%: Idling	The VVT duty signal value during intrusive operation.
VVT Change Angle (Bank 1)*	VVT change angle (Bank 1)/ Min.: 0° FR, Max.: 60° FR	0 to 5° FR: Idling	The displacement angle during intrusive operation.
VVT OCV Duty (Bank 1)*	VVT OCV operation duty (Bank 1)/ Min.: 0%, Max.: 100%	0%: Idling	The requested duty value for intrusive operation.
VVT EX Hold Lrn Val (Bank 1)*	VVT exhaust hold duty ratio learning value (Bank 1)/ Min.: 0%, Max.: 100%	0 to 80%: Idling	-
VVT EX Chg Angle (Bank 1)*	VVT exhaust change angle (Bank 1)/ Min.: 0°FR, Max.: 60°FR	0 to 40°FR: Idling	The displacement angle during intrusive operation.
VVT EX OCV Duty (Bank 1)*	VVT exhaust OCV duty (Bank 1)/ Min.: 0%, Max.: 100%	0 to 100%: Idling	The requested duty value for intrusive operation.
VVT Aim Angle (Bank 2)*	VVT aim angle (Bank 2)/ Min.: 0%, Max.: 100%	0%: Idling	The VVT duty signal value during intrusive operation.
VVT Change Angle (Bank 2)*	VVT change angle (Bank 2)/ Min.: 0° FR, Max.: 60° FR	0 to 5° FR: Idling	The displacement angle during intrusive operation.
VVT OCV Duty (Bank 2)*	VVT OCV operation duty (Bank 2)/ Min.: 0%, Max.: 100%	0%: Idling	The requested duty value for intrusive operation.
VVT EX Hold Lrn Val (Bank 2)*	VVT exhaust hold duty ratio learning value (Bank 2)/ Min.: 0%, Max.: 100%	0 to 80%: Idling	-
VVT EX Chg Angle (Bank 2)*	VVT exhaust change angle (Bank 2)/ Min.: 0°FR, Max.: 60°FR	0 to 40°FR: Idling	The displacement angle during intrusive operation.
VVT EX OCV Duty (Bank 2)*	VVT exhaust OCV duty (Bank 2)/ Min.: 0%, Max.: 100%	0 to 100%: Idling	The requested duty value for intrusive operation.
Idle Fuel Cut	Fuel cut idle/ ON or OFF	ON: Fuel cut operation	Idle Fuel Cut is "ON" when the throttle valve is fully closed and the engine speed is more than 2800 rpm.
FC TAU	Fuel cut TAU: Fuel cut during very light load/ ON or OFF	ON: Fuel cut operation	The fuel cut being performed under a very light load to prevent the engine combustion from becoming incomplete.
Ignition	Ignition counter/ Min.: 0, Max.: 800	0 to 800	-
Cylinder #1 Misfire Count to Cylinder #8 Misfire Count	Misfire count of the cylinder 1 to 8/ Min.: 0, Max.: 255	0%	This item is displayed only when idling the engine.
All Cylinders Misfire Count	All cylinders misfire count/ Min.: 0, Max.: 255	0 to 35	-
Multi Cylinders Misfire Count	Multiple cylinder misfire count/ Min.: 0 Max.:65535	0 to 65,535	-

Misfire RPM	Engine speed for first misfire range/ Min.: 0 rpm, Max.: 6375 rpm	0 rpm: Misfire 0	-
Misfire Load	Engine load for first misfire range/ Min.: 0 g/rev, Max.: 3.98 g/rev	0 g/rev: Misfire 0	-
Misfire Margin	Misfire monitoring/ Min.: -100%, Max.: 99.22%	-100 to 99.2%	The misfire detecting margin.
Catalyst OT MF F/C	Catalyst over temperature misfire prevention F/C/ Not Avl or Avail	Avail: Cat OT MF F/C available Not Avl: Cat OT MF F/C not available	-
Cat OT MF F/C History	Catalyst over temperature misfire prevention F/C history/ OFF or ON	ON: Fuel cut operation history exists	-
Cat OT MF F/C Cylinder #1	Display of fuel cut operation in No. 1 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #2	Display of fuel cut operation in No. 2 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #3	Display of fuel cut operation in No. 3 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #4	Display of fuel cut operation in No. 4 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #5	Display of fuel cut operation in No. 5 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #6	Display of fuel cut operation in No. 6 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #7	Display of fuel cut operation in No. 7 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
Cat OT MF F/C Cylinder #8	Display of fuel cut operation in No. 8 cylinder (if certain level of misfire malfunction is detected)/ ON or OFF	ON: Fuel cut operating	-
# Codes	#Codes/ Min.: 0, Max.: 255	-	The number of stored DTCs.
Check Mode	Check mode/ ON or OFF	ON: Check mode ON	Refer to the Check Mode Procedure (Click here).
SPD Test	Check mode result for vehicle speed sensor/ Compl or Incmpl	-	-
AS Test	Check mode result for secondary air injection system/ Compl or Incmpl	-	-
Misfire Test	Check mode result for misfire monitor/ Compl or Incmpl	-	-
OXS2 Test	Check mode result for heated oxygen sensor (Bank 2)/ Compl or Incmpl	-	-
OXS1 Test	Check mode result for heated oxygen sensor (Bank 1)/ Compl or Incmpl	-	-
A/F Test Results (Bank 2)	Check mode result for air fuel ratio sensor (Bank 2)/ Compl or Incmpl	-	-
	Check mode result for air fuel ratio		

A/F Test Results (Bank 1)	sensor (Bank 1)/ Compl or Incmpl	-	-
MIL	MIL status/ ON or OFF	ON: MIL ON	-
MIL ON Run Distance	MIL ON run distance/ Min.: 0 km, Max.: 65535 km	Distance after DTC stored	-
Running Time from MIL ON	Running time from MIL ON/ Min.: 0 minute, Max.: 65535 minutes	Equivalent to running time after MIL ON	-
Engine Run Time	Engine run time/ Min.: 0 seconds, Max.: 65535 seconds	Time after engine start	The service data.
Time after DTC Cleared	Time after DTC cleared/ Min.: 0 minutes, Max.: 65535 minutes	Equivalent to time after DTCs cleared	-
Distance from DTC Cleared	Distance after DTC cleared/ Min.: 0 km, Max.: 65535 km	Equivalent to drive distance after DTCs cleared	-
Warmup Cycle Cleared DTC	Warm-up cycle after DTC cleared/ Min.: 0, Max.: 255	-	The number of warm-up cycles after the DTC is cleared.
OBD Requirements	OBD requirement	E-OBD	-
Number of Emission DTC	Emission related DTCs	-	The number of emission related DTCs.
Complete Parts Monitor	Comprehensive component monitor/ Not Avl or Avail	-	-
Fuel System Monitor	Fuel system monitor/ Not Avl or Avail	-	-
Misfire Monitor	Misfire monitor/ Not Avl or Avail	-	-
EGR Monitor	EGR monitor/ Not Avl or Avail	-	-
EGR Monitor	EGR monitor/ Compl or Incmpl	-	-
O2S(A/FS) Heater Monitor	O2S (A/FS) heater monitor/ Not Avl or Avail	-	-
O2S(A/FS) Heater Monitor	O2S (A/FS) heater monitor/ Compl or Incmpl	-	-
O2S(A/FS) Monitor	O2S (A/FS) monitor/ Not Avl or Avail	-	-
O2S(A/FS) Monitor	O2S (A/FS) monitor/ Compl or Incmpl	-	-
A/C Monitor	A/C Monitor/ Not Avl or Avail	-	-
A/C Monitor	A/C Monitor/ Compl or Incmpl	-	-
2nd Air Monitor	2nd air monitor/ Not Avl or Avail	-	-
2nd Air Monitor	2nd air monitor/ Compl or Incmpl	-	-
EVAP Monitor	EVAP monitor/ Not Avl or Avail	-	-
EVAP Monitor	EVAP monitor/ Compl or Incmpl	-	-
Heated Catalyst Monitor	Heated Catalyst Monitor/ Not Avl or Avail	-	-
Heated Catalyst Monitor	Heated Catalyst Monitor/ Compl or Incmpl	-	-
Catalyst Monitor	Catalyst monitor/ Not Avl or Avail	-	-
Catalyst Monitor	Catalyst monitor/ Compl or Incmpl	-	-
Model Code	Model code	-	Identifying the model code: URJ2###.
Engine Type	Engine type	-	Identifying the engine type: 3URFE.
			Identifying the number of

Cylinder Number	Number of cylinders/ Min.: 0, Max.: 255	-	cylinders: 8.
Transmission Type	Transmission type	-	Identifying the transmission type: ECT 6th.
Destination	Destination	-	Identifying the destination: W.
Model Year	Model year/ Min.: 0, Max.: 255	-	Identifying the model year: 200#.
System Identification	System identification	-	Identifying the engine system: Gasoline (gasoline engine).

HINT:

- **Normal Condition: If no conditions are specifically stated for "idling", the shift lever is in N or P, the A/C switch is off and all accessory switches are off.**
- ***: Data List values are only displayed when performing the following Active Tests: Control the VVT Linear (Bank 1), Control the VVT Linear (Bank 2), Control the VVT Exhaust Linear (Bank 1) and Control the VVT Exhaust Linear (Bank 2). For other Active Tests, the Data List value will be 0.**

ACTIVE TEST

HINT:

Using the intelligent tester to perform Active Tests allows relays, VSVs, actuators and other items to be operated without removing any parts. This non-intrusive functional inspection can be very useful because intermittent operation may be discovered before parts or wiring is disturbed. Performing Active Tests early in troubleshooting is one way to save diagnostic time. Data List information can be displayed while performing Active Tests.

a. Warm up the engine.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / Active Test.

g. According to the display on the tester, perform the Active Test.

Tester Display	Test Part	Control Range	Diagnostic Note
Control the Injection Volume	Change injection volume	Between -12.5% and 24.8%	• All the injectors are tested at the same time. • Perform the test at less than 3000 rpm. • The injection volume can be changed in 1% graduations within the control range.
Control the Injection Volume for A/F Sensor	Change injection volume	Lower by 12.5% or increase 24.8%	• Perform the test at less than 3000 rpm. • Control the Injection Volume for A/F Sensor enables the checking and graphing of the A/F (Air Fuel Ratio) sensor voltage outputs. • To conduct the test, enter the following menus: Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and

			O2S B1 S2 or AFS B2 S1 and O2S B2 S2.
Activate the VSV for Secondary Air Control	Activate the Secondary Air System	ON/OFF	• Do not perform the test for 5 seconds or more. • After the test, do not perform the test again for 30 seconds.
Activate the VSV for Intake Control	Activate VSV for intake control	ON/OFF	-
Activate the VSV for Evap Control	Activate purge VSV control	ON/OFF	-
Control the A/C Cut Signal	Control A/C cut signal	ON/OFF	-
Control the Fuel Pump / Speed	Activate fuel pump	ON/OFF	-
Connect the TC and TE1	Turn on and off TC and TE1 connection	ON/OFF	• ON: TC and TE1 are connected. • OFF: TC and TE1 are disconnected.
Control the Idle Fuel Cut Prohibit	Prohibit idling fuel cut control	ON/OFF	-
Prohibit the Catalyst OT Misfire prevent F/C	Prohibit catalyst overheat malfunction prevention fuel cut operation during misfire	ON: Fuel cut is prohibited	Confirm that the vehicle is stopped and the engine speed is 3000 rpm or less.
Activate the Starter Relay	Activate the starter relay	ON/OFF	The engine is stopped.
Activate the ACC Cut Relay	Activate the ACC CUT relay	ON/OFF	The engine is stopped.
Control the ETCS Open/Close Slow Speed	Throttle actuator	ON: throttle valve opens slowly	This test is possible when the following conditions are met: • The engine switch is on (IG). • The engine does not starts. • Fully depressing the accelerator pedal (APP: 58 degrees or more).
Control the ETCS Open/Close Fast Speed	Throttle actuator	ON: throttle valve opens fast	Same as above.
Control the VVT Linear (Bank 1)	Control Variable Valve Timing (VVT) [Bank 1]	-128 to 127% This valve added to present OCV control duty 100%: Maximum advance -100%: Maximum retard	• The engine stalls or idles roughly when the VVT actuator is operated by 100%. • The test is possible during idle.
Control the VVT System (Bank 1)	Turn on and off Oil Control Valve (OCV)	ON/OFF	• The engine stalls or idles roughly when the OCV is turned on. • The engine runs or idles normally when the OCV is OFF.
Control the VVT Linear (Bank 2)	Control Variable Valve Timing (VVT) [Bank 2]	-128 to 127% This valve added to present OCV control duty 100%: Maximum advance -100%: Maximum retard	• The engine stalls or idles roughly when the VVT actuator is operated by 100%. • The test is possible during idle.
Control the VVT System (Bank 2)	Turn on and off Oil Control Valve (OCV)	ON/OFF	• The engine stalls or idles roughly when the OCV is turned on. • The engine runs or idles normally when the OCV is OFF.
			• The engine stalls

Control the VVT Exhaust Linear (Bank 1)	Control VVT (Bank 1)	-128 to 127% This valve added to present OCV control duty 100%: Maximum advance -100%: Maximum retard	or idles roughly when the VVT actuator is operated by 100%. • The test is possible while the engine is idling.
Control the VVT Exhaust Linear (Bank 2)	Control VVT (Bank 2)	-128 to 127% This valve added to present OCV control duty 100%: Maximum advance -100%: Maximum retard	• The engine stalls or idles roughly when the VVT actuator is operated by 100%. • The test is possible while the engine is idling.
Control the Cylinder #1 Fuel Cut	Cylinder #1 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #2 Fuel Cut	Cylinder #2 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #3 Fuel Cut	Cylinder #3 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #4 Fuel Cut	Cylinder #4 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #5 Fuel Cut	Cylinder #5 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #6 Fuel Cut	Cylinder #6 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #7 Fuel Cut	Cylinder #7 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the Cylinder #8 Fuel Cut	Cylinder #8 injector fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Control the All Cylinders Fuel Cut	All cylinder fuel cut	ON/OFF	The test is possible while the vehicle is stopped and the engine is idling.*1
Check the Cylinder Compression*2	Check the cylinder compression pressure	ON/OFF	Fuel injection and ignition stop in all cylinders.

NOTICE:

- ***1: If the display of the Data List Prohibit the Catalyst OT Misfire prevent F/C item is Not Avl, perform this Active Test with the vehicle stopped and the engine idling.**
- ***1: If the display of the Data List Prohibit the Catalyst OT Misfire prevent F/C item is Avail, perform this Active Test as described below.**
    1. **Stop the engine and turn the engine switch on (IG) to turn Control the Cylinder#1 Fuel Cut (to Control the Cylinder#8 Fuel Cut) on.**
    2. **Start the engine.**

HINT:

*2: When cranking the engine, each cylinder measures the engine speed.

In this Active Test, the fuel and ignition of all cylinders is cut, and cranking occurs for approximately 10 seconds. Then, each cylinder measures the engine speed. If a cylinder engine speed is higher than the other, that cylinder compression pressure is compared to the other, and whether or not the compression pressure is low can be determined.

1. Warm up the engine.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Active Test / Check the Cylinder Compression.

   HINT:

   To display the entire Data List, press the pull down menu button next to Primary. Then select Compression.

6. While the engine is not running, press the RIGHT or LEFT button to change the Check the Cylinder Compression to ON.

   HINT:

After performing the above procedure, the Active Test Check the Cylinder Compression will start. Fuel injection for all cylinders is prohibited, and each cylinder engine speed measurement will enter standby.

7. Fully open the throttle.
8. Crank the engine for about 10 seconds.
9. Monitor the engine speed (Engine Speed of Cyl #1 to #8) displayed on the intelligent tester.

HINT:

At first, the intelligent tester display will show each cylinder engine speed measurement to be extremely high. After approximately 10 seconds of engine cranking, each cylinder engine speed measurement will change to the actual engine speed.

NOTICE:

- **When the Check the Cylinder Compression test is OFF and the engine is cranked, the engine will start.**
- **If the Check the Cylinder Compression test needs to be performed after it is turned on and performed once, press Exit to return to the Active Test menu screen. Then perform the Check the Cylinder Compression test again.**
- **Use a fully-charged battery.**

SYSTEM CHECK

HINT:

Performing a System Check enables the system, which consists of multiple actuators, to be operated without removing any parts. In addition, it can show whether or not any DTCs are stored, and can detect potential malfunctions in the system. The System Check can be performed with the intelligent tester.

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Utility.

e. Perform the System Check by referring to the table below.

Tester Display	Test Part	Control Range	Diagnostic Notes
Secondary air Injection Check (Automatic Mode)	Perform secondary air injection system operation automatically	With warm engine, engine switch turned off once	• If no DTCs are in Pending after performing this test, the system is functioning normally. • Refer to the inspection procedure for secondary air injection system DTCs. • When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with engine switch turned on (IG) or the engine running. • Turn the engine switch off when the Secondary Air Injection Check is finished.
			• This is used to detect malfunctioning parts. • Refer to the inspection procedure for secondary air injection system

Secondary air Injection Check (Manual Mode)	Perform 8 operations in order to operate air injection system monitor manually	With warm engine, engine switch turned off once	DTCs. • When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with engine switch turned on (IG) or the engine running. • Turn engine switch off when the Secondary Air Injection Check finishes.

for Preparation Click here

HINT:

Parameters listed in the chart may be different than your readings depending on the type of instrument and other factors.

For details of each DTC, refer to the "See page" below.

*: The MIL flashes when a catalyst damaged misfire is detected.

SFI System

DTC Code	Detection Item	Trouble Areas	MIL	Memory	See page
P0010	Camshaft Position "A" Actuator Circuit (Bank 1)	- Open or short in OCV for intake camshaft (for Bank 1) circuit - OCV for intake camshaft (for Bank 1) - ECM	Comes on	DTC stored	Click here
P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)	- Open or short in OCV for exhaust camshaft (for Bank 1) circuit - OCV for exhaust camshaft (for Bank 1) - ECM	Comes on	DTC stored	Click here
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	- Valve timing - Oil control valve (OCV) for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	- Valve timing - OCV for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0020	Camshaft Position "A" Actuator Circuit (Bank 2)	- Open or short in OCV for intake camshaft (for Bank 2) circuit - OCV for intake camshaft (for Bank 2) - ECM	Comes on	DTC stored	Click here
P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here

P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)	- Open or short in OCV for exhaust camshaft (for Bank 2) circuit - OCV for exhaust camshaft (for Bank 2) - ECM	Comes on	DTC stored	Click here
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	- Valve timing - Oil control valve (OCV) for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)	- Valve timing - OCV for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)	- Open in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)	- Short in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)	- Open in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)	- Short in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)	- Open in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)	- Short in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0057	Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)	- Open in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)	- Short in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0102	Mass or Volume Air Flow Circuit Low Input	- Open or short in MAF meter circuit - MAF meter - ECM	Comes on	DTC stored	Click here
P0103	Mass or Volume Air Flow Circuit High Input	- Open or short in MAF meter circuit - MAF meter - ECM	Comes on	DTC stored	Click here
P0110	Intake Air Temperature Circuit Malfunction	- Open or short in Intake Air Temperature (IAT) sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0112	Intake Air Temperature Circuit Low Input	- Short in IAT sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0113	Intake Air Temperature Circuit High Input	- Open in IAT sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0115	Engine Coolant Temperature Circuit Malfunction	- Open or short in Engine Coolant Temperature (ECT) sensor circuit - ECT sensor	Comes on	DTC stored	Click here

P0116	Engine Coolant Temperature Circuit Range / Performance Problem	- ECM - Thermostat - ECT sensor	Comes on	DTC stored	Click here
P0117	Engine Coolant Temperature Circuit Low Input	- Short in ECT sensor - ECT sensor - ECM	Comes on	DTC stored	Click here
P0118	Engine Coolant Temperature Circuit High Input	- Open in ECT sensor circuit - ECT sensor - ECM	Comes on	DTC stored	Click here
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction	- Throttle Position (TP) sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	Click here
P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input	- TP sensor (built into throttle body) - Short in VTA1 circuit - Open in VC circuit - ECM	Comes on	DTC stored	Click here
P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input	- TP sensor (built into throttle body) - Open in VTA1 circuit - Open in E2 circuit - Short between VC and VTA1 circuits - ECM	Comes on	DTC stored	Click here
P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)	- Open or short in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - HO2 sensor heater (for Bank 1) - Air Fuel ratio (A/F) sensor (for Bank 1) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)	- Open in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - HO2 sensor heater (for Bank 1) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)	- Short in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - ECM internal circuit malfunction - Air Fuel ratio (A/F) sensor (for Bank 1)	Comes on	DTC stored	Click here
P0156	Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)	- Open or short in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - HO2 sensor heater (for Bank 2) - Air Fuel ratio (A/F) sensor (for Bank 2) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0157	Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)	- Open in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - HO2 sensor heater (for Bank 2) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0158	Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)	- Short in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - ECM internal circuit malfunction - Air Fuel ratio (A/F) sensor (for Bank 2)	Comes on	DTC stored	Click here
P0171	System Too Lean (Bank 1)	- Air induction system - Injector blockage - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - PCV valve and hose - PCV hose connections - ECM	Comes on	DTC stored	Click here
		- Injector leakage or blockage - MAF meter - ECT sensor - Ignition system - Fuel pressure			

P0172	System Too Rich (Bank 1)	- Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - ECM	Comes on	DTC stored	Click here
P0174	System Too Lean (Bank 2)	- Air induction system - Injector blockage - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - PCV valve and hose - PCV hose connections - ECM	Comes on	DTC stored	Click here
P0175	System Too Rich (Bank 2)	- Injector leakage or blockage - MAF meter - ECT sensor - Ignition system - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - ECM	Comes on	DTC stored	Click here
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	- TP sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P0222	Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input	- TP sensor (built into throttle body) - Short in VTA2 circuit - Open in VC circuit - ECM	Comes on	DTC stored	Click here
P0223	Throttle / Pedal Position Sensor / Switch "B" Circuit High Input	- TP sensor (built into throttle body) - Open in VTA2 circuit - Open in E2 circuit - Short between VC and VTA2 circuits - ECM	Comes on	DTC stored	Click here
P0230	Fuel Pump Primary Circuit	- Open or short in fuel pump circuit - Fuel pump - Fuel pump ECU - ECM	-	DTC stored	Click here
P0300	Random / Multiple Cylinder Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0301	Cylinder 1 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections	Comes on/Blinks*	DTC stored	Click here

		- Air induction system - ECM			
P0302	Cylinder 2 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0303	Cylinder 3 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0304	Cylinder 4 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0305	Cylinder 5 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0306	Cylinder 6 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
		- Open or short in Engine wire harness - Connector connection			

P0307	Cylinder 7 Misfire Detected	- Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0308	Cylinder 8 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)	- Short in knock sensor (for Bank 1 Sensor 1) circuit - Knock sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)	- Open in knock sensor (for Bank 1 Sensor 1) circuit - Knock sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P032C	Knock Sensor 3 Circuit Low	- Short in knock sensor (for Bank 1 Sensor 2) circuit - Knock sensor (for Bank 1 Sensor 2) - ECM	Comes on	DTC stored	Click here
P032D	Knock Sensor 3 Circuit High	- Open in knock sensor (for Bank 1 Sensor 2) circuit - Knock sensor (for Bank 1 Sensor 2) - ECM	Comes on	DTC stored	Click here
P0332	Knock Sensor 2 Circuit Low Input (Bank 2)	- Short in knock sensor (for Bank 2 Sensor1) circuit - Knock sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0333	Knock Sensor 2 Circuit High Input (Bank 2)	- Open in knock sensor (for Bank 2 Sensor1) circuit - Knock sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0335	Crankshaft Position Sensor "A" Circuit	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0337	Crankshaft Position Sensor "A" Circuit Low Input	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0338	Crankshaft Position Sensor "A" Circuit High Input	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0339	Crankshaft Position Sensor "A" Circuit Intermittent	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	-	DTC stored	Click here
P033C	Knock Sensor 4 Circuit Low Input	- Short in knock sensor (for Bank 2 Sensor 2) circuit - Knock sensor (for Bank 2 Sensor 2) - ECM	Comes on	DTC stored	Click here
		- Open in knock sensor (for Bank 2 Sensor 2)			

P033D	Knock Sensor 4 Circuit High Input	circuit - Knock sensor (for Bank 2 Sensor 2) - ECM	Comes on	DTC stored	Click here
P0340	Camshaft Position Sensor Circuit Malfunction	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)	- Open or short in VVT sensor for intake camshaft circuit - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0345	Camshaft Position Sensor "A" Circuit (Bank 2)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)	- Open or short in VVT sensor for intake camshaft circuit - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0351	Ignition Coil "A" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT1 circuit between ignition coil and ECM - No. 1 ignition coil - ECM	Comes on	DTC stored	Click here
P0352	Ignition Coil "B" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT2 circuit between ignition coil and ECM - No. 2 ignition coil - ECM	Comes on	DTC stored	Click here
P0353	Ignition Coil "C" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT3 circuit between ignition coil and ECM - No. 3 ignition coil - ECM	Comes on	DTC stored	Click here
P0354	Ignition Coil "D" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT4 circuit between ignition coil and ECM - No. 4 ignition coil - ECM	Comes on	DTC stored	Click here
P0355	Ignition Coil "E" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT5 circuit between ignition coil and ECM - No. 5 ignition coil - ECM	Comes on	DTC stored	Click here
P0356	Ignition Coil "F" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT6 circuit between ignition coil and ECM - No. 6 ignition coil - ECM	Comes on	DTC stored	Click here
P0357	Ignition Coil "G" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT7 circuit between ignition coil and ECM	Comes on	DTC	Click

		- No. 7 ignition coil - ECM		stored	here
P0358	Ignition Coil "H" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT8 circuit between ignition coil and ECM - No. 8 ignition coil - ECM	Comes on	DTC stored	Click here
P0365	Camshaft Position Sensor "B" Circuit (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0390	Camshaft Position Sensor "B" Circuit (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0412	Secondary Air Injection System Switching Valve "A" Circuit	- Open in ASV drive circuit - Short between ASV drive circuit and body ground - AID - ASV - ECM	Comes on	DTC stored	Click here
P0415	Secondary Air Injection System Switching Valve "B" Circuit	- Open in ASV drive circuit - Short between ASV drive circuit and body ground - AID - ASV - ECM	Comes on	DTC stored	Click here
P0418	Secondary Air Injection System Control "A" Circuit	- Open in air pump drive circuit - Short between air pump drive circuit and body ground - Air pump - AID - ECM	Comes on	DTC stored	Click here
P0419	Secondary Air Injection System Control "B" Circuit	- Open in air pump drive circuit - Short between air pump drive circuit and body ground - Air pump - AID - ECM	Comes on	DTC stored	Click here
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	- Gas leakage from exhaust system - Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) - Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) - Front No. 2 exhaust pipe (TWC)	Comes on	DTC stored	Click here

P0430	Catalyst System Efficiency Below Threshold (Bank 2)	- Gas leakage from exhaust system - Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) - Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) - Front exhaust pipe (TWC)	Comes on	DTC stored	Click here
P0443	Evaporative Emission Control System Purge Control Valve Circuit	- Open or short in purge VSV circuit - Purge VSV - ECM	Comes on	DTC stored	Click here
P0500	Vehicle Speed Sensor "A"	- Open or short in speed signal circuit - Combination meter - ECM	Comes on	DTC stored	Click here
P0504	Brake Switch "A" / "B" Correlation	- Short in stop light switch signal circuit - STOP fuse - IGN fuse - Stop light switch - ECM	-	DTC stored	Click here
P0505	Idle Control System Malfunction	- ETCS - Air induction system - PCV hose connections - ECM	Comes on	DTC stored	Click here
P0550	Power Steering Pressure Sensor Circuit Malfunction	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0552	Power Steering Pressure Sensor Circuit Low Input	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0553	Power Steering Pressure Sensor Circuit High Input	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0560	System Voltage	- Open in back up power source circuit - Battery - Battery terminals - EFI NO. 1 fuse - ECM	Comes on	DTC stored	Click here
P0604	Random Access Memory (RAM)	ECM	Comes on	DTC stored	Click here
P0606	ECM / PCM Processor	ECM	Comes on	DTC stored	Click here
P060A	Internal Control Module Monitoring Processor Performance	ECM	Comes on	DTC stored	Click here
P060B	Internal Control Module A/D Processing Performance	ECM	Comes on	DTC stored	Click here
P060D	Internal Control Module Accelerator Pedal Position Performance	ECM	Comes on	DTC stored	Click here
P060E	Internal Control Module Throttle Position Performance	ECM	Comes on	DTC stored	Click here
P0617	Starter Relay Circuit High	- Park/Neutral Position (PNP) switch - Starter relay circuit - Engine switch - ECM	Comes on	DTC stored	Click here
P0657	Actuator Supply Voltage Circuit / Open	ECM	Comes on	DTC stored	Click here
P0660	Intake Manifold Tuning Valve Control Circuit / Open (Bank 1)	- Open or short in VSV for ACIS circuit - VSV for ACIS - ECM	Comes on	DTC stored	Click here
P1340	Camshaft Position Sensor "A" (Bank 1 Sensor 2)	- Open or short in camshaft position sensor circuit - Camshaft position sensor - Camshaft timing plate LH - ECM	Comes on	DTC stored	Click here
P1342	Camshaft Position Sensor "A" Low Input (MRE)	- Open or short in camshaft position sensor circuit - Camshaft position sensor - Camshaft timing plate LH - ECM	Comes on	DTC stored	Click here
P1343	Camshaft Position Sensor "A" High Input (MRE)	- Open or short in camshaft position sensor circuit - Camshaft position sensor	Comes on	DTC	Click

		- Camshaft timing plate LH		stored	here
P1607	Cruise Control Input Processor	- ECM ECM	Comes on	DTC stored	Click here
P1613	Secondary Air Injection Driver Malfunction	- Short in diagnostic information signal circuit (AID - ECM) - Open in diagnostic information signal circuit (AID - ECM) - Open or short in air pump and air switching valve command signal circuit (AID - ECM) - Open or short in AID power source circuit - Open in AID ground circuit - AID - ECM	Comes on	DTC stored	Click here
P1614	Secondary Air Injection System Driver Bank 2	- Short in diagnostic information signal circuit (AID - ECM) - Open in diagnostic information signal circuit (AID - ECM) - Open or short in air pump and air switching valve command signal circuit (AID - ECM) - Open or short in AID power source circuit - Open in AID ground circuit - AID - ECM	Comes on	DTC stored	Click here
P2102	Throttle Actuator Control Motor Circuit Low	- Open in throttle actuator circuit - Throttle actuator - ECM	Comes on	DTC stored	Click here
P2103	Throttle Actuator Control Motor Circuit High	- Short in throttle actuator circuit - Throttle actuator - Throttle valve - Throttle body assembly - ECM	Comes on	DTC stored	Click here
P2111	Throttle Actuator Control System - Stuck Open	- Throttle actuator - Throttle body assembly - Throttle valve	Comes on	DTC stored	Click here
P2112	Throttle Actuator Control System - Stuck Closed	- Throttle actuator - Throttle body assembly - Throttle valve	Comes on	DTC stored	Click here
P2118	Throttle Actuator Control Motor Current Range / Performance	- Open in ETCS power source circuit - Battery - Battery terminals - ETCS fuse - ECM	Comes on	DTC stored	Click here
P2119	Throttle Actuator Control Throttle Body Range / Performance	- ETCS - ECM	Comes on	DTC stored	Click here
P2120	Throttle / Pedal Position Sensor / Switch "D" Circuit	- APP sensor - ECM	Comes on	DTC stored	Click here
P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance	- Accelerator Pedal Position (APP) sensor - ECM	Comes on	DTC stored	Click here
P2122	Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input	- APP sensor - Open in VCPA circuit - Open or ground short in VPA circuit - ECM	Comes on	DTC stored	Click here
P2123	Throttle / Pedal Position Sensor / Switch "D" Circuit High Input	- APP sensor - Open in EPA circuit - ECM	Comes on	DTC stored	Click here
P2125	Throttle / Pedal Position Sensor / Switch "E" Circuit	- APP sensor - ECM	Comes on	DTC stored	Click here
P2127	Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input	- APP sensor - Open in VCP2 circuit - Open or ground short in VPA2 circuit - ECM	Comes on	DTC stored	Click here
P2128	Throttle / Pedal Position Sensor / Switch "E" Circuit High Input	- APP sensor - Open in EPA2 circuit - ECM	Comes on	DTC stored	Click here
P2135	Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation	- Short between VTA1 and VTA2 circuits - TP sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P2138	Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation	- Short between VPA and VPA2 circuits - APP sensor	Comes on	DTC stored	Click here

		- ECM			
P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2237	Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)	- Open in Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) circuit - Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2240	Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)	- Open in Air Fuel Ratio (A/F) sensor (for Bank 2 Sensor 1) circuit - Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1)	Comes on	DTC stored	Click here

		- ECM			
P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2431	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2432	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2433	Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2436	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2437	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2438	Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2440	Secondary Air Injection System Switching Valve Stuck Open Bank1	- ASV - Open or short in ASV circuit - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2441	Secondary Air Injection System Switching Valve Stuck Close Bank1	- ASV - Open or short in ASV circuit - Vacuum hose (ASV - pressure sensor) - Air injection hose - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2442	Secondary Air Injection System Switching Valve Stuck Open Bank 2	- ASV - Open or short in ASV circuit - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2443	Secondary Air Injection System Switching Valve Stuck Closed Bank 2	- ASV - Open or short in ASV circuit - Vacuum hose (ASV - pressure sensor) - Air injection hose - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2444	Secondary Air Injection System Pump Stuck On Bank1	- Short in air pump circuit - Open or short in pressure sensor circuit - Pressure sensor - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2445	Secondary Air Injection System Pump Stuck Off Bank1	- Air pump - Open in air pump circuit - Air injection system piping - Vacuum hose (pressure sensor - air switching valve) - Pressure sensor - Open or short in pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2446	Secondary Air Injection System Pump Stuck On Bank 2	- Short in air pump circuit - Open or short in pressure sensor circuit - Pressure sensor - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
		- Air pump			

P2447	Secondary Air Injection System Pump Stuck Off Bank 2	- Open in air pump circuit - Air injection system piping - Vacuum hose (pressure sensor - air switching valve) - Pressure sensor - Open or short in pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)	- Open or short in A/F sensor circuit (for Bank 1) - A/F sensor (for Bank 1) - ECM	Comes on	DTC stored	Click here
P2A03	A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)	- Open or short in A/F sensor circuit (for Bank 2) - A/F sensor (for Bank 2) - ECM	Comes on	DTC stored	Click here

for Preparation Click here

HINT:

Parameters listed in the chart may be different than your readings depending on the type of instrument and other factors.

For details of each DTC, refer to the "See page" below.

*: The MIL flashes when a catalyst damaged misfire is detected.

SFI System

DTC Code	Detection Item	Trouble Areas	MIL	Memory	See page
P0010	Camshaft Position "A" Actuator Circuit (Bank 1)	- Open or short in OCV for intake camshaft (for Bank 1) circuit - OCV for intake camshaft (for Bank 1) - ECM	Comes on	DTC stored	Click here
P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)	- Open or short in OCV for exhaust camshaft (for Bank 1) circuit - OCV for exhaust camshaft (for Bank 1) - ECM	Comes on	DTC stored	Click here
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	- Valve timing - Oil control valve (OCV) for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	- Valve timing - OCV for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0020	Camshaft Position "A" Actuator Circuit (Bank 2)	- Open or short in OCV for intake camshaft (for Bank 2) circuit - OCV for intake camshaft (for Bank 2) - ECM	Comes on	DTC stored	Click here
P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here

P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)	- Open or short in OCV for exhaust camshaft (for Bank 2) circuit - OCV for exhaust camshaft (for Bank 2) - ECM	Comes on	DTC stored	Click here
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	- Valve timing - Oil control valve (OCV) for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)	- Valve timing - OCV for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)	- Open in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)	- Short in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)	- Open in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)	- Short in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)	- Open in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)	- Short in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0057	Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)	- Open in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)	- Short in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0102	Mass or Volume Air Flow Circuit Low Input	- Open or short in MAF meter circuit - MAF meter - ECM	Comes on	DTC stored	Click here
P0103	Mass or Volume Air Flow Circuit High Input	- Open or short in MAF meter circuit - MAF meter - ECM	Comes on	DTC stored	Click here
P0110	Intake Air Temperature Circuit Malfunction	- Open or short in Intake Air Temperature (IAT) sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0112	Intake Air Temperature Circuit Low Input	- Short in IAT sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0113	Intake Air Temperature Circuit High Input	- Open in IAT sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0115	Engine Coolant Temperature Circuit Malfunction	- Open or short in Engine Coolant Temperature (ECT) sensor circuit - ECT sensor	Comes on	DTC stored	Click here

P0116	Engine Coolant Temperature Circuit Range / Performance Problem	- ECM - Thermostat - ECT sensor	Comes on	DTC stored	Click here
P0117	Engine Coolant Temperature Circuit Low Input	- Short in ECT sensor - ECT sensor - ECM	Comes on	DTC stored	Click here
P0118	Engine Coolant Temperature Circuit High Input	- Open in ECT sensor circuit - ECT sensor - ECM	Comes on	DTC stored	Click here
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction	- Throttle Position (TP) sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	Click here
P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input	- TP sensor (built into throttle body) - Short in VTA1 circuit - Open in VC circuit - ECM	Comes on	DTC stored	Click here
P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input	- TP sensor (built into throttle body) - Open in VTA1 circuit - Open in E2 circuit - Short between VC and VTA1 circuits - ECM	Comes on	DTC stored	Click here
P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)	- Open or short in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - HO2 sensor heater (for Bank 1) - Air Fuel ratio (A/F) sensor (for Bank 1) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)	- Open in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - HO2 sensor heater (for Bank 1) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)	- Short in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - ECM internal circuit malfunction - Air Fuel ratio (A/F) sensor (for Bank 1)	Comes on	DTC stored	Click here
P0156	Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)	- Open or short in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - HO2 sensor heater (for Bank 2) - Air Fuel ratio (A/F) sensor (for Bank 2) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0157	Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)	- Open in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - HO2 sensor heater (for Bank 2) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0158	Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)	- Short in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - ECM internal circuit malfunction - Air Fuel ratio (A/F) sensor (for Bank 2)	Comes on	DTC stored	Click here
P0171	System Too Lean (Bank 1)	- Air induction system - Injector blockage - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - PCV valve and hose - PCV hose connections - ECM	Comes on	DTC stored	Click here
		- Injector leakage or blockage - MAF meter - ECT sensor - Ignition system - Fuel pressure			

P0172	System Too Rich (Bank 1)	- Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - ECM	Comes on	DTC stored	Click here
P0174	System Too Lean (Bank 2)	- Air induction system - Injector blockage - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - PCV valve and hose - PCV hose connections - ECM	Comes on	DTC stored	Click here
P0175	System Too Rich (Bank 2)	- Injector leakage or blockage - MAF meter - ECT sensor - Ignition system - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - ECM	Comes on	DTC stored	Click here
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	- TP sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P0222	Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input	- TP sensor (built into throttle body) - Short in VTA2 circuit - Open in VC circuit - ECM	Comes on	DTC stored	Click here
P0223	Throttle / Pedal Position Sensor / Switch "B" Circuit High Input	- TP sensor (built into throttle body) - Open in VTA2 circuit - Open in E2 circuit - Short between VC and VTA2 circuits - ECM	Comes on	DTC stored	Click here
P0230	Fuel Pump Primary Circuit	- Open or short in fuel pump circuit - Fuel pump - Fuel pump ECU - ECM	-	DTC stored	Click here
P0300	Random / Multiple Cylinder Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0301	Cylinder 1 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections	Comes on/Blinks*	DTC stored	Click here

		- Air induction system - ECM			
P0302	Cylinder 2 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0303	Cylinder 3 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0304	Cylinder 4 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0305	Cylinder 5 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0306	Cylinder 6 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
		- Open or short in Engine wire harness - Connector connection			

P0307	Cylinder 7 Misfire Detected	- Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0308	Cylinder 8 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)	- Short in knock sensor (for Bank 1 Sensor 1) circuit - Knock sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)	- Open in knock sensor (for Bank 1 Sensor 1) circuit - Knock sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P032C	Knock Sensor 3 Circuit Low	- Short in knock sensor (for Bank 1 Sensor 2) circuit - Knock sensor (for Bank 1 Sensor 2) - ECM	Comes on	DTC stored	Click here
P032D	Knock Sensor 3 Circuit High	- Open in knock sensor (for Bank 1 Sensor 2) circuit - Knock sensor (for Bank 1 Sensor 2) - ECM	Comes on	DTC stored	Click here
P0332	Knock Sensor 2 Circuit Low Input (Bank 2)	- Short in knock sensor (for Bank 2 Sensor1) circuit - Knock sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0333	Knock Sensor 2 Circuit High Input (Bank 2)	- Open in knock sensor (for Bank 2 Sensor1) circuit - Knock sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0335	Crankshaft Position Sensor "A" Circuit	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0337	Crankshaft Position Sensor "A" Circuit Low Input	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0338	Crankshaft Position Sensor "A" Circuit High Input	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0339	Crankshaft Position Sensor "A" Circuit Intermittent	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	-	DTC stored	Click here
P033C	Knock Sensor 4 Circuit Low Input	- Short in knock sensor (for Bank 2 Sensor 2) circuit - Knock sensor (for Bank 2 Sensor 2) - ECM	Comes on	DTC stored	Click here
		- Open in knock sensor (for Bank 2 Sensor 2)			

P033D	Knock Sensor 4 Circuit High Input	circuit - Knock sensor (for Bank 2 Sensor 2) - ECM	Comes on	DTC stored	Click here
P0340	Camshaft Position Sensor Circuit Malfunction	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)	- Open or short in VVT sensor for intake camshaft circuit - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0345	Camshaft Position Sensor "A" Circuit (Bank 2)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)	- Open or short in VVT sensor for intake camshaft circuit - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0351	Ignition Coil "A" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT1 circuit between ignition coil and ECM - No. 1 ignition coil - ECM	Comes on	DTC stored	Click here
P0352	Ignition Coil "B" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT2 circuit between ignition coil and ECM - No. 2 ignition coil - ECM	Comes on	DTC stored	Click here
P0353	Ignition Coil "C" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT3 circuit between ignition coil and ECM - No. 3 ignition coil - ECM	Comes on	DTC stored	Click here
P0354	Ignition Coil "D" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT4 circuit between ignition coil and ECM - No. 4 ignition coil - ECM	Comes on	DTC stored	Click here
P0355	Ignition Coil "E" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT5 circuit between ignition coil and ECM - No. 5 ignition coil - ECM	Comes on	DTC stored	Click here
P0356	Ignition Coil "F" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT6 circuit between ignition coil and ECM - No. 6 ignition coil - ECM	Comes on	DTC stored	Click here
P0357	Ignition Coil "G" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT7 circuit between ignition coil and ECM	Comes on	DTC	Click

		- No. 7 ignition coil - ECM		stored	here
P0358	Ignition Coil "H" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT8 circuit between ignition coil and ECM - No. 8 ignition coil - ECM	Comes on	DTC stored	Click here
P0365	Camshaft Position Sensor "B" Circuit (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0390	Camshaft Position Sensor "B" Circuit (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0412	Secondary Air Injection System Switching Valve "A" Circuit	- Open in ASV drive circuit - Short between ASV drive circuit and body ground - AID - ASV - ECM	Comes on	DTC stored	Click here
P0415	Secondary Air Injection System Switching Valve "B" Circuit	- Open in ASV drive circuit - Short between ASV drive circuit and body ground - AID - ASV - ECM	Comes on	DTC stored	Click here
P0418	Secondary Air Injection System Control "A" Circuit	- Open in air pump drive circuit - Short between air pump drive circuit and body ground - Air pump - AID - ECM	Comes on	DTC stored	Click here
P0419	Secondary Air Injection System Control "B" Circuit	- Open in air pump drive circuit - Short between air pump drive circuit and body ground - Air pump - AID - ECM	Comes on	DTC stored	Click here
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	- Gas leakage from exhaust system - Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) - Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) - Front No. 2 exhaust pipe (TWC)	Comes on	DTC stored	Click here

P0430	Catalyst System Efficiency Below Threshold (Bank 2)	- Gas leakage from exhaust system - Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) - Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) - Front exhaust pipe (TWC)	Comes on	DTC stored	Click here
P0443	Evaporative Emission Control System Purge Control Valve Circuit	- Open or short in purge VSV circuit - Purge VSV - ECM	Comes on	DTC stored	Click here
P0500	Vehicle Speed Sensor "A"	- Open or short in speed signal circuit - Combination meter - ECM	Comes on	DTC stored	Click here
P0504	Brake Switch "A" / "B" Correlation	- Short in stop light switch signal circuit - STOP fuse - IGN fuse - Stop light switch - ECM	-	DTC stored	Click here
P0505	Idle Control System Malfunction	- ETCS - Air induction system - PCV hose connections - ECM	Comes on	DTC stored	Click here
P0550	Power Steering Pressure Sensor Circuit Malfunction	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0552	Power Steering Pressure Sensor Circuit Low Input	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0553	Power Steering Pressure Sensor Circuit High Input	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0560	System Voltage	- Open in back up power source circuit - Battery - Battery terminals - EFI NO. 1 fuse - ECM	Comes on	DTC stored	Click here
P0604	Random Access Memory (RAM)	ECM	Comes on	DTC stored	Click here
P0606	ECM / PCM Processor	ECM	Comes on	DTC stored	Click here
P060A	Internal Control Module Monitoring Processor Performance	ECM	Comes on	DTC stored	Click here
P060B	Internal Control Module A/D Processing Performance	ECM	Comes on	DTC stored	Click here
P060D	Internal Control Module Accelerator Pedal Position Performance	ECM	Comes on	DTC stored	Click here
P060E	Internal Control Module Throttle Position Performance	ECM	Comes on	DTC stored	Click here
P0617	Starter Relay Circuit High	- Park/Neutral Position (PNP) switch - Starter relay circuit - Engine switch - ECM	Comes on	DTC stored	Click here
P0657	Actuator Supply Voltage Circuit / Open	ECM	Comes on	DTC stored	Click here
P0660	Intake Manifold Tuning Valve Control Circuit / Open (Bank 1)	- Open or short in VSV for ACIS circuit - VSV for ACIS - ECM	Comes on	DTC stored	Click here
P1340	Camshaft Position Sensor "A" (Bank 1 Sensor 2)	- Open or short in camshaft position sensor circuit - Camshaft position sensor - Camshaft timing plate LH - ECM	Comes on	DTC stored	Click here
P1342	Camshaft Position Sensor "A" Low Input (MRE)	- Open or short in camshaft position sensor circuit - Camshaft position sensor - Camshaft timing plate LH - ECM	Comes on	DTC stored	Click here
P1343	Camshaft Position Sensor "A" High Input (MRE)	- Open or short in camshaft position sensor circuit - Camshaft position sensor	Comes on	DTC	Click

		- Camshaft timing plate LH		stored	here
P1607	Cruise Control Input Processor	- ECM ECM	Comes on	DTC stored	Click here
P1613	Secondary Air Injection Driver Malfunction	- Short in diagnostic information signal circuit (AID - ECM) - Open in diagnostic information signal circuit (AID - ECM) - Open or short in air pump and air switching valve command signal circuit (AID - ECM) - Open or short in AID power source circuit - Open in AID ground circuit - AID - ECM	Comes on	DTC stored	Click here
P1614	Secondary Air Injection System Driver Bank 2	- Short in diagnostic information signal circuit (AID - ECM) - Open in diagnostic information signal circuit (AID - ECM) - Open or short in air pump and air switching valve command signal circuit (AID - ECM) - Open or short in AID power source circuit - Open in AID ground circuit - AID - ECM	Comes on	DTC stored	Click here
P2102	Throttle Actuator Control Motor Circuit Low	- Open in throttle actuator circuit - Throttle actuator - ECM	Comes on	DTC stored	Click here
P2103	Throttle Actuator Control Motor Circuit High	- Short in throttle actuator circuit - Throttle actuator - Throttle valve - Throttle body assembly - ECM	Comes on	DTC stored	Click here
P2111	Throttle Actuator Control System - Stuck Open	- Throttle actuator - Throttle body assembly - Throttle valve	Comes on	DTC stored	Click here
P2112	Throttle Actuator Control System - Stuck Closed	- Throttle actuator - Throttle body assembly - Throttle valve	Comes on	DTC stored	Click here
P2118	Throttle Actuator Control Motor Current Range / Performance	- Open in ETCS power source circuit - Battery - Battery terminals - ETCS fuse - ECM	Comes on	DTC stored	Click here
P2119	Throttle Actuator Control Throttle Body Range / Performance	- ETCS - ECM	Comes on	DTC stored	Click here
P2120	Throttle / Pedal Position Sensor / Switch "D" Circuit	- APP sensor - ECM	Comes on	DTC stored	Click here
P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance	- Accelerator Pedal Position (APP) sensor - ECM	Comes on	DTC stored	Click here
P2122	Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input	- APP sensor - Open in VCPA circuit - Open or ground short in VPA circuit - ECM	Comes on	DTC stored	Click here
P2123	Throttle / Pedal Position Sensor / Switch "D" Circuit High Input	- APP sensor - Open in EPA circuit - ECM	Comes on	DTC stored	Click here
P2125	Throttle / Pedal Position Sensor / Switch "E" Circuit	- APP sensor - ECM	Comes on	DTC stored	Click here
P2127	Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input	- APP sensor - Open in VCP2 circuit - Open or ground short in VPA2 circuit - ECM	Comes on	DTC stored	Click here
P2128	Throttle / Pedal Position Sensor / Switch "E" Circuit High Input	- APP sensor - Open in EPA2 circuit - ECM	Comes on	DTC stored	Click here
P2135	Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation	- Short between VTA1 and VTA2 circuits - TP sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P2138	Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation	- Short between VPA and VPA2 circuits - APP sensor	Comes on	DTC stored	Click here

		- ECM			
P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2237	Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)	- Open in Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) circuit - Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2240	Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)	- Open in Air Fuel Ratio (A/F) sensor (for Bank 2 Sensor 1) circuit - Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1)	Comes on	DTC stored	Click here

		- ECM			
P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2431	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2432	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2433	Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2436	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2437	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2438	Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2440	Secondary Air Injection System Switching Valve Stuck Open Bank1	- ASV - Open or short in ASV circuit - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2441	Secondary Air Injection System Switching Valve Stuck Close Bank1	- ASV - Open or short in ASV circuit - Vacuum hose (ASV - pressure sensor) - Air injection hose - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2442	Secondary Air Injection System Switching Valve Stuck Open Bank 2	- ASV - Open or short in ASV circuit - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2443	Secondary Air Injection System Switching Valve Stuck Closed Bank 2	- ASV - Open or short in ASV circuit - Vacuum hose (ASV - pressure sensor) - Air injection hose - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2444	Secondary Air Injection System Pump Stuck On Bank1	- Short in air pump circuit - Open or short in pressure sensor circuit - Pressure sensor - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2445	Secondary Air Injection System Pump Stuck Off Bank1	- Air pump - Open in air pump circuit - Air injection system piping - Vacuum hose (pressure sensor - air switching valve) - Pressure sensor - Open or short in pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2446	Secondary Air Injection System Pump Stuck On Bank 2	- Short in air pump circuit - Open or short in pressure sensor circuit - Pressure sensor - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
		- Air pump			

P2447	Secondary Air Injection System Pump Stuck Off Bank 2	- Open in air pump circuit - Air injection system piping - Vacuum hose (pressure sensor - air switching valve) - Pressure sensor - Open or short in pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)	- Open or short in A/F sensor circuit (for Bank 1) - A/F sensor (for Bank 1) - ECM	Comes on	DTC stored	Click here
P2A03	A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)	- Open or short in A/F sensor circuit (for Bank 2) - A/F sensor (for Bank 2) - ECM	Comes on	DTC stored	Click here

for Preparation Click here

HINT:

Parameters listed in the chart may be different than your readings depending on the type of instrument and other factors.

For details of each DTC, refer to the "See page" below.

*: The MIL flashes when a catalyst damaged misfire is detected.

SFI System

DTC Code	Detection Item	Trouble Areas	MIL	Memory	See page
P0010	Camshaft Position "A" Actuator Circuit (Bank 1)	- Open or short in OCV for intake camshaft (for Bank 1) circuit - OCV for intake camshaft (for Bank 1) - ECM	Comes on	DTC stored	Click here
P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)	- Open or short in OCV for exhaust camshaft (for Bank 1) circuit - OCV for exhaust camshaft (for Bank 1) - ECM	Comes on	DTC stored	Click here
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	- Valve timing - Oil control valve (OCV) for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	- Valve timing - OCV for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	- Mechanical system (Timing chain has jumped tooth or chain stretched) - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0020	Camshaft Position "A" Actuator Circuit (Bank 2)	- Open or short in OCV for intake camshaft (for Bank 2) circuit - OCV for intake camshaft (for Bank 2) - ECM	Comes on	DTC stored	Click here
P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here

P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)	- Valve timing - OCV for intake camshaft - OCV filter - Intake camshaft timing gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)	- Open or short in OCV for exhaust camshaft (for Bank 2) circuit - OCV for exhaust camshaft (for Bank 2) - ECM	Comes on	DTC stored	Click here
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	- Valve timing - Oil control valve (OCV) for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)	- Valve timing - OCV for exhaust camshaft - OCV filter - Camshaft timing exhaust gear - ECM	Comes on (Euro-OBD) Does not come on (M-OBD)	DTC stored	Click here
P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)	- Open in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)	- Short in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)	- Open in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)	- Short in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)	- Open in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)	- Short in A/F sensor heater circuit - A/F sensor heater (for Sensor 1) - Integration relay - ECM	Comes on	DTC stored	Click here
P0057	Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)	- Open in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)	- Short in HO2 sensor heater circuit - HO2 sensor heater (for Sensor 2) - Integration relay - ECM	Comes on	DTC stored	Click here
P0102	Mass or Volume Air Flow Circuit Low Input	- Open or short in MAF meter circuit - MAF meter - ECM	Comes on	DTC stored	Click here
P0103	Mass or Volume Air Flow Circuit High Input	- Open or short in MAF meter circuit - MAF meter - ECM	Comes on	DTC stored	Click here
P0110	Intake Air Temperature Circuit Malfunction	- Open or short in Intake Air Temperature (IAT) sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0112	Intake Air Temperature Circuit Low Input	- Short in IAT sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0113	Intake Air Temperature Circuit High Input	- Open in IAT sensor circuit - IAT sensor (built into MAF meter) - ECM	Comes on	DTC stored	Click here
P0115	Engine Coolant Temperature Circuit Malfunction	- Open or short in Engine Coolant Temperature (ECT) sensor circuit - ECT sensor	Comes on	DTC stored	Click here

P0116	Engine Coolant Temperature Circuit Range / Performance Problem	- ECM - Thermostat - ECT sensor	Comes on	DTC stored	Click here
P0117	Engine Coolant Temperature Circuit Low Input	- Short in ECT sensor - ECT sensor - ECM	Comes on	DTC stored	Click here
P0118	Engine Coolant Temperature Circuit High Input	- Open in ECT sensor circuit - ECT sensor - ECM	Comes on	DTC stored	Click here
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction	- Throttle Position (TP) sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	Click here
P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input	- TP sensor (built into throttle body) - Short in VTA1 circuit - Open in VC circuit - ECM	Comes on	DTC stored	Click here
P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input	- TP sensor (built into throttle body) - Open in VTA1 circuit - Open in E2 circuit - Short between VC and VTA1 circuits - ECM	Comes on	DTC stored	Click here
P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)	- Open or short in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - HO2 sensor heater (for Bank 1) - Air Fuel ratio (A/F) sensor (for Bank 1) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)	- Open in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - HO2 sensor heater (for Bank 1) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)	- Short in HO2 sensor (for Bank 1) circuit - HO2 sensor (for Bank 1) - ECM internal circuit malfunction - Air Fuel ratio (A/F) sensor (for Bank 1)	Comes on	DTC stored	Click here
P0156	Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)	- Open or short in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - HO2 sensor heater (for Bank 2) - Air Fuel ratio (A/F) sensor (for Bank 2) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0157	Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)	- Open in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - HO2 sensor heater (for Bank 2) - Integration relay - Gas leakage from exhaust system	Comes on	DTC stored	Click here
P0158	Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)	- Short in HO2 sensor (for Bank 2) circuit - HO2 sensor (for Bank 2) - ECM internal circuit malfunction - Air Fuel ratio (A/F) sensor (for Bank 2)	Comes on	DTC stored	Click here
P0171	System Too Lean (Bank 1)	- Air induction system - Injector blockage - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - PCV valve and hose - PCV hose connections - ECM	Comes on	DTC stored	Click here
		- Injector leakage or blockage - MAF meter - ECT sensor - Ignition system - Fuel pressure			

P0172	System Too Rich (Bank 1)	- Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - ECM	Comes on	DTC stored	Click here
P0174	System Too Lean (Bank 2)	- Air induction system - Injector blockage - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - PCV valve and hose - PCV hose connections - ECM	Comes on	DTC stored	Click here
P0175	System Too Rich (Bank 2)	- Injector leakage or blockage - MAF meter - ECT sensor - Ignition system - Fuel pressure - Gas leakage from exhaust system - Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - ECM	Comes on	DTC stored	Click here
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	- TP sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P0222	Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input	- TP sensor (built into throttle body) - Short in VTA2 circuit - Open in VC circuit - ECM	Comes on	DTC stored	Click here
P0223	Throttle / Pedal Position Sensor / Switch "B" Circuit High Input	- TP sensor (built into throttle body) - Open in VTA2 circuit - Open in E2 circuit - Short between VC and VTA2 circuits - ECM	Comes on	DTC stored	Click here
P0230	Fuel Pump Primary Circuit	- Open or short in fuel pump circuit - Fuel pump - Fuel pump ECU - ECM	-	DTC stored	Click here
P0300	Random / Multiple Cylinder Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0301	Cylinder 1 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections	Comes on/Blinks*	DTC stored	Click here

		- Air induction system - ECM			
P0302	Cylinder 2 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0303	Cylinder 3 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0304	Cylinder 4 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0305	Cylinder 5 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0306	Cylinder 6 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
		- Open or short in Engine wire harness - Connector connection			

P0307	Cylinder 7 Misfire Detected	- Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0308	Cylinder 8 Misfire Detected	- Open or short in Engine wire harness - Connector connection - Vacuum hose connections - Ignition system - Fuel injector - Fuel pressure - Mass Air Flow (MAF) meter - Engine Coolant Temperature (ECT) sensor - Compression pressure - Valve timing - PCV Valve and hose - PCV hose connections - Air induction system - ECM	Comes on/Blinks*	DTC stored	Click here
P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)	- Short in knock sensor (for Bank 1 Sensor 1) circuit - Knock sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)	- Open in knock sensor (for Bank 1 Sensor 1) circuit - Knock sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P032C	Knock Sensor 3 Circuit Low	- Short in knock sensor (for Bank 1 Sensor 2) circuit - Knock sensor (for Bank 1 Sensor 2) - ECM	Comes on	DTC stored	Click here
P032D	Knock Sensor 3 Circuit High	- Open in knock sensor (for Bank 1 Sensor 2) circuit - Knock sensor (for Bank 1 Sensor 2) - ECM	Comes on	DTC stored	Click here
P0332	Knock Sensor 2 Circuit Low Input (Bank 2)	- Short in knock sensor (for Bank 2 Sensor1) circuit - Knock sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0333	Knock Sensor 2 Circuit High Input (Bank 2)	- Open in knock sensor (for Bank 2 Sensor1) circuit - Knock sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P0335	Crankshaft Position Sensor "A" Circuit	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0337	Crankshaft Position Sensor "A" Circuit Low Input	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0338	Crankshaft Position Sensor "A" Circuit High Input	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	Comes on	DTC stored	Click here
P0339	Crankshaft Position Sensor "A" Circuit Intermittent	- Open or short in CKP sensor circuit - CKP sensor - CKP sensor plate - ECM	-	DTC stored	Click here
P033C	Knock Sensor 4 Circuit Low Input	- Short in knock sensor (for Bank 2 Sensor 2) circuit - Knock sensor (for Bank 2 Sensor 2) - ECM	Comes on	DTC stored	Click here
		- Open in knock sensor (for Bank 2 Sensor 2)			

P033D	Knock Sensor 4 Circuit High Input	circuit - Knock sensor (for Bank 2 Sensor 2) - ECM	Comes on	DTC stored	Click here
P0340	Camshaft Position Sensor Circuit Malfunction	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)	- Open or short in VVT sensor for intake camshaft circuit - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0345	Camshaft Position Sensor "A" Circuit (Bank 2)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)	- Open or short in VVT sensor circuit for intake camshaft - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)	- Open or short in VVT sensor for intake camshaft circuit - VVT sensor for intake camshaft - Camshaft timing gear for intake camshaft - Jumped tooth of timing chain for intake camshaft - ECM	Comes on	DTC stored	Click here
P0351	Ignition Coil "A" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT1 circuit between ignition coil and ECM - No. 1 ignition coil - ECM	Comes on	DTC stored	Click here
P0352	Ignition Coil "B" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT2 circuit between ignition coil and ECM - No. 2 ignition coil - ECM	Comes on	DTC stored	Click here
P0353	Ignition Coil "C" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT3 circuit between ignition coil and ECM - No. 3 ignition coil - ECM	Comes on	DTC stored	Click here
P0354	Ignition Coil "D" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT4 circuit between ignition coil and ECM - No. 4 ignition coil - ECM	Comes on	DTC stored	Click here
P0355	Ignition Coil "E" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT5 circuit between ignition coil and ECM - No. 5 ignition coil - ECM	Comes on	DTC stored	Click here
P0356	Ignition Coil "F" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT6 circuit between ignition coil and ECM - No. 6 ignition coil - ECM	Comes on	DTC stored	Click here
P0357	Ignition Coil "G" Primary / Secondary Circuit	- Ignition system - Open or short in IGF1 or IGT7 circuit between ignition coil and ECM	Comes on	DTC	Click

		- No. 7 ignition coil - ECM		stored	here
P0358	Ignition Coil "H" Primary / Secondary Circuit	- Ignition system - Open or short in IGF2 or IGT8 circuit between ignition coil and ECM - No. 8 ignition coil - ECM	Comes on	DTC stored	Click here
P0365	Camshaft Position Sensor "B" Circuit (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0390	Camshaft Position Sensor "B" Circuit (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM	Comes on	DTC stored	Click here
P0412	Secondary Air Injection System Switching Valve "A" Circuit	- Open in ASV drive circuit - Short between ASV drive circuit and body ground - AID - ASV - ECM	Comes on	DTC stored	Click here
P0415	Secondary Air Injection System Switching Valve "B" Circuit	- Open in ASV drive circuit - Short between ASV drive circuit and body ground - AID - ASV - ECM	Comes on	DTC stored	Click here
P0418	Secondary Air Injection System Control "A" Circuit	- Open in air pump drive circuit - Short between air pump drive circuit and body ground - Air pump - AID - ECM	Comes on	DTC stored	Click here
P0419	Secondary Air Injection System Control "B" Circuit	- Open in air pump drive circuit - Short between air pump drive circuit and body ground - Air pump - AID - ECM	Comes on	DTC stored	Click here
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	- Gas leakage from exhaust system - Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) - Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) - Front No. 2 exhaust pipe (TWC)	Comes on	DTC stored	Click here

P0430	Catalyst System Efficiency Below Threshold (Bank 2)	- Gas leakage from exhaust system - Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) - Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) - Front exhaust pipe (TWC)	Comes on	DTC stored	Click here
P0443	Evaporative Emission Control System Purge Control Valve Circuit	- Open or short in purge VSV circuit - Purge VSV - ECM	Comes on	DTC stored	Click here
P0500	Vehicle Speed Sensor "A"	- Open or short in speed signal circuit - Combination meter - ECM	Comes on	DTC stored	Click here
P0504	Brake Switch "A" / "B" Correlation	- Short in stop light switch signal circuit - STOP fuse - IGN fuse - Stop light switch - ECM	-	DTC stored	Click here
P0505	Idle Control System Malfunction	- ETCS - Air induction system - PCV hose connections - ECM	Comes on	DTC stored	Click here
P0550	Power Steering Pressure Sensor Circuit Malfunction	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0552	Power Steering Pressure Sensor Circuit Low Input	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0553	Power Steering Pressure Sensor Circuit High Input	- Open or short in power steering oil pressure sensor circuit - Power steering oil pressure sensor - ECM	Comes on	DTC stored	Click here
P0560	System Voltage	- Open in back up power source circuit - Battery - Battery terminals - EFI NO. 1 fuse - ECM	Comes on	DTC stored	Click here
P0604	Random Access Memory (RAM)	ECM	Comes on	DTC stored	Click here
P0606	ECM / PCM Processor	ECM	Comes on	DTC stored	Click here
P060A	Internal Control Module Monitoring Processor Performance	ECM	Comes on	DTC stored	Click here
P060B	Internal Control Module A/D Processing Performance	ECM	Comes on	DTC stored	Click here
P060D	Internal Control Module Accelerator Pedal Position Performance	ECM	Comes on	DTC stored	Click here
P060E	Internal Control Module Throttle Position Performance	ECM	Comes on	DTC stored	Click here
P0617	Starter Relay Circuit High	- Park/Neutral Position (PNP) switch - Starter relay circuit - Engine switch - ECM	Comes on	DTC stored	Click here
P0657	Actuator Supply Voltage Circuit / Open	ECM	Comes on	DTC stored	Click here
P0660	Intake Manifold Tuning Valve Control Circuit / Open (Bank 1)	- Open or short in VSV for ACIS circuit - VSV for ACIS - ECM	Comes on	DTC stored	Click here
P1340	Camshaft Position Sensor "A" (Bank 1 Sensor 2)	- Open or short in camshaft position sensor circuit - Camshaft position sensor - Camshaft timing plate LH - ECM	Comes on	DTC stored	Click here
P1342	Camshaft Position Sensor "A" Low Input (MRE)	- Open or short in camshaft position sensor circuit - Camshaft position sensor - Camshaft timing plate LH - ECM	Comes on	DTC stored	Click here
P1343	Camshaft Position Sensor "A" High Input (MRE)	- Open or short in camshaft position sensor circuit - Camshaft position sensor	Comes on	DTC	Click

		- Camshaft timing plate LH		stored	here
P1607	Cruise Control Input Processor	- ECM ECM	Comes on	DTC stored	Click here
P1613	Secondary Air Injection Driver Malfunction	- Short in diagnostic information signal circuit (AID - ECM) - Open in diagnostic information signal circuit (AID - ECM) - Open or short in air pump and air switching valve command signal circuit (AID - ECM) - Open or short in AID power source circuit - Open in AID ground circuit - AID - ECM	Comes on	DTC stored	Click here
P1614	Secondary Air Injection System Driver Bank 2	- Short in diagnostic information signal circuit (AID - ECM) - Open in diagnostic information signal circuit (AID - ECM) - Open or short in air pump and air switching valve command signal circuit (AID - ECM) - Open or short in AID power source circuit - Open in AID ground circuit - AID - ECM	Comes on	DTC stored	Click here
P2102	Throttle Actuator Control Motor Circuit Low	- Open in throttle actuator circuit - Throttle actuator - ECM	Comes on	DTC stored	Click here
P2103	Throttle Actuator Control Motor Circuit High	- Short in throttle actuator circuit - Throttle actuator - Throttle valve - Throttle body assembly - ECM	Comes on	DTC stored	Click here
P2111	Throttle Actuator Control System - Stuck Open	- Throttle actuator - Throttle body assembly - Throttle valve	Comes on	DTC stored	Click here
P2112	Throttle Actuator Control System - Stuck Closed	- Throttle actuator - Throttle body assembly - Throttle valve	Comes on	DTC stored	Click here
P2118	Throttle Actuator Control Motor Current Range / Performance	- Open in ETCS power source circuit - Battery - Battery terminals - ETCS fuse - ECM	Comes on	DTC stored	Click here
P2119	Throttle Actuator Control Throttle Body Range / Performance	- ETCS - ECM	Comes on	DTC stored	Click here
P2120	Throttle / Pedal Position Sensor / Switch "D" Circuit	- APP sensor - ECM	Comes on	DTC stored	Click here
P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance	- Accelerator Pedal Position (APP) sensor - ECM	Comes on	DTC stored	Click here
P2122	Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input	- APP sensor - Open in VCPA circuit - Open or ground short in VPA circuit - ECM	Comes on	DTC stored	Click here
P2123	Throttle / Pedal Position Sensor / Switch "D" Circuit High Input	- APP sensor - Open in EPA circuit - ECM	Comes on	DTC stored	Click here
P2125	Throttle / Pedal Position Sensor / Switch "E" Circuit	- APP sensor - ECM	Comes on	DTC stored	Click here
P2127	Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input	- APP sensor - Open in VCP2 circuit - Open or ground short in VPA2 circuit - ECM	Comes on	DTC stored	Click here
P2128	Throttle / Pedal Position Sensor / Switch "E" Circuit High Input	- APP sensor - Open in EPA2 circuit - ECM	Comes on	DTC stored	Click here
P2135	Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation	- Short between VTA1 and VTA2 circuits - TP sensor (built into throttle body) - ECM	Comes on	DTC stored	Click here
P2138	Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation	- Short between VPA and VPA2 circuits - APP sensor	Comes on	DTC stored	Click here

		- ECM			
P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Sensor 1) circuit - A/F sensor (for Sensor 1) - A/F sensor heater (for Sensor 1) - Integration relay - A/F sensor heater and integration relay circuits - Air induction system - Fuel pressure - Fuel injector - ECM	Comes on	DTC stored	Click here
P2237	Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)	- Open in Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) circuit - Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2240	Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)	- Open in Air Fuel Ratio (A/F) sensor (for Bank 2 Sensor 1) circuit - Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	- Open or short in A/F sensor (for Bank 1 Sensor 1) circuit - A/F sensor (for Bank 1 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1)	Comes on	DTC stored	Click here

		- ECM			
P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)	- Open or short in A/F sensor (for Bank 2 Sensor 1) circuit - A/F sensor (for Bank 2 Sensor 1) - ECM	Comes on	DTC stored	Click here
P2431	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2432	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2433	Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2436	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2437	Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2438	Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2	- Pressure sensor - Open or short in pressure sensor circuit - ECM	Comes on	DTC stored	Click here
P2440	Secondary Air Injection System Switching Valve Stuck Open Bank1	- ASV - Open or short in ASV circuit - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2441	Secondary Air Injection System Switching Valve Stuck Close Bank1	- ASV - Open or short in ASV circuit - Vacuum hose (ASV - pressure sensor) - Air injection hose - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2442	Secondary Air Injection System Switching Valve Stuck Open Bank 2	- ASV - Open or short in ASV circuit - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2443	Secondary Air Injection System Switching Valve Stuck Closed Bank 2	- ASV - Open or short in ASV circuit - Vacuum hose (ASV - pressure sensor) - Air injection hose - Pressure sensor - Pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2444	Secondary Air Injection System Pump Stuck On Bank1	- Short in air pump circuit - Open or short in pressure sensor circuit - Pressure sensor - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2445	Secondary Air Injection System Pump Stuck Off Bank1	- Air pump - Open in air pump circuit - Air injection system piping - Vacuum hose (pressure sensor - air switching valve) - Pressure sensor - Open or short in pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2446	Secondary Air Injection System Pump Stuck On Bank 2	- Short in air pump circuit - Open or short in pressure sensor circuit - Pressure sensor - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
		- Air pump			

P2447	Secondary Air Injection System Pump Stuck Off Bank 2	- Open in air pump circuit - Air injection system piping - Vacuum hose (pressure sensor - air switching valve) - Pressure sensor - Open or short in pressure sensor circuit - Air Injection Control Driver (AID) - ECM	Comes on	DTC stored	Click here
P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)	- Open or short in A/F sensor circuit (for Bank 1) - A/F sensor (for Bank 1) - ECM	Comes on	DTC stored	Click here
P2A03	A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)	- Open or short in A/F sensor circuit (for Bank 2) - A/F sensor (for Bank 2) - ECM	Comes on	DTC stored	Click here

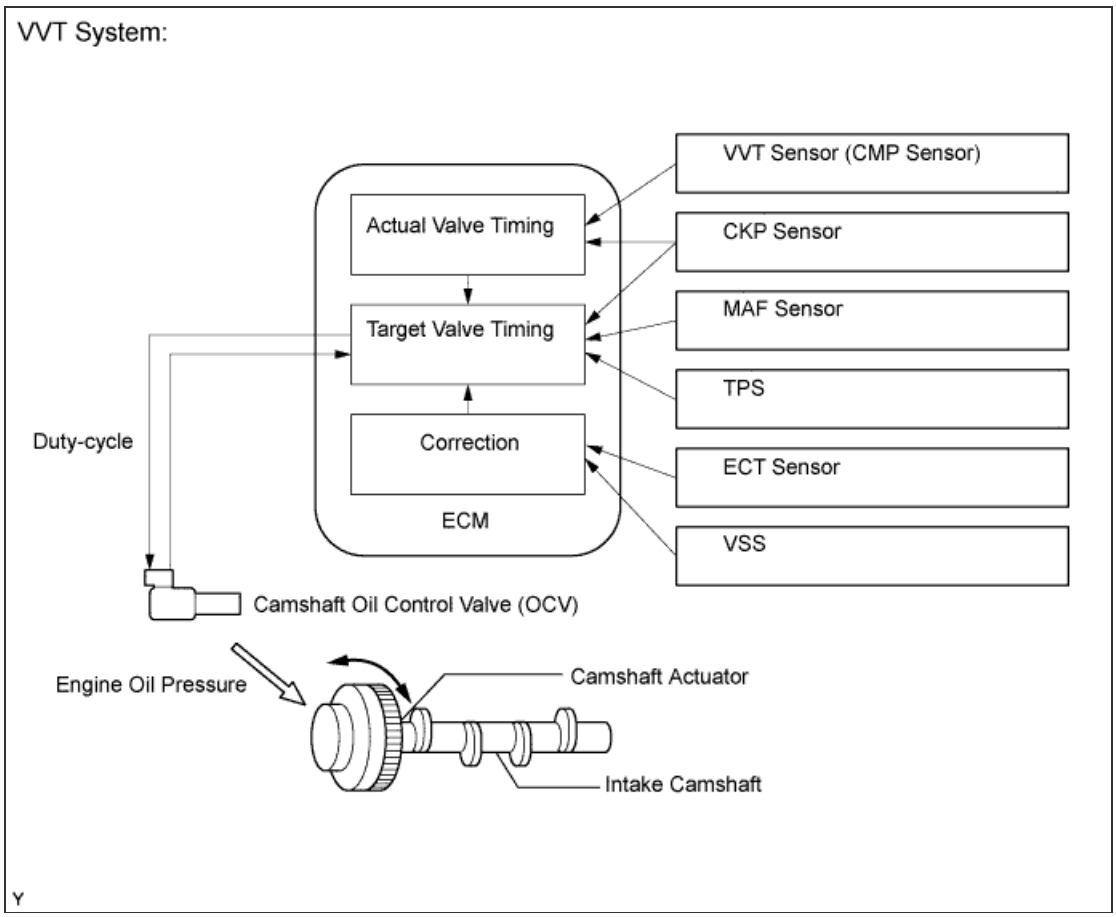
DTC P0010 Camshaft Position "A" Actuator Circuit (Bank 1)

DTC P0020 Camshaft Position "A" Actuator Circuit (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 V to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.



DTC Code	DTC Detection Condition	Trouble Area
P0010	An open or short in the Camshaft Oil Control Valve (OCV) for intake side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for intake side of Bank 1) circuit • OCV (for intake side of Bank 1) • ECM
P0020	An open or short in the OCV for intake side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for intake side of Bank 2) circuit • OCV (for intake side of Bank 2) • ECM

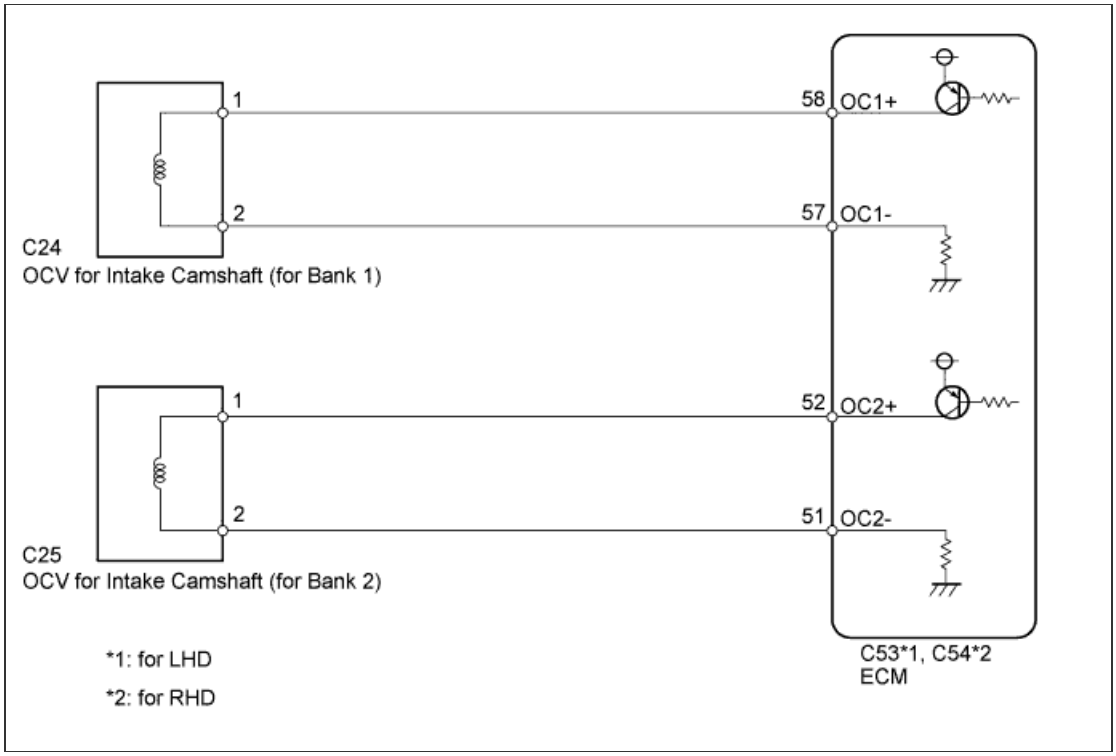
HINT:

This DTC relates to the Camshaft Oil Control Valve (OCV).

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK DTC

a. Clear DTC after recording the freeze frame data and DTC (Click here).

b. Turn the engine switch off.

c. Allow the engine to idle and check DTC.

d. Check that P0010 or P0020 is not output.

OK:
P0010 or P0020 is not output.

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

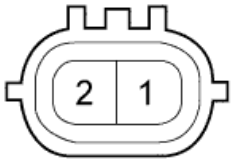
a. Disconnect the C24 or C25 camshaft oil control valve (OCV) connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

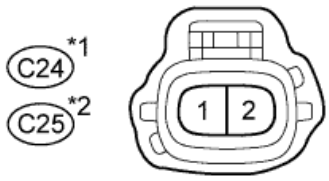
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C24 or C25 OCV connector.

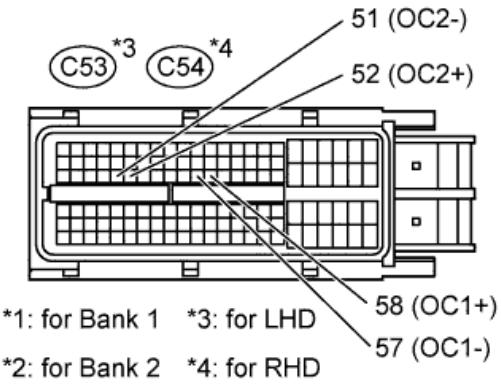
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C24-1 - C53-58 (OC1+)	Always	Below 1 Ω
C25-1 - C53-52 (OC2+)	Always	Below 1 Ω
C24-2 - C53-57 (OC1-)	Always	Below 1 Ω
C25-2 - C53-51 (OC2-)	Always	Below 1 Ω

C24-1 or C53-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C53-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C53-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C53-51 (OC2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C24-1 - C54-58 (OC1+)	Always	Below 1 Ω
C25-1 - C54-52 (OC2+)	Always	Below 1 Ω
C24-2 - C54-57 (OC1-)	Always	Below 1 Ω
C25-2 - C54-51 (OC2-)	Always	Below 1 Ω
C24-1 or C54-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C54-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C54-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C54-51 (OC2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

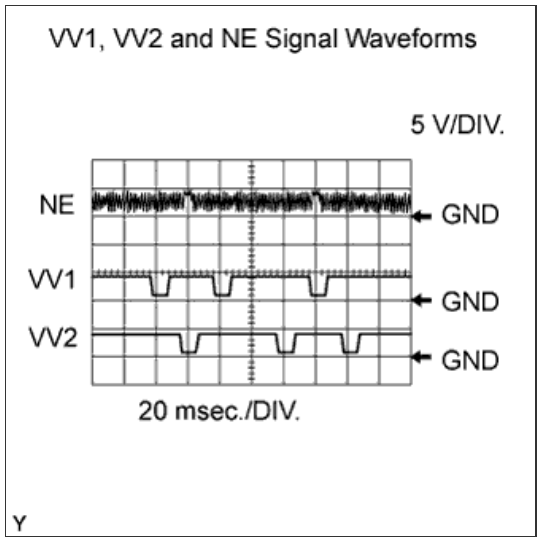
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

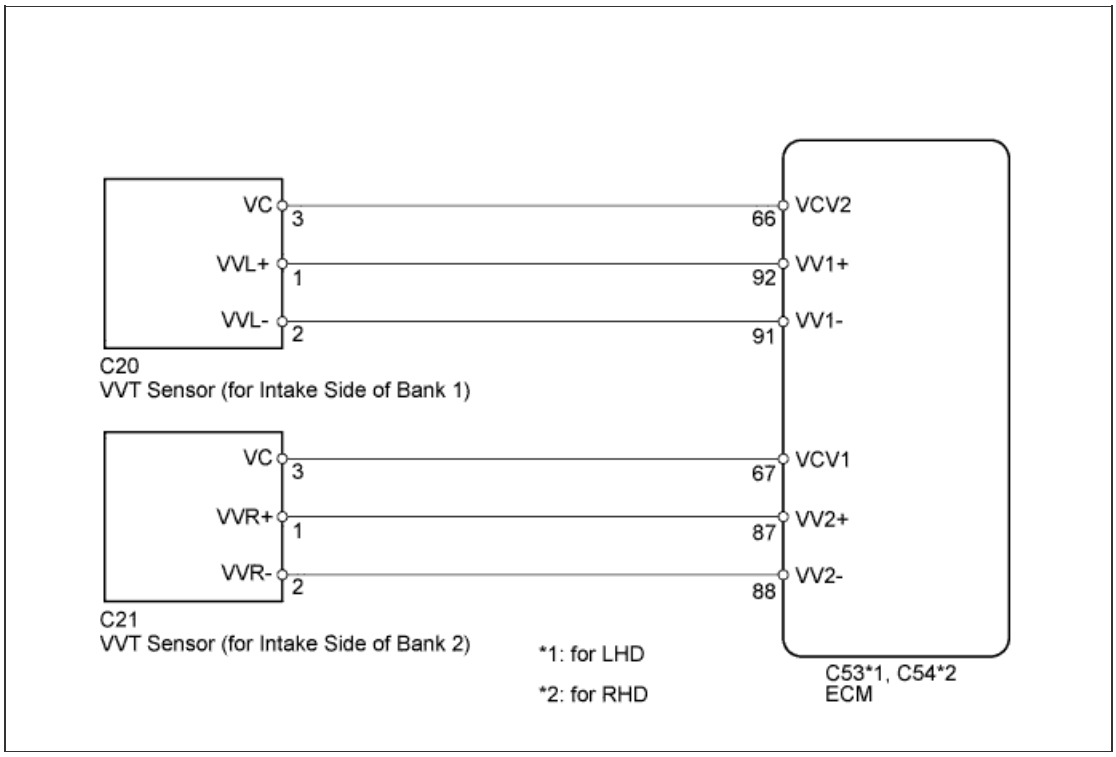
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

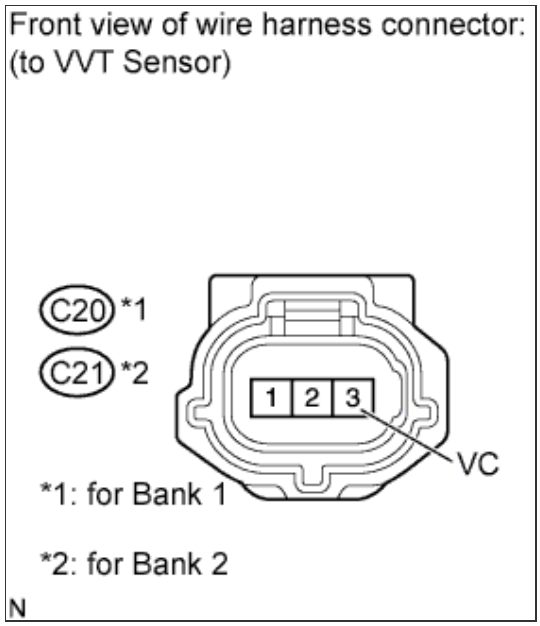
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

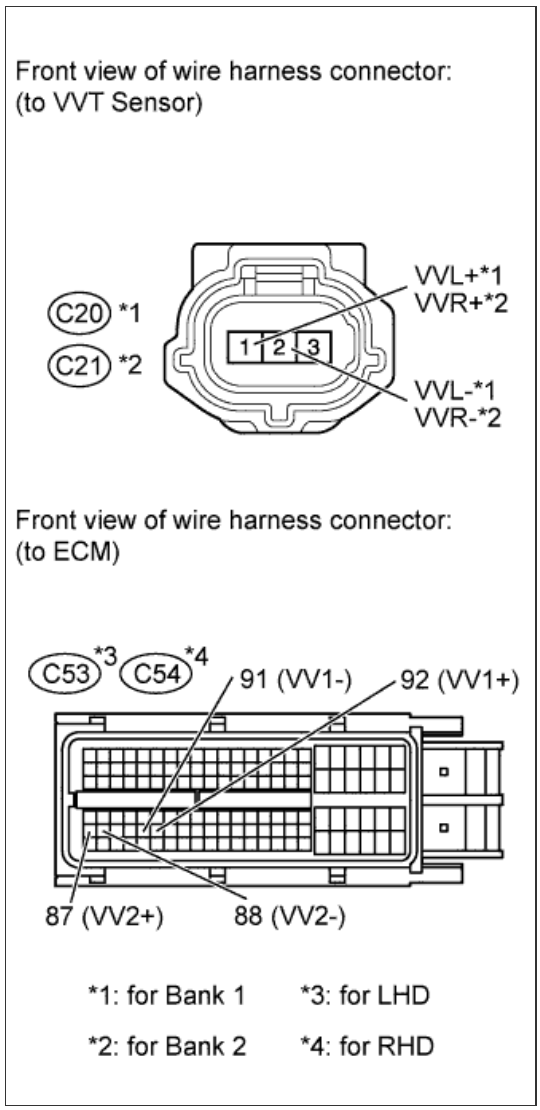
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

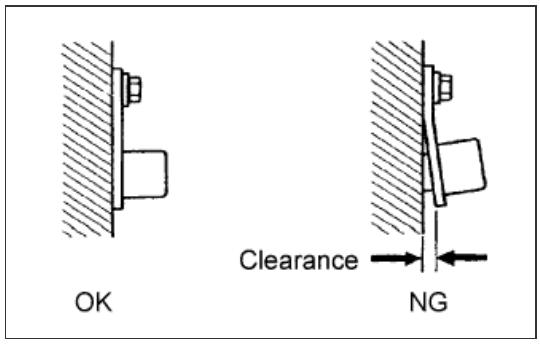
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

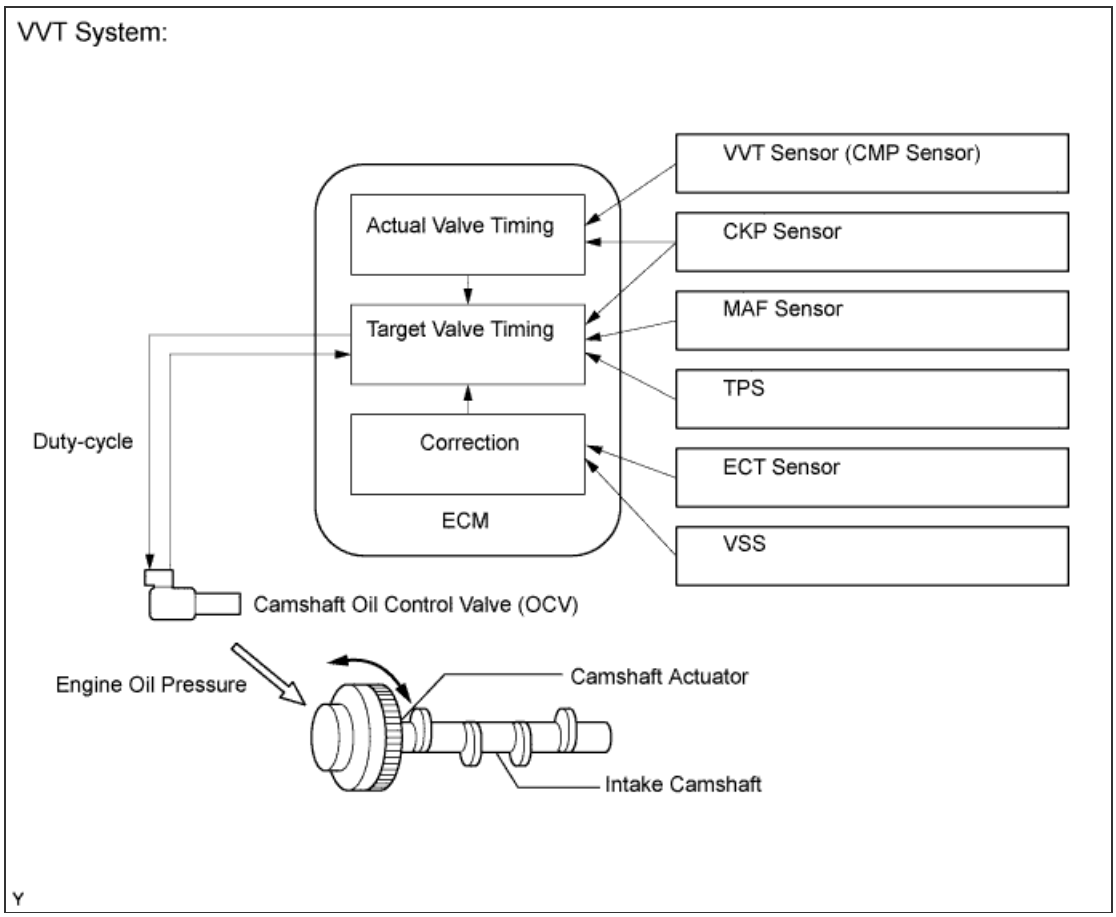
DTC P0010 Camshaft Position "A" Actuator Circuit (Bank 1)

DTC P0020 Camshaft Position "A" Actuator Circuit (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 V to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.



DTC Code	DTC Detection Condition	Trouble Area
P0010	An open or short in the Camshaft Oil Control Valve (OCV) for intake side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for intake side of Bank 1) circuit • OCV (for intake side of Bank 1) • ECM
P0020	An open or short in the OCV for intake side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for intake side of Bank 2) circuit • OCV (for intake side of Bank 2) • ECM

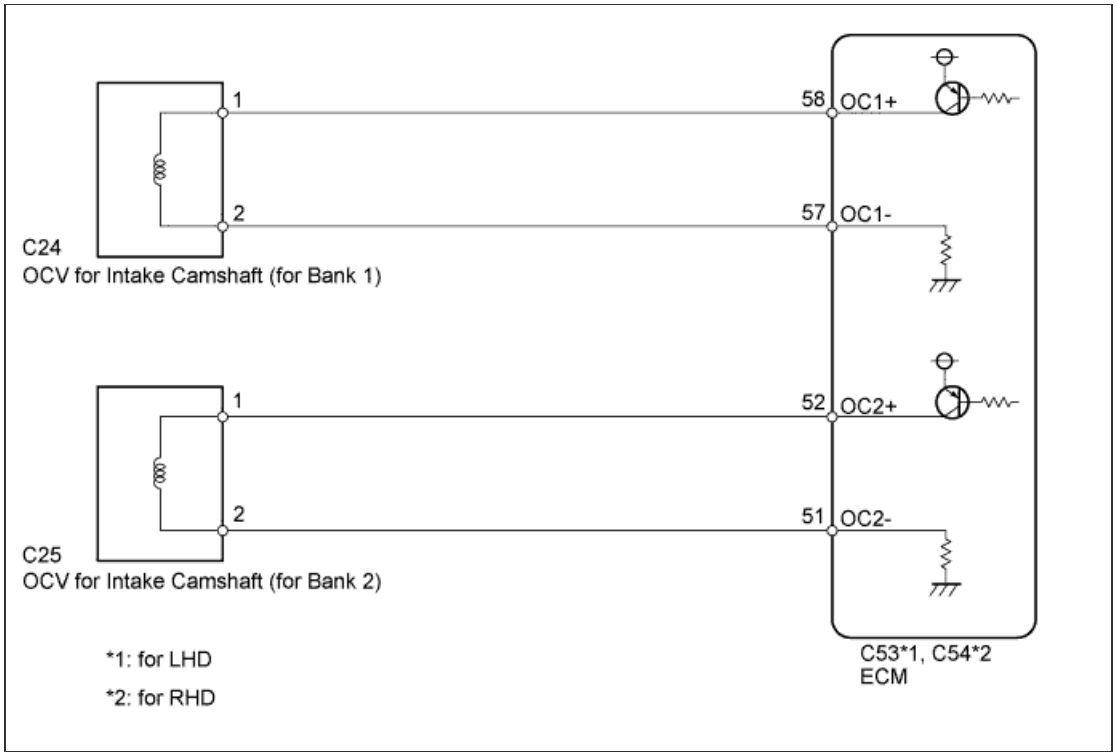
HINT:

This DTC relates to the Camshaft Oil Control Valve (OCV).

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK DTC

a. Clear DTC after recording the freeze frame data and DTC (Click here).

b. Turn the engine switch off.

c. Allow the engine to idle and check DTC.

d. Check that P0010 or P0020 is not output.

OK:
P0010 or P0020 is not output.

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

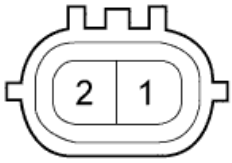
a. Disconnect the C24 or C25 camshaft oil control valve (OCV) connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

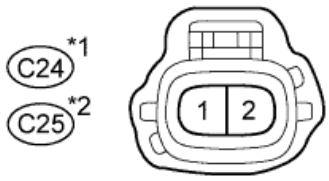
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C24 or C25 OCV connector.

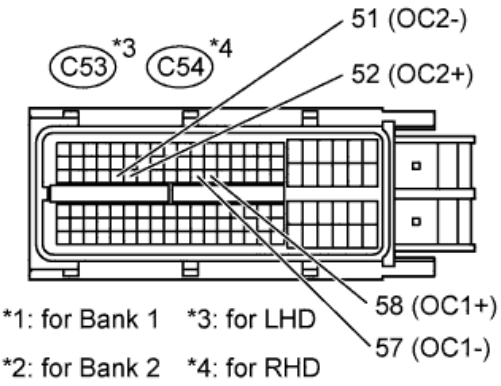
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C24-1 - C53-58 (OC1+)	Always	Below 1 Ω
C25-1 - C53-52 (OC2+)	Always	Below 1 Ω
C24-2 - C53-57 (OC1-)	Always	Below 1 Ω
C25-2 - C53-51 (OC2-)	Always	Below 1 Ω

C24-1 or C53-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C53-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C53-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C53-51 (OC2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C24-1 - C54-58 (OC1+)	Always	Below 1 Ω
C25-1 - C54-52 (OC2+)	Always	Below 1 Ω
C24-2 - C54-57 (OC1-)	Always	Below 1 Ω
C25-2 - C54-51 (OC2-)	Always	Below 1 Ω
C24-1 or C54-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C54-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C54-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C54-51 (OC2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

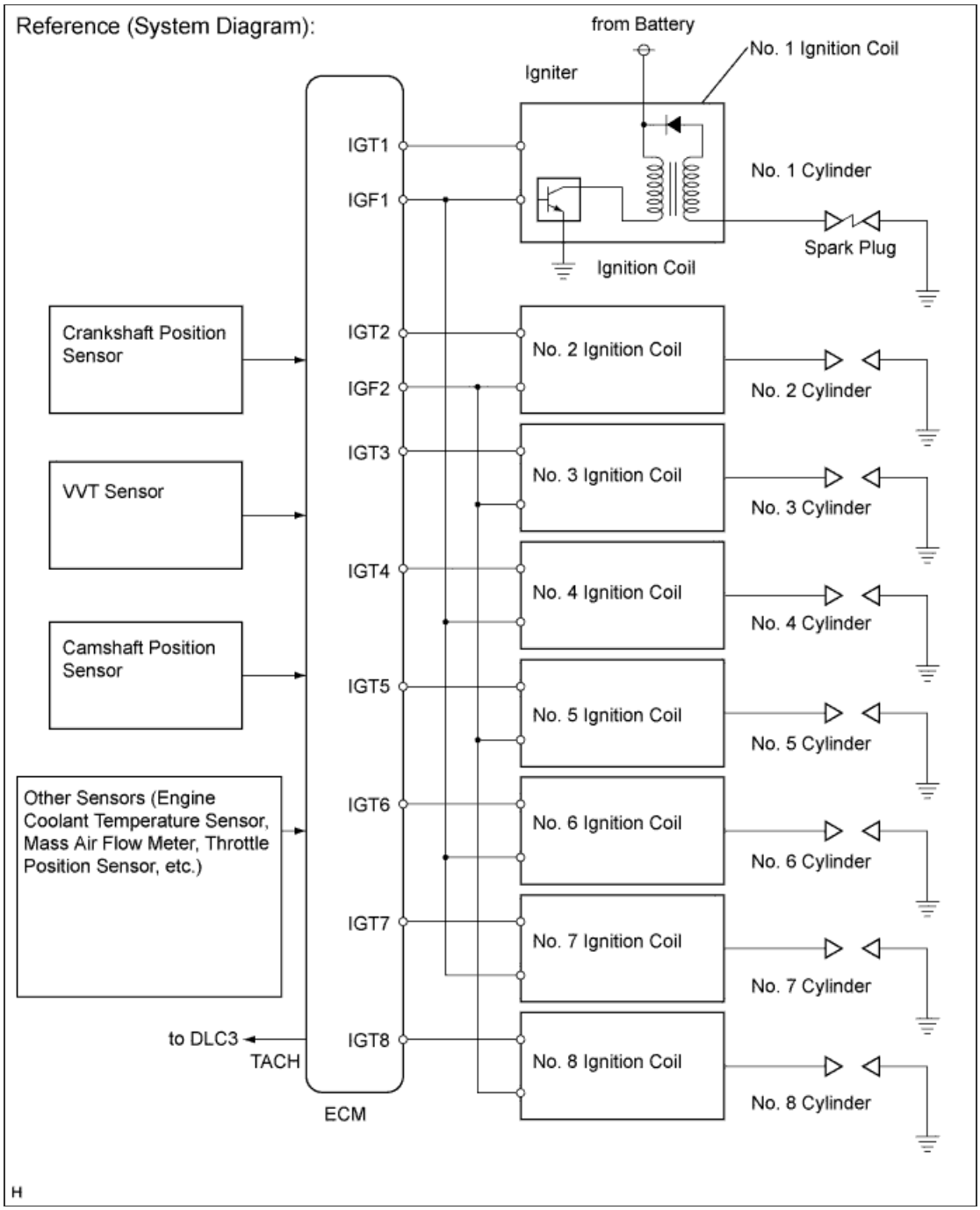
for Preparation Click here

DESCRIPTION

HINT:

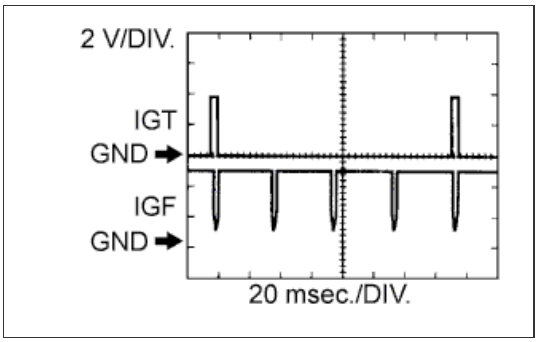
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

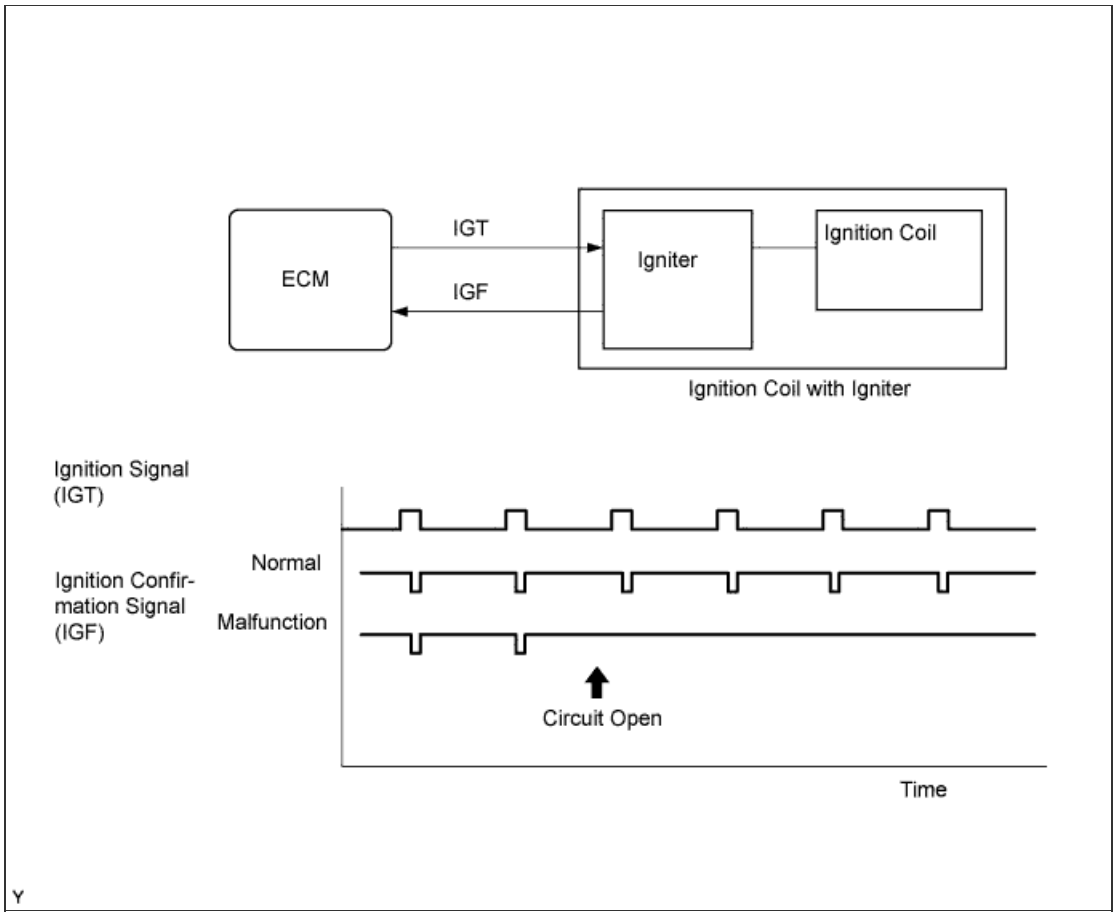
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

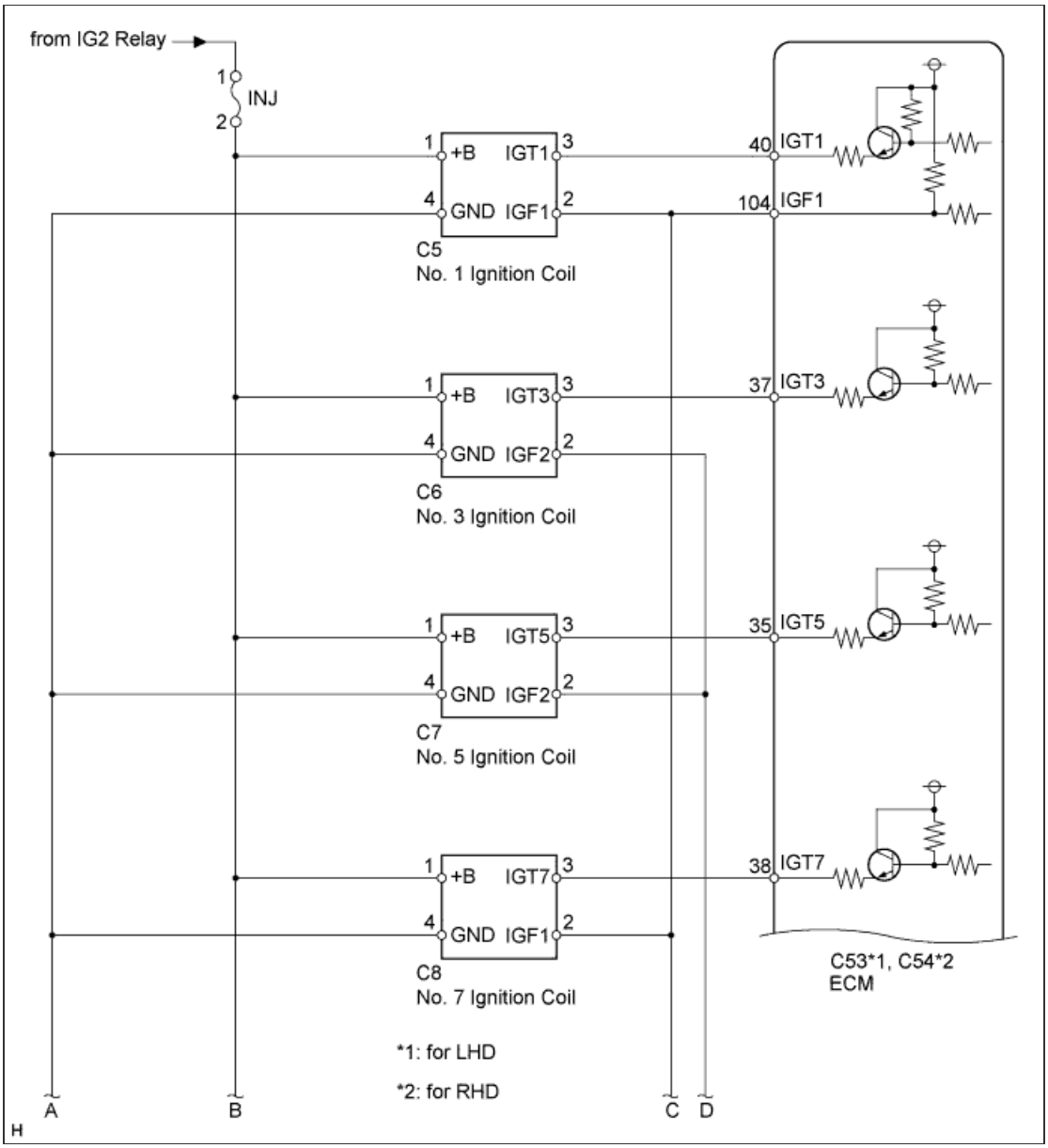
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

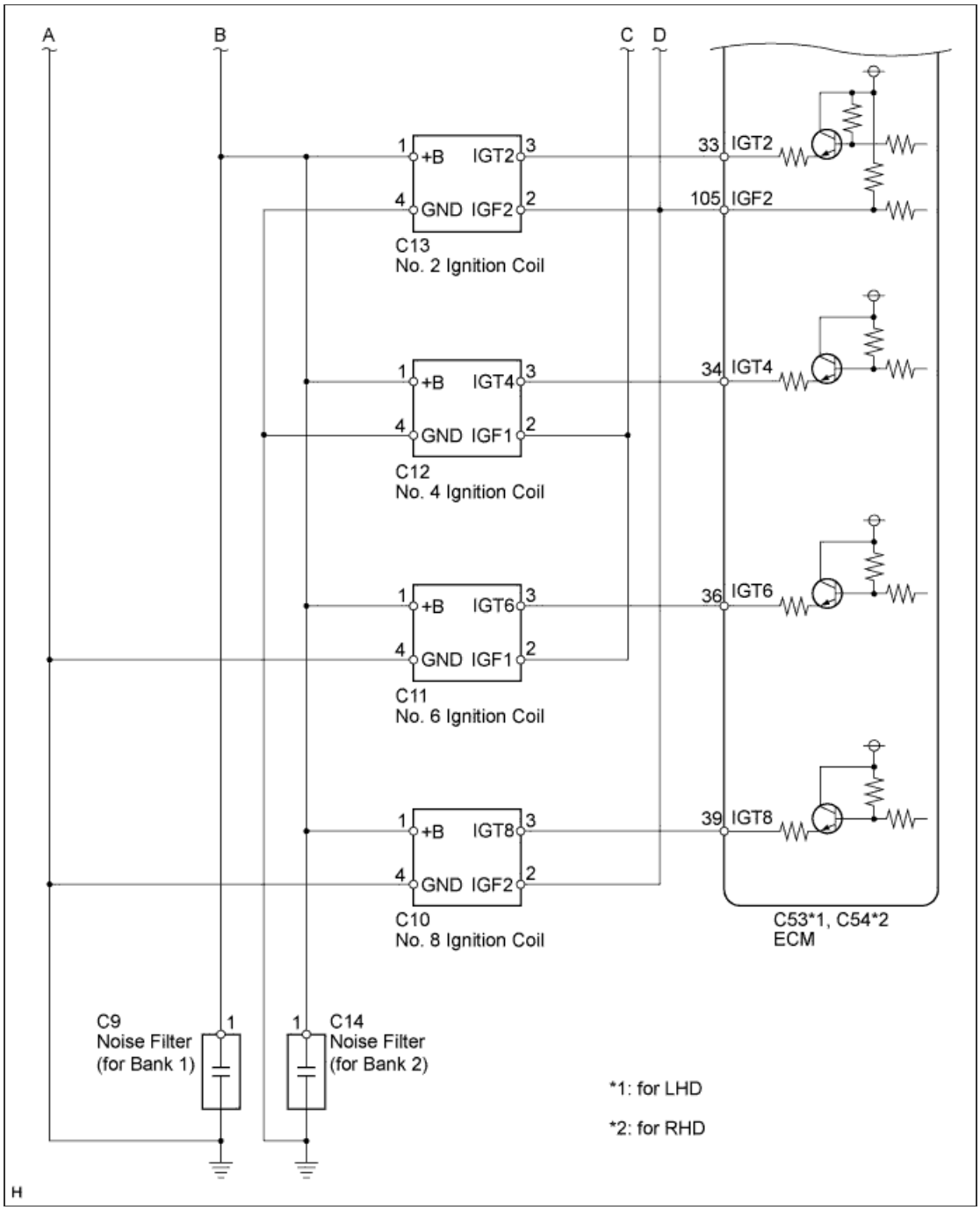
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

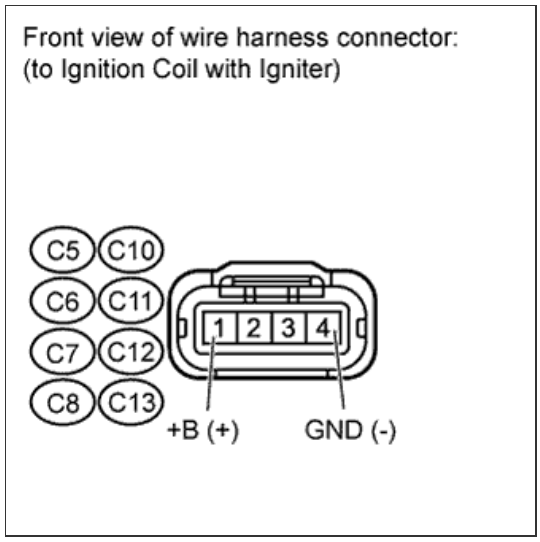
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

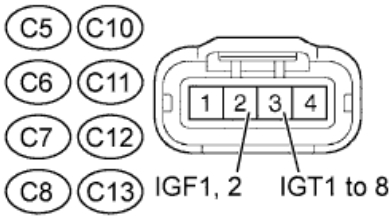
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

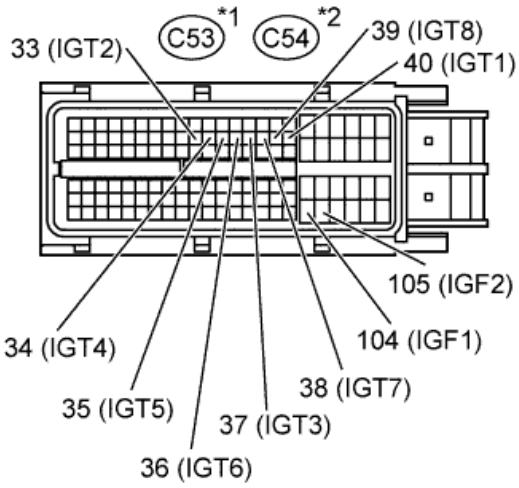
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

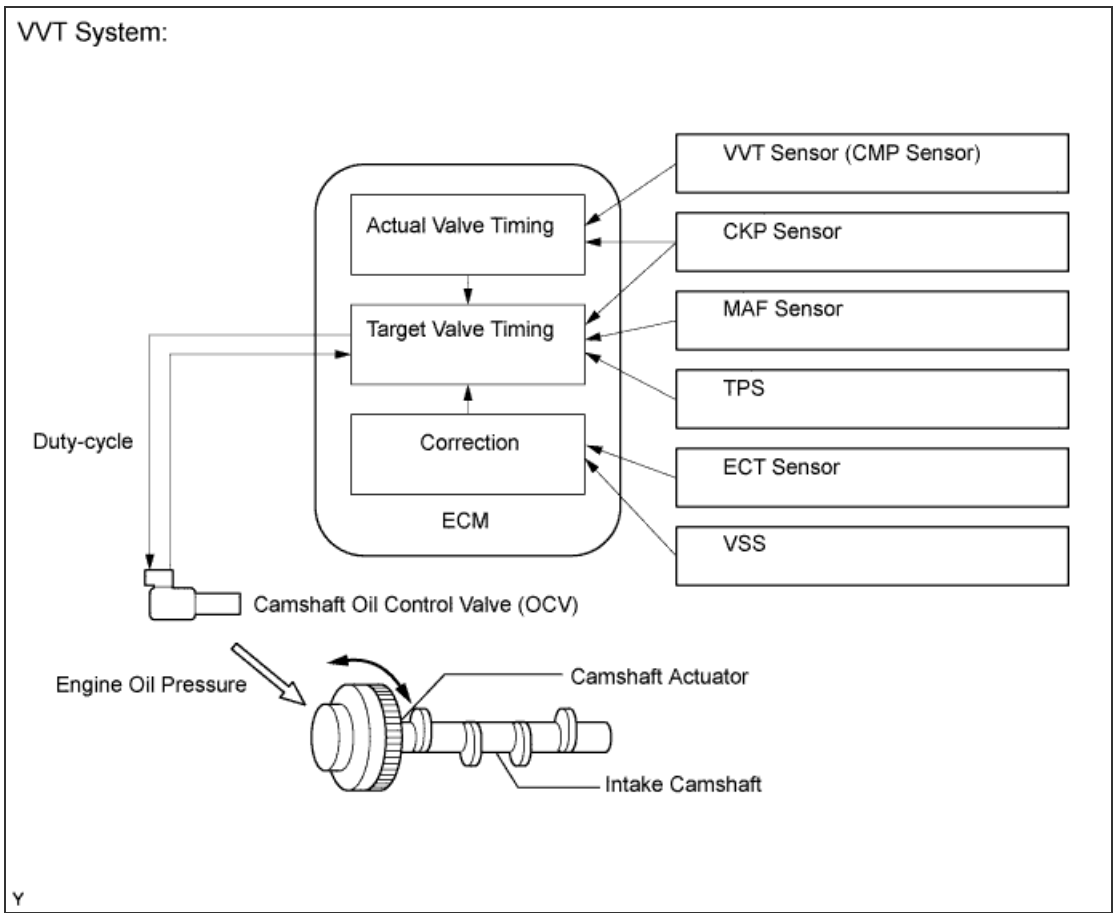
DTC P0010 Camshaft Position "A" Actuator Circuit (Bank 1)

DTC P0020 Camshaft Position "A" Actuator Circuit (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 V to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.



DTC Code	DTC Detection Condition	Trouble Area
P0010	An open or short in the Camshaft Oil Control Valve (OCV) for intake side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for intake side of Bank 1) circuit • OCV (for intake side of Bank 1) • ECM
P0020	An open or short in the OCV for intake side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for intake side of Bank 2) circuit • OCV (for intake side of Bank 2) • ECM

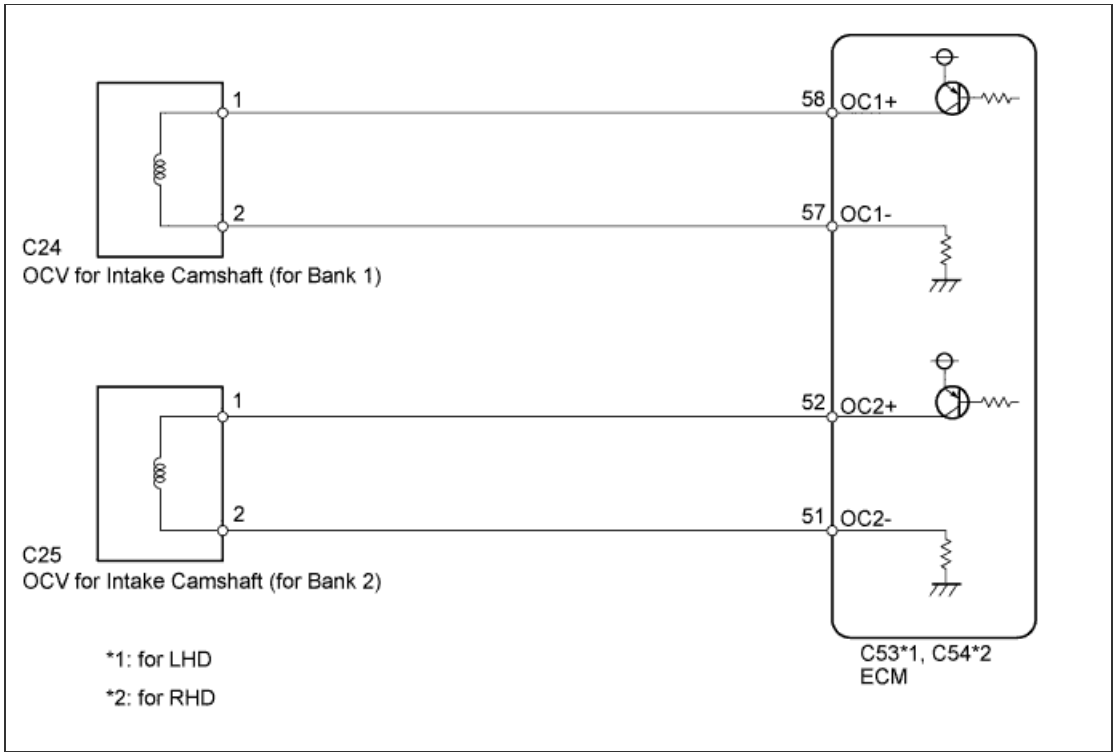
HINT:

This DTC relates to the Camshaft Oil Control Valve (OCV).

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK DTC

a. Clear DTC after recording the freeze frame data and DTC (Click here).

b. Turn the engine switch off.

c. Allow the engine to idle and check DTC.

d. Check that P0010 or P0020 is not output.

OK:
P0010 or P0020 is not output.

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

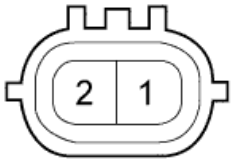
a. Disconnect the C24 or C25 camshaft oil control valve (OCV) connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

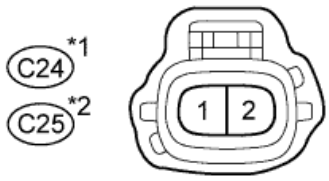
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C24 or C25 OCV connector.

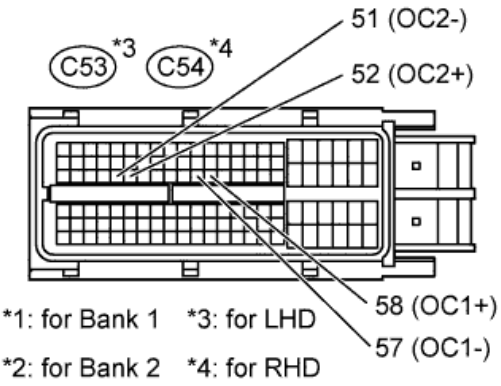
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C24-1 - C53-58 (OC1+)	Always	Below 1 Ω
C25-1 - C53-52 (OC2+)	Always	Below 1 Ω
C24-2 - C53-57 (OC1-)	Always	Below 1 Ω
C25-2 - C53-51 (OC2-)	Always	Below 1 Ω

C24-1 or C53-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C53-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C53-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C53-51 (OC2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C24-1 - C54-58 (OC1+)	Always	Below 1 Ω
C25-1 - C54-52 (OC2+)	Always	Below 1 Ω
C24-2 - C54-57 (OC1-)	Always	Below 1 Ω
C25-2 - C54-51 (OC2-)	Always	Below 1 Ω
C24-1 or C54-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C54-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C54-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C54-51 (OC2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

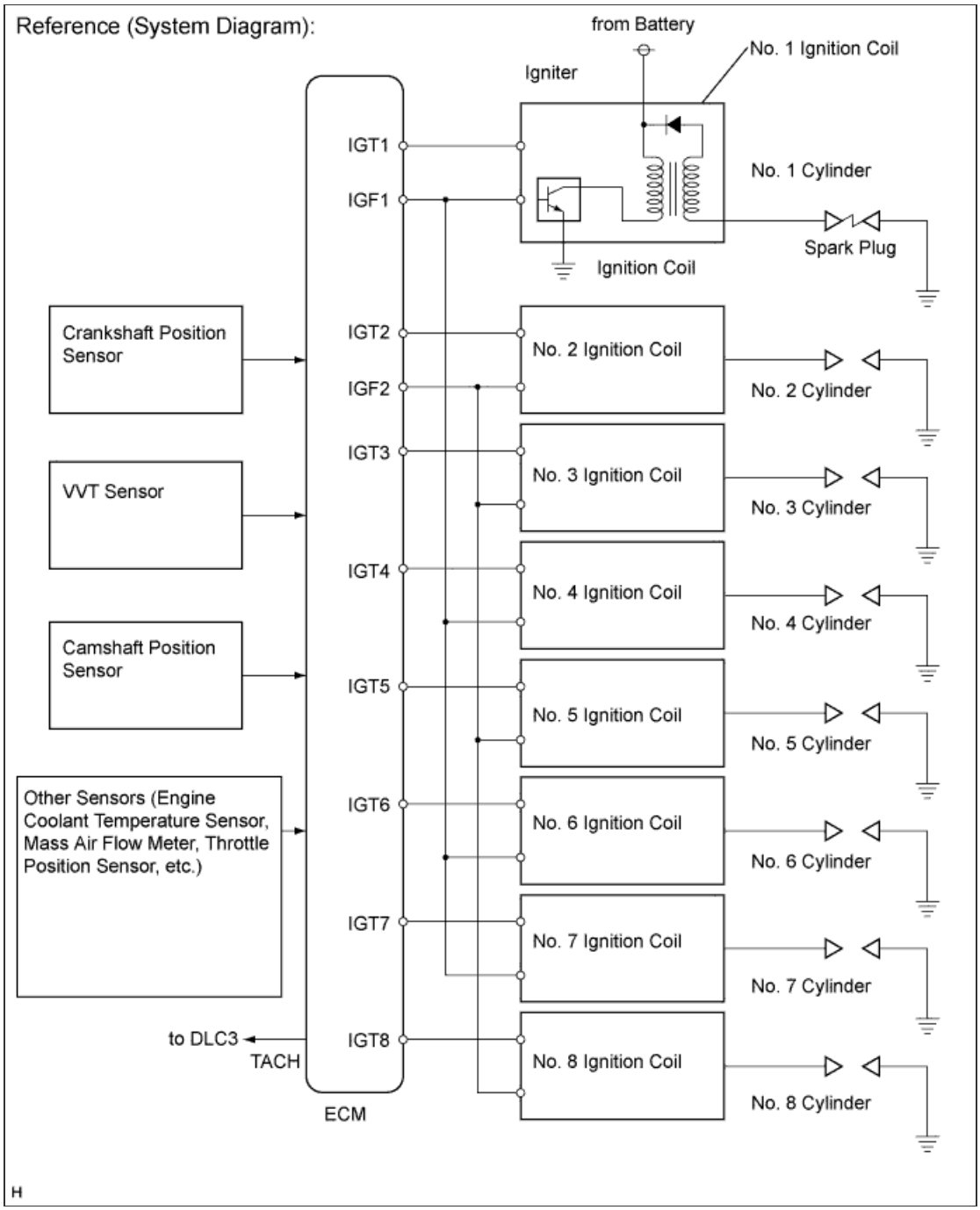
for Preparation Click here

DESCRIPTION

HINT:

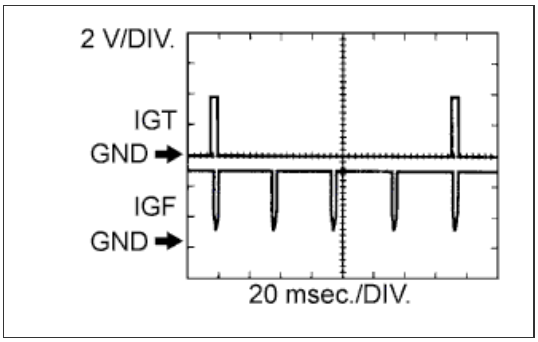
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

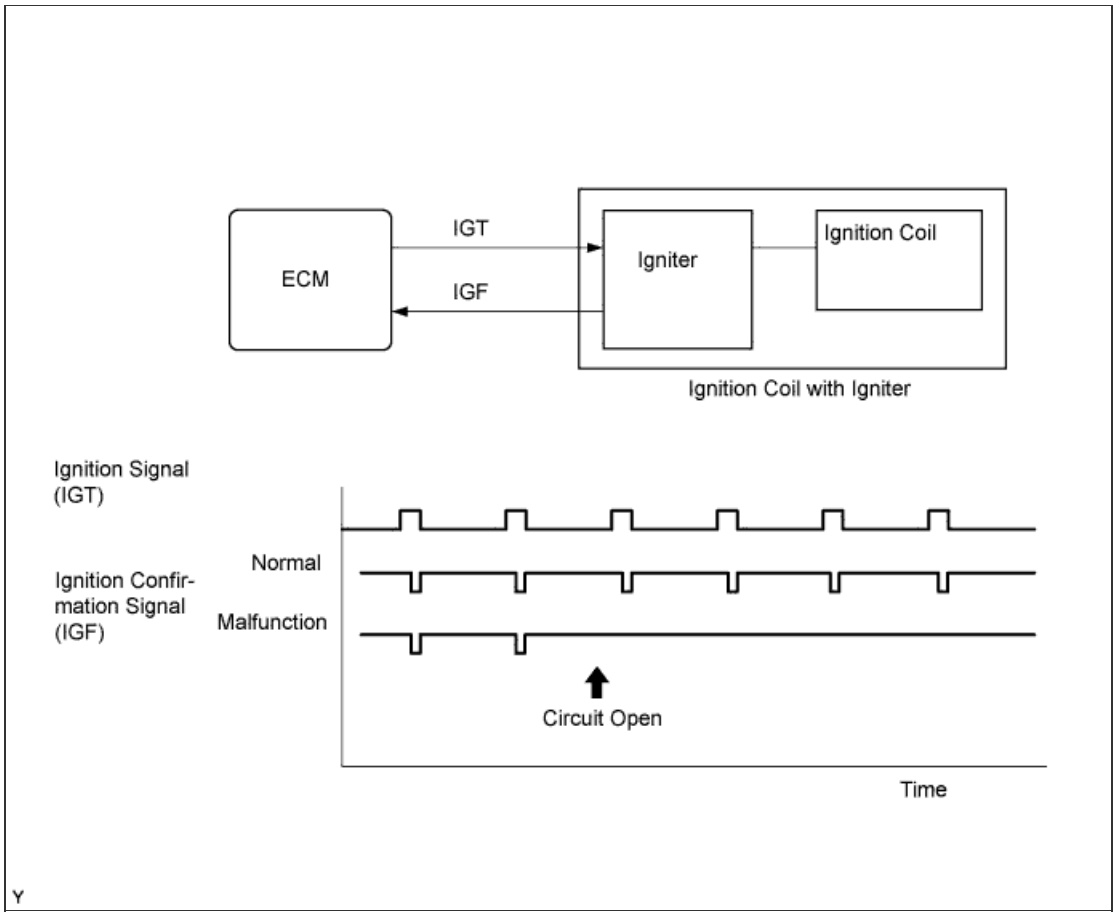
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

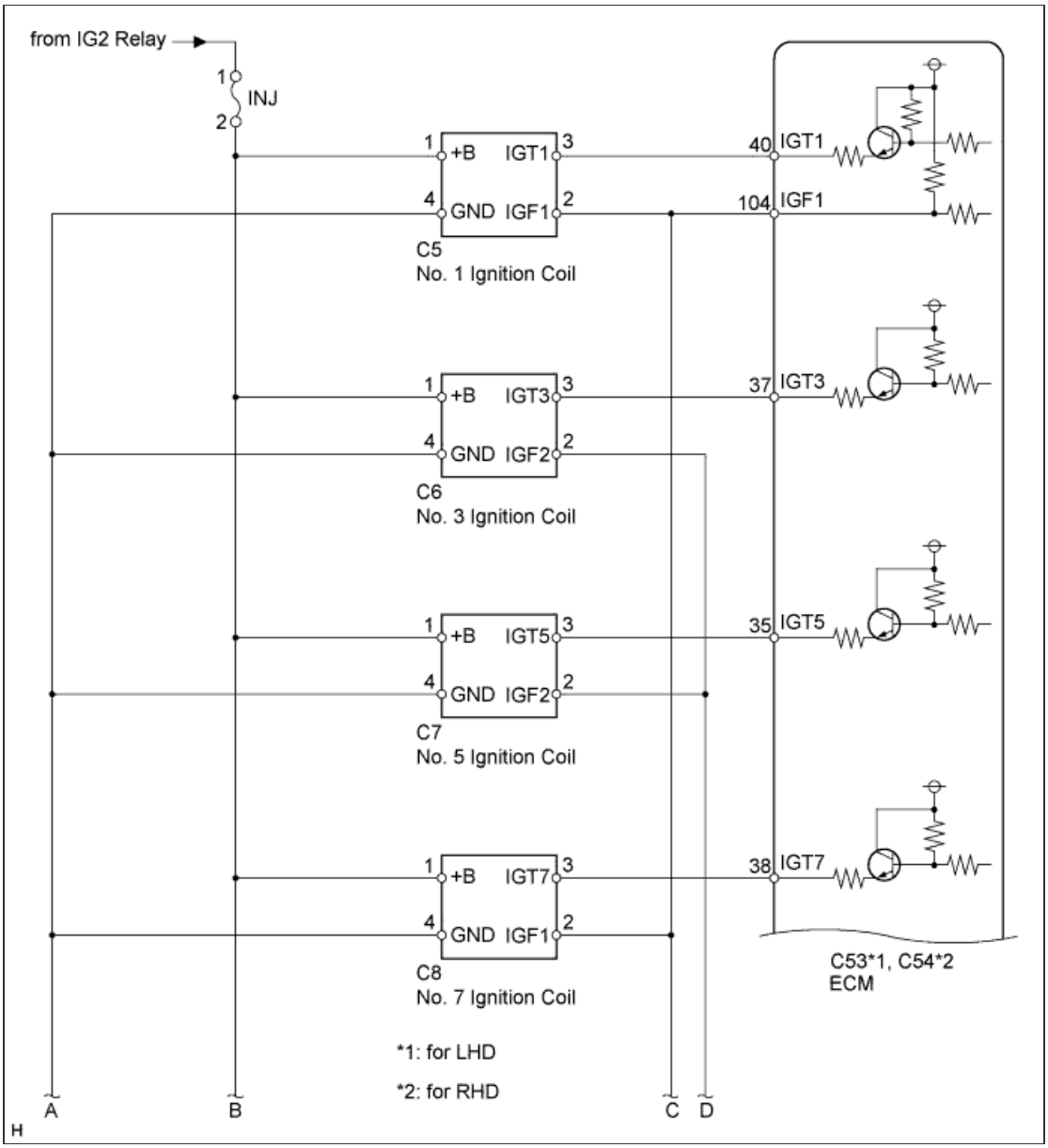
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

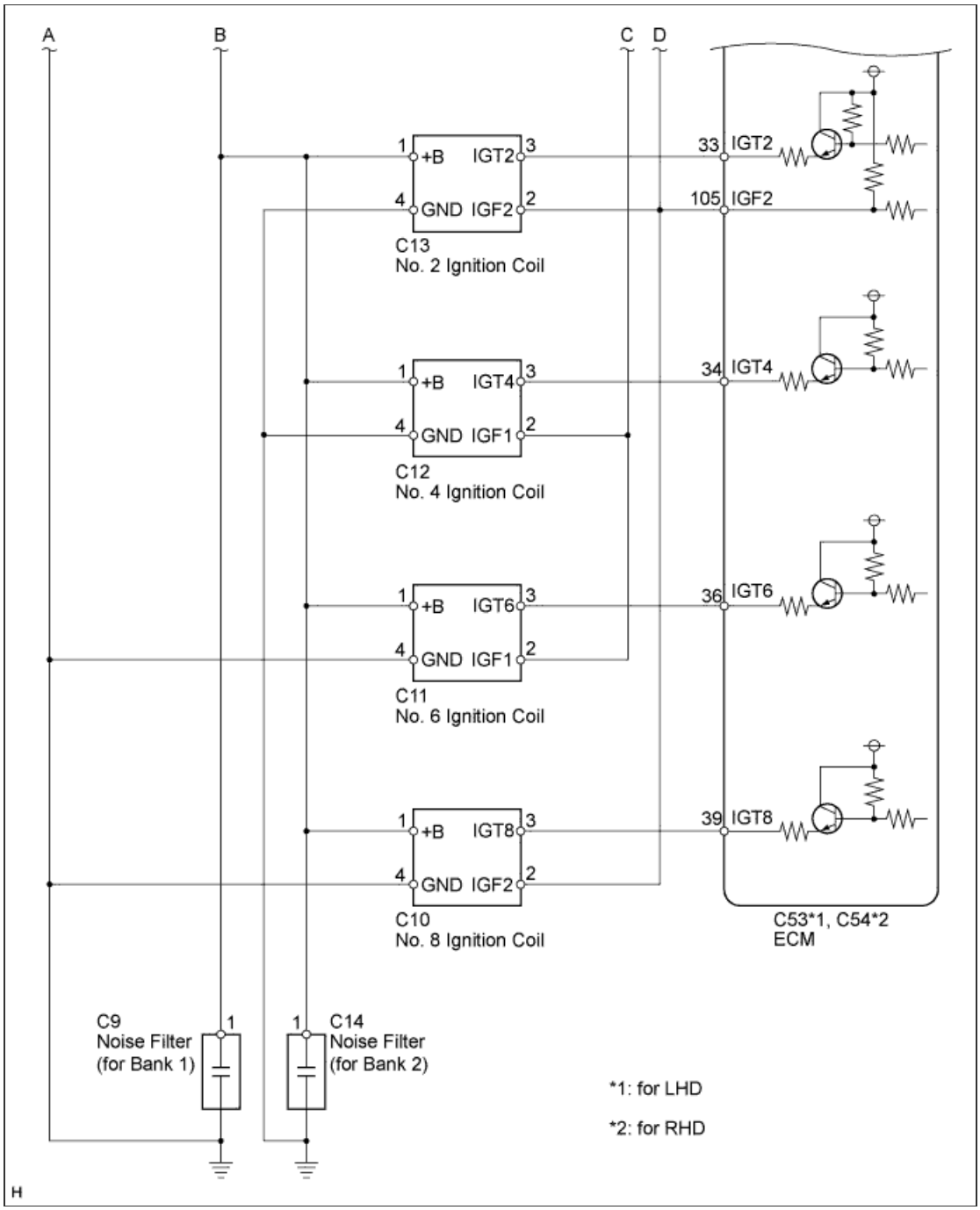
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

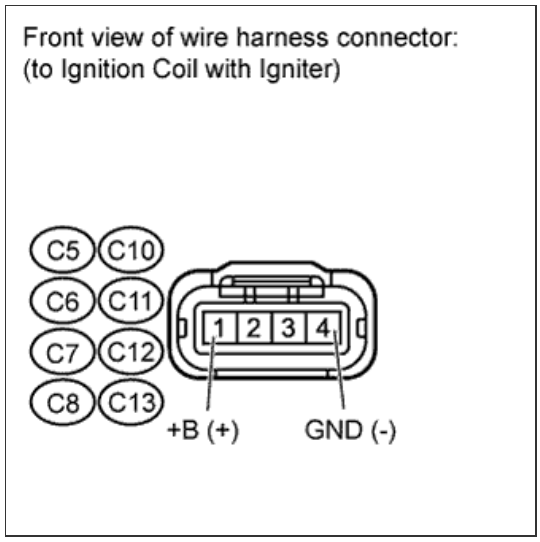
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

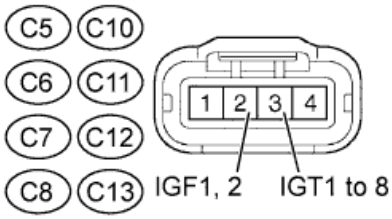
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

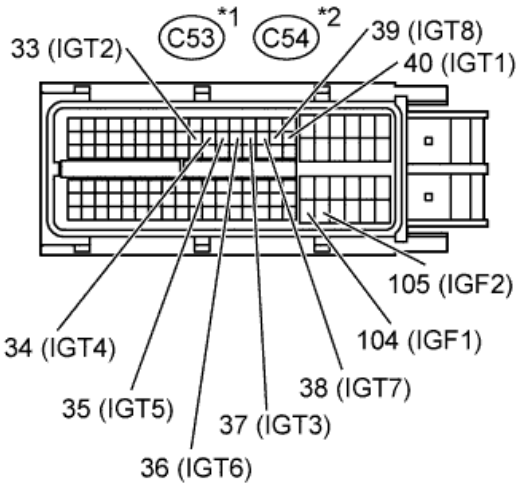
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

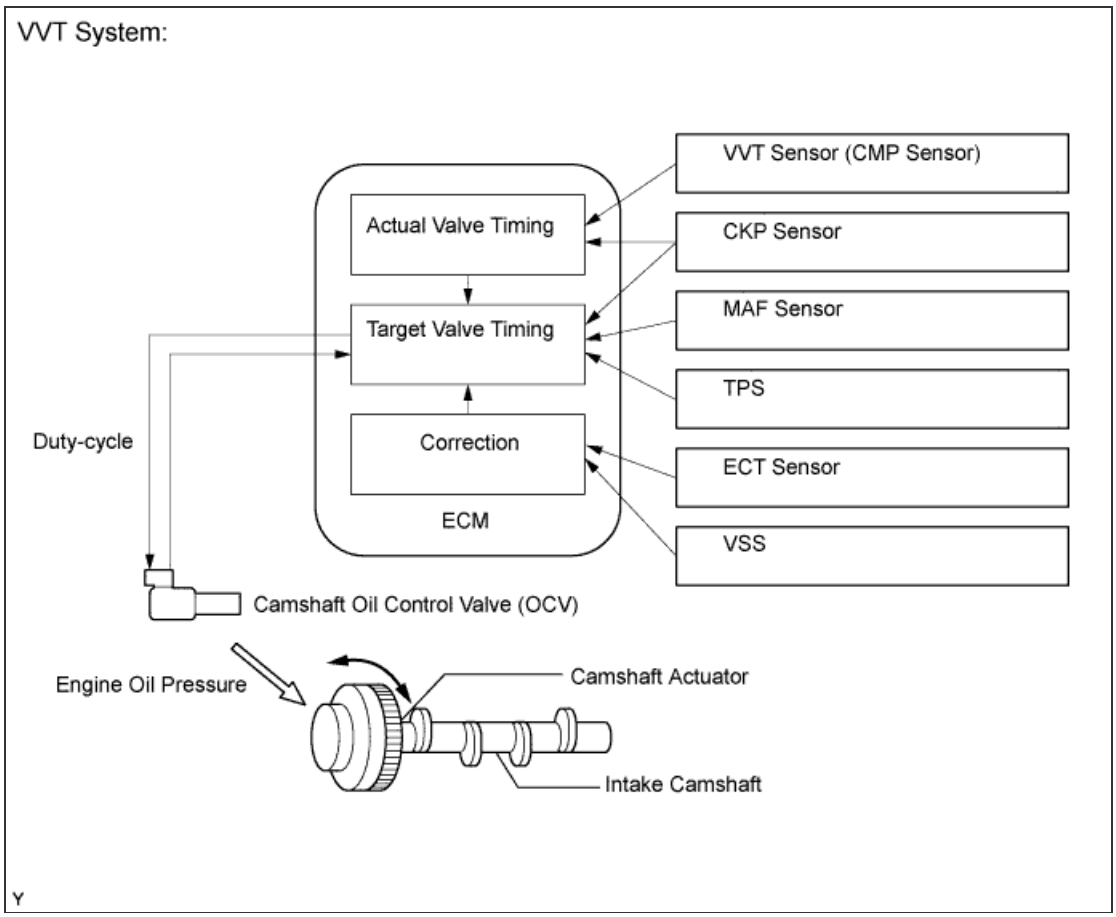
DTC P0010 Camshaft Position "A" Actuator Circuit (Bank 1)

DTC P0020 Camshaft Position "A" Actuator Circuit (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 V to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.



DTC Code	DTC Detection Condition	Trouble Area
P0010	An open or short in the Camshaft Oil Control Valve (OCV) for intake side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for intake side of Bank 1) circuit • OCV (for intake side of Bank 1) • ECM
P0020	An open or short in the OCV for intake side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for intake side of Bank 2) circuit • OCV (for intake side of Bank 2) • ECM

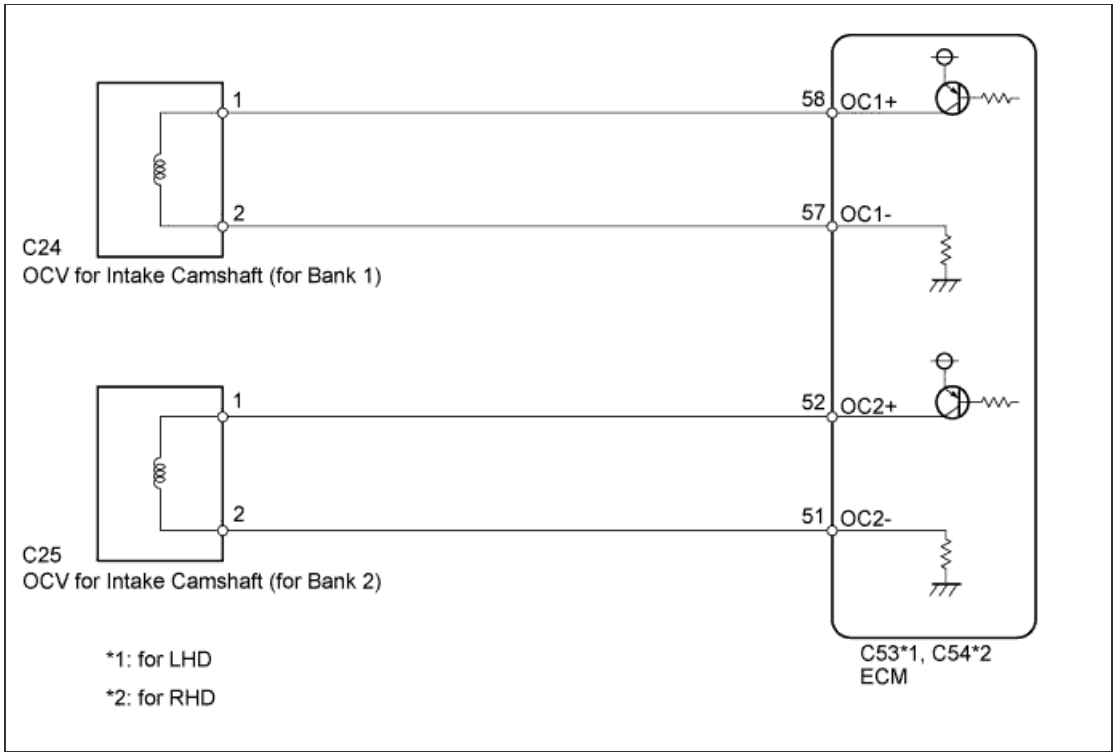
HINT:

This DTC relates to the Camshaft Oil Control Valve (OCV).

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK DTC

a. Clear DTC after recording the freeze frame data and DTC (Click here).

b. Turn the engine switch off.

c. Allow the engine to idle and check DTC.

d. Check that P0010 or P0020 is not output.

OK:
P0010 or P0020 is not output.

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

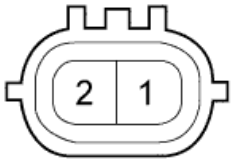
a. Disconnect the C24 or C25 camshaft oil control valve (OCV) connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

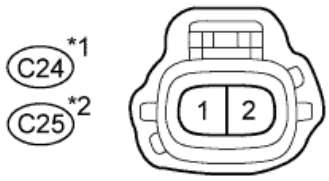
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C24 or C25 OCV connector.

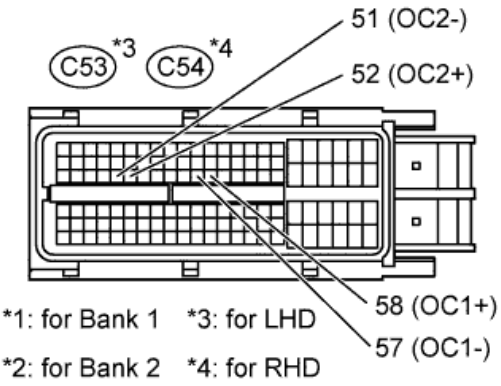
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C24-1 - C53-58 (OC1+)	Always	Below 1 Ω
C25-1 - C53-52 (OC2+)	Always	Below 1 Ω
C24-2 - C53-57 (OC1-)	Always	Below 1 Ω
C25-2 - C53-51 (OC2-)	Always	Below 1 Ω

C24-1 or C53-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C53-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C53-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C53-51 (OC2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C24-1 - C54-58 (OC1+)	Always	Below 1 Ω
C25-1 - C54-52 (OC2+)	Always	Below 1 Ω
C24-2 - C54-57 (OC1-)	Always	Below 1 Ω
C25-2 - C54-51 (OC2-)	Always	Below 1 Ω
C24-1 or C54-58 (OC1+) - Body ground	Always	10 kΩ or higher
C25-1 or C54-52 (OC2+) - Body ground	Always	10 kΩ or higher
C24-2 or C54-57 (OC1-) - Body ground	Always	10 kΩ or higher
C25-2 or C54-51 (OC2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

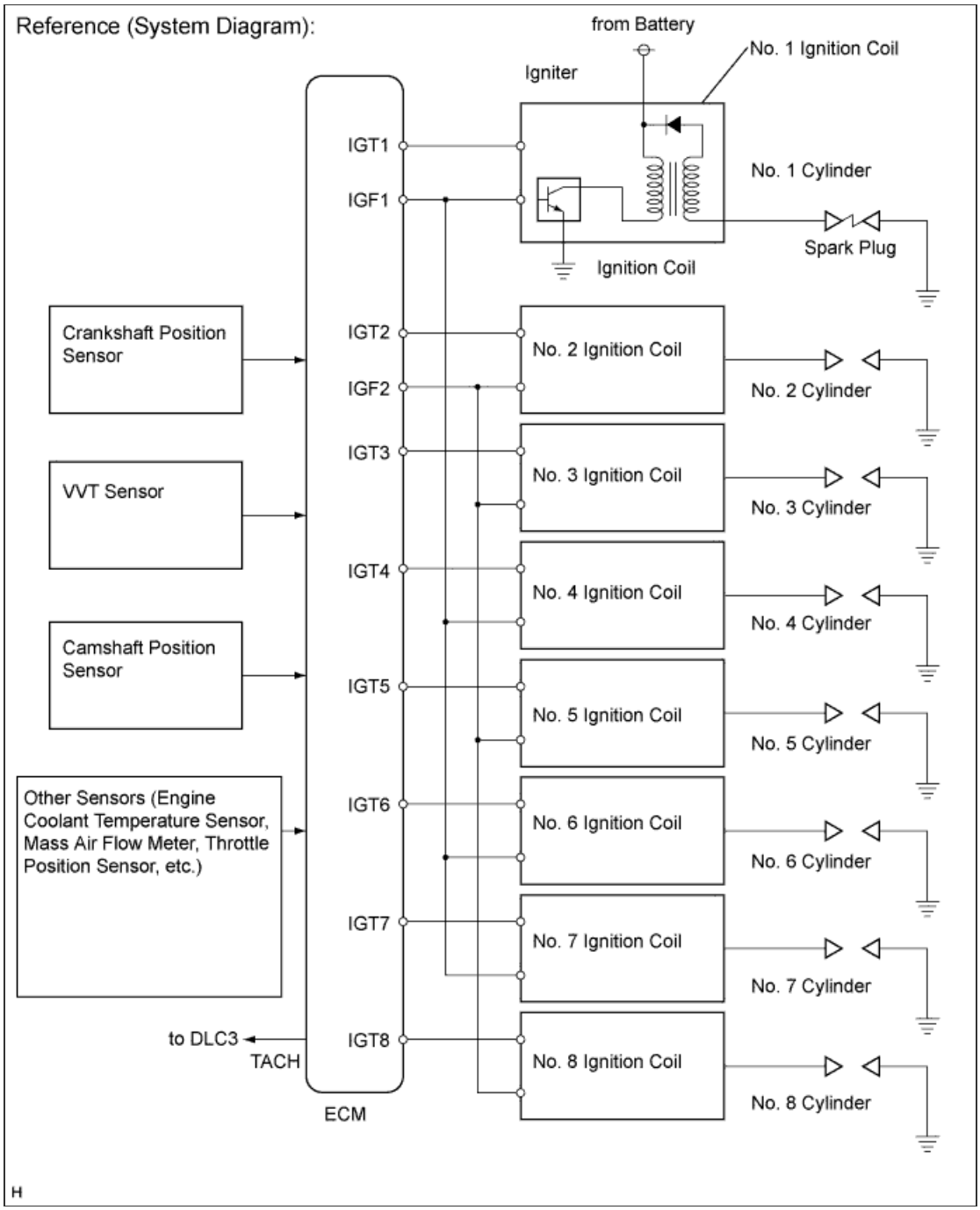
for Preparation Click here

DESCRIPTION

HINT:

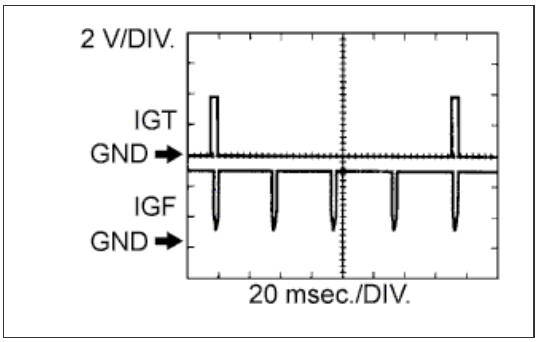
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

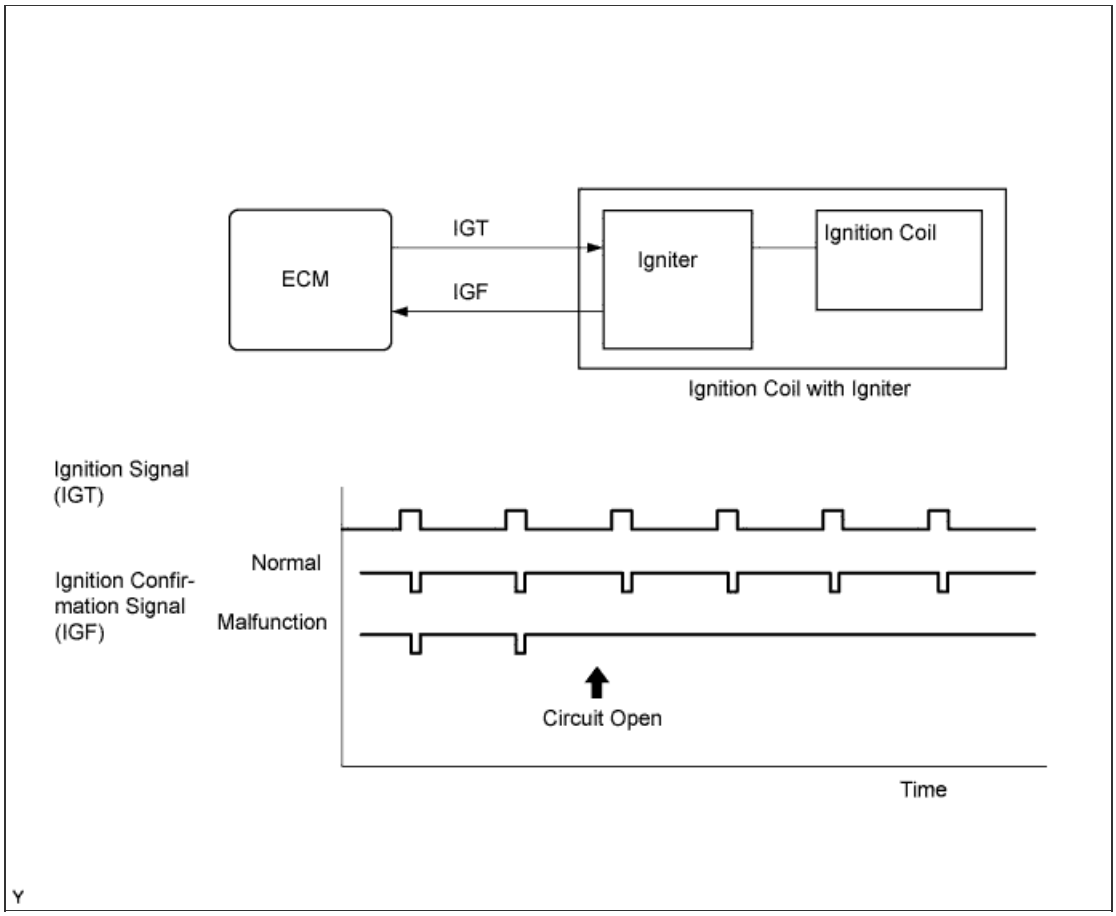
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

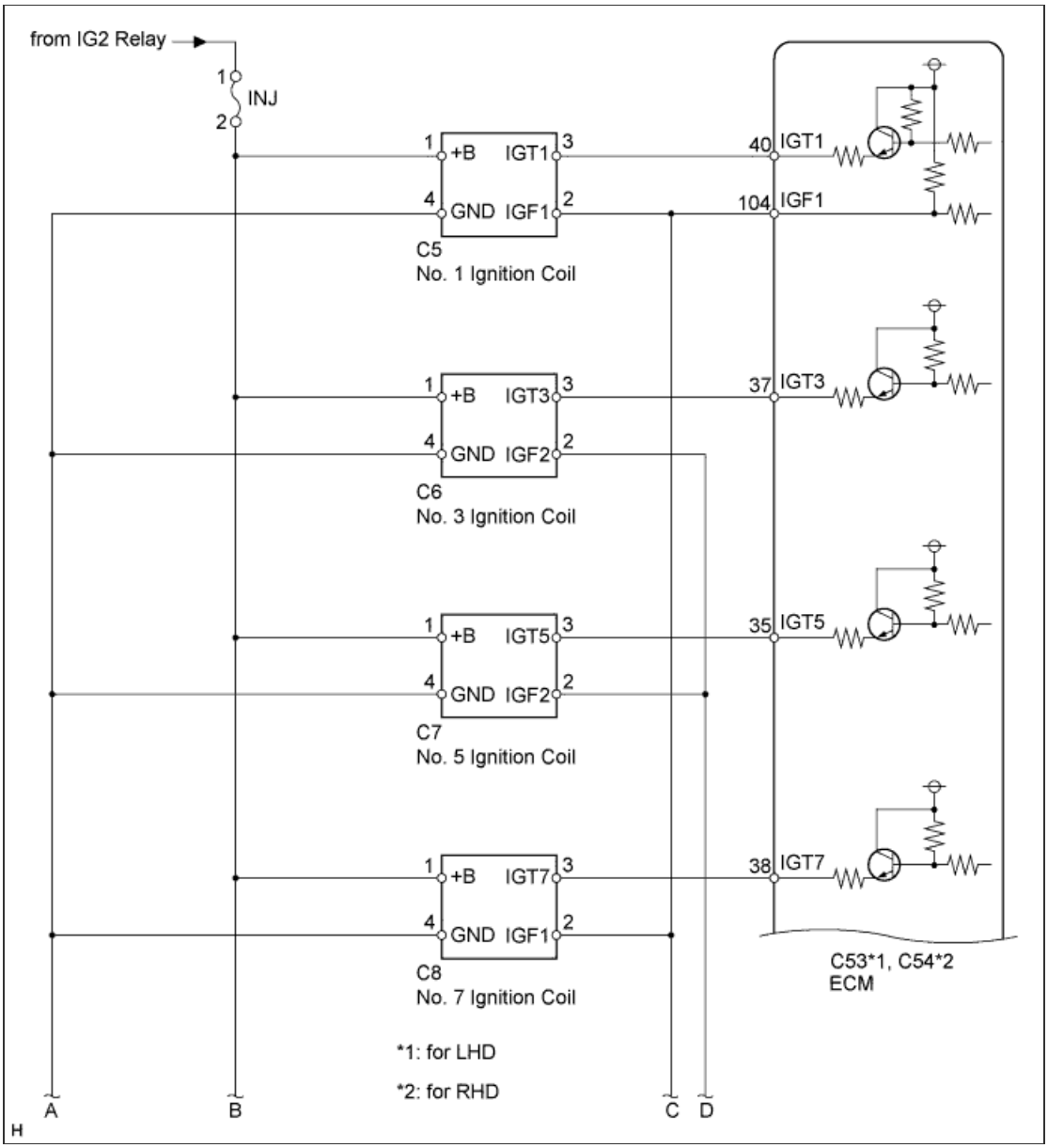
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

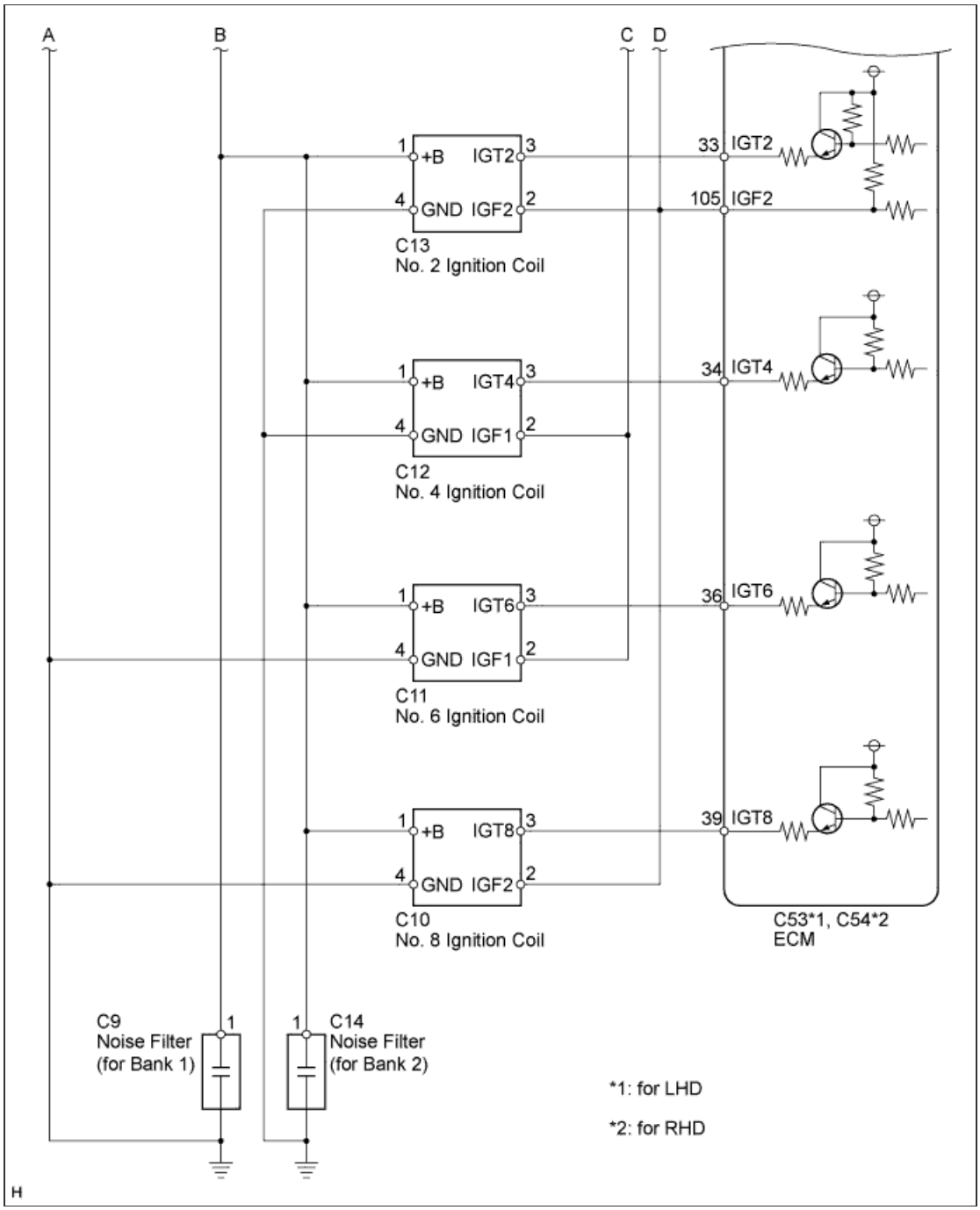
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

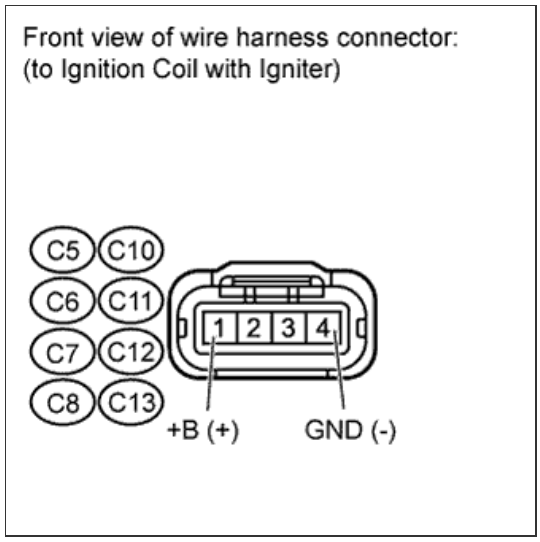
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

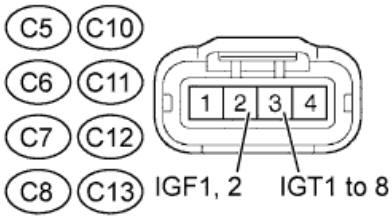
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

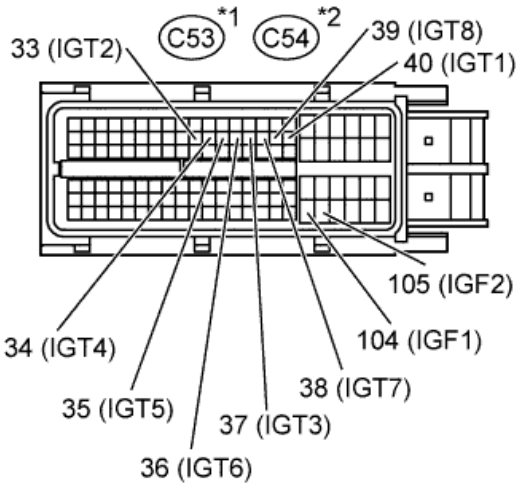
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

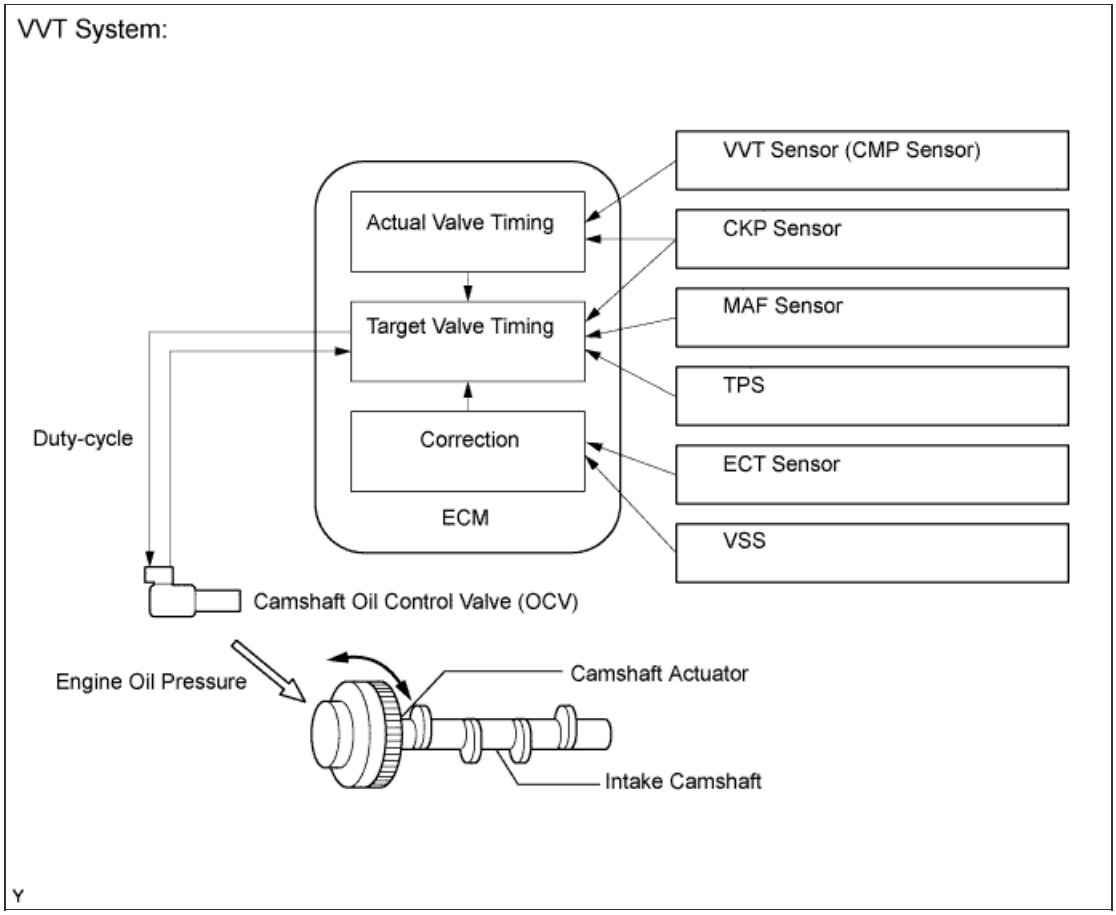
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

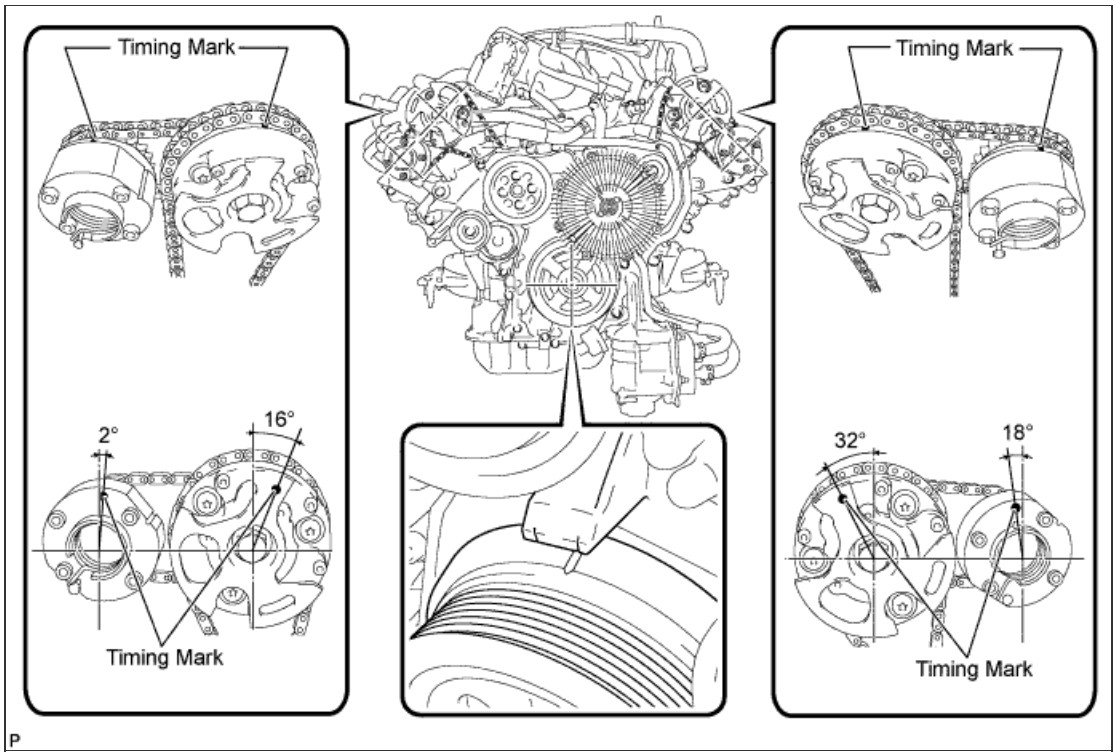
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

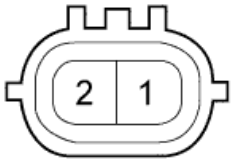
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

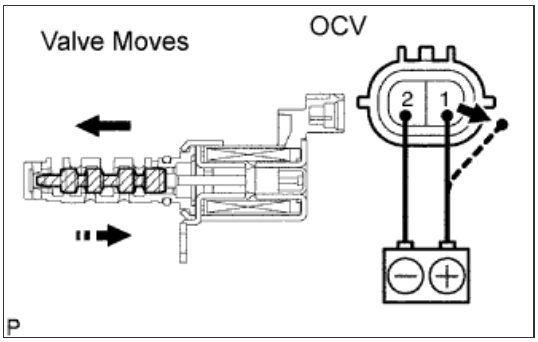
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

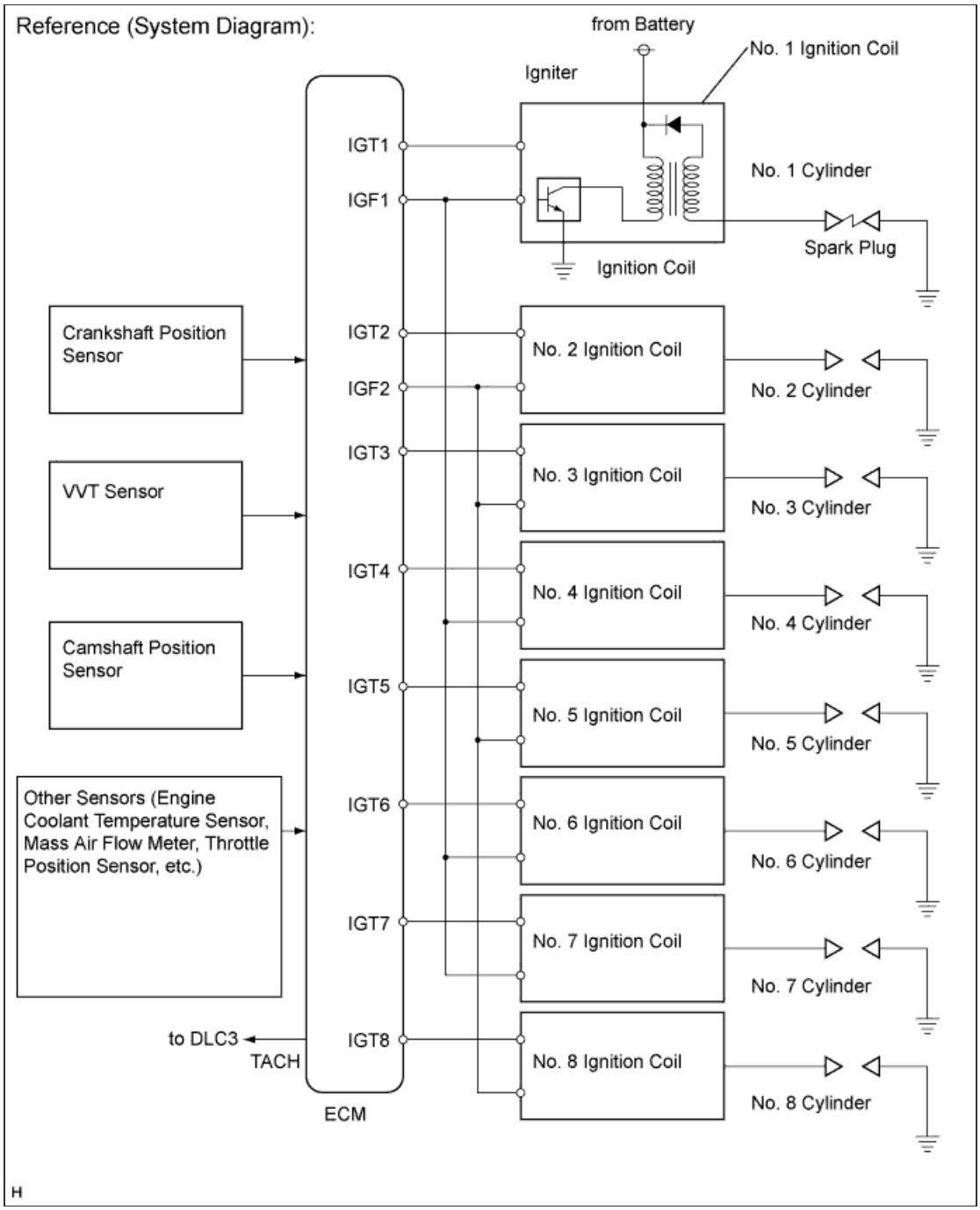
for Preparation Click here

DESCRIPTION

HINT:

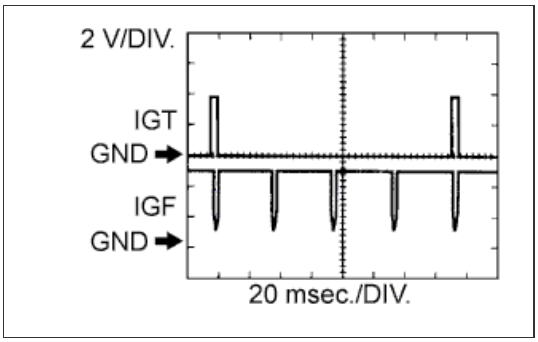
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

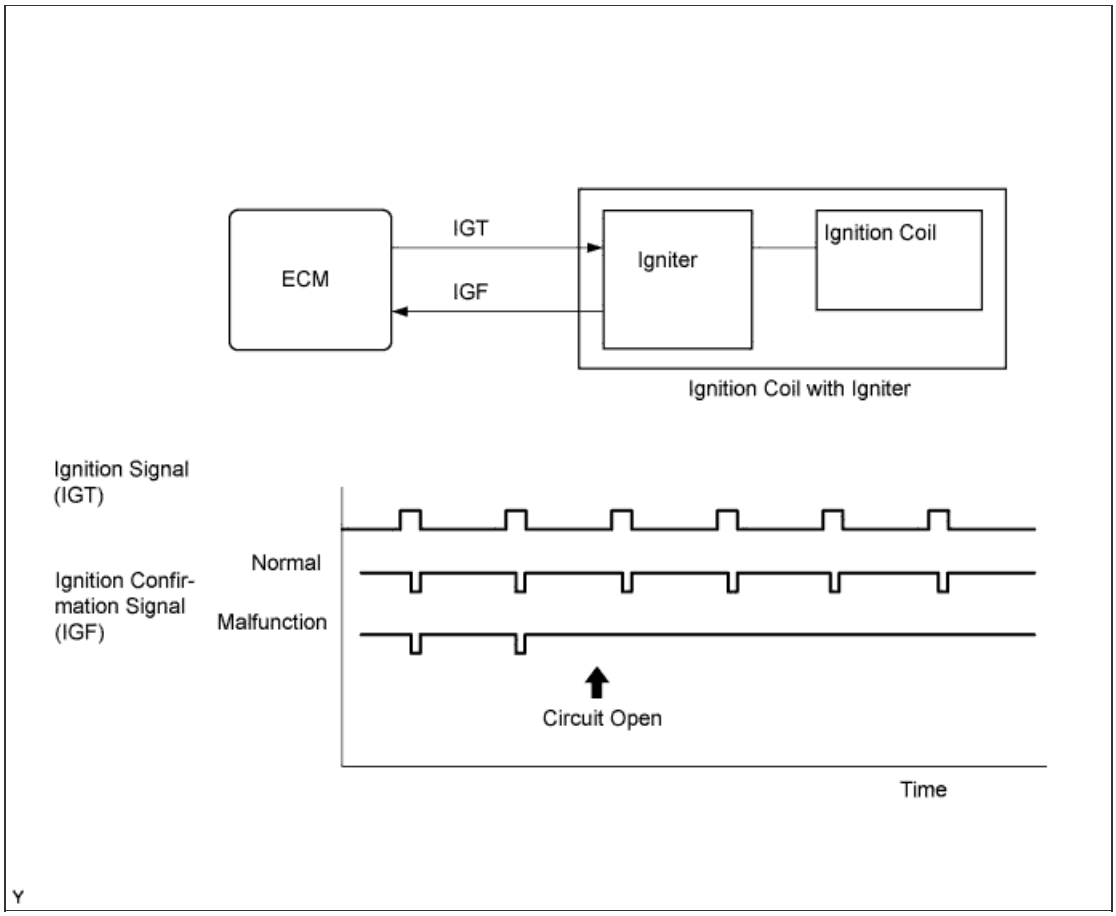
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

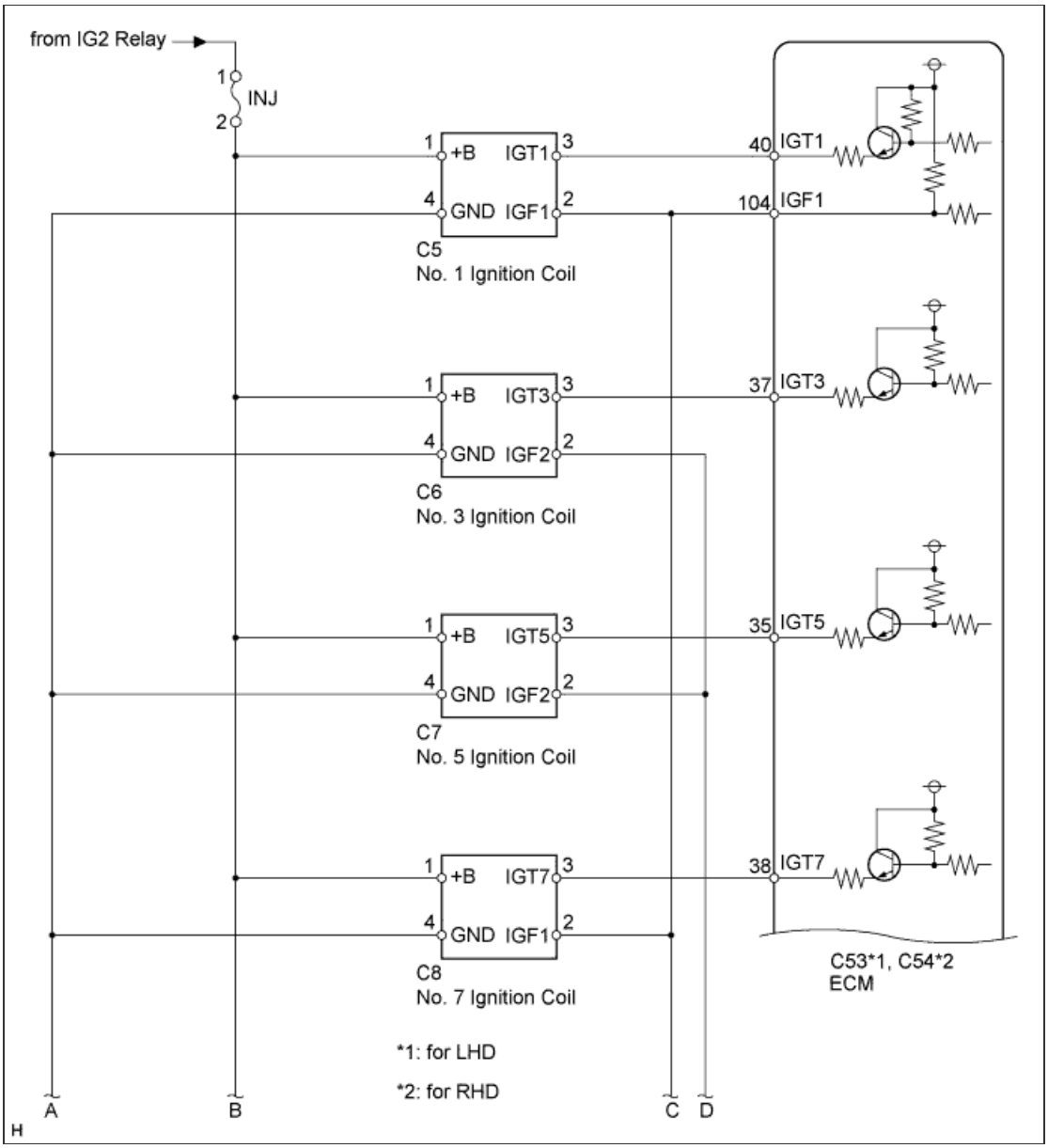
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

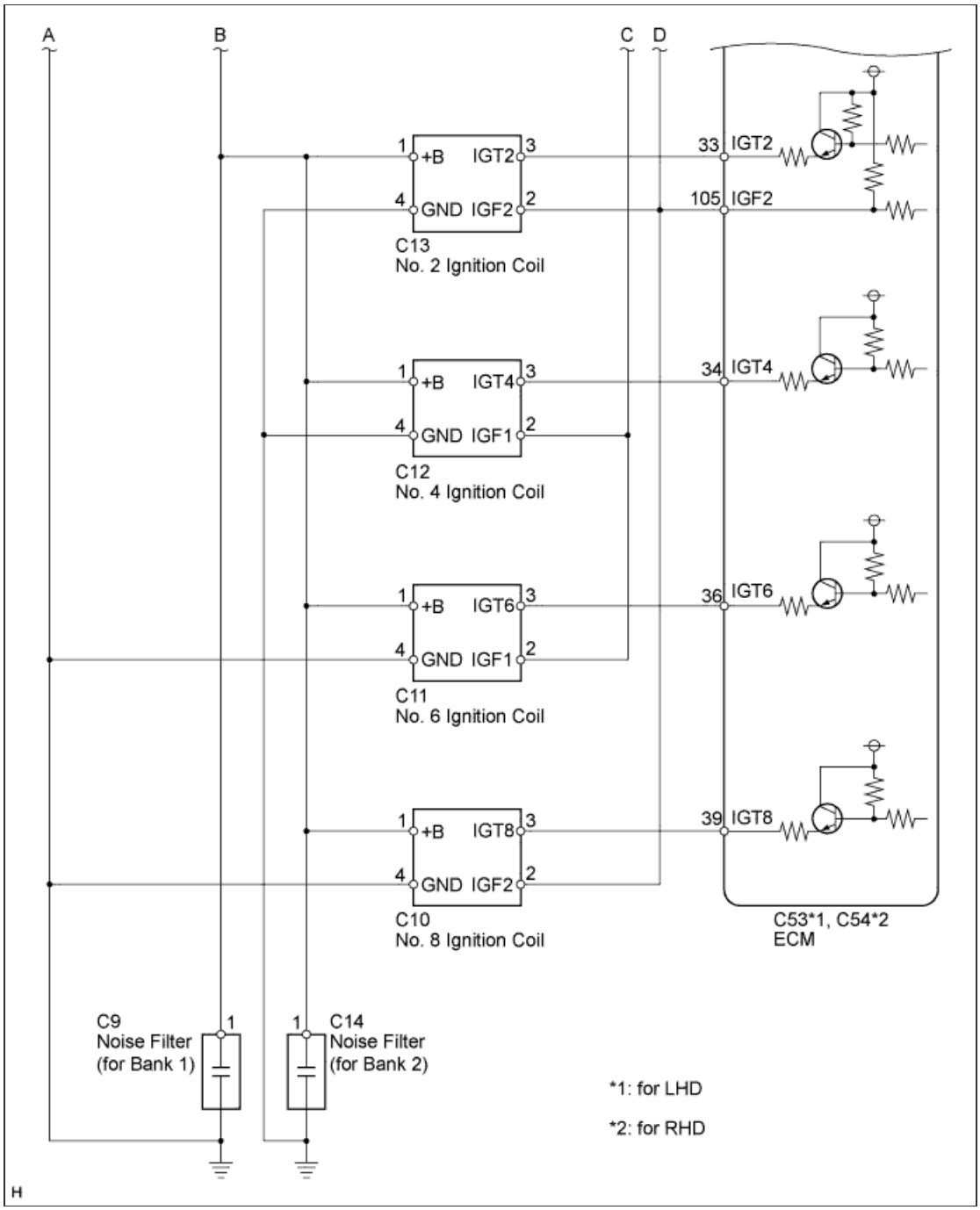
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

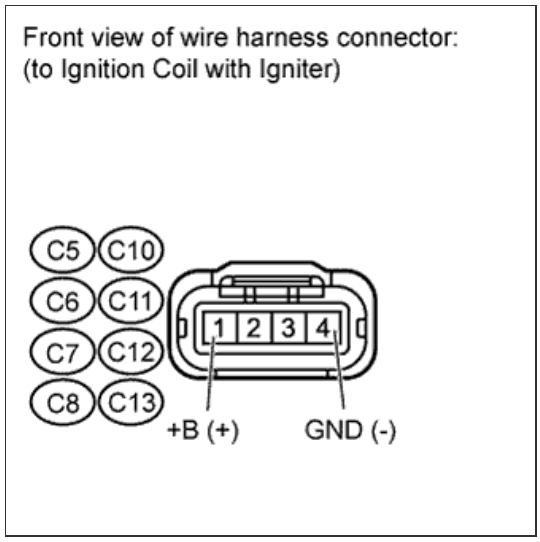
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

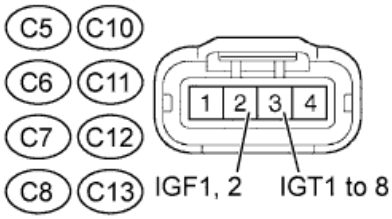
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

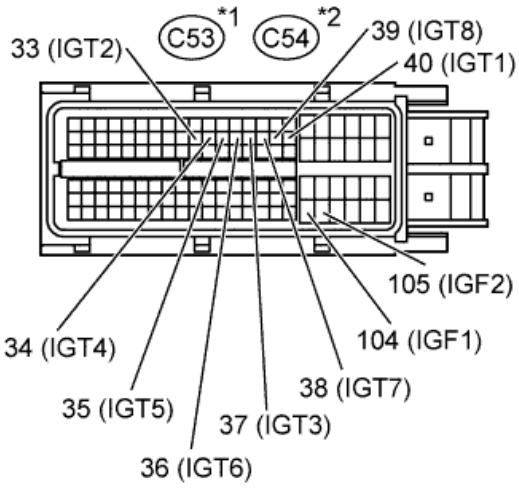
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

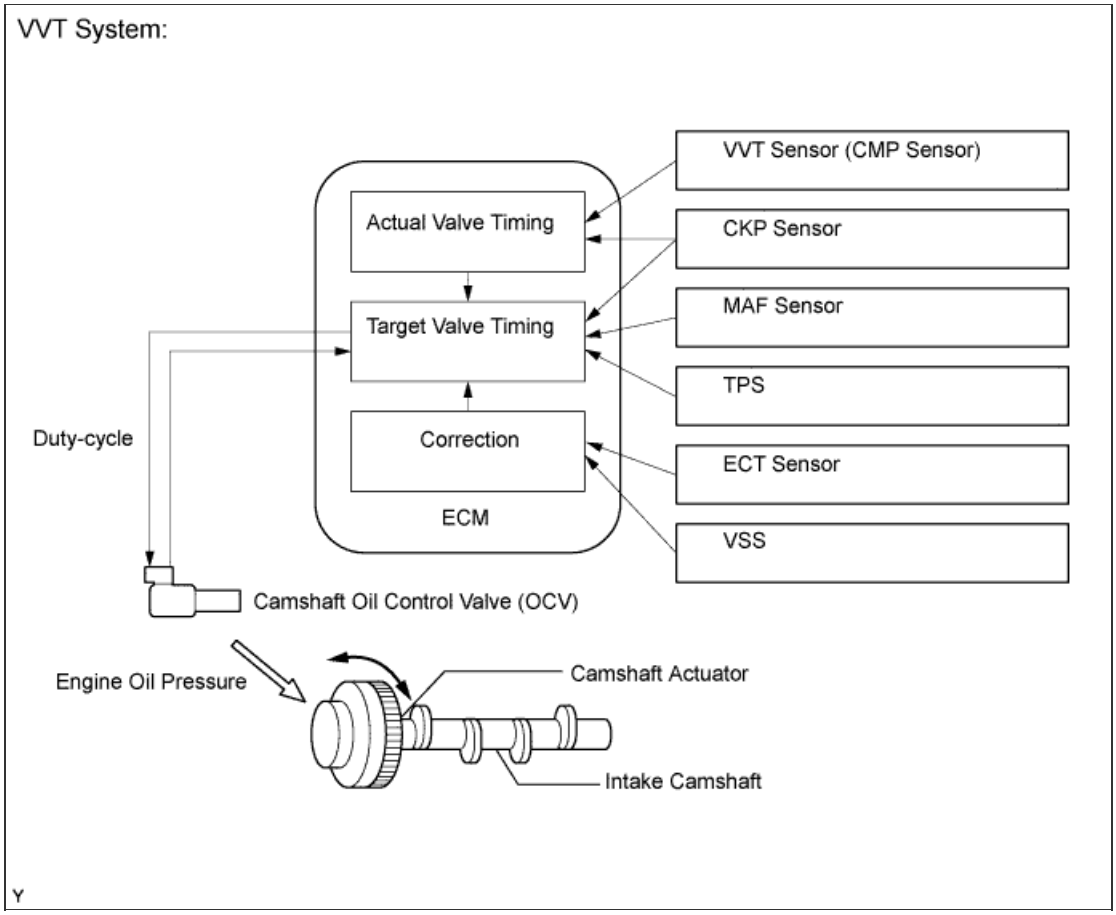
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

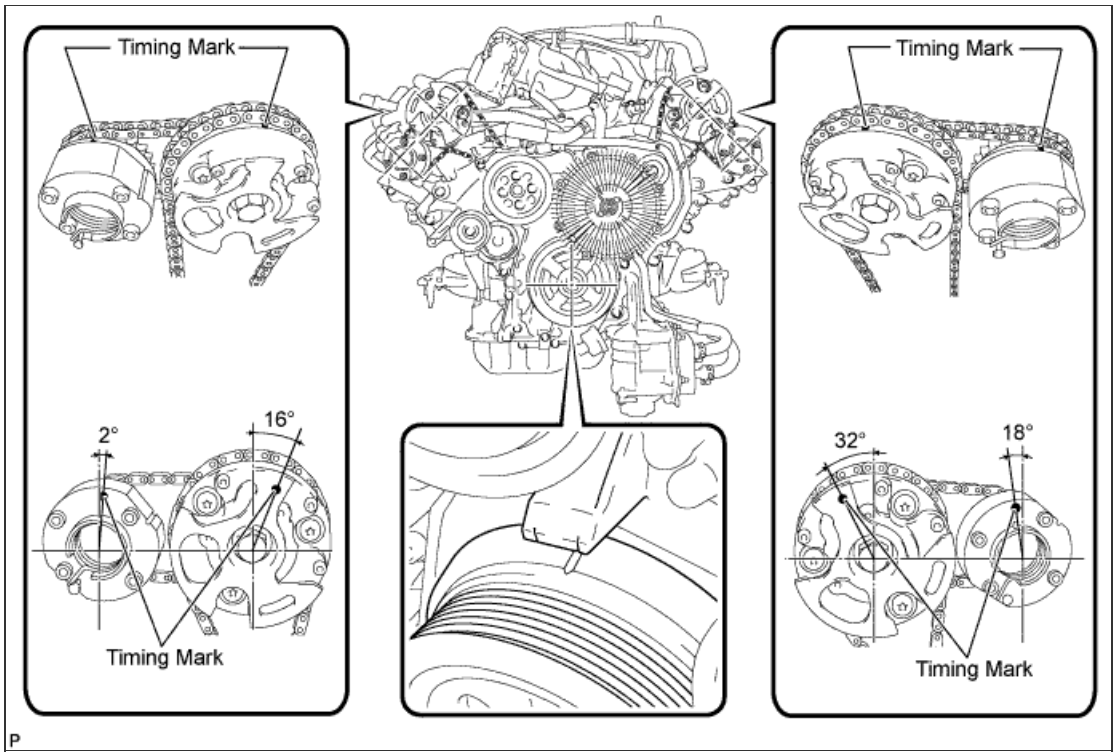
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

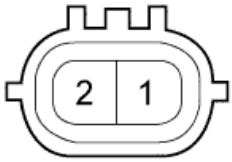
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

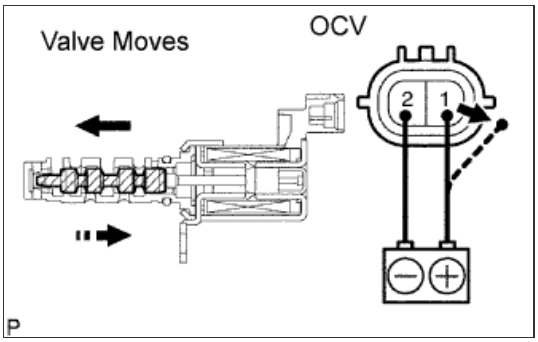
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

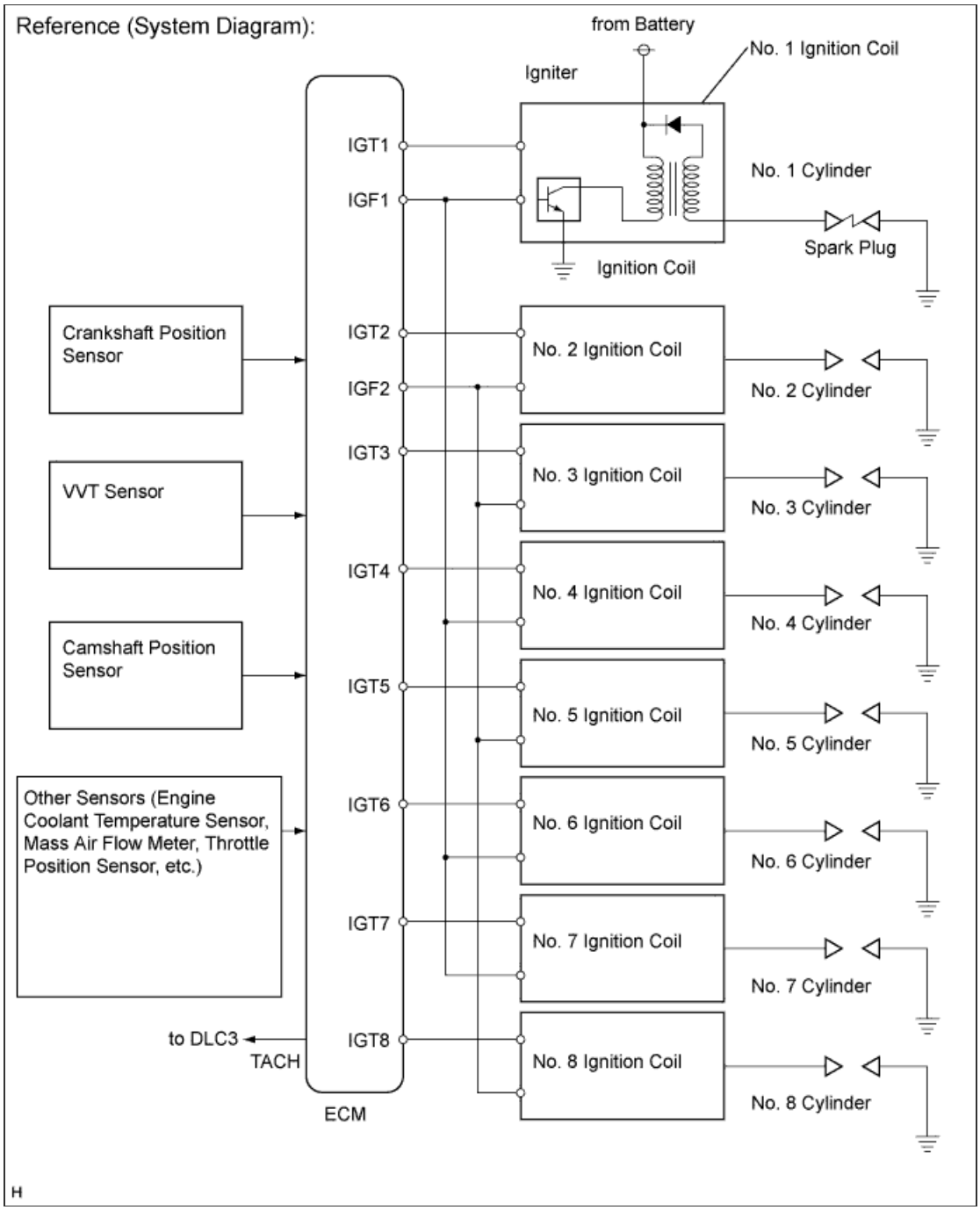
for Preparation Click here

DESCRIPTION

HINT:

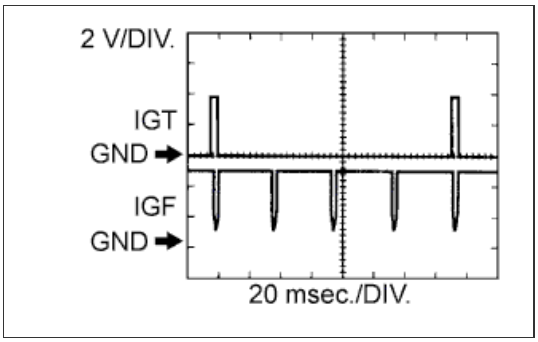
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

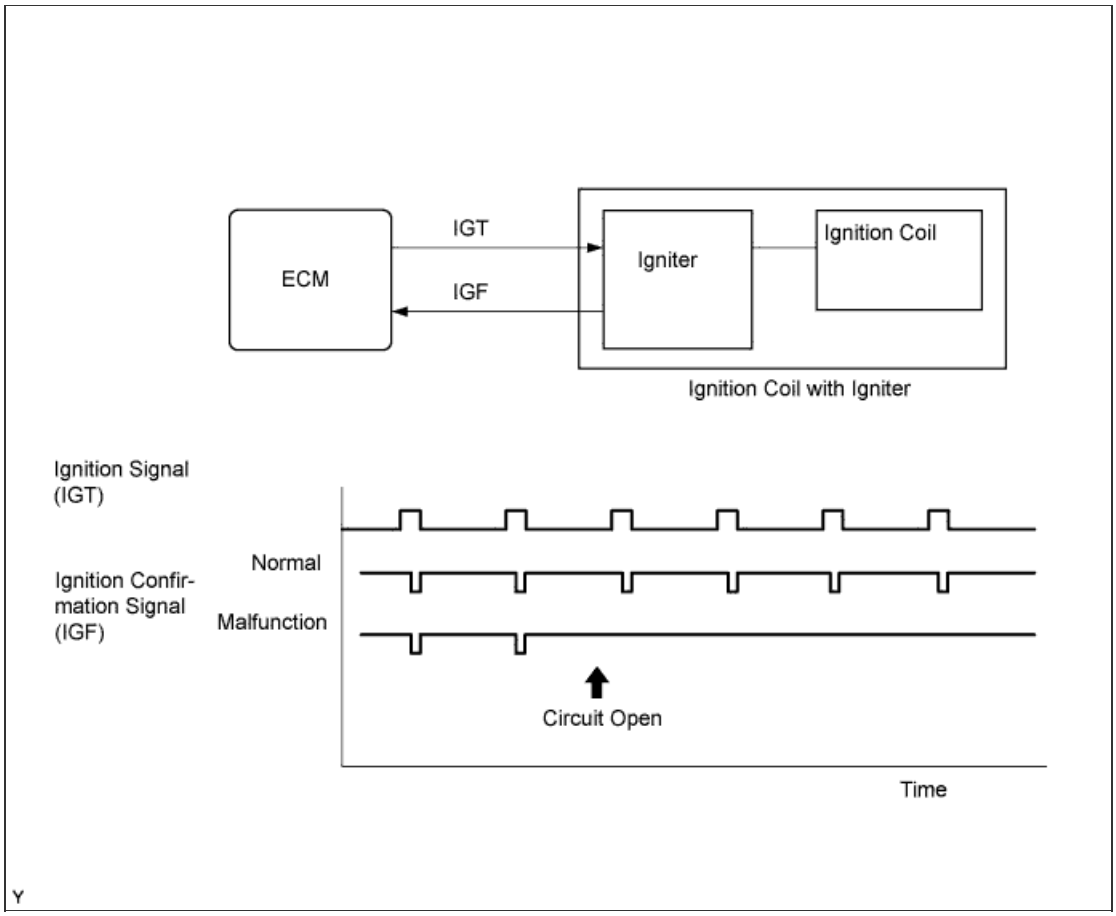
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

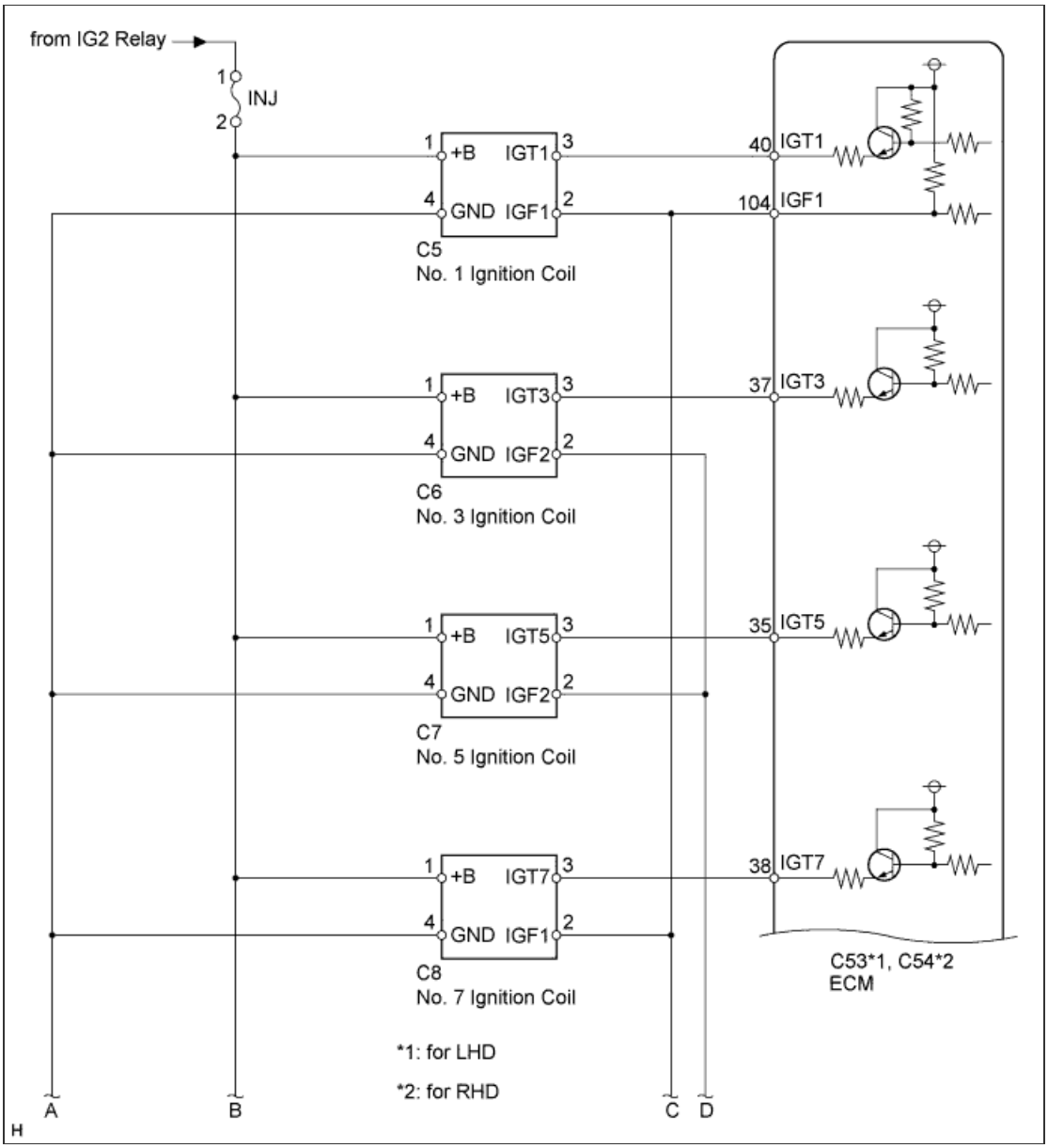
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

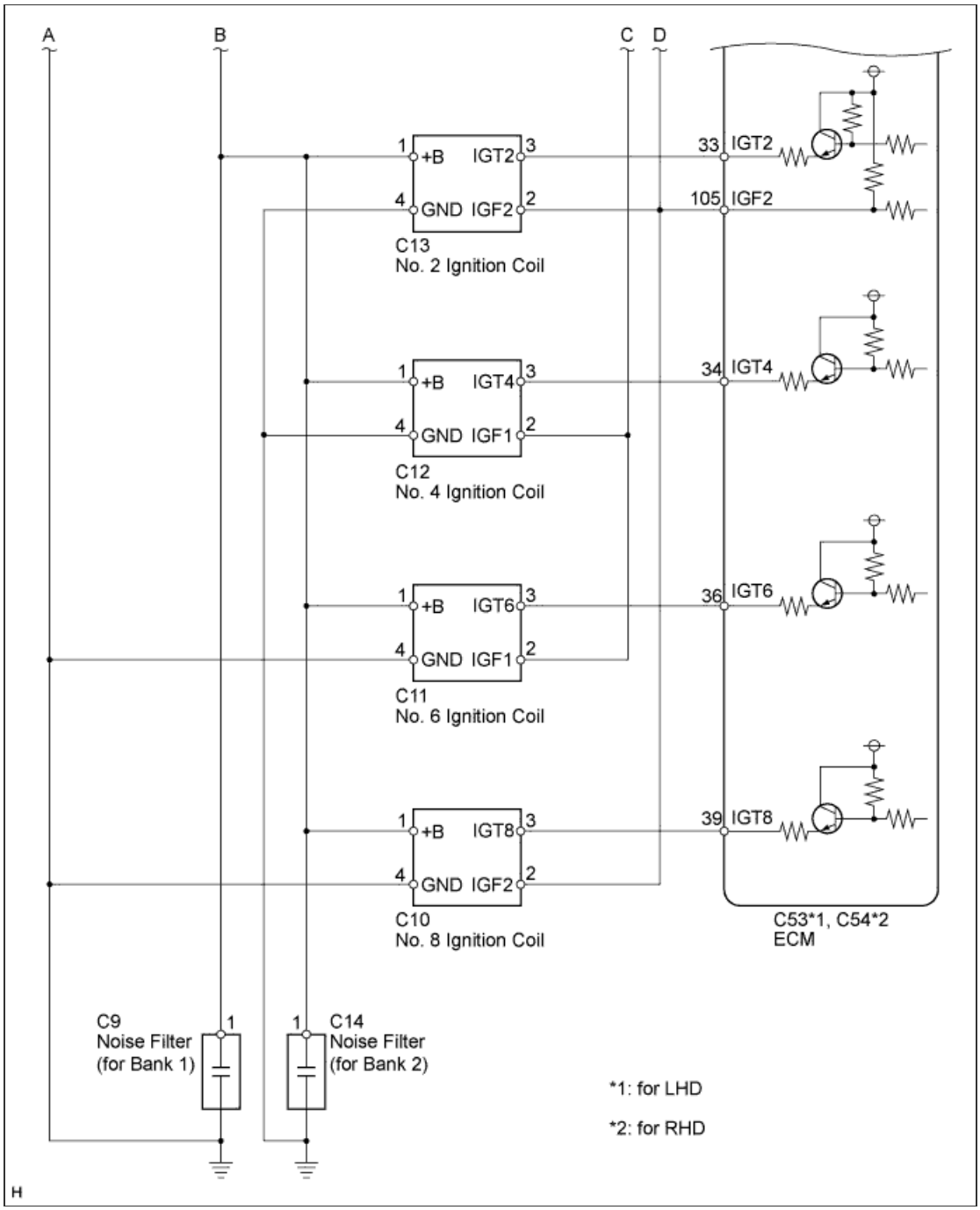
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

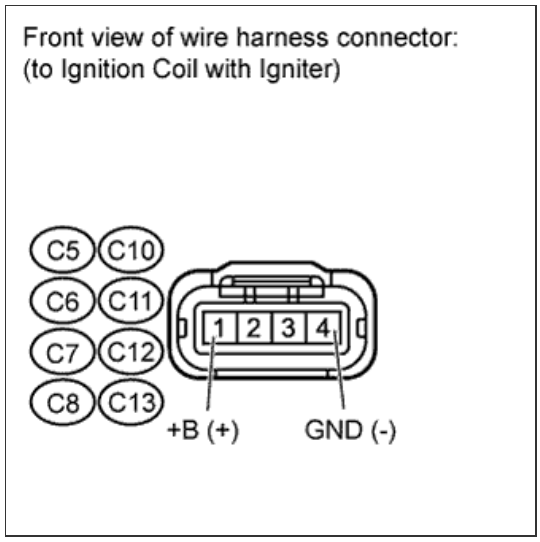
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

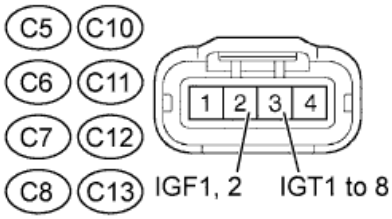
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

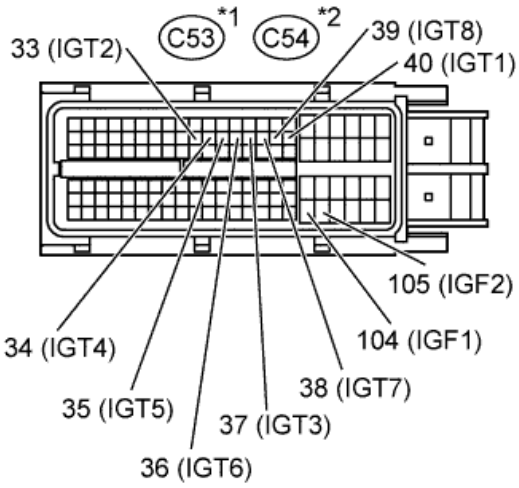
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

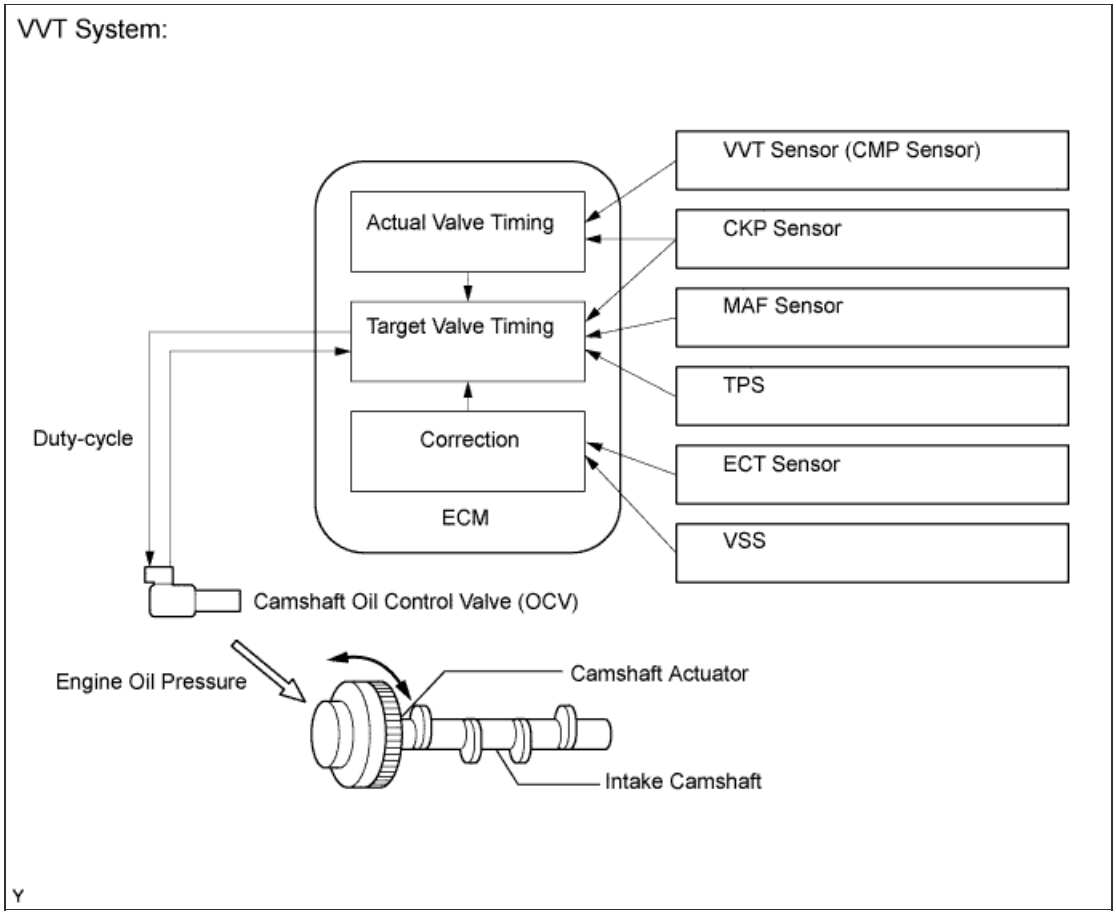
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

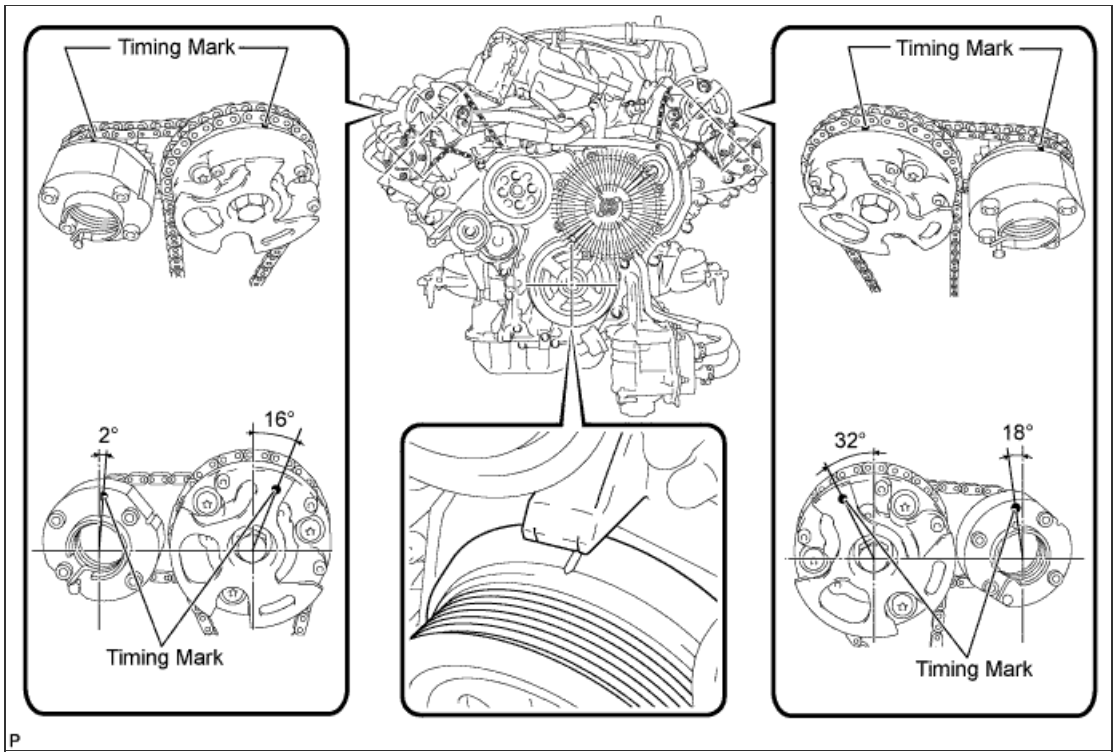
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

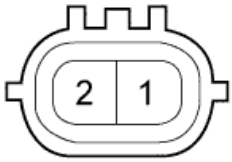
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

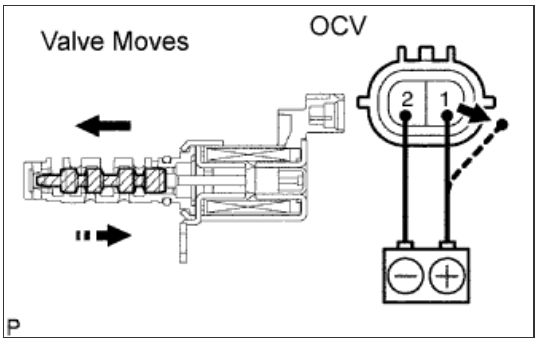
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

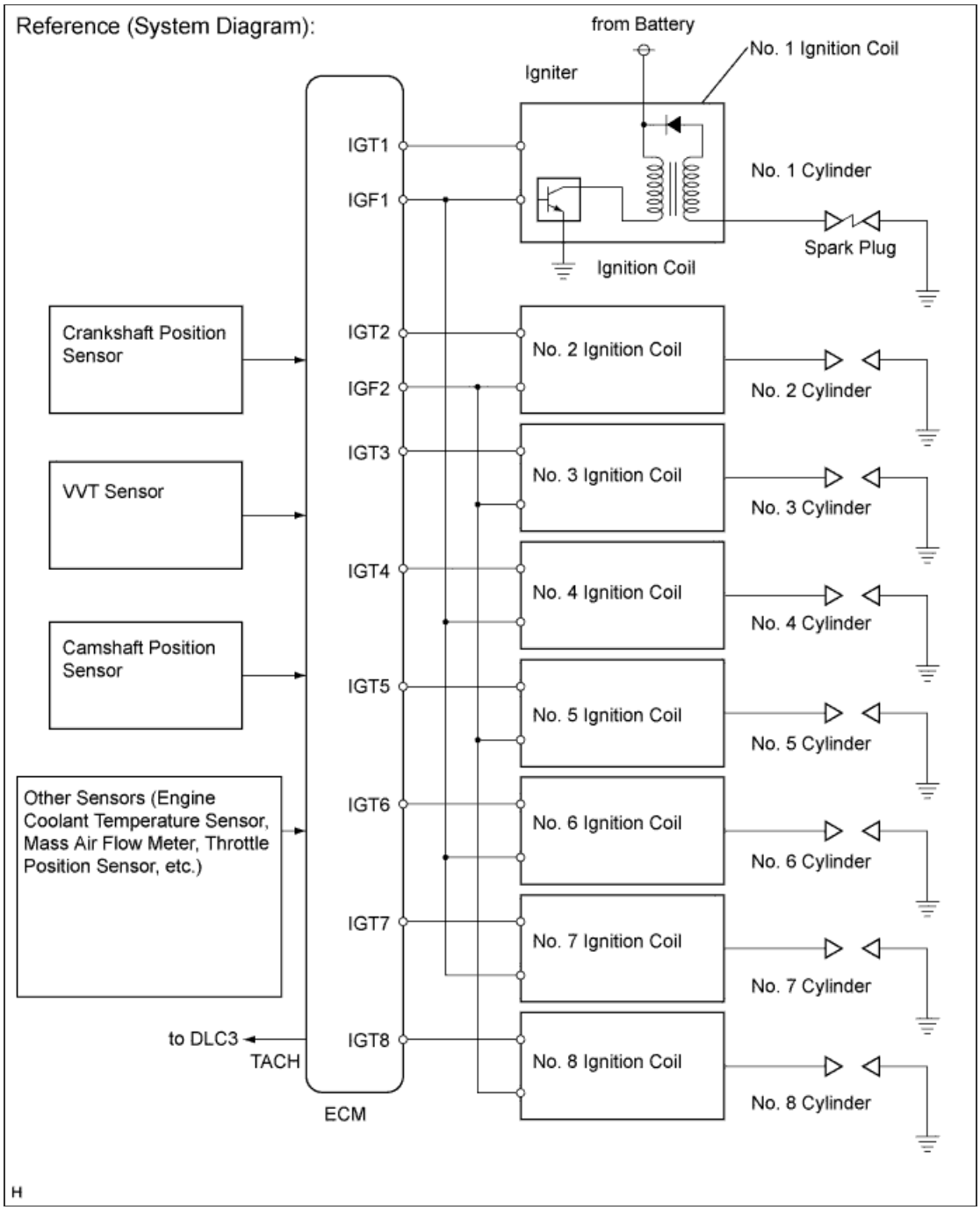
for Preparation Click here

DESCRIPTION

HINT:

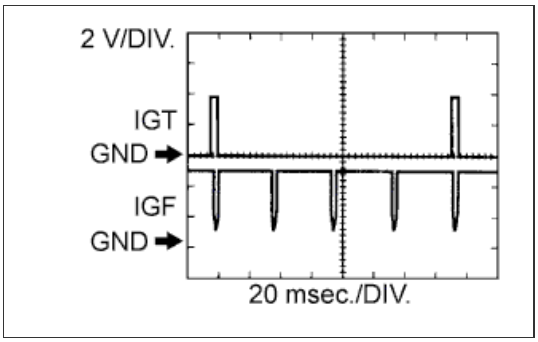
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

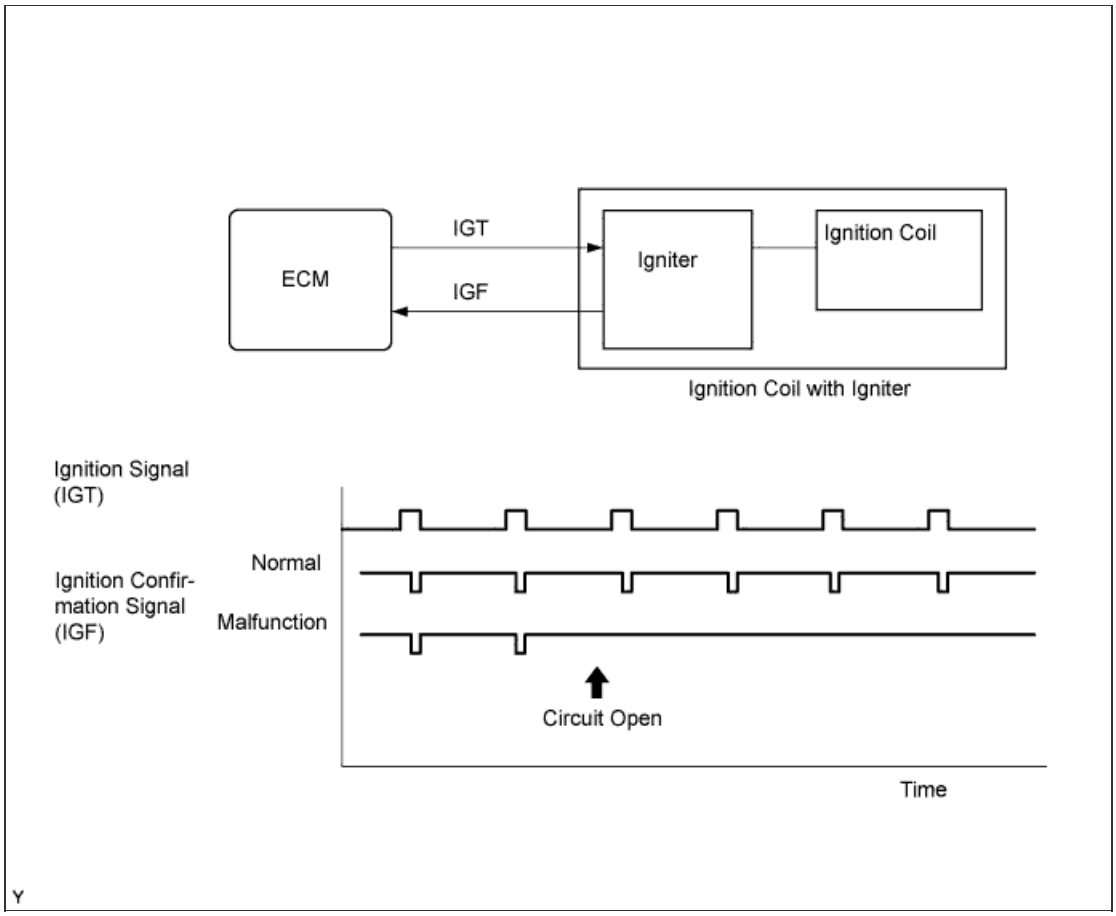
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

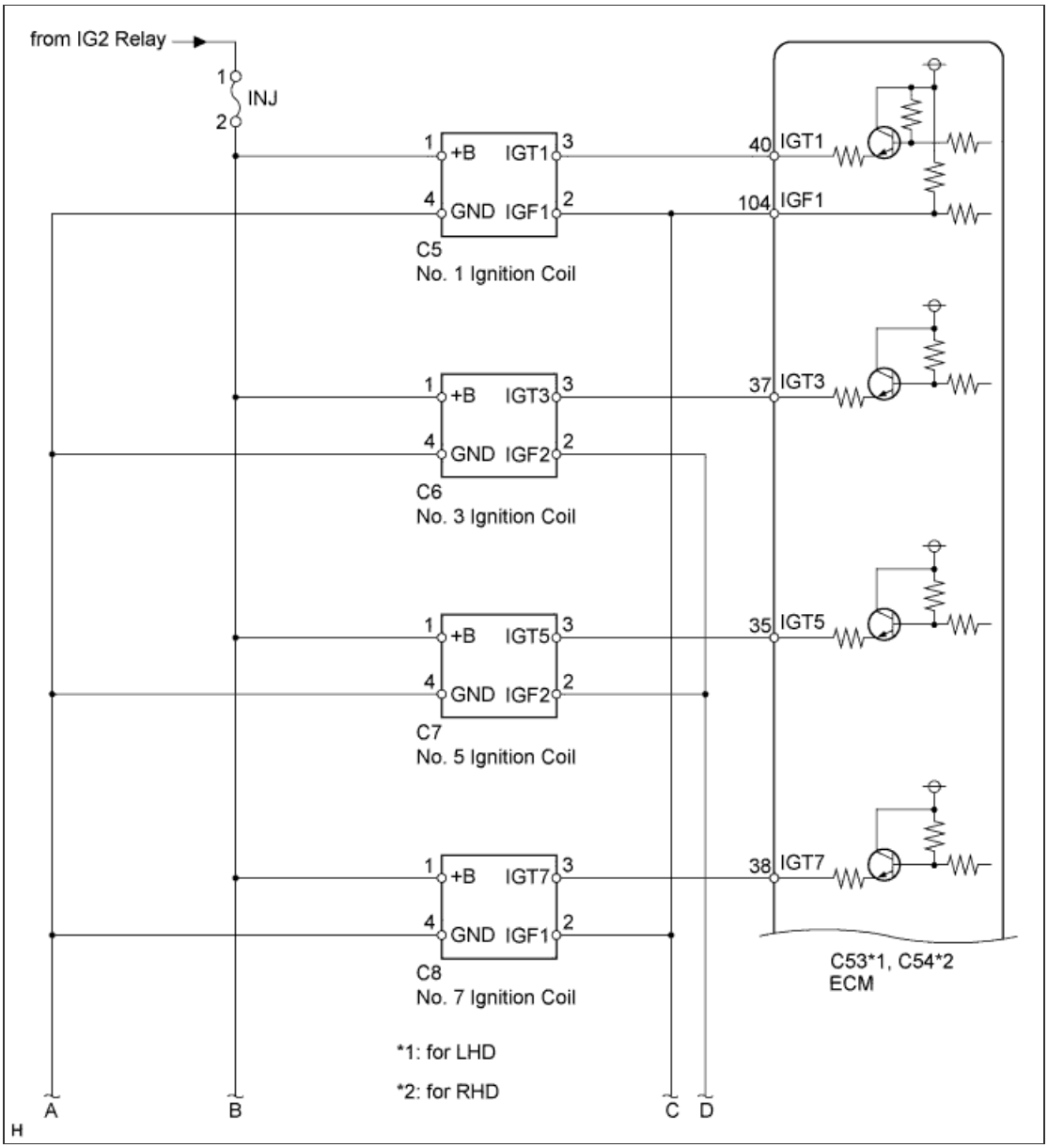
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

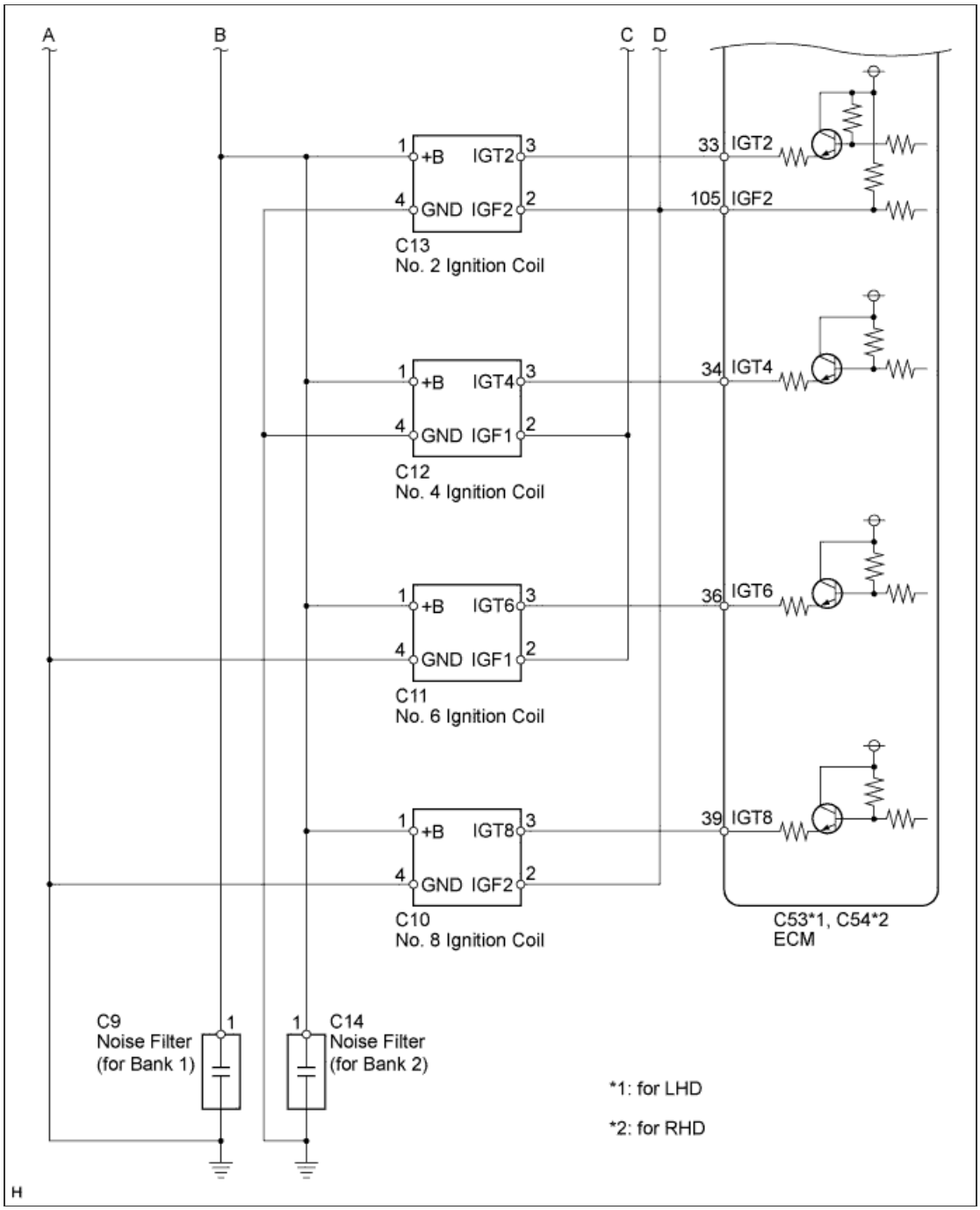
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

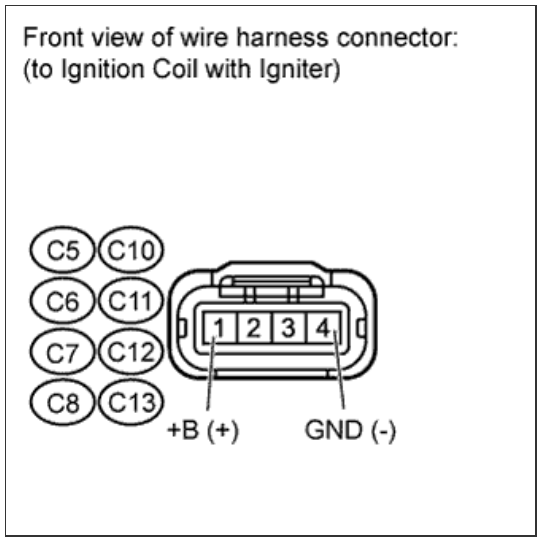
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

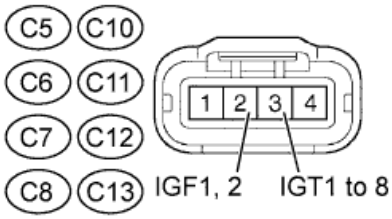
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

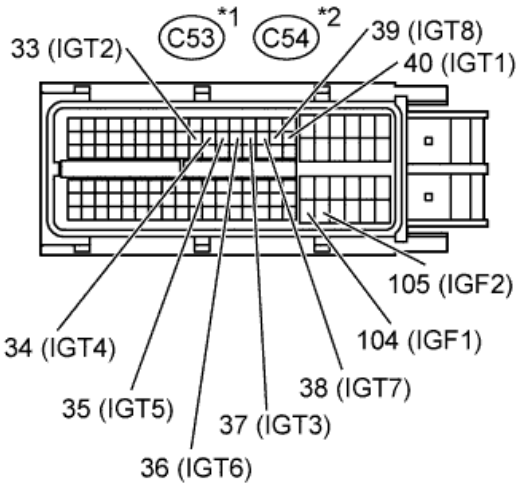
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

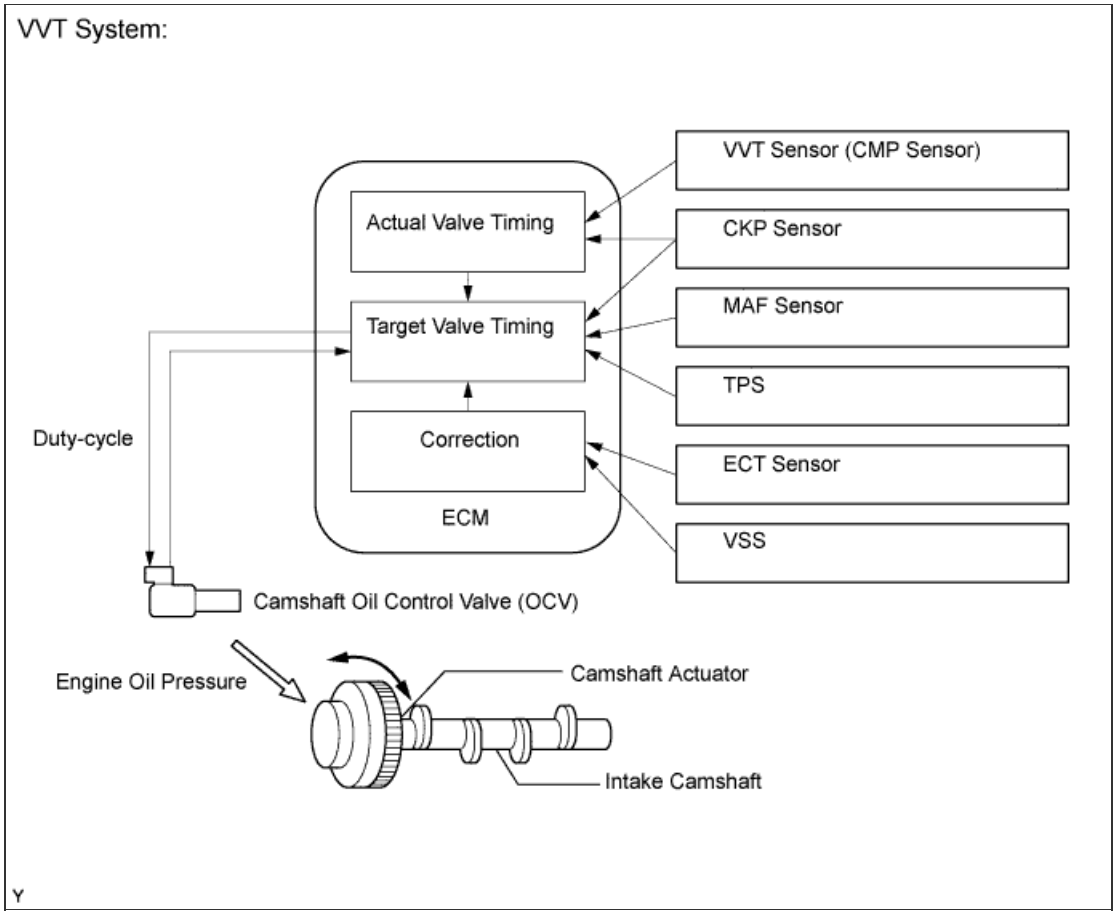
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

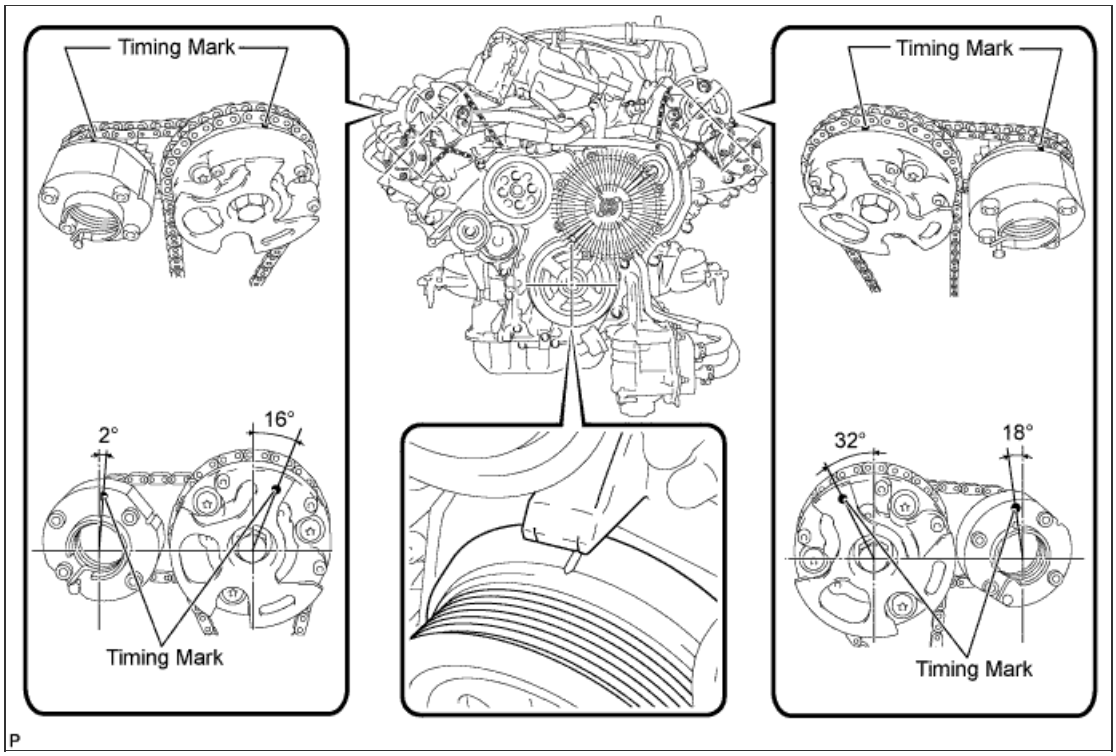
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

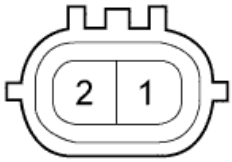
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

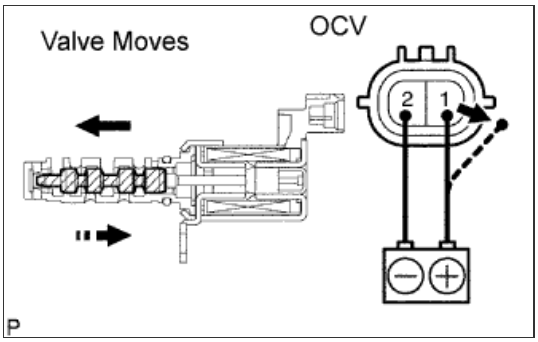
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

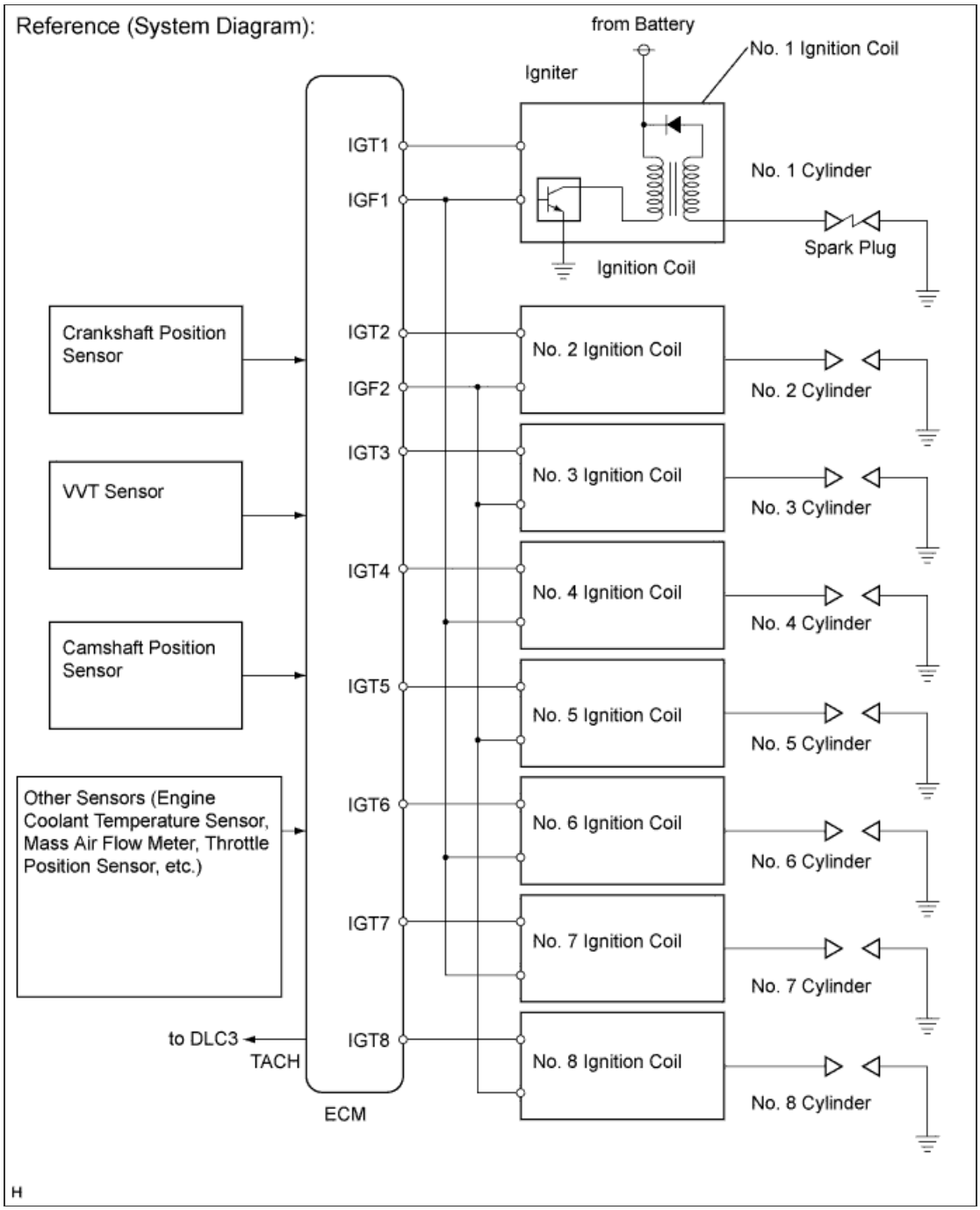
for Preparation Click here

DESCRIPTION

HINT:

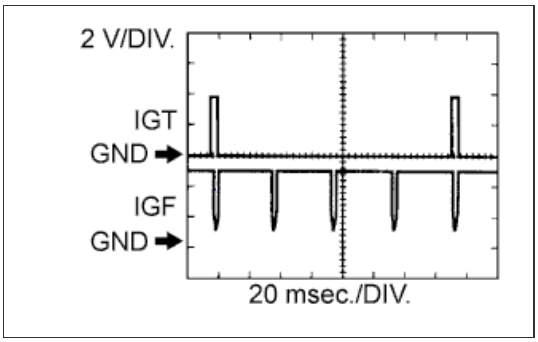
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

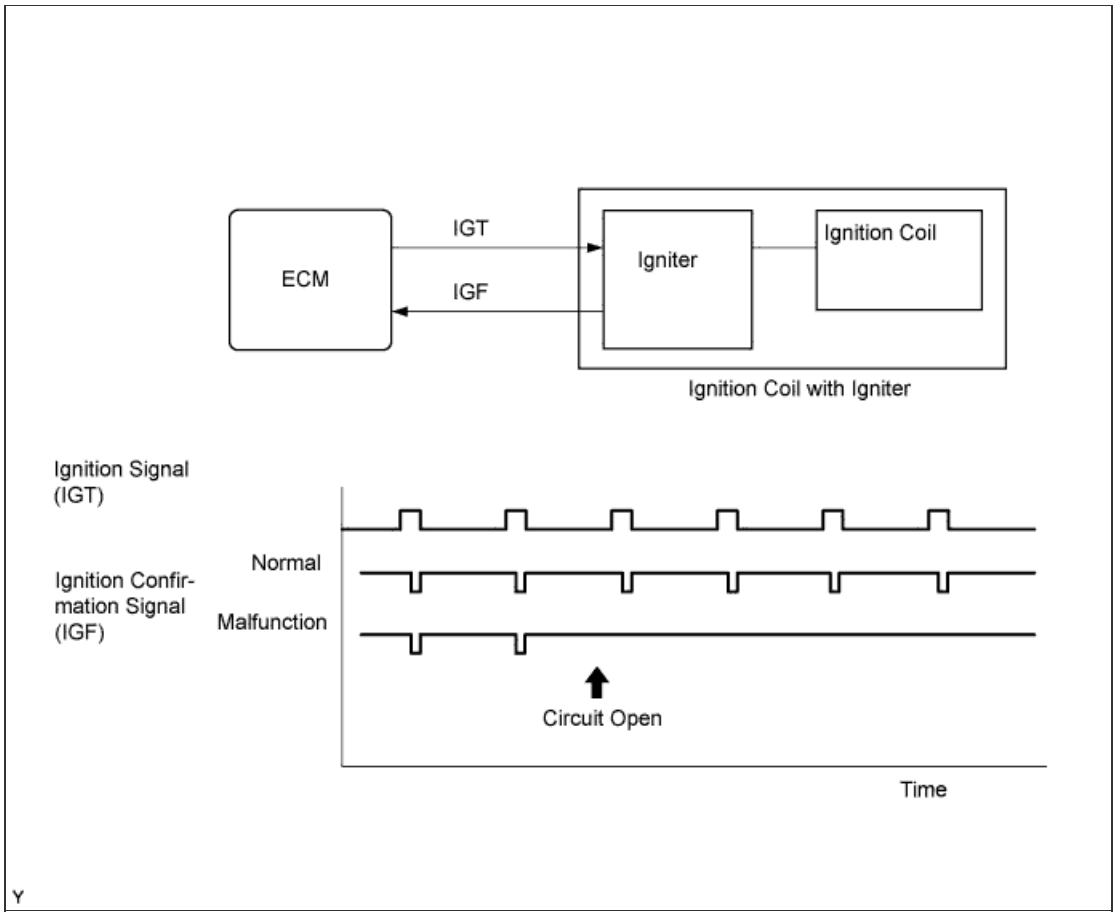
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

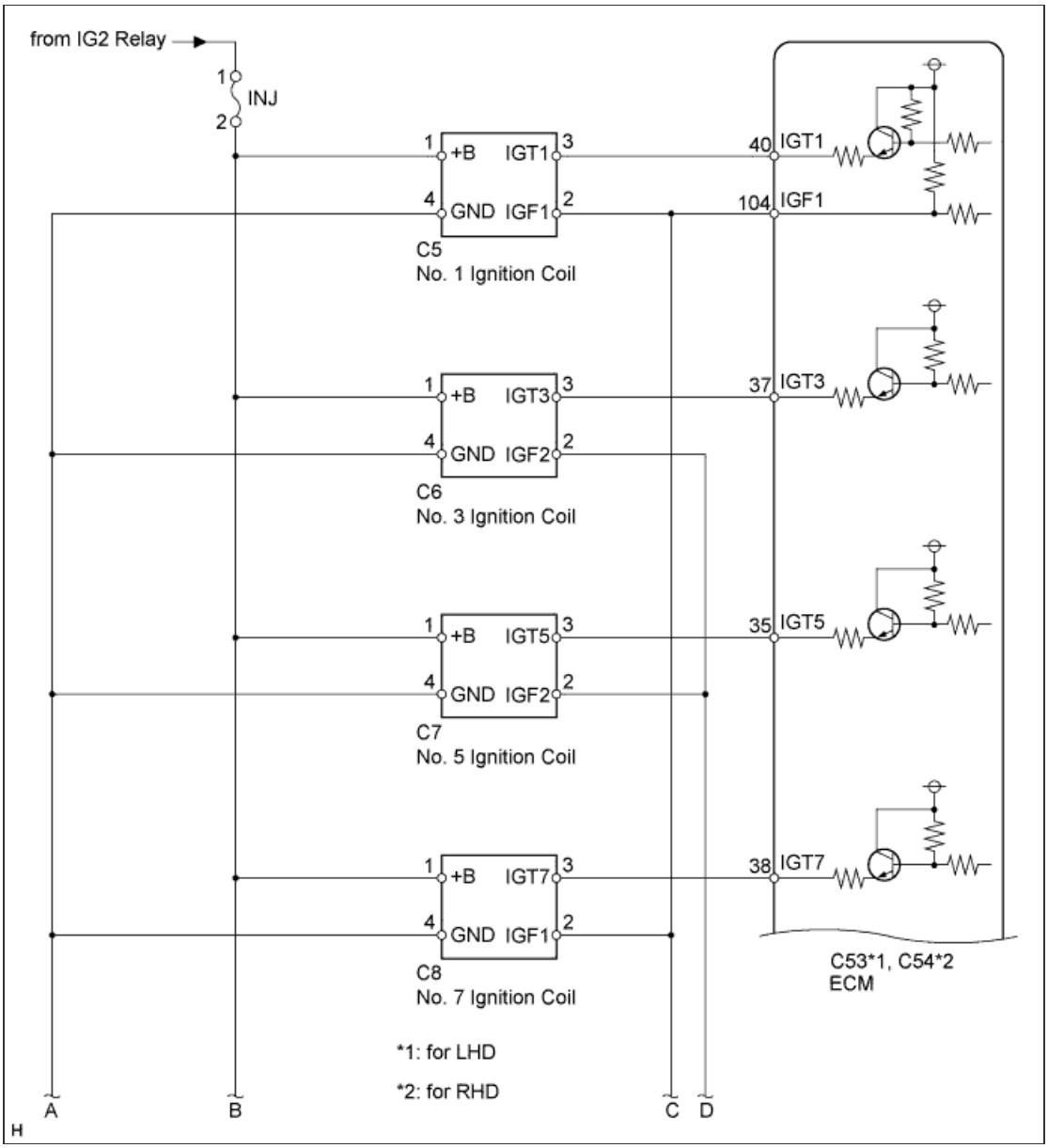
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

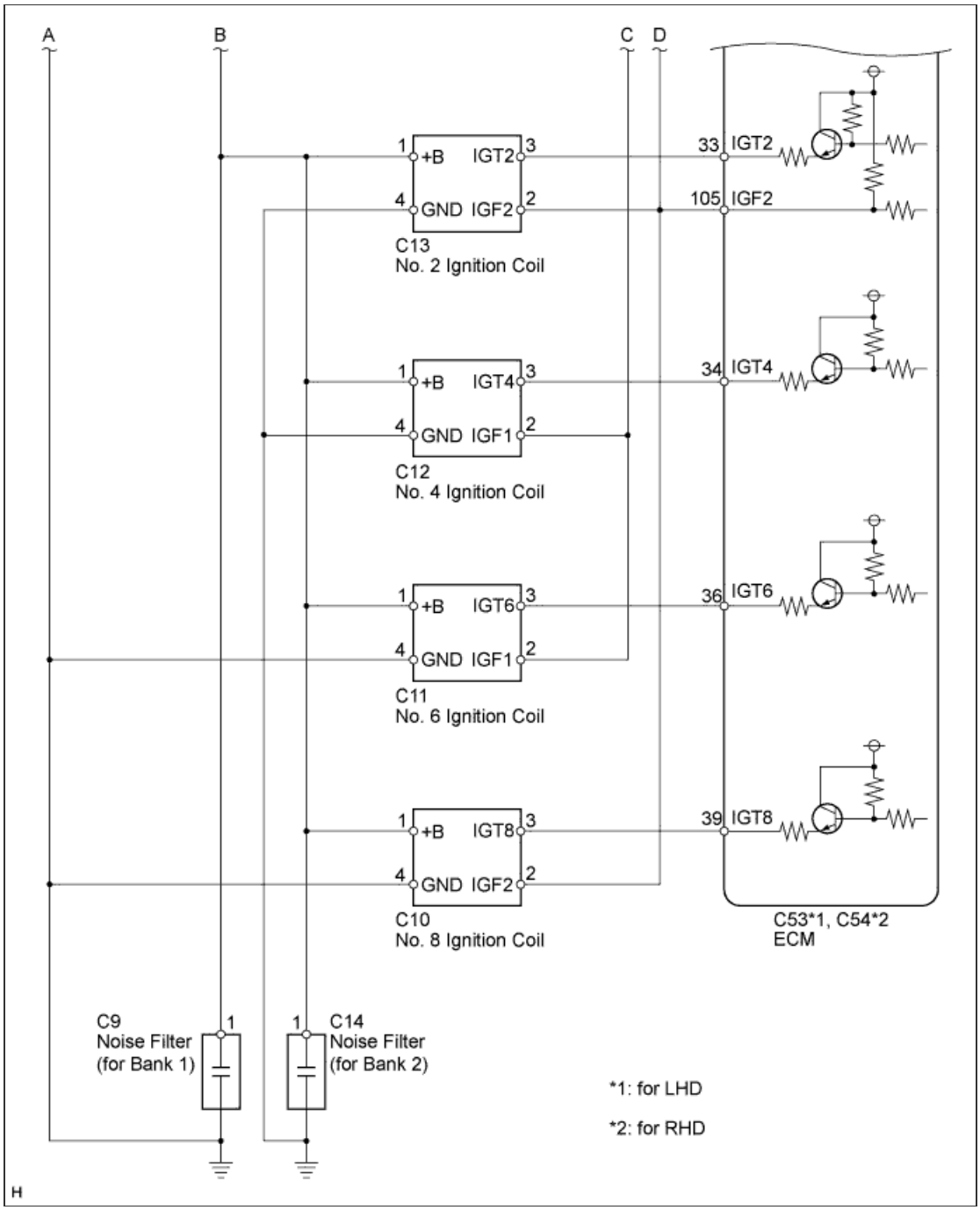
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

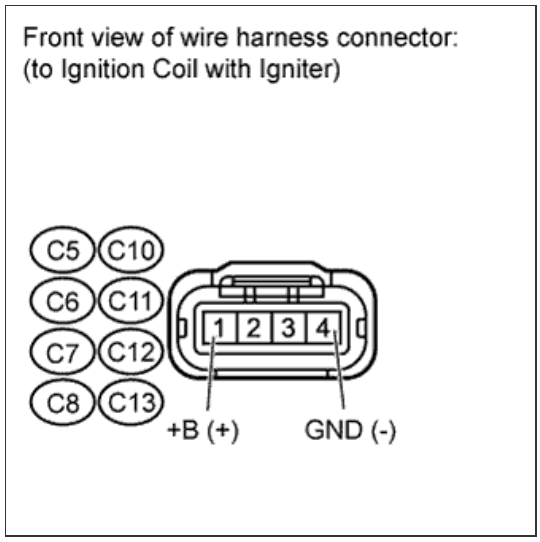
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

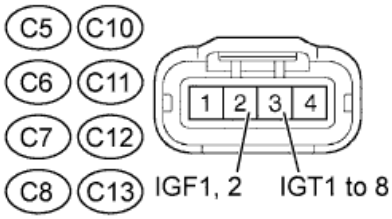
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

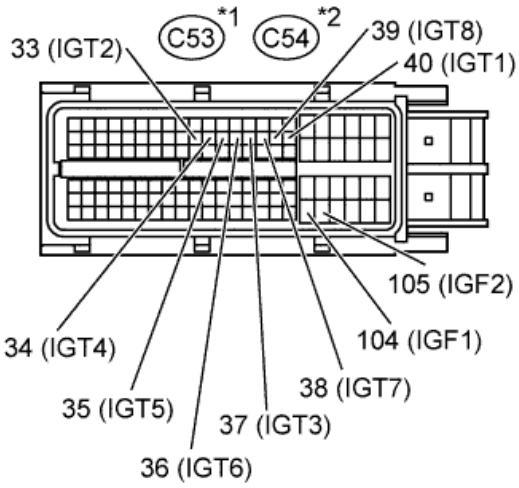
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

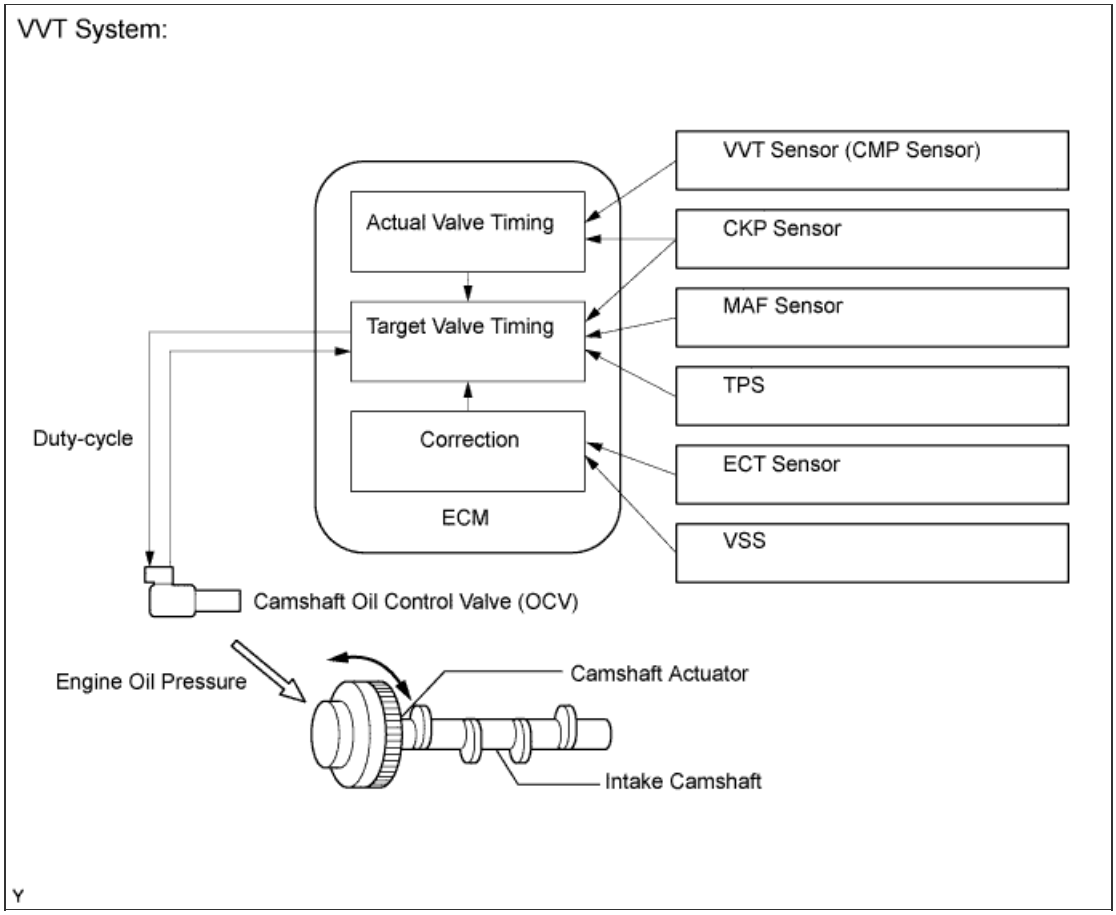
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

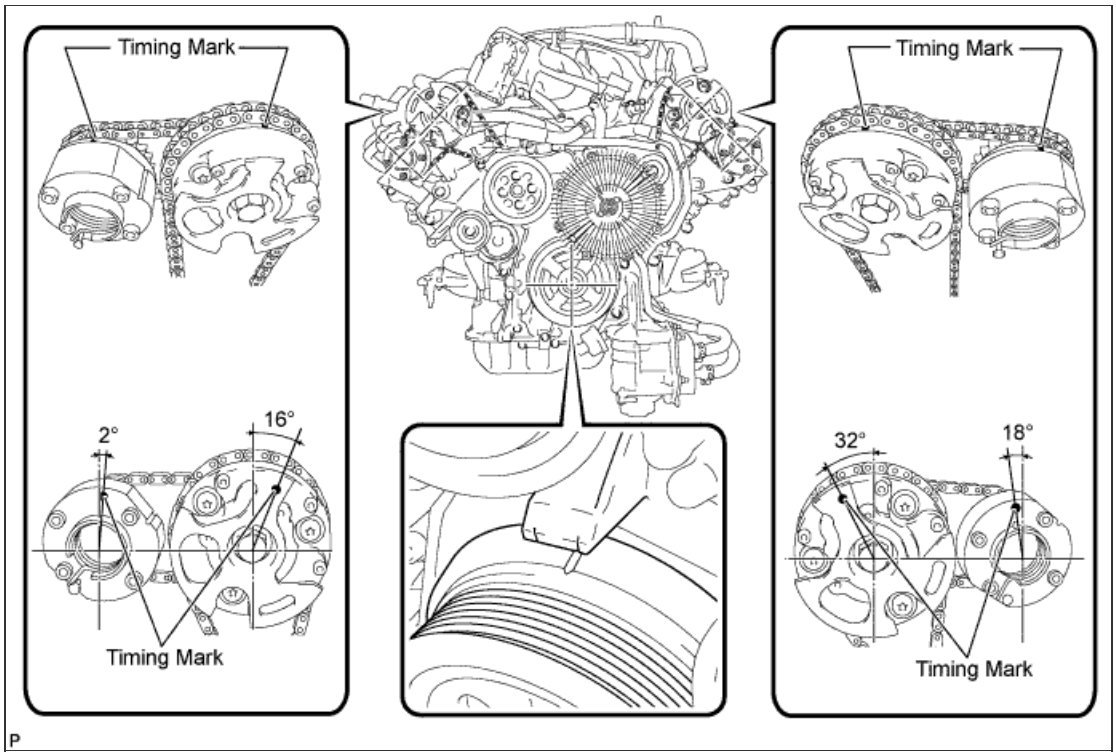
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

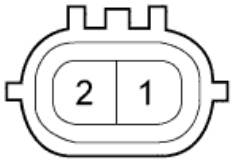
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

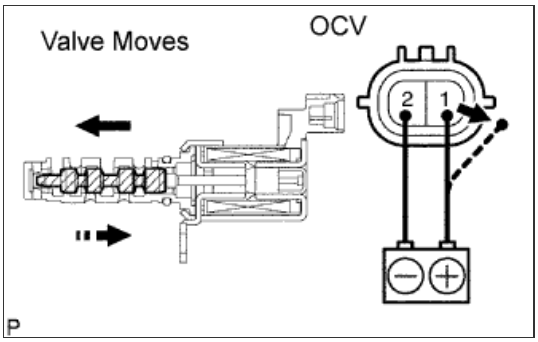
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

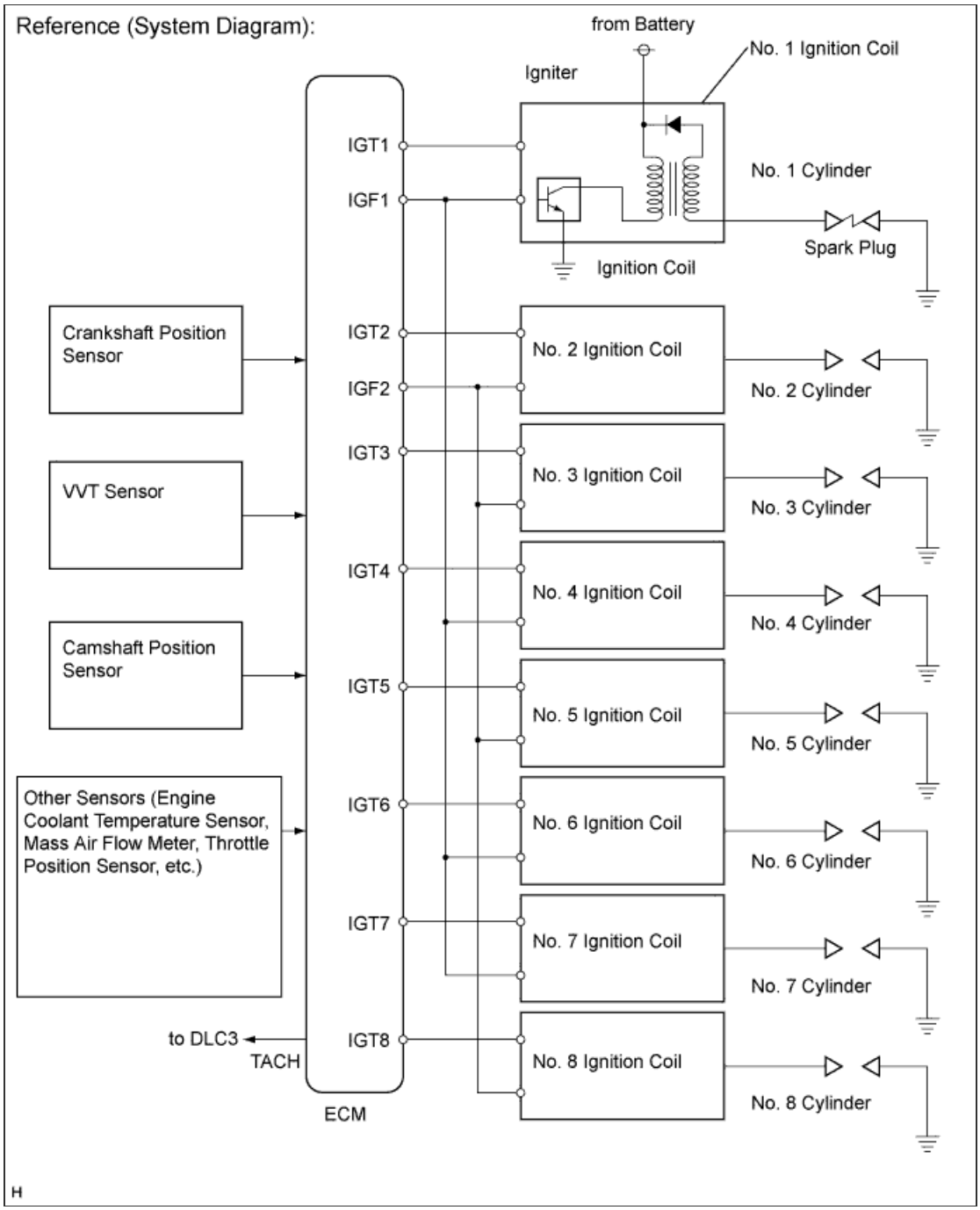
for Preparation Click here

DESCRIPTION

HINT:

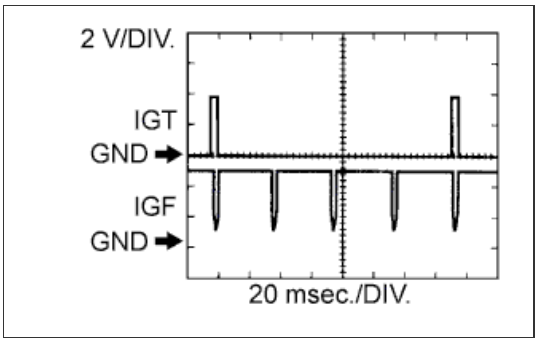
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

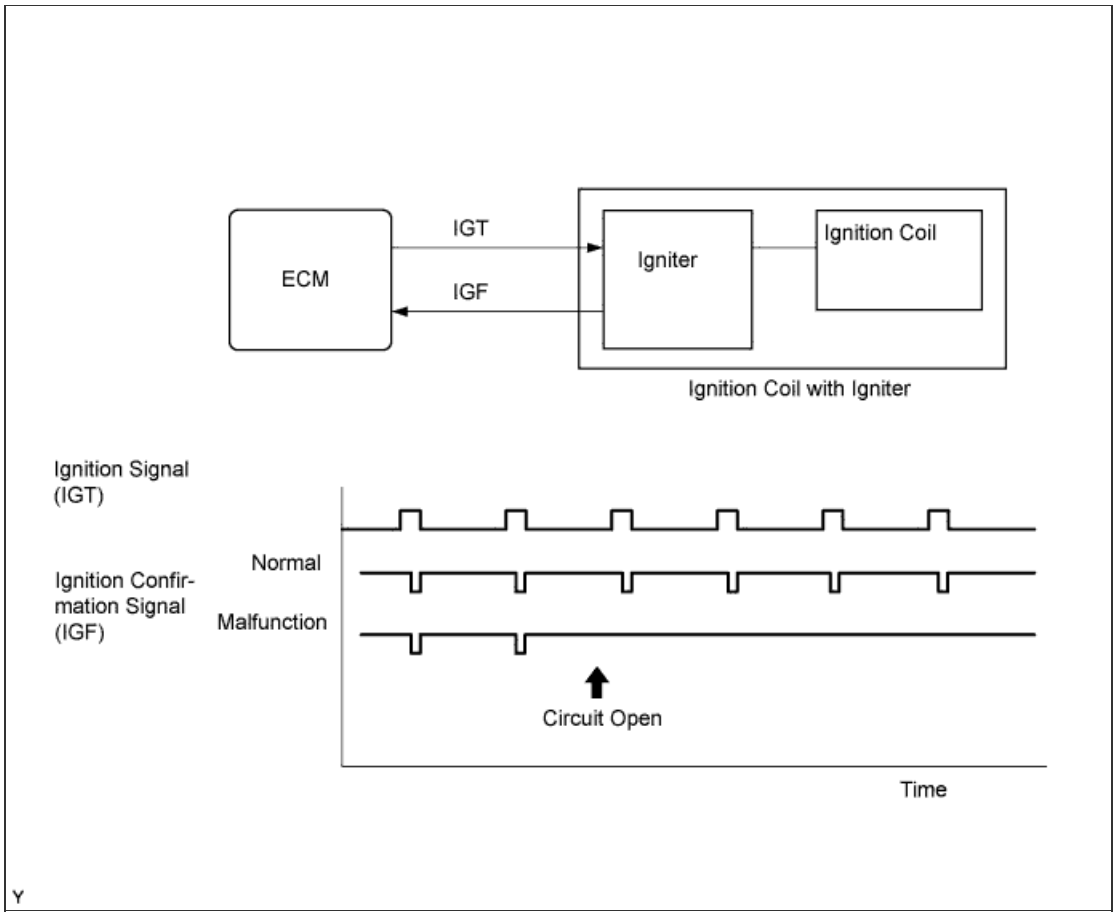
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

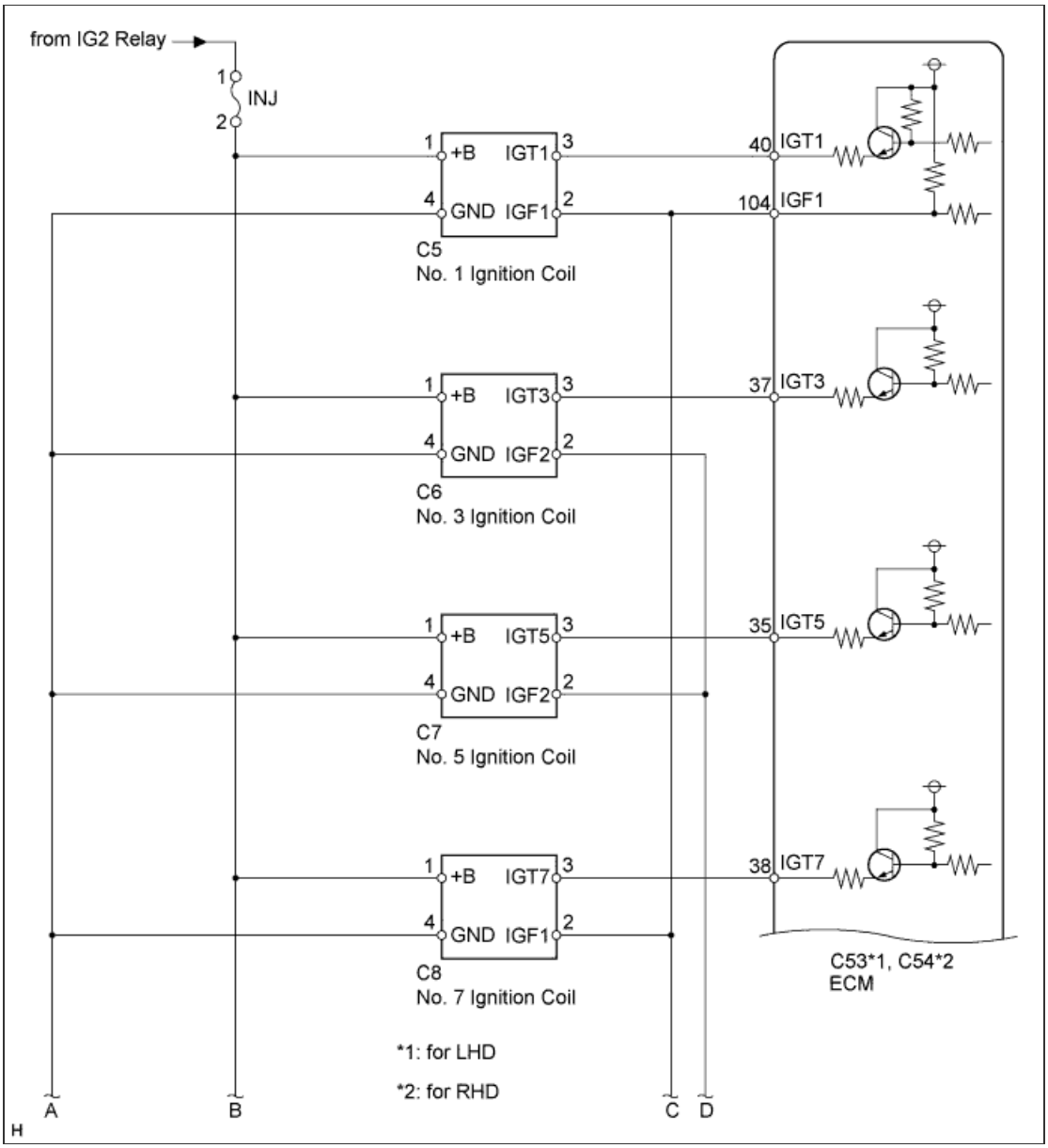
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

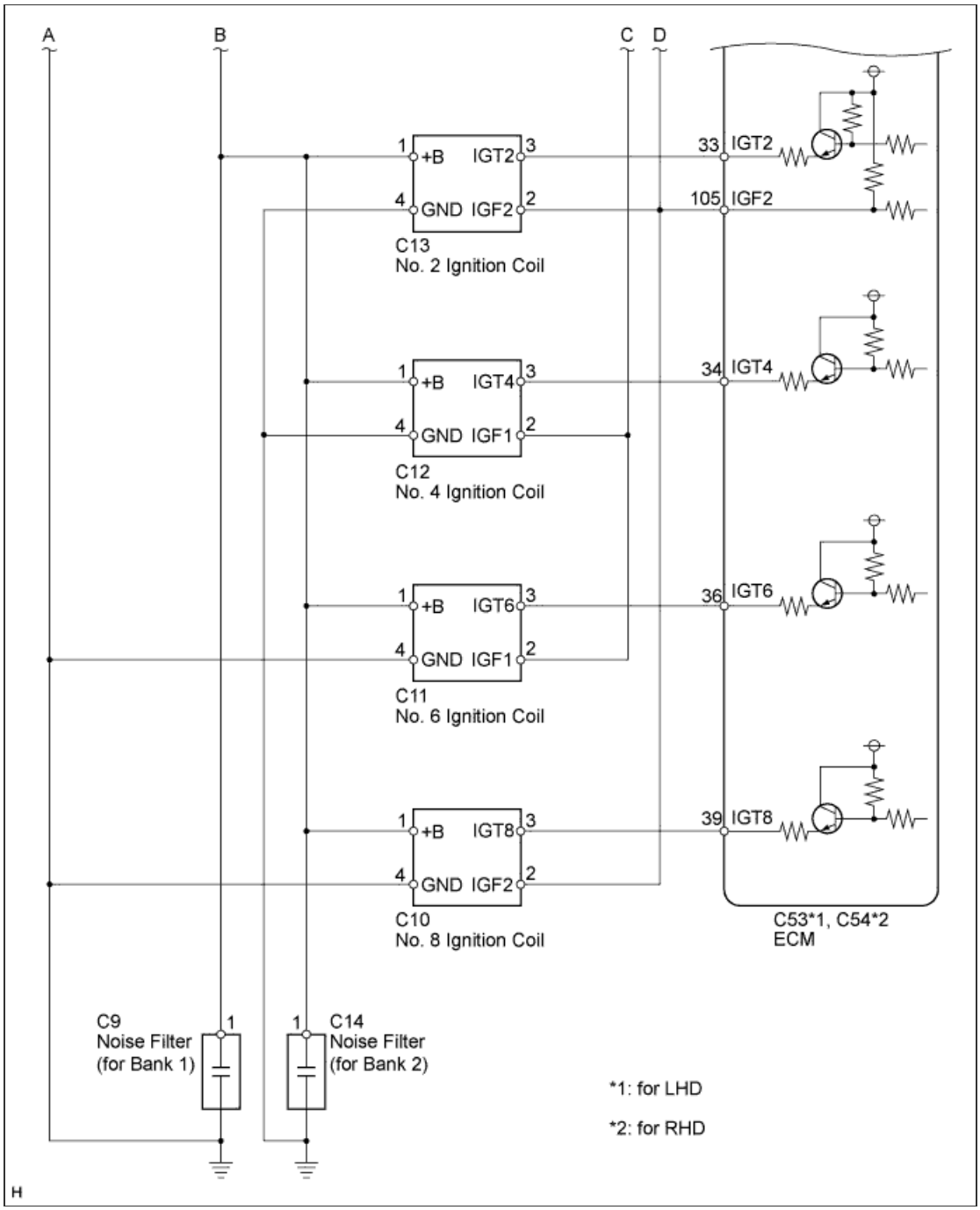
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

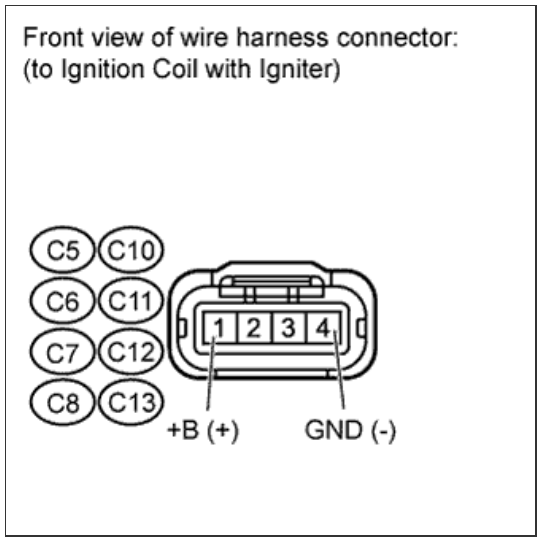
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

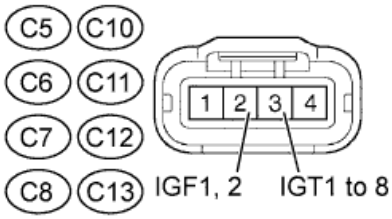
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

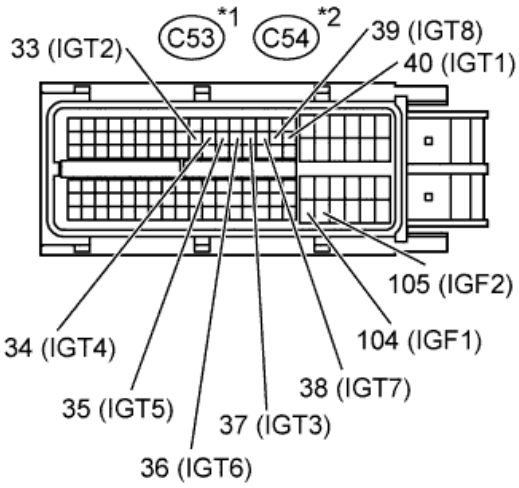
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

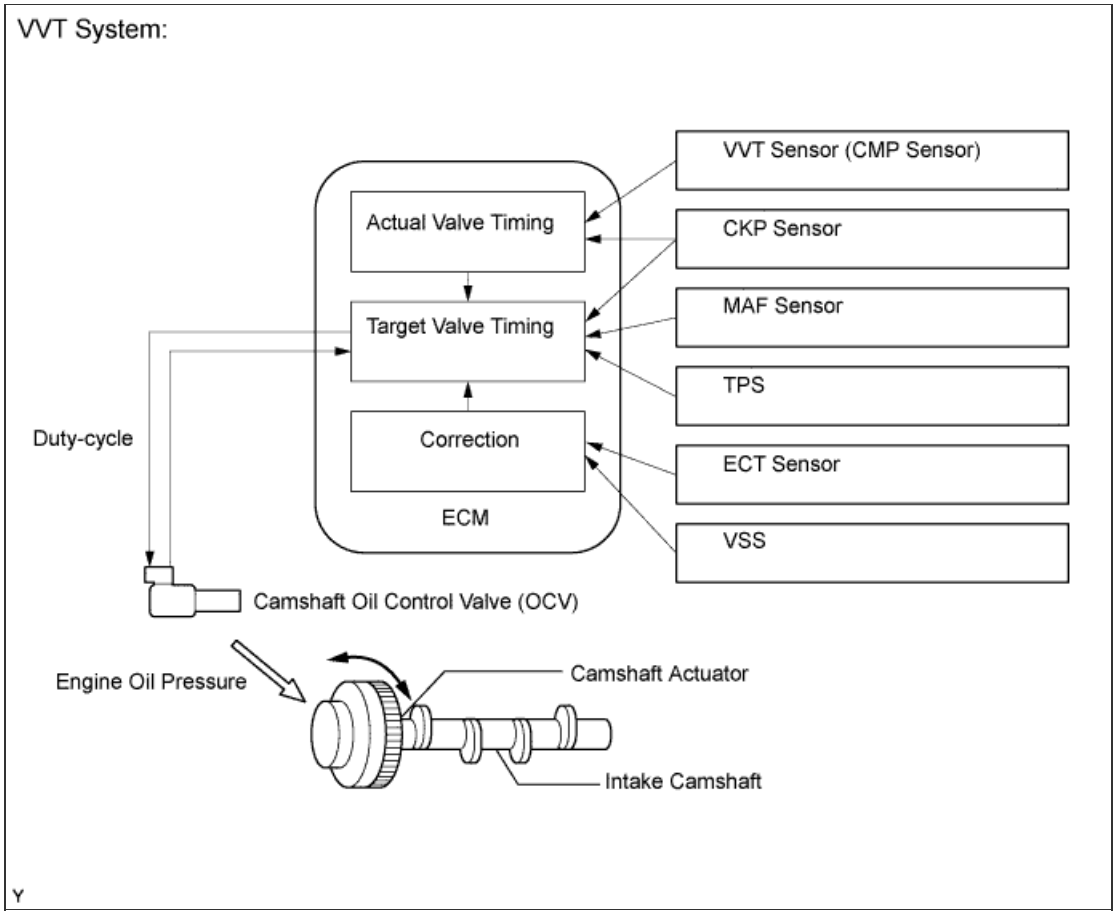
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

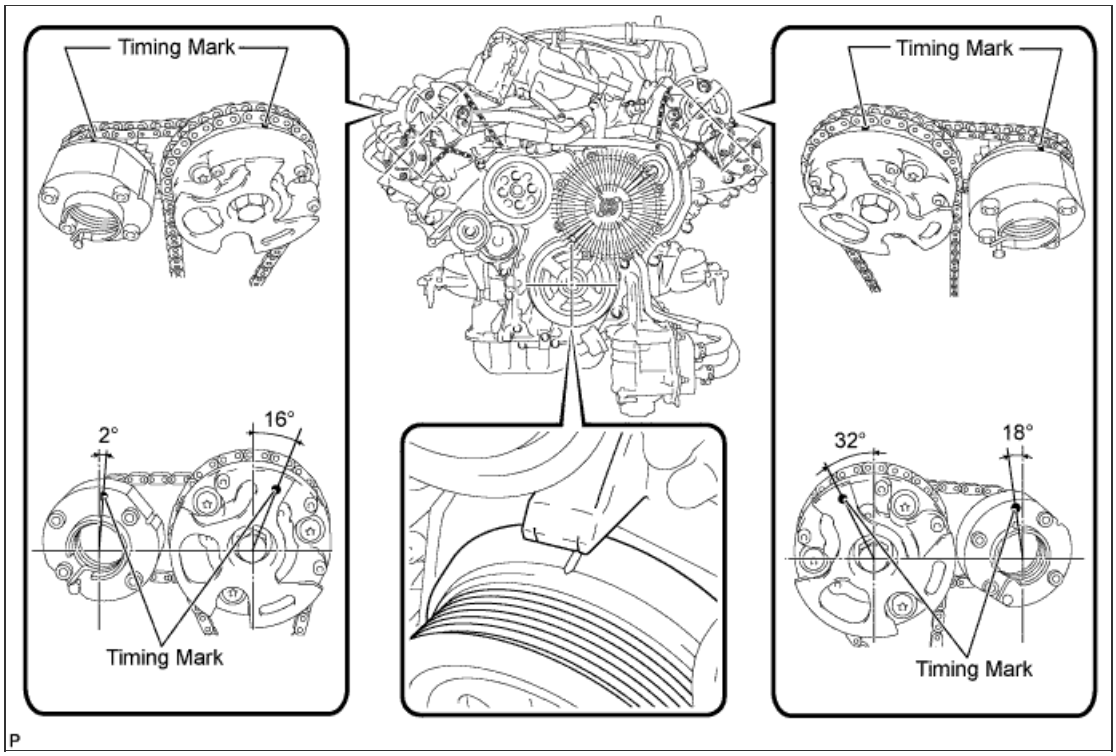
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

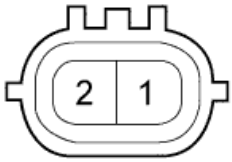
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

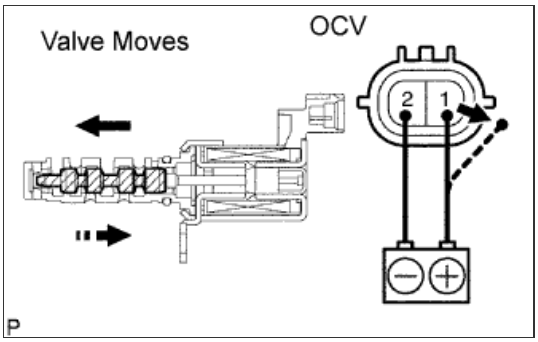
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

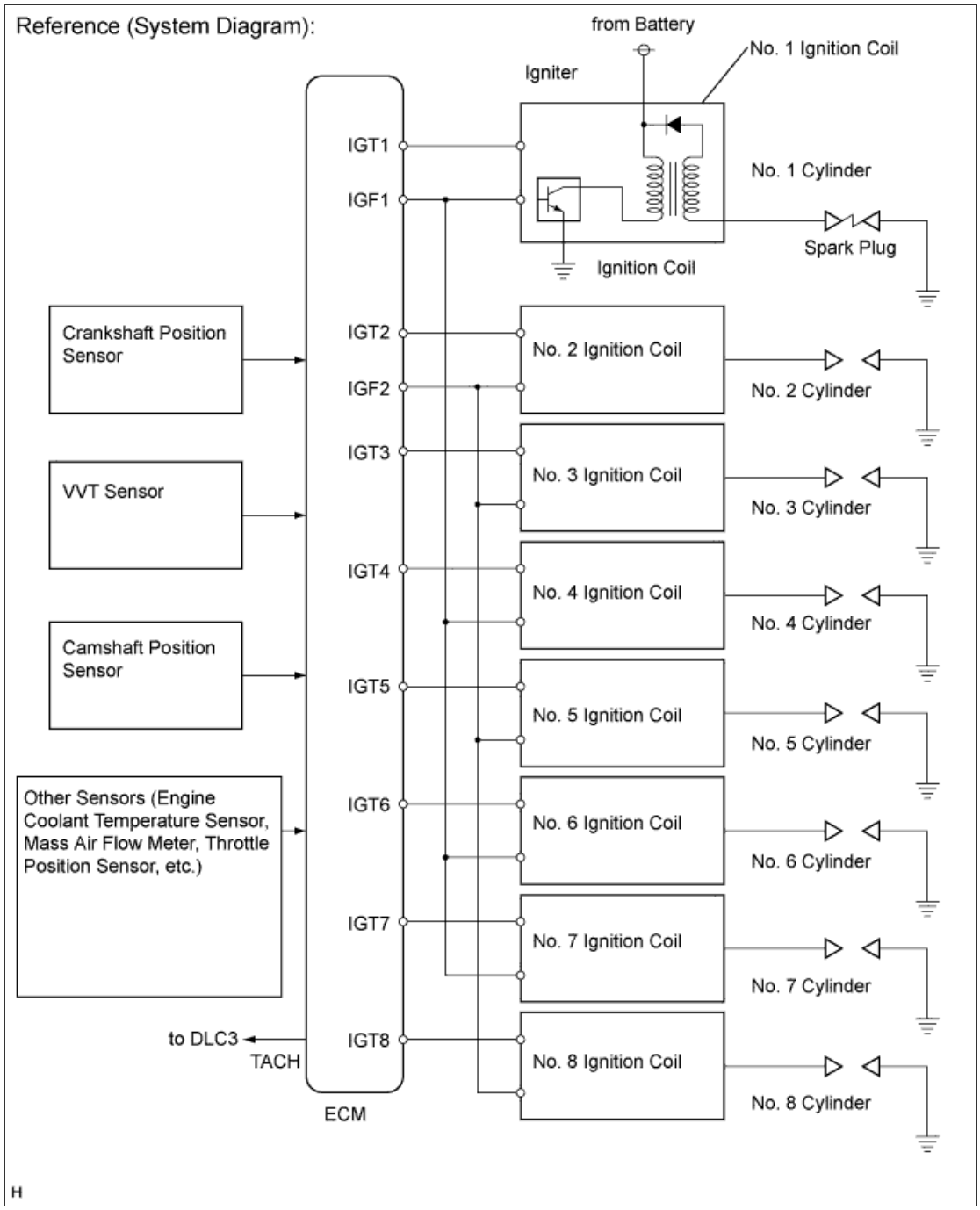
for Preparation Click here

DESCRIPTION

HINT:

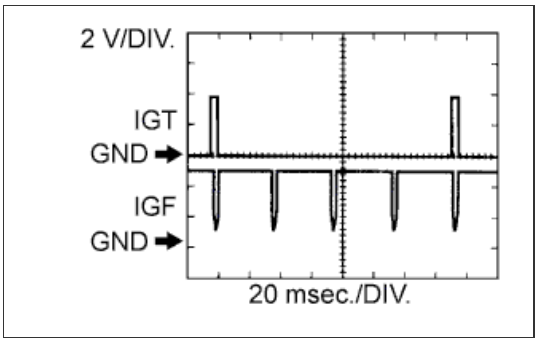
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

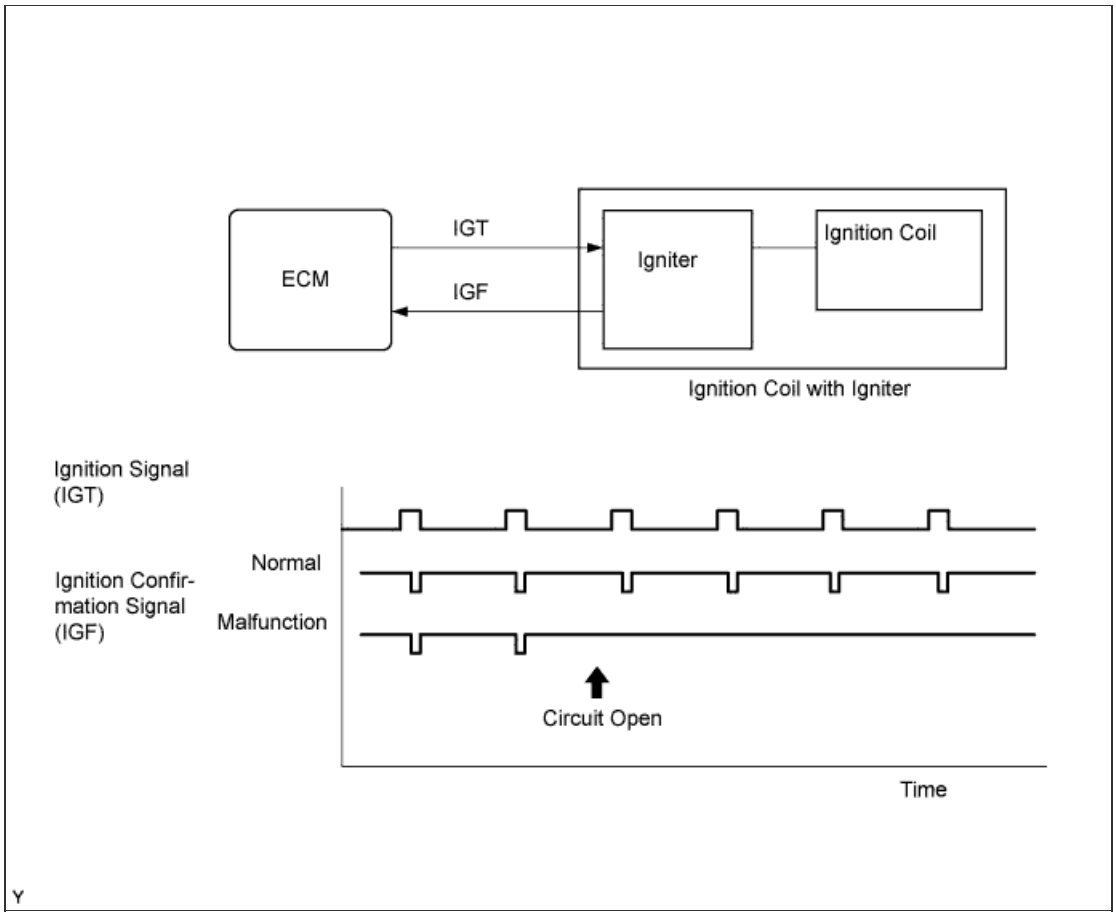
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

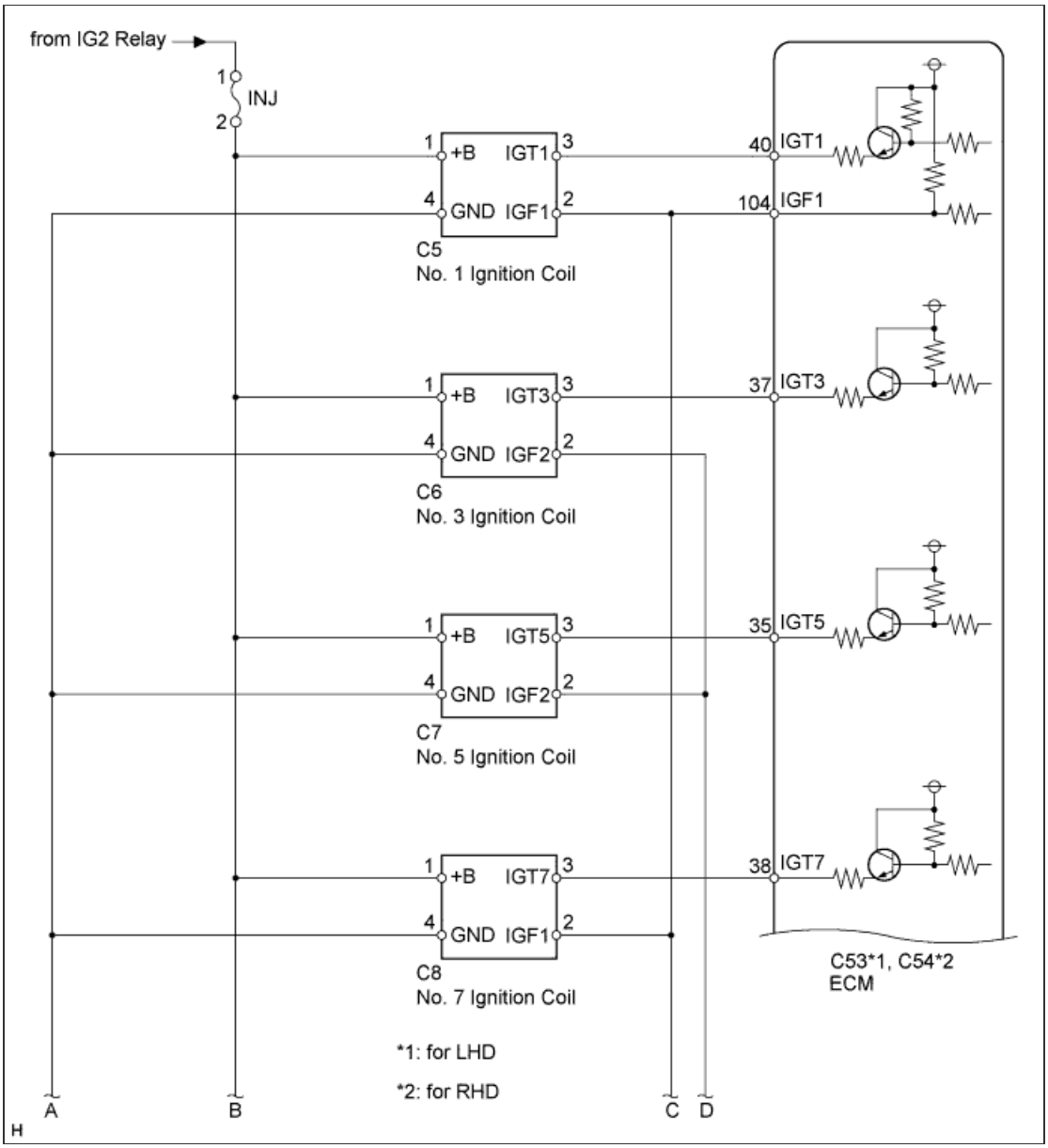
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

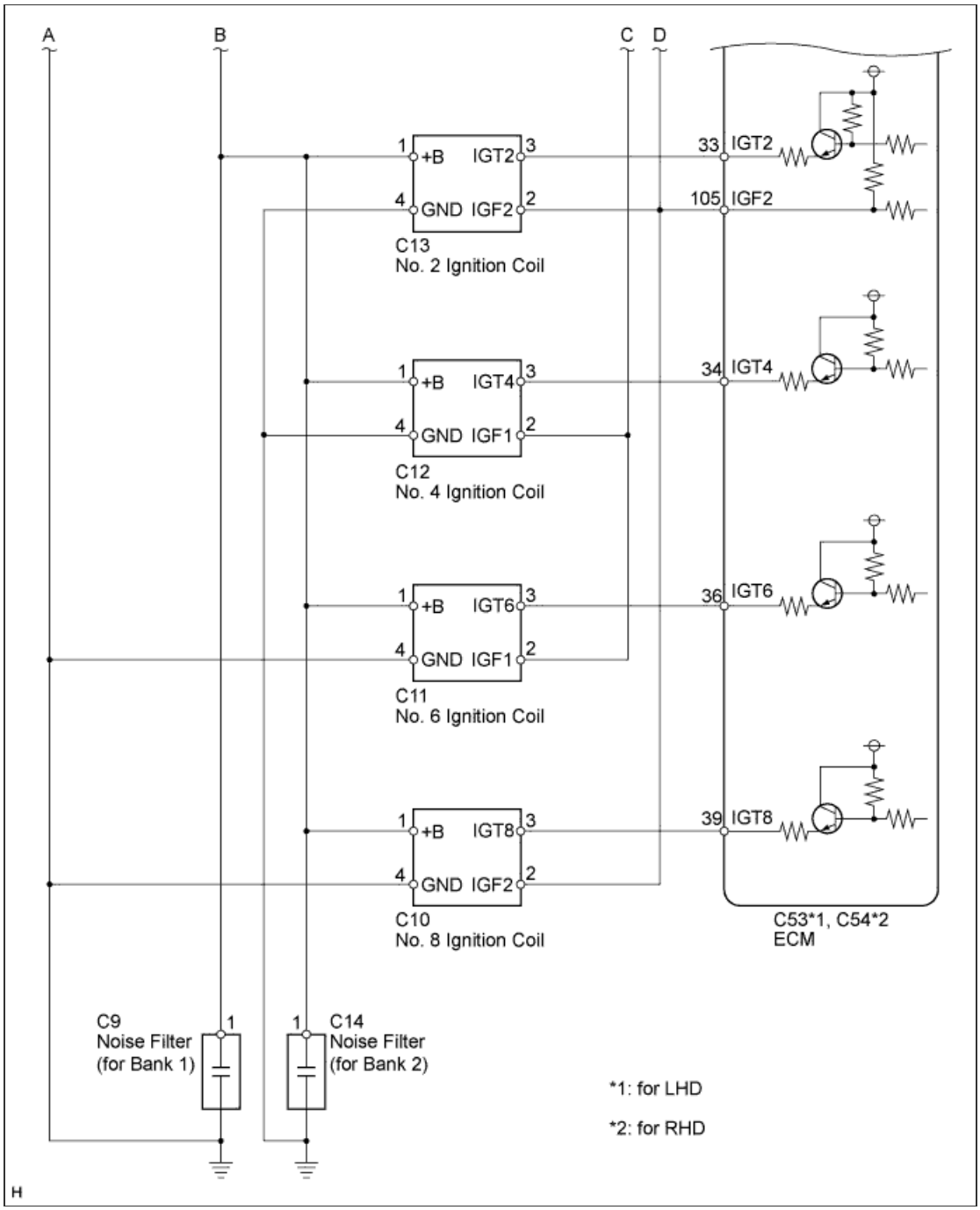
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

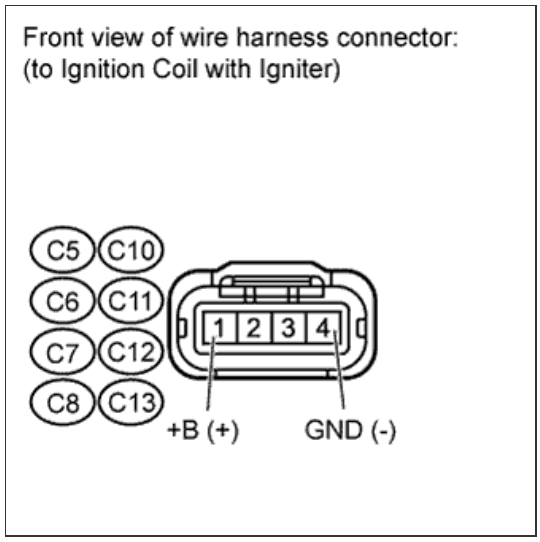
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

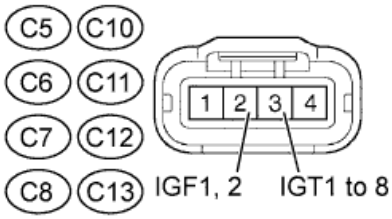
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

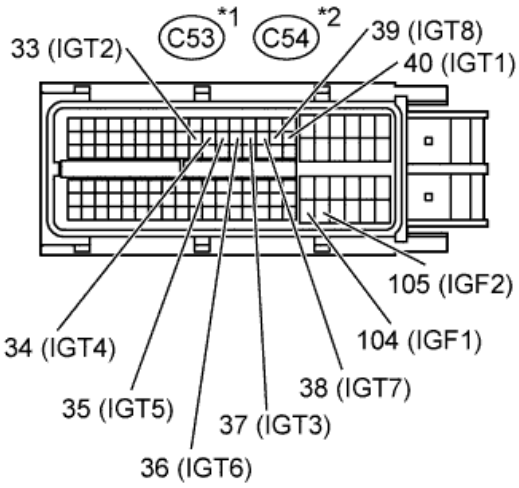
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

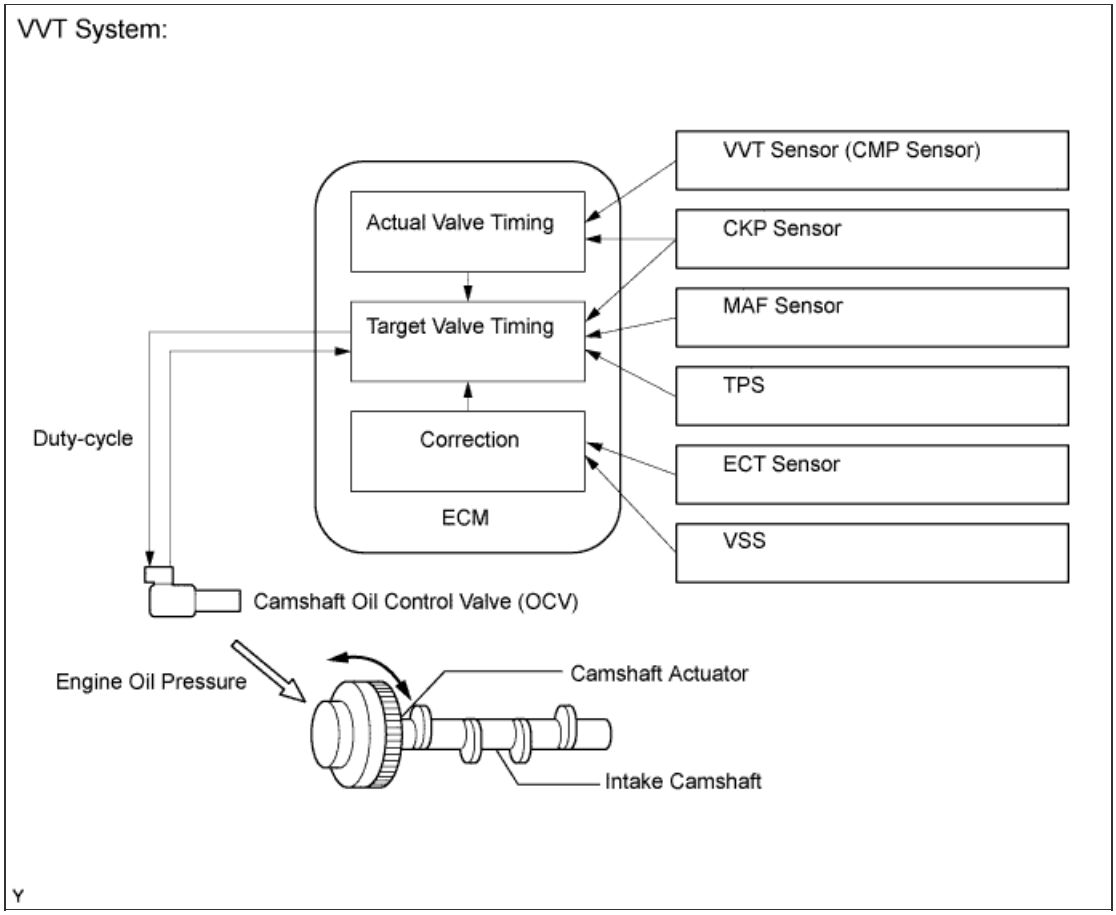
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

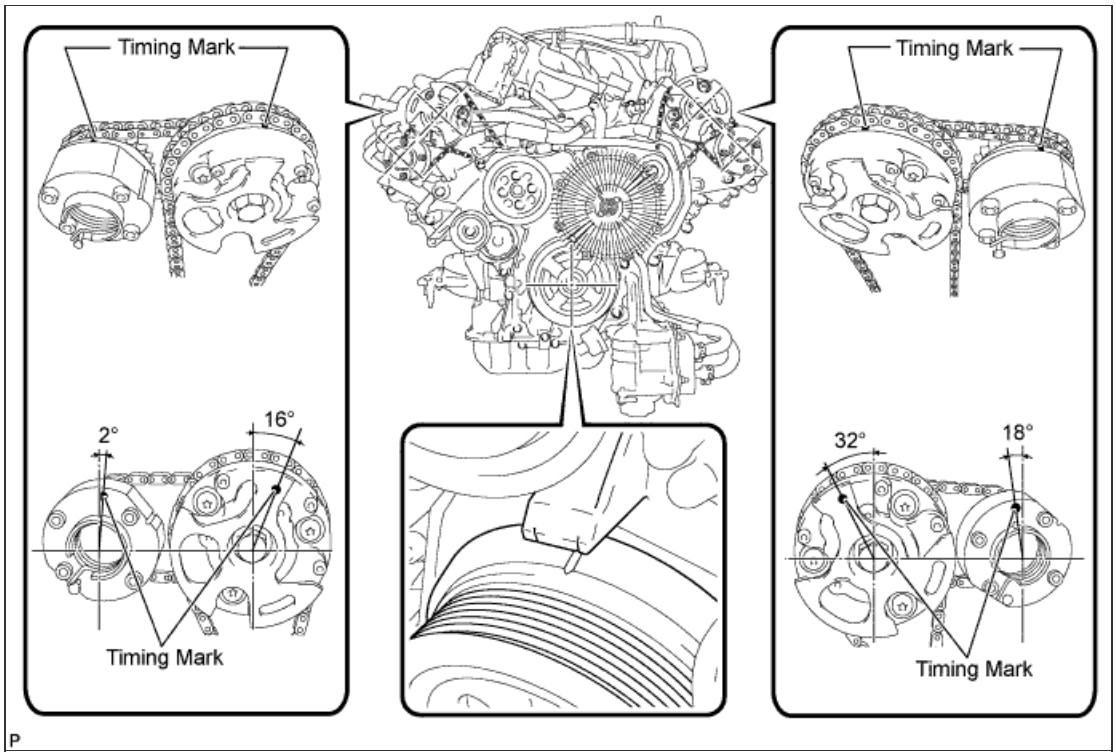
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

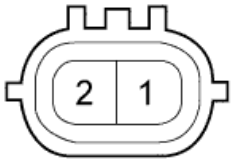
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

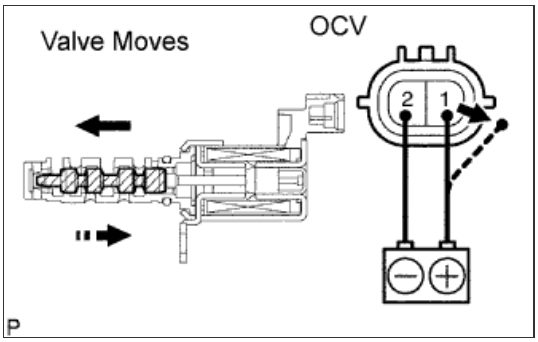
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

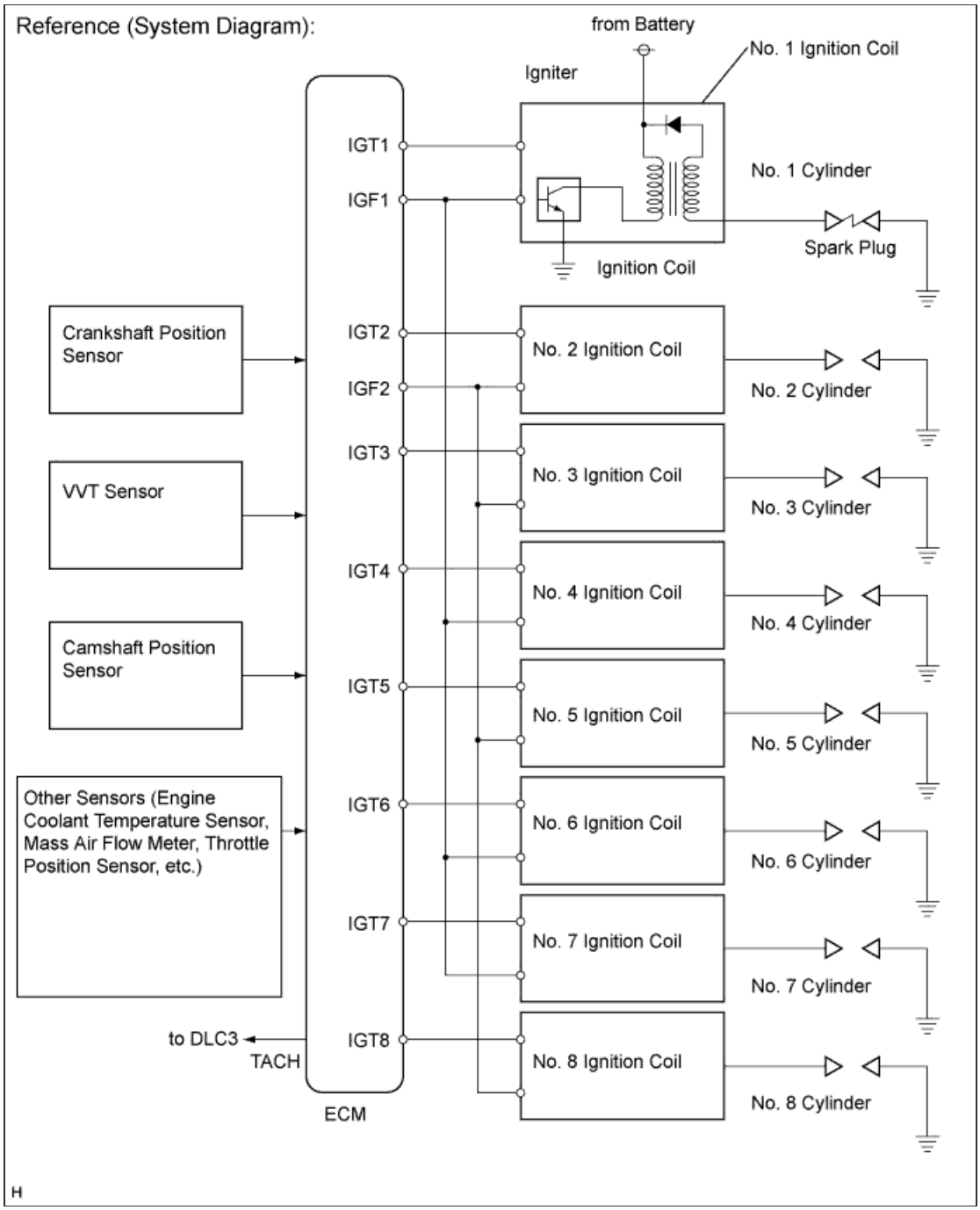
for Preparation Click here

DESCRIPTION

HINT:

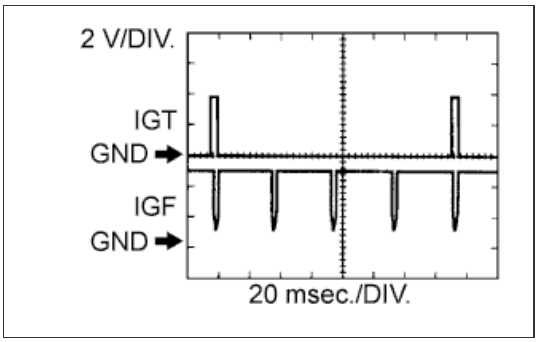
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

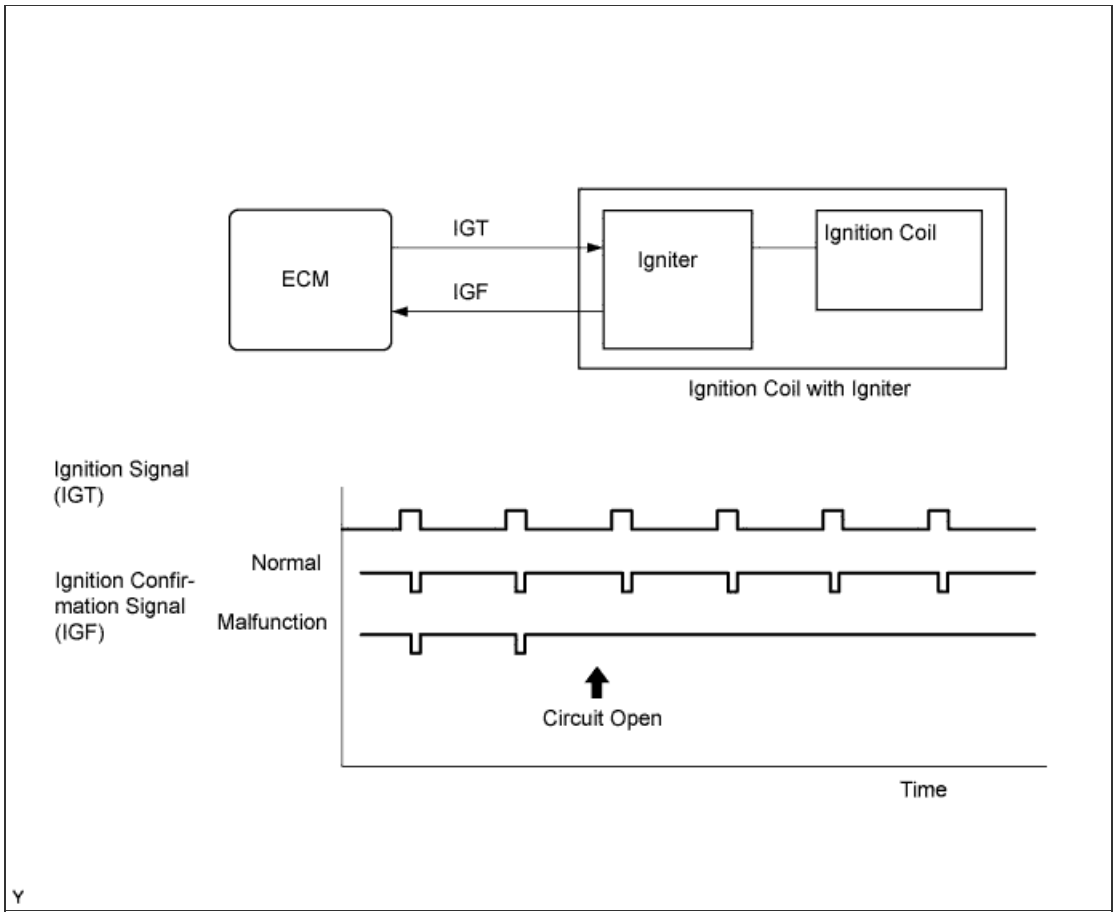
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

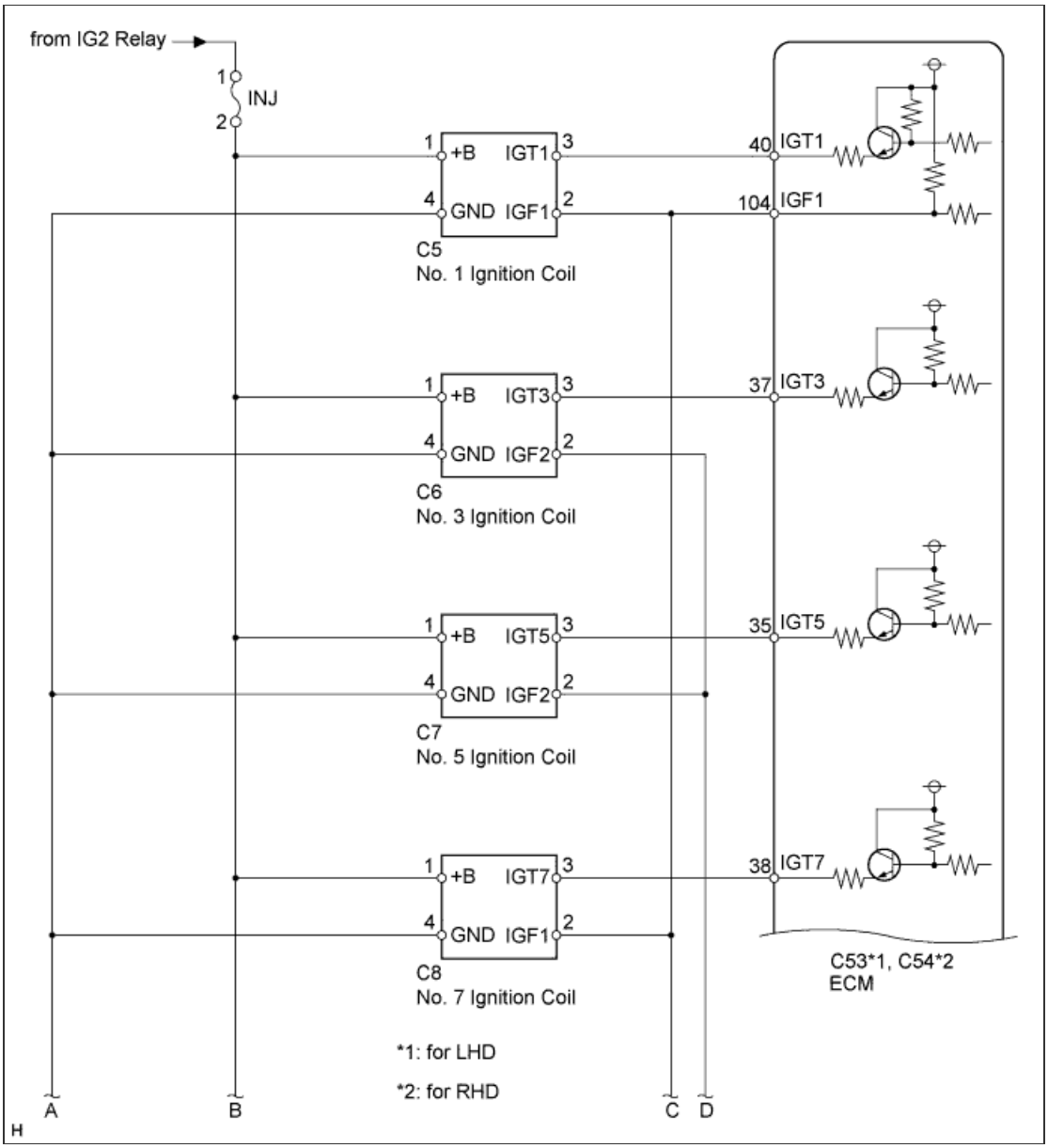
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

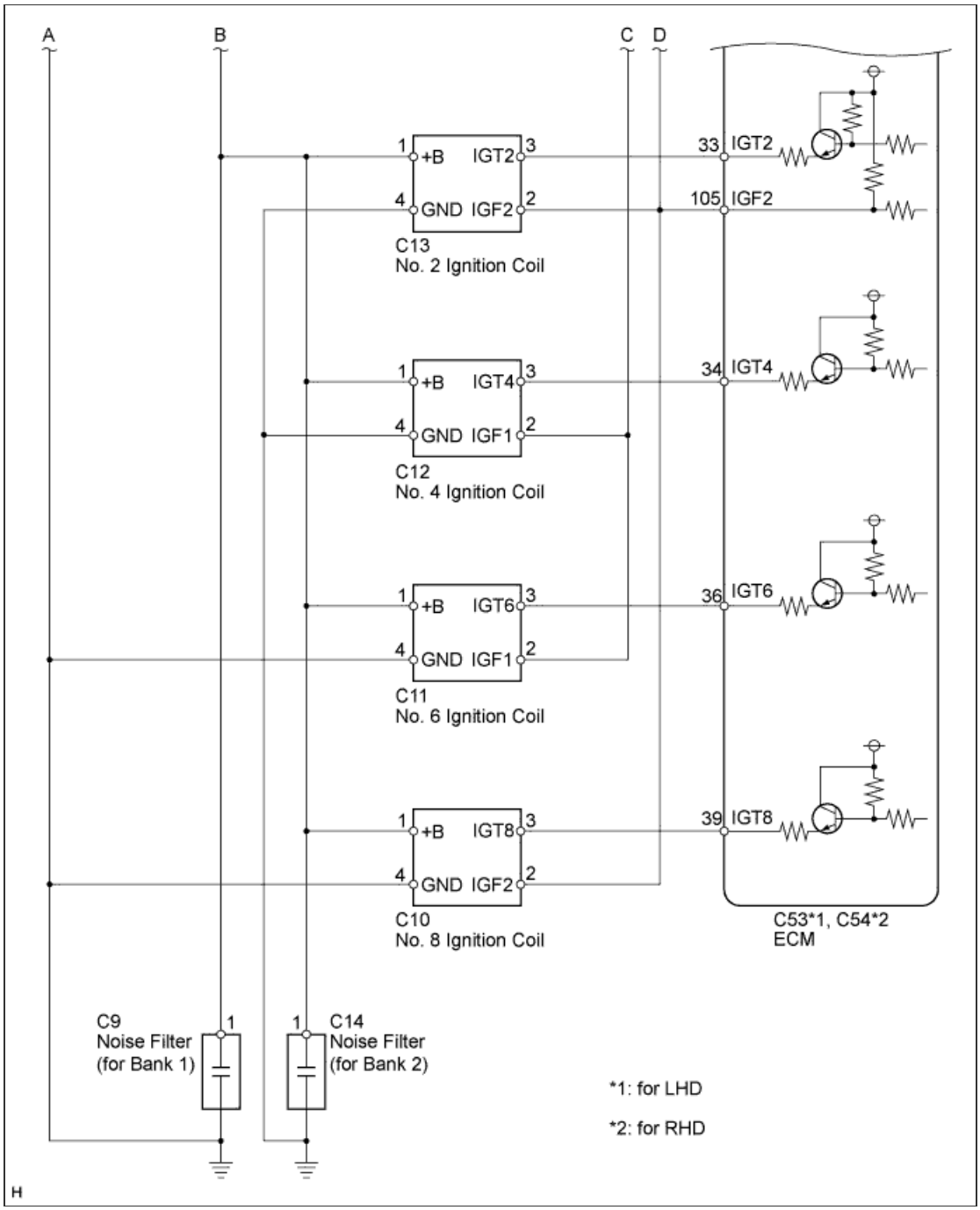
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

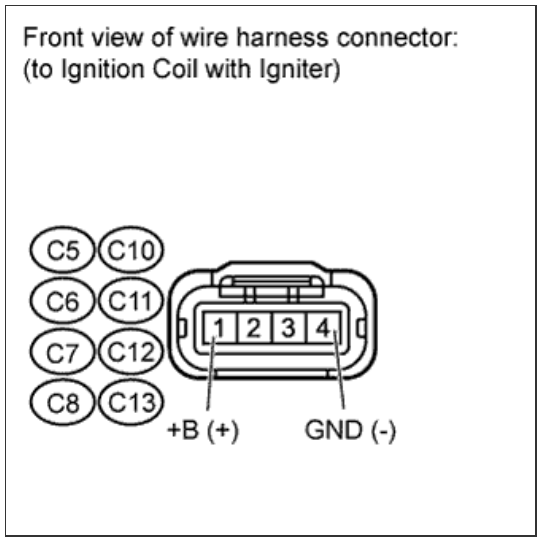
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

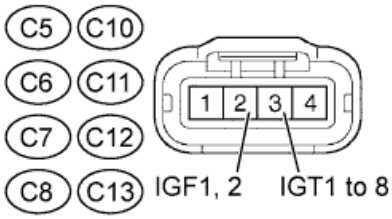
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

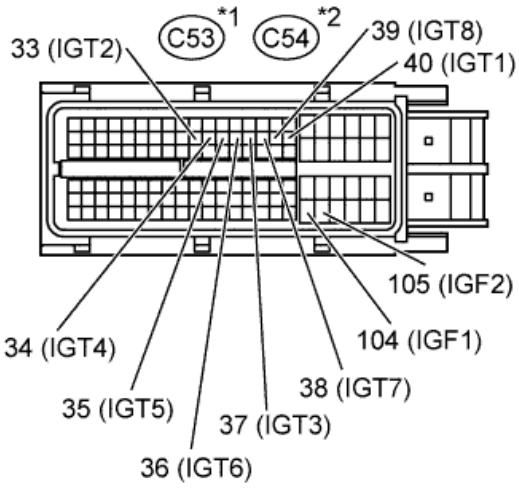
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0011 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0012 Camshaft Position "A" - Timing Over-Retarded (Bank 1)

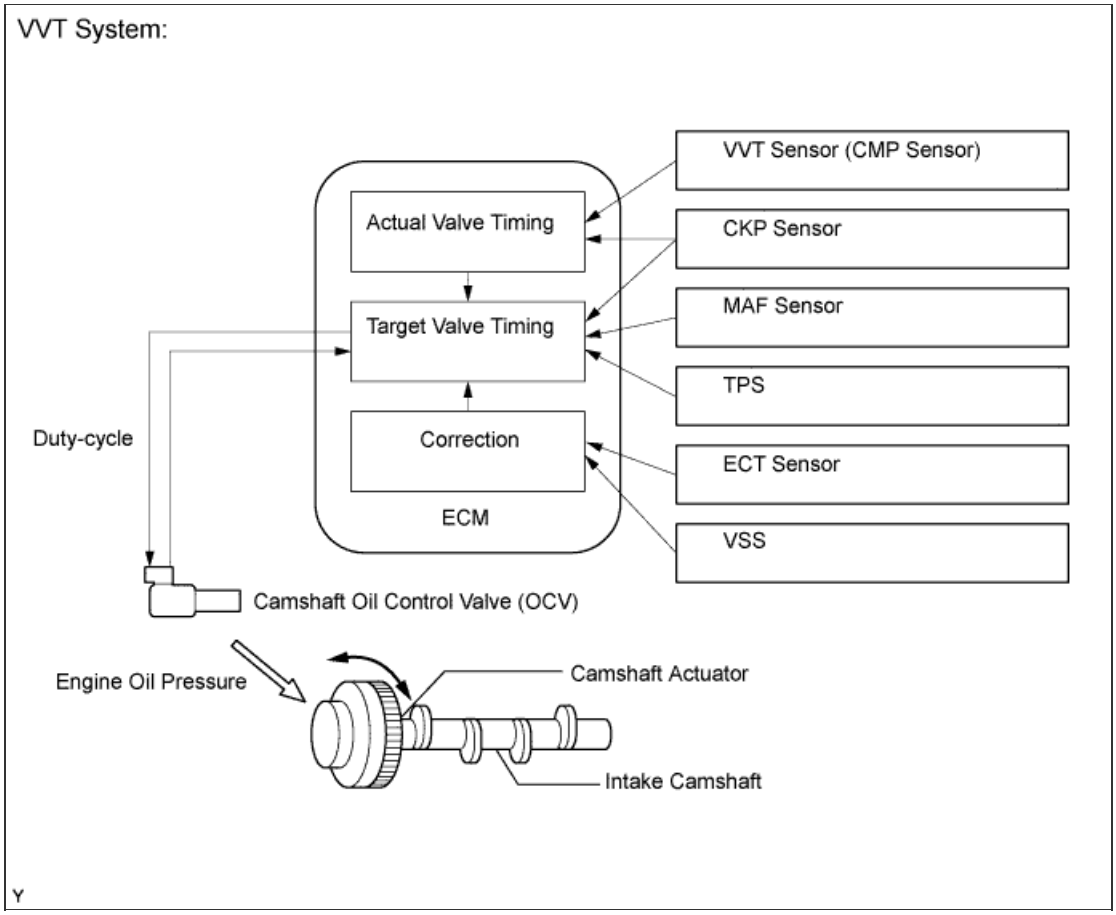
DTC P0021 Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0022 Camshaft Position "A" - Timing Over-Retarded (Bank 2)

for Preparation Click here

DESCRIPTION

The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0011 P0021	The intake valve timing is not adjusted in the valve timing advance range (1 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM
P0012 P0022	The intake valve timing is not adjusted in the valve timing retard range (2 trip detection logic).	• Valve timing • OCV (for intake side of Bank 1, 2) • OCV filter • Camshaft timing gear • ECM

MONITOR DESCRIPTION

The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).

Example:
A DTC is stored when the following conditions 1, 2 and 3 are met:

1. The difference between the target and actual intake valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
2. It takes 5 seconds or more to change the valve timing by 5° CA.
3. After above conditions 1 and 2 are met, the OCV is forcibly activated during 10 seconds.

DTC P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTC P0012 and P0022 (Retarded Cam Timing) are subject to 2 trip detection logic.
These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
The monitor will run if all of the following conditions are met:

- The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
- The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
- The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0010 (Click here).

INSPECTION PROCEDURE

HINT:

DTC P0011, P0012, P0021 or P0022 may be stored when foreign objects in the engine oil are caught in some parts of the system. The DTC will remain stored even if the system returns to normal after a short time. Foreign objects are filtered out by the oil filter.

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- **If DTC P0011 or P0012 is output, check the left bank VVT system for intake side circuit (for Bank 1).**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0021 or P0022 is output, check the right bank VVT system for intake side circuit (for Bank 2).**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0011, P0012, P0021 or P0022 is output	A
P0011, P0012, P0021 or P0022 and other DTCs are output	B

HINT:

If any DTCs other than P0011, P0012, P0021 or P0022 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0011, P0012, P0021 OR P0022)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read DTCs using the tester.

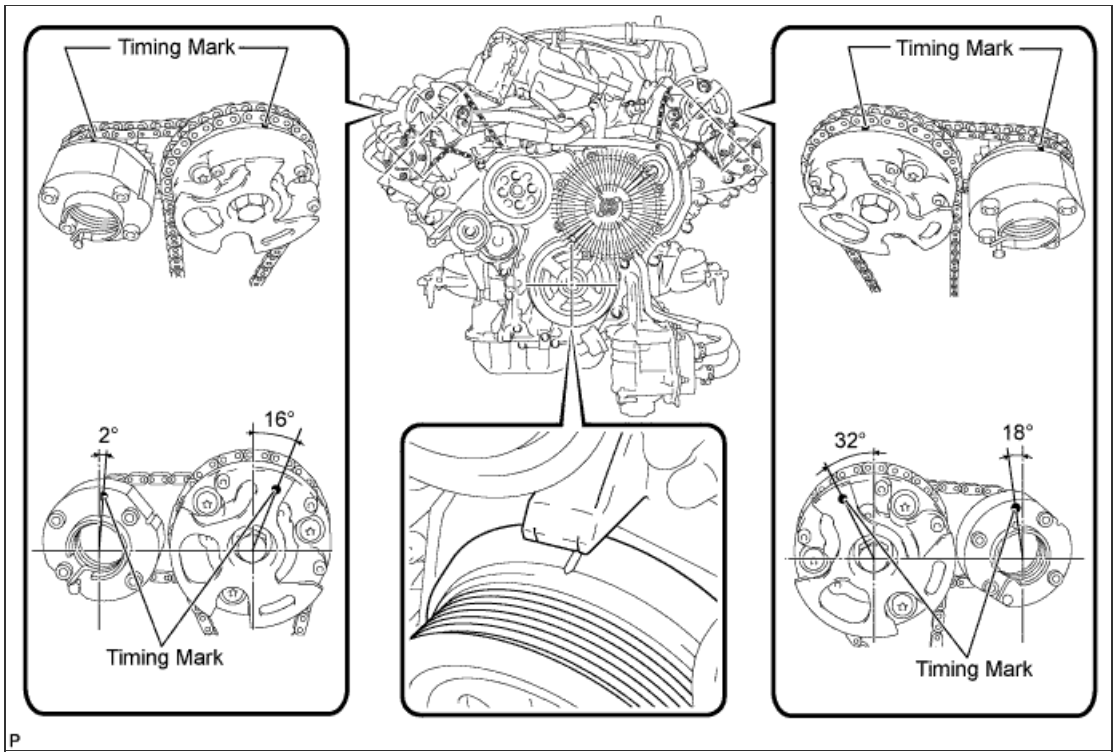
OK:
No DTC output.

NG → **Go to step 4**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

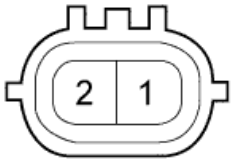
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

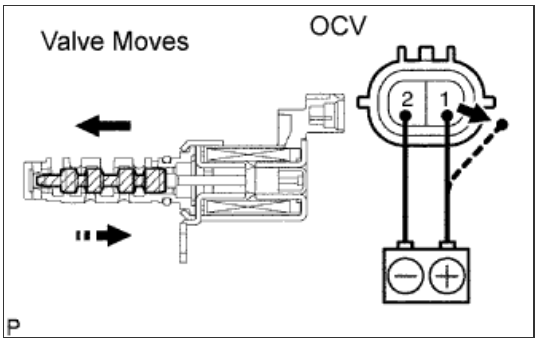
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the OCV filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE INTAKE CAMSHAFT TIMING GEAR

a. Replace the intake camshaft timing gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTCs (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester.

f. Drive the vehicle for more than 10 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC is output.

HINT:

DTC P0011, P0012, P0021 or P0022 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

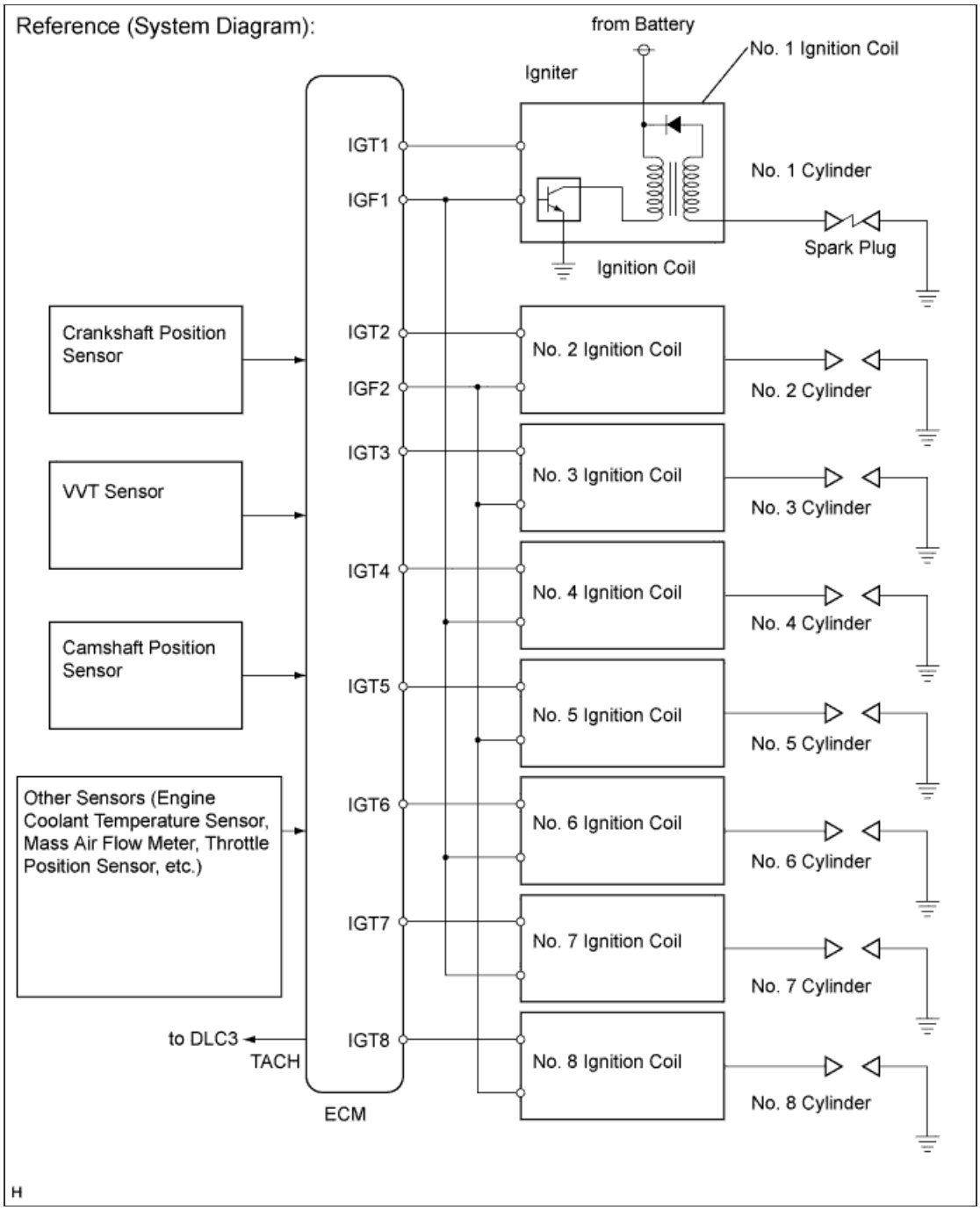
for Preparation Click here

DESCRIPTION

HINT:

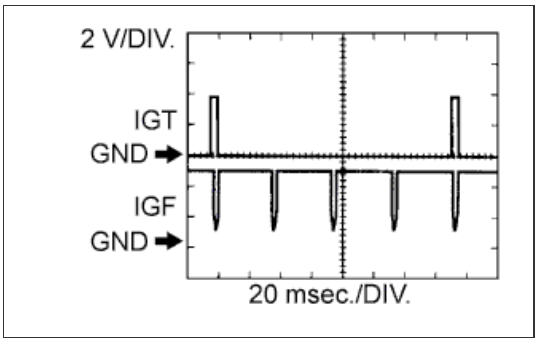
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

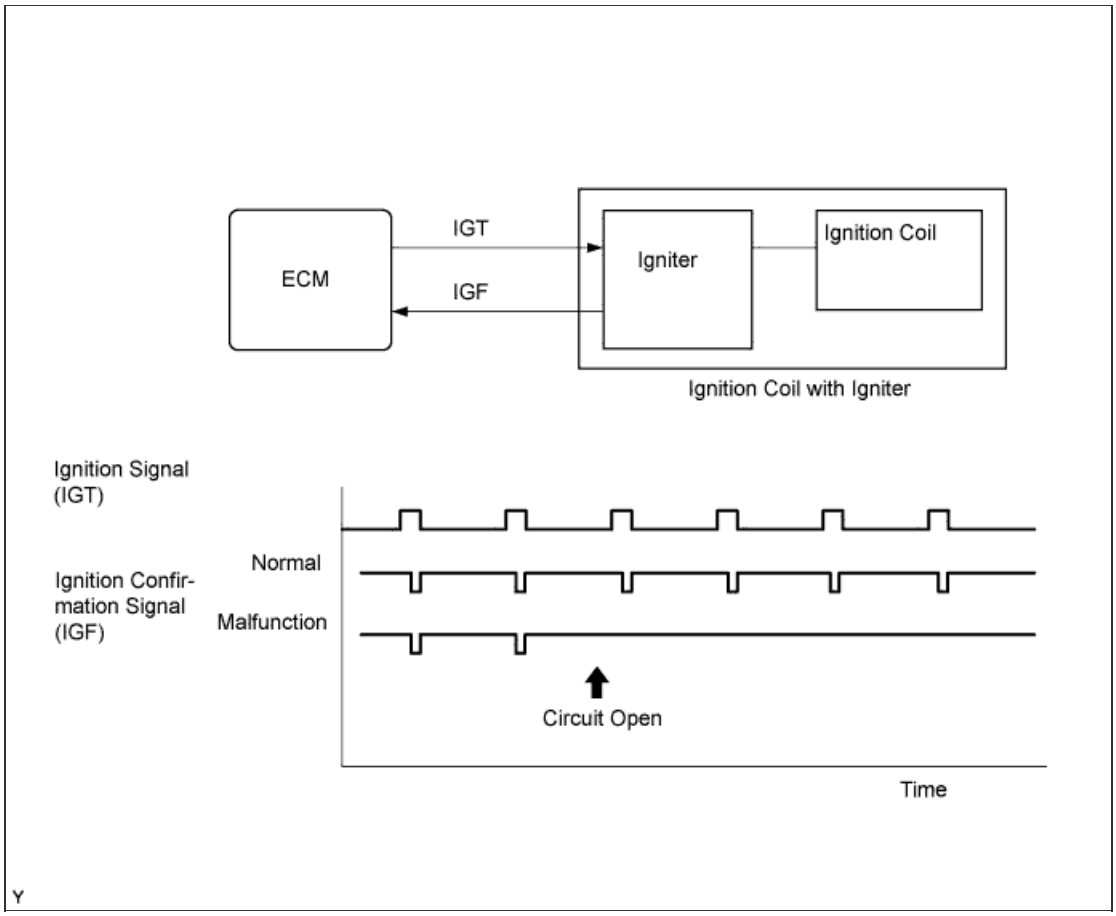
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

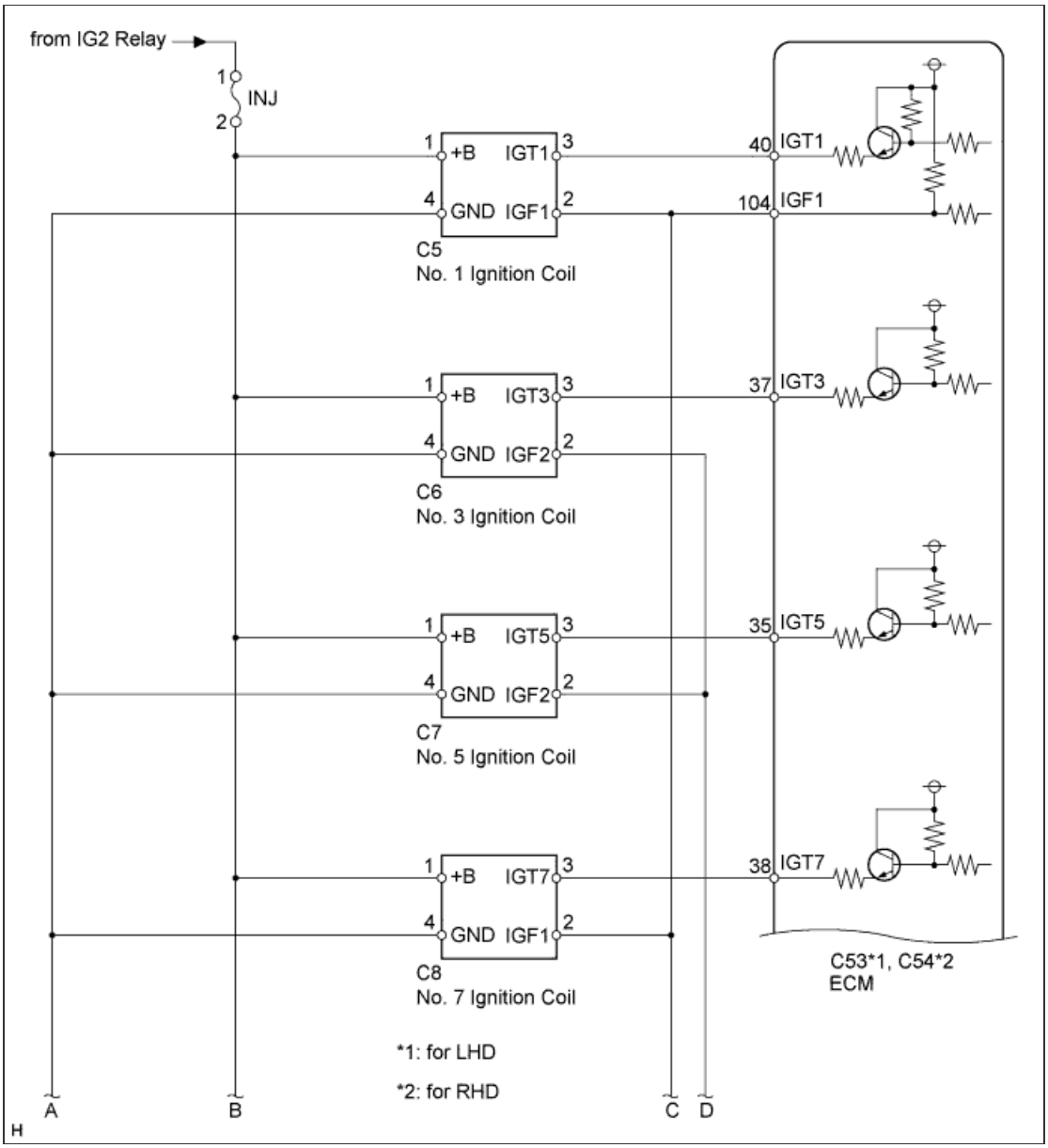
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

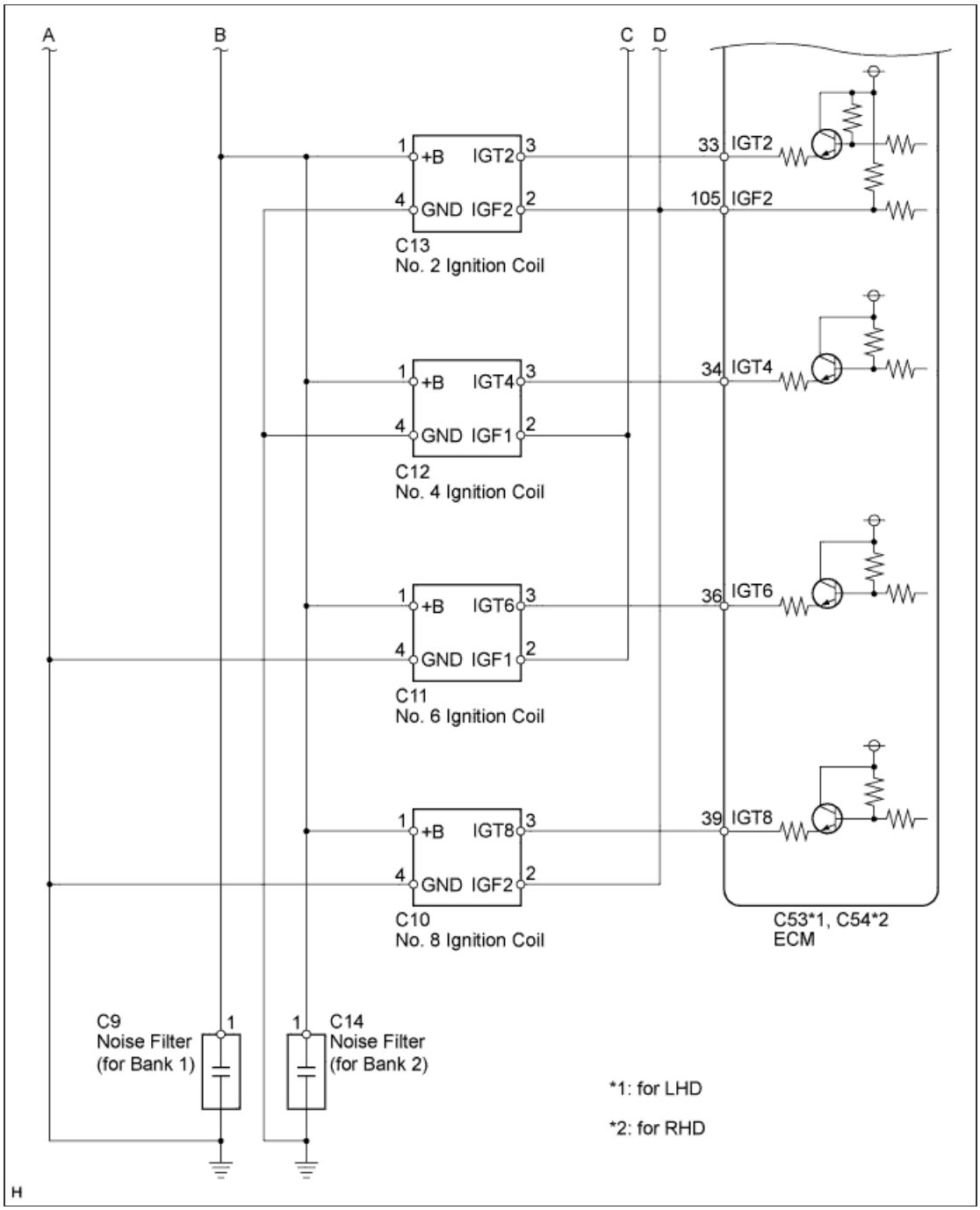
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

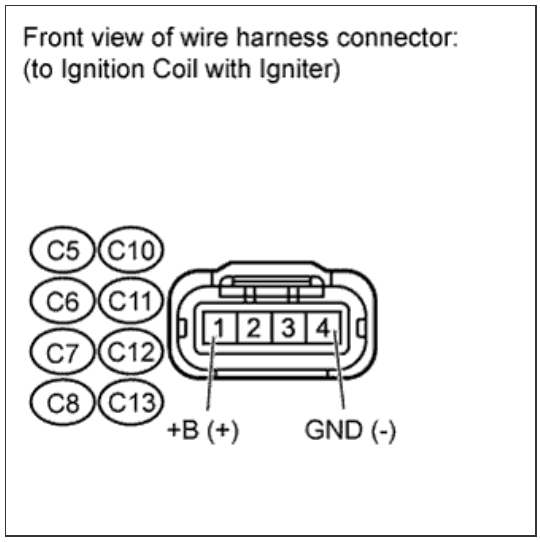
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

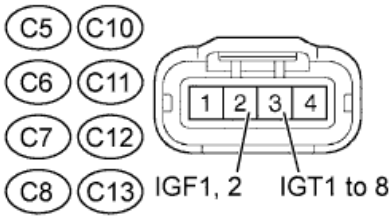
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

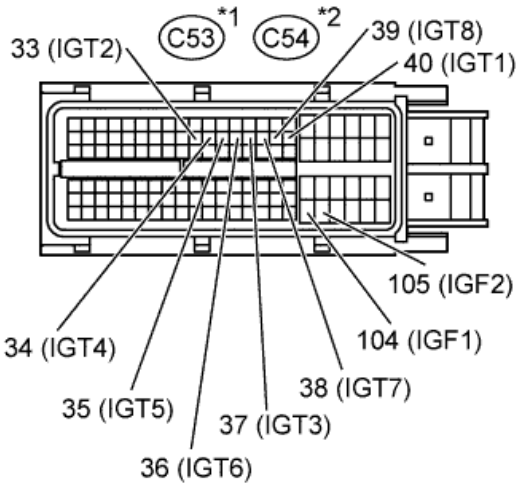
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

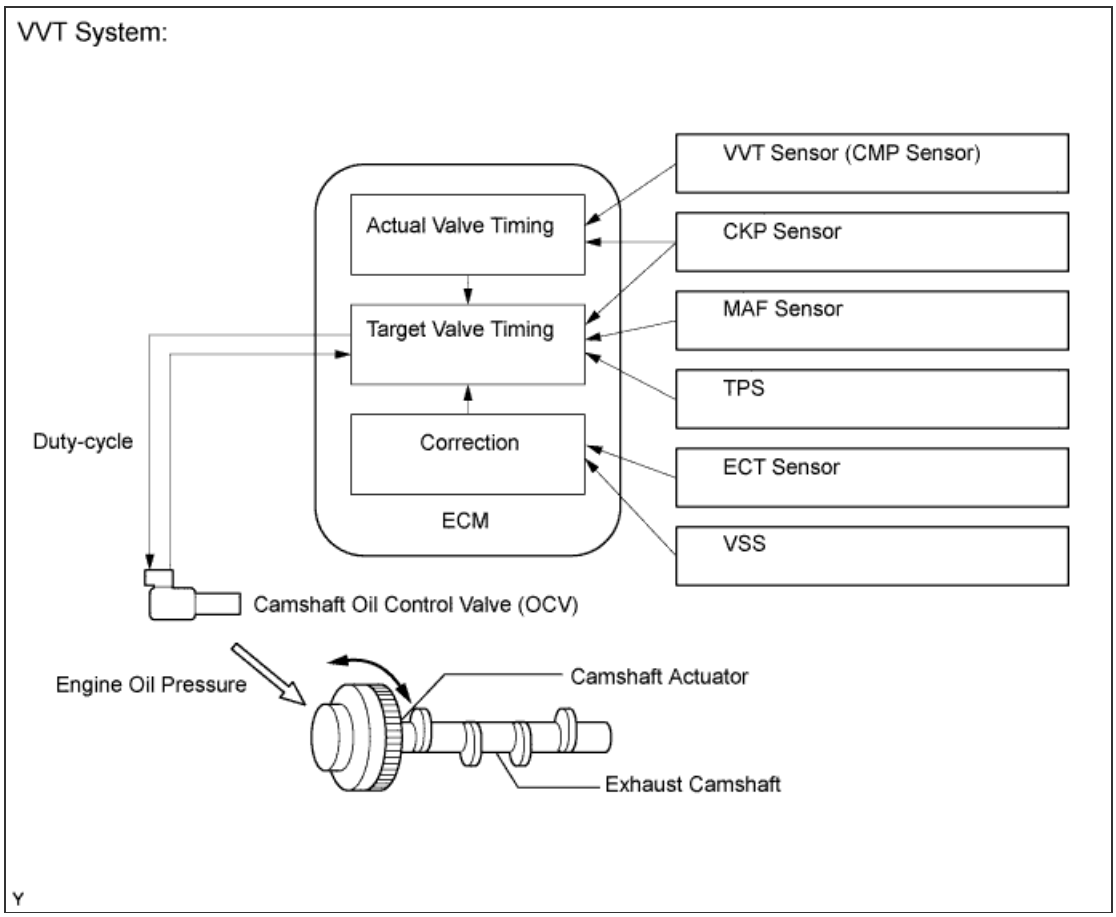
DTC P0013 Camshaft Position "B" Actuator Circuit / Open (Bank 1)

DTC P0023 Camshaft Position "B" Actuator Circuit / Open (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the Camshaft Oil Control Valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 volts to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.

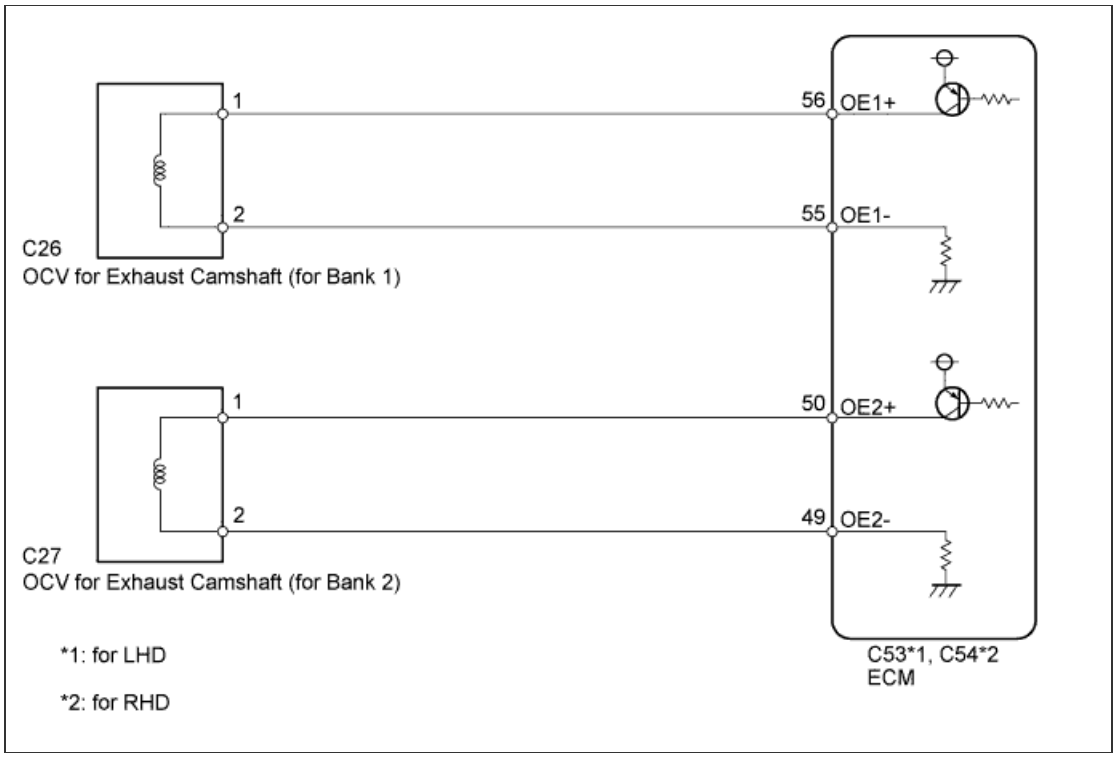


DTC Code	DTC Detection Condition	Trouble Area
P0013	An open or short in the Camshaft Oil Control Valve (OCV) for exhaust side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1) circuit • OCV (for exhaust side of Bank 1) • ECM
P0023	An open or short in the OCV for exhaust side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for exhaust side of Bank 2) circuit • OCV (for exhaust side of Bank 2) • ECM

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If DTC P0013 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0023 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK DTC (DTC P0013 OR P0023)

a. Connect the intelligent tester to the DLC3.

b. Clear DTC after recording the freeze frame data and DTC.

c. Turn the engine switch off.

d. Allow the engine to idle and check DTC.

e. Check that P0013 or P0023 is not output.

OK:
P0013 or P0023 is not output.

NG → **Go to step 2**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Disconnect the C26 or C27 OCV connector.

b. Remove the camshaft oil control valve (OCV) (Click here).

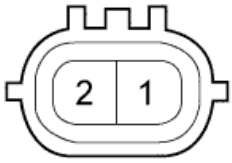
c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified

		Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG

REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

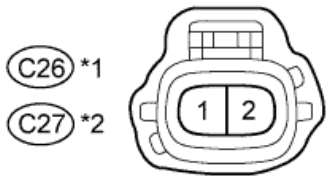
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C26 or C27 OCV connector.

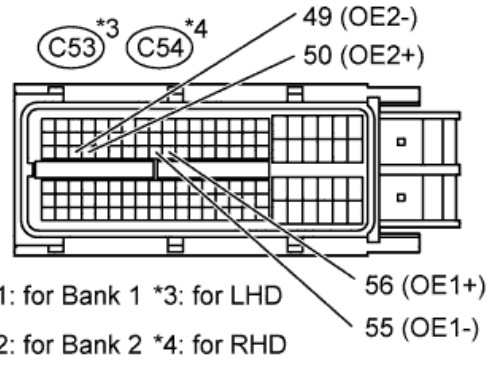
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C26-1 - C53-56 (OE1+)	Always	Below 1 Ω
C26-2 - C53-55 (OE1-)	Always	Below 1 Ω
C27-1 - C53-50 (OE2+)	Always	Below 1 Ω
C27-2 - C53-49 (OE2-)	Always	Below 1 Ω

C26-1 or C53-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C53-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C53-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C53-49 (OE2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C26-1 - C54-56 (OE1+)	Always	Below 1 Ω
C26-2 - C54-55 (OE1-)	Always	Below 1 Ω
C27-1 - C54-50 (OE2+)	Always	Below 1 Ω
C27-2 - C54-49 (OE2-)	Always	Below 1 Ω
C26-1 or C54-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C54-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C54-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C54-49 (OE2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

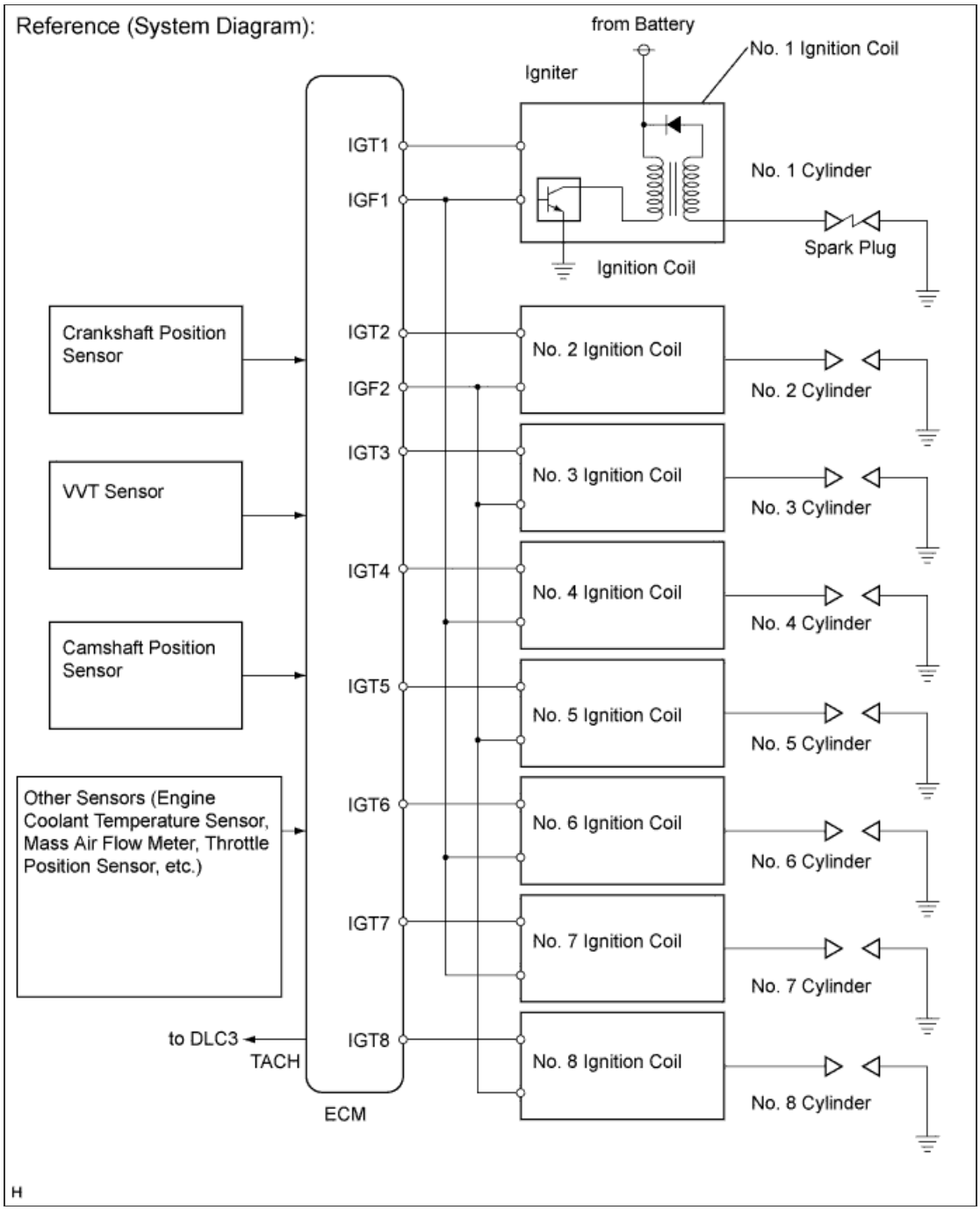
for Preparation Click here

DESCRIPTION

HINT:

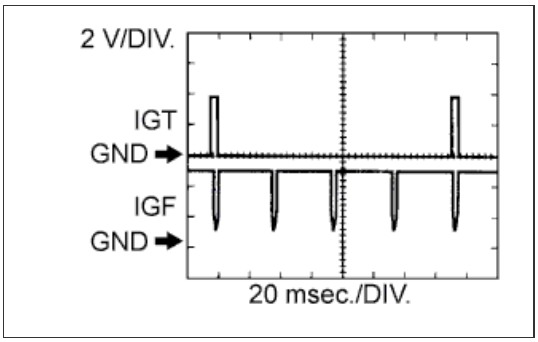
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

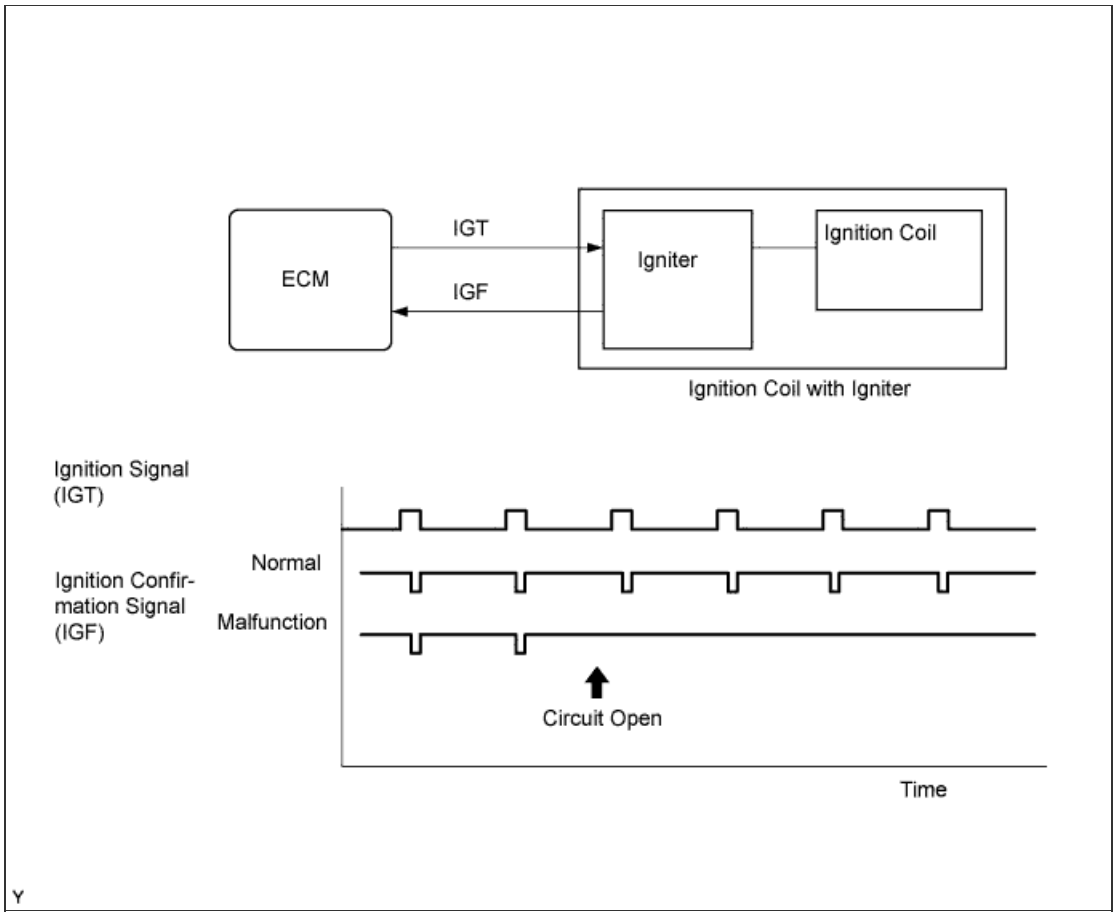
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

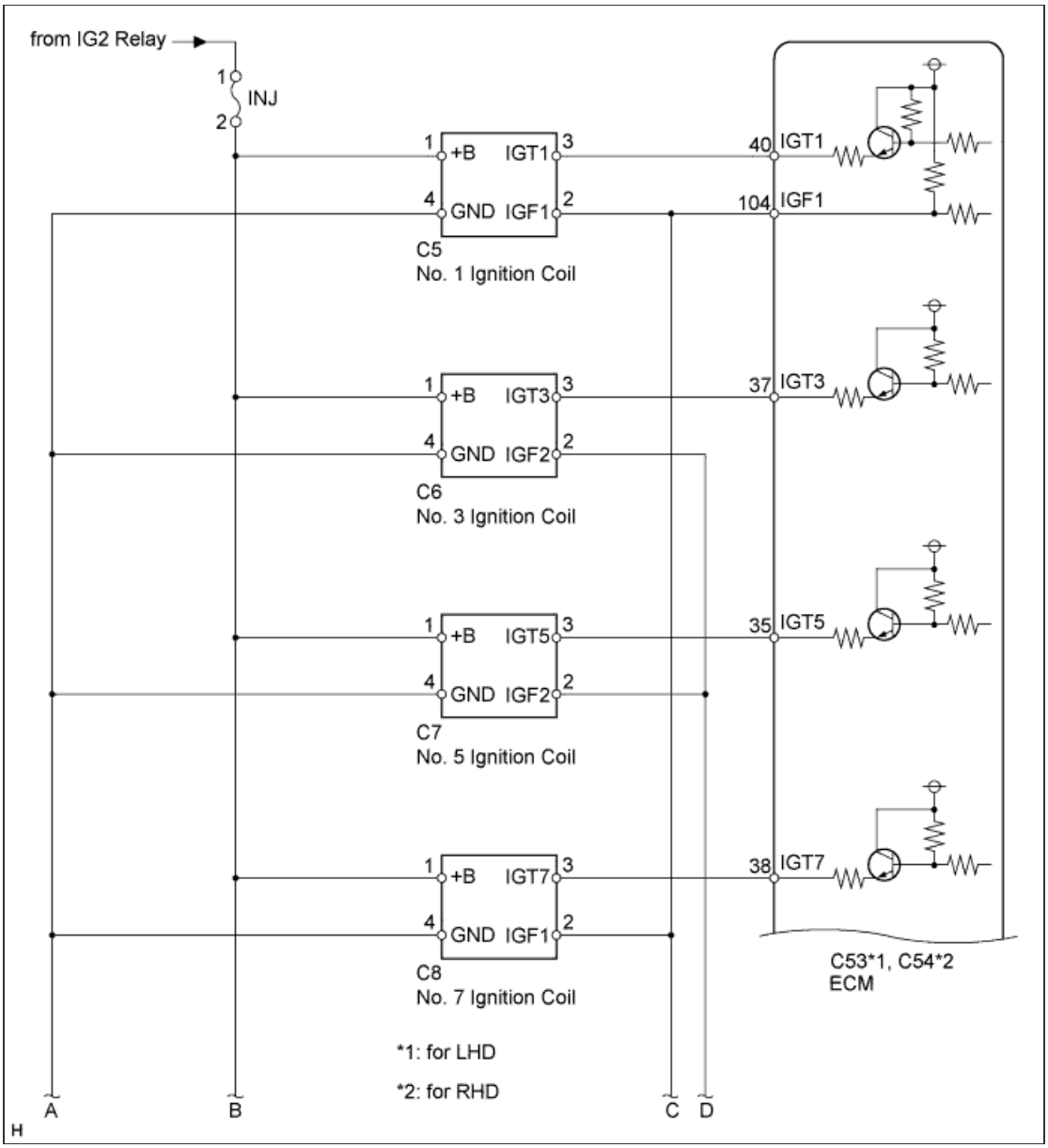
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

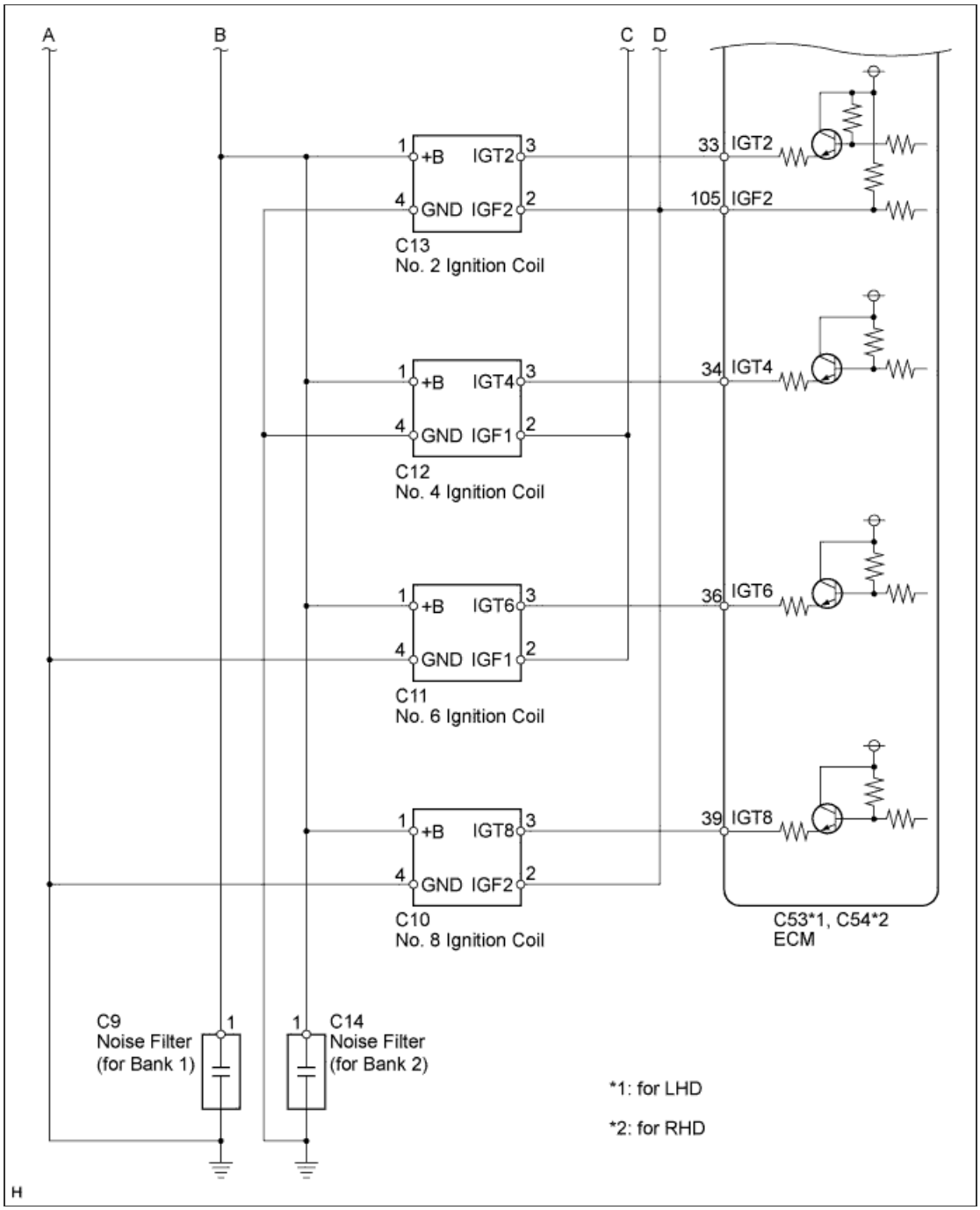
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

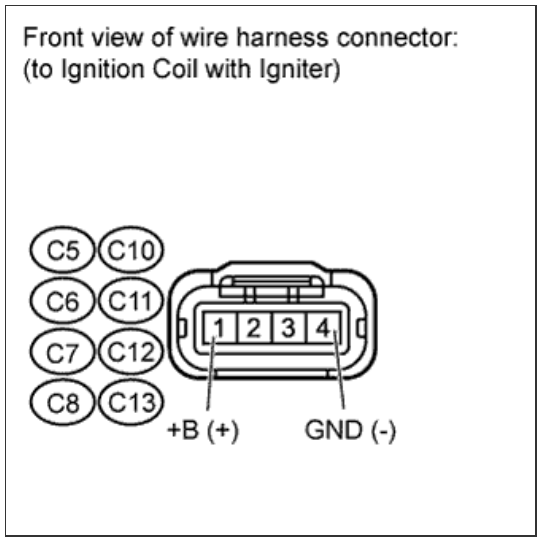
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

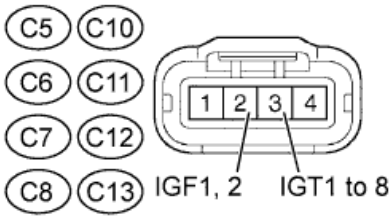
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

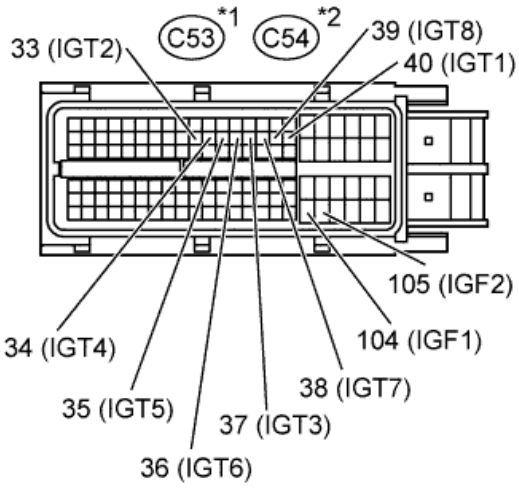
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

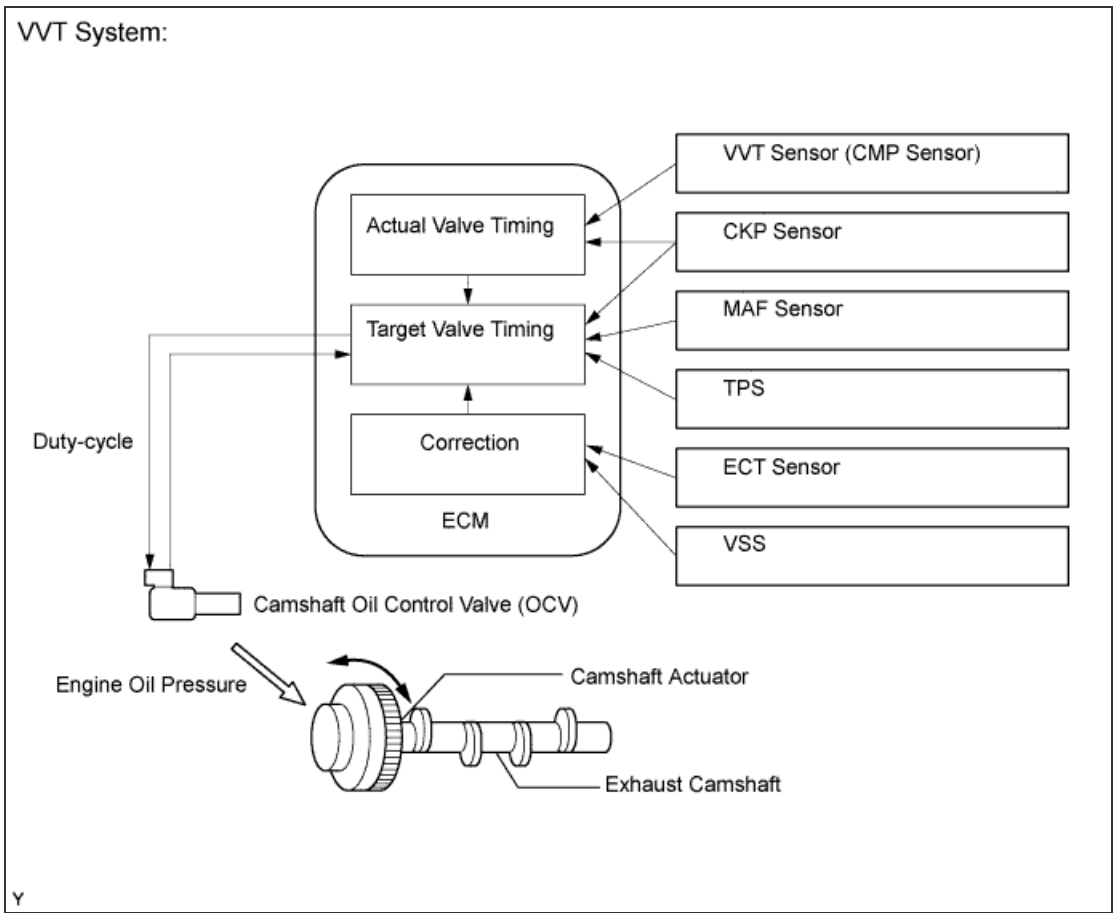
DTC P0013 Camshaft Position "B" Actuator Circuit / Open (Bank 1)

DTC P0023 Camshaft Position "B" Actuator Circuit / Open (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the Camshaft Oil Control Valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 volts to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.

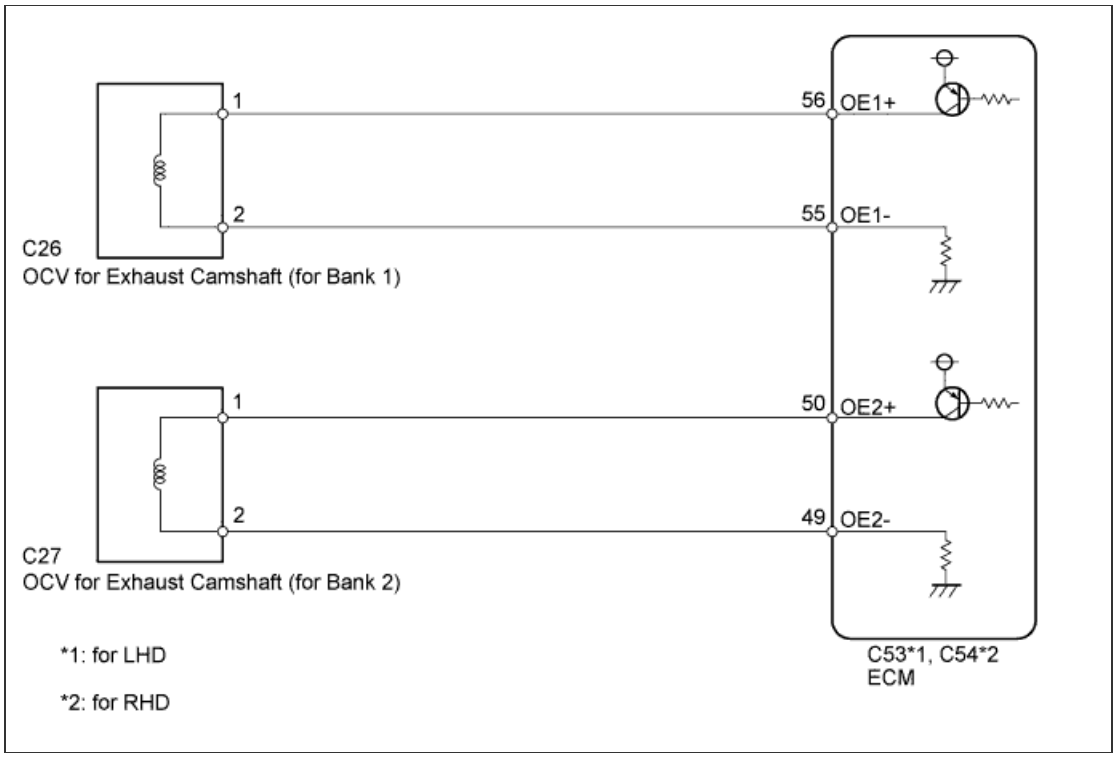


DTC Code	DTC Detection Condition	Trouble Area
P0013	An open or short in the Camshaft Oil Control Valve (OCV) for exhaust side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1) circuit • OCV (for exhaust side of Bank 1) • ECM
P0023	An open or short in the OCV for exhaust side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for exhaust side of Bank 2) circuit • OCV (for exhaust side of Bank 2) • ECM

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If DTC P0013 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0023 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK DTC (DTC P0013 OR P0023)

a. Connect the intelligent tester to the DLC3.

b. Clear DTC after recording the freeze frame data and DTC.

c. Turn the engine switch off.

d. Allow the engine to idle and check DTC.

e. Check that P0013 or P0023 is not output.

OK:
P0013 or P0023 is not output.

NG → **Go to step 2**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Disconnect the C26 or C27 OCV connector.

b. Remove the camshaft oil control valve (OCV) (Click here).

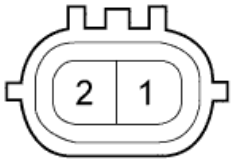
c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified

		Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG

REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

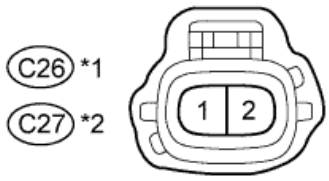
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C26 or C27 OCV connector.

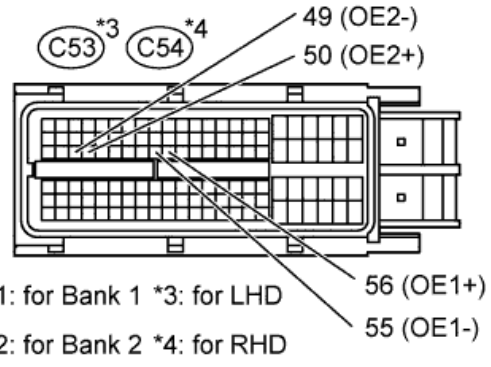
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C26-1 - C53-56 (OE1+)	Always	Below 1 Ω
C26-2 - C53-55 (OE1-)	Always	Below 1 Ω
C27-1 - C53-50 (OE2+)	Always	Below 1 Ω
C27-2 - C53-49 (OE2-)	Always	Below 1 Ω

C26-1 or C53-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C53-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C53-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C53-49 (OE2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C26-1 - C54-56 (OE1+)	Always	Below 1 Ω
C26-2 - C54-55 (OE1-)	Always	Below 1 Ω
C27-1 - C54-50 (OE2+)	Always	Below 1 Ω
C27-2 - C54-49 (OE2-)	Always	Below 1 Ω
C26-1 or C54-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C54-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C54-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C54-49 (OE2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

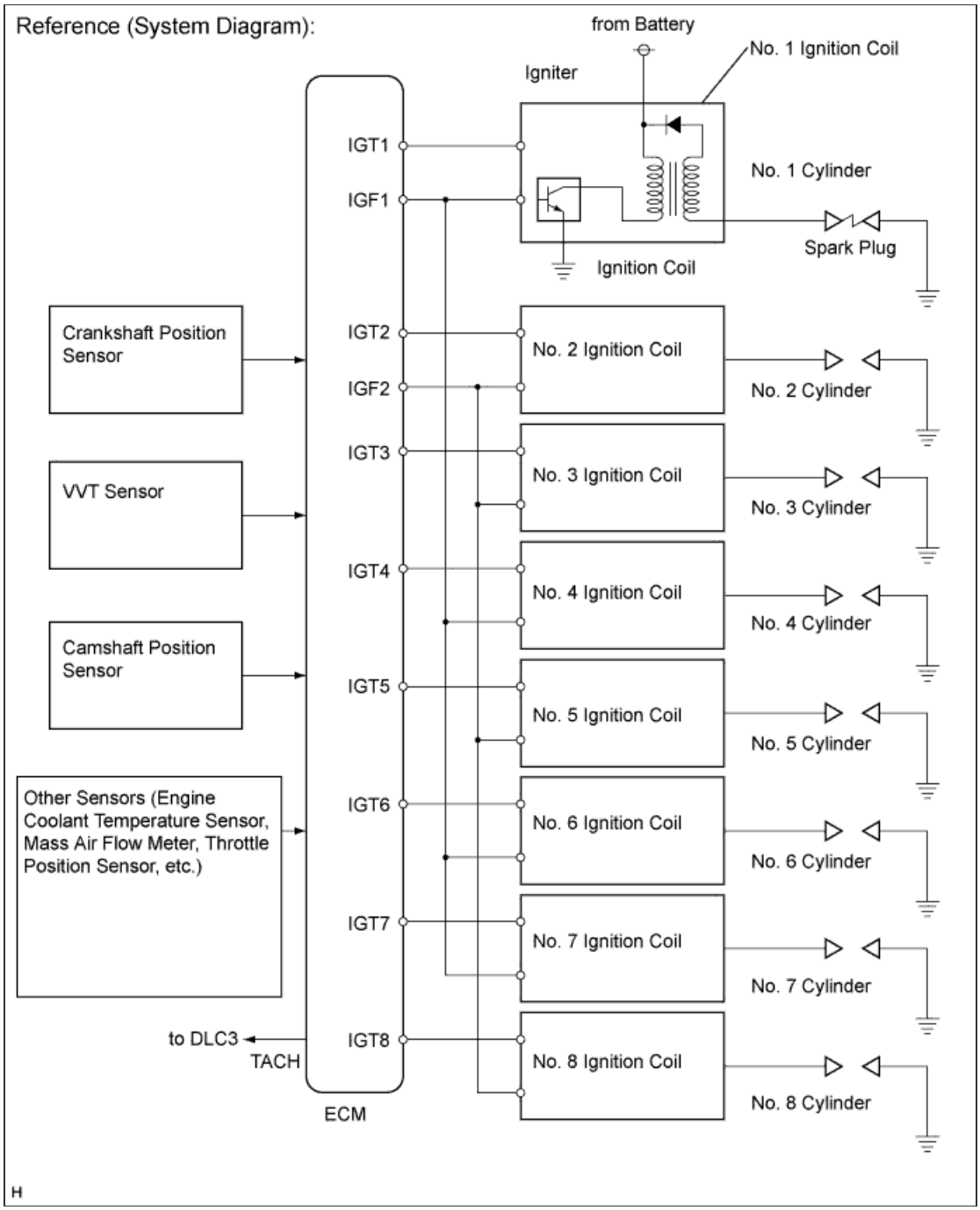
for Preparation Click here

DESCRIPTION

HINT:

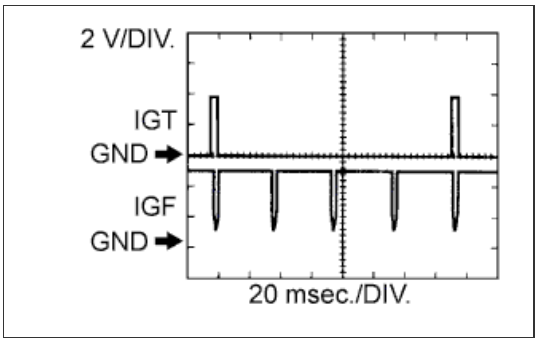
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

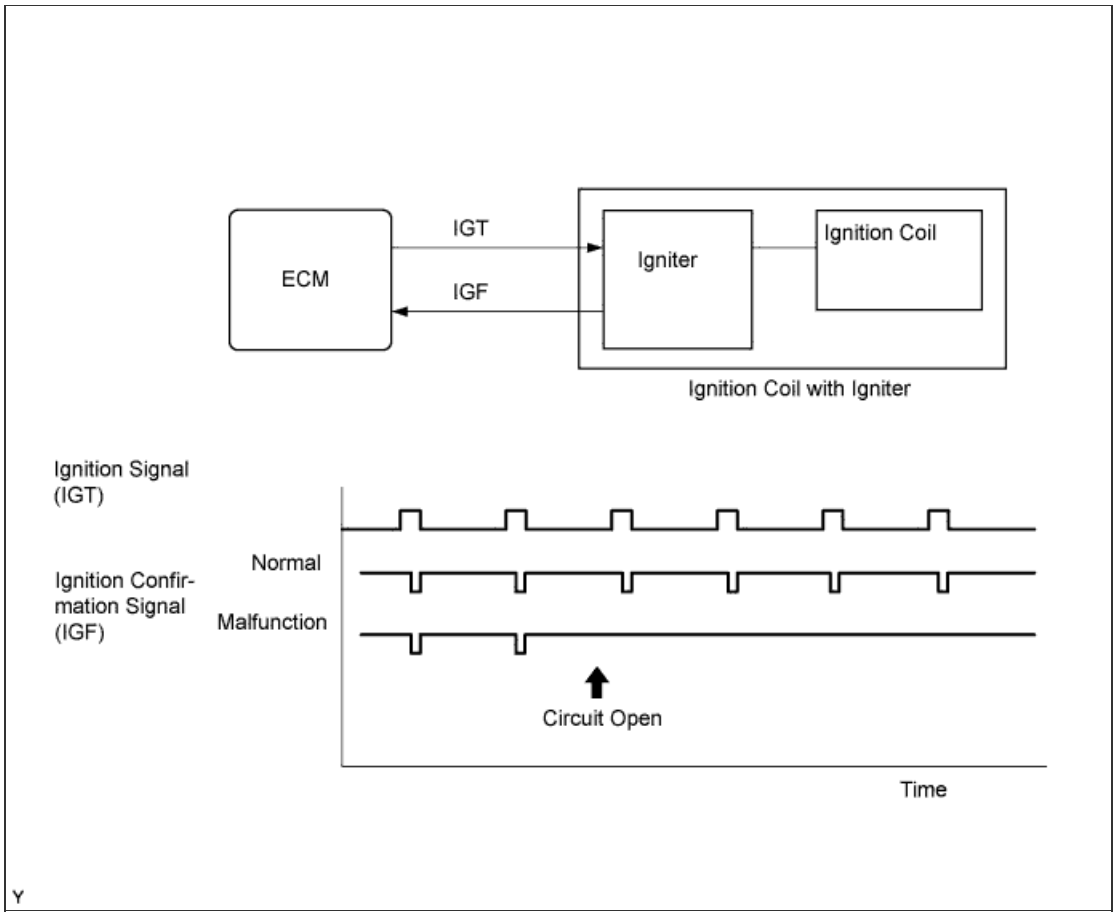
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

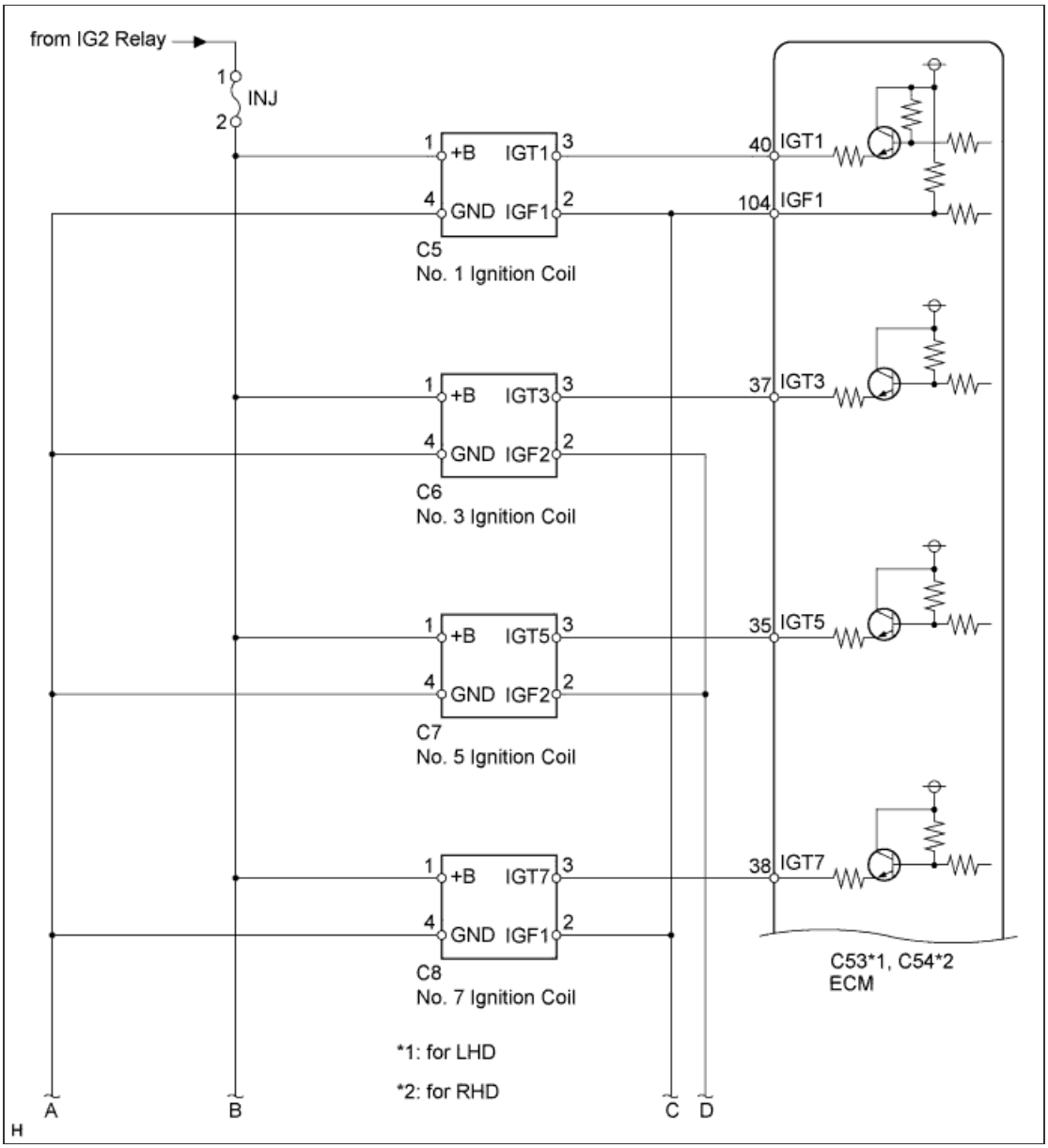
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

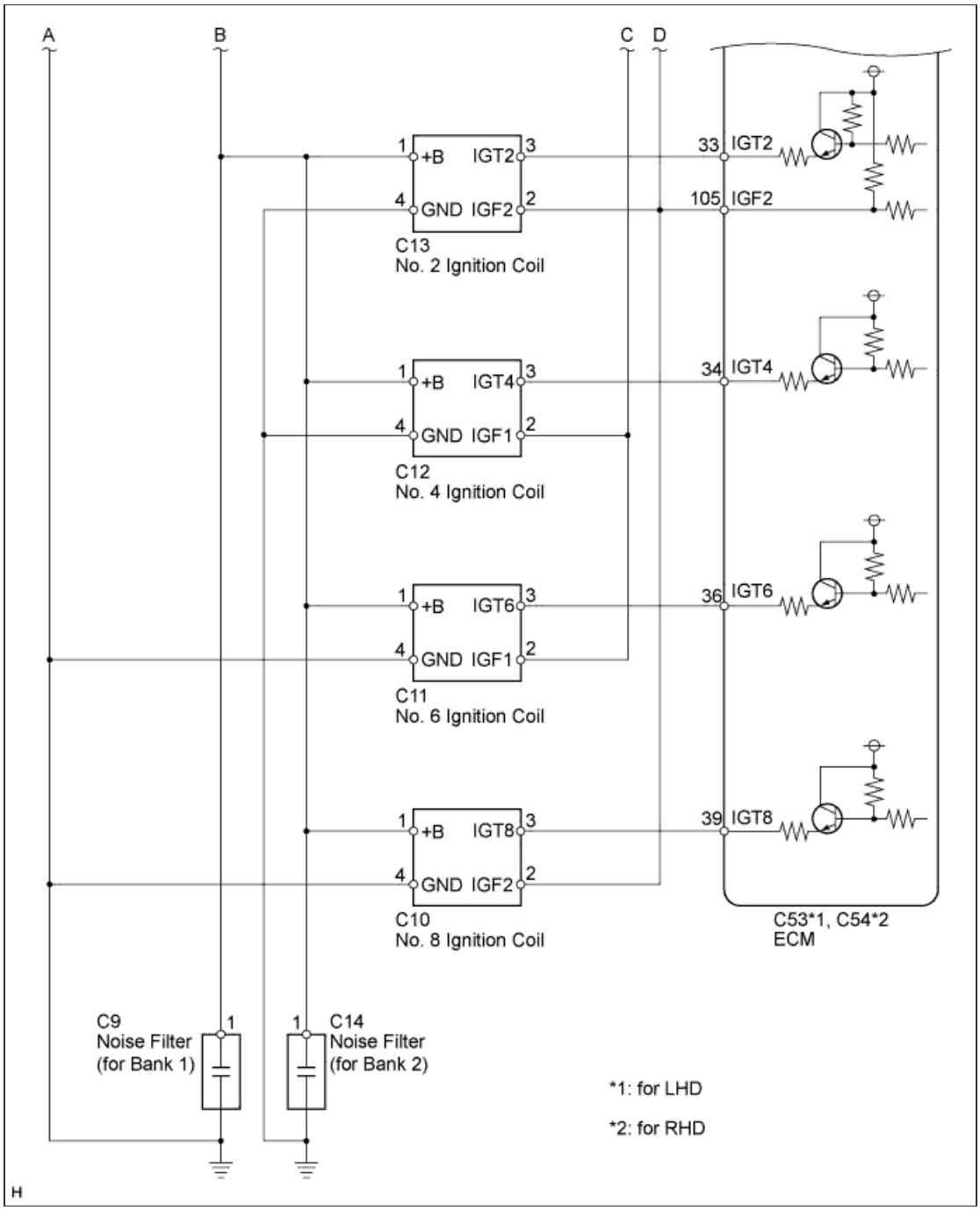
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

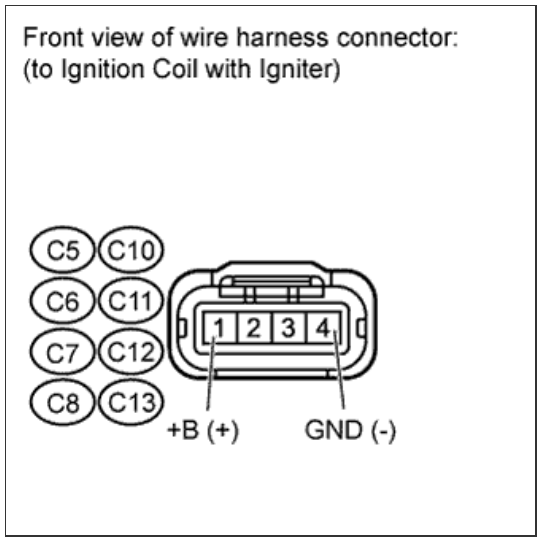
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

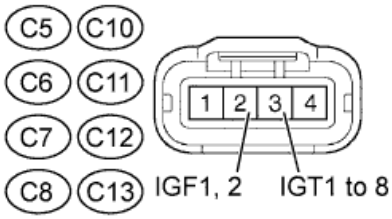
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

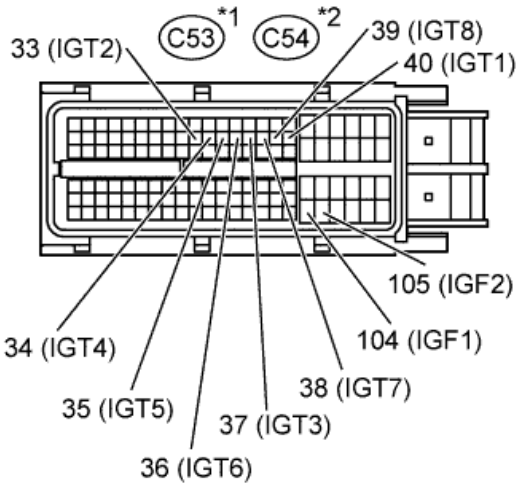
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

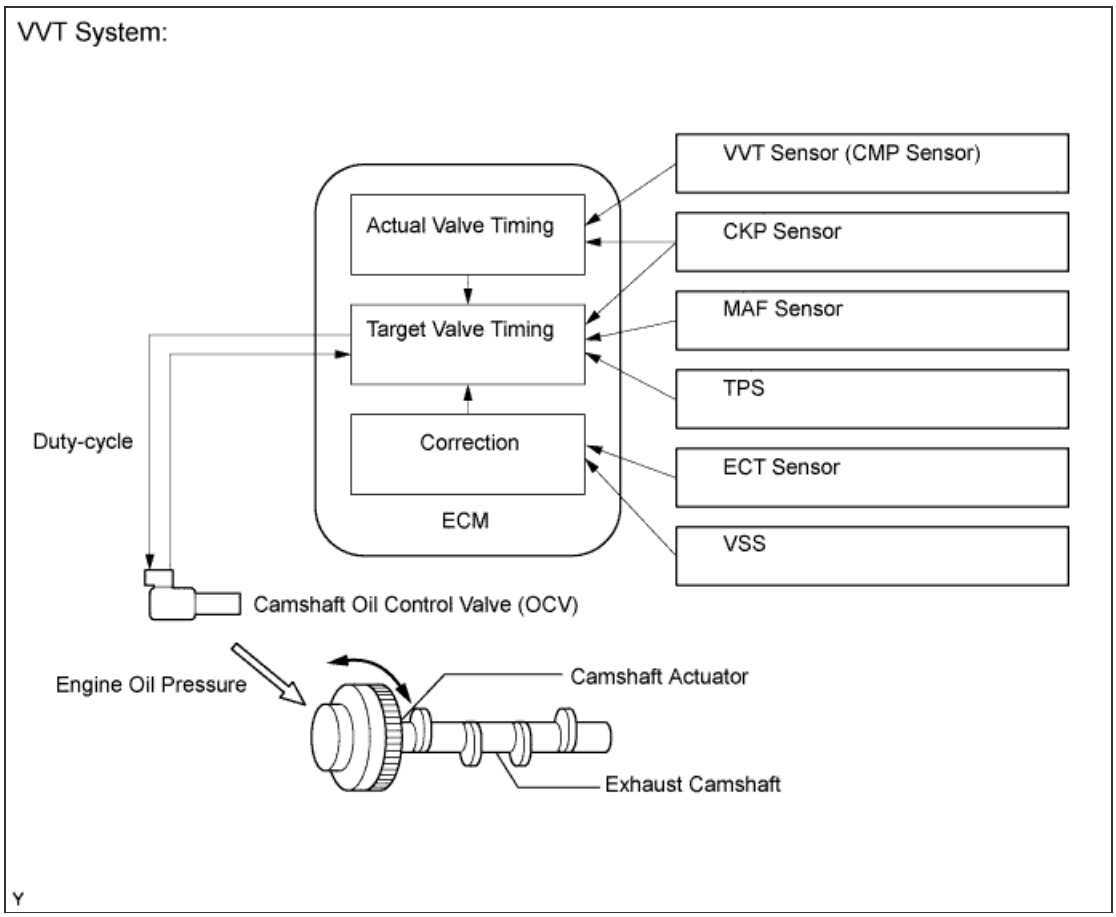
DTC P0013 Camshaft Position "B" Actuator Circuit / Open (Bank 1)

DTC P0023 Camshaft Position "B" Actuator Circuit / Open (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the Camshaft Oil Control Valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 volts to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.

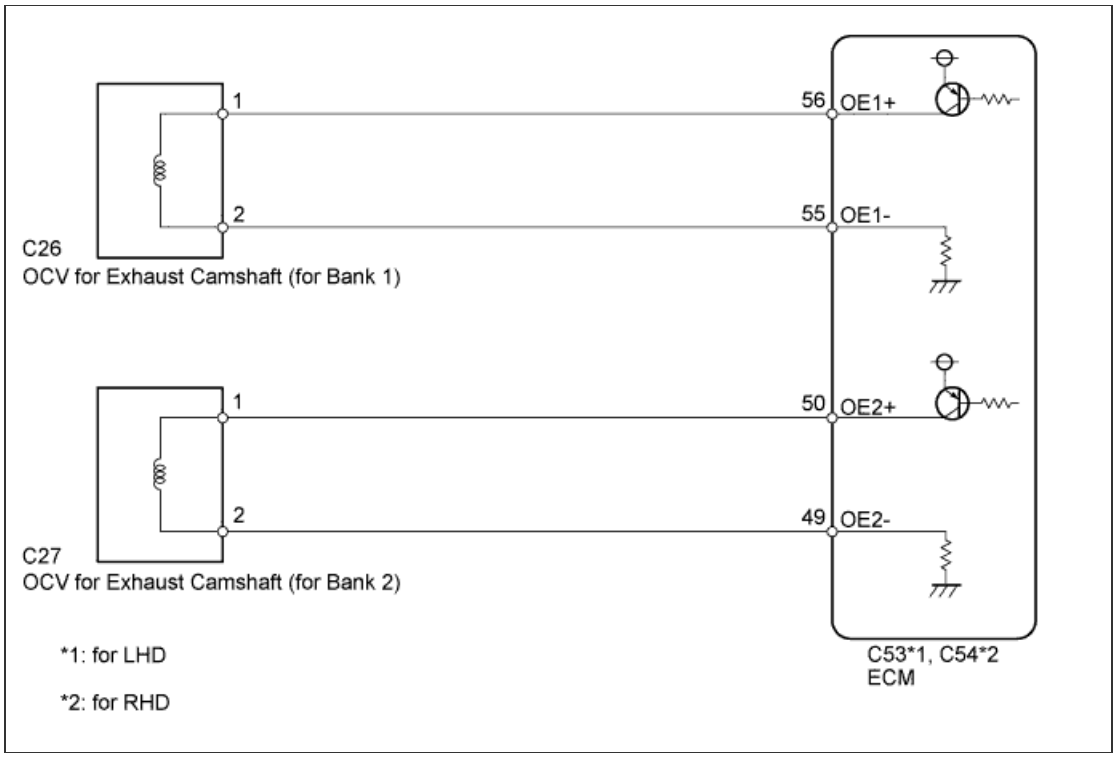


DTC Code	DTC Detection Condition	Trouble Area
P0013	An open or short in the Camshaft Oil Control Valve (OCV) for exhaust side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1) circuit • OCV (for exhaust side of Bank 1) • ECM
P0023	An open or short in the OCV for exhaust side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for exhaust side of Bank 2) circuit • OCV (for exhaust side of Bank 2) • ECM

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If DTC P0013 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0023 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK DTC (DTC P0013 OR P0023)

a. Connect the intelligent tester to the DLC3.

b. Clear DTC after recording the freeze frame data and DTC.

c. Turn the engine switch off.

d. Allow the engine to idle and check DTC.

e. Check that P0013 or P0023 is not output.

OK:
P0013 or P0023 is not output.

NG → **Go to step 2**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Disconnect the C26 or C27 OCV connector.

b. Remove the camshaft oil control valve (OCV) (Click here).

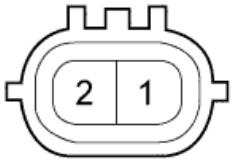
c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified

		Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG

REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

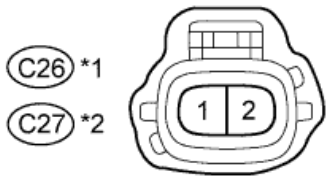
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C26 or C27 OCV connector.

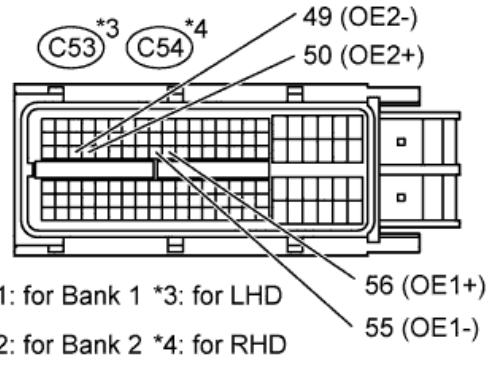
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C26-1 - C53-56 (OE1+)	Always	Below 1 Ω
C26-2 - C53-55 (OE1-)	Always	Below 1 Ω
C27-1 - C53-50 (OE2+)	Always	Below 1 Ω
C27-2 - C53-49 (OE2-)	Always	Below 1 Ω

C26-1 or C53-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C53-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C53-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C53-49 (OE2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C26-1 - C54-56 (OE1+)	Always	Below 1 Ω
C26-2 - C54-55 (OE1-)	Always	Below 1 Ω
C27-1 - C54-50 (OE2+)	Always	Below 1 Ω
C27-2 - C54-49 (OE2-)	Always	Below 1 Ω
C26-1 or C54-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C54-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C54-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C54-49 (OE2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

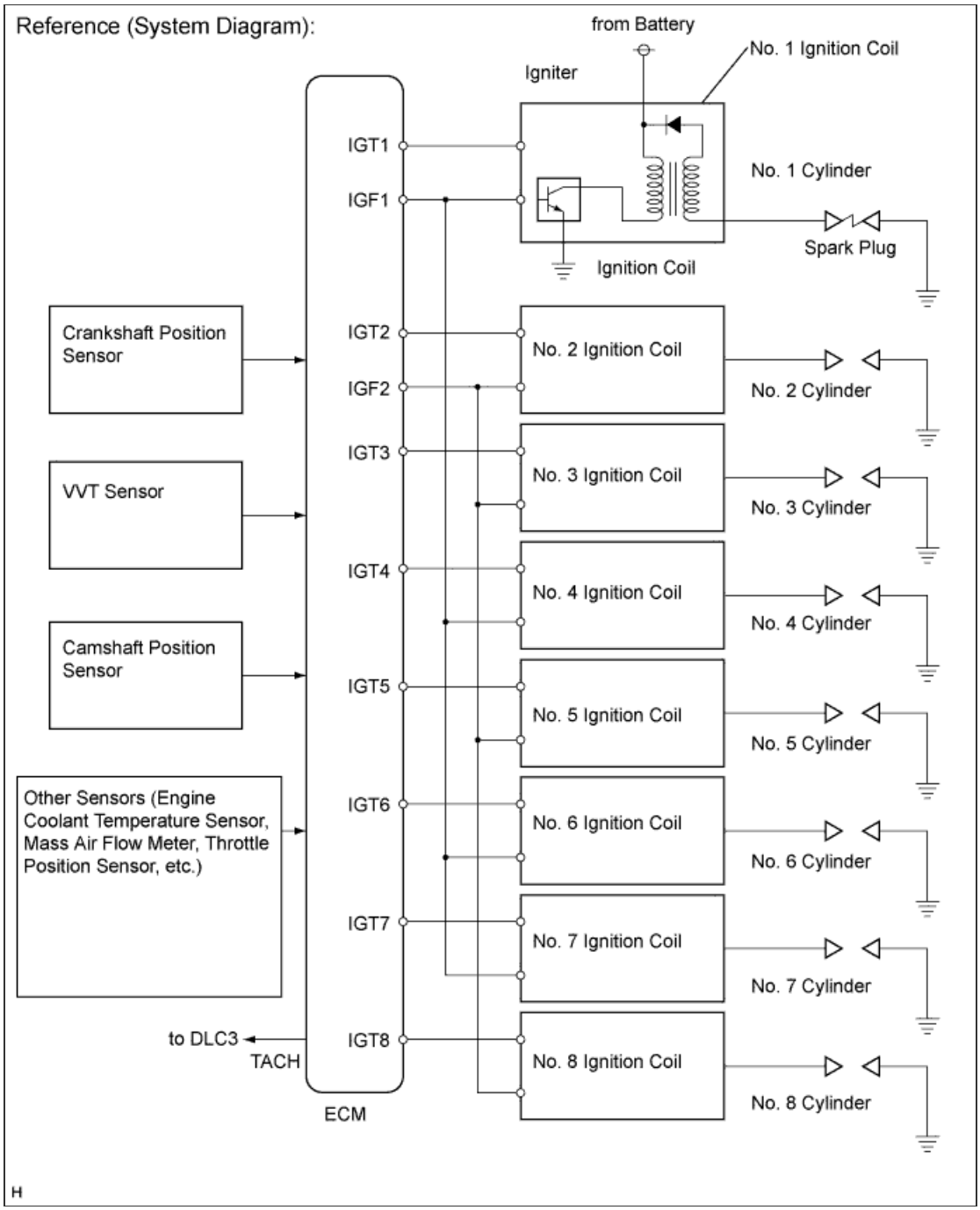
for Preparation Click here

DESCRIPTION

HINT:

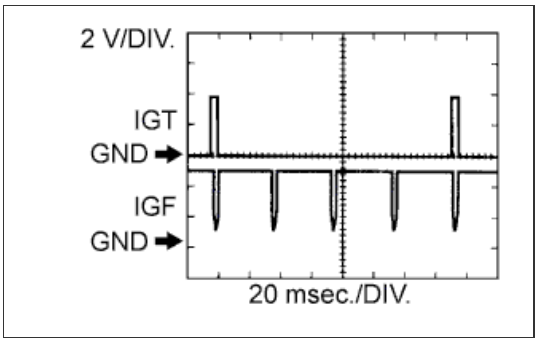
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

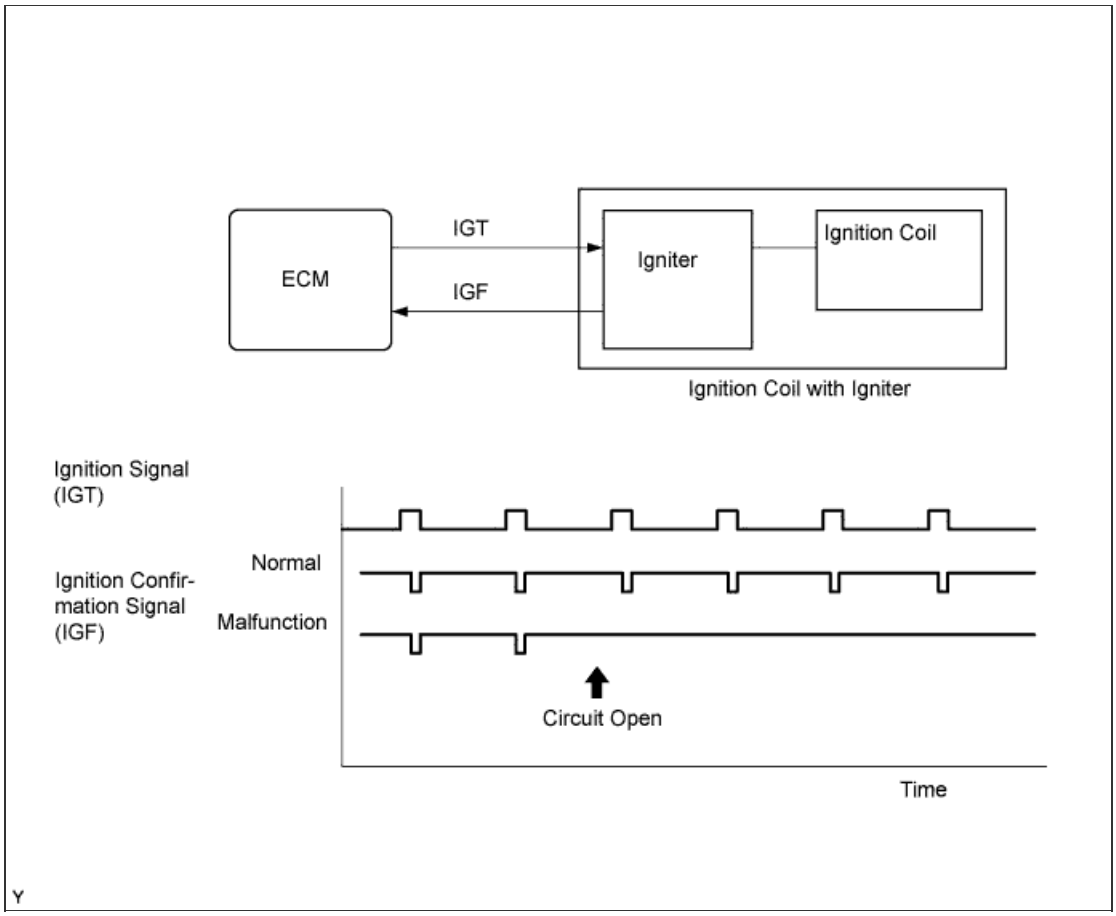
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

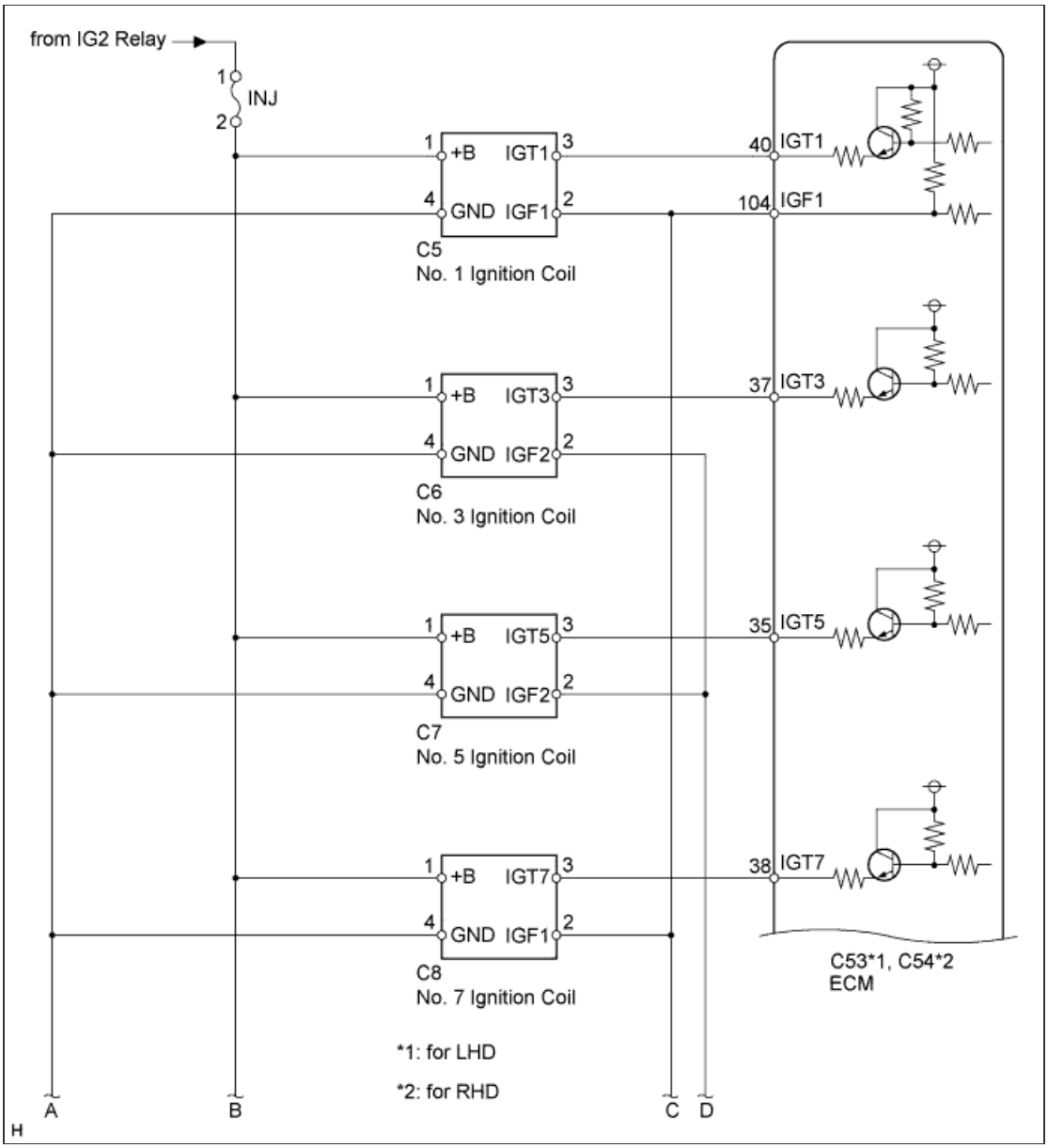
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

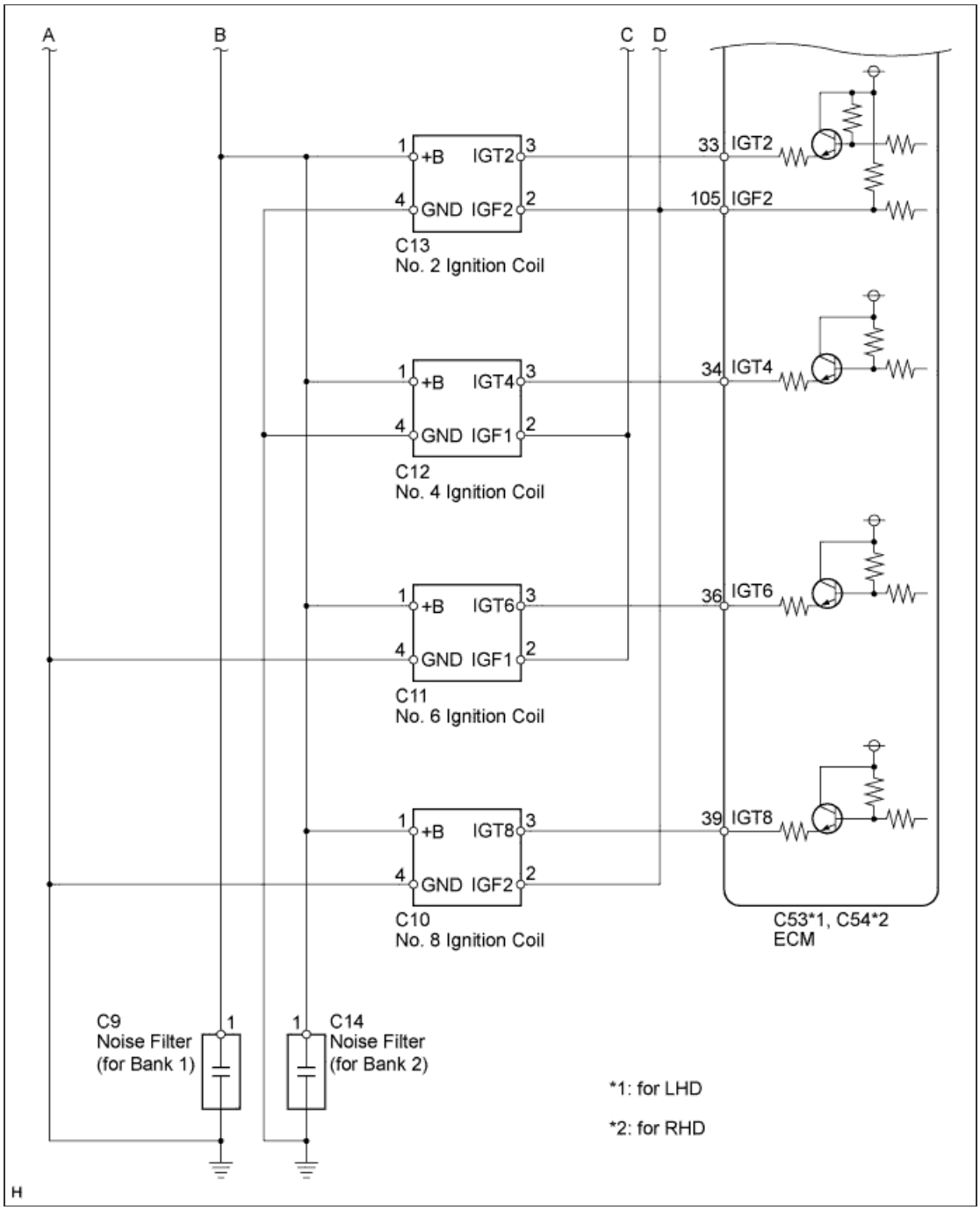
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

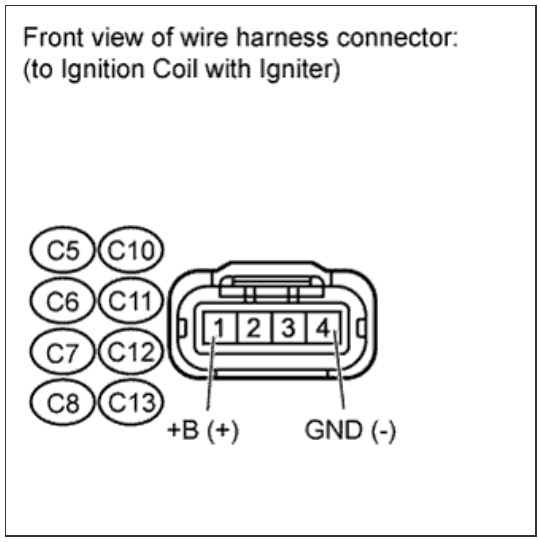
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

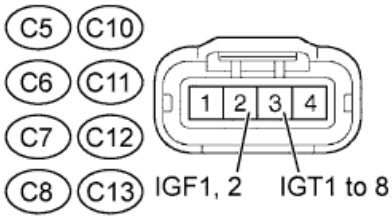
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

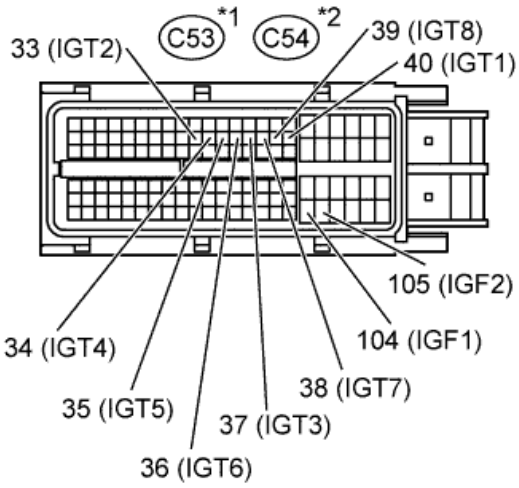
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

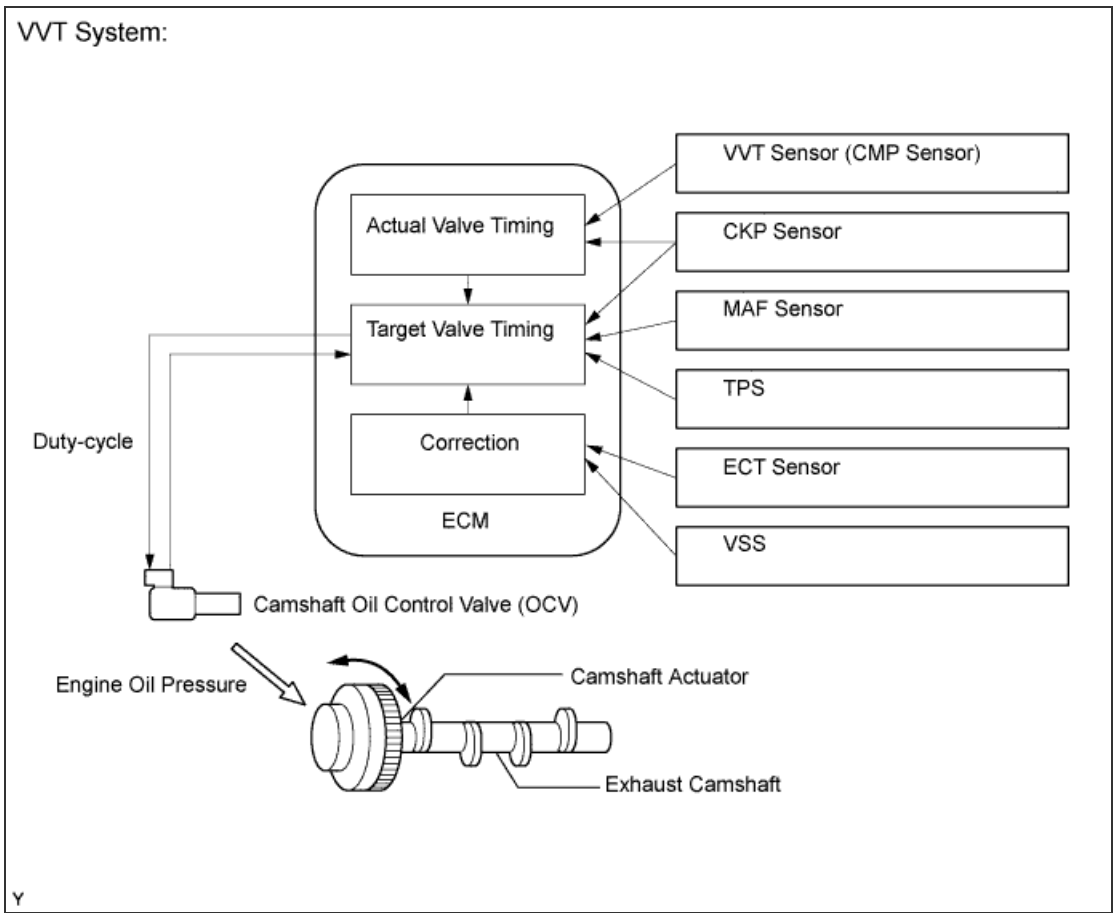
DTC P0013 Camshaft Position "B" Actuator Circuit / Open (Bank 1)

DTC P0023 Camshaft Position "B" Actuator Circuit / Open (Bank 2)

for Preparation Click here

DESCRIPTION

- This DTC is designed to detect opens or shorts in the Camshaft Oil Control Valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.
- The VVT (variable valve timing) system adjusts the intake valve timing to improve the driveability. The engine oil pressure turns the camshaft actuator to adjust the valve timing. The OCV is a solenoid valve and switches the engine oil line. The valve moves when the ECM applies 12 volts to the solenoid. The ECM changes the energizing time to the solenoid (duty-cycle) in accordance with the camshaft position, crankshaft position, throttle position, etc.

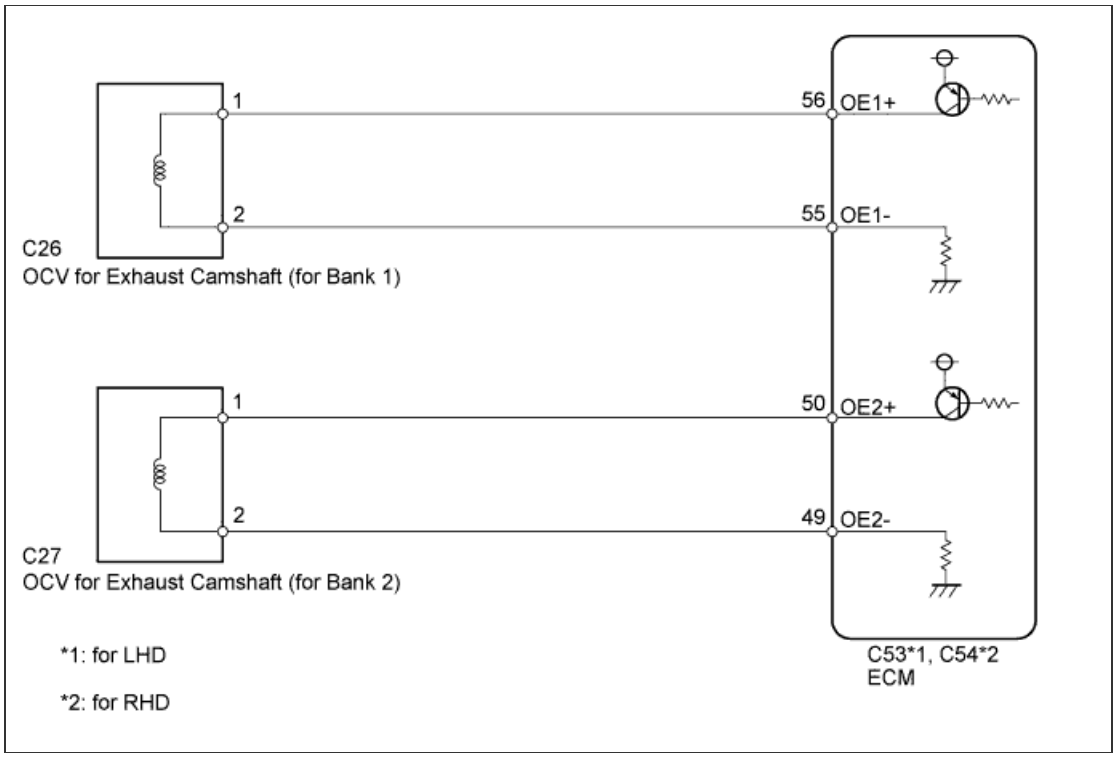


DTC Code	DTC Detection Condition	Trouble Area
P0013	An open or short in the Camshaft Oil Control Valve (OCV) for exhaust side (for Bank 1) circuit (1 trip detection logic).	• Open or short in Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1) circuit • OCV (for exhaust side of Bank 1) • ECM
P0023	An open or short in the OCV for exhaust side (for Bank 2) circuit (1 trip detection logic).	• Open or short in OCV (for exhaust side of Bank 2) circuit • OCV (for exhaust side of Bank 2) • ECM

MONITOR DESCRIPTION

This DTC is designed to detect opens or shorts in the camshaft oil control valve (OCV) circuit. If the OCV duty-cycle is excessively high or low while the engine is running, the ECM will illuminate the MIL and store the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If DTC P0013 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0023 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK DTC (DTC P0013 OR P0023)

a. Connect the intelligent tester to the DLC3.

b. Clear DTC after recording the freeze frame data and DTC.

c. Turn the engine switch off.

d. Allow the engine to idle and check DTC.

e. Check that P0013 or P0023 is not output.

OK:
P0013 or P0023 is not output.

NG → **Go to step 2**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. Disconnect the C26 or C27 OCV connector.

b. Remove the camshaft oil control valve (OCV) (Click here).

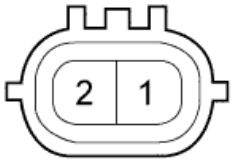
c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified

		Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

Component without harness connected:
(Oil Control Valve)



NG

REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

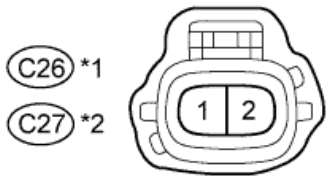
3.CHECK HARNESS AND CONNECTOR (OCV - ECM)

a. Disconnect the C26 or C27 OCV connector.

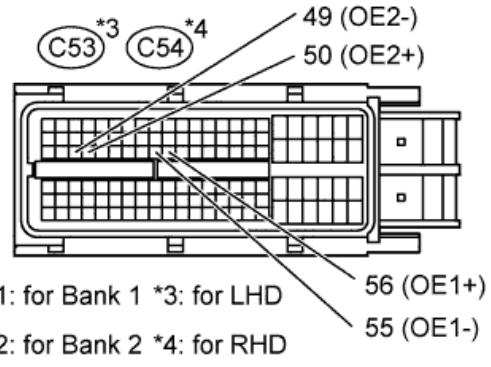
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Oil Control Valve)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C26-1 - C53-56 (OE1+)	Always	Below 1 Ω
C26-2 - C53-55 (OE1-)	Always	Below 1 Ω
C27-1 - C53-50 (OE2+)	Always	Below 1 Ω
C27-2 - C53-49 (OE2-)	Always	Below 1 Ω

C26-1 or C53-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C53-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C53-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C53-49 (OE2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C26-1 - C54-56 (OE1+)	Always	Below 1 Ω
C26-2 - C54-55 (OE1-)	Always	Below 1 Ω
C27-1 - C54-50 (OE2+)	Always	Below 1 Ω
C27-2 - C54-49 (OE2-)	Always	Below 1 Ω
C26-1 or C54-56 (OE1+) - Body ground	Always	10 kΩ or higher
C26-2 or C54-55 (OE1-) - Body ground	Always	10 kΩ or higher
C27-1 or C54-50 (OE2+) - Body ground	Always	10 kΩ or higher
C27-2 or C54-49 (OE2-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

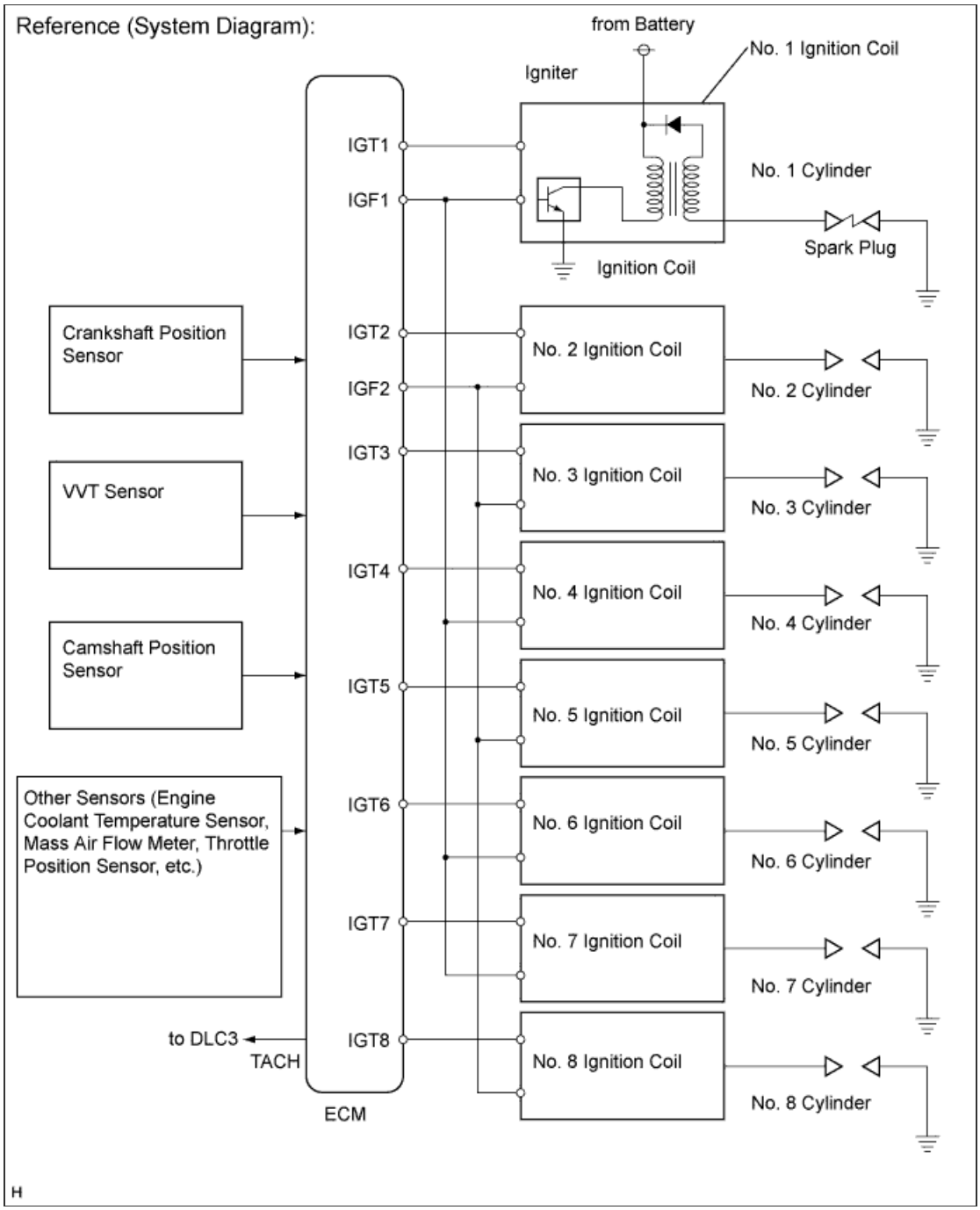
for Preparation Click here

DESCRIPTION

HINT:

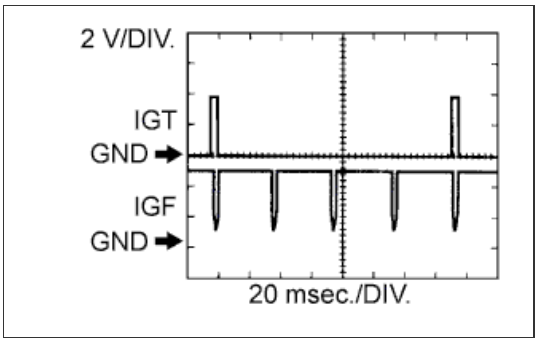
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

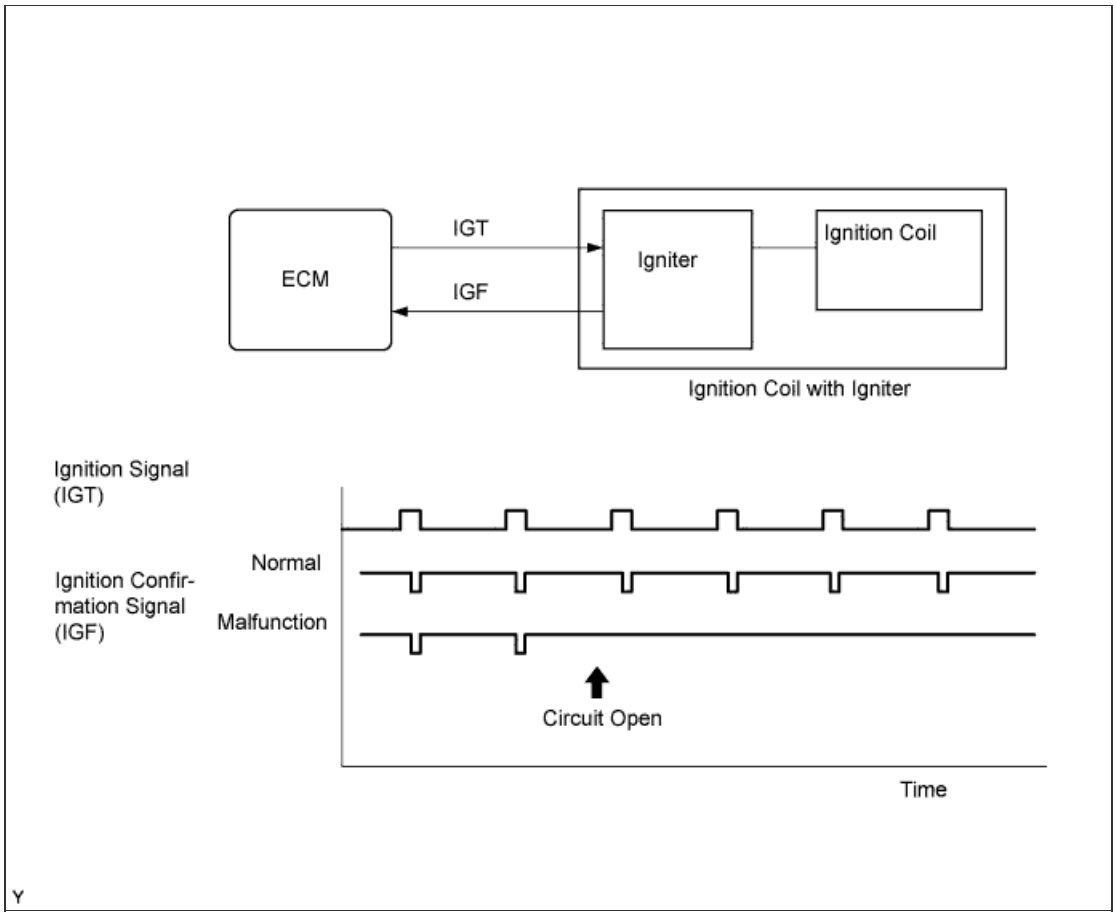
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

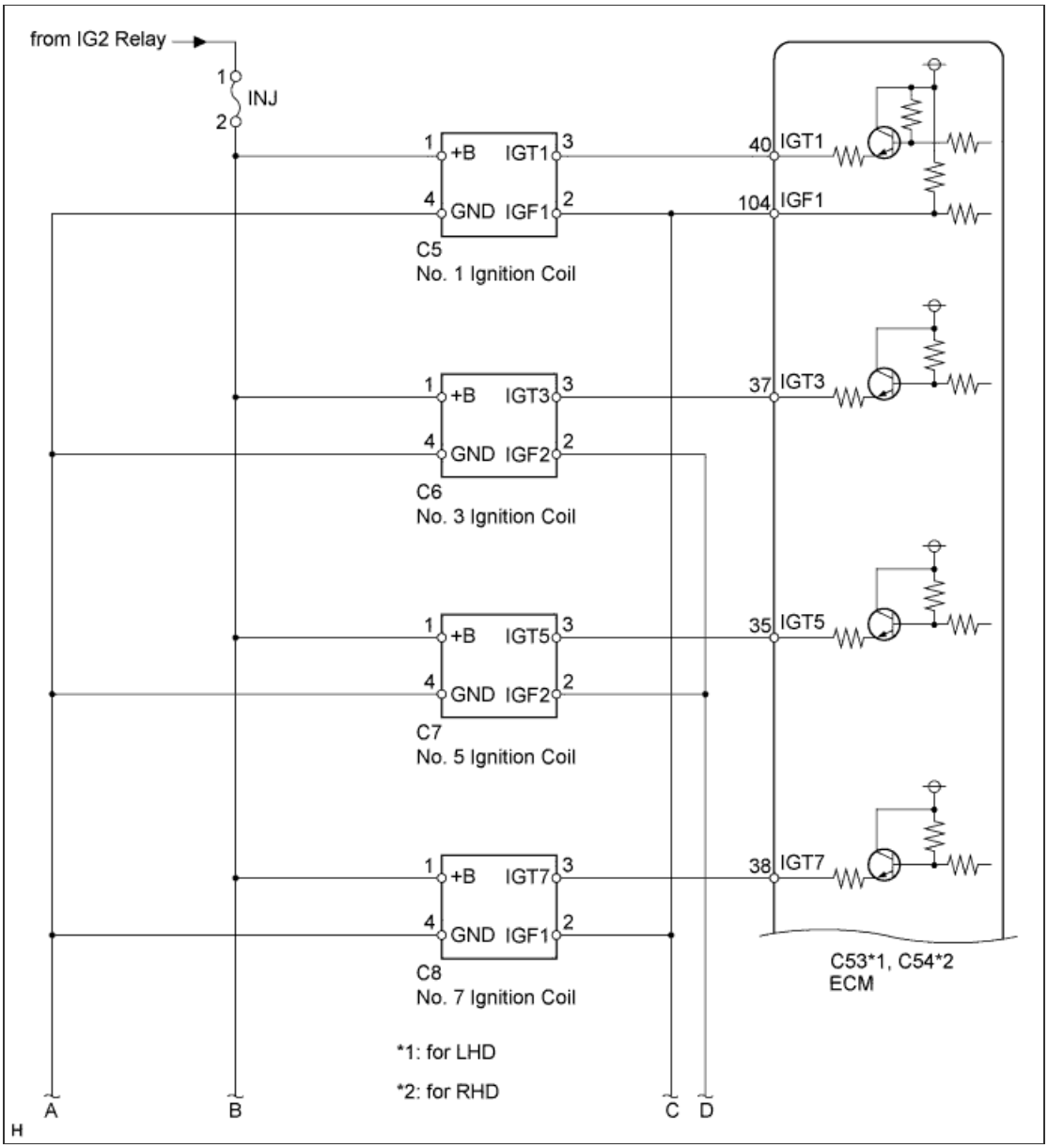
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

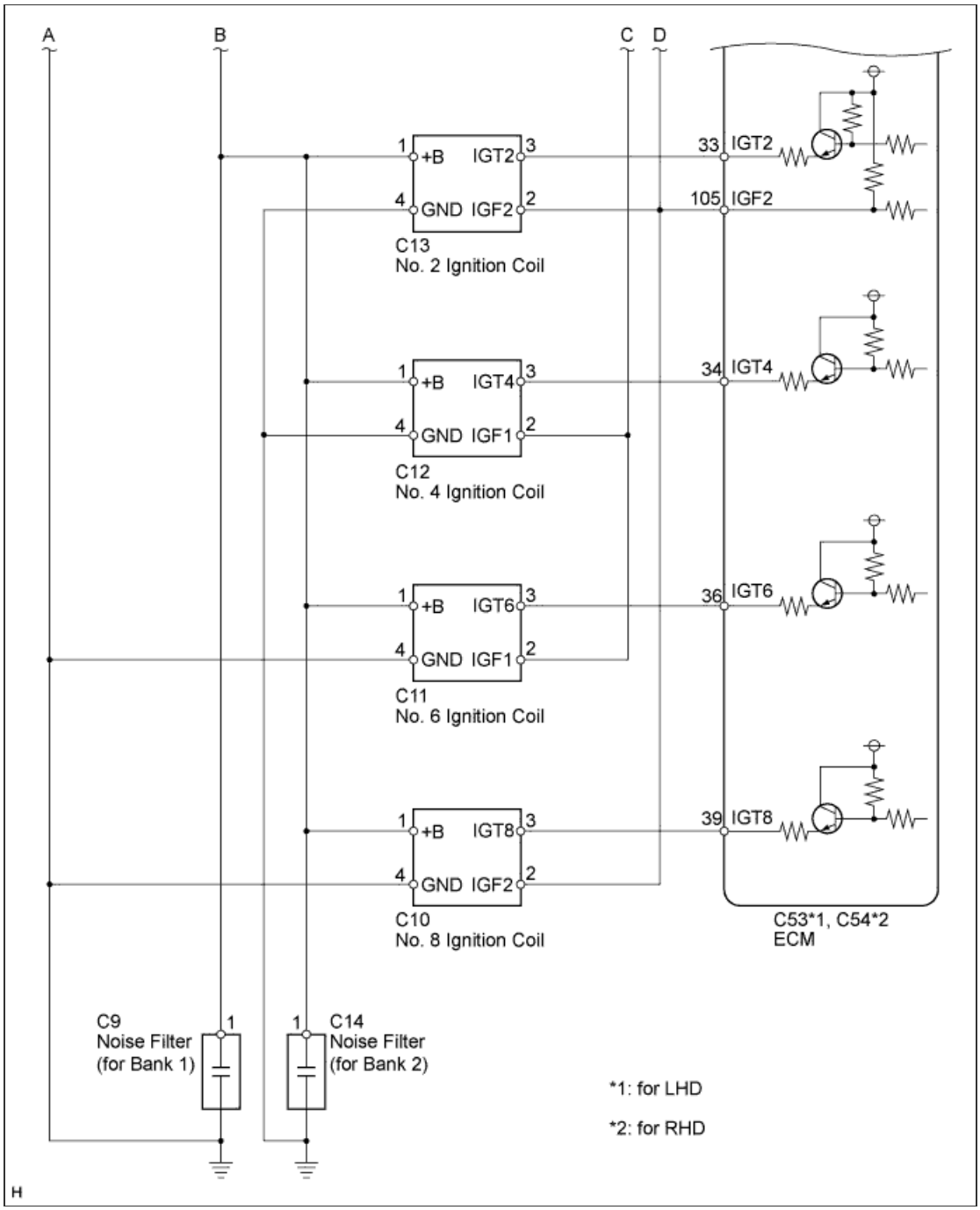
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

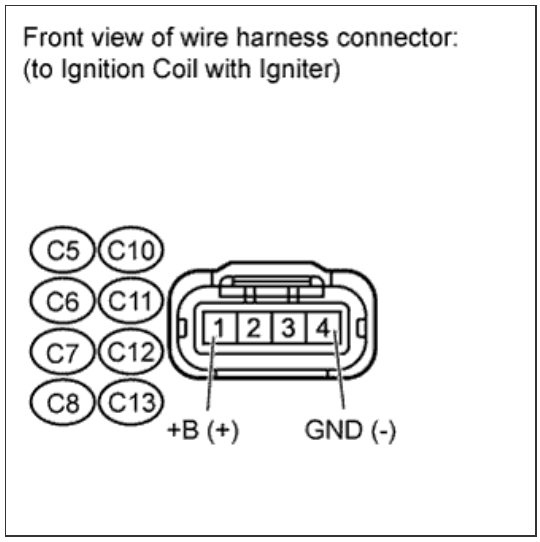
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

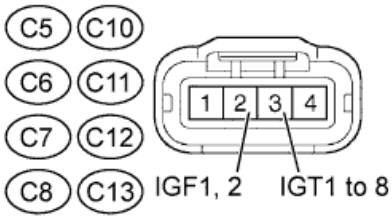
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

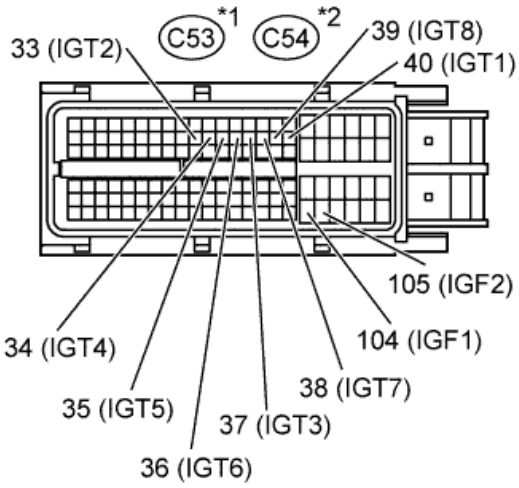
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

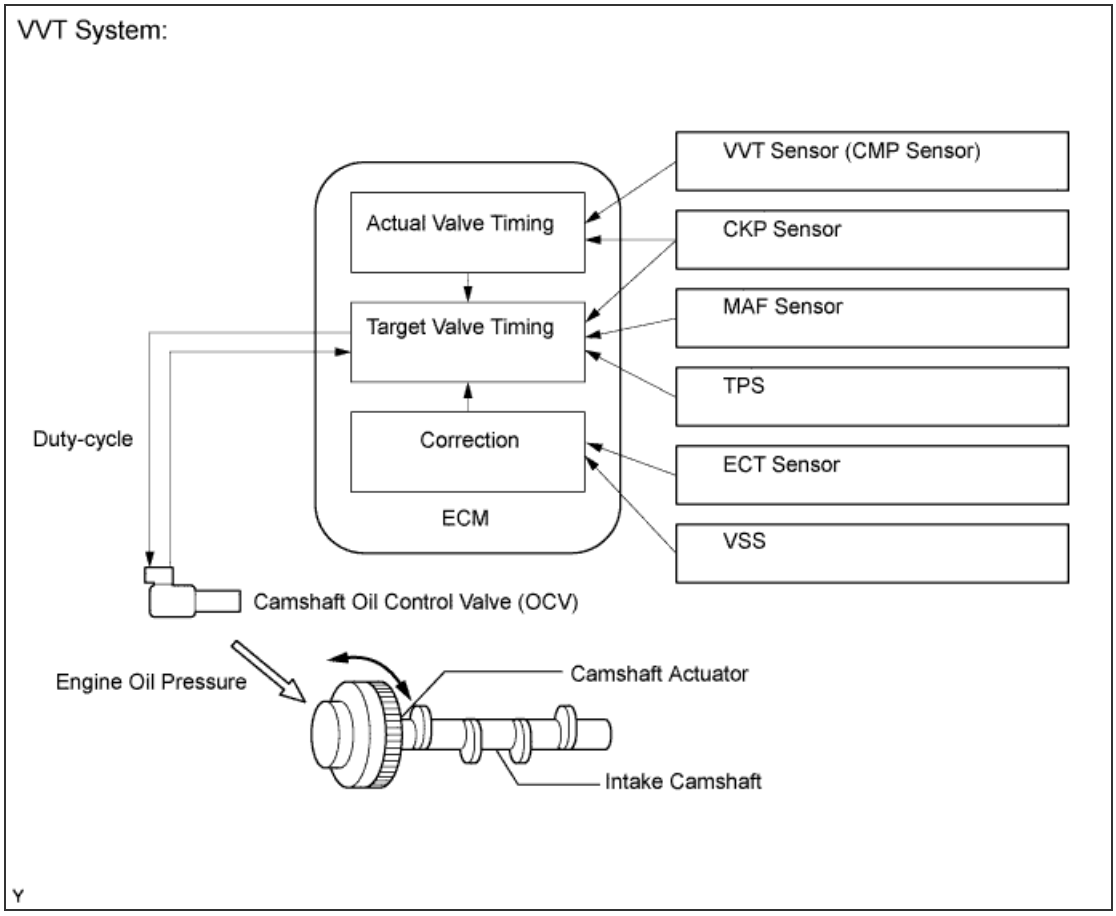
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

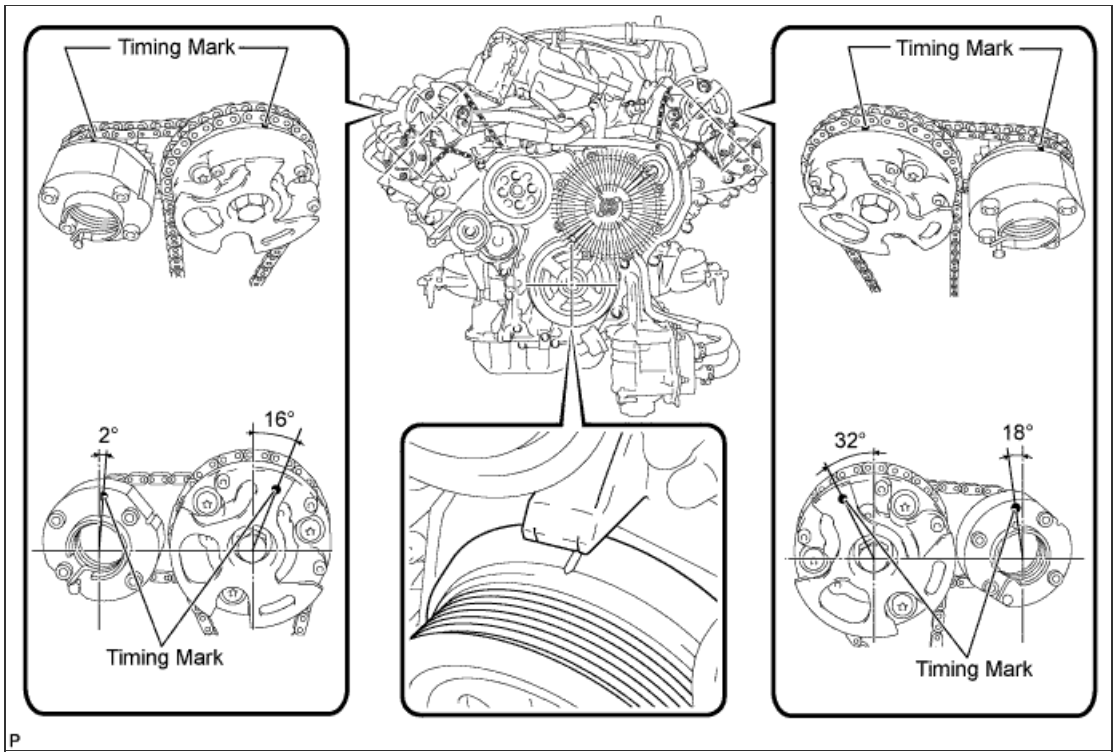
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

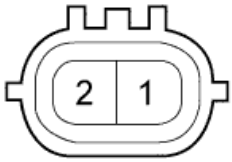
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

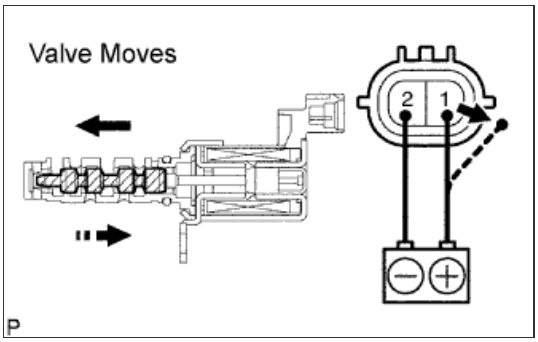
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0351 Ignition Coil "A" Primary / Secondary Circuit

DTC P0352 Ignition Coil "B" Primary / Secondary Circuit

DTC P0353 Ignition Coil "C" Primary / Secondary Circuit

DTC P0354 Ignition Coil "D" Primary / Secondary Circuit

DTC P0355 Ignition Coil "E" Primary / Secondary Circuit

DTC P0356 Ignition Coil "F" Primary / Secondary Circuit

DTC P0357 Ignition Coil "G" Primary / Secondary Circuit

DTC P0358 Ignition Coil "H" Primary / Secondary Circuit

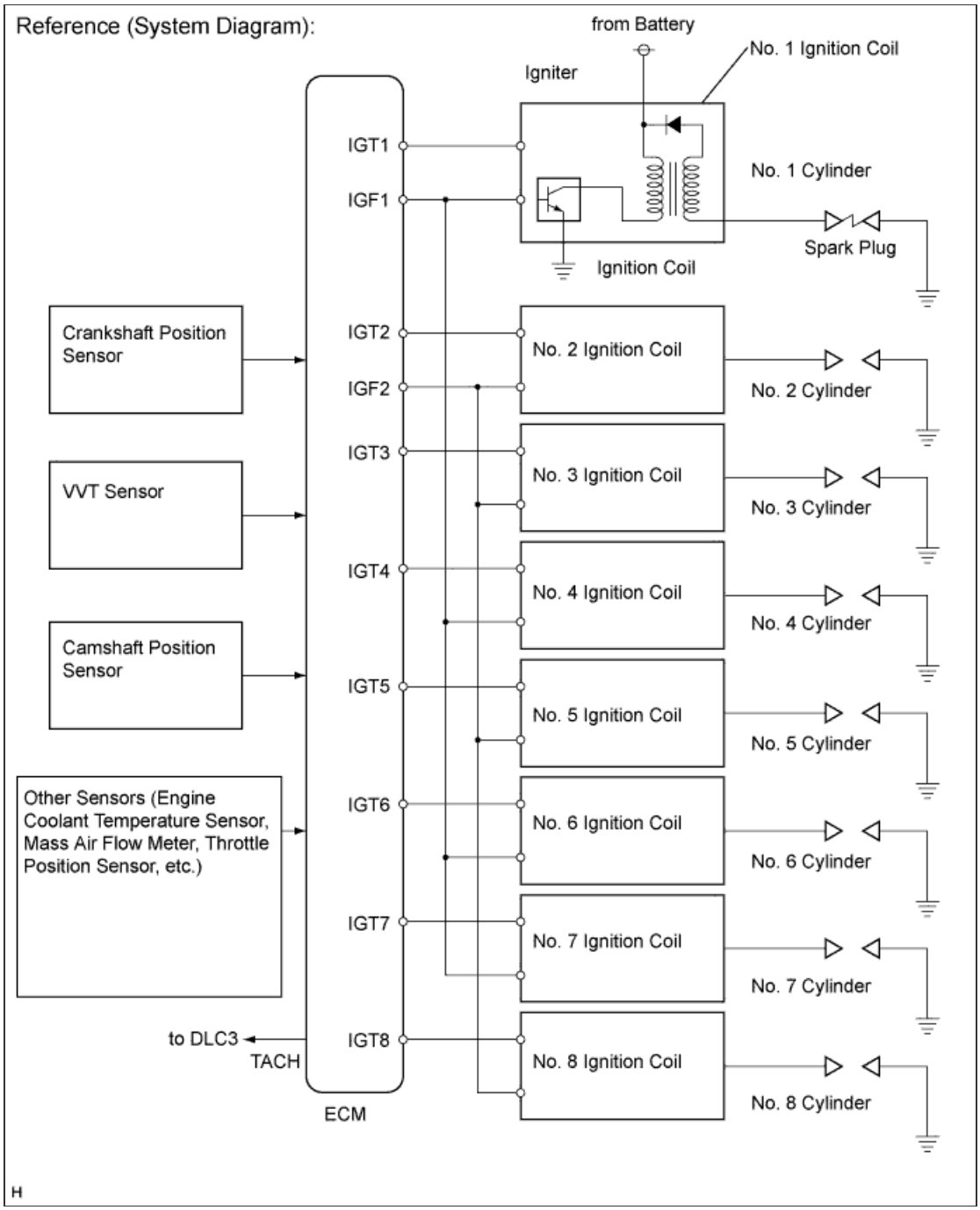
for Preparation Click here

DESCRIPTION

HINT:

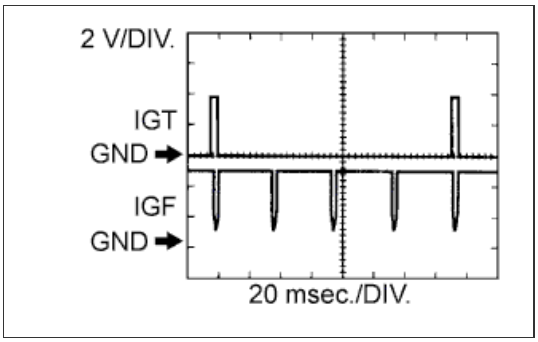
- **These DTCs indicate malfunctions relating to the primary circuit.**
- **If DTC P0351 is output, check the No. 1 ignition coil circuit.**
- **If DTC P0352 is output, check the No. 2 ignition coil circuit.**
- **If DTC P0353 is output, check the No. 3 ignition coil circuit.**
- **If DTC P0354 is output, check the No. 4 ignition coil circuit.**
- **If DTC P0355 is output, check the No. 5 ignition coil circuit.**
- **If DTC P0356 is output, check the No. 6 ignition coil circuit.**
- **If DTC P0357 is output, check the No. 7 ignition coil circuit.**
- **If DTC P0358 is output, check the No. 8 ignition coil circuit.**

A Direct Ignition System (DIS) is used on this vehicle.
The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and one spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.
The ECM determines the ignition timing and transmits the ignition (IGT) signals to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil, the igniter sends back an ignition confirmation (IGF) signal to the ECM for each cylinder ignition.



DTC Code	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356 P0357 P0358	No IGF signal is sent to the ECM while the engine is running (1 trip detection logic).	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 8) between ignition coil and ECM • No. 1 to No. 8 ignition coils • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-40 (IGT1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-33 (IGT2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-37 (IGT3) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-34 (IGT4) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-35 (IGT5) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-36 (IGT6) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-38 (IGT7) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-39 (IGT8) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-104 (IGF1) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C53-105 (IGF2) - C53-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

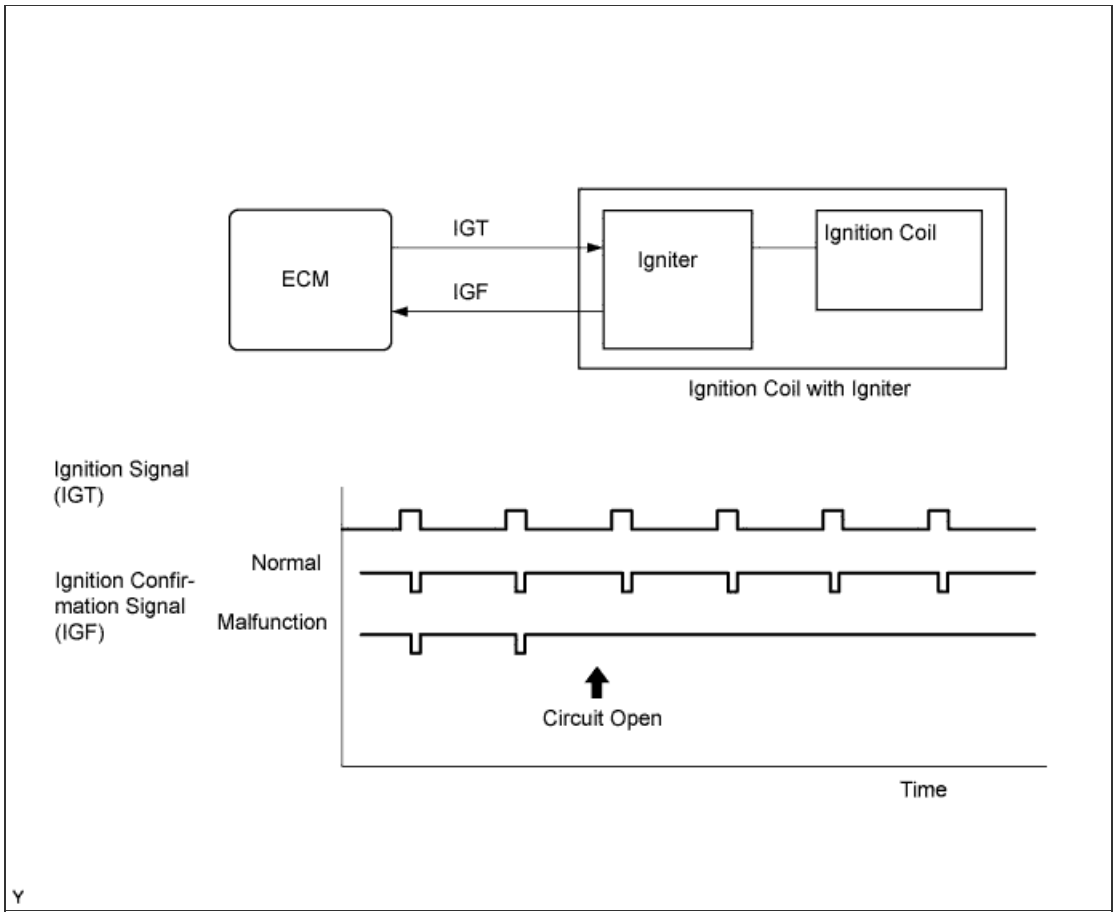
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-40 (IGT1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-33 (IGT2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-37 (IGT3) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-34 (IGT4) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-35 (IGT5) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-36 (IGT6) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-38 (IGT7) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-39 (IGT8) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-104 (IGF1) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown
C54-105 (IGF2) - C54-81 (E1)	2 V/DIV., 20 msec./DIV.	Idling	The correct waveform is as shown

HINT:

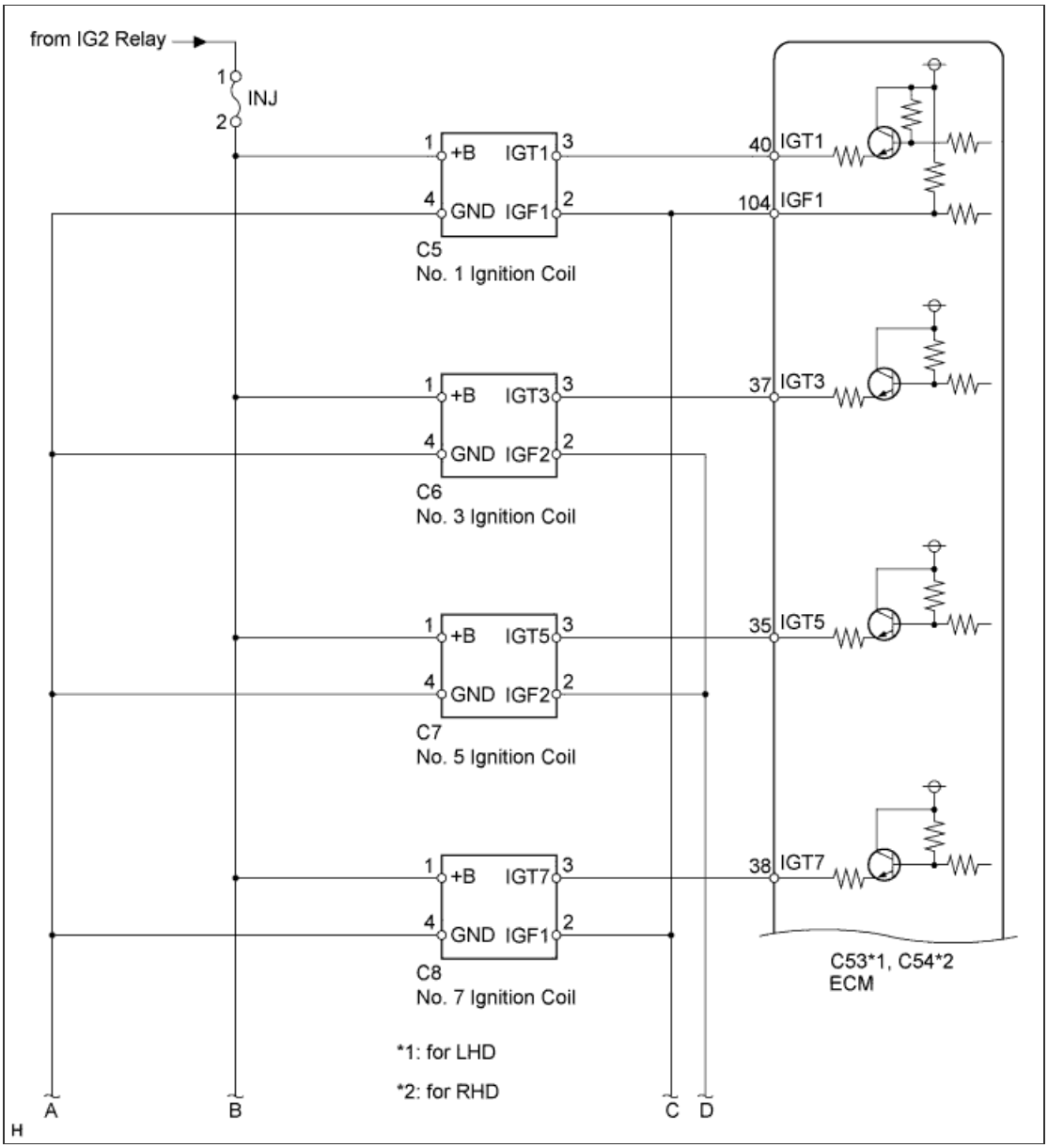
While cranking or idling the engine, check the waveform between terminals IGT (1 to 8) and E1, and IGF1 or IGF2 and E1 of the ECM connector.

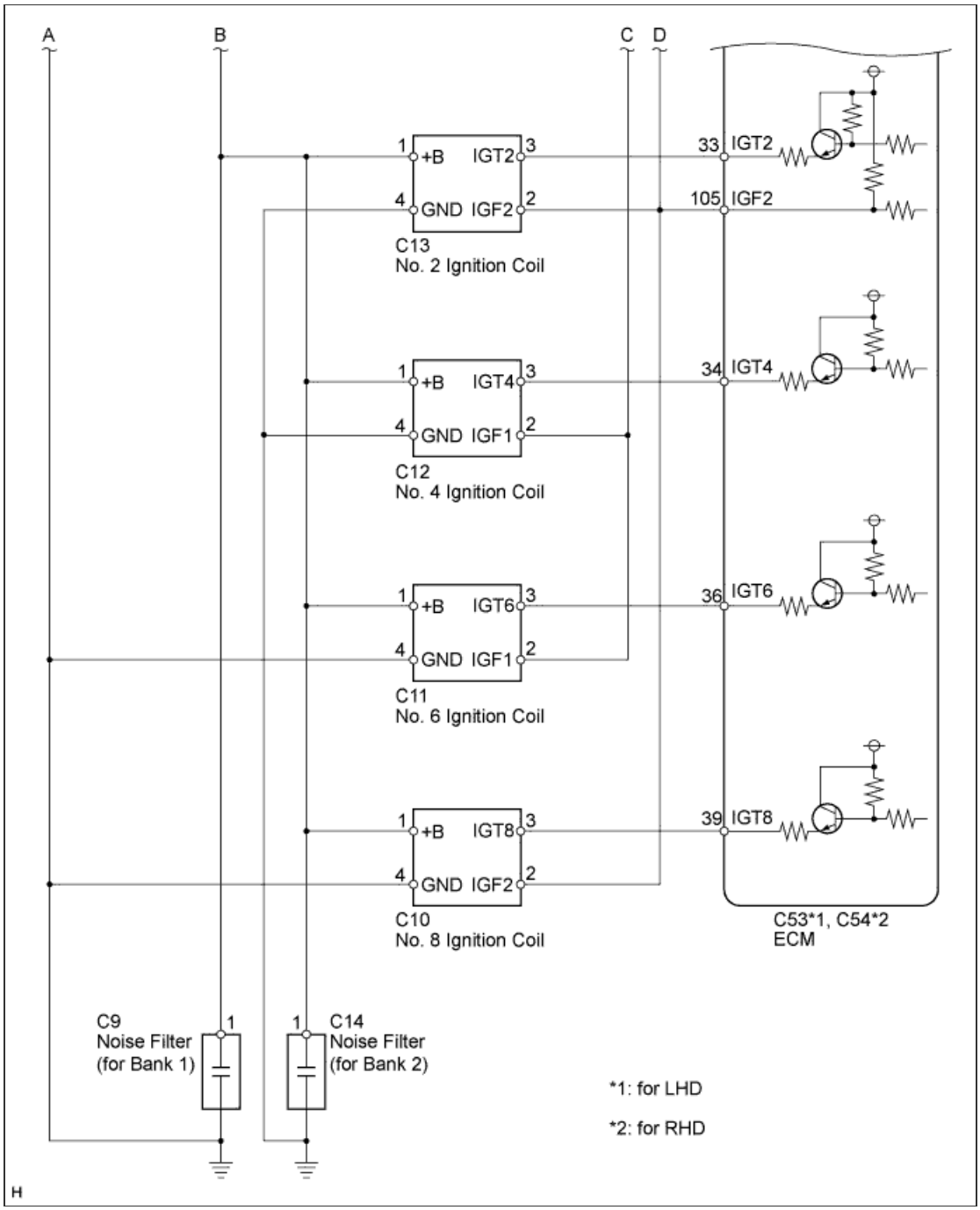
MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 1 second after the engine is next started.

WIRING DIAGRAM


from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

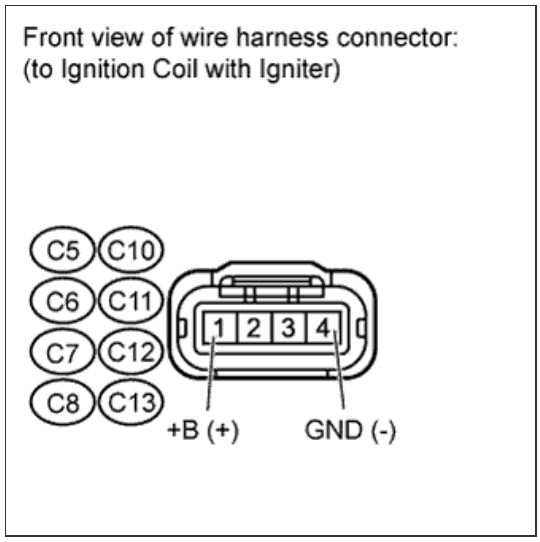
Tester Connection	Condition	Specified Condition
C5-4 (GND) - Body ground	Always	Below 1 Ω
C13-4 (GND) - Body ground	Always	Below 1 Ω
C6-4 (GND) - Body ground	Always	Below 1 Ω

C12-4 (GND) - Body ground	Always	Below 1 Ω
C7-4 (GND) - Body ground	Always	Below 1 Ω
C11-4 (GND) - Body ground	Always	Below 1 Ω
C8-4 (GND) - Body ground	Always	Below 1 Ω
C10-4 (GND) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C5-1 (+B) - C5-4 (GND)	Engine switch on (IG)	11 to 14 V
C13-1 (+B) - C13-4 (GND)	Engine switch on (IG)	11 to 14 V
C6-1 (+B) - C6-4 (GND)	Engine switch on (IG)	11 to 14 V
C12-1 (+B) - C12-4 (GND)	Engine switch on (IG)	11 to 14 V
C7-1 (+B) - C7-4 (GND)	Engine switch on (IG)	11 to 14 V
C11-1 (+B) - C11-4 (GND)	Engine switch on (IG)	11 to 14 V
C8-1 (+B) - C8-4 (GND)	Engine switch on (IG)	11 to 14 V
C10-1 (+B) - C10-4 (GND)	Engine switch on (IG)	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

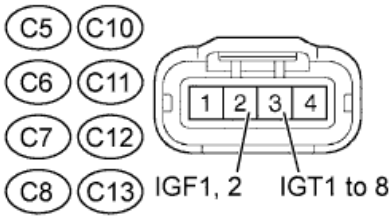
2.CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM)

a. Disconnect the C5, C6, C7, C8, C10, C11, C12 or C13 ignition coil connector.

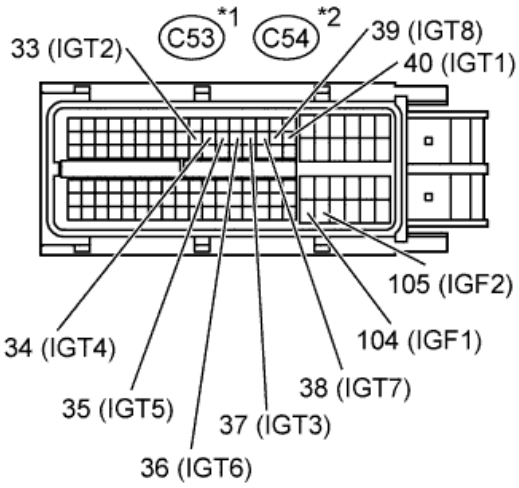
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Ignition Coil with Igniter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C53-104 (IGF1)	Always	Below 1 Ω

C10-2 (IGF2) - C53-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C53-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C53-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C53-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C53-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C53-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C53-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C53-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C53-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C13-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C53-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C53-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C53-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C53-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C53-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C53-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C53-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C53-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C53-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C53-39 (IGT8) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C5-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C13-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C6-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C12-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C7-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C11-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C8-2 (IGF1) - C54-104 (IGF1)	Always	Below 1 Ω
C10-2 (IGF2) - C54-105 (IGF2)	Always	Below 1 Ω
C5-3 (IGT1) - C54-40 (IGT1)	Always	Below 1 Ω
C13-3 (IGT2) - C54-33 (IGT2)	Always	Below 1 Ω
C6-3 (IGT3) - C54-37 (IGT3)	Always	Below 1 Ω
C12-3 (IGT4) - C54-34 (IGT4)	Always	Below 1 Ω
C7-3 (IGT5) - C54-35 (IGT5)	Always	Below 1 Ω
C11-3 (IGT6) - C54-36 (IGT6)	Always	Below 1 Ω
C8-3 (IGT7) - C54-38 (IGT7)	Always	Below 1 Ω
C10-3 (IGT8) - C54-39 (IGT8)	Always	Below 1 Ω
C5-2 (IGF1) or C54-104 (IGF1) -	Always	10 kΩ or

Body ground		higher
C13-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C6-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C12-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C7-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C11-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C8-2 (IGF1) or C54-104 (IGF1) - Body ground	Always	10 kΩ or higher
C10-2 (IGF2) or C54-105 (IGF2) - Body ground	Always	10 kΩ or higher
C5-3 (IGT1) or C54-40 (IGT1) - Body ground	Always	10 kΩ or higher
C13-3 (IGT2) or C54-33 (IGT2) - Body ground	Always	10 kΩ or higher
C6-3 (IGT3) or C54-37 (IGT3) - Body ground	Always	10 kΩ or higher
C12-3 (IGT4) or C54-34 (IGT4) - Body ground	Always	10 kΩ or higher
C7-3 (IGT5) or C54-35 (IGT5) - Body ground	Always	10 kΩ or higher
C11-3 (IGT6) or C54-36 (IGT6) - Body ground	Always	10 kΩ or higher
C8-3 (IGT7) or C54-38 (IGT7) - Body ground	Always	10 kΩ or higher
C10-3 (IGT8) or C54-39 (IGT8) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353, P0354, P0355, P0356, P0357 OR P0358)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Shuffle the arrangement of the ignition coils (among No. 1 to No. 8 cylinders).

NOTICE:

Do not shuffle the connectors.

e. Perform a simulation test.

f. Check DTCs displayed on the tester.

Result

Result	Proceed to
Same DTC is output	A
Different ignition coil DTC is output	B

B → REPLACE IGNITION COIL ASSEMBLY (Click here)

A

REPLACE ECM (Click here)

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

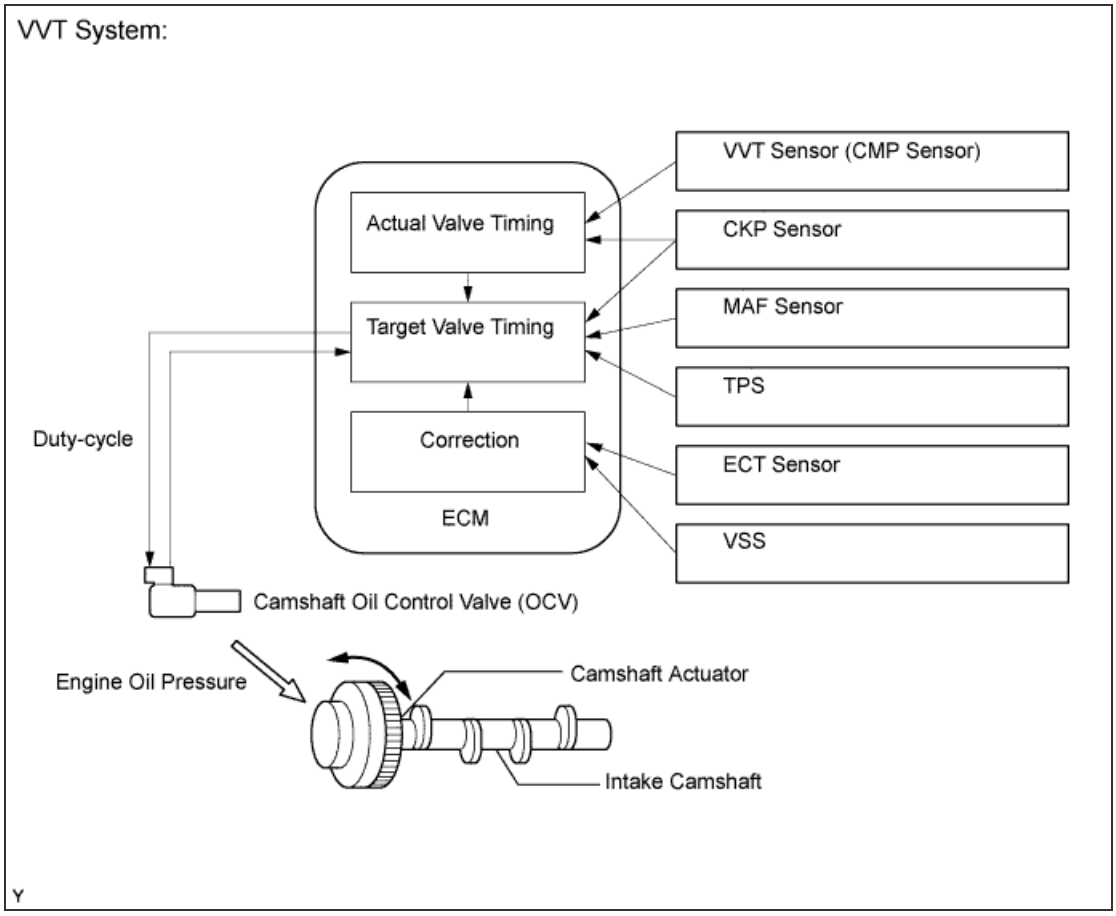
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

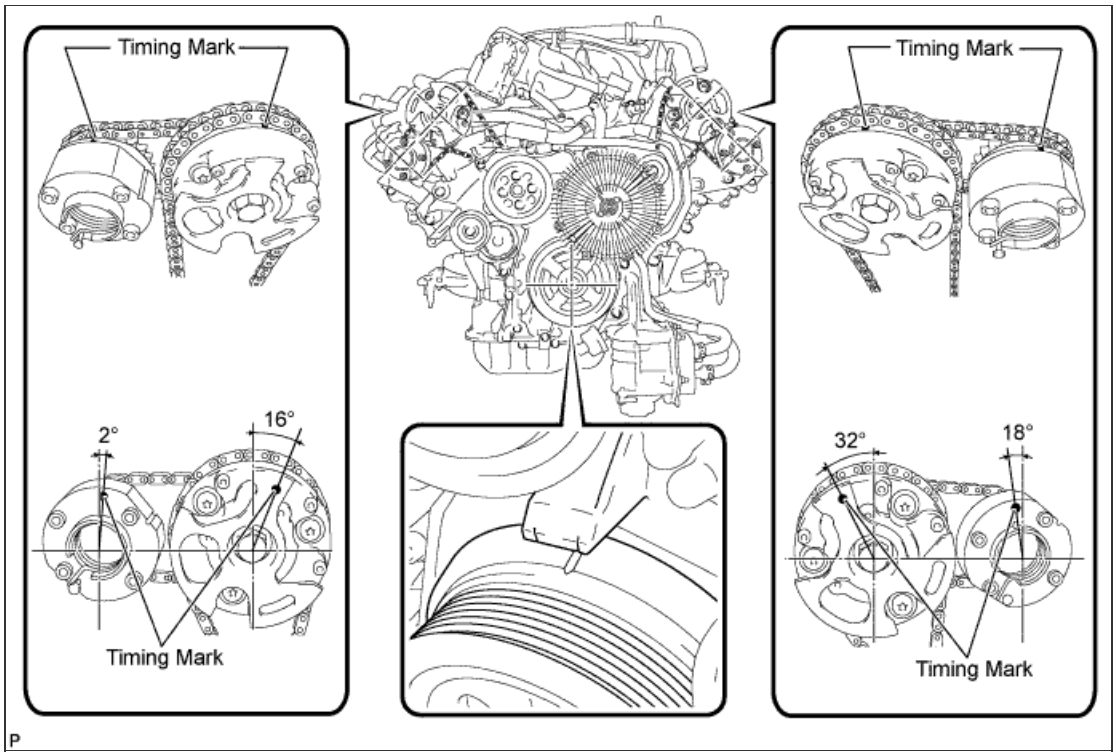
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

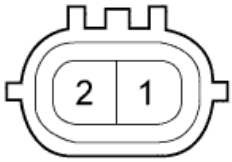
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

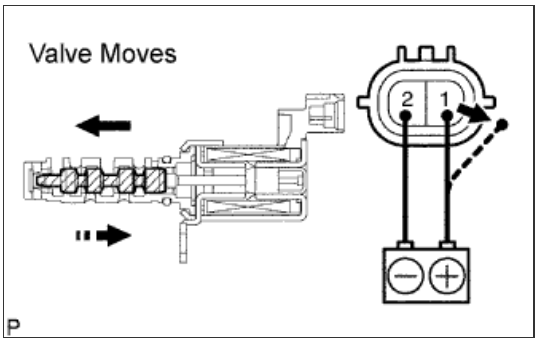
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

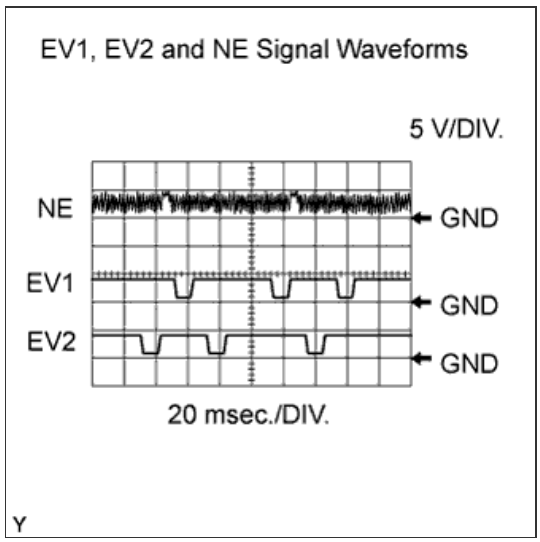
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

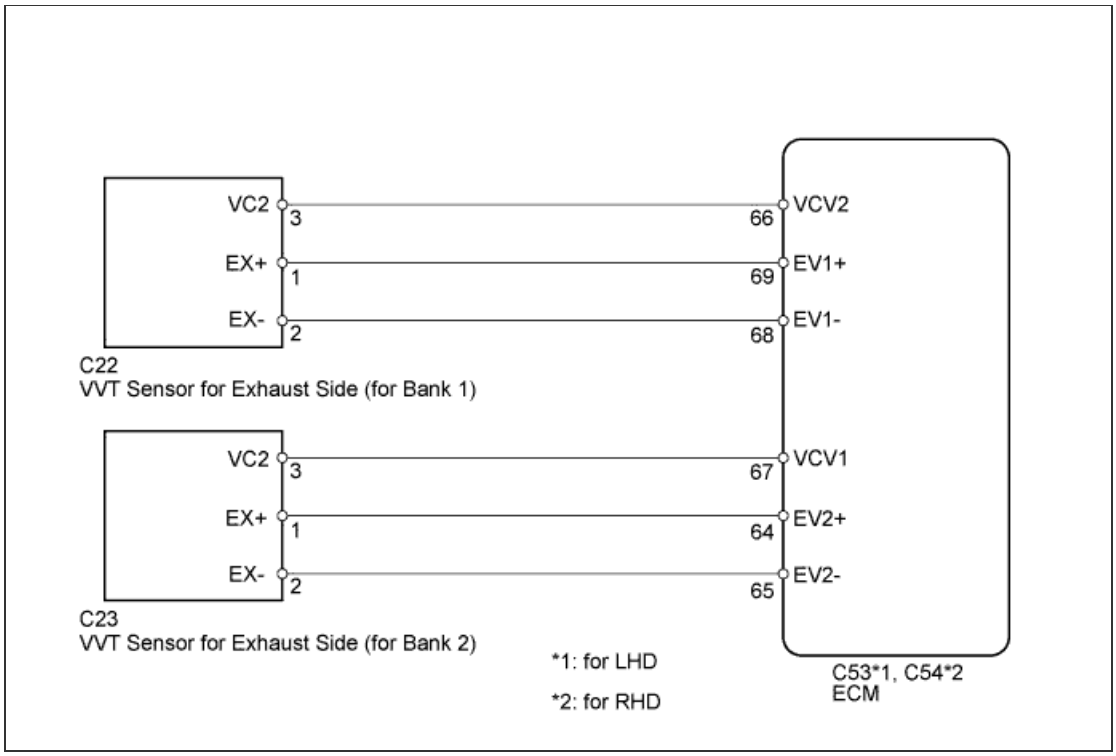
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

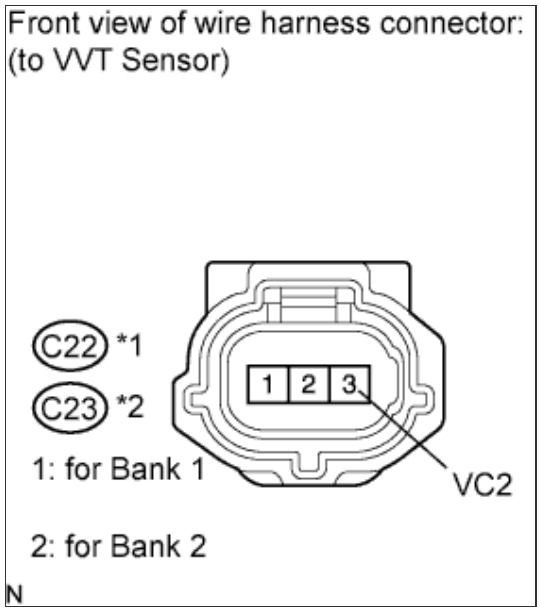
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

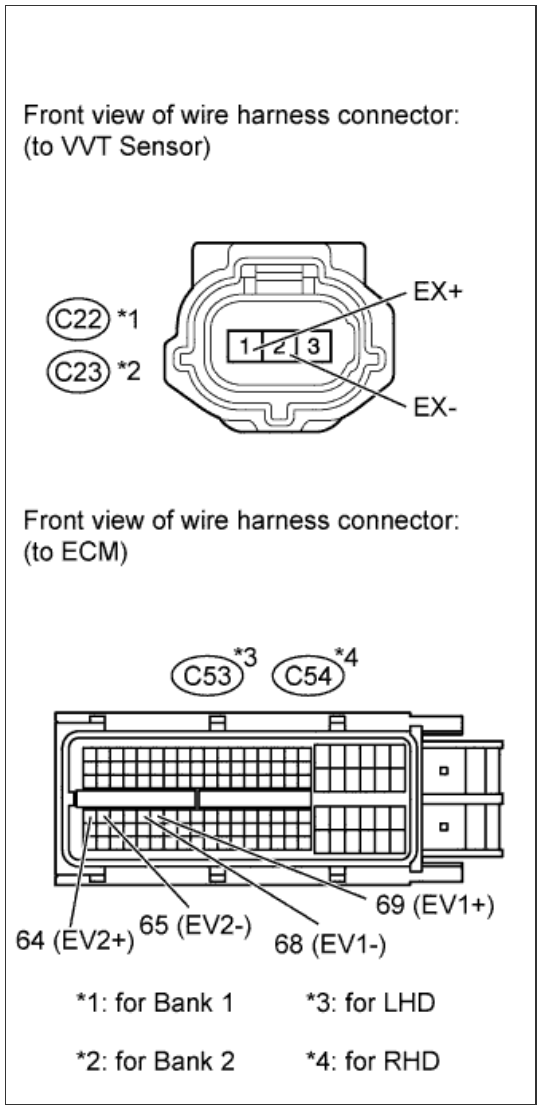
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

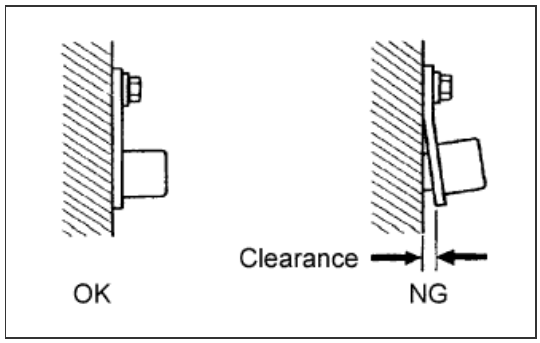
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

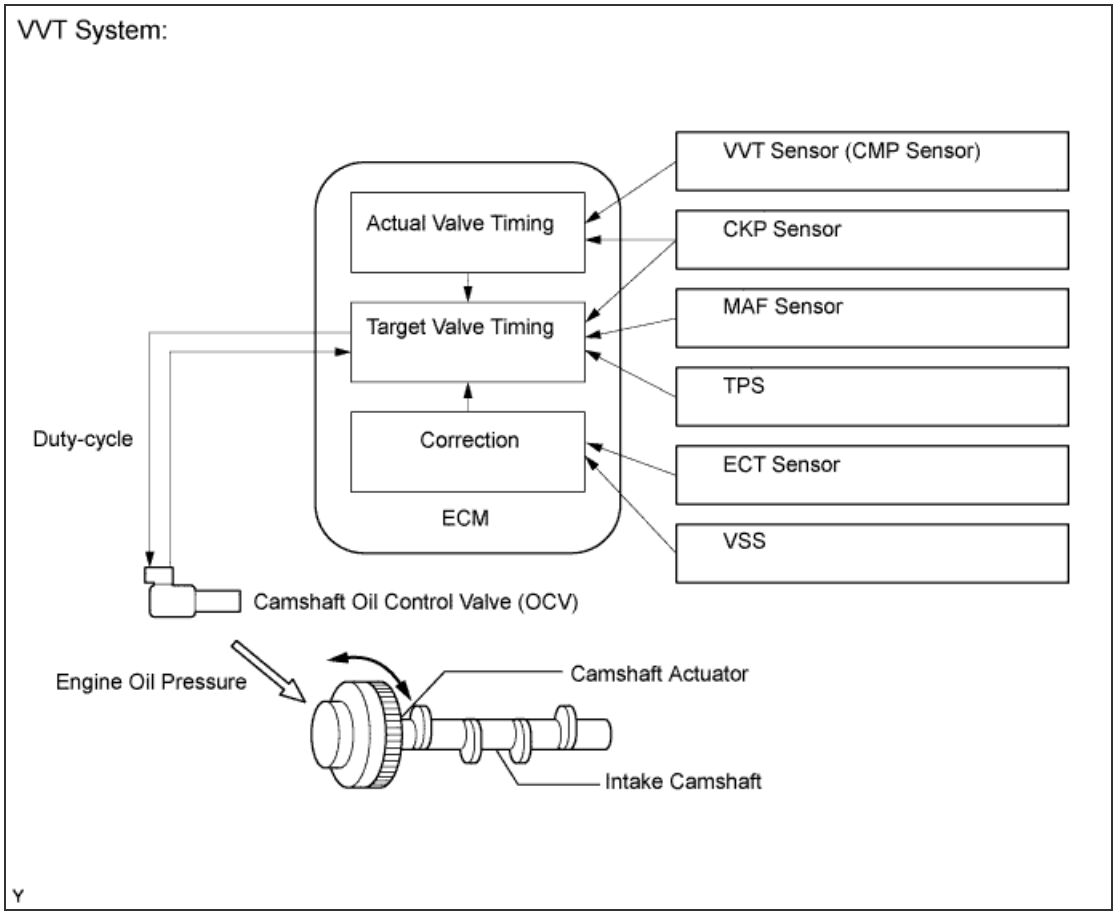
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

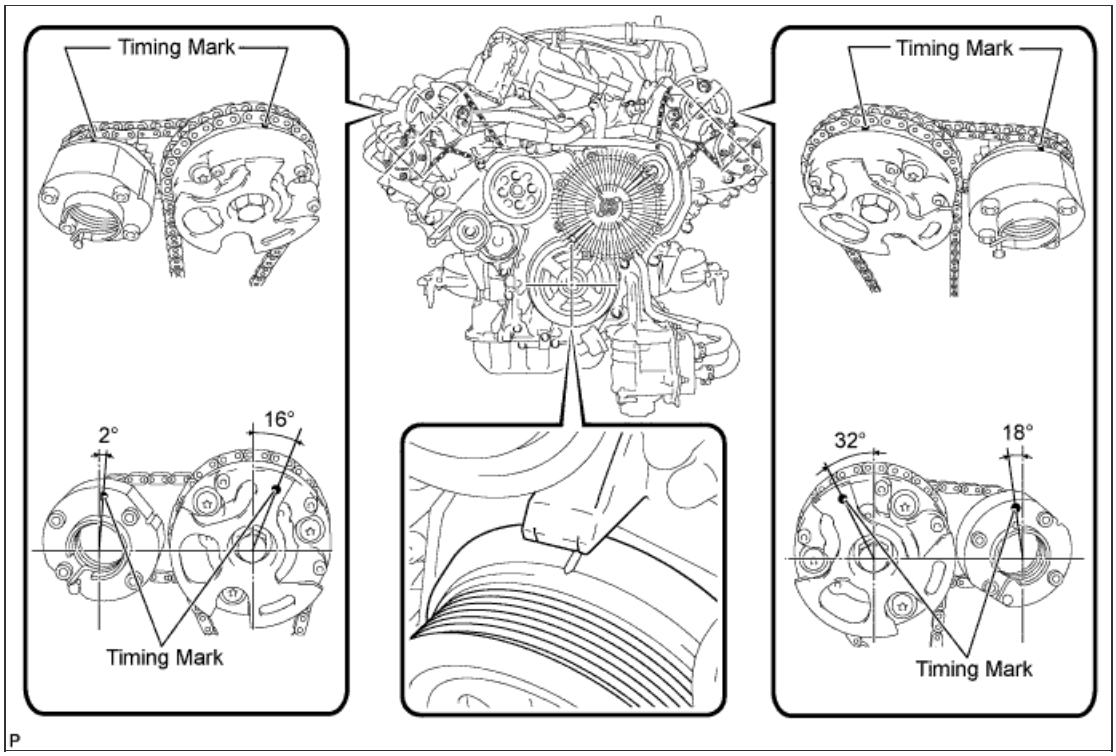
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

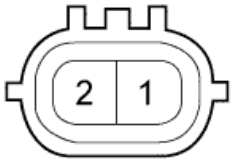
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

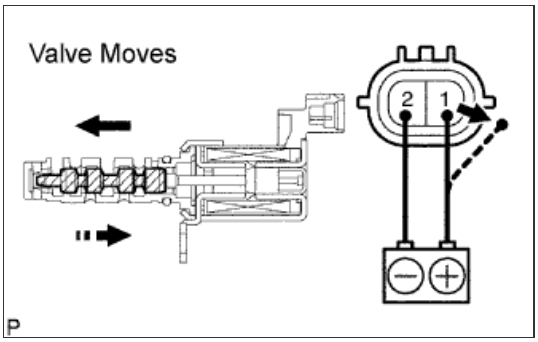
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

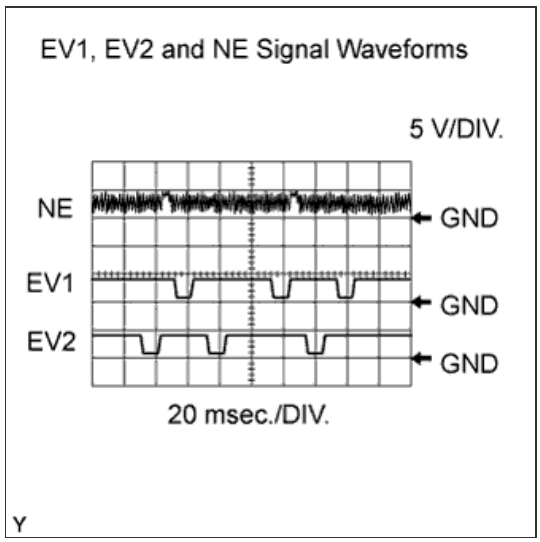
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

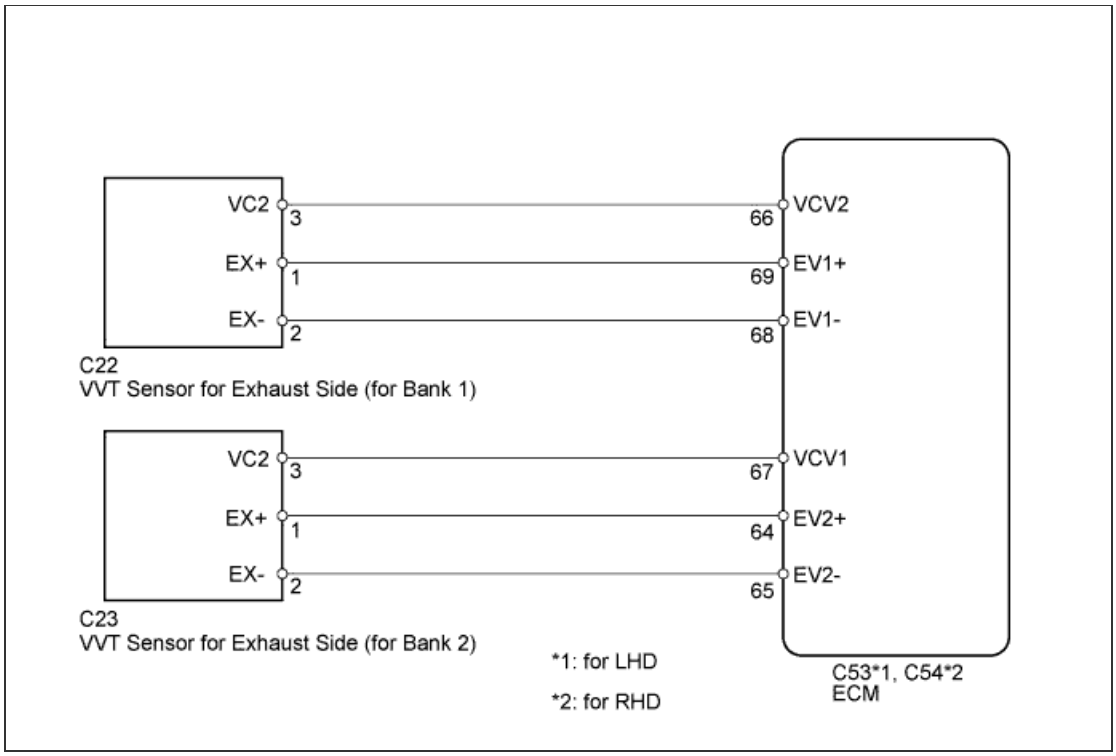
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

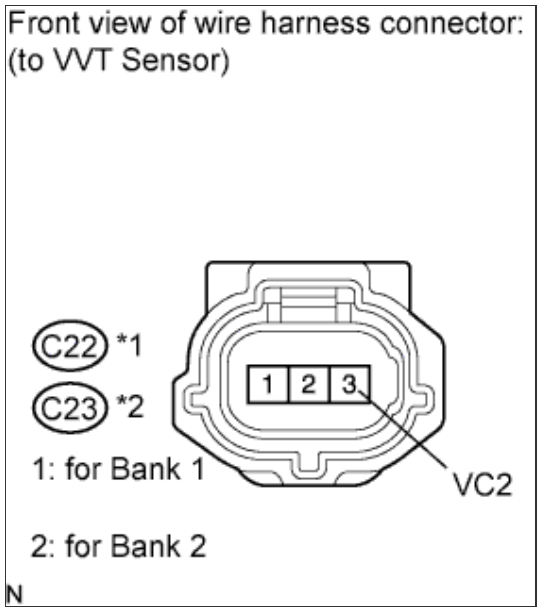
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

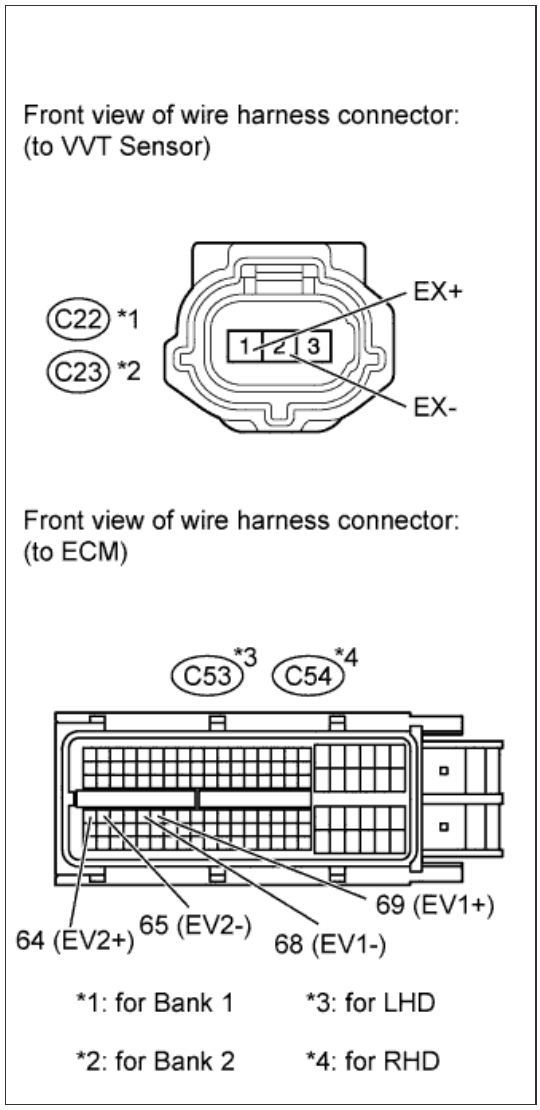
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

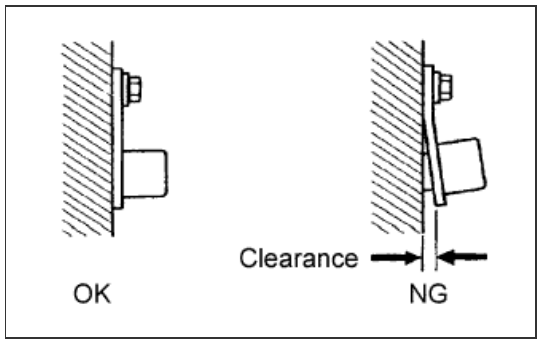
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

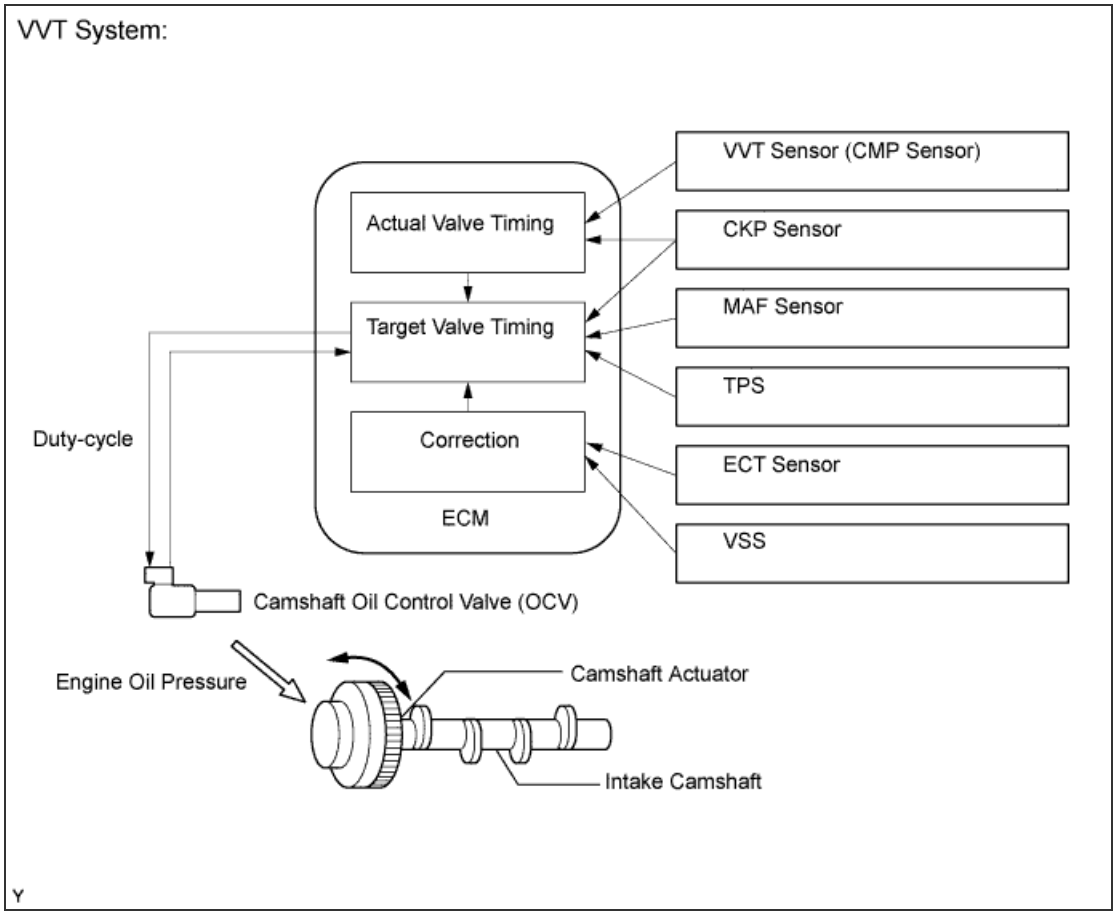
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

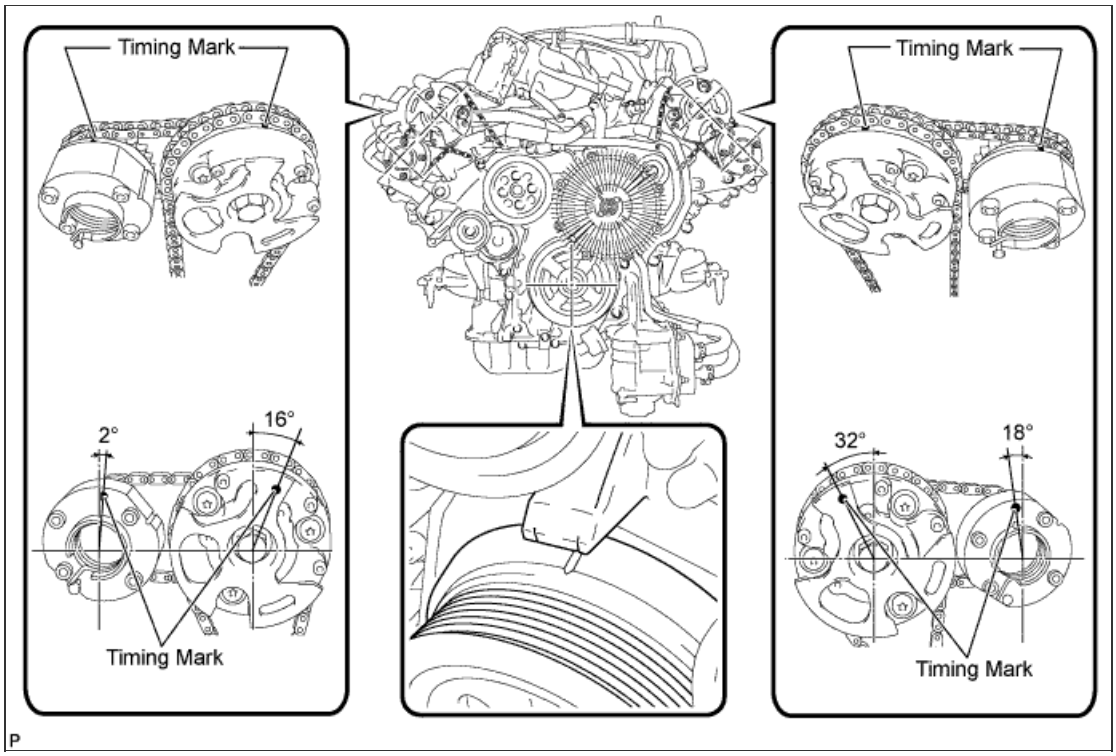
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

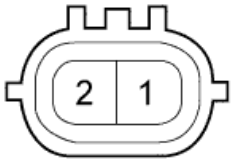
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

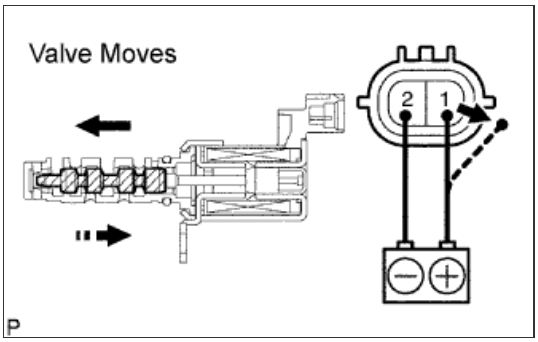
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

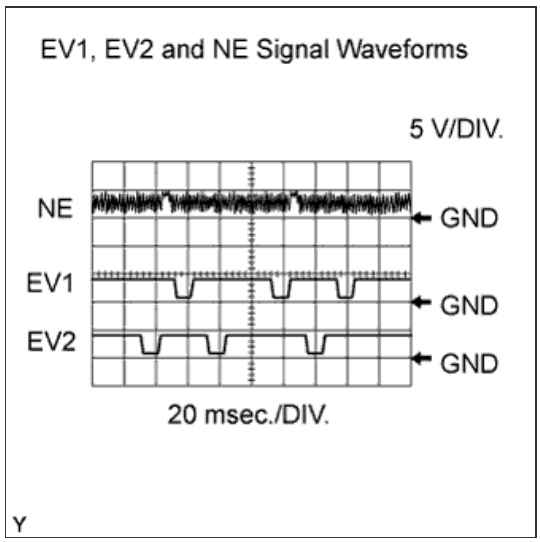
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

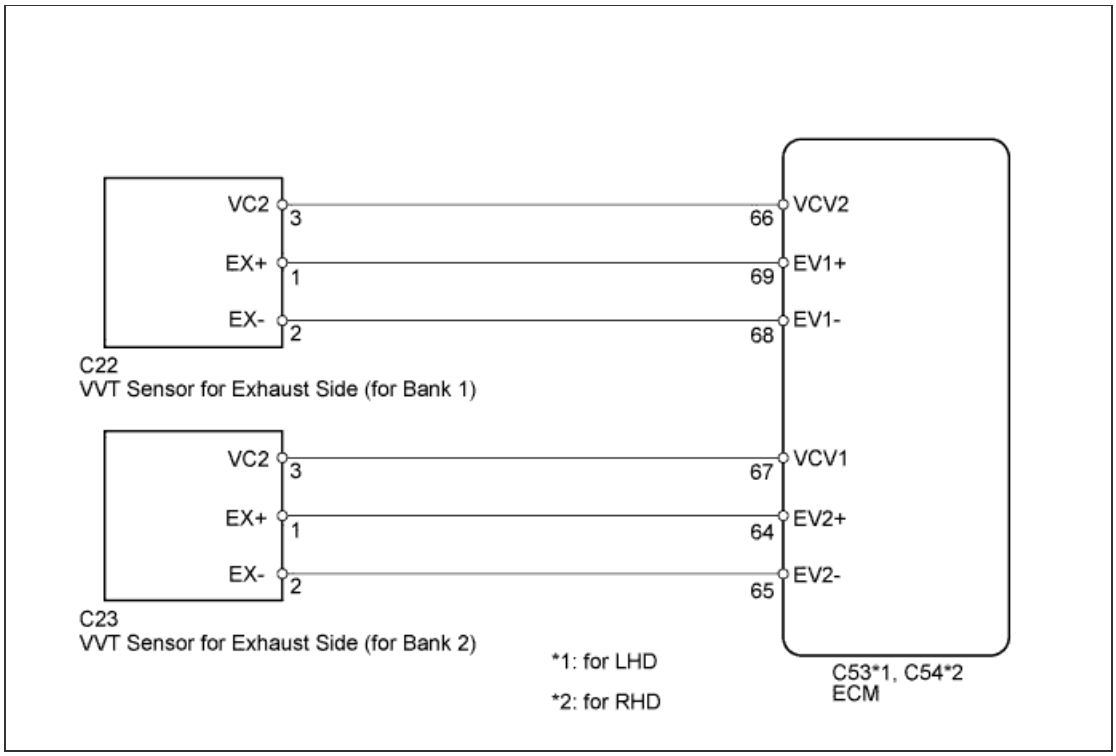
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

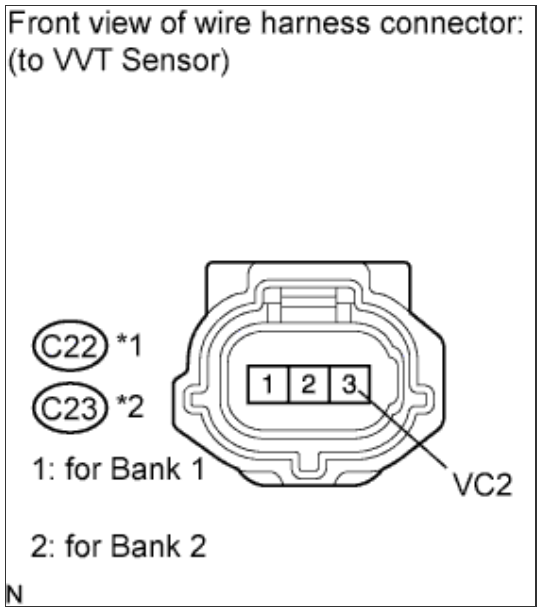
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

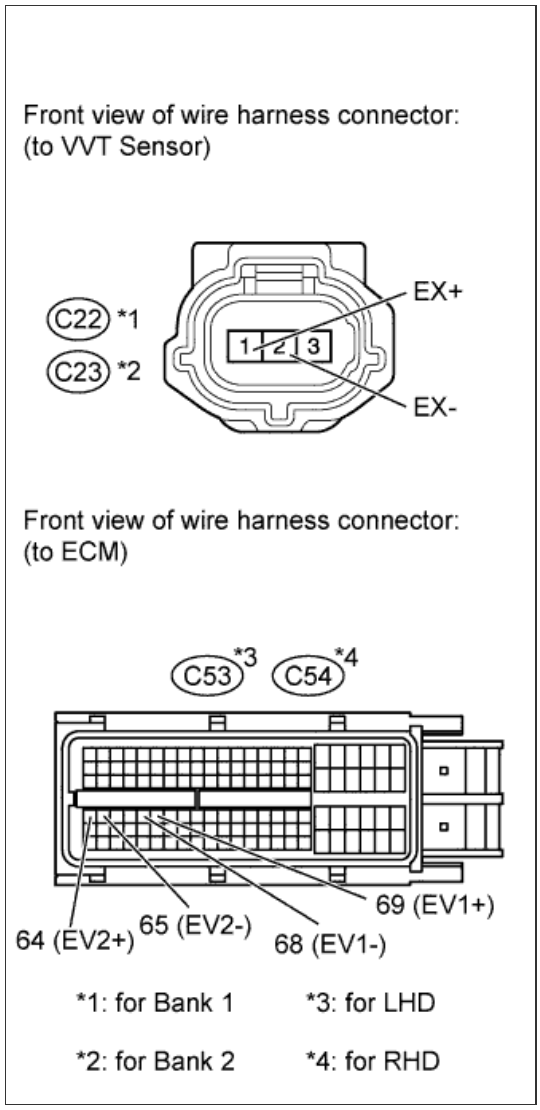
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

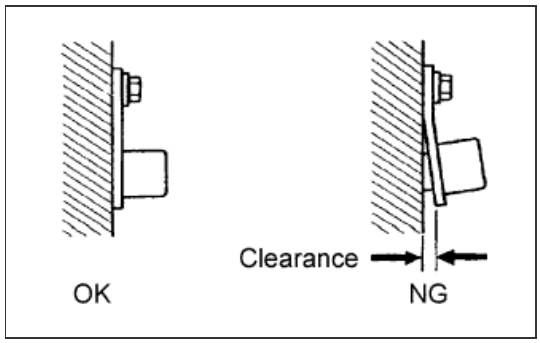
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

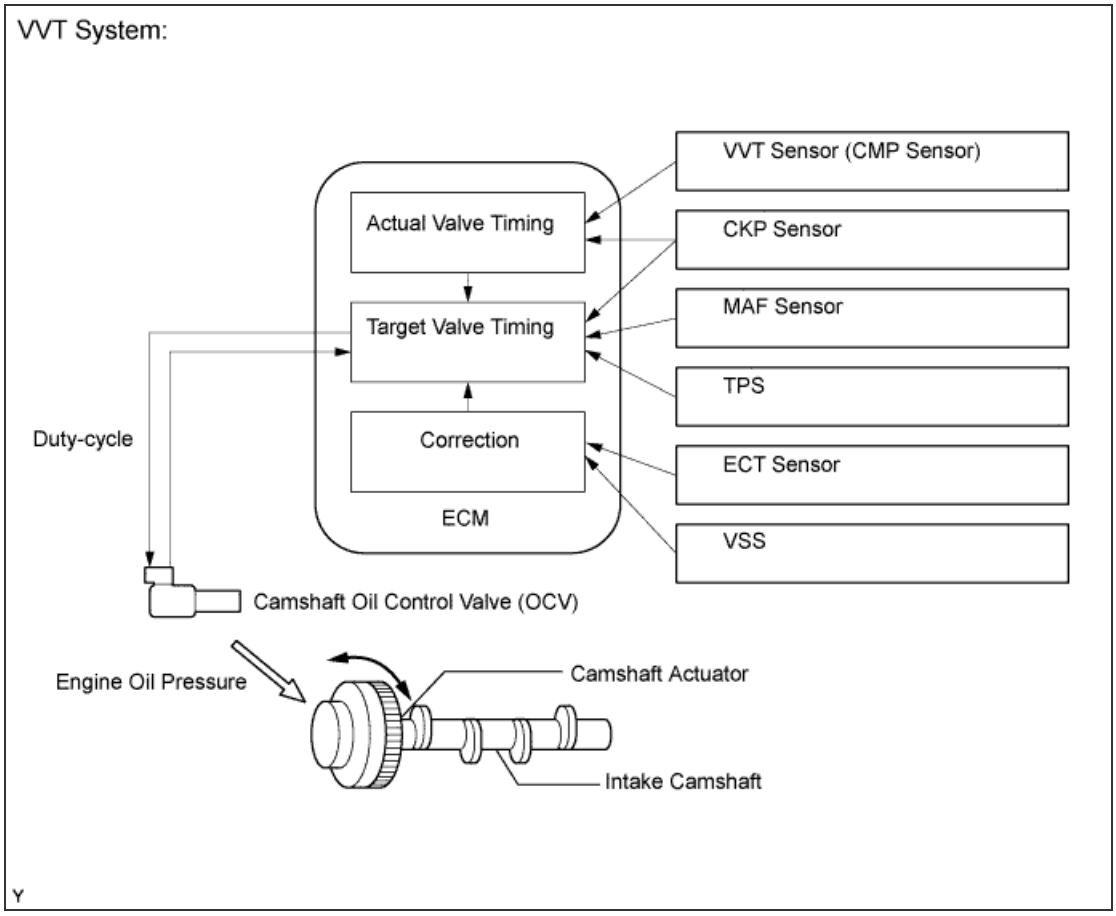
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

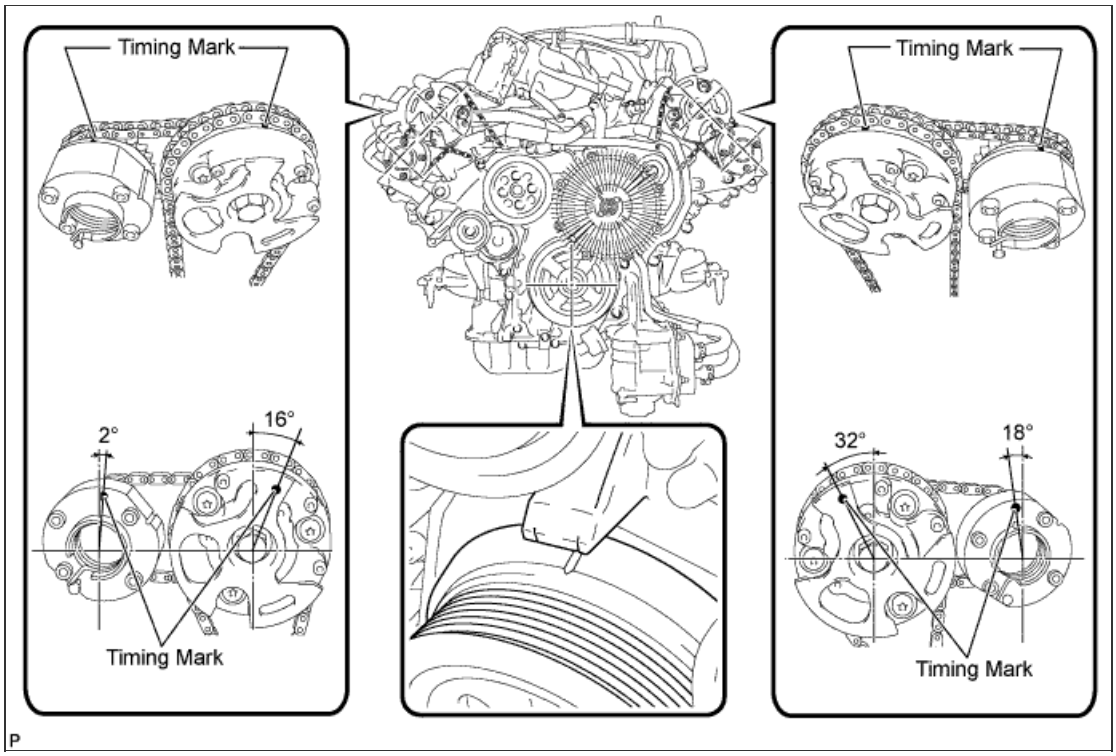
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

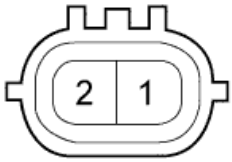
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

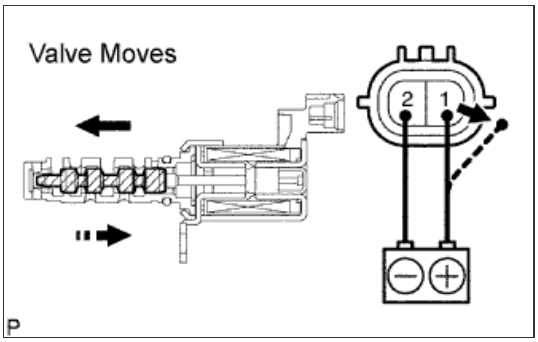
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

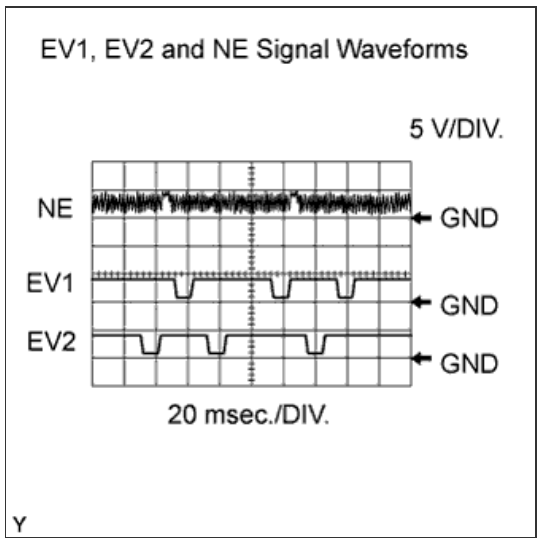
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

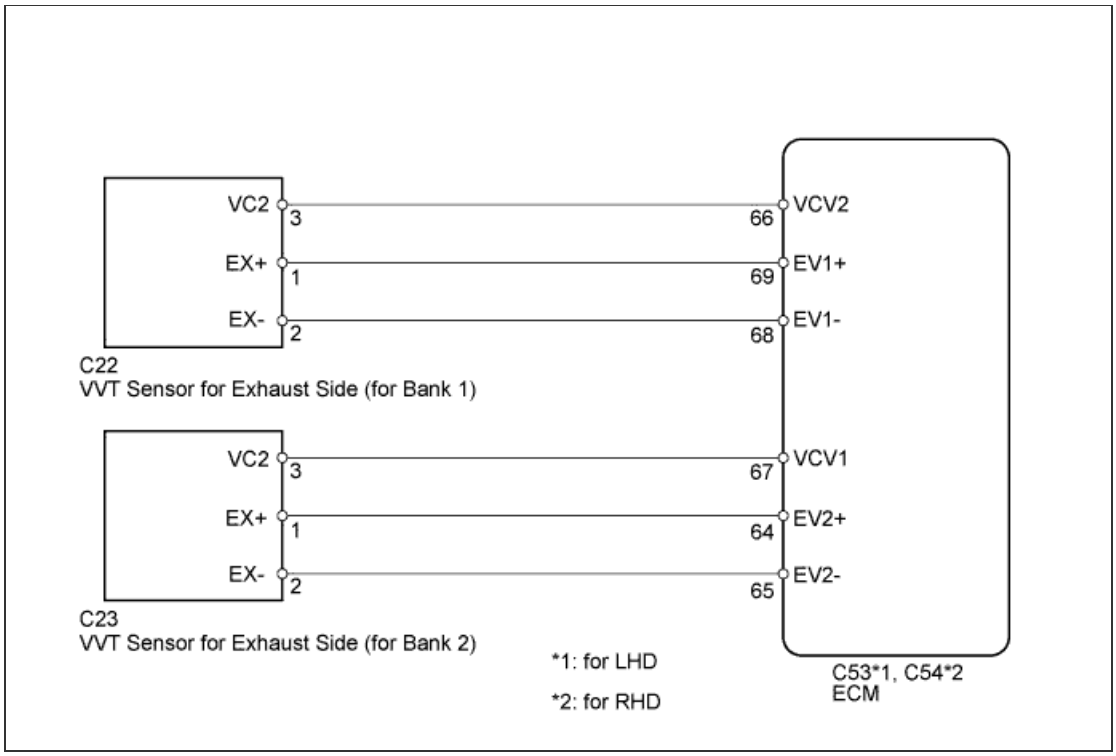
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

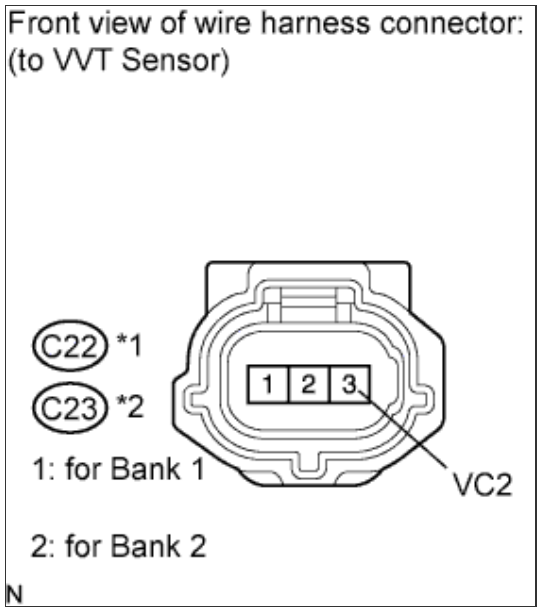
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

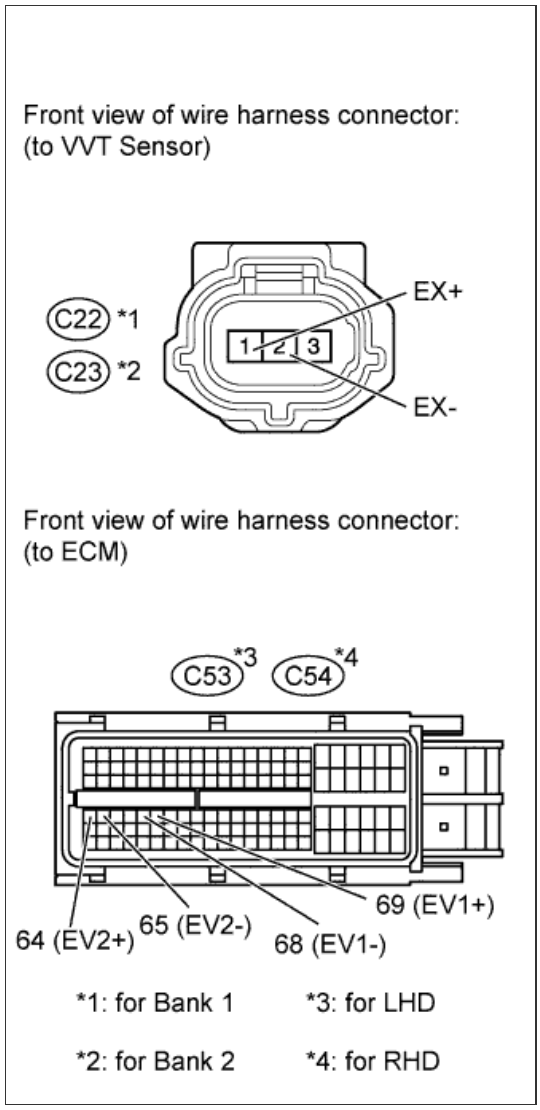
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

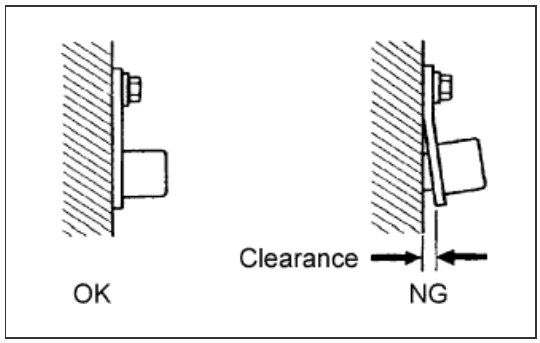
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

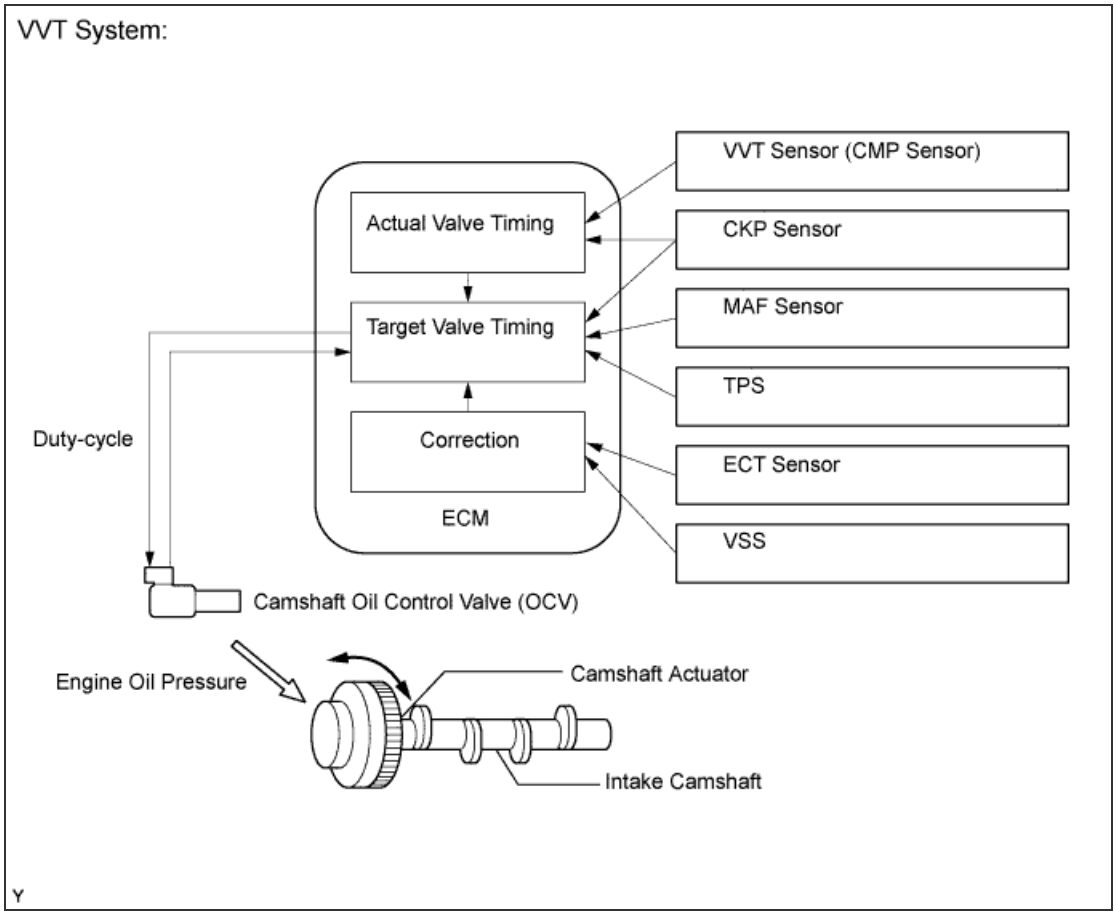
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

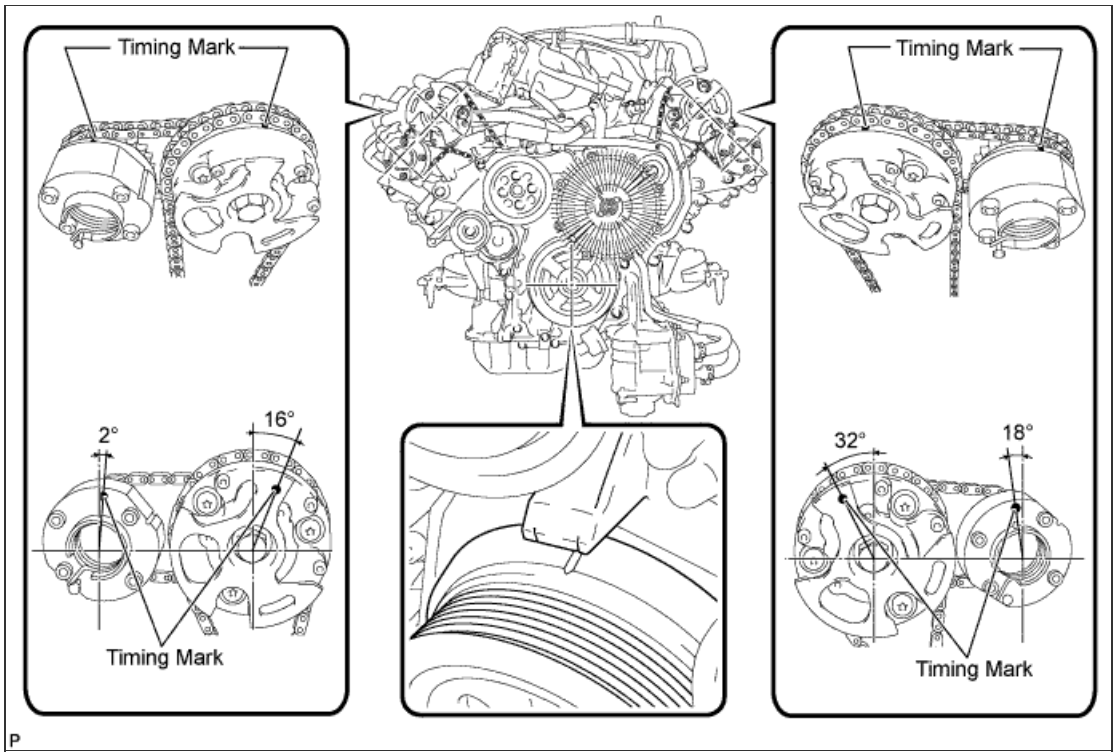
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

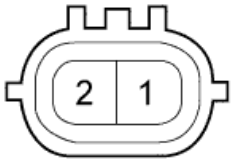
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

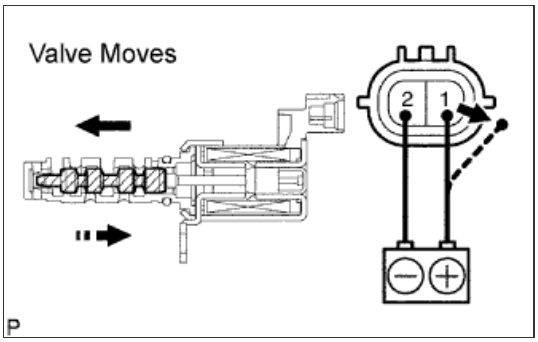
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

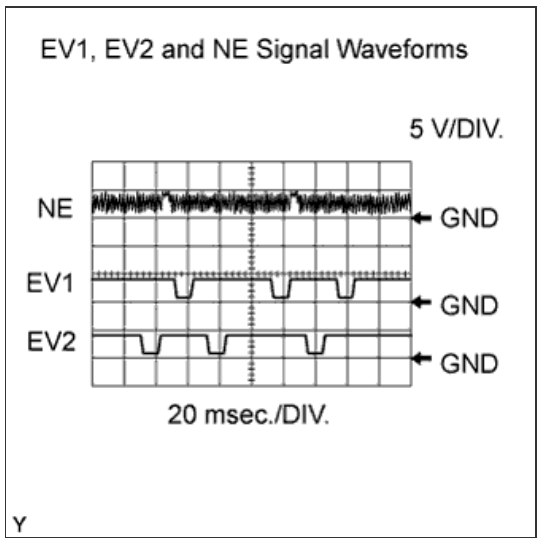
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

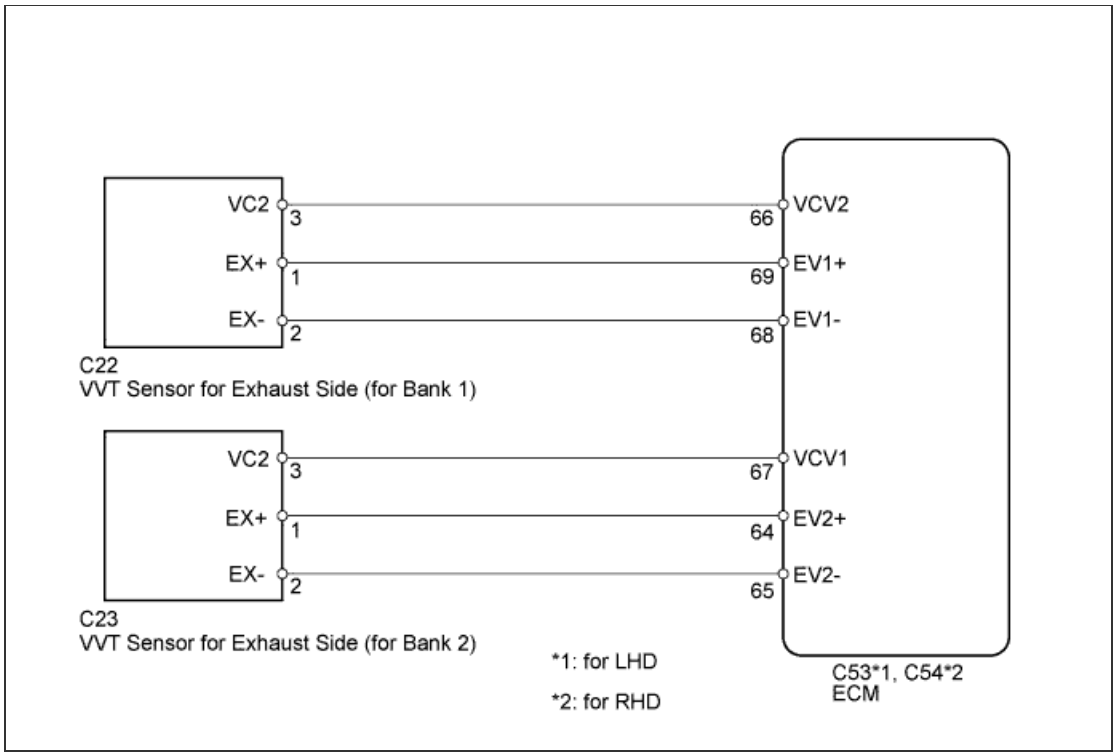
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

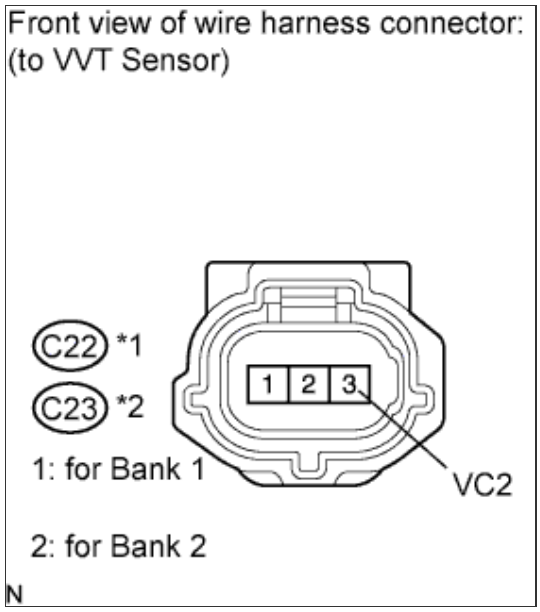
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

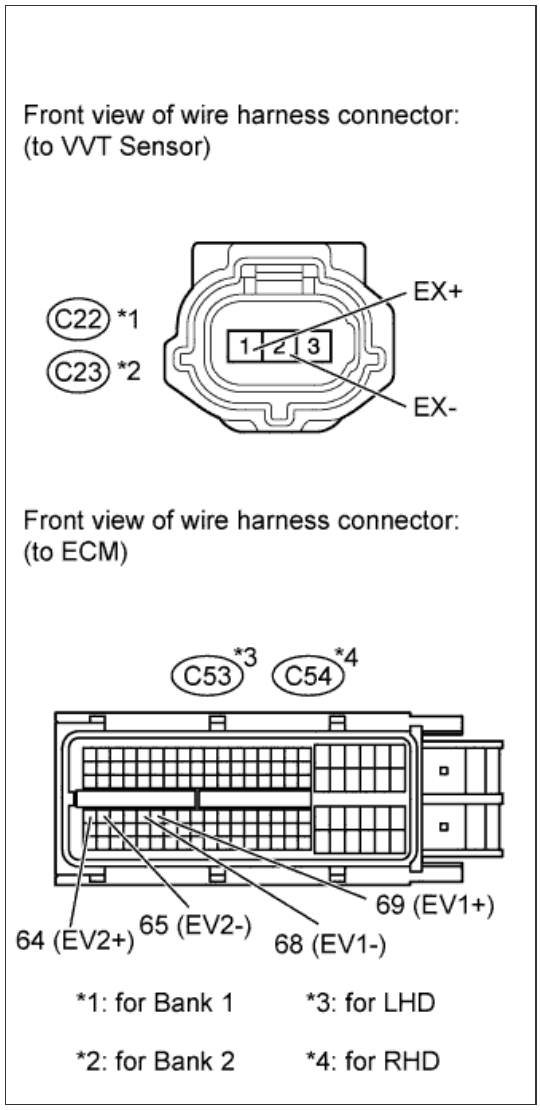
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

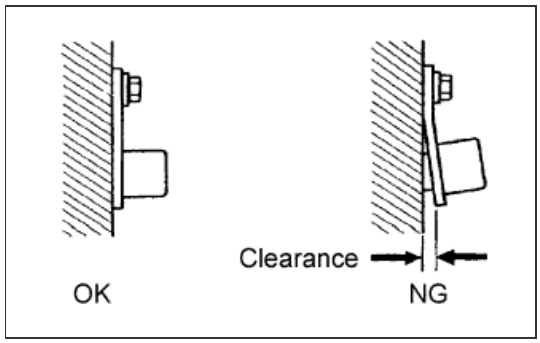
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

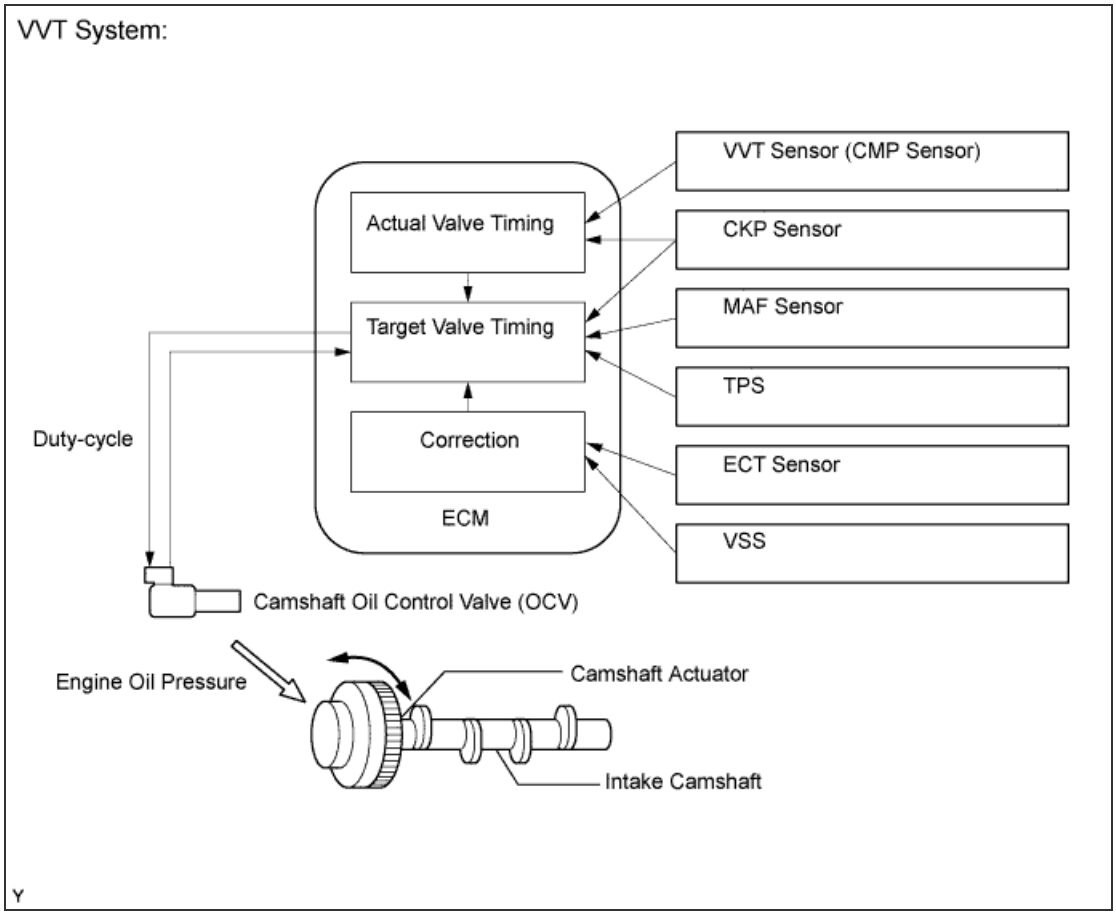
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

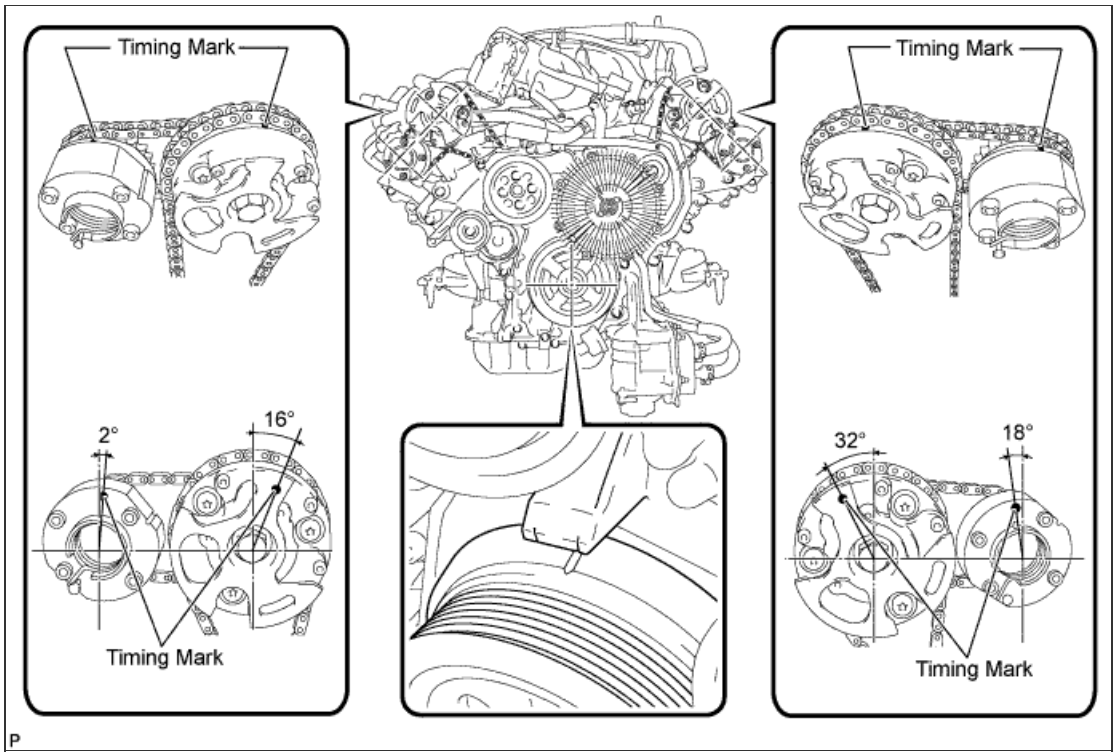
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

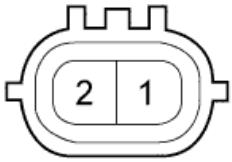
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

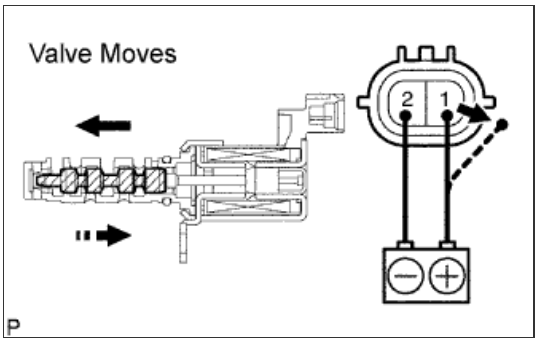
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

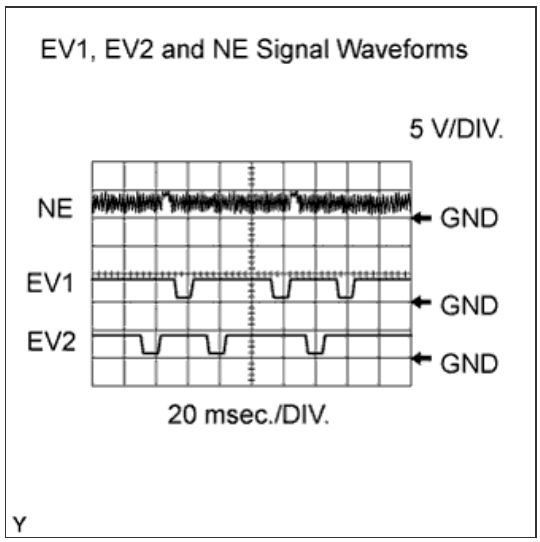
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

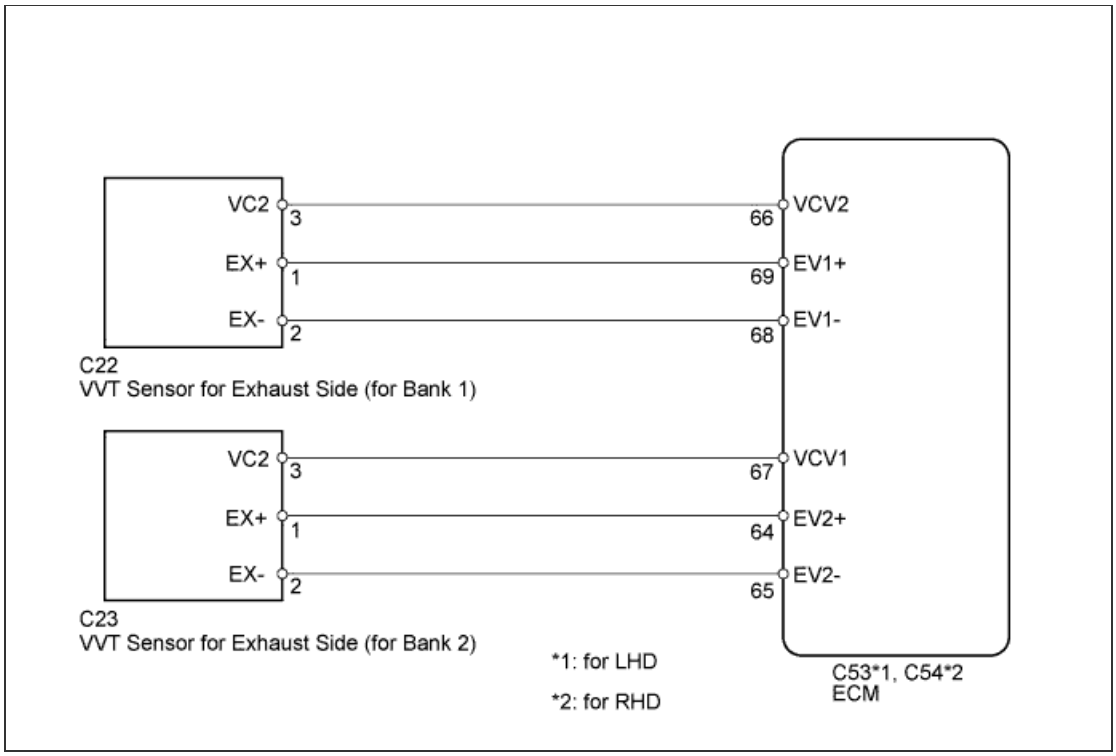
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

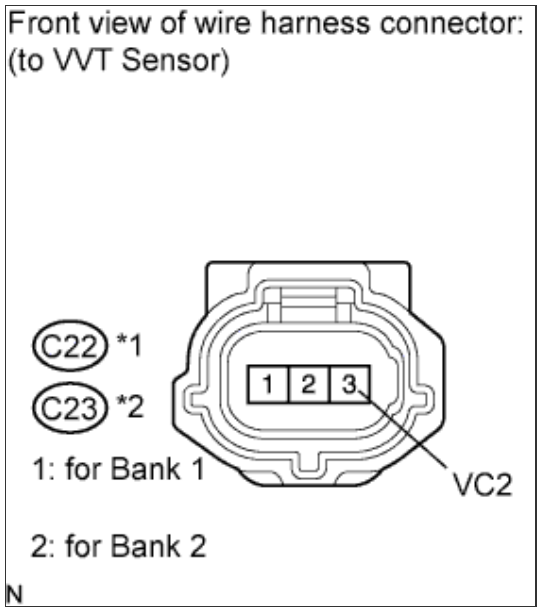
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

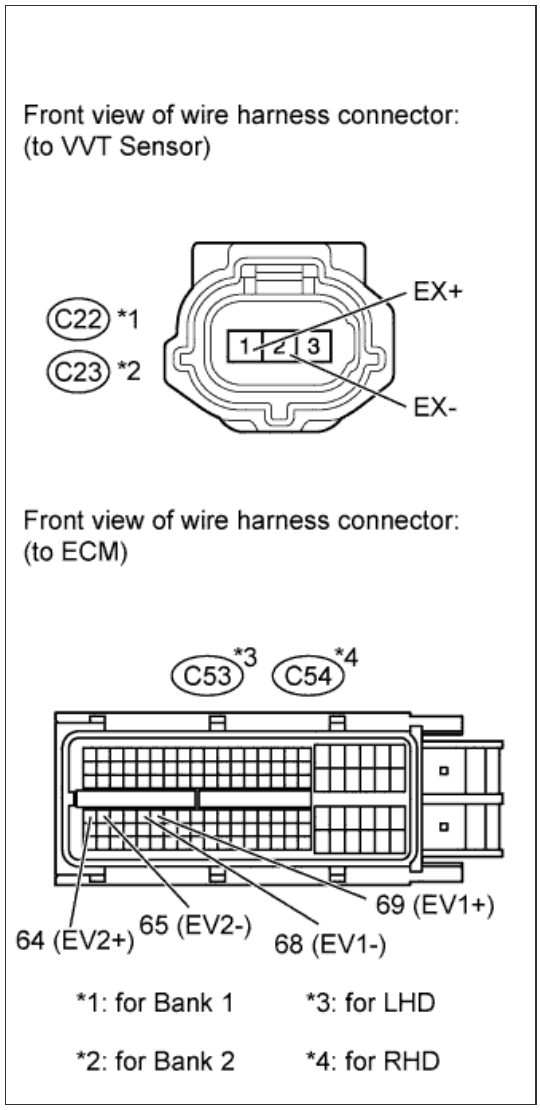
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

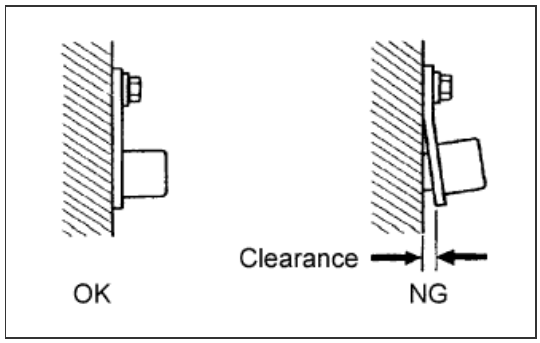
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0014 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)

DTC P0015 Camshaft Position "B" - Timing Over-Retarded (Bank 1)

DTC P0024 Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)

DTC P0025 Camshaft Position "B" - Timing Over-Retarded (Bank 2)

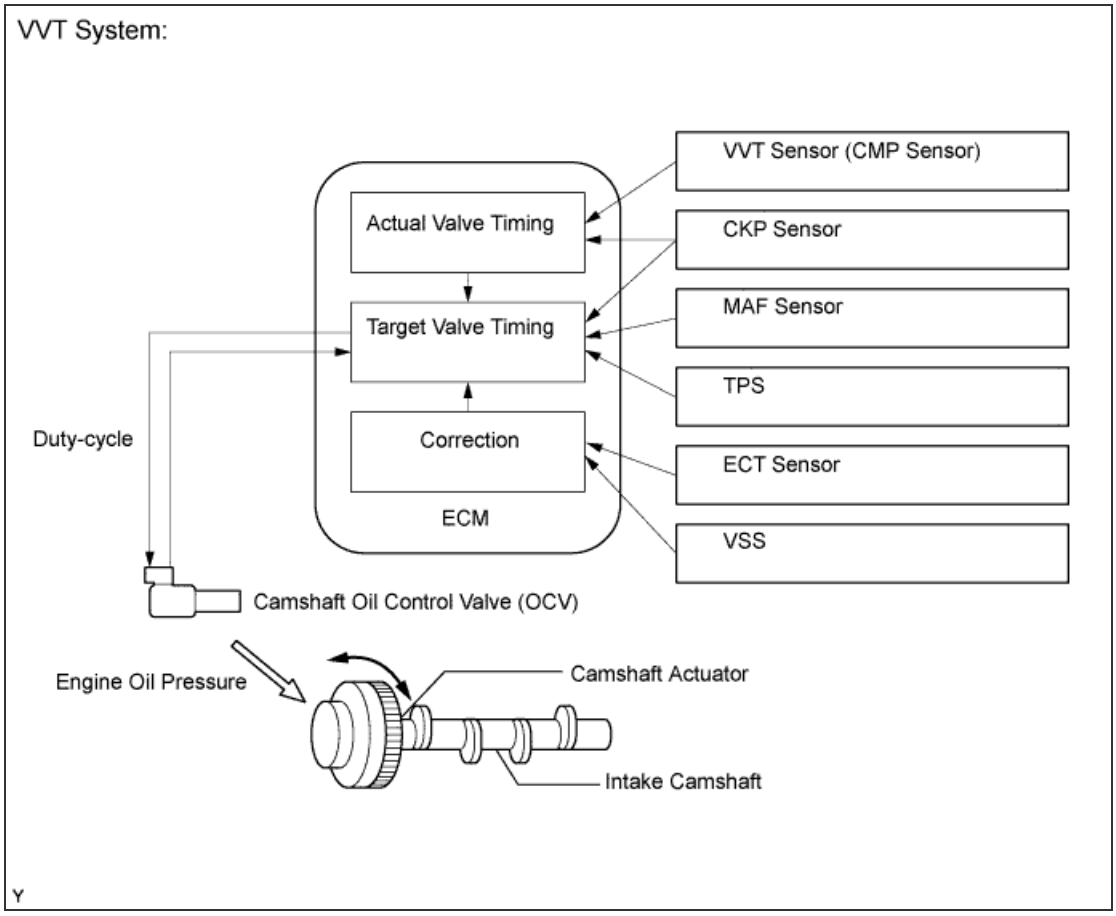
for Preparation Click here

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is output, check the VVT (Variable Valve Timing) system.

The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target exhaust valve timing is verified by the ECM.



DTC Code	DTC Detection Condition	Trouble Area
P0014 P0024	The exhaust valve timing is not adjusted in the valve timing advance range (2 trip detection logic).	• Valve timing • Camshaft Oil Control Valve (OCV) (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM
P0015 P0025	The exhaust valve timing is not adjusted in the valve timing retard range (1 trip detection logic).	• Valve timing • OCV (for exhaust side of Bank 1, 2) • OCV filter • Camshaft timing exhaust gear • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, Camshaft Oil Control Valve (OCV) and VVT controller.
2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timing is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and stores DTC(s).
   Example:
   A DTC is stored when the following conditions 1, 2 and 3 are met:
   1. The difference between the target and actual exhaust valve timing is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   2. It takes 5 seconds or more to change the valve timing by 5° CA (Procedure "B").
   3. After above procedures "A" and "B" are met, the OCV is forcibly activated during 10 seconds.
3. DTCs P0014 and P0024 (Advanced Cam Timing) are subject to 2 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are subject to 1 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   1. The engine is warm (the engine coolant temperature is 75°C [167°F] or higher).
   2. The vehicle has been driven at more than 64 km/h (40 mph) for 3 minutes.
   3. The engine has idled for 3 minutes.

WIRING DIAGRAM

Refer to DTC P0013 (Click here).

INSPECTION PROCEDURE

HINT:

Abnormal Bank	Advanced Timing Over (Valve Timing is Out of Specified Range)	Retarded Timing Over (Valve Timing is Out of Specified Range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- **If DTC P0014 or P0015 is output, check the bank 1 VVT system for exhaust side circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **If DTC P0024 or P0025 is output, check the bank 2 VVT system for exhaust side circuit.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:

If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
0%	Normal engine speed
100%	Engine idles roughly or stalls

NG → **Go to step 4**

OK ↓

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read DTCs using the tester.

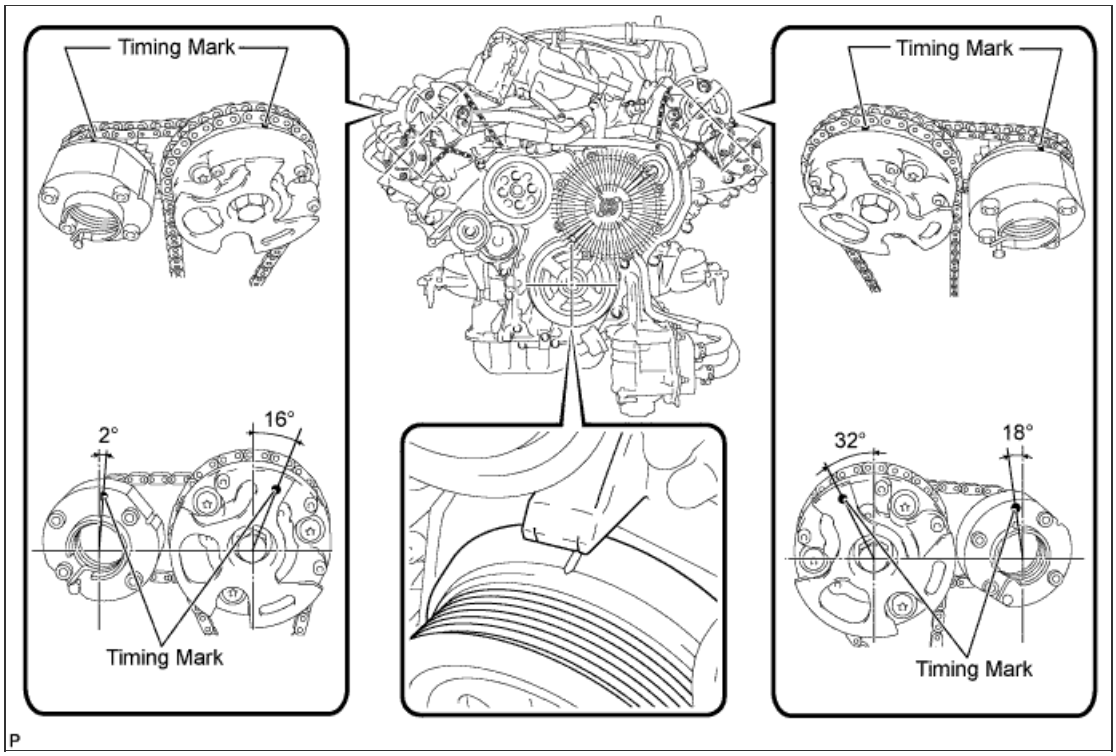
OK:
No DTC output.

NG → **Go to step 4**

OK ↓

CHECK FOR INTERMITTENT PROBLEMS (Click here)

4.CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:

Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → **ADJUST VALVE TIMING (Click here)**

OK

5.INSPECT CAMSHAFT OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)

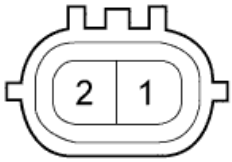
a. Remove the OCV (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

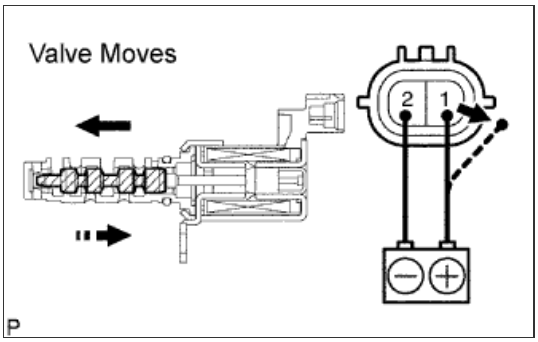
Component without harness connected:
(Oil Control Valve)



c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly



NG → REPLACE CAMSHAFT OIL CONTROL VALVE ASSEMBLY (Click here)

OK

6.INSPECT OIL CONTROL VALVE FILTER

a. Remove the oil control valve filter (Click here).

b. Check that the filter is not clogged.

OK:
Filter is not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER

OK

7.REPLACE CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing exhaust gear (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the tester on.

c. Clear the DTCs (Click here).

d. Warm up the engine.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. With the engine warmed up, idle it for 1 minute. Then drive the vehicle for 5 minutes.

g. Read the output DTCs using the tester.

OK:
No DTC output.

HINT:

DTC P0014, P0015, P0024 or P0025 is output when foreign objects in the engine oil are caught in some parts of the system. These codes will stay stored even if the system returns to normal after a short time. These foreign objects are then captured by the oil filter, thus eliminating the source of the problem.

NG → REPLACE ECM (Click here)

OK

SYSTEM IS OK

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

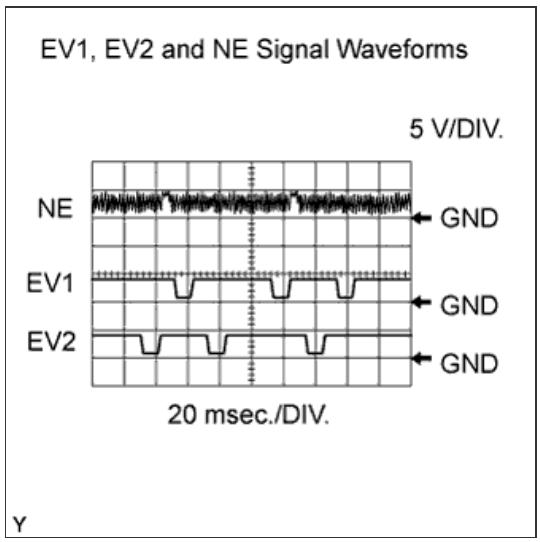
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

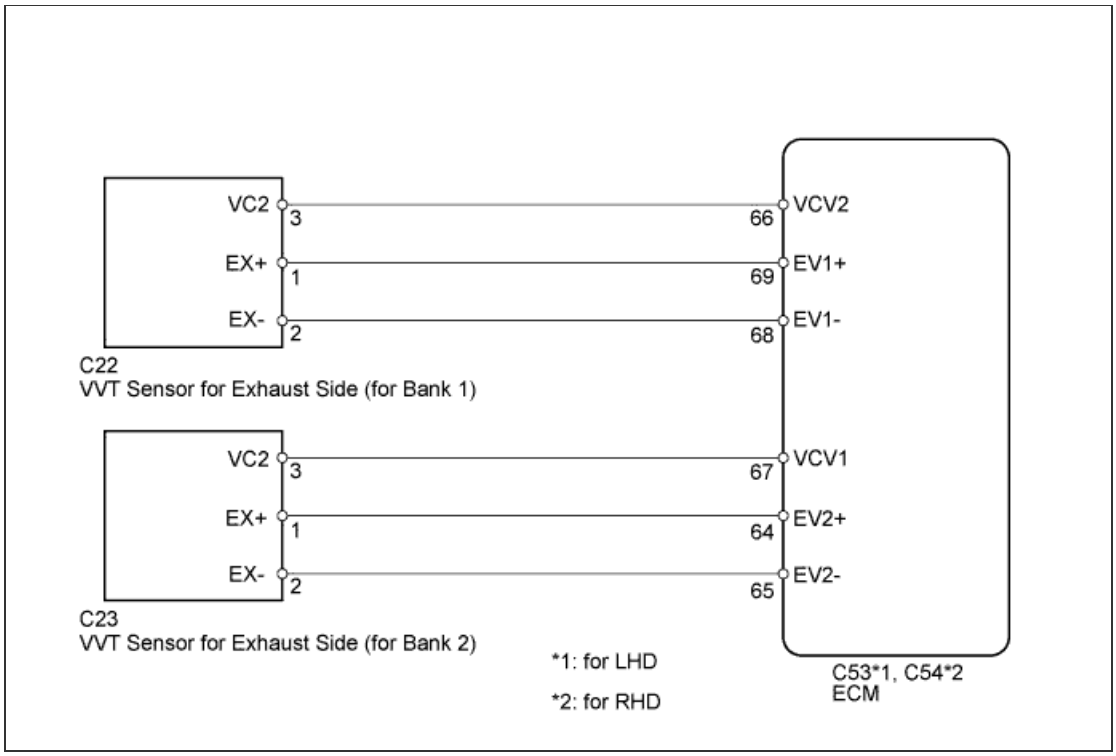
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

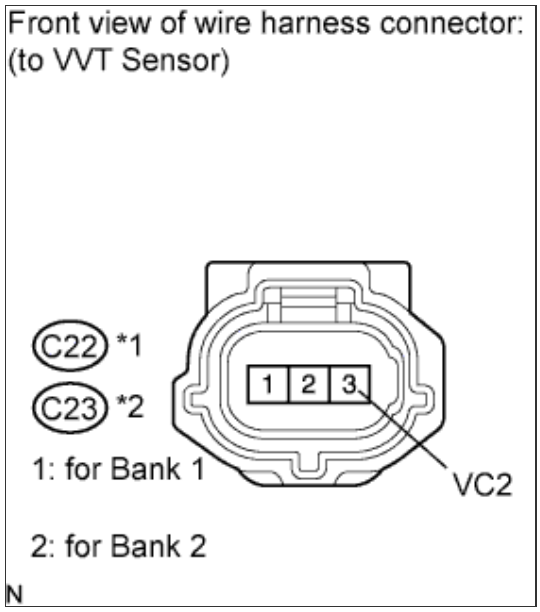
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

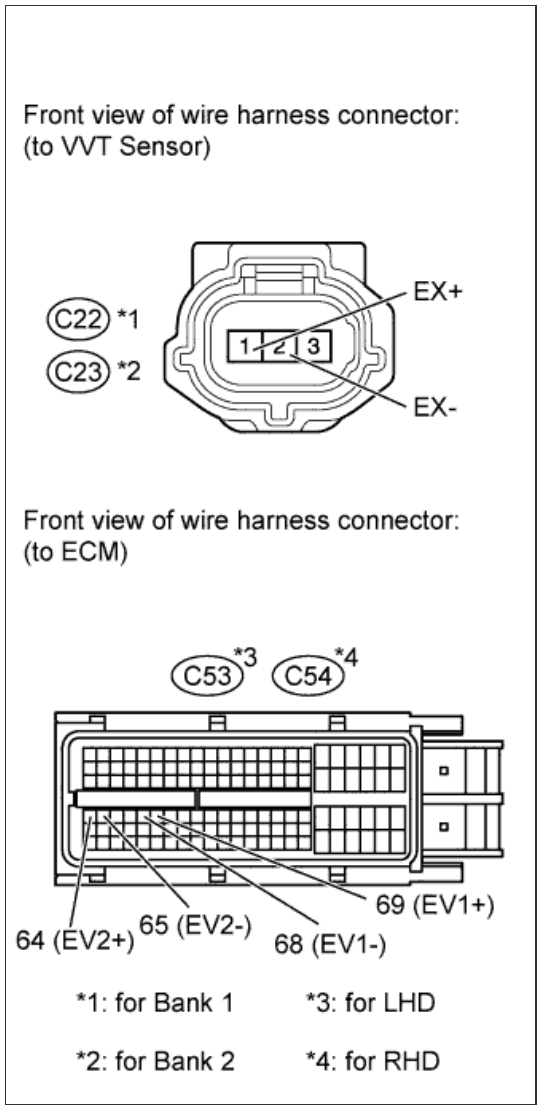
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

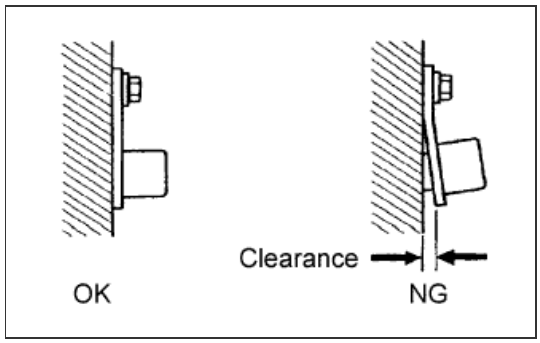
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

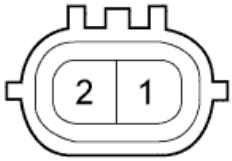
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

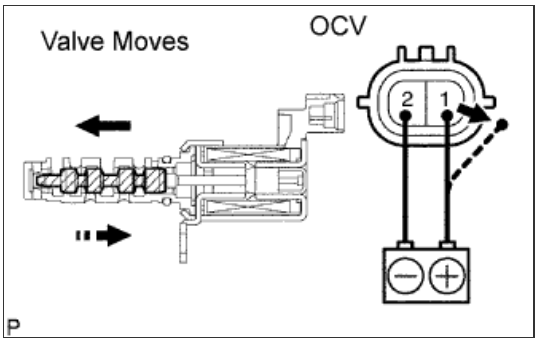
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

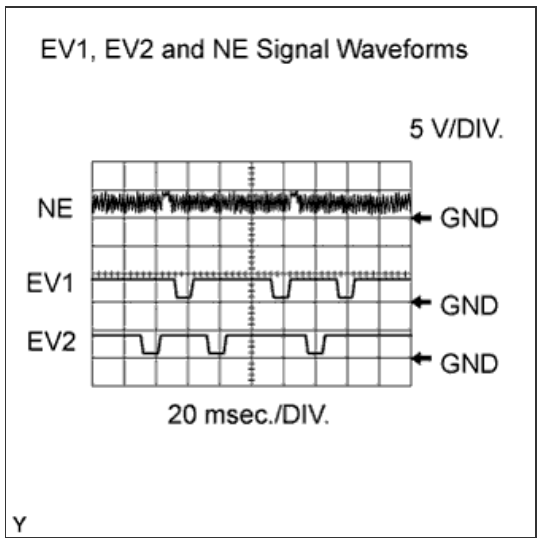
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

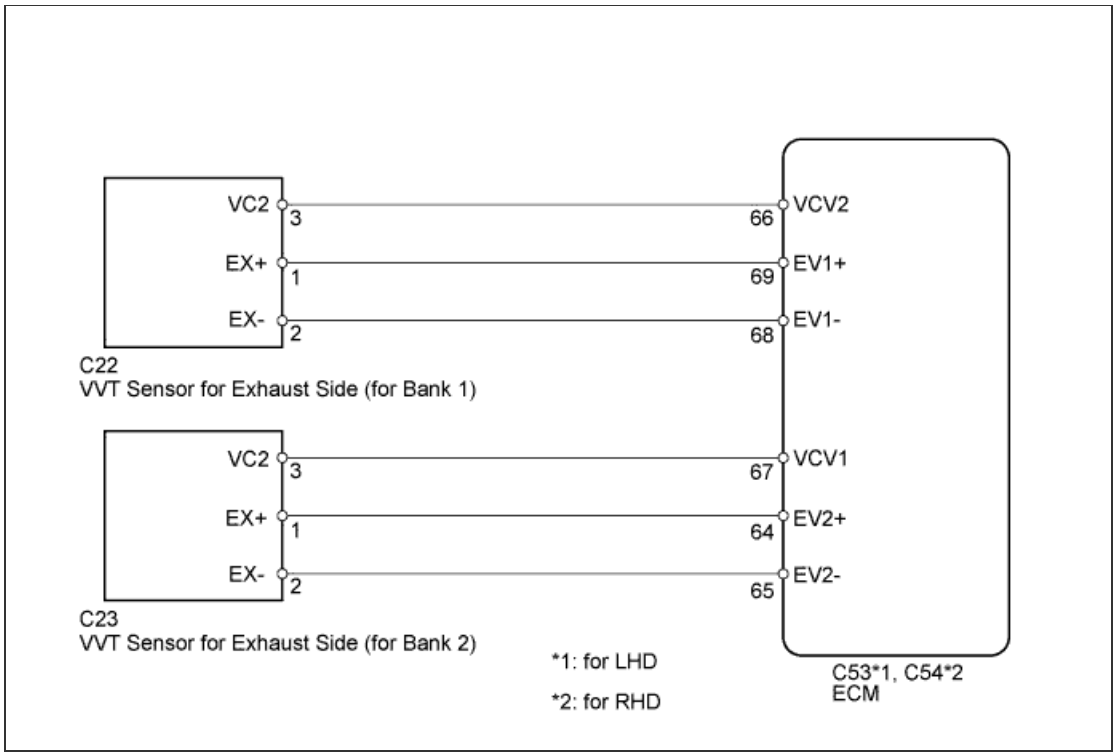
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

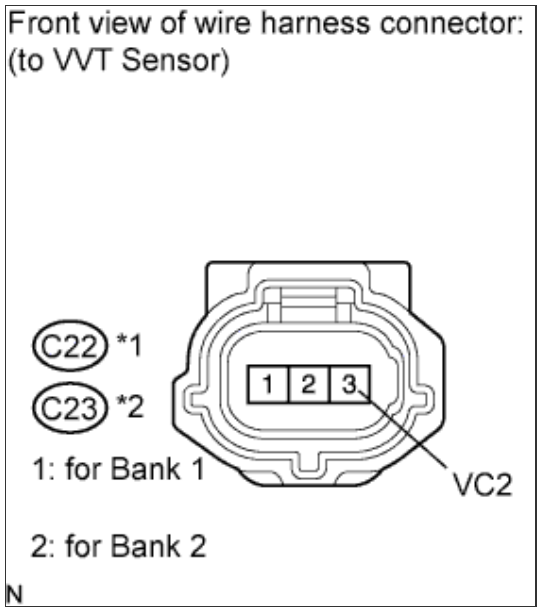
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

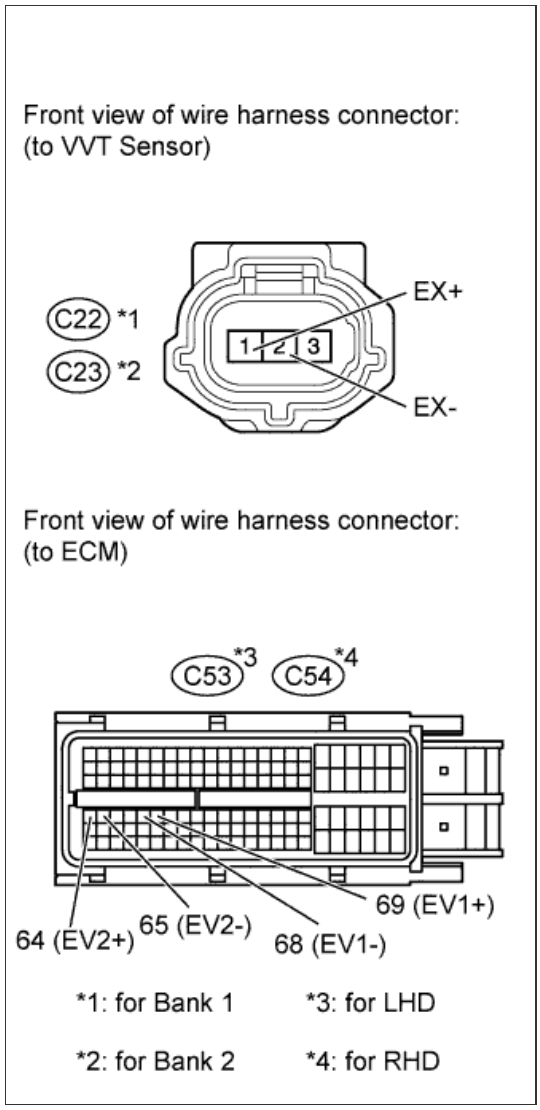
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

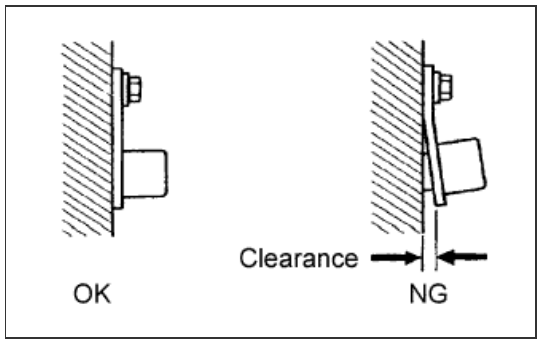
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

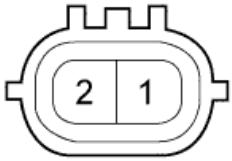
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

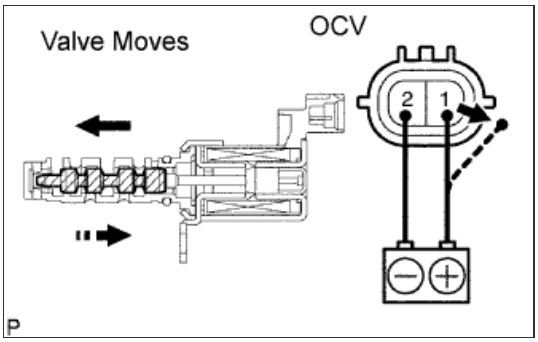
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

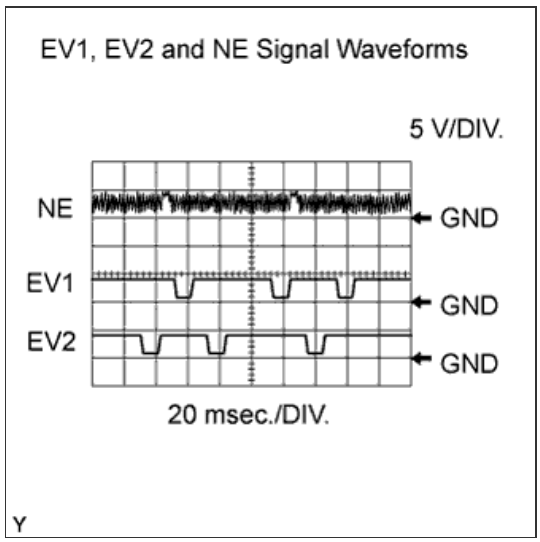
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

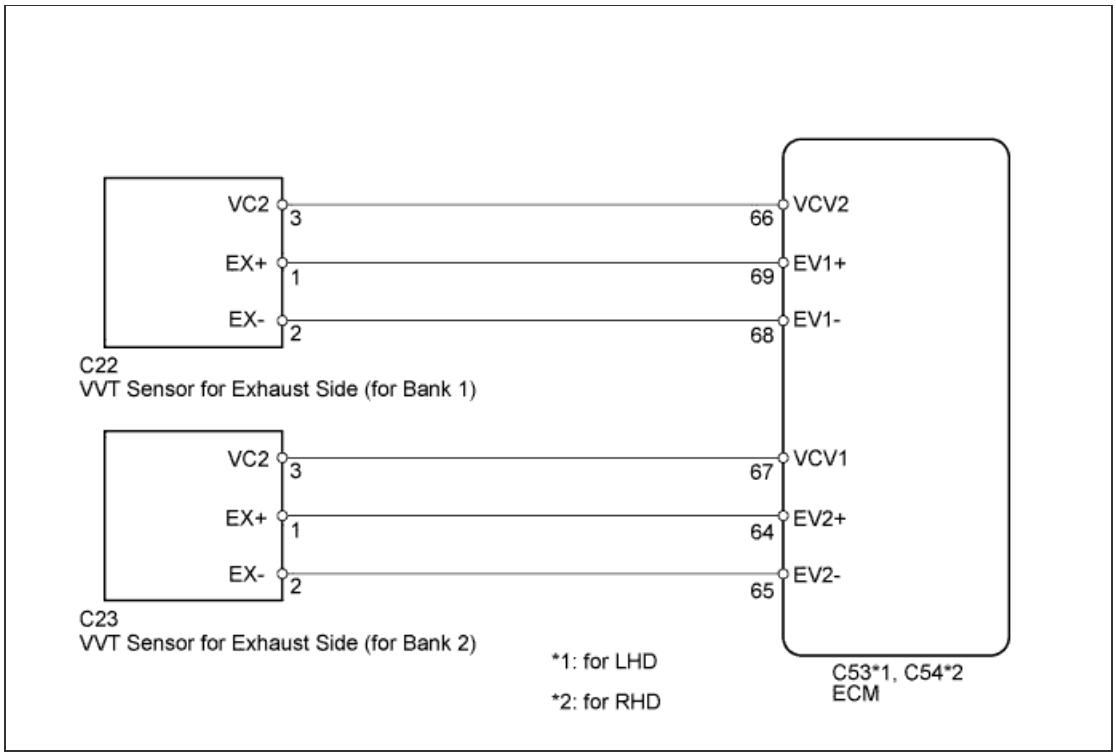
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

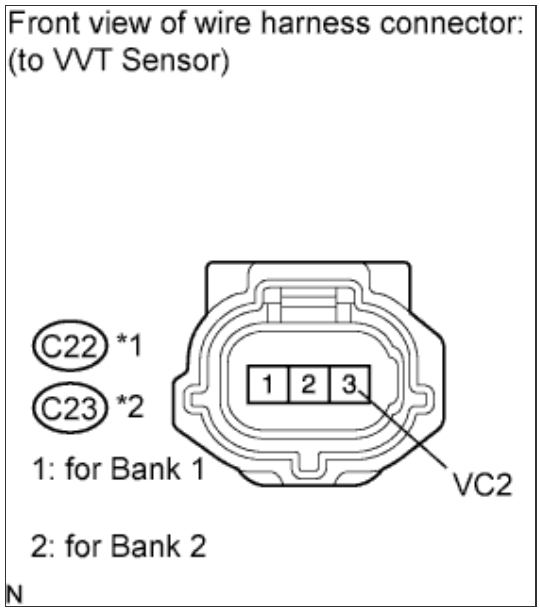
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

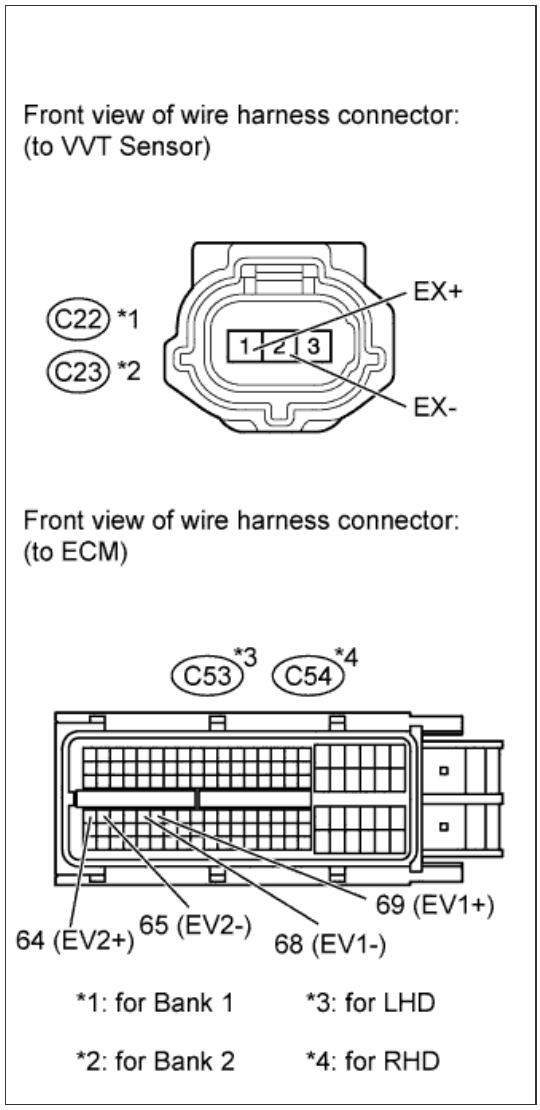
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

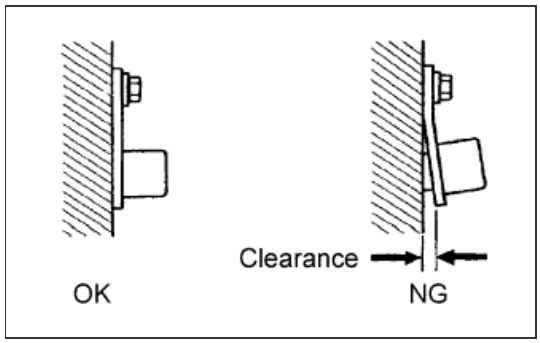
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

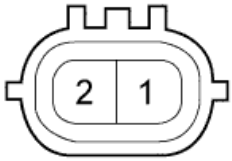
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

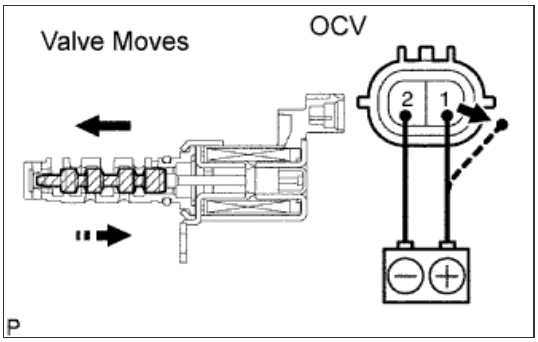
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

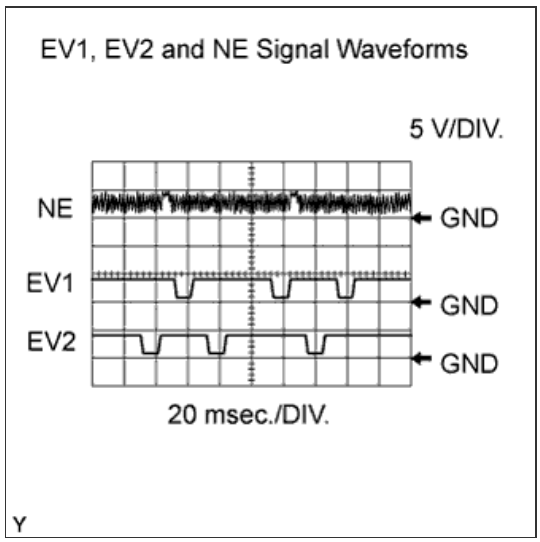
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

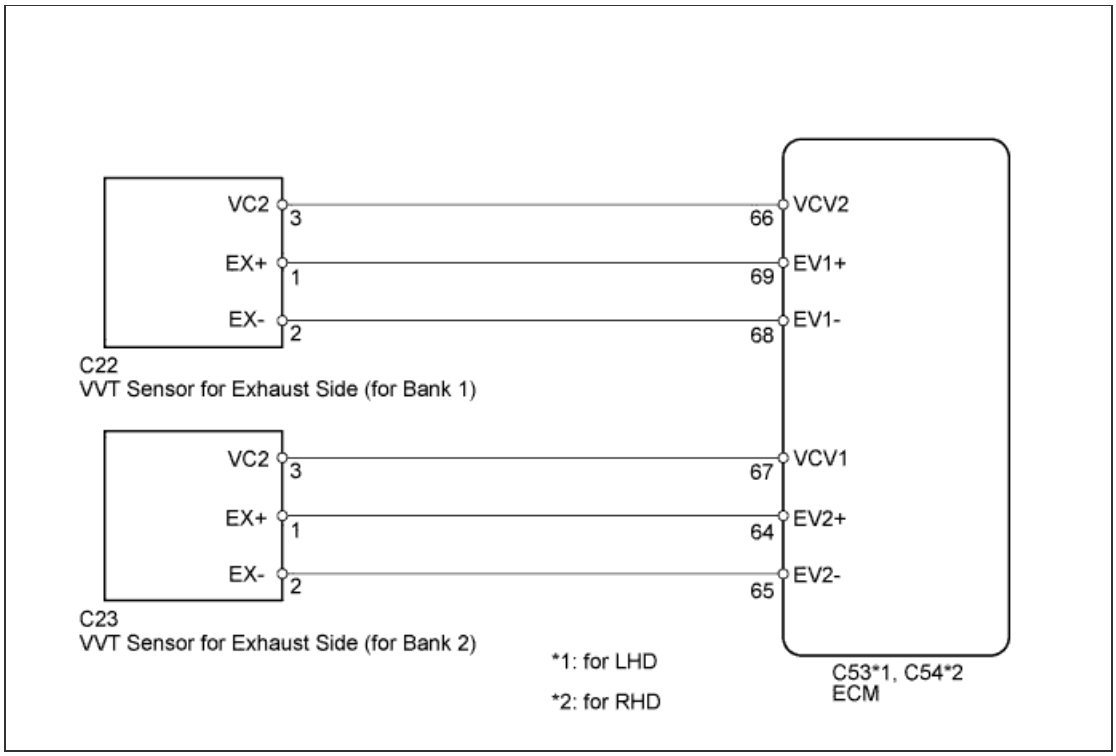
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

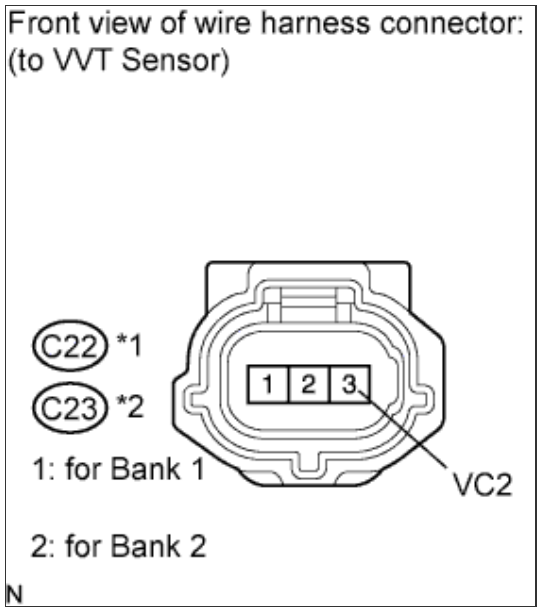
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

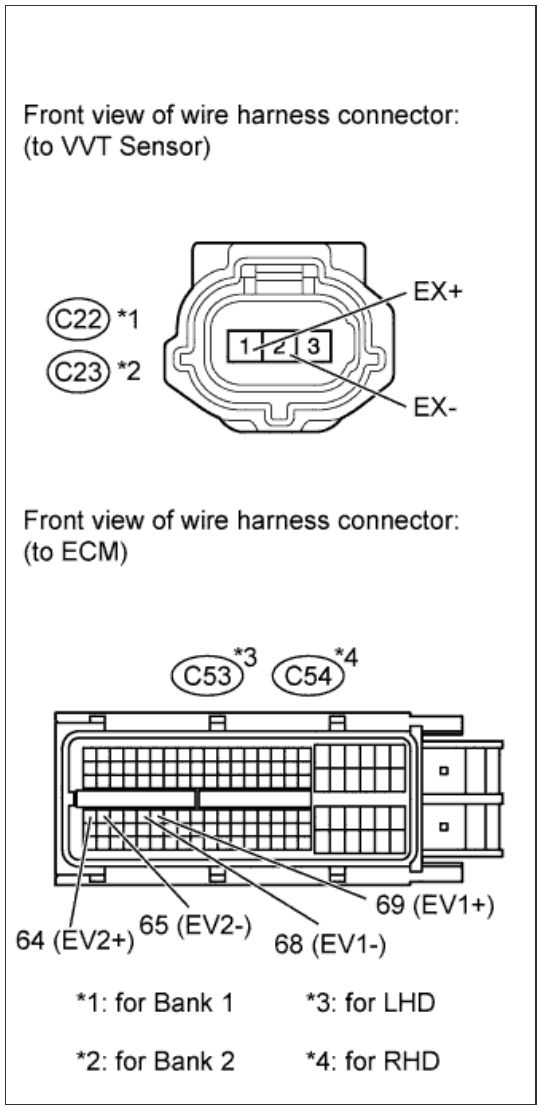
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

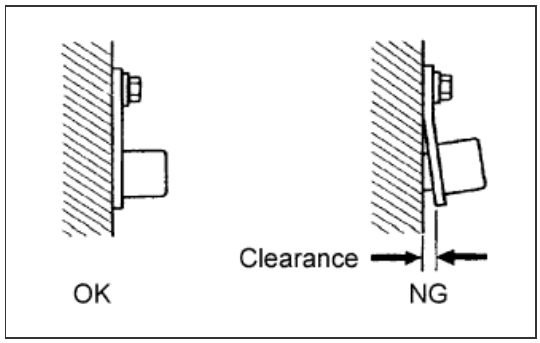
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

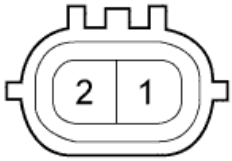
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

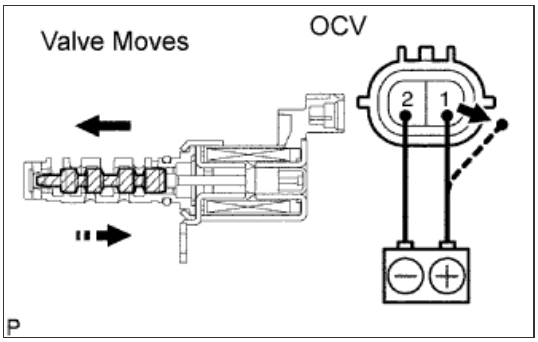
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

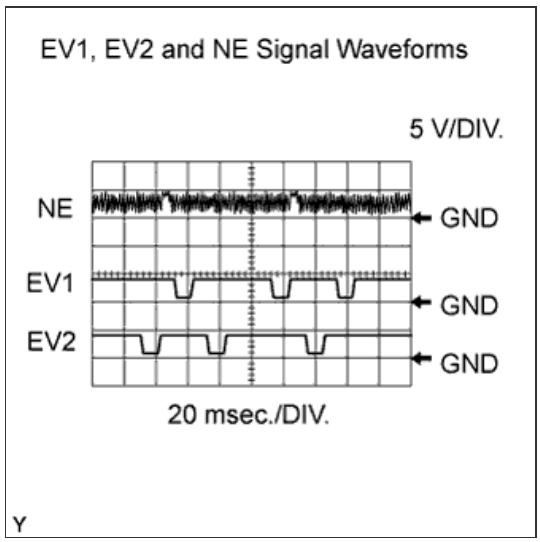
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

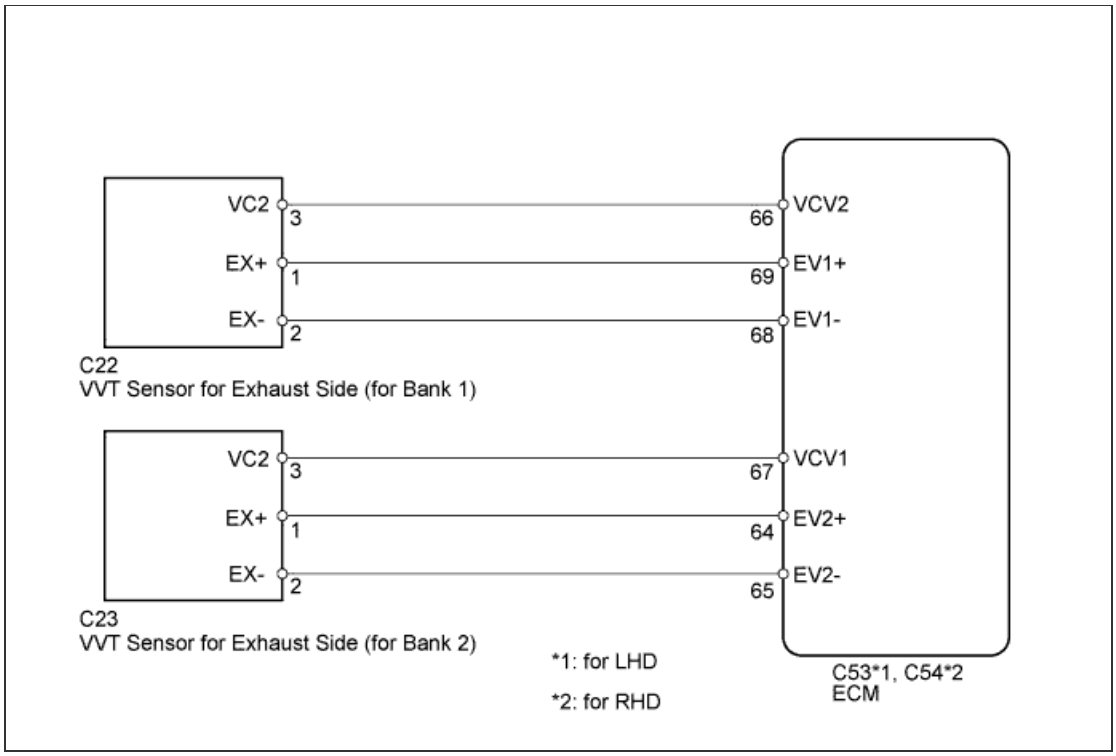
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

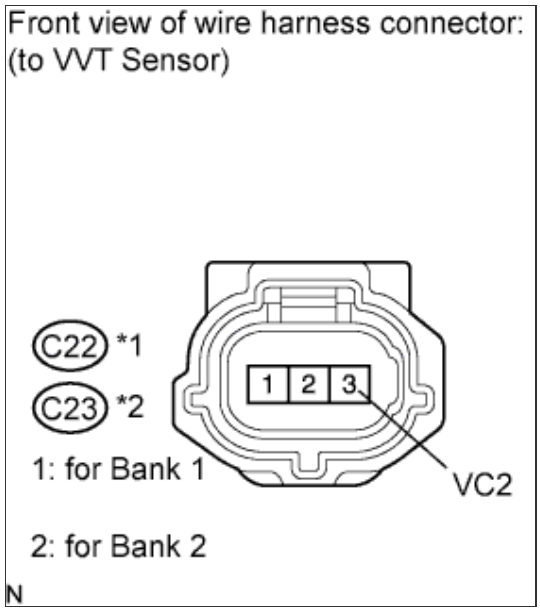
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

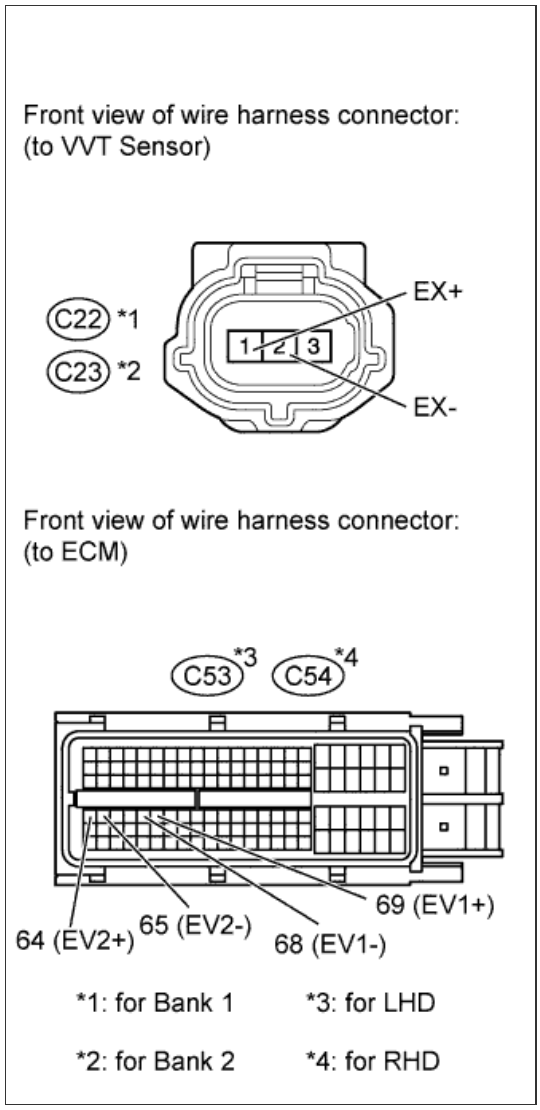
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

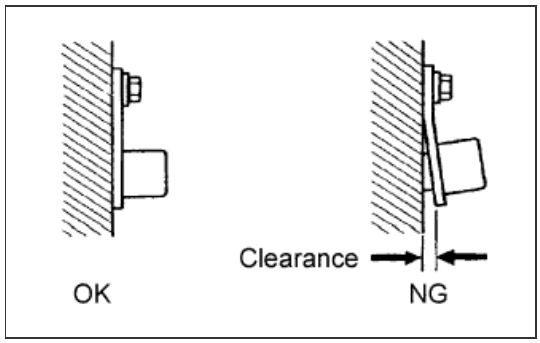
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

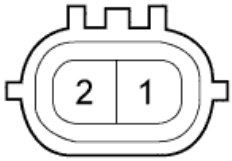
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

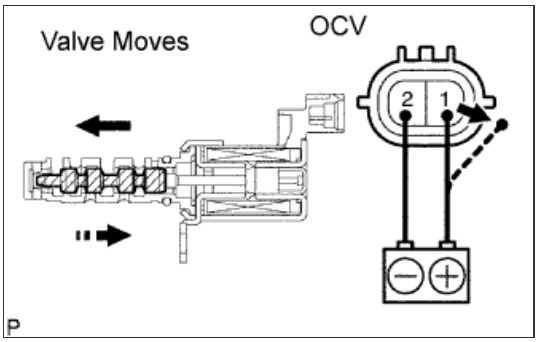
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0365 Camshaft Position Sensor "B" Circuit (Bank 1)

DTC P0367 Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC P0368 Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC P0390 Camshaft Position Sensor "B" Circuit (Bank 2)

DTC P0392 Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC P0393 Camshaft Position Sensor "B" Circuit High Input (Bank 2)

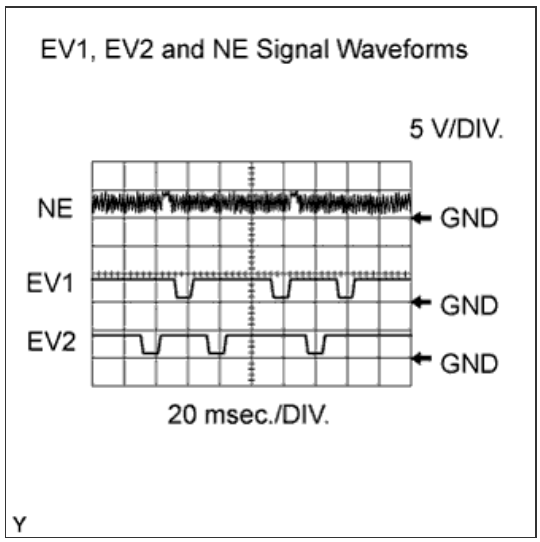
for Preparation Click here

DESCRIPTION

The exhaust camshaft Variable Valve Timing (VVT) sensor (EV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference. When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0365 P0390	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for more than 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0367 P0392	The output voltage of the VVT sensor is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM
P0368 P0393	The output voltage of the VVT sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for exhaust side) circuit • VVT sensor (for exhaust side) • Exhaust camshaft • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-69 (EV1+) - C53-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-64 (EV2+) - C53-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-69 (EV1+) - C54-68 (EV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-64 (EV2+) - C54-65 (EV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

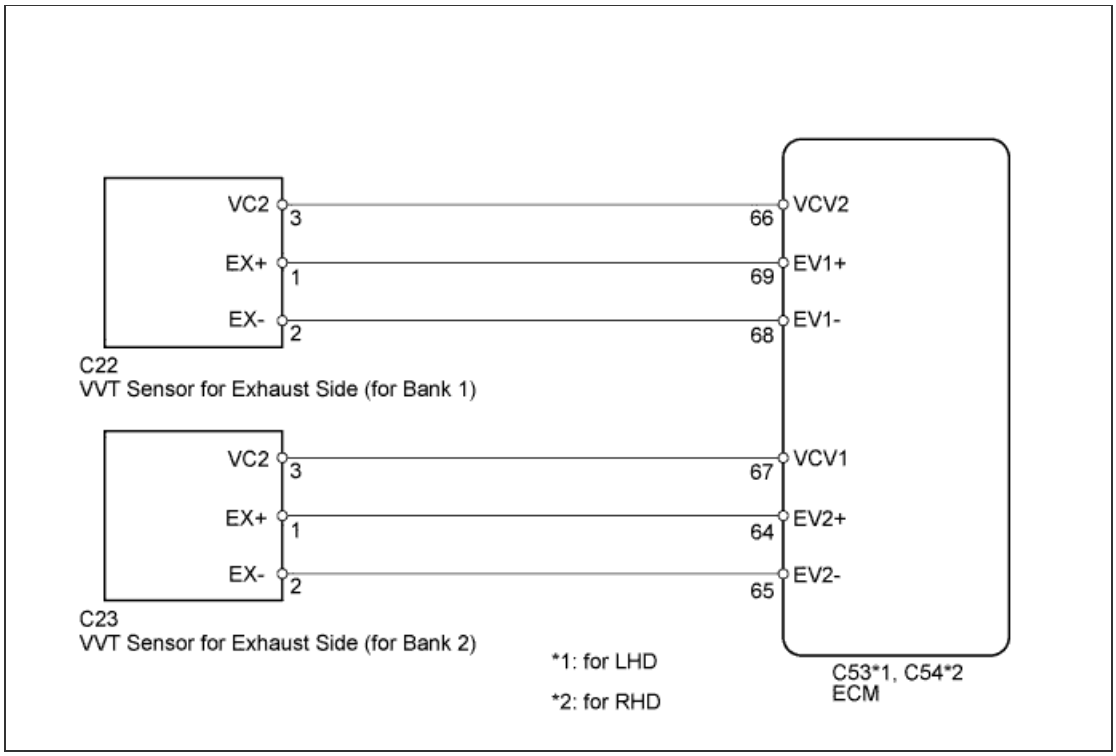
HINT:

EV1+ and EV2+ stand for the VVT sensor (for exhaust side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

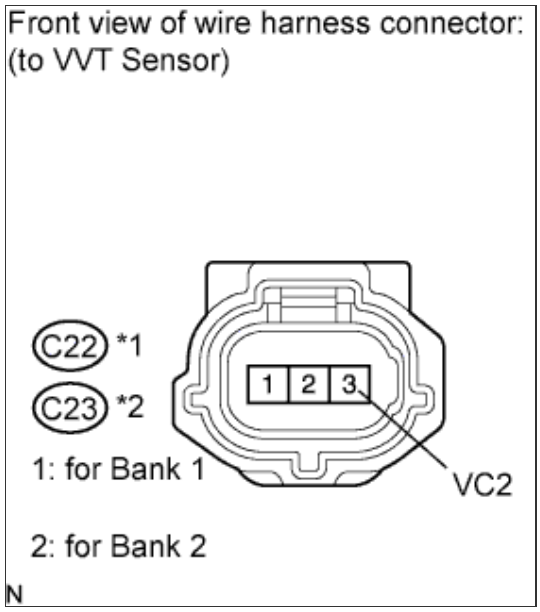
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C22 or C23 VVT sensor (for exhaust side) connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C22-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C23-3 (VC2) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

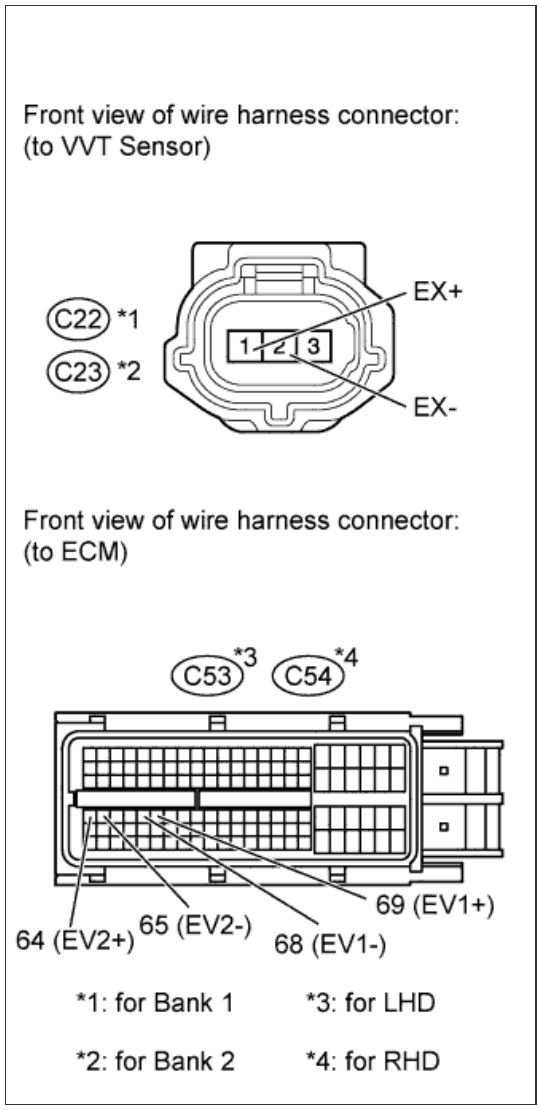
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR (for Exhaust Side) - ECM)

a. Disconnect the C22 or C23 VVT (for exhaust side) sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C53-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C53-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C53-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C53-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C53-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C53-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C53-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C53-65 (EV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C22-1 (EX+) - C54-69 (EV1+)	Always	Below 1 Ω
C22-2 (EX-) - C54-68 (EV1-)	Always	Below 1 Ω
C23-1 (EX+) - C54-64 (EV2+)	Always	Below 1 Ω
C23-2 (EX-) - C54-65 (EV2-)	Always	Below 1 Ω
C22-1 (EX+) or C54-69 (EV1+) - Body ground	Always	10 kΩ or higher
C22-2 (EX-) or C54-68 (EV1-) - Body ground	Always	10 kΩ or higher
C23-1 (EX+) or C54-64 (EV2+) - Body ground	Always	10 kΩ or higher
C23-2 (EX-) or C54-65 (EV2-) - Body ground	Always	10 kΩ or higher

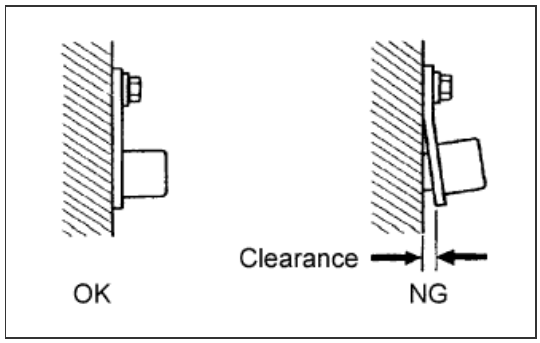
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for exhaust side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK EXHAUST CAMSHAFT

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE EXHAUST CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Exhaust Side)

a. Replace the VVT sensor (for exhaust side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0365, P0367, P0368, P0390, P0392 or P0393	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

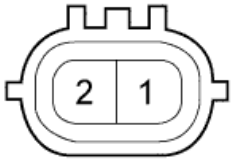
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

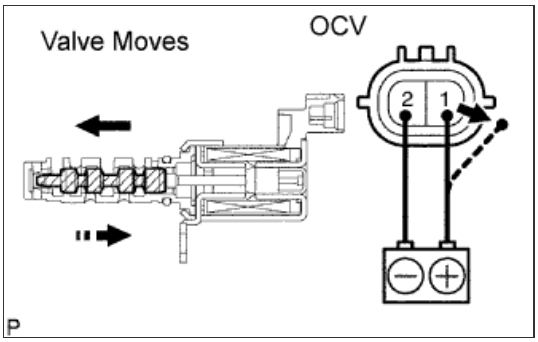
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0412 Secondary Air Injection System Switching Valve "A" Circuit

DTC P0415 Secondary Air Injection System Switching Valve "B" Circuit

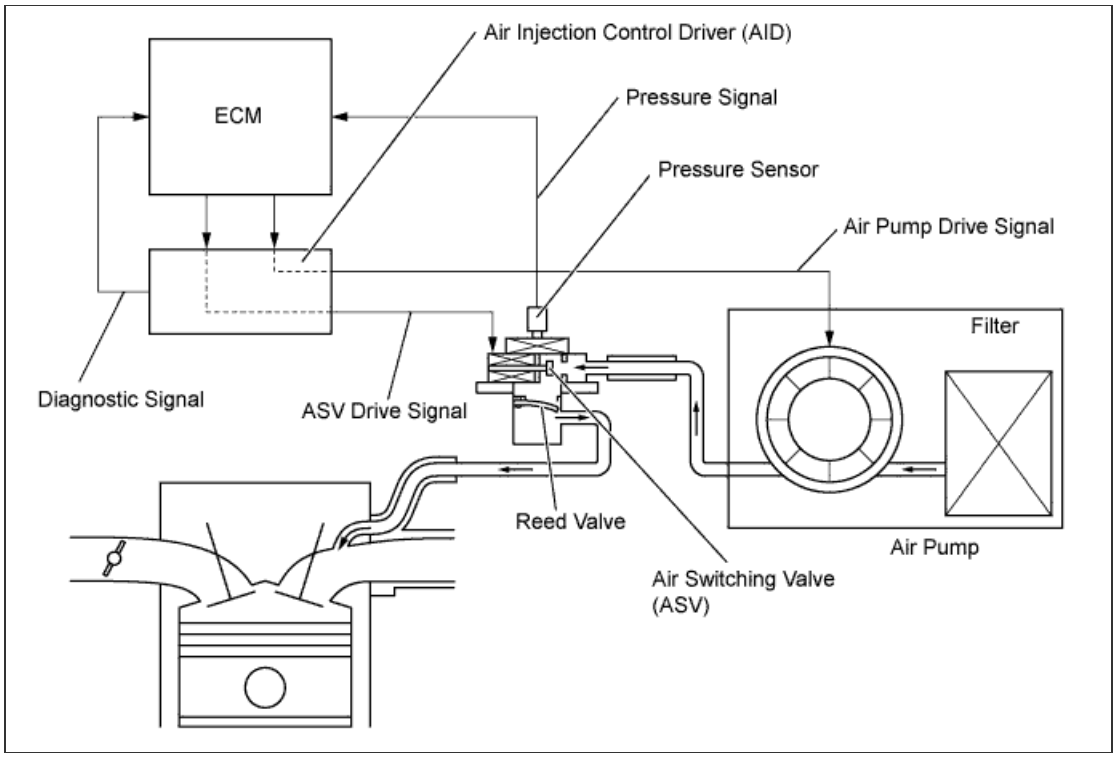
for Preparation Click here

DESCRIPTION

The Secondary Air Injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P0412 P0415	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. The Secondary Air Injection (AIR) system is not operating (air pump OFF, Air Switching Valve [ASV] OFF). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 40%. 3. The battery voltage is 8 V or higher.	• Open in Air Switching Valve (ASV) drive circuit • Air Injection Control Driver (AID) • Air Switching Valve (ASV) • ECM
P0412 P0415	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. The Secondary Air Injection (AIR) system is operating (air pump ON, Air Switching Valve [ASV] ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 40%. 3. The battery voltage is 8 V or higher.	• Short between ASV drive circuit and body ground • AID • ASV • ECM

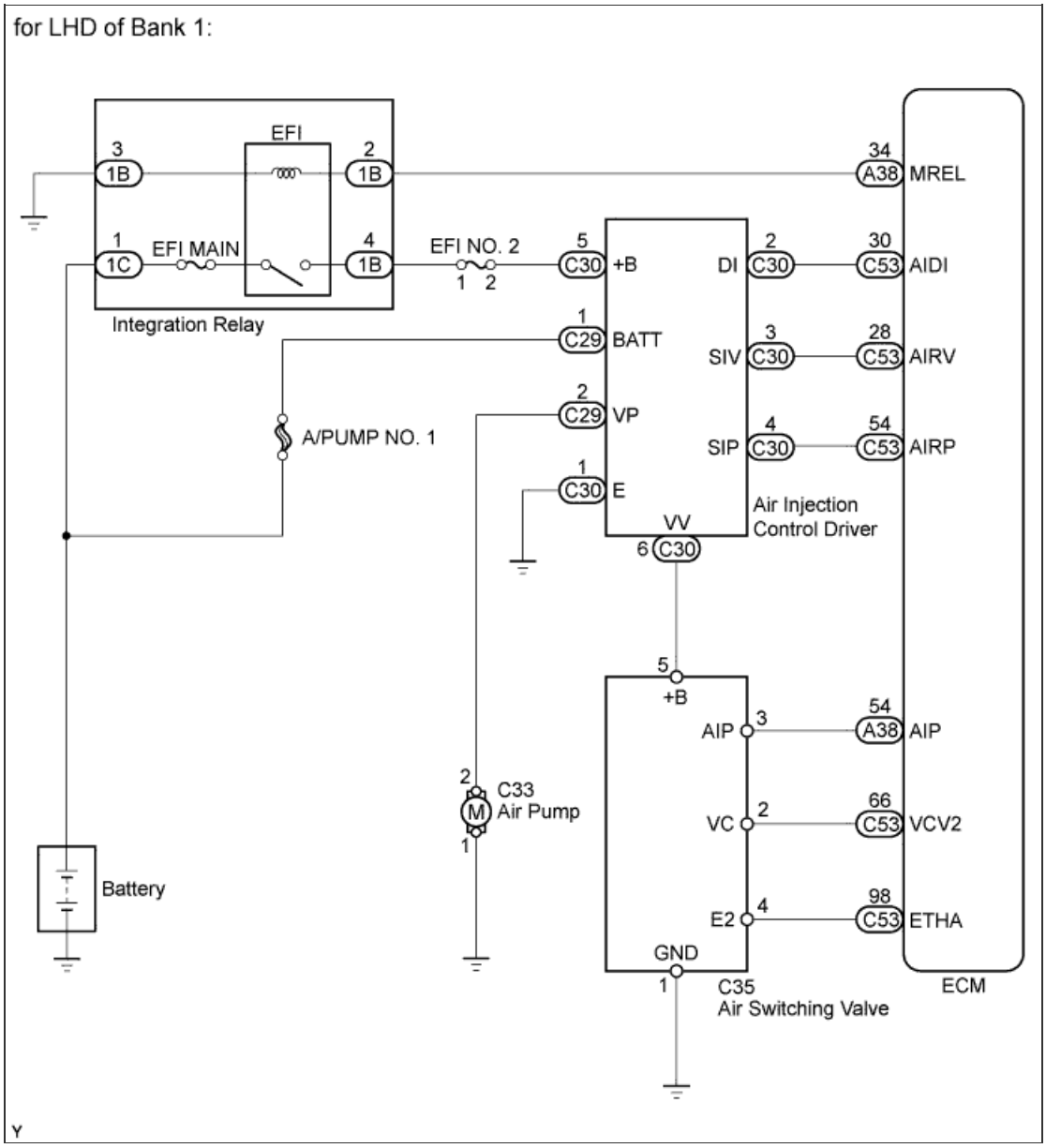
MONITOR DESCRIPTION

The Air Injection Control Driver (AID) detects open and short circuits according to the voltages of the air pump terminal (VP) and the Air Switching Valve (ASV) terminal (VV), and transmits diagnostic information as a signal to the ECM.
For a short time after a cold engine start, the ECM transmits command signals to the AID to drive the air pump and ASV.
The AID transmits an ASV malfunction signal to the ECM if either of the following conditions is met:

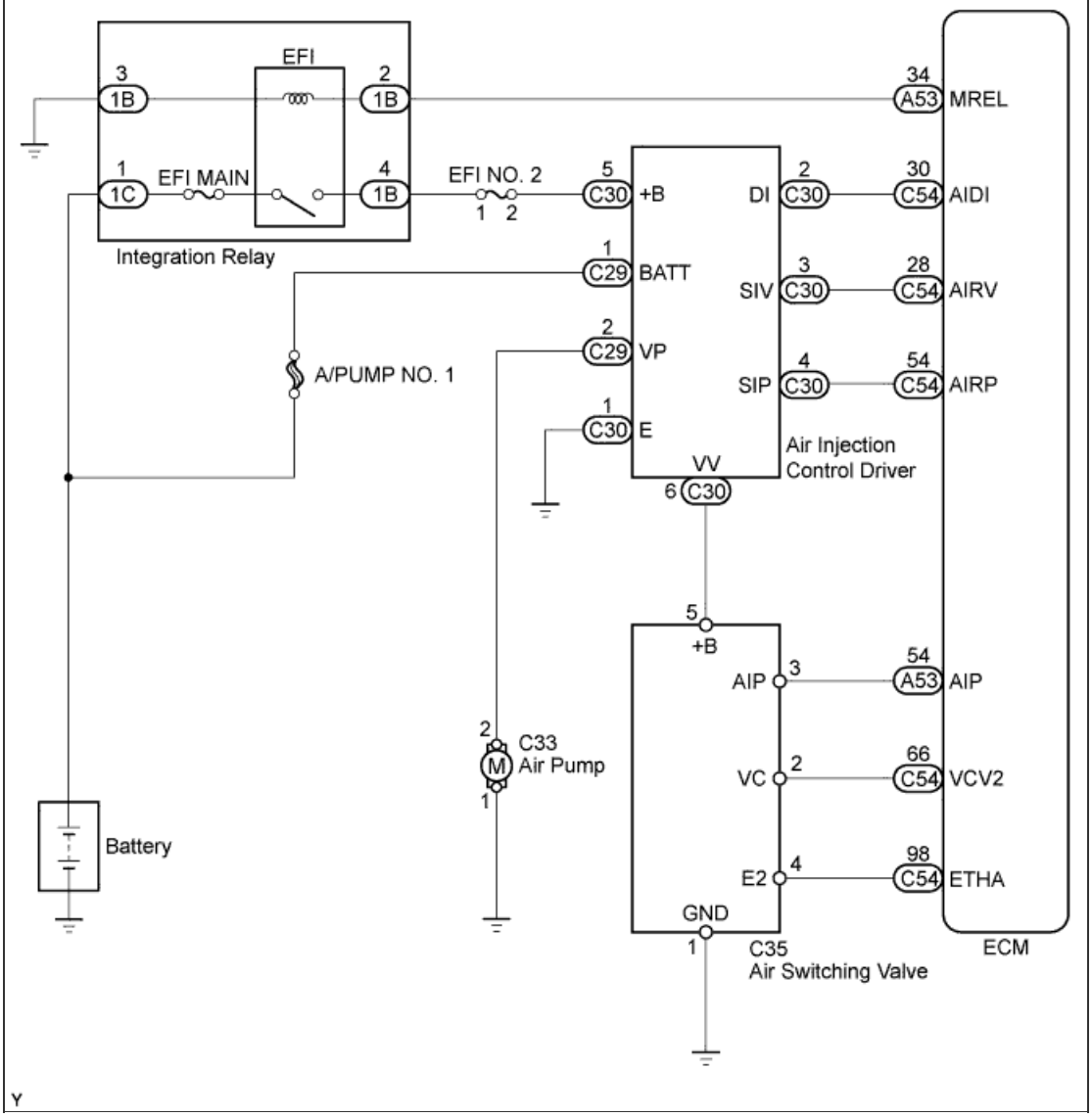
- The voltage at the AID terminal relating to the ASV is low despite the AID receiving command signals from the ECM to drive the ASV.
- The voltage at the AID terminal relating to the ASV is high despite the AID receiving no command signals from the ECM to drive the ASV.

The ECM stores the DTC based on diagnostic signals from the AID.

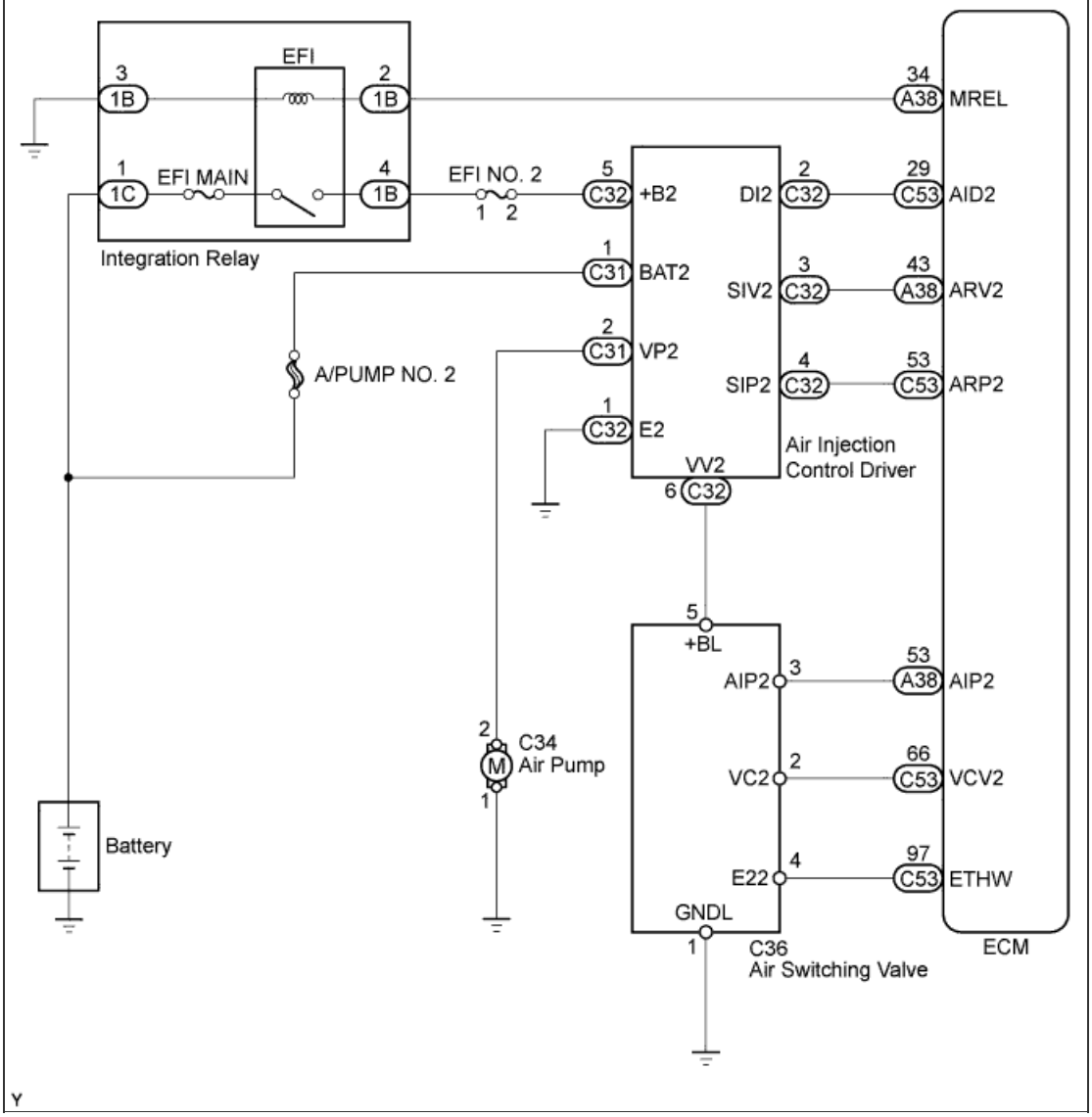
WIRING DIAGRAM

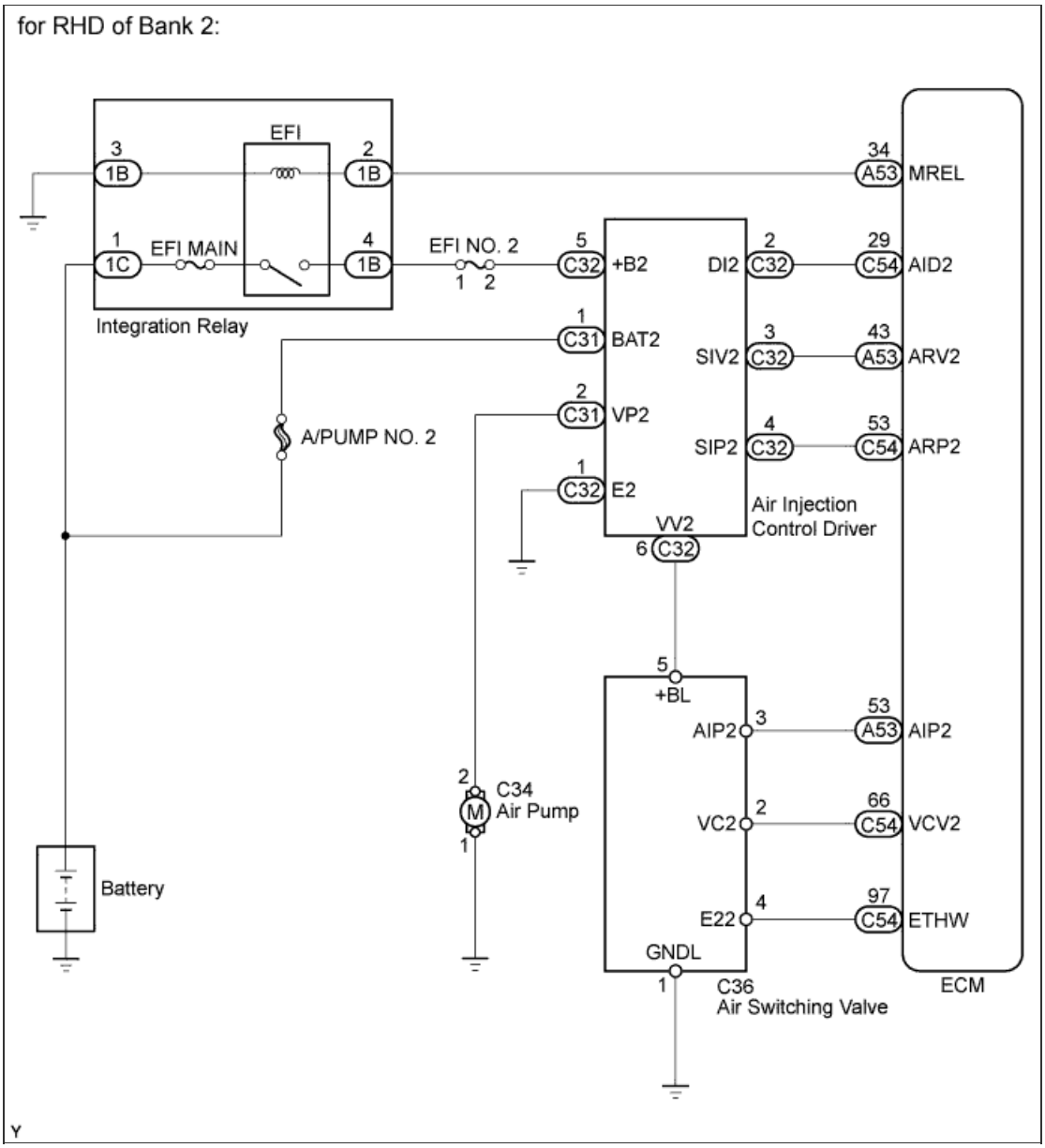


for RHD of Bank 1:



for LHD of Bank 2:





INSPECTION PROCEDURE

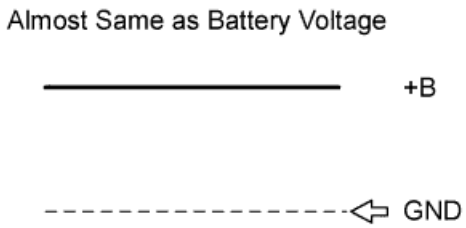
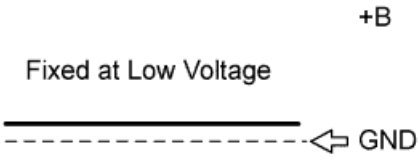
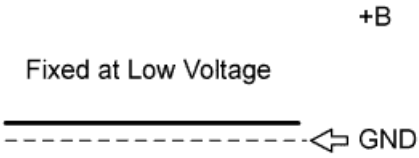
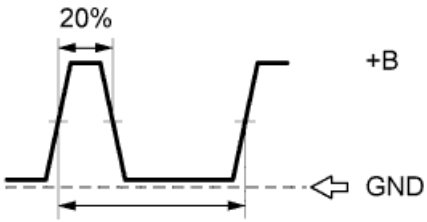
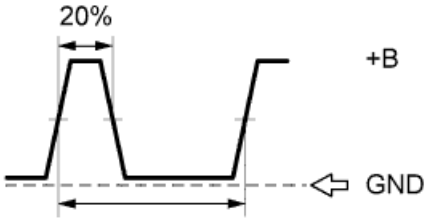
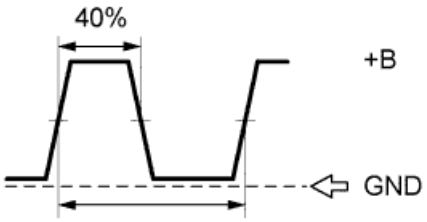
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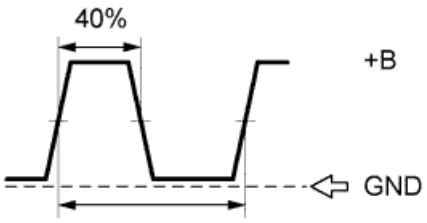
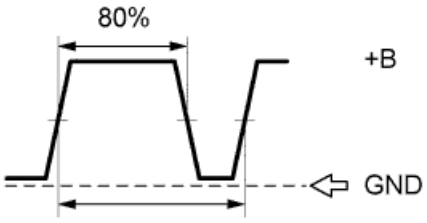
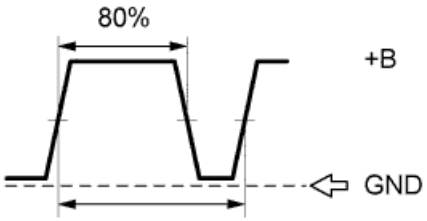
The diagnostic information output from Air Injection Control Driver (AID) can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the Utility function allows the possible trouble areas to be narrowed down.

NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).**
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100% Duty Ratio			• Open in diagnostic signal circuit

	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio 	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio			

	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT AIR SWITCHING VALVE ASSEMBLY

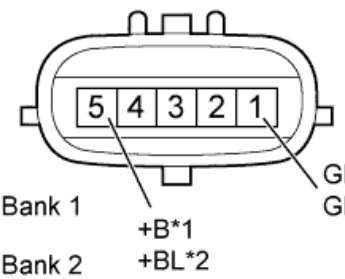
a. Disconnect the C35 or C36 air switching valve (ASV) connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C35-5 (+B) - C35-1 (GND)	20°C (68°F)	4.5 to 5.5 Ω
C36-5 (+BL) - C36-1 (GNDL)	20°C (68°F)	4.5 to 5.5 Ω

Component without harness connected:
(Air Switching Valve)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR SWITCHING VALVE ASSEMBLY (Click here)

OK

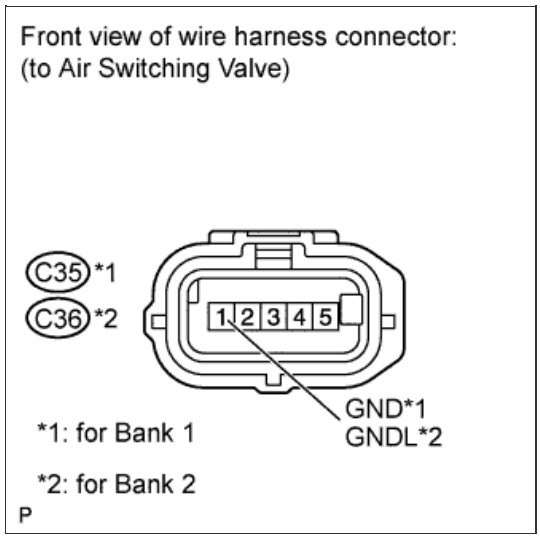
2.CHECK HARNESS AND CONNECTOR (AIR SWITCHING VALVE - BODY GROUND)

a. Disconnect the C35 or C36 ASV connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C35-1 (GND) - Body ground	Always	Below 1 Ω
C36-1 (GNDL) - Body ground	Always	Below 1 Ω



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK HARNESS AND CONNECTOR (AIR SWITCHING VALVE - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C35 or C36 ASV connector.

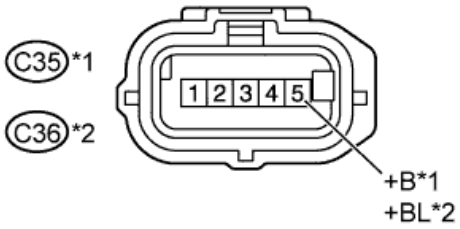
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

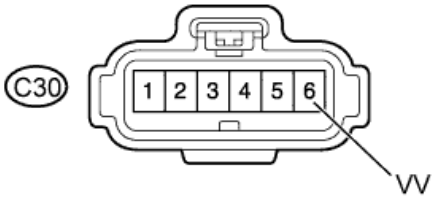
Standard Resistance:

Tester Connection	Condition	Specified Condition
C35-5 (+B) - C30-6 (VV)	Always	Below 1 Ω
C36-5 (+BL) - C32-6 (VV2)	Always	Below 1 Ω
C35-5 (+B) or C30-6 (VV) - Body ground	Always	1 kΩ or higher
C36-5 (+BL) or C32-6 (VV2) - Body ground	Always	1 kΩ or higher

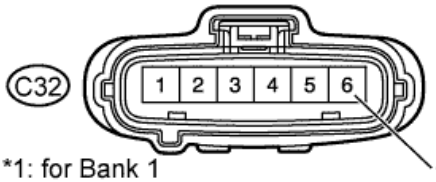
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to Air Injection Control Driver*1)



Front view of wire harness connector:
(to Air Injection Control Driver*2)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE AIR INJECTION CONTROL DRIVER (Click here)

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

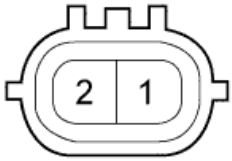
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

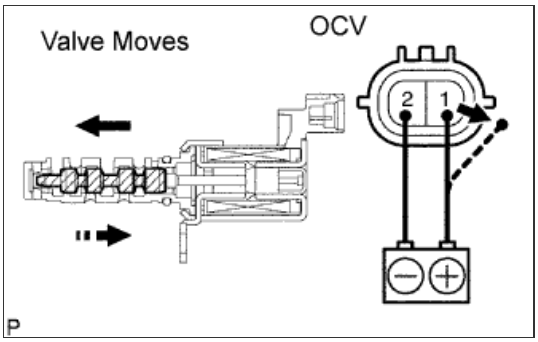
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0412 Secondary Air Injection System Switching Valve "A" Circuit

DTC P0415 Secondary Air Injection System Switching Valve "B" Circuit

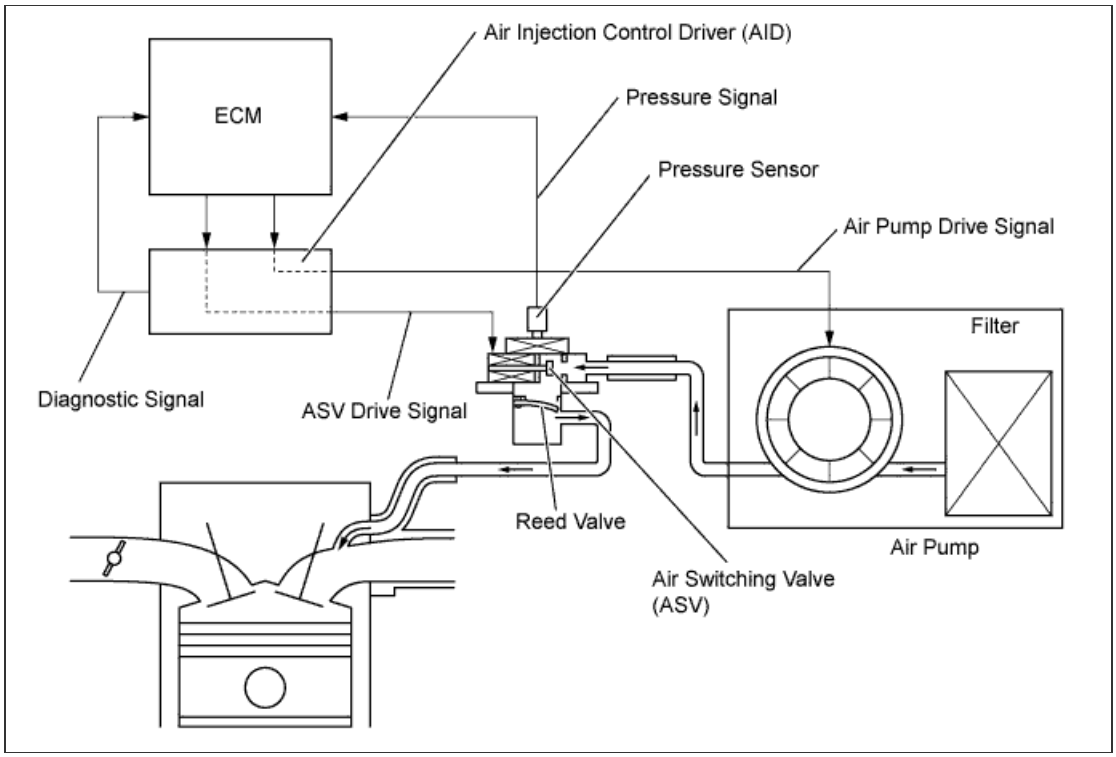
for Preparation Click here

DESCRIPTION

The Secondary Air Injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P0412 P0415	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. The Secondary Air Injection (AIR) system is not operating (air pump OFF, Air Switching Valve [ASV] OFF). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 40%. 3. The battery voltage is 8 V or higher.	• Open in Air Switching Valve (ASV) drive circuit • Air Injection Control Driver (AID) • Air Switching Valve (ASV) • ECM
P0412 P0415	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. The Secondary Air Injection (AIR) system is operating (air pump ON, Air Switching Valve [ASV] ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 40%. 3. The battery voltage is 8 V or higher.	• Short between ASV drive circuit and body ground • AID • ASV • ECM

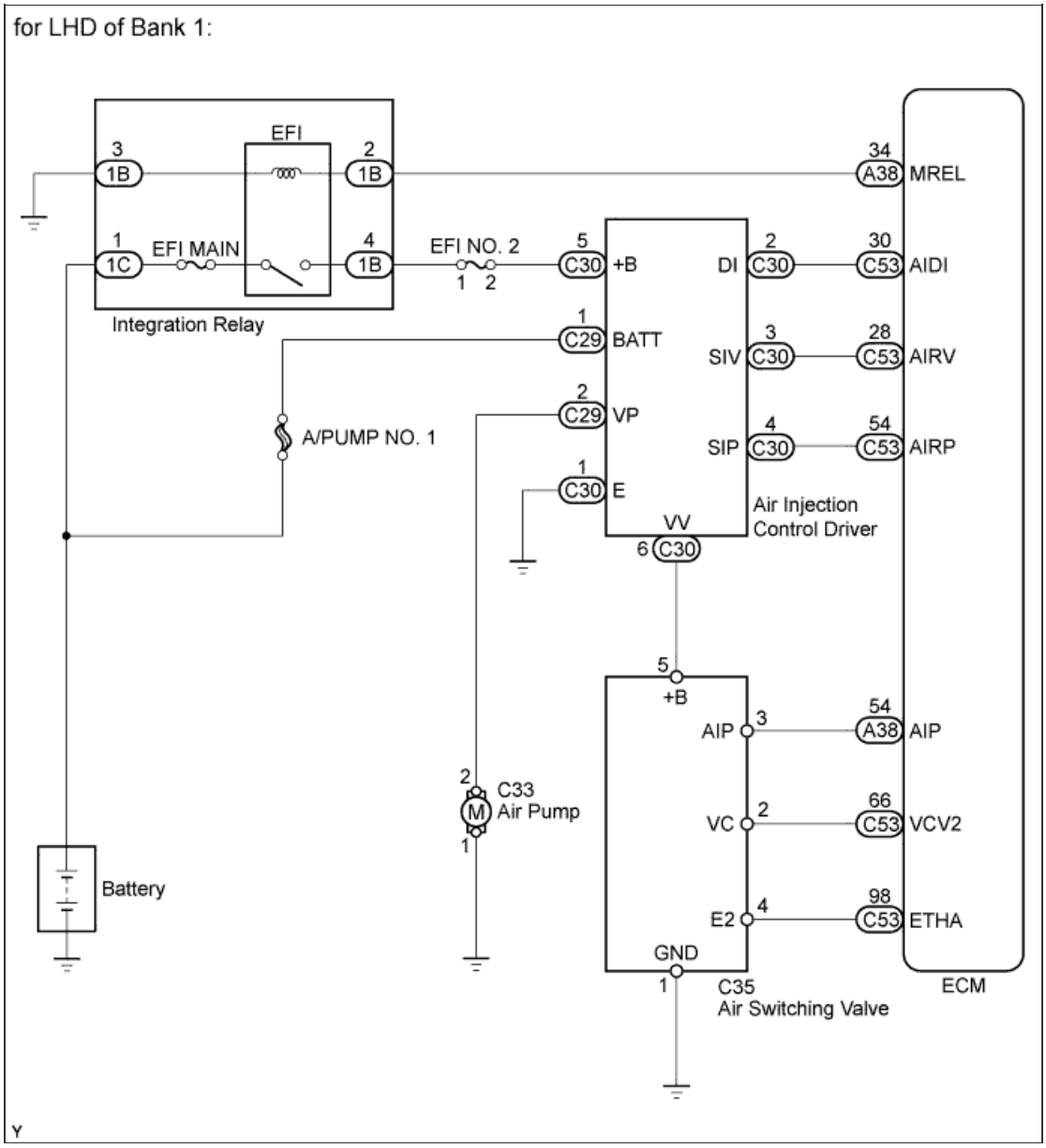
MONITOR DESCRIPTION

The Air Injection Control Driver (AID) detects open and short circuits according to the voltages of the air pump terminal (VP) and the Air Switching Valve (ASV) terminal (VV), and transmits diagnostic information as a signal to the ECM.
For a short time after a cold engine start, the ECM transmits command signals to the AID to drive the air pump and ASV.
The AID transmits an ASV malfunction signal to the ECM if either of the following conditions is met:

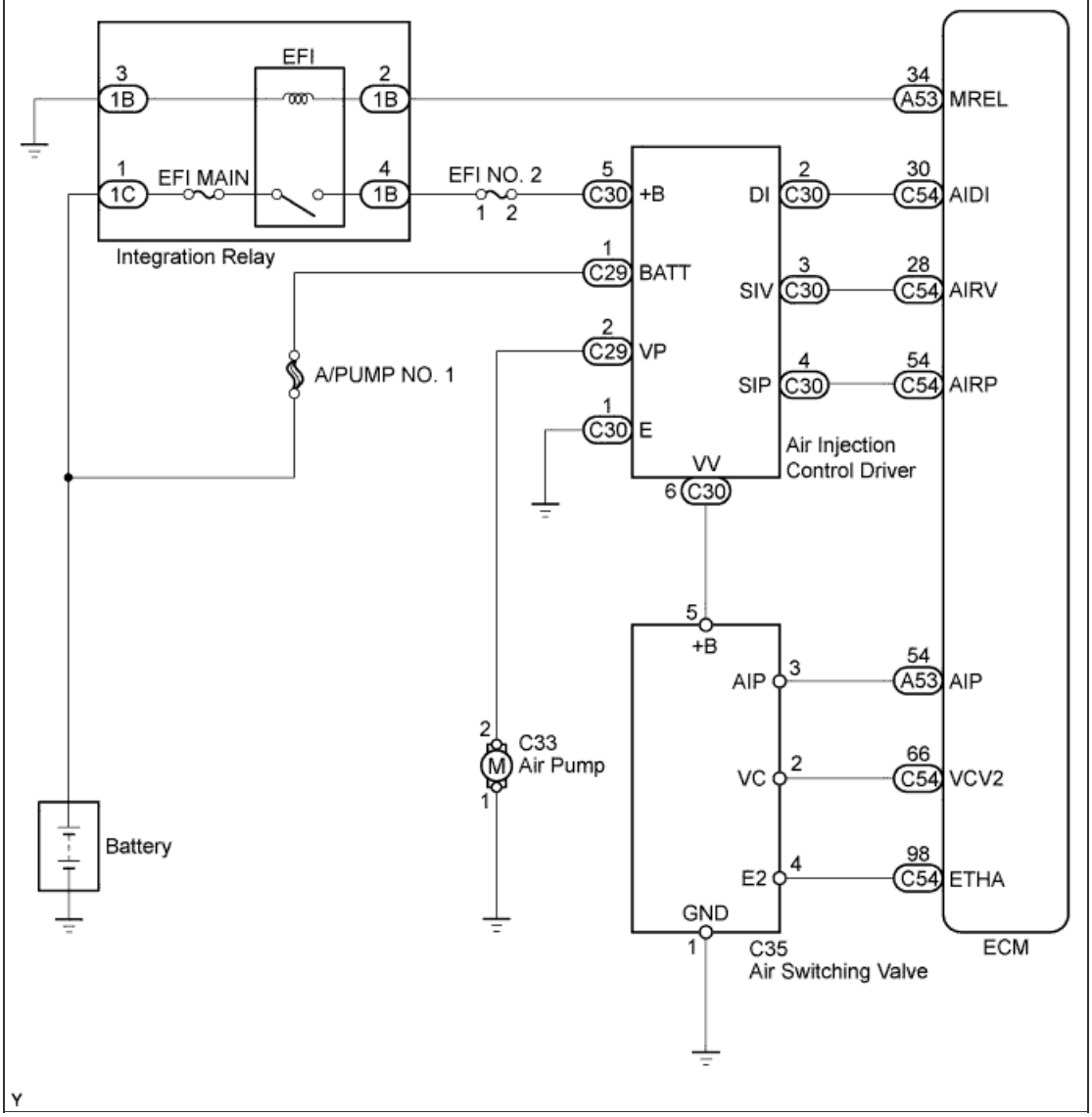
- The voltage at the AID terminal relating to the ASV is low despite the AID receiving command signals from the ECM to drive the ASV.
- The voltage at the AID terminal relating to the ASV is high despite the AID receiving no command signals from the ECM to drive the ASV.

The ECM stores the DTC based on diagnostic signals from the AID.

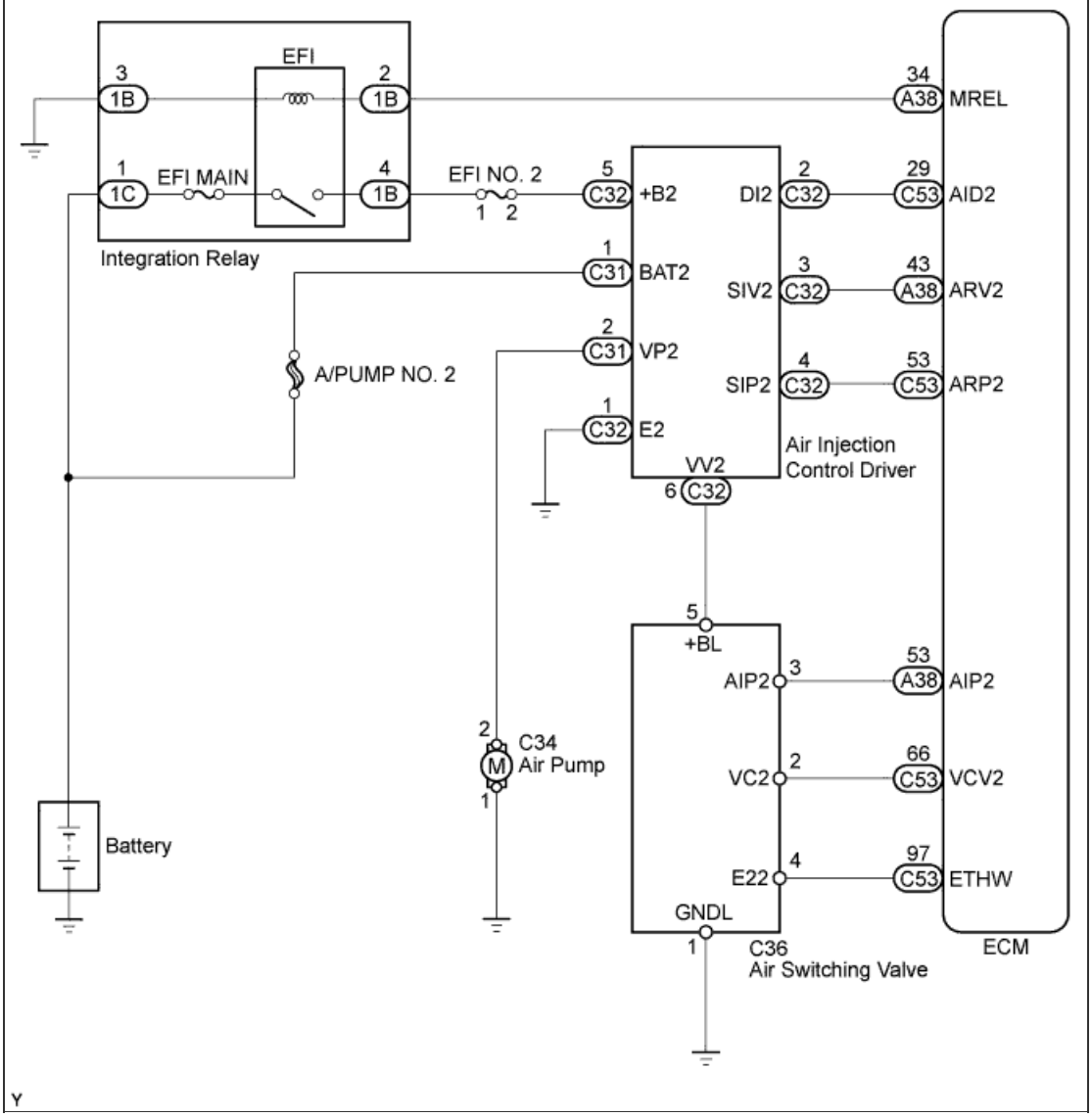
WIRING DIAGRAM

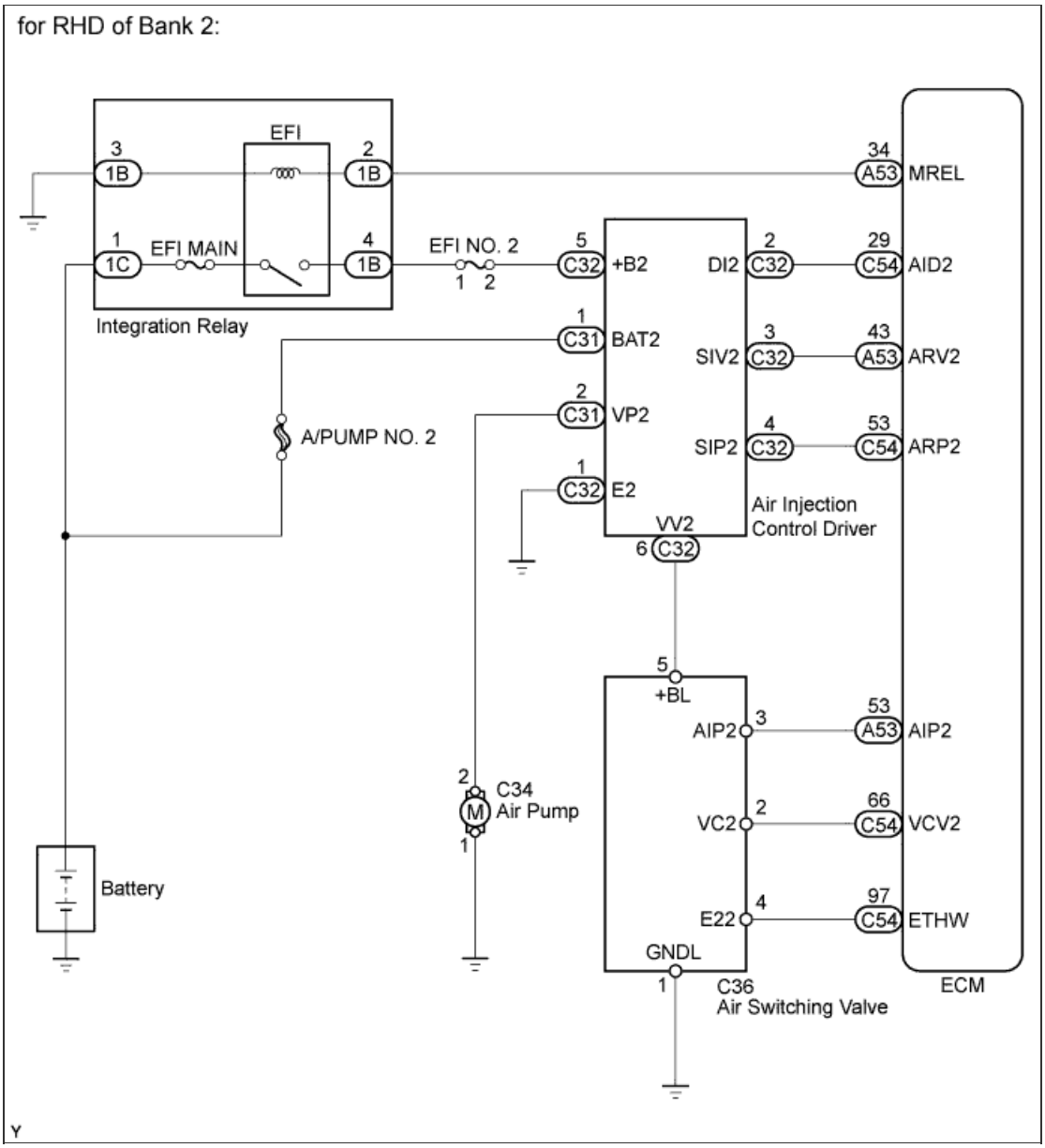


for RHD of Bank 1:



for LHD of Bank 2:





INSPECTION PROCEDURE

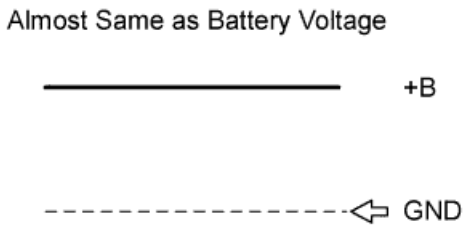
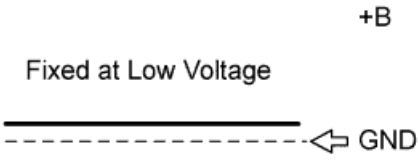
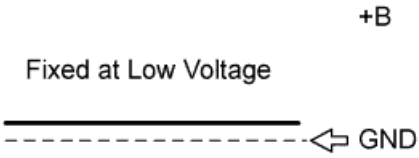
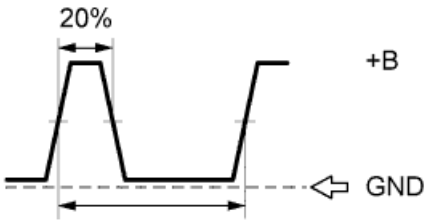
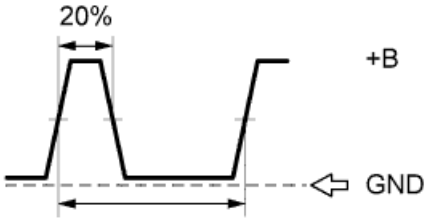
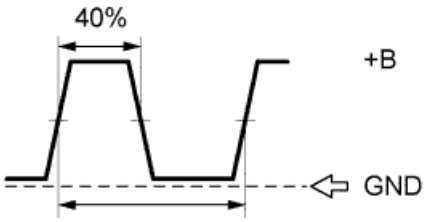
HINT:

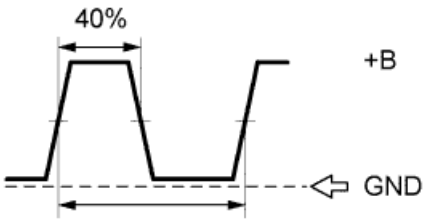
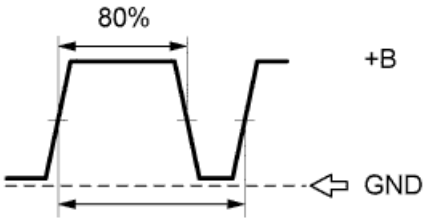
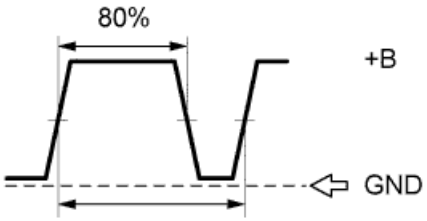
The diagnostic information output from Air Injection Control Driver (AID) can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the Utility function allows the possible trouble areas to be narrowed down.

NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).**
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100% Duty Ratio			• Open in diagnostic signal circuit

	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio 	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio			

	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT AIR SWITCHING VALVE ASSEMBLY

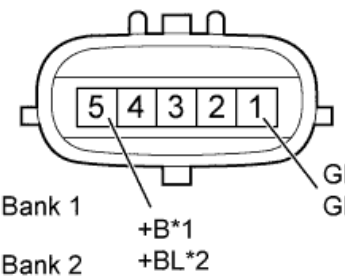
a. Disconnect the C35 or C36 air switching valve (ASV) connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C35-5 (+B) - C35-1 (GND)	20°C (68°F)	4.5 to 5.5 Ω
C36-5 (+BL) - C36-1 (GNDL)	20°C (68°F)	4.5 to 5.5 Ω

Component without harness connected:
(Air Switching Valve)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR SWITCHING VALVE ASSEMBLY (Click here)

OK

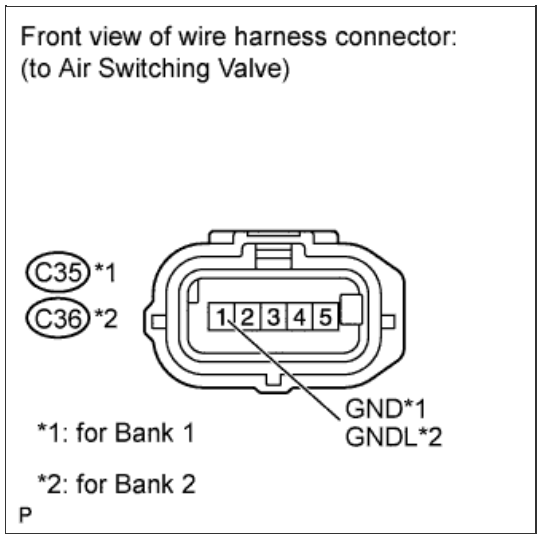
2.CHECK HARNESS AND CONNECTOR (AIR SWITCHING VALVE - BODY GROUND)

a. Disconnect the C35 or C36 ASV connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C35-1 (GND) - Body ground	Always	Below 1 Ω
C36-1 (GNDL) - Body ground	Always	Below 1 Ω



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK HARNESS AND CONNECTOR (AIR SWITCHING VALVE - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C35 or C36 ASV connector.

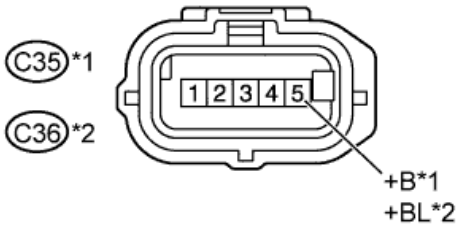
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

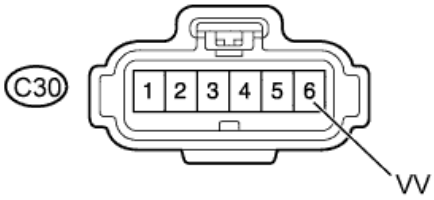
Standard Resistance:

Tester Connection	Condition	Specified Condition
C35-5 (+B) - C30-6 (VV)	Always	Below 1 Ω
C36-5 (+BL) - C32-6 (VV2)	Always	Below 1 Ω
C35-5 (+B) or C30-6 (VV) - Body ground	Always	1 kΩ or higher
C36-5 (+BL) or C32-6 (VV2) - Body ground	Always	1 kΩ or higher

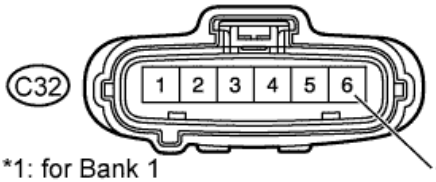
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to Air Injection Control Driver*1)



Front view of wire harness connector:
(to Air Injection Control Driver*2)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE AIR INJECTION CONTROL DRIVER (Click here)

DTC P0016 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC P0017 Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC P0018 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC P0019 Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

for Preparation Click here

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake and exhaust valve open and close timing is controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the camshaft and crankshaft.

DTC Code	DTC Detection Condition	Trouble Area
P0016	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Camshaft oil control valve (OCV) (for intake side of bank 1) • Camshaft timing gear assembly • ECM
P0017	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 1) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 1) • Camshaft timing exhaust gear assembly • ECM
P0018	Deviation in the crankshaft position sensor signal and VVT sensor (for Intake side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for intake side of bank 2) • Camshaft timing gear assembly • ECM
P0019	Deviation in the crankshaft position sensor signal and VVT sensor (for Exhaust side of Bank 2) signal (2 trip detection logic).	• Mechanical system (Timing chain has jumped tooth or chain stretched) • OCV (for exhaust side of bank 2) • Camshaft timing exhaust gear assembly • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0016 (Bank 1) or P0018 (Bank 2).
To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and stores DTC P0017 (Bank 1) or P0019 (Bank 2).

WIRING DIAGRAM

Refer to DTC P0335 (Click here).
Refer to DTC P0340 (Click here).
Refer to DTC P0365 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0016, P0017, P0018 OR P0019)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0016, P0017, P0018 or P0019 is output	A
P0016, P0017, P0018 or P0019 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT System (Bank 1) or Control the VVT System (Bank 2).

e. Check the engine speed while operating the Camshaft Oil Control Valve (OCV) using the tester.

OK:

Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

NG → Go to step 4

OK

3.ADJUST VALVE TIMING

a. Adjust the valve timing (Click here).

NEXT → Go to step 6

4.INSPECT CAMSHAFT OIL CONTROL VALVE (FOR INTAKE SIDE OR EXHAUST SIDE)

a. Remove the OCV.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

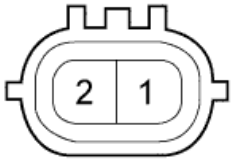
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

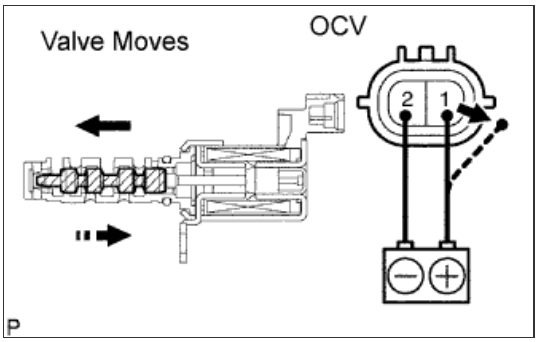
c. Check the valve operation.

OK:

Measurement Condition	Specified Condition
No battery voltage applied to terminals 1 and 2 → Battery voltage applied to terminals 1 and 2	Valve moves quickly

Component without harness connected:
(Oil Control Valve)





NG → REPLACE CAMSHAFT OIL CONTROL VALVE (Click here)

OK

5.REPLACE CAMSHAFT TIMING GEAR OR CAMSHAFT TIMING EXHAUST GEAR

a. Replace the camshaft timing gear (Click here).

b. Replace the camshaft timing exhaust gear (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear the DTC (Click here).

d. Start the engine and warm it up.

e. Switch the ECM from normal mode to check mode using the tester (Click here).

f. Drive the vehicle in an urban area for approximately 10 minutes.

g. Read DTCs using the tester.

OK:
No DTC is output.

NG → GO TO DTC CHART (Click here)

OK

END

DTC P0418 Secondary Air Injection System Control "A" Circuit

DTC P0419 Secondary Air Injection System Control "B" Circuit

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P0418 P0419	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. Secondary Air Injection (AIR) system not operating (air pump OFF, Air Switching Valve [ASV] OFF) 2. The diagnostic signal from the Air Injection Control Driver (AID) is 20%. 3. The battery voltage is 8 V or higher.	• Open in air pump drive circuit • Air pump • Air injection control driver (AID) • ECM
P0418 P0419	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. The Secondary Air Injection (AIR) system is operating (air pump ON, Air Switching Valve [ASV] ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 20%. 3. The battery voltage is 8 V or higher.	• Short between air pump drive circuit and body ground • Air pump • Air injection control driver (AID) • ECM

MONITOR DESCRIPTION

The Air Injection Control Driver (AID) detects open and short circuits according to the voltages of the air pump terminal (VP) and the Air Switching Valve (ASV) terminal (VV), and transmits diagnostic information as a signal to the ECM.
For a short time after a cold engine start, the ECM transmits command signals to the AID to drive the air pump and ASV.
The AID transmits an air pump malfunction signal to the ECM if either of the following conditions is met:

- The voltage at the AID terminal relating to the air pump is low despite the AID receiving command signals from the ECM to drive the air pump.
- The voltage at the AID terminal relating to the air pump is high despite the AID receiving no command signals from the ECM to drive the air pump.

The ECM stores the DTC based on diagnostic signals from the AID.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

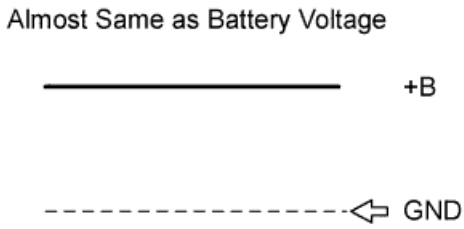
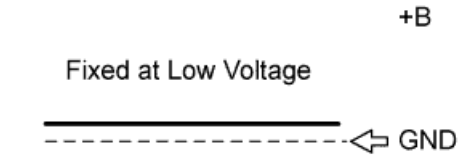
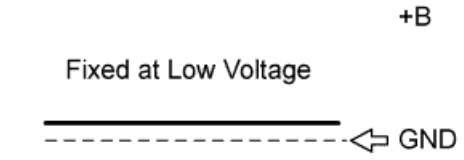
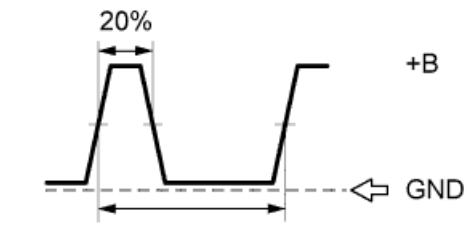
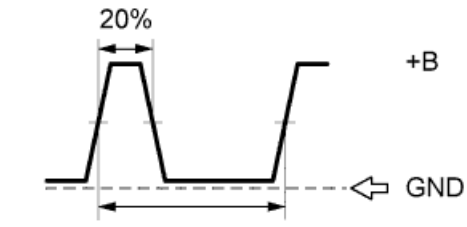
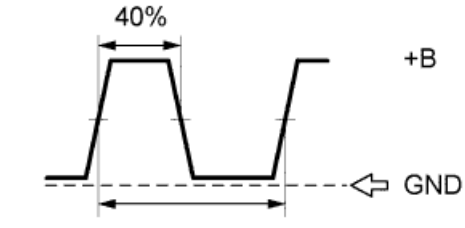
HINT:

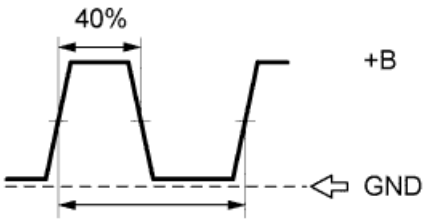
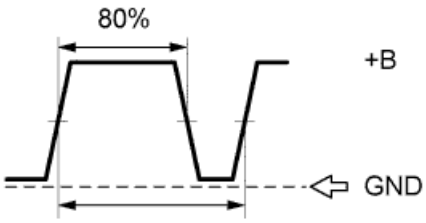
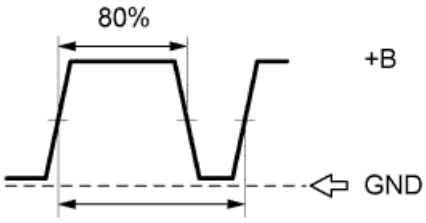
Diagnostic information output by the AID can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the Utility function allows the possible trouble areas to be narrowed down.

NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).**
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

AID Diagnostic Signal Waveforms	ECM	DTCs	Suspected Trouble Areas

	Commands	(ECM Output)	
100% Duty Ratio 	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio 	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio			

	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT AIR PUMP ASSEMBLY

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	0.44 to 1 Ω

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP ASSEMBLY (Click here)

OK

2.CHECK HARNESS AND CONNECTOR (AIR PUMP - BODY GROUND)

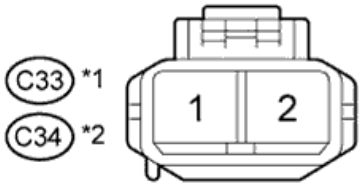
a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C33-1 - Body ground	Always	Below 1 Ω
C34-1 - Body ground	Always	Below 1 Ω

Front view of wire harness connector:
(to Air Pump)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK HARNESS AND CONNECTOR (AIR PUMP - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C33 or C34 air pump connector.

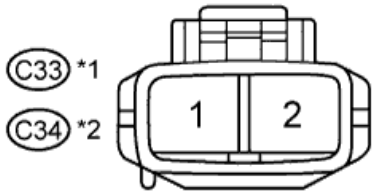
b. Disconnect the C29 or C31 AID connector.

c. Measure the resistance according to the value(s) in the table below.

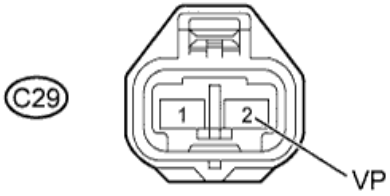
Standard Resistance:

Tester Connection	Condition	Specified Condition
C33-2 - C29-2 (VP)	Always	Below 1 Ω
C34-2 - C31-2 (VP2)	Always	Below 1 Ω

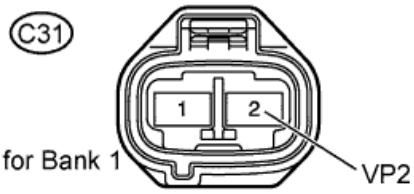
Front view of wire harness connector:
(to Air Pump)



Front view of wire harness connector:
(to Air Injection Control Driver*1)



Front view of wire harness connector:
(to Air Injection Control Driver*2)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE AIR INJECTION CONTROL DRIVER (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

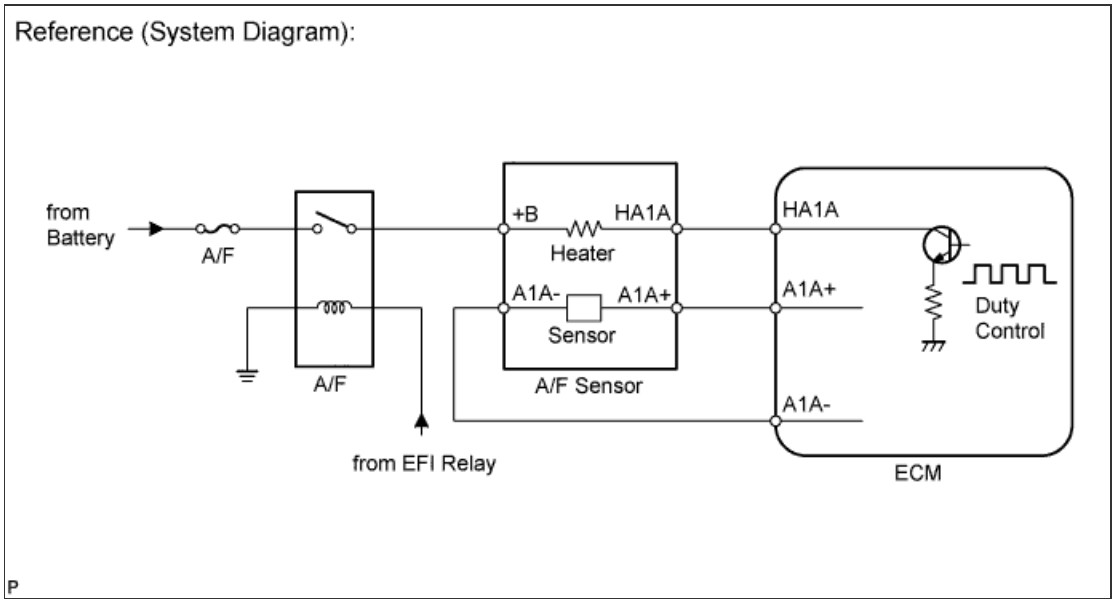
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

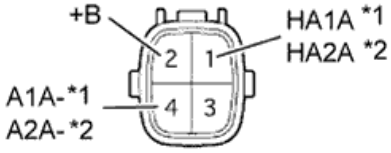
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

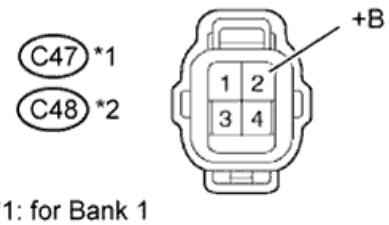
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

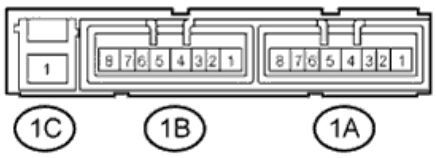
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

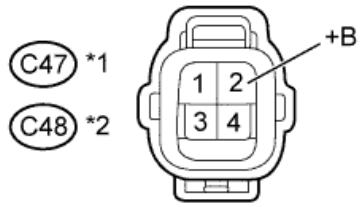
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

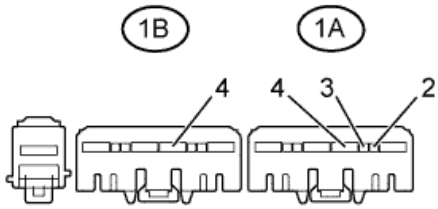
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

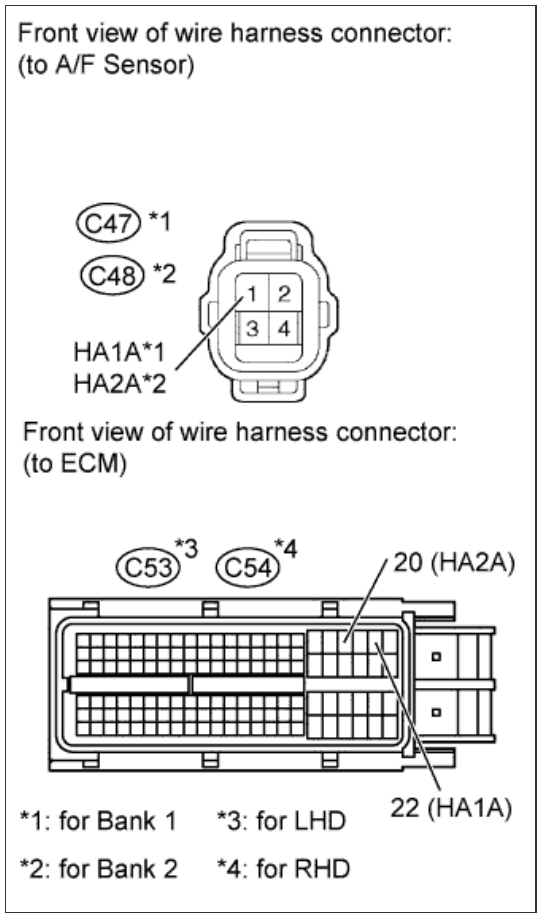
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0418 Secondary Air Injection System Control "A" Circuit

DTC P0419 Secondary Air Injection System Control "B" Circuit

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P0418 P0419	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. Secondary Air Injection (AIR) system not operating (air pump OFF, Air Switching Valve [ASV] OFF) 2. The diagnostic signal from the Air Injection Control Driver (AID) is 20%. 3. The battery voltage is 8 V or higher.	• Open in air pump drive circuit • Air pump • Air injection control driver (AID) • ECM
P0418 P0419	After a cold engine start, all of the following conditions are met (1 trip detection logic): 1. The Secondary Air Injection (AIR) system is operating (air pump ON, Air Switching Valve [ASV] ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 20%. 3. The battery voltage is 8 V or higher.	• Short between air pump drive circuit and body ground • Air pump • Air injection control driver (AID) • ECM

MONITOR DESCRIPTION

The Air Injection Control Driver (AID) detects open and short circuits according to the voltages of the air pump terminal (VP) and the Air Switching Valve (ASV) terminal (VV), and transmits diagnostic information as a signal to the ECM.
For a short time after a cold engine start, the ECM transmits command signals to the AID to drive the air pump and ASV.
The AID transmits an air pump malfunction signal to the ECM if either of the following conditions is met:

- The voltage at the AID terminal relating to the air pump is low despite the AID receiving command signals from the ECM to drive the air pump.
- The voltage at the AID terminal relating to the air pump is high despite the AID receiving no command signals from the ECM to drive the air pump.

The ECM stores the DTC based on diagnostic signals from the AID.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

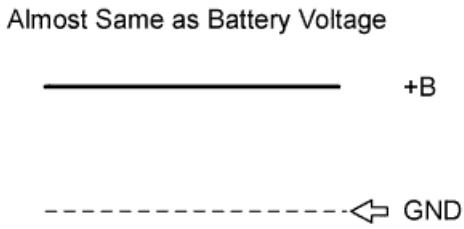
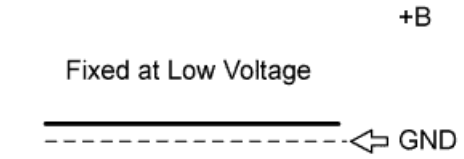
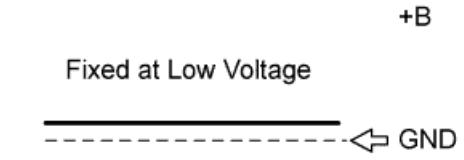
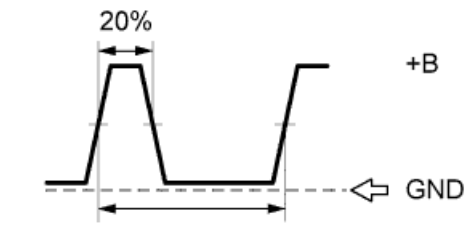
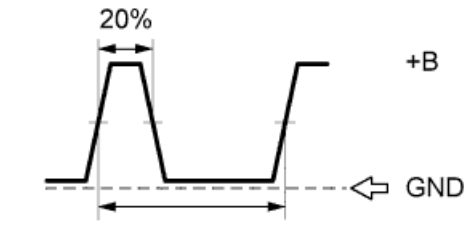
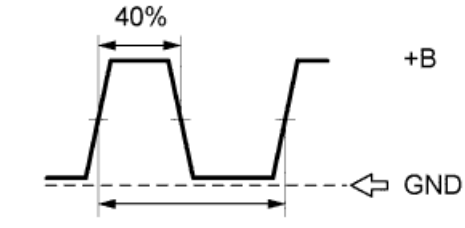
HINT:

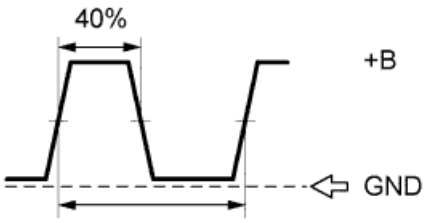
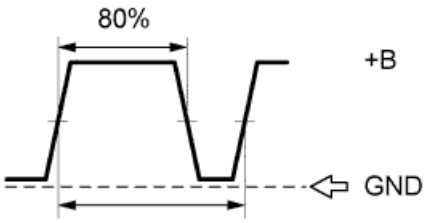
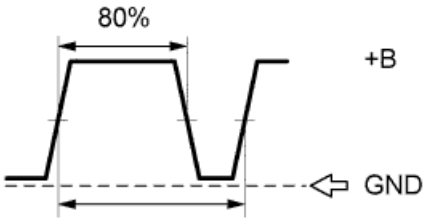
Diagnostic information output by the AID can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the Utility function allows the possible trouble areas to be narrowed down.

NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).**
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

AID Diagnostic Signal Waveforms	ECM	DTCs	Suspected Trouble Areas

	Commands	(ECM Output)	
100% Duty Ratio 	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio 	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio			

	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT AIR PUMP ASSEMBLY

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	0.44 to 1 Ω

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP ASSEMBLY (Click here)

OK

2.CHECK HARNESS AND CONNECTOR (AIR PUMP - BODY GROUND)

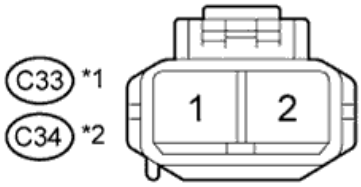
a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C33-1 - Body ground	Always	Below 1 Ω
C34-1 - Body ground	Always	Below 1 Ω

Front view of wire harness connector:
(to Air Pump)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK HARNESS AND CONNECTOR (AIR PUMP - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C33 or C34 air pump connector.

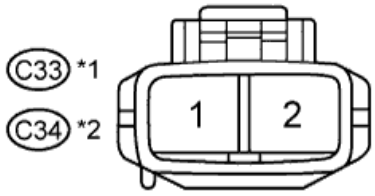
b. Disconnect the C29 or C31 AID connector.

c. Measure the resistance according to the value(s) in the table below.

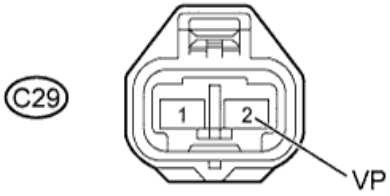
Standard Resistance:

Tester Connection	Condition	Specified Condition
C33-2 - C29-2 (VP)	Always	Below 1 Ω
C34-2 - C31-2 (VP2)	Always	Below 1 Ω

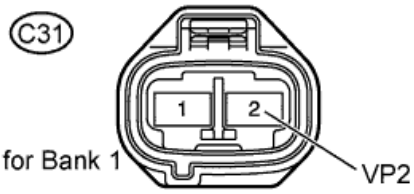
Front view of wire harness connector:
(to Air Pump)



Front view of wire harness connector:
(to Air Injection Control Driver*1)



Front view of wire harness connector:
(to Air Injection Control Driver*2)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE AIR INJECTION CONTROL DRIVER (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

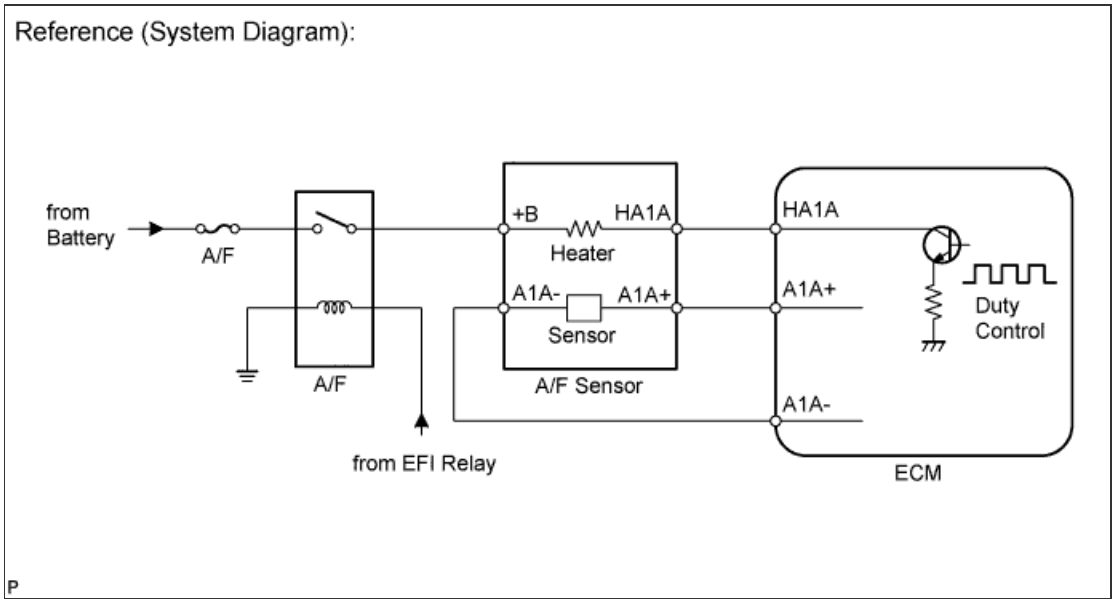
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

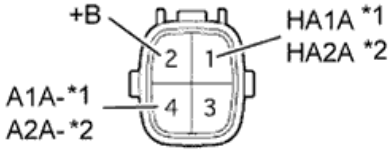
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

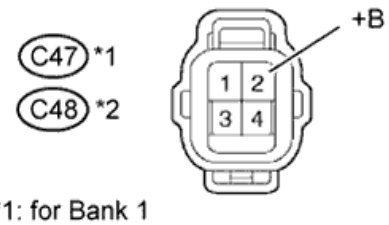
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

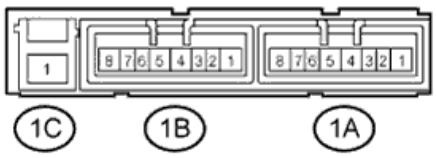
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

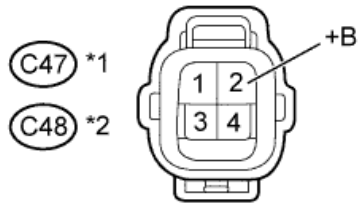
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

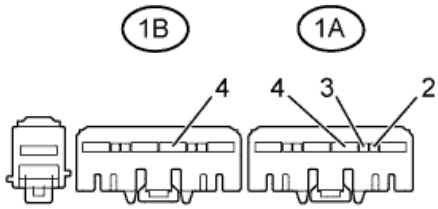
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

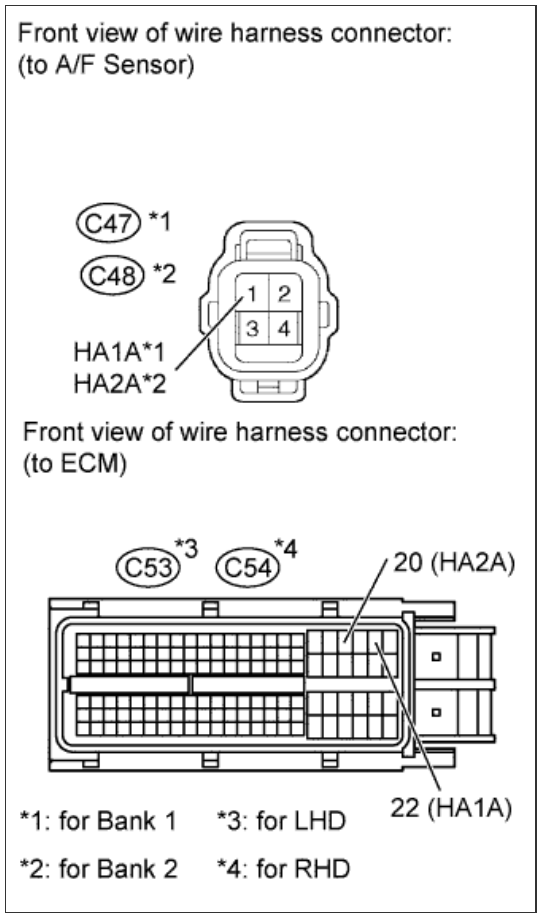
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0420 Catalyst System Efficiency Below Threshold (Bank 1)

DTC P0430 Catalyst System Efficiency Below Threshold (Bank 2)

for Preparation Click here

MONITOR DESCRIPTION

The ECM uses sensors mounted in front of and behind the Three-Way Catalytic Converter (TWC) to monitor its efficiency.
The first sensor, the Air Fuel ratio (A/F) sensor, sends pre-catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor, sends post-catalyst information to the ECM. In order to detect any deterioration in the TWC, the ECM calculates the Oxygen Storage Capacity (OSC) of the TWC. This calculation is based on the voltage output of the HO2 sensor while performing active air-fuel ratio control.
The OSC value is an indication of the oxygen storage capacity of the TWC. When the vehicle is being driven with a warm engine, active air-fuel ratio control is performed for approximately 15 to 20 seconds. When it is performed, the ECM deliberately sets the air-fuel ratio to lean or rich levels. If the rich-lean cycle of the HO2 sensor is long, the OSC becomes greater. There is a direct correlation between the OSCs of the HO2 sensor and the TWC.
The ECM uses the OSC value to determine the state of the TWC. If any deterioration has occurred, it illuminates the MIL and stores the DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0420	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) • Front No. 2 exhaust pipe assembly (TWC)
P0430	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) • Front exhaust pipe assembly (TWC)

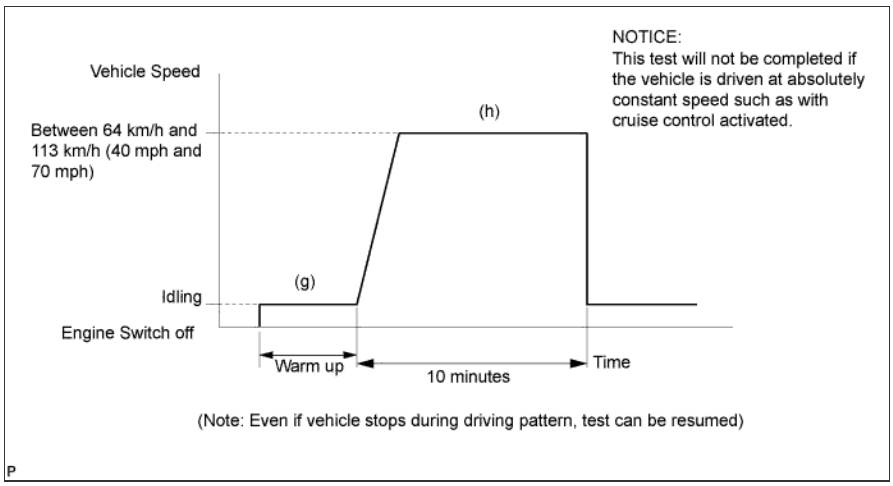
HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the catalyst monitor. This is very useful for verifying the completion of a repair.



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear DTCs (if output) (Click here).
(e) Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Catalyst Monitor.
(f) Check that Catalyst Monitor is incomplete.
(g) Start the engine and warm it up.
(h) Drive the vehicle at between 64 km/h and 113 km/h (40 mph and 70 mph) for at least 10 minutes.
(i) Note the state of the Readiness Tests items. Those items will change to Complete as Catalyst Monitor monitor operates.
(j) Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.
(k) Check if any DTCs (any pending DTCs) are output.

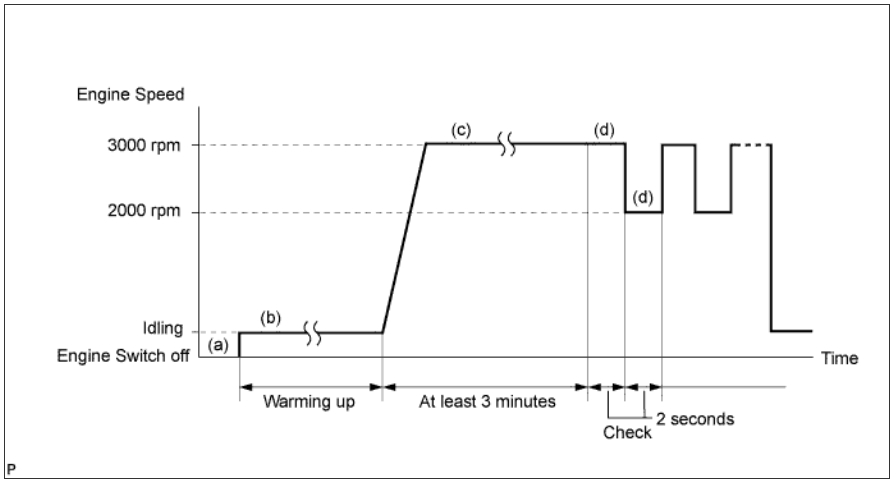
HINT:

If Catalyst Monitor does not change to Complete, and any pending DTCs fail to be stored, extend the driving time.

CONDITIONING FOR SENSOR TESTING

HINT:

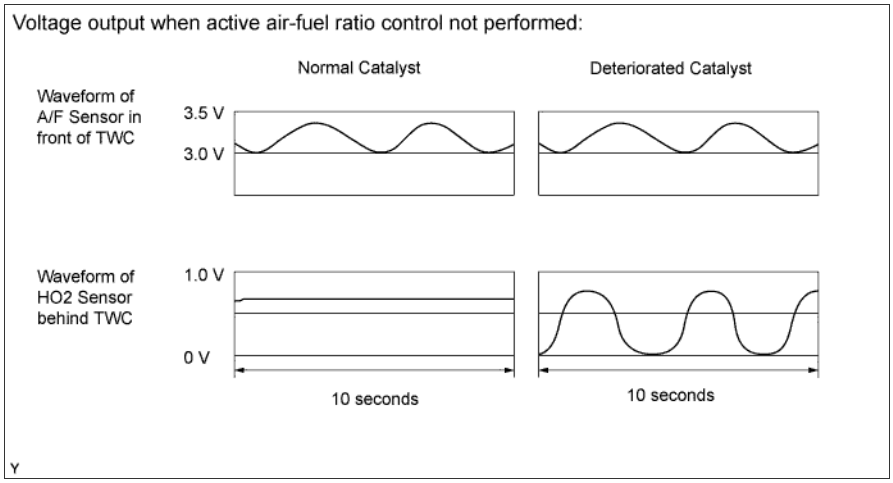
Perform the operation with the engine speeds and time durations described below prior to checking the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.



(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and warm it up with all the accessories switched off until the engine coolant temperature stabilizes.
(c) Run the engine at an engine speed of between 2500 rpm and 3000 rpm for at least 3 minutes.
(d) While running the engine at 3000 rpm and 2000 rpm at 2 second intervals, check the waveforms of the A/F and HO2 sensors using the tester.

HINT:

- **If either voltage output of the Air Fuel ratio (A/F) or Heated Oxygen (HO2) sensor does not fluctuate, or there is a noise in the waveform of either sensor, the sensor may be malfunctioning.**
- **If the voltage outputs of both the sensors remain lean or rich, the air-fuel ratio may be extremely lean or rich. In such cases, perform the following Control the Injection Volume for A/F Sensor using the intelligent tester.**
- **If the Three-Way Catalytic Converter (TWC) has deteriorated, the HO2 sensor (located behind the TWC) voltage output fluctuates up and down frequently, even under normal driving conditions (active air-fuel ratio control is not performed).**



INSPECTION PROCEDURE

HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 OR P0430)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0420 or P0430 is output	A
P0420 or P0430 and other DTCs are output	B

HINT:

If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (Control the Injection Volume for A/F Sensor)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

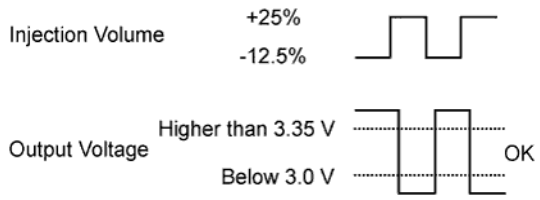
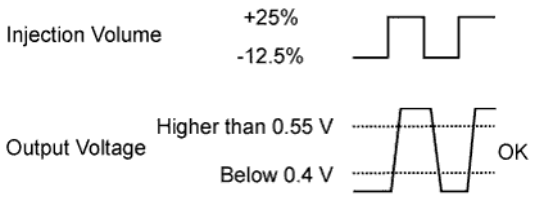
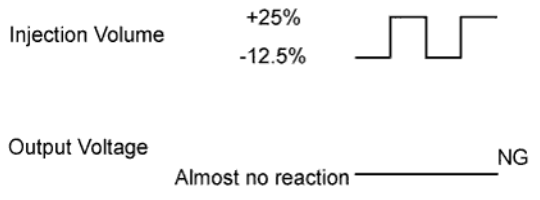
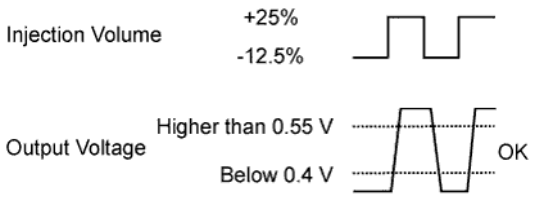
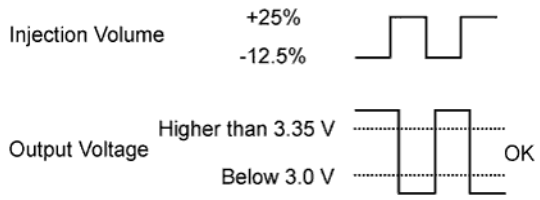
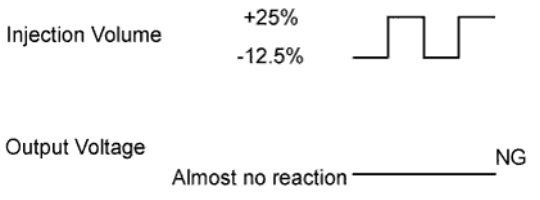
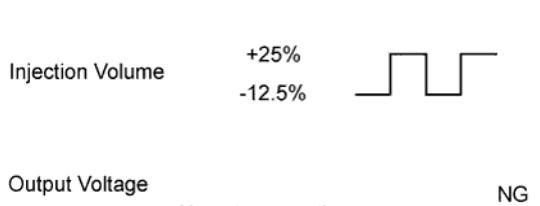
e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

f. Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
A/F sensor reacts in accordance with increases and decreases in fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	A
Case 2	B
Case 3	C
Case 4	D

B	REPLACE AIR FUEL RATIO SENSOR (Click here)
C	Go to step 4
	CHECK CAUSE OF EXTREMELY RICH OR LEAN ACTUAL AIR-FUEL RATIO,

D → REPLACE FAULTY AREA AND GO TO NEXT STEP

A

3.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

A

REPAIR OR REPLACE EXHAUST GAS LEAK POINT

4.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK

REPLACE HEATED OXYGEN SENSOR (Click here)

5.CHECK DTC OUTPUT (DTC P0420 AND/OR P0430)

a. According to the output DTCs in the step 1 (Check Any Other DTCs Output), proceed to next step referring to the table below.

Result

Result	Proceed to
P0420	A
P0430	B
P0420 and P0430	A and B

B → REPLACE FRONT EXHAUST PIPE ASSEMBLY (Click here)

A

REPLACE FRONT NO. 2 EXHAUST PIPE ASSEMBLY (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

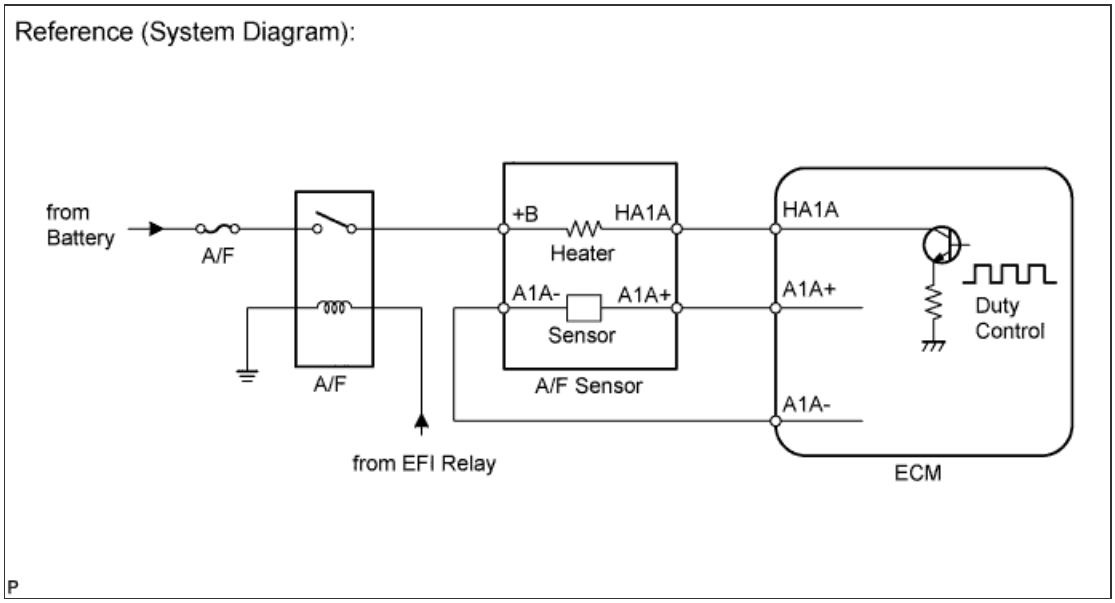
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

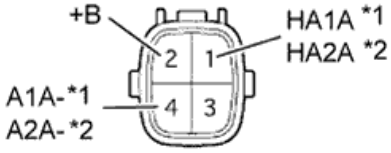
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

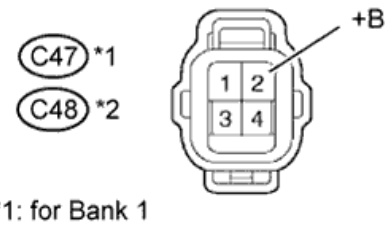
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

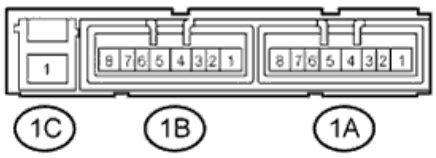
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

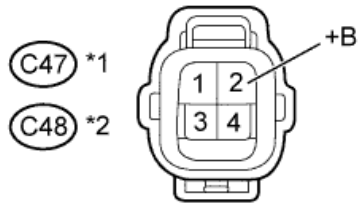
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

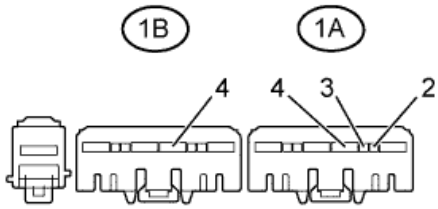
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

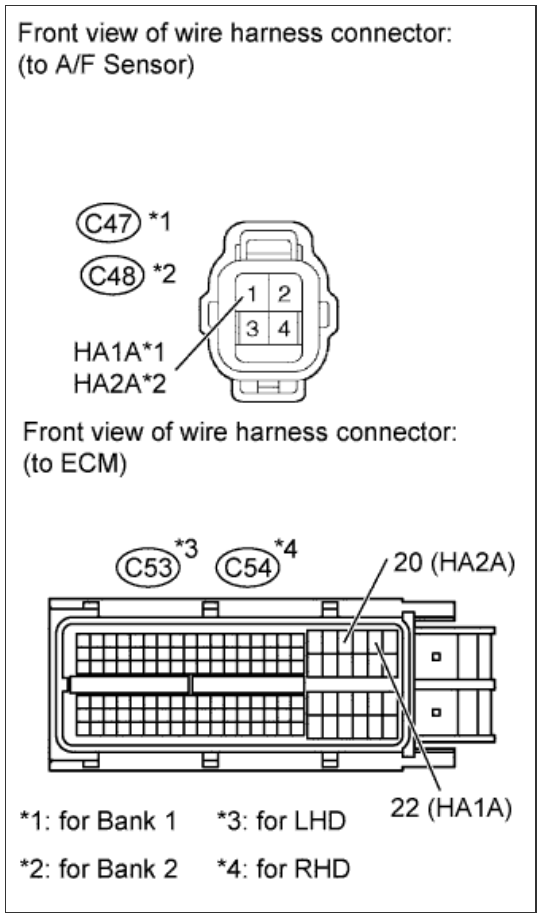
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0420 Catalyst System Efficiency Below Threshold (Bank 1)

DTC P0430 Catalyst System Efficiency Below Threshold (Bank 2)

for Preparation Click here

MONITOR DESCRIPTION

The ECM uses sensors mounted in front of and behind the Three-Way Catalytic Converter (TWC) to monitor its efficiency.
The first sensor, the Air Fuel ratio (A/F) sensor, sends pre-catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor, sends post-catalyst information to the ECM. In order to detect any deterioration in the TWC, the ECM calculates the Oxygen Storage Capacity (OSC) of the TWC. This calculation is based on the voltage output of the HO2 sensor while performing active air-fuel ratio control.
The OSC value is an indication of the oxygen storage capacity of the TWC. When the vehicle is being driven with a warm engine, active air-fuel ratio control is performed for approximately 15 to 20 seconds. When it is performed, the ECM deliberately sets the air-fuel ratio to lean or rich levels. If the rich-lean cycle of the HO2 sensor is long, the OSC becomes greater. There is a direct correlation between the OSCs of the HO2 sensor and the TWC.
The ECM uses the OSC value to determine the state of the TWC. If any deterioration has occurred, it illuminates the MIL and stores the DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0420	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) • Front No. 2 exhaust pipe assembly (TWC)
P0430	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) • Front exhaust pipe assembly (TWC)

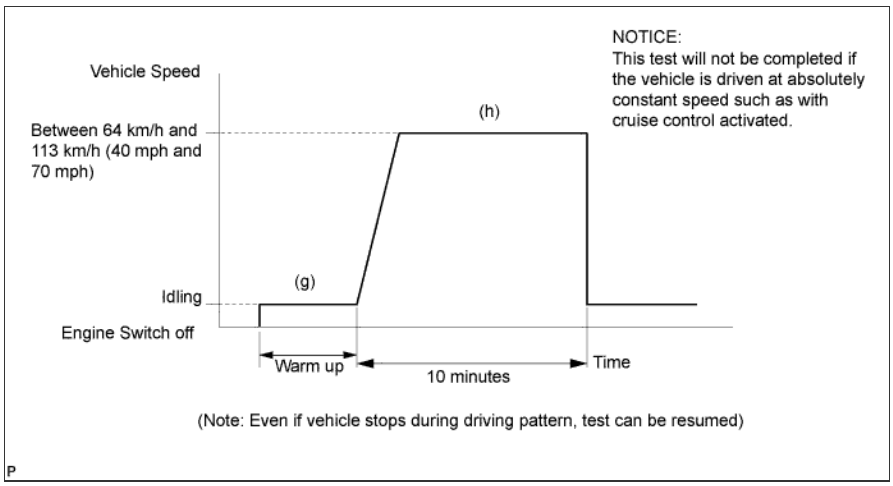
HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the catalyst monitor. This is very useful for verifying the completion of a repair.



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear DTCs (if output) (Click here).
(e) Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Catalyst Monitor.
(f) Check that Catalyst Monitor is incomplete.
(g) Start the engine and warm it up.
(h) Drive the vehicle at between 64 km/h and 113 km/h (40 mph and 70 mph) for at least 10 minutes.
(i) Note the state of the Readiness Tests items. Those items will change to Complete as Catalyst Monitor monitor operates.
(j) Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.
(k) Check if any DTCs (any pending DTCs) are output.

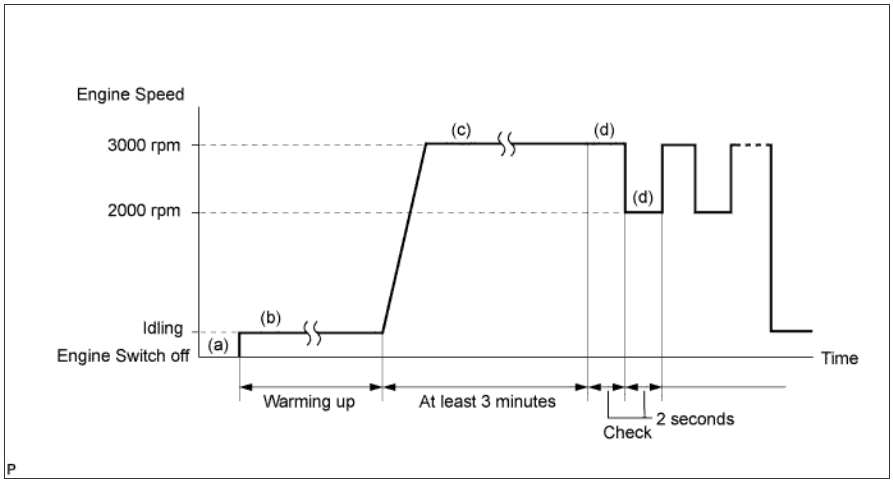
HINT:

If Catalyst Monitor does not change to Complete, and any pending DTCs fail to be stored, extend the driving time.

CONDITIONING FOR SENSOR TESTING

HINT:

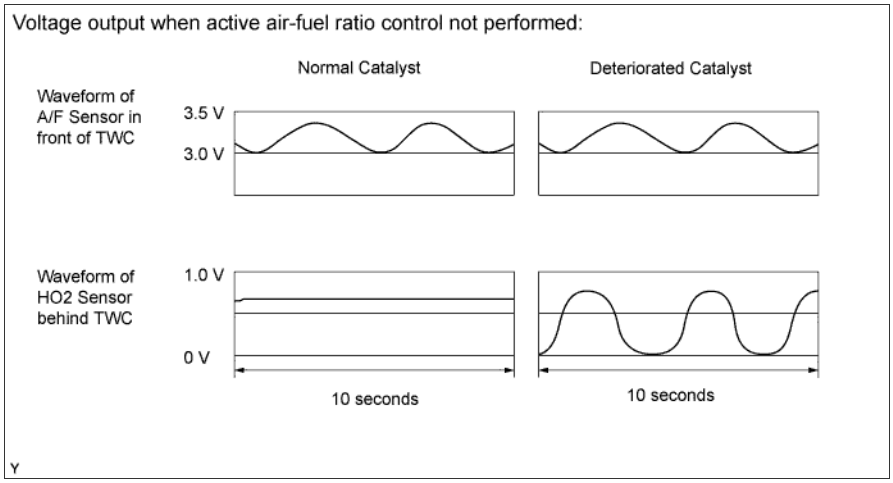
Perform the operation with the engine speeds and time durations described below prior to checking the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.



(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and warm it up with all the accessories switched off until the engine coolant temperature stabilizes.
(c) Run the engine at an engine speed of between 2500 rpm and 3000 rpm for at least 3 minutes.
(d) While running the engine at 3000 rpm and 2000 rpm at 2 second intervals, check the waveforms of the A/F and HO2 sensors using the tester.

HINT:

- **If either voltage output of the Air Fuel ratio (A/F) or Heated Oxygen (HO2) sensor does not fluctuate, or there is a noise in the waveform of either sensor, the sensor may be malfunctioning.**
- **If the voltage outputs of both the sensors remain lean or rich, the air-fuel ratio may be extremely lean or rich. In such cases, perform the following Control the Injection Volume for A/F Sensor using the intelligent tester.**
- **If the Three-Way Catalytic Converter (TWC) has deteriorated, the HO2 sensor (located behind the TWC) voltage output fluctuates up and down frequently, even under normal driving conditions (active air-fuel ratio control is not performed).**



INSPECTION PROCEDURE

HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 OR P0430)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0420 or P0430 is output	A
P0420 or P0430 and other DTCs are output	B

HINT:

If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (Control the Injection Volume for A/F Sensor)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

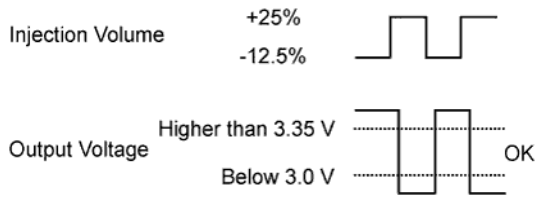
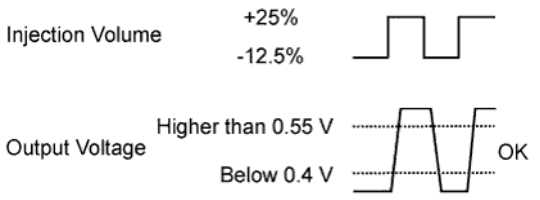
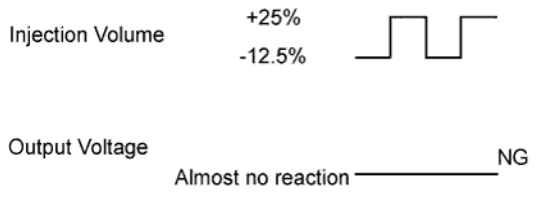
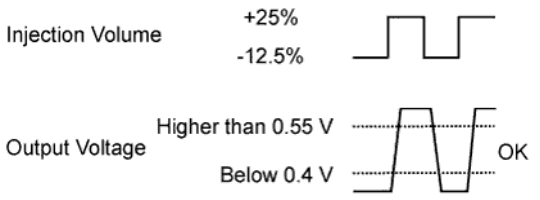
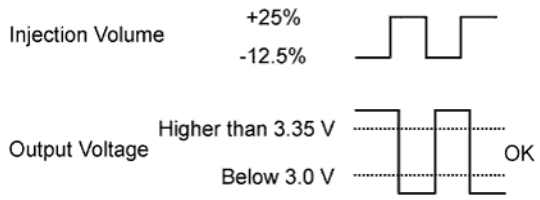
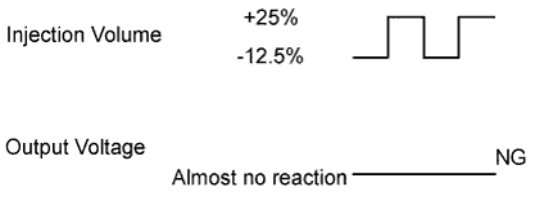
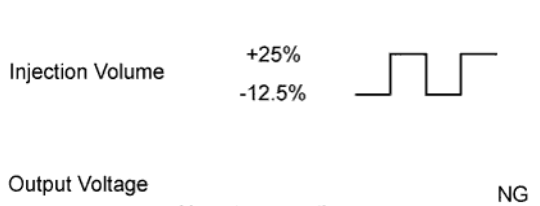
e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

f. Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
A/F sensor reacts in accordance with increases and decreases in fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	A
Case 2	B
Case 3	C
Case 4	D

B	REPLACE AIR FUEL RATIO SENSOR (Click here)
C	Go to step 4
	CHECK CAUSE OF EXTREMELY RICH OR LEAN ACTUAL AIR-FUEL RATIO,

D → REPLACE FAULTY AREA AND GO TO NEXT STEP

A

3.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

A

REPAIR OR REPLACE EXHAUST GAS LEAK POINT

4.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK

REPLACE HEATED OXYGEN SENSOR (Click here)

5.CHECK DTC OUTPUT (DTC P0420 AND/OR P0430)

a. According to the output DTCs in the step 1 (Check Any Other DTCs Output), proceed to next step referring to the table below.

Result

Result	Proceed to
P0420	A
P0430	B
P0420 and P0430	A and B

B → REPLACE FRONT EXHAUST PIPE ASSEMBLY (Click here)

A

REPLACE FRONT NO. 2 EXHAUST PIPE ASSEMBLY (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

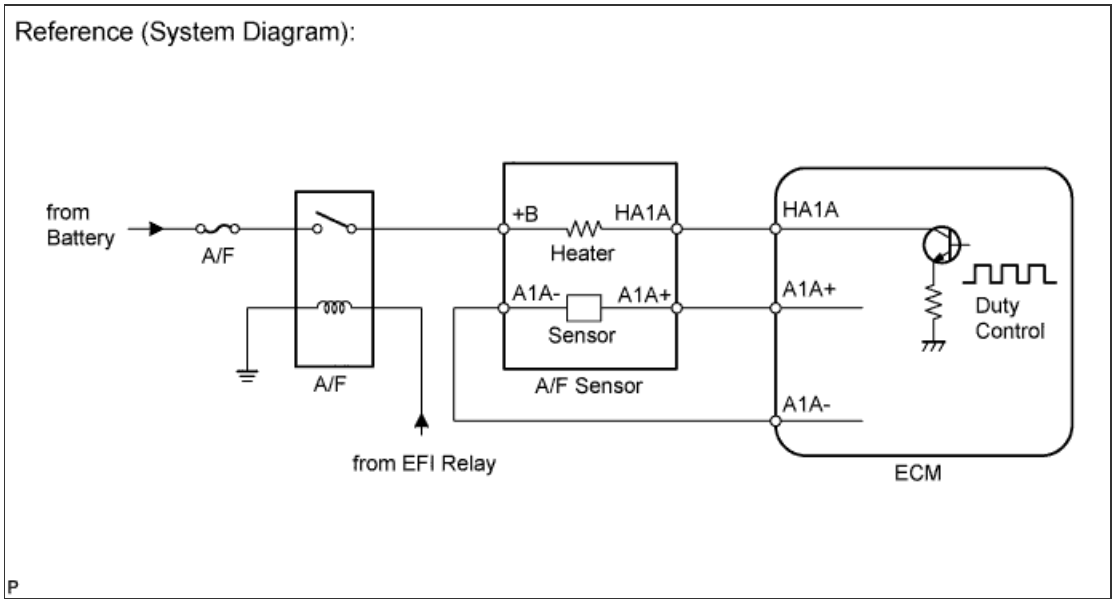
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

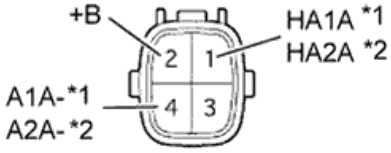
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

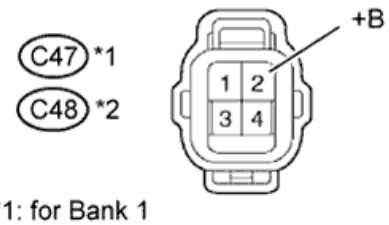
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

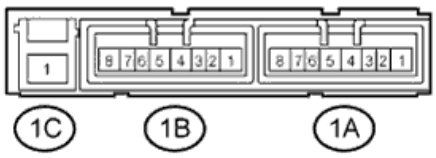
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

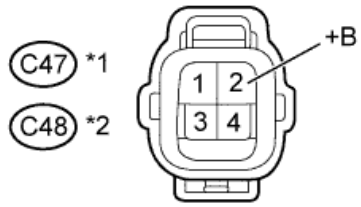
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

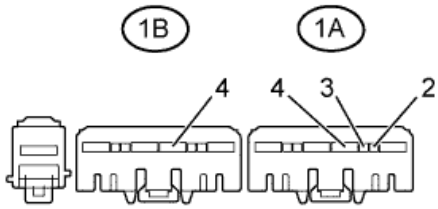
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

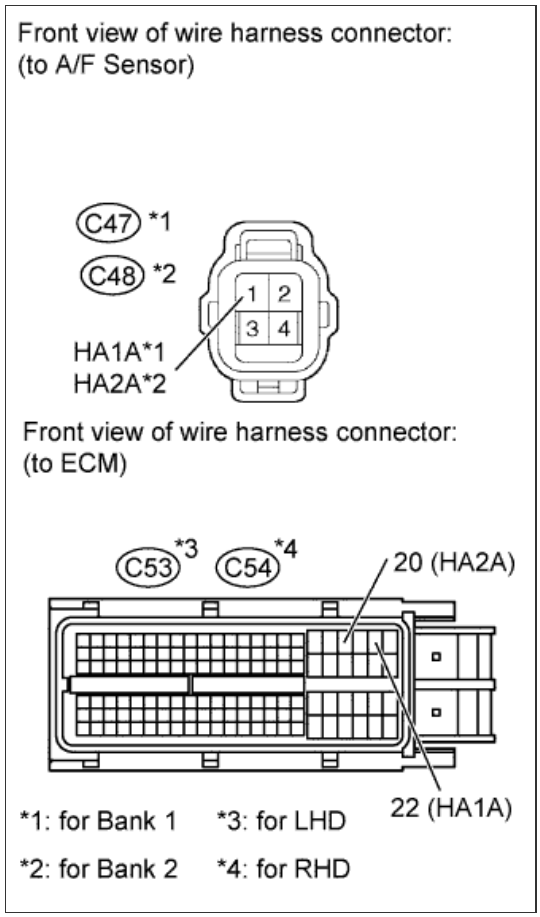
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0420 Catalyst System Efficiency Below Threshold (Bank 1)

DTC P0430 Catalyst System Efficiency Below Threshold (Bank 2)

for Preparation Click here

MONITOR DESCRIPTION

The ECM uses sensors mounted in front of and behind the Three-Way Catalytic Converter (TWC) to monitor its efficiency.
The first sensor, the Air Fuel ratio (A/F) sensor, sends pre-catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor, sends post-catalyst information to the ECM. In order to detect any deterioration in the TWC, the ECM calculates the Oxygen Storage Capacity (OSC) of the TWC. This calculation is based on the voltage output of the HO2 sensor while performing active air-fuel ratio control.
The OSC value is an indication of the oxygen storage capacity of the TWC. When the vehicle is being driven with a warm engine, active air-fuel ratio control is performed for approximately 15 to 20 seconds. When it is performed, the ECM deliberately sets the air-fuel ratio to lean or rich levels. If the rich-lean cycle of the HO2 sensor is long, the OSC becomes greater. There is a direct correlation between the OSCs of the HO2 sensor and the TWC.
The ECM uses the OSC value to determine the state of the TWC. If any deterioration has occurred, it illuminates the MIL and stores the DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0420	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) • Front No. 2 exhaust pipe assembly (TWC)
P0430	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) • Front exhaust pipe assembly (TWC)

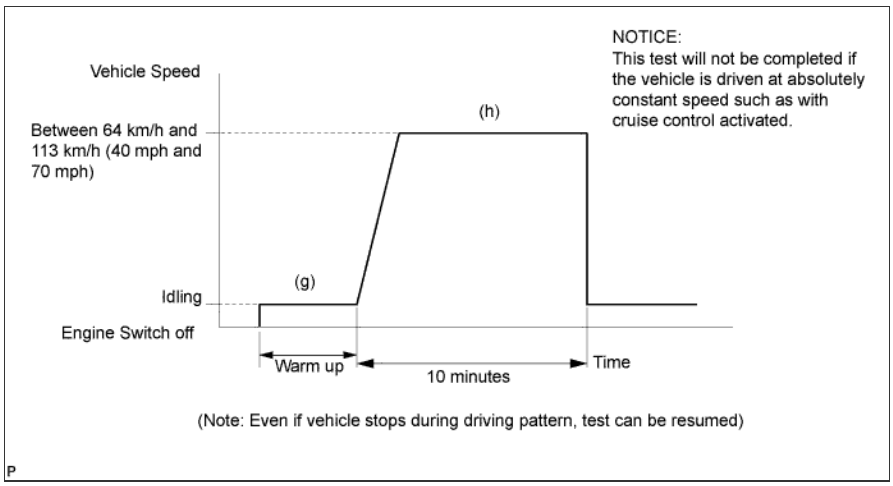
HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the catalyst monitor. This is very useful for verifying the completion of a repair.



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear DTCs (if output) (Click here).
(e) Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Catalyst Monitor.
(f) Check that Catalyst Monitor is incomplete.
(g) Start the engine and warm it up.
(h) Drive the vehicle at between 64 km/h and 113 km/h (40 mph and 70 mph) for at least 10 minutes.
(i) Note the state of the Readiness Tests items. Those items will change to Complete as Catalyst Monitor monitor operates.
(j) Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.
(k) Check if any DTCs (any pending DTCs) are output.

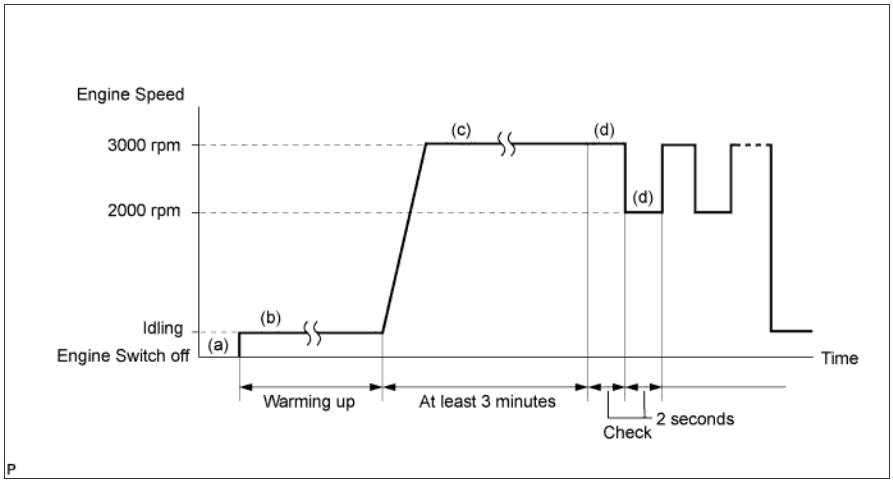
HINT:

If Catalyst Monitor does not change to Complete, and any pending DTCs fail to be stored, extend the driving time.

CONDITIONING FOR SENSOR TESTING

HINT:

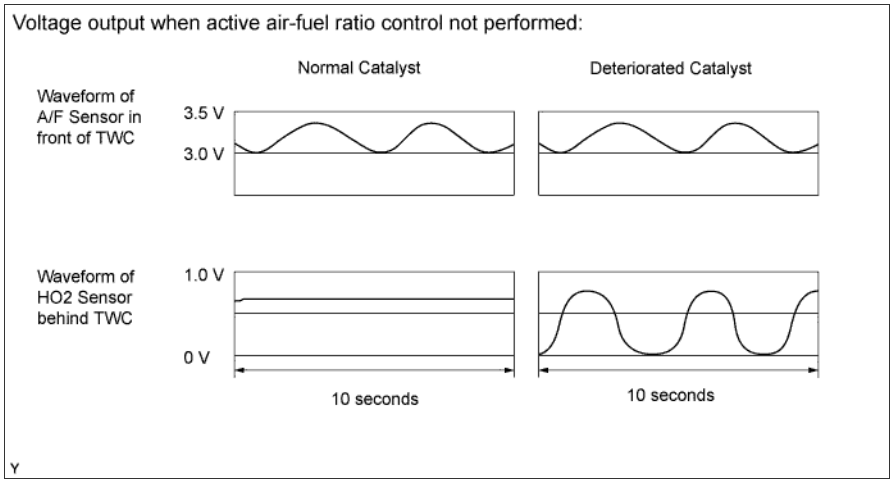
Perform the operation with the engine speeds and time durations described below prior to checking the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.



(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and warm it up with all the accessories switched off until the engine coolant temperature stabilizes.
(c) Run the engine at an engine speed of between 2500 rpm and 3000 rpm for at least 3 minutes.
(d) While running the engine at 3000 rpm and 2000 rpm at 2 second intervals, check the waveforms of the A/F and HO2 sensors using the tester.

HINT:

- **If either voltage output of the Air Fuel ratio (A/F) or Heated Oxygen (HO2) sensor does not fluctuate, or there is a noise in the waveform of either sensor, the sensor may be malfunctioning.**
- **If the voltage outputs of both the sensors remain lean or rich, the air-fuel ratio may be extremely lean or rich. In such cases, perform the following Control the Injection Volume for A/F Sensor using the intelligent tester.**
- **If the Three-Way Catalytic Converter (TWC) has deteriorated, the HO2 sensor (located behind the TWC) voltage output fluctuates up and down frequently, even under normal driving conditions (active air-fuel ratio control is not performed).**



INSPECTION PROCEDURE

HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 OR P0430)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0420 or P0430 is output	A
P0420 or P0430 and other DTCs are output	B

HINT:

If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (Control the Injection Volume for A/F Sensor)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

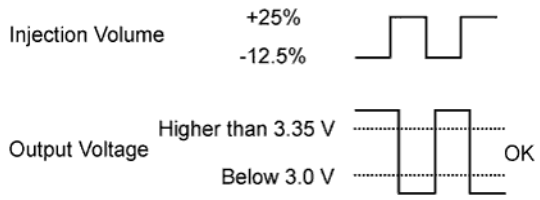
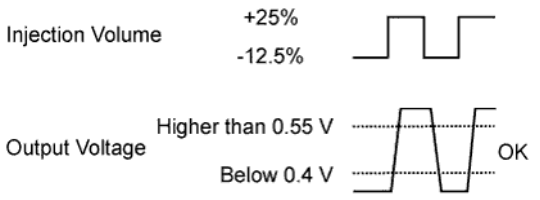
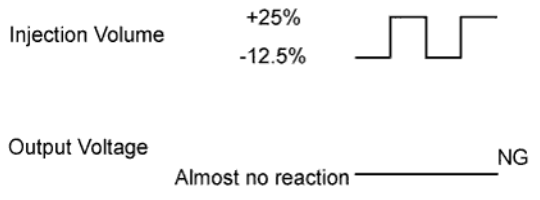
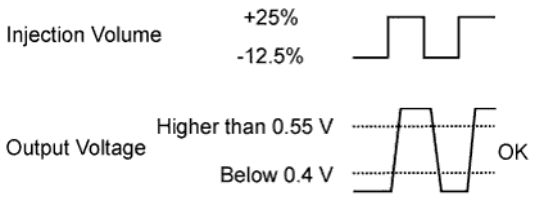
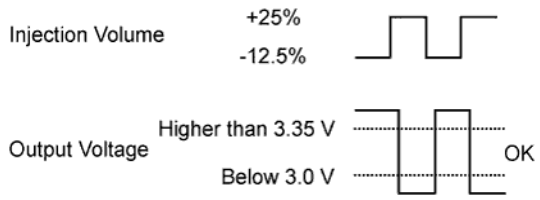
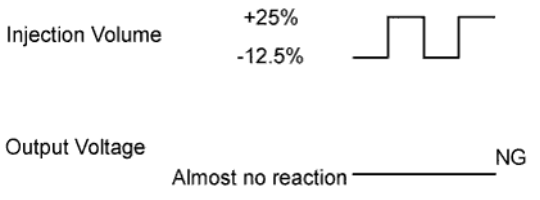
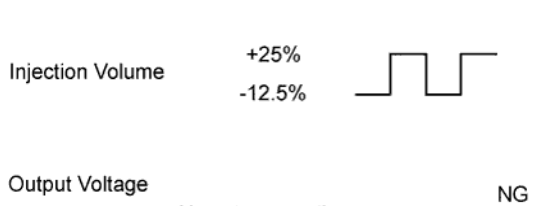
e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

f. Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
A/F sensor reacts in accordance with increases and decreases in fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	A
Case 2	B
Case 3	C
Case 4	D

B	REPLACE AIR FUEL RATIO SENSOR (Click here)
C	Go to step 4
	CHECK CAUSE OF EXTREMELY RICH OR LEAN ACTUAL AIR-FUEL RATIO,

D → REPLACE FAULTY AREA AND GO TO NEXT STEP

A

3.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

A

REPAIR OR REPLACE EXHAUST GAS LEAK POINT

4.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK

REPLACE HEATED OXYGEN SENSOR (Click here)

5.CHECK DTC OUTPUT (DTC P0420 AND/OR P0430)

a. According to the output DTCs in the step 1 (Check Any Other DTCs Output), proceed to next step referring to the table below.

Result

Result	Proceed to
P0420	A
P0430	B
P0420 and P0430	A and B

B → REPLACE FRONT EXHAUST PIPE ASSEMBLY (Click here)

A

REPLACE FRONT NO. 2 EXHAUST PIPE ASSEMBLY (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

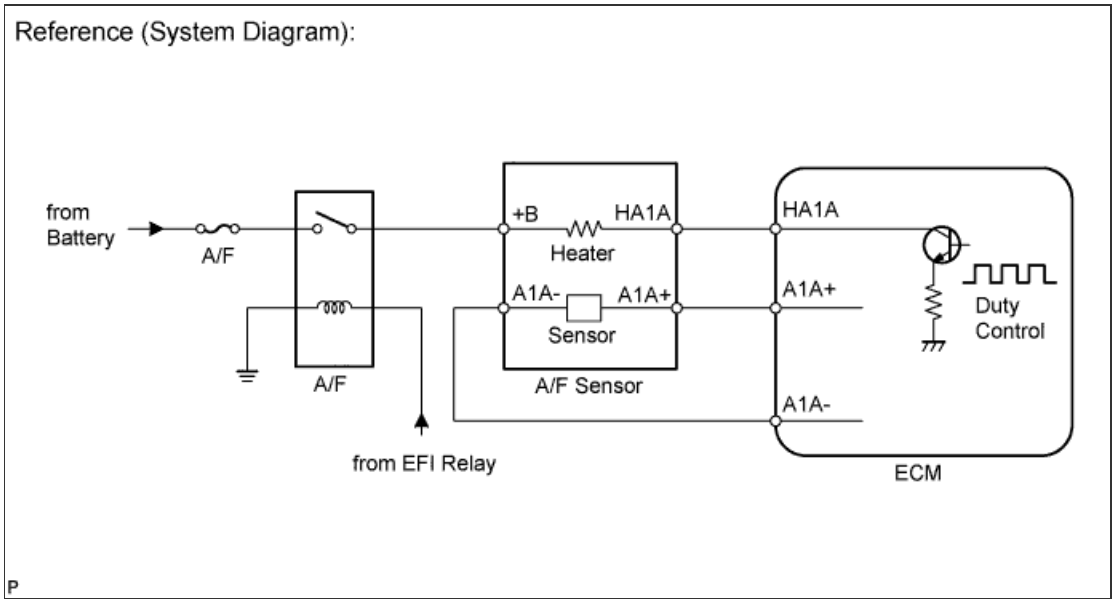
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

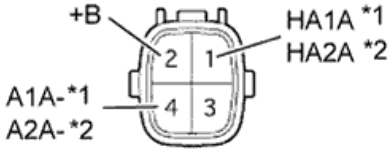
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

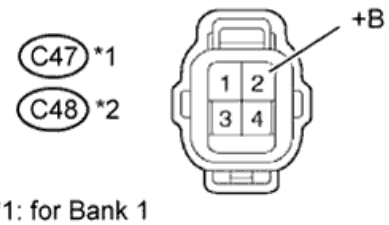
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

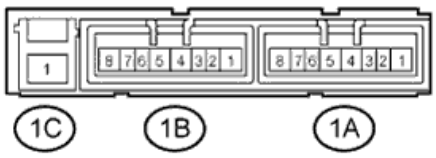
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

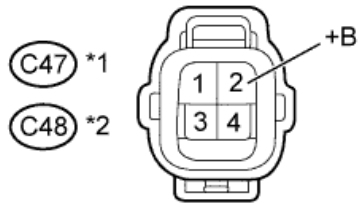
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

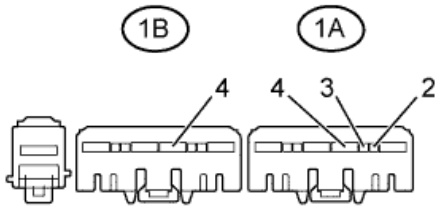
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

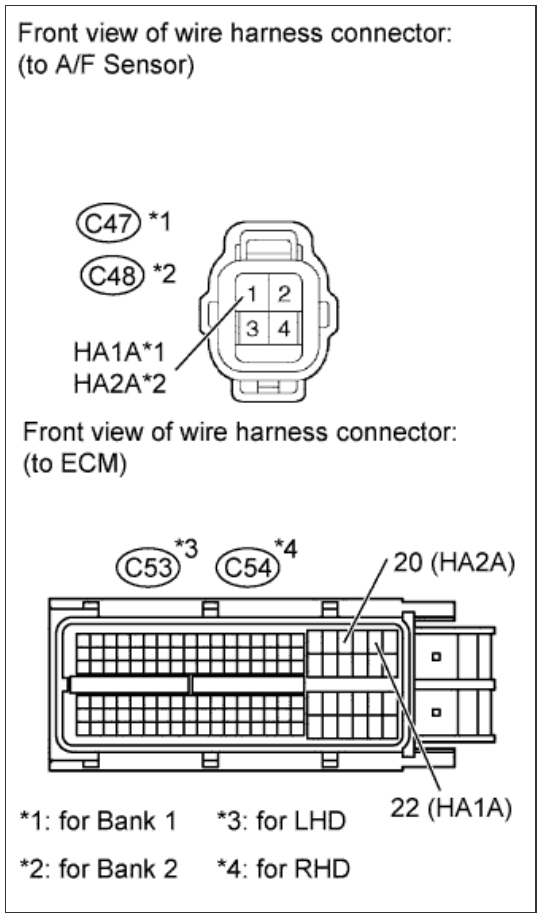
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0420 Catalyst System Efficiency Below Threshold (Bank 1)

DTC P0430 Catalyst System Efficiency Below Threshold (Bank 2)

for Preparation Click here

MONITOR DESCRIPTION

The ECM uses sensors mounted in front of and behind the Three-Way Catalytic Converter (TWC) to monitor its efficiency.
The first sensor, the Air Fuel ratio (A/F) sensor, sends pre-catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor, sends post-catalyst information to the ECM. In order to detect any deterioration in the TWC, the ECM calculates the Oxygen Storage Capacity (OSC) of the TWC. This calculation is based on the voltage output of the HO2 sensor while performing active air-fuel ratio control.
The OSC value is an indication of the oxygen storage capacity of the TWC. When the vehicle is being driven with a warm engine, active air-fuel ratio control is performed for approximately 15 to 20 seconds. When it is performed, the ECM deliberately sets the air-fuel ratio to lean or rich levels. If the rich-lean cycle of the HO2 sensor is long, the OSC becomes greater. There is a direct correlation between the OSCs of the HO2 sensor and the TWC.
The ECM uses the OSC value to determine the state of the TWC. If any deterioration has occurred, it illuminates the MIL and stores the DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0420	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 1 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 1 Sensor 2) • Front No. 2 exhaust pipe assembly (TWC)
P0430	The OSC value is less than the standard value under active air-fuel ratio control (2 trip detection logic).	• Gas leakage from exhaust system • Air Fuel ratio (A/F) sensor (for Bank 2 Sensor 1) • Heated Oxygen (HO2) sensor (for Bank 2 Sensor 2) • Front exhaust pipe assembly (TWC)

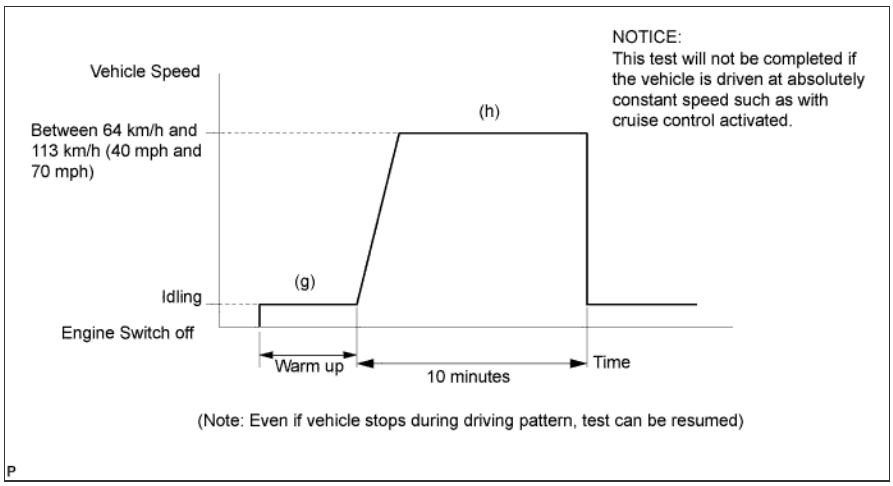
HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the catalyst monitor. This is very useful for verifying the completion of a repair.



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear DTCs (if output) (Click here).
(e) Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Catalyst Monitor.
(f) Check that Catalyst Monitor is incomplete.
(g) Start the engine and warm it up.
(h) Drive the vehicle at between 64 km/h and 113 km/h (40 mph and 70 mph) for at least 10 minutes.
(i) Note the state of the Readiness Tests items. Those items will change to Complete as Catalyst Monitor monitor operates.
(j) Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.
(k) Check if any DTCs (any pending DTCs) are output.

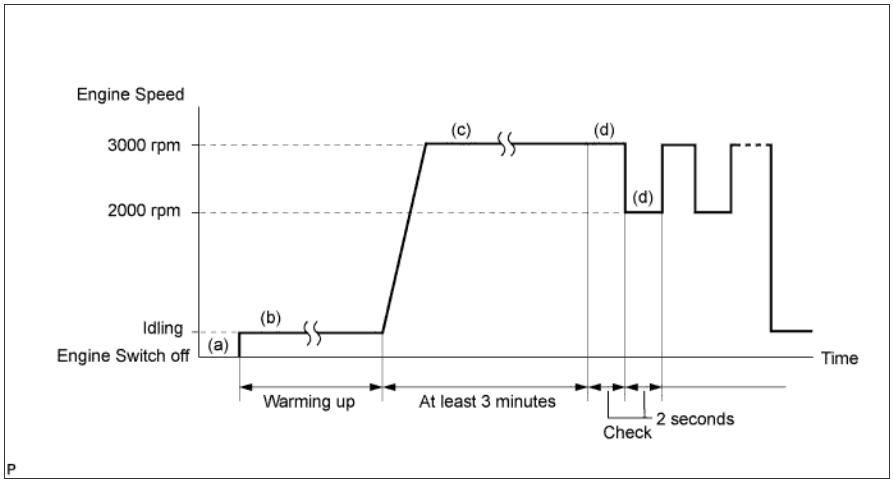
HINT:

If Catalyst Monitor does not change to Complete, and any pending DTCs fail to be stored, extend the driving time.

CONDITIONING FOR SENSOR TESTING

HINT:

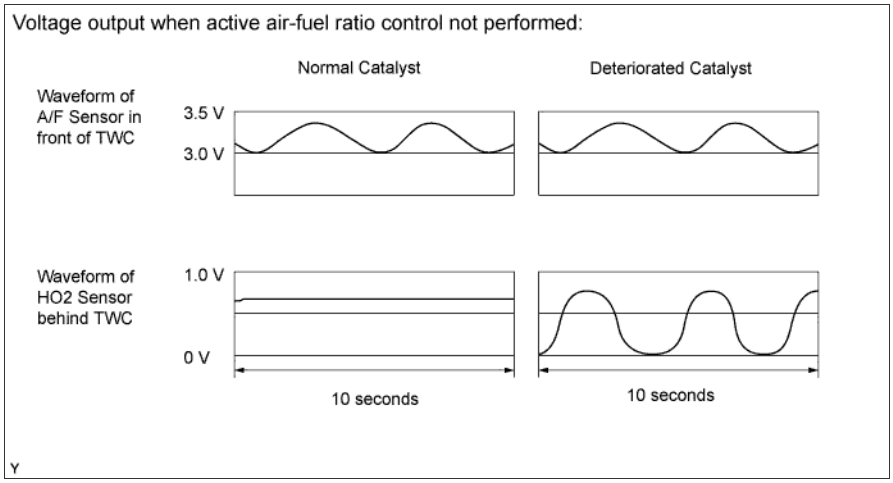
Perform the operation with the engine speeds and time durations described below prior to checking the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.



(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and warm it up with all the accessories switched off until the engine coolant temperature stabilizes.
(c) Run the engine at an engine speed of between 2500 rpm and 3000 rpm for at least 3 minutes.
(d) While running the engine at 3000 rpm and 2000 rpm at 2 second intervals, check the waveforms of the A/F and HO2 sensors using the tester.

HINT:

- **If either voltage output of the Air Fuel ratio (A/F) or Heated Oxygen (HO2) sensor does not fluctuate, or there is a noise in the waveform of either sensor, the sensor may be malfunctioning.**
- **If the voltage outputs of both the sensors remain lean or rich, the air-fuel ratio may be extremely lean or rich. In such cases, perform the following Control the Injection Volume for A/F Sensor using the intelligent tester.**
- **If the Three-Way Catalytic Converter (TWC) has deteriorated, the HO2 sensor (located behind the TWC) voltage output fluctuates up and down frequently, even under normal driving conditions (active air-fuel ratio control is not performed).**



INSPECTION PROCEDURE

HINT:

- **DTC P0420 and P0430 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 OR P0430)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0420 or P0430 is output	A
P0420 or P0430 and other DTCs are output	B

HINT:

If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (Control the Injection Volume for A/F Sensor)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

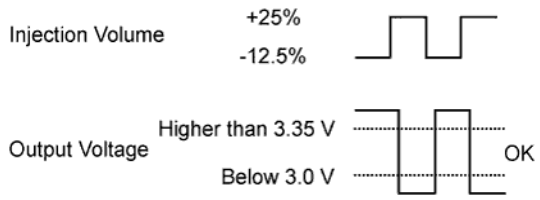
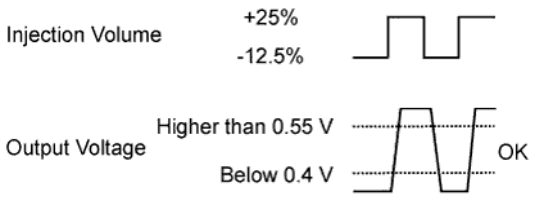
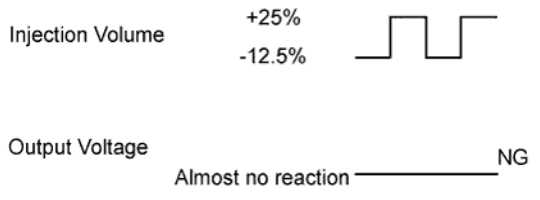
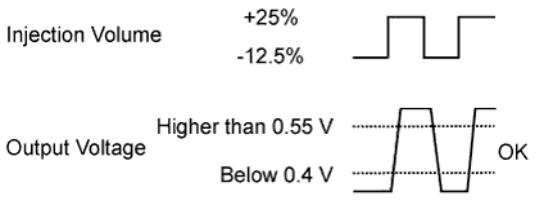
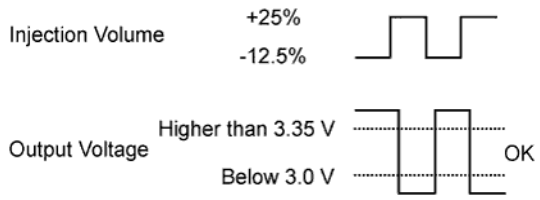
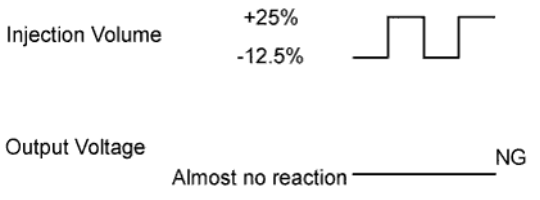
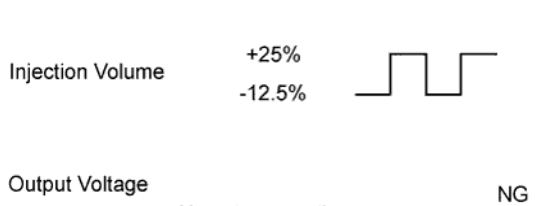
e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

f. Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
A/F sensor reacts in accordance with increases and decreases in fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	A
Case 2	B
Case 3	C
Case 4	D

B	REPLACE AIR FUEL RATIO SENSOR (Click here)
C	Go to step 4
	CHECK CAUSE OF EXTREMELY RICH OR LEAN ACTUAL AIR-FUEL RATIO,

D → REPLACE FAULTY AREA AND GO TO NEXT STEP

A

3.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

A

REPAIR OR REPLACE EXHAUST GAS LEAK POINT

4.INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK

REPLACE HEATED OXYGEN SENSOR (Click here)

5.CHECK DTC OUTPUT (DTC P0420 AND/OR P0430)

a. According to the output DTCs in the step 1 (Check Any Other DTCs Output), proceed to next step referring to the table below.

Result

Result	Proceed to
P0420	A
P0430	B
P0420 and P0430	A and B

B → REPLACE FRONT EXHAUST PIPE ASSEMBLY (Click here)

A

REPLACE FRONT NO. 2 EXHAUST PIPE ASSEMBLY (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

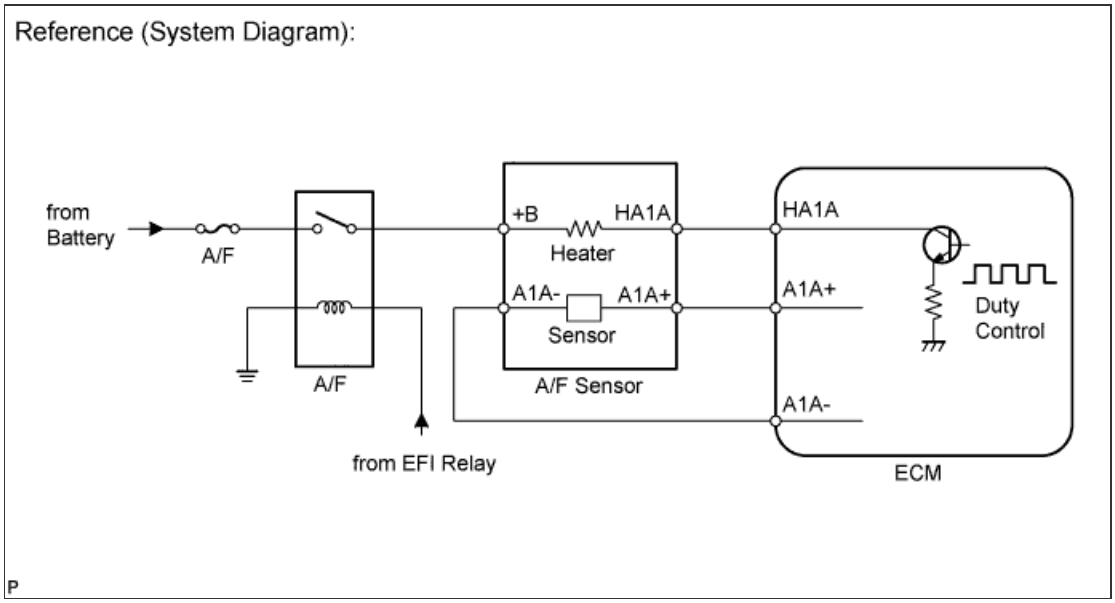
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

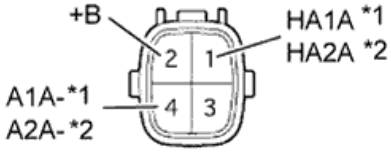
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

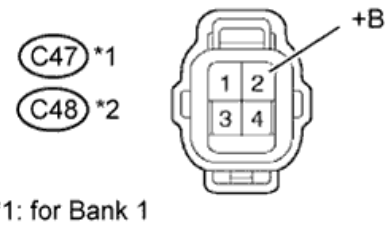
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

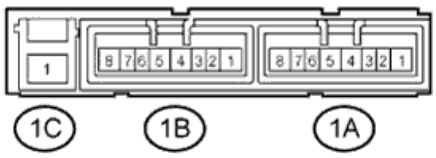
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

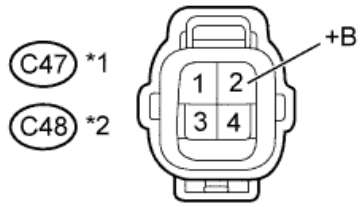
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

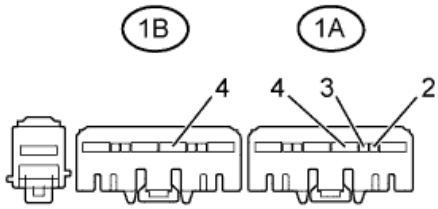
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

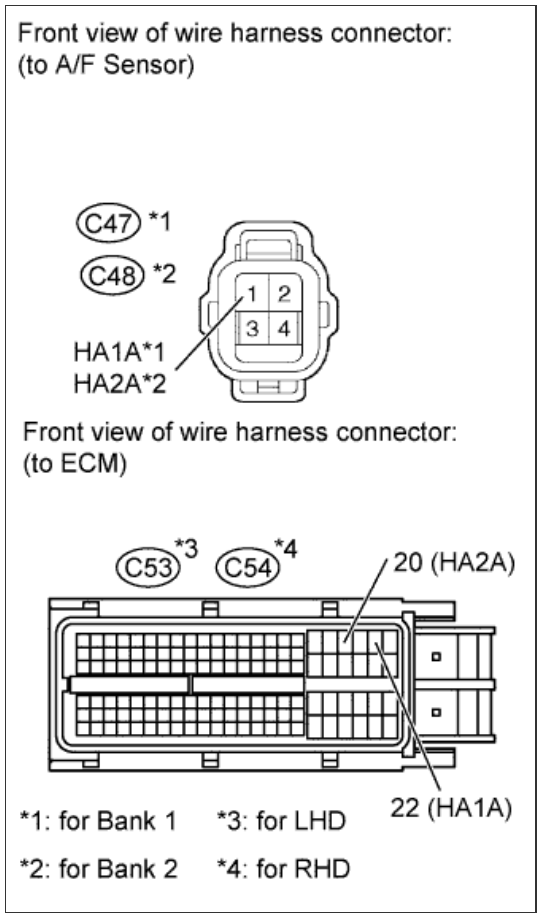
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0443 Evaporative Emission Control System Purge Control Valve Circuit

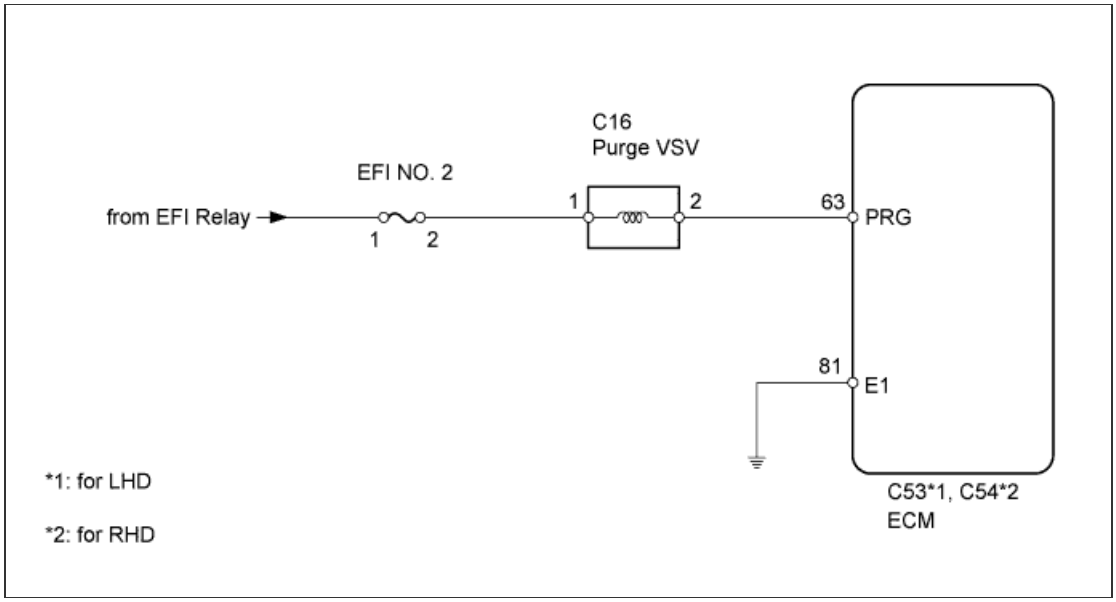
for Preparation Click here

DESCRIPTION

To reduce HC emissions, evaporated fuel from the fuel tank is routed through a charcoal canister to the intake manifold for combustion in the cylinders. The ECM changes the duty signals to the purge VSV so that the intake amount of HC emissions is appropriate for driving conditions (engine load, engine speed, vehicle speed, etc.) after the engine is warmed up.

DTC Code	DTC Detection Condition	Trouble Area
P0443	The terminal voltage of the ECM output circuit does not correspond with the drive signals from the ECM to the purge VSV (1 trip detection logic).	• Open or short in purge VSV circuit • Purge VSV • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (ACTIVATE THE VSV FOR EVAP CONTROL)

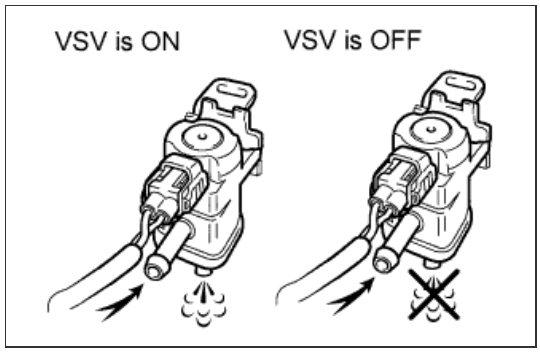
a. Connect the intelligent tester to the DLC3.

b. Remove the vacuum hose of the purge VSV from the charcoal canister.

c. Start the engine and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Activate the VSV for Evap Control.

e. When the purge VSV is operated using the tester, check whether the disconnected hose applies suction to your finger.



OK:

Tester Operation	Specified Condition
VSV is ON	Disconnected hose applies suction to finger
VSV is OFF	Disconnected hose applies no suction to finger

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

NG

2.INSPECT PURGE VSV

a. Inspect the purge VSV (Click here).

NG → REPLACE PURGE VSV (Click here)

OK

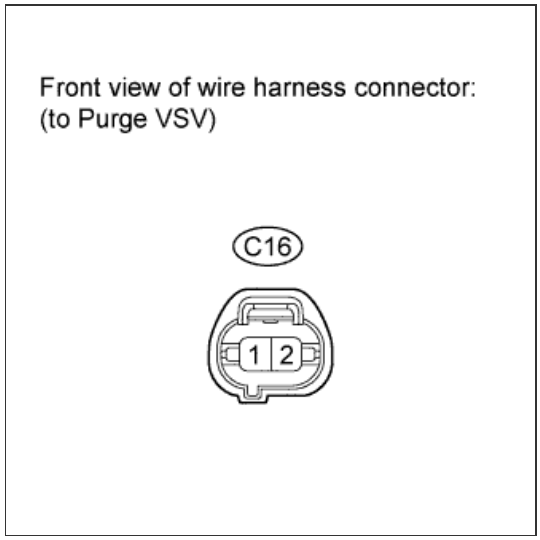
3.INSPECT PURGE VSV (POWER SOURCE VOLTAGE)

a. Disconnect the purge VSV connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C16-1 - Body ground	Engine switch on (IG)	11 to 14 V



OK → Go to step 5

NG

4.CHECK HARNESS AND CONNECTOR (PURGE VSV - EFI NO. 2 FUSE)

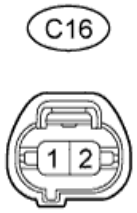
a. Remove the EFI NO. 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

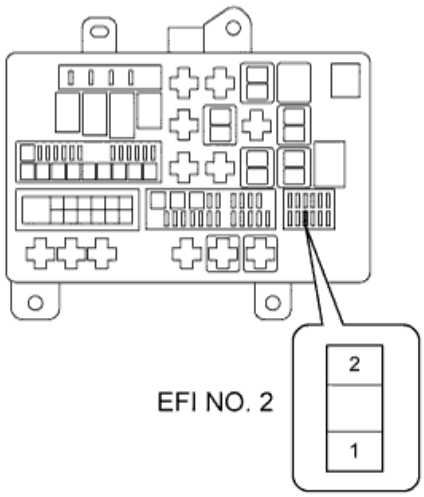
Standard Resistance:

Tester Connection	Condition	Specified Condition
C16-1 - EFI NO. 2 fuse (2)	Always	Below 1 Ω
C16-1 or EFI NO. 2 fuse (2) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Purge VSV)



Front view of wire harness connector:
(to Engine Room Relay Block)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPAIR OR REPLACE POWER SOURCE CIRCUIT COMPONENTS

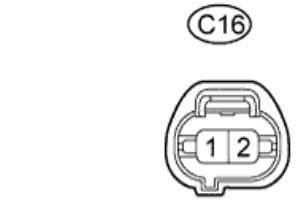
5.CHECK HARNESS AND CONNECTOR (PURGE VSV - ECM)

a. Disconnect the purge VSV connector.

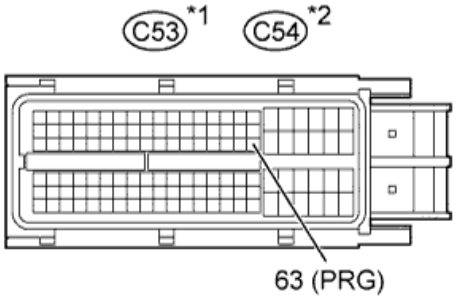
b. Disconnect the ECM connector.

c. Measure the resistance between the terminals of the wire harness side connectors.

Front view of wire harness connector:
(to Purge VSV)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C16-2 - C53-63 (PRG)	Always	Below 1 Ω
C16-2 or C53-63 (PRG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C16-2 - C54-63 (PRG)	Always	Below 1 Ω
C16-2 or C54-63 (PRG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

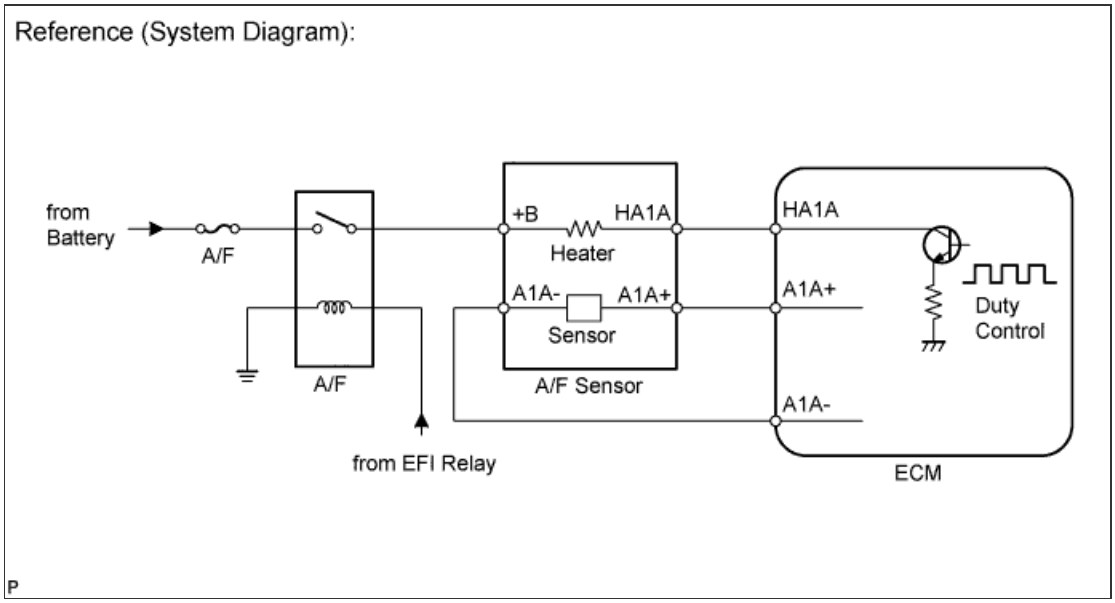
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

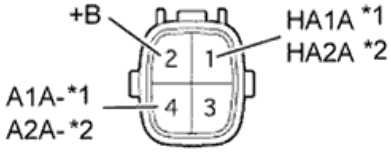
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

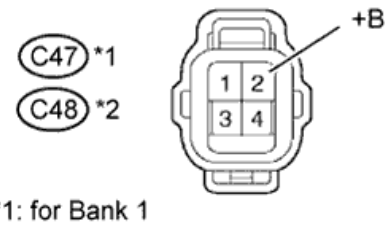
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

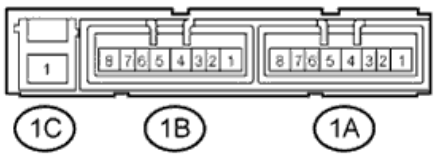
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

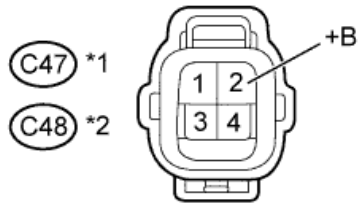
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

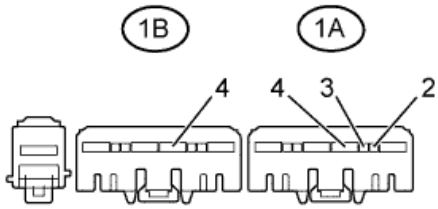
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

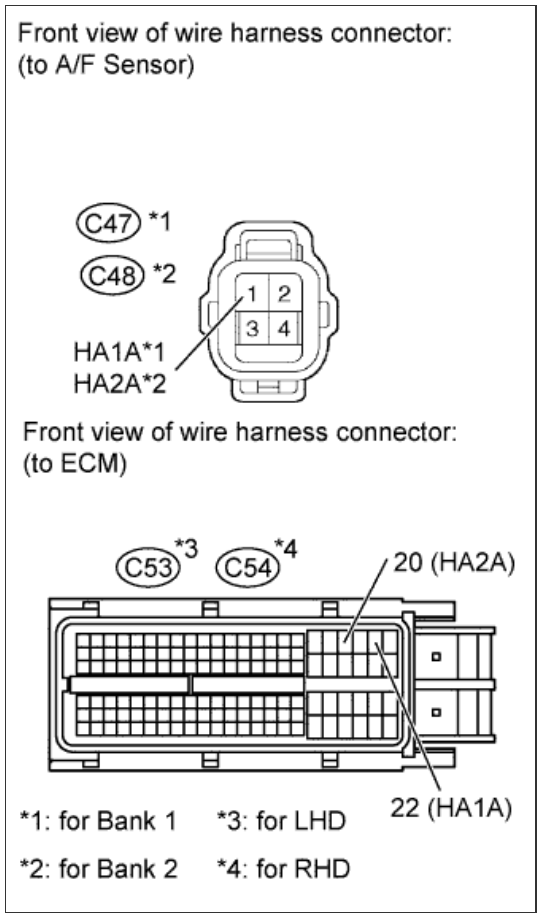
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0443 Evaporative Emission Control System Purge Control Valve Circuit

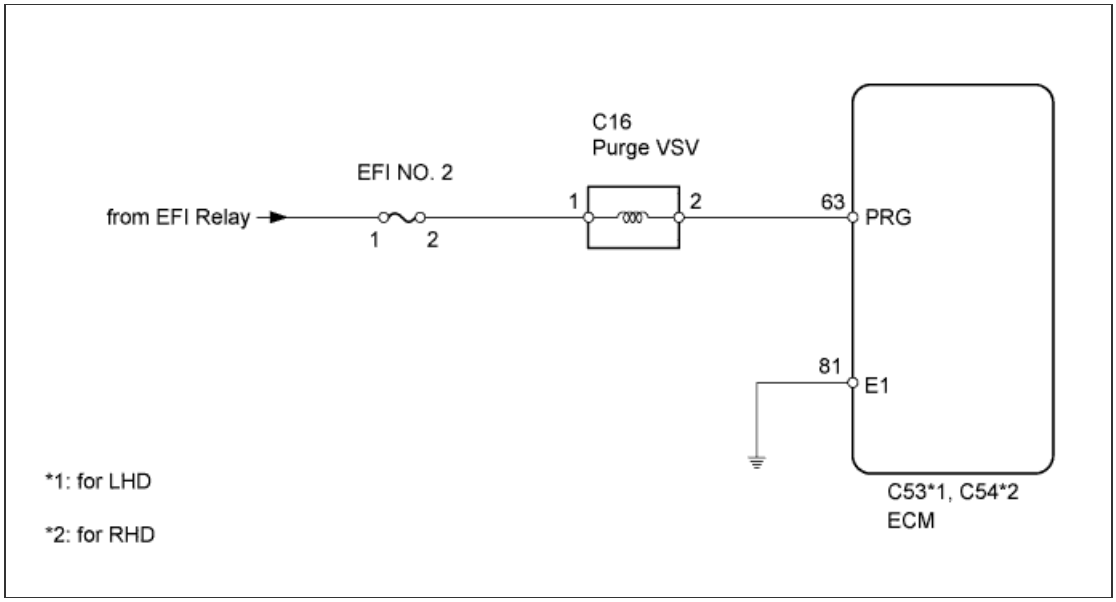
for Preparation Click here

DESCRIPTION

To reduce HC emissions, evaporated fuel from the fuel tank is routed through a charcoal canister to the intake manifold for combustion in the cylinders. The ECM changes the duty signals to the purge VSV so that the intake amount of HC emissions is appropriate for driving conditions (engine load, engine speed, vehicle speed, etc.) after the engine is warmed up.

DTC Code	DTC Detection Condition	Trouble Area
P0443	The terminal voltage of the ECM output circuit does not correspond with the drive signals from the ECM to the purge VSV (1 trip detection logic).	• Open or short in purge VSV circuit • Purge VSV • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (ACTIVATE THE VSV FOR EVAP CONTROL)

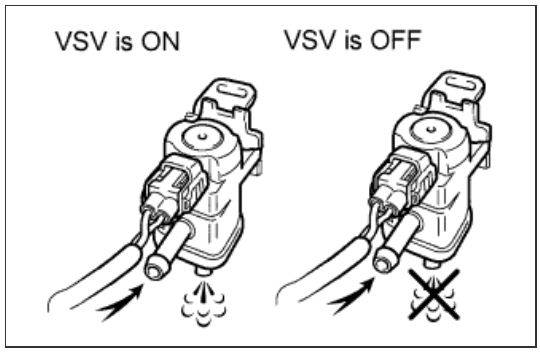
a. Connect the intelligent tester to the DLC3.

b. Remove the vacuum hose of the purge VSV from the charcoal canister.

c. Start the engine and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Activate the VSV for Evap Control.

e. When the purge VSV is operated using the tester, check whether the disconnected hose applies suction to your finger.



OK:

Tester Operation	Specified Condition
VSV is ON	Disconnected hose applies suction to finger
VSV is OFF	Disconnected hose applies no suction to finger

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

NG

2.INSPECT PURGE VSV

a. Inspect the purge VSV (Click here).

NG → REPLACE PURGE VSV (Click here)

OK

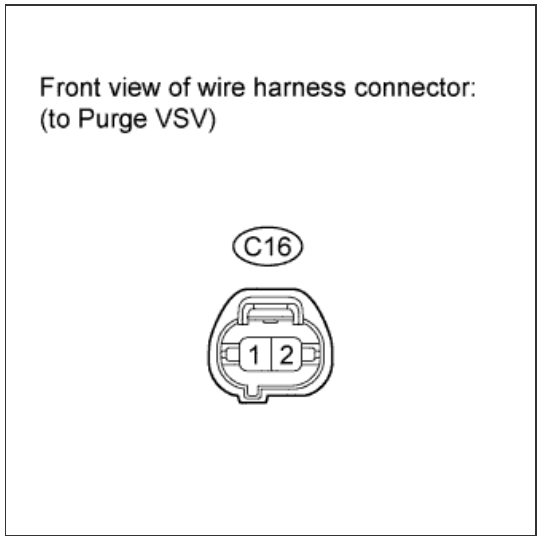
3.INSPECT PURGE VSV (POWER SOURCE VOLTAGE)

a. Disconnect the purge VSV connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C16-1 - Body ground	Engine switch on (IG)	11 to 14 V



OK → Go to step 5

NG

4.CHECK HARNESS AND CONNECTOR (PURGE VSV - EFI NO. 2 FUSE)

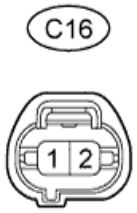
a. Remove the EFI NO. 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

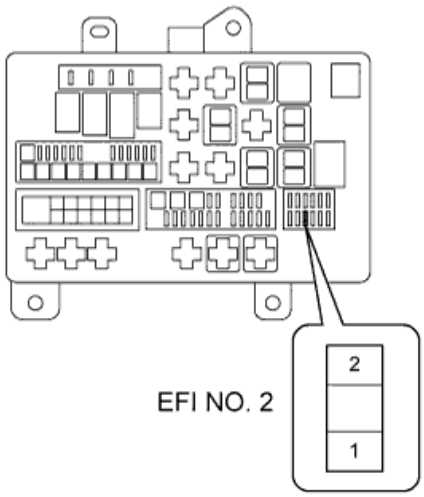
Standard Resistance:

Tester Connection	Condition	Specified Condition
C16-1 - EFI NO. 2 fuse (2)	Always	Below 1 Ω
C16-1 or EFI NO. 2 fuse (2) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Purge VSV)



Front view of wire harness connector:
(to Engine Room Relay Block)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPAIR OR REPLACE POWER SOURCE CIRCUIT COMPONENTS

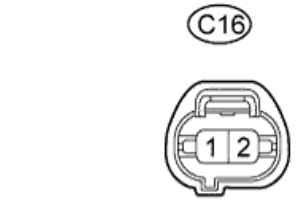
5.CHECK HARNESS AND CONNECTOR (PURGE VSV - ECM)

a. Disconnect the purge VSV connector.

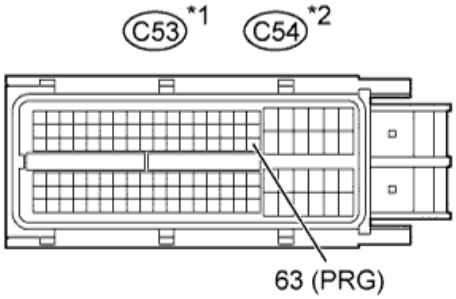
b. Disconnect the ECM connector.

c. Measure the resistance between the terminals of the wire harness side connectors.

Front view of wire harness connector:
(to Purge VSV)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C16-2 - C53-63 (PRG)	Always	Below 1 Ω
C16-2 or C53-63 (PRG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C16-2 - C54-63 (PRG)	Always	Below 1 Ω
C16-2 or C54-63 (PRG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0031 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC P0032 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC P0051 Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC P0052 Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

for Preparation Click here

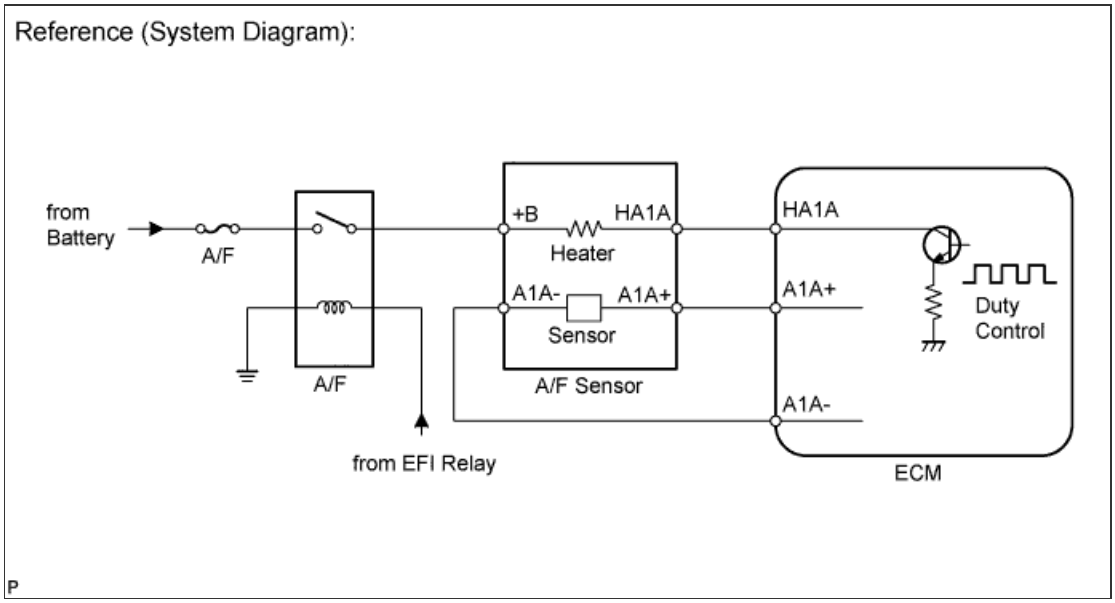
DESCRIPTION

Refer to DTC P2195 (Click here).

HINT:

- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **When one of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**

- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0031 P0051	The Air Fuel ratio (A/F) sensor heater current is below 0.8 A (1 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM
P0032 P0052	An Air Fuel ratio (A/F) sensor heater current failure (1 trip detection logic).	• Short in A/F sensor heater circuit • A/F sensor heater (for Sensor 1) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The ECM uses information from the Air Fuel ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor becomes inaccurate. As a result, the ECM is unable to regulate the air-fuel ratio properly.
When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and stores DTC(s).
Example:
The ECM stores DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is below 0.8 A, DTC P0031 or P0051 is stored.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

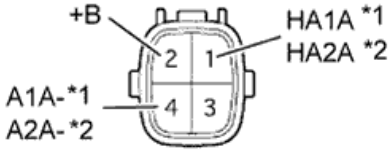
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Measure the voltage according to the value(s) in the table below.

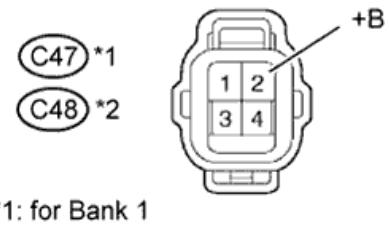
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to A/F Sensor)



*1: for Bank 1

*2: for Bank 2

B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

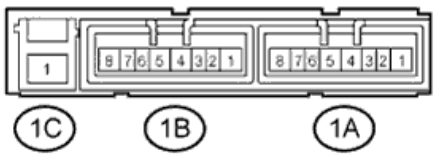
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

4.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - A/F SENSOR AND BODY GROUND)

a. Disconnect the C47 or C48 A/F sensor connector.

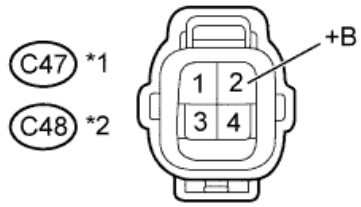
b. Remove the integration relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

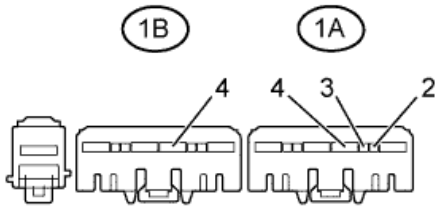
Standard Resistance:

Tester Connection	Condition	Specified Condition
C47-2 (+B) - 1A-4	Always	Below 1 Ω
C48-2 (+B) - 1A-4	Always	Below 1 Ω
1A-2 - 1B-4	Always	Below 1 Ω
1A-3 - Body ground	Always	Below 1 Ω
C47-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
C48-2 (+B) or 1A-4 - Body ground	Always	10 kΩ or higher
1A-2 or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to A/F Sensor)



Front view of wire harness connector:
(to Integration Relay)



*1: for Bank 1

*2: for Bank 2

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

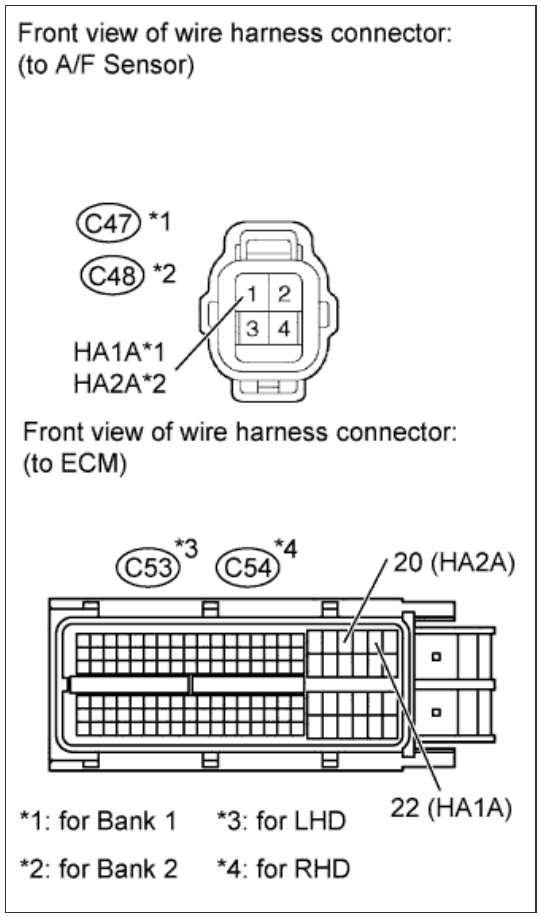
CHECK ECM POWER SOURCE CIRCUIT (Click here)

5.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 A/F sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 1 minute or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0031, P0032, P0051 or P0052 is output	B

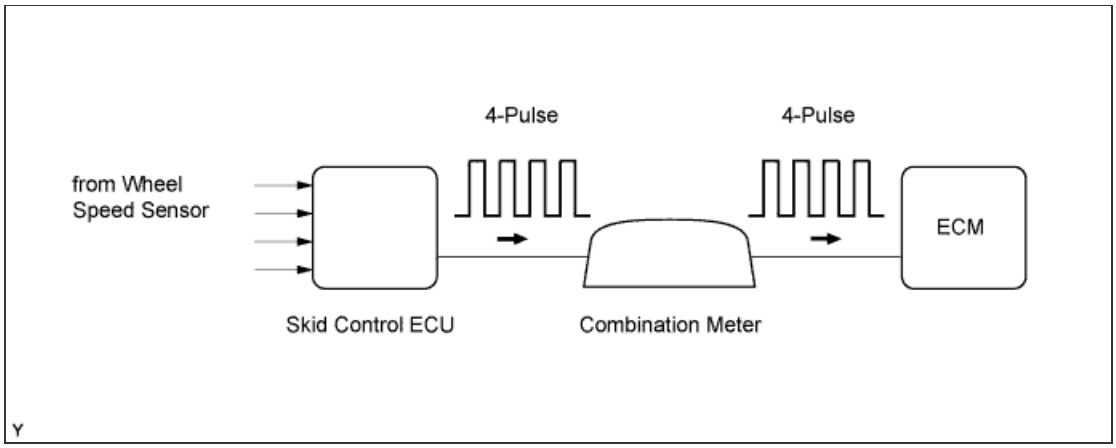
B → REPLACE ECM (Click here)

A → CHECK FOR INTERMITTENT PROBLEMS (Click here)

for Preparation Click here

DESCRIPTION

The speed sensor detects the wheel speed and sends the appropriate signals to the skid control ECU. The skid control ECU converts these wheel speed signals into a 4-pulse signal and outputs it to the ECM via the combination meter. The ECM determines the vehicle speed based on the frequency of these pulse signals.

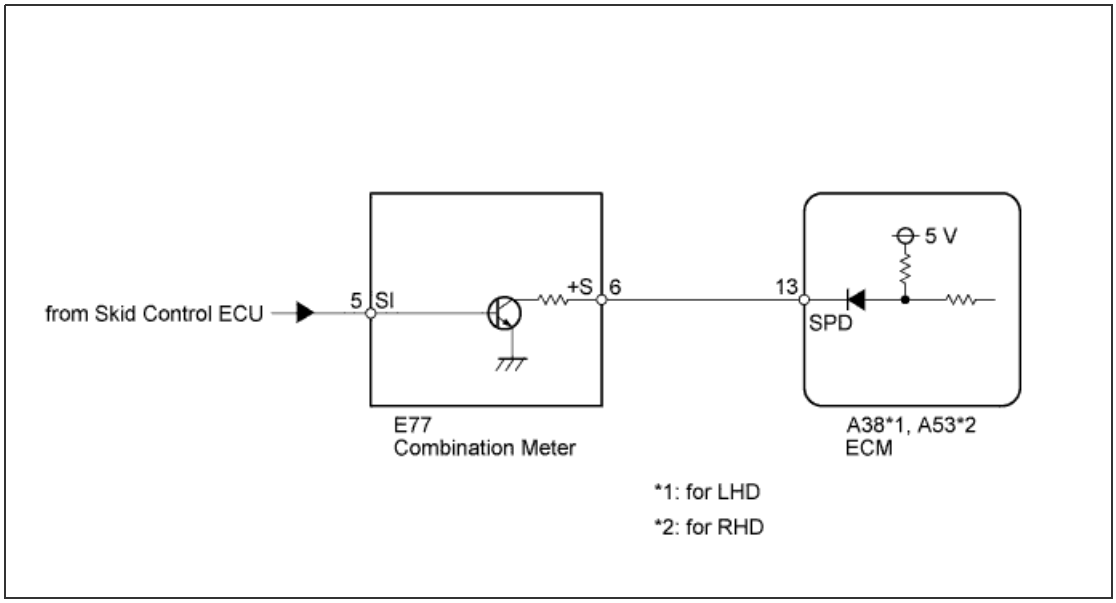


DTC Code	DTC Detection Condition	Trouble Area
P0500	While the vehicle is being driven, no vehicle speed sensor signal is transmitted to the ECM (2 trip detection logic).	• Open or short in speed signal circuit • Combination meter • ECM

MONITOR DESCRIPTION

The ECM assumes that the vehicle is being driven when the indicated vehicle speed is more than 9 km/h (5.6 mph). If there is no speed signal from the combination meter despite these conditions being met, the ECM interprets this as a malfunction in the speed signal circuit. The ECM then illuminates the MIL and stores the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When

troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK OPERATION OF SPEEDOMETER

a. Drive the vehicle and check whether the operation of the speedometer in the combination meter is normal.

HINT:

- **The vehicle speed sensor is operating normally if the speedometer reading is normal.**
- **If the speedometer does not operate, check it by following the procedure described in Speedometer Malfunction (Click here).**

NG → **GO TO MALFUNCTION IN SPEEDOMETER (Click here)**

OK

2.READ VALUE USING INTELLIGENT TESTER (VEHICLE SPD)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Vehicle Speed.

e. Drive the vehicle.

f. Read the value displayed on the tester.

OK:
Vehicle speeds displayed on tester and speedometer display are equal.

NG → **Go to step 3**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

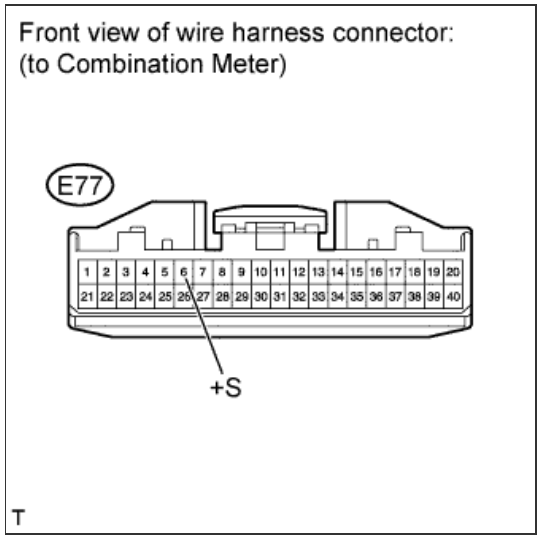
3.CHECK COMBINATION METER ASSEMBLY (+S VOLTAGE)

a. Disconnect the E77 combination meter connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
E77-6 (+S) - Body ground	Engine switch on (IG)	4.5 to 5.5 V



NG → **Go to step 5**

OK

4.CHECK COMBINATION METER ASSEMBLY (SPD SIGNAL WAVEFORM)

a. Move the shift lever to N.

b. Jack up the vehicle.

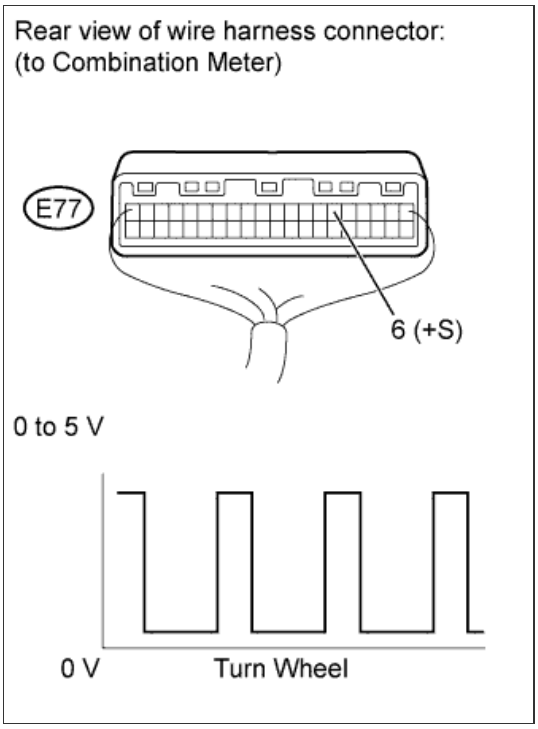
c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
E77-6 (+S) - Body ground	• Engine switch on (IG) • Wheel turned slowly	Voltage generated intermittently

HINT:

The output voltage should fluctuate up and down, similarly to the diagram, when the wheel is turned slowly.



NG → REPLACE COMBINATION METER ASSEMBLY (Click here)

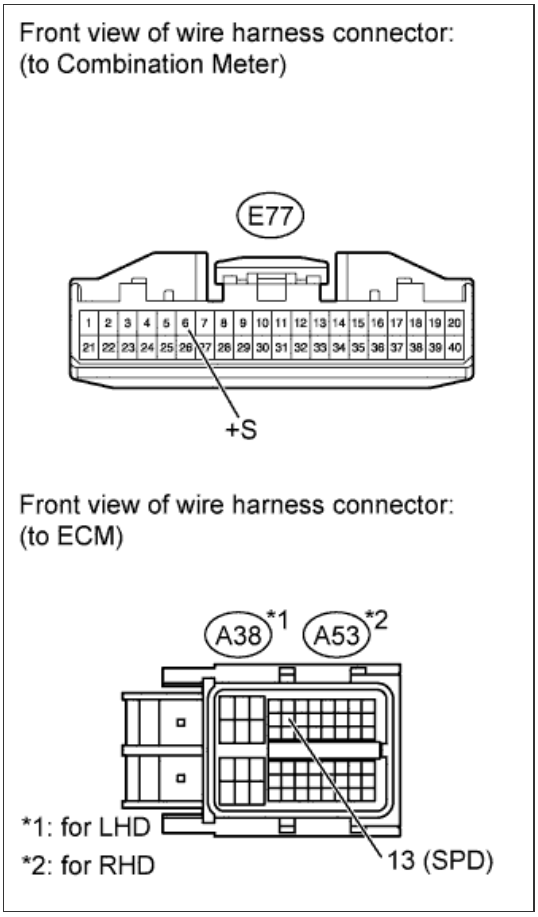
OK

5.CHECK HARNESS AND CONNECTOR (COMBINATION METER - ECM)

a. Disconnect the E77 combination meter connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E77-6 (+S) - A38-13 (SPD)	Always	Below 1 Ω
E77-6 (+S) or A38-13 (SPD) -		10 kΩ or

Body ground	Always	higher

for RHD

Tester Connection	Condition	Specified Condition
E77-6 (+S) - A53-13 (SPD)	Always	Below 1 Ω
E77-6 (+S) or A53-13 (SPD) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

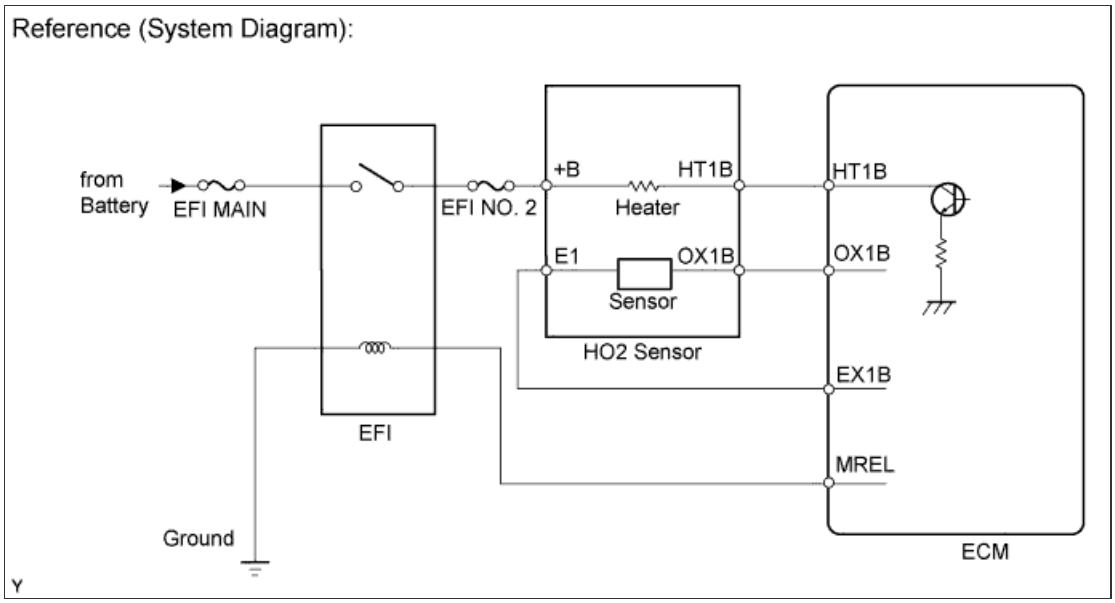
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

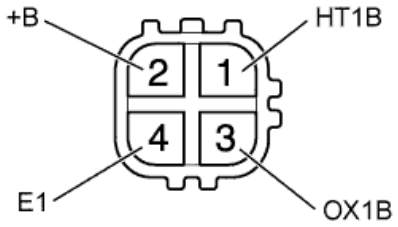
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

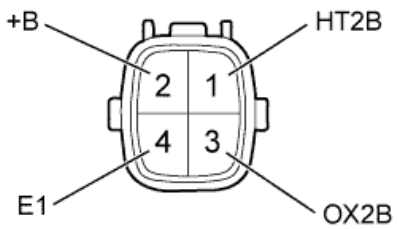
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

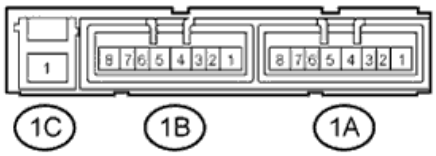
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

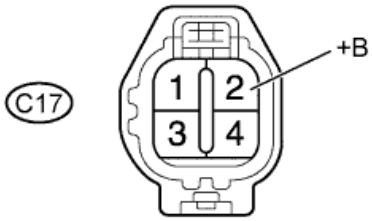
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

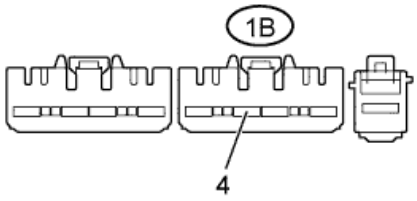
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

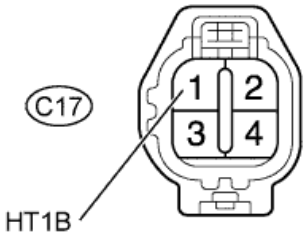
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

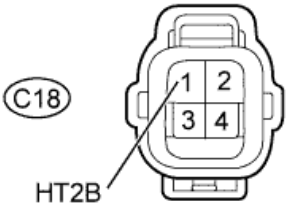
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

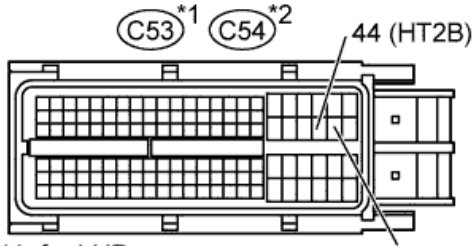
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0500 Vehicle Speed Sensor "A"

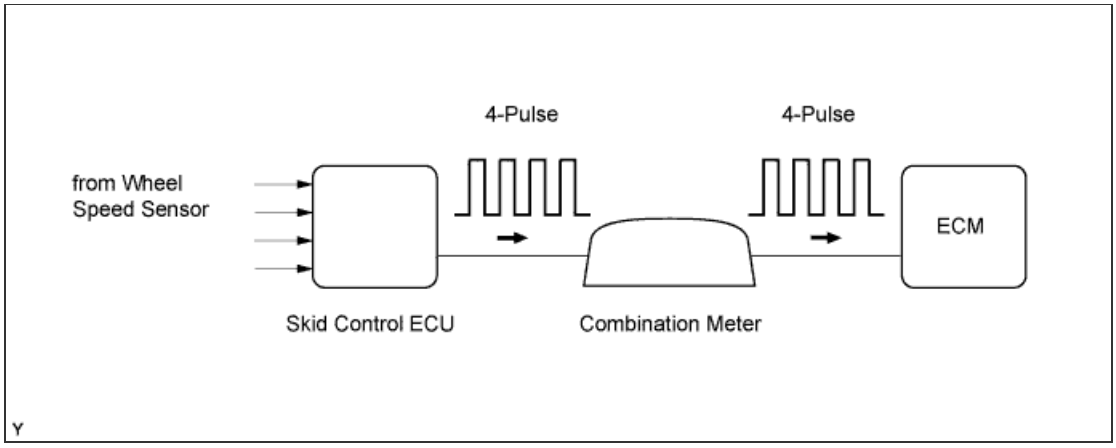
for Preparation Click here

DESCRIPTION

The speed sensor detects the wheel speed and sends the appropriate signals to the skid control ECU. The skid control ECU converts these wheel speed signals into a 4-pulse signal and outputs it to the ECM via the combination meter. The ECM determines the vehicle speed based on the frequency of these pulse signals.

HINT:

- **A voltage of 12 V or 5 V is output from each ECU and then input to the combination meter. The signal is changed to a pulse signal at the transistor in the combination meter. Each ECU controls the respective system based on the pulse signal.**
- **If a short occurs in any of the ECUs or in the wire harness connected to an ECU, all systems in the diagram below will not operate normally.**

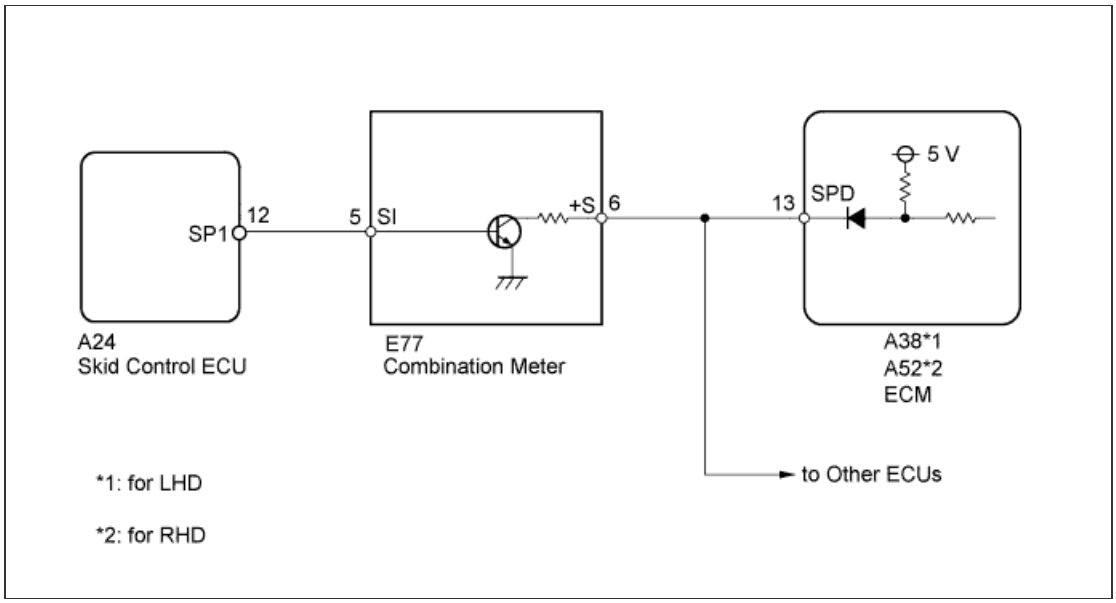


DTC Code	DTC Detection Condition	Trouble Area
P0500	While the vehicle is being driven, no vehicle speed sensor signal is transmitted to the ECM (2 trip detection logic).	• Open or short in speed signal circuit • Combination meter • ECM • Skid control ECU

MONITOR DESCRIPTION

The ECM assumes that the vehicle is being driven when the indicated vehicle speed is more than 9 km/h (5.6 mph). If there is no speed signal from the combination meter despite these conditions being met, the ECM interprets this as a malfunction in the speed signal circuit. The ECM then illuminates the MIL and stores the DTC.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK OPERATION OF SPEEDOMETER

a. Drive the vehicle and check whether the operation of the speedometer in the combination meter is normal.

OK:
Speedometer operation is normal.

HINT:

- **The vehicle speed sensor is operating normally if the speedometer reading is normal.**
- **If the speedometer does not operate, check it by following the procedure described in Speedometer Malfunction (Click here).**

NG → GO TO MALFUNCTION IN SPEEDOMETER (Click here)

OK

2.READ VALUE USING INTELLIGENT TESTER (VEHICLE SPD)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Vehicle Speed.

e. Drive the vehicle.

f. Read the value displayed on the tester.

OK:
Vehicle speeds displayed on tester and speedometer display are equal.

NG → Go to step 3

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

3.CHECK HARNESS AND CONNECTOR (COMBINATION METER ASSEMBLY - ECM)

a. Disconnect the combination meter connector.

b. Disconnect the ECM connector.

c. Measure the resistance according to the value(s) in the table below.

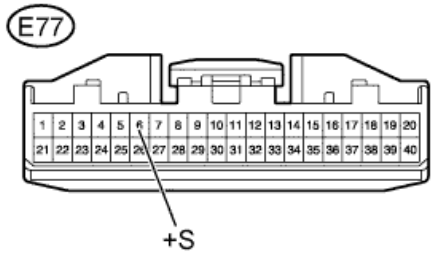
Standard Resistance (for LHD):

Tester Connection	Condition	Specified Condition
E77-6 (+S) - A38-13 (SPD)	Always	Below 1 Ω
E77-6 (+S) or A38-13 (SPD) - Body ground	Always	10 kΩ or higher

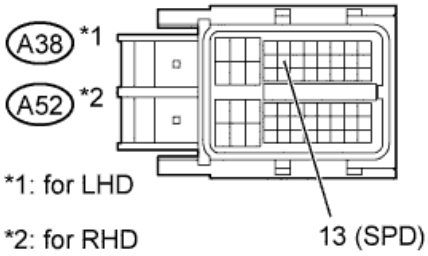
Standard Resistance (for RHD):

Tester Connection	Condition	Specified Condition
E77-6 (+S) - A52-13 (SPD)	Always	Below 1 Ω
E77-6 (+S) or A52-13 (SPD) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Combination Meter)



Front view of wire harness connector:
(to ECM)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR (OTHER SYSTEMS RELATED TO SPEED SIGNAL)

OK

4.CHECK COMBINATION METER ASSEMBLY (+S VOLTAGE)

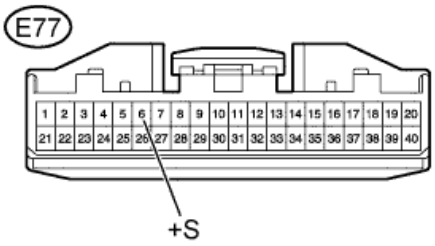
a. Disconnect the combination meter connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
E77-6 (+S) - Body ground	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Combination Meter)



T

NG → REPLACE ECM (Click here)

OK

5.CHECK COMBINATION METER ASSEMBLY (SPD SIGNAL WAVEFORM)

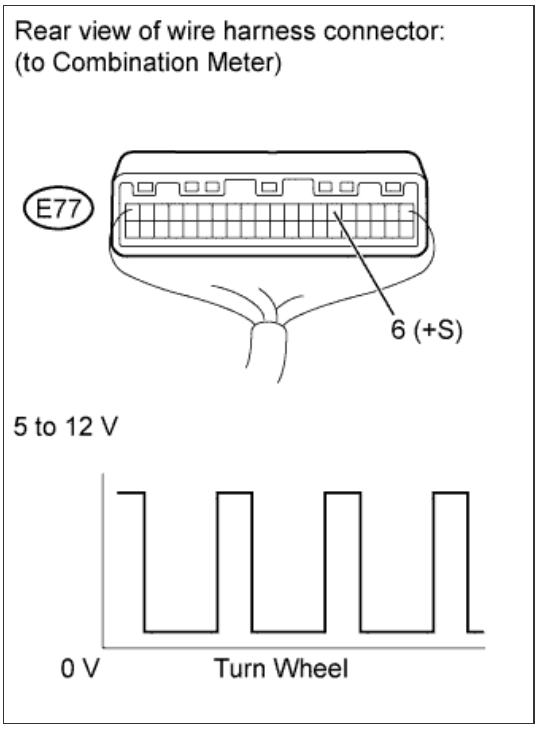
a. Move the shift lever to N.

b. Jack up the vehicle.

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
E77-6 (+S) - Body ground	• Engine switch on (IG) • Wheel is turned slowly	Voltage generated intermittently



HINT:

The output voltage should fluctuate up and down, similarly to the diagram, when the wheel is turned slowly.

NG → Go to step 6

OK

REPLACE ECM (Click here)

6.CHECK COMBINATION METER ASSEMBLY (SPD SIGNAL WAVEFORM)

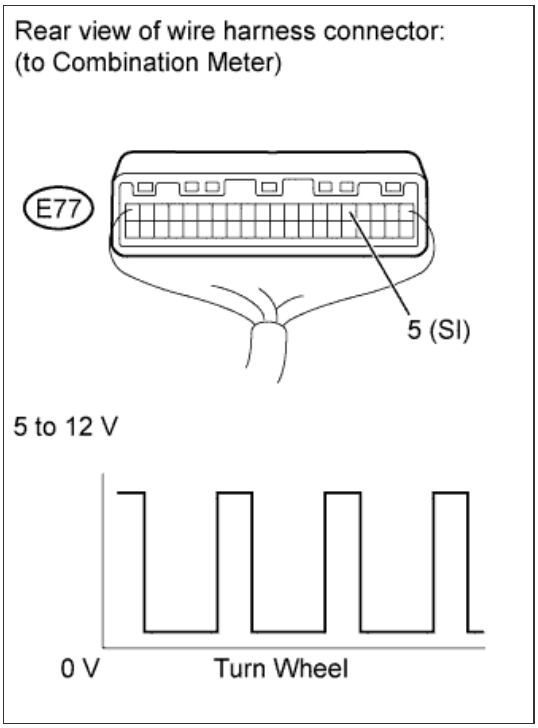
a. Move the shift lever to N.

b. Jack up the vehicle.

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
E77-5 (IS) - Body ground	• Engine switch on (IG) • Wheel is turned slowly	Voltage generated intermittently



HINT:

The output voltage should fluctuate up and down, similarly to the diagram, when the wheel is turned slowly.

NG → Go to step 7

OK

REPLACE COMBINATION METER ASSEMBLY (Click here)

7.CHECK HARNESS AND CONNECTOR (COMBINATION METER ASSEMBLY - SKID CONTROL ECU)

a. Disconnect the combination meter connector.

b. Disconnect the skid control ECU connector.

c. Measure the resistance according to the value(s) in the table below.

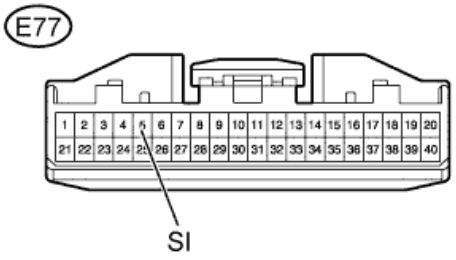
Standard Resistance:

Tester Connection	Condition	Specified Condition
E77-5 (IS) - A24-12 (SPD)	Always	Below 1 Ω
E77-5 (IS) or A24-12 (SPD) - Body ground	Always	10 kΩ or higher

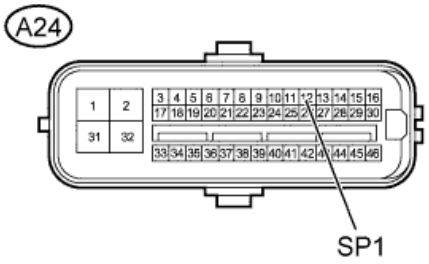
Result

Result	Proceed to
NG	A
OK (for LHD)	B
OK (for RHD)	C

Front view of wire harness connector:
(to Combination Meter)



Front view of wire harness connector:
(to Skid Control ECU)



B → REPLACE MASTER CYLINDER SOLENOID (Click here)

C → REPLACE MASTER CYLINDER SOLENOID (Click here)

A → REPAIR OR REPLACE HARNESS OR CONNECTOR

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

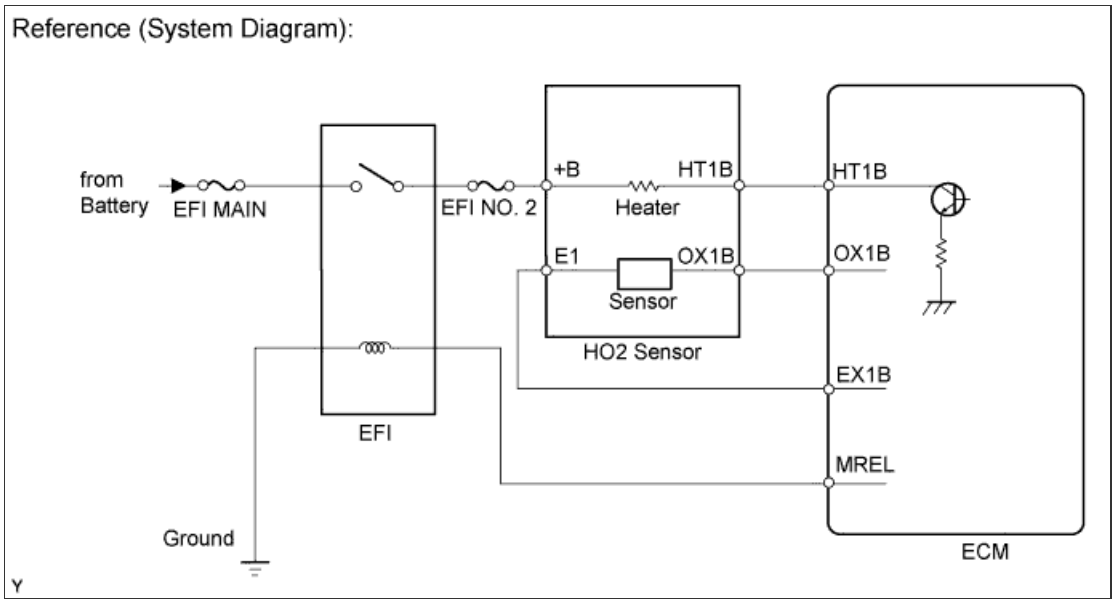
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

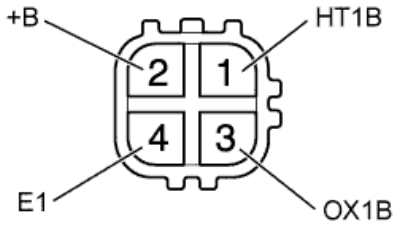
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

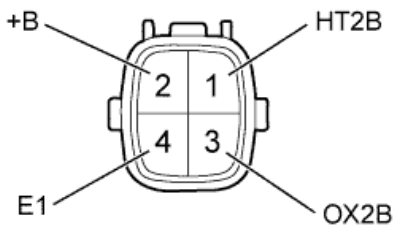
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

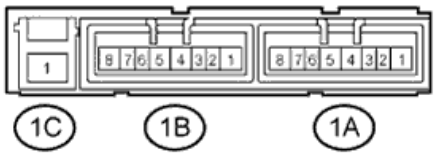
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

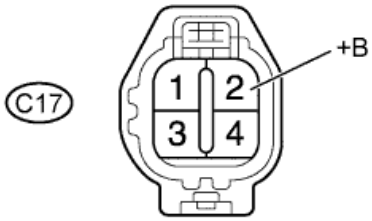
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

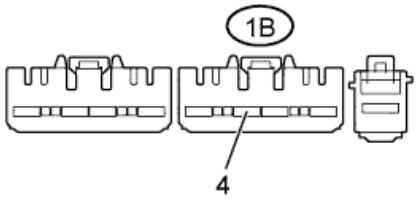
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

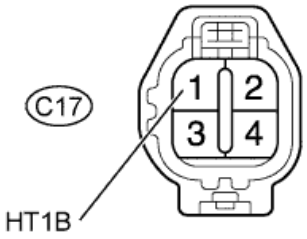
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

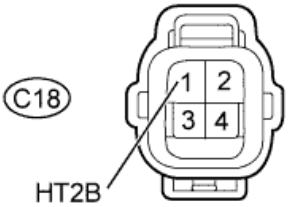
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

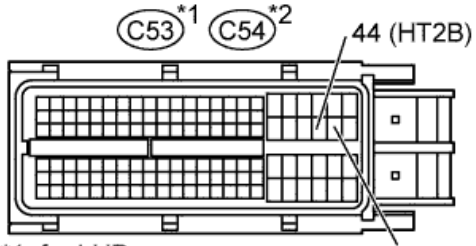
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0504 Brake Switch "A" / "B" Correlation

for Preparation Click here

DESCRIPTION

The stop light switch is a duplex system that transmits two signals: STP and ST1-. These two signals are used by the ECM to monitor whether or not the brake system is working properly. If the signals, which indicate the brake pedal is being depressed and released, are detected simultaneously, the ECM interprets this as a malfunction in the stop light switch and stores the DTC.

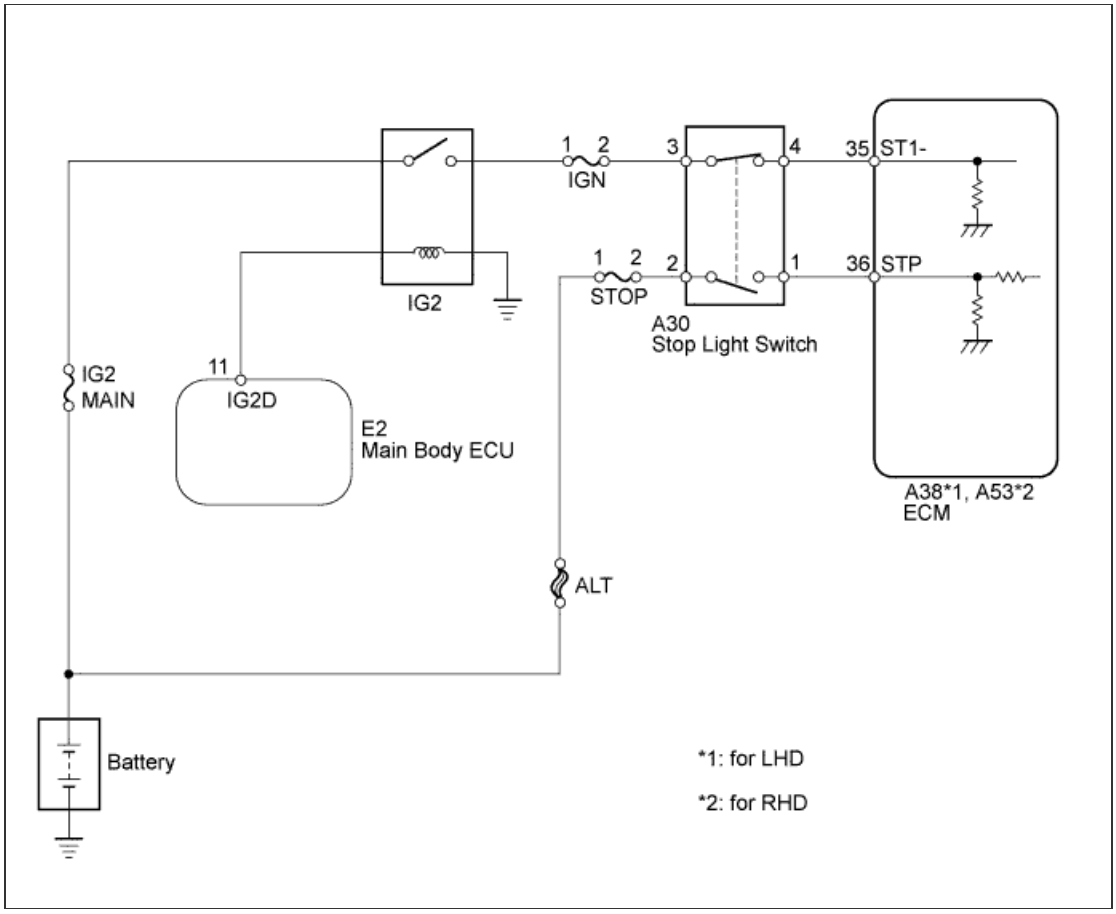
DTC Code	DTC Detection Condition	Trouble Area
P0504	Conditions (a), (b) and (c) continue for 0.5 seconds or more (1 trip detection logic): (a) The engine switch is on (IG). (b) The brake pedal is released. (c) The STP signal is OFF when the ST1- signal is OFF.	• Short in stop light switch signal circuit • STOP fuse • IGN fuse • Stop light switch • ECM

HINT:

The normal conditions are as shown in the table below. The signals can be read using the intelligent tester.

Signal	Brake Pedal Released	In Transition	Brake Pedal Depressed
STP	OFF	ON	ON
ST1-	ON	ON	OFF

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was**

warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

- STP signal conditions can be checked using the intelligent tester.
  1. Connect the tester to the DLC3.
  2. Turn the engine switch on (IG).
  3. Turn the tester on.
  4. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Stop Light Switch.
  5. Check the STP signal when the brake pedal is depressed and released.

Brake Pedal Operation	Specified Condition
Depressed	STP signal ON
Released	STP signal OFF

1.CHECK STOP LIGHT SWITCH ASSEMBLY (B+ VOLTAGE)

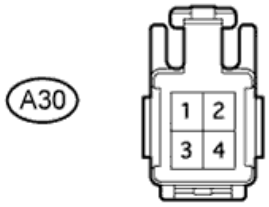
a. Disconnect the A30 stop light switch connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A30-2 - Body ground	Always	11 to 14 V
A30-3 - Body ground	Engine switch on (IG)	11 to 14 V

Front view of wire Harness connector:
(to Stop Light Switch)



NG → Go to step 4

OK ↓

2.INSPECT STOP LIGHT SWITCH ASSEMBLY

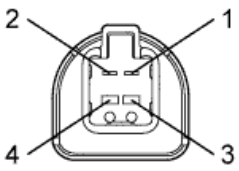
a. Remove the stop light switch.

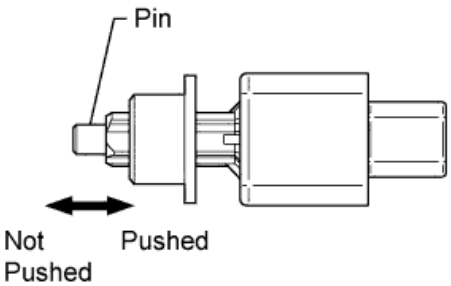
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Pin not pushed	Below 1 Ω
	Pin pushed	10 kΩ or higher
3 - 4	Pin not pushed	10 kΩ or higher
	Pin pushed	Below 1 Ω

Component without harness connected:
(Stop Light Switch)





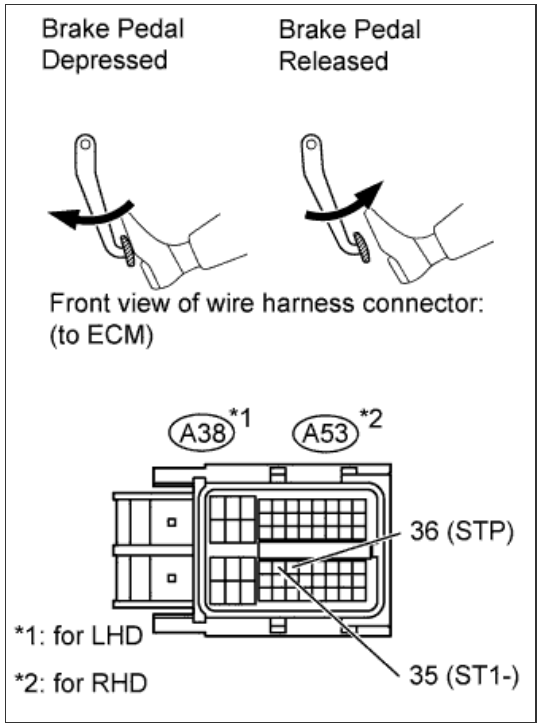
NG → REPLACE STOP LIGHT SWITCH ASSEMBLY (Click here)

OK ↓

3.CHECK ECM (STP AND ST1 - VOLTAGE)

a. Disconnect the A38 or A53 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Condition	Specified Condition
A38-35 (ST1-) - Body ground	Brake pedal released	11 to 14 V
	Brake pedal depressed	0 to 3 V
A38-36 (STP) - Body ground	Brake pedal released	0 to 3 V
	Brake pedal depressed	11 to 14 V

for RHD

Tester Connection	Condition	Specified Condition
A53-35 (ST1-) - Body ground	Brake pedal released	11 to 14 V
	Brake pedal depressed	0 to 3 V
A53-36 (STP) - Body ground	Brake pedal released	0 to 3 V
	Brake pedal depressed	11 to 14 V

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

4.INSPECT FUSE (STOP AND IGN)

a. Remove the STOP and IGN fuses from the engine room relay block.

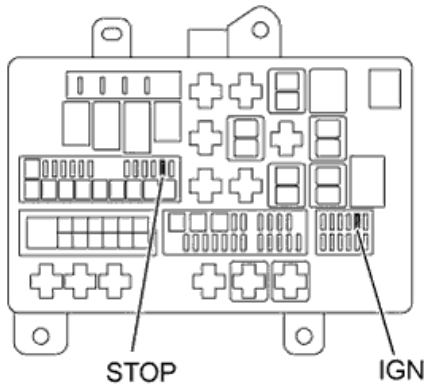
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
STOP fuse	Always	Below 1 Ω

IGN fuse	Always	Below 1 Ω

Engine Room Relay Block:



NG

CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR (ECM - STOP LIGHT SWITCH)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

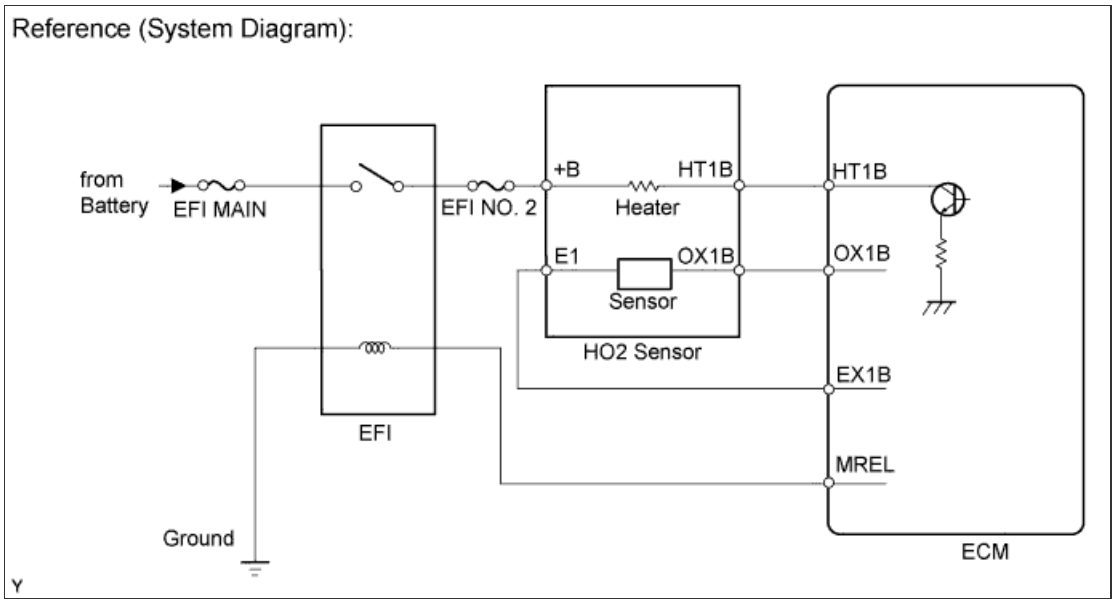
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

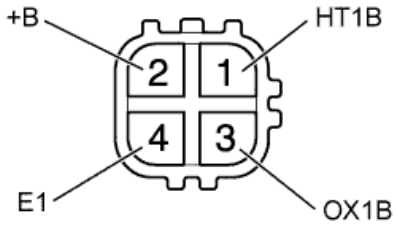
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

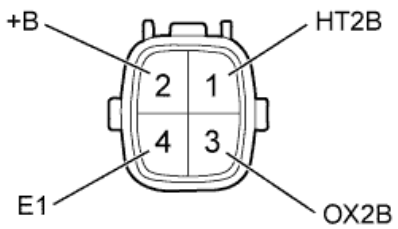
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

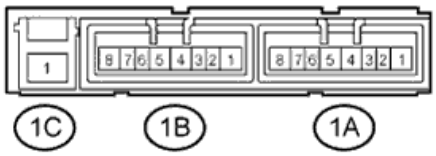
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

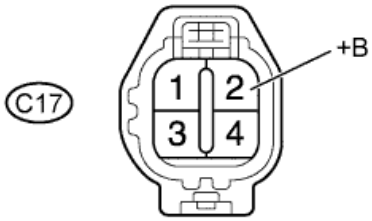
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

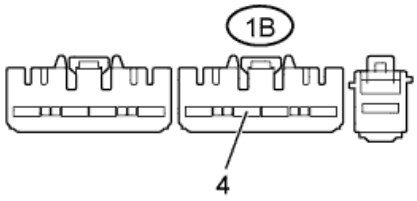
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

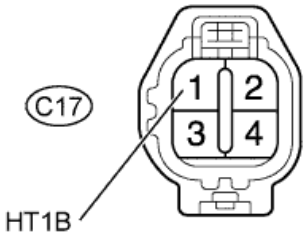
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

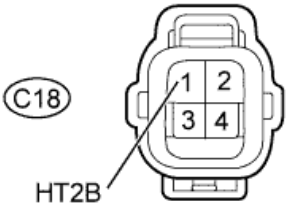
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

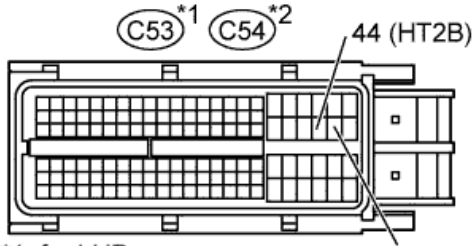
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0505 Idle Control System Malfunction

for Preparation Click here

DESCRIPTION

The idling speed is controlled by the ETCS (Electronic Throttle Control System). The ETCS is comprised of: 1) the one valve type throttle body; 2) the throttle actuator, which operates the throttle valve; 3) the Throttle Position (TP) sensor, which detects the opening angle of the throttle valve; 4) the Accelerator Pedal Position (APP) sensor, which detects the accelerator pedal position; and 5) the ECM, which controls the ETCS. Based on the target idling speed, the ECM controls the throttle actuator to provide the proper throttle valve opening angle.

DTC Code	DTC Detection Condition	Trouble Area
P0505	The idling speed continues to vary greatly from the target idling speed (2 trip detection logic).	• ETCS • Air induction system • PCV hose connections • ECM

MONITOR DESCRIPTION

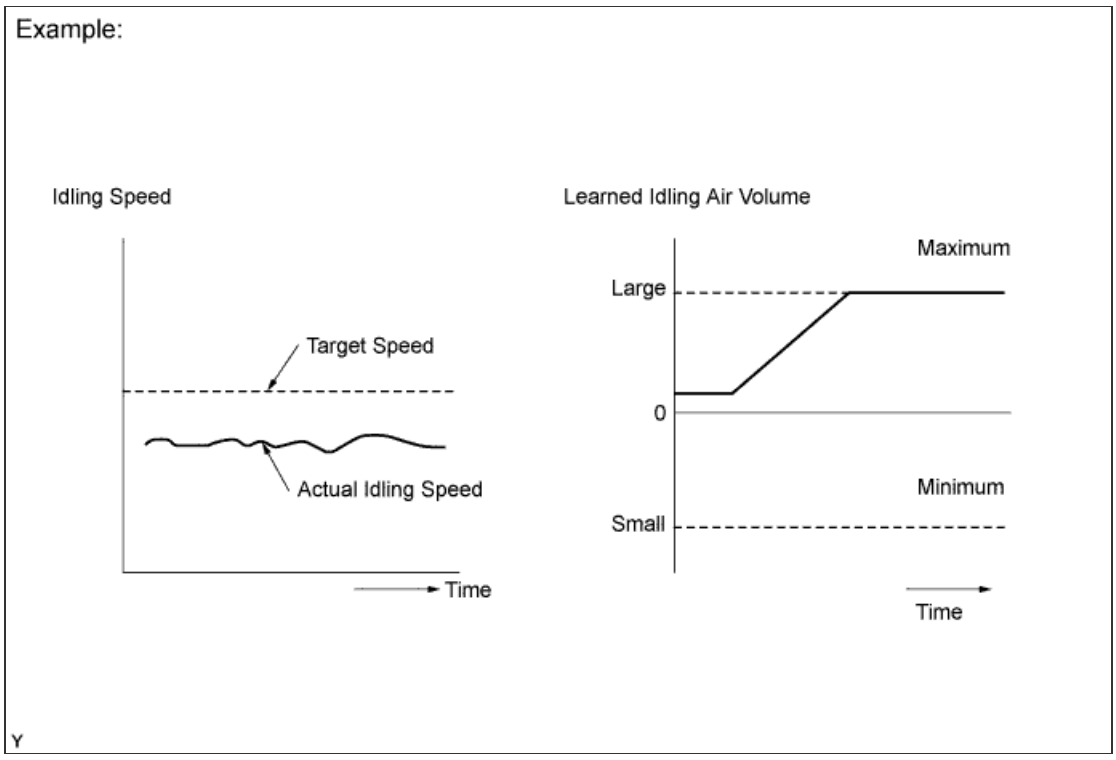
The ECM monitors the idling speed and idling air flow volume to conduct Idle Speed Control (ISC). The ECM determines that the ISC system is malfunctioning if the following conditions apply:

- The learned idling air flow volume remains at the maximum or minimum volume for 5 seconds during a drive cycle.
- After driving at 10 km/h (6.25 mph) or more, the actual engine idling speed varies from the target idling speed by between 100 rpm and 150 rpm, 5 times or more during a drive cycle.

Example:
If the actual idling speed varies from the target idling speed by more than 150 rpm* 5 times during a drive cycle, the ECM illuminates the MIL and stores the DTC.

HINT:

*: Threshold idling speed varies with engine load.



INSPECTION PROCEDURE

HINT:

- **DTC P0505 is for Euro-OBD only.**
- **The following conditions may also cause DTC P0505 to be stored:**
  1. **The floor carpet overlapping slightly onto the accelerator pedal, causing the accelerator pedal to be slightly depressed and therefore the throttle valve position to be slightly open.**
  2. **The accelerator pedal being not fully released.**

- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0505)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0505 is output	A
P0505 and other DTCs are output	B

HINT:

If any DTCs other than P0505 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → **REPAIR OR REPLACE PCV HOSE (Click here)**

OK

3.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)**

OK

4.CHECK THROTTLE VALVE

a. Check the throttle valve condition.

OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → **REPLACE THROTTLE BODY ASSEMBLY (Click here)**

OK

REPLACE ECM (Click here)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

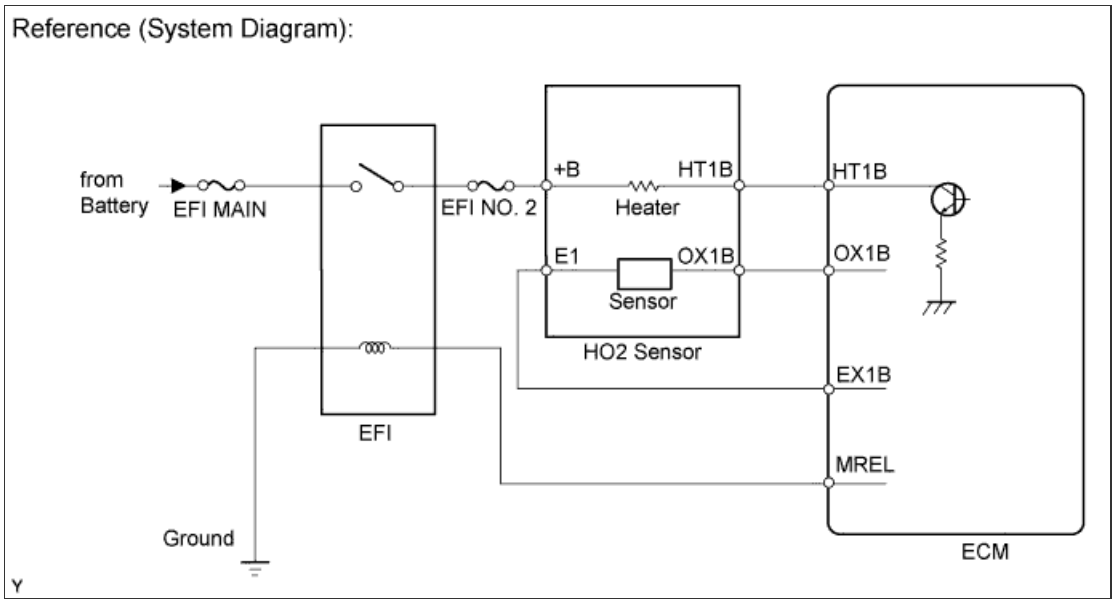
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

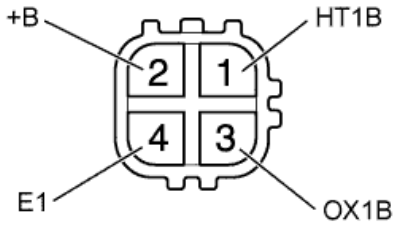
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

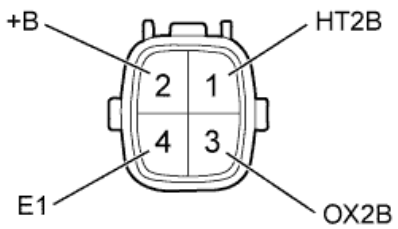
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

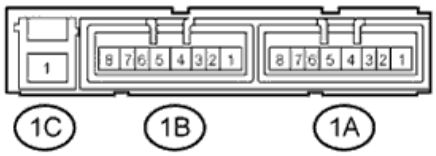
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

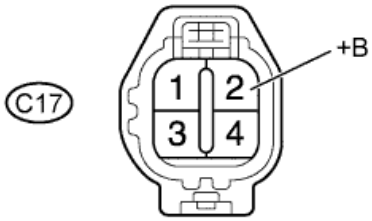
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

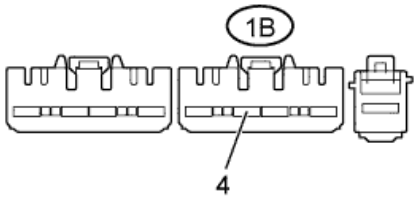
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

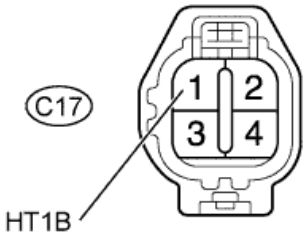
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

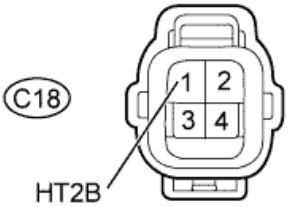
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

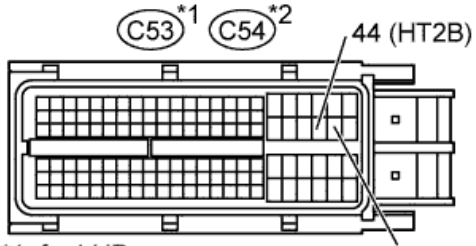
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0505 Idle Control System Malfunction

for Preparation Click here

DESCRIPTION

The idling speed is controlled by the ETCS (Electronic Throttle Control System). The ETCS is comprised of: 1) the one valve type throttle body; 2) the throttle actuator, which operates the throttle valve; 3) the Throttle Position (TP) sensor, which detects the opening angle of the throttle valve; 4) the Accelerator Pedal Position (APP) sensor, which detects the accelerator pedal position; and 5) the ECM, which controls the ETCS. Based on the target idling speed, the ECM controls the throttle actuator to provide the proper throttle valve opening angle.

DTC Code	DTC Detection Condition	Trouble Area
P0505	The idling speed continues to vary greatly from the target idling speed (2 trip detection logic).	• ETCS • Air induction system • PCV hose connections • ECM

MONITOR DESCRIPTION

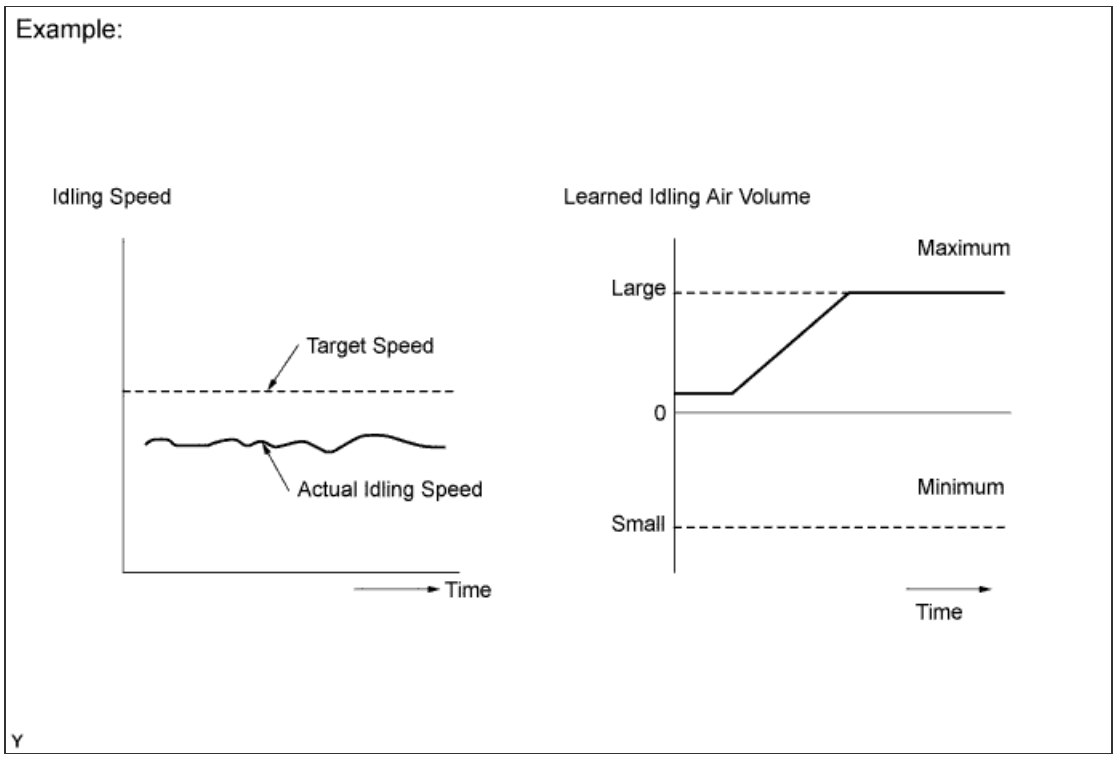
The ECM monitors the idling speed and idling air flow volume to conduct Idle Speed Control (ISC). The ECM determines that the ISC system is malfunctioning if the following conditions apply:

- The learned idling air flow volume remains at the maximum or minimum volume for 5 seconds during a drive cycle.
- After driving at 10 km/h (6.25 mph) or more, the actual engine idling speed varies from the target idling speed by between 100 rpm and 150 rpm, 5 times or more during a drive cycle.

Example:
If the actual idling speed varies from the target idling speed by more than 150 rpm* 5 times during a drive cycle, the ECM illuminates the MIL and stores the DTC.

HINT:

*: Threshold idling speed varies with engine load.



INSPECTION PROCEDURE

HINT:

- **DTC P0505 is for Euro-OBD only.**
- **The following conditions may also cause DTC P0505 to be stored:**
  1. **The floor carpet overlapping slightly onto the accelerator pedal, causing the accelerator pedal to be slightly depressed and therefore the throttle valve position to be slightly open.**
  2. **The accelerator pedal being not fully released.**

- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0505)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0505 is output	A
P0505 and other DTCs are output	B

HINT:

If any DTCs other than P0505 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → **REPAIR OR REPLACE PCV HOSE (Click here)**

OK

3.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)**

OK

4.CHECK THROTTLE VALVE

a. Check the throttle valve condition.

OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → **REPLACE THROTTLE BODY ASSEMBLY (Click here)**

OK

REPLACE ECM (Click here)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

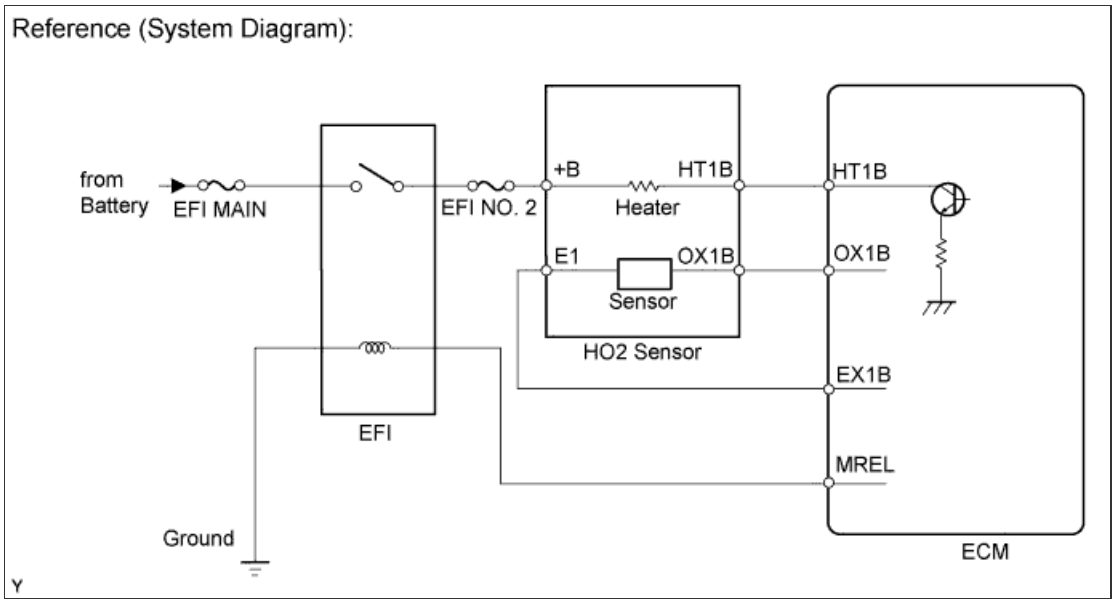
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

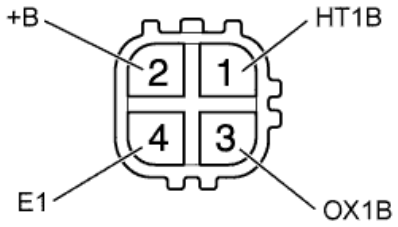
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

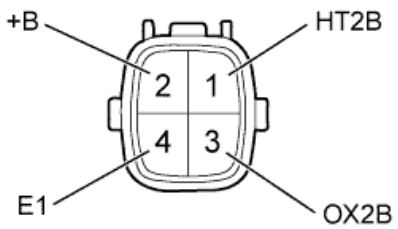
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

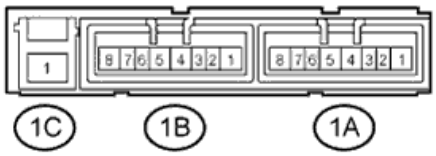
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

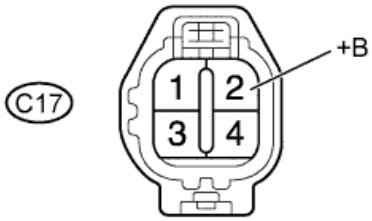
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

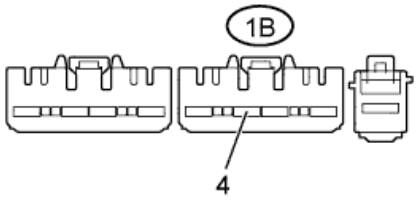
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

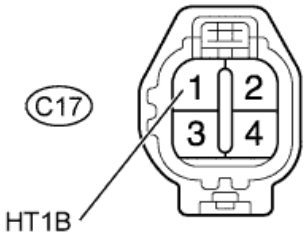
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

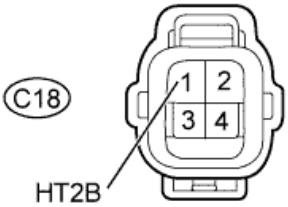
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

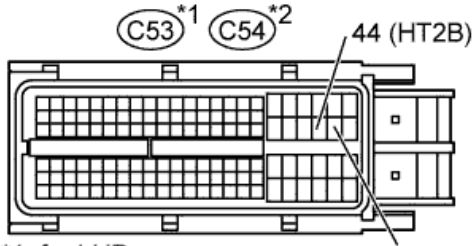
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0550 Power Steering Pressure Sensor Circuit Malfunction

DTC P0552 Power Steering Pressure Sensor Circuit Low Input

DTC P0553 Power Steering Pressure Sensor Circuit High Input

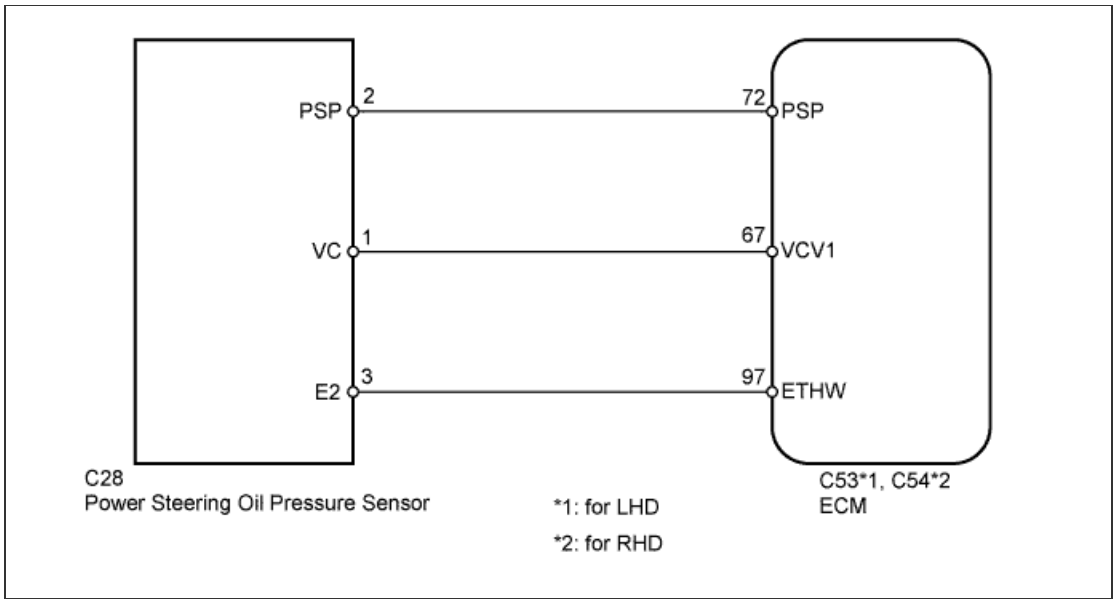
for Preparation Click here

DESCRIPTION

The power steering oil pressure sensor is turned on when a power steering wheel load occurs by turning the steering wheel. The ECM regulates the engine idling RPM according to the voltage output of the sensor.

DTC Code	DTC Detection Condition	Trouble Area
P0550	Power steering oil pressure sensor voltage less than 0.28 V, or more than 4.9 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM
P0552	Power steering oil pressure sensor voltage less than 0.28 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM
P0553	Power steering oil pressure sensor voltage more than 4.9 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM

WIRING DIAGRAM



MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to regulate the engine idling speed. When the sensor output voltage deviates from the normal operating range, the ECM determines that there is a malfunction in the power steering oil pressure sensor and stores DTC(s).

INSPECTION PROCEDURE

HINT:

- **If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

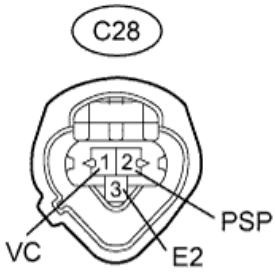
1.CHECK HARNESS AND CONNECTOR (ECM - POWER STEERING OIL PRESSURE SENSOR)

a. Disconnect the C53 or C54 ECM connector.

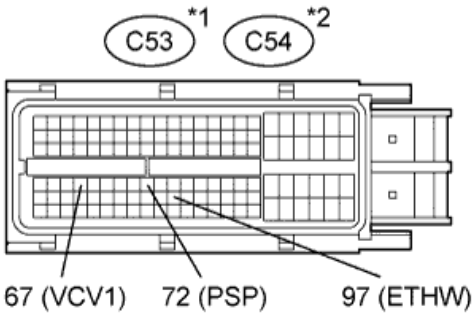
b. Disconnect the C28 power steering oil pressure sensor connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Power Steering Oil Pressure Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C28-2 (PSP) - C53-72 (PSP)	Always	Below 1 Ω
C28-1 (VC) - C53-67 (VCV1)	Always	Below 1 Ω
C28-3 (E2) - C53-97 (ETHW)	Always	Below 1 Ω
C28-2 (PSP) or C53-72 (PSP) - Body ground	Always	10 kΩ or higher
C28-1 (VC) or C53-67 (VCV1) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C28-2 (PSP) - C54-72 (PSP)	Always	Below 1 Ω
C28-1 (VC) - C54-67 (VCV1)	Always	Below 1 Ω
C28-3 (E2) - C54-97 (ETHW)	Always	Below 1 Ω
C28-2 (PSP) or C54-72 (PSP) - Body ground	Always	10 kΩ or higher
C28-1 (VC) or C54-67 (VCV1) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE POWER STEERING OIL PRESSURE SENSOR

a. Replace the power steering oil pressure sensor (Click here).

NEXT

3.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read the DTCs.

Result

Result	Proceed to
P0550, P0552 and/or P0553 are output	A
No DTC is output	B

B → END

A

REPLACE ECM (Click here)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

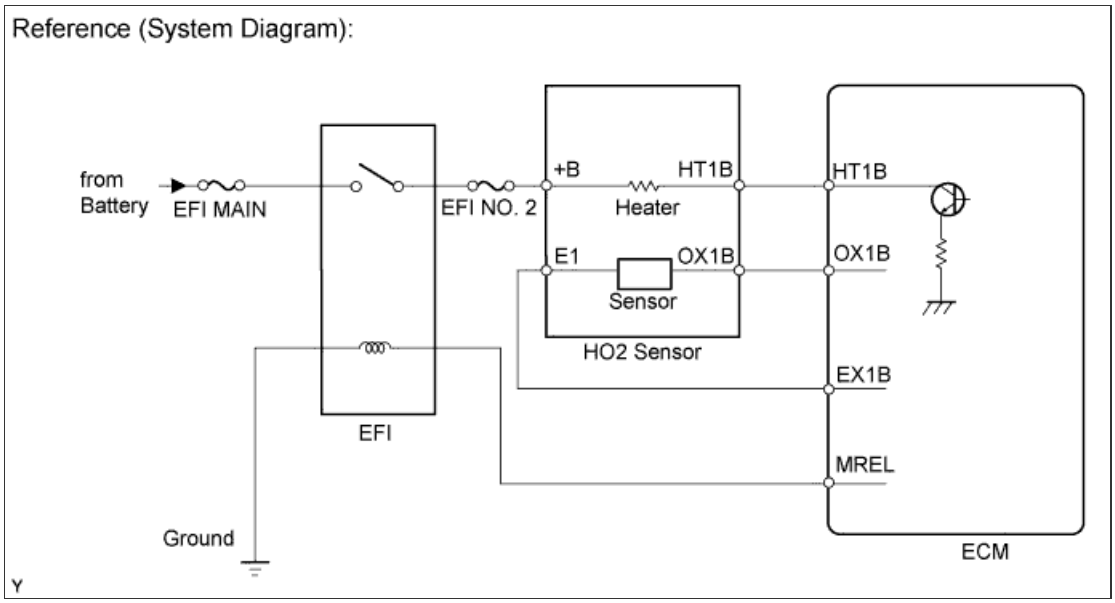
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

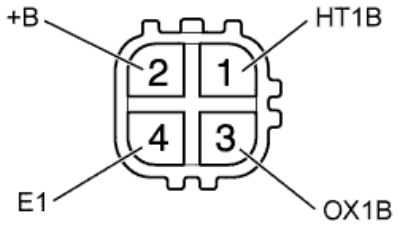
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

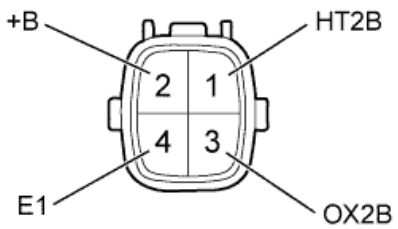
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

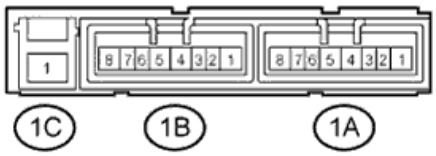
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

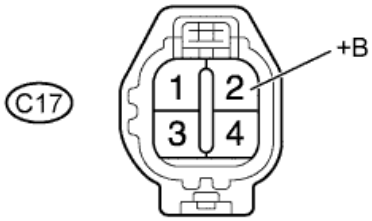
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

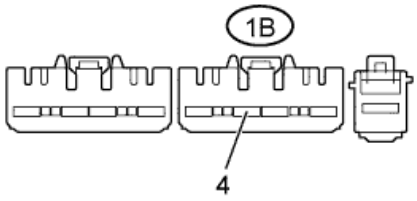
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

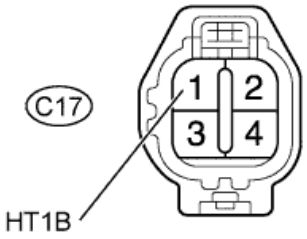
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

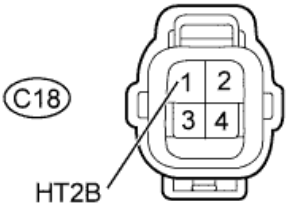
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

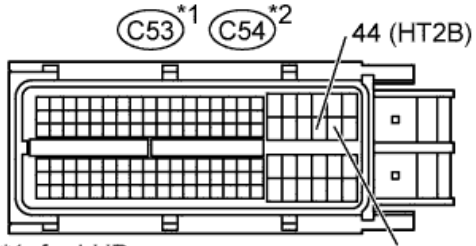
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0550 Power Steering Pressure Sensor Circuit Malfunction

DTC P0552 Power Steering Pressure Sensor Circuit Low Input

DTC P0553 Power Steering Pressure Sensor Circuit High Input

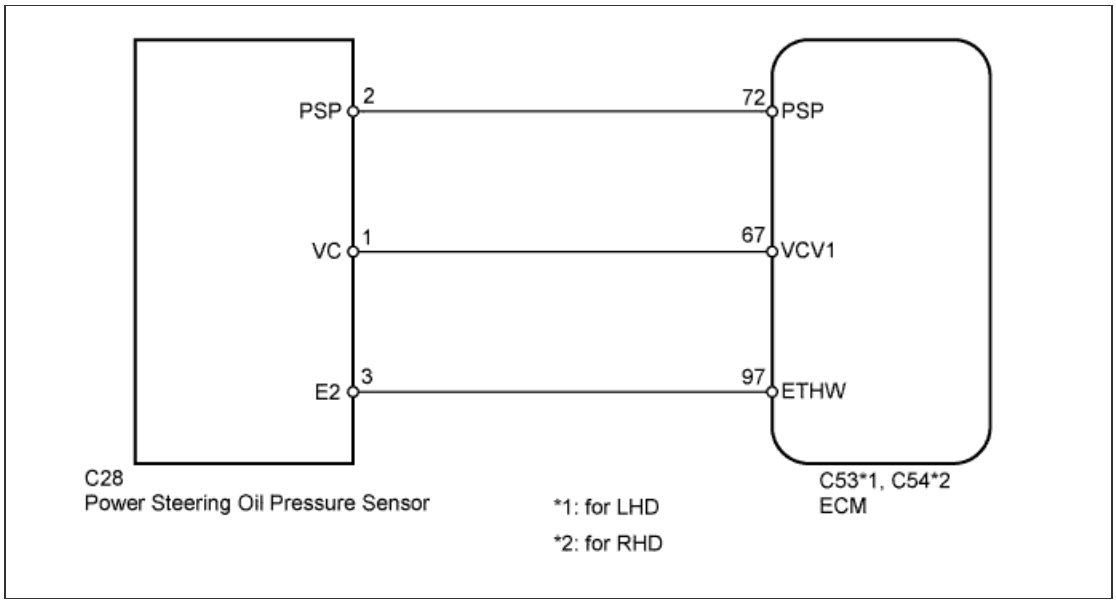
for Preparation Click here

DESCRIPTION

The power steering oil pressure sensor is turned on when a power steering wheel load occurs by turning the steering wheel. The ECM regulates the engine idling RPM according to the voltage output of the sensor.

DTC Code	DTC Detection Condition	Trouble Area
P0550	Power steering oil pressure sensor voltage less than 0.28 V, or more than 4.9 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM
P0552	Power steering oil pressure sensor voltage less than 0.28 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM
P0553	Power steering oil pressure sensor voltage more than 4.9 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM

WIRING DIAGRAM



MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to regulate the engine idling speed. When the sensor output voltage deviates from the normal operating range, the ECM determines that there is a malfunction in the power steering oil pressure sensor and stores DTC(s).

INSPECTION PROCEDURE

HINT:

- **If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

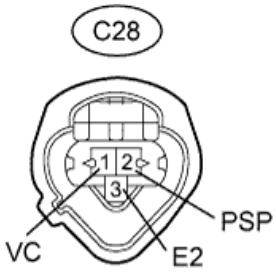
1.CHECK HARNESS AND CONNECTOR (ECM - POWER STEERING OIL PRESSURE SENSOR)

a. Disconnect the C53 or C54 ECM connector.

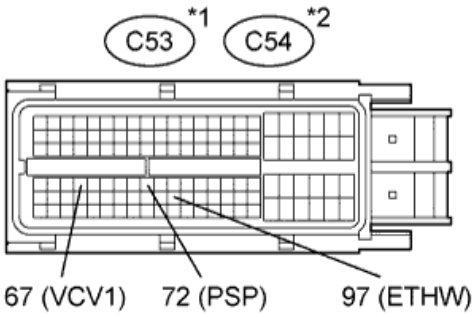
b. Disconnect the C28 power steering oil pressure sensor connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Power Steering Oil Pressure Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C28-2 (PSP) - C53-72 (PSP)	Always	Below 1 Ω
C28-1 (VC) - C53-67 (VCV1)	Always	Below 1 Ω
C28-3 (E2) - C53-97 (ETHW)	Always	Below 1 Ω
C28-2 (PSP) or C53-72 (PSP) - Body ground	Always	10 kΩ or higher
C28-1 (VC) or C53-67 (VCV1) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C28-2 (PSP) - C54-72 (PSP)	Always	Below 1 Ω
C28-1 (VC) - C54-67 (VCV1)	Always	Below 1 Ω
C28-3 (E2) - C54-97 (ETHW)	Always	Below 1 Ω
C28-2 (PSP) or C54-72 (PSP) - Body ground	Always	10 kΩ or higher
C28-1 (VC) or C54-67 (VCV1) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE POWER STEERING OIL PRESSURE SENSOR

a. Replace the power steering oil pressure sensor (Click here).

NEXT

3.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read the DTCs.

Result

Result	Proceed to
P0550, P0552 and/or P0553 are output	A
No DTC is output	B

B → END

A

REPLACE ECM (Click here)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

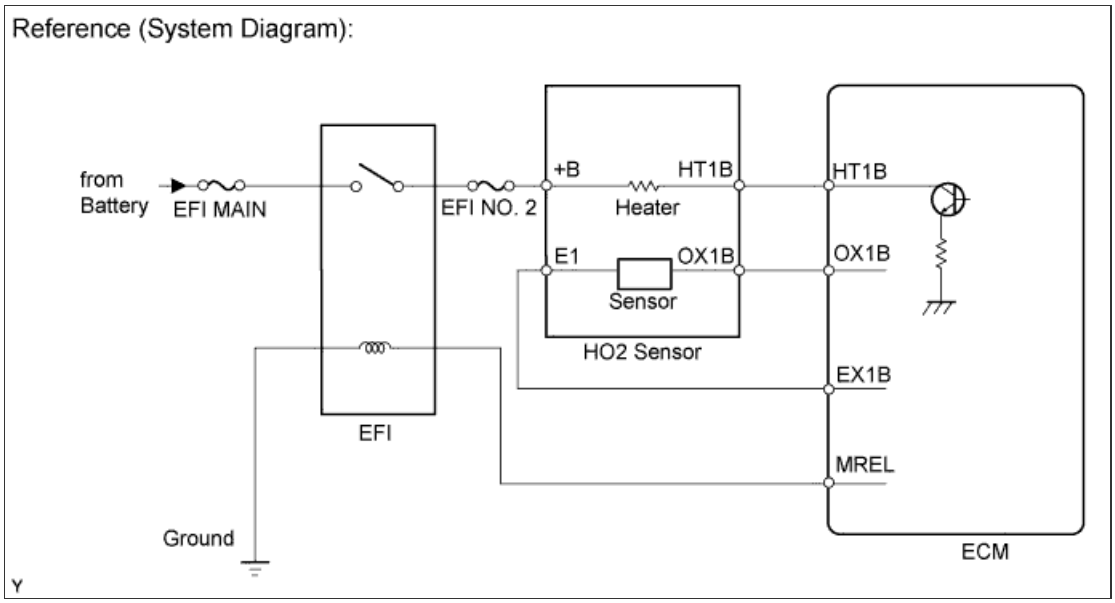
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

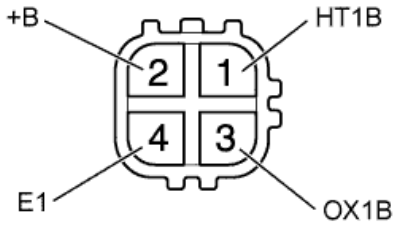
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

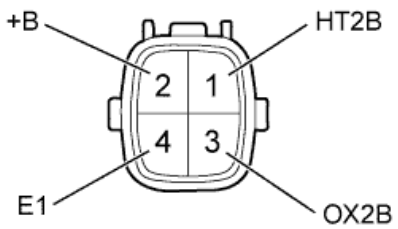
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

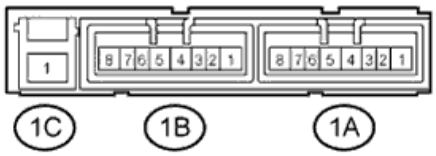
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

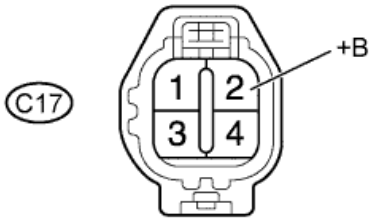
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

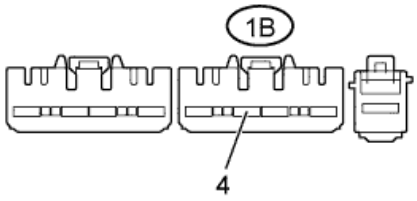
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

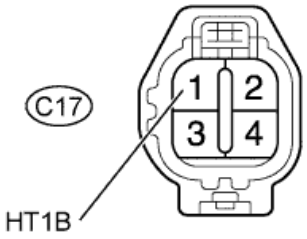
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

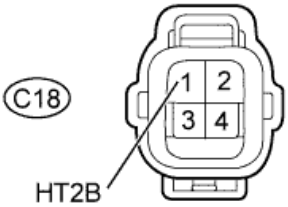
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

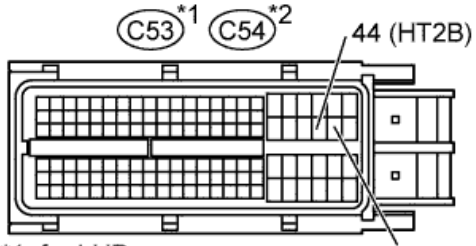
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

DTC P0550 Power Steering Pressure Sensor Circuit Malfunction

DTC P0552 Power Steering Pressure Sensor Circuit Low Input

DTC P0553 Power Steering Pressure Sensor Circuit High Input

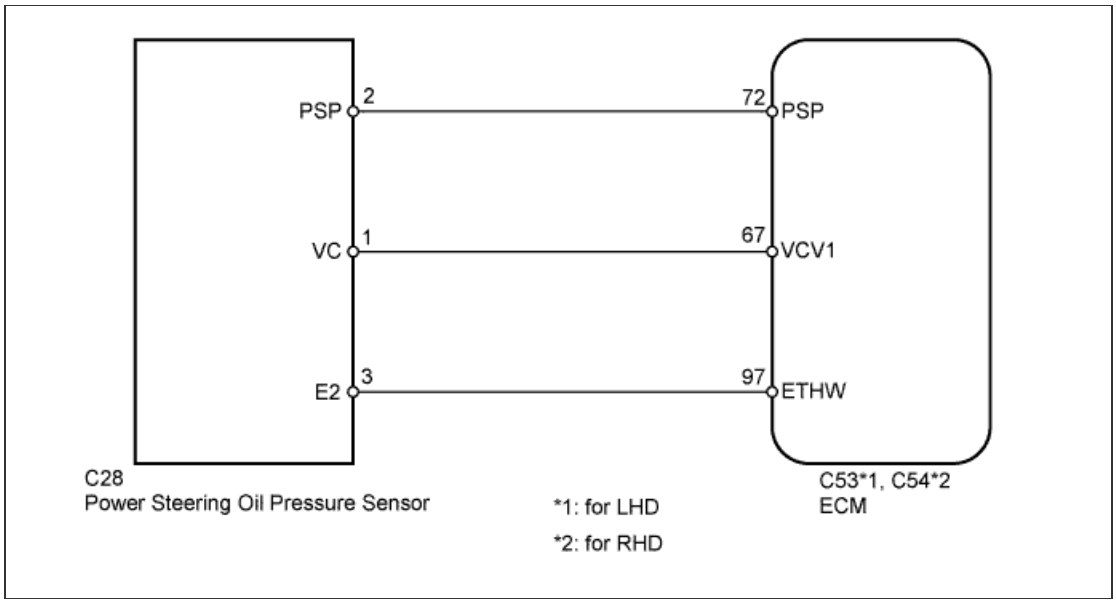
for Preparation Click here

DESCRIPTION

The power steering oil pressure sensor is turned on when a power steering wheel load occurs by turning the steering wheel. The ECM regulates the engine idling RPM according to the voltage output of the sensor.

DTC Code	DTC Detection Condition	Trouble Area
P0550	Power steering oil pressure sensor voltage less than 0.28 V, or more than 4.9 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM
P0552	Power steering oil pressure sensor voltage less than 0.28 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM
P0553	Power steering oil pressure sensor voltage more than 4.9 V for 0.5 seconds while engine running. (1 trip detection logic)	• Open or short in power steering oil pressure sensor circuit • Power steering oil pressure sensor • ECM

WIRING DIAGRAM



MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to regulate the engine idling speed. When the sensor output voltage deviates from the normal operating range, the ECM determines that there is a malfunction in the power steering oil pressure sensor and stores DTC(s).

INSPECTION PROCEDURE

HINT:

- **If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

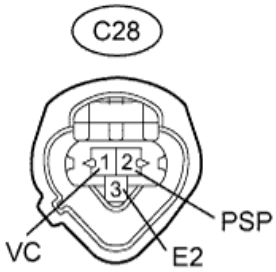
1.CHECK HARNESS AND CONNECTOR (ECM - POWER STEERING OIL PRESSURE SENSOR)

a. Disconnect the C53 or C54 ECM connector.

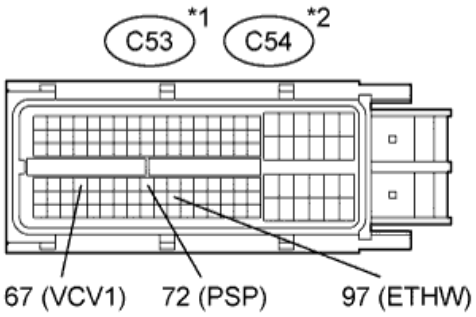
b. Disconnect the C28 power steering oil pressure sensor connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Power Steering Oil Pressure Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C28-2 (PSP) - C53-72 (PSP)	Always	Below 1 Ω
C28-1 (VC) - C53-67 (VCV1)	Always	Below 1 Ω
C28-3 (E2) - C53-97 (ETHW)	Always	Below 1 Ω
C28-2 (PSP) or C53-72 (PSP) - Body ground	Always	10 kΩ or higher
C28-1 (VC) or C53-67 (VCV1) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C28-2 (PSP) - C54-72 (PSP)	Always	Below 1 Ω
C28-1 (VC) - C54-67 (VCV1)	Always	Below 1 Ω
C28-3 (E2) - C54-97 (ETHW)	Always	Below 1 Ω
C28-2 (PSP) or C54-72 (PSP) - Body ground	Always	10 kΩ or higher
C28-1 (VC) or C54-67 (VCV1) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE POWER STEERING OIL PRESSURE SENSOR

a. Replace the power steering oil pressure sensor (Click here).

NEXT

3.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read the DTCs.

Result

Result	Proceed to
P0550, P0552 and/or P0553 are output	A
No DTC is output	B

B → END

A

REPLACE ECM (Click here)

DTC P0037 Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC P0038 Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC P0057 Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)

DTC P0058 Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

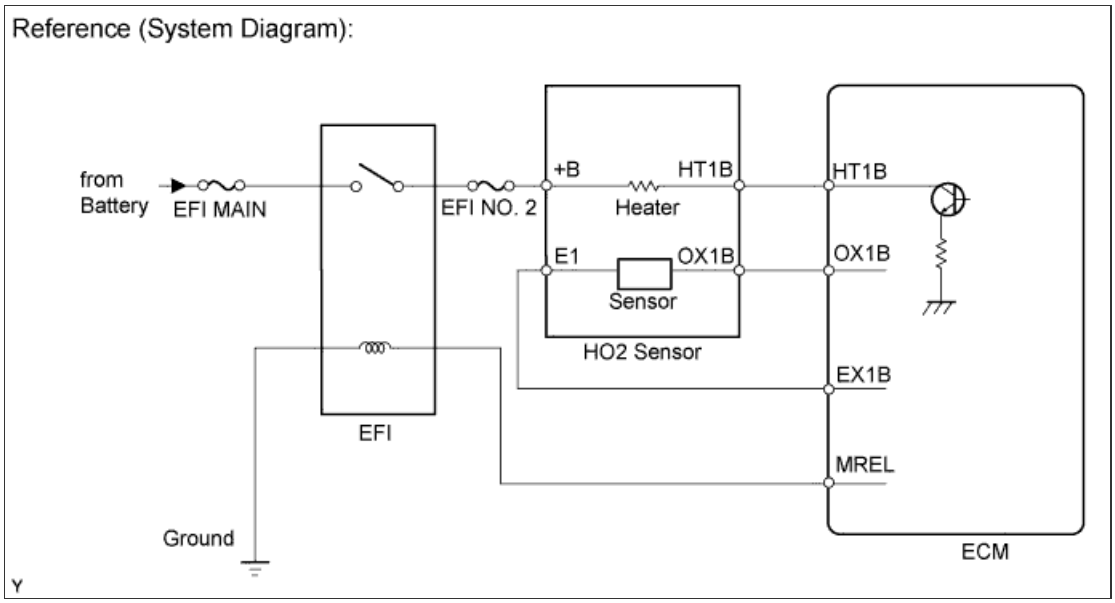
for Preparation Click here

DESCRIPTION

Refer to DTC P0136 (Click here).

HINT:

- **When any of these DTCs is stored, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.**
- **The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the +B side of the circuit.**



DTC Code	DTC Detection Condition	Trouble Area
P0037 P0057	The Heated Oxygen (HO2) sensor heater current is below 0.3 A (1 trip detection logic).	• Open in Heated Oxygen (HO2) sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM
P0038 P0058	The Heated Oxygen (HO2) sensor heater current is higher than 2 A (1 trip detection logic).	• Short in HO2 sensor heater circuit • HO2 sensor heater (for Sensor 2) • Integration relay • ECM

HINT:

- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that does not include the No. 1 cylinder.**
- **Sensor 1 refers to the sensor closest to the engine assembly.**
- **Sensor 2 refers to the sensor farthest away from the engine assembly.**

MONITOR DESCRIPTION

The sensing portion of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037, P0038, P0057 and P0058):
The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM determines that there is an open circuit in the heater. If the current is higher than the threshold value, the ECM determines that there is a short circuit in the heater.
The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and stores a DTC.
If a malfunction is detected, the ECM cuts off the current applied to the heater.
Example:
The ECM stores DTC P0038 or P0058 when the current in the HO2 sensor heater is higher than 2 A. Conversely, when the heater current is below 0.3 A, DTC P0037 or P0057 is stored.

WIRING DIAGRAM

Refer to DTC P0136 (Click here).

CONFIRMATION DRIVING PATTERN

These DTCs are stored when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:

- **Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

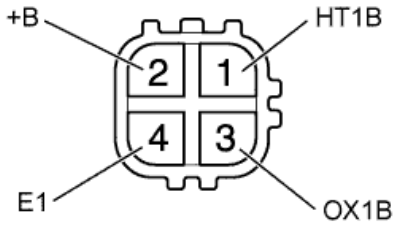
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

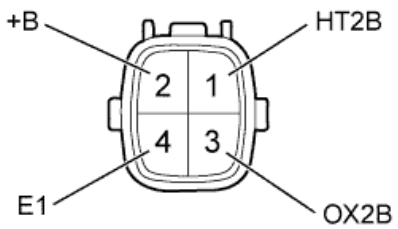
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

2.CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

Result

Result	Proceed to
NG	A
OK	B

Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



B → Go to step 5

A

3.INSPECT INTEGRATION NO.1 RELAY (EFI)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

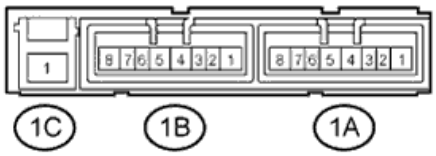
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (EFI)

OK

4.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C17 or C18 HO2 sensor connector.

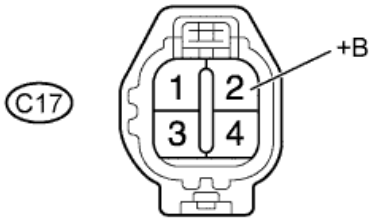
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C17-2 (+B) - 1B-4	Always	Below 1 Ω
C18-2 (+B) - 1B-4	Always	Below 1 Ω
C17-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
C18-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

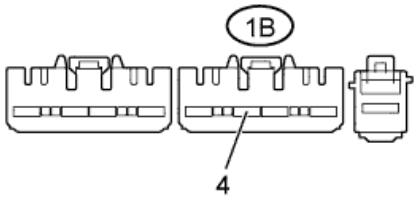
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

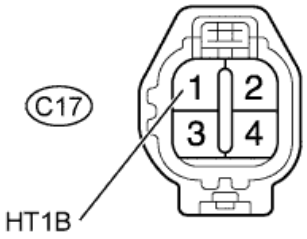
5.CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

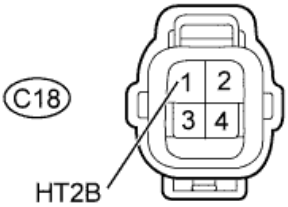
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

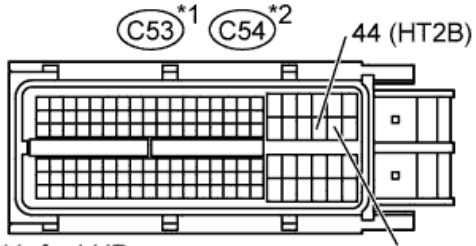
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 2 minutes or more.

g. Enter the following menus: Powertrain / Engine and ECT / DTC.

h. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0037, P0038, P0057 and/or P0058 are output	B

B

REPLACE ECM (**Click here**)

A

CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

for Preparation Click here

DESCRIPTION

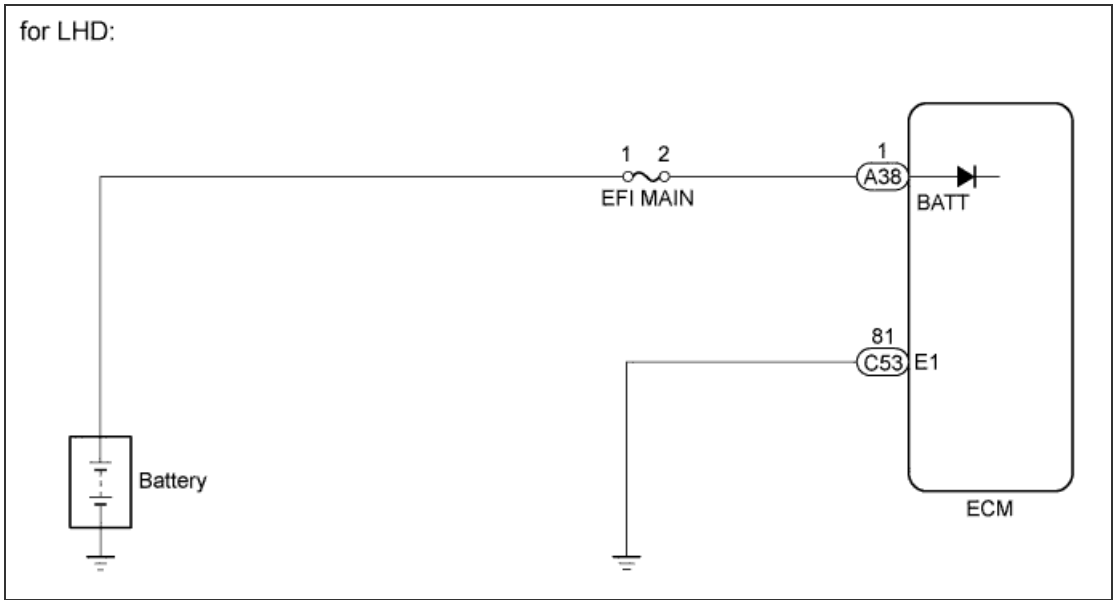
The battery supplies electricity to the ECM even when the engine switch is off. This power allows the ECM to store data such as DTC history, freeze frame data and fuel trim values. If the battery voltage falls below a minimum level, the memory is cleared and the ECM determines that there is a malfunction in the power supply circuit. When the engine is next started, the ECM illuminates the MIL and stores the DTC.

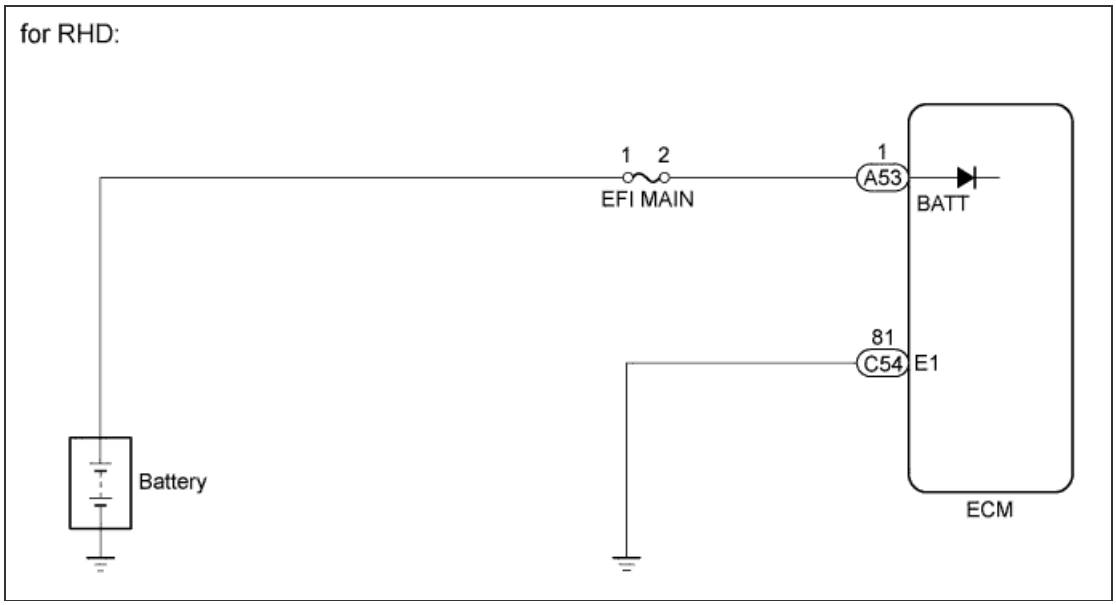
DTC Code	DTC Detection Condition	Trouble Area
P0560	An open in the ECM back up power source circuit (1 trip detection logic).	• Open in back up power source circuit • Battery • Battery terminals • EFI MAIN fuse • ECM

HINT:

If DTC P0560 is stored, the ECM does not store other DTCs or the data stored in the ECM is partly cleared.

WIRING DIAGRAM





INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT FUSE (EFI MAIN)

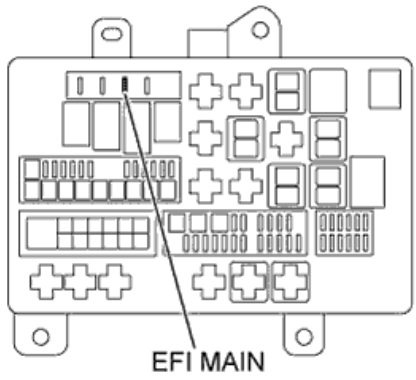
a. Remove the EFI MAIN fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

Engine Room Relay Block:



NG → CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE

OK

2.CHECK HARNESS AND CONNECTOR (EFI NO. 1 FUSE - ECM, BATTERY)

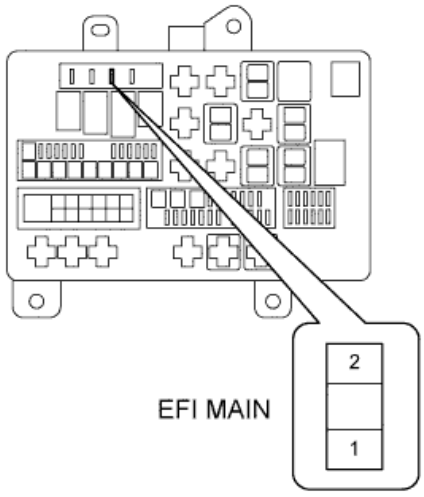
a. Check the harness and the connector between the EFI MAIN fuse and ECM.

i. Remove the EFI MAIN fuse from the engine room relay block.

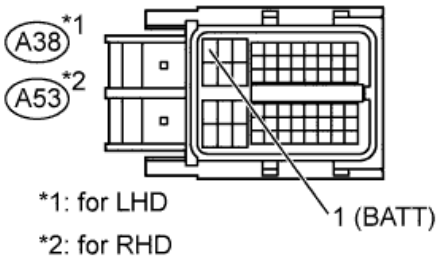
ii. Disconnect the A38 or A53 ECM connector.

iii. Measure the resistance according to the value(s) in the table below.

Engine Room Relay Block:



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
EFI MAIN fuse terminal 2 - A38-1 (BATT)	Always	Below 1 Ω
EFI MAIN fuse terminal 2 or A38-1 (BATT) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
EFI MAIN fuse terminal 2 - A53-1 (BATT)	Always	Below 1 Ω
EFI MAIN fuse terminal 2 or A53-1 (BATT) - Body ground	Always	10 kΩ or higher

b. Check the harness and the connector between the EFI MAIN fuse and battery.

i. Remove the EFI MAIN fuse from the engine room relay block.

ii. Disconnect the positive battery terminal.

iii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Battery positive (+) terminal - EFI MAIN fuse terminal 1	Always	Below 1 Ω
Battery positive		

(+) terminal or EFI MAIN fuse terminal 1- Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT BATTERY

a. Check that the battery is not depleted (Click here).

OK:
Battery is not depleted.

NG → REPLACE BATTERY

OK

4.CHECK BATTERY TERMINAL

a. Check that the battery terminals are not loose or corroded.

OK:
Battery terminals are not loose or corroded.

NG → REPAIR BATTERY TERMINAL

OK

5.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Turn the engine switch off and turn the tester off.

e. Start the engine and turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0560 is output	A
No DTC is output	B

B → CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

A

REPLACE ECM (**Click here**)

DTC P0102 Mass or Volume Air Flow Circuit Low Input

DTC P0103 Mass or Volume Air Flow Circuit High Input

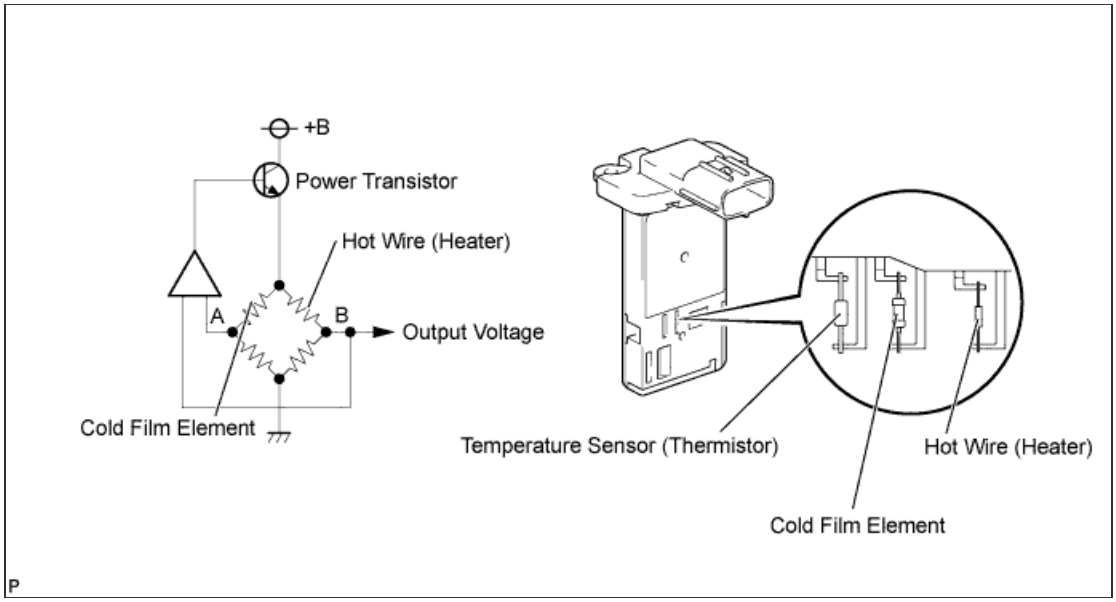
for Preparation Click here

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the throttle valve.
The ECM uses this information to determine the fuel injection time and to provide the appropriate air-fuel ratio.
Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.
By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter.
The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.
The circuit is constructed so that the platinum hot wire and the cold film element create a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.

HINT:

When any of these DTCs are stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine speed and throttle valve position. Fail-safe mode continues until a pass condition is detected.



DTC Code	DTC Detection Condition	Trouble Area
P0102	The Mass Air Flow (MAF) meter voltage is below 0.2 V for 3 seconds (1 trip detection logic).	• Open or short in Mass Air Flow (MAF) meter circuit • MAF meter • ECM
P0103	The MAF meter voltage is higher than 4.9 V for 3 seconds (1 trip detection logic).	• Open or short in MAF meter circuit • MAF meter • ECM

HINT:

When any of these DTCs is output, check the air-flow rate by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

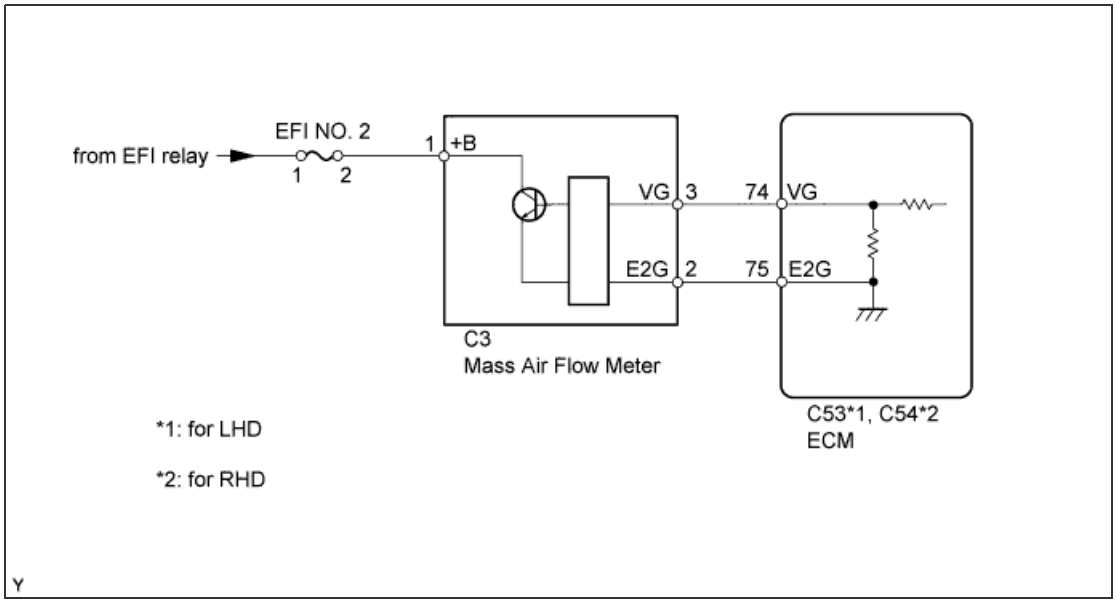
Mass Air Flow Rate (g/sec.)	Malfunction
Approximately 0.0	• **Open in Mass Air Flow (MAF) meter power source circuit** • **Open or short in VG circuit**
271.0 or more	Open in E2G circuit

MONITOR DESCRIPTION

If there is a defect in the MAF meter or an open or short circuit, the voltage level deviates from the normal operating range. The ECM interprets this

deviation as a malfunction in the MAF meter and stores DTC(s).
Example:
When the sensor output voltage remains at below 0.2 V, or higher than 4.9 V for more than 3 seconds, the ECM stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 3 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (MASS AIR FLOW RATE)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

e. Read the values displayed on the tester.

Result

Mass Air Flow Rate (g/sec.)	Proceed to
0.0	A
271.0 or more	B
Between 1.0 and 270.0*	C

HINT:

*: The value must change when the throttle valve is open or closed with the engine running.

B → Go to step 6

C → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

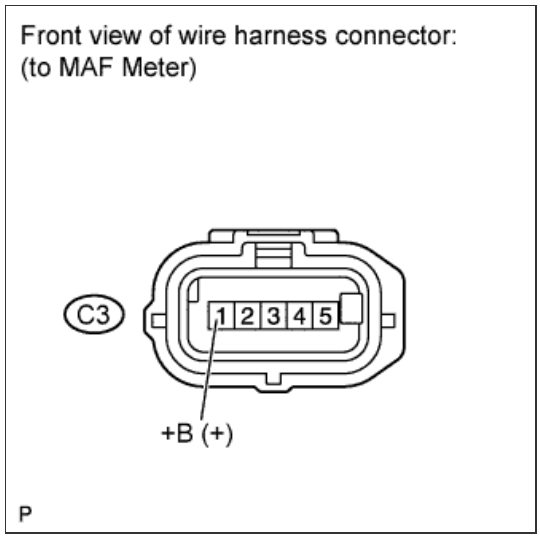
2.INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C3-1 (+B) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 5

OK

3.INSPECT MASS AIR FLOW METER

a. Remove the Mass Air Flow (MAF) meter (Click here).

b. Inspect the MAF meter.

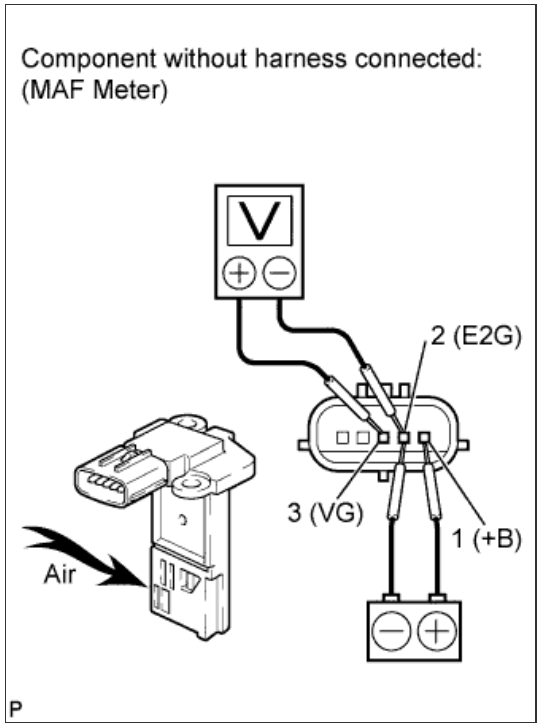
i. Measure the voltage according to the value(s) in the table below.

OK:

Tester Connection	Condition	Specified Condition
2 (E2G) - 3 (VG)	• Battery voltage applied to terminals 1 (+B) - 2 (E2G) • Air blown into the MAF meter	Voltage fluctuates

NOTICE:

While using the battery during inspection, do not bring the positive and negative tester probes too close to each other as a short circuit may occur.



NG → REPLACE MASS AIR FLOW METER (Click here)

OK

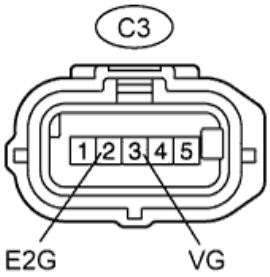
4.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

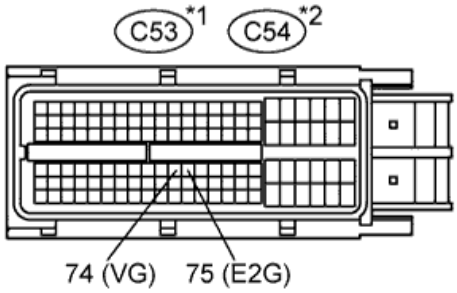
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C3 MAF meter connector.

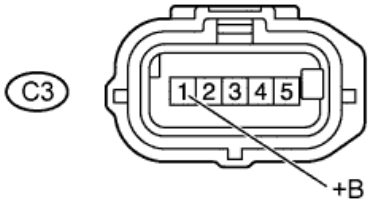
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

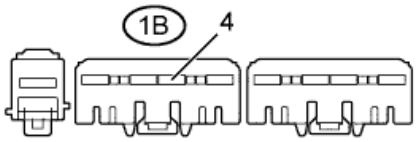
Standard Resistance:

Tester Connection	Condition	Specified Condition
C3-1 (+B) - 1B-4	Always	Below 1 Ω
C3-1 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

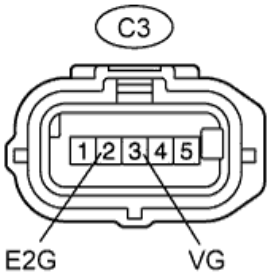
6.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

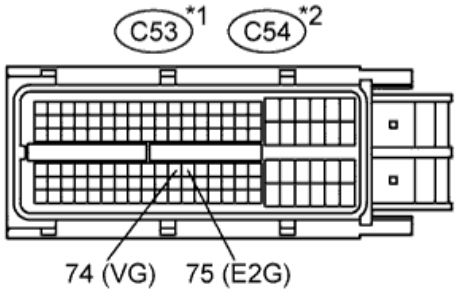
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.CHECK HARNESS AND CONNECTOR (SENSOR GROUND)

a. Disconnect the C3 MAF meter connector.

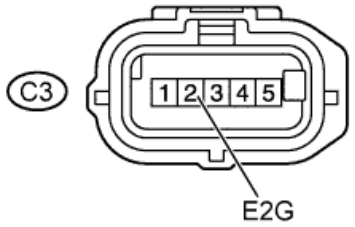
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

		Specified

Tester Connection	Condition	Condition
C3-2 (E2G) - Body ground	Always	Below 1 Ω

Front view of wire harness connector:
(to MAF Meter)



P

NG → REPLACE ECM (Click here)

OK → REPLACE MASS AIR FLOW METER (Click here)

for Preparation Click here

DESCRIPTION

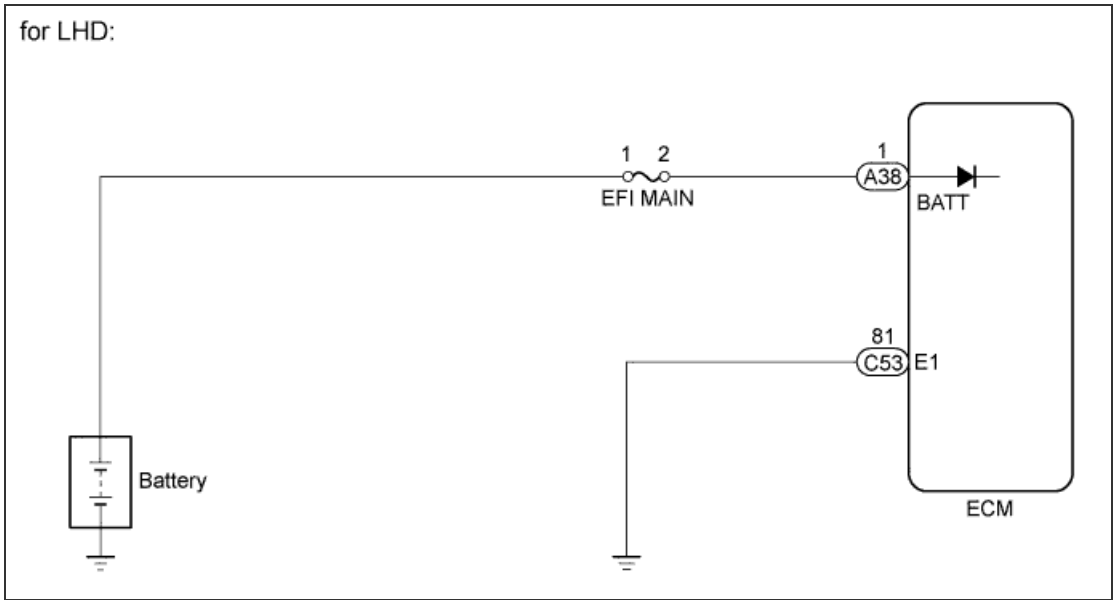
The battery supplies electricity to the ECM even when the engine switch is off. This power allows the ECM to store data such as DTC history, freeze frame data and fuel trim values. If the battery voltage falls below a minimum level, the memory is cleared and the ECM determines that there is a malfunction in the power supply circuit. When the engine is next started, the ECM illuminates the MIL and stores the DTC.

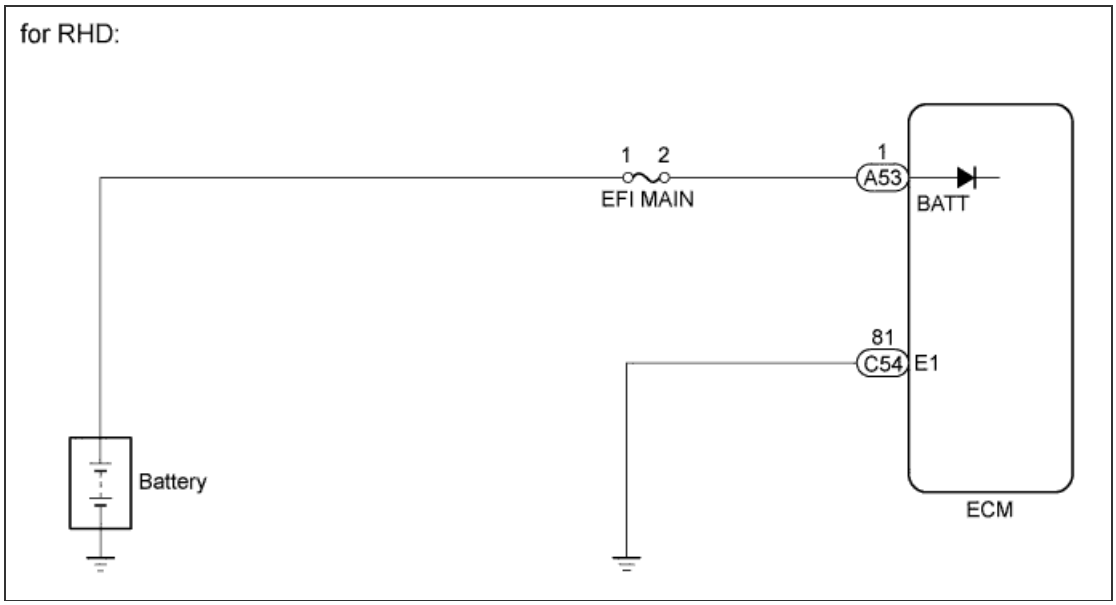
DTC Code	DTC Detection Condition	Trouble Area
P0560	An open in the ECM back up power source circuit (1 trip detection logic).	• Open in back up power source circuit • Battery • Battery terminals • EFI MAIN fuse • ECM

HINT:

If DTC P0560 is stored, the ECM does not store other DTCs or the data stored in the ECM is partly cleared.

WIRING DIAGRAM





INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT FUSE (EFI MAIN)

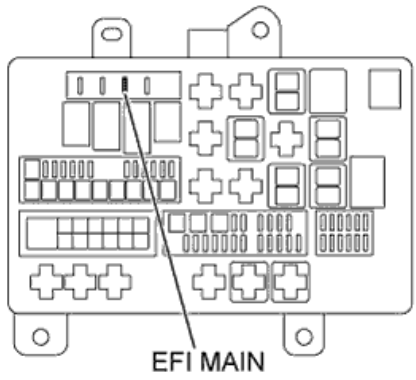
a. Remove the EFI MAIN fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

Engine Room Relay Block:



NG → CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE

OK

2.CHECK HARNESS AND CONNECTOR (EFI NO. 1 FUSE - ECM, BATTERY)

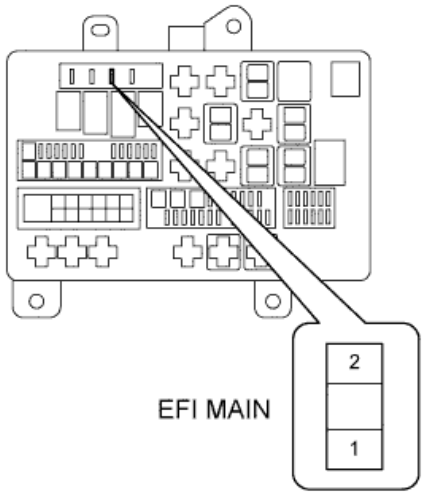
a. Check the harness and the connector between the EFI MAIN fuse and ECM.

i. Remove the EFI MAIN fuse from the engine room relay block.

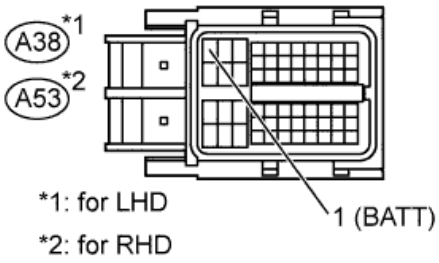
ii. Disconnect the A38 or A53 ECM connector.

iii. Measure the resistance according to the value(s) in the table below.

Engine Room Relay Block:



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
EFI MAIN fuse terminal 2 - A38-1 (BATT)	Always	Below 1 Ω
EFI MAIN fuse terminal 2 or A38-1 (BATT) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
EFI MAIN fuse terminal 2 - A53-1 (BATT)	Always	Below 1 Ω
EFI MAIN fuse terminal 2 or A53-1 (BATT) - Body ground	Always	10 kΩ or higher

b. Check the harness and the connector between the EFI MAIN fuse and battery.

i. Remove the EFI MAIN fuse from the engine room relay block.

ii. Disconnect the positive battery terminal.

iii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Battery positive (+) terminal - EFI MAIN fuse terminal 1	Always	Below 1 Ω
Battery positive		

(+) terminal or EFI MAIN fuse terminal 1- Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT BATTERY

a. Check that the battery is not depleted (Click here).

OK:
Battery is not depleted.

NG → REPLACE BATTERY

OK

4.CHECK BATTERY TERMINAL

a. Check that the battery terminals are not loose or corroded.

OK:
Battery terminals are not loose or corroded.

NG → REPAIR BATTERY TERMINAL

OK

5.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Turn the engine switch off and turn the tester off.

e. Start the engine and turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0560 is output	A
No DTC is output	B

B → CHECK FOR INTERMITTENT PROBLEMS (**Click here**)

A

REPLACE ECM (**Click here**)

DTC P0102 Mass or Volume Air Flow Circuit Low Input

DTC P0103 Mass or Volume Air Flow Circuit High Input

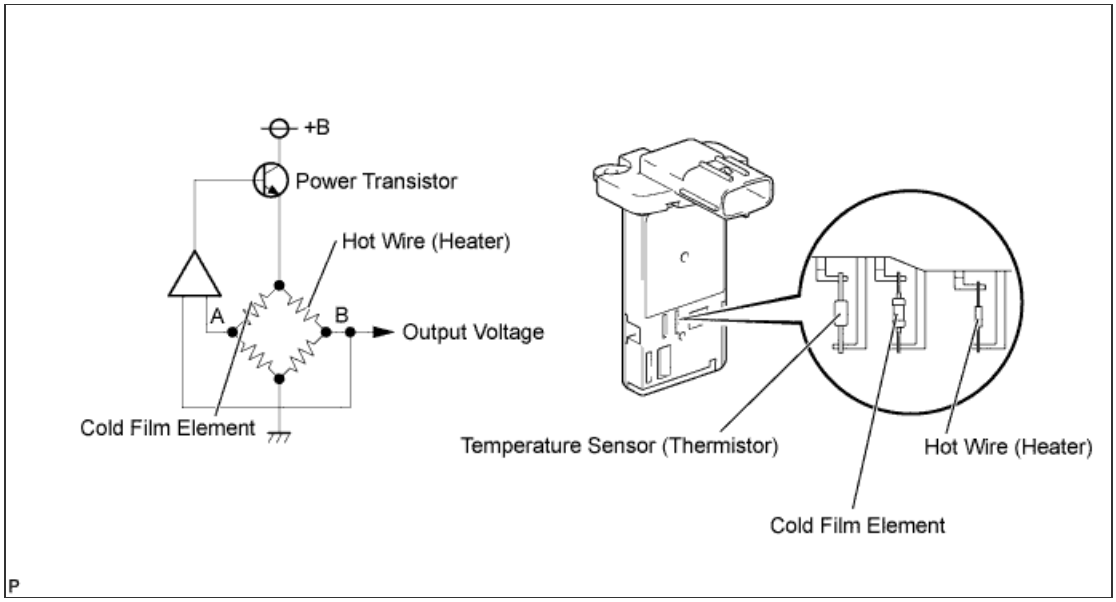
for Preparation Click here

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the throttle valve.
The ECM uses this information to determine the fuel injection time and to provide the appropriate air-fuel ratio.
Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.
By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter.
The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.
The circuit is constructed so that the platinum hot wire and the cold film element create a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.

HINT:

When any of these DTCs are stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine speed and throttle valve position. Fail-safe mode continues until a pass condition is detected.



DTC Code	DTC Detection Condition	Trouble Area
P0102	The Mass Air Flow (MAF) meter voltage is below 0.2 V for 3 seconds (1 trip detection logic).	• Open or short in Mass Air Flow (MAF) meter circuit • MAF meter • ECM
P0103	The MAF meter voltage is higher than 4.9 V for 3 seconds (1 trip detection logic).	• Open or short in MAF meter circuit • MAF meter • ECM

HINT:

When any of these DTCs is output, check the air-flow rate by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

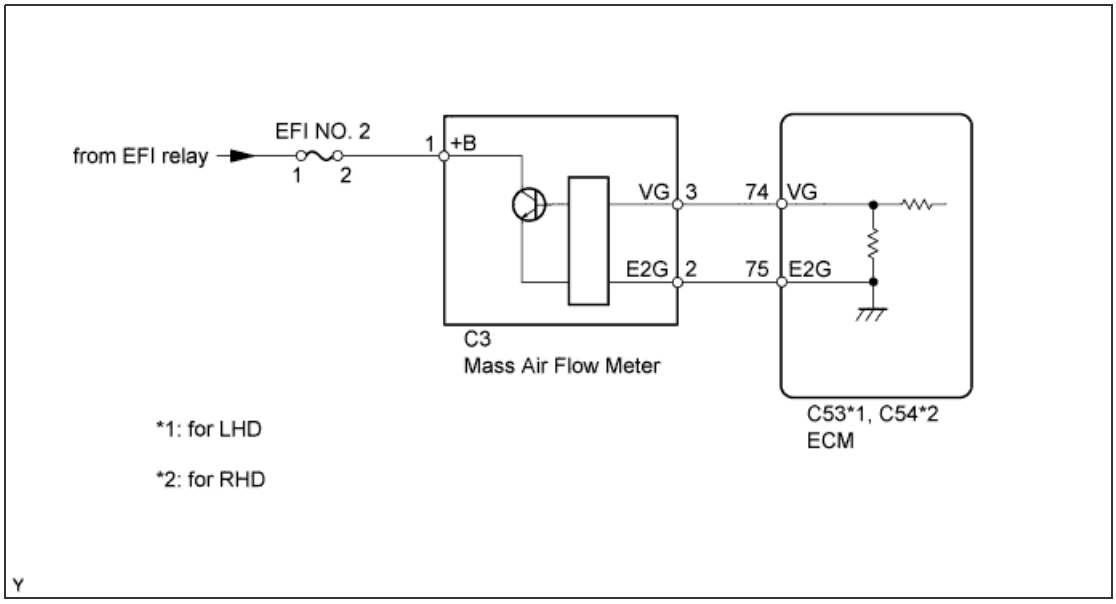
Mass Air Flow Rate (g/sec.)	Malfunction
Approximately 0.0	• **Open in Mass Air Flow (MAF) meter power source circuit** • **Open or short in VG circuit**
271.0 or more	Open in E2G circuit

MONITOR DESCRIPTION

If there is a defect in the MAF meter or an open or short circuit, the voltage level deviates from the normal operating range. The ECM interprets this

deviation as a malfunction in the MAF meter and stores DTC(s).
Example:
When the sensor output voltage remains at below 0.2 V, or higher than 4.9 V for more than 3 seconds, the ECM stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 3 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (MASS AIR FLOW RATE)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

e. Read the values displayed on the tester.

Result

Mass Air Flow Rate (g/sec.)	Proceed to
0.0	A
271.0 or more	B
Between 1.0 and 270.0*	C

HINT:

*: The value must change when the throttle valve is open or closed with the engine running.

B → Go to step 6

C → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

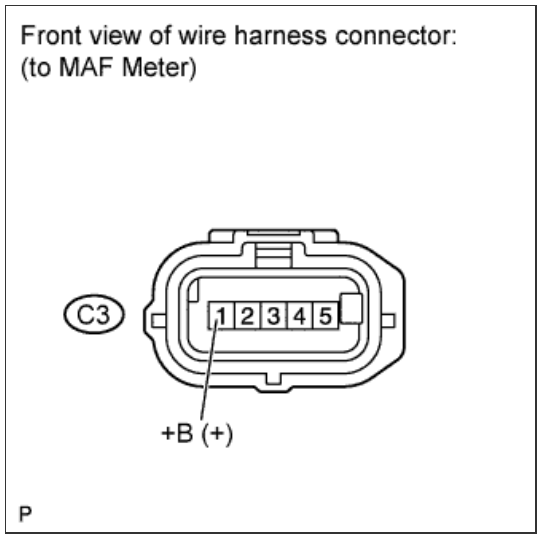
2.INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C3-1 (+B) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 5

OK

3.INSPECT MASS AIR FLOW METER

a. Remove the Mass Air Flow (MAF) meter (Click here).

b. Inspect the MAF meter.

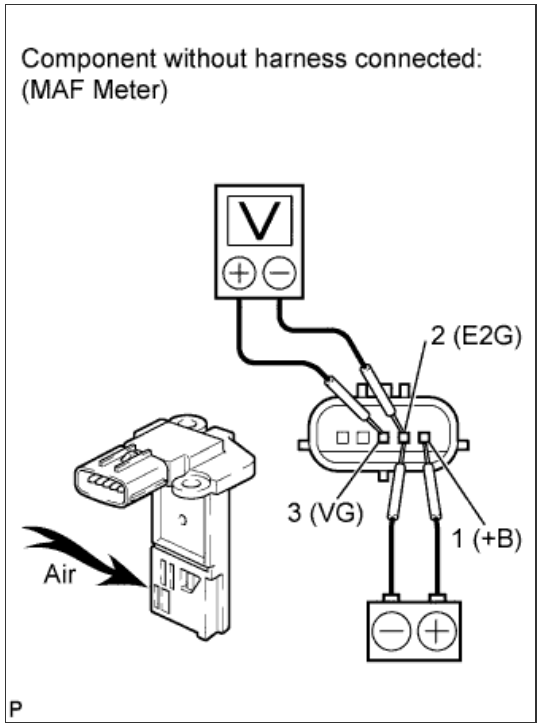
i. Measure the voltage according to the value(s) in the table below.

OK:

Tester Connection	Condition	Specified Condition
2 (E2G) - 3 (VG)	• Battery voltage applied to terminals 1 (+B) - 2 (E2G) • Air blown into the MAF meter	Voltage fluctuates

NOTICE:

While using the battery during inspection, do not bring the positive and negative tester probes too close to each other as a short circuit may occur.



NG → REPLACE MASS AIR FLOW METER (Click here)

OK

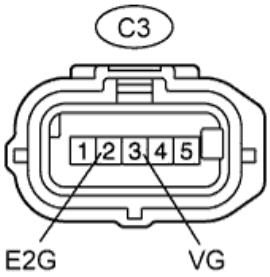
4.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

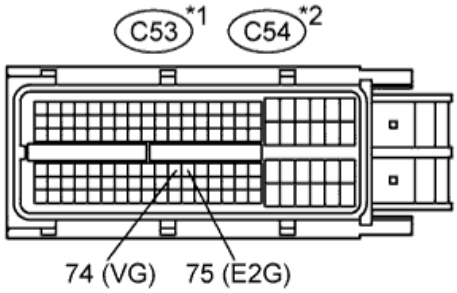
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C3 MAF meter connector.

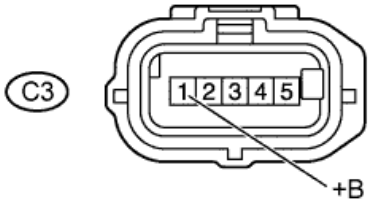
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

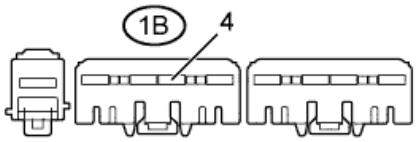
Standard Resistance:

Tester Connection	Condition	Specified Condition
C3-1 (+B) - 1B-4	Always	Below 1 Ω
C3-1 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

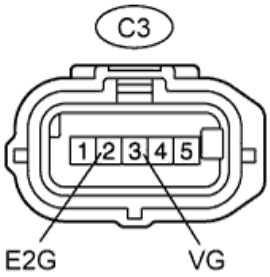
6.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

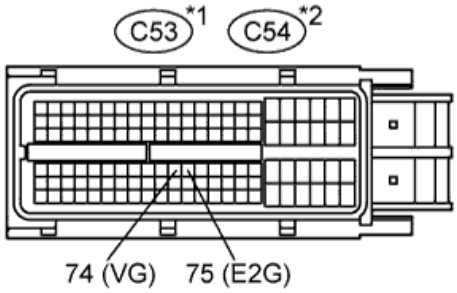
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.CHECK HARNESS AND CONNECTOR (SENSOR GROUND)

a. Disconnect the C3 MAF meter connector.

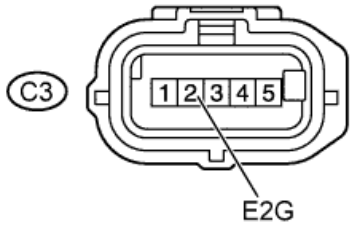
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

		Specified

Tester Connection	Condition	Condition
C3-2 (E2G) - Body ground	Always	Below 1 Ω

Front view of wire harness connector:
(to MAF Meter)



P

NG → REPLACE ECM (Click here)

OK → REPLACE MASS AIR FLOW METER (Click here)

DTC P0604 Random Access Memory (RAM)

for Preparation Click here

DESCRIPTION

The ECM continuously monitors its internal memory status. This self-check ensures that the ECM is functioning properly. This is diagnosed by internal "mirroring" of the main CPU and sub CPU to detect Random Access Memory (RAM) errors. If outputs from these CPUs are different and deviate from the standard, the ECM will illuminate the MIL and store DTC(s) immediately.

DTC Code	DTC Detection Condition	Trouble Area
P0604	ECM RAM errors.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P0604 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0102 Mass or Volume Air Flow Circuit Low Input

DTC P0103 Mass or Volume Air Flow Circuit High Input

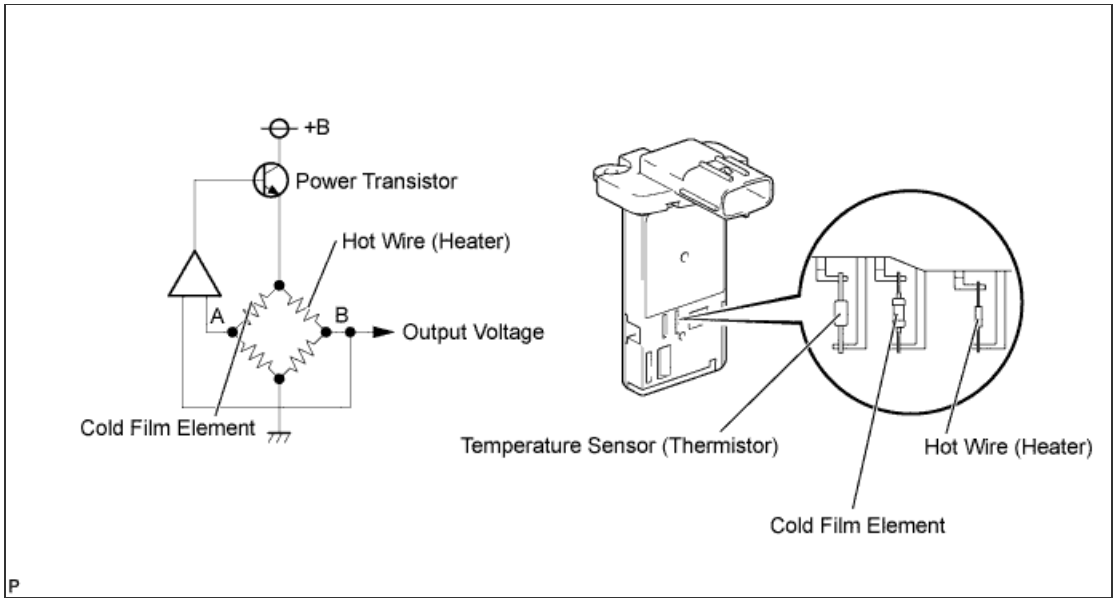
for Preparation Click here

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the throttle valve.
The ECM uses this information to determine the fuel injection time and to provide the appropriate air-fuel ratio.
Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.
By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter.
The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.
The circuit is constructed so that the platinum hot wire and the cold film element create a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.

HINT:

When any of these DTCs are stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine speed and throttle valve position. Fail-safe mode continues until a pass condition is detected.



DTC Code	DTC Detection Condition	Trouble Area
P0102	The Mass Air Flow (MAF) meter voltage is below 0.2 V for 3 seconds (1 trip detection logic).	• Open or short in Mass Air Flow (MAF) meter circuit • MAF meter • ECM
P0103	The MAF meter voltage is higher than 4.9 V for 3 seconds (1 trip detection logic).	• Open or short in MAF meter circuit • MAF meter • ECM

HINT:

When any of these DTCs is output, check the air-flow rate by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

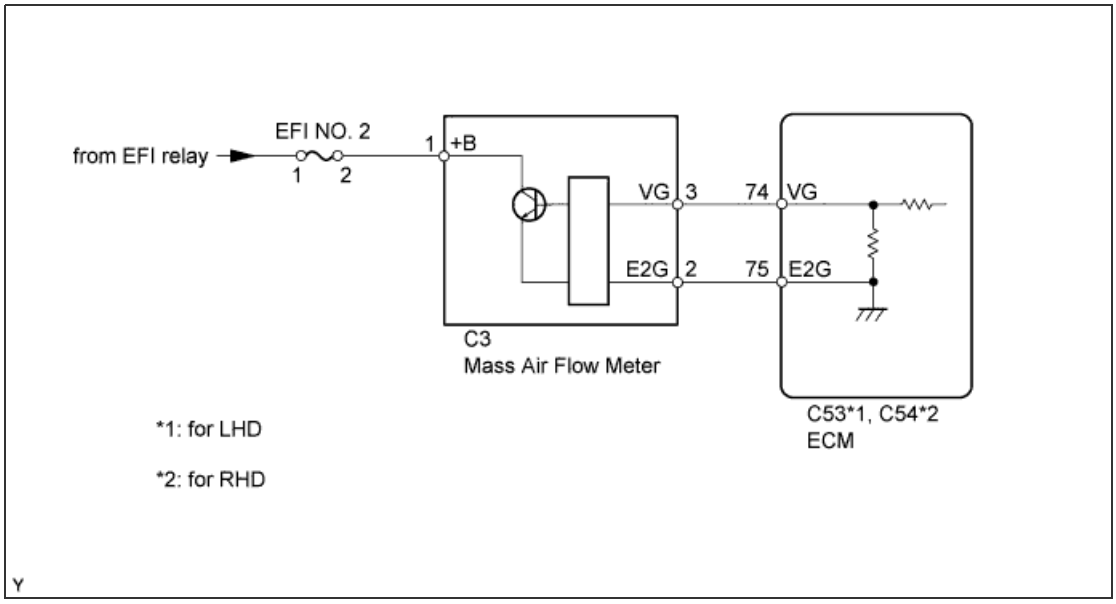
Mass Air Flow Rate (g/sec.)	Malfunction
Approximately 0.0	• **Open in Mass Air Flow (MAF) meter power source circuit** • **Open or short in VG circuit**
271.0 or more	Open in E2G circuit

MONITOR DESCRIPTION

If there is a defect in the MAF meter or an open or short circuit, the voltage level deviates from the normal operating range. The ECM interprets this

deviation as a malfunction in the MAF meter and stores DTC(s).
Example:
When the sensor output voltage remains at below 0.2 V, or higher than 4.9 V for more than 3 seconds, the ECM stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 3 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (MASS AIR FLOW RATE)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

e. Read the values displayed on the tester.

Result

Mass Air Flow Rate (g/sec.)	Proceed to
0.0	A
271.0 or more	B
Between 1.0 and 270.0*	C

HINT:

*: The value must change when the throttle valve is open or closed with the engine running.

B → Go to step 6

C → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

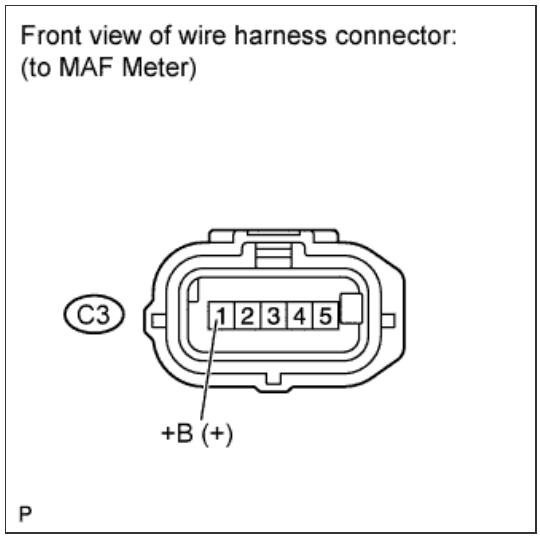
2.INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C3-1 (+B) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 5

OK

3.INSPECT MASS AIR FLOW METER

a. Remove the Mass Air Flow (MAF) meter (Click here).

b. Inspect the MAF meter.

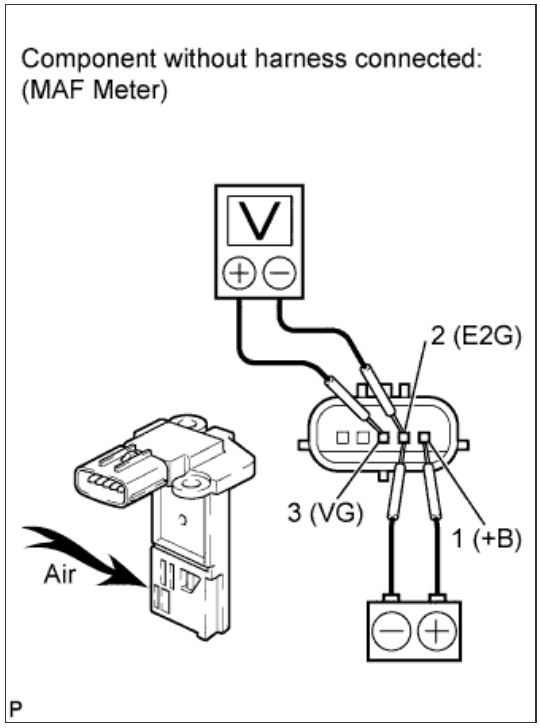
i. Measure the voltage according to the value(s) in the table below.

OK:

Tester Connection	Condition	Specified Condition
2 (E2G) - 3 (VG)	• Battery voltage applied to terminals 1 (+B) - 2 (E2G) • Air blown into the MAF meter	Voltage fluctuates

NOTICE:

While using the battery during inspection, do not bring the positive and negative tester probes too close to each other as a short circuit may occur.



NG → REPLACE MASS AIR FLOW METER (Click here)

OK

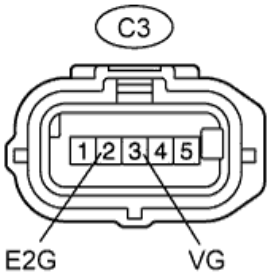
4.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

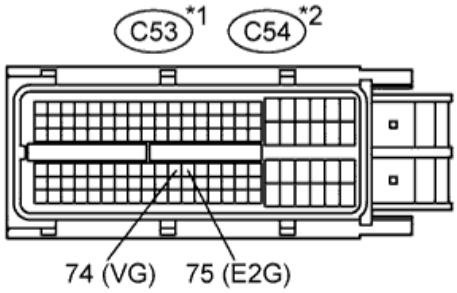
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C3 MAF meter connector.

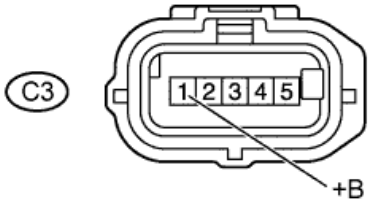
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

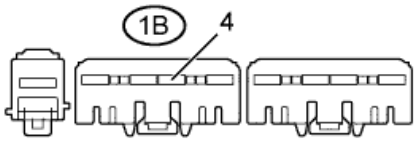
Standard Resistance:

Tester Connection	Condition	Specified Condition
C3-1 (+B) - 1B-4	Always	Below 1 Ω
C3-1 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

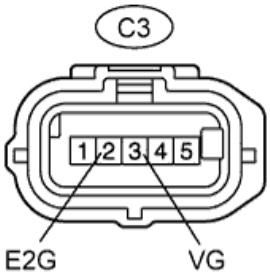
6.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

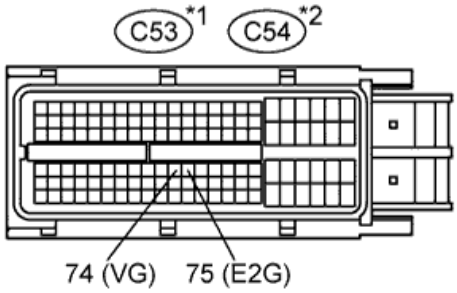
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.CHECK HARNESS AND CONNECTOR (SENSOR GROUND)

a. Disconnect the C3 MAF meter connector.

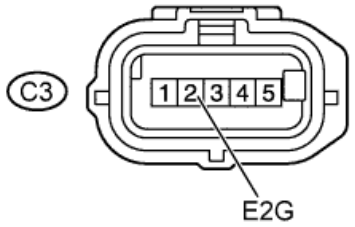
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

		Specified

Tester Connection	Condition	Condition
C3-2 (E2G) - Body ground	Always	Below 1 Ω

Front view of wire harness connector:
(to MAF Meter)



P

NG → REPLACE ECM (Click here)

OK → REPLACE MASS AIR FLOW METER (Click here)

DTC P0604 Random Access Memory (RAM)

for Preparation Click here

DESCRIPTION

The ECM continuously monitors its internal memory status. This self-check ensures that the ECM is functioning properly. This is diagnosed by internal "mirroring" of the main CPU and sub CPU to detect Random Access Memory (RAM) errors. If outputs from these CPUs are different and deviate from the standard, the ECM will illuminate the MIL and store DTC(s) immediately.

DTC Code	DTC Detection Condition	Trouble Area
P0604	ECM RAM errors.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P0604 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0102 Mass or Volume Air Flow Circuit Low Input

DTC P0103 Mass or Volume Air Flow Circuit High Input

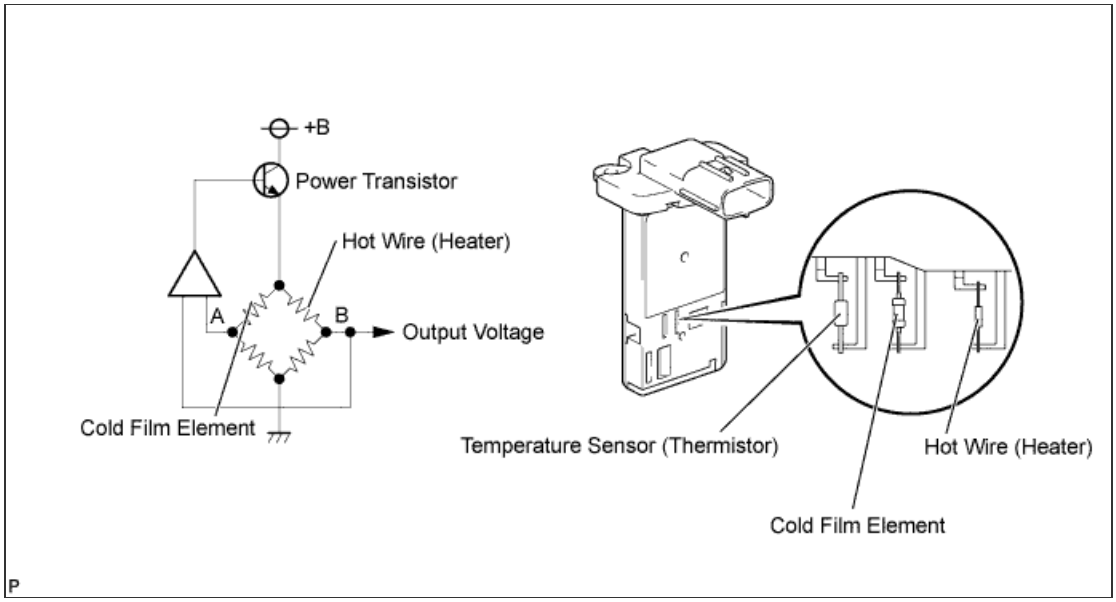
for Preparation Click here

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the throttle valve.
The ECM uses this information to determine the fuel injection time and to provide the appropriate air-fuel ratio.
Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.
By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter.
The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.
The circuit is constructed so that the platinum hot wire and the cold film element create a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.

HINT:

When any of these DTCs are stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine speed and throttle valve position. Fail-safe mode continues until a pass condition is detected.



DTC Code	DTC Detection Condition	Trouble Area
P0102	The Mass Air Flow (MAF) meter voltage is below 0.2 V for 3 seconds (1 trip detection logic).	• Open or short in Mass Air Flow (MAF) meter circuit • MAF meter • ECM
P0103	The MAF meter voltage is higher than 4.9 V for 3 seconds (1 trip detection logic).	• Open or short in MAF meter circuit • MAF meter • ECM

HINT:

When any of these DTCs is output, check the air-flow rate by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

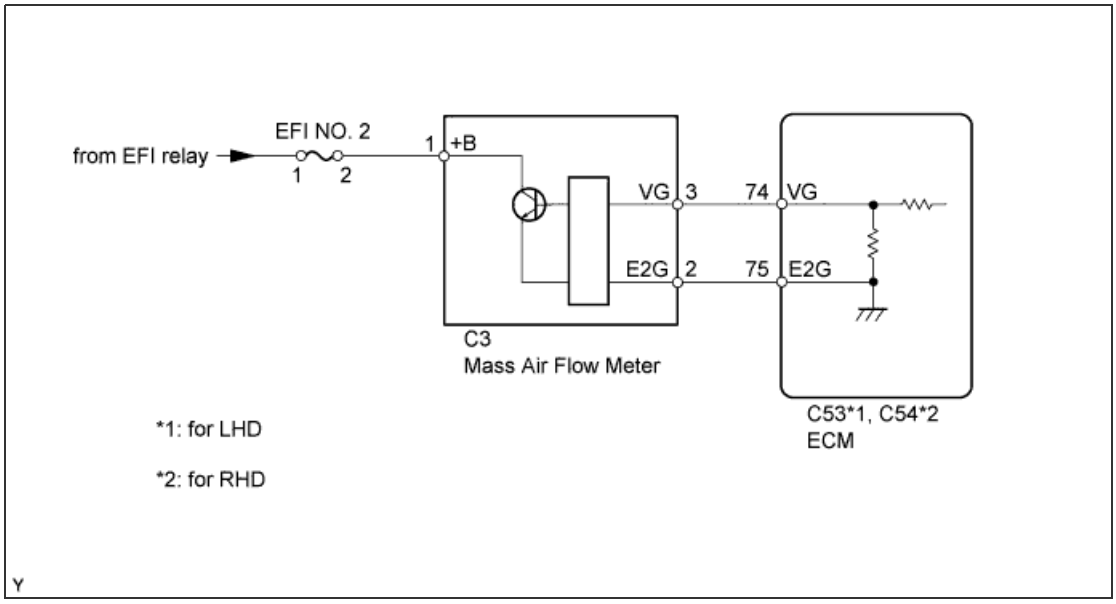
Mass Air Flow Rate (g/sec.)	Malfunction
Approximately 0.0	• **Open in Mass Air Flow (MAF) meter power source circuit** • **Open or short in VG circuit**
271.0 or more	Open in E2G circuit

MONITOR DESCRIPTION

If there is a defect in the MAF meter or an open or short circuit, the voltage level deviates from the normal operating range. The ECM interprets this

deviation as a malfunction in the MAF meter and stores DTC(s).
Example:
When the sensor output voltage remains at below 0.2 V, or higher than 4.9 V for more than 3 seconds, the ECM stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored 3 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (MASS AIR FLOW RATE)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / MAF.

e. Read the values displayed on the tester.

Result

Mass Air Flow Rate (g/sec.)	Proceed to
0.0	A
271.0 or more	B
Between 1.0 and 270.0*	C

HINT:

*: The value must change when the throttle valve is open or closed with the engine running.

B → Go to step 6

C → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

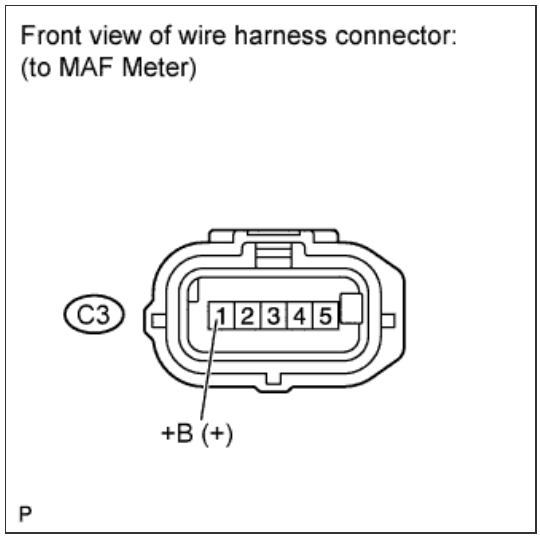
2.INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C3-1 (+B) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 5

OK

3.INSPECT MASS AIR FLOW METER

a. Remove the Mass Air Flow (MAF) meter (Click here).

b. Inspect the MAF meter.

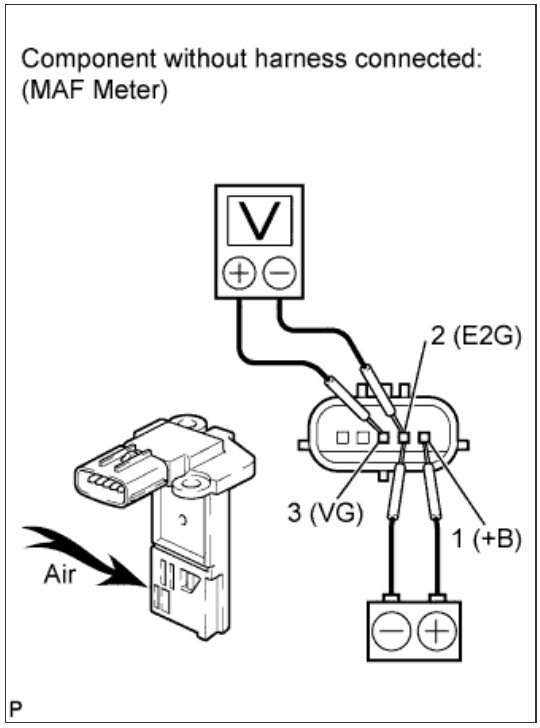
i. Measure the voltage according to the value(s) in the table below.

OK:

Tester Connection	Condition	Specified Condition
2 (E2G) - 3 (VG)	• Battery voltage applied to terminals 1 (+B) - 2 (E2G) • Air blown into the MAF meter	Voltage fluctuates

NOTICE:

While using the battery during inspection, do not bring the positive and negative tester probes too close to each other as a short circuit may occur.



NG → REPLACE MASS AIR FLOW METER (Click here)

OK

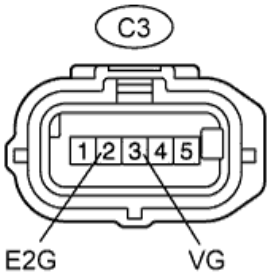
4.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

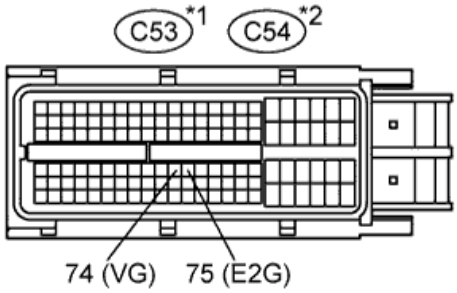
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - INTEGRATION RELAY)

a. Check the EFI NO. 2 fuse.

i. Remove the EFI NO. 2 fuse from the engine room relay block.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 fuse	Always	Below 1 Ω

iii. Reinstall the EFI NO. 2 fuse.

b. Disconnect the C3 MAF meter connector.

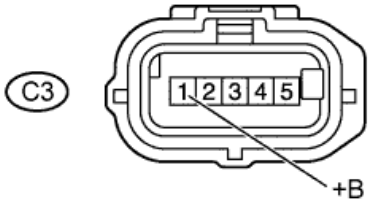
c. Remove the integration relay from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

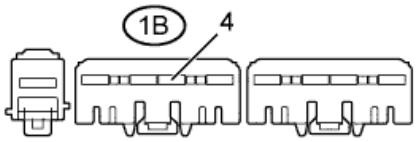
Standard Resistance:

Tester Connection	Condition	Specified Condition
C3-1 (+B) - 1B-4	Always	Below 1 Ω
C3-1 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (Click here)

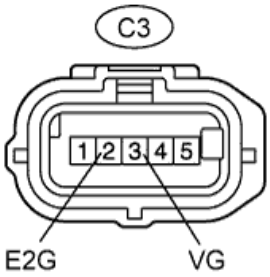
6.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

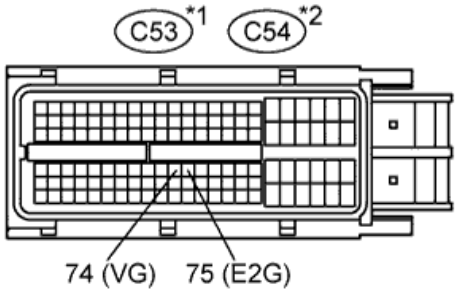
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C53-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C53-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C53-74 (VG) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-3 (VG) - C54-74 (VG)	Always	Below 1 Ω
C3-2 (E2G) - C54-75 (E2G)	Always	Below 1 Ω
C3-3 (VG) or C54-74 (VG) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.CHECK HARNESS AND CONNECTOR (SENSOR GROUND)

a. Disconnect the C3 MAF meter connector.

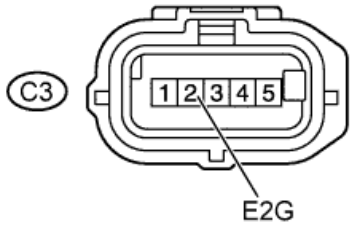
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

		Specified

Tester Connection	Condition	Condition
C3-2 (E2G) - Body ground	Always	Below 1 Ω

Front view of wire harness connector:
(to MAF Meter)



P

NG → REPLACE ECM (Click here)

OK → REPLACE MASS AIR FLOW METER (Click here)

DTC P0606 ECM / PCM Processor

for Preparation Click here

DESCRIPTION

The ECM continuously monitors its main and sub CPUs. This self-check ensures that the ECM is functioning properly. If outputs from the CPUs are different and deviate from the standard, the ECM will illuminate the MIL and store DTC(s) immediately.

DTC Code	DTC Detection Condition	Trouble Area
P0606	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P0606 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

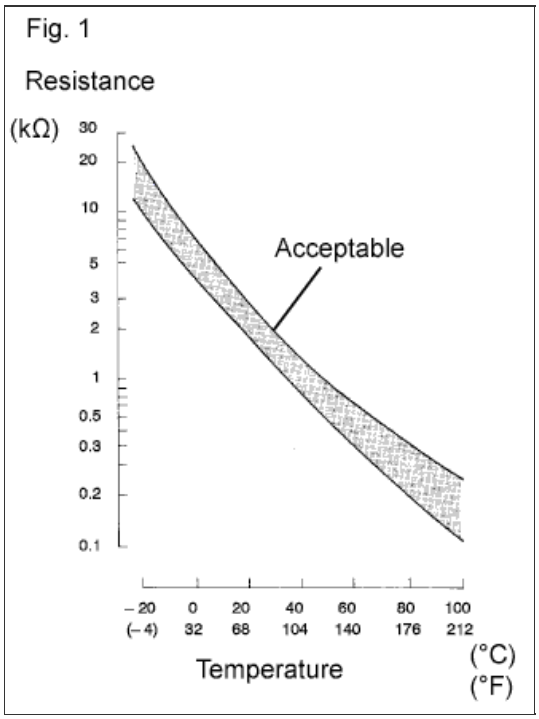
DTC P0110 Intake Air Temperature Circuit Malfunction

DTC P0112 Intake Air Temperature Circuit Low Input

DTC P0113 Intake Air Temperature Circuit High Input

for Preparation Click here

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 is stored, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0110	An open or short in the Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Intake Air Temperature (IAT) sensor circuit • IAT sensor (built into Mass Air Flow [MAF] meter) • ECM
P0112	A short in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	An open in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:

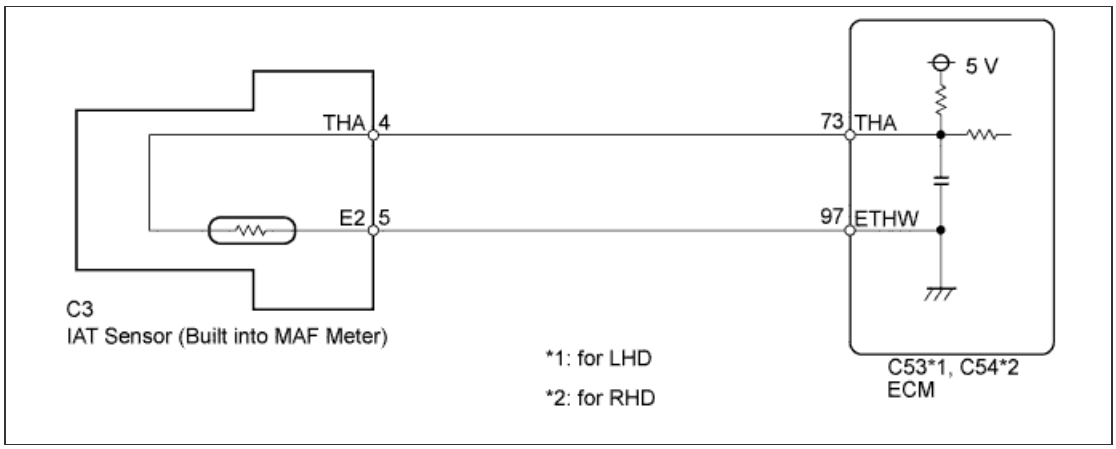
When any of these DTCs are output, check the IAT by entering the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the IAT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and stores a DTC.
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and stores DTC P0113. Conversely, if the output voltage is below 0.18 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0112.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

e. Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Connect terminals 4 (THA) and 5 (E2) of the MAF meter wire harness side connector.

c. Connect the intelligent tester to the DLC3.

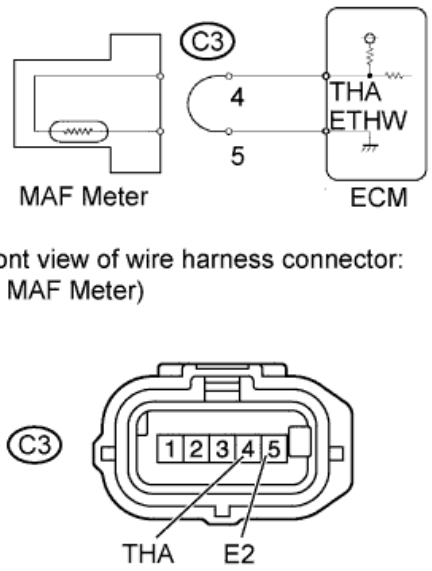
d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



NG → Go to step 3

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER (Click here)

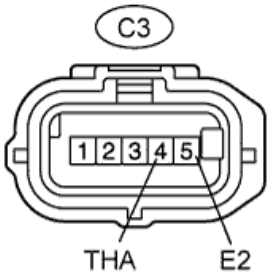
3.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

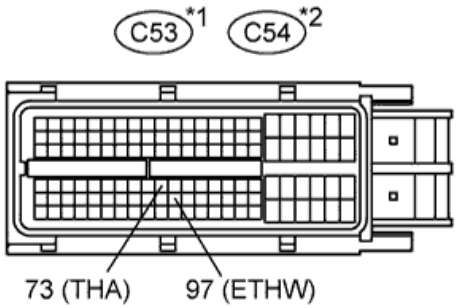
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C53-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C53-97 (ETHW)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C54-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C54-97 (ETHW)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

4.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C3 MAF meter connector.

b. Connect the intelligent tester to the DLC3.

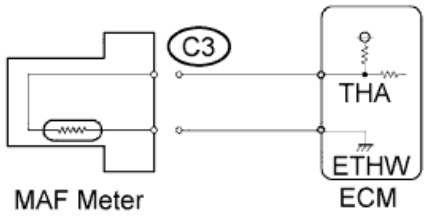
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE MASS AIR FLOW METER (Click here)

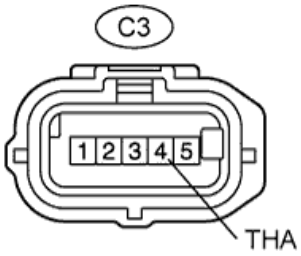
5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

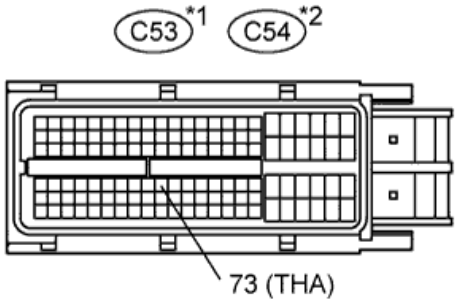
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C53-73 (THA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C54-73 (THA) -		10 kΩ or

Body ground	Always	higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0606 ECM / PCM Processor

for Preparation Click here

DESCRIPTION

The ECM continuously monitors its main and sub CPUs. This self-check ensures that the ECM is functioning properly. If outputs from the CPUs are different and deviate from the standard, the ECM will illuminate the MIL and store DTC(s) immediately.

DTC Code	DTC Detection Condition	Trouble Area
P0606	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P0606 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

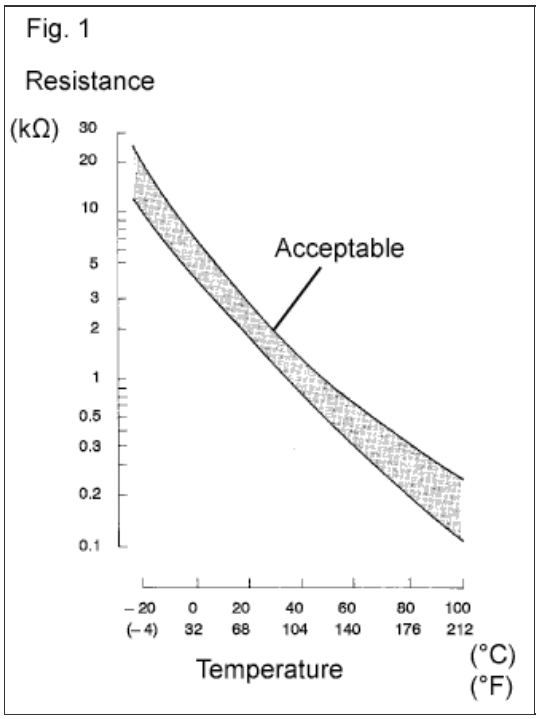
DTC P0110 Intake Air Temperature Circuit Malfunction

DTC P0112 Intake Air Temperature Circuit Low Input

DTC P0113 Intake Air Temperature Circuit High Input

for Preparation Click here

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 is stored, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0110	An open or short in the Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Intake Air Temperature (IAT) sensor circuit • IAT sensor (built into Mass Air Flow [MAF] meter) • ECM
P0112	A short in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	An open in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:

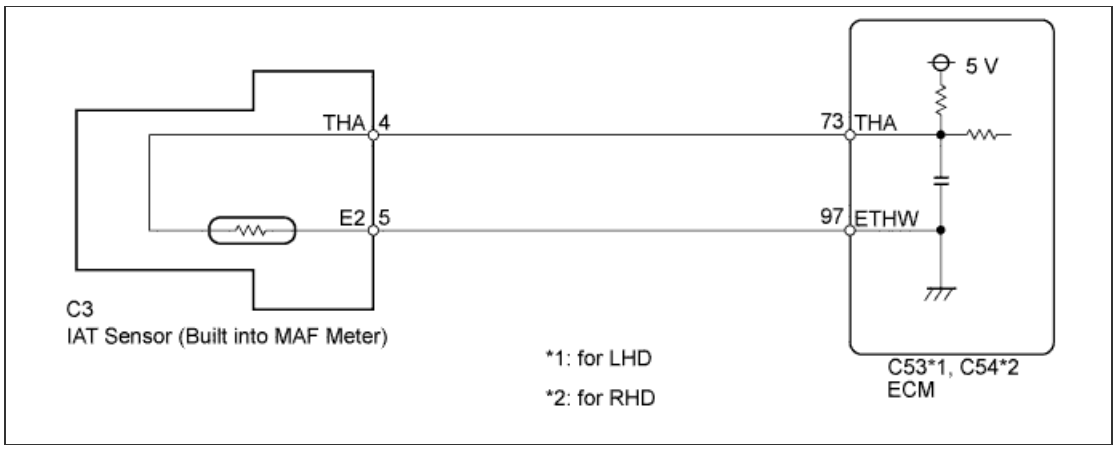
When any of these DTCs are output, check the IAT by entering the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the IAT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and stores a DTC.
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and stores DTC P0113. Conversely, if the output voltage is below 0.18 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0112.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

e. Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Connect terminals 4 (THA) and 5 (E2) of the MAF meter wire harness side connector.

c. Connect the intelligent tester to the DLC3.

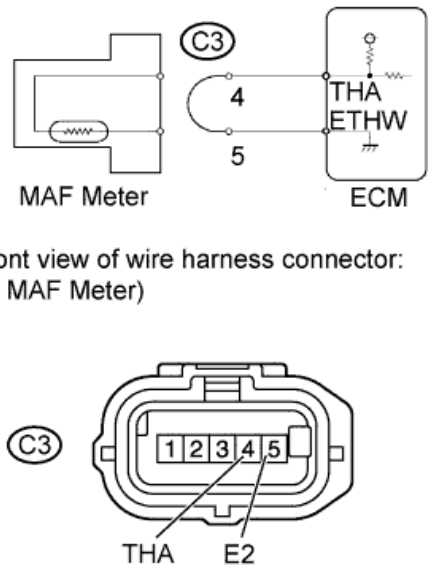
d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



NG → Go to step 3

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER (Click here)

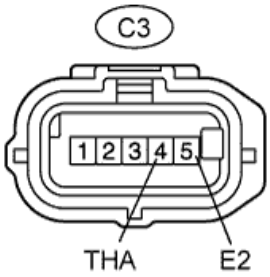
3.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

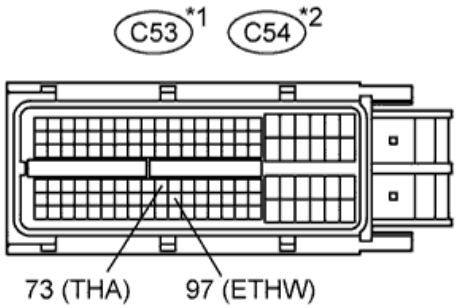
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C53-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C53-97 (ETHW)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C54-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C54-97 (ETHW)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

4.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C3 MAF meter connector.

b. Connect the intelligent tester to the DLC3.

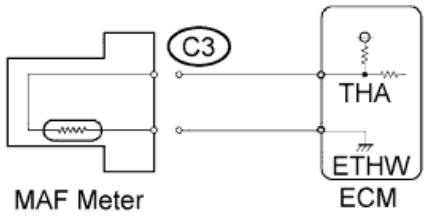
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE MASS AIR FLOW METER (Click here)

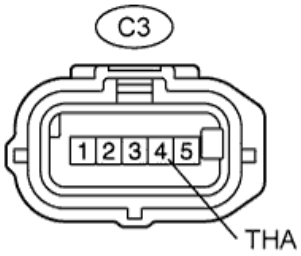
5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

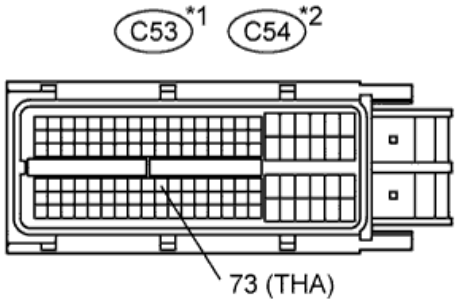
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C53-73 (THA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C54-73 (THA) -		10 kΩ or

Body ground	Always	higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060A Internal Control Module Monitoring Processor Performance

for Preparation Click here

DESCRIPTION

The main CPU and sub CPU of the ECM perform data communication between each other. The main CPU monitors the communications and WDC pulses from the sub CPU. When the signal malfunctions below are detected, a DTC is stored.

DTC Code	DTC Detection Condition	Trouble Area
P060A	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error. • An electronic throttle monitoring CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060A is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

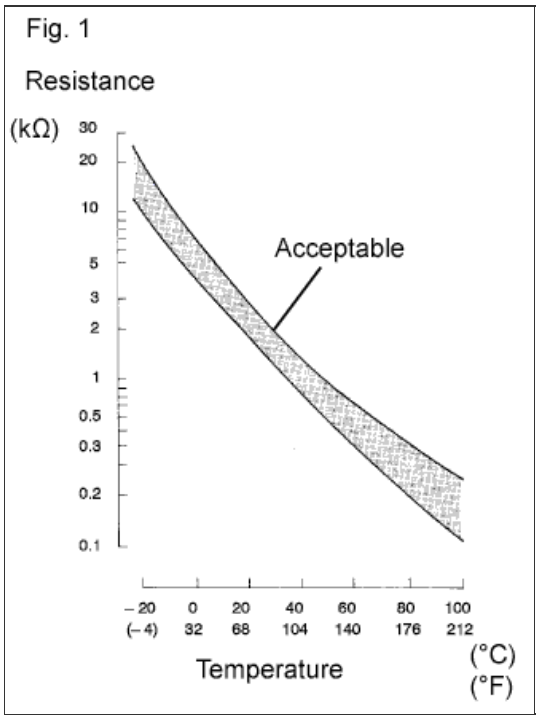
DTC P0110 Intake Air Temperature Circuit Malfunction

DTC P0112 Intake Air Temperature Circuit Low Input

DTC P0113 Intake Air Temperature Circuit High Input

for Preparation Click here

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 is stored, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0110	An open or short in the Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Intake Air Temperature (IAT) sensor circuit • IAT sensor (built into Mass Air Flow [MAF] meter) • ECM
P0112	A short in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	An open in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:

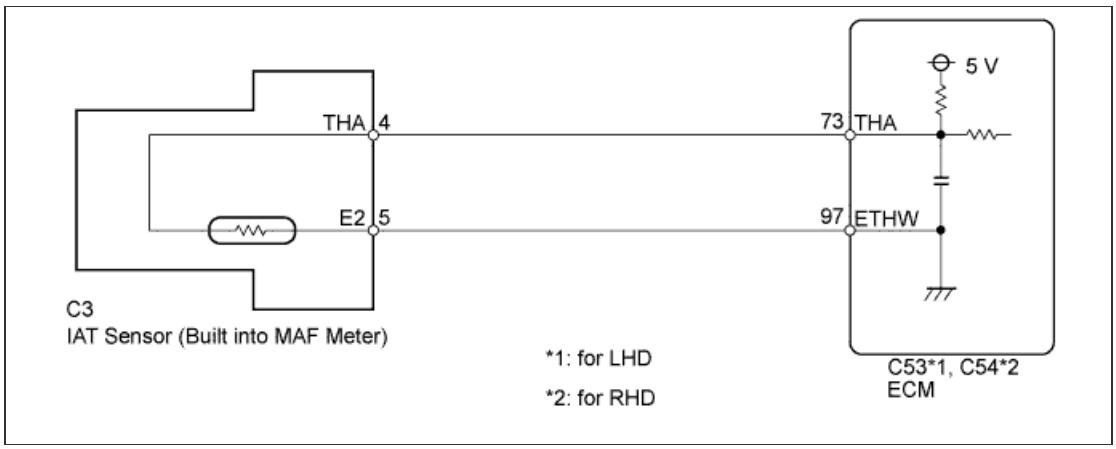
When any of these DTCs are output, check the IAT by entering the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the IAT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and stores a DTC.
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and stores DTC P0113. Conversely, if the output voltage is below 0.18 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0112.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

e. Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Connect terminals 4 (THA) and 5 (E2) of the MAF meter wire harness side connector.

c. Connect the intelligent tester to the DLC3.

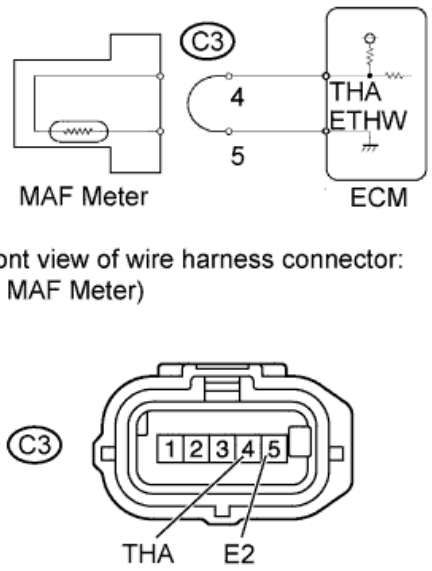
d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



NG → Go to step 3

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER (Click here)

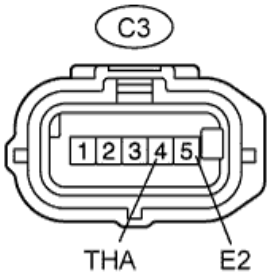
3.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

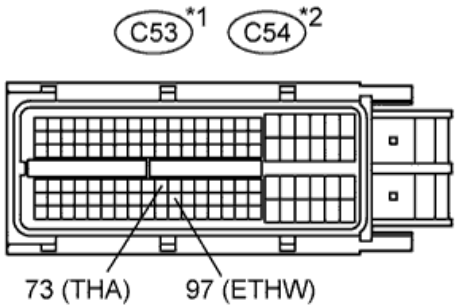
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C53-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C53-97 (ETHW)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C54-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C54-97 (ETHW)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

4.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C3 MAF meter connector.

b. Connect the intelligent tester to the DLC3.

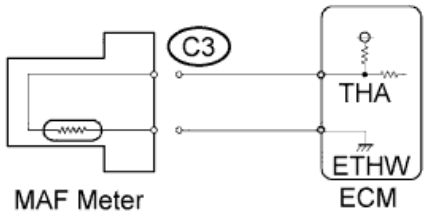
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE MASS AIR FLOW METER (Click here)

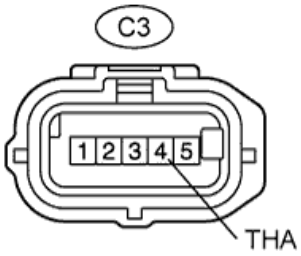
5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

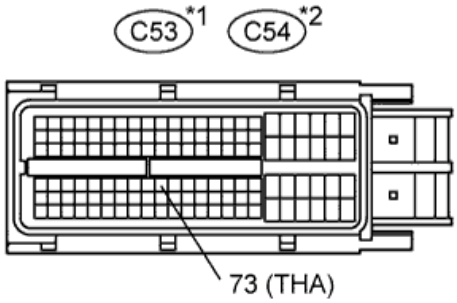
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C53-73 (THA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C54-73 (THA) -		10 kΩ or

Body ground	Always	higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060A Internal Control Module Monitoring Processor Performance

for Preparation Click here

DESCRIPTION

The main CPU and sub CPU of the ECM perform data communication between each other. The main CPU monitors the communications and WDC pulses from the sub CPU. When the signal malfunctions below are detected, a DTC is stored.

DTC Code	DTC Detection Condition	Trouble Area
P060A	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error. • An electronic throttle monitoring CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060A is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

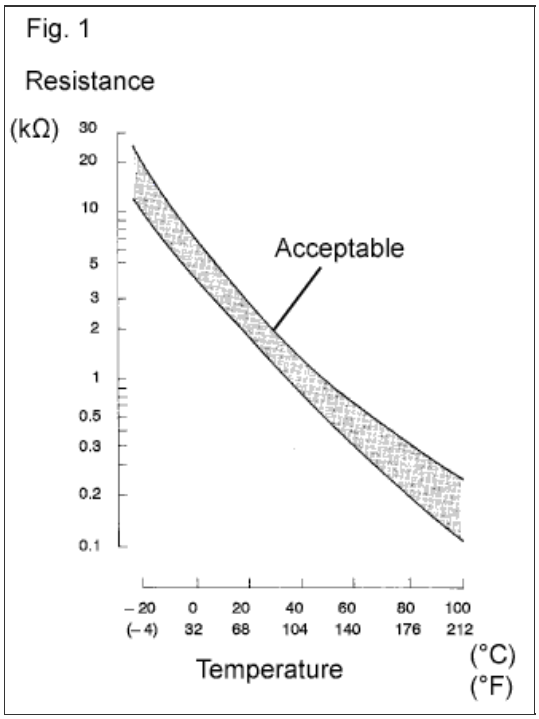
DTC P0110 Intake Air Temperature Circuit Malfunction

DTC P0112 Intake Air Temperature Circuit Low Input

DTC P0113 Intake Air Temperature Circuit High Input

for Preparation Click here

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 is stored, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0110	An open or short in the Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Intake Air Temperature (IAT) sensor circuit • IAT sensor (built into Mass Air Flow [MAF] meter) • ECM
P0112	A short in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	An open in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:

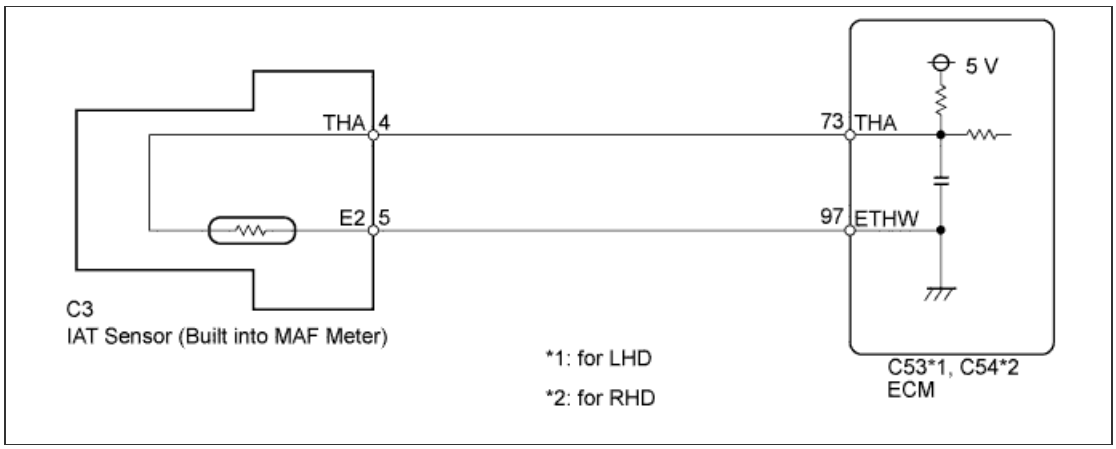
When any of these DTCs are output, check the IAT by entering the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the IAT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and stores a DTC.
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and stores DTC P0113. Conversely, if the output voltage is below 0.18 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0112.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

e. Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Connect terminals 4 (THA) and 5 (E2) of the MAF meter wire harness side connector.

c. Connect the intelligent tester to the DLC3.

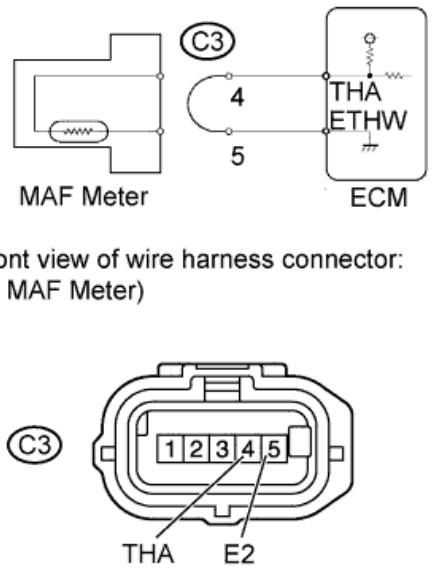
d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



NG → Go to step 3

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER (Click here)

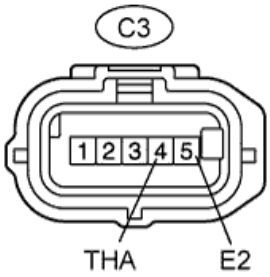
3.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

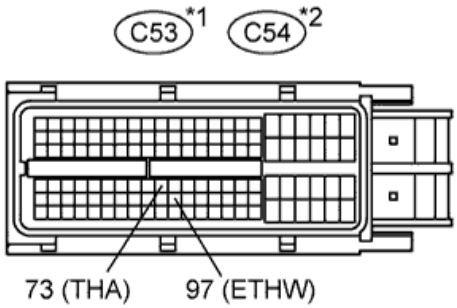
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C53-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C53-97 (ETHW)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C54-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C54-97 (ETHW)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

4.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C3 MAF meter connector.

b. Connect the intelligent tester to the DLC3.

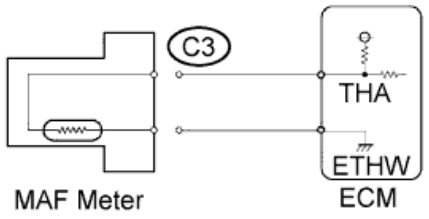
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE MASS AIR FLOW METER (Click here)

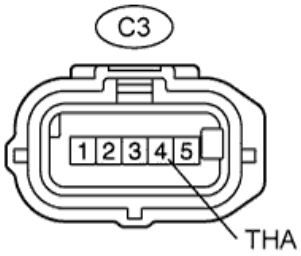
5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

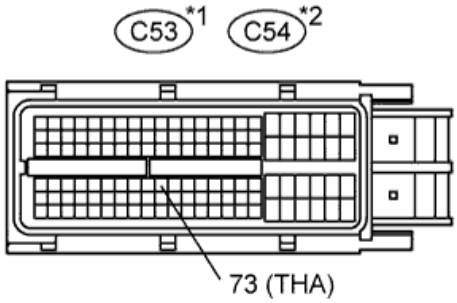
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C53-73 (THA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C54-73 (THA) -		10 kΩ or

Body ground	Always	higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060B Internal Control Module A/D Processing Performance

for Preparation Click here

DESCRIPTION

This DTC is stored when a communication error occurs in the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P060B	An ECM main CPU communication error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060B is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

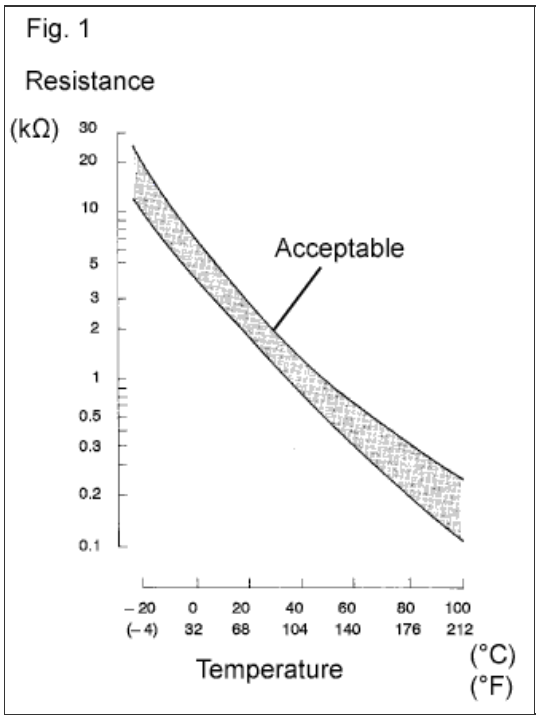
DTC P0110 Intake Air Temperature Circuit Malfunction

DTC P0112 Intake Air Temperature Circuit Low Input

DTC P0113 Intake Air Temperature Circuit High Input

for Preparation Click here

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 is stored, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0110	An open or short in the Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Intake Air Temperature (IAT) sensor circuit • IAT sensor (built into Mass Air Flow [MAF] meter) • ECM
P0112	A short in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	An open in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:

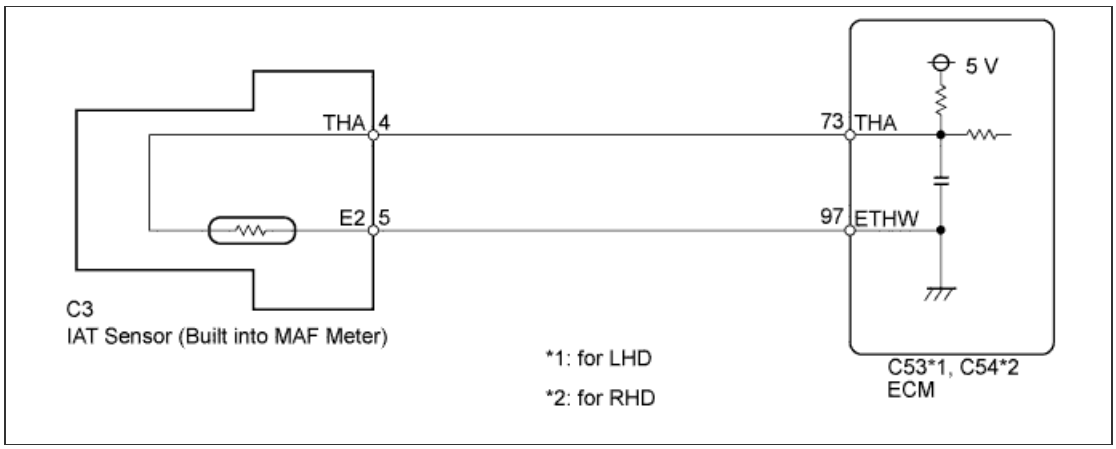
When any of these DTCs are output, check the IAT by entering the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the IAT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and stores a DTC.
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and stores DTC P0113. Conversely, if the output voltage is below 0.18 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0112.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

e. Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Connect terminals 4 (THA) and 5 (E2) of the MAF meter wire harness side connector.

c. Connect the intelligent tester to the DLC3.

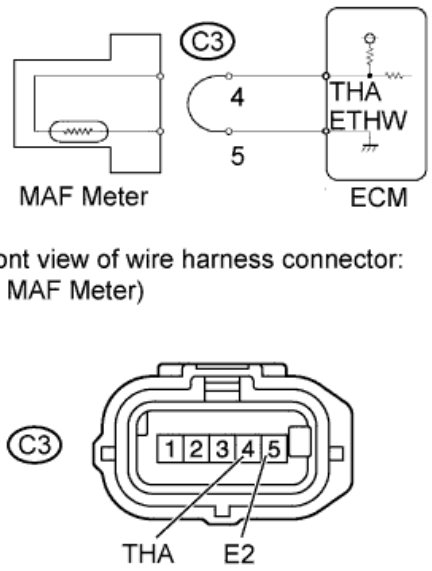
d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



NG → Go to step 3

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER (Click here)

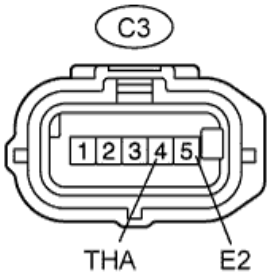
3.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

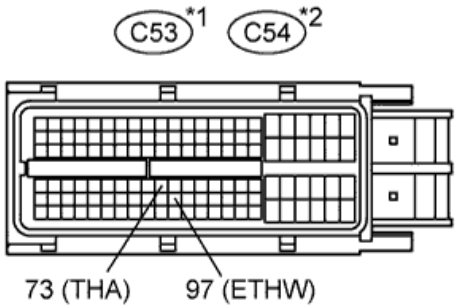
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C53-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C53-97 (ETHW)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C54-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C54-97 (ETHW)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

4.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C3 MAF meter connector.

b. Connect the intelligent tester to the DLC3.

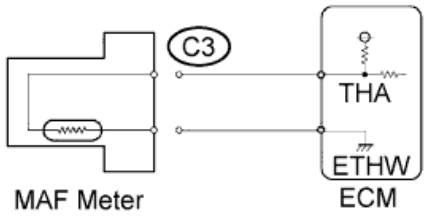
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE MASS AIR FLOW METER (Click here)

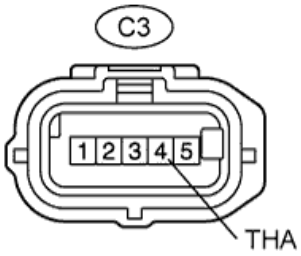
5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

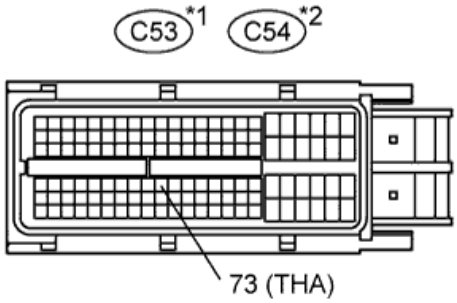
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C53-73 (THA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C54-73 (THA) -		10 kΩ or

Body ground	Always	higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060B Internal Control Module A/D Processing Performance

for Preparation Click here

DESCRIPTION

This DTC is stored when a communication error occurs in the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P060B	An ECM main CPU communication error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060B is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

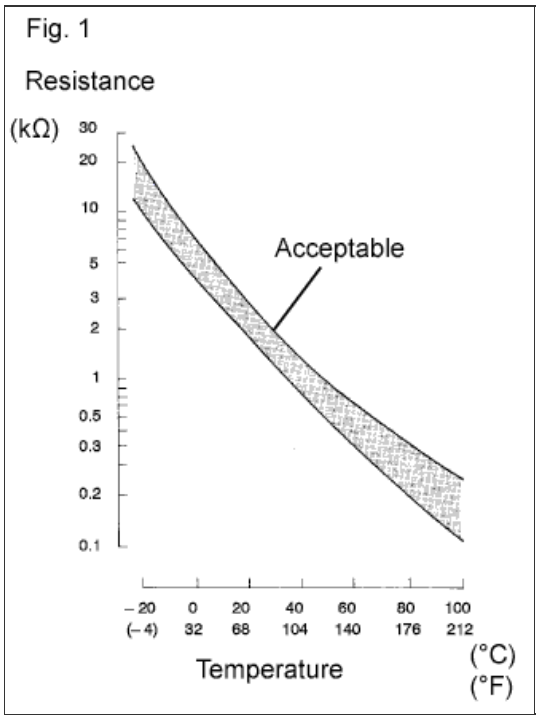
DTC P0110 Intake Air Temperature Circuit Malfunction

DTC P0112 Intake Air Temperature Circuit Low Input

DTC P0113 Intake Air Temperature Circuit High Input

for Preparation Click here

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 is stored, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0110	An open or short in the Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Intake Air Temperature (IAT) sensor circuit • IAT sensor (built into Mass Air Flow [MAF] meter) • ECM
P0112	A short in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	An open in the IAT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:

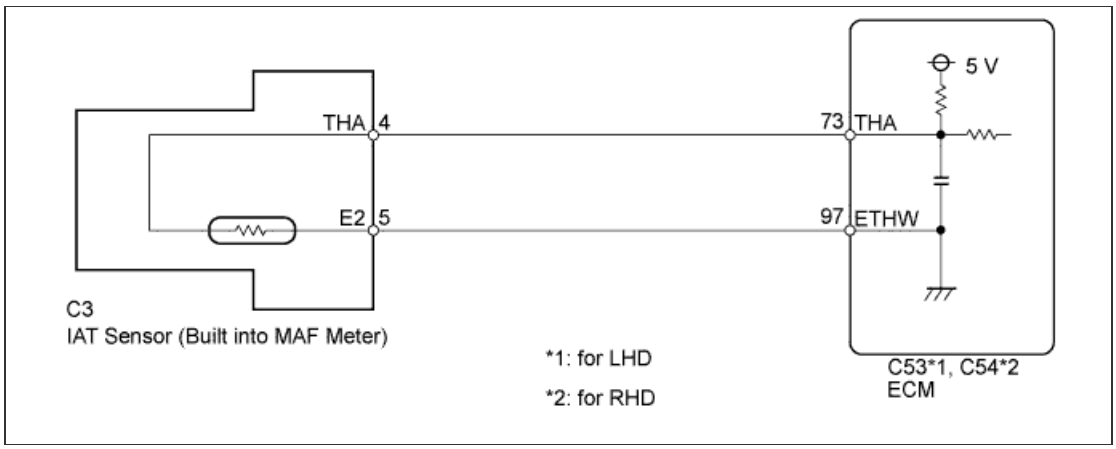
When any of these DTCs are output, check the IAT by entering the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the IAT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and stores a DTC.
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and stores DTC P0113. Conversely, if the output voltage is below 0.18 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0112.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

e. Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C3 Mass Air Flow (MAF) meter connector.

b. Connect terminals 4 (THA) and 5 (E2) of the MAF meter wire harness side connector.

c. Connect the intelligent tester to the DLC3.

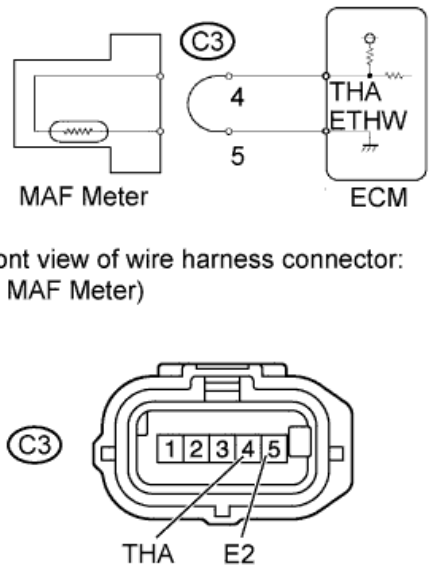
d. Turn the engine switch on (IG).

e. Turn the tester on.

f. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



NG → Go to step 3

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER (Click here)

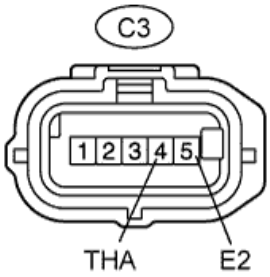
3.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

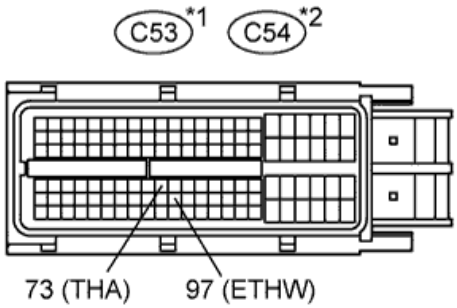
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Mass Air Flow Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C53-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C53-97 (ETHW)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) - C54-73 (THA)	Always	Below 1 Ω
C3-5 (E2) - C54-97 (ETHW)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

4.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C3 MAF meter connector.

b. Connect the intelligent tester to the DLC3.

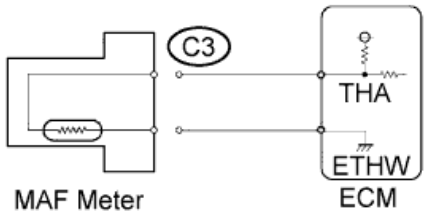
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / All Data / Intake Air.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE MASS AIR FLOW METER (Click here)

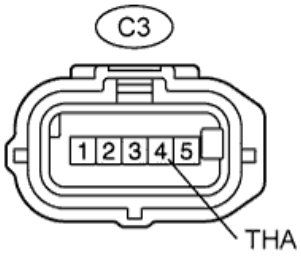
5.CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

a. Disconnect the C3 MAF meter connector.

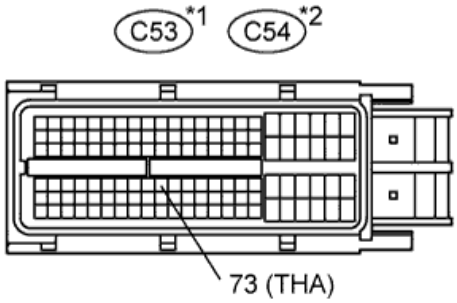
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to MAF Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C53-73 (THA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C3-4 (THA) or C54-73 (THA) -		10 kΩ or

Body ground	Always	higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060D Internal Control Module Accelerator Pedal Position Performance

for Preparation Click here

DESCRIPTION

The ECM monitors the input signals of the Accelerator Pedal Position (APP) sensor No. 1. When the input signals and control signals are deviated, a DTC is stored.

DTC Code	DTC Detection Condition	Trouble Area
P060D	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060D is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0115 Engine Coolant Temperature Circuit Malfunction

DTC P0117 Engine Coolant Temperature Circuit Low Input

DTC P0118 Engine Coolant Temperature Circuit High Input

for Preparation Click here

DESCRIPTION

A thermistor, whose resistance value varies according to the ECT, is built into the Engine Coolant Temperature (ECT) sensor.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 is stored, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0115	An open or short in the Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Engine Coolant Temperature (ECT) sensor circuit • ECT sensor • ECM
P0117	A short in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in ECT sensor • ECT sensor • ECM
P0118	An open in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

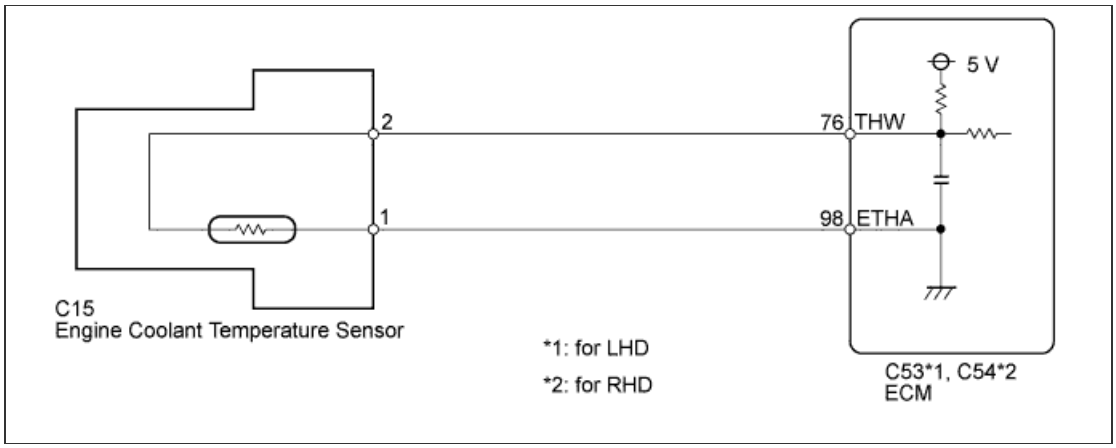
When any of these DTCs is output, check the ECT by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and stores DTC(s).
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and stores DTC P0118. Conversely, if the voltage output is below 0.14 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0117.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

e. Read the value displayed on the tester.

Standard value:
Between 80 and 100°C (167 and 212°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80 and 100°C (176 and 212°F)	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C15 Engine Coolant Temperature (ECT) sensor connector.

b. Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.

c. Connect the intelligent tester to the DLC3.

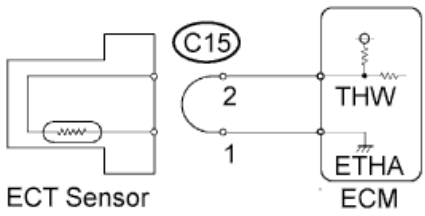
d. Turn the engine switch on (IG).

e. Turn the tester on.

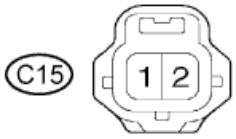
f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



Front view of wire harness connector:
(to ECT Sensor)



NG → Go to step 3

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

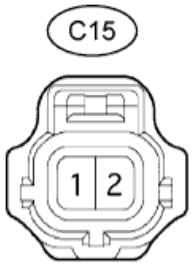
3.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

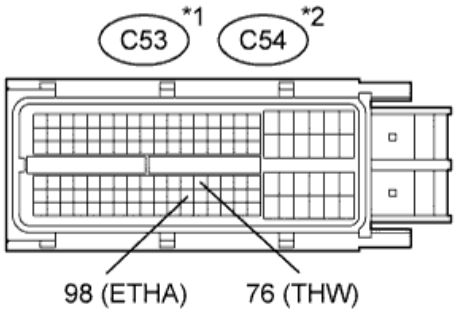
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 - C53-76 (THW)	Always	Below 1 Ω
C15-1 - C53-98 (ETHA)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C15-2 - C54-76 (THW)	Always	Below 1 Ω
C15-1 - C54-98 (ETHA)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

4.READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C15 ECT sensor connector.

b. Connect the intelligent tester to the DLC3.

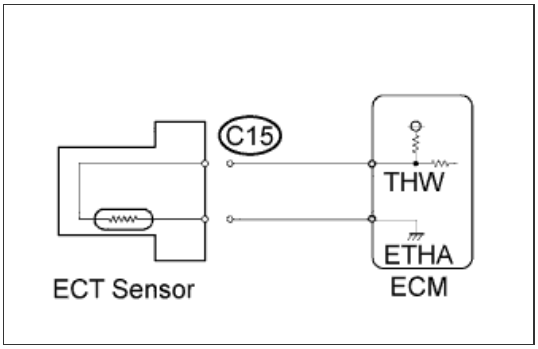
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

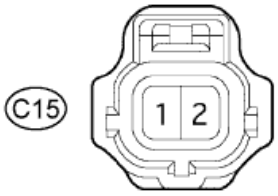
5.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

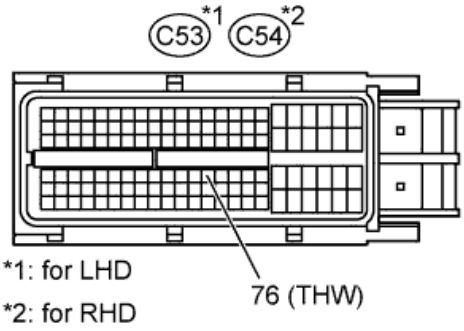
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 or C53-76 (THW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C15-2 or C54-76 (THW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060D Internal Control Module Accelerator Pedal Position Performance

for Preparation Click here

DESCRIPTION

The ECM monitors the input signals of the Accelerator Pedal Position (APP) sensor No. 1. When the input signals and control signals are deviated, a DTC is stored.

DTC Code	DTC Detection Condition	Trouble Area
P060D	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060D is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0115 Engine Coolant Temperature Circuit Malfunction

DTC P0117 Engine Coolant Temperature Circuit Low Input

DTC P0118 Engine Coolant Temperature Circuit High Input

for Preparation Click here

DESCRIPTION

A thermistor, whose resistance value varies according to the ECT, is built into the Engine Coolant Temperature (ECT) sensor.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 is stored, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0115	An open or short in the Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Engine Coolant Temperature (ECT) sensor circuit • ECT sensor • ECM
P0117	A short in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in ECT sensor • ECT sensor • ECM
P0118	An open in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

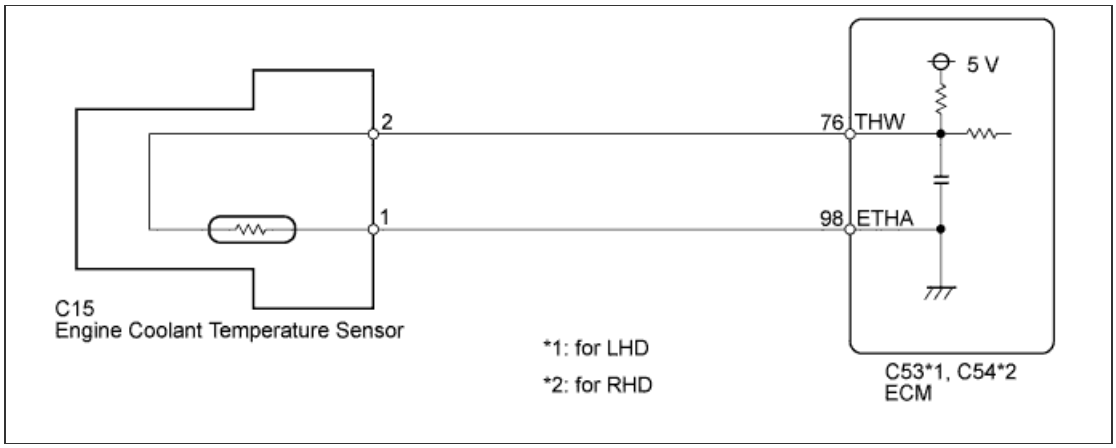
When any of these DTCs is output, check the ECT by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and stores DTC(s).
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and stores DTC P0118. Conversely, if the voltage output is below 0.14 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0117.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

e. Read the value displayed on the tester.

Standard value:
Between 80 and 100°C (167 and 212°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80 and 100°C (176 and 212°F)	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C15 Engine Coolant Temperature (ECT) sensor connector.

b. Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.

c. Connect the intelligent tester to the DLC3.

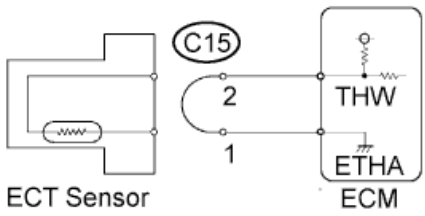
d. Turn the engine switch on (IG).

e. Turn the tester on.

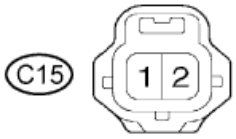
f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



Front view of wire harness connector:
(to ECT Sensor)



NG → Go to step 3

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

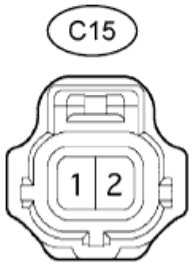
3.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

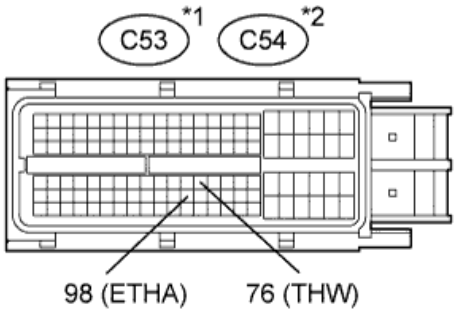
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 - C53-76 (THW)	Always	Below 1 Ω
C15-1 - C53-98 (ETHA)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C15-2 - C54-76 (THW)	Always	Below 1 Ω
C15-1 - C54-98 (ETHA)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

4.READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C15 ECT sensor connector.

b. Connect the intelligent tester to the DLC3.

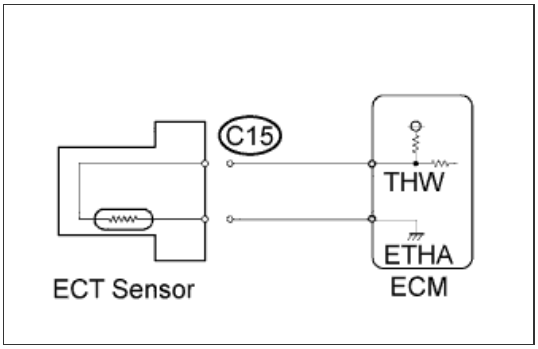
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

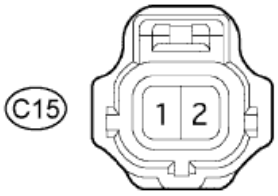
5.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

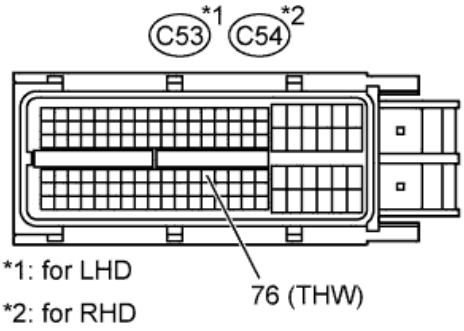
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 or C53-76 (THW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C15-2 or C54-76 (THW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060E Internal Control Module Throttle Position Performance

for Preparation Click here

DESCRIPTION

The ECM monitors the input signals of the Throttle Position (TP) sensor No. 1 and stop light switch. As the ECM monitors the input signals of the TP sensor No. 1 and the STP signals of the stop light switch, if the input signals and control signals are deviated, a DTC is stored.

DTC Code	DTC Detection Condition	Trouble Area
P060E	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060E is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0115 Engine Coolant Temperature Circuit Malfunction

DTC P0117 Engine Coolant Temperature Circuit Low Input

DTC P0118 Engine Coolant Temperature Circuit High Input

for Preparation Click here

DESCRIPTION

A thermistor, whose resistance value varies according to the ECT, is built into the Engine Coolant Temperature (ECT) sensor.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 is stored, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0115	An open or short in the Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Engine Coolant Temperature (ECT) sensor circuit • ECT sensor • ECM
P0117	A short in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in ECT sensor • ECT sensor • ECM
P0118	An open in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

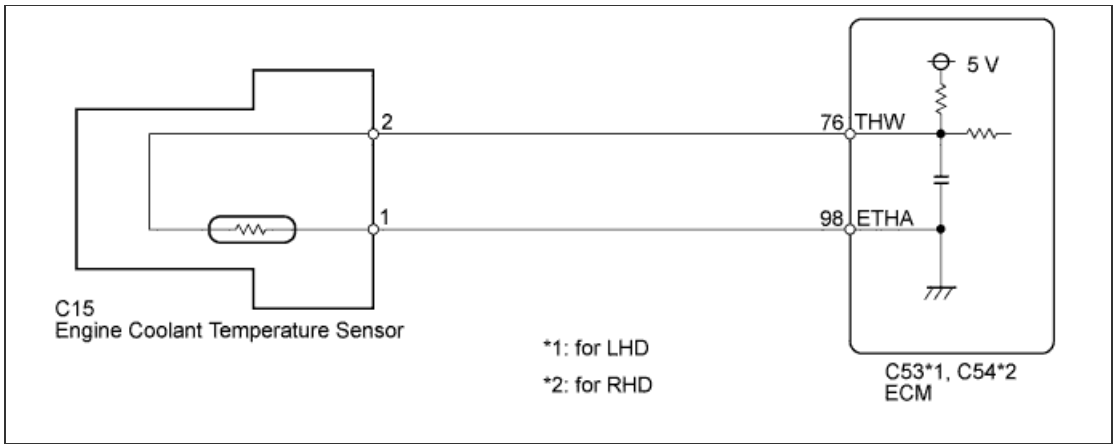
When any of these DTCs is output, check the ECT by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and stores DTC(s).
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and stores DTC P0118. Conversely, if the voltage output is below 0.14 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0117.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

e. Read the value displayed on the tester.

Standard value:
Between 80 and 100°C (167 and 212°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80 and 100°C (176 and 212°F)	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C15 Engine Coolant Temperature (ECT) sensor connector.

b. Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.

c. Connect the intelligent tester to the DLC3.

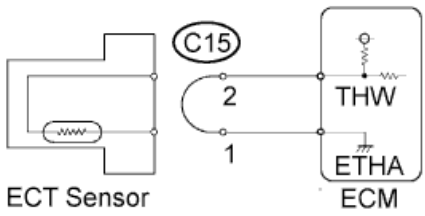
d. Turn the engine switch on (IG).

e. Turn the tester on.

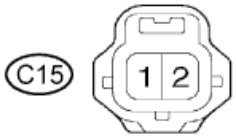
f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



Front view of wire harness connector:
(to ECT Sensor)



NG → Go to step 3

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

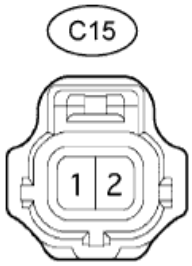
3.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

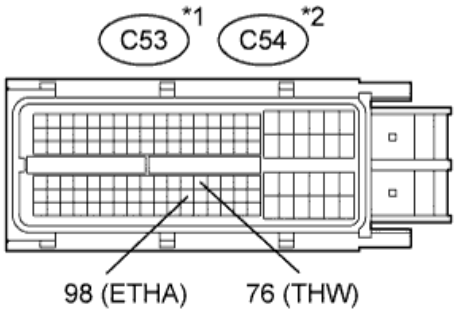
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 - C53-76 (THW)	Always	Below 1 Ω
C15-1 - C53-98 (ETHA)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C15-2 - C54-76 (THW)	Always	Below 1 Ω
C15-1 - C54-98 (ETHA)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

4.READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C15 ECT sensor connector.

b. Connect the intelligent tester to the DLC3.

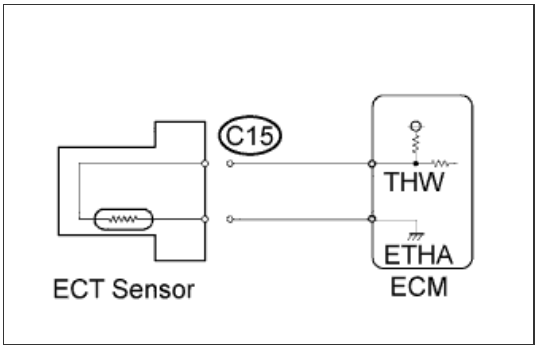
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

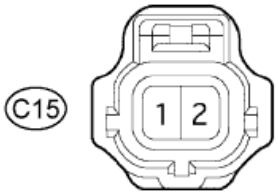
5.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

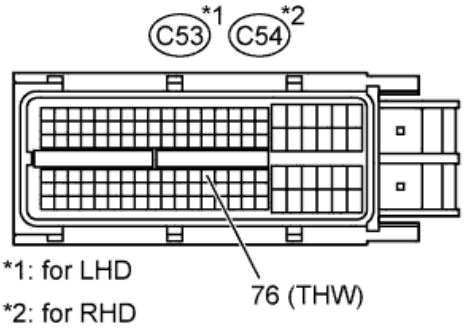
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 or C53-76 (THW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C15-2 or C54-76 (THW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P060E Internal Control Module Throttle Position Performance

for Preparation Click here

DESCRIPTION

The ECM monitors the input signals of the Throttle Position (TP) sensor No. 1 and stop light switch. As the ECM monitors the input signals of the TP sensor No. 1 and the STP signals of the stop light switch, if the input signals and control signals are deviated, a DTC is stored.

DTC Code	DTC Detection Condition	Trouble Area
P060E	When either condition below is met: • An ECM main CPU error. • An ECM sub CPU error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P060E is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0115 Engine Coolant Temperature Circuit Malfunction

DTC P0117 Engine Coolant Temperature Circuit Low Input

DTC P0118 Engine Coolant Temperature Circuit High Input

for Preparation Click here

DESCRIPTION

A thermistor, whose resistance value varies according to the ECT, is built into the Engine Coolant Temperature (ECT) sensor.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 is stored, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0115	An open or short in the Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Engine Coolant Temperature (ECT) sensor circuit • ECT sensor • ECM
P0117	A short in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in ECT sensor • ECT sensor • ECM
P0118	An open in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

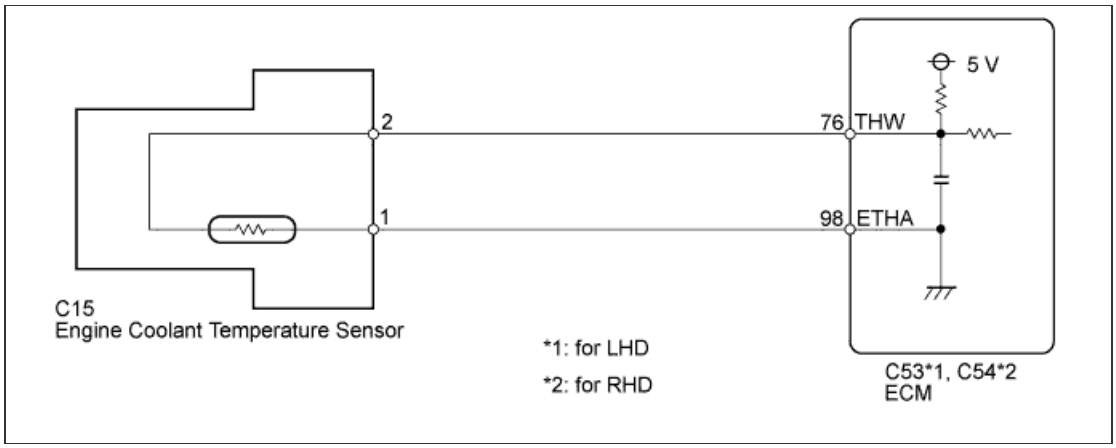
When any of these DTCs is output, check the ECT by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and stores DTC(s).
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and stores DTC P0118. Conversely, if the voltage output is below 0.14 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0117.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

e. Read the value displayed on the tester.

Standard value:
Between 80 and 100°C (167 and 212°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80 and 100°C (176 and 212°F)	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C15 Engine Coolant Temperature (ECT) sensor connector.

b. Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.

c. Connect the intelligent tester to the DLC3.

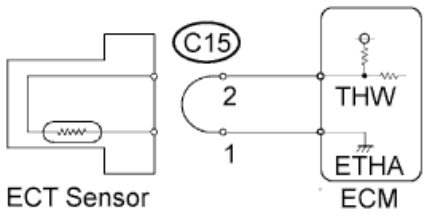
d. Turn the engine switch on (IG).

e. Turn the tester on.

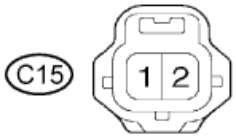
f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



Front view of wire harness connector:
(to ECT Sensor)



NG → Go to step 3

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

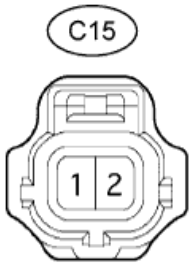
3.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

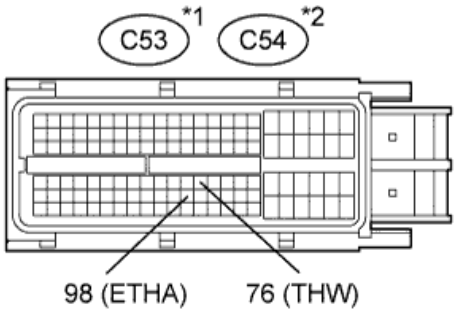
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 - C53-76 (THW)	Always	Below 1 Ω
C15-1 - C53-98 (ETHA)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C15-2 - C54-76 (THW)	Always	Below 1 Ω
C15-1 - C54-98 (ETHA)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

4.READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C15 ECT sensor connector.

b. Connect the intelligent tester to the DLC3.

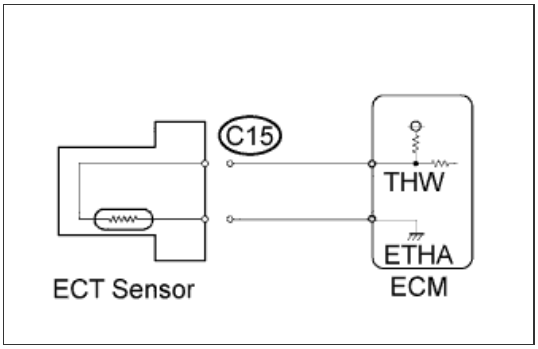
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

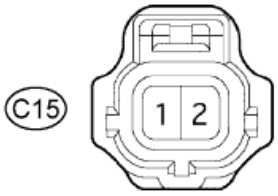
5.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

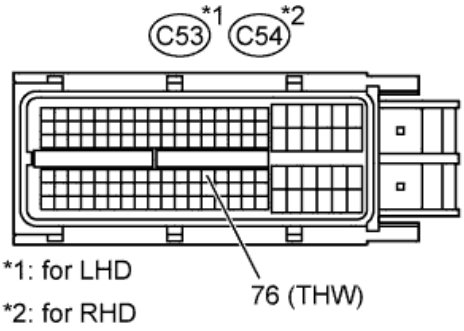
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 or C53-76 (THW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C15-2 or C54-76 (THW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0617 Starter Relay Circuit High

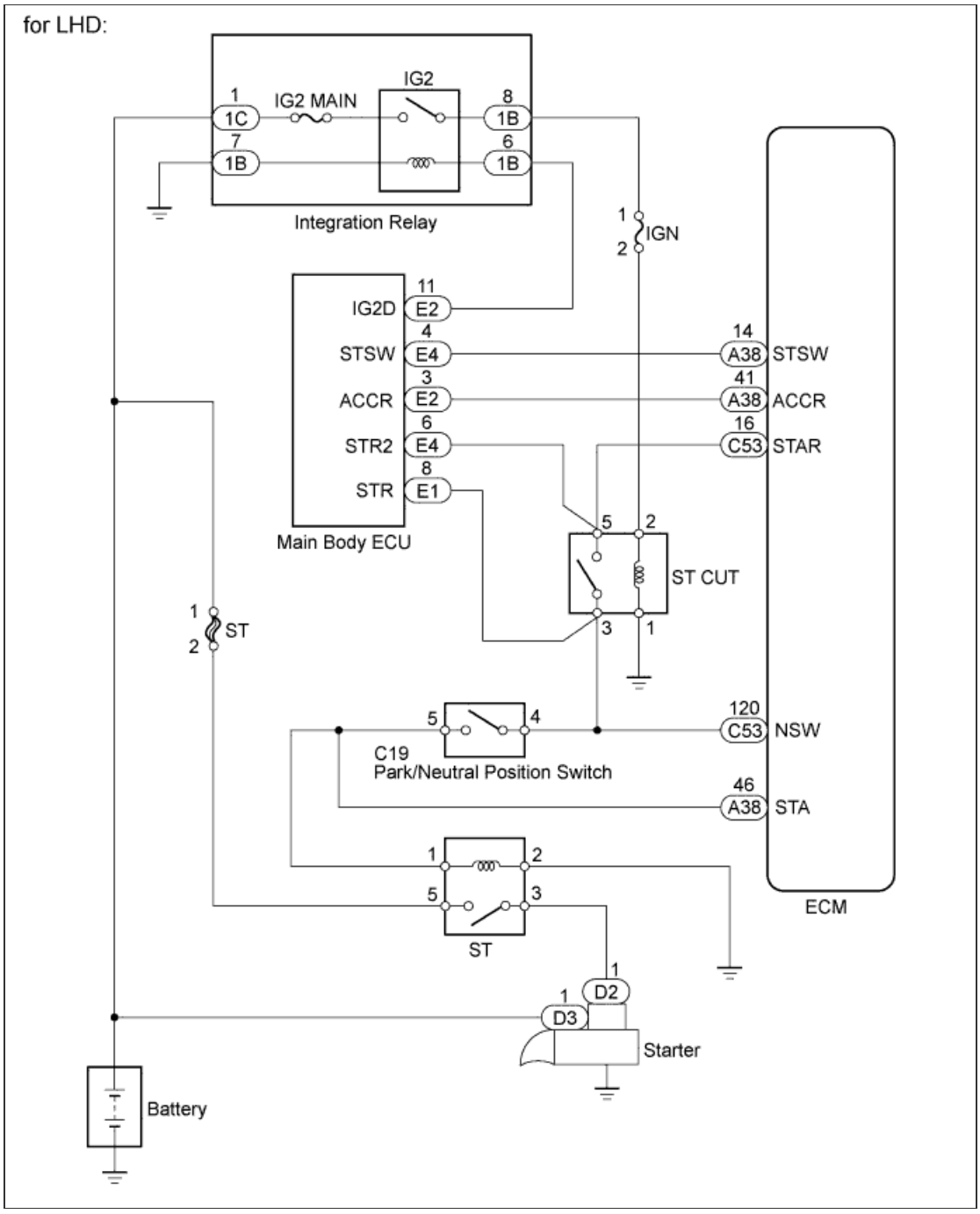
for Preparation Click here

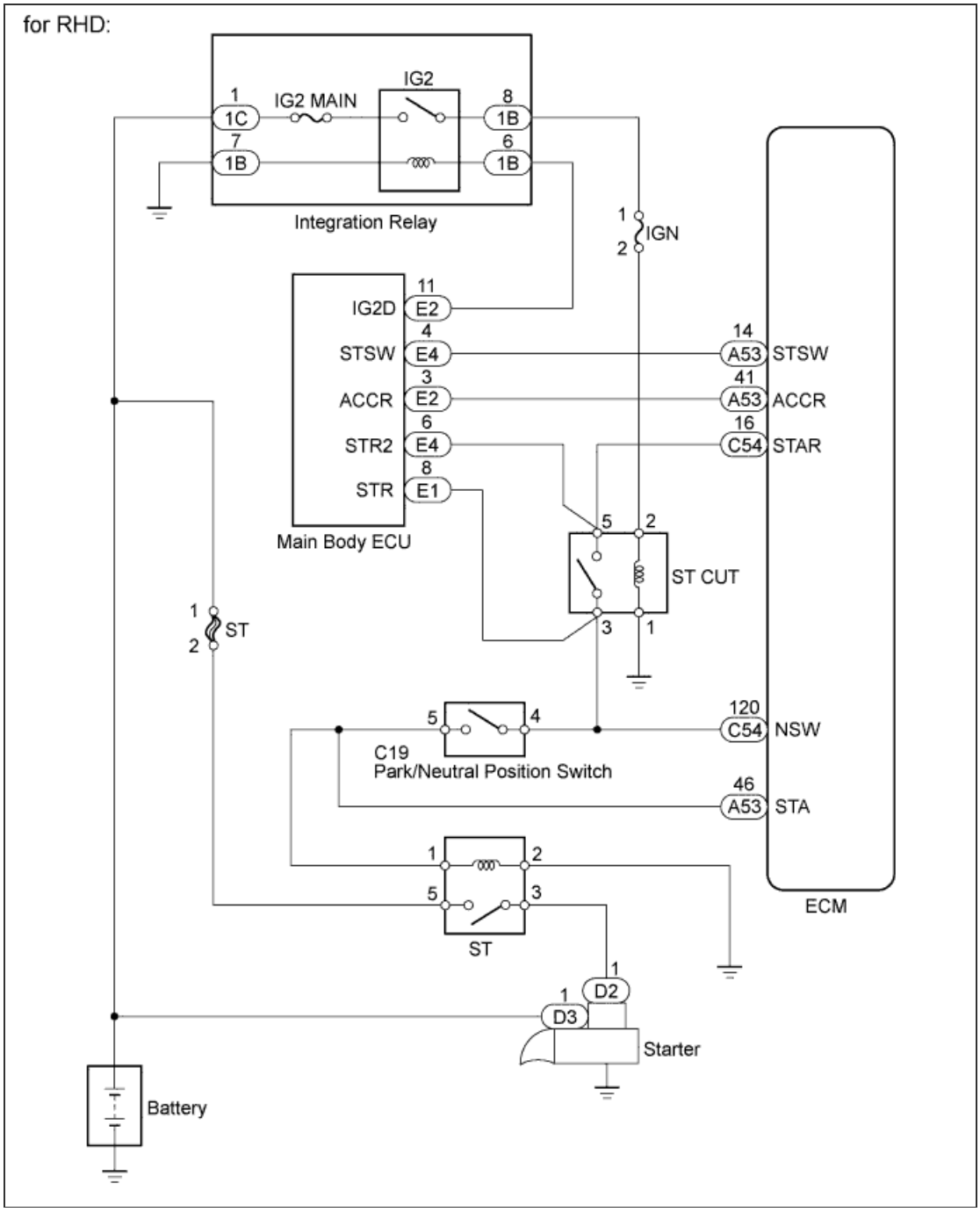
DESCRIPTION

While the engine is being cranked, the positive battery voltage is applied to terminal STA of the ECM. If the ECM detects the Starter Control (STA) signal while the vehicle is being driven, it determines that there is a malfunction in the STA circuit. The ECM then illuminates the MIL and stores the DTC.
This monitor runs when the vehicle is driven at 20 km/h (12.4 mph) for over 20 seconds.

DTC Code	DTC Detection Condition	Trouble Area
P0617	When conditions (a), (b) and (c) are met, and a positive (+B) battery voltage of 10.5 V or higher is applied to the ECM for 20 seconds (1 trip detection logic). (a) The vehicle speed is 20 km/h (12.4 mph) or more. (b) The engine speed is 1000 rpm or more. (c) The STA signal is ON.	• Park/Neutral Position (PNP) switch • Starter relay circuit • Engine switch • ECM

WIRING DIAGRAM





INSPECTION PROCEDURE

HINT:

- **The following troubleshooting flowchart is based on the premise that the engine is cranked normally.**
  If the engine will not crank, proceed to the Problem Symptoms Table (Click here).
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (STARTER SIGNAL)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Starter Signal.

d. Check the value displayed on the tester when the engine switch is turned to the START positions.

OK:

Engine Switch Position	Starter Signal
On (IG)	OFF

START	ON

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT PARK/NEUTRAL POSITION SWITCH ASSEMBLY

a. Inspect the park/neutral position switch (Click here).

NG → REPLACE PARK/NEUTRAL POSITION SWITCH ASSEMBLY (Click here)

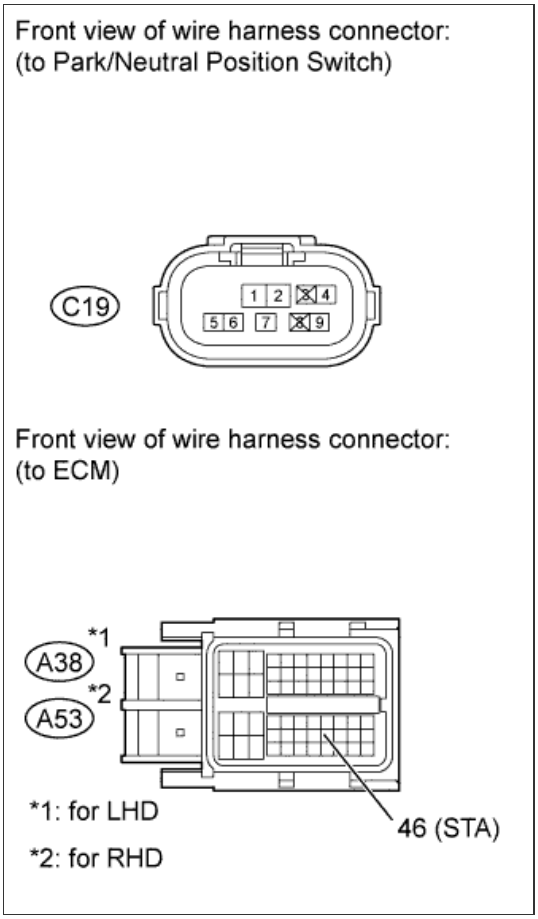
OK

3.CHECK HARNESS AND CONNECTOR (PNP SWITCH - ECM)

a. Disconnect the C19 PNP switch connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C19-5 - A38-46 (STA)	Always	Below 1 Ω
C19-5 or A38-46 (STA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C19-5 - A53-46 (STA)	Always	Below 1 Ω
C19-5 or A53-46 (STA) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO CRANKING HOLDING FUNCTION CIRCUIT (Click here)

DTC P0115 Engine Coolant Temperature Circuit Malfunction

DTC P0117 Engine Coolant Temperature Circuit Low Input

DTC P0118 Engine Coolant Temperature Circuit High Input

for Preparation Click here

DESCRIPTION

A thermistor, whose resistance value varies according to the ECT, is built into the Engine Coolant Temperature (ECT) sensor.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 is stored, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0115	An open or short in the Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Engine Coolant Temperature (ECT) sensor circuit • ECT sensor • ECM
P0117	A short in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in ECT sensor • ECT sensor • ECM
P0118	An open in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

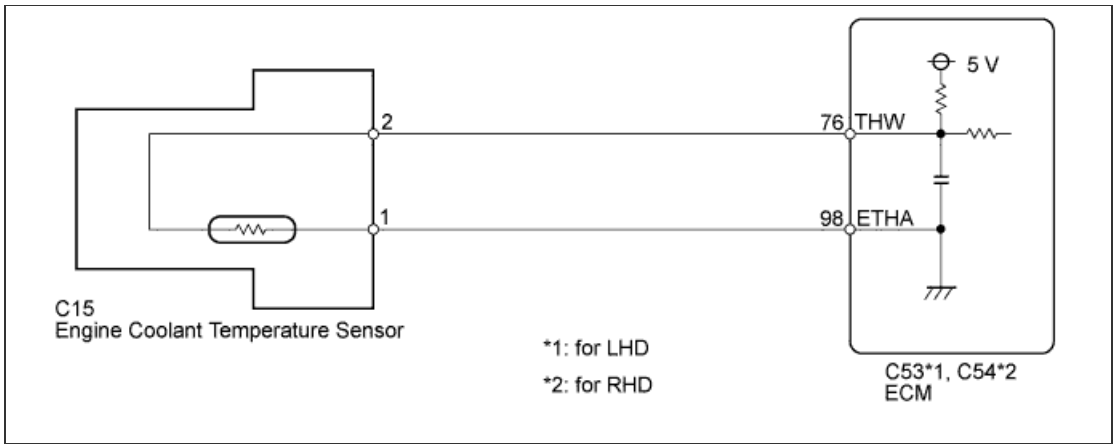
When any of these DTCs is output, check the ECT by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and stores DTC(s).
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and stores DTC P0118. Conversely, if the voltage output is below 0.14 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0117.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

e. Read the value displayed on the tester.

Standard value:
Between 80 and 100°C (167 and 212°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80 and 100°C (176 and 212°F)	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C15 Engine Coolant Temperature (ECT) sensor connector.

b. Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.

c. Connect the intelligent tester to the DLC3.

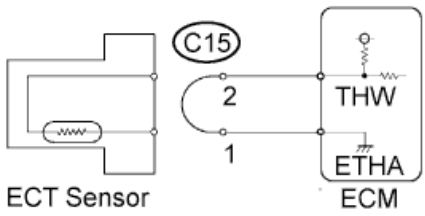
d. Turn the engine switch on (IG).

e. Turn the tester on.

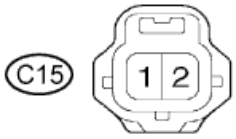
f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



Front view of wire harness connector:
(to ECT Sensor)



NG → Go to step 3

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

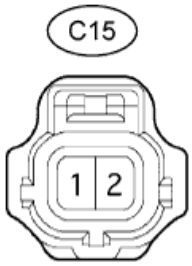
3.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

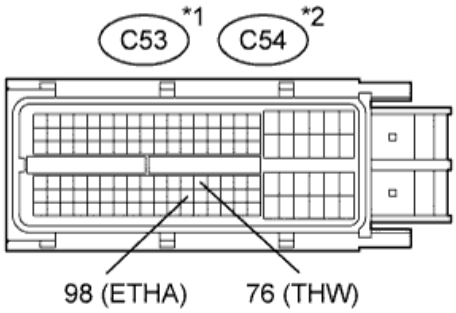
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 - C53-76 (THW)	Always	Below 1 Ω
C15-1 - C53-98 (ETHA)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C15-2 - C54-76 (THW)	Always	Below 1 Ω
C15-1 - C54-98 (ETHA)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

4.READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C15 ECT sensor connector.

b. Connect the intelligent tester to the DLC3.

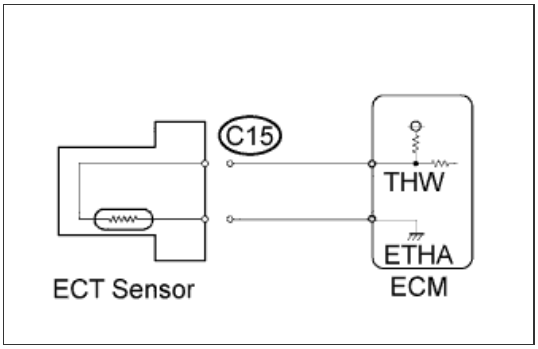
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

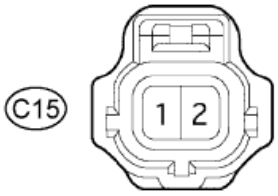
5.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

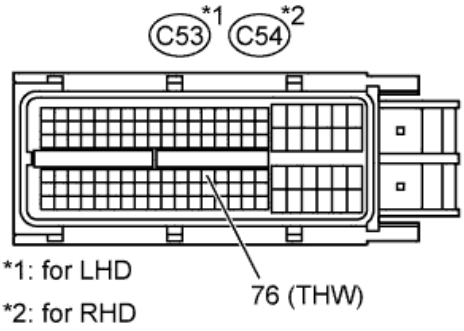
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 or C53-76 (THW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C15-2 or C54-76 (THW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0617 Starter Relay Circuit High

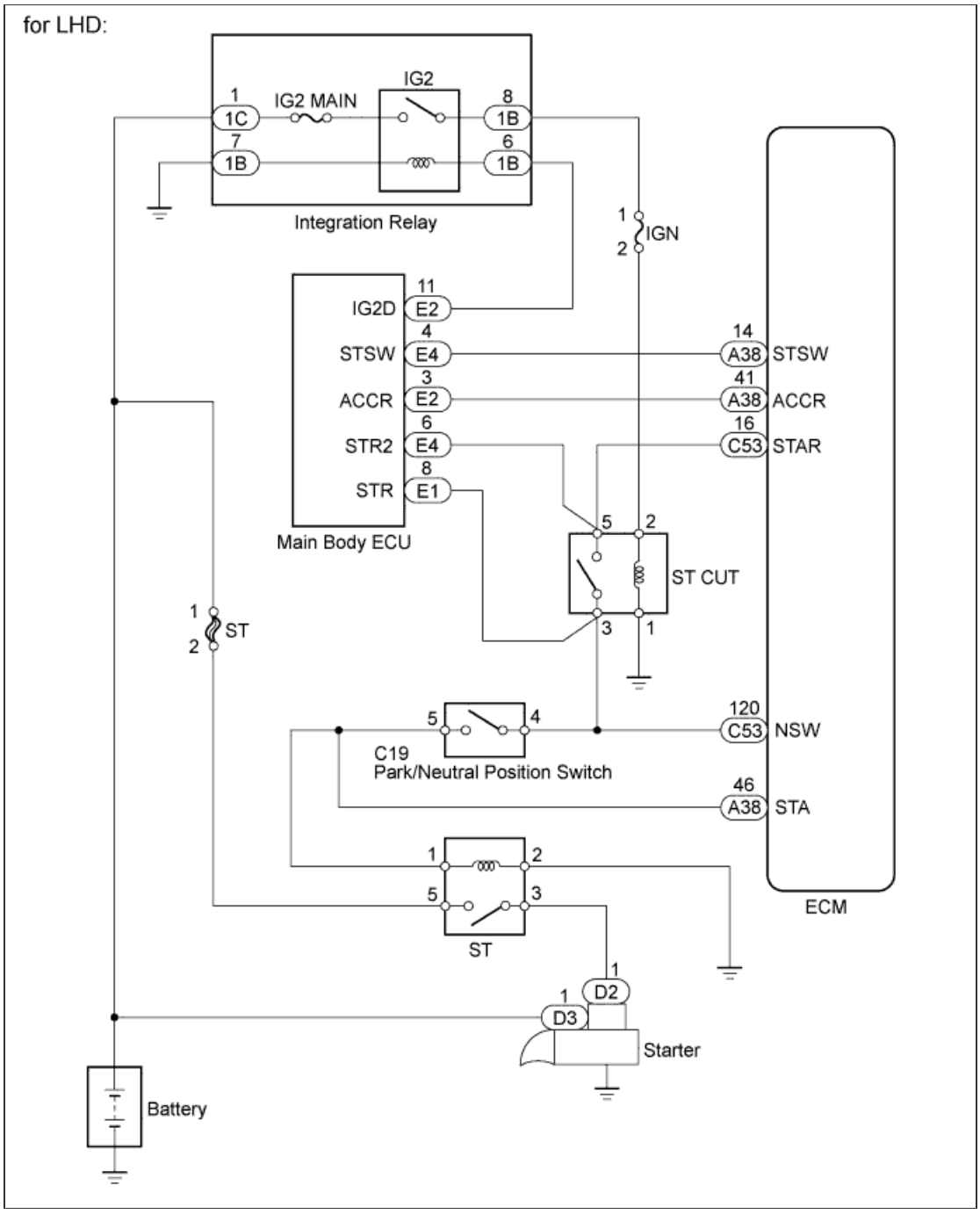
for Preparation Click here

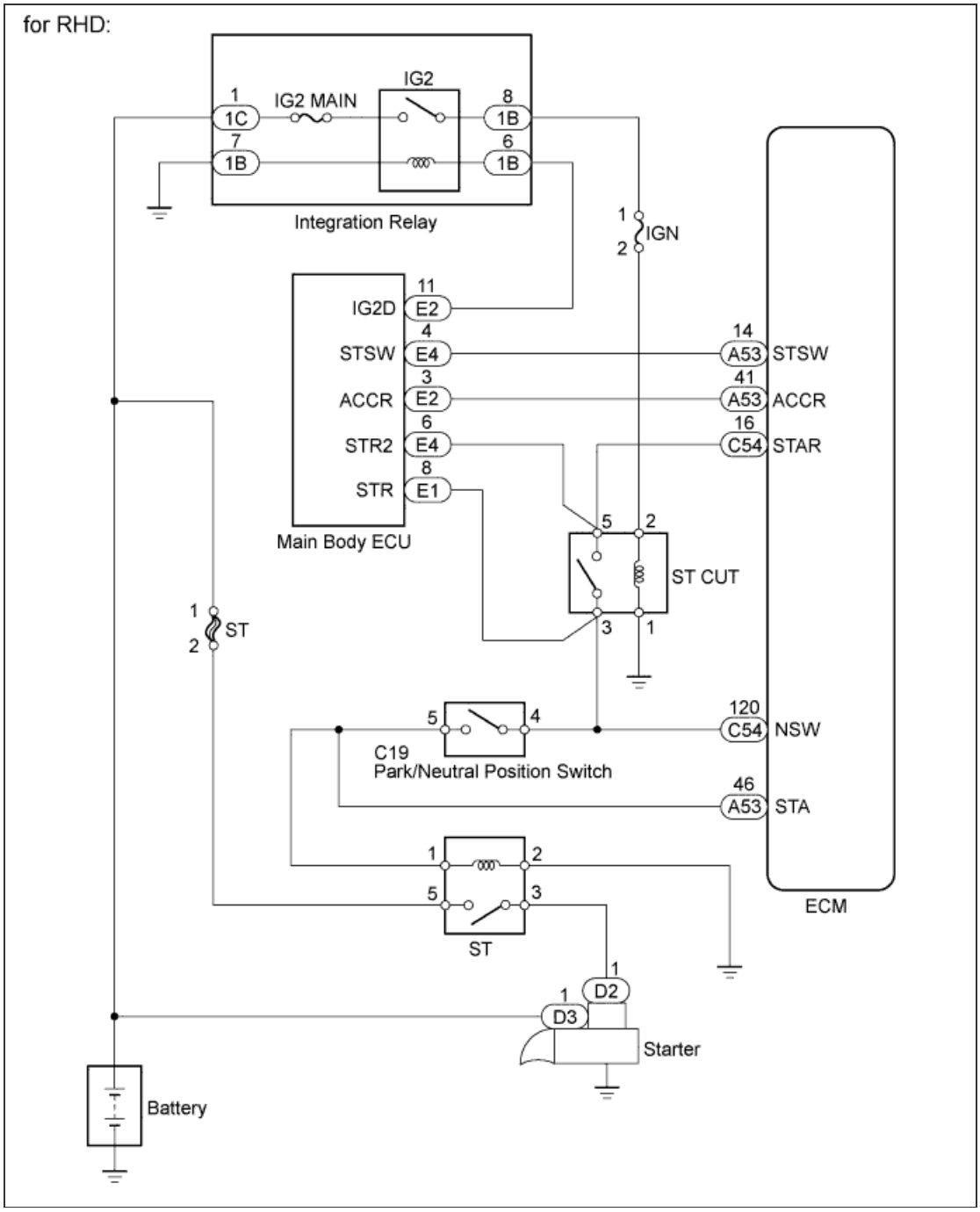
DESCRIPTION

While the engine is being cranked, the positive battery voltage is applied to terminal STA of the ECM. If the ECM detects the Starter Control (STA) signal while the vehicle is being driven, it determines that there is a malfunction in the STA circuit. The ECM then illuminates the MIL and stores the DTC.
This monitor runs when the vehicle is driven at 20 km/h (12.4 mph) for over 20 seconds.

DTC Code	DTC Detection Condition	Trouble Area
P0617	When conditions (a), (b) and (c) are met, and a positive (+B) battery voltage of 10.5 V or higher is applied to the ECM for 20 seconds (1 trip detection logic). (a) The vehicle speed is 20 km/h (12.4 mph) or more. (b) The engine speed is 1000 rpm or more. (c) The STA signal is ON.	• Park/Neutral Position (PNP) switch • Starter relay circuit • Engine switch • ECM

WIRING DIAGRAM





INSPECTION PROCEDURE

HINT:

- **The following troubleshooting flowchart is based on the premise that the engine is cranked normally.**
  If the engine will not crank, proceed to the Problem Symptoms Table (Click here).
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (STARTER SIGNAL)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Starter Signal.

d. Check the value displayed on the tester when the engine switch is turned to the START positions.

OK:

Engine Switch Position	Starter Signal
On (IG)	OFF

START	ON

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

2.INSPECT PARK/NEUTRAL POSITION SWITCH ASSEMBLY

a. Inspect the park/neutral position switch (Click here).

NG → REPLACE PARK/NEUTRAL POSITION SWITCH ASSEMBLY (Click here)

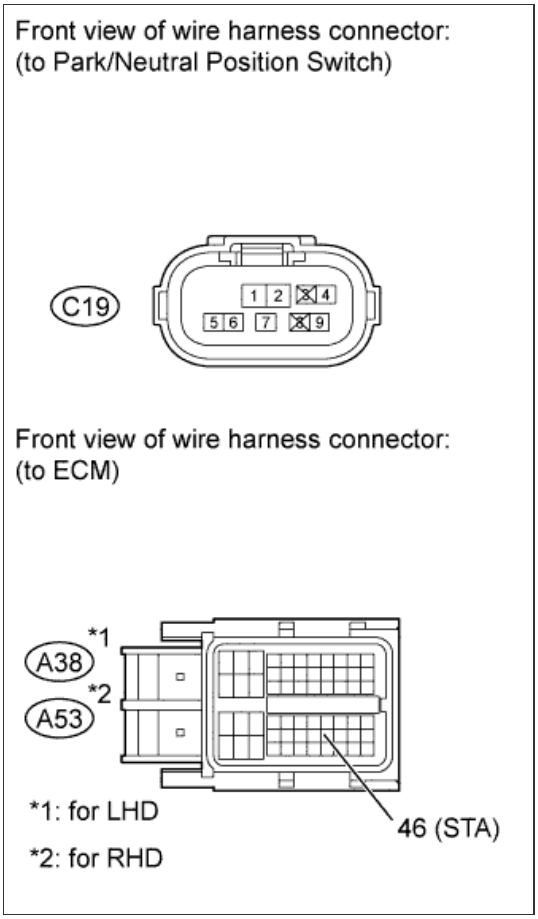
OK

3.CHECK HARNESS AND CONNECTOR (PNP SWITCH - ECM)

a. Disconnect the C19 PNP switch connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C19-5 - A38-46 (STA)	Always	Below 1 Ω
C19-5 or A38-46 (STA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C19-5 - A53-46 (STA)	Always	Below 1 Ω
C19-5 or A53-46 (STA) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO CRANKING HOLDING FUNCTION CIRCUIT (Click here)

DTC P0115 Engine Coolant Temperature Circuit Malfunction

DTC P0117 Engine Coolant Temperature Circuit Low Input

DTC P0118 Engine Coolant Temperature Circuit High Input

for Preparation Click here

DESCRIPTION

A thermistor, whose resistance value varies according to the ECT, is built into the Engine Coolant Temperature (ECT) sensor.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 is stored, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC Code	DTC Detection Condition	Trouble Area
P0115	An open or short in the Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic).	• Open or short in Engine Coolant Temperature (ECT) sensor circuit • ECT sensor • ECM
P0117	A short in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Short in ECT sensor • ECT sensor • ECM
P0118	An open in the ECT sensor circuit for 0.5 seconds (1 trip detection logic).	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

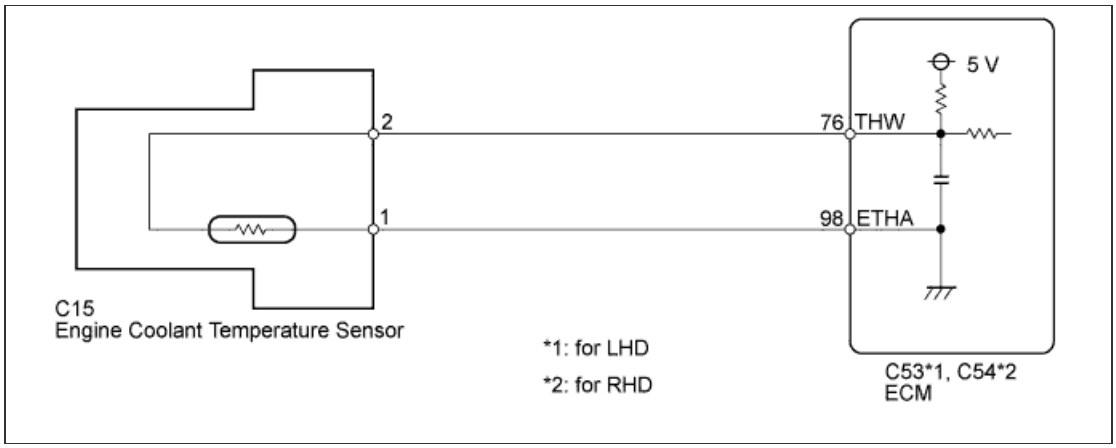
When any of these DTCs is output, check the ECT by entering the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and stores DTC(s).
Example:
If the sensor output voltage is higher than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and stores DTC P0118. Conversely, if the voltage output is below 0.14 V for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and stores DTC P0117.
If the malfunction is not repaired successfully, a DTC is stored 0.5 seconds after the engine is next started.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

e. Read the value displayed on the tester.

Standard value:
Between 80 and 100°C (167 and 212°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80 and 100°C (176 and 212°F)	C

HINT:

- **If there is an open circuit, the tester indicates -40°C (-40°F).**
- **If there is a short circuit, the tester indicates 140°C (284°F) or higher.**

B	Go to step 4
C	CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

a. Disconnect the C15 Engine Coolant Temperature (ECT) sensor connector.

b. Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.

c. Connect the intelligent tester to the DLC3.

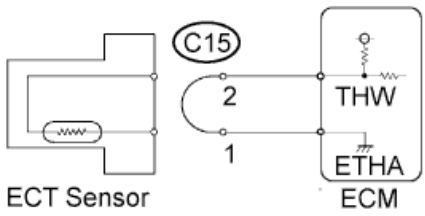
d. Turn the engine switch on (IG).

e. Turn the tester on.

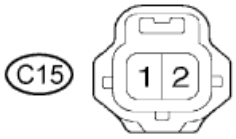
f. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

g. Read the value displayed on the tester.

Standard value:
140°C (284°F) or higher



Front view of wire harness connector:
(to ECT Sensor)



NG → Go to step 3

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM (Click here)

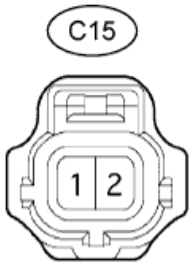
3.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

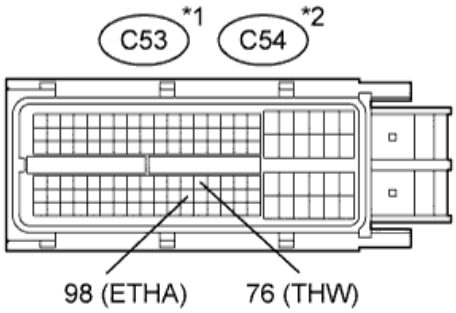
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 - C53-76 (THW)	Always	Below 1 Ω
C15-1 - C53-98 (ETHA)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C15-2 - C54-76 (THW)	Always	Below 1 Ω
C15-1 - C54-98 (ETHA)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

4.READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

a. Disconnect the C15 ECT sensor connector.

b. Connect the intelligent tester to the DLC3.

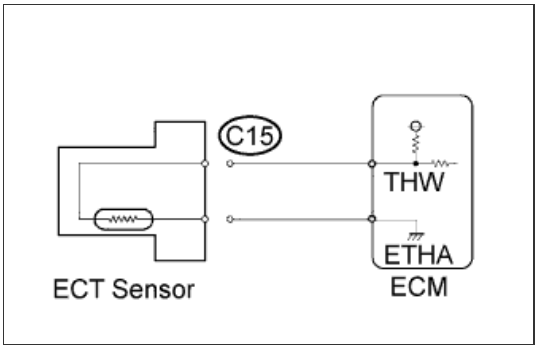
c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

f. Read the value displayed on the tester.

Standard value:
-40°C (-40°F)



NG → Go to step 5

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

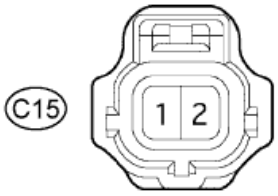
5.CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

a. Disconnect the C15 ECT sensor connector.

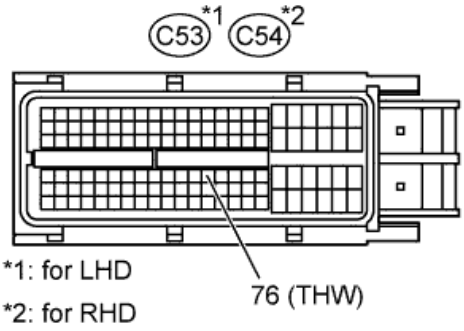
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to ECT Sensor)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C15-2 or C53-76 (THW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C15-2 or C54-76 (THW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0657 Actuator Supply Voltage Circuit / Open

for Preparation Click here

DESCRIPTION

The ECM monitors the output voltage to the throttle actuator. This self-check ensures that the ECM is functioning properly. The output voltage usually is 0 V when the engine switch is turned off. If the output voltage is higher than 7 V when the engine switch is turned off, the ECM will illuminate the MIL and store DTC(s) when the engine switch is turned on (IG).

DTC Code	DTC Detection Condition	Trouble Area
P0657	A throttle actuator power supply error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG) for 10 seconds.

f. Turn the engine switch off.

g. Turn the engine switch on (IG).

h. Check DTC.

OK:
P0657 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0116 Engine Coolant Temperature Circuit Range / Performance Problem

for Preparation Click here

DESCRIPTION

Refer to DTC P0115 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P0116	The Engine Coolant Temperature (ECT) is between 35°C and 60°C (95°F and 140°F) when the engine is started, and conditions (a) and (b) are met (2 trip detection logic): (a) The vehicle is driven at varying speeds (accelerated and decelerated). (b) The ECT remains within 3°C (5.4°F) of the initial ECT.	• Water inlet sub-assembly with thermostat • ECT sensor

MONITOR DESCRIPTION

The ECT sensor is used to monitor the ECT. The ECT sensor has a built-in thermistor with a resistance that varies according to the temperature of the engine coolant. When the ECT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in the resistance are reflected in the output voltage from the ECT sensor.
The ECM monitors the sensor voltage and uses this value to calculate the ECT. If the sensor output voltage deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the ECT sensor and stores the DTC.
Example:
Upon starting the engine, the ECT is between 35°C and 60°C (95°F and 140°F). If after driving for 250 seconds, the ECT remains within 3°C (5.4°F) of the starting temperature, the DTC is stored (2 trip detection logic).

INSPECTION PROCEDURE

HINT:

- **If any of DTCs P0115, P0117, P0118 or P0125 is output simultaneously with DTC P0116, the ECT sensor may have an open or a short circuit. Troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0116)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read the DTC.

Result

Result	Proceed to
P0116 is output	A
P0116 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.INSPECT WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

a. Remove the water inlet sub-assembly with thermostat (Click here).

b. Measure the valve opening temperature of the water inlet sub-assembly with thermostat.

Standard opening temperature:
80 to 84°C (176 to 183°F)

HINT:

In addition to the above check, confirm that the valve is completely closed when the temperature is below the standard.

c. Reinstall the water inlet sub-assembly with thermostat (Click here).

NG → REPLACE WATER INLET SUB-ASSEMBLY WITH THERMOSTAT (**Click here**)

OK → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (**Click here**)

DTC P0657 Actuator Supply Voltage Circuit / Open

for Preparation Click here

DESCRIPTION

The ECM monitors the output voltage to the throttle actuator. This self-check ensures that the ECM is functioning properly. The output voltage usually is 0 V when the engine switch is turned off. If the output voltage is higher than 7 V when the engine switch is turned off, the ECM will illuminate the MIL and store DTC(s) when the engine switch is turned on (IG).

DTC Code	DTC Detection Condition	Trouble Area
P0657	A throttle actuator power supply error.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG) for 10 seconds.

f. Turn the engine switch off.

g. Turn the engine switch on (IG).

h. Check DTC.

OK:
P0657 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0116 Engine Coolant Temperature Circuit Range / Performance Problem

for Preparation Click here

DESCRIPTION

Refer to DTC P0115 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P0116	The Engine Coolant Temperature (ECT) is between 35°C and 60°C (95°F and 140°F) when the engine is started, and conditions (a) and (b) are met (2 trip detection logic): (a) The vehicle is driven at varying speeds (accelerated and decelerated). (b) The ECT remains within 3°C (5.4°F) of the initial ECT.	• Water inlet sub-assembly with thermostat • ECT sensor

MONITOR DESCRIPTION

The ECT sensor is used to monitor the ECT. The ECT sensor has a built-in thermistor with a resistance that varies according to the temperature of the engine coolant. When the ECT is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in the resistance are reflected in the output voltage from the ECT sensor.
The ECM monitors the sensor voltage and uses this value to calculate the ECT. If the sensor output voltage deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the ECT sensor and stores the DTC.
Example:
Upon starting the engine, the ECT is between 35°C and 60°C (95°F and 140°F). If after driving for 250 seconds, the ECT remains within 3°C (5.4°F) of the starting temperature, the DTC is stored (2 trip detection logic).

INSPECTION PROCEDURE

HINT:

- **If any of DTCs P0115, P0117, P0118 or P0125 is output simultaneously with DTC P0116, the ECT sensor may have an open or a short circuit. Troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0116)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read the DTC.

Result

Result	Proceed to
P0116 is output	A
P0116 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A

2.INSPECT WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

a. Remove the water inlet sub-assembly with thermostat (Click here).

b. Measure the valve opening temperature of the water inlet sub-assembly with thermostat.

Standard opening temperature:
80 to 84°C (176 to 183°F)

HINT:

In addition to the above check, confirm that the valve is completely closed when the temperature is below the standard.

c. Reinstall the water inlet sub-assembly with thermostat (Click here).

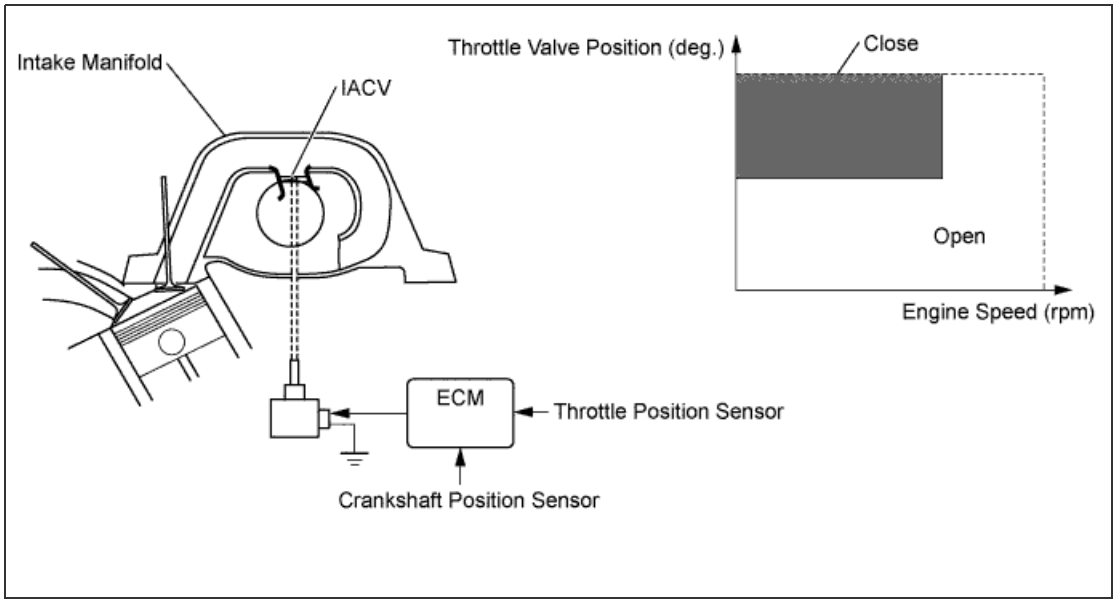
NG → REPLACE WATER INLET SUB-ASSEMBLY WITH THERMOSTAT (**Click here**)

OK → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (**Click here**)

for Preparation Click here

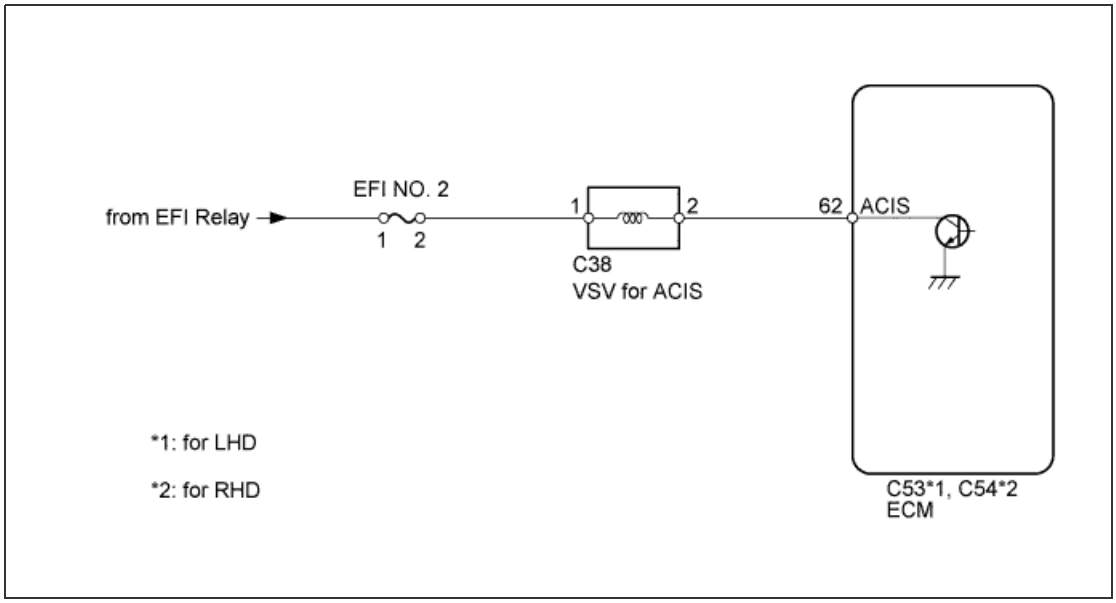
DESCRIPTION

This circuit opens and closes the Intake Air Control Valve (IACV) in response to the engine load in order to increase the intake efficiency (ACIS: Acoustic Control Induction System).



DTC Code	DTC Detection Condition	Trouble Area
P0660	Conditions (a) and (b) are met for 0.5 sec. or more (2 trip detection logic): (a) The voltage of terminal ACIS of the ECM is low when the VSV is OFF. (b) The engine has started.	• Open or short in VSV for ACIS circuit • VSV for ACIS • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE VSV FOR ACIS)

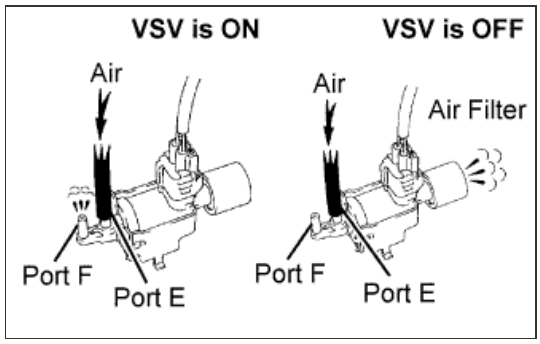
a. Disconnect the vacuum hose.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Active the VSV for Intake Control. Operate the VSV for ACIS.

e. Check the VSV operation when it is operated using the tester.



Standard:

Tester Operation	Specified Condition
VSV ON	Air from port E flows out through port F
VSV OFF	Air from port E flows out through air filter

NG → Go to step 4

OK ↓

2.CHECK VACUUM HOSE

a. Check that the vacuum hose is connected correctly, and that there are no cracks, holes, damage, or looseness.

OK:
Vacuum hose is normal.

NG → REPAIR OR REPLACE VACUUM HOSE

OK ↓

3.INSPECT INTAKE MANIFOLD (INTAKE AIR CONTROL VALVE)

a. Inspect the intake air control valve (Click here).

NG → REPLACE INTAKE MANIFOLD (INTAKE AIR CONTROL VALVE) (Click here)

OK ↓

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

4.INSPECT VSV FOR ACIS (OPERATION)

a. Inspect the VSV for ACIS (Click here).

NG → REPLACE VSV FOR ACIS (Click here)

OK ↓

5.CHECK HARNESS AND CONNECTOR (VSV FOR ACIS - ECM, VSV FOR ACIS - EFI NO. 2 FUSE)

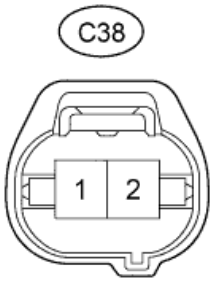
a. Check the wire harness and connectors between the VSV for ACIS and ECM.

i. Disconnect the VSV for ACIS connector.

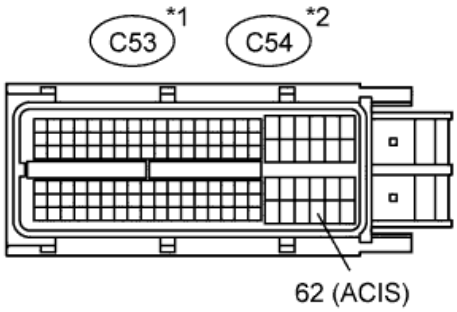
ii. Disconnect the ECM connector.

iii. Measure the resistance according to the value(s) in the table below.

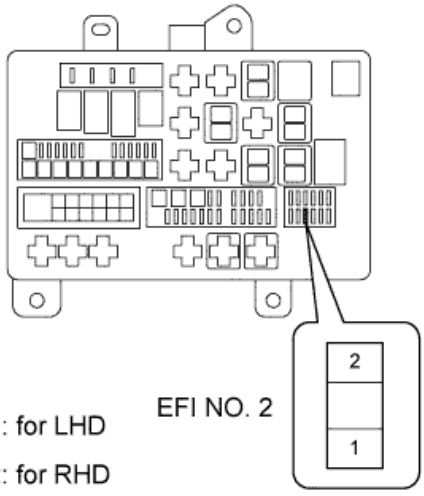
Front view of wire harness connector:
(to VSV for ACIS)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to Engine Room Relay Block)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C38-2 - C53-62 (ACIS)	Always	Below 1 Ω
C38-2 or C53-62 (ACIS) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C38-2 - C54-62 (ACIS)	Always	Below 1 Ω

C38-2 or C54-62 (ACIS) - Body ground	Always	10 kΩ or higher

b. Check the wire harness between the VSV for ACIS and EFI NO. 2 fuse.

i. Disconnect the VSV for ACIS connector.

ii. Remove the EFI NO. 2 fuse from the engine room relay block.

iii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C38-1 - EFI NO. 2 fuse	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

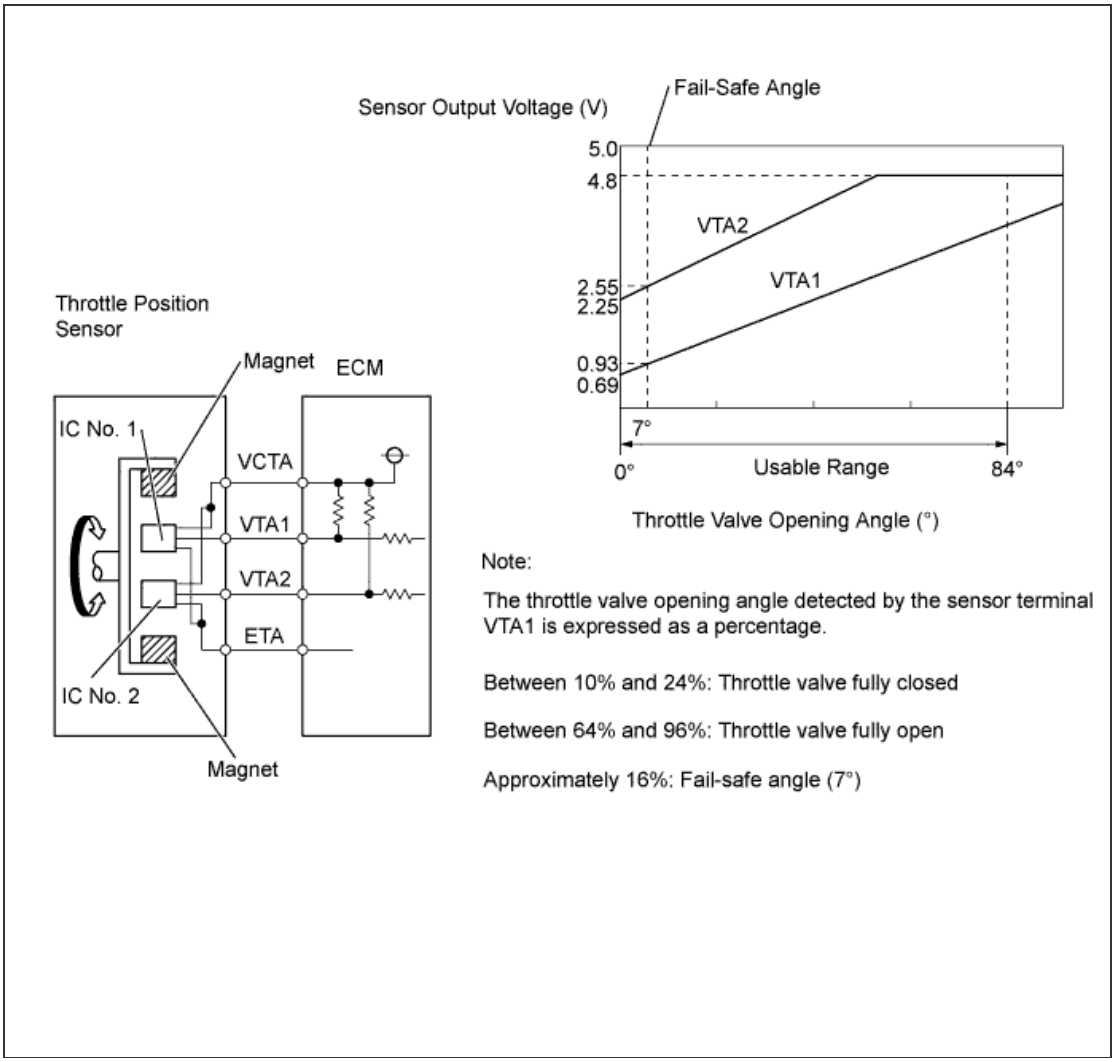
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

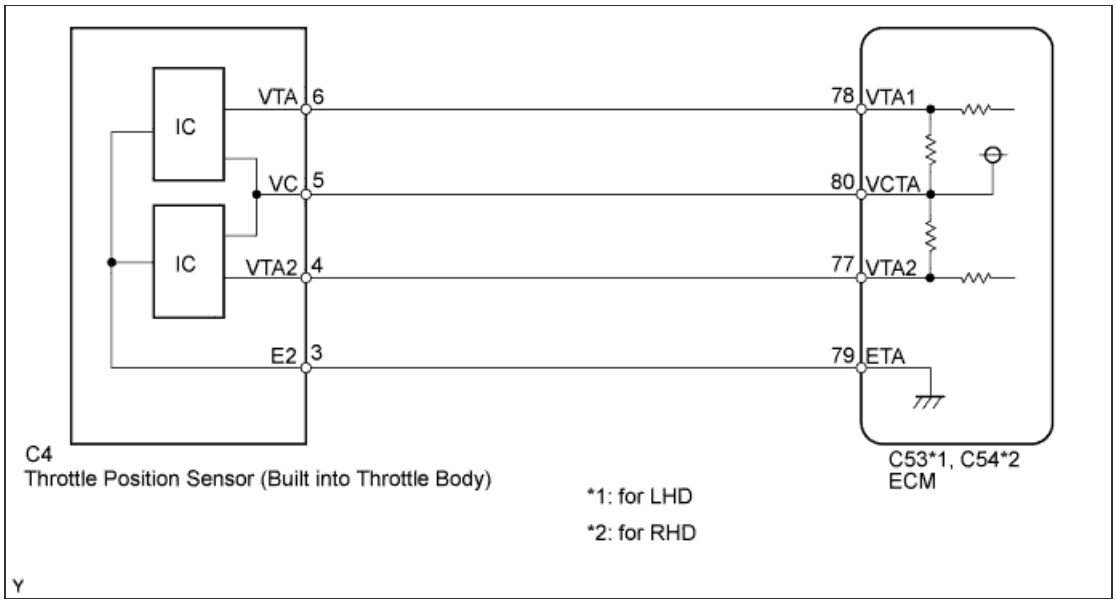
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

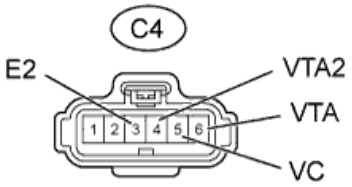
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

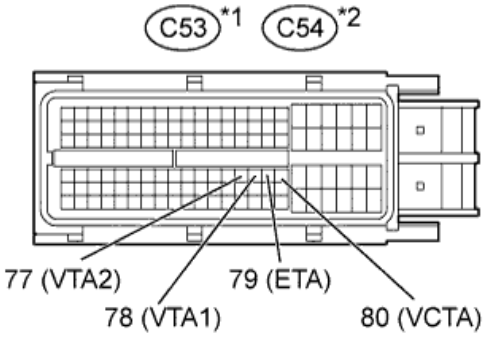
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

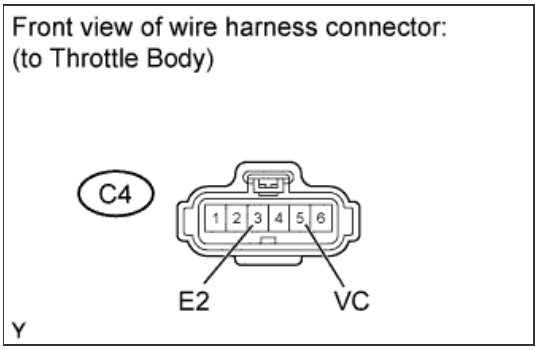
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1340 Camshaft Position Sensor "A" (Bank 1 Sensor 2)

DTC P1342 Camshaft Position Sensor "A" Low Input (MRE)

DTC P1343 Camshaft Position Sensor "A" High Input (MRE)

for Preparation Click here

DESCRIPTION

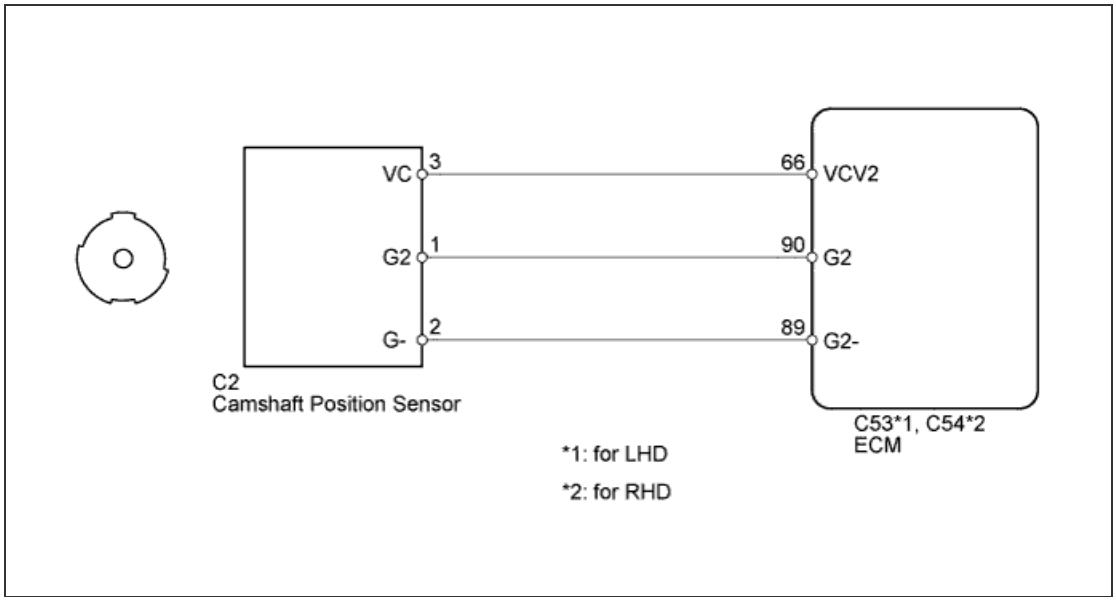
The camshaft position sensor (G signal) consists of a magnet and MRE (Magnetic Resistance Element).
The camshaft drive gear (LH) has 3 teeth on its inner circumstance. When the camshaft gear rotates, air gap changes between the protrusion on the teeth and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE.
The crankshaft position sensor plate has 34 teeth and is installed to the rear end of the crankshaft. The crankshaft position sensor generates 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

DTC Code	DTC Detection Condition	Trouble Area
P1340	No camshaft position sensor signal is sent to the ECM during cranking (2 trip detection logic).	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing plate LH • ECM
	No camshaft position sensor signal is sent to the ECM with an engine speed of 600 rpm or more.	
P1342	The output voltage of the camshaft position sensor is below 0.3 V for 4 seconds (1 trip detection logic).	
P1343	The output voltage of the camshaft position sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	

MONITOR DESCRIPTION

The camshaft position sensor (G signal) consists of a magnet and MRE.
The camshaft drive gear has 3 teeth on its inner circumference. When the camshaft gear rotates, air gap changes between the protrusion on the gear and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE. The crankshaft position sensor plate has 34 teeth and outputs 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air fuel ratio was lean or rich, and other data from the time the malfunction occurred.

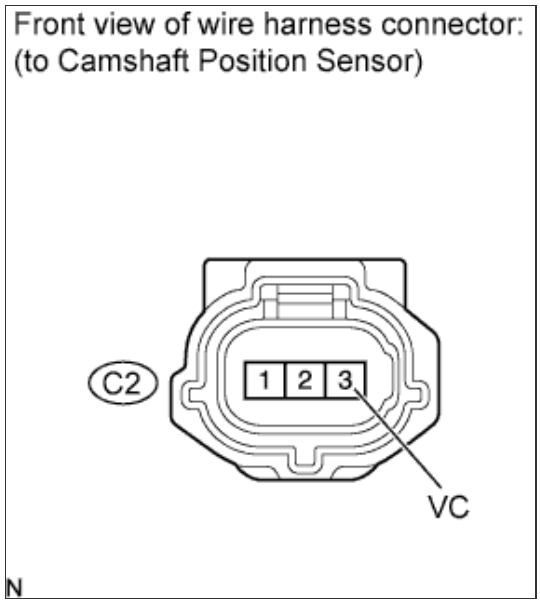
1.INSPECT CAMSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C2 camshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C2-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

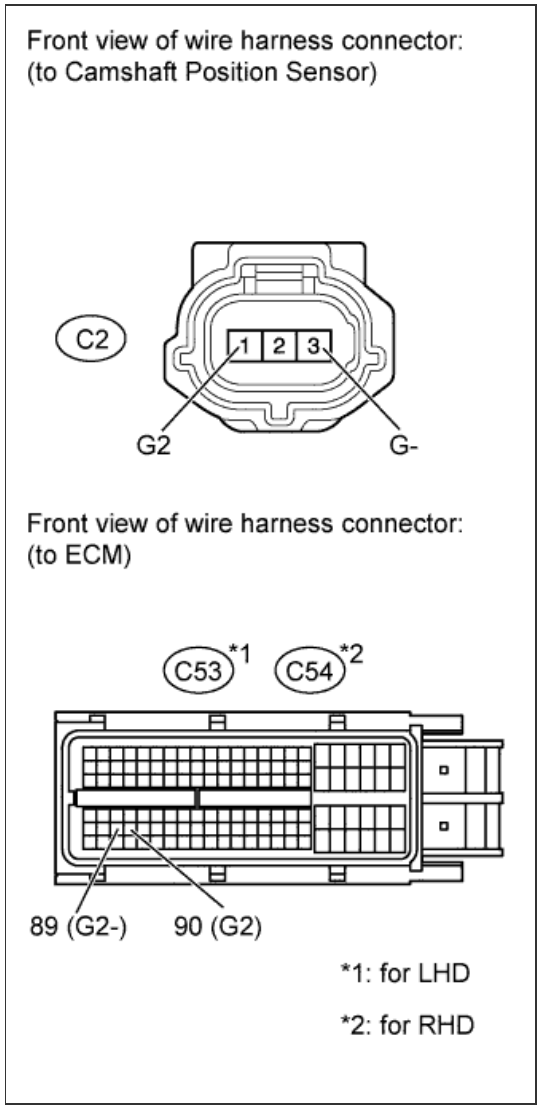
OK

2.CHECK HARNESS AND CONNECTOR (ECM - CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition

C2-1 (G2) - C53-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C53-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C53-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C53-89 (G2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C2-1 (G2) - C54-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C54-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C54-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C54-89 (G2-) - Body ground	Always	10 kΩ or higher

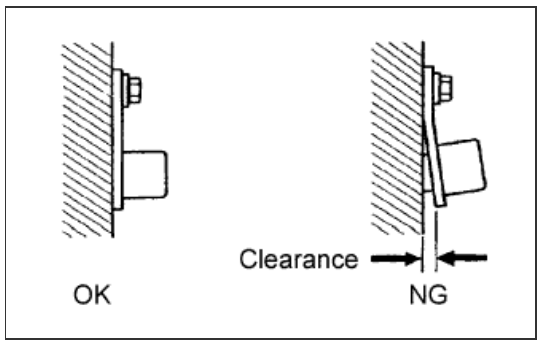
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT SENSOR INSTALLATION

a. Check the camshaft position sensor installation.

OK:
The camshaft position sensor is installed properly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.INSPECT CAMSHAFT TIMING PLATE (SIGNAL PLATE TOOTH)

a. Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT TIMING PLATE (Click here)

OK

5.REPLACE CAMSHAFT POSITION SENSOR

a. Replace the camshaft position sensor (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P1340, P1342 and/or P1343 are output	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

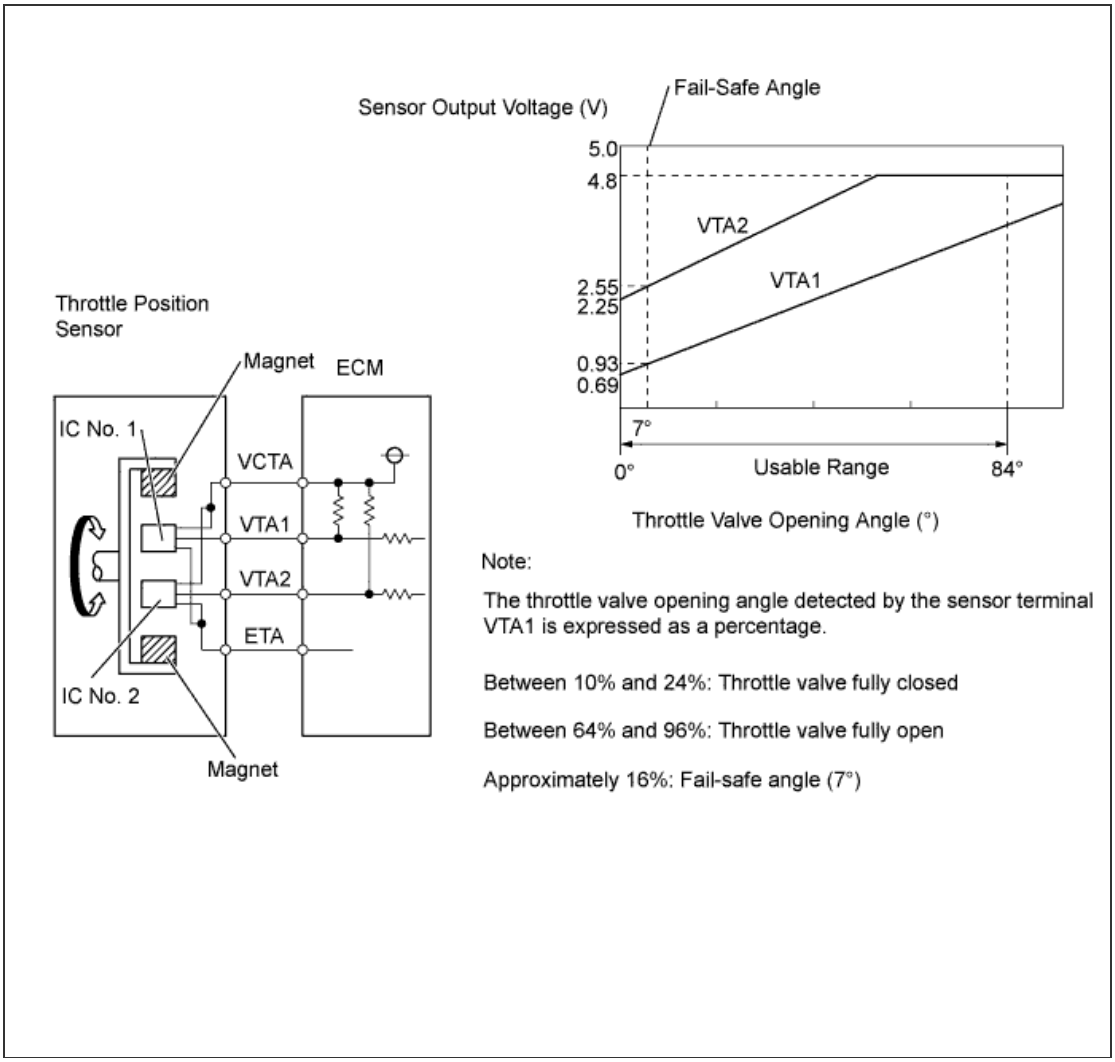
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

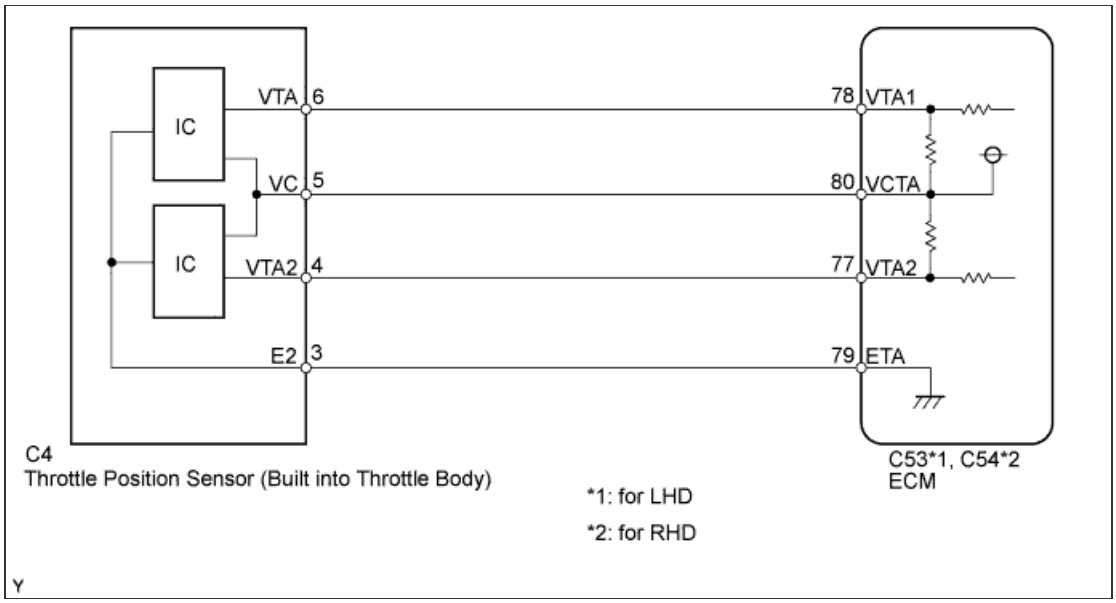
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

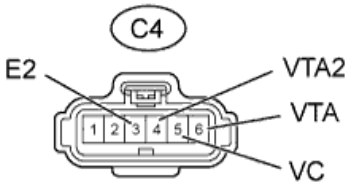
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

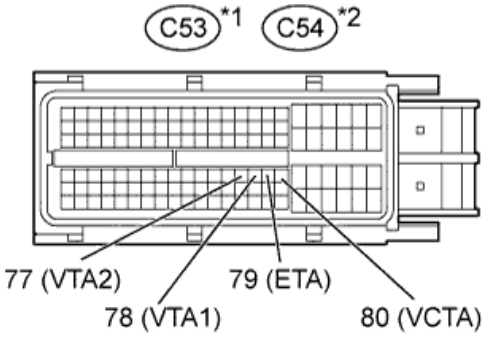
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

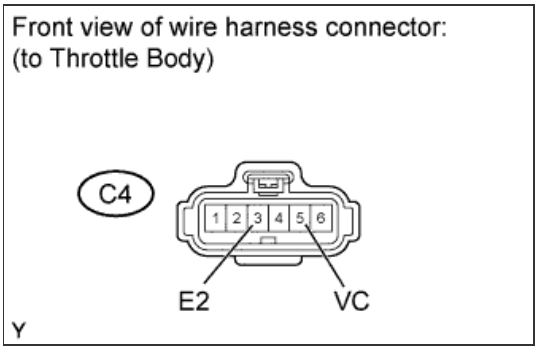
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1340 Camshaft Position Sensor "A" (Bank 1 Sensor 2)

DTC P1342 Camshaft Position Sensor "A" Low Input (MRE)

DTC P1343 Camshaft Position Sensor "A" High Input (MRE)

for Preparation Click here

DESCRIPTION

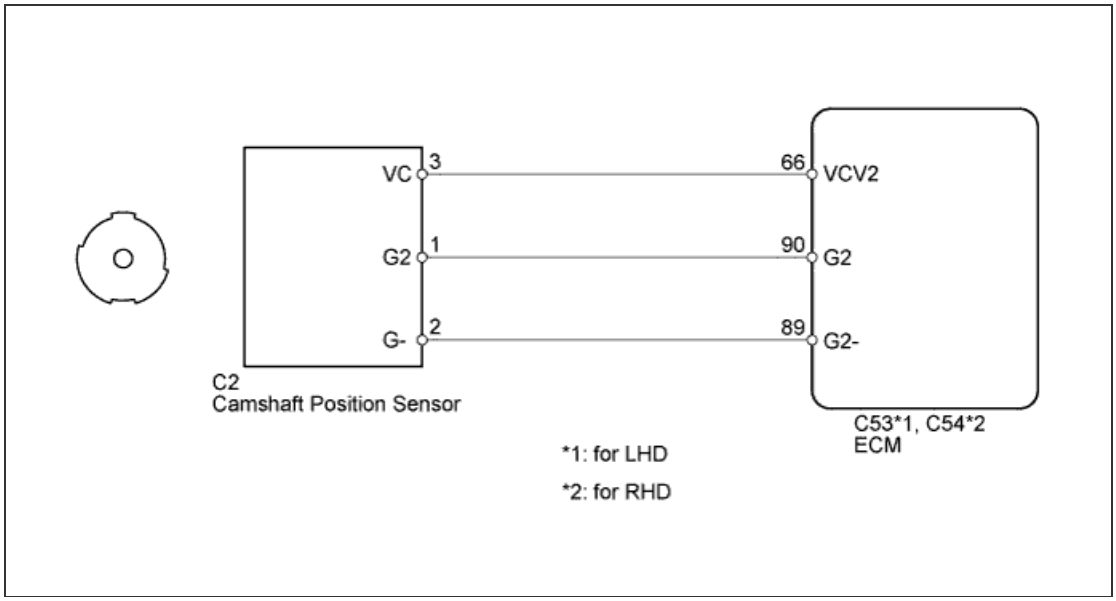
The camshaft position sensor (G signal) consists of a magnet and MRE (Magnetic Resistance Element).
The camshaft drive gear (LH) has 3 teeth on its inner circumstance. When the camshaft gear rotates, air gap changes between the protrusion on the teeth and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE.
The crankshaft position sensor plate has 34 teeth and is installed to the rear end of the crankshaft. The crankshaft position sensor generates 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

DTC Code	DTC Detection Condition	Trouble Area
P1340	No camshaft position sensor signal is sent to the ECM during cranking (2 trip detection logic).	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing plate LH • ECM
	No camshaft position sensor signal is sent to the ECM with an engine speed of 600 rpm or more.	
P1342	The output voltage of the camshaft position sensor is below 0.3 V for 4 seconds (1 trip detection logic).	
P1343	The output voltage of the camshaft position sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	

MONITOR DESCRIPTION

The camshaft position sensor (G signal) consists of a magnet and MRE.
The camshaft drive gear has 3 teeth on its inner circumference. When the camshaft gear rotates, air gap changes between the protrusion on the gear and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE. The crankshaft position sensor plate has 34 teeth and outputs 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air fuel ratio was lean or rich, and other data from the time the malfunction occurred.

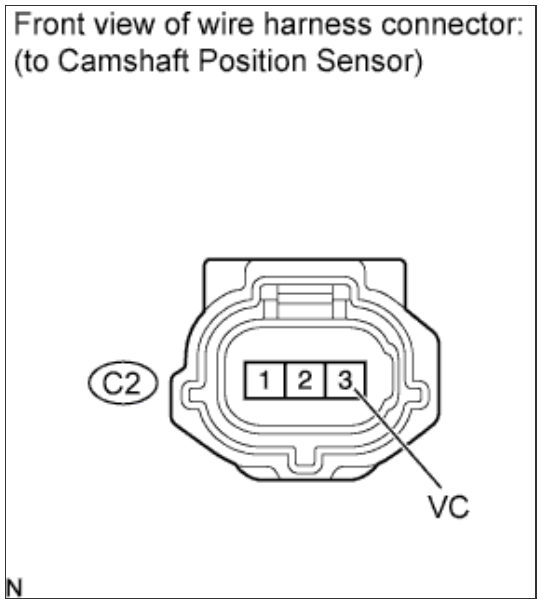
1.INSPECT CAMSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C2 camshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C2-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

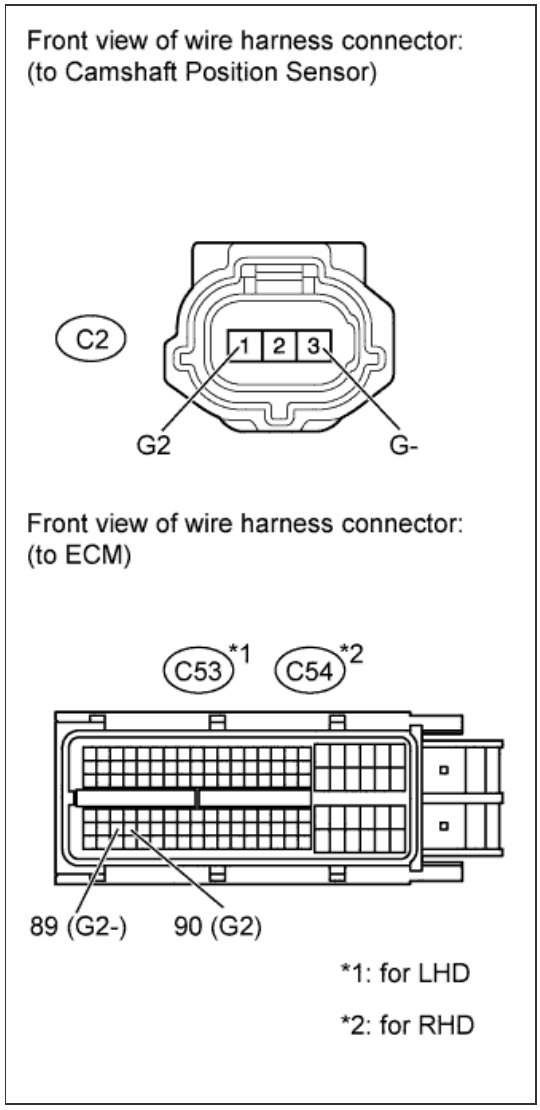
OK

2.CHECK HARNESS AND CONNECTOR (ECM - CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition

C2-1 (G2) - C53-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C53-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C53-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C53-89 (G2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C2-1 (G2) - C54-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C54-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C54-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C54-89 (G2-) - Body ground	Always	10 kΩ or higher

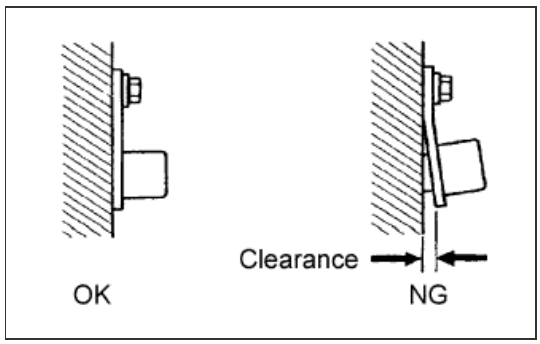
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT SENSOR INSTALLATION

a. Check the camshaft position sensor installation.

OK:
The camshaft position sensor is installed properly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.INSPECT CAMSHAFT TIMING PLATE (SIGNAL PLATE TOOTH)

a. Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT TIMING PLATE (Click here)

OK

5.REPLACE CAMSHAFT POSITION SENSOR

a. Replace the camshaft position sensor (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P1340, P1342 and/or P1343 are output	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

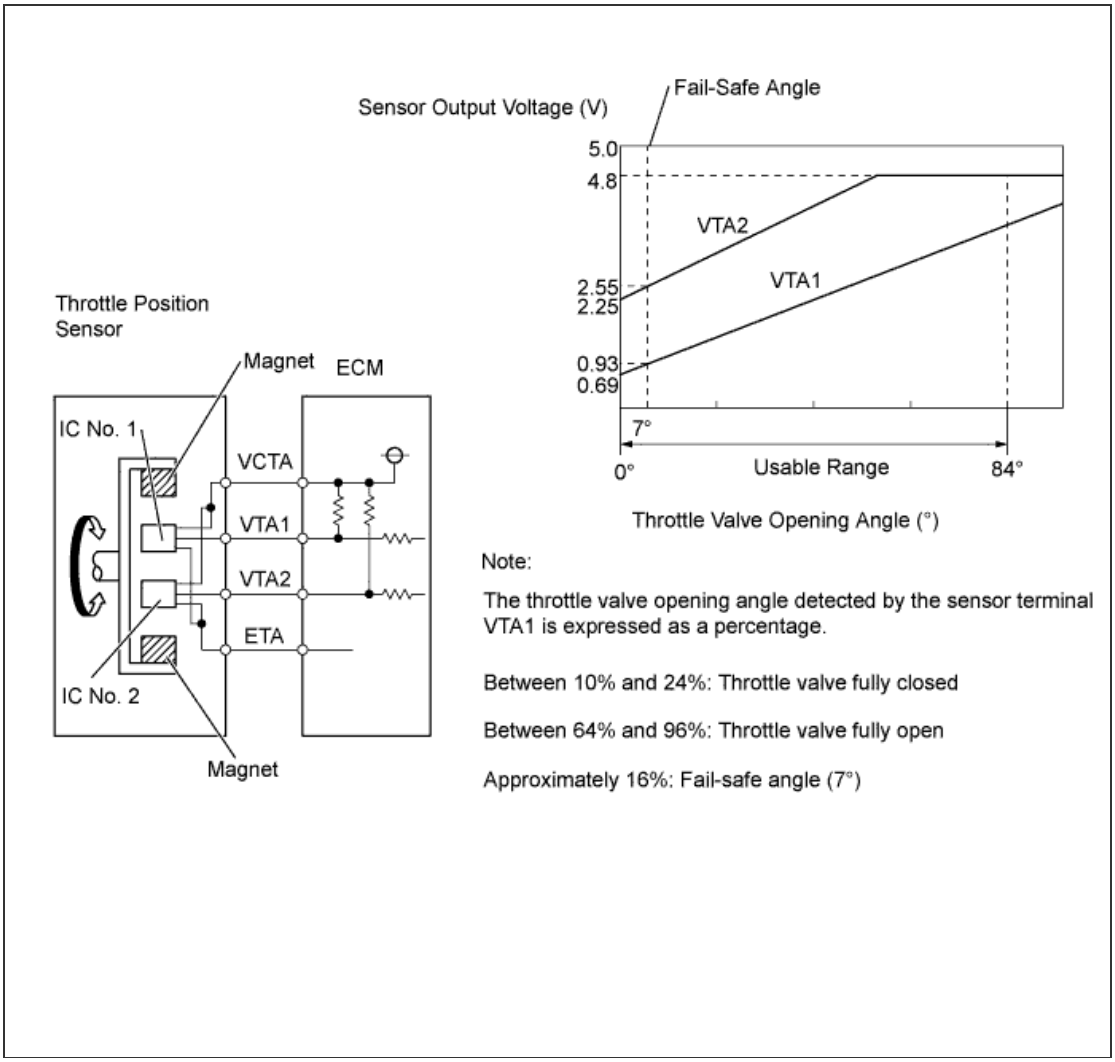
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

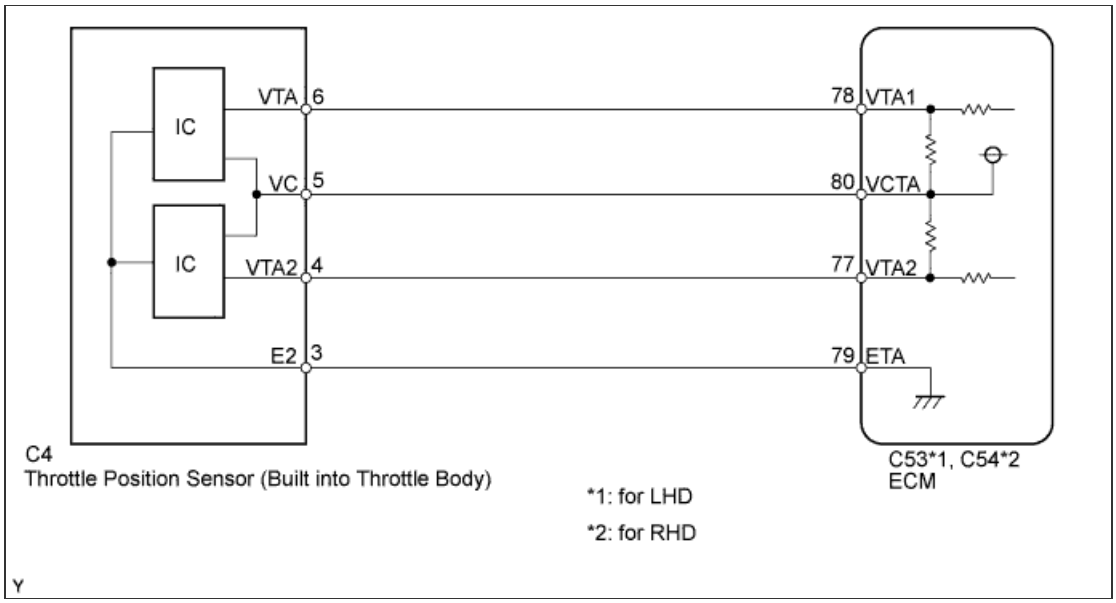
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

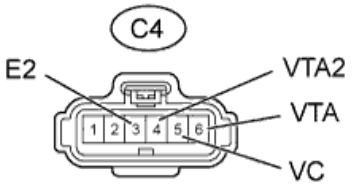
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

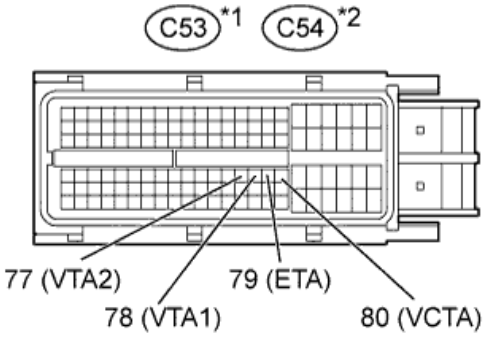
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

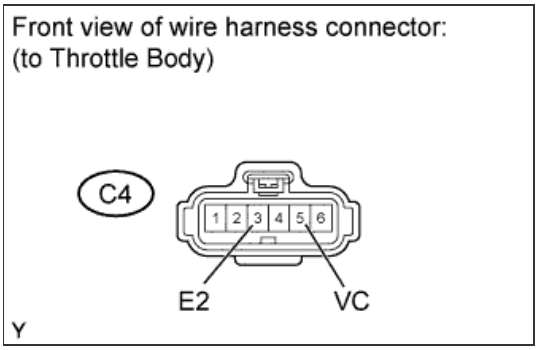
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1340 Camshaft Position Sensor "A" (Bank 1 Sensor 2)

DTC P1342 Camshaft Position Sensor "A" Low Input (MRE)

DTC P1343 Camshaft Position Sensor "A" High Input (MRE)

for Preparation Click here

DESCRIPTION

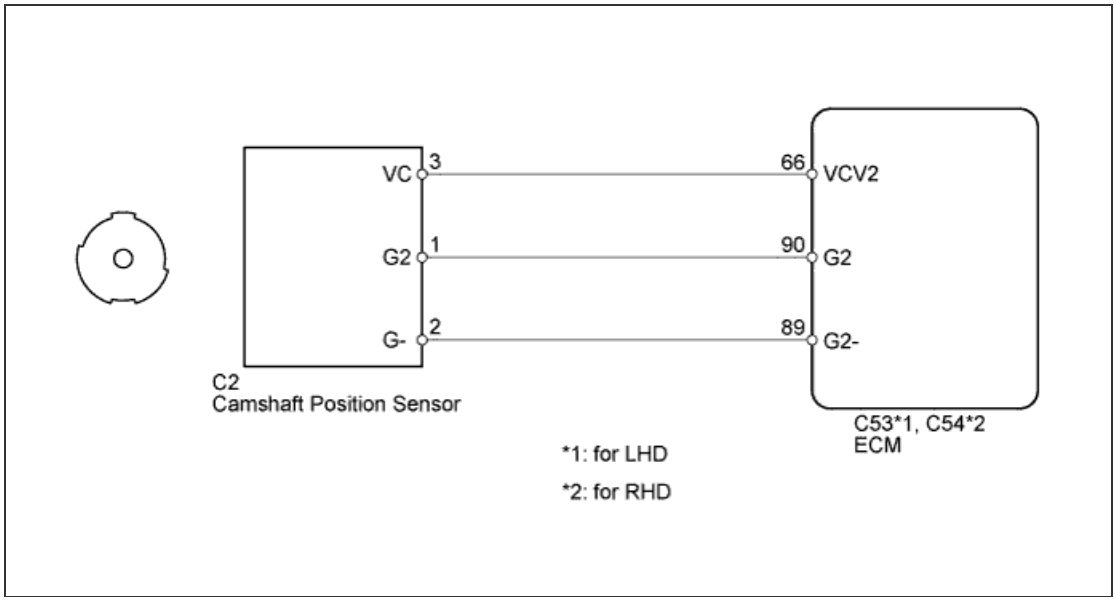
The camshaft position sensor (G signal) consists of a magnet and MRE (Magnetic Resistance Element).
The camshaft drive gear (LH) has 3 teeth on its inner circumstance. When the camshaft gear rotates, air gap changes between the protrusion on the teeth and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE.
The crankshaft position sensor plate has 34 teeth and is installed to the rear end of the crankshaft. The crankshaft position sensor generates 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

DTC Code	DTC Detection Condition	Trouble Area
P1340	No camshaft position sensor signal is sent to the ECM during cranking (2 trip detection logic).	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing plate LH • ECM
	No camshaft position sensor signal is sent to the ECM with an engine speed of 600 rpm or more.	
P1342	The output voltage of the camshaft position sensor is below 0.3 V for 4 seconds (1 trip detection logic).	
P1343	The output voltage of the camshaft position sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	

MONITOR DESCRIPTION

The camshaft position sensor (G signal) consists of a magnet and MRE.
The camshaft drive gear has 3 teeth on its inner circumference. When the camshaft gear rotates, air gap changes between the protrusion on the gear and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE. The crankshaft position sensor plate has 34 teeth and outputs 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air fuel ratio was lean or rich, and other data from the time the malfunction occurred.

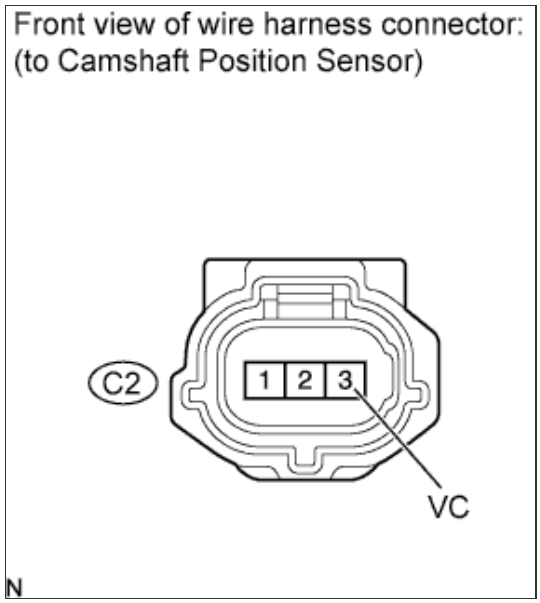
1.INSPECT CAMSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C2 camshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C2-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

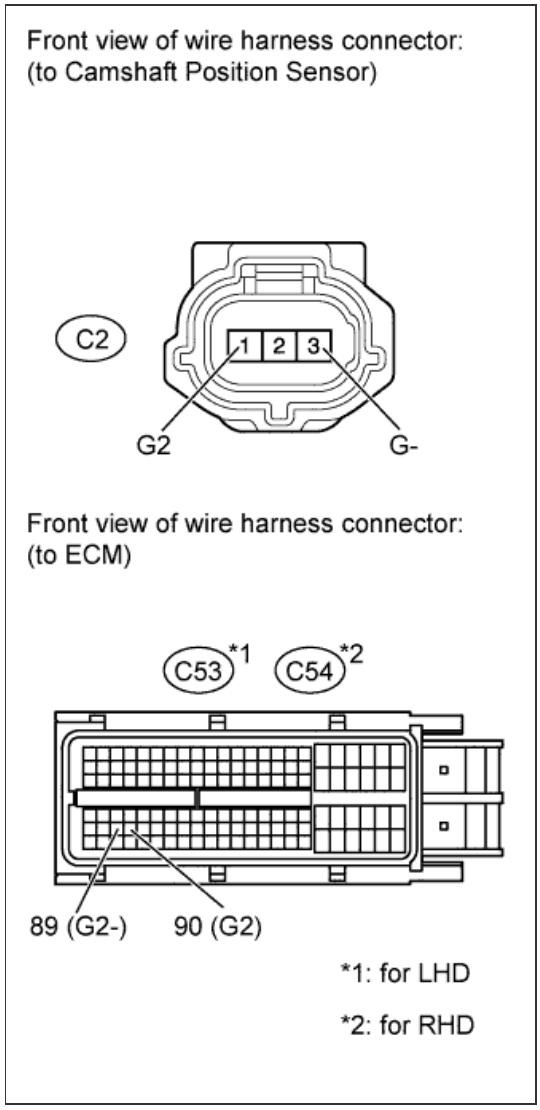
OK

2.CHECK HARNESS AND CONNECTOR (ECM - CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition

C2-1 (G2) - C53-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C53-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C53-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C53-89 (G2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C2-1 (G2) - C54-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C54-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C54-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C54-89 (G2-) - Body ground	Always	10 kΩ or higher

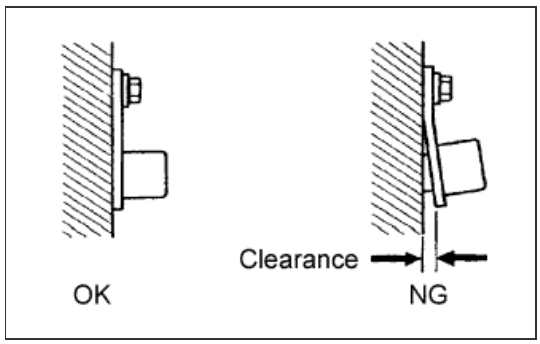
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT SENSOR INSTALLATION

a. Check the camshaft position sensor installation.

OK:
The camshaft position sensor is installed properly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.INSPECT CAMSHAFT TIMING PLATE (SIGNAL PLATE TOOTH)

a. Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT TIMING PLATE (Click here)

OK

5.REPLACE CAMSHAFT POSITION SENSOR

a. Replace the camshaft position sensor (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P1340, P1342 and/or P1343 are output	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

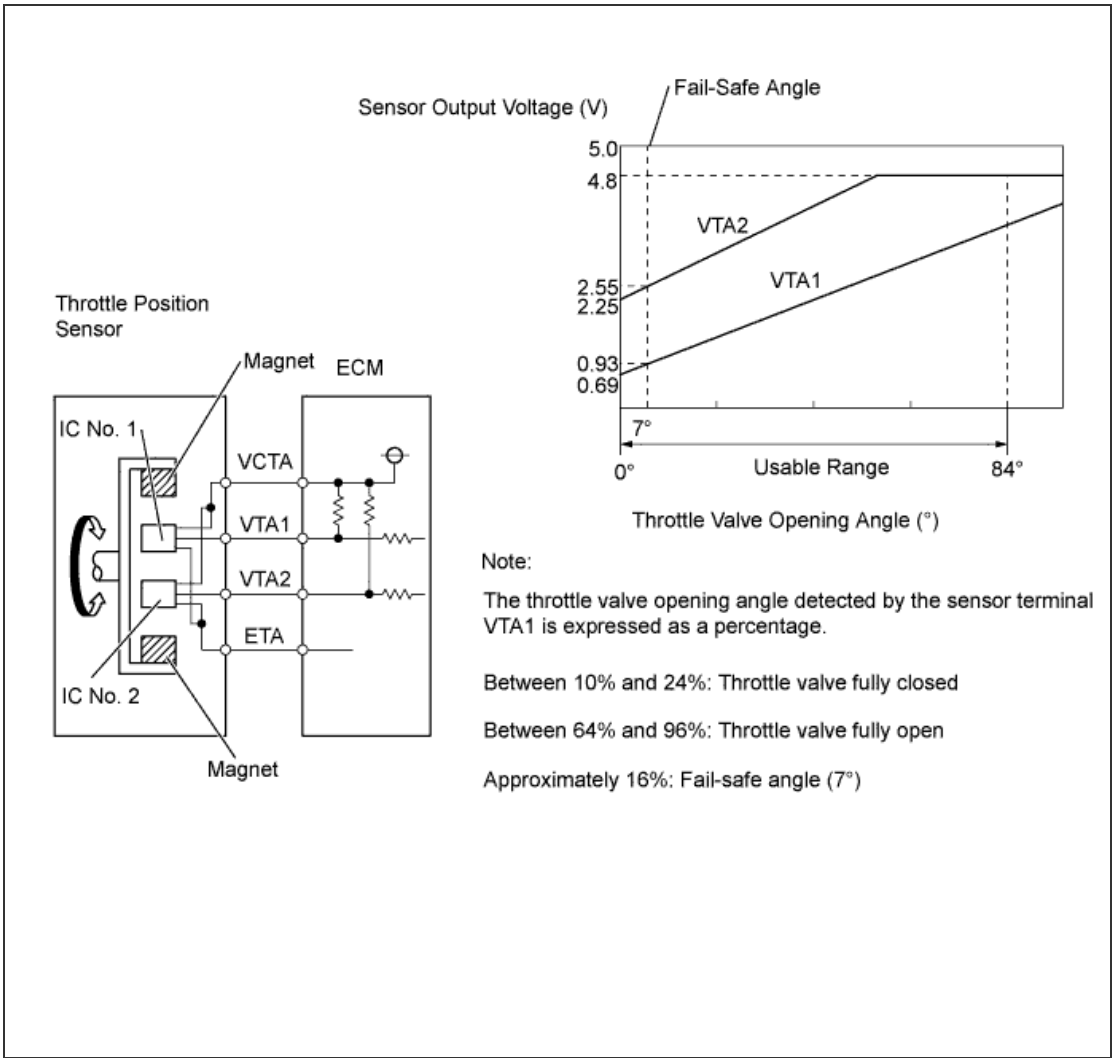
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

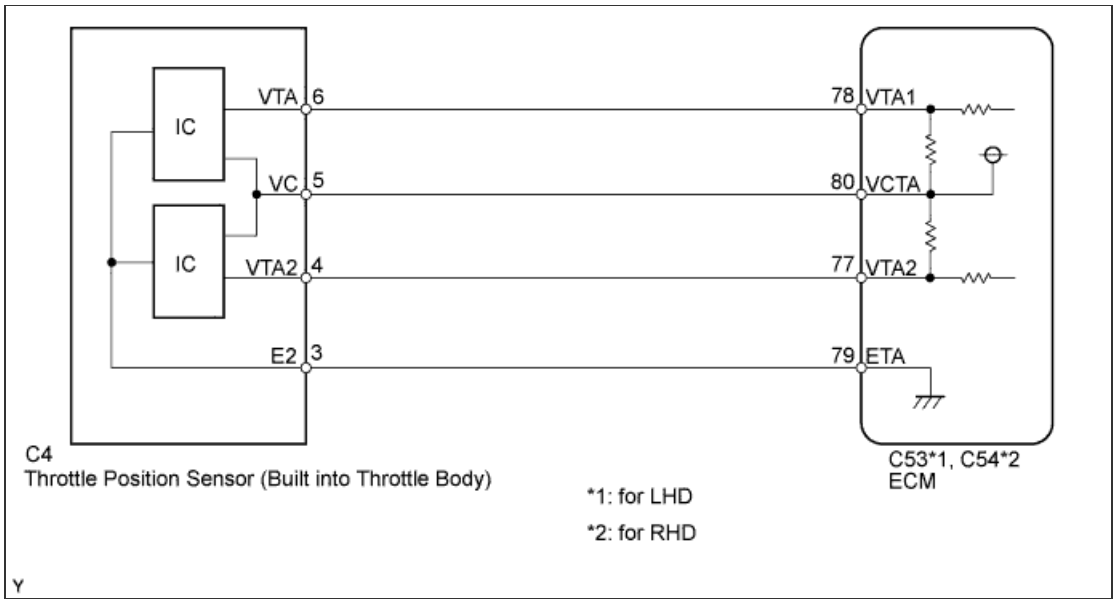
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

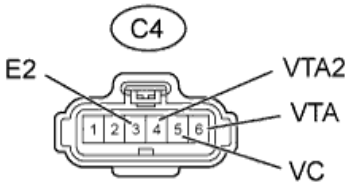
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

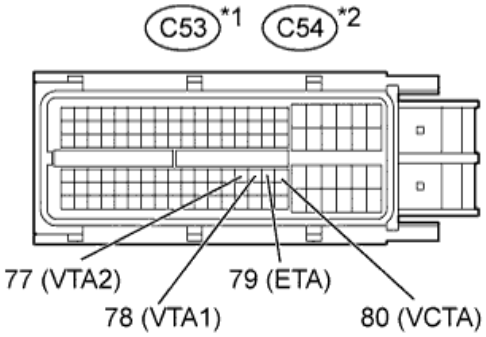
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

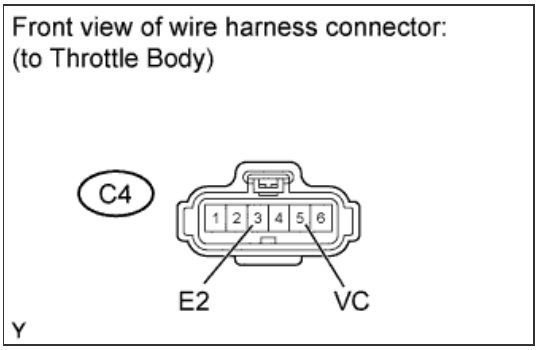
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1340 Camshaft Position Sensor "A" (Bank 1 Sensor 2)

DTC P1342 Camshaft Position Sensor "A" Low Input (MRE)

DTC P1343 Camshaft Position Sensor "A" High Input (MRE)

for Preparation Click here

DESCRIPTION

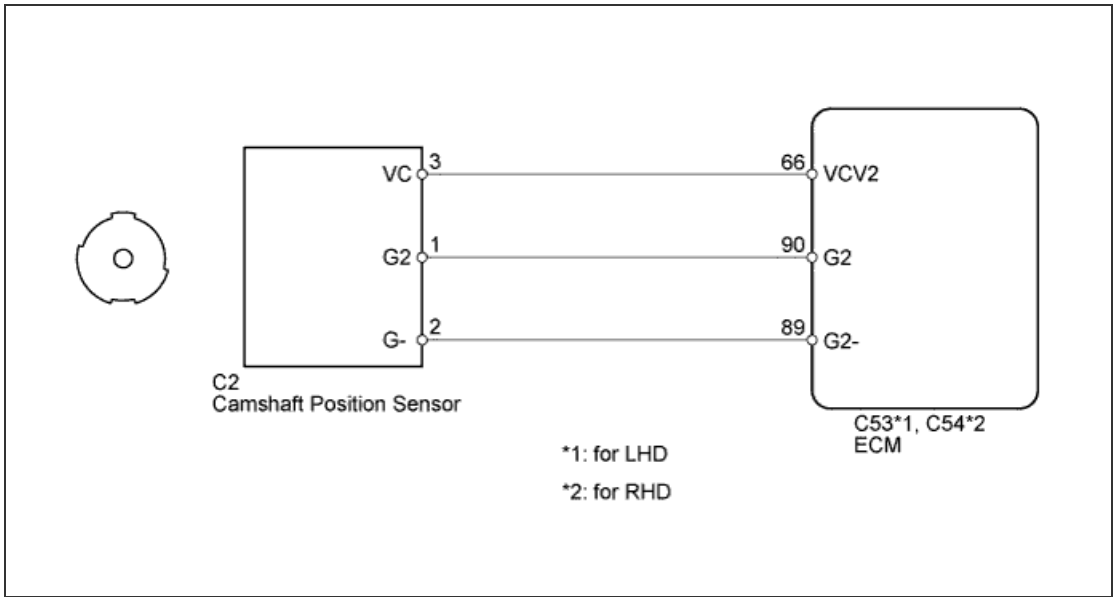
The camshaft position sensor (G signal) consists of a magnet and MRE (Magnetic Resistance Element).
The camshaft drive gear (LH) has 3 teeth on its inner circumstance. When the camshaft gear rotates, air gap changes between the protrusion on the teeth and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE.
The crankshaft position sensor plate has 34 teeth and is installed to the rear end of the crankshaft. The crankshaft position sensor generates 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

DTC Code	DTC Detection Condition	Trouble Area
P1340	No camshaft position sensor signal is sent to the ECM during cranking (2 trip detection logic).	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing plate LH • ECM
	No camshaft position sensor signal is sent to the ECM with an engine speed of 600 rpm or more.	
P1342	The output voltage of the camshaft position sensor is below 0.3 V for 4 seconds (1 trip detection logic).	
P1343	The output voltage of the camshaft position sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	

MONITOR DESCRIPTION

The camshaft position sensor (G signal) consists of a magnet and MRE.
The camshaft drive gear has 3 teeth on its inner circumference. When the camshaft gear rotates, air gap changes between the protrusion on the gear and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE. The crankshaft position sensor plate has 34 teeth and outputs 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air fuel ratio was lean or rich, and other data from the time the malfunction occurred.

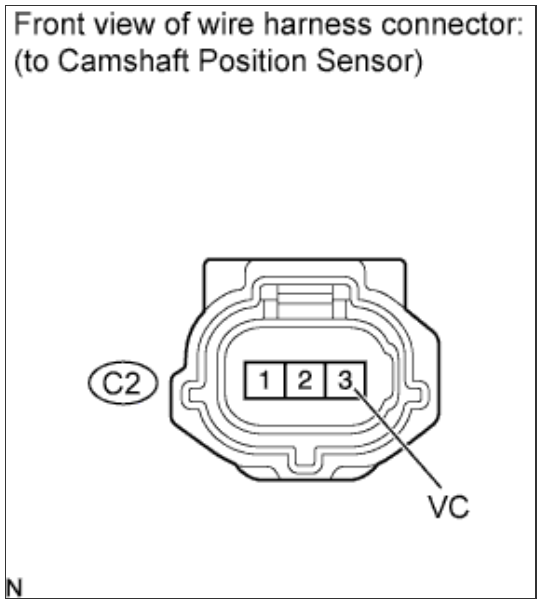
1.INSPECT CAMSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C2 camshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C2-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

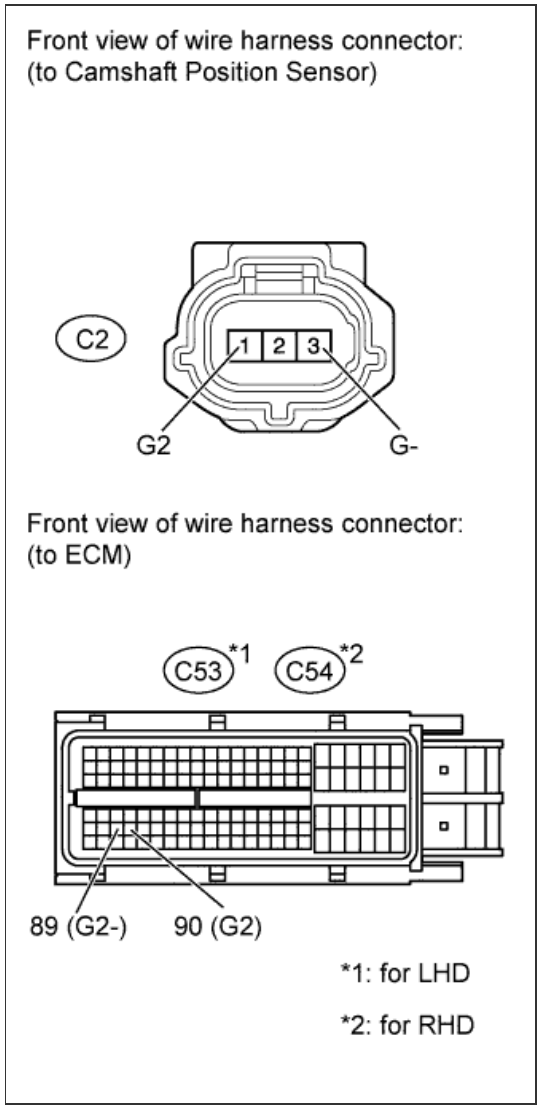
OK

2.CHECK HARNESS AND CONNECTOR (ECM - CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition

C2-1 (G2) - C53-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C53-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C53-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C53-89 (G2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C2-1 (G2) - C54-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C54-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C54-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C54-89 (G2-) - Body ground	Always	10 kΩ or higher

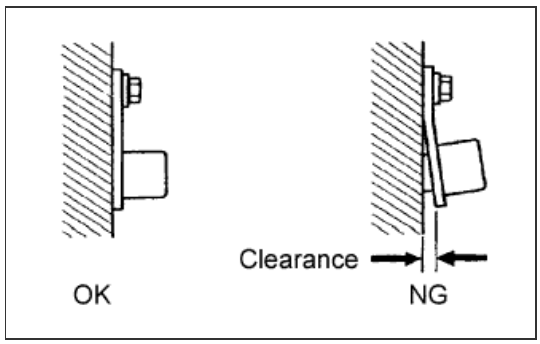
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT SENSOR INSTALLATION

a. Check the camshaft position sensor installation.

OK:
The camshaft position sensor is installed properly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.INSPECT CAMSHAFT TIMING PLATE (SIGNAL PLATE TOOTH)

a. Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT TIMING PLATE (Click here)

OK

5.REPLACE CAMSHAFT POSITION SENSOR

a. Replace the camshaft position sensor (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P1340, P1342 and/or P1343 are output	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

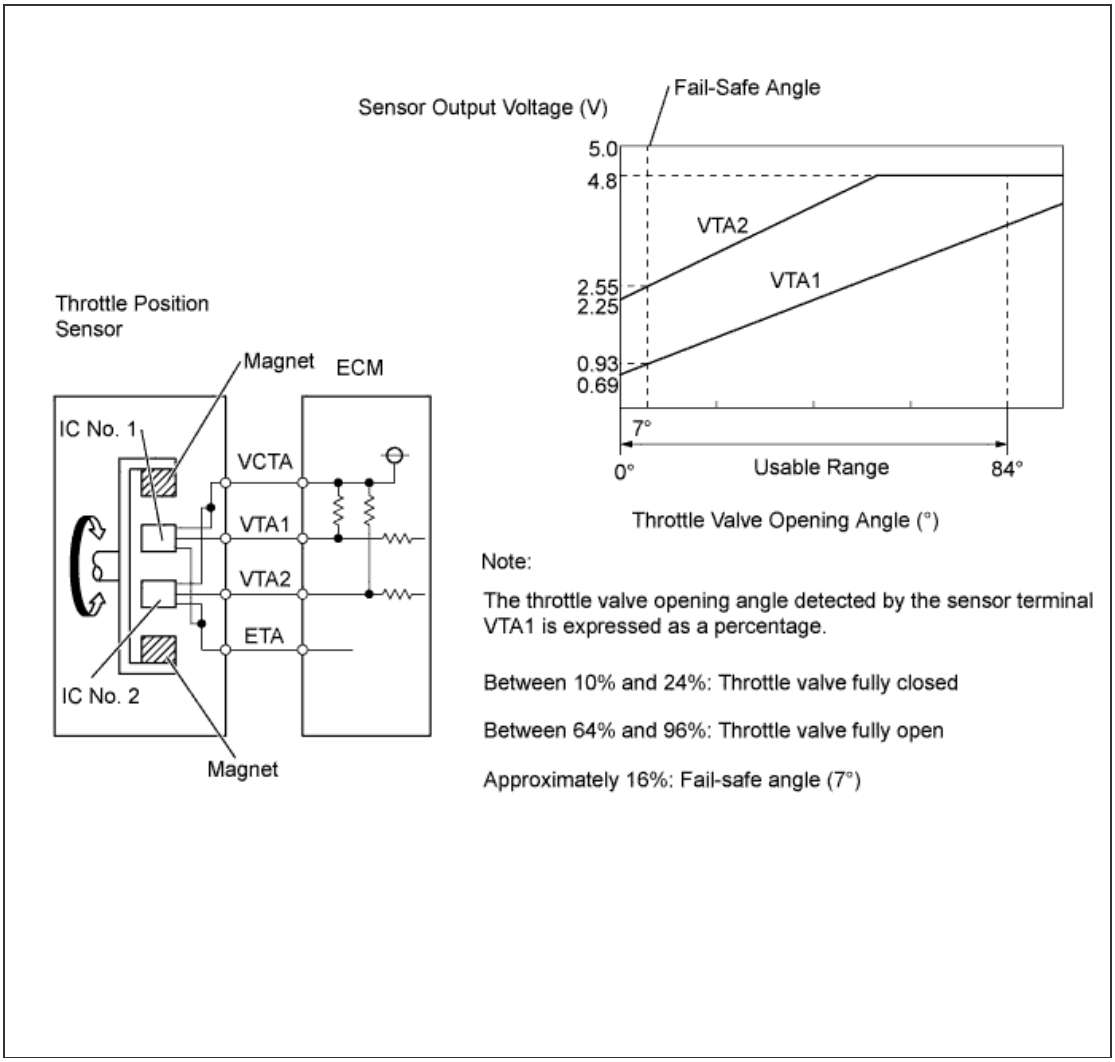
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

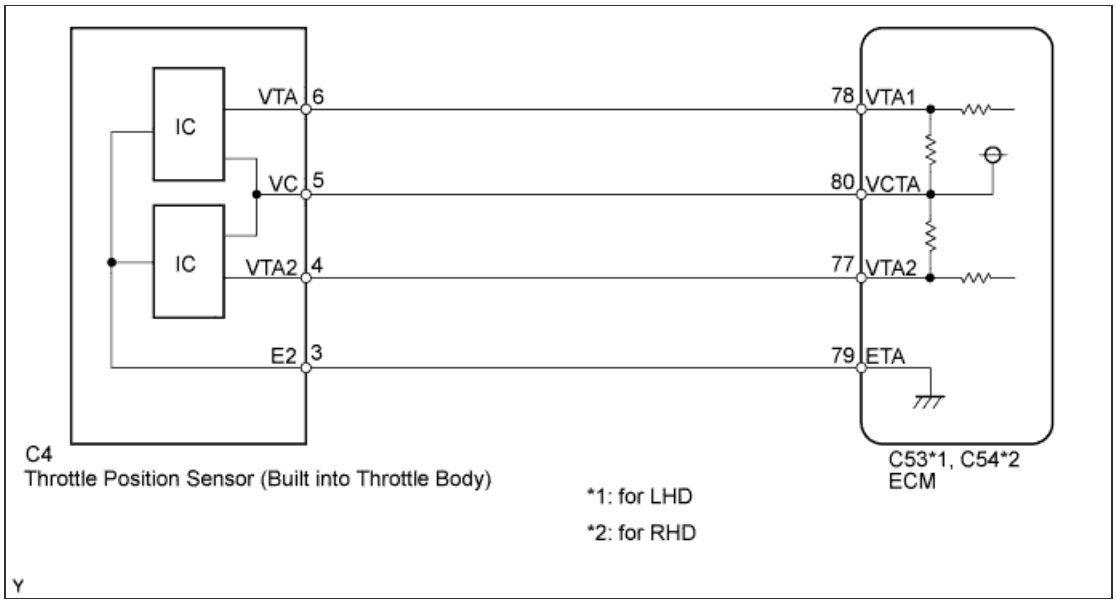
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

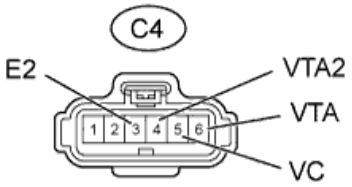
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

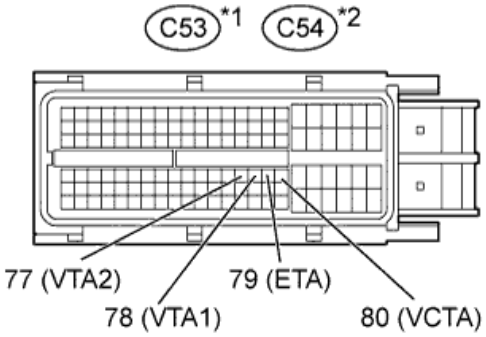
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

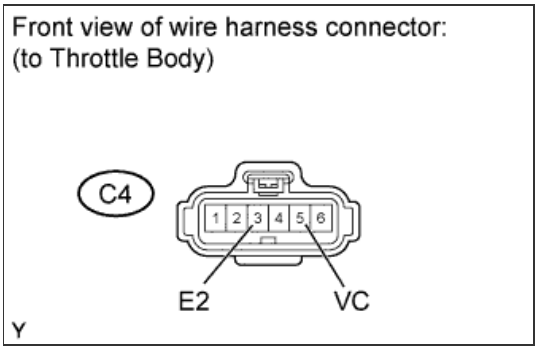
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1340 Camshaft Position Sensor "A" (Bank 1 Sensor 2)

DTC P1342 Camshaft Position Sensor "A" Low Input (MRE)

DTC P1343 Camshaft Position Sensor "A" High Input (MRE)

for Preparation Click here

DESCRIPTION

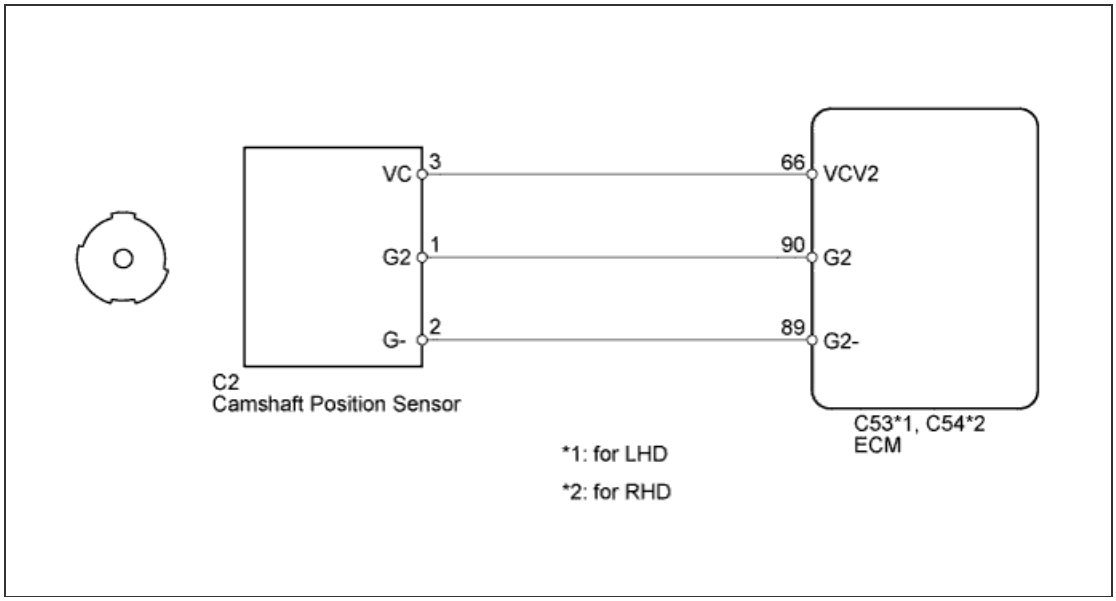
The camshaft position sensor (G signal) consists of a magnet and MRE (Magnetic Resistance Element).
The camshaft drive gear (LH) has 3 teeth on its inner circumstance. When the camshaft gear rotates, air gap changes between the protrusion on the teeth and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE.
The crankshaft position sensor plate has 34 teeth and is installed to the rear end of the crankshaft. The crankshaft position sensor generates 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

DTC Code	DTC Detection Condition	Trouble Area
P1340	No camshaft position sensor signal is sent to the ECM during cranking (2 trip detection logic).	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing plate LH • ECM
	No camshaft position sensor signal is sent to the ECM with an engine speed of 600 rpm or more.	
P1342	The output voltage of the camshaft position sensor is below 0.3 V for 4 seconds (1 trip detection logic).	
P1343	The output voltage of the camshaft position sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	

MONITOR DESCRIPTION

The camshaft position sensor (G signal) consists of a magnet and MRE.
The camshaft drive gear has 3 teeth on its inner circumference. When the camshaft gear rotates, air gap changes between the protrusion on the gear and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE. The crankshaft position sensor plate has 34 teeth and outputs 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air fuel ratio was lean or rich, and other data from the time the malfunction occurred.

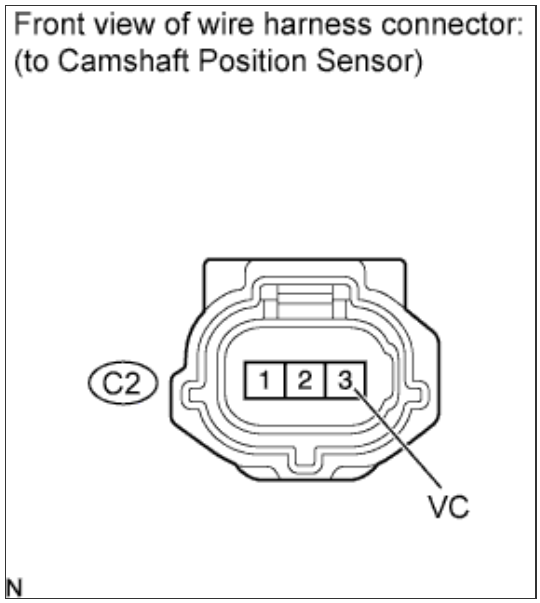
1.INSPECT CAMSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C2 camshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C2-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

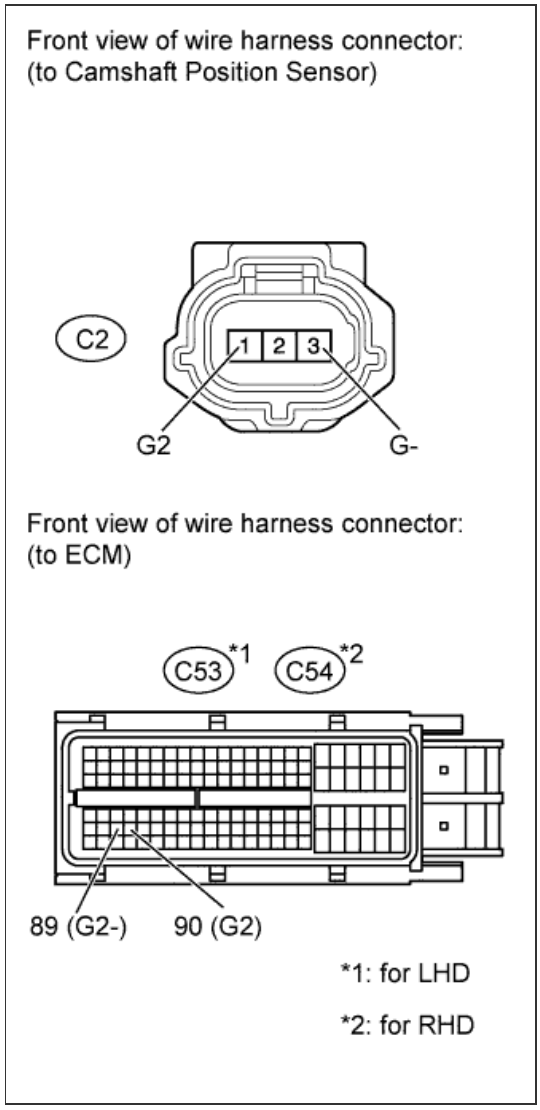
OK

2.CHECK HARNESS AND CONNECTOR (ECM - CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition

C2-1 (G2) - C53-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C53-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C53-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C53-89 (G2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C2-1 (G2) - C54-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C54-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C54-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C54-89 (G2-) - Body ground	Always	10 kΩ or higher

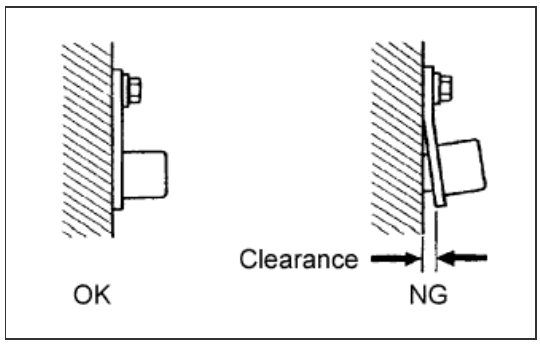
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT SENSOR INSTALLATION

a. Check the camshaft position sensor installation.

OK:
The camshaft position sensor is installed properly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.INSPECT CAMSHAFT TIMING PLATE (SIGNAL PLATE TOOTH)

a. Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT TIMING PLATE (Click here)

OK

5.REPLACE CAMSHAFT POSITION SENSOR

a. Replace the camshaft position sensor (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P1340, P1342 and/or P1343 are output	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

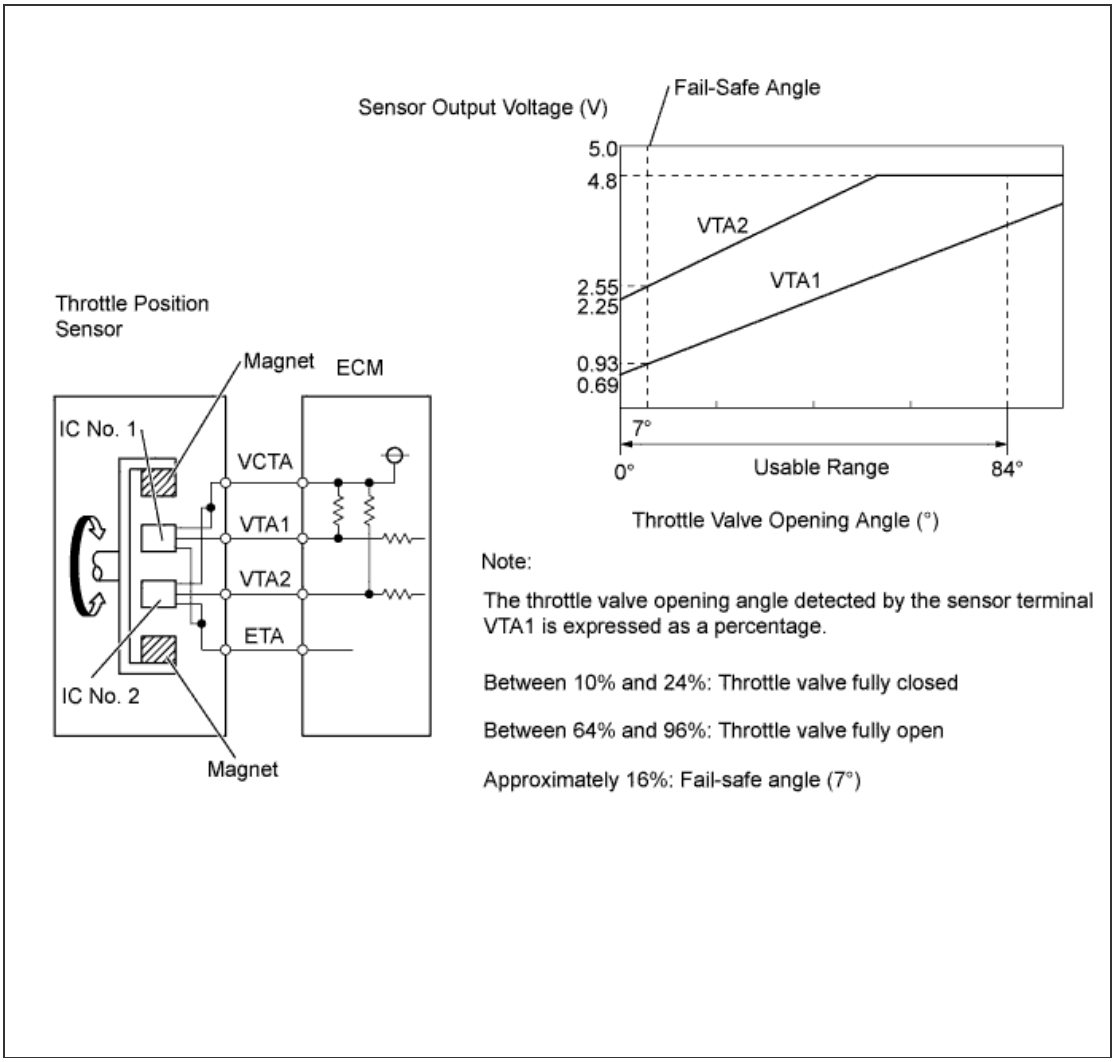
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

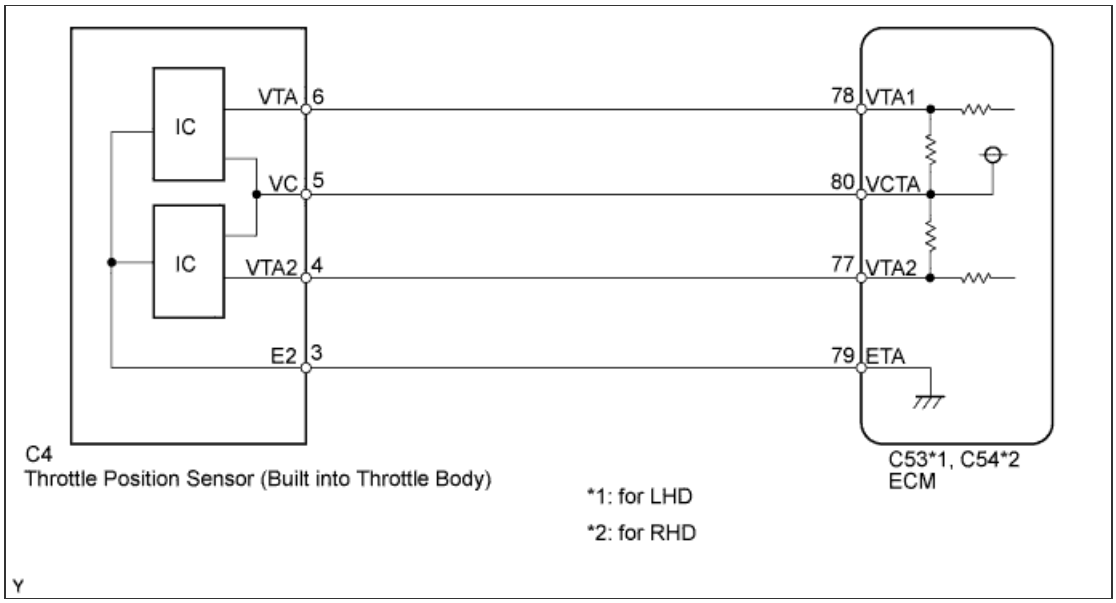
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

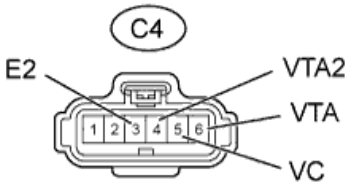
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

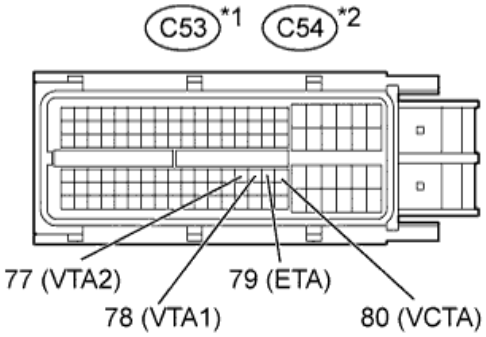
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

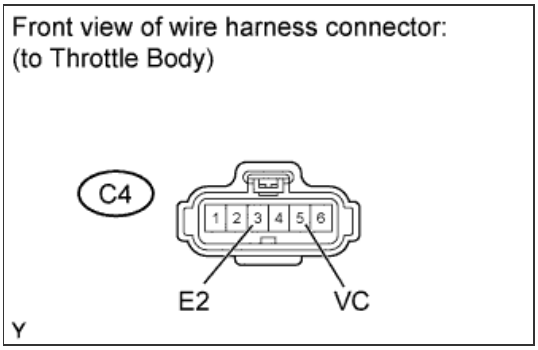
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1340 Camshaft Position Sensor "A" (Bank 1 Sensor 2)

DTC P1342 Camshaft Position Sensor "A" Low Input (MRE)

DTC P1343 Camshaft Position Sensor "A" High Input (MRE)

for Preparation Click here

DESCRIPTION

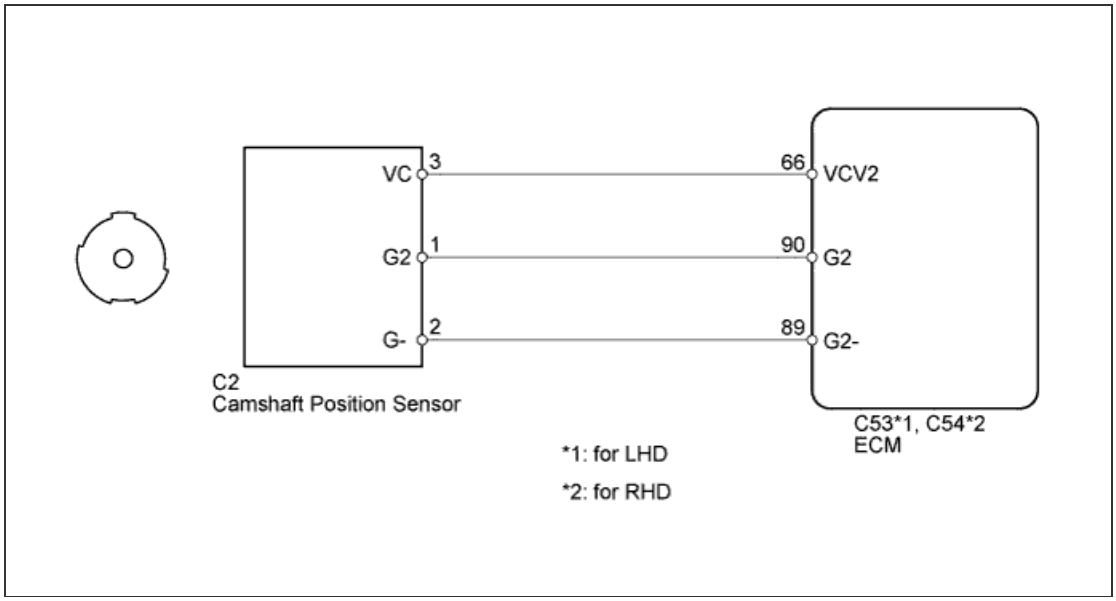
The camshaft position sensor (G signal) consists of a magnet and MRE (Magnetic Resistance Element).
The camshaft drive gear (LH) has 3 teeth on its inner circumstance. When the camshaft gear rotates, air gap changes between the protrusion on the teeth and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE.
The crankshaft position sensor plate has 34 teeth and is installed to the rear end of the crankshaft. The crankshaft position sensor generates 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

DTC Code	DTC Detection Condition	Trouble Area
P1340	No camshaft position sensor signal is sent to the ECM during cranking (2 trip detection logic).	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing plate LH • ECM
	No camshaft position sensor signal is sent to the ECM with an engine speed of 600 rpm or more.	
P1342	The output voltage of the camshaft position sensor is below 0.3 V for 4 seconds (1 trip detection logic).	
P1343	The output voltage of the camshaft position sensor is higher than 4.7 V for 4 seconds (1 trip detection logic).	

MONITOR DESCRIPTION

The camshaft position sensor (G signal) consists of a magnet and MRE.
The camshaft drive gear has 3 teeth on its inner circumference. When the camshaft gear rotates, air gap changes between the protrusion on the gear and the MRE. The change affects the magnetic field and results in changes in the resistance of the MRE. The crankshaft position sensor plate has 34 teeth and outputs 34 signals with every revolution. The ECM detects the standard crankshaft angle based on the G signal, and the actual crankshaft angle and engine speed by the NE signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air fuel ratio was lean or rich, and other data from the time the malfunction occurred.

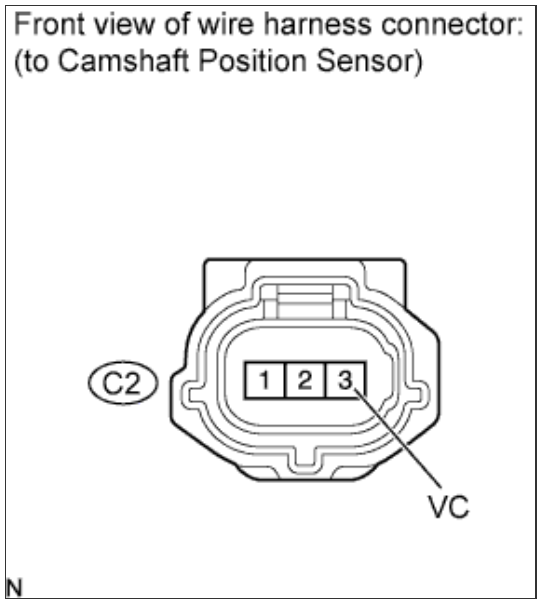
1.INSPECT CAMSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C2 camshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C2-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

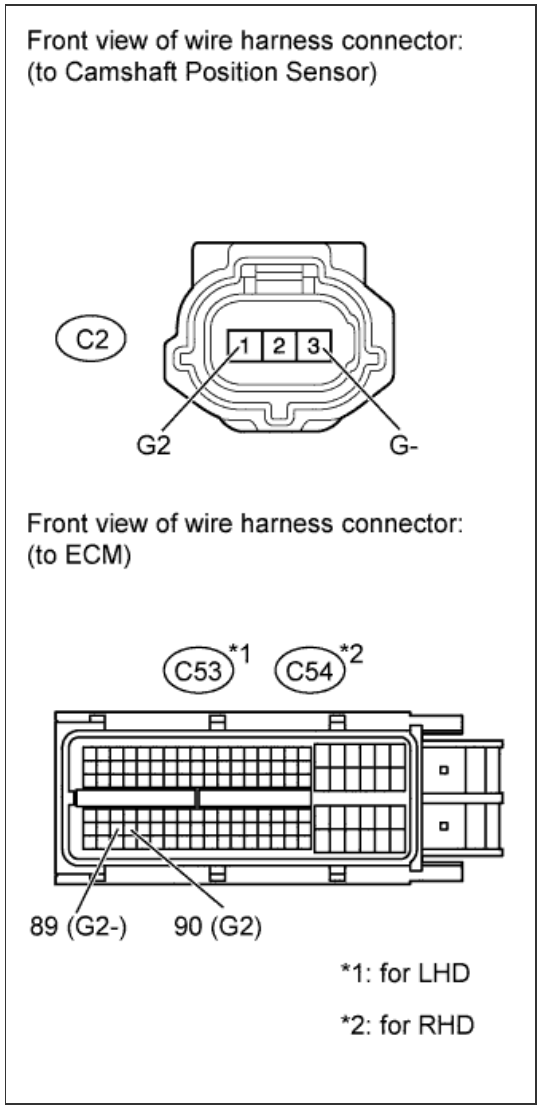
OK

2.CHECK HARNESS AND CONNECTOR (ECM - CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition

C2-1 (G2) - C53-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C53-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C53-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C53-89 (G2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C2-1 (G2) - C54-90 (G2)	Always	Below 1 Ω
C2-2 (G-) - C54-89 (G2-)	Always	Below 1 Ω
C2-1 (G2) or C54-90 (G2) - Body ground	Always	10 kΩ or higher
C2-2 (G-) or C54-89 (G2-) - Body ground	Always	10 kΩ or higher

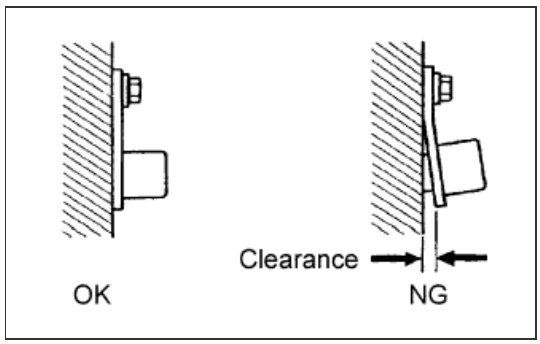
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT SENSOR INSTALLATION

a. Check the camshaft position sensor installation.

OK:
The camshaft position sensor is installed properly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.INSPECT CAMSHAFT TIMING PLATE (SIGNAL PLATE TOOTH)

a. Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT TIMING PLATE (Click here)

OK

5.REPLACE CAMSHAFT POSITION SENSOR

a. Replace the camshaft position sensor (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P1340, P1342 and/or P1343 are output	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

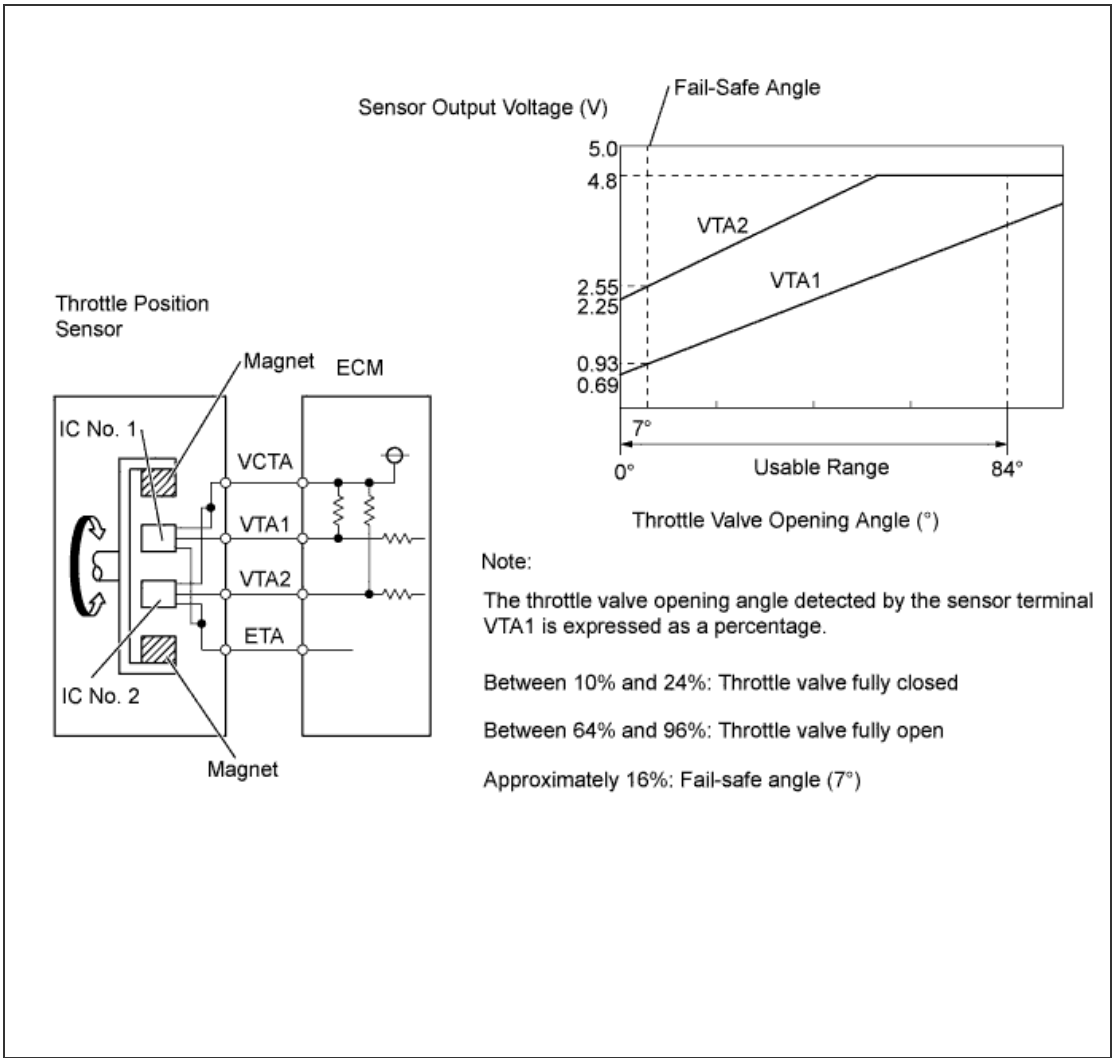
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

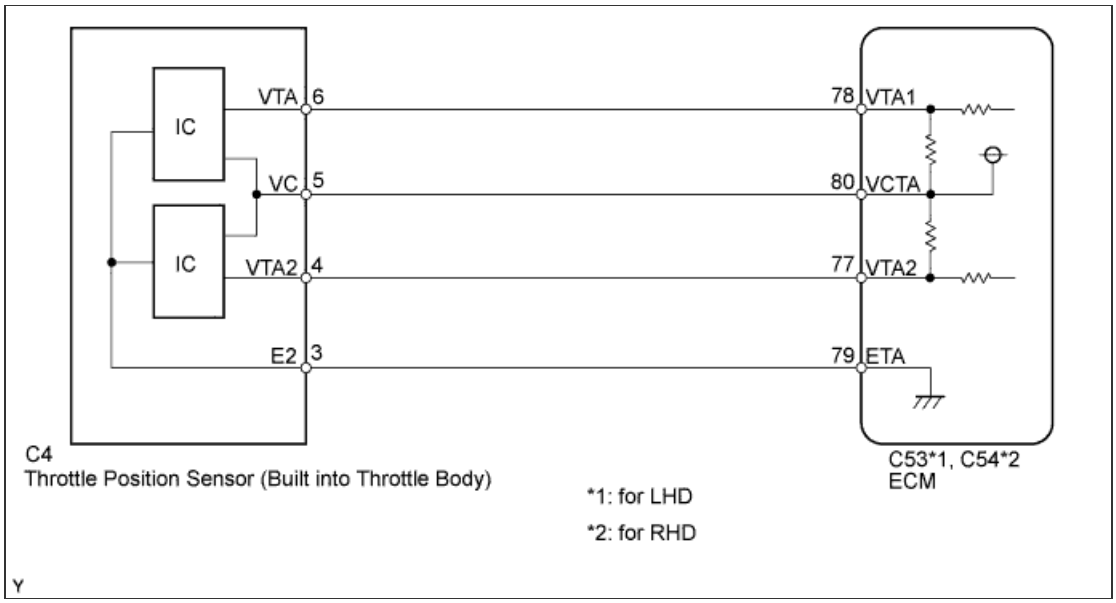
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

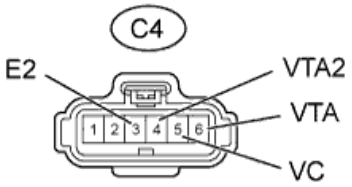
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

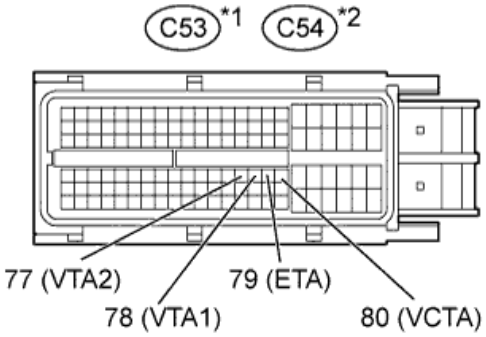
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

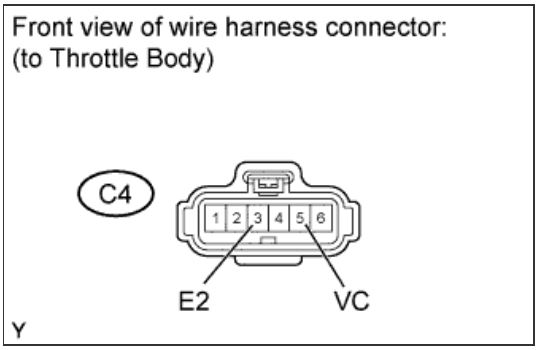
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1607 Cruise Control Input Processor

for Preparation Click here

DESCRIPTION

The ECM continuously monitors its main and sub CPUs. This self-check ensures that the ECM is functioning properly. If outputs from the CPUs are different and deviate from the standard, the ECM will illuminate the MIL and store DTC(s) immediately.

DTC Code	DTC Detection Condition	Trouble Area
P1607	The ECM CPUs malfunction.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P1607 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

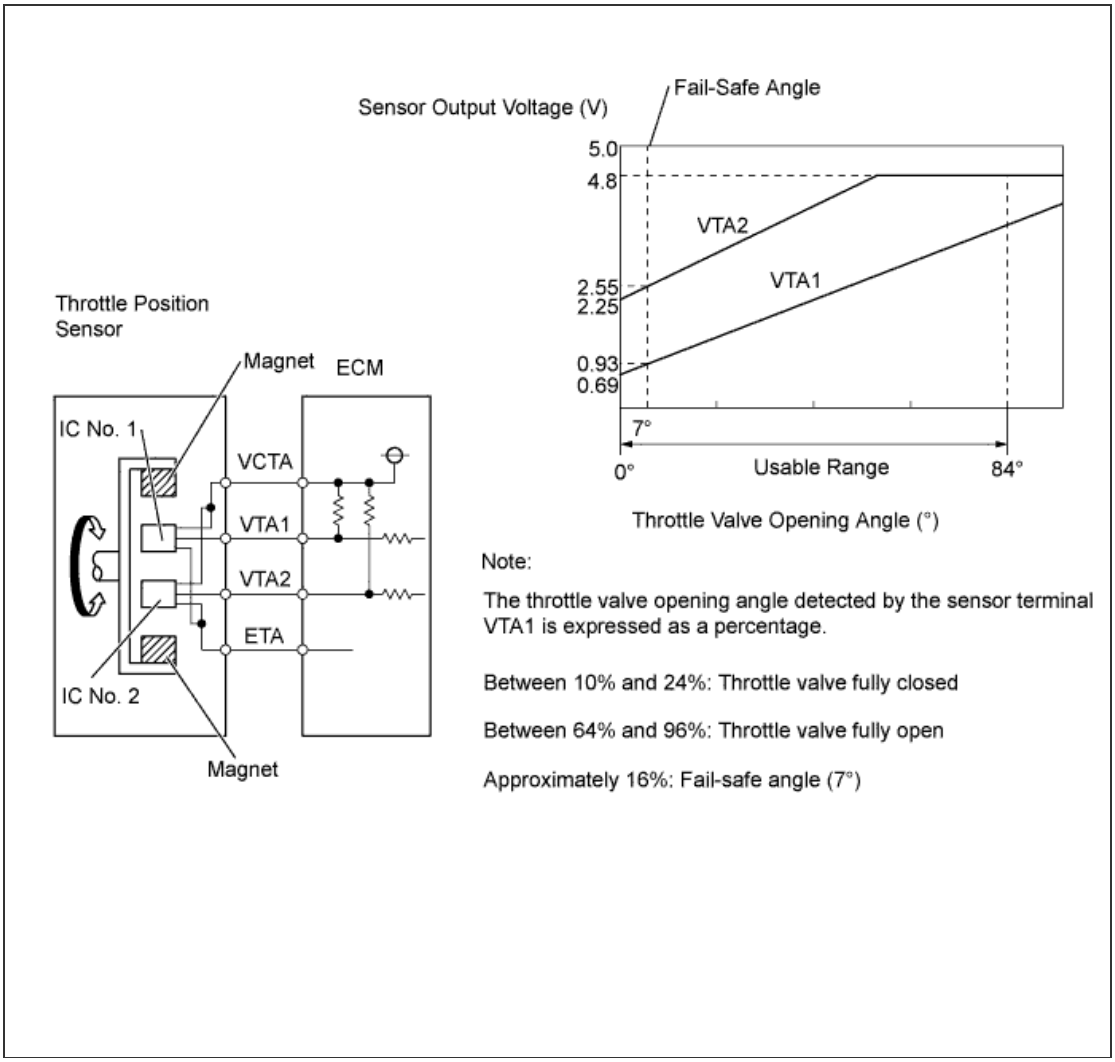
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

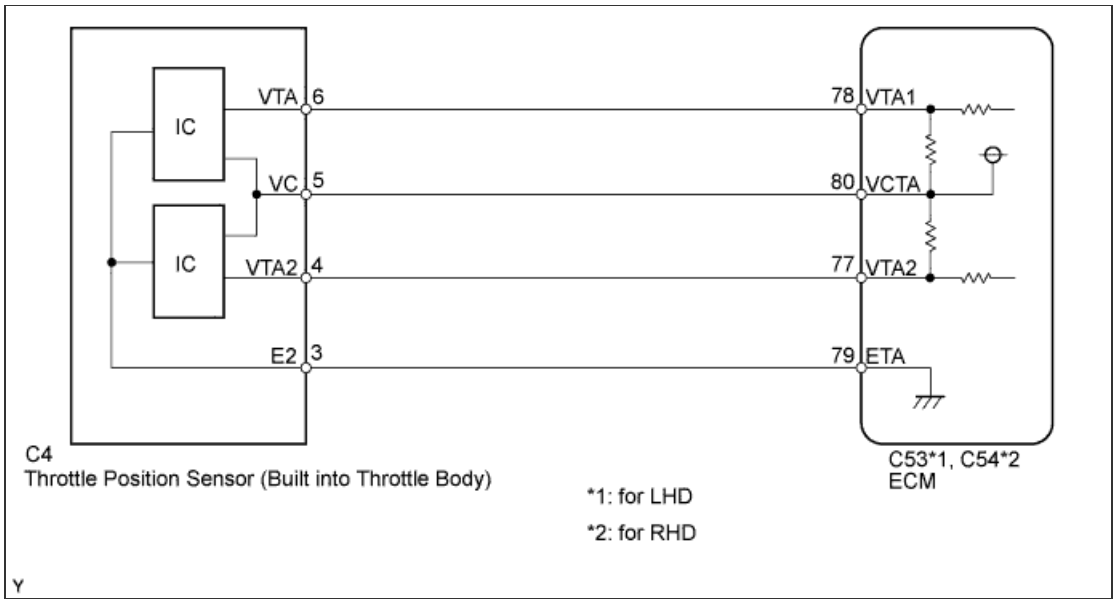
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

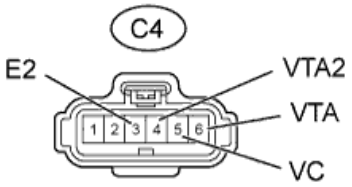
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

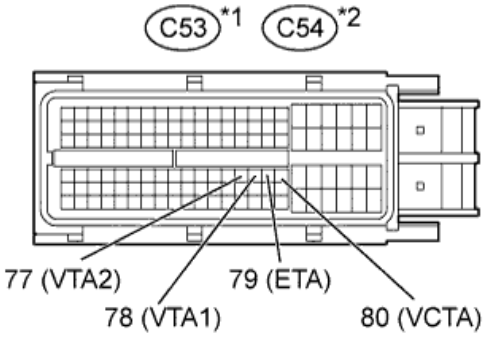
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

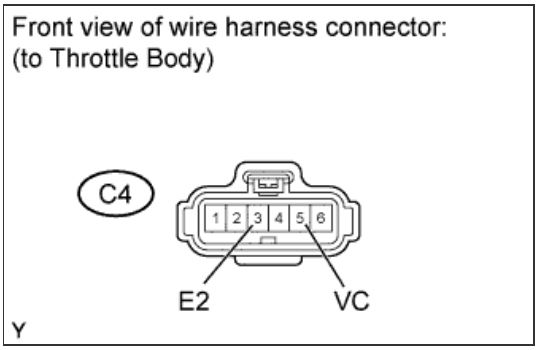
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1607 Cruise Control Input Processor

for Preparation Click here

DESCRIPTION

The ECM continuously monitors its main and sub CPUs. This self-check ensures that the ECM is functioning properly. If outputs from the CPUs are different and deviate from the standard, the ECM will illuminate the MIL and store DTC(s) immediately.

DTC Code	DTC Detection Condition	Trouble Area
P1607	The ECM CPUs malfunction.	ECM

INSPECTION PROCEDURE

1.CHECK DTC

a. Clear DTC (Click here).

b. Turn the engine switch off.

c. Disconnect the cable from the negative (-) battery terminal and wait for 1 minute.

d. Connect the cable to the negative (-) battery terminal.

e. Turn the engine switch on (IG).

f. Check DTC.

OK:
P1607 is not output.

NG → **REPLACE ECM (Click here)**

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

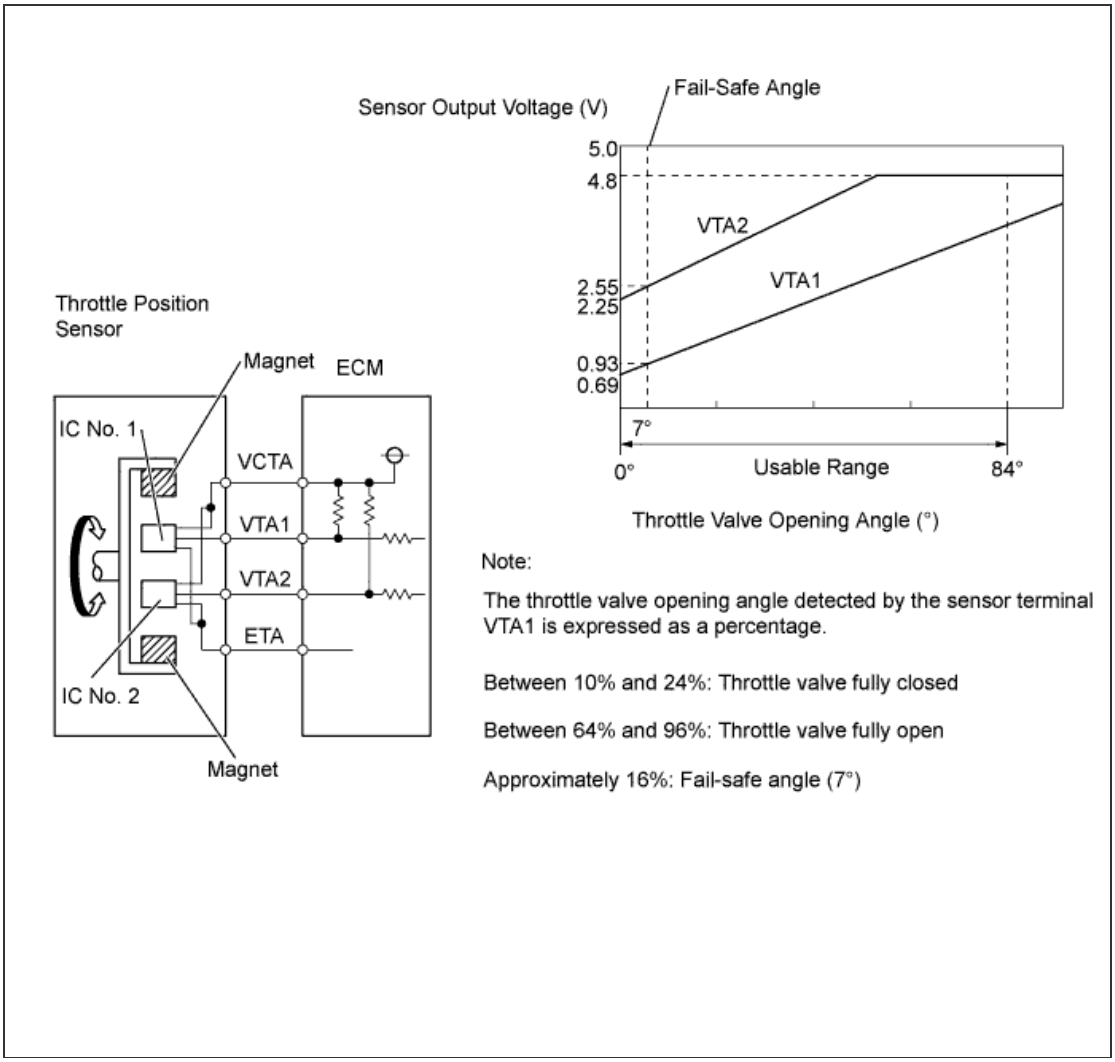
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

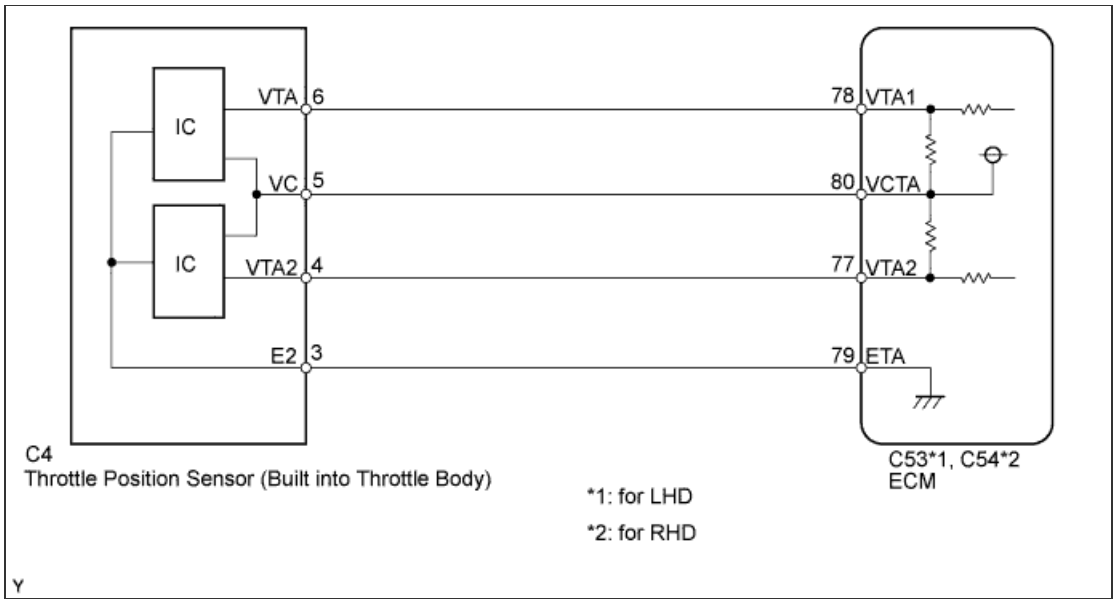
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

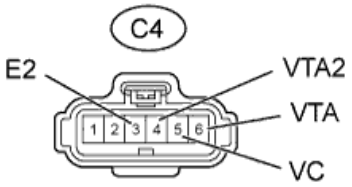
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

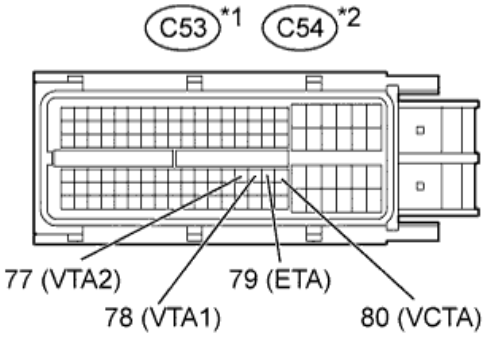
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

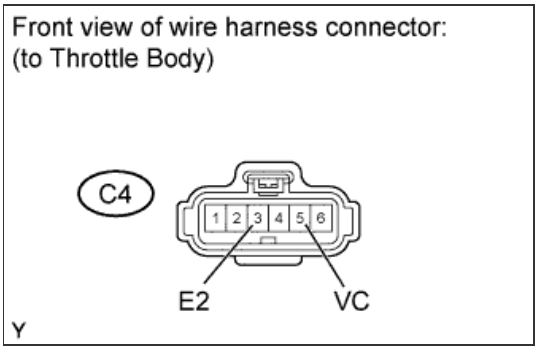
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1613 Secondary Air Injection Driver Malfunction

DTC P1614 Secondary Air Injection System Driver Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P1613 P1614	Either of the following conditions (1) or (2) is met: (1) All of the following conditions are met (1 trip detection logic): • Either the air pump or the air switching valve is not operating. • The diagnostic signal from the Air Injection Control Driver (AID) is 80%. • The battery voltage is 8 V or higher. (2) Both of the following conditions are met (1 trip detection logic): • The battery voltage is 8 V or higher. • The diagnostic signal from the AID is abnormal (duty signal other than 0, 20, 40, 80 and 100%).	• Air Injection Control Driver (AID) • Open in AID ground circuit
P1613 P1614	All of the following conditions are met (1 trip detection logic): 1. The air injection system is operating (Air Switching Valve [ASV] ON and air pump ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 0%. 3. The battery voltage is 8 V or higher.	• Short in diagnostic information signal circuit (AID - ECM) • Open or short in air pump and air switching valve command signal circuit (AID - ECM) • Open in AID ground circuit • AID • ECM
P1613 P1614	Both of the following conditions are met (1 trip detection logic): 1. The battery voltage is 8 V or higher. 2. The diagnostic signal from the Air Injection Control Driver (AID) is 100%.	• Open or short in AID +B circuit • Open in diagnostic information signal circuit (AID - ECM) • AID • ECM

MONITOR DESCRIPTION

For a short time after a cold engine start, the ECM transmits command signals to the Air Injection Control Driver (AID) to drive the air pump and the Air Switching Valve (ASV). The AID detects open and short circuits according to the voltages at the AID terminals to the air pump and ASV, and the circuit voltage of the AID power source, and transmits diagnostic information as a signal to the ECM.
If the Secondary Air Injection (AIR) system circuit or the AID itself malfunctions, the AID sends a malfunction signal (duty signal) as diagnostic information to the ECM (when the system is normal, a system normal signal is sent). The ECM stores the DTC based on the diagnostic information from the AID.
EXAMPLE:

1. The duty ratio of the diagnostic signal from the AID is 0 or 100% (remains at 0 V or the same as battery voltage).
2. The duty ratio of the diagnostic signal from the AID shows an impossible ratio (other than 0, 20, 40, 80 and 100%).
3. The AID outputs the normal signal (normal duty signal: 80%) while the system is not operating.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

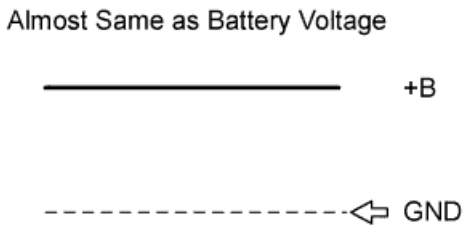
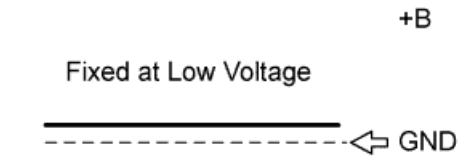
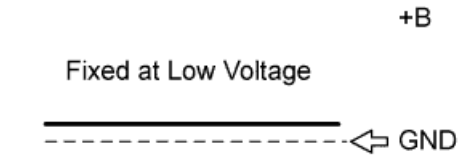
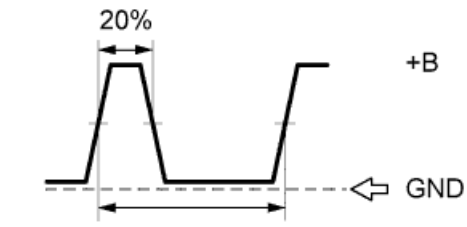
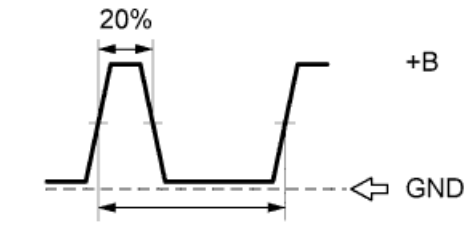
Diagnostic information output by the Air Injection Control Driver (AID) can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the System Check function, allows the possible trouble areas to be narrowed down.

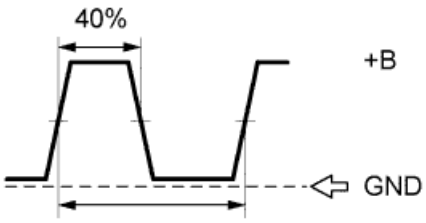
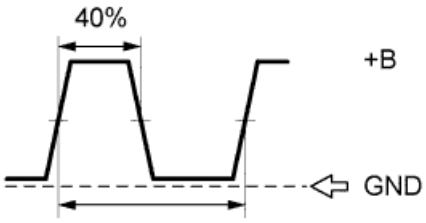
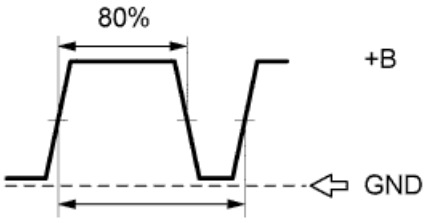
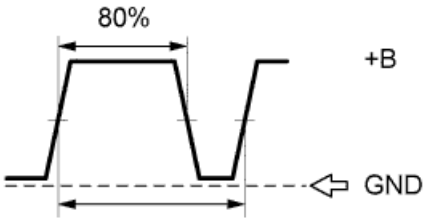
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore,**

the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.
- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100% Duty Ratio 	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio			

	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio 	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P1613 OR P1614)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P1613 and/or P1614 are output	A
P1613 and/or P1614 and other DTCs are output	B

If any DTCs other than P1613 and P1614 are output, troubleshoot those DTCs first.

B

GO TO DTC CHART (Click here)

A

2.CHECK AIR INJECTION CONTROL DRIVER (POWER SOURCE CIRCUIT)

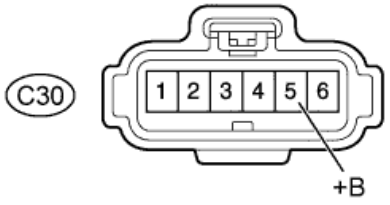
a. Disconnect the C30 or C32 Air Injection Control Driver (AID) connector.

b. Measure the voltage according to the value(s) in the table below.

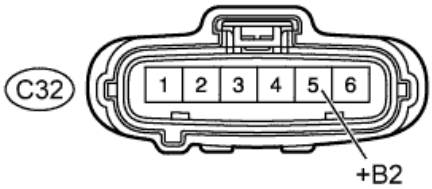
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

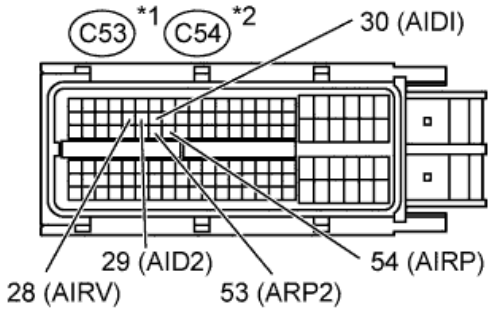
3.CHECK HARNESS AND CONNECTOR (AID - ECM, BODY GROUND)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

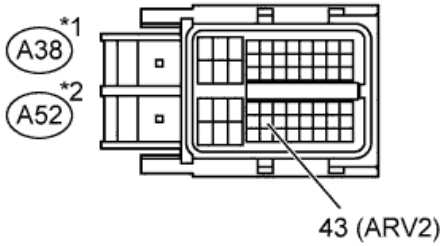
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

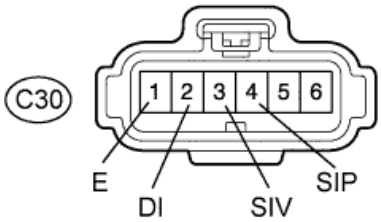
Front view of wire harness connector:
(to ECM)



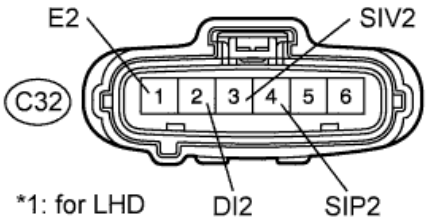
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C53-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C53-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω

C32-1 (E2) - Body ground	Always	Below 1 Ω
C53-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C53-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C53-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A38-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C53-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C53-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C54-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C54-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω
C54-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C54-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C54-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A53-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C54-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C54-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.INSPECT AIR INJECTION CONTROL DRIVER (DI TERMINAL VOLTAGE)

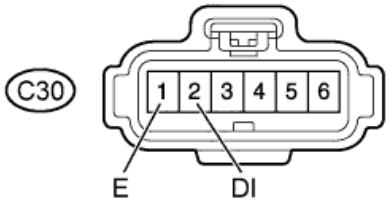
a. Disconnect the C30 or C32 AID connector.

b. Measure the voltage according to the value(s) in the table below.

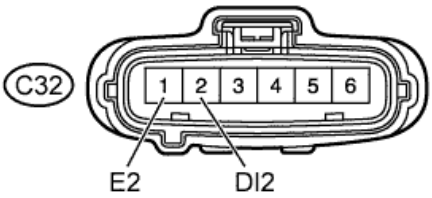
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-2 (DI) - C30-1 (E)	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-2 (DI2) - C32-1 (E2)	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPLACE ECM (Click here)

OK

5.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the tester initialization is finished.

h. Perform the Automatic Mode operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Enter the following menus: Powertrain / Engine and ECT / DTC.

k. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
Other DTCs are output	B

I. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

B	GO TO DTC CHART (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

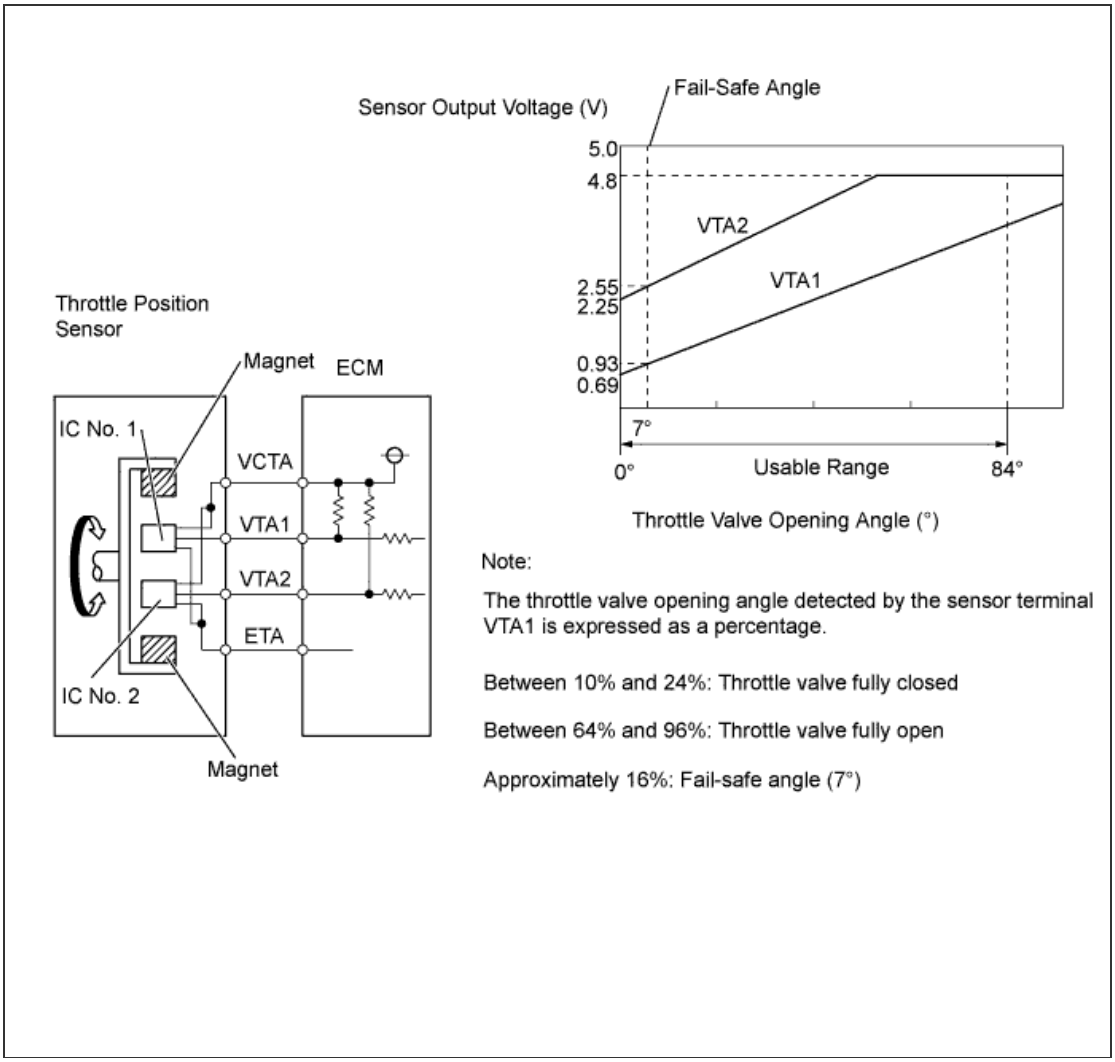
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

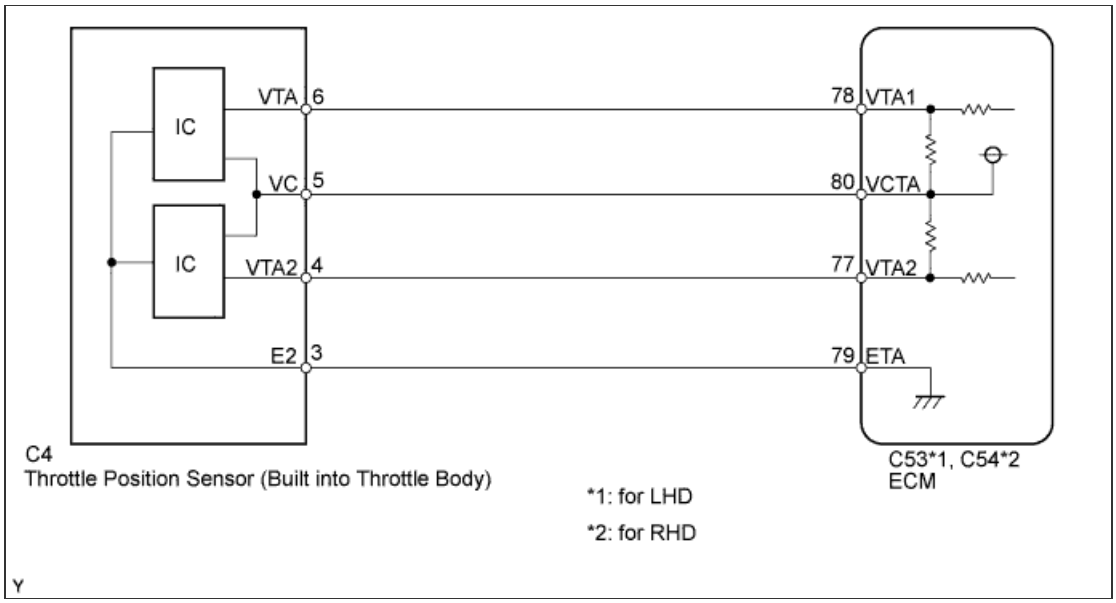
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

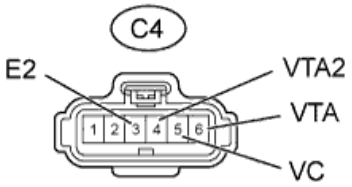
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

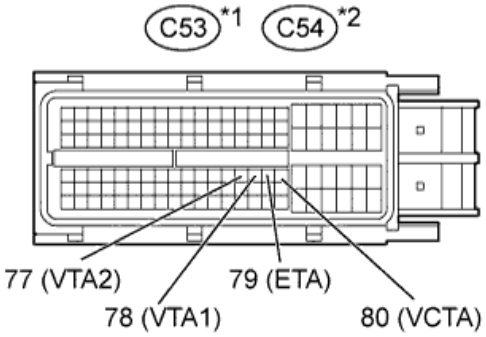
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

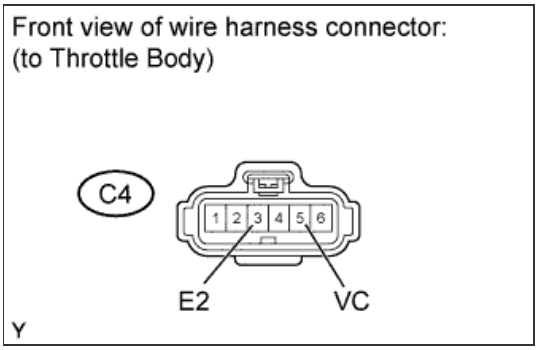
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1613 Secondary Air Injection Driver Malfunction

DTC P1614 Secondary Air Injection System Driver Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P1613 P1614	Either of the following conditions (1) or (2) is met: (1) All of the following conditions are met (1 trip detection logic): • Either the air pump or the air switching valve is not operating. • The diagnostic signal from the Air Injection Control Driver (AID) is 80%. • The battery voltage is 8 V or higher. (2) Both of the following conditions are met (1 trip detection logic): • The battery voltage is 8 V or higher. • The diagnostic signal from the AID is abnormal (duty signal other than 0, 20, 40, 80 and 100%).	• Air Injection Control Driver (AID) • Open in AID ground circuit
P1613 P1614	All of the following conditions are met (1 trip detection logic): 1. The air injection system is operating (Air Switching Valve [ASV] ON and air pump ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 0%. 3. The battery voltage is 8 V or higher.	• Short in diagnostic information signal circuit (AID - ECM) • Open or short in air pump and air switching valve command signal circuit (AID - ECM) • Open in AID ground circuit • AID • ECM
P1613 P1614	Both of the following conditions are met (1 trip detection logic): 1. The battery voltage is 8 V or higher. 2. The diagnostic signal from the Air Injection Control Driver (AID) is 100%.	• Open or short in AID +B circuit • Open in diagnostic information signal circuit (AID - ECM) • AID • ECM

MONITOR DESCRIPTION

For a short time after a cold engine start, the ECM transmits command signals to the Air Injection Control Driver (AID) to drive the air pump and the Air Switching Valve (ASV). The AID detects open and short circuits according to the voltages at the AID terminals to the air pump and ASV, and the circuit voltage of the AID power source, and transmits diagnostic information as a signal to the ECM.
If the Secondary Air Injection (AIR) system circuit or the AID itself malfunctions, the AID sends a malfunction signal (duty signal) as diagnostic information to the ECM (when the system is normal, a system normal signal is sent). The ECM stores the DTC based on the diagnostic information from the AID.
EXAMPLE:

1. The duty ratio of the diagnostic signal from the AID is 0 or 100% (remains at 0 V or the same as battery voltage).
2. The duty ratio of the diagnostic signal from the AID shows an impossible ratio (other than 0, 20, 40, 80 and 100%).
3. The AID outputs the normal signal (normal duty signal: 80%) while the system is not operating.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

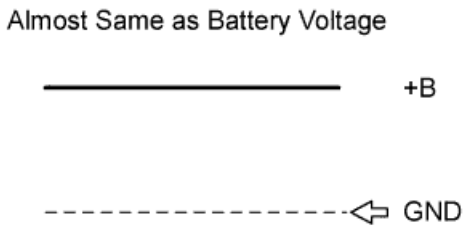
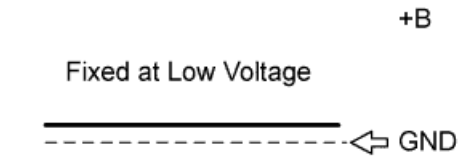
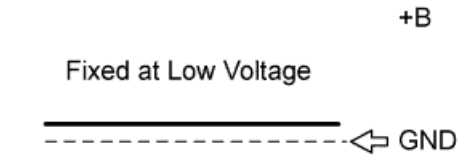
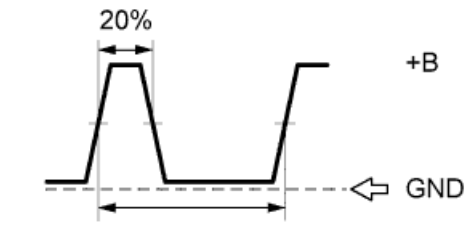
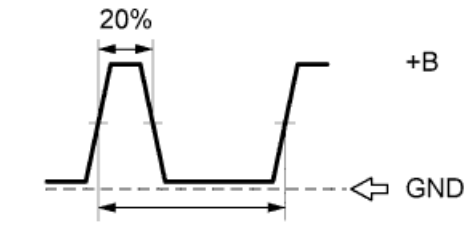
Diagnostic information output by the Air Injection Control Driver (AID) can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the System Check function, allows the possible trouble areas to be narrowed down.

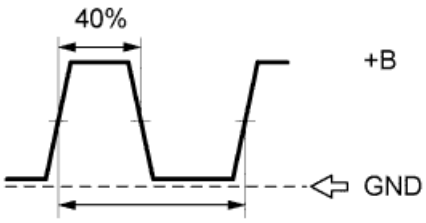
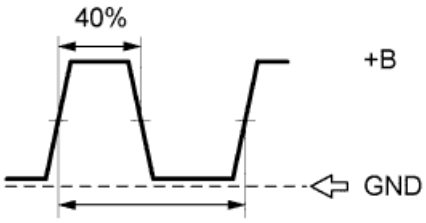
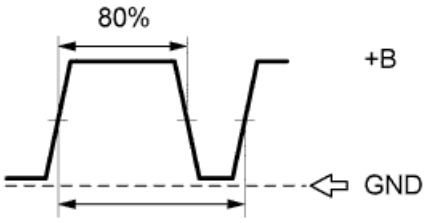
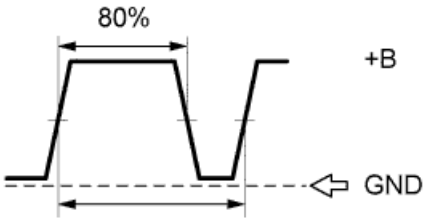
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore,**

the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.
- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100% Duty Ratio 	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio			

	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio 	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P1613 OR P1614)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P1613 and/or P1614 are output	A
P1613 and/or P1614 and other DTCs are output	B

If any DTCs other than P1613 and P1614 are output, troubleshoot those DTCs first.

B

GO TO DTC CHART (Click here)

A

2.CHECK AIR INJECTION CONTROL DRIVER (POWER SOURCE CIRCUIT)

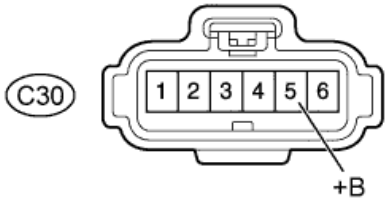
a. Disconnect the C30 or C32 Air Injection Control Driver (AID) connector.

b. Measure the voltage according to the value(s) in the table below.

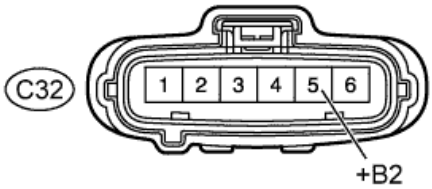
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

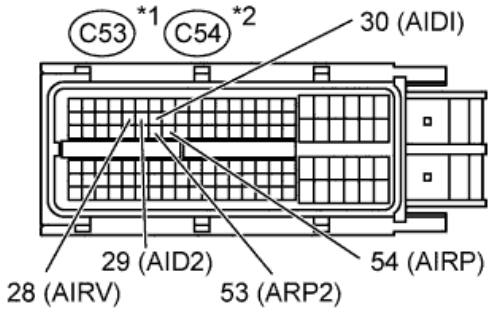
3.CHECK HARNESS AND CONNECTOR (AID - ECM, BODY GROUND)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

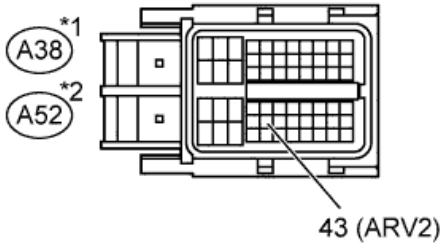
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

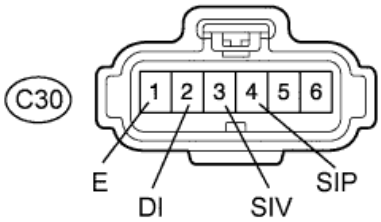
Front view of wire harness connector:
(to ECM)



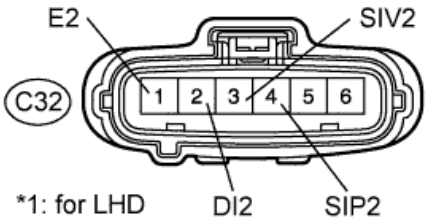
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C53-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C53-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω

C32-1 (E2) - Body ground	Always	Below 1 Ω
C53-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C53-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C53-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A38-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C53-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C53-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C54-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C54-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω
C54-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C54-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C54-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A53-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C54-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C54-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.INSPECT AIR INJECTION CONTROL DRIVER (DI TERMINAL VOLTAGE)

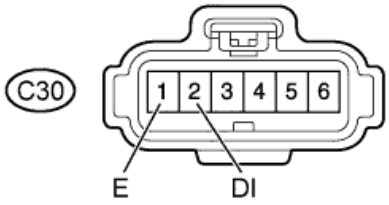
a. Disconnect the C30 or C32 AID connector.

b. Measure the voltage according to the value(s) in the table below.

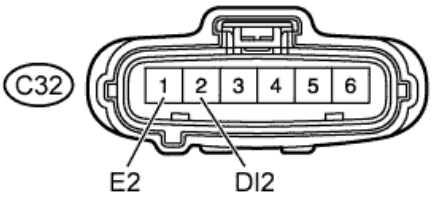
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-2 (DI) - C30-1 (E)	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-2 (DI2) - C32-1 (E2)	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPLACE ECM (Click here)

OK

5.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the tester initialization is finished.

h. Perform the Automatic Mode operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Enter the following menus: Powertrain / Engine and ECT / DTC.

k. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
Other DTCs are output	B

I. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

B	GO TO DTC CHART (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

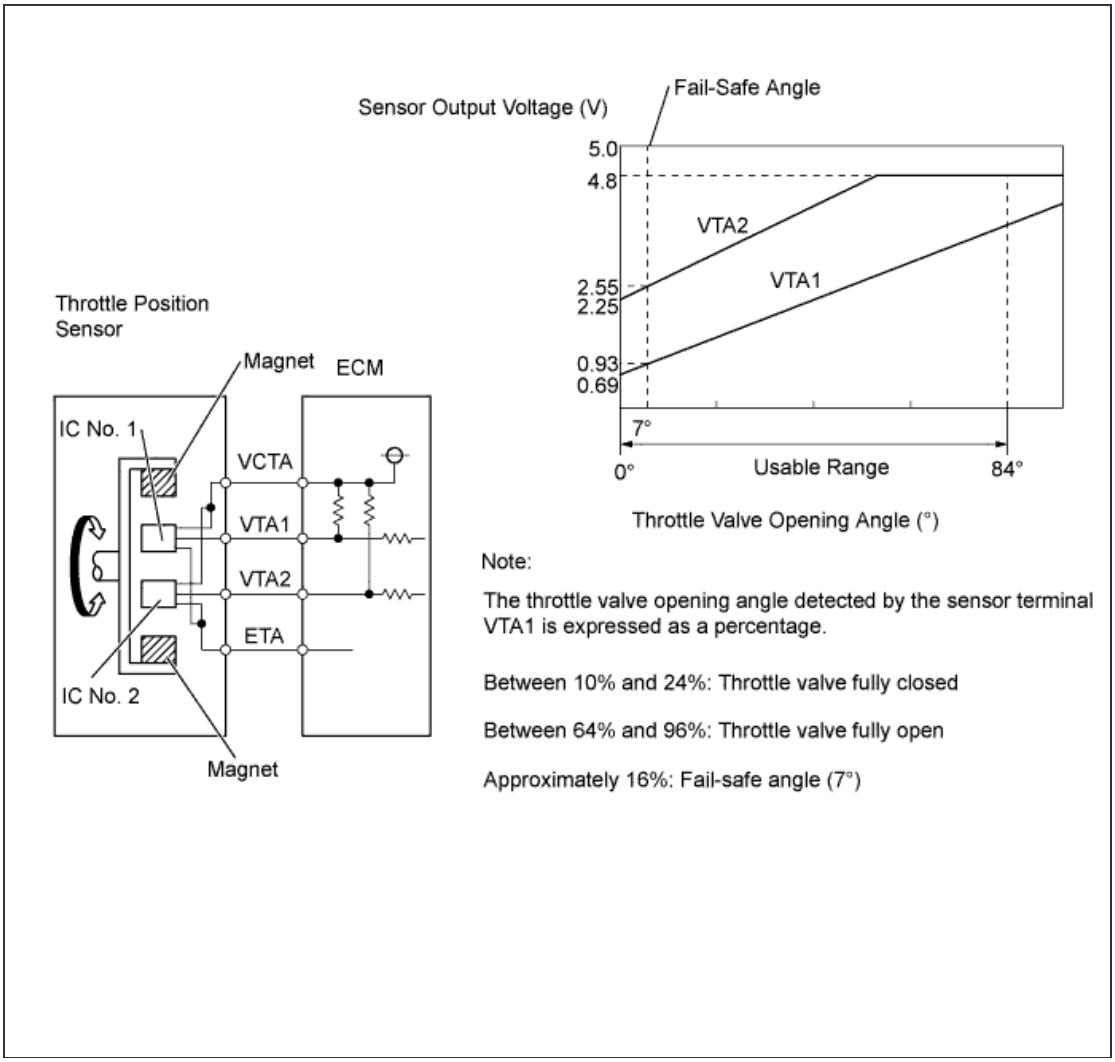
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

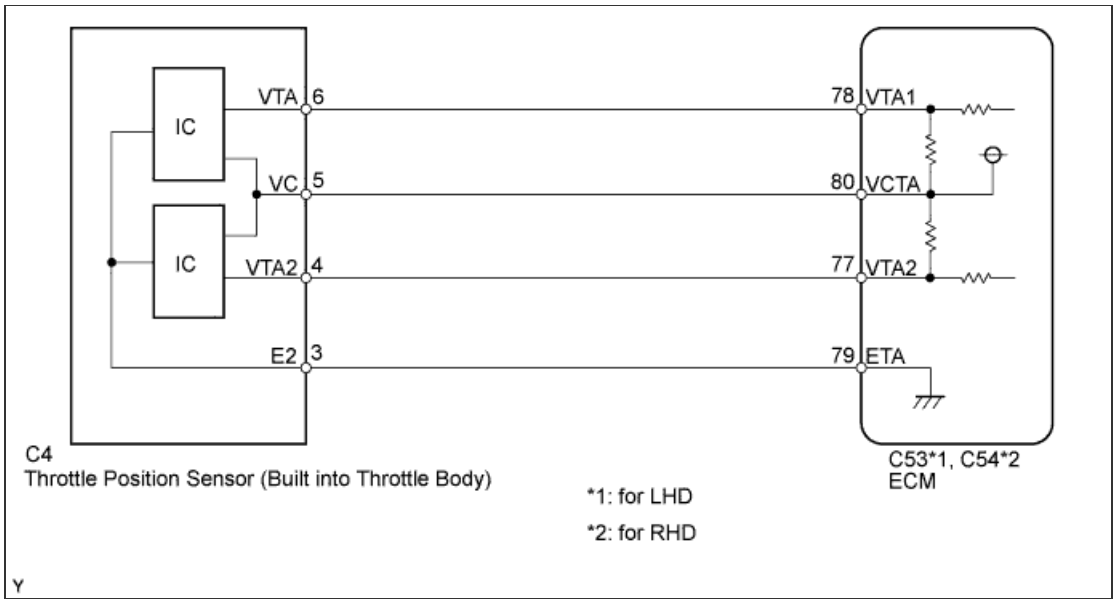
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

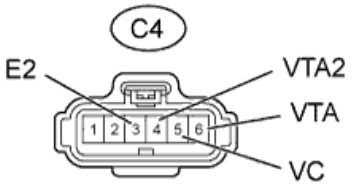
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

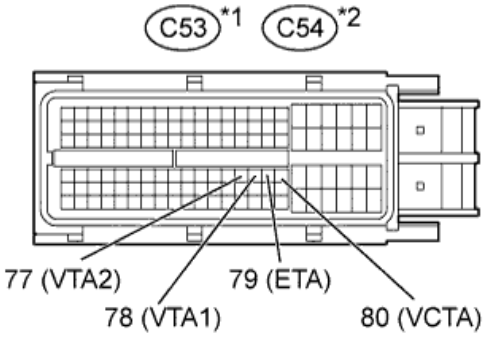
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

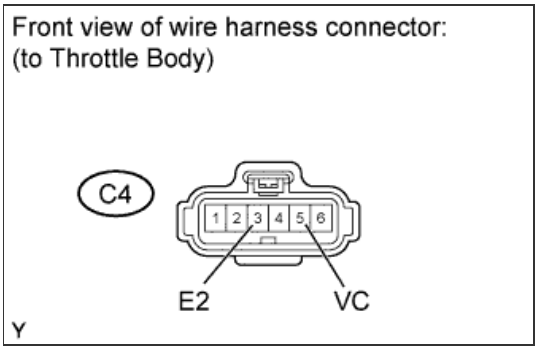
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1613 Secondary Air Injection Driver Malfunction

DTC P1614 Secondary Air Injection System Driver Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P1613 P1614	Either of the following conditions (1) or (2) is met: (1) All of the following conditions are met (1 trip detection logic): • Either the air pump or the air switching valve is not operating. • The diagnostic signal from the Air Injection Control Driver (AID) is 80%. • The battery voltage is 8 V or higher. (2) Both of the following conditions are met (1 trip detection logic): • The battery voltage is 8 V or higher. • The diagnostic signal from the AID is abnormal (duty signal other than 0, 20, 40, 80 and 100%).	• Air Injection Control Driver (AID) • Open in AID ground circuit
P1613 P1614	All of the following conditions are met (1 trip detection logic): 1. The air injection system is operating (Air Switching Valve [ASV] ON and air pump ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 0%. 3. The battery voltage is 8 V or higher.	• Short in diagnostic information signal circuit (AID - ECM) • Open or short in air pump and air switching valve command signal circuit (AID - ECM) • Open in AID ground circuit • AID • ECM
P1613 P1614	Both of the following conditions are met (1 trip detection logic): 1. The battery voltage is 8 V or higher. 2. The diagnostic signal from the Air Injection Control Driver (AID) is 100%.	• Open or short in AID +B circuit • Open in diagnostic information signal circuit (AID - ECM) • AID • ECM

MONITOR DESCRIPTION

For a short time after a cold engine start, the ECM transmits command signals to the Air Injection Control Driver (AID) to drive the air pump and the Air Switching Valve (ASV). The AID detects open and short circuits according to the voltages at the AID terminals to the air pump and ASV, and the circuit voltage of the AID power source, and transmits diagnostic information as a signal to the ECM.
If the Secondary Air Injection (AIR) system circuit or the AID itself malfunctions, the AID sends a malfunction signal (duty signal) as diagnostic information to the ECM (when the system is normal, a system normal signal is sent). The ECM stores the DTC based on the diagnostic information from the AID.
EXAMPLE:

1. The duty ratio of the diagnostic signal from the AID is 0 or 100% (remains at 0 V or the same as battery voltage).
2. The duty ratio of the diagnostic signal from the AID shows an impossible ratio (other than 0, 20, 40, 80 and 100%).
3. The AID outputs the normal signal (normal duty signal: 80%) while the system is not operating.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

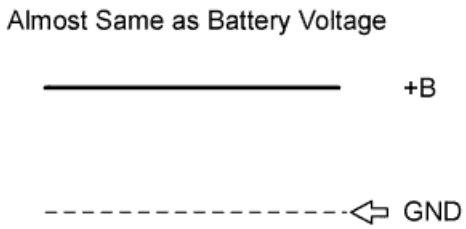
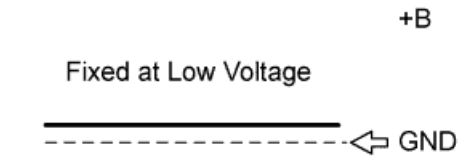
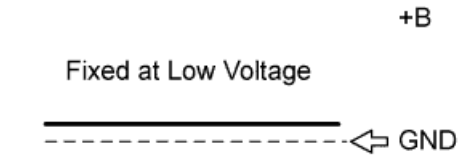
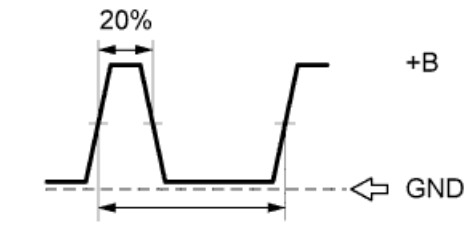
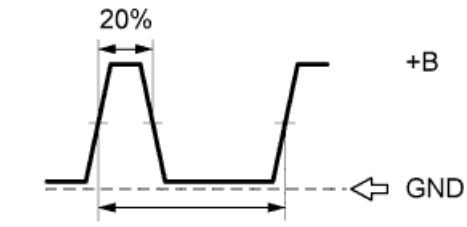
Diagnostic information output by the Air Injection Control Driver (AID) can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the System Check function, allows the possible trouble areas to be narrowed down.

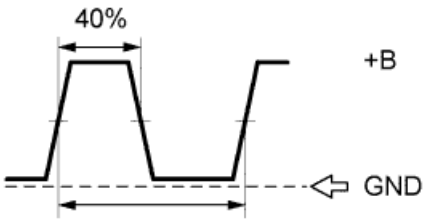
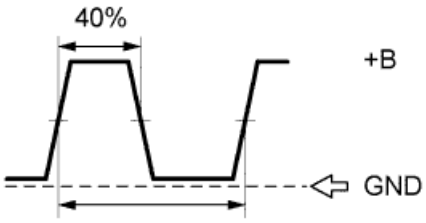
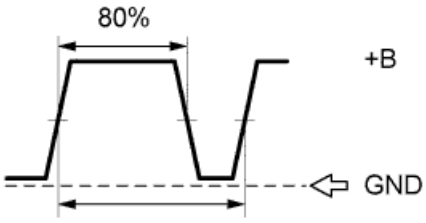
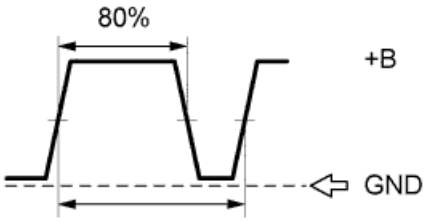
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore,**

the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.
- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100% Duty Ratio 	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio			

	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio 	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P1613 OR P1614)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P1613 and/or P1614 are output	A
P1613 and/or P1614 and other DTCs are output	B

If any DTCs other than P1613 and P1614 are output, troubleshoot those DTCs first.

B

GO TO DTC CHART (Click here)

A

2.CHECK AIR INJECTION CONTROL DRIVER (POWER SOURCE CIRCUIT)

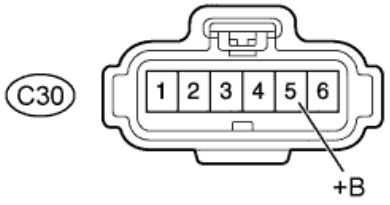
a. Disconnect the C30 or C32 Air Injection Control Driver (AID) connector.

b. Measure the voltage according to the value(s) in the table below.

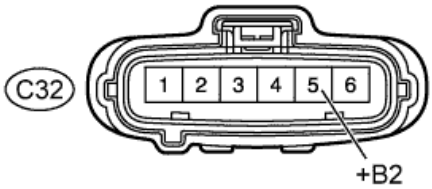
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

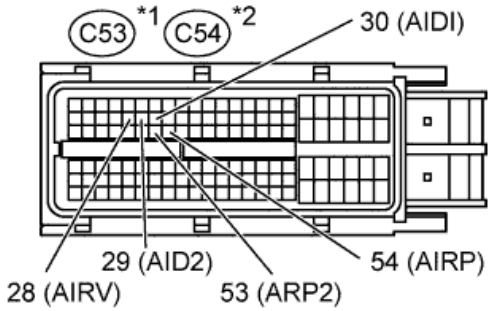
3.CHECK HARNESS AND CONNECTOR (AID - ECM, BODY GROUND)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

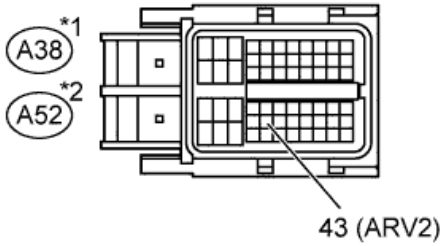
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

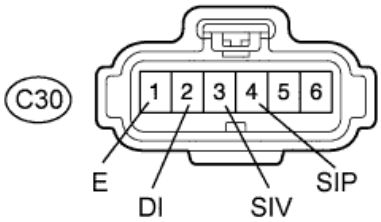
Front view of wire harness connector:
(to ECM)



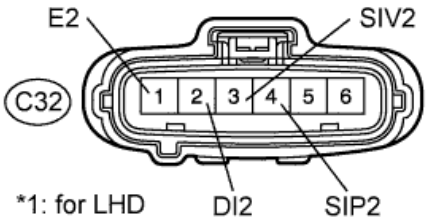
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C53-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C53-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω

C32-1 (E2) - Body ground	Always	Below 1 Ω
C53-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C53-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C53-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A38-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C53-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C53-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C54-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C54-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω
C54-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C54-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C54-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A53-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C54-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C54-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.INSPECT AIR INJECTION CONTROL DRIVER (DI TERMINAL VOLTAGE)

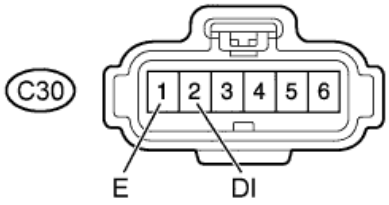
a. Disconnect the C30 or C32 AID connector.

b. Measure the voltage according to the value(s) in the table below.

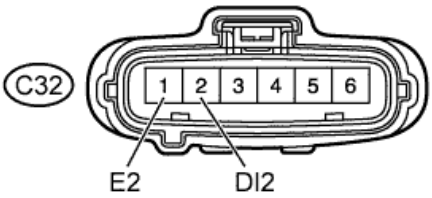
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-2 (DI) - C30-1 (E)	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-2 (DI2) - C32-1 (E2)	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPLACE ECM (Click here)

OK

5.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the tester initialization is finished.

h. Perform the Automatic Mode operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Enter the following menus: Powertrain / Engine and ECT / DTC.

k. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
Other DTCs are output	B

I. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

B	GO TO DTC CHART (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

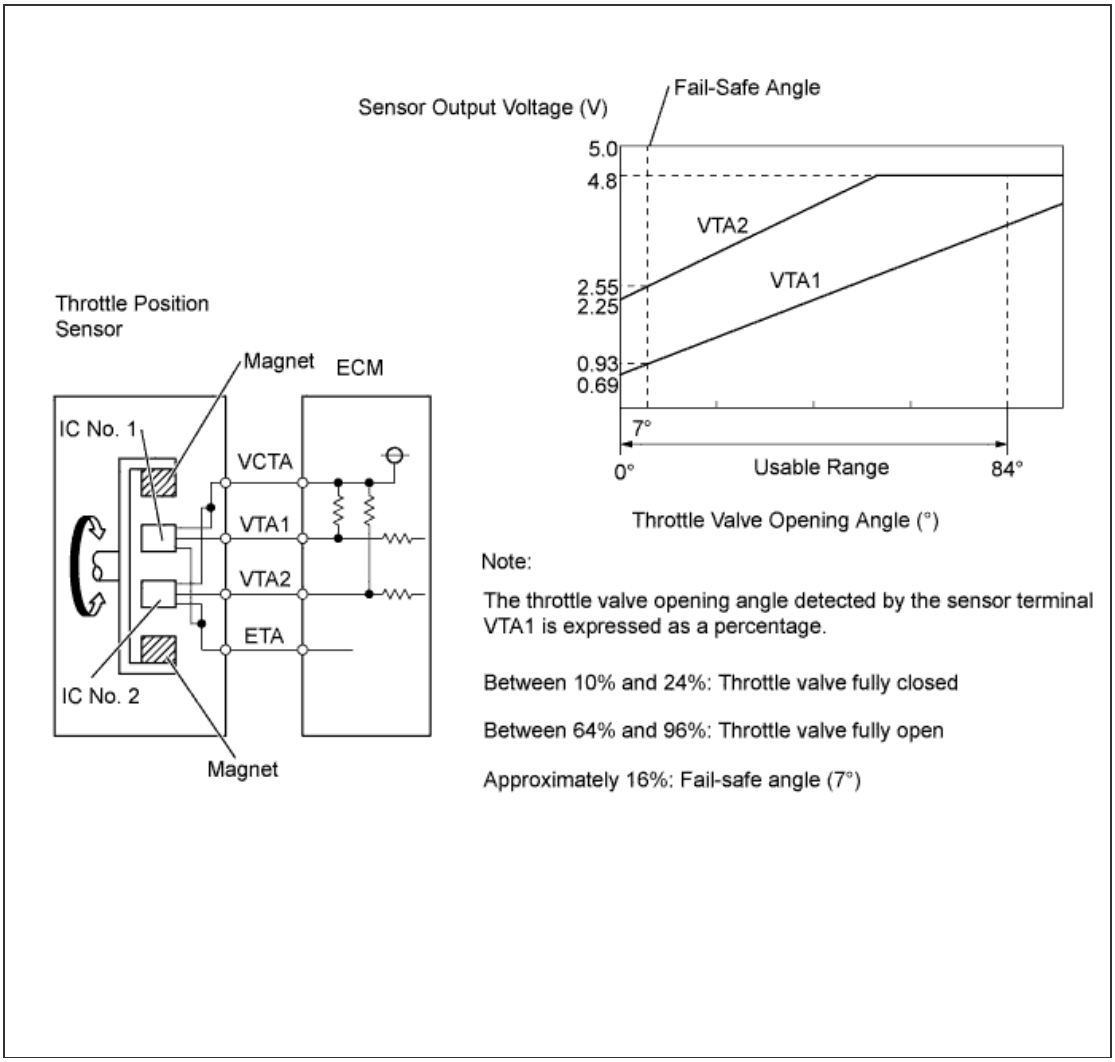
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

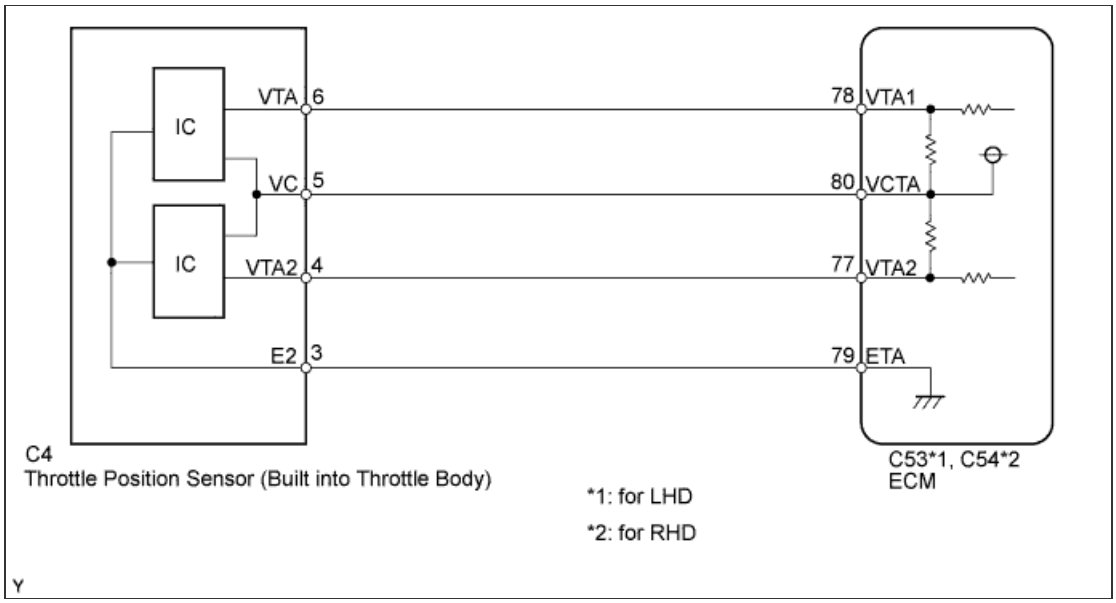
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

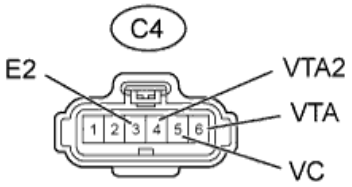
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

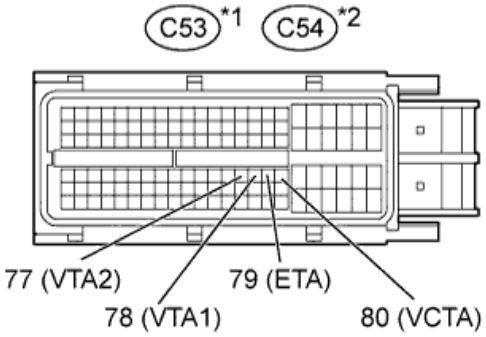
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

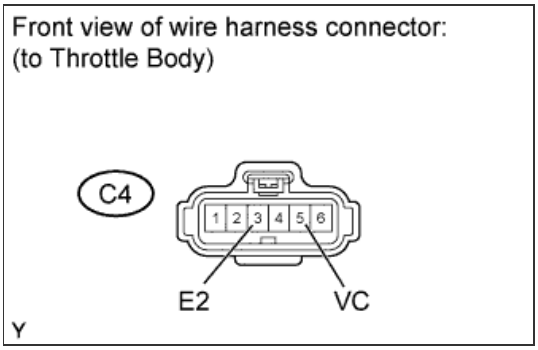
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P1613 Secondary Air Injection Driver Malfunction

DTC P1614 Secondary Air Injection System Driver Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P1613 P1614	Either of the following conditions (1) or (2) is met: (1) All of the following conditions are met (1 trip detection logic): • Either the air pump or the air switching valve is not operating. • The diagnostic signal from the Air Injection Control Driver (AID) is 80%. • The battery voltage is 8 V or higher. (2) Both of the following conditions are met (1 trip detection logic): • The battery voltage is 8 V or higher. • The diagnostic signal from the AID is abnormal (duty signal other than 0, 20, 40, 80 and 100%).	• Air Injection Control Driver (AID) • Open in AID ground circuit
P1613 P1614	All of the following conditions are met (1 trip detection logic): 1. The air injection system is operating (Air Switching Valve [ASV] ON and air pump ON). 2. The diagnostic signal from the Air Injection Control Driver (AID) is 0%. 3. The battery voltage is 8 V or higher.	• Short in diagnostic information signal circuit (AID - ECM) • Open or short in air pump and air switching valve command signal circuit (AID - ECM) • Open in AID ground circuit • AID • ECM
P1613 P1614	Both of the following conditions are met (1 trip detection logic): 1. The battery voltage is 8 V or higher. 2. The diagnostic signal from the Air Injection Control Driver (AID) is 100%.	• Open or short in AID +B circuit • Open in diagnostic information signal circuit (AID - ECM) • AID • ECM

MONITOR DESCRIPTION

For a short time after a cold engine start, the ECM transmits command signals to the Air Injection Control Driver (AID) to drive the air pump and the Air Switching Valve (ASV). The AID detects open and short circuits according to the voltages at the AID terminals to the air pump and ASV, and the circuit voltage of the AID power source, and transmits diagnostic information as a signal to the ECM.
If the Secondary Air Injection (AIR) system circuit or the AID itself malfunctions, the AID sends a malfunction signal (duty signal) as diagnostic information to the ECM (when the system is normal, a system normal signal is sent). The ECM stores the DTC based on the diagnostic information from the AID.
EXAMPLE:

1. The duty ratio of the diagnostic signal from the AID is 0 or 100% (remains at 0 V or the same as battery voltage).
2. The duty ratio of the diagnostic signal from the AID shows an impossible ratio (other than 0, 20, 40, 80 and 100%).
3. The AID outputs the normal signal (normal duty signal: 80%) while the system is not operating.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

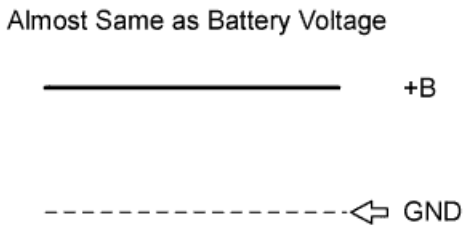
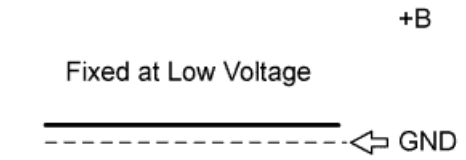
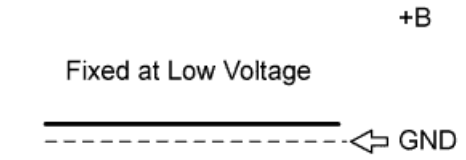
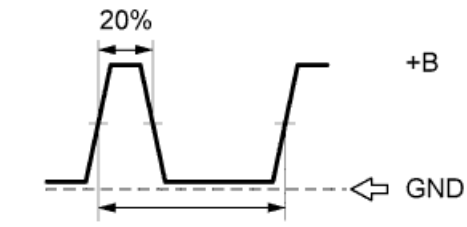
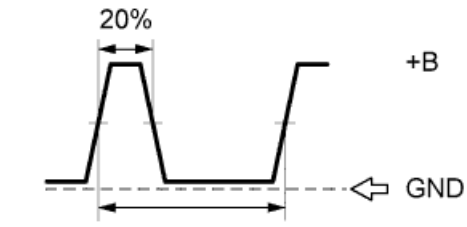
Diagnostic information output by the Air Injection Control Driver (AID) can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the System Check function, allows the possible trouble areas to be narrowed down.

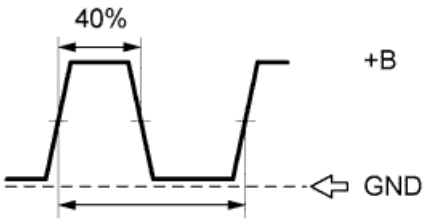
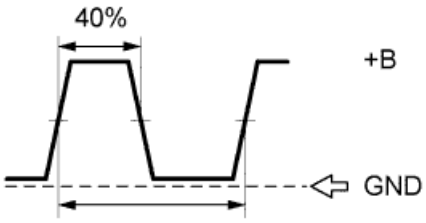
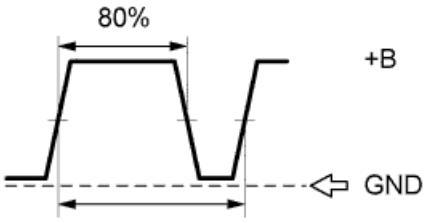
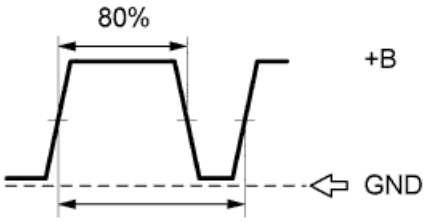
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore,**

the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.
- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100% Duty Ratio 	Any Secondary Air Injection (AIR) System operation	P1613 P1614	• Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID BATT circuit • Short between +B and diagnostic signal circuits
0% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	P1613 P1614	• Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM - AID) • Short between diagnostic signal circuit and body ground • AID • ECM
0% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20% Duty Ratio 	Air Pump: ON	P0418 P0419	• Short between air pump drive circuit and body ground • Harness and connector (AID - Pump) • Air pump • AID • ECM
20% Duty Ratio 	Air Pump: OFF	P0418 P0419	• Open in air pump drive circuit (AID - Pump) • Harness and connector (AID - Pump) • Air pump • AID • ECM
40% Duty Ratio			

	ASV: ON	P0412 P0415	• Short between ASV drive circuit and body ground • Harness and connector (AID - ASV) • ASV • AID • ECM
40% Duty Ratio 	ASV: OFF	P0412 P0415	• Open in ASV drive circuit (AID-ASV) • Harness and connector (AID - ASV) • AID • ASV • ECM
80% Duty Ratio 	AIR System: OFF (Air pump OFF, ASV OFF)	P1613 P1614	• AID • ECM
80% Duty Ratio 	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100% duty)	-	P1613 P1614	• AID • Open in AID ground circuit

HINT:

- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P1613 OR P1614)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P1613 and/or P1614 are output	A
P1613 and/or P1614 and other DTCs are output	B

If any DTCs other than P1613 and P1614 are output, troubleshoot those DTCs first.

B

GO TO DTC CHART (Click here)

A

2.CHECK AIR INJECTION CONTROL DRIVER (POWER SOURCE CIRCUIT)

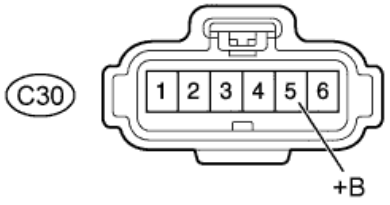
a. Disconnect the C30 or C32 Air Injection Control Driver (AID) connector.

b. Measure the voltage according to the value(s) in the table below.

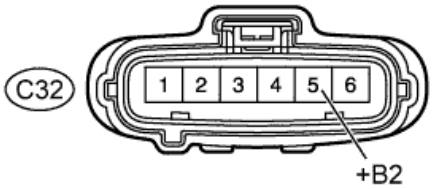
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

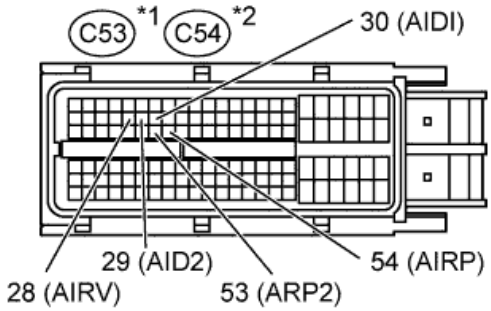
3.CHECK HARNESS AND CONNECTOR (AID - ECM, BODY GROUND)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

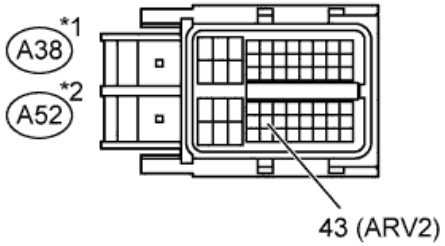
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

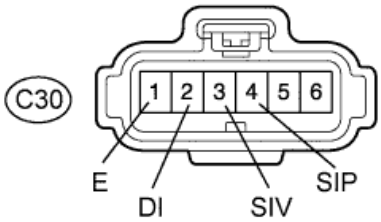
Front view of wire harness connector:
(to ECM)



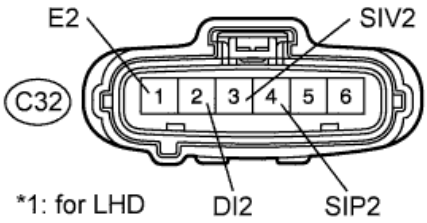
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C53-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C53-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω

C32-1 (E2) - Body ground	Always	Below 1 Ω
C53-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C53-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C53-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A38-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C53-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C53-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω
A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω
C54-30 (AIDI) - C30-2 (DI)	Always	Below 1 Ω
C54-29 (AID2) - C32-2 (DI2)	Always	Below 1 Ω
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω
C54-54 (AIRP) or C30-4 (SIP) - Body ground	Always	10 kΩ or higher
C54-28 (AIRV) or C30-3 (SIV) - Body ground	Always	10 kΩ or higher
C54-53 (ARP2) or C32-4 (SIP2) - Body ground	Always	10 kΩ or higher
A53-43 (ARV2) or C32-3 (SIV2) - Body ground	Always	10 kΩ or higher
C54-30 (AIDI) or C30-2 (DI) - Body ground	Always	10 kΩ or higher
C54-29 (AID2) or C32-2 (DI2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.INSPECT AIR INJECTION CONTROL DRIVER (DI TERMINAL VOLTAGE)

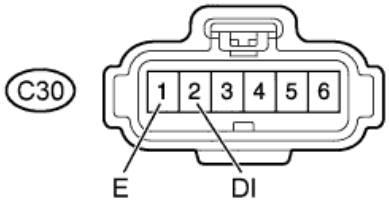
a. Disconnect the C30 or C32 AID connector.

b. Measure the voltage according to the value(s) in the table below.

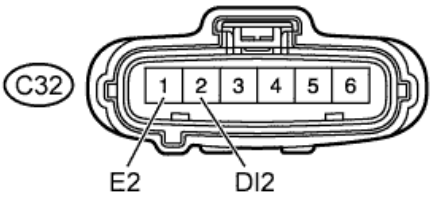
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C30-2 (DI) - C30-1 (E)	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-2 (DI2) - C32-1 (E2)	Engine switch on (IG)	11 to 14 V (near battery voltage)

Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPLACE ECM (Click here)

OK

5.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

6.CONFIRM WHETHER DTC OUTPUT RECURS

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the tester initialization is finished.

h. Perform the Automatic Mode operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Enter the following menus: Powertrain / Engine and ECT / DTC.

k. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
Other DTCs are output	B

I. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

B	GO TO DTC CHART (Click here)

A

END

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

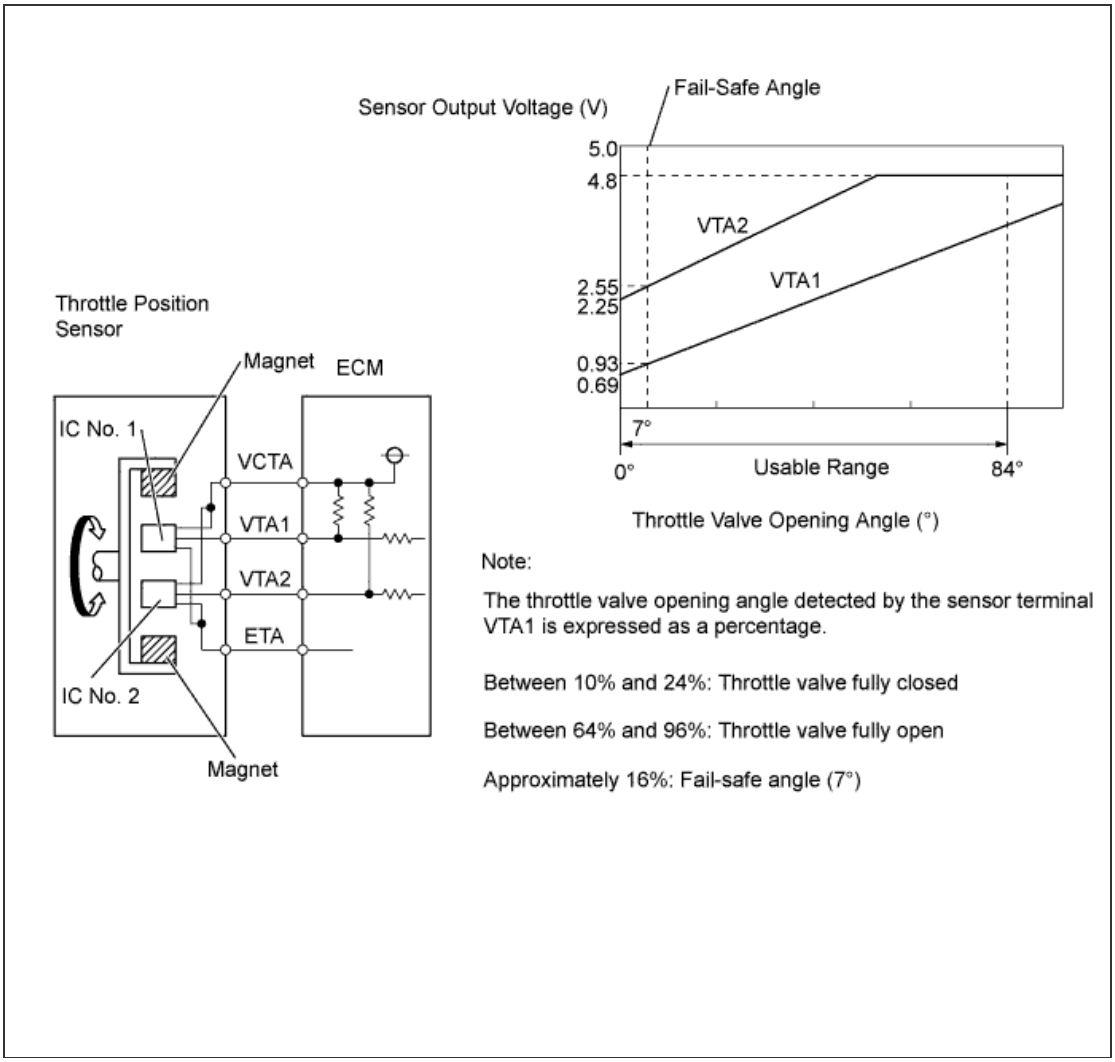
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

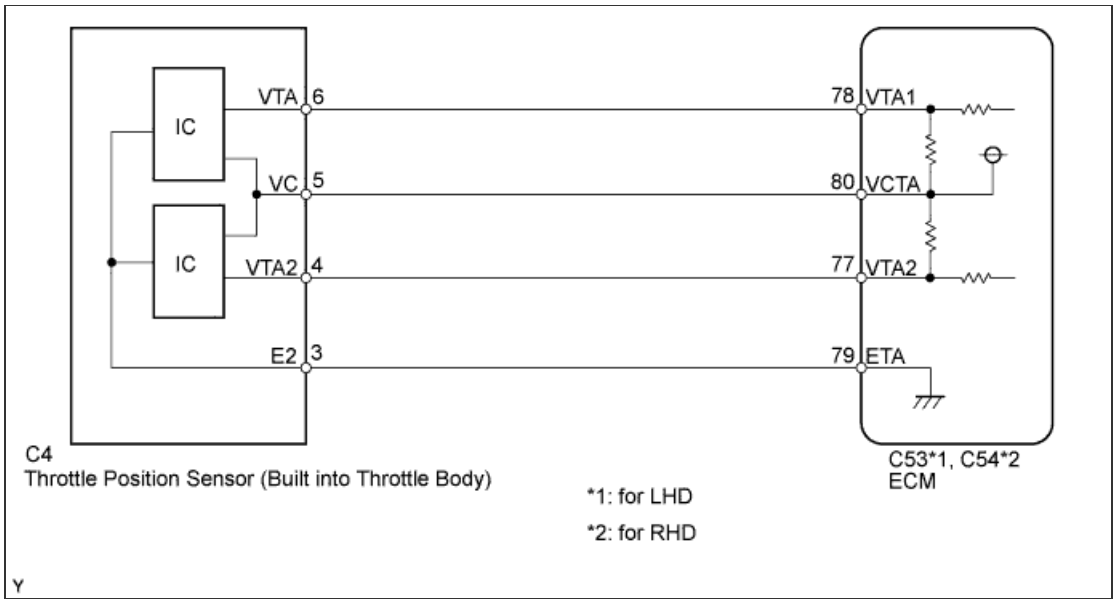
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

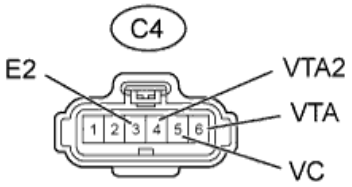
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

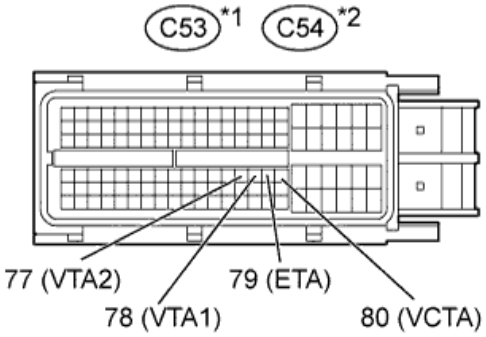
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

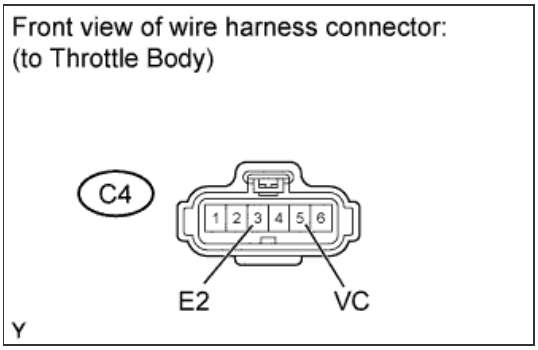
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P2102 Throttle Actuator Control Motor Circuit Low

DTC P2103 Throttle Actuator Control Motor Circuit High

for Preparation Click here

DESCRIPTION

The throttle actuator is operated by the ECM and opens and closes the throttle valve using gears.
The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM. This feedback allows the ECM to appropriately control the throttle actuator and monitor the throttle opening angle as the ECM responds to driver inputs.

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC Code	DTC Detection Condition	Trouble Area
P2102	Conditions (a) and (b) continue for 2.0 seconds (1 trip detection logic): (a) The throttle actuator duty ratio is 80% or more. (b) The throttle actuator current is below 0.5 A.	• **Open in throttle actuator circuit** • **Throttle actuator** • **ECM**
P2103	Either of the following conditions is met (1 trip detection logic): • **A hybrid IC diagnosis signal failure.** • **A hybrid IC current limiter port failure.**	• **Short in throttle actuator circuit** • **Throttle actuator** • **Throttle valve** • **Throttle body assembly** • **ECM**

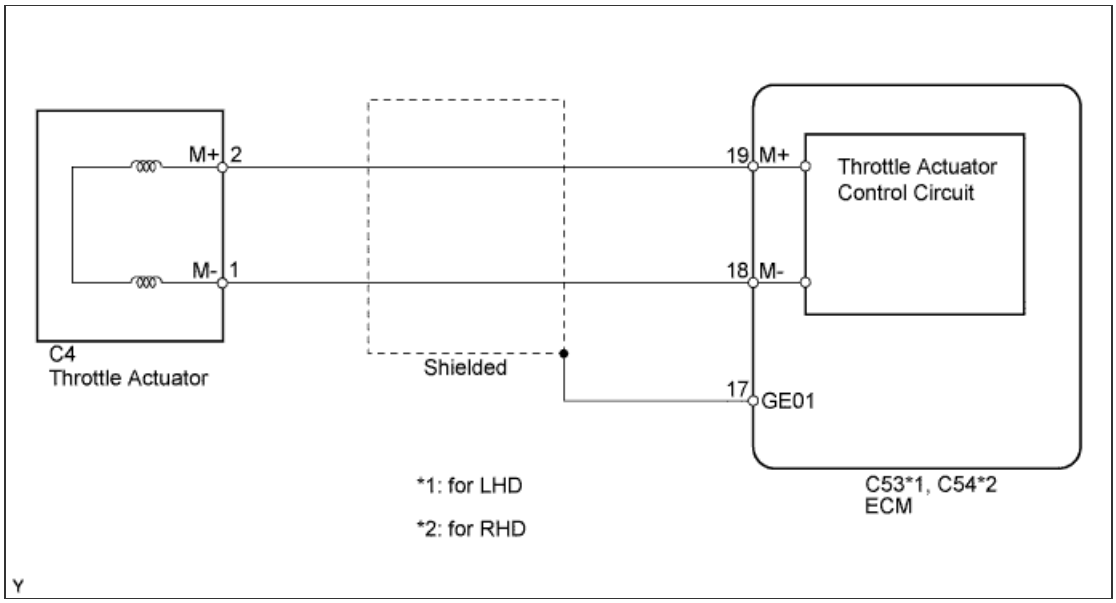
MONITOR DESCRIPTION

The ECM monitors the electrical current through the electronic actuator, and detects malfunctions and open circuits in the throttle actuator based on this value. If the current is outside the standard range, the ECM determines that there is a malfunction in the throttle actuator. In addition, if the throttle valve does not function properly (for example, stuck on), the ECM determines that there is a malfunction. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the electrical current is below 0.5 A and the throttle actuator duty ratio exceeds 80%, the ECM interprets this as the current being outside the standard range, illuminates the MIL and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored when the engine is quickly revved to a high rpm several times after the engine is started and has idled for 5 seconds.

FAIL-SAFE

When either of these DTCs, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **The throttle actuator current (Throttle Motor Current) and the throttle actuator duty ratio (Throttle Motor Open Duty / Throttle Motor Close Duty) can be read using the intelligent tester. However, the ECM shuts off the throttle actuator current when the ETCS malfunctions.**

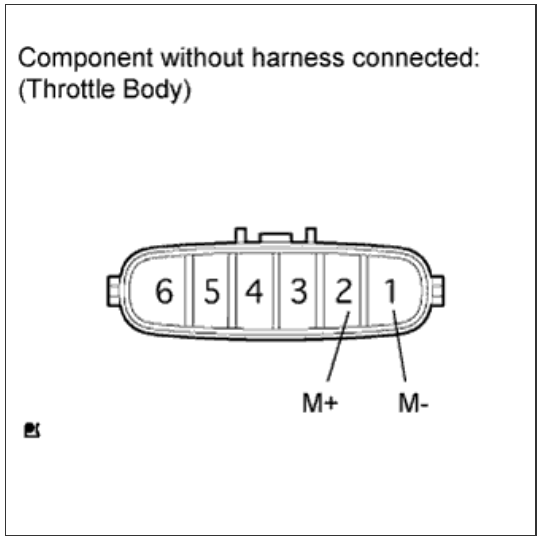
1.INSPECT THROTTLE BODY ASSEMBLY (RESISTANCE OF THROTTLE ACTUATOR)

a. Disconnect the C4 throttle body connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (M+) - 1 (M-)	20°C (68°F)	0.3 to 100 Ω



NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

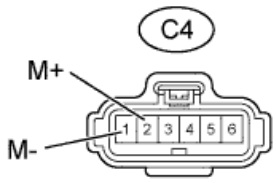
2.CHECK HARNESS AND CONNECTOR (THROTTLE ACTUATOR - ECM)

a. Disconnect the C4 throttle body connector.

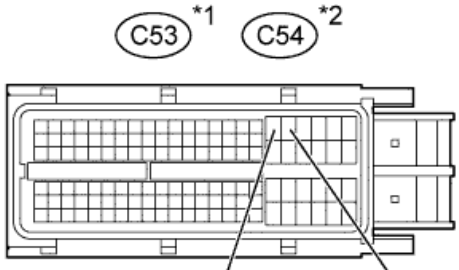
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Body)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-2 (M+) - C53-19 (M+)	Always	Below 1 Ω
C4-1 (M-) - C53-18 (M-)	Always	Below 1 Ω
C4-2 (M+) or C53-19 (M+) - Body ground	Always	10 kΩ or higher
C4-1 (M-) or C53-18 (M-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-2 (M+) - C54-19 (M+)	Always	Below 1 Ω
C4-1 (M-) - C54-18 (M-)	Always	Below 1 Ω
C4-2 (M+) or C54-19 (M+) - Body ground	Always	10 kΩ or higher
C4-1 (M-) or C54-18 (M-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT THROTTLE BODY ASSEMBLY

a. Check for foreign objects between the throttle valve and the housing.

OK:

No foreign objects between throttle valve and housing.

NG → REMOVE FOREIGN OBJECT AND CLEAN THROTTLE BODY

OK

4.INSPECT THROTTLE VALVE

a. Check if the throttle valve opens and closes smoothly.

OK:
Throttle valve opens and closes smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

DTC P0120 Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction

DTC P0122 Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input

DTC P0123 Throttle / Pedal Position Sensor / Switch "A" Circuit High Input

DTC P0220 Throttle / Pedal Position Sensor / Switch "B" Circuit

DTC P0222 Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input

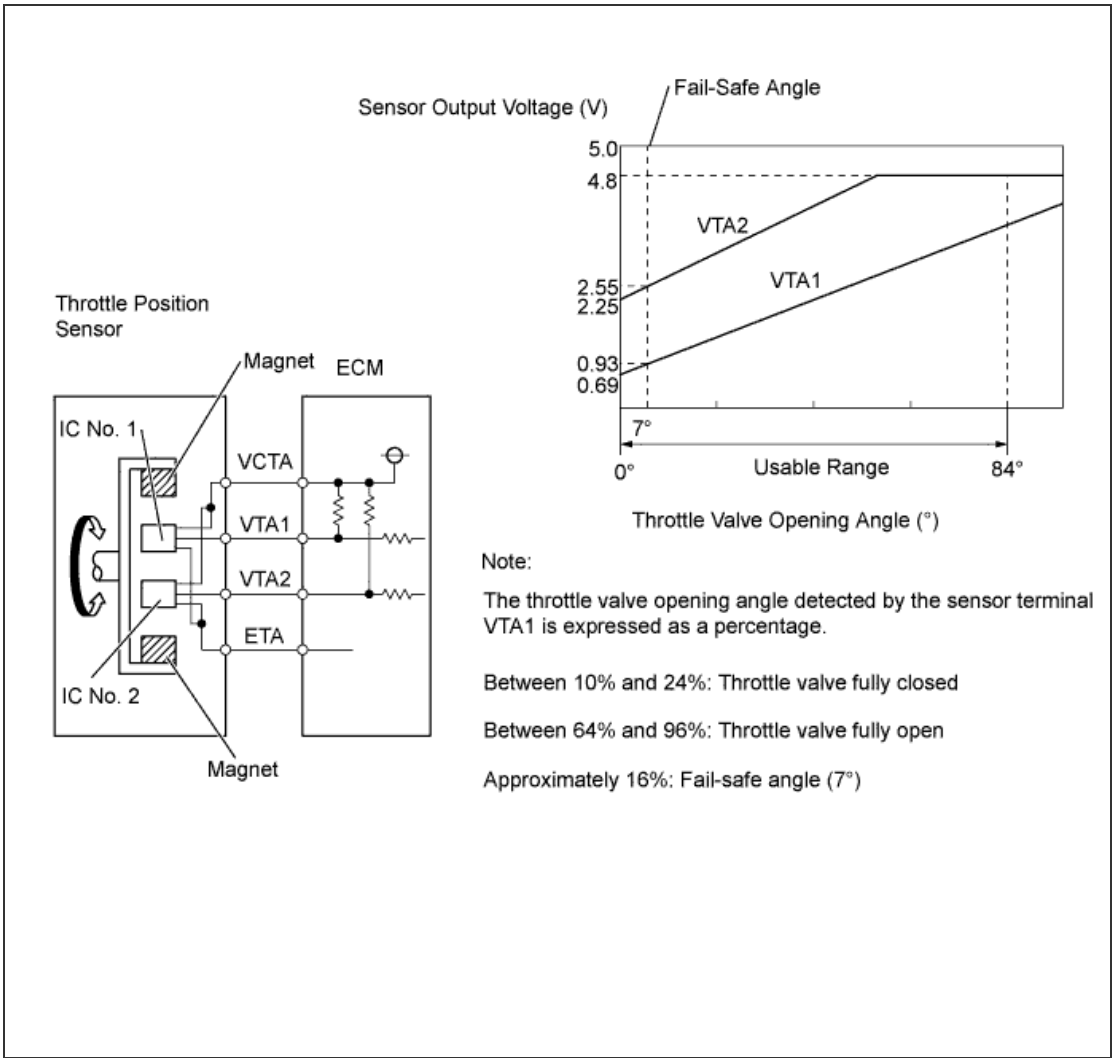
DTC P0223 Throttle / Pedal Position Sensor / Switch "B" Circuit High Input

DTC P2135 Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

for Preparation Click here

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has 2 sensor circuits, each of which transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel cut control.



DTC Code	DTC Detection Condition	Trouble Area
P0120	The output voltage of VTA1 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• Throttle Position (TP) sensor (built into throttle body) • ECM

P0122	The output voltage of VTA1 is 0.2 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	The output voltage of VTA1 is 4.535 V or higher for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	The output voltage of VTA2 quickly fluctuates beyond the lower and upper malfunction thresholds for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • ECM
P0222	The output voltage of VTA2 is 1.75 V or less for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	The output voltage of VTA2 is 4.8 V or higher, and VTA1 is between 0.2 V and 2.02 V for 2 seconds when the accelerator pedal is depressed (1 trip detection logic).	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) The difference between the output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more. (b) The output voltage of VTA1 is 0.2 V or less and VTA2 is 1.75 V or less for 0.4 seconds or more.	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- **When any of these DTCs is output, check the throttle valve opening angle by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.**
- **Throttle Position No.1 is the VTA1 signal, and Throttle Position No.2 is the VTA2 signal.**

Reference (Normal Condition):

Display Item	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
Throttle Position No.1	0.5 to 1.1 V	3.3 to 4.9 V
Throttle Position No.2	2.1 to 3.1 V	4.6 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

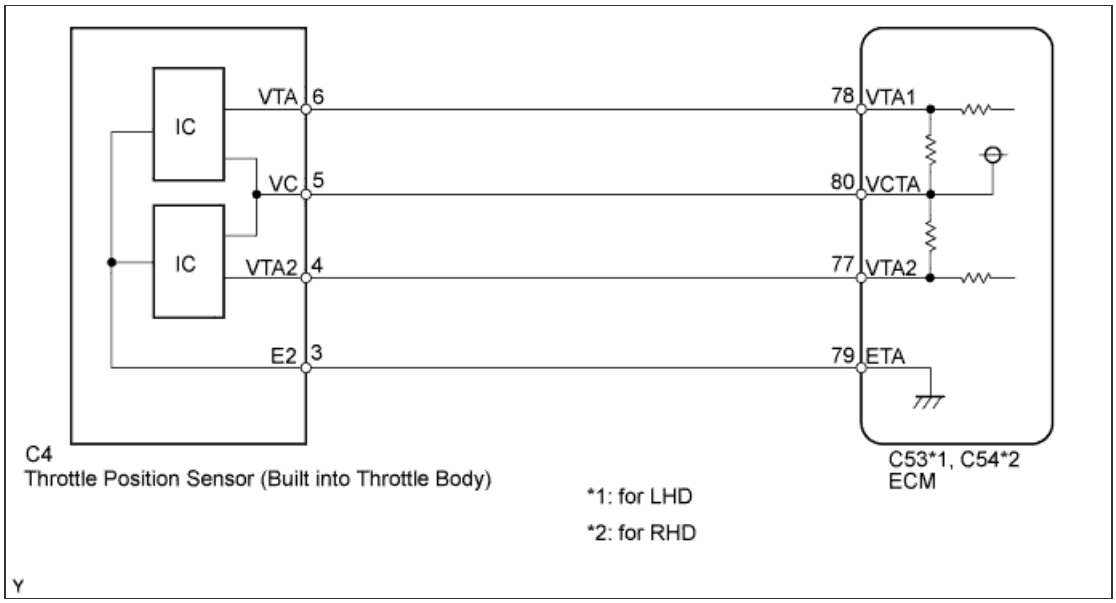
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and stores DTC(s).
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and stores DTC(s).

If the malfunction is not repaired successfully, a DTC is stored 10 seconds after the engine is next started.

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (THROTTLE POSITION)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Throttle Position No.1 and Throttle Position No.2.

d. Check the values displayed on the tester.

Result

TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Area	Proceed to
0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	VC circuit open	A
4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	E2 circuit open	A
0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	2.4 to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	A
0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	0.7 to 1.3 V (Fail-safe)	0 to 0.2 V, or 4.5 to 5.0 V	VTA2 circuit open or ground short	A
0.5 to 1.1 V	2.1 to 3.1 V	3.3 to 4.9 V (Not fail-safe)	4.6 to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:

TP#1 stands for Throttle Position No. 1, and TP#2 stands for Throttle Position No. 2.

B → Go to step 5

A

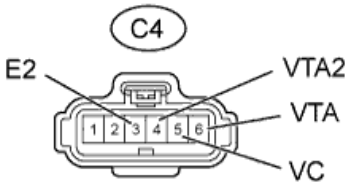
2.CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

a. Disconnect the C4 throttle body connector.

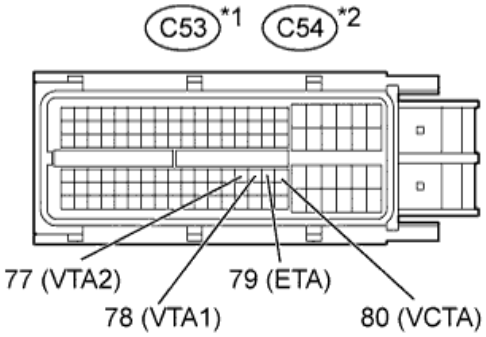
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C53-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C53-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C53-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C53-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C53-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C53-77 (VTA2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-5 (VC) - C54-80 (VCTA)	Always	Below 1 Ω
C4-6 (VTA) - C54-78 (VTA1)	Always	Below 1 Ω
C4-4 (VTA2) - C54-77 (VTA2)	Always	Below 1 Ω
C4-3 (E2) - C54-79 (ETA)	Always	Below 1 Ω
C4-5 (VC) or C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
C4-6 (VTA) or C54-78 (VTA1) - Body ground	Always	10 kΩ or higher
C4-4 (VTA2) or C54-77 (VTA2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

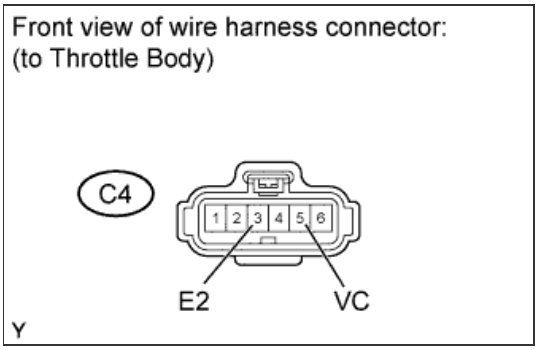
3.INSPECT ECM (VC VOLTAGE)

a. Disconnect the C4 throttle body connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C4-5 (VC) - C4-3 (E2)	Engine switch on (IG)	4.5 to 5.5 V



NG → REPLACE ECM (Click here)

OK

4.REPLACE THROTTLE BODY ASSEMBLY

a. Replace the throttle body assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135 are output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P2102 Throttle Actuator Control Motor Circuit Low

DTC P2103 Throttle Actuator Control Motor Circuit High

for Preparation Click here

DESCRIPTION

The throttle actuator is operated by the ECM and opens and closes the throttle valve using gears.
The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM. This feedback allows the ECM to appropriately control the throttle actuator and monitor the throttle opening angle as the ECM responds to driver inputs.

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC Code	DTC Detection Condition	Trouble Area
P2102	Conditions (a) and (b) continue for 2.0 seconds (1 trip detection logic): (a) The throttle actuator duty ratio is 80% or more. (b) The throttle actuator current is below 0.5 A.	• **Open in throttle actuator circuit** • **Throttle actuator** • **ECM**
P2103	Either of the following conditions is met (1 trip detection logic): • **A hybrid IC diagnosis signal failure.** • **A hybrid IC current limiter port failure.**	• **Short in throttle actuator circuit** • **Throttle actuator** • **Throttle valve** • **Throttle body assembly** • **ECM**

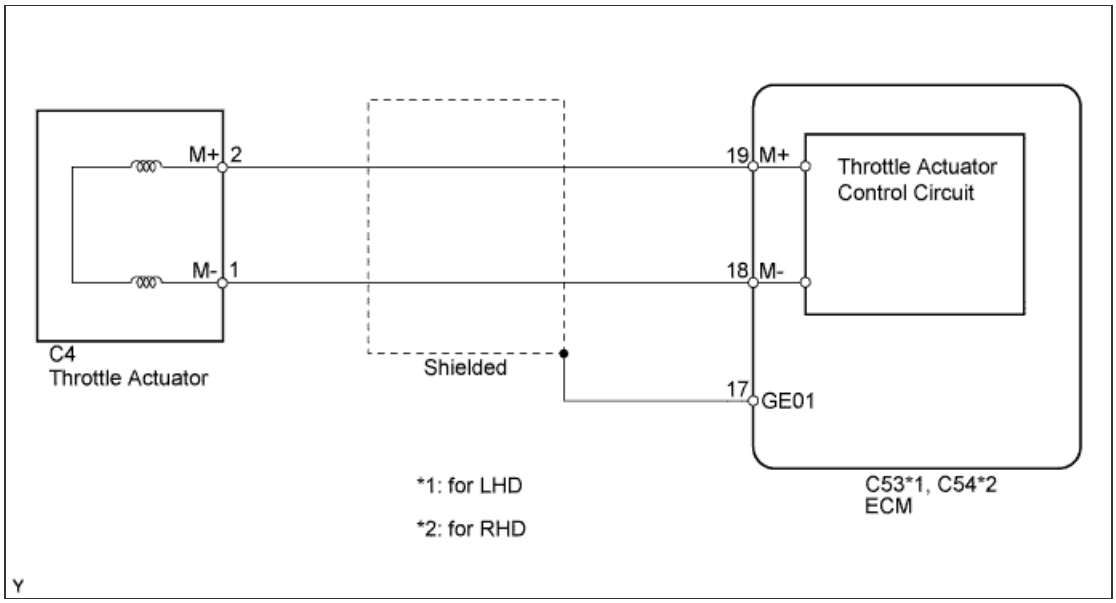
MONITOR DESCRIPTION

The ECM monitors the electrical current through the electronic actuator, and detects malfunctions and open circuits in the throttle actuator based on this value. If the current is outside the standard range, the ECM determines that there is a malfunction in the throttle actuator. In addition, if the throttle valve does not function properly (for example, stuck on), the ECM determines that there is a malfunction. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the electrical current is below 0.5 A and the throttle actuator duty ratio exceeds 80%, the ECM interprets this as the current being outside the standard range, illuminates the MIL and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored when the engine is quickly revved to a high rpm several times after the engine is started and has idled for 5 seconds.

FAIL-SAFE

When either of these DTCs, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **The throttle actuator current (Throttle Motor Current) and the throttle actuator duty ratio (Throttle Motor Open Duty / Throttle Motor Close Duty) can be read using the intelligent tester. However, the ECM shuts off the throttle actuator current when the ETCS malfunctions.**

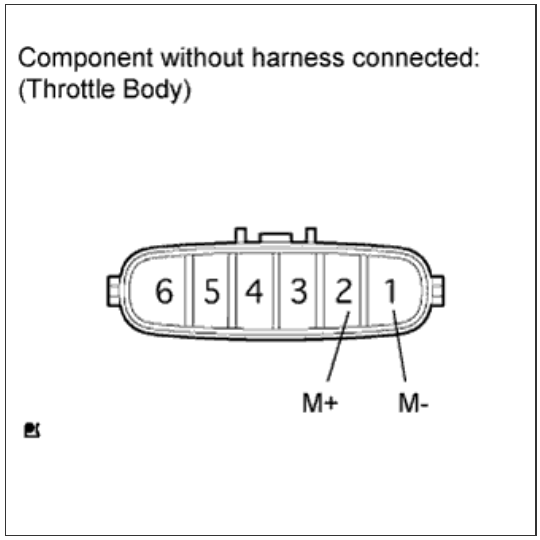
1.INSPECT THROTTLE BODY ASSEMBLY (RESISTANCE OF THROTTLE ACTUATOR)

a. Disconnect the C4 throttle body connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (M+) - 1 (M-)	20°C (68°F)	0.3 to 100 Ω



NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

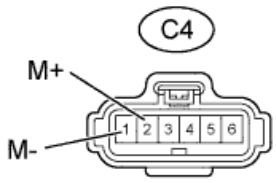
2.CHECK HARNESS AND CONNECTOR (THROTTLE ACTUATOR - ECM)

a. Disconnect the C4 throttle body connector.

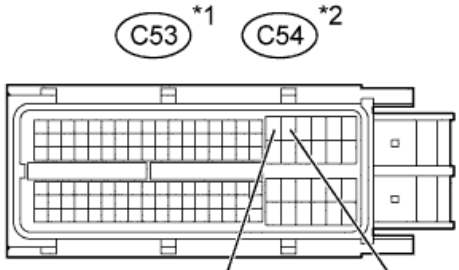
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Throttle Body)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C4-2 (M+) - C53-19 (M+)	Always	Below 1 Ω
C4-1 (M-) - C53-18 (M-)	Always	Below 1 Ω
C4-2 (M+) or C53-19 (M+) - Body ground	Always	10 kΩ or higher
C4-1 (M-) or C53-18 (M-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C4-2 (M+) - C54-19 (M+)	Always	Below 1 Ω
C4-1 (M-) - C54-18 (M-)	Always	Below 1 Ω
C4-2 (M+) or C54-19 (M+) - Body ground	Always	10 kΩ or higher
C4-1 (M-) or C54-18 (M-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.INSPECT THROTTLE BODY ASSEMBLY

a. Check for foreign objects between the throttle valve and the housing.

OK:

No foreign objects between throttle valve and housing.

NG → REMOVE FOREIGN OBJECT AND CLEAN THROTTLE BODY

OK

4.INSPECT THROTTLE VALVE

a. Check if the throttle valve opens and closes smoothly.

OK:
Throttle valve opens and closes smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

DTC P0121 Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem

for Preparation Click here

DESCRIPTION

Refer to DTC P0120 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P0121	The difference between the VTA1 and VTA2 voltages is below 0.8 V, or higher than 1.6 V for 2 seconds (1 trip detection logic).	Throttle Position (TP) sensor (built into throttle body)

MONITOR DESCRIPTION

The ECM uses the TP sensor to monitor the throttle valve opening angle.
This sensor transmits two signals: VTA1 and VTA2. VTA1 is used to detect the throttle opening angle and VTA2 is used to detect malfunctions in VTA1.
The ECM performs several checks to confirm the proper operation of the TP sensor and VTA1.
For each throttle opening angle, a specific voltage difference is expected between the outputs of VTA1 and VTA2. If the output voltage difference between the two signals deviates from the normal operating range, the ECM interprets this as a malfunction of the TP sensor. The ECM illuminates the MIL and stores the DTC.
If the malfunction is not repaired successfully, the DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When this DTC, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

INSPECTION PROCEDURE

HINT:

- **This DTC relates to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0121)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0121 is output	A
P0121 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A → REPLACE THROTTLE BODY ASSEMBLY (Click here)

DTC P2111 Throttle Actuator Control System - Stuck Open

DTC P2112 Throttle Actuator Control System - Stuck Closed

for Preparation Click here

DESCRIPTION

The throttle actuator is operated by the ECM, and opens and closes the throttle valve using gears. The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM so that it can control the throttle actuator (throttle valve) appropriately in response to driver inputs.

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC Code	DTC Detection Condition	Trouble Area
P2111	The throttle actuator does not close when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**
P2112	The throttle actuator does not open when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**

MONITOR DESCRIPTION

The ECM determines that there is a malfunction in the ETCS when the throttle valve remains at a fixed angle despite a high drive current from the ECM. The ECM illuminates the MIL and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored when the accelerator pedal is fully depressed and released quickly (to fully open and close the throttle valve) after the engine is next started.

FAIL-SAFE

When either of these DTCs, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2111 or P2112 is output	A
P2111 or P2112 and other DTCs are output	B

HINT:

If any DTCs other than P2111 or P2112 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT THROTTLE BODY ASSEMBLY (VISUALLY CHECK THROTTLE VALVE)

a. Check for contamination between the throttle valve and the housing. If necessary, clean the throttle body. And check that the throttle valve moves smoothly.

OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine, and fully depress and release the accelerator pedal quickly (to fully open and close the throttle valve).

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P2111 or P2112 is output	B

B → REPLACE ECM (Click here)

A

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0121 Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem

for Preparation Click here

DESCRIPTION

Refer to DTC P0120 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P0121	The difference between the VTA1 and VTA2 voltages is below 0.8 V, or higher than 1.6 V for 2 seconds (1 trip detection logic).	Throttle Position (TP) sensor (built into throttle body)

MONITOR DESCRIPTION

The ECM uses the TP sensor to monitor the throttle valve opening angle.
This sensor transmits two signals: VTA1 and VTA2. VTA1 is used to detect the throttle opening angle and VTA2 is used to detect malfunctions in VTA1.
The ECM performs several checks to confirm the proper operation of the TP sensor and VTA1.
For each throttle opening angle, a specific voltage difference is expected between the outputs of VTA1 and VTA2. If the output voltage difference between the two signals deviates from the normal operating range, the ECM interprets this as a malfunction of the TP sensor. The ECM illuminates the MIL and stores the DTC.
If the malfunction is not repaired successfully, the DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When this DTC, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

INSPECTION PROCEDURE

HINT:

- **This DTC relates to the Throttle Position (TP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0121)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0121 is output	A
P0121 and other DTCs are output	B

B → GO TO DTC CHART (Click here)

A → REPLACE THROTTLE BODY ASSEMBLY (Click here)

DTC P2111 Throttle Actuator Control System - Stuck Open

DTC P2112 Throttle Actuator Control System - Stuck Closed

for Preparation Click here

DESCRIPTION

The throttle actuator is operated by the ECM, and opens and closes the throttle valve using gears. The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM so that it can control the throttle actuator (throttle valve) appropriately in response to driver inputs.

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC Code	DTC Detection Condition	Trouble Area
P2111	The throttle actuator does not close when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**
P2112	The throttle actuator does not open when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**

MONITOR DESCRIPTION

The ECM determines that there is a malfunction in the ETCS when the throttle valve remains at a fixed angle despite a high drive current from the ECM. The ECM illuminates the MIL and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored when the accelerator pedal is fully depressed and released quickly (to fully open and close the throttle valve) after the engine is next started.

FAIL-SAFE

When either of these DTCs, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2111 or P2112 is output	A
P2111 or P2112 and other DTCs are output	B

HINT:

If any DTCs other than P2111 or P2112 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT THROTTLE BODY ASSEMBLY (VISUALLY CHECK THROTTLE VALVE)

a. Check for contamination between the throttle valve and the housing. If necessary, clean the throttle body. And check that the throttle valve moves smoothly.

OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine, and fully depress and release the accelerator pedal quickly (to fully open and close the throttle valve).

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P2111 or P2112 is output	B

B → REPLACE ECM (Click here)

A

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

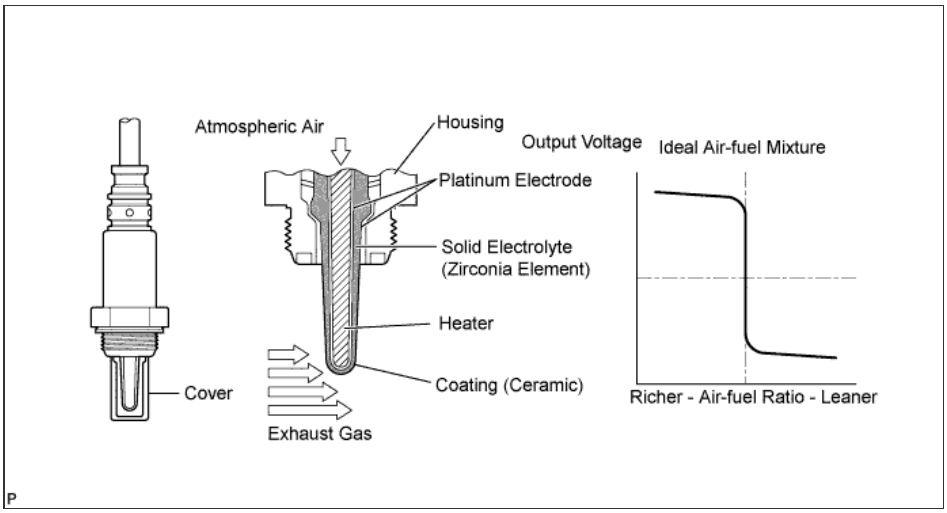
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

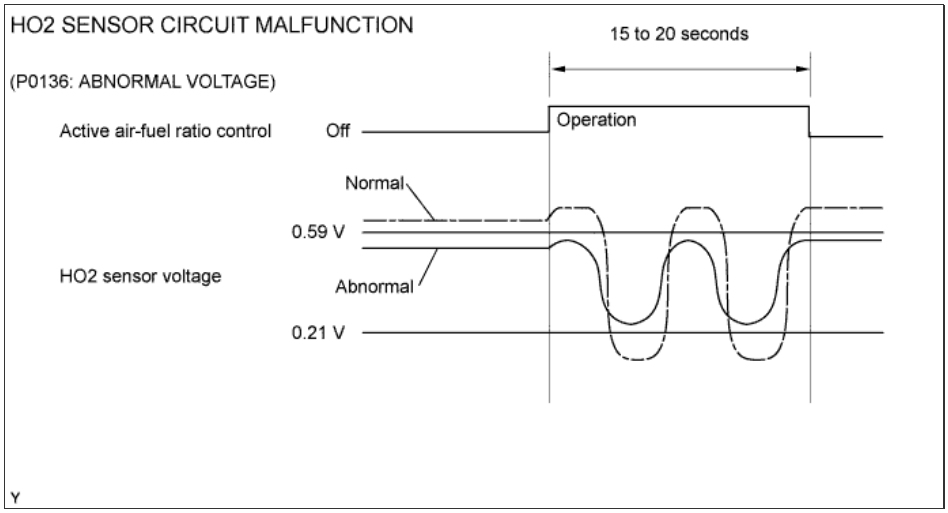
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

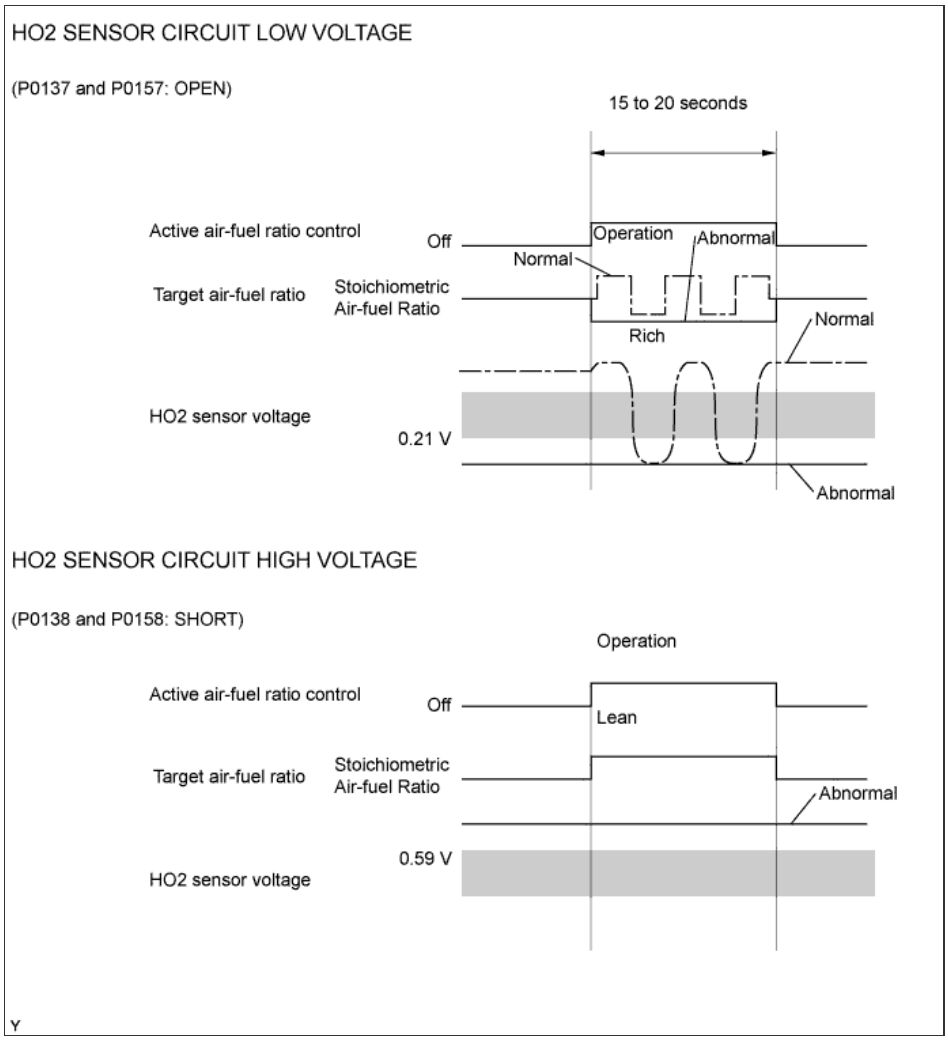
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

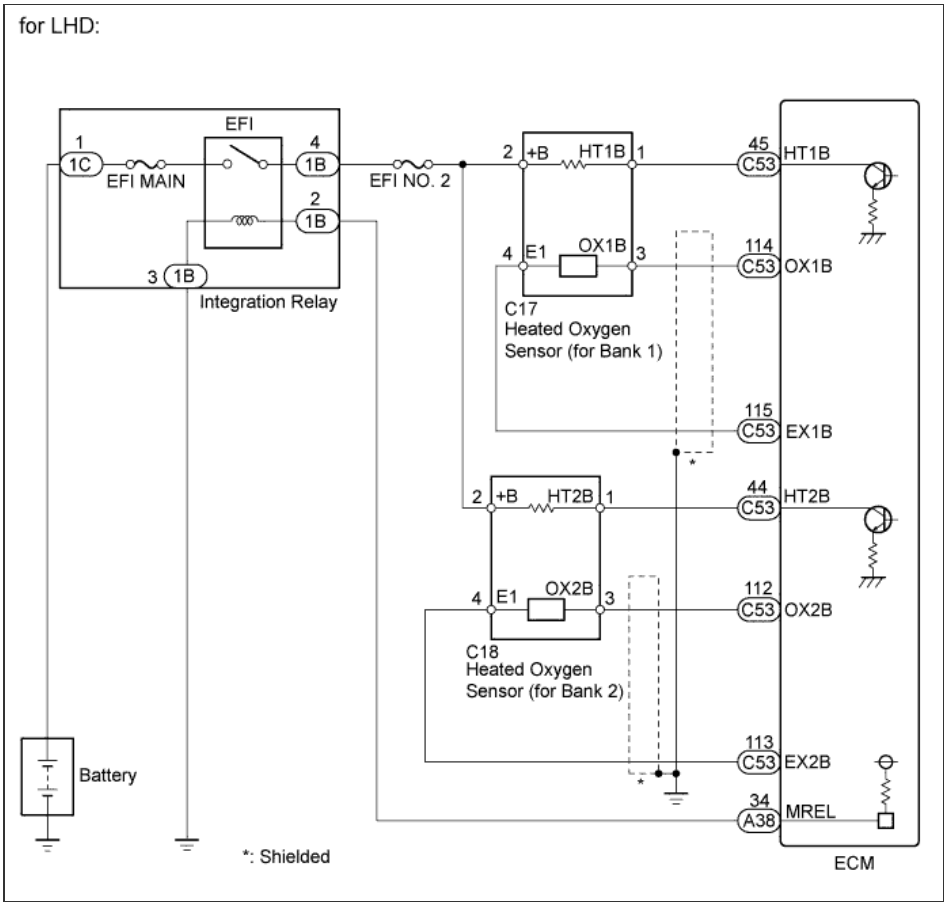
HINT:

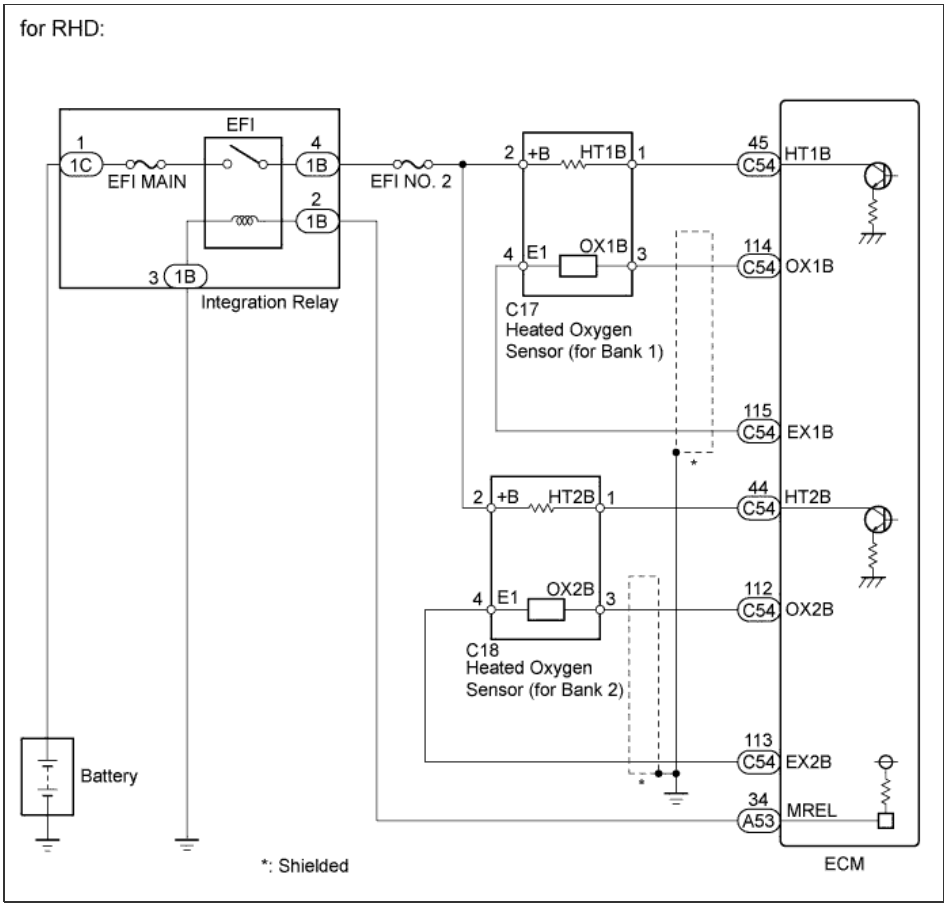
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





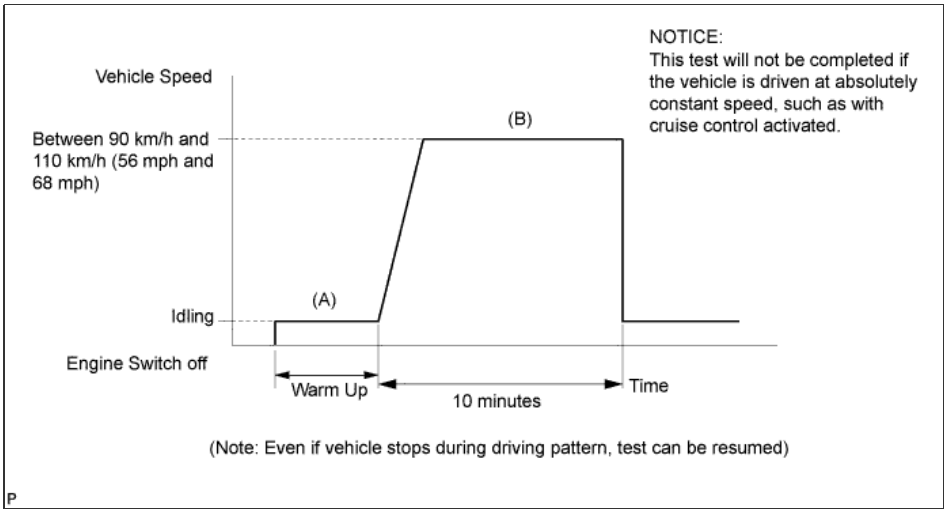
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

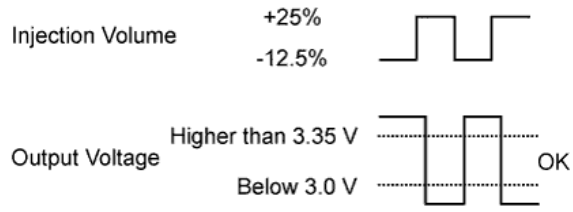
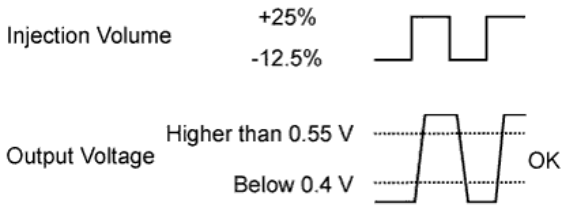
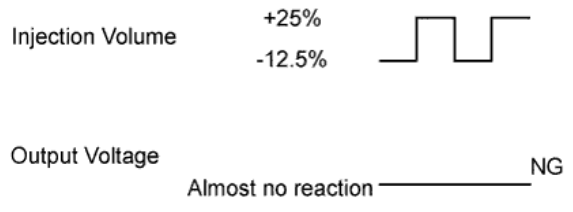
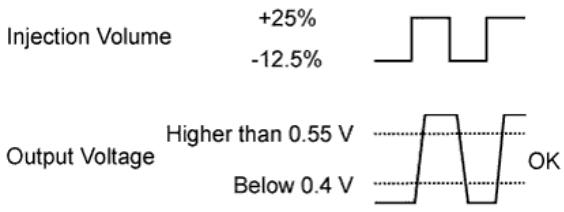
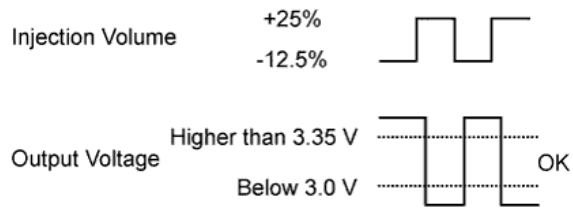
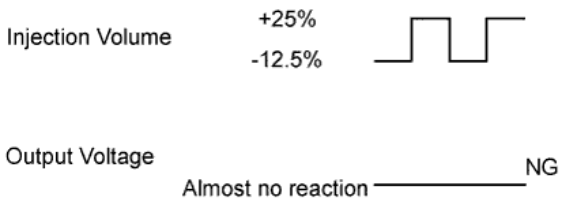
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

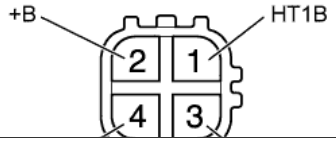
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

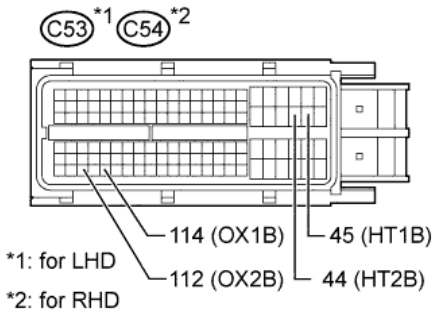
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

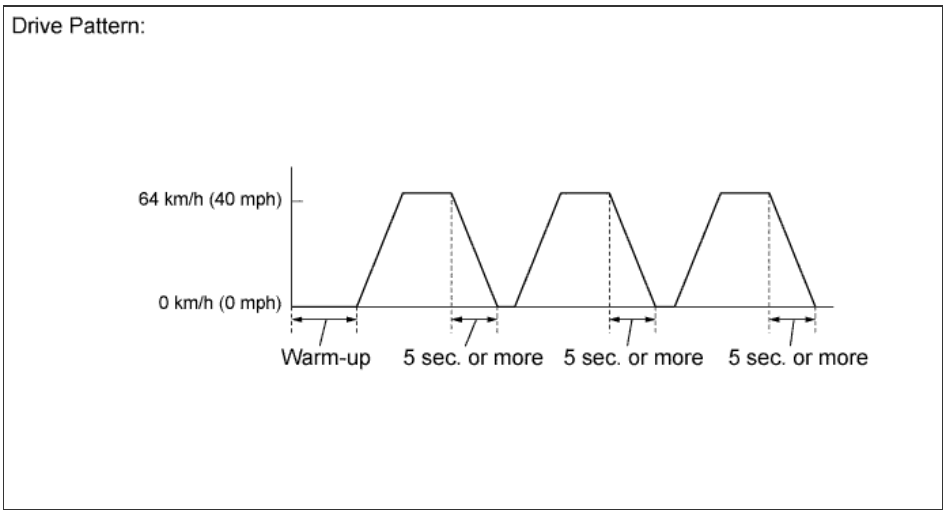
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

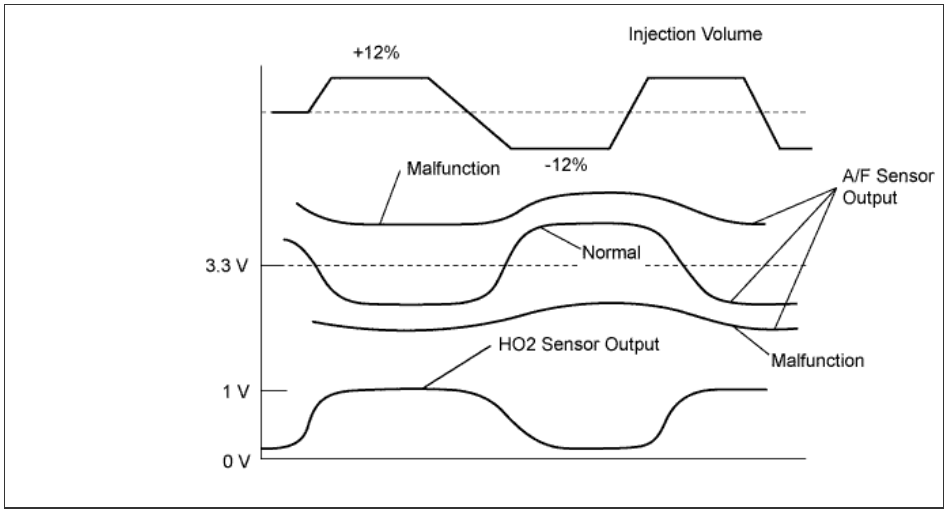
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

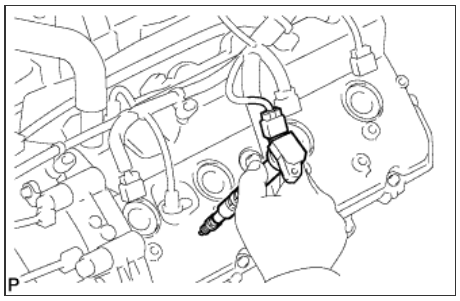
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

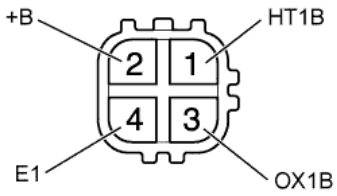
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

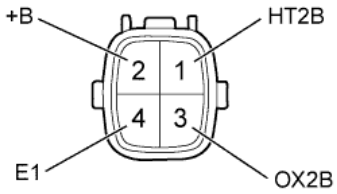
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

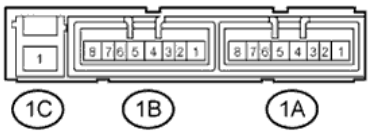
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

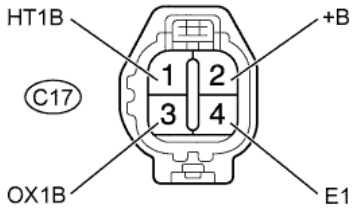
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

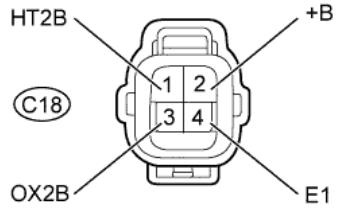
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

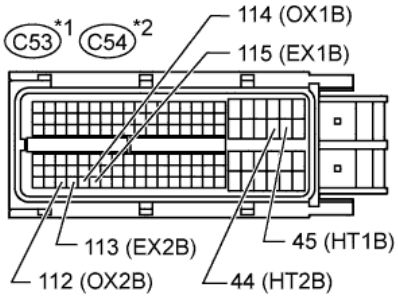
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



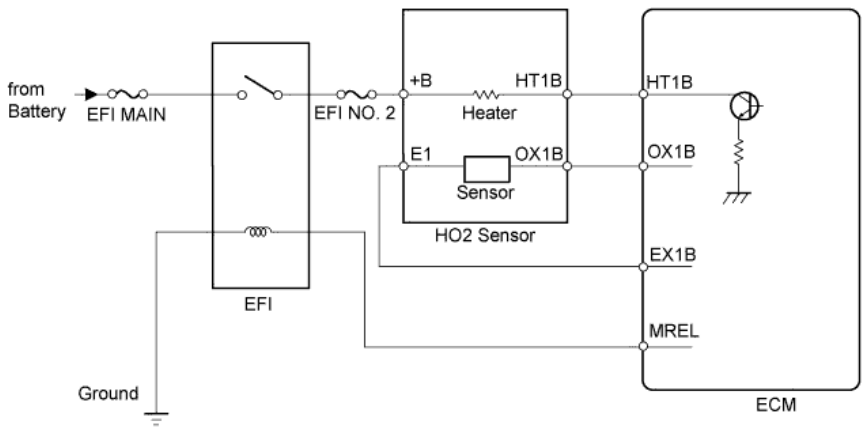
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

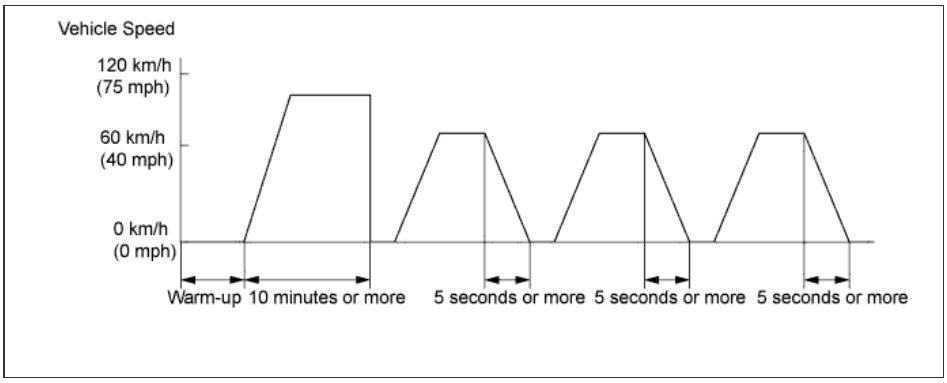
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

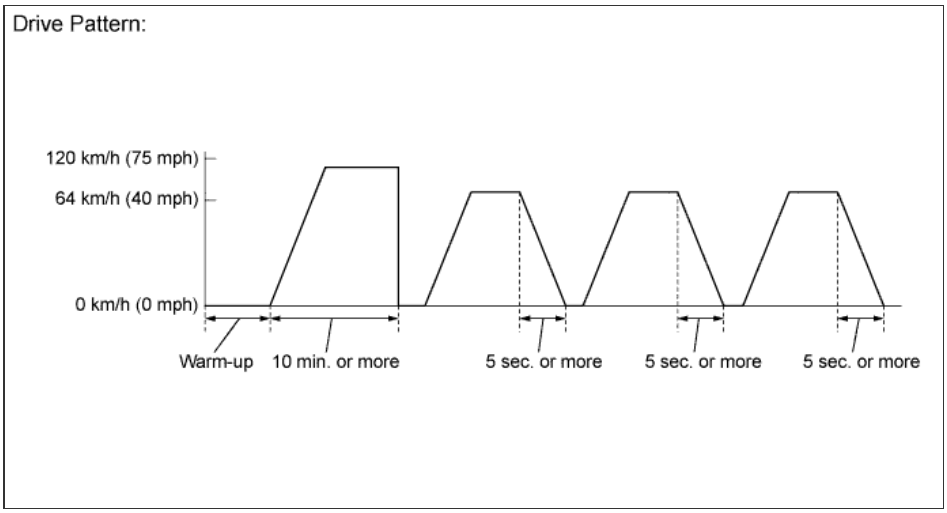
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2111 Throttle Actuator Control System - Stuck Open

DTC P2112 Throttle Actuator Control System - Stuck Closed

for Preparation Click here

DESCRIPTION

The throttle actuator is operated by the ECM, and opens and closes the throttle valve using gears. The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM so that it can control the throttle actuator (throttle valve) appropriately in response to driver inputs.

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC Code	DTC Detection Condition	Trouble Area
P2111	The throttle actuator does not close when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**
P2112	The throttle actuator does not open when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**

MONITOR DESCRIPTION

The ECM determines that there is a malfunction in the ETCS when the throttle valve remains at a fixed angle despite a high drive current from the ECM. The ECM illuminates the MIL and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored when the accelerator pedal is fully depressed and released quickly (to fully open and close the throttle valve) after the engine is next started.

FAIL-SAFE

When either of these DTCs, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2111 or P2112 is output	A
P2111 or P2112 and other DTCs are output	B

HINT:

If any DTCs other than P2111 or P2112 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT THROTTLE BODY ASSEMBLY (VISUALLY CHECK THROTTLE VALVE)

a. Check for contamination between the throttle valve and the housing. If necessary, clean the throttle body. And check that the throttle valve moves smoothly.

OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine, and fully depress and release the accelerator pedal quickly (to fully open and close the throttle valve).

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P2111 or P2112 is output	B

B → REPLACE ECM (Click here)

A

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

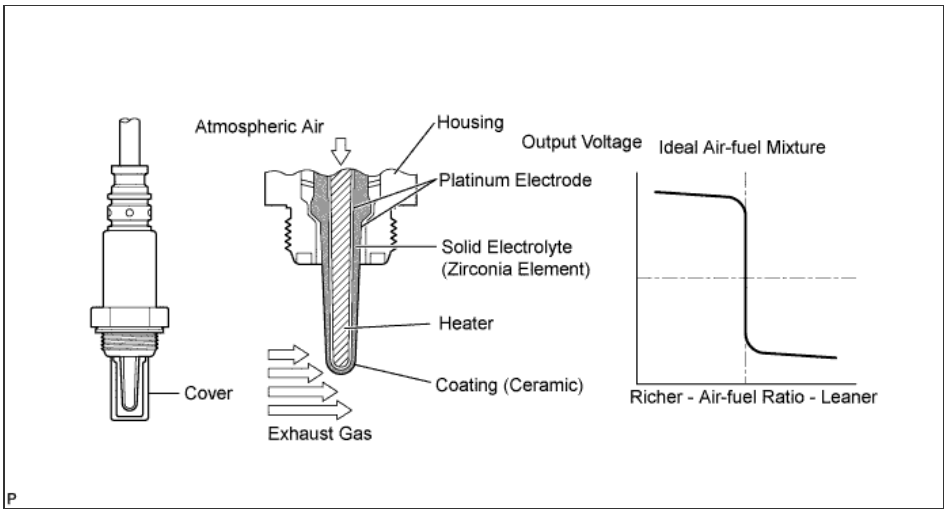
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

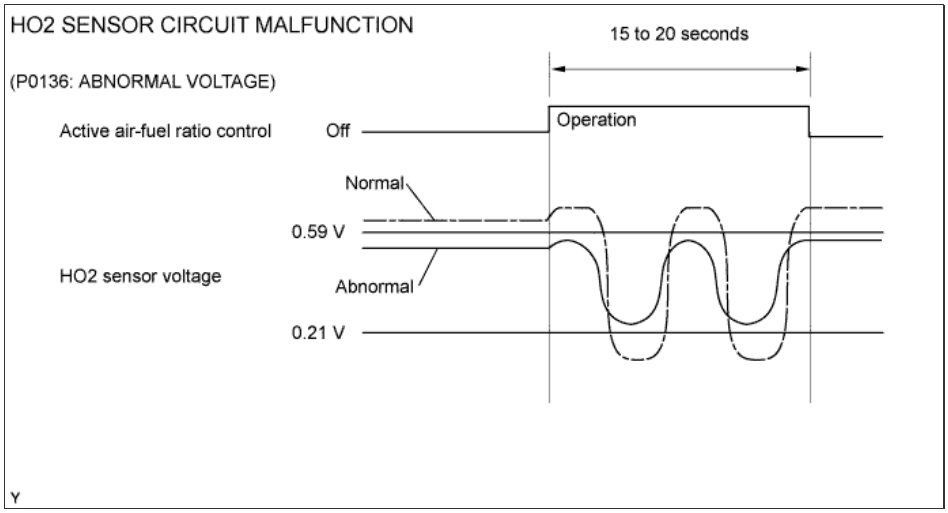
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

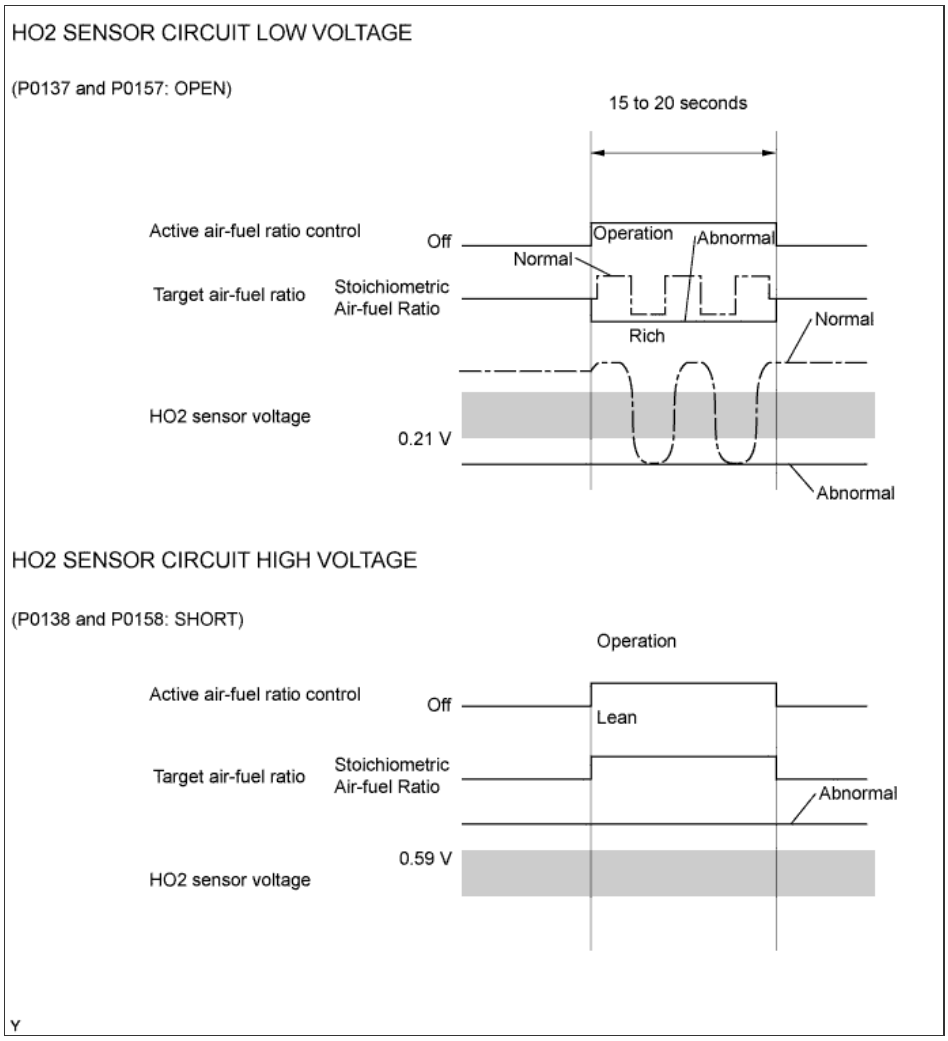
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

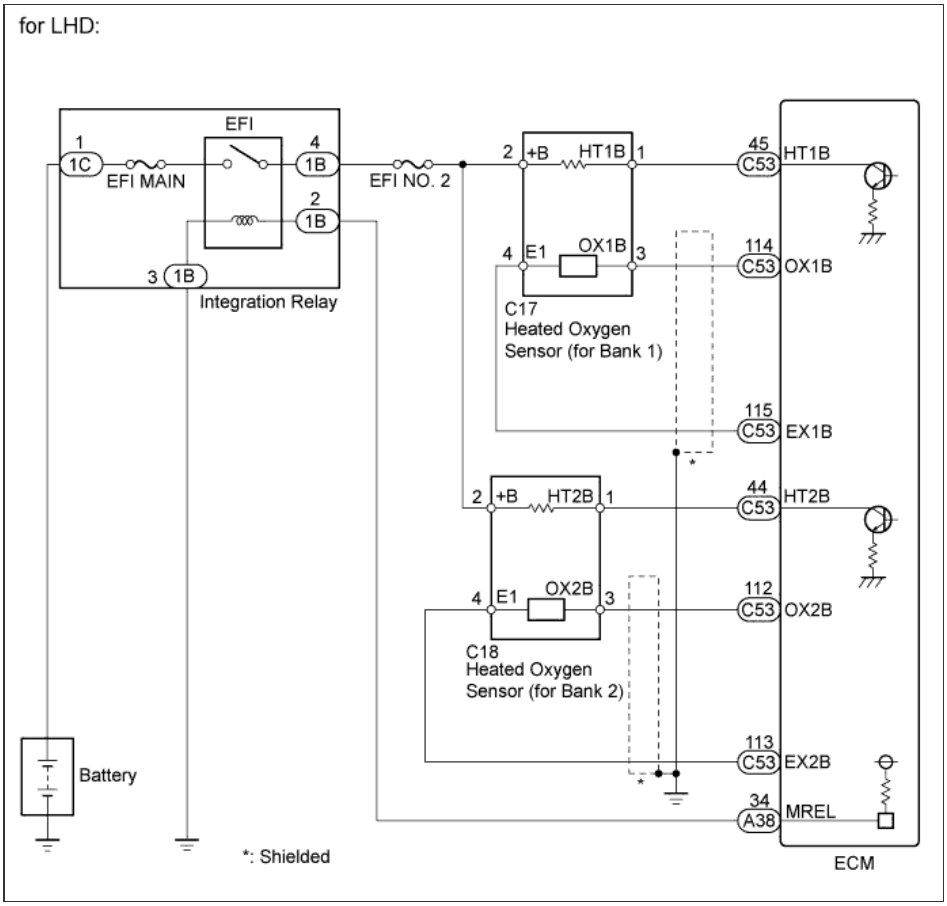
HINT:

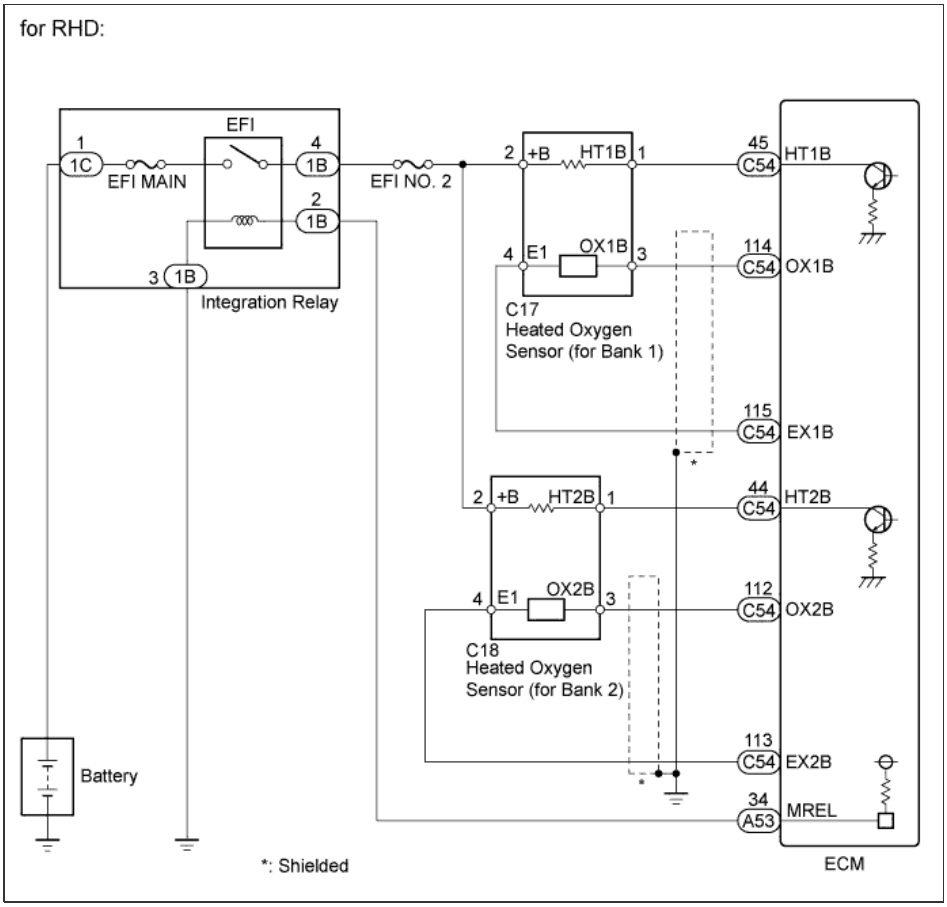
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





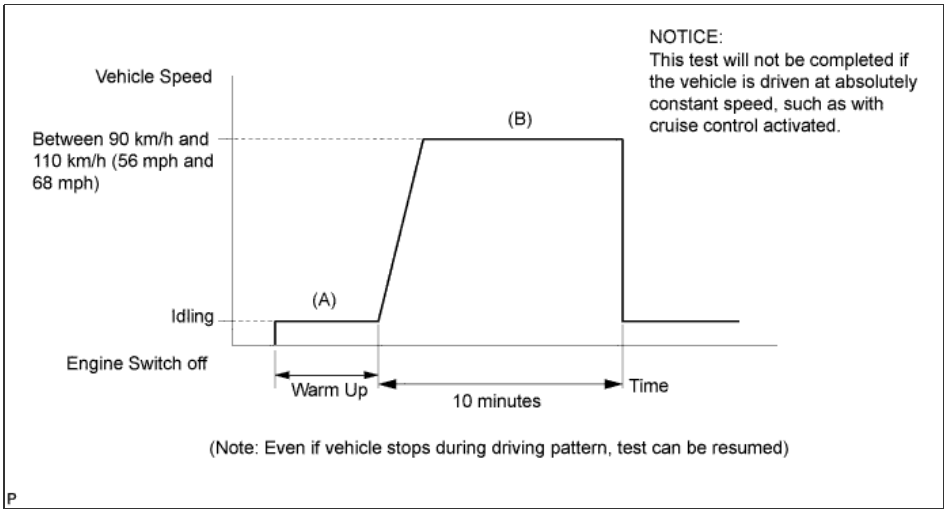
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

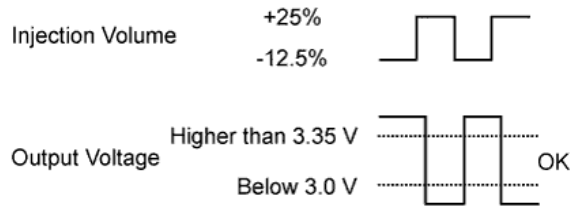
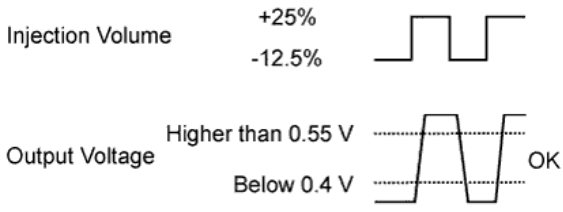
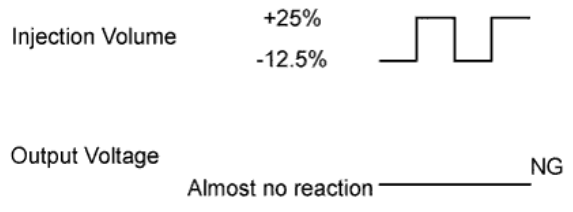
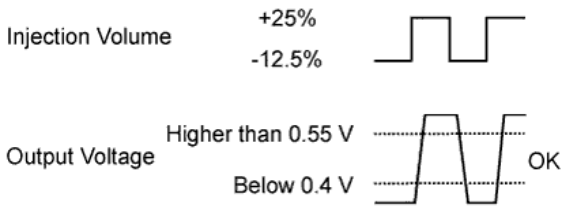
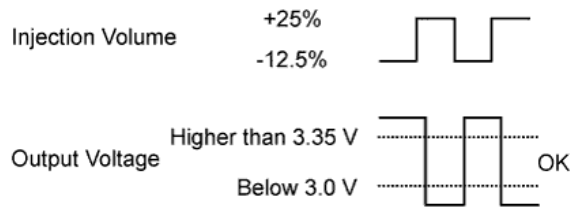
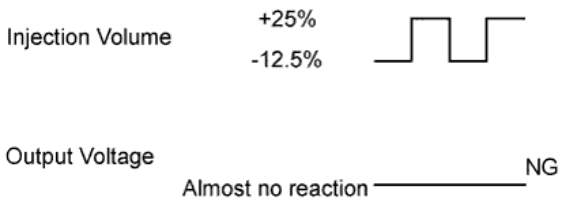
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

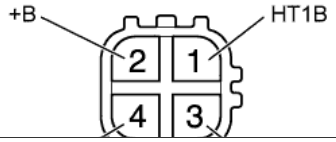
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

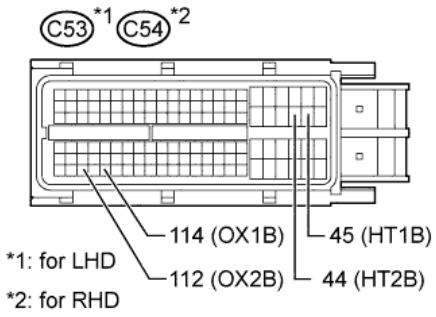
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

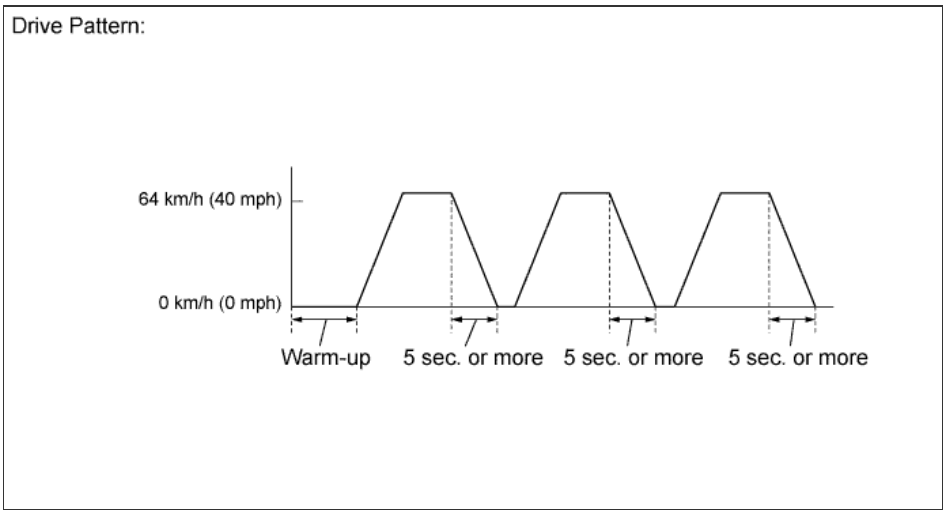
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

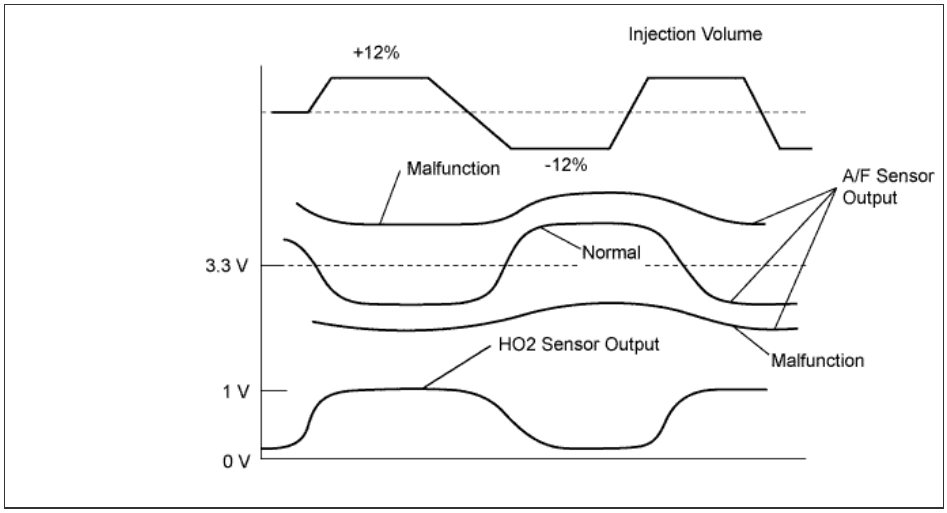
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

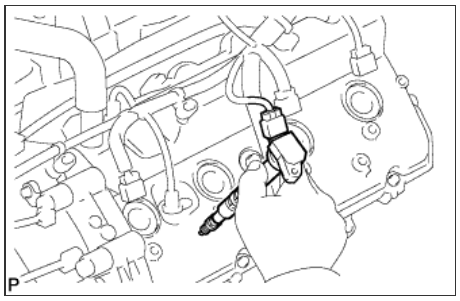
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

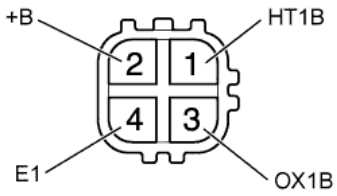
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

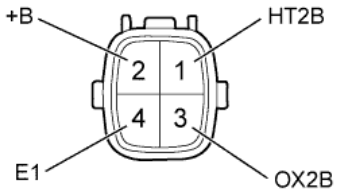
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

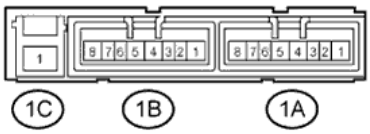
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

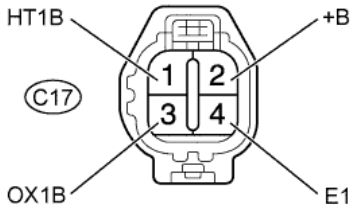
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

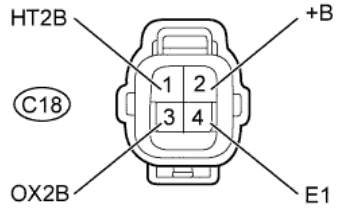
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

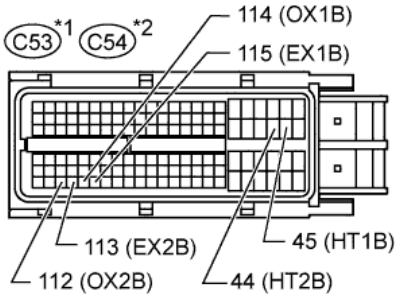
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



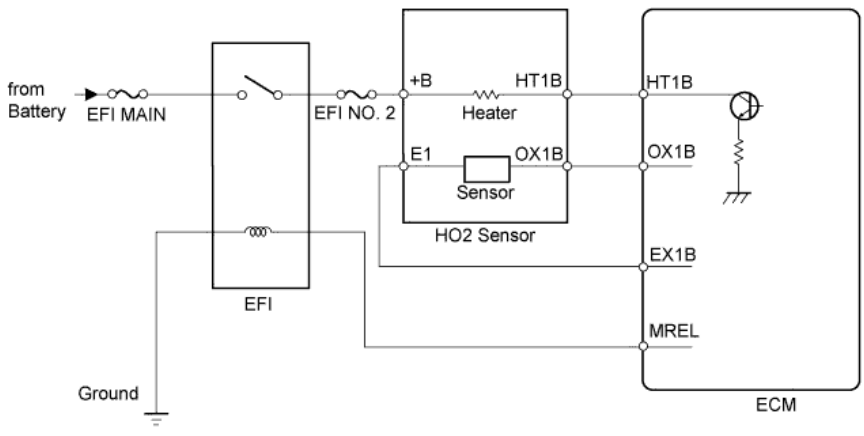
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

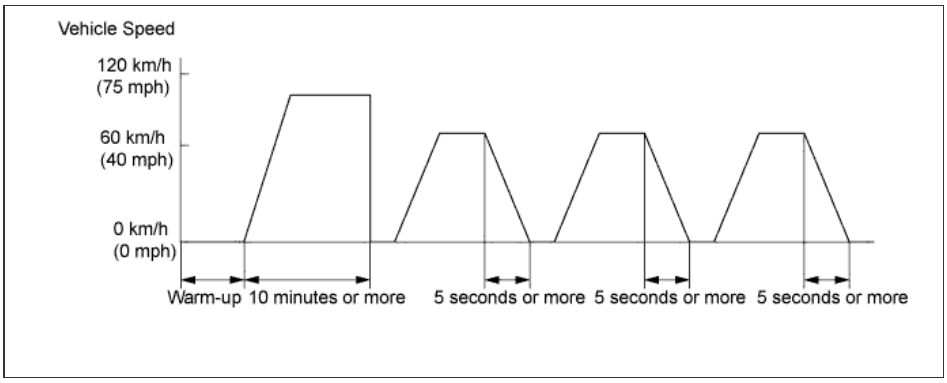
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

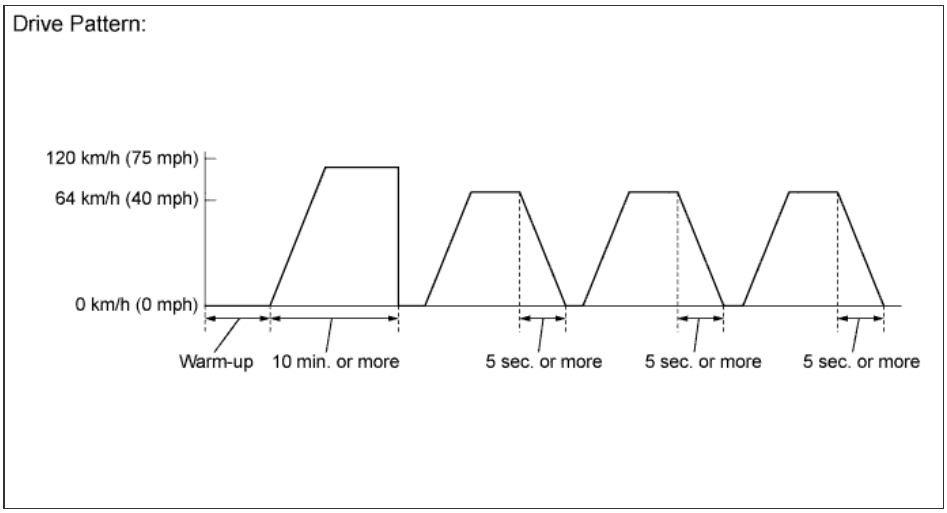
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2111 Throttle Actuator Control System - Stuck Open

DTC P2112 Throttle Actuator Control System - Stuck Closed

for Preparation Click here

DESCRIPTION

The throttle actuator is operated by the ECM, and opens and closes the throttle valve using gears. The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM so that it can control the throttle actuator (throttle valve) appropriately in response to driver inputs.

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC Code	DTC Detection Condition	Trouble Area
P2111	The throttle actuator does not close when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**
P2112	The throttle actuator does not open when signaled by the ECM (1 trip detection logic).	• **Throttle actuator** • **Throttle body assembly** • **Throttle valve**

MONITOR DESCRIPTION

The ECM determines that there is a malfunction in the ETCS when the throttle valve remains at a fixed angle despite a high drive current from the ECM. The ECM illuminates the MIL and stores DTC(s).
If the malfunction is not repaired successfully, a DTC is stored when the accelerator pedal is fully depressed and released quickly (to fully open and close the throttle valve) after the engine is next started.

FAIL-SAFE

When either of these DTCs, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2111 or P2112 is output	A
P2111 or P2112 and other DTCs are output	B

HINT:

If any DTCs other than P2111 or P2112 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT THROTTLE BODY ASSEMBLY (VISUALLY CHECK THROTTLE VALVE)

a. Check for contamination between the throttle valve and the housing. If necessary, clean the throttle body. And check that the throttle valve moves smoothly.

OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2111 OR P2112)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine, and fully depress and release the accelerator pedal quickly (to fully open and close the throttle valve).

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P2111 or P2112 is output	B

B → REPLACE ECM (Click here)

A

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

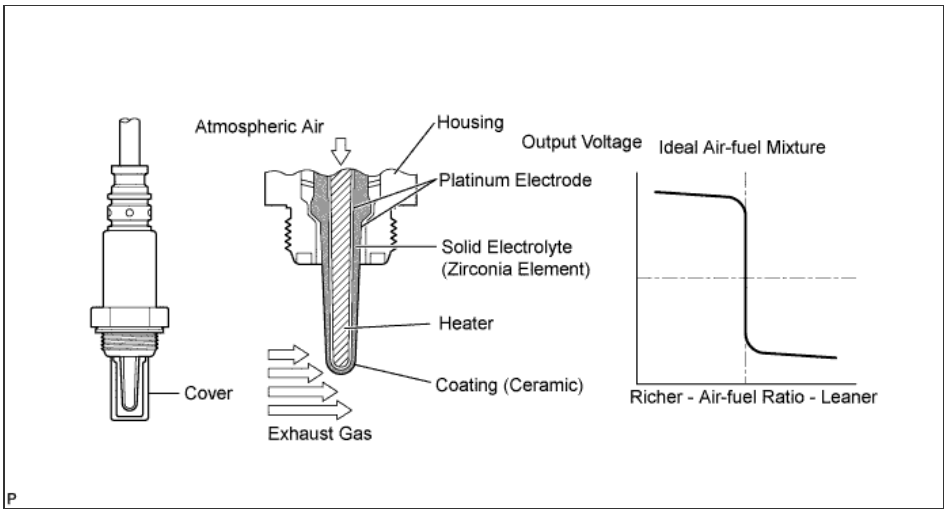
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

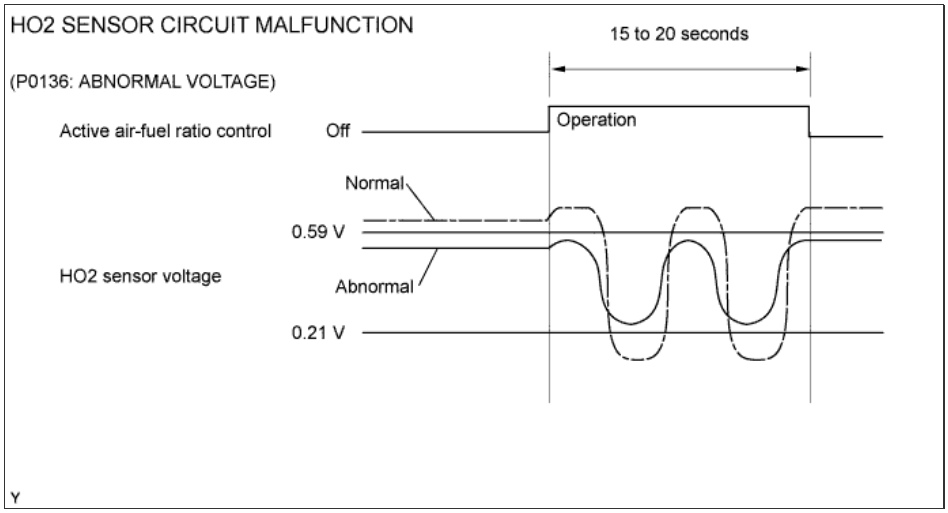
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

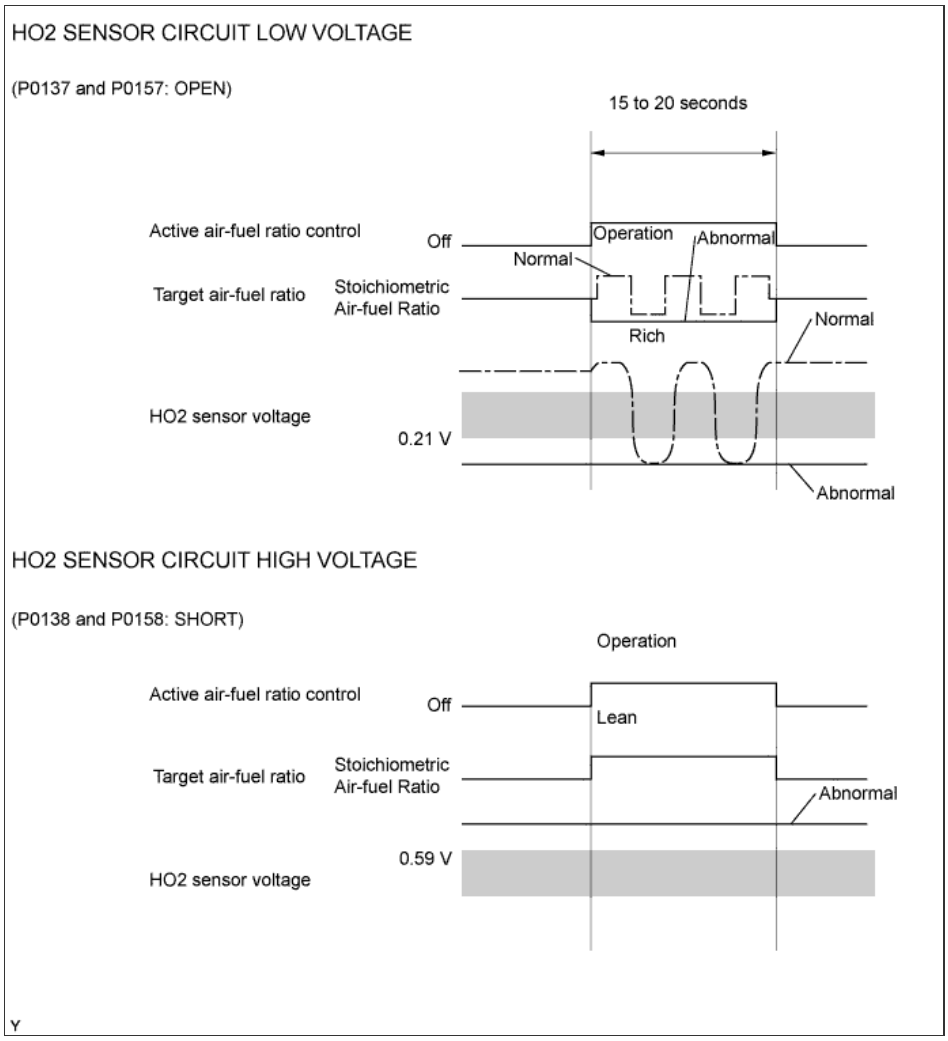
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

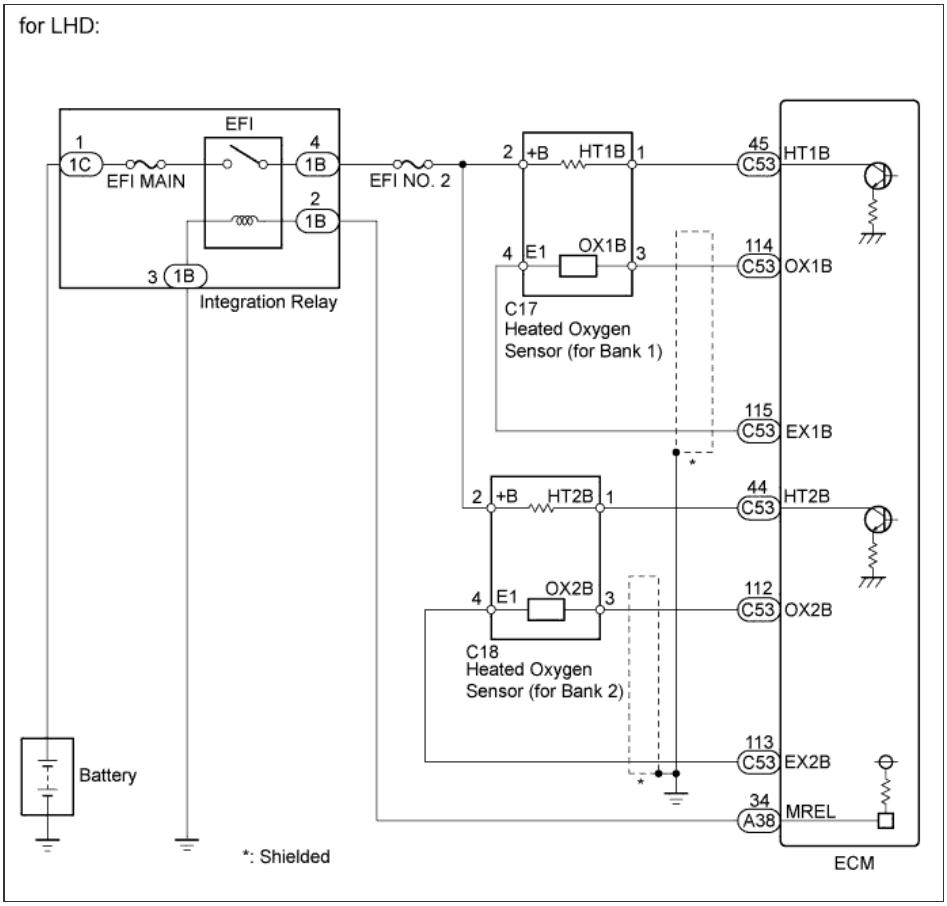
HINT:

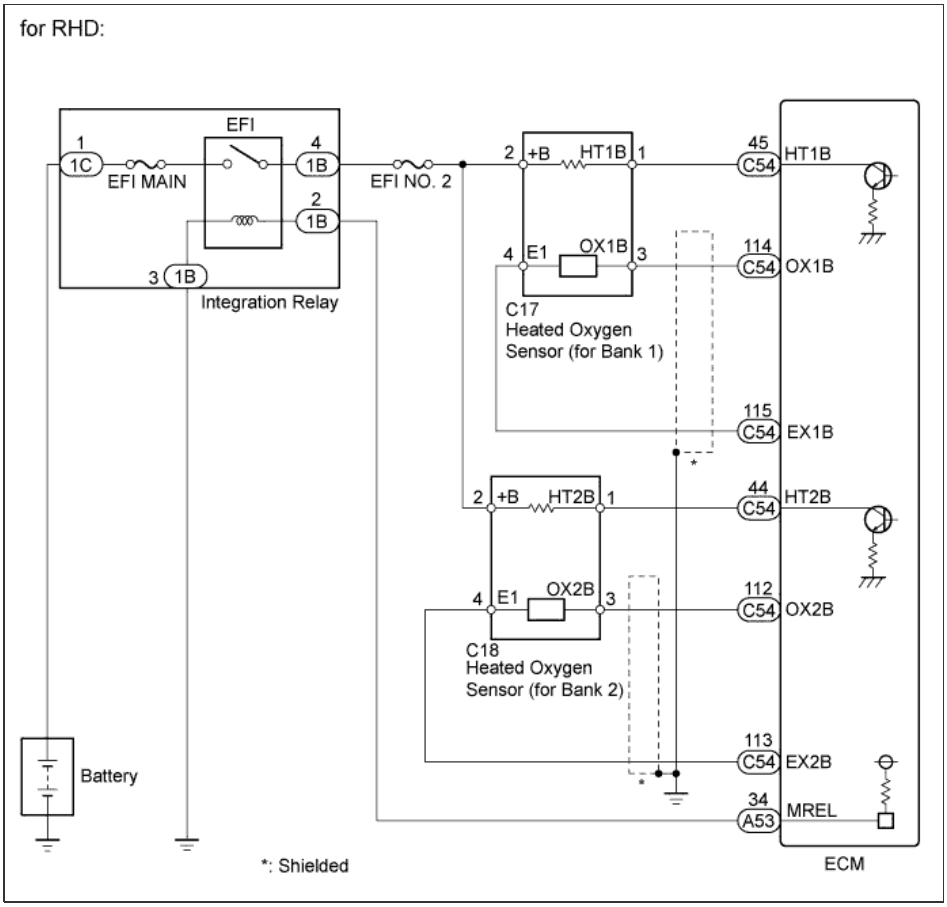
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





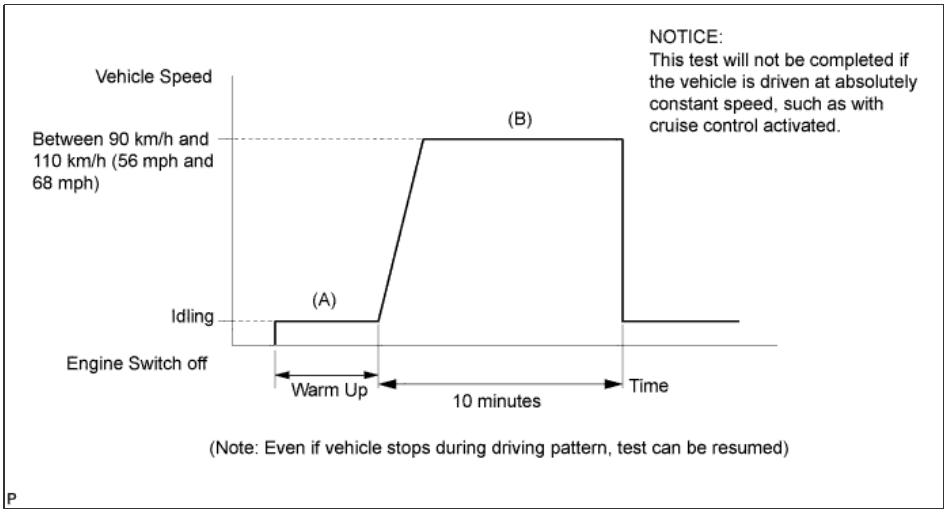
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

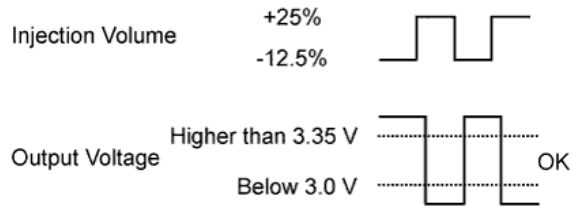
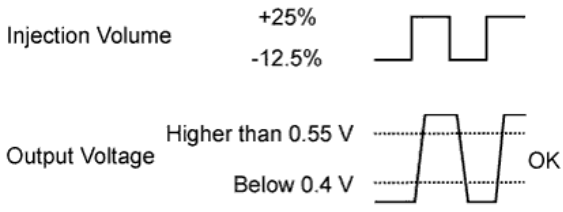
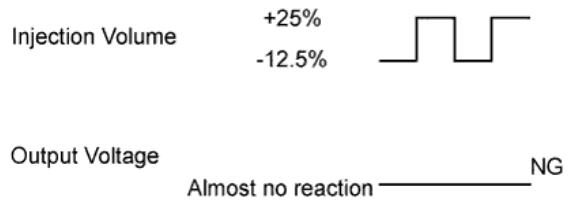
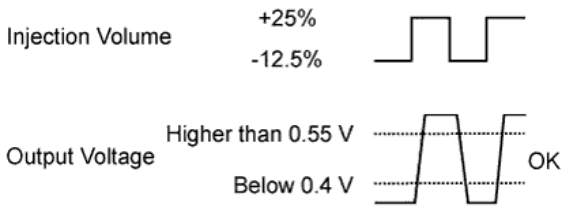
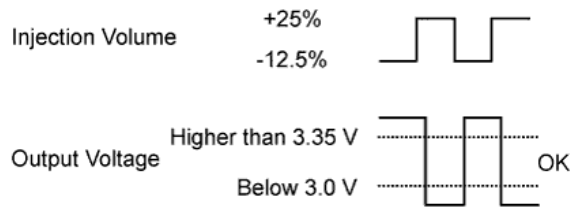
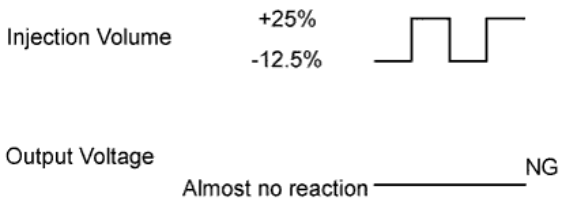
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

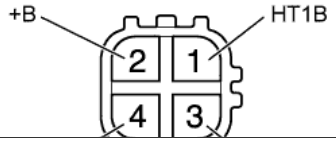
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

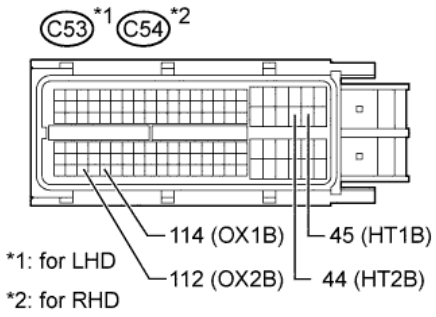
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

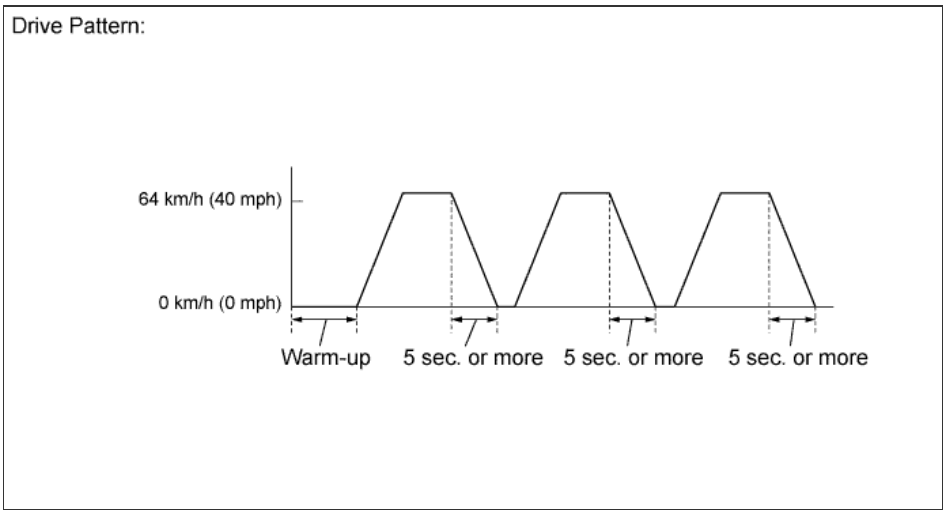
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

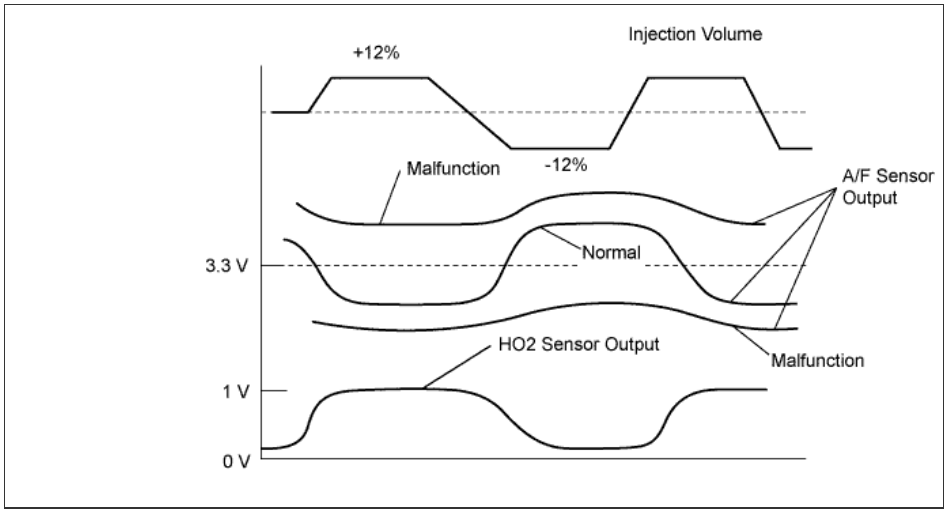
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

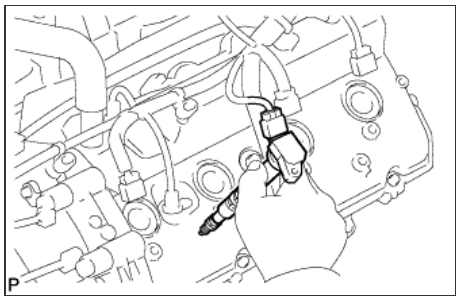
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

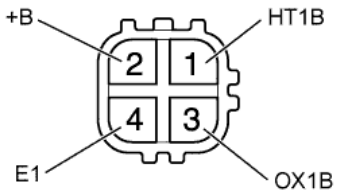
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

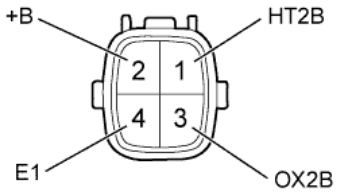
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

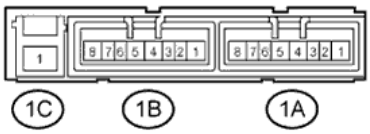
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

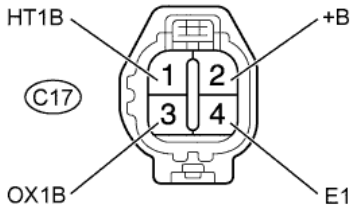
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

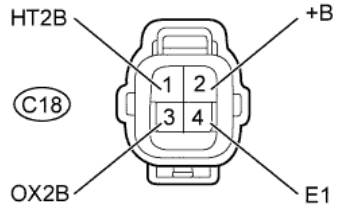
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

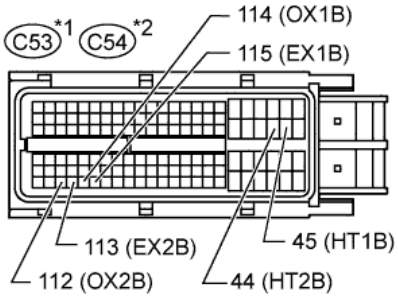
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



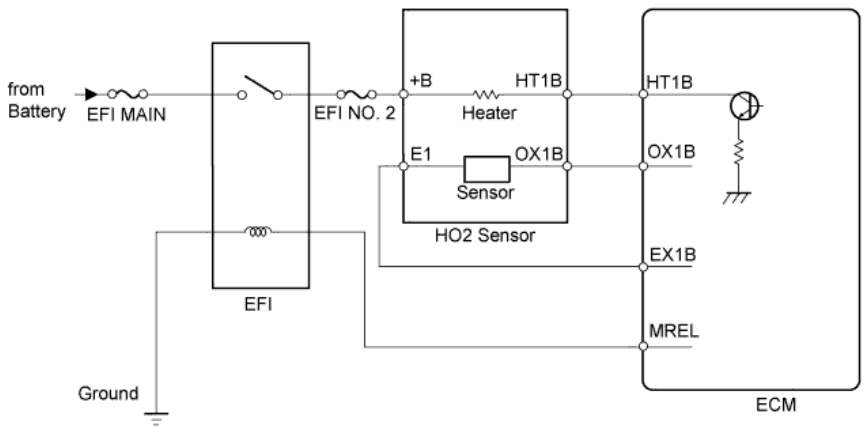
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

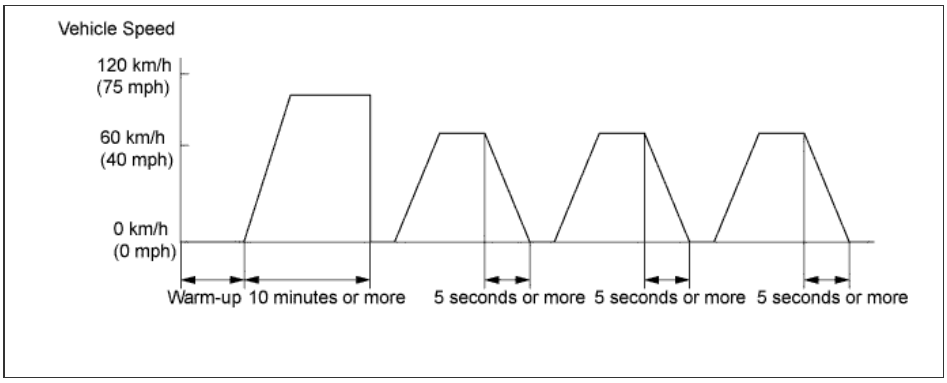
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

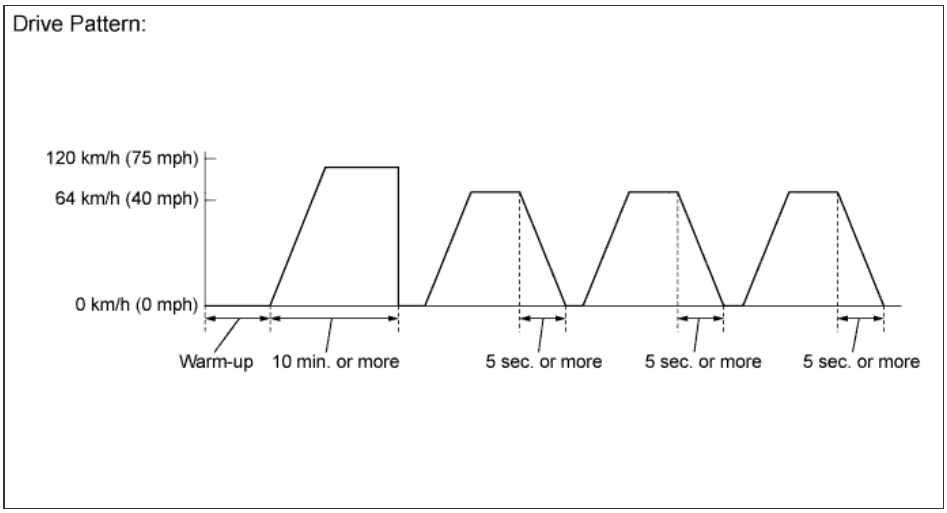
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

for Preparation Click here

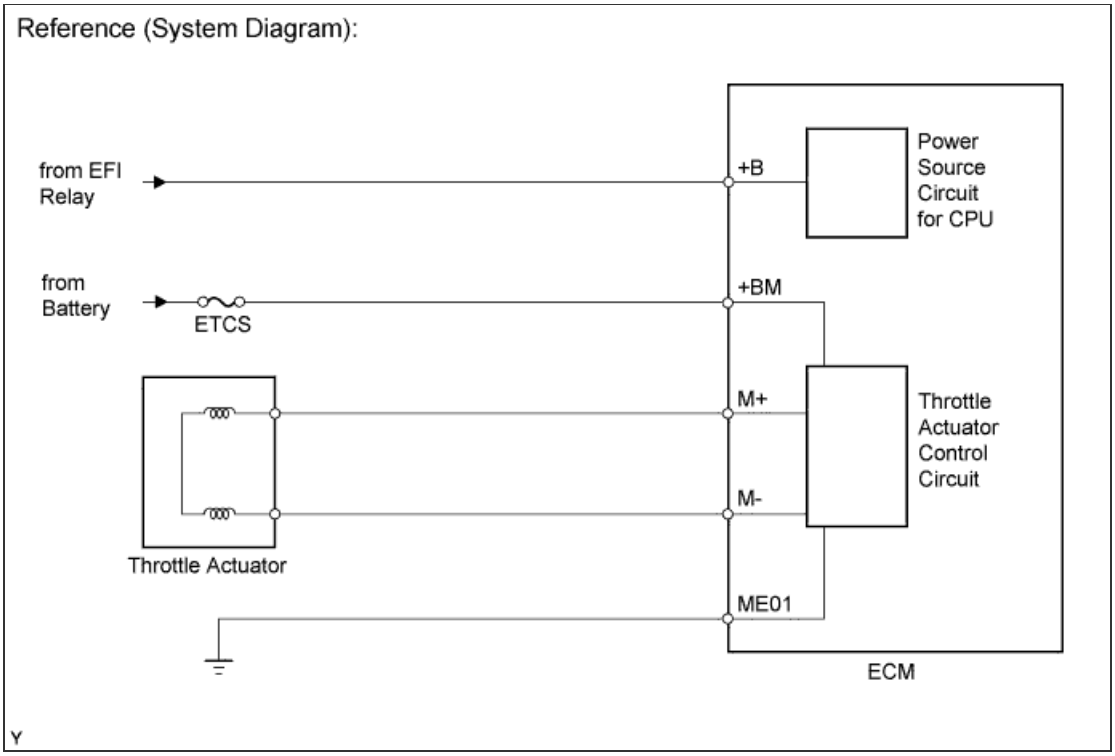
DESCRIPTION

The ETCS (Electronic Throttle Control System) has a dedicated power supply circuit. The voltage (+BM) is monitored and when it is low (below 4 V), the ECM determines that there is a malfunction in the ETCS and cuts off the current to the throttle actuator.
When the voltage becomes unstable, the ETCS itself becomes unstable. For this reason, when the voltage is low, the current to the throttle actuator is cut. If repairs are made and the system returns to normal, turn the engine switch off. The ECM then allows the current to flow to the throttle actuator so that it can be restarted.

HINT:

The ETCS does not use a throttle cable.

Reference (System Diagram):



DTC Code	DTC Detection Condition	Trouble Area
P2118	An open in the ETCS power source (+BM) circuit (1 trip detection logic).	• Open in ETCS power source circuit • ETCS fuse • ECM

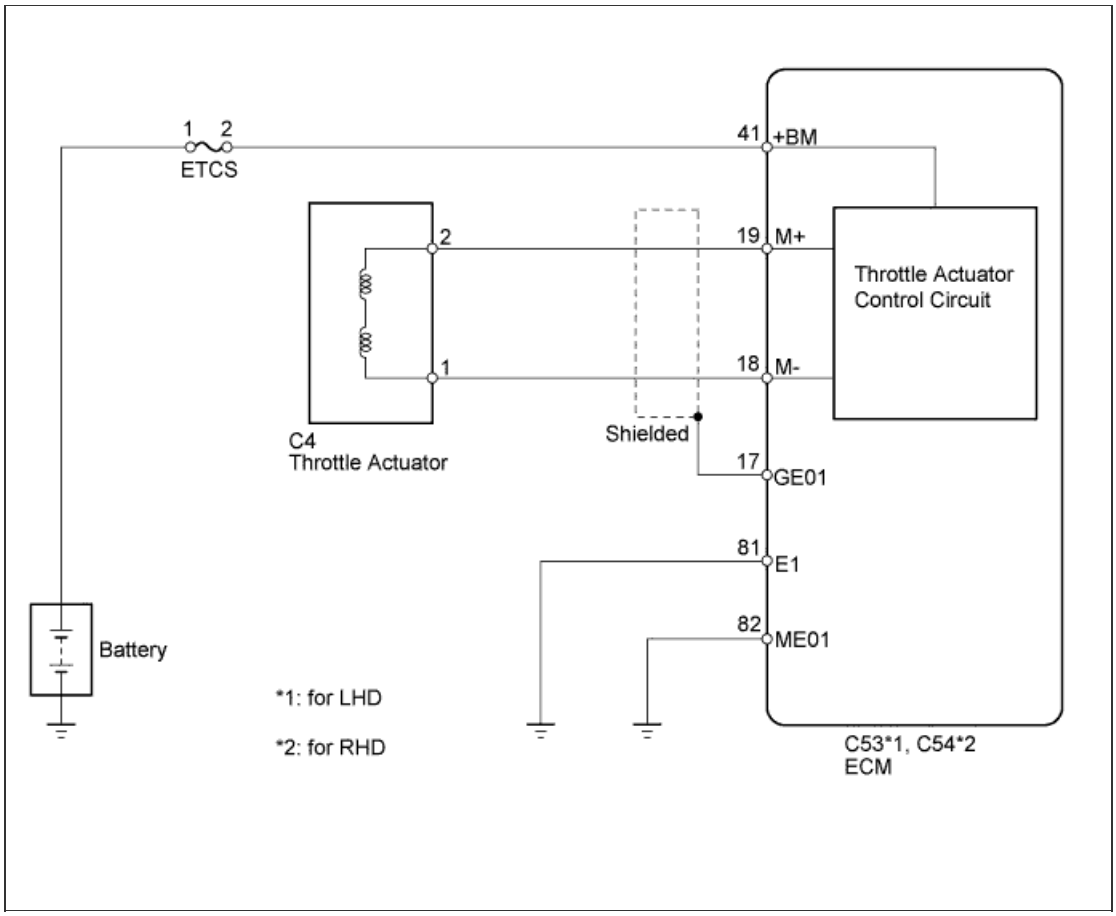
MONITOR DESCRIPTION

The ECM monitors the battery supply voltage applied to the throttle actuator.
When the power supply voltage (+BM) drops below 4 V for 0.8 seconds or more, the ECM interprets this as an open in the power supply circuit (+BM). The ECM illuminates the MIL and stores the DTC.
If the malfunction is not repaired successfully, the DTC is stored 5 seconds after the engine is next started.

FAIL-SAFE

When this DTC, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.INSPECT FUSE (ETCS)

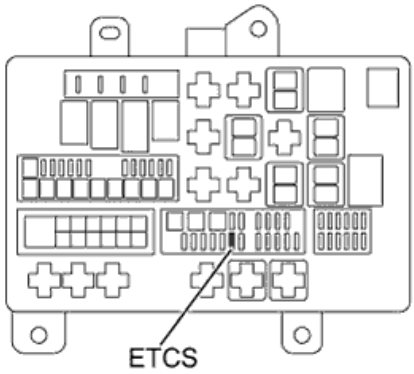
a. Remove the ETCS fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
ETCS fuse	Always	Below 1 Ω

Engine Room Relay Block:



NG → CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE

OK

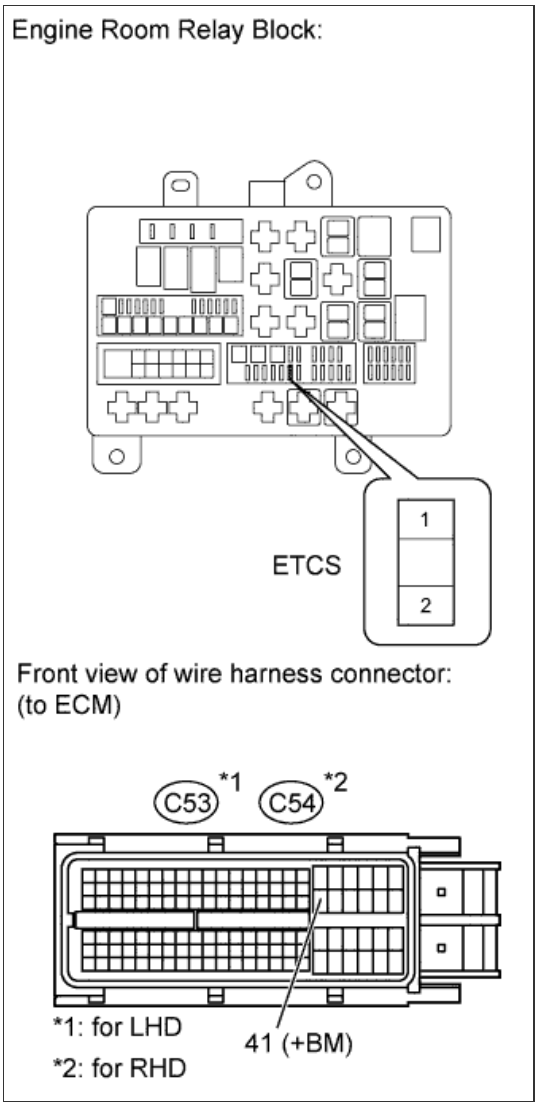
2.CHECK HARNESS AND CONNECTOR (ECM - ETCS FUSE, ETCS FUSE - BATTERY)

a. Check the harness and connector between the ETCS fuse and ECM.

i. Remove the ETCS fuse from the engine room relay block.

ii. Disconnect the C53 or C54 ECM connector.

iii. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
ETCS fuse terminal 2 - C53-41 (+BM)	Always	Below 1 Ω
ETCS fuse terminal 2 or C53-41 (+BM) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
ETCS fuse terminal 2 - C54-41 (+BM)	Always	Below 1 Ω
ETCS fuse terminal 2 or C54-41 (+BM) - Body ground	Always	10 kΩ or higher

b. Check the harness and connector between the ETCS fuse and positive battery cable.

i. Remove the ETCS fuse from the engine room relay block.

ii. Disconnect the cable from the positive (+) battery terminal.

iii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Positive battery cable - ETCS fuse terminal 1	Always	Below 1 Ω
Positive battery cable or ETCS	Always	10 kΩ or higher

fuse terminal 1 - Body ground		

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

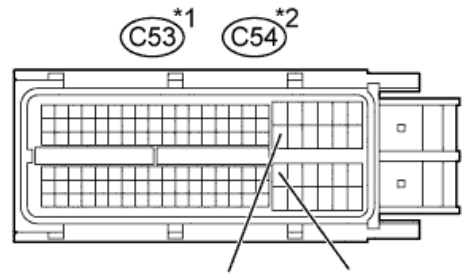
OK

3.INSPECT ECM (+BM VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.

Front view of wire harness connector: (to ECM)



*1: for LHD

*2: for RHD

Standard Voltage:

for LHD

Tester Connection	Condition	Specified Condition
C53-41 (+BM) - C53-81 (E1)	Always	11 to 14 V

for RHD

Tester Connection	Condition	Specified Condition
C54-41 (+BM) - C54-81 (E1)	Always	11 to 14 V

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR (TERMINAL E1 - BODY GROUND)

OK

REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

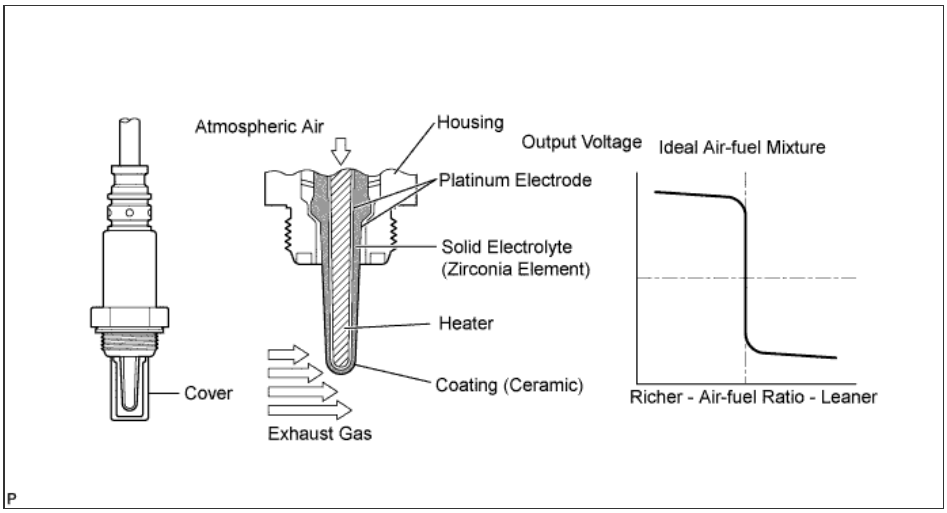
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

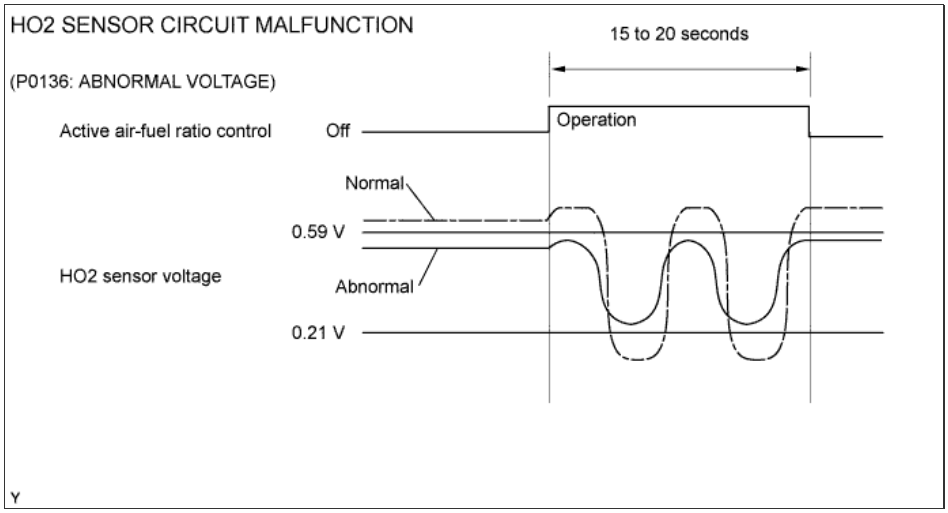
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

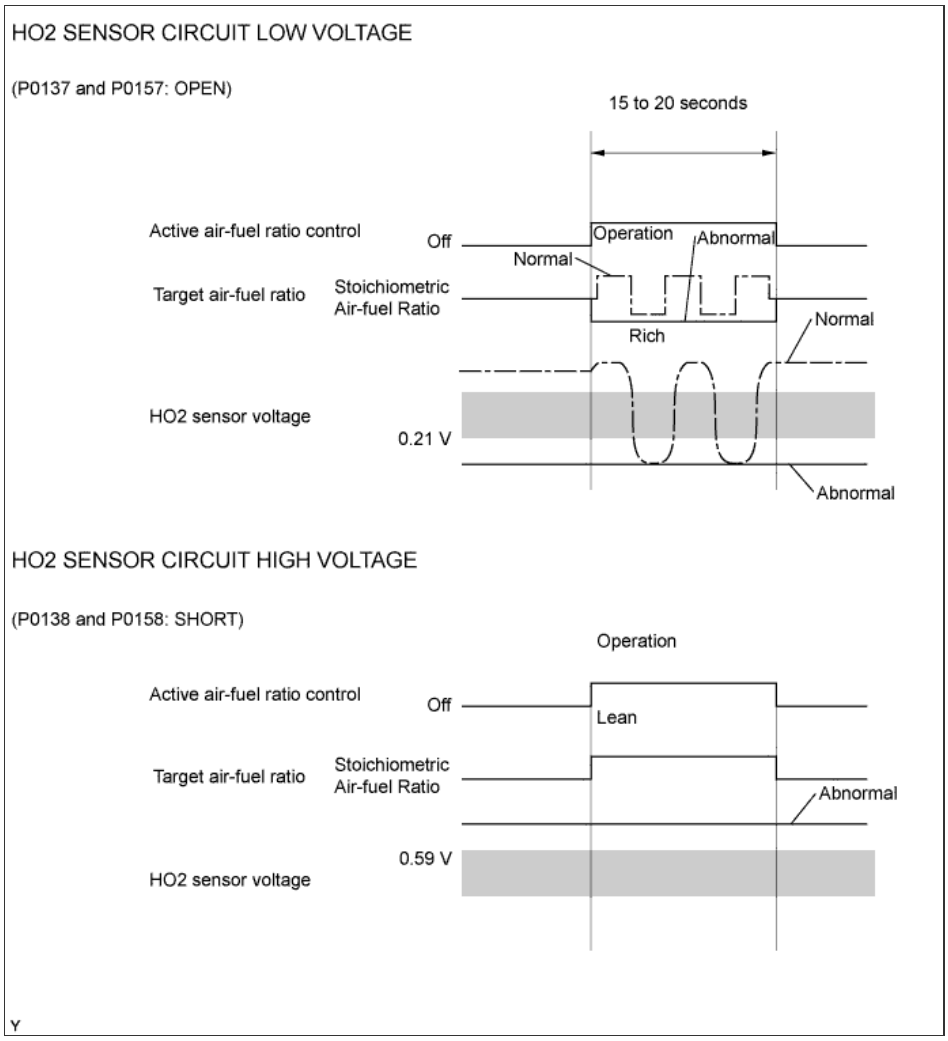
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

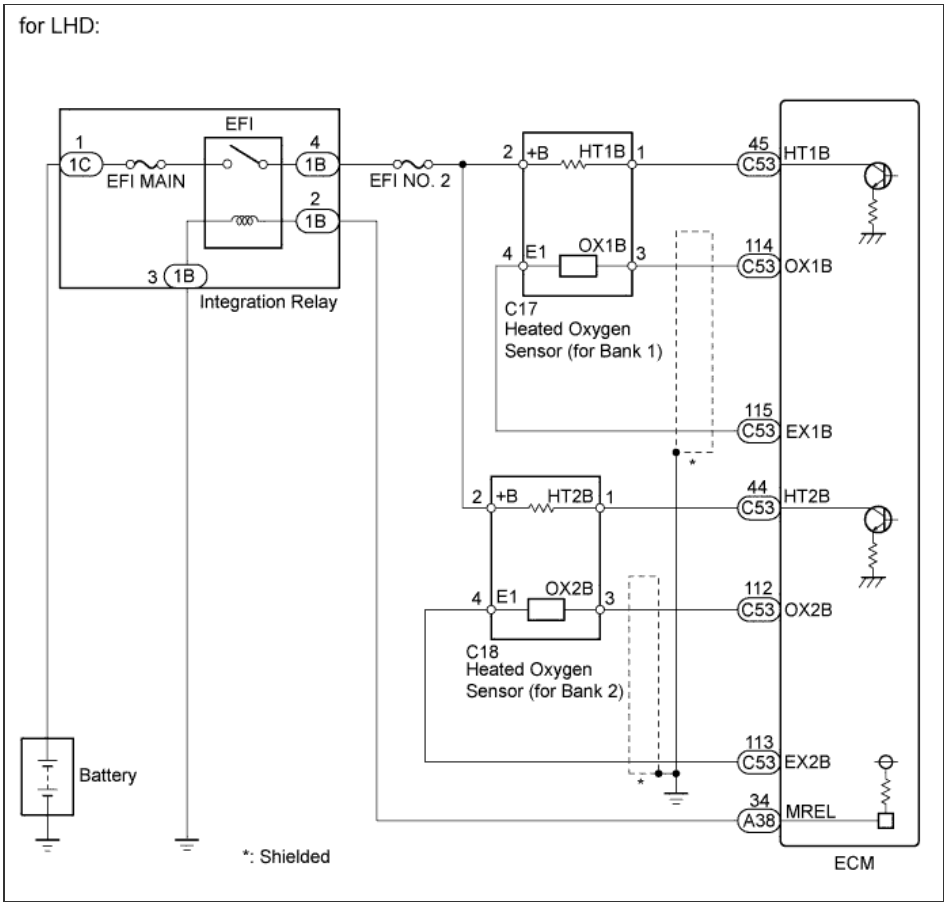
HINT:

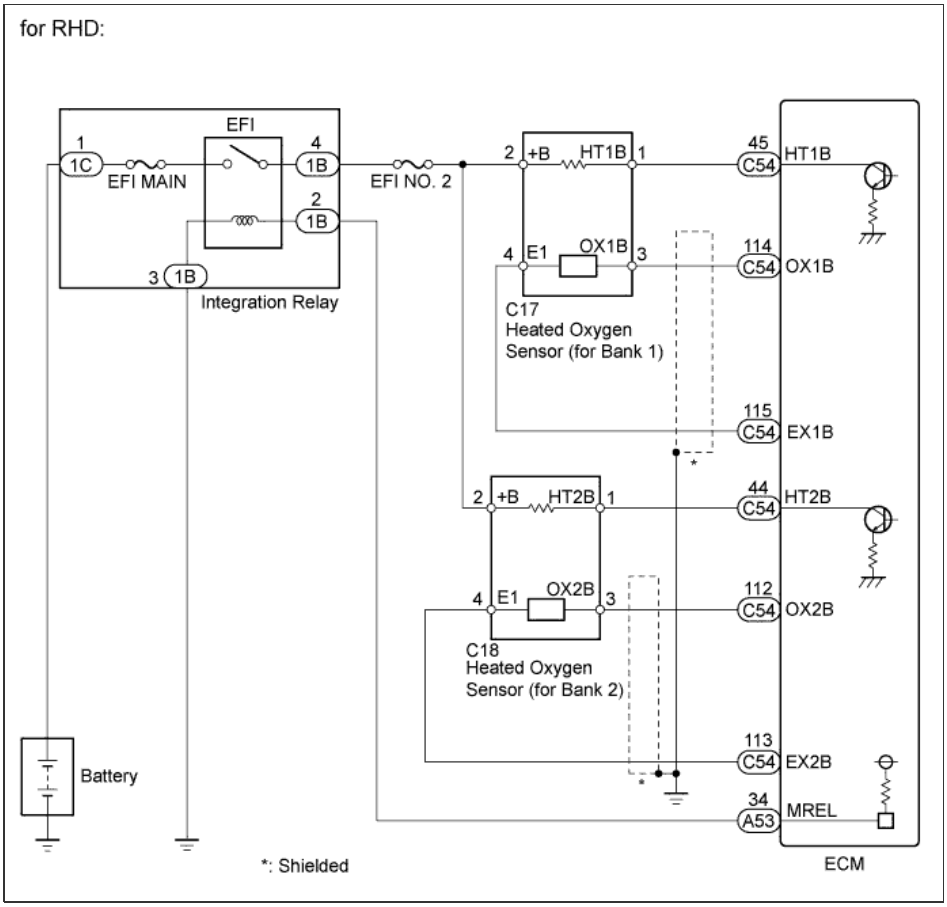
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





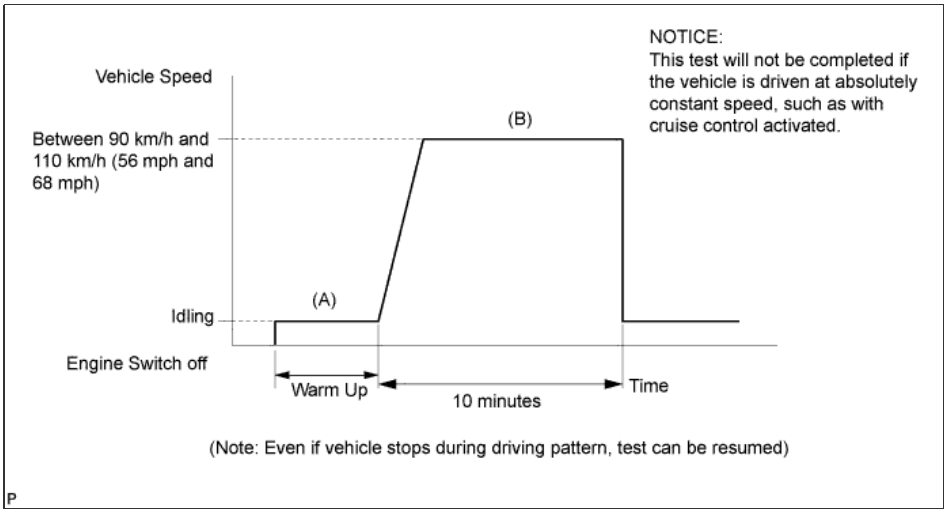
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

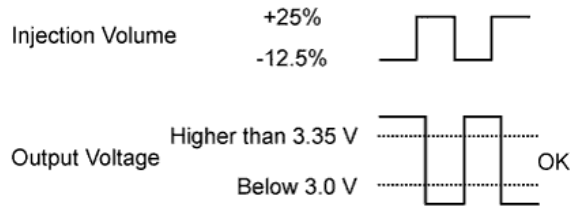
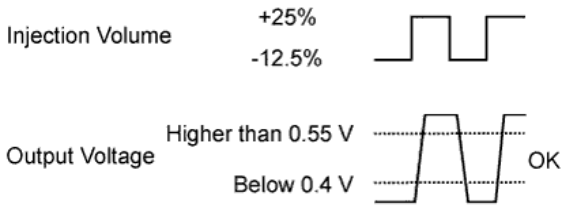
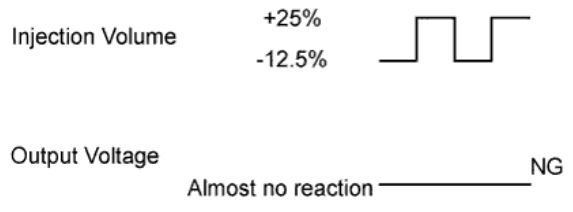
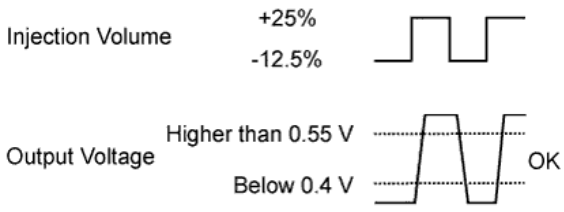
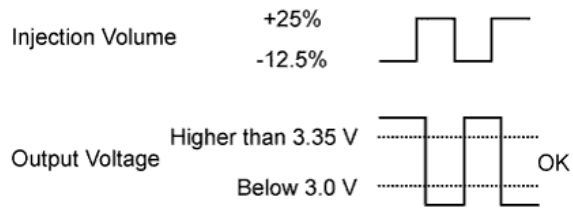
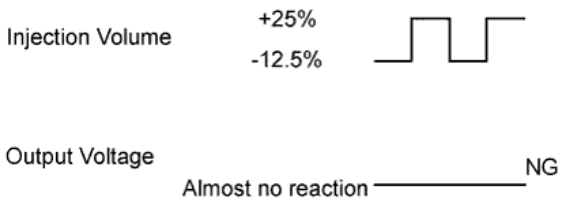
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

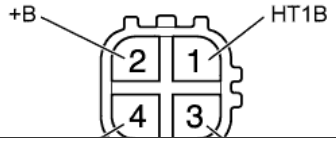
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

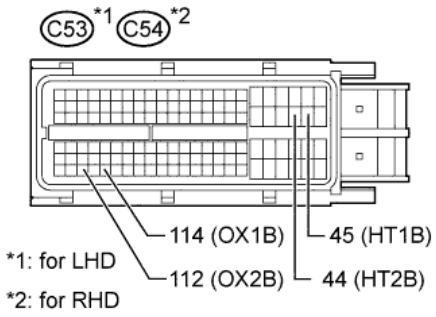
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

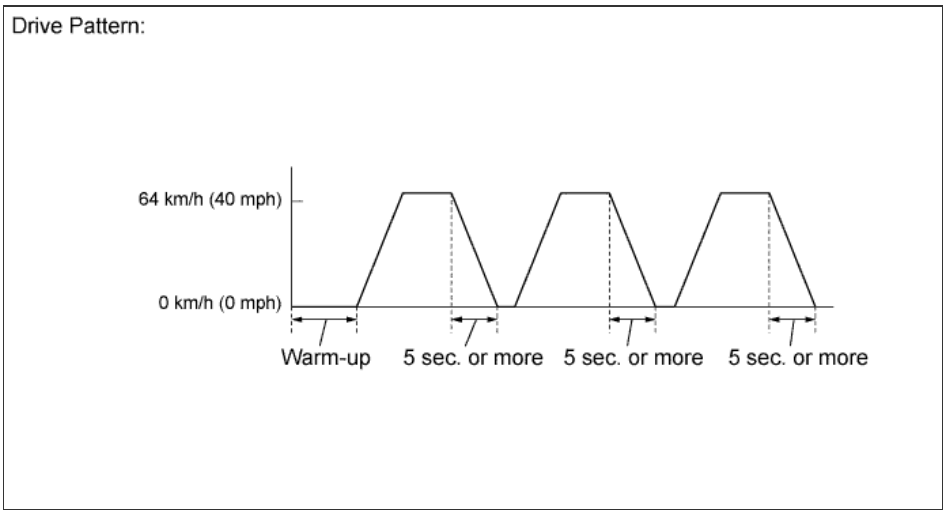
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

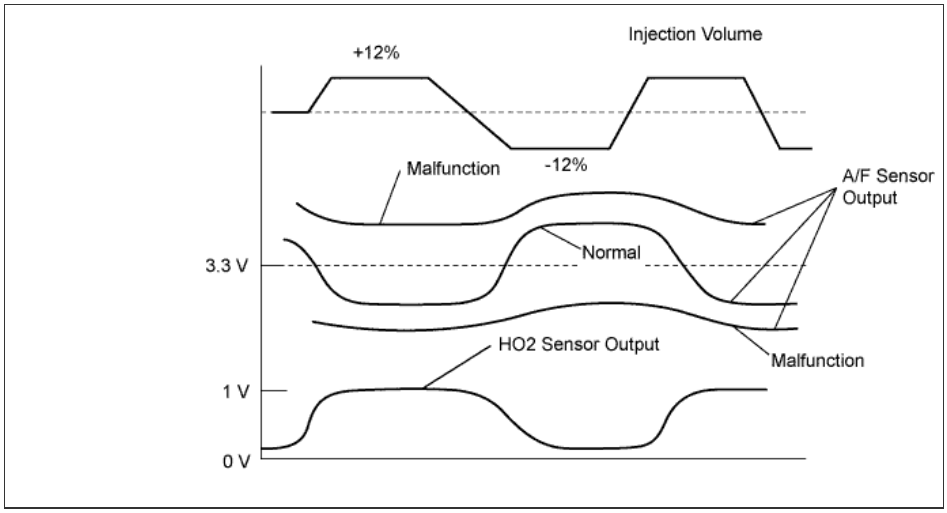
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

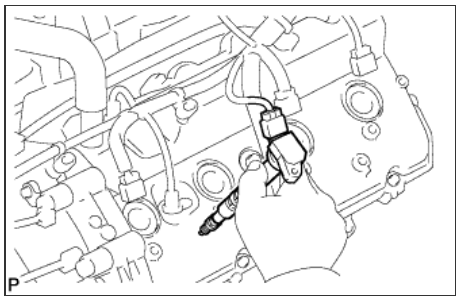
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

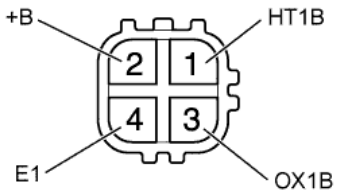
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

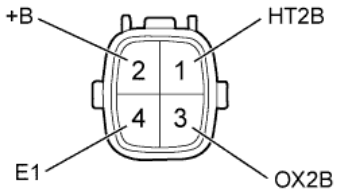
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

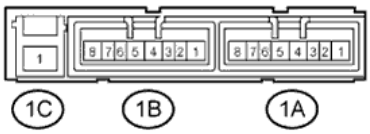
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

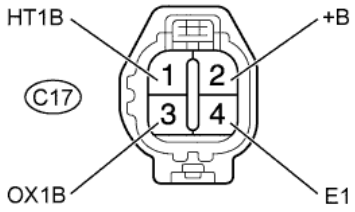
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

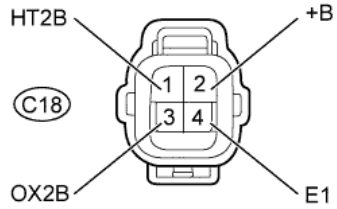
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

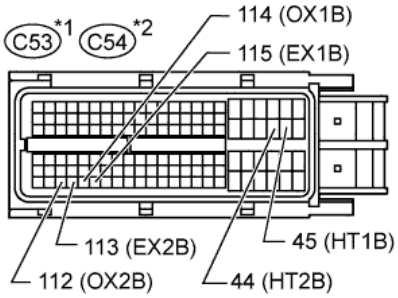
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



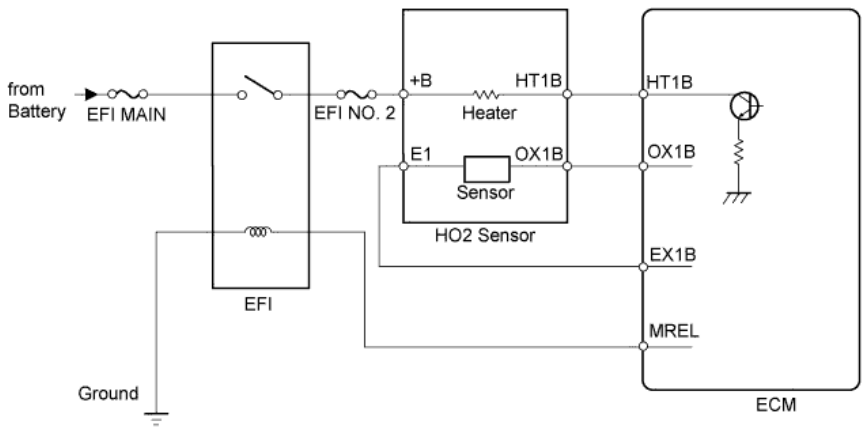
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

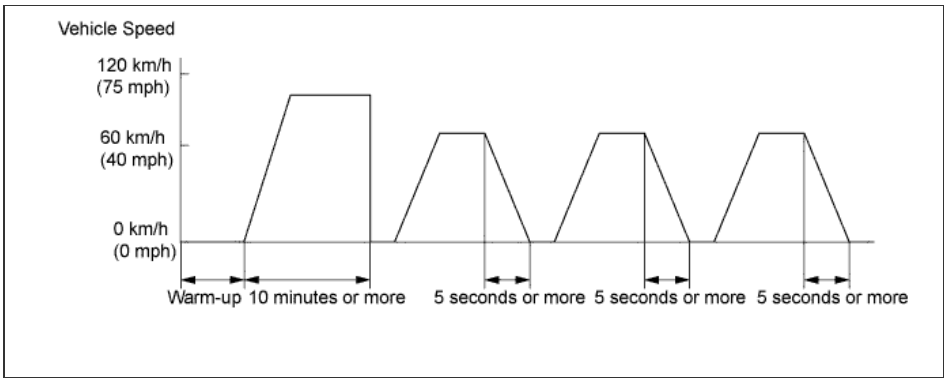
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

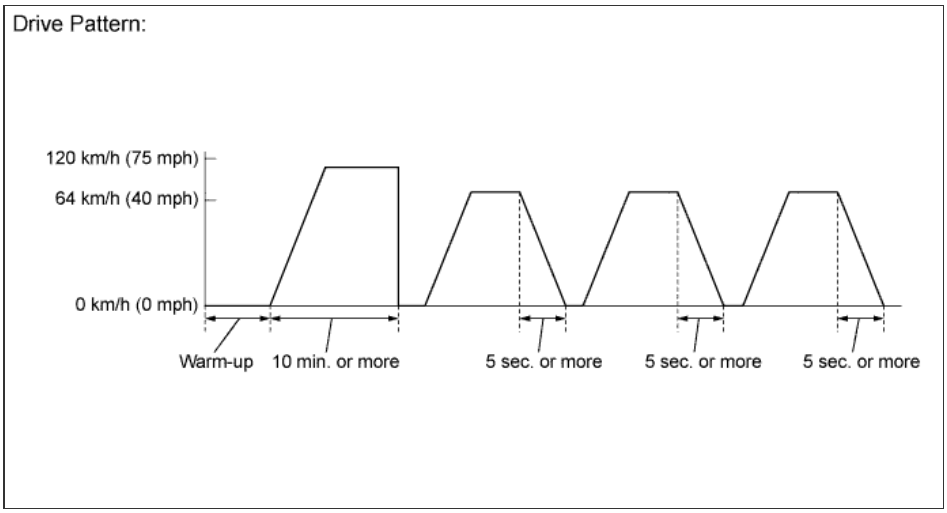
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2119 Throttle Actuator Control Throttle Body Range / Performance

for Preparation Click here

DESCRIPTION

The Electronic Throttle Control System (ETCS) is composed of the throttle actuator, Throttle Position (TP) sensor, Accelerator Pedal Position (APP) sensor, and ECM. The ECM operates the throttle actuator to regulate the throttle valve in response to driver inputs. The TP sensor detects the opening angle of the throttle valve, and provides the ECM with feedback so that the throttle valve can be appropriately controlled by the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P2119	The throttle valve opening angle continues to vary greatly from the target opening angle (1 trip detection logic).	• ETCS • ECM

MONITOR DESCRIPTION

The ECM determines the actual opening angle of the throttle valve from the TP sensor signal. The actual opening angle is compared to the target opening angle commanded by the ECM. If the difference between these two values is outside the standard range, the ECM interprets this as a malfunction in the ETCS. The ECM then illuminates the MIL and stores the DTC.
If the malfunction is not repaired successfully, the DTC is stored when the accelerator pedal is quickly released (to close the throttle valve) after the engine speed reaches 5000 rpm by the accelerator pedal being fully depressed (fully open the throttle valve).

FAIL-SAFE

When this DTC, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly. Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2119)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2119 is output	A
P2119 and other DTCs are output	B

HINT:

If any DTCs other than P2119 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.CHECK WHETHER DTC OUTPUT RECURS (DTC P2119)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 15 seconds.

g. Fully depress and release the accelerator pedal several times quickly.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read DTCs.

OK:
No DTC is output.

HINT:

The output voltage of the throttle position sensor can be checked using the tester. Variations in the output voltage indicate that the throttle actuator is in operation. To check the output voltage using the tester, enter the following menus: Powertrain / Engine and ECT / ETCS / Throttle Position No. 1.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

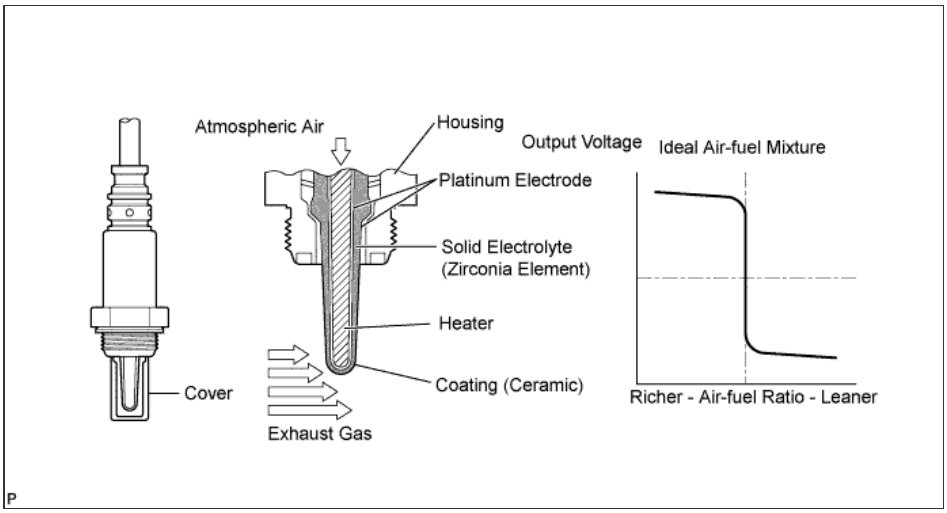
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

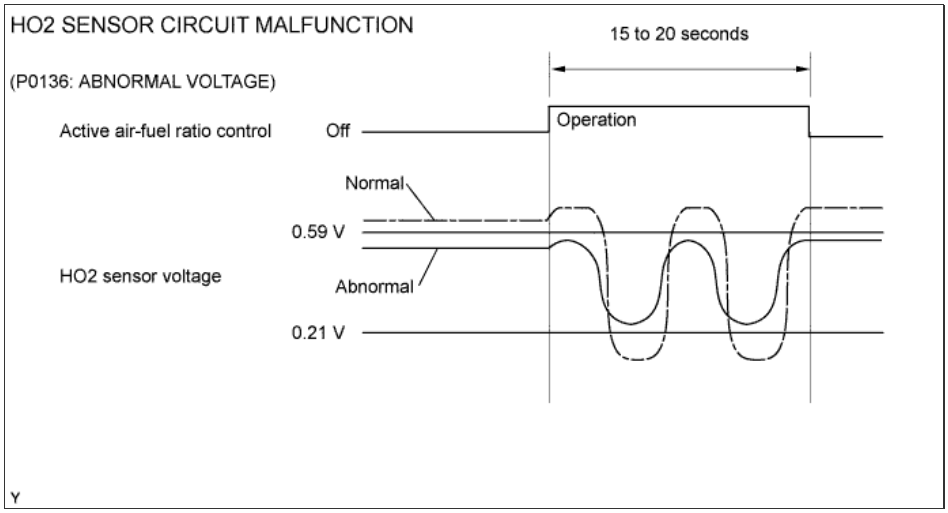
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

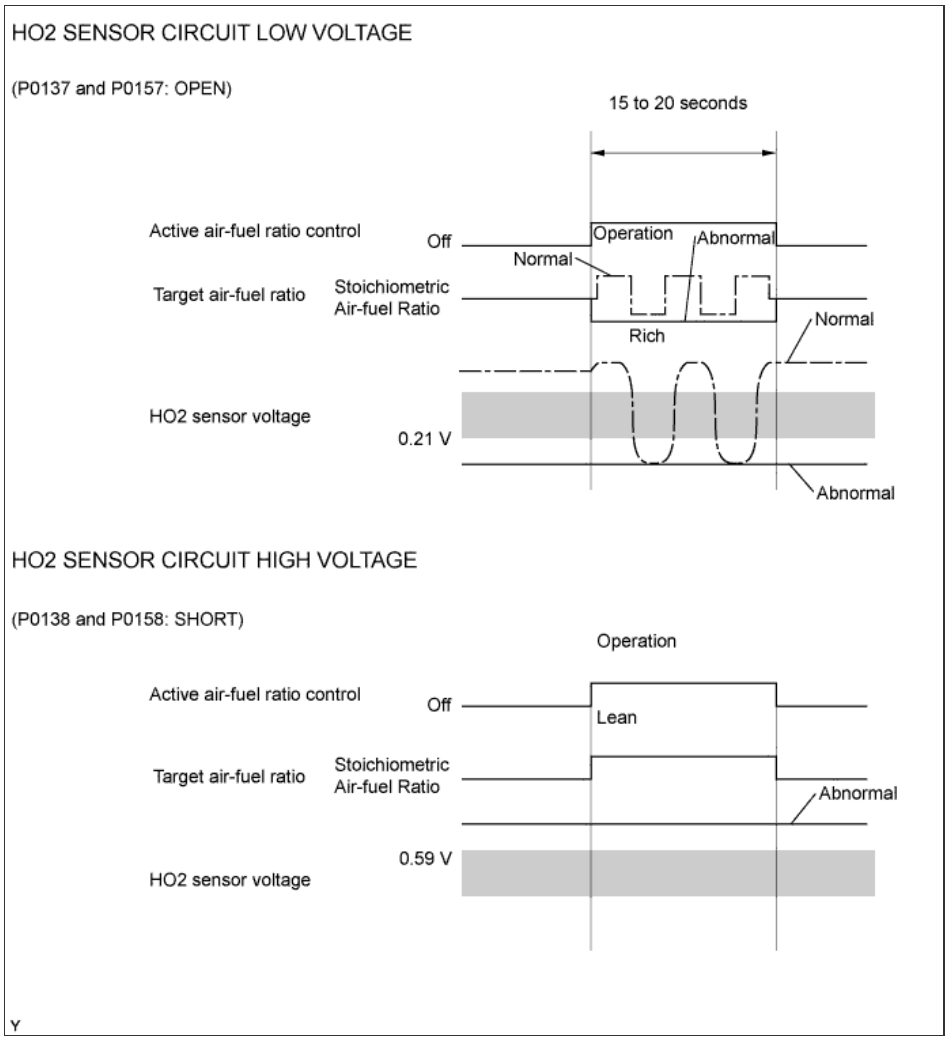
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

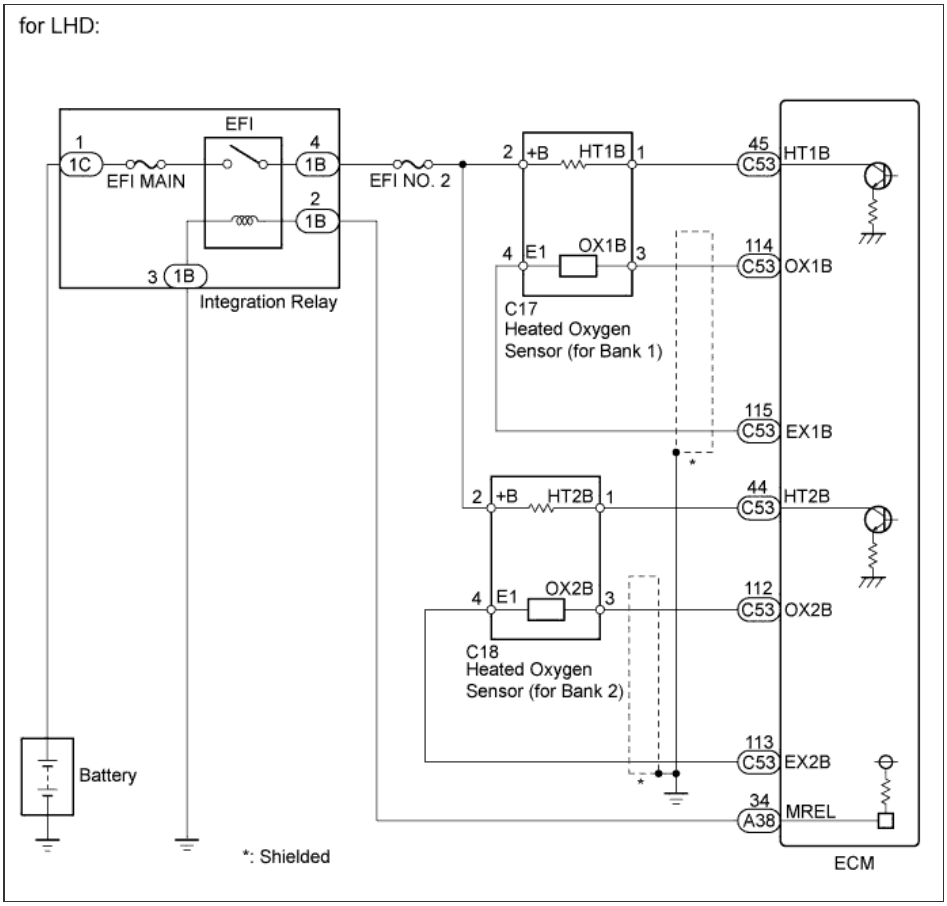
HINT:

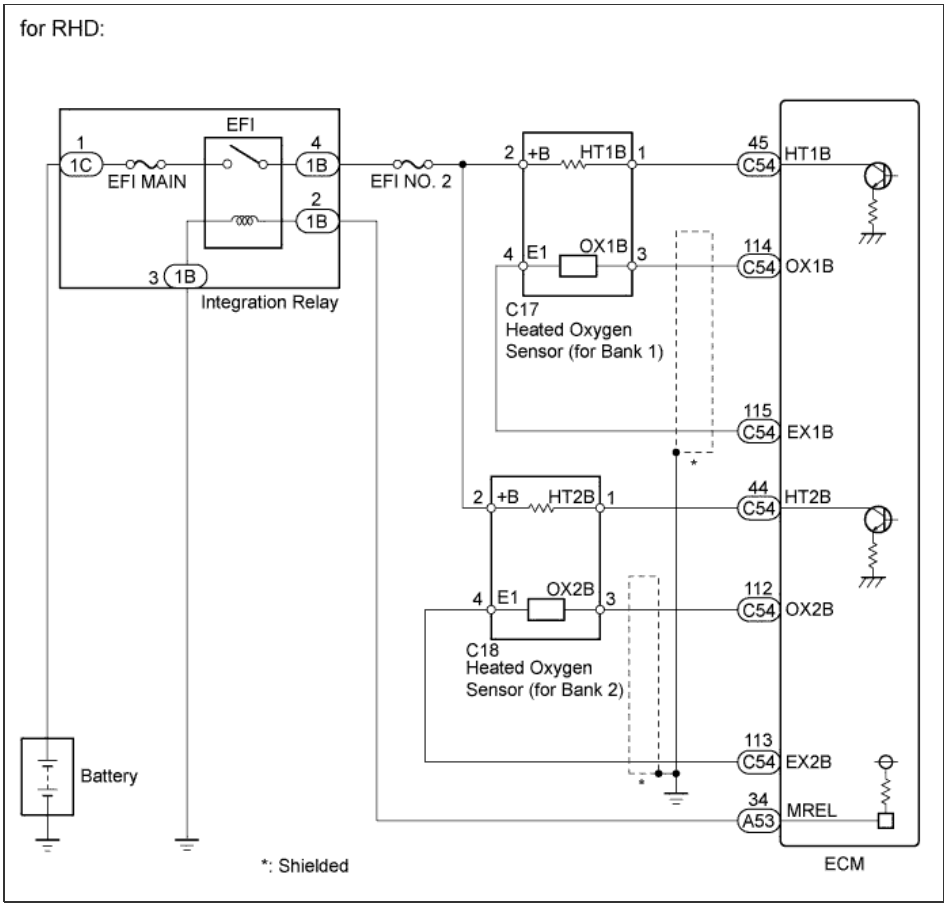
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





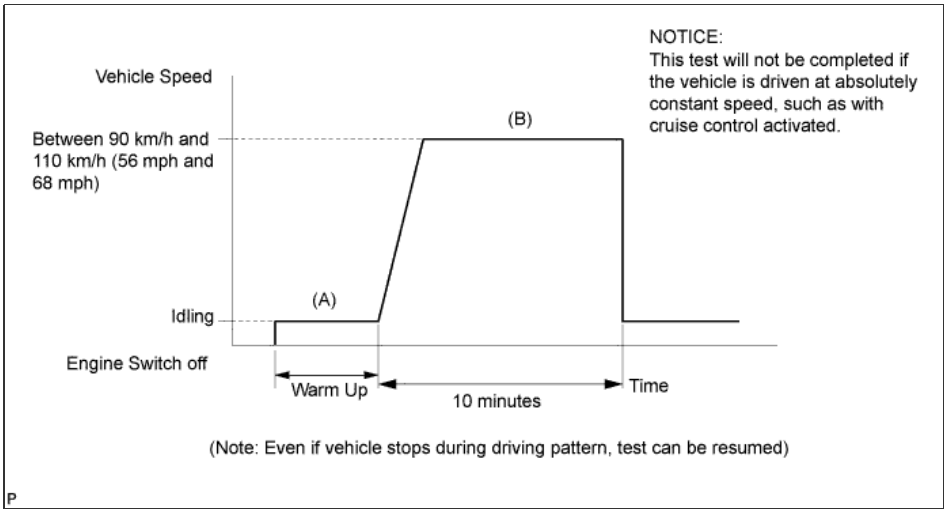
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

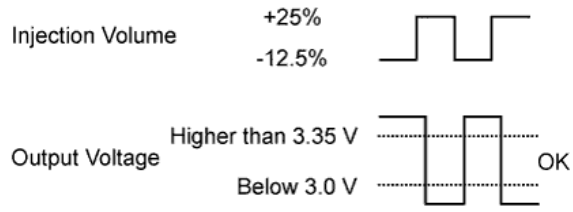
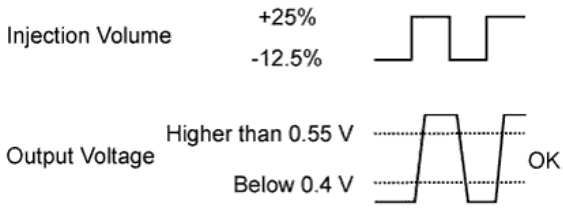
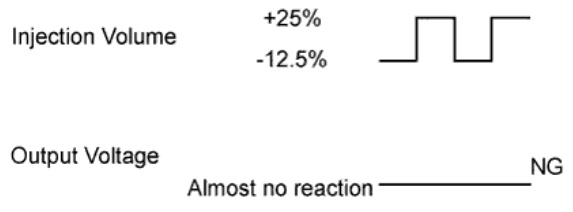
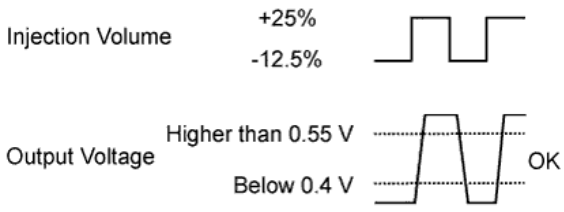
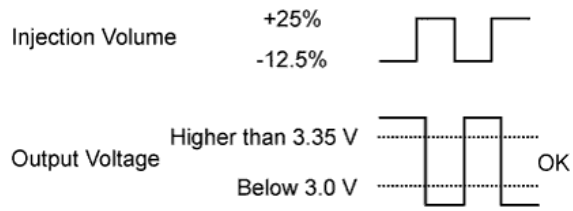
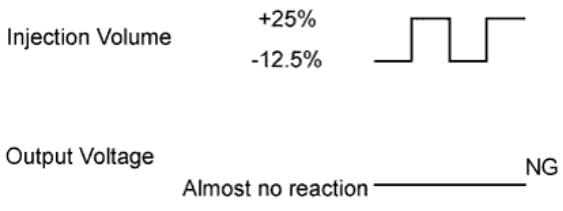
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

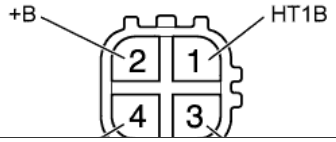
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

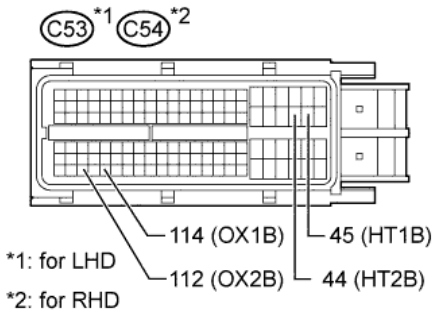
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

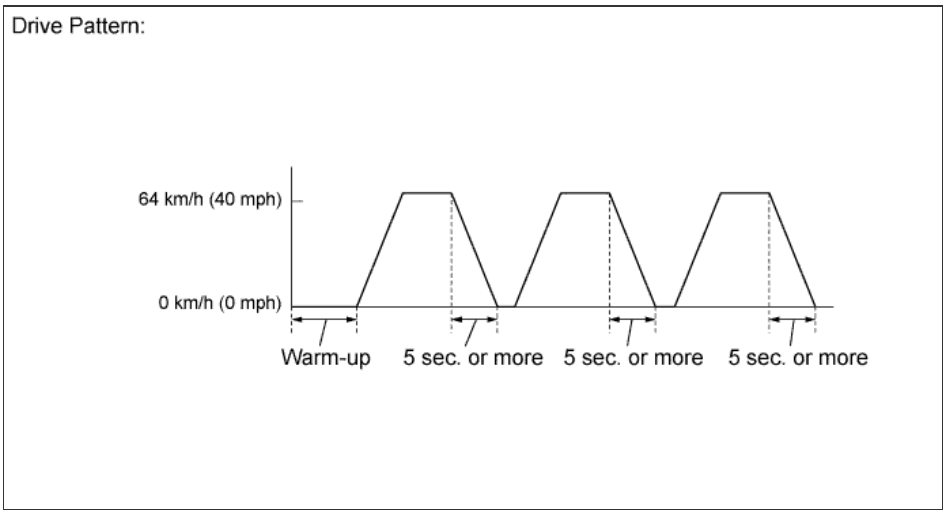
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

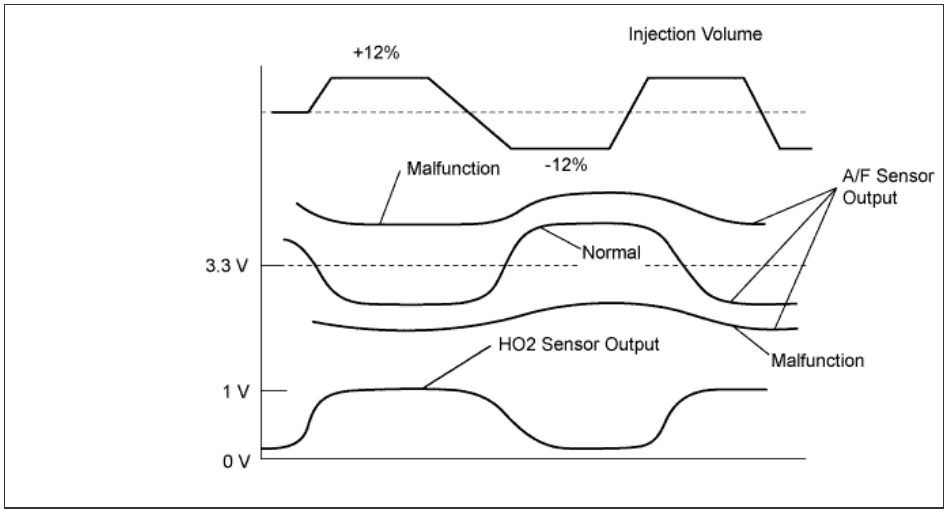
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

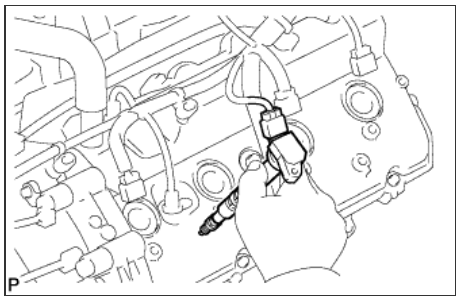
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

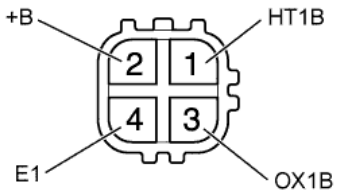
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

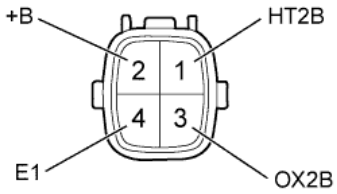
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

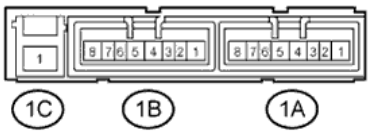
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

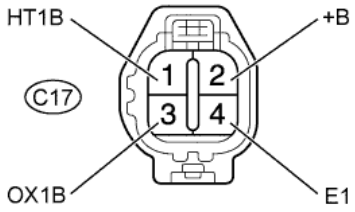
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

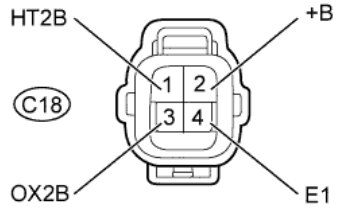
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

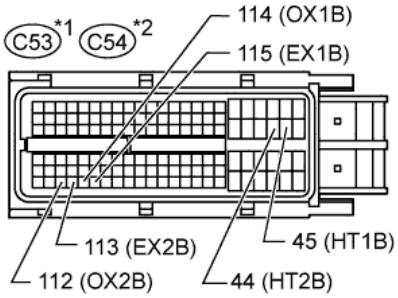
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



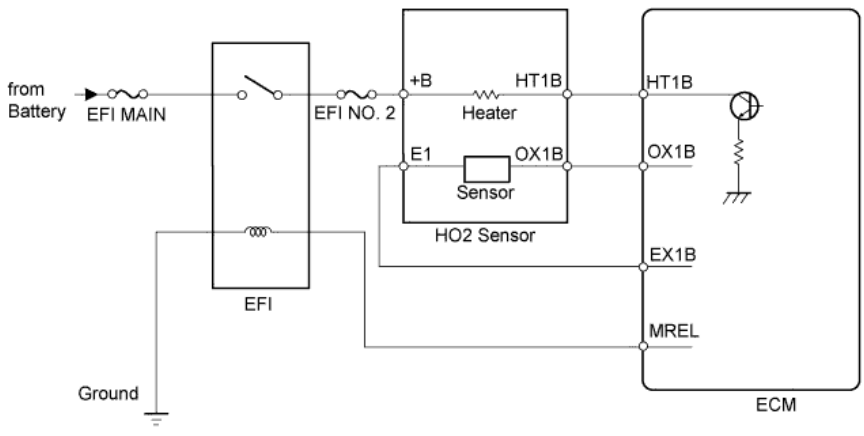
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

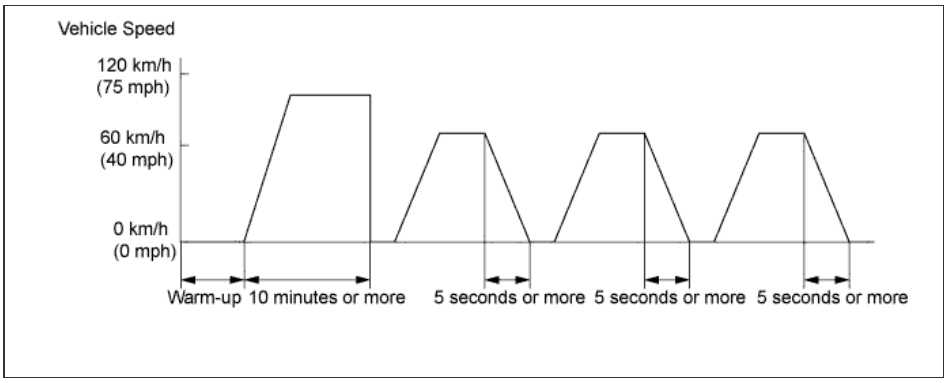
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

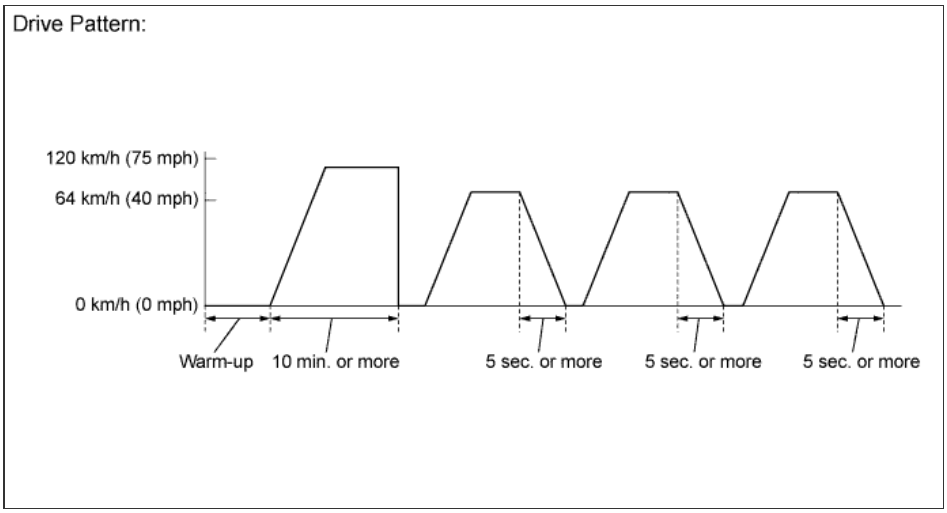
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2119 Throttle Actuator Control Throttle Body Range / Performance

for Preparation Click here

DESCRIPTION

The Electronic Throttle Control System (ETCS) is composed of the throttle actuator, Throttle Position (TP) sensor, Accelerator Pedal Position (APP) sensor, and ECM. The ECM operates the throttle actuator to regulate the throttle valve in response to driver inputs. The TP sensor detects the opening angle of the throttle valve, and provides the ECM with feedback so that the throttle valve can be appropriately controlled by the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P2119	The throttle valve opening angle continues to vary greatly from the target opening angle (1 trip detection logic).	• ETCS • ECM

MONITOR DESCRIPTION

The ECM determines the actual opening angle of the throttle valve from the TP sensor signal. The actual opening angle is compared to the target opening angle commanded by the ECM. If the difference between these two values is outside the standard range, the ECM interprets this as a malfunction in the ETCS. The ECM then illuminates the MIL and stores the DTC.
If the malfunction is not repaired successfully, the DTC is stored when the accelerator pedal is quickly released (to close the throttle valve) after the engine speed reaches 5000 rpm by the accelerator pedal being fully depressed (fully open the throttle valve).

FAIL-SAFE

When this DTC, or other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions are stored, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator, and the throttle valve is returned to a 7° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly. Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2119)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2119 is output	A
P2119 and other DTCs are output	B

HINT:

If any DTCs other than P2119 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.CHECK WHETHER DTC OUTPUT RECURS (DTC P2119)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Allow the engine to idle for 15 seconds.

g. Fully depress and release the accelerator pedal several times quickly.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read DTCs.

OK:
No DTC is output.

HINT:

The output voltage of the throttle position sensor can be checked using the tester. Variations in the output voltage indicate that the throttle actuator is in operation. To check the output voltage using the tester, enter the following menus: Powertrain / Engine and ECT / ETCS / Throttle Position No. 1.

NG → REPLACE THROTTLE BODY ASSEMBLY (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

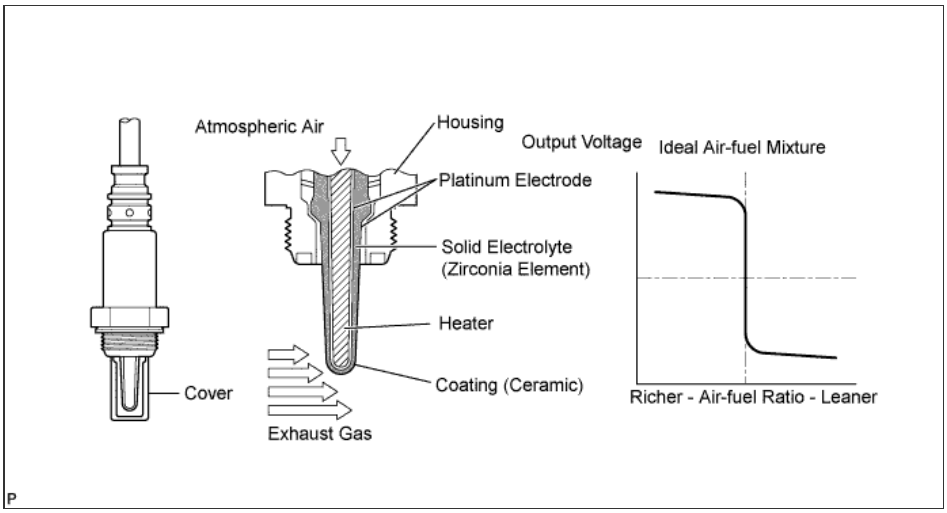
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

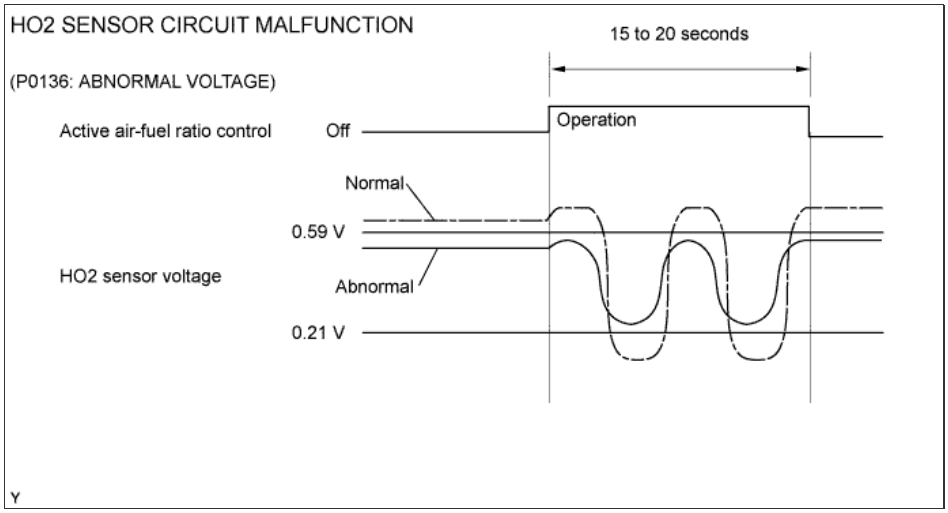
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

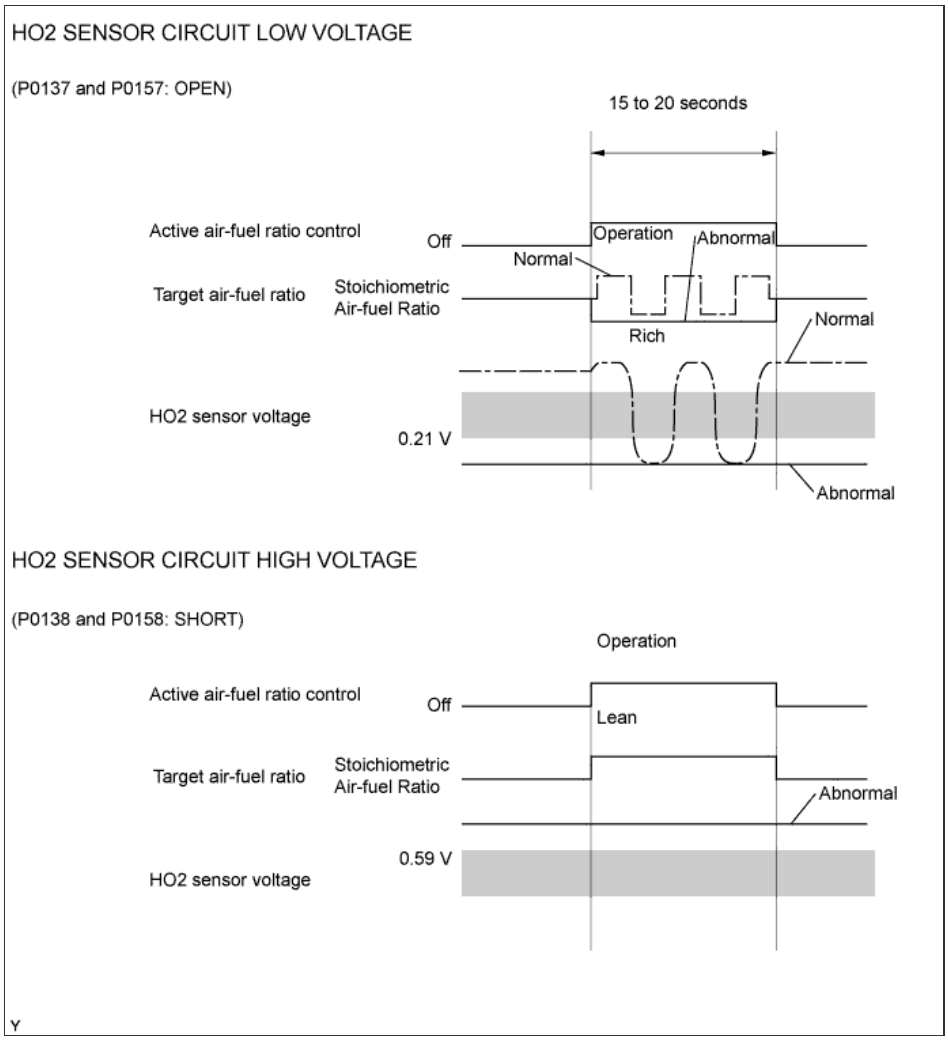
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

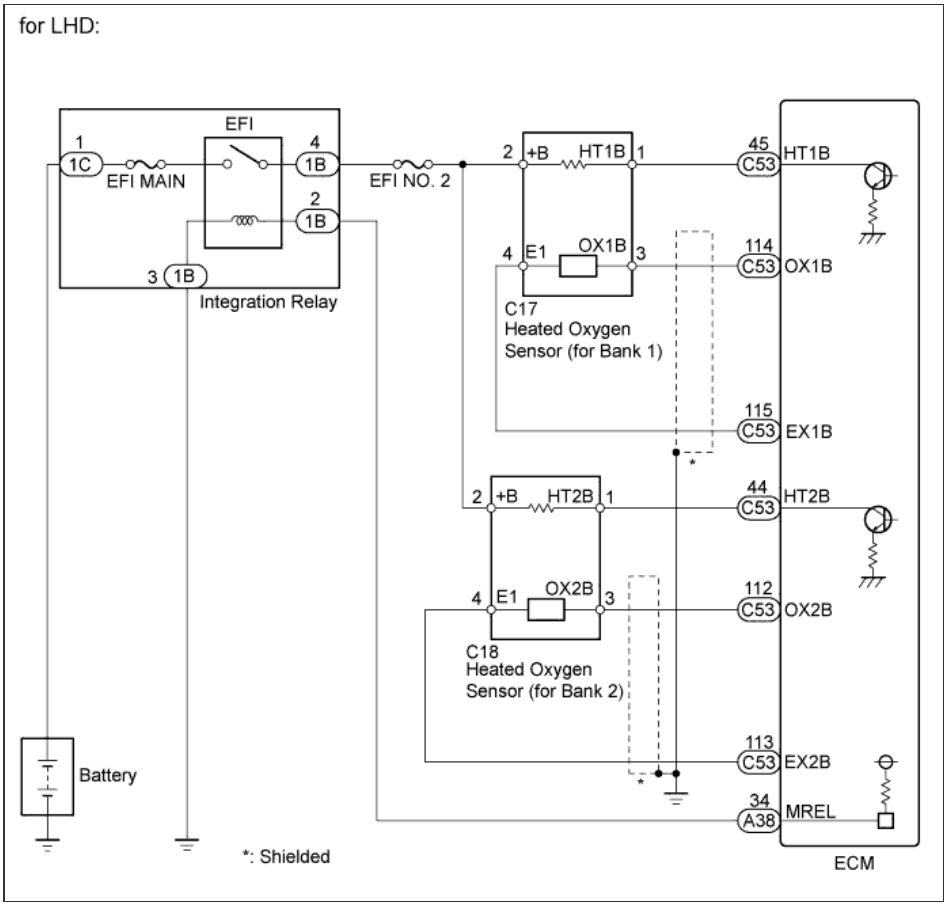
HINT:

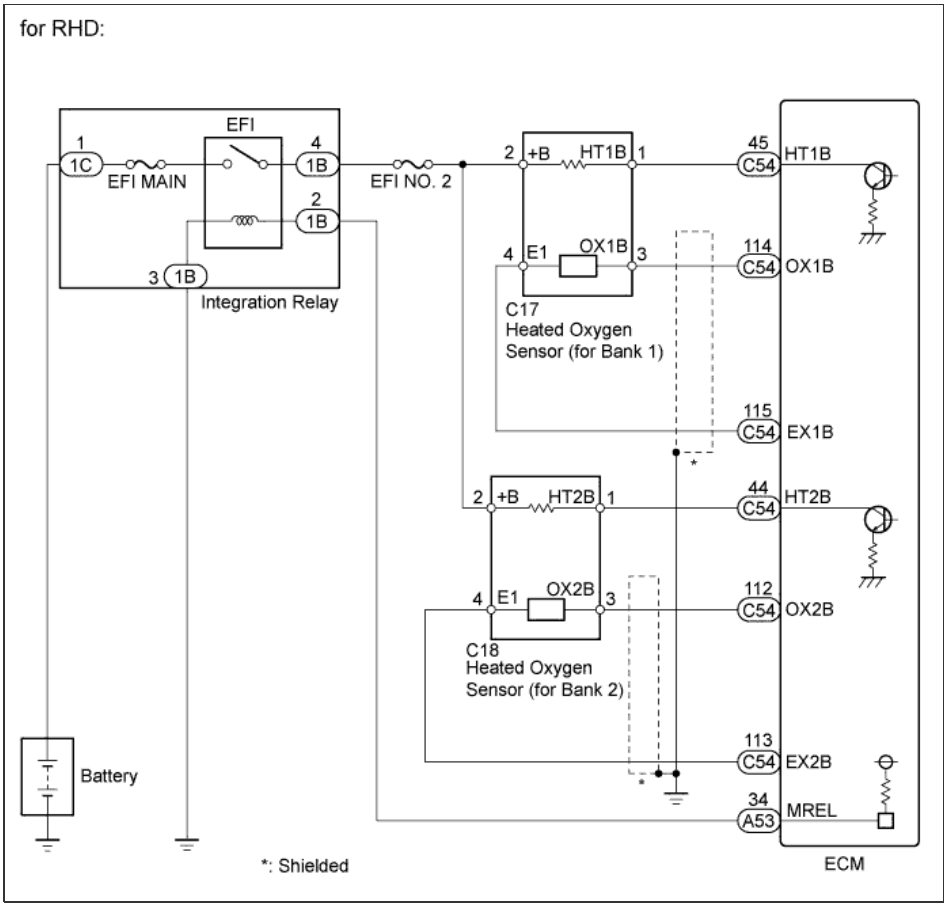
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





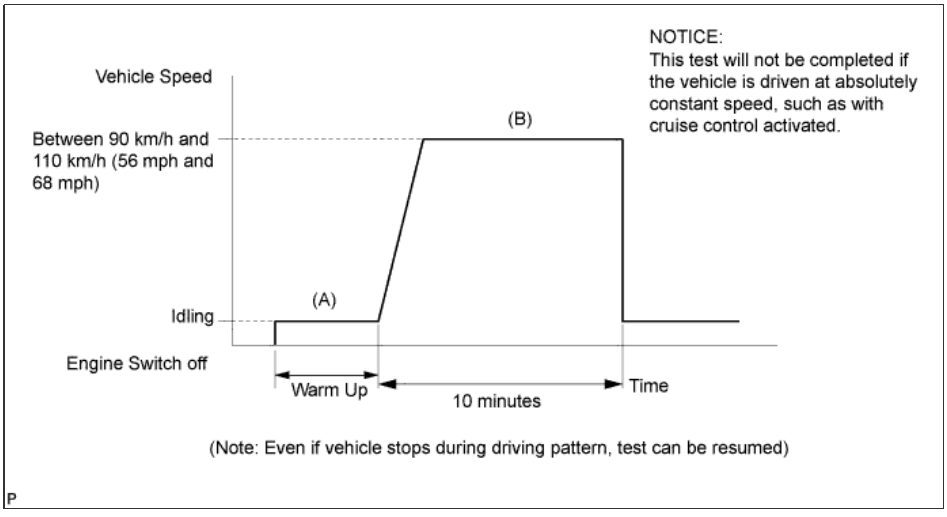
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

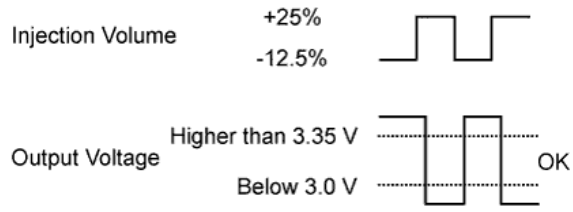
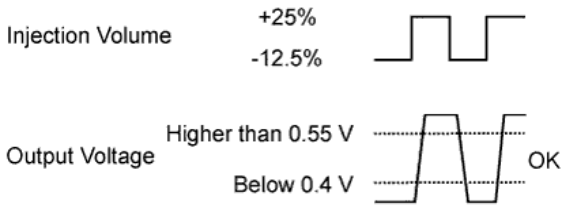
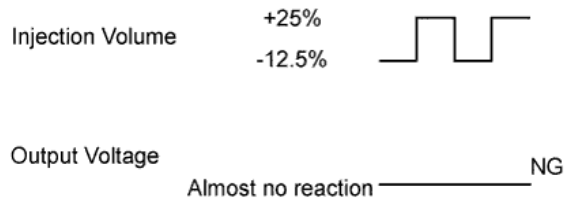
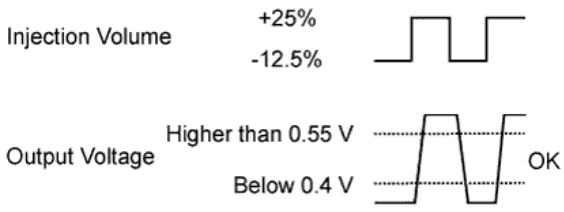
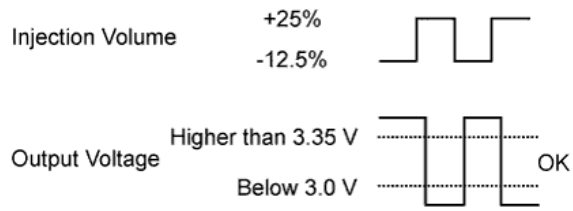
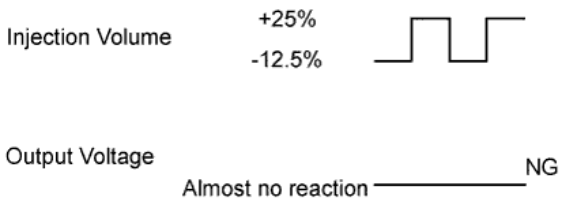
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

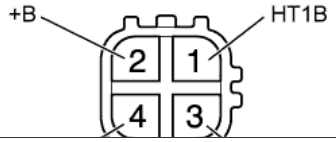
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

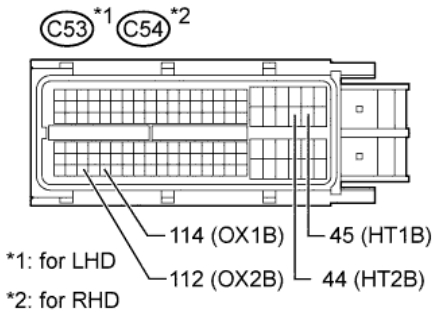
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

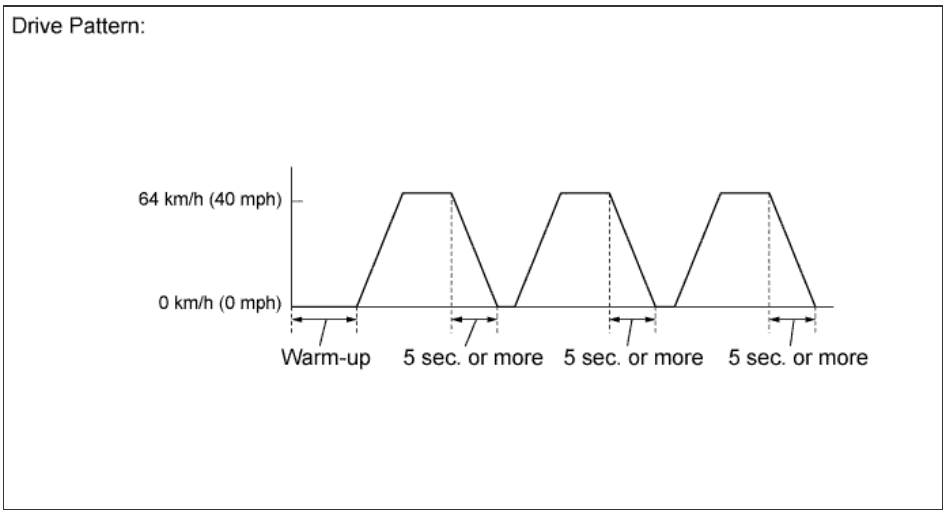
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

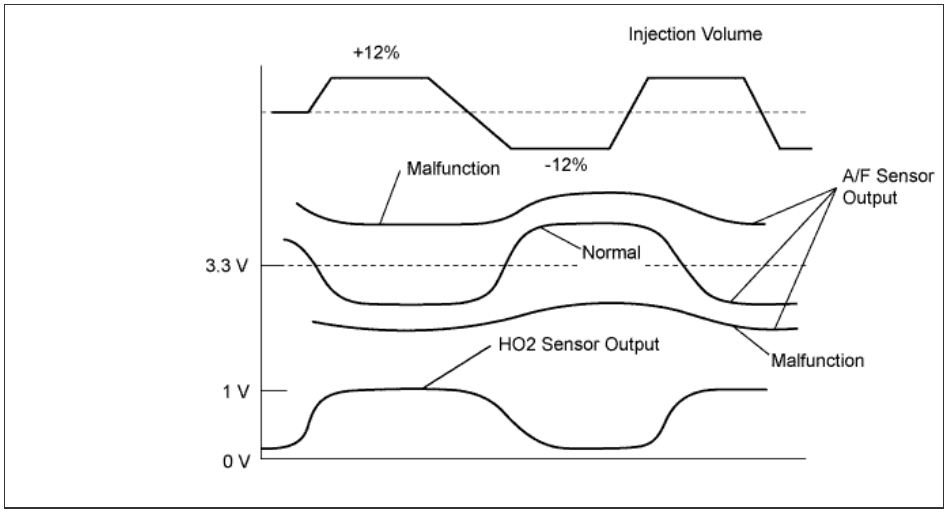
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

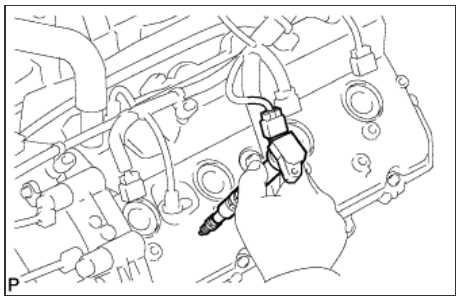
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

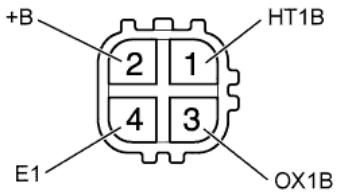
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

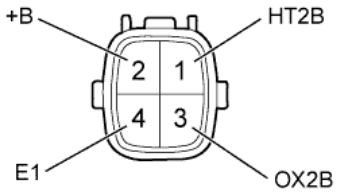
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

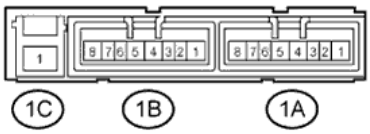
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

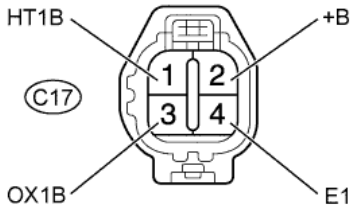
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

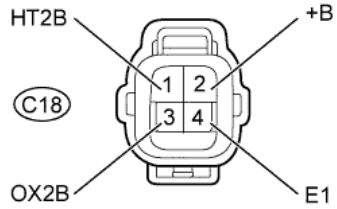
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

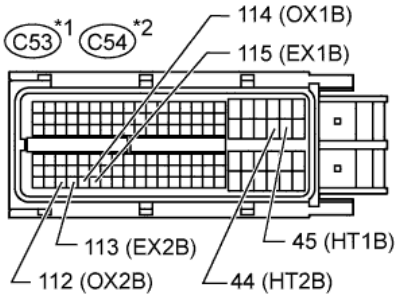
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



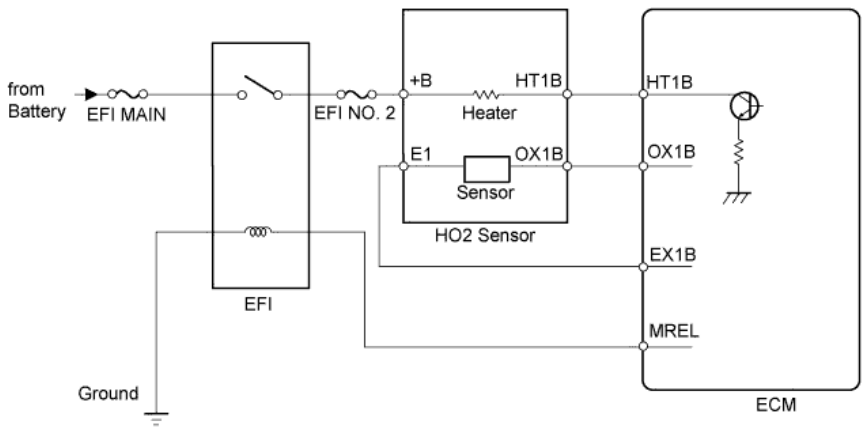
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

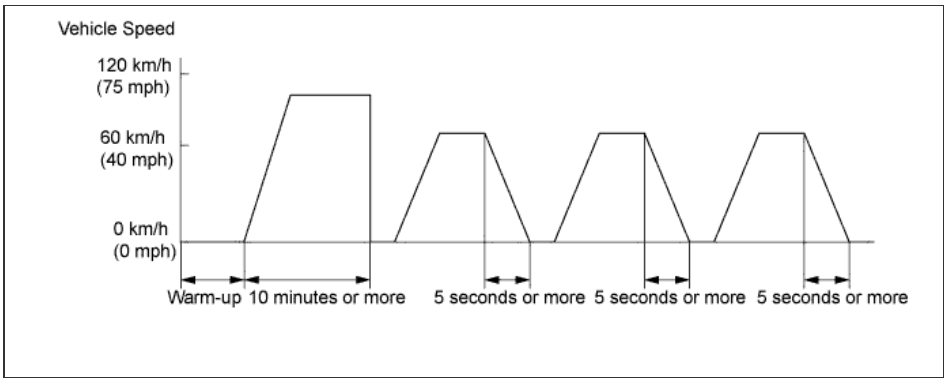
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

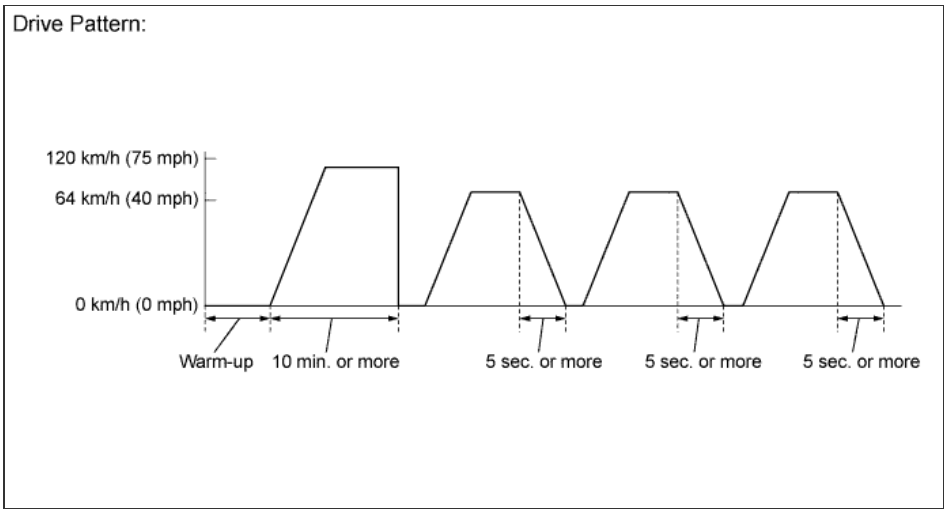
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

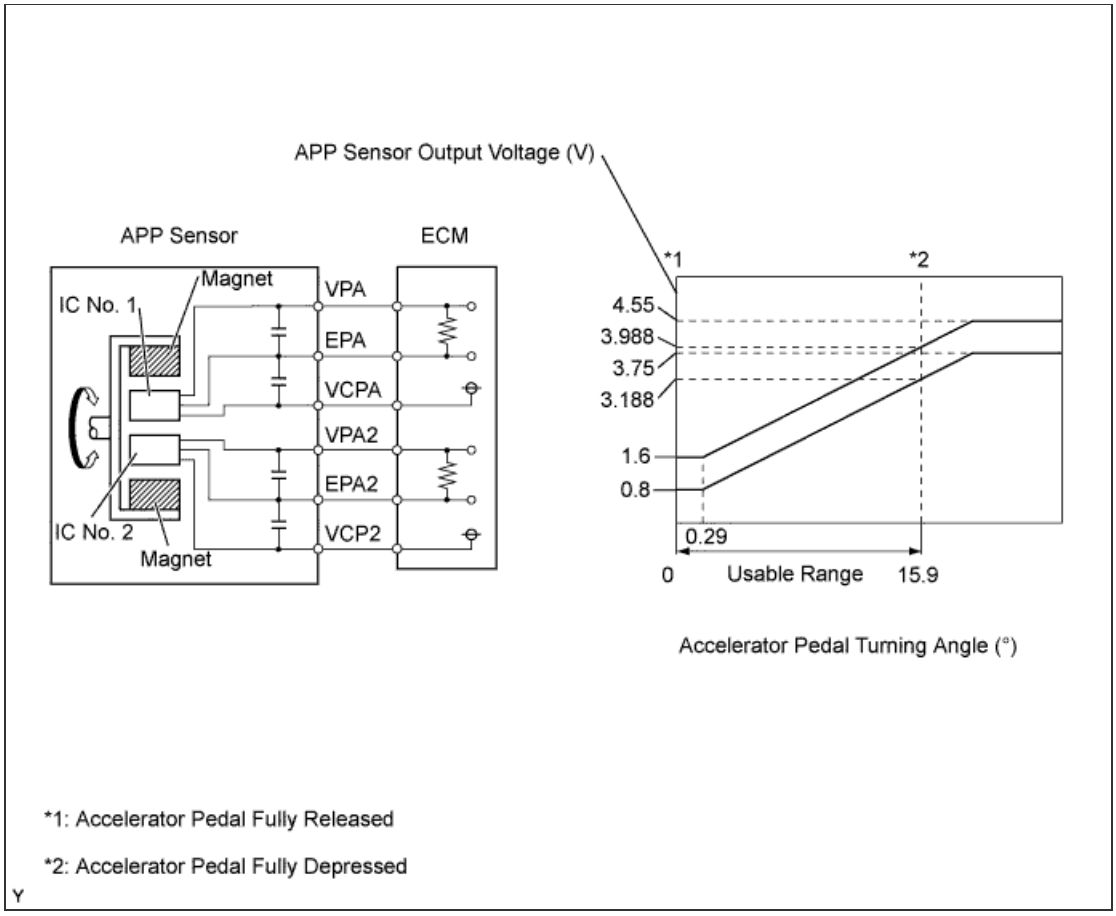
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

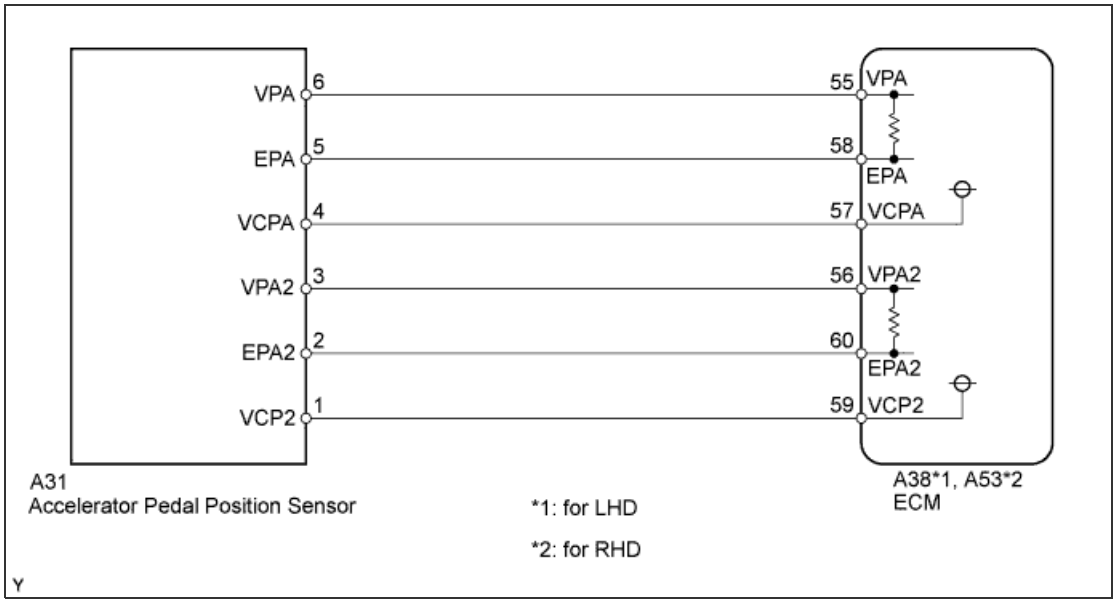
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

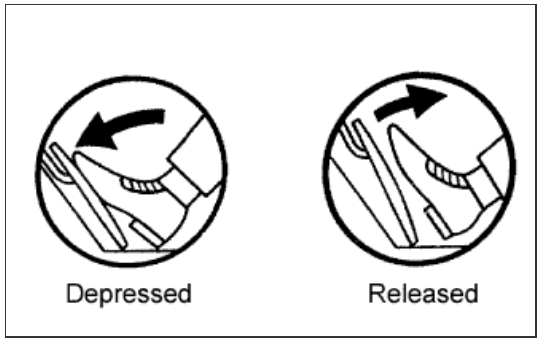
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

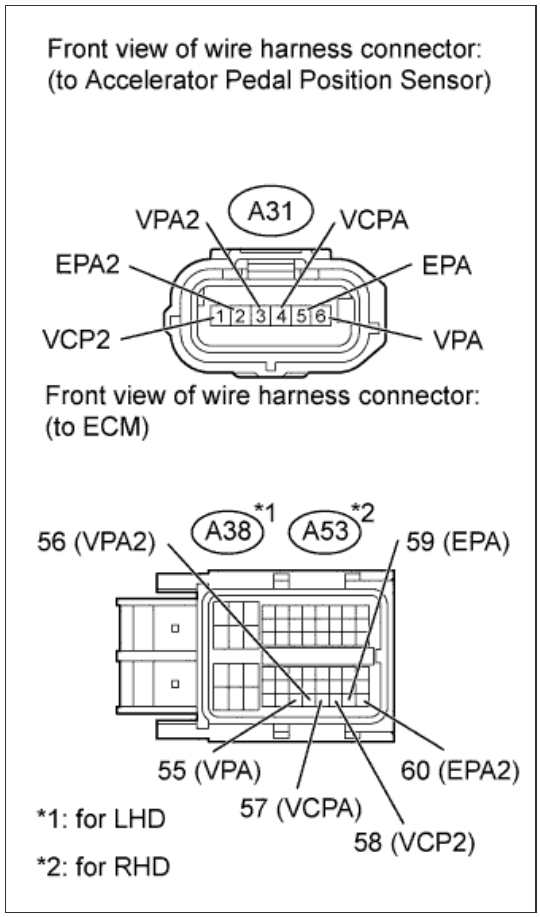
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

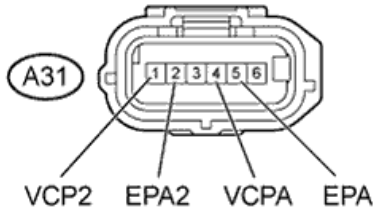
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

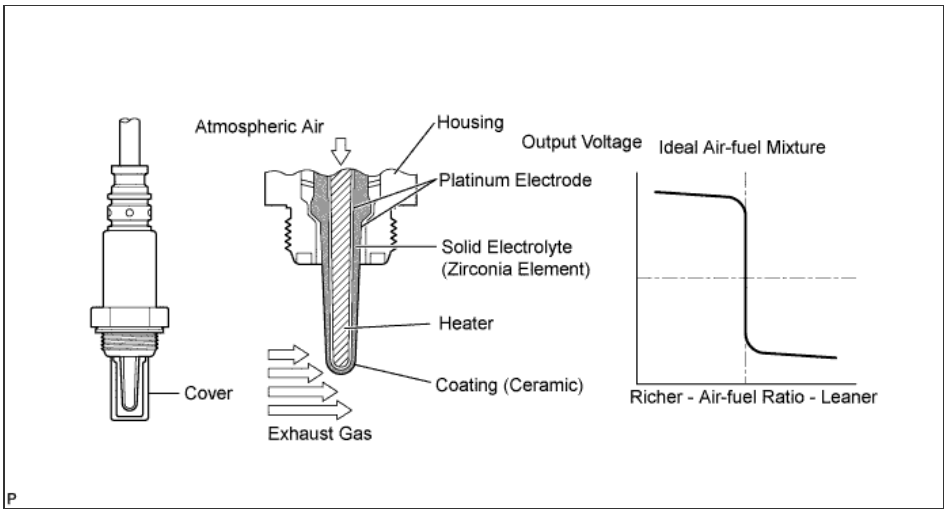
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

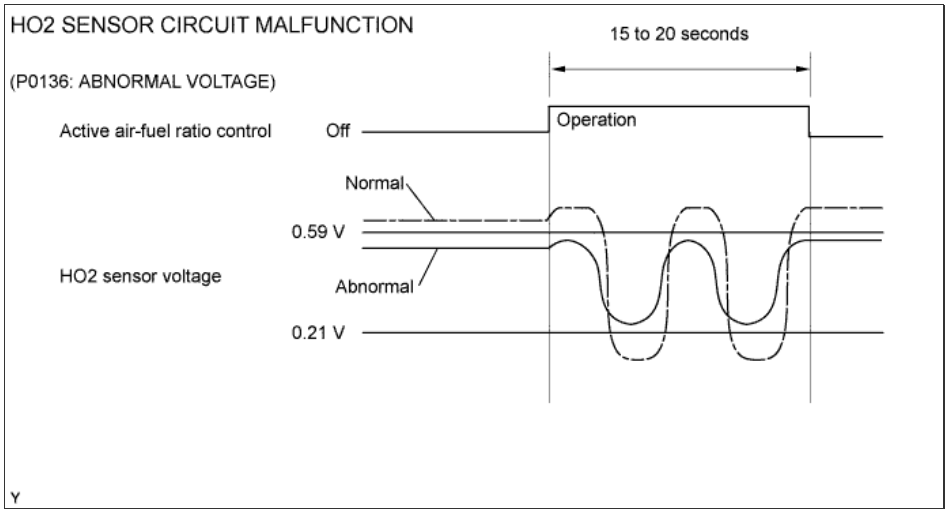
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

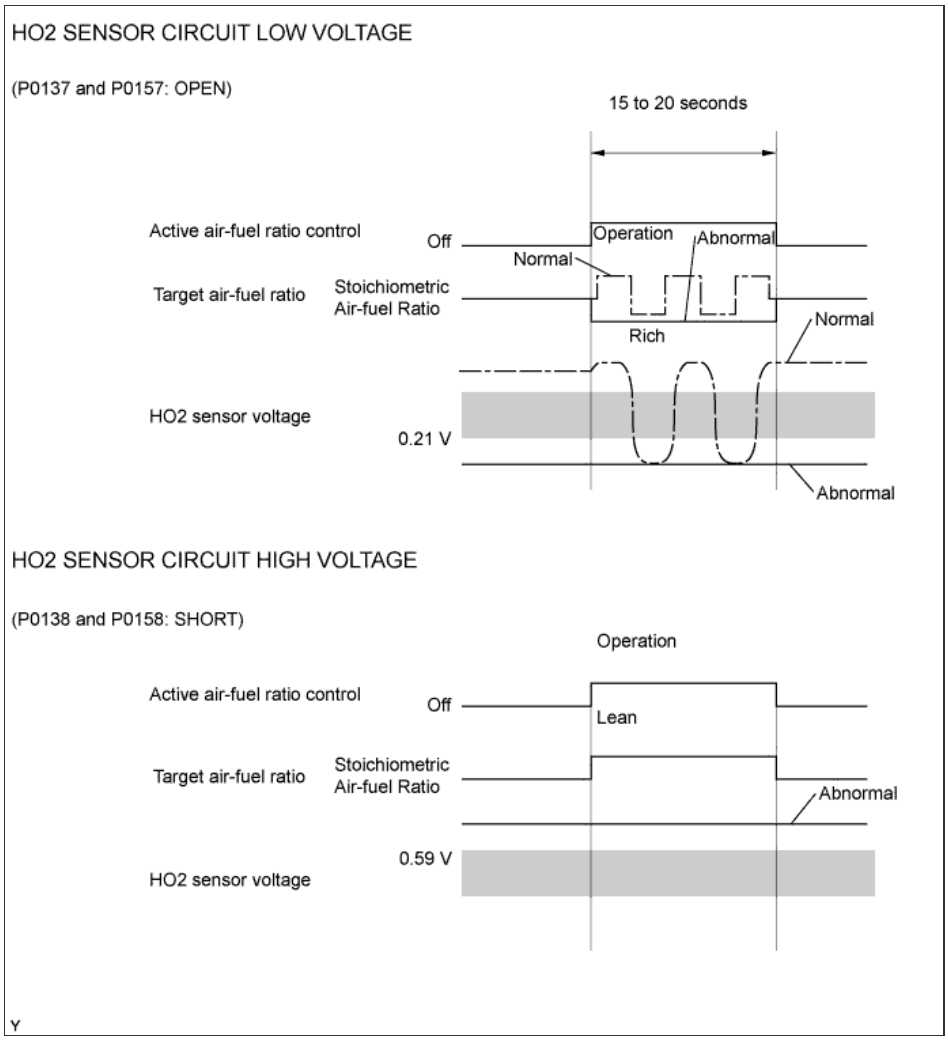
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

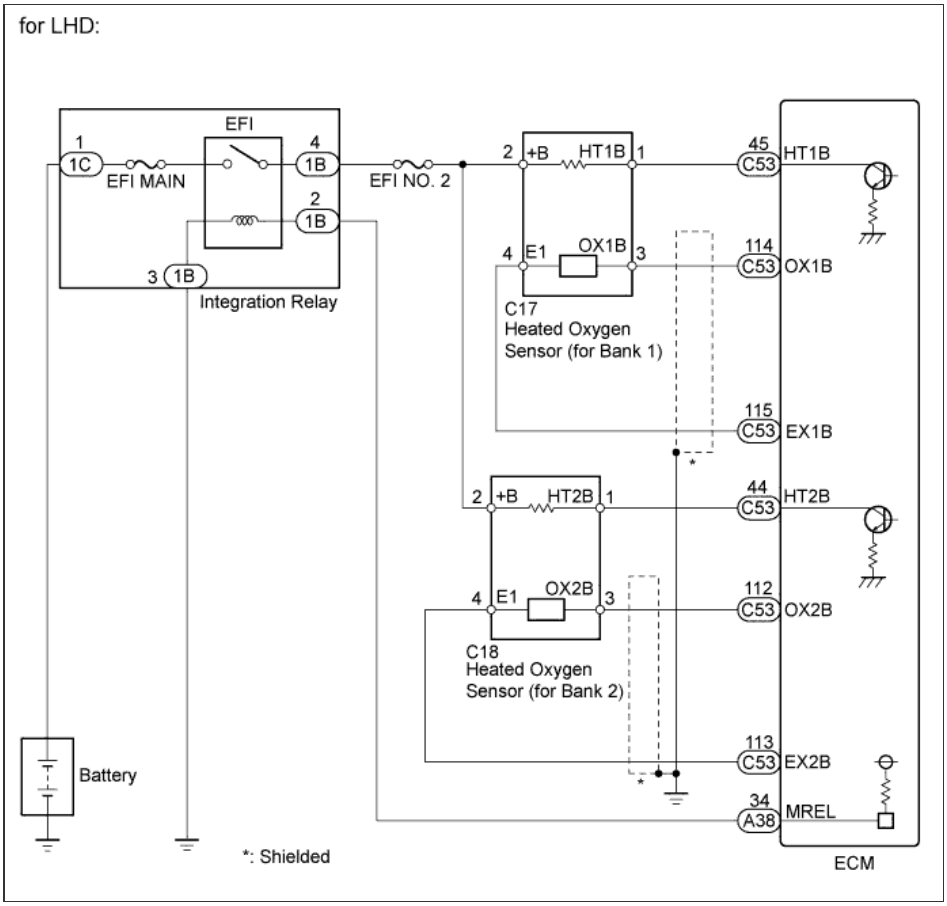
HINT:

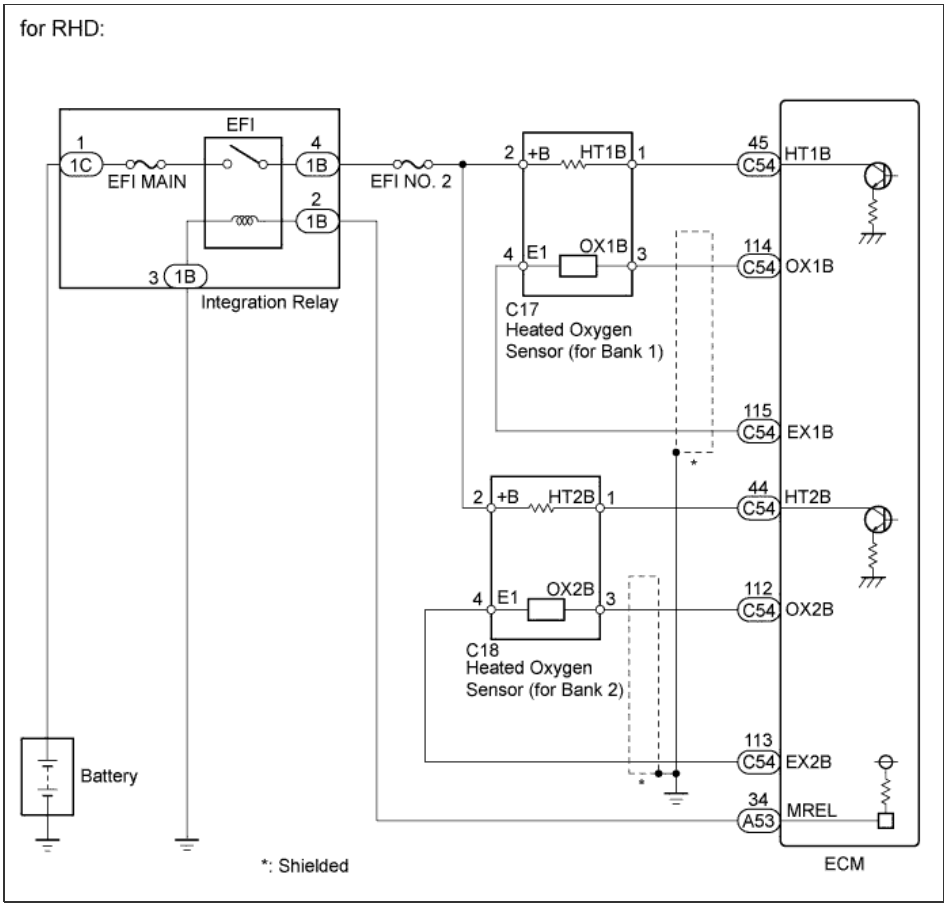
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





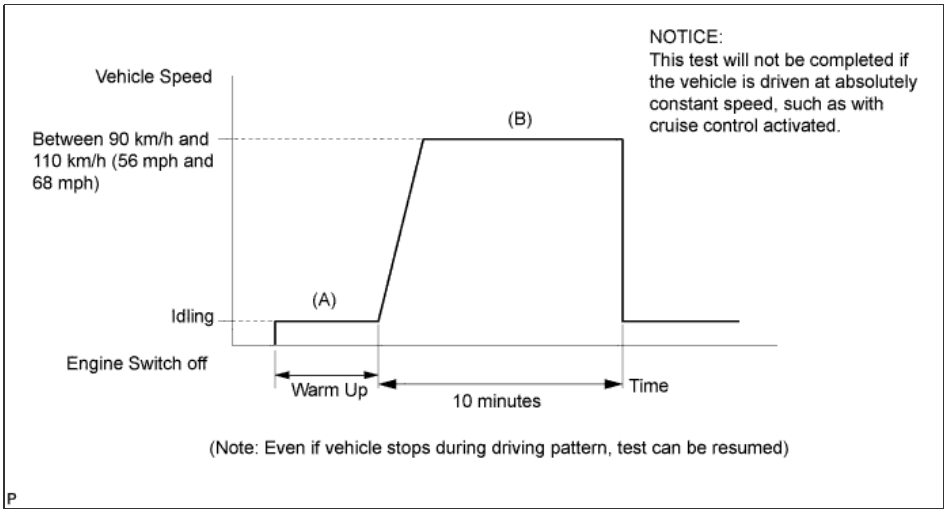
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

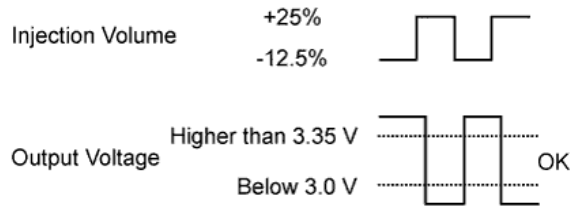
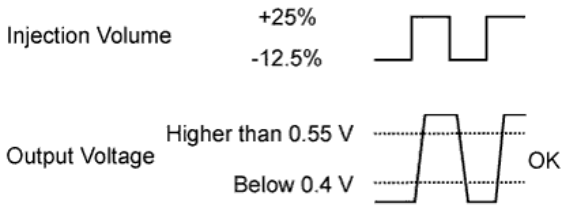
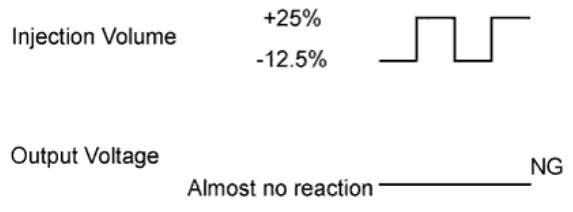
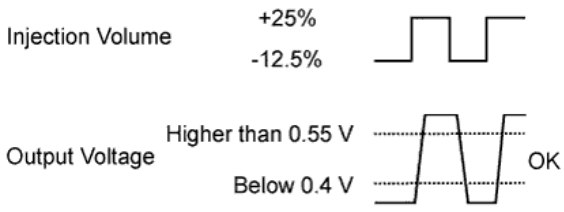
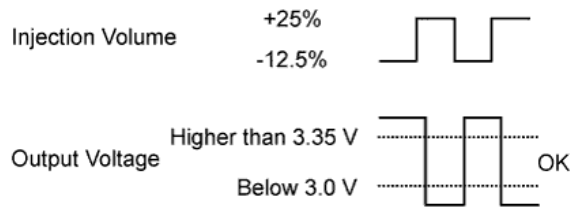
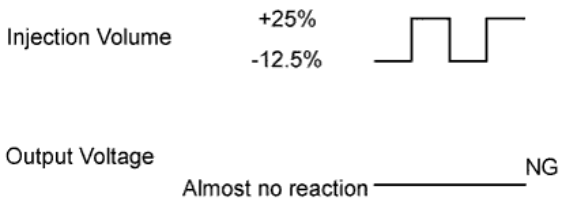
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

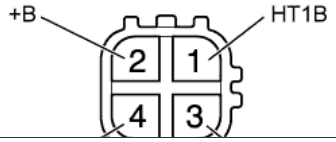
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

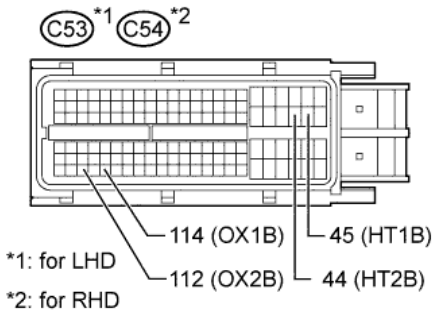
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

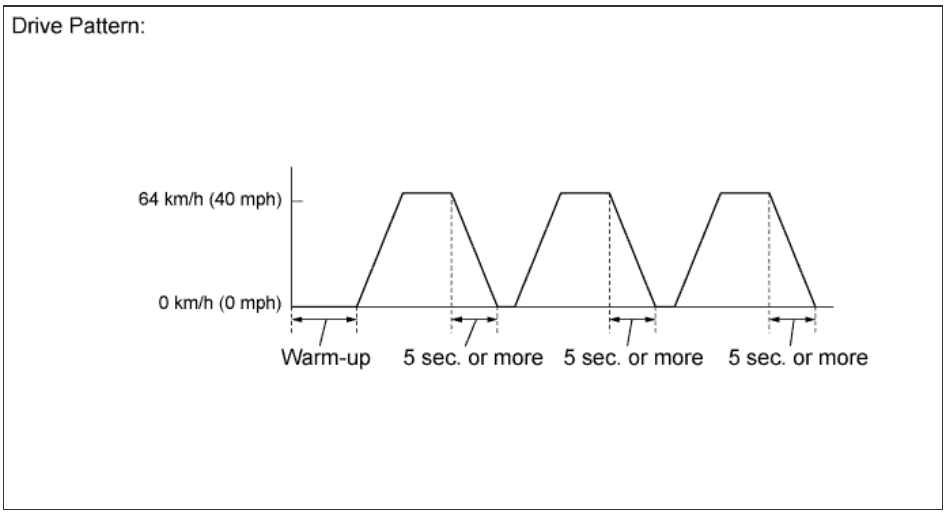
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

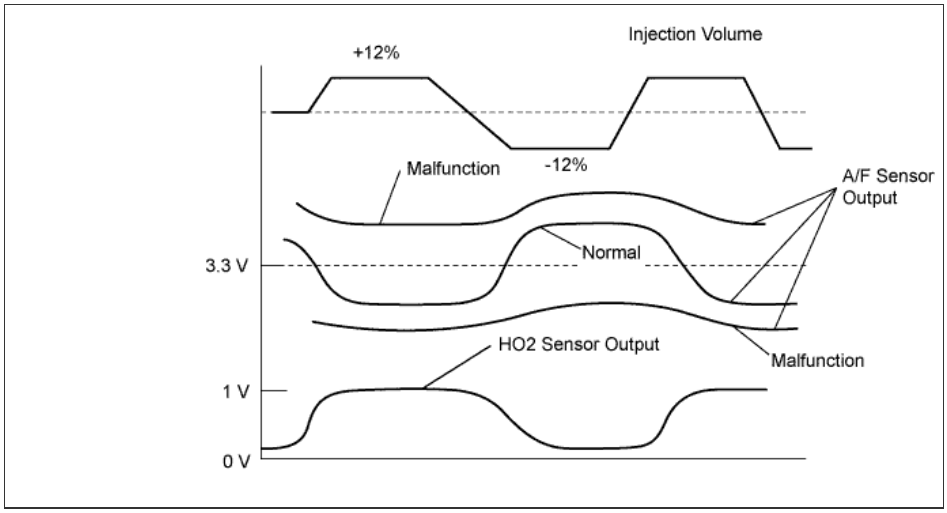
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

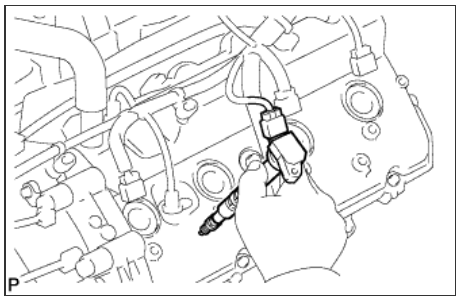
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

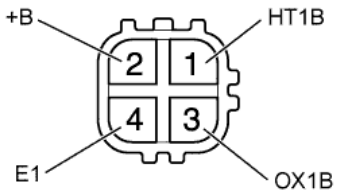
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

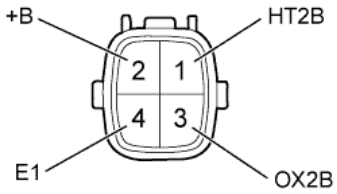
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

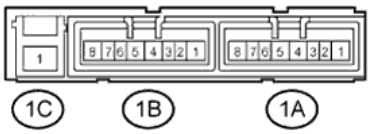
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

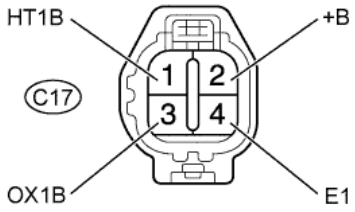
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

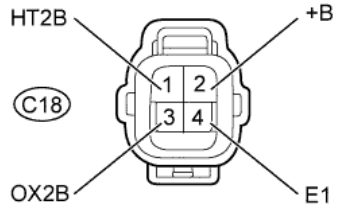
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

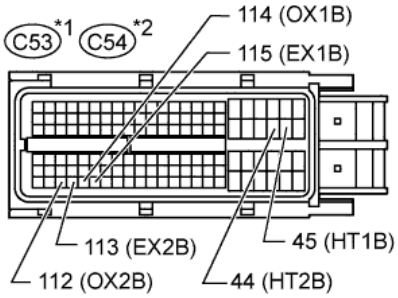
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



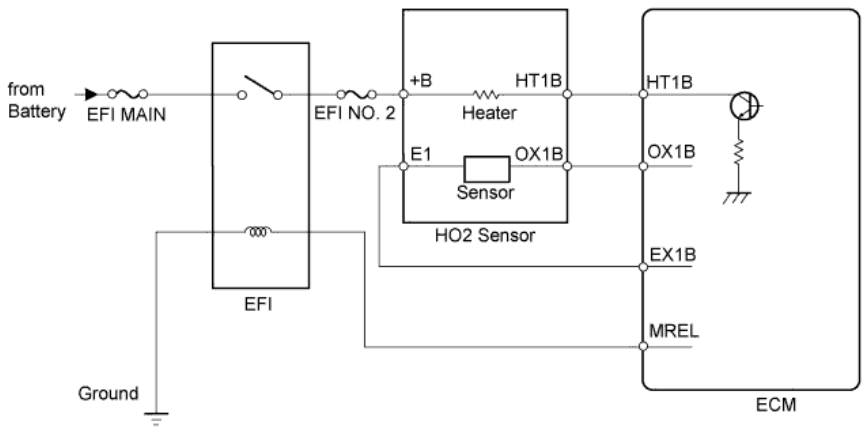
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

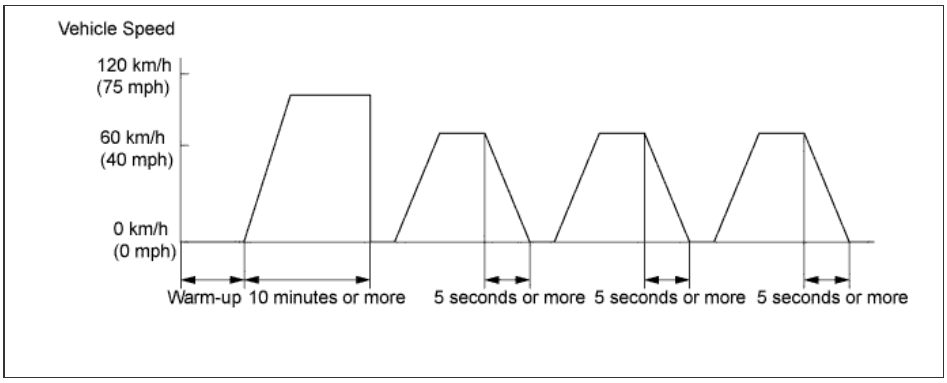
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

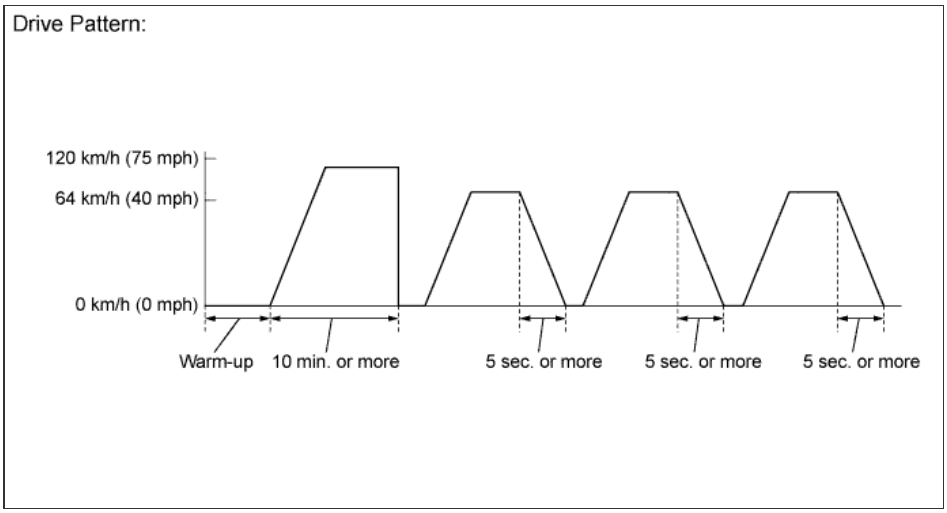
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

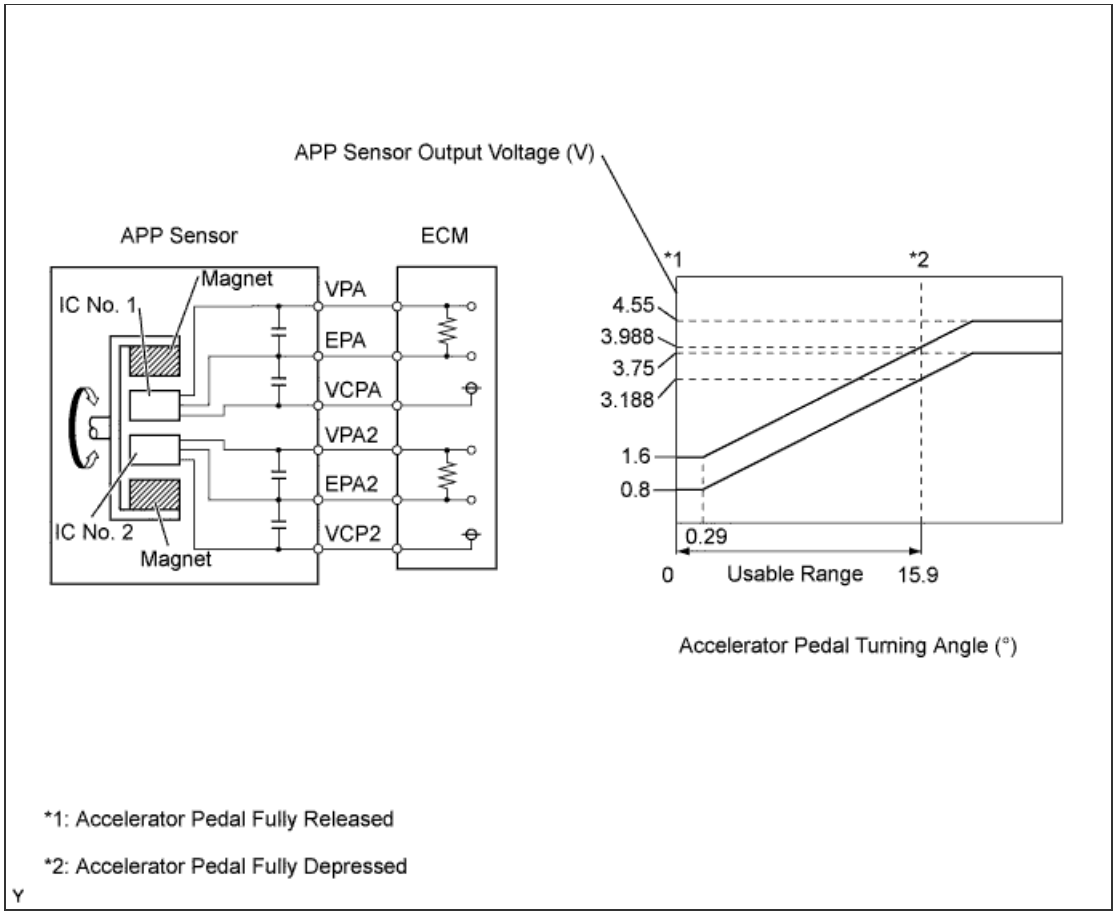
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

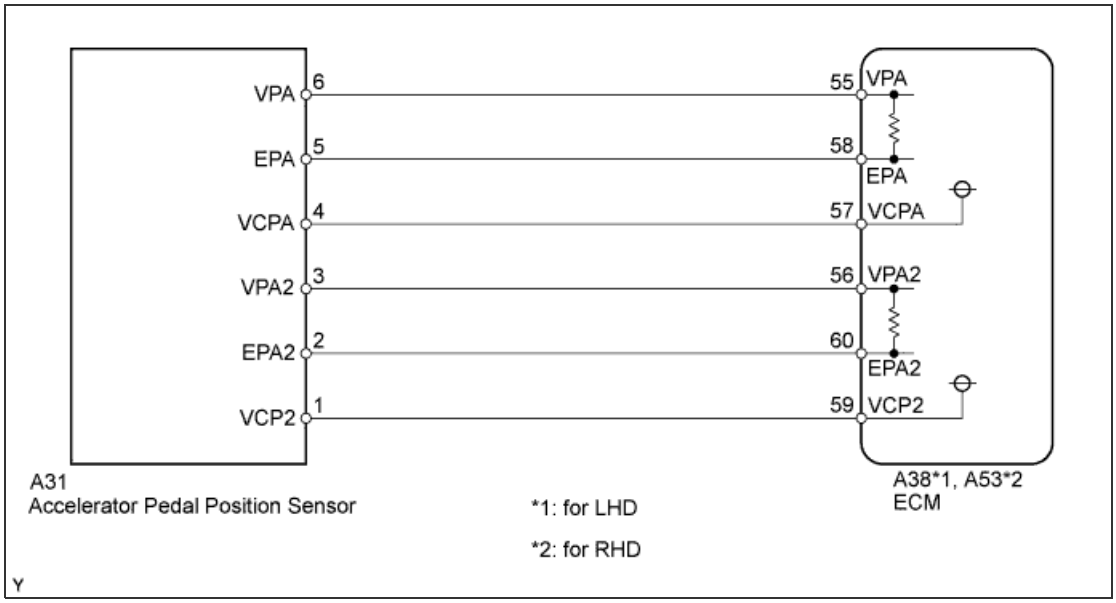
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

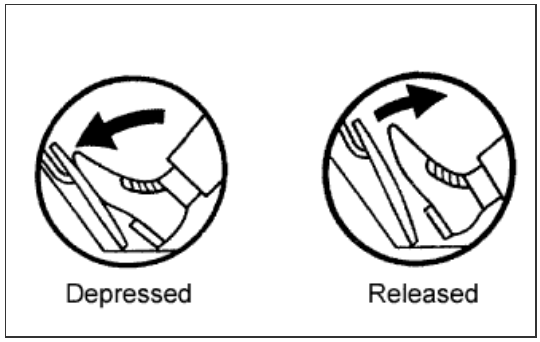
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

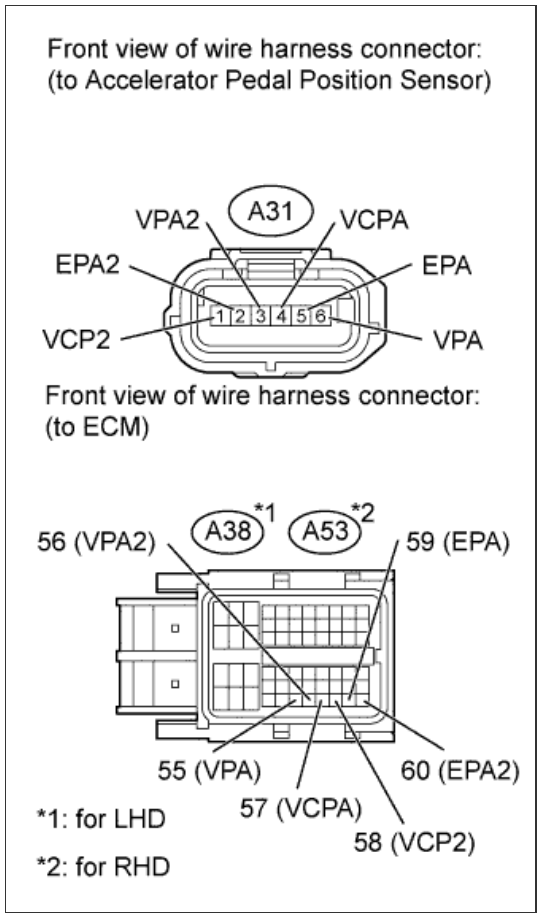
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

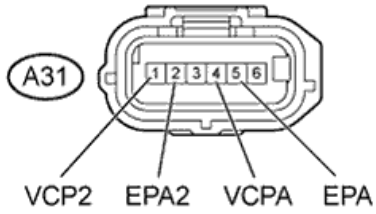
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

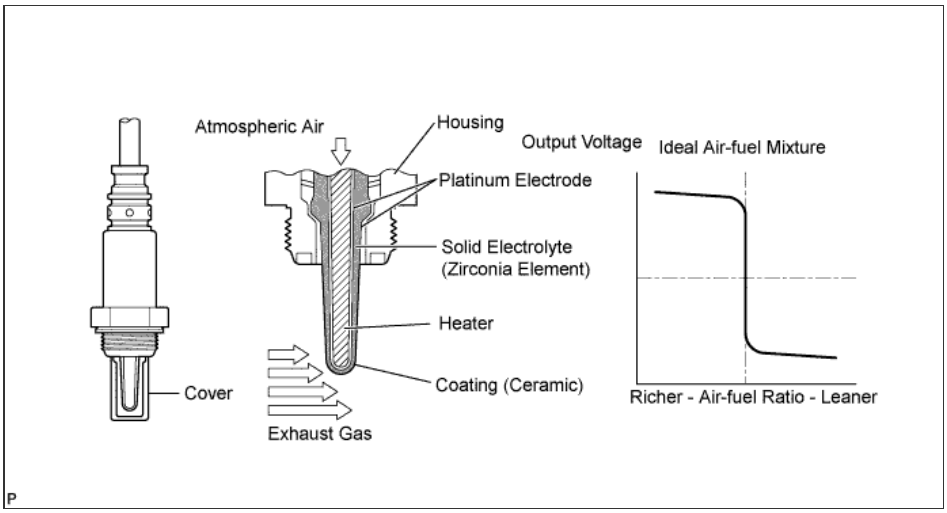
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

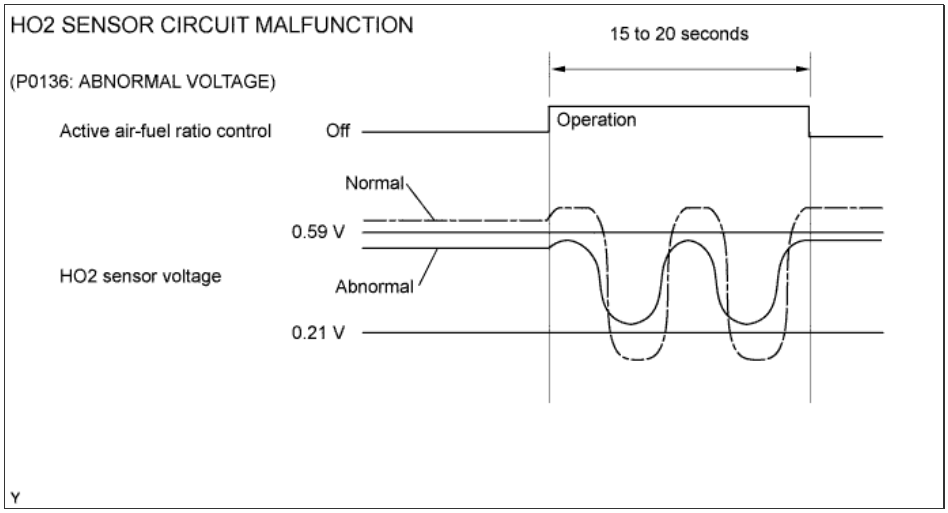
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

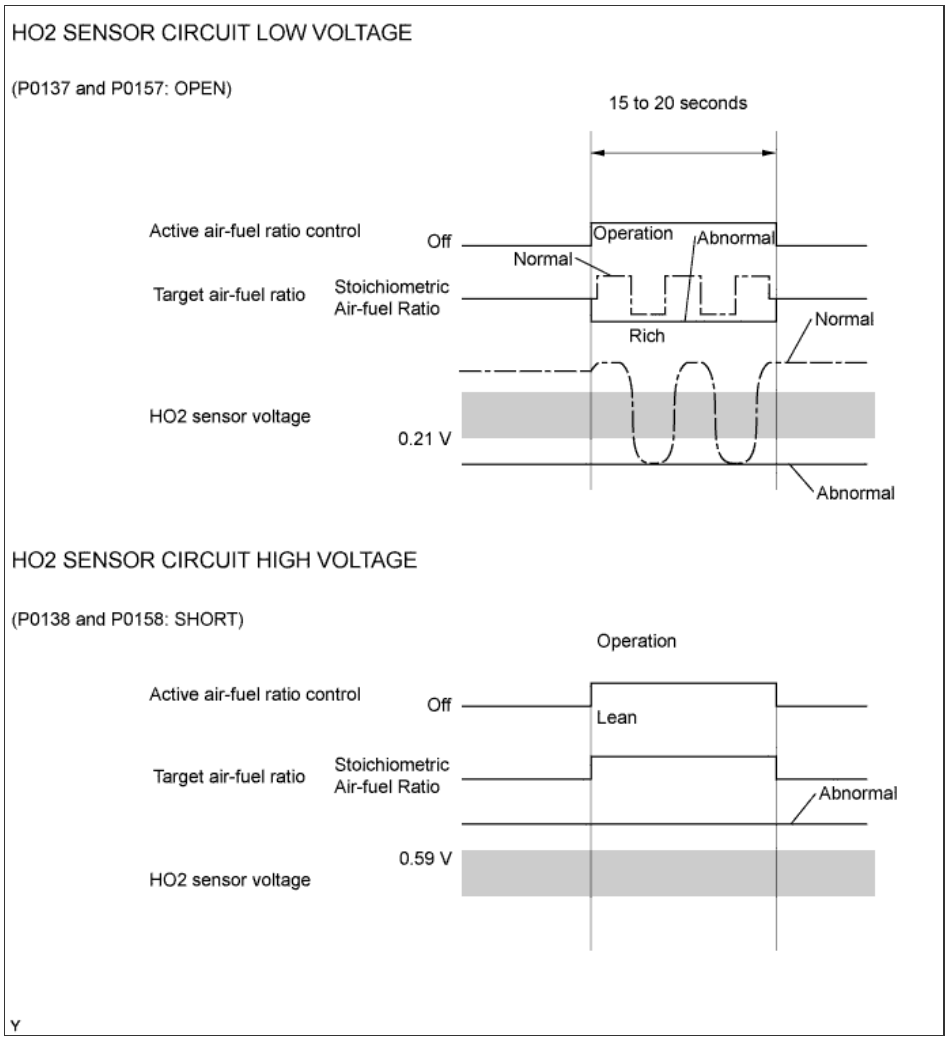
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

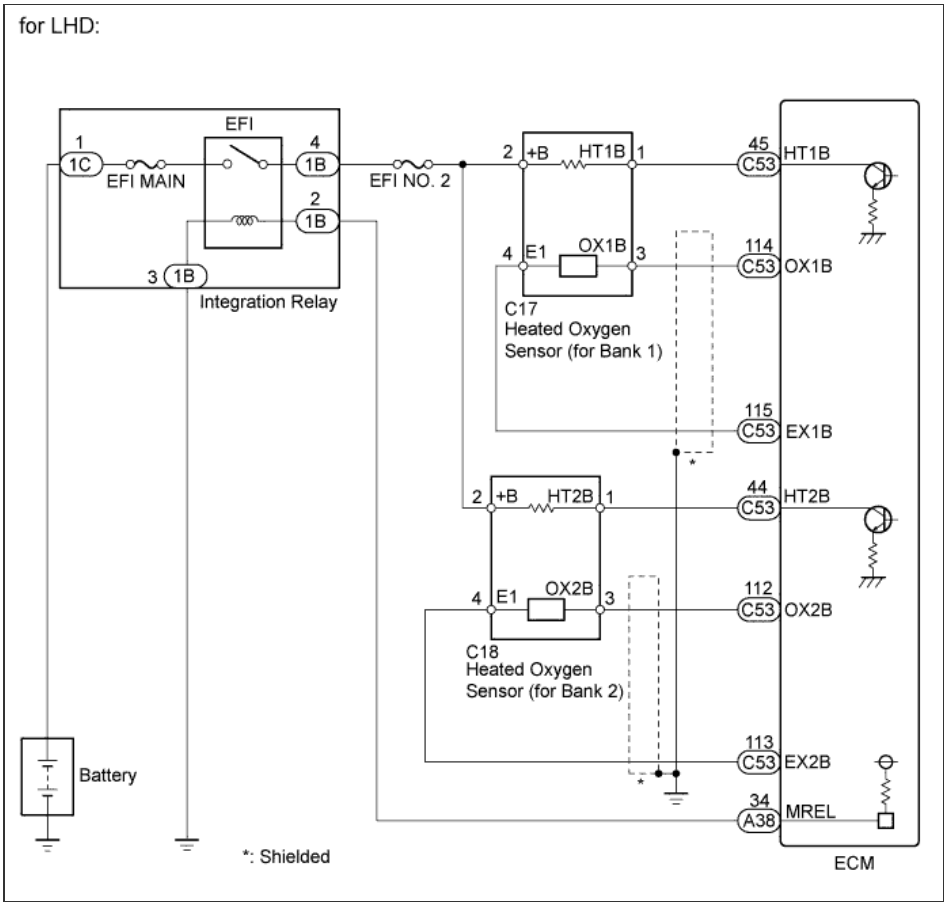
HINT:

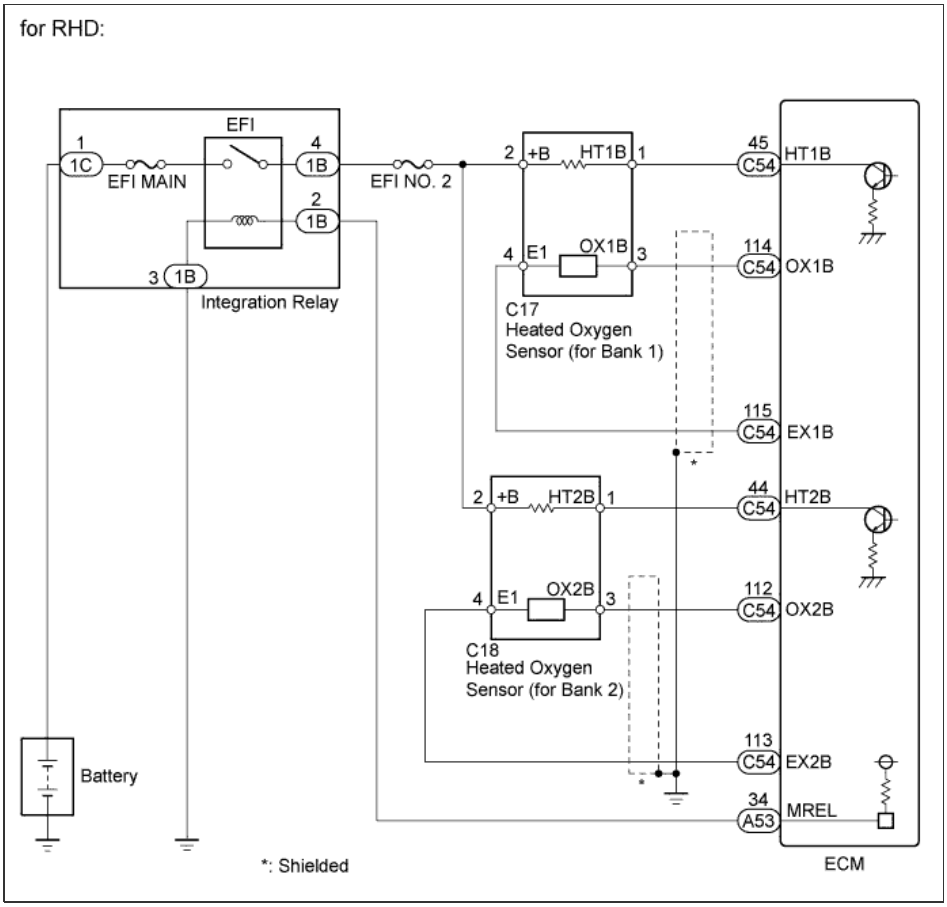
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





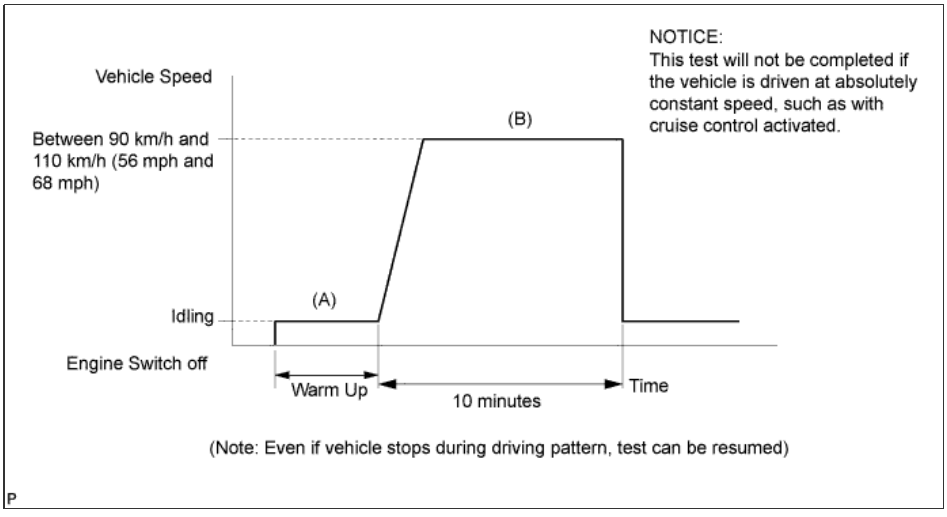
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

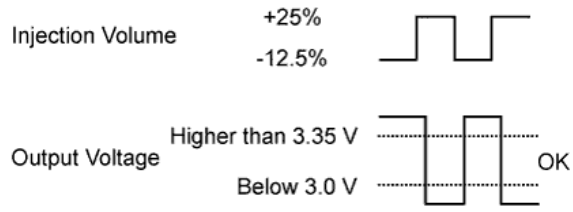
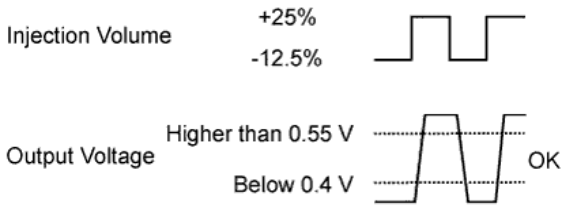
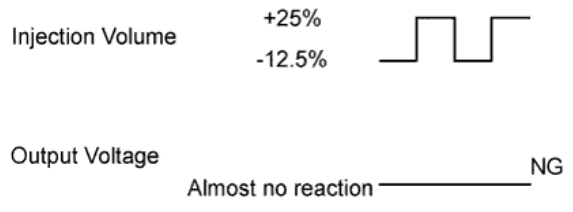
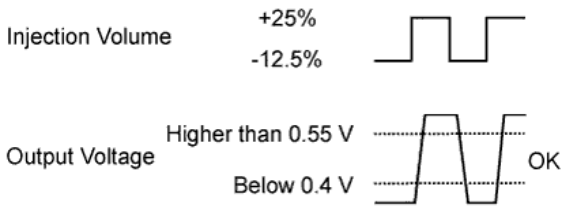
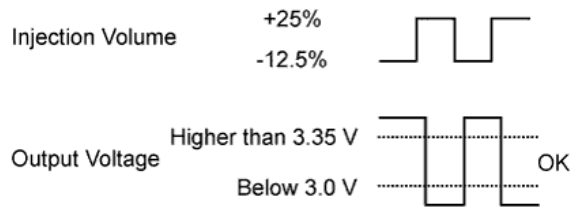
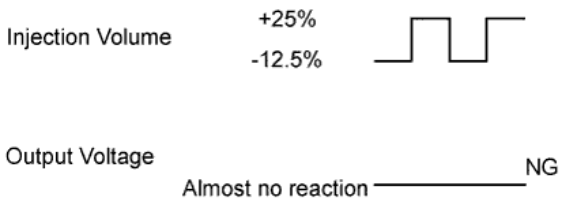
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

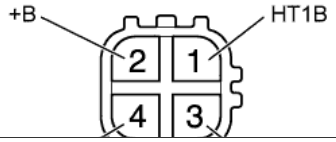
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

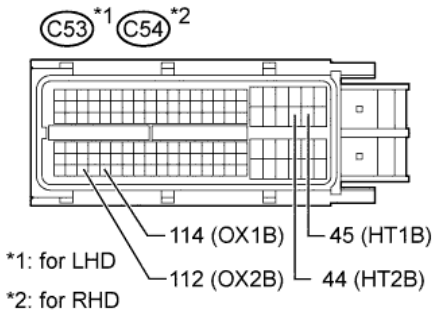
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

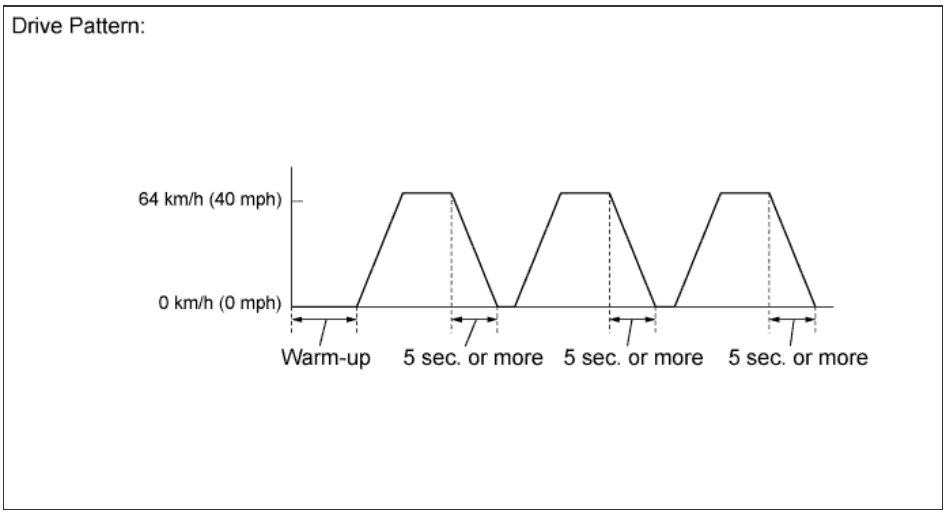
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

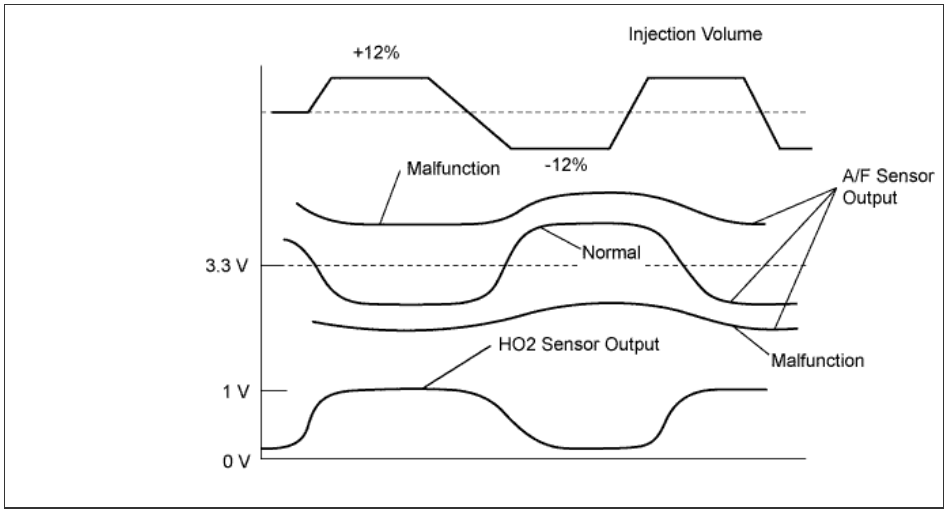
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

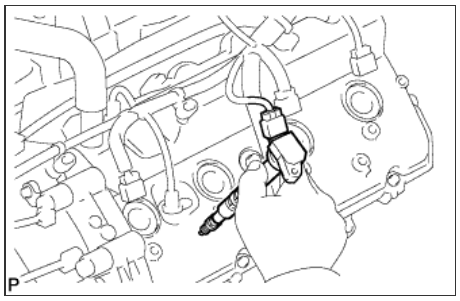
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

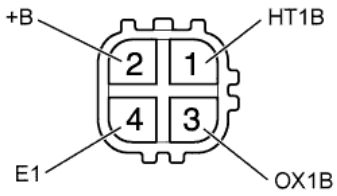
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

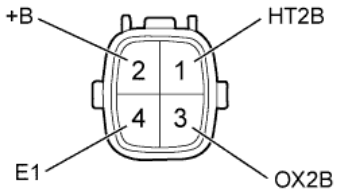
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

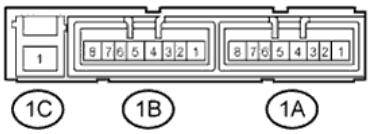
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

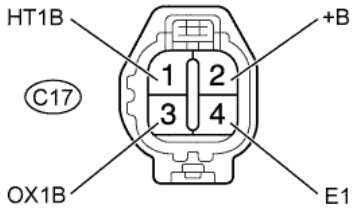
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

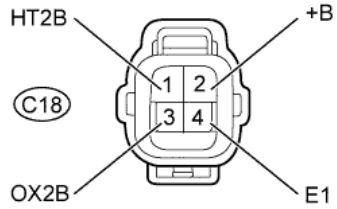
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

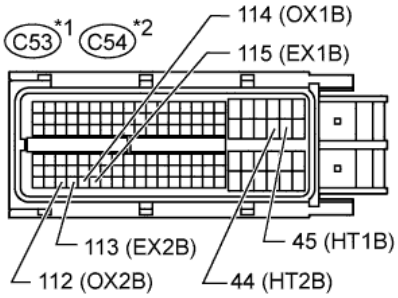
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



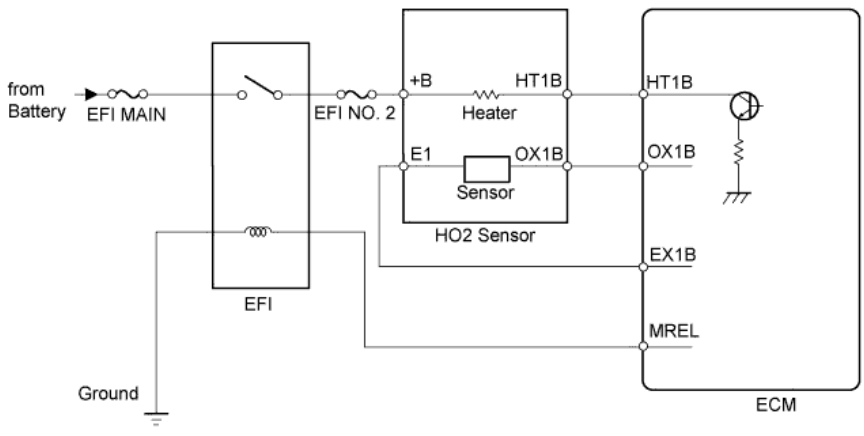
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

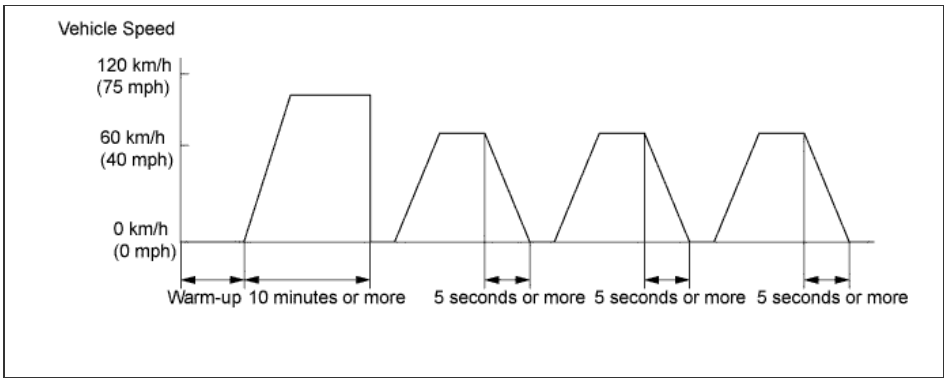
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

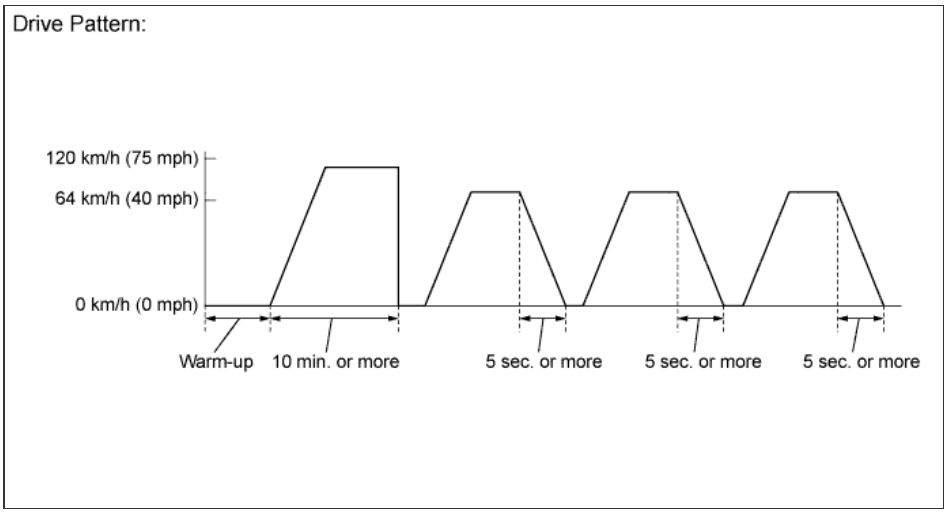
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

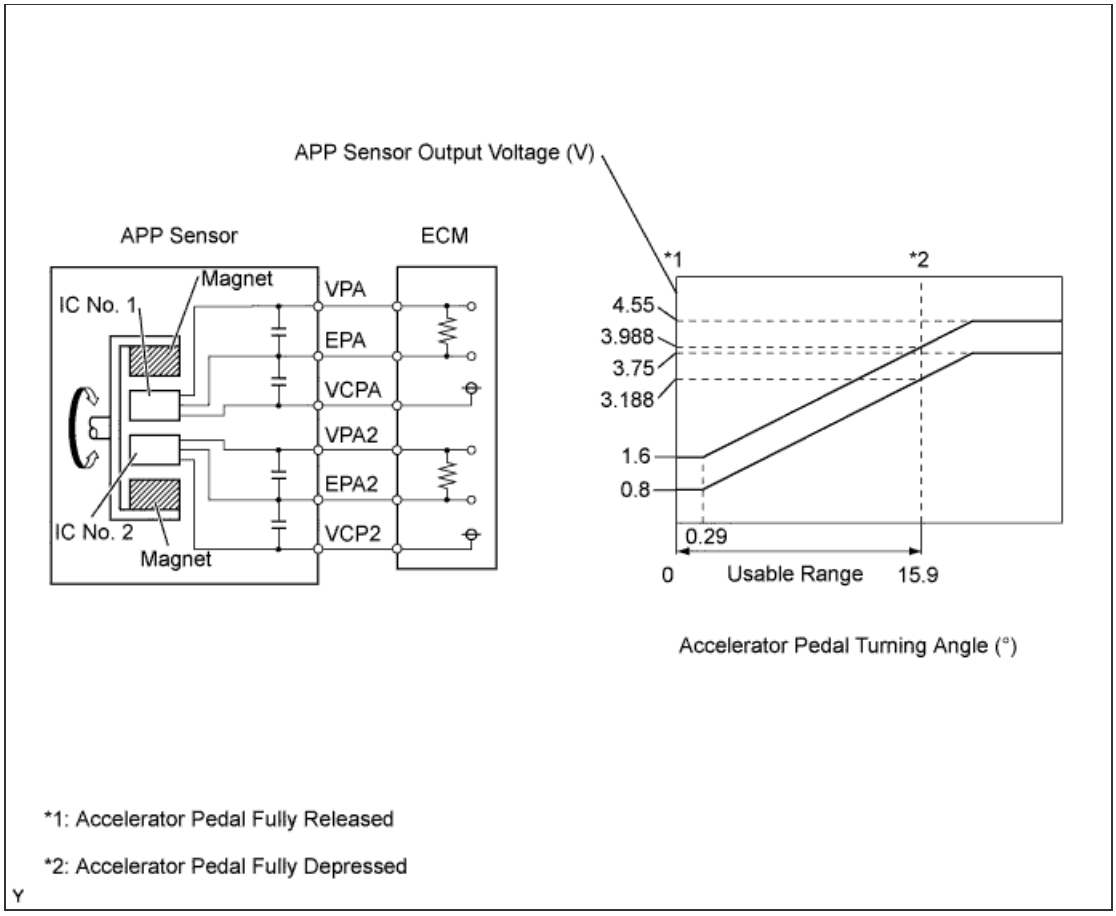
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

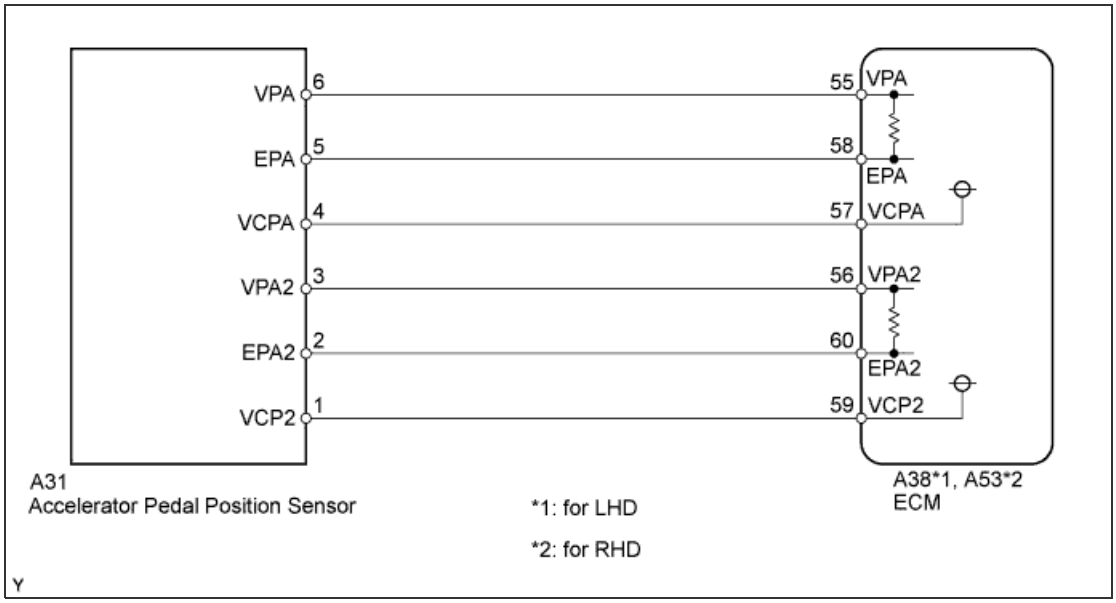
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

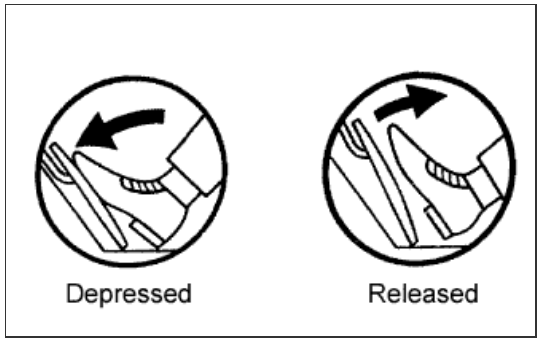
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

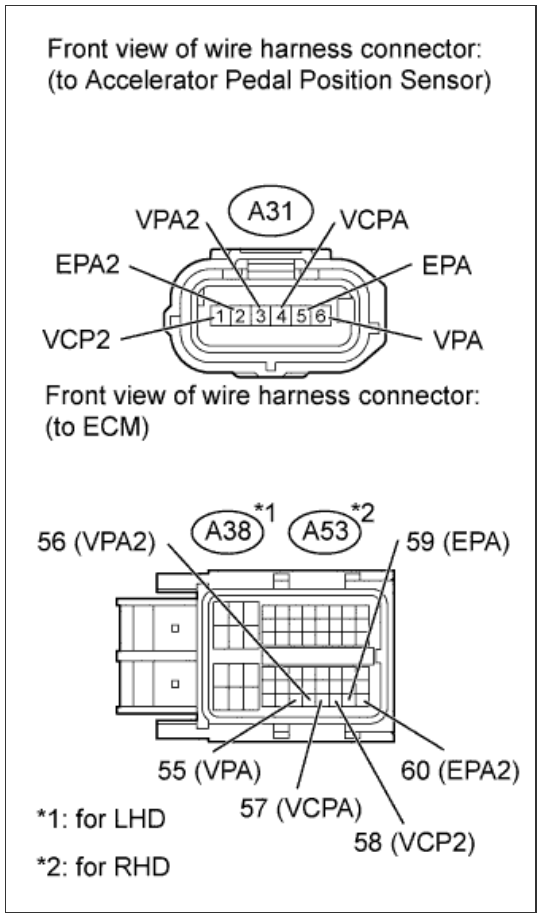
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

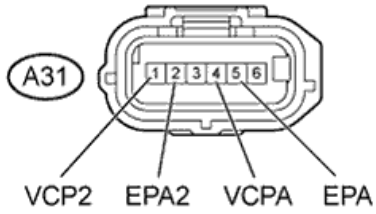
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

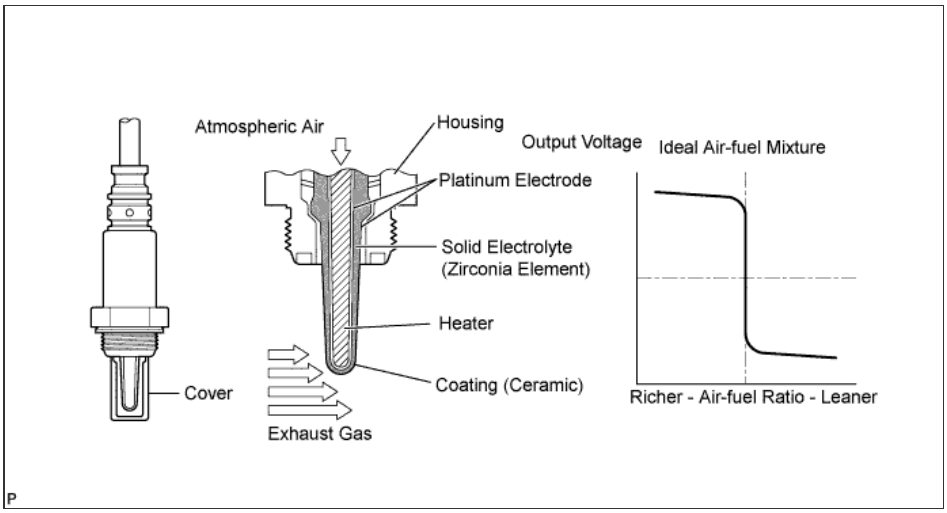
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

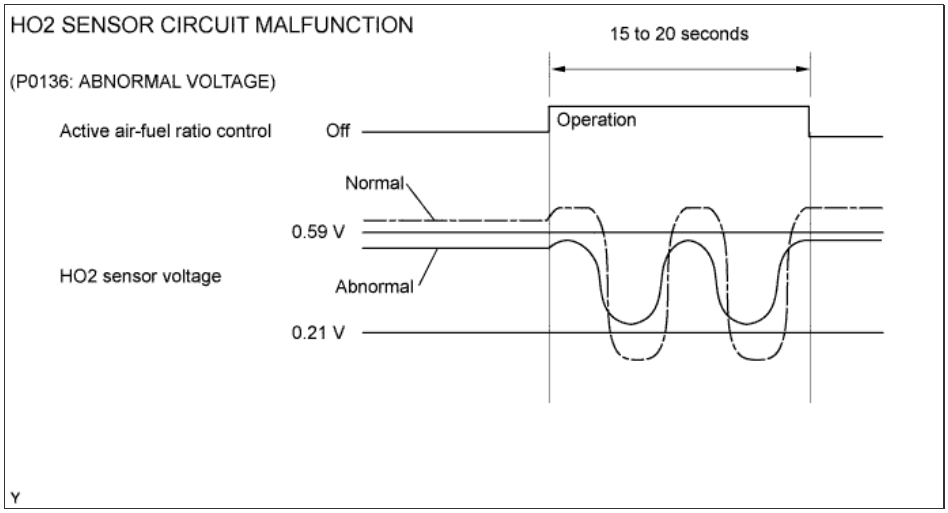
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

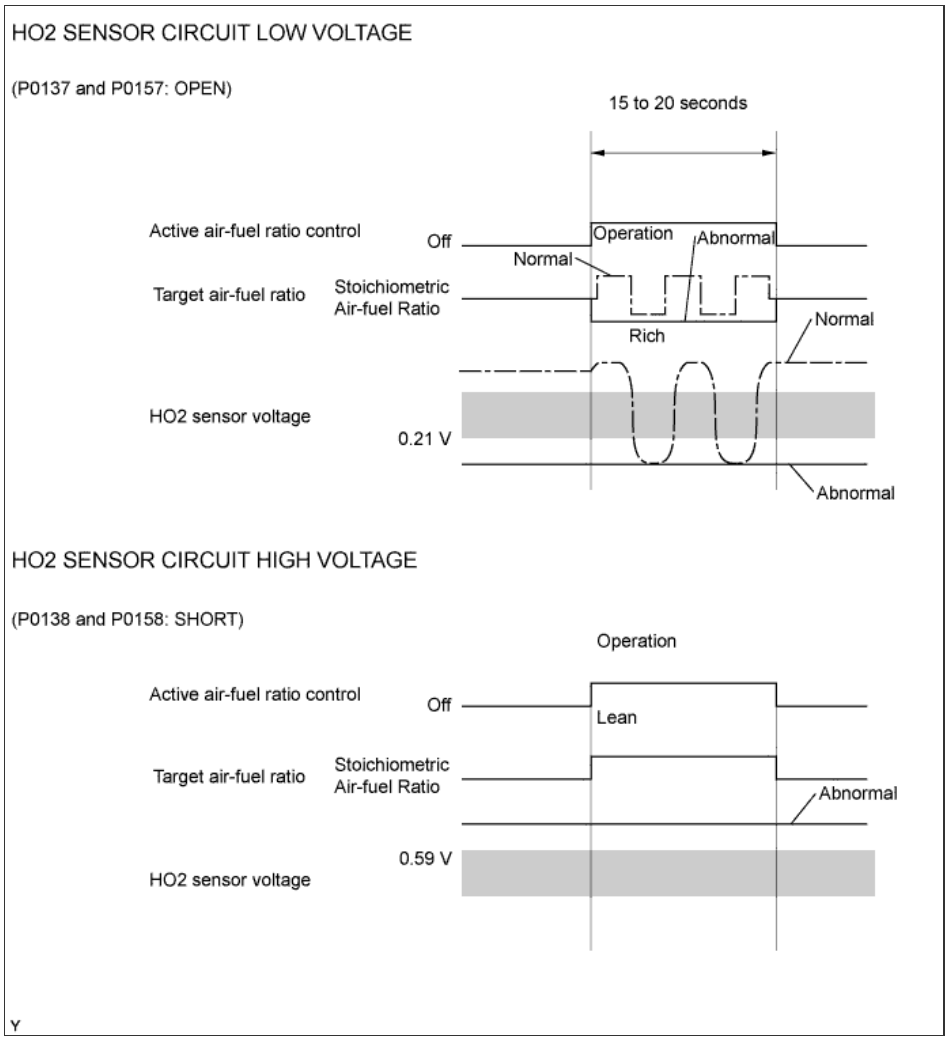
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

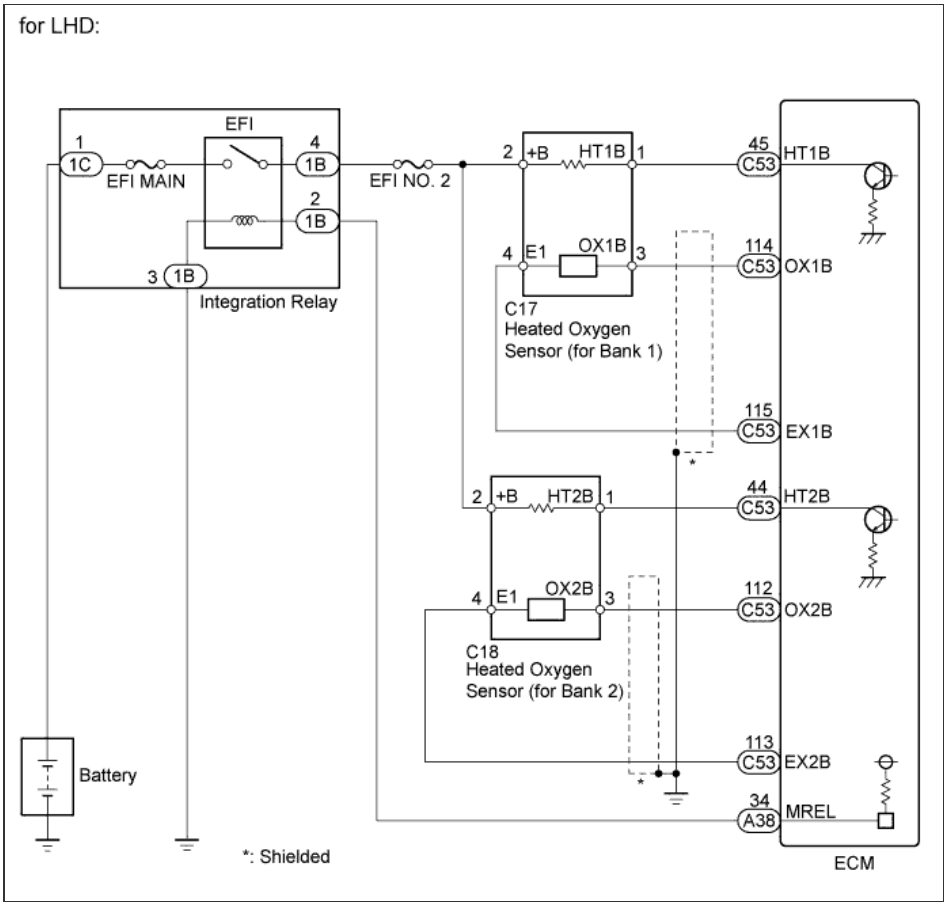
HINT:

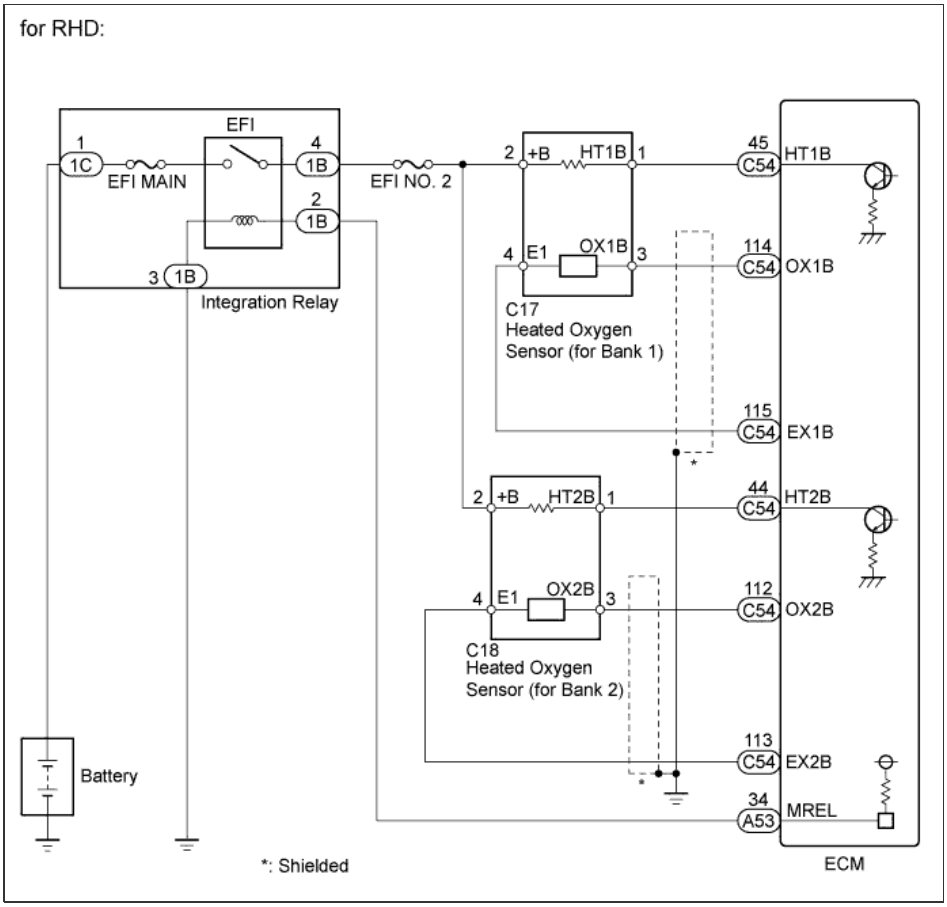
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





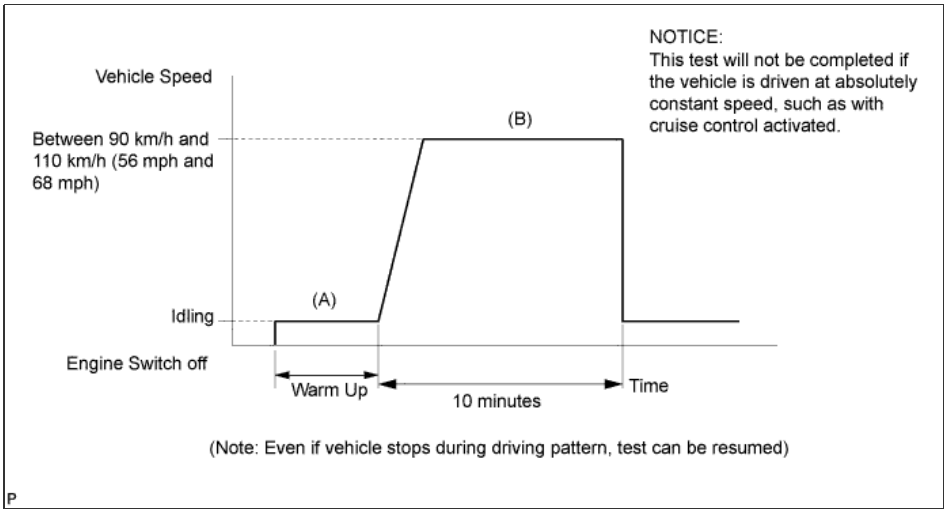
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

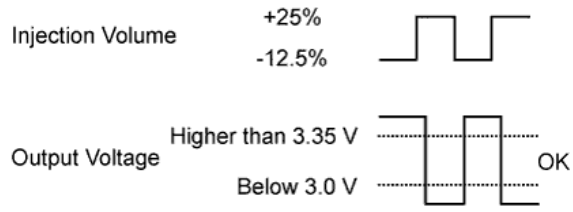
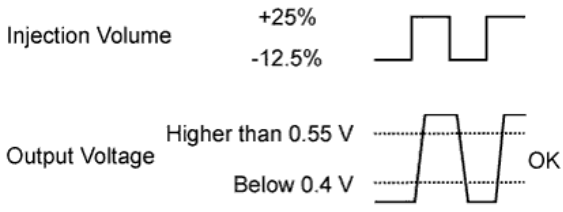
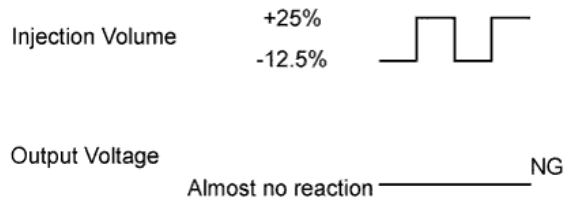
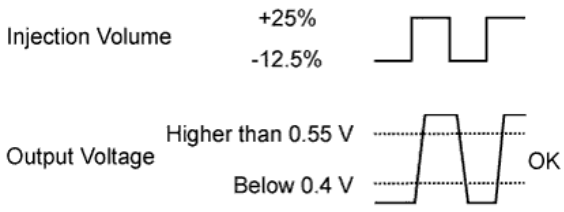
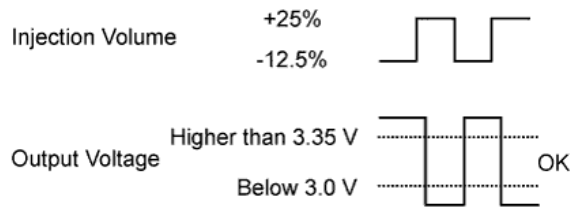
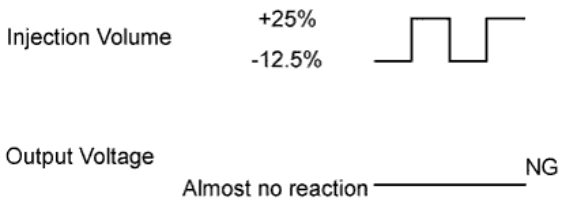
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

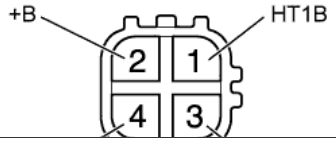
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

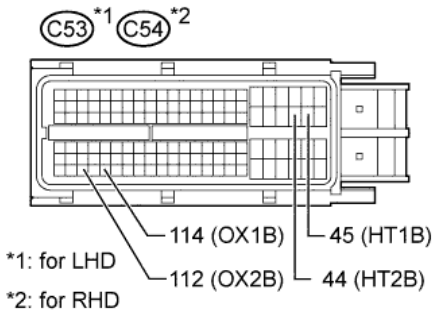
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

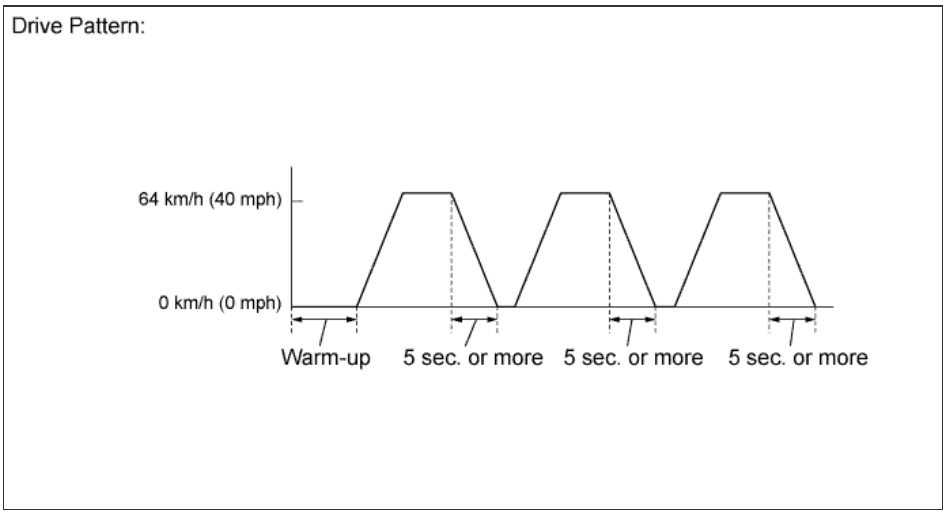
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

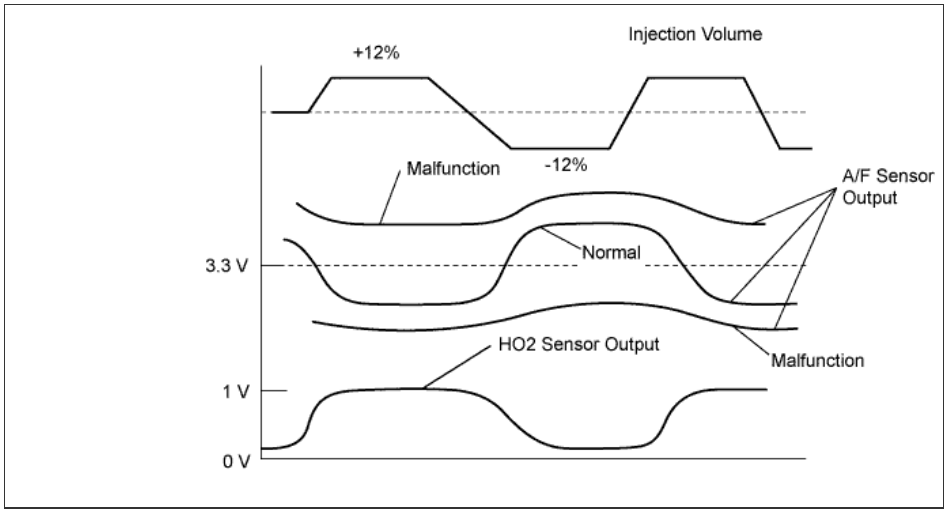
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

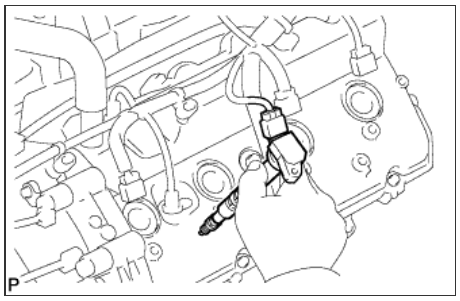
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

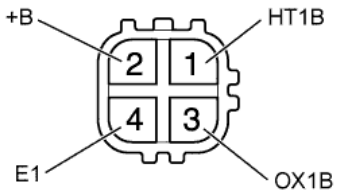
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

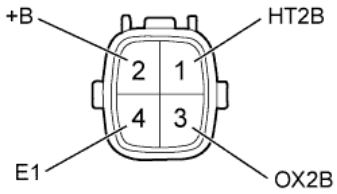
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

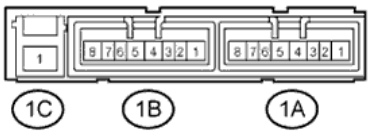
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

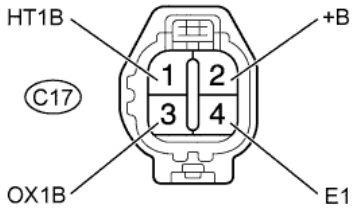
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

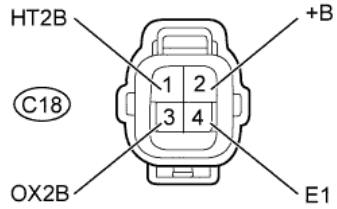
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

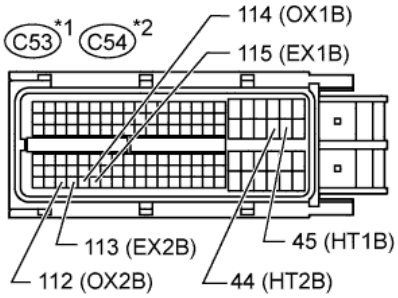
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



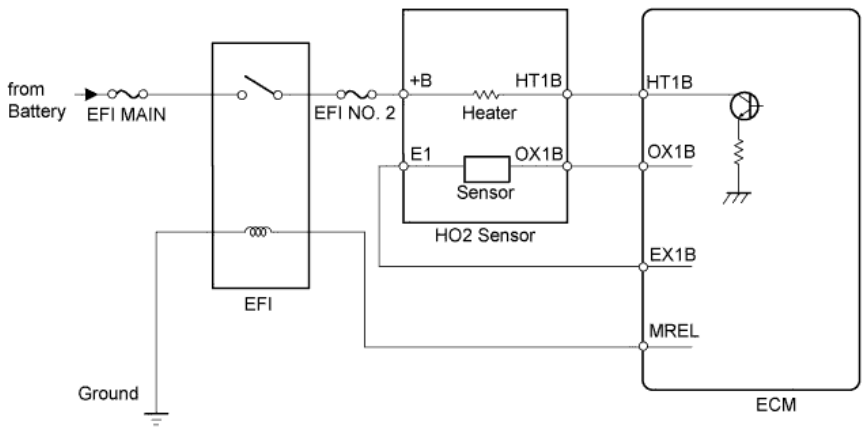
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

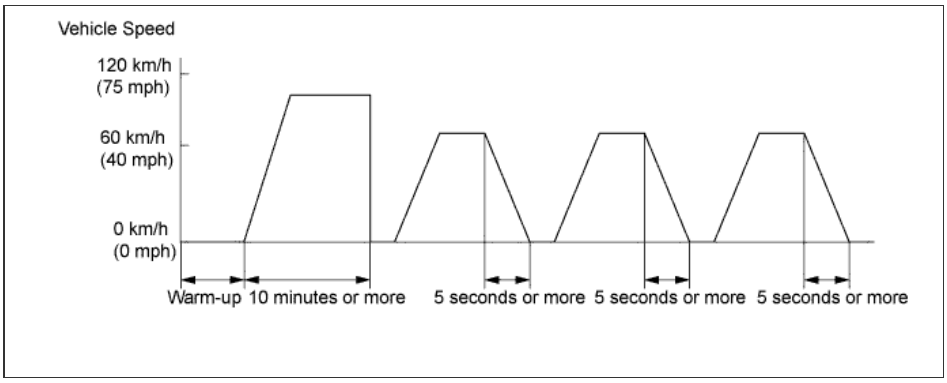
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

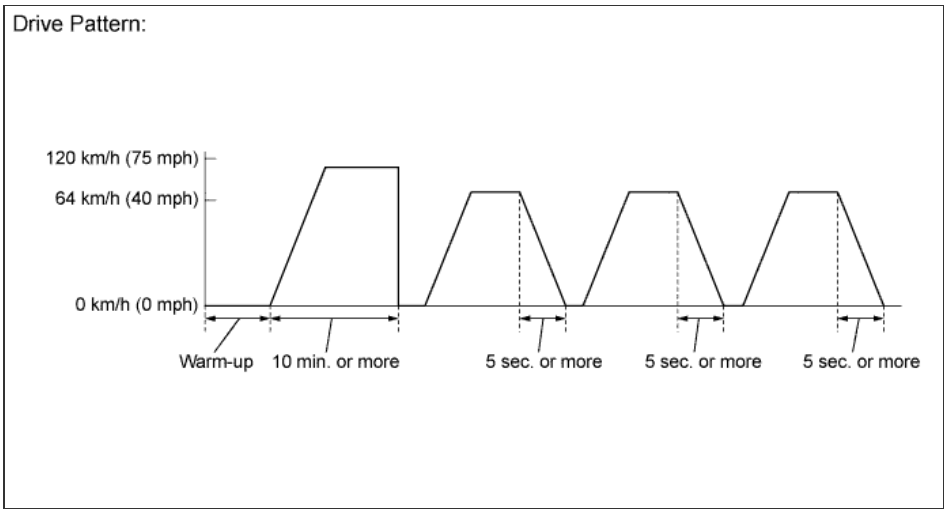
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

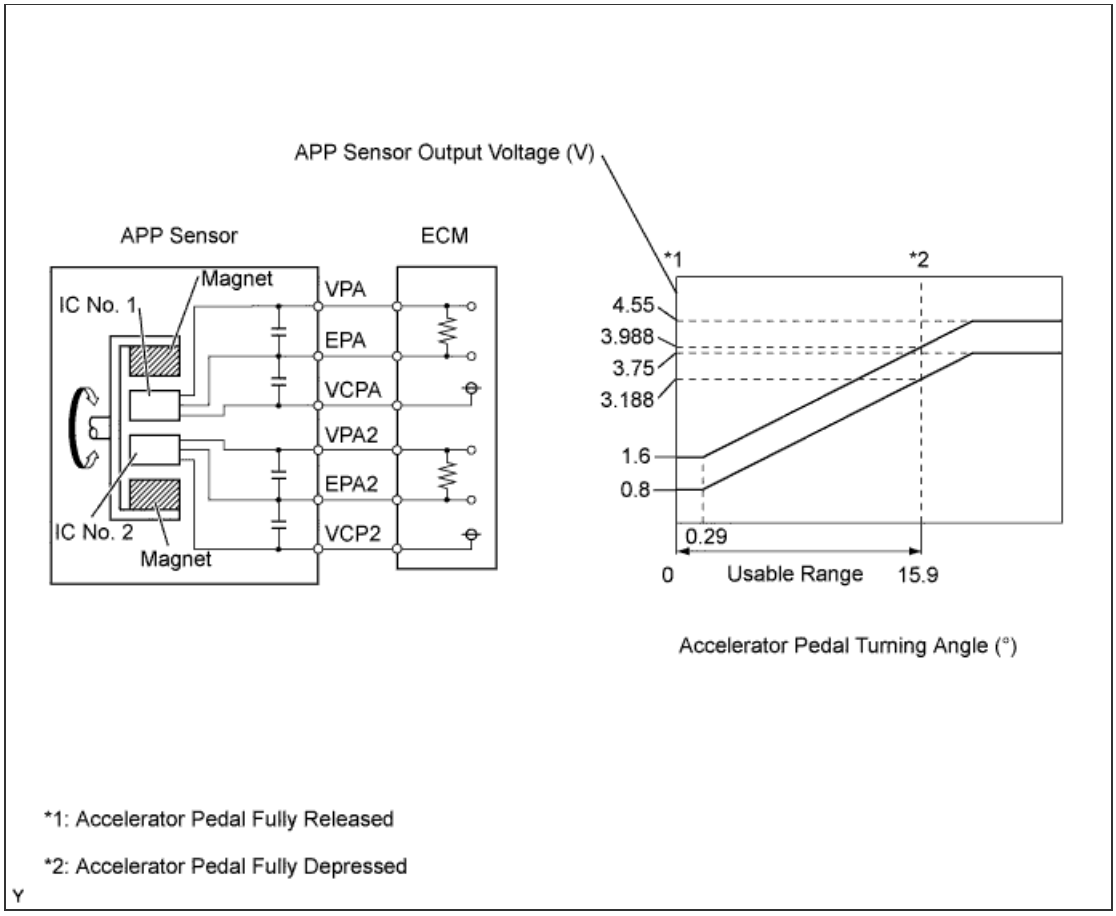
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

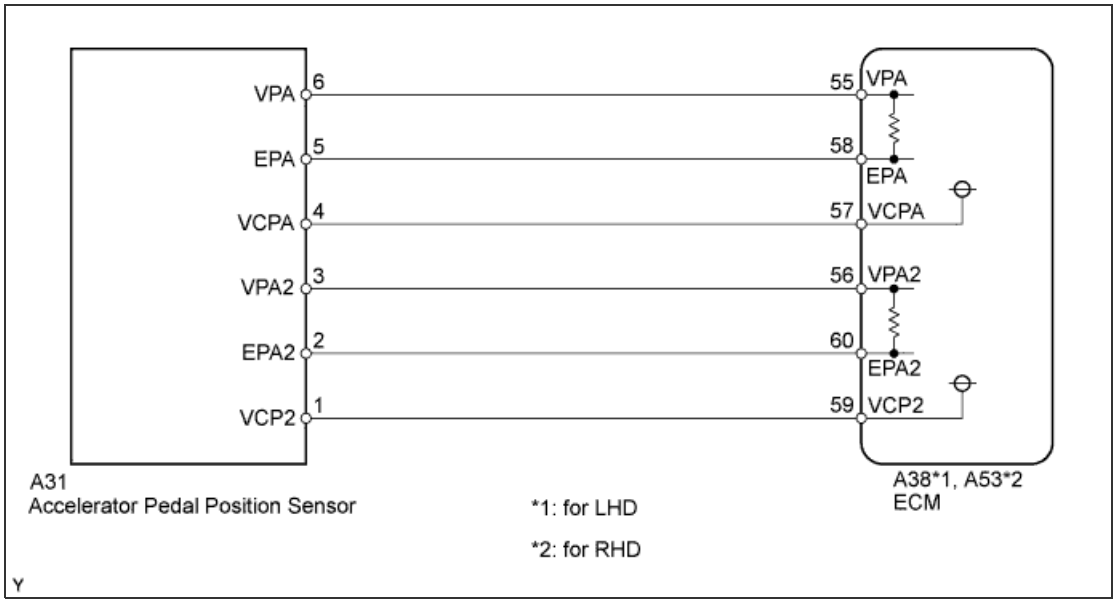
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

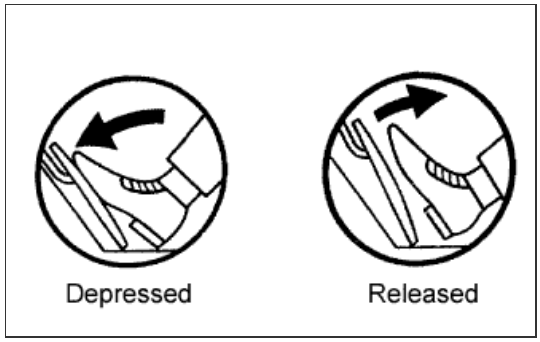
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

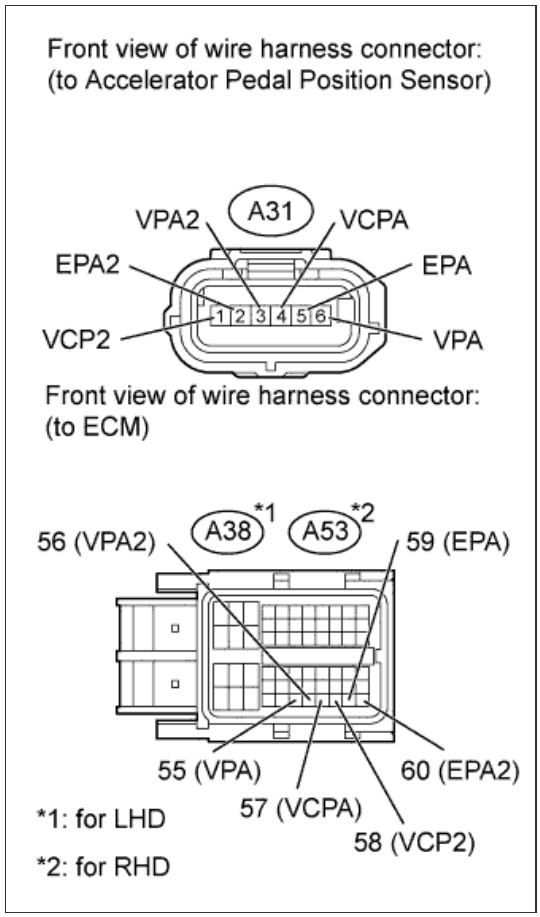
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

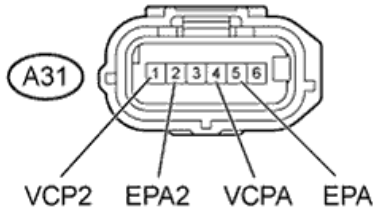
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

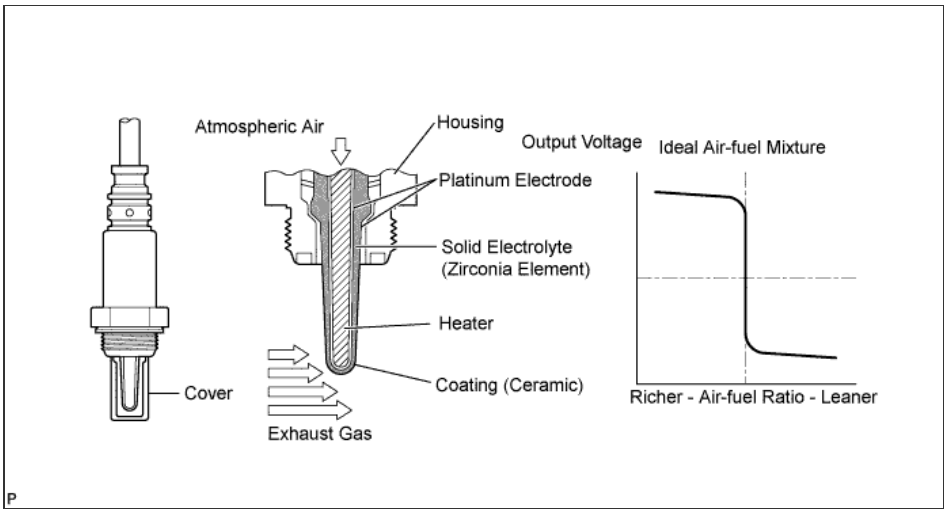
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

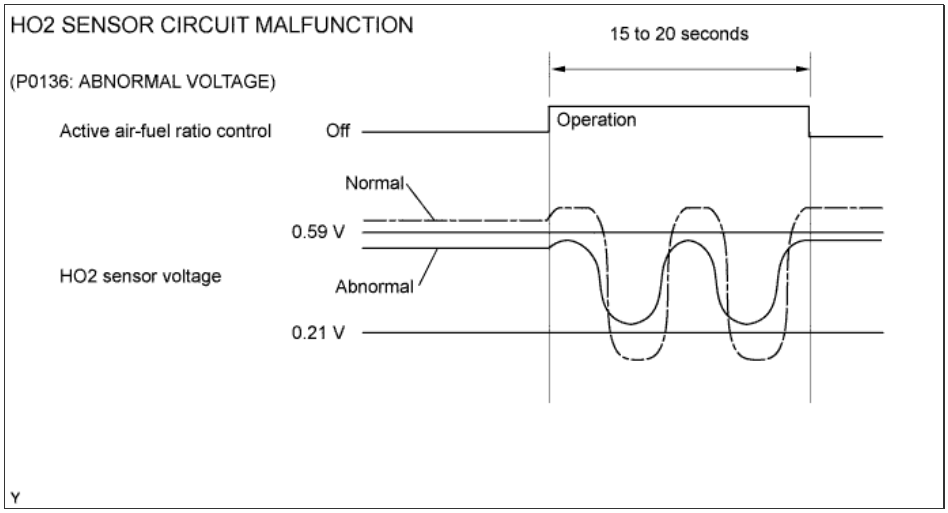
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

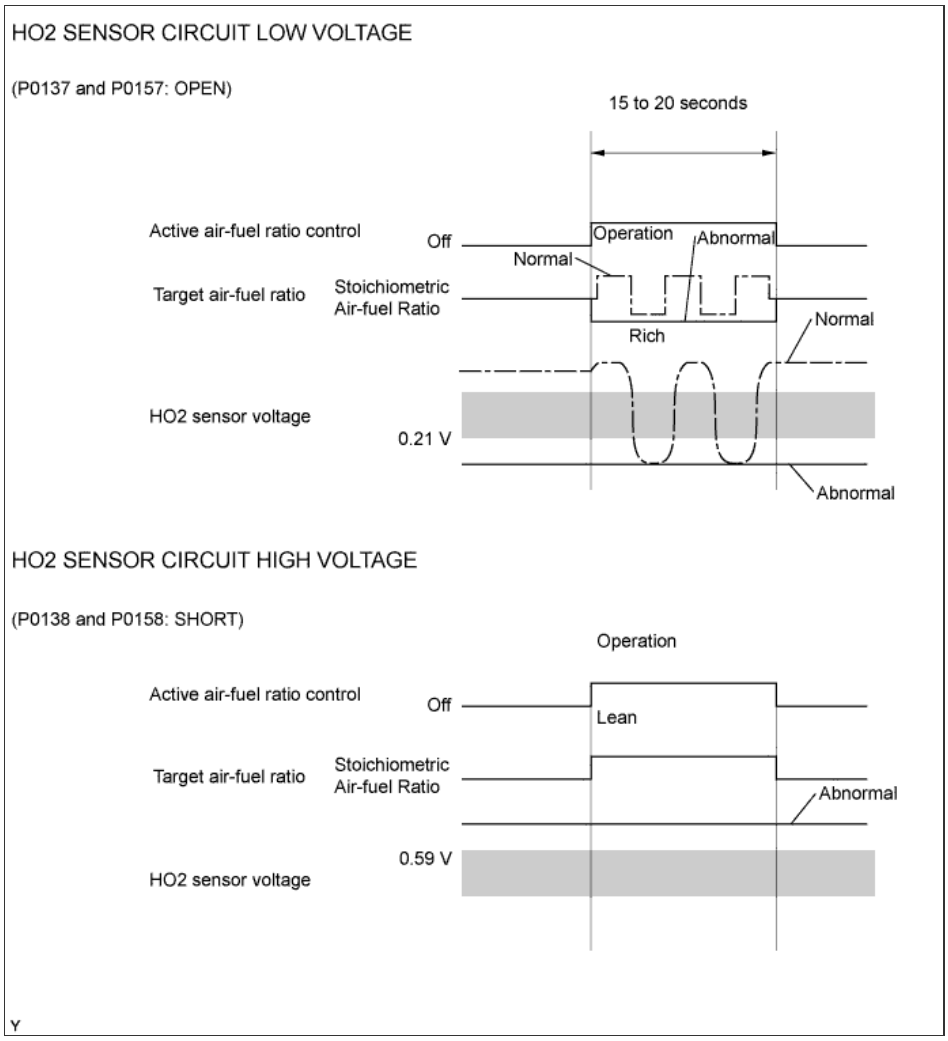
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

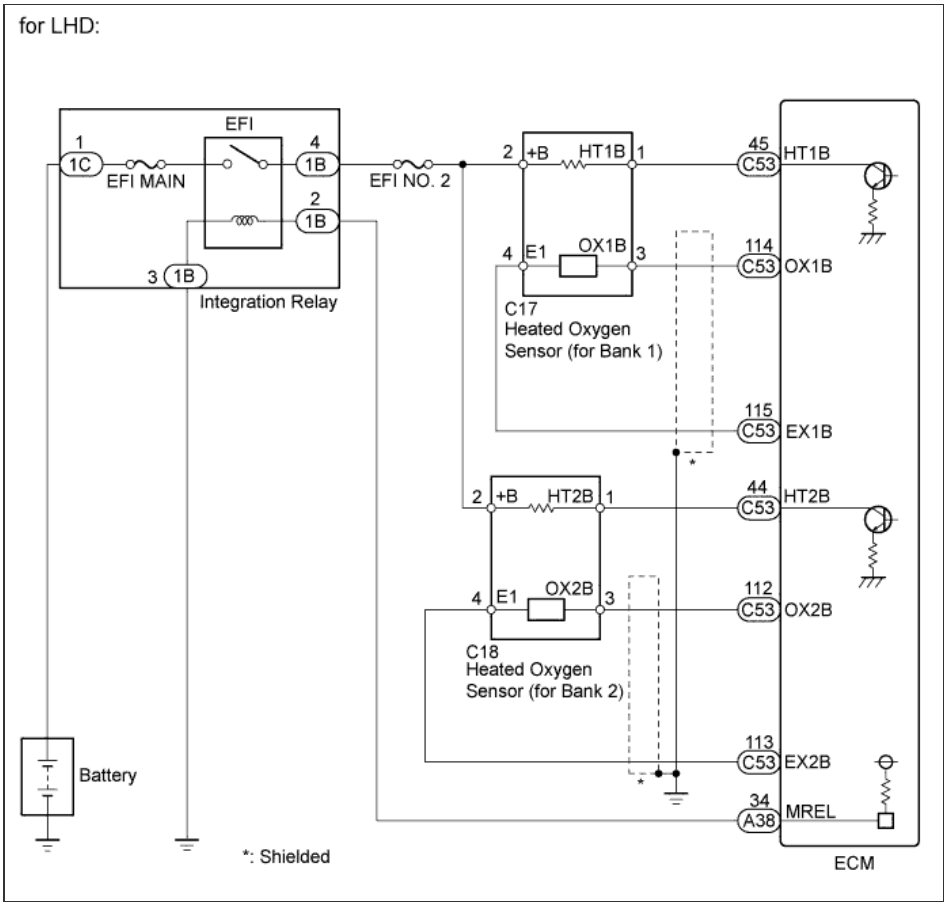
HINT:

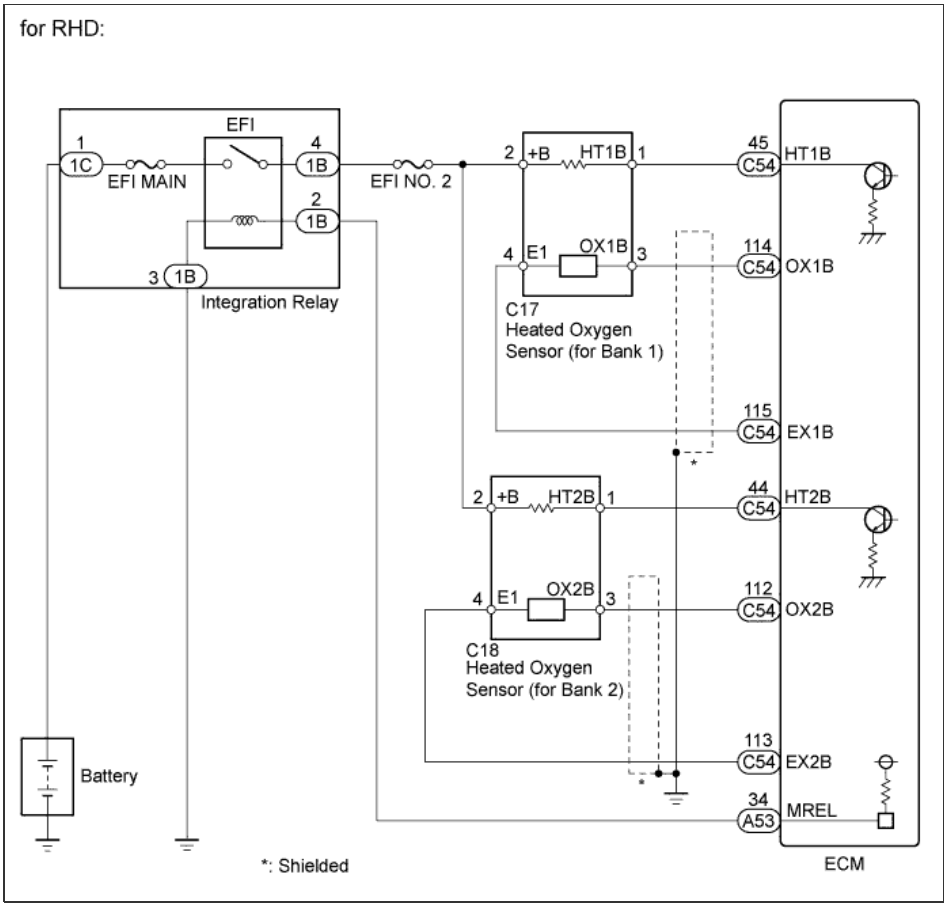
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





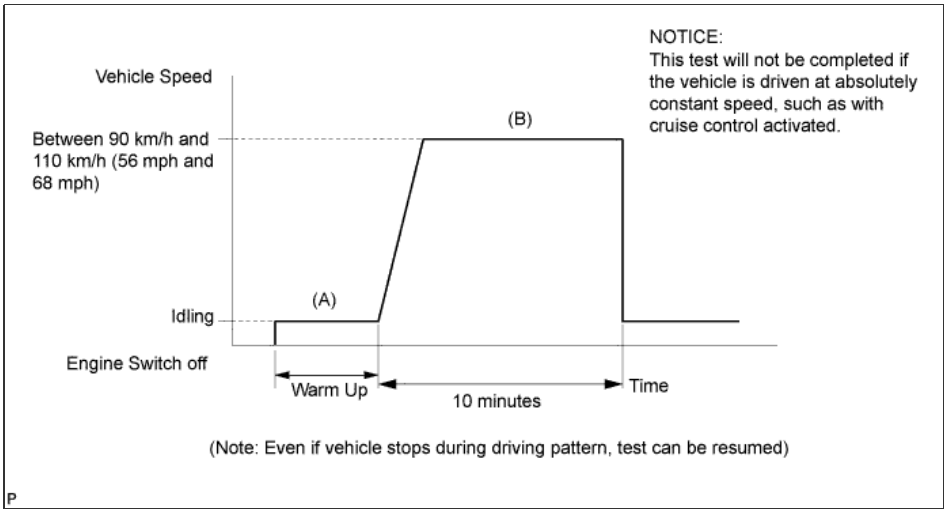
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

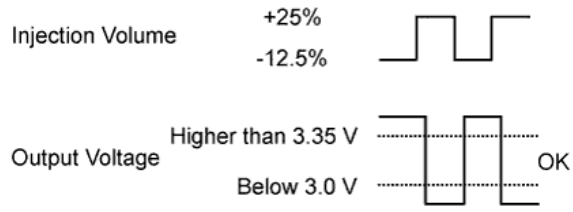
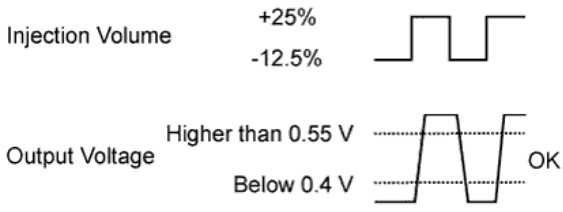
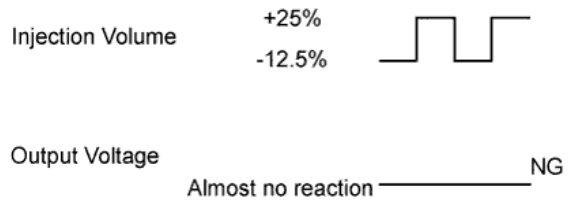
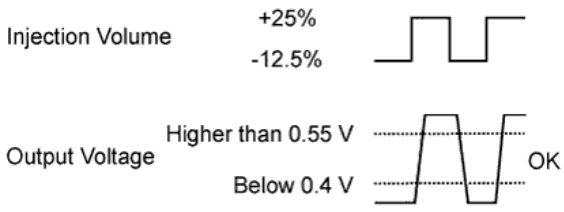
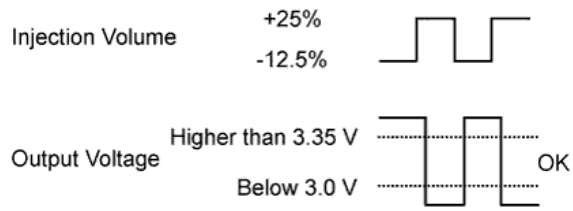
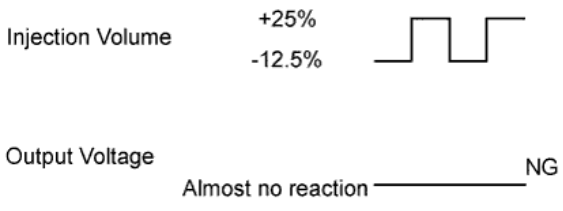
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

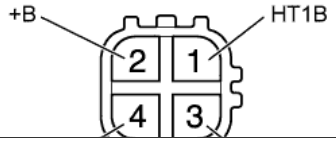
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

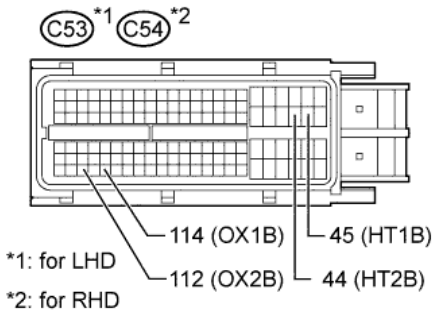
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

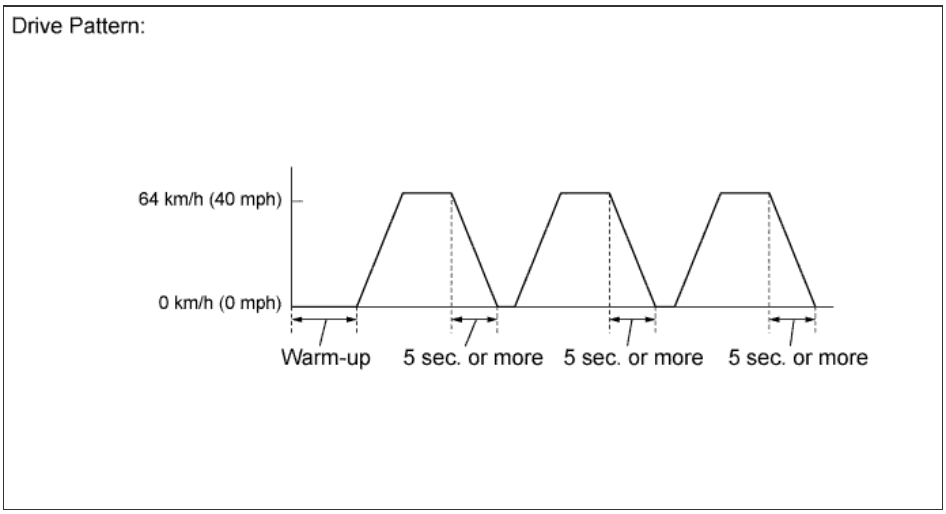
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

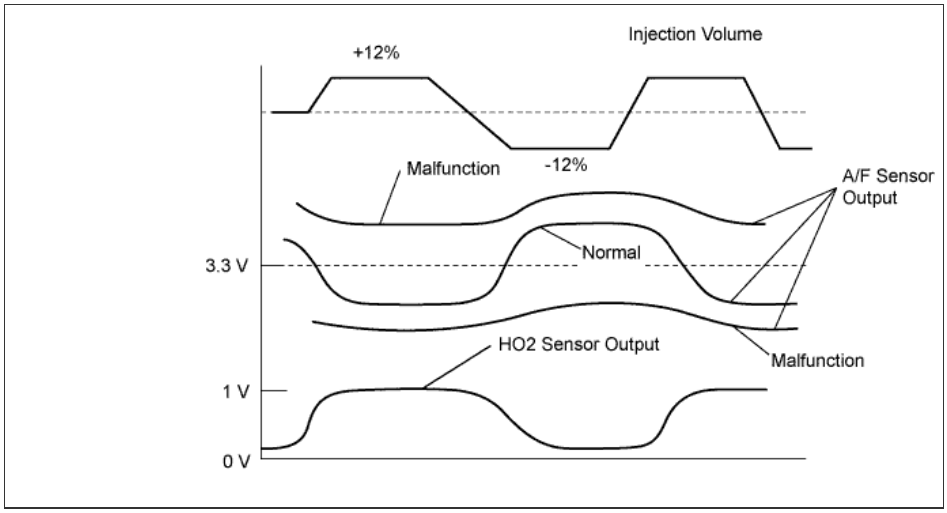
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

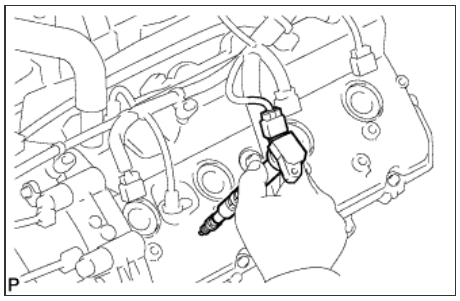
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

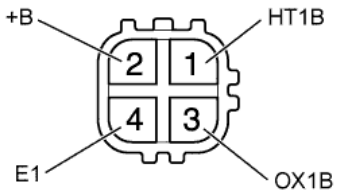
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

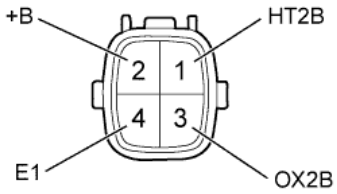
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

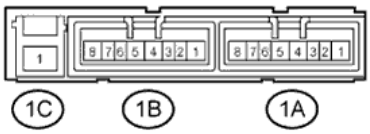
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

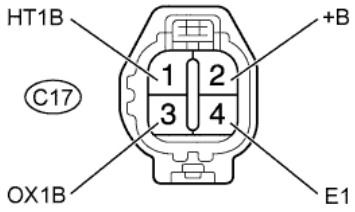
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

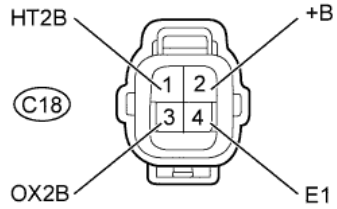
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

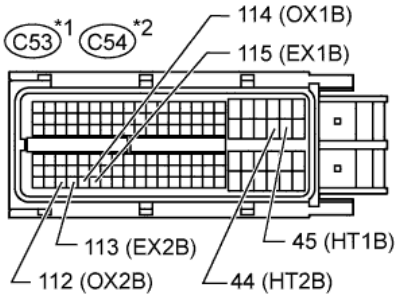
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



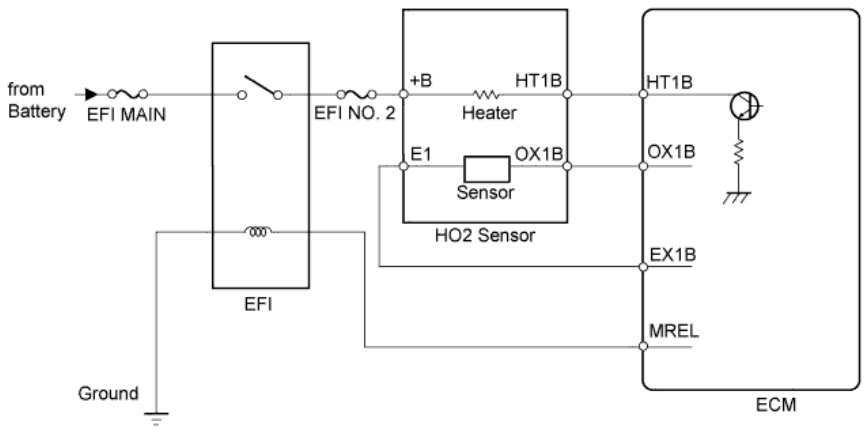
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

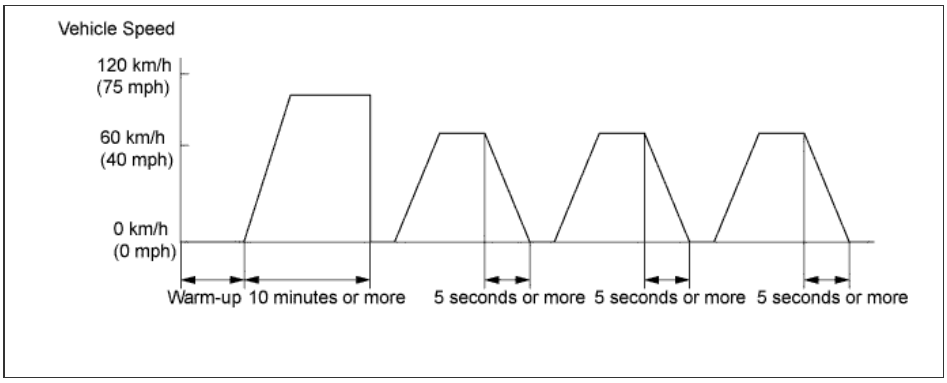
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

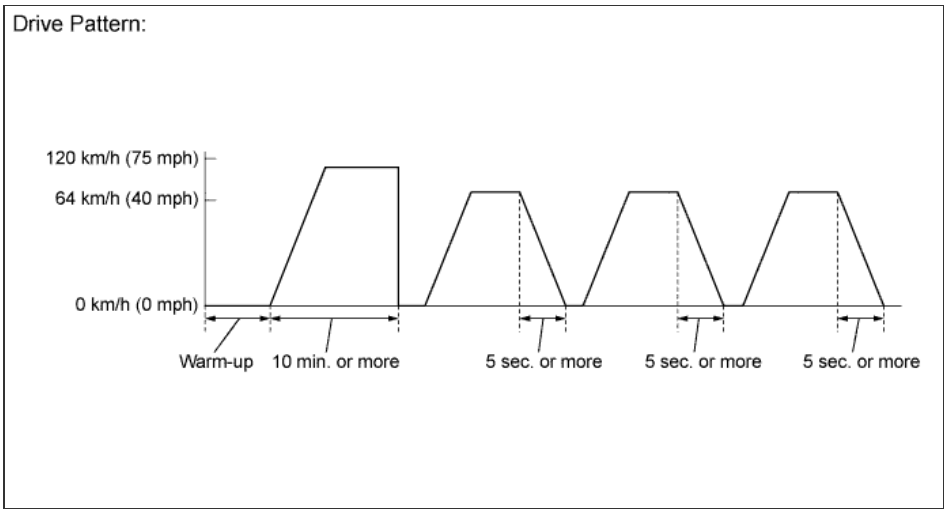
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

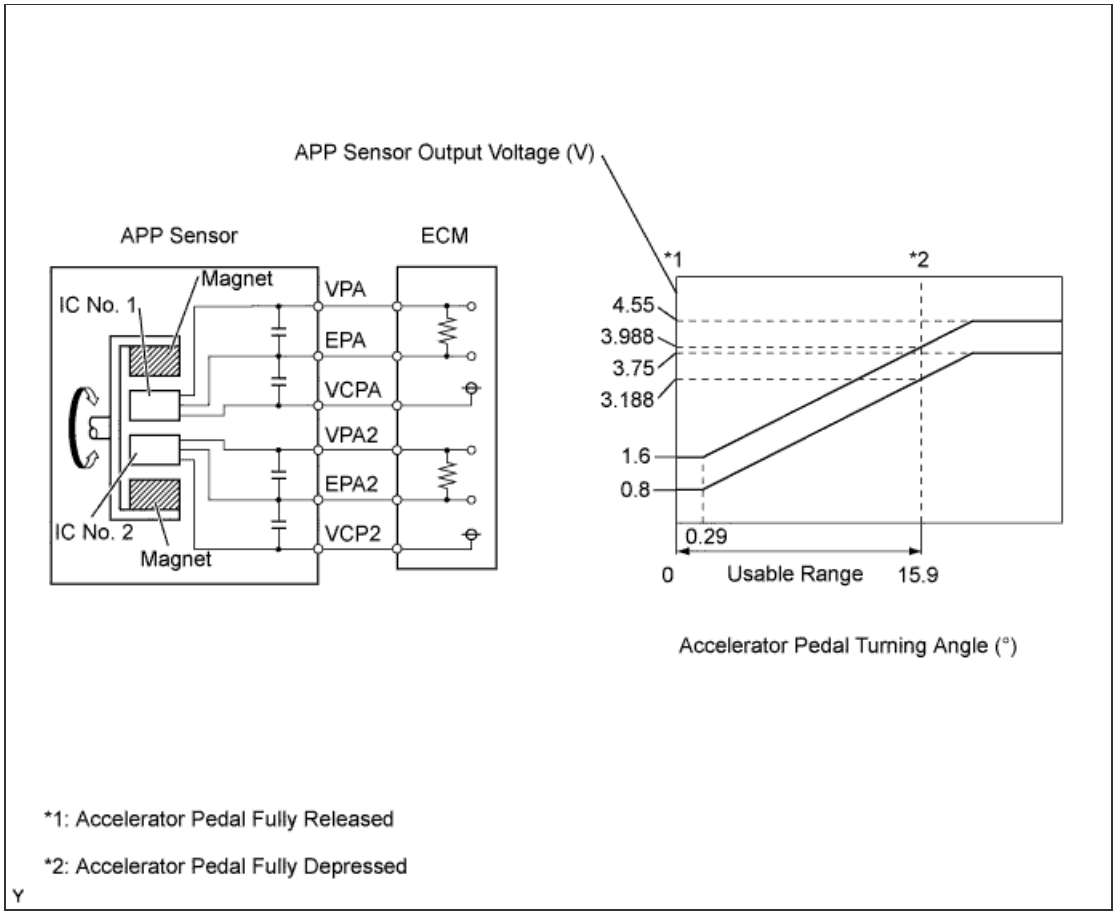
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

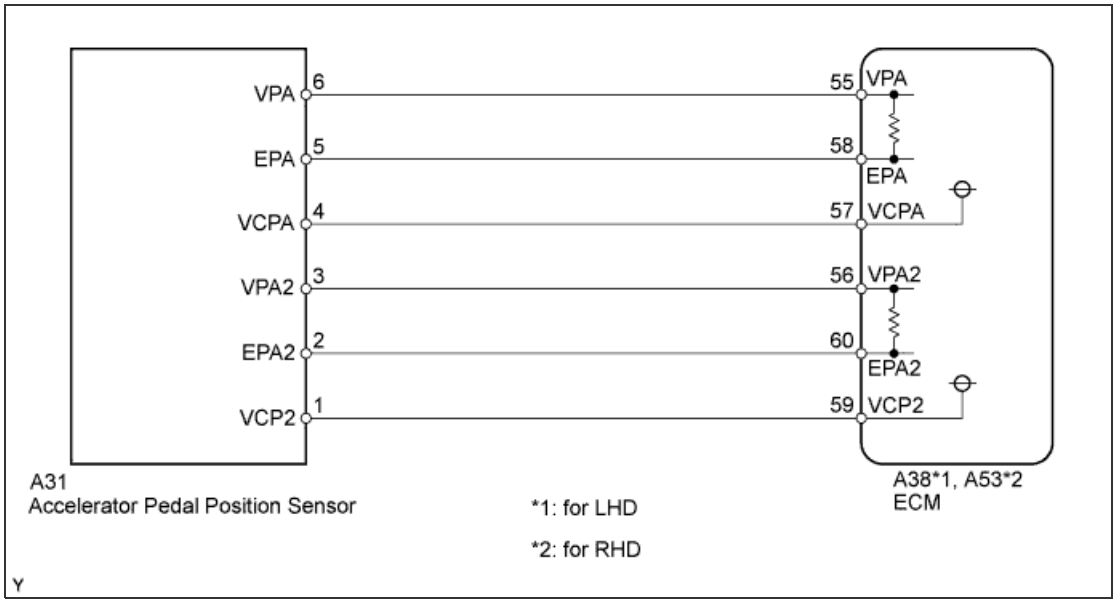
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

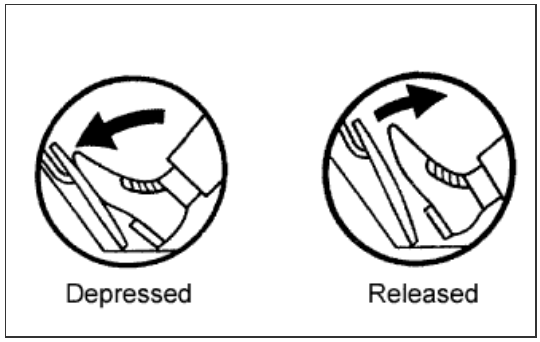
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

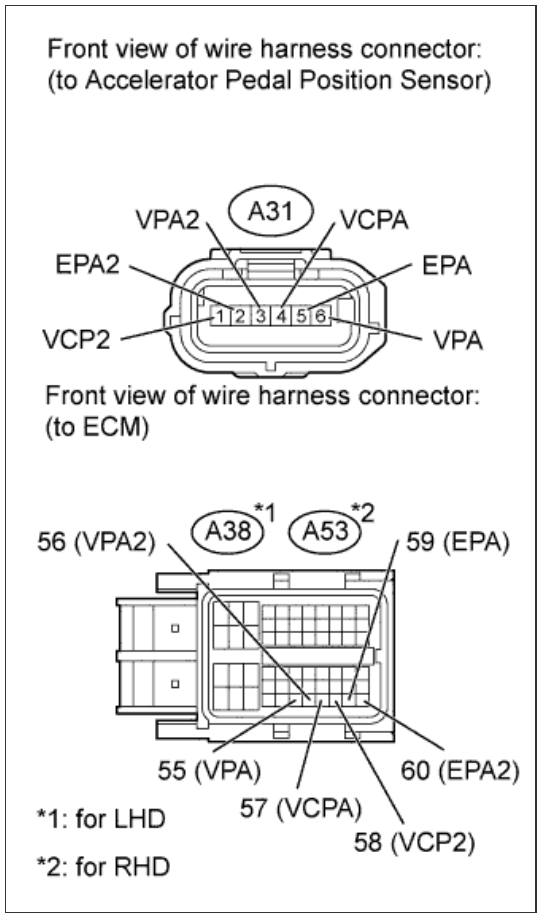
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

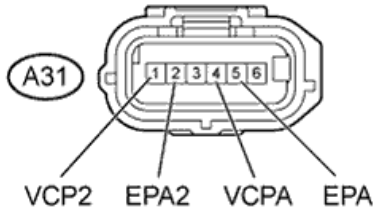
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

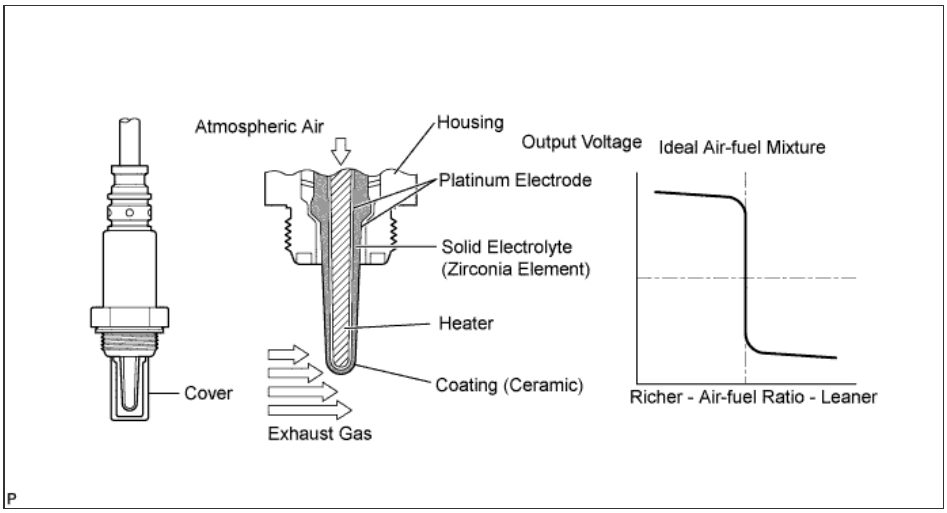
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

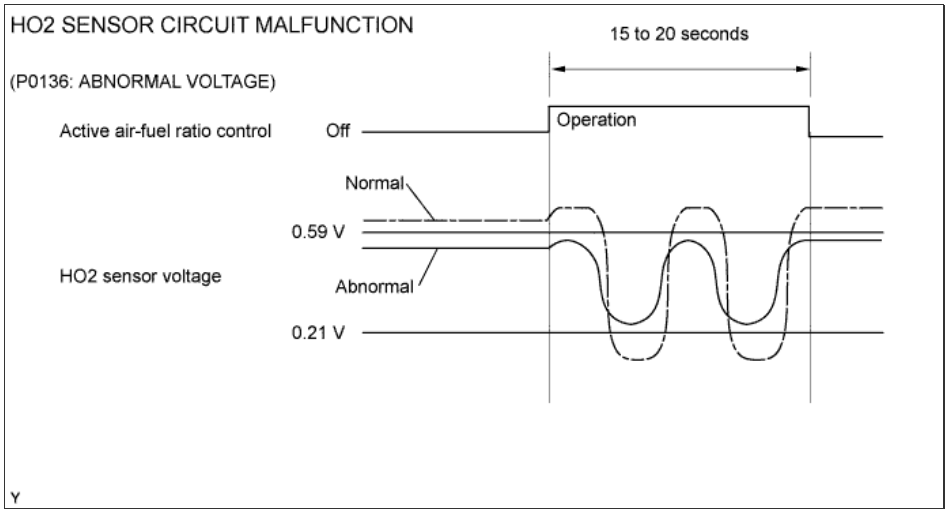
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

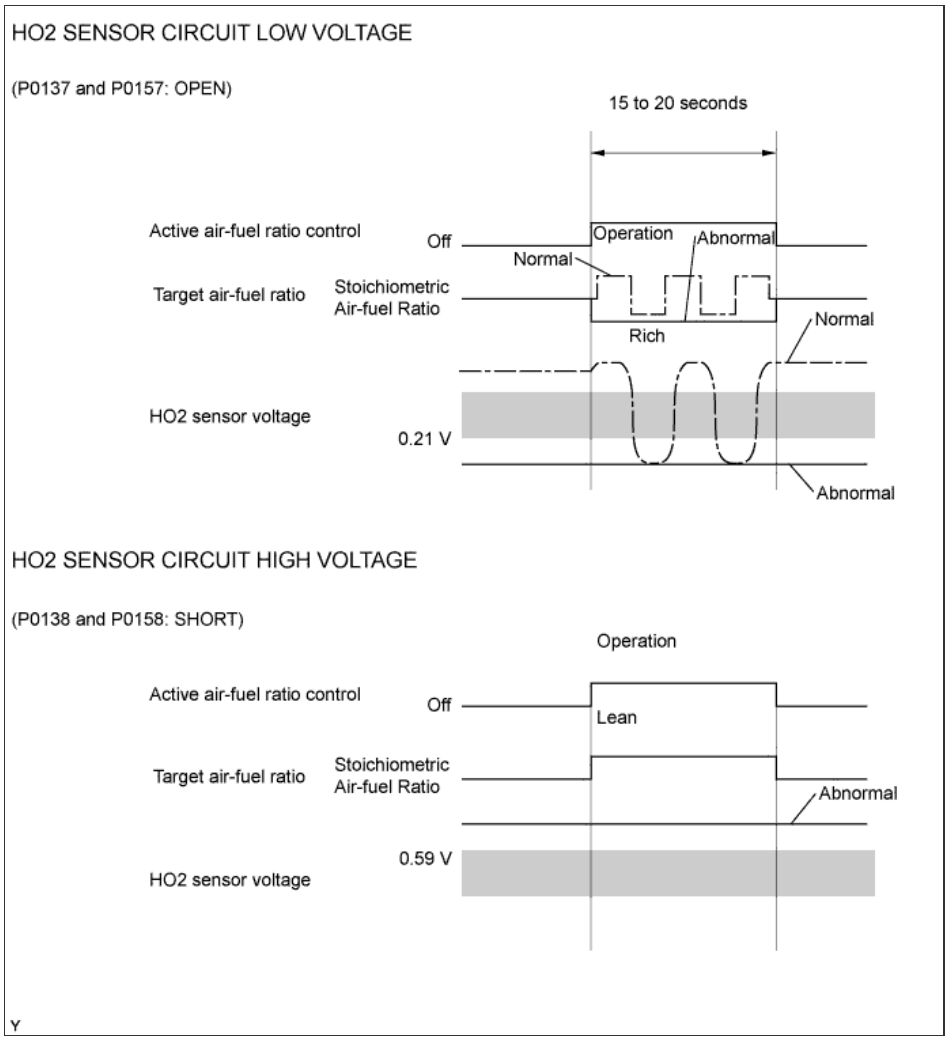
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

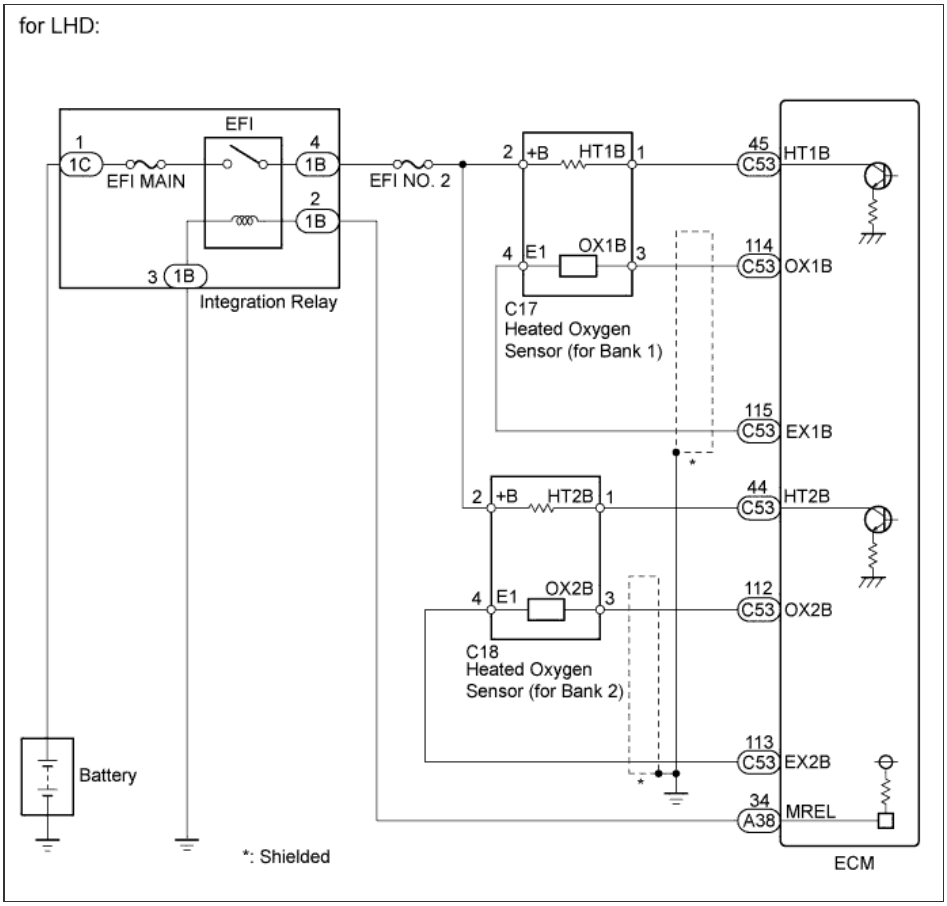
HINT:

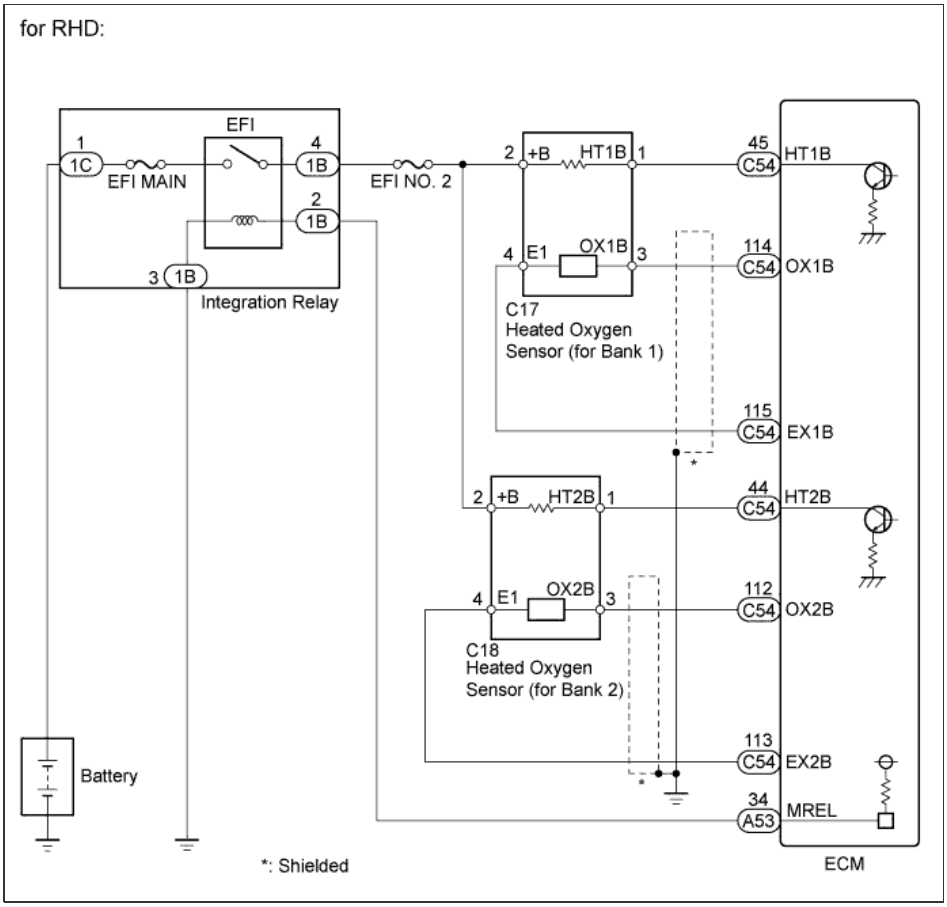
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





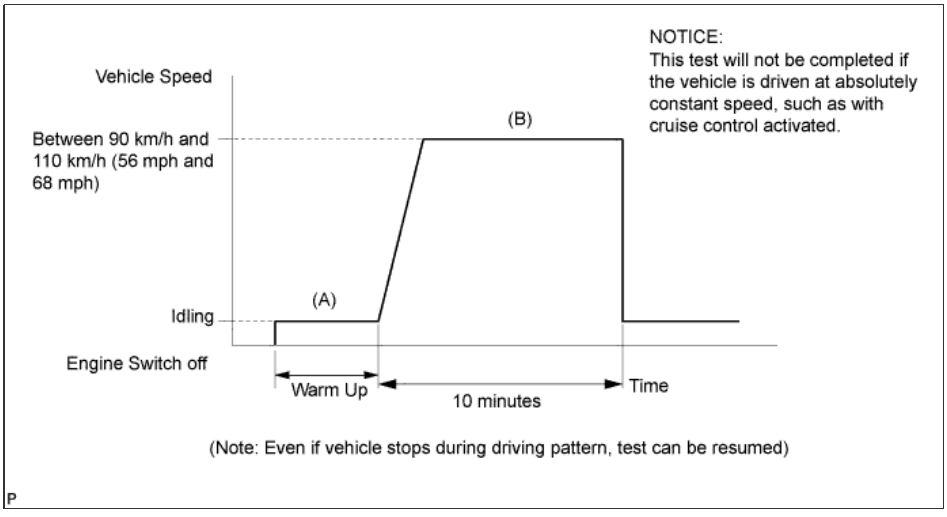
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

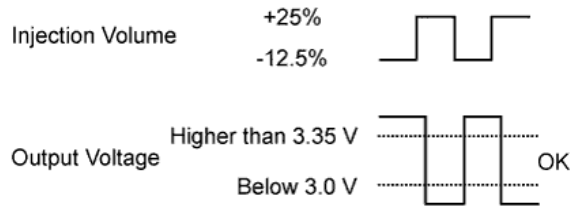
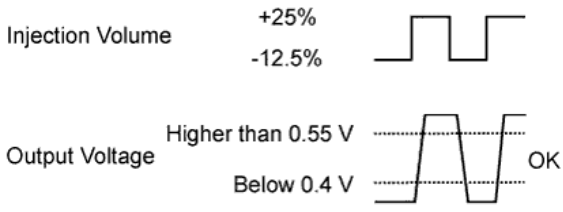
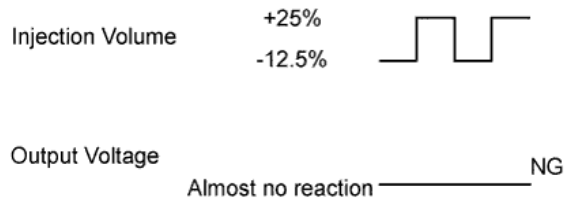
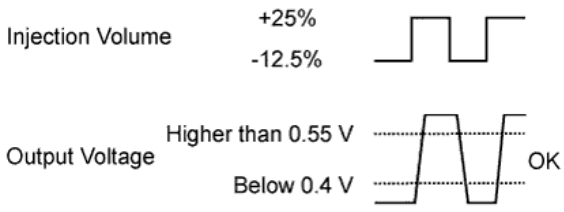
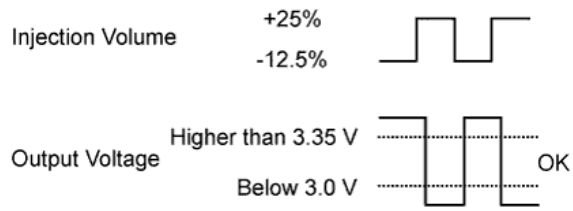
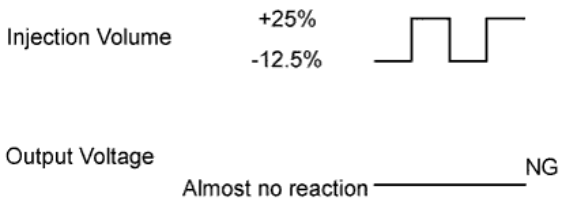
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

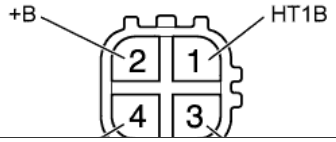
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

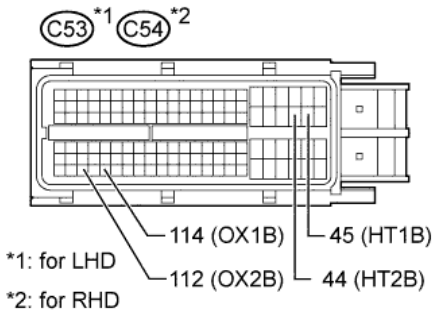
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

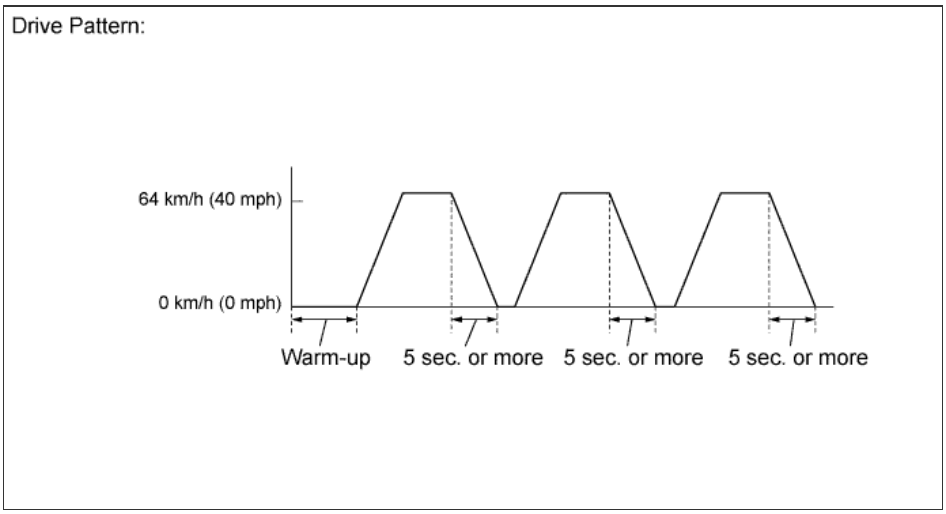
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

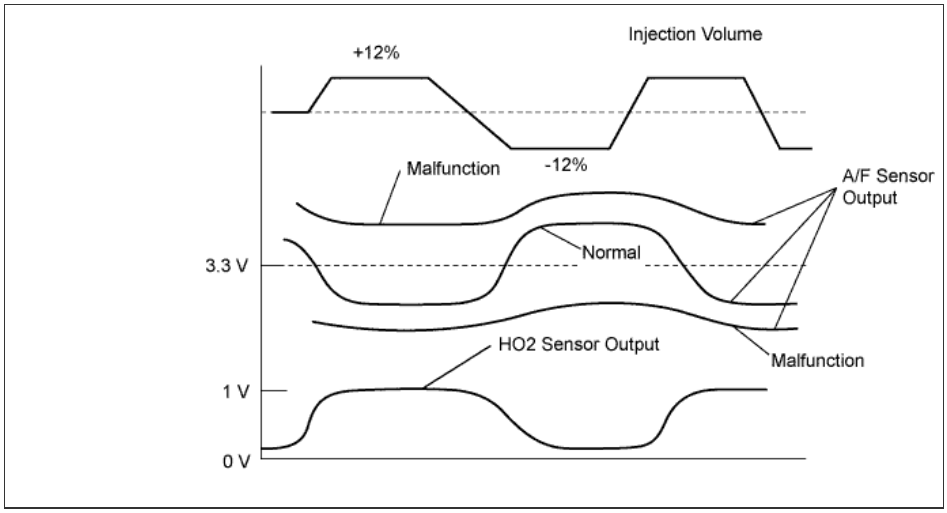
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

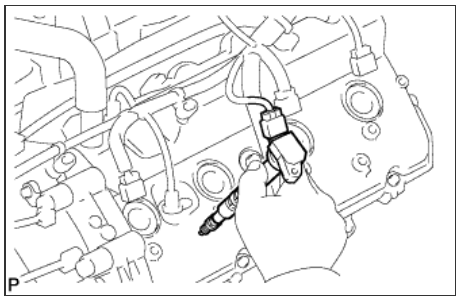
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

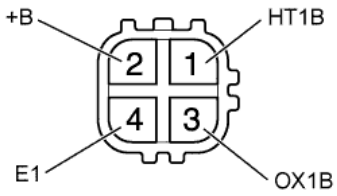
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

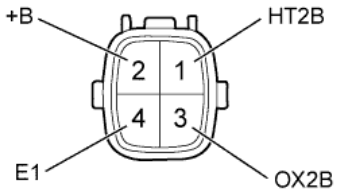
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

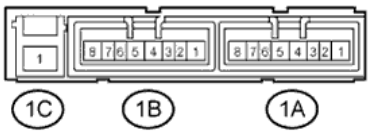
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

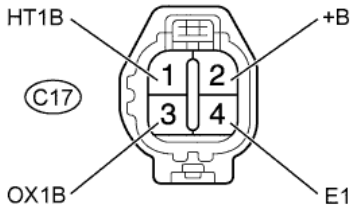
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

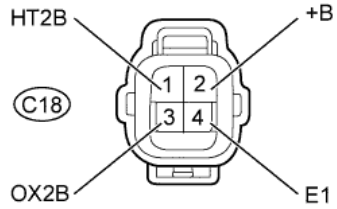
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

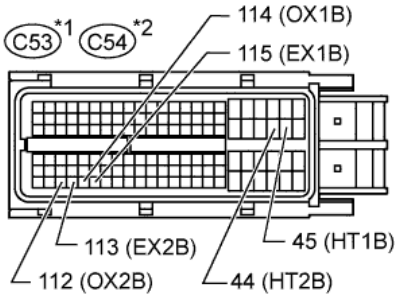
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



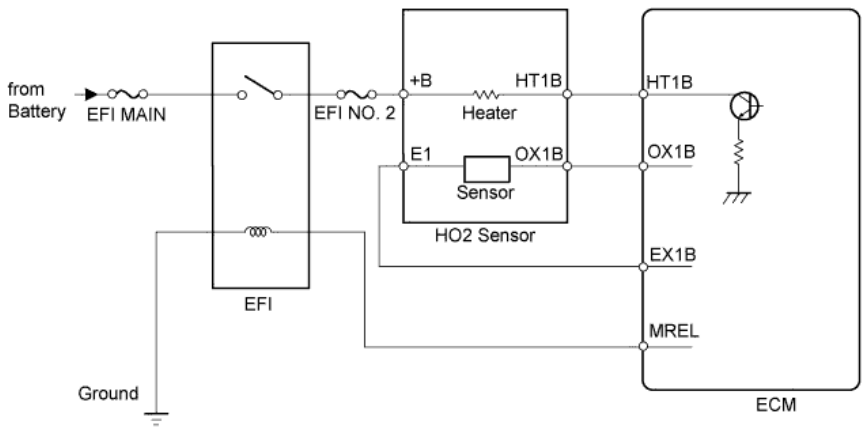
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

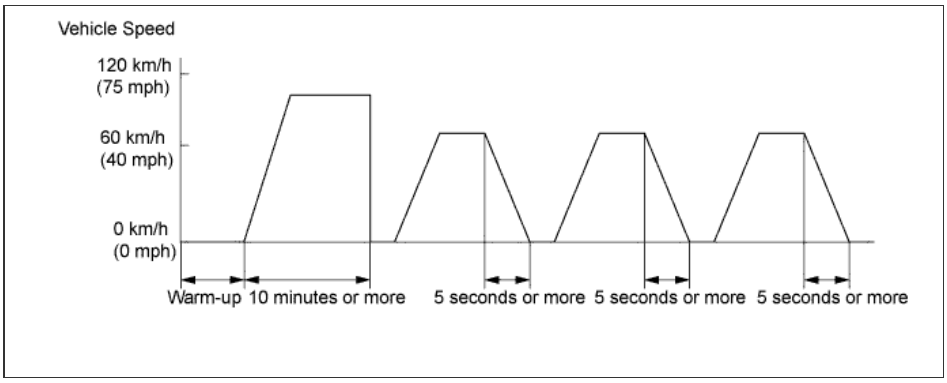
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

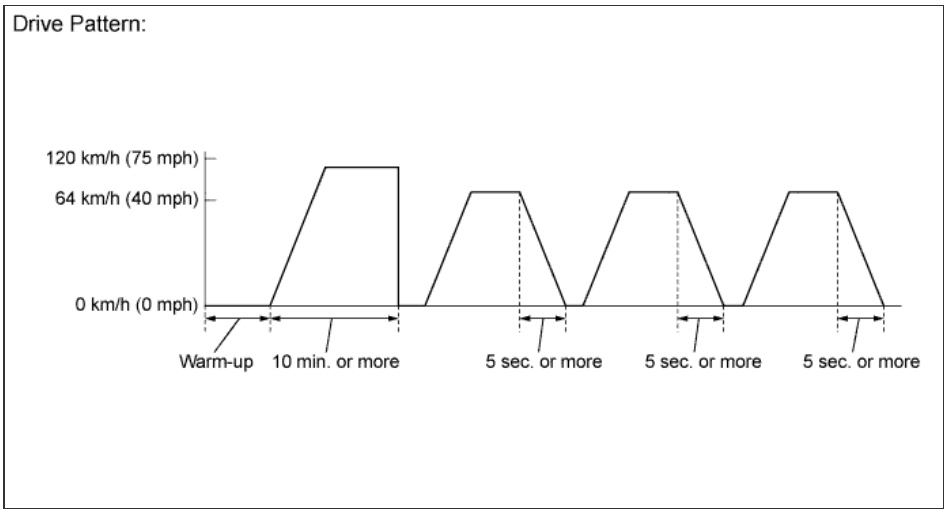
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

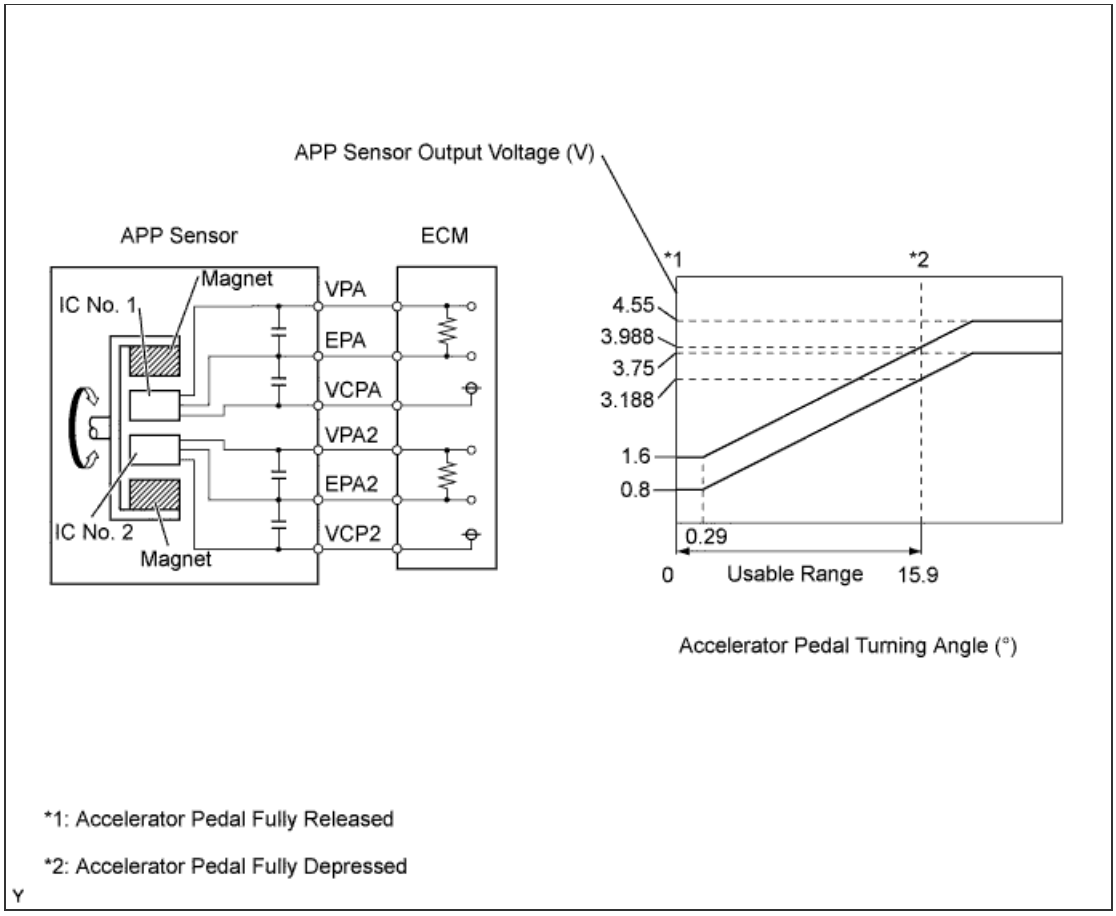
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

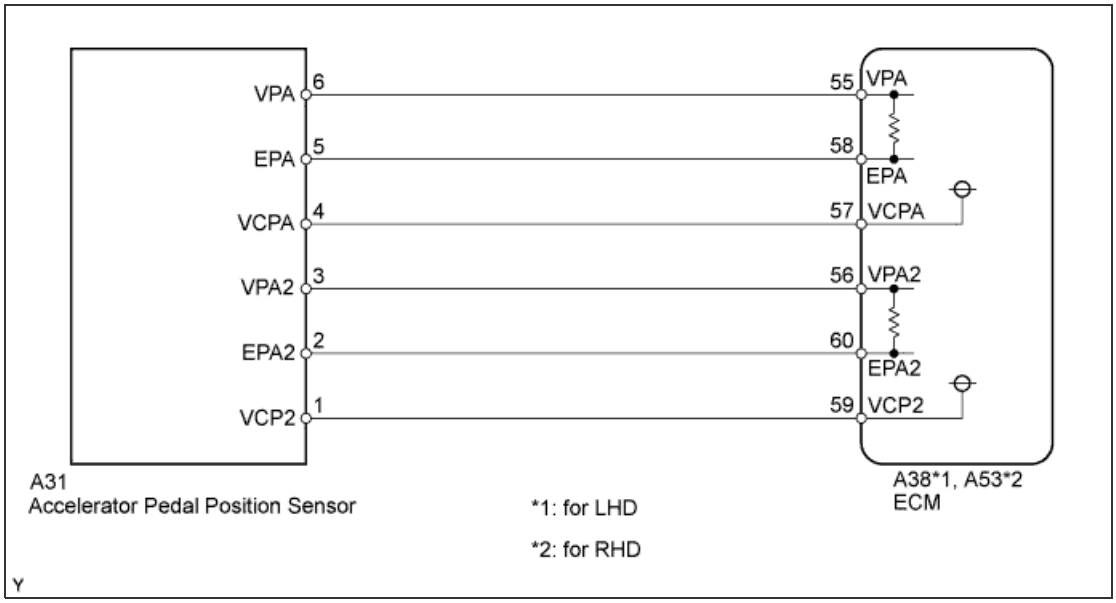
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

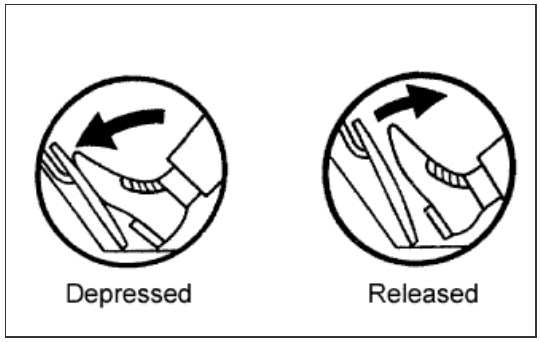
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

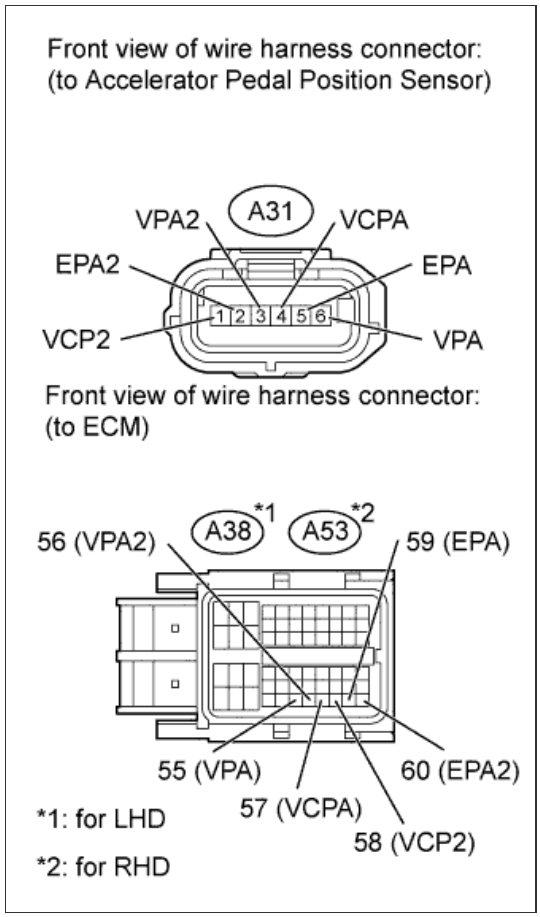
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

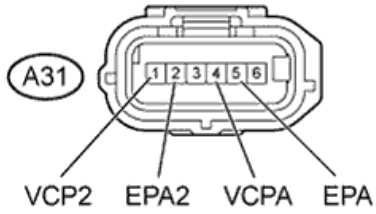
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0136 Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

DTC P0137 Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138 Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0156 Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)

DTC P0157 Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158 Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

for Preparation Click here

DESCRIPTION

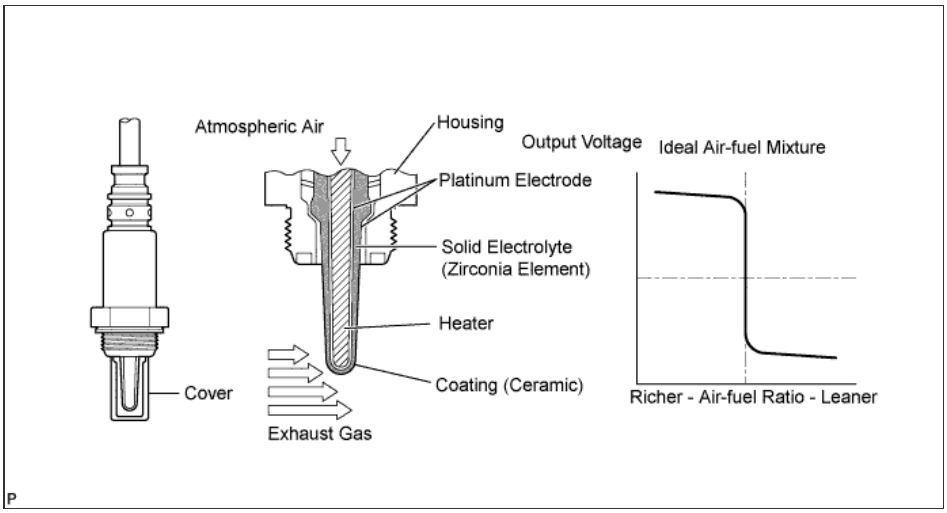
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas is rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. below 0.45 V).

Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel ratio, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. higher than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



DTC Code	DTC Detection Condition	Trouble Area
P0136* P0156*	Abnormal voltage is output: During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The Heated Oxygen (HO2) sensor voltage does not decrease to below 0.59 V 2. The HO2 sensor voltage does not increase to higher than 0.21 V.	• Open or short in Heated Oxygen (HO2) sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Air Fuel ratio (A/F) sensor (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0137 P0157	Low voltage (open): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is below 0.21 V. 2. The target air-fuel ratio is rich.	• Open in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • HO2 sensor heater (for Bank 1, 2) • Integration relay • Gas leakage from exhaust system
P0138* P0158*	High voltage (short): During active air-fuel ratio control, the following conditions (a) and (b) are met for a certain period of time (2 trip detection logic): 1. The HO2 sensor voltage output is higher than 0.59 V. 2. The target air-fuel ratio is lean.	• Short in HO2 sensor (for Bank 1, 2) circuit • HO2 sensor (for Bank 1, 2) • ECM internal circuit malfunction • Air Fuel ratio (A/F) sensor (for Bank 1, 2)

HINT:

*: DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.

MONITOR DESCRIPTION

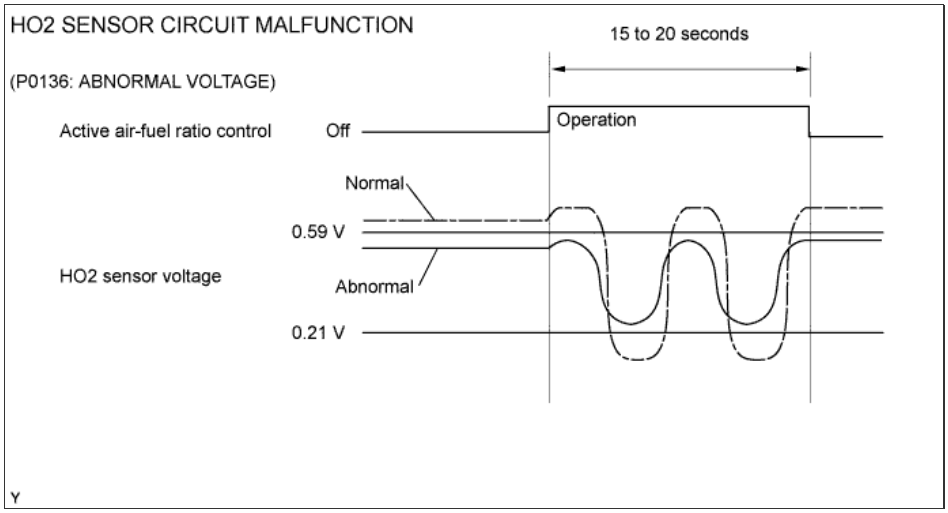
Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air Fuel ratio (A/F) sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, a DTC is stored.

Abnormal Voltage Output of HO2 Sensor (DTC P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to below 0.21 V and does not increase to higher than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and stores DTC P0136 or P0156.



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 and P0157 or P0138 and P0158)

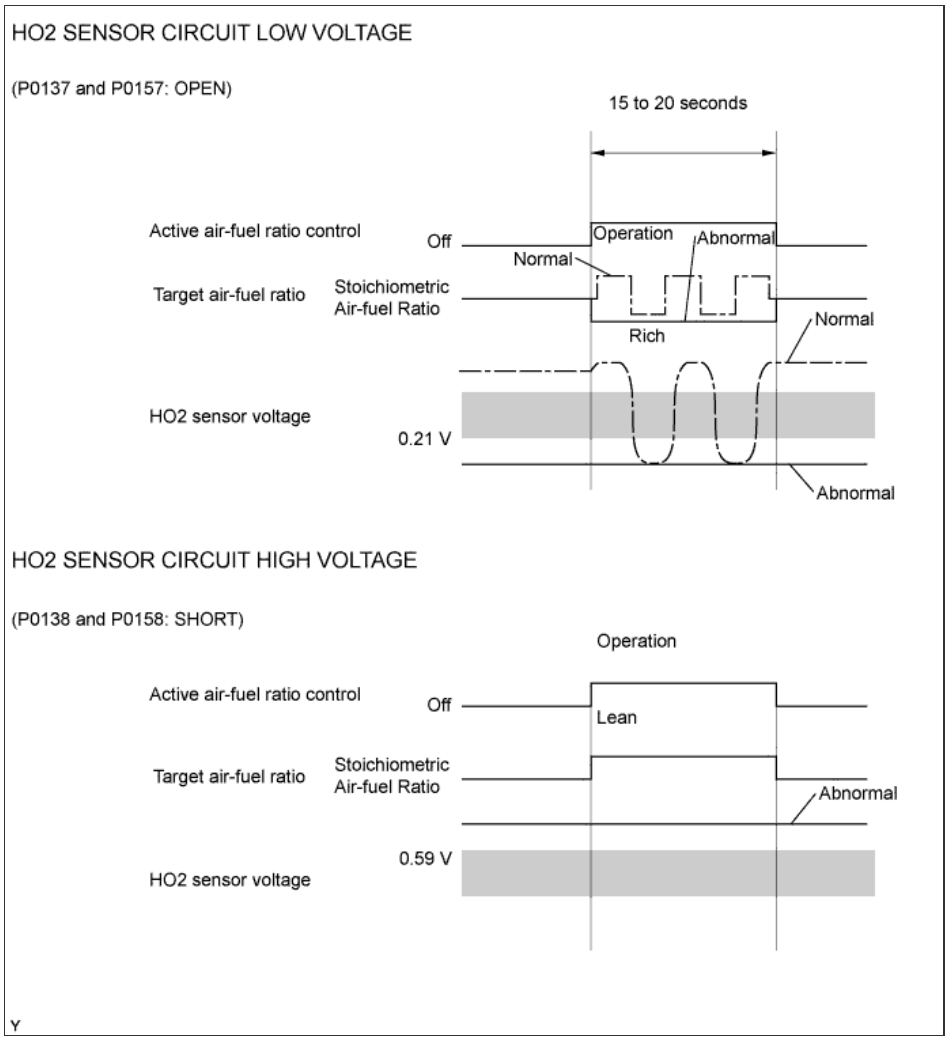
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short, or the voltage output of the sensor decreases significantly, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and stores DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or higher (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and stores DTC P0138 or P0158.

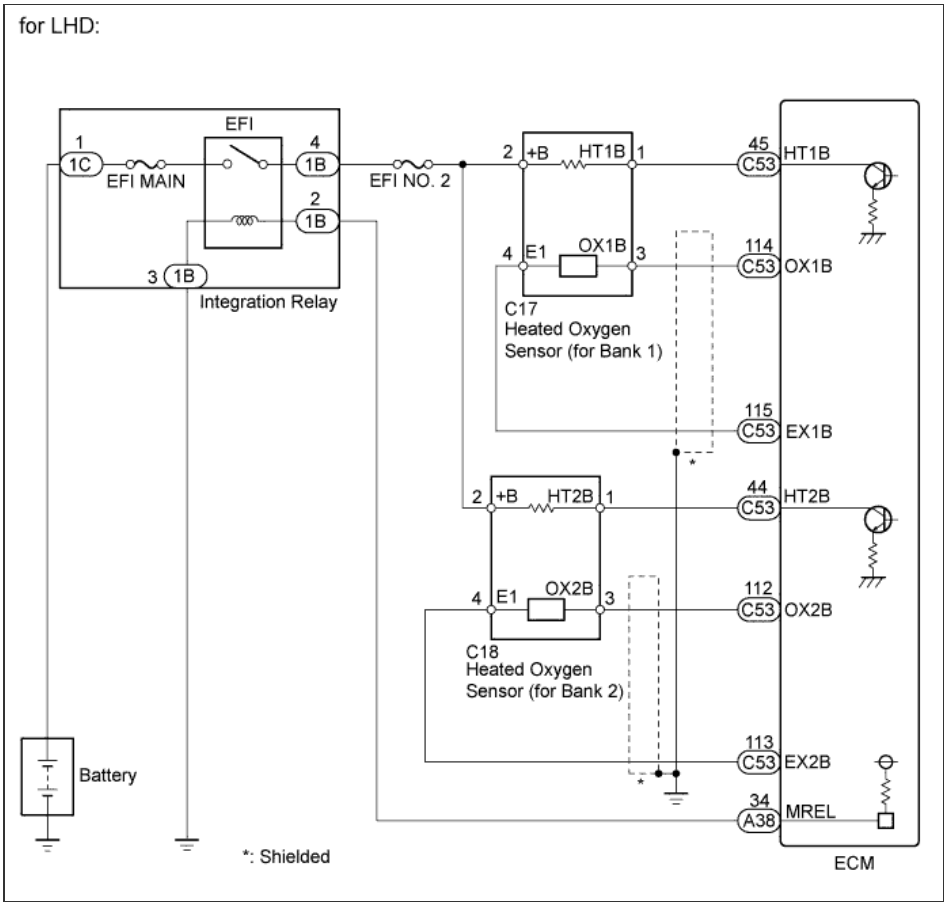
HINT:

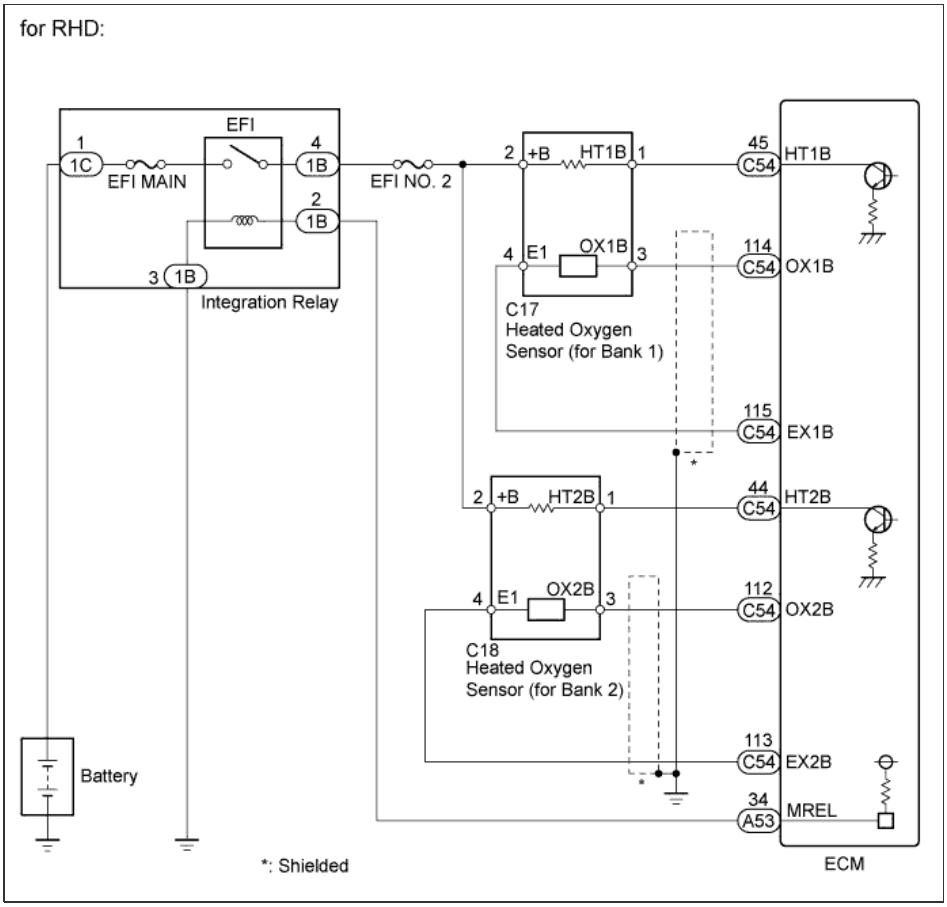
DTC P0138 or P0158 is also stored if the HO2 sensor voltage output is higher than 1.2 V for 10 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated based on the calculated OSC value (Click here).



WIRING DIAGRAM





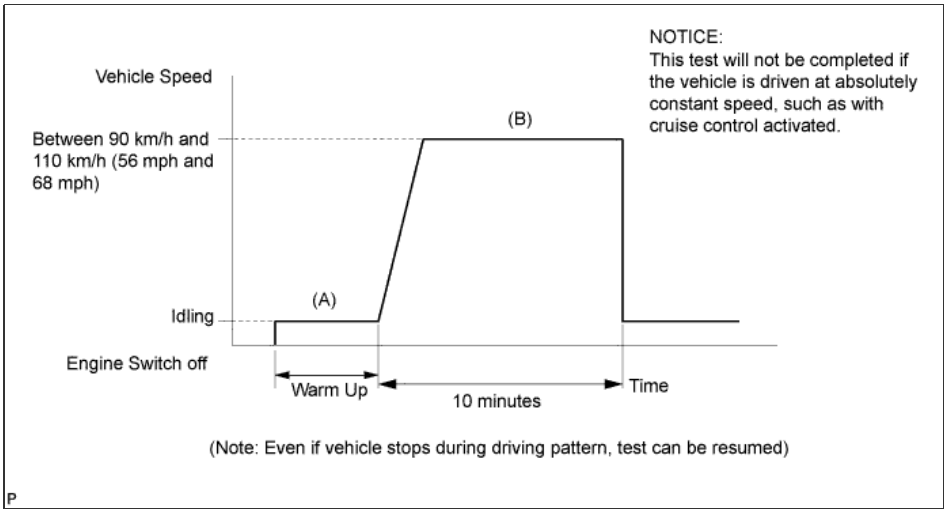
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Enter the following menus: Powertrain / Engine and ECT / DTC / Clear.
5. Clear DTCs.
6. Switch the ECM from normal mode to check mode
7. Enter the following menus: Powertrain / Engine and ECT / Data List / O2S (A/FS) Monitor.
8. Check that the item O2S (A/FS) Monitor displays Incmpl (Incomplete).
9. Start the engine and warm it up. (Proceed to "A")
10. Drive the vehicle at between 90 km/h and 110 km/h (56 mph and 68 mph) for at least 10 minutes. (Proceed to "B")
11. Note the state of the Data List items. Those items will change to Compl (Complete) as the O2 Sensor monitor operates.
12. On the tester, enter the following menus: Powertrain / Engine and ECT / DTC / Pending and check if any DTCs (any pending DTCs) are output.

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

1. **Connect the tester to the DLC3.**
2. **Start the engine and turn the tester on.**
3. **Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.**
4. **Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.**
5. **Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).**
6. **Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.**

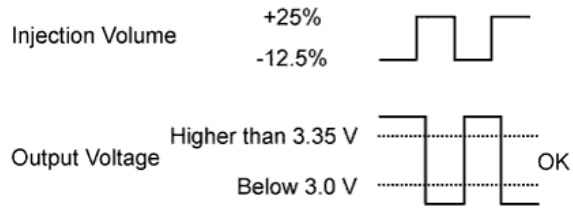
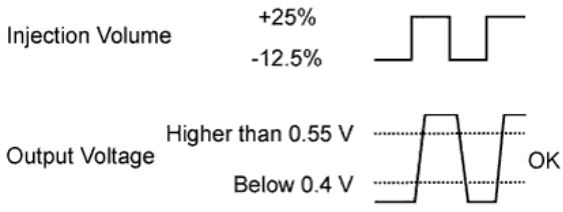
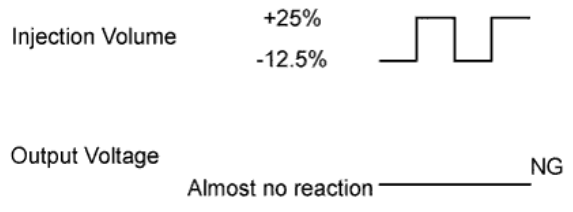
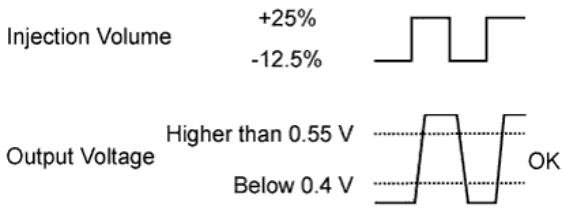
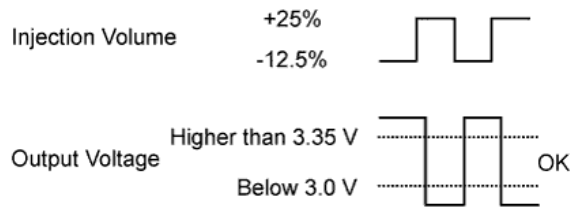
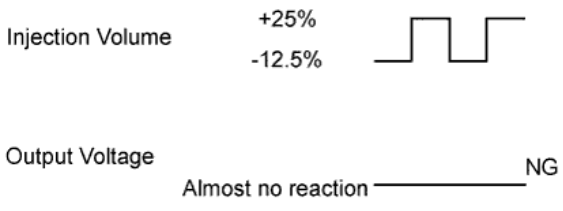
HINT:

- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 or AFS B2 S1 (A/F)	+25%	Rich	Below 3.0 V
AFS B1 S1 or AFS B2 S1 (A/F)	-12.5%	Lean	Higher than 3.35 V
O2S B1 S2 or O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55 V
O2S B1 S2 or O2S B2 S2 (HO2)	-12.5%	Lean	Below 0.4 V

NOTICE:

The Air Fuel ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

- Following the Control the Injection Volume for A/F sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.

- To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **DTC P0136, P0138, P0156 and P0158 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be stored.**
- **If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be stored.**

1.READ OUTPUT DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

B	Go to step 16
C	Go to step 6

A

2.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

d. Allow the engine to idle.

e. Read the Heated Oxygen (HO2) sensor output voltage while idling.

Standard voltage:
Below 1.0 V

OK	Go to step 5
NG	Go to step 3

3.CHECK HEATED OXYGEN SENSOR

a. Disconnect the C17 or C18 HO2 sensor connector.

b. Measure the resistance according to the value(s) in the table below.

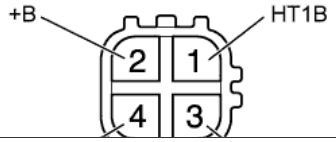
Standard Resistance:

Tester Connection	Condition	Specified Condition
2 (+B) - 3 (OX1B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher
2 (+B) - 3 (OX2B)	Always	10 kΩ or higher
2 (+B) - 4 (E1)	Always	10 kΩ or higher

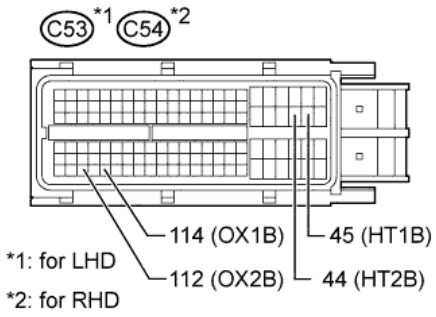
NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

Component without harness connected
(HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to ECM)



4.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Turn the engine switch off and wait for 5 minutes.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-45 (HT1B) - C53-114 (OX1B)	Always	10 kΩ or higher
C53-44 (HT2B) - C53-112 (OX2B)	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-45 (HT1B) - C54-114 (OX1B)	Always	10 kΩ or higher
C54-44 (HT2B) - C54-112 (OX2B)	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

5.CHECK AIR FUEL RATIO SENSOR

HINT:

This Air Fuel ratio (A/F) sensor test is to check the A/F sensor current during the fuel cut. When the sensor is normal, the sensor current will indicate below 3 mA in this test.

a. Clear DTC (Click here).

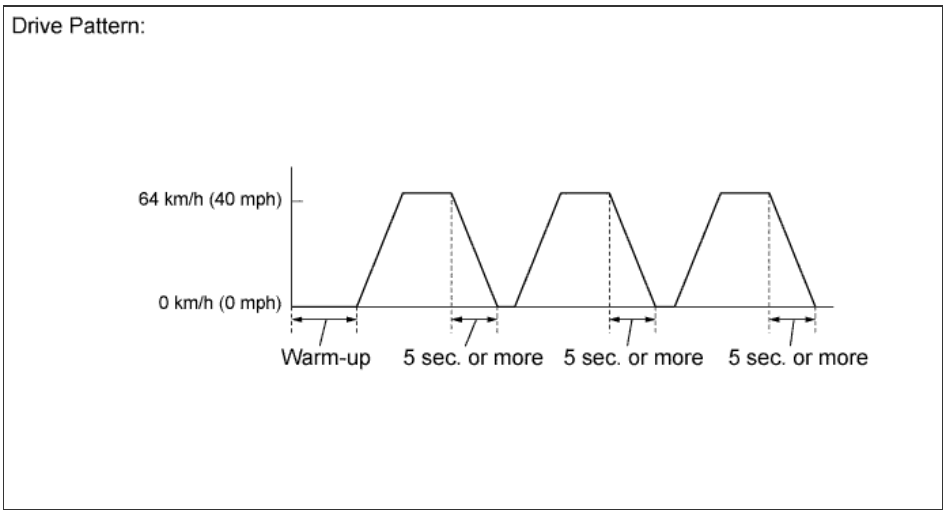
b. Drive the vehicle by the drive pattern as listed below:

i. Warm up the engine.

ii. Drive the vehicle at 60 km/h (40 mph) or more for 10 minutes or more.

iii. Stop the vehicle.

iv. Accelerator the vehicle until 60 km/h (40 mph) or more and decelerate for 5 seconds or more. Perform this 3 times.



c. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 and AFS B2 S1.

d. Read the value.

Standard current:
Below 3.0 mA

NOTICE:

Do not turn the engine switch off during this step because the test results will be lost.

OK	Go to step 20
NG	Go to step 22

6.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / O2S B1 S2 or O2S B2 S2.

e. After warming up the engine, run the engine at an engine speed of 2500 rpm for 3 minutes.

f. Read the output voltage of the HO2 sensor when the engine speed is suddenly increased.

HINT:

Quickly accelerate the engine to 4000 rpm 3 times using the accelerator pedal.

Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or higher.

NG	Go to step 16

OK

7.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume.

e. Change the fuel injection volume using the tester, and monitor the voltage output of Air Fuel ratio (A/F) and HO2 sensors displayed on the tester.

HINT:

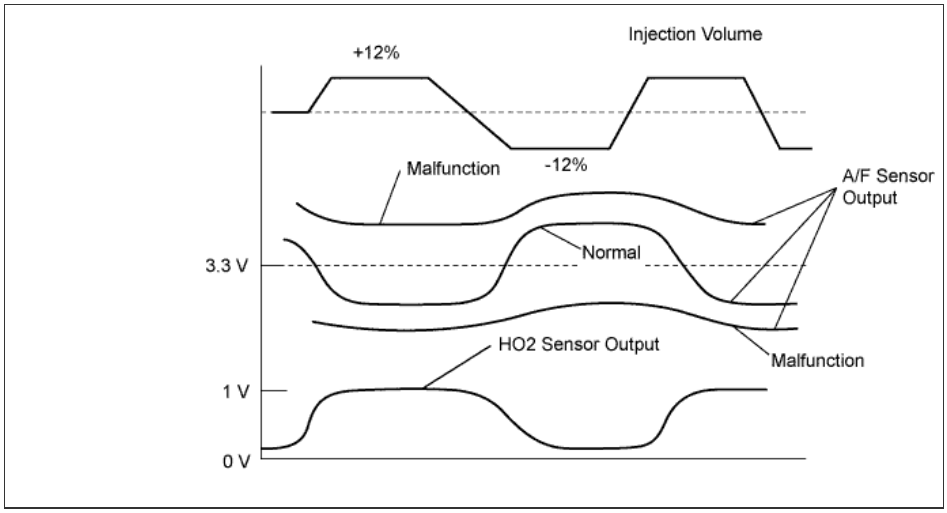
- **Change the fuel injection volume within the range of -12% and +12%. The injection volume can be changed in 1% graduations within the range.**
- **The A/F sensor is displayed as AFS B1 S1 or AFS B2 S1, and the HO2 sensor is displayed as O2S B1 S2 or O2S B2 S2 on the tester.**

Result

Display Item (Sensor)	Voltage Variation	Proceed to
AFS B1 S1 (A/F) AFS B2 S1 (A/F)	Alternates between higher than and below 3.3 V	OK
	Remains at higher than 3.3 V	NG
	Remains at below 3.3 V	NG

HINT:

A normal HO2 sensor voltage (O2S B1 S2 or O2S B2 S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains at either less or higher than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → Go to step 22

OK ↓

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK ↓

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (**Click here**)

OK ↓

11.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (**Click here**)

OK ↓

12.INSPECT ENGINE COOLANT TEMPERATURE SENSOR

a. Inspect the engine coolant temperature sensor (Click here).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

13.INSPECT PCV HOSE

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

14.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

15.CHECK SPARKS AND IGNITION

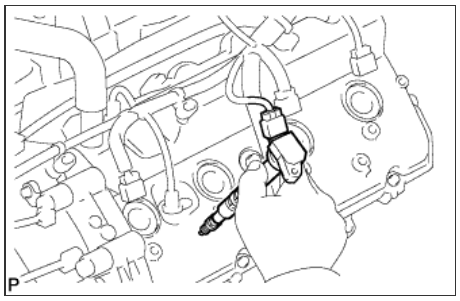
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

REPLACE ECM (Click here)

16.CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

17.INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

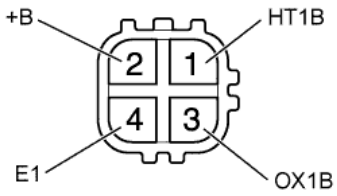
a. Disconnect the C17 or C18 heated oxygen (HO2) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

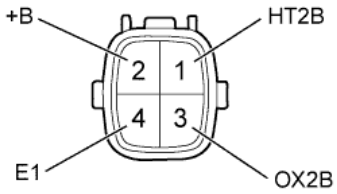
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT1B) - 4 (E1)	Always	10 kΩ or higher
1 (HT2B) - 2 (+B)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 4 (E1)	Always	10 kΩ or higher

Component without harness connected
(HO2 Sensor for Bank 1)



Component without harness connected
(HO2 Sensor for Bank 2)



NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK

18.INSPECT INTEGRATION NO.1 RELAY (EFI RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

iii. Reinstall the EFI MAIN fuse.

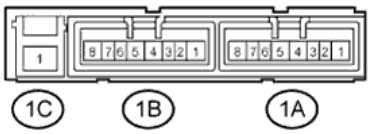
c. Inspect the EFI relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	No battery voltage applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage applied to terminals 1B-2 and 1B-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY

OK

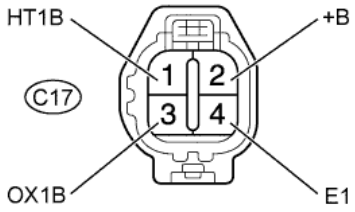
19.CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

a. Disconnect the C17 or C18 HO2 sensor connector.

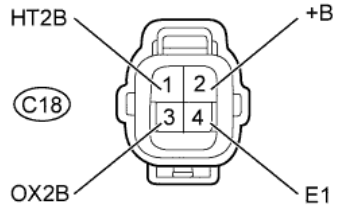
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

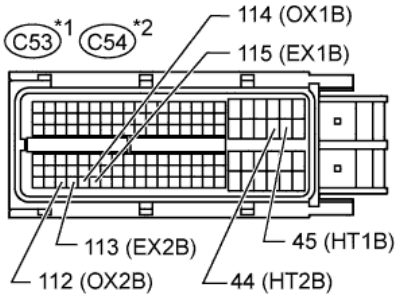
Front view of wire harness connector:
(to HO2 Sensor for Bank 1)



Front view of wire harness connector:
(to HO2 Sensor for Bank 2)



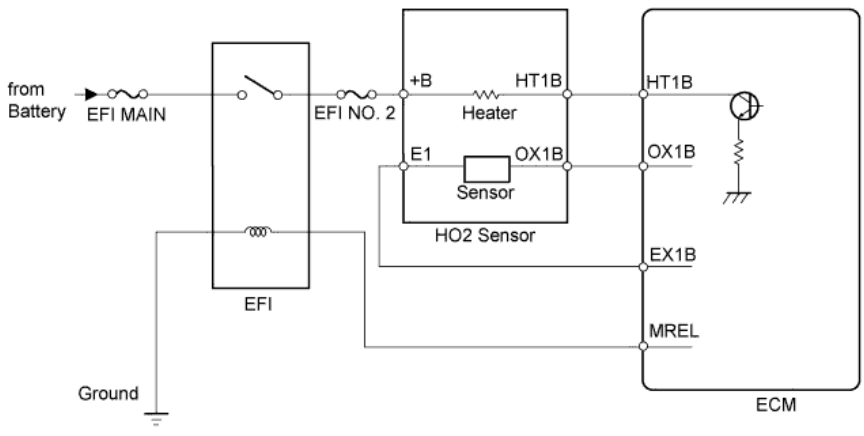
Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Reference (System Diagram):



Y

Tester Connection	Switch Condition	Specified Condition
C17-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C18-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.

e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C53-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C53-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C53-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C53-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C53-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C53-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C53-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C53-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C53-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C53-112 (OX2B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C17-1 (HT1B) - C54-45 (HT1B)	Always	Below 1 Ω
C17-3 (OX1B) - C54-114 (OX1B)	Always	Below 1 Ω
C17-4 (E1) - C54-115 (EX1B)	Always	Below 1 Ω
C18-1 (HT2B) - C54-44 (HT2B)	Always	Below 1 Ω
C18-3 (OX2B) - C54-112 (OX2B)	Always	Below 1 Ω
C18-4 (E1) - C54-113 (EX2B)	Always	Below 1 Ω
C17-1 (HT1B) or C54-45 (HT1B) - Body ground	Always	10 kΩ or higher
C17-3 (OX1B) or C54-114 (OX1B) - Body ground	Always	10 kΩ or higher
C18-1 (HT2B) or C54-44 (HT2B) - Body ground	Always	10 kΩ or higher
C18-3 (OX2B) or C54-112 (OX2B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

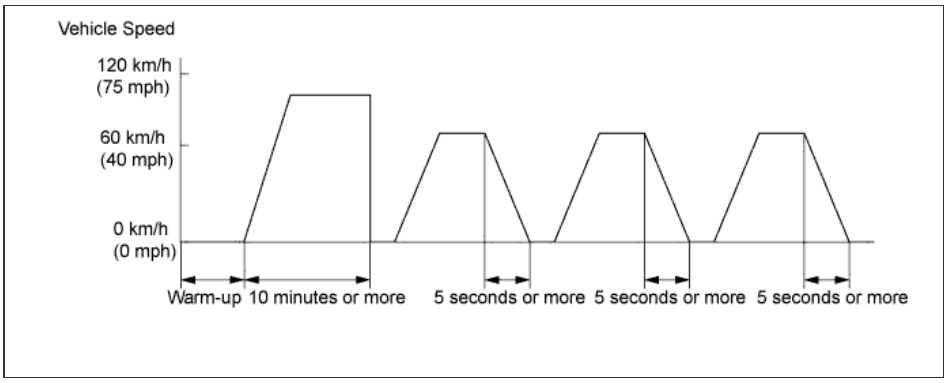
OK

20.REPLACE HEATED OXYGEN SENSOR

a. Replace the heated oxygen sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Turn the tester on.

g. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

h. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

i. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE AIR FUEL RATIO SENSOR (**Click here**)

OK

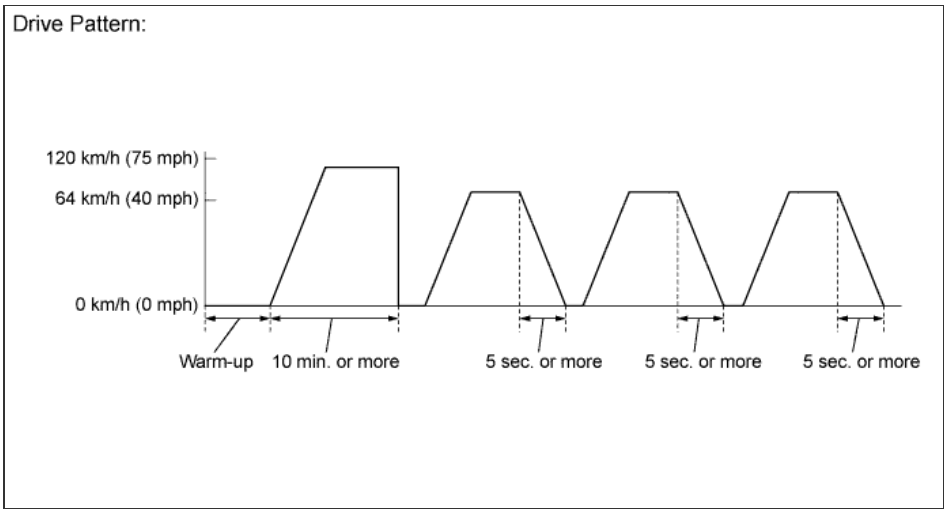
REPAIR COMPLETE

22.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

23.PERFORM CONFIRMATION DRIVING PATTERN



a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Warm up the engine until the engine coolant temperature is 75°C (167°F) or higher.

d. Drive the vehicle at 60 to 120 km/h (40 to 75 mph) for at least 10 minutes.

e. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times.

f. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.

g. Input DTCs: P0136, P0137, P0138, P0156, P0157 and P0158.

h. Check that DTC monitor is NORMAL. If DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

OK:
No DTC is output.

NG → REPLACE HEATED OXYGEN SENSOR (Click here)

OK → REPAIR COMPLETE

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

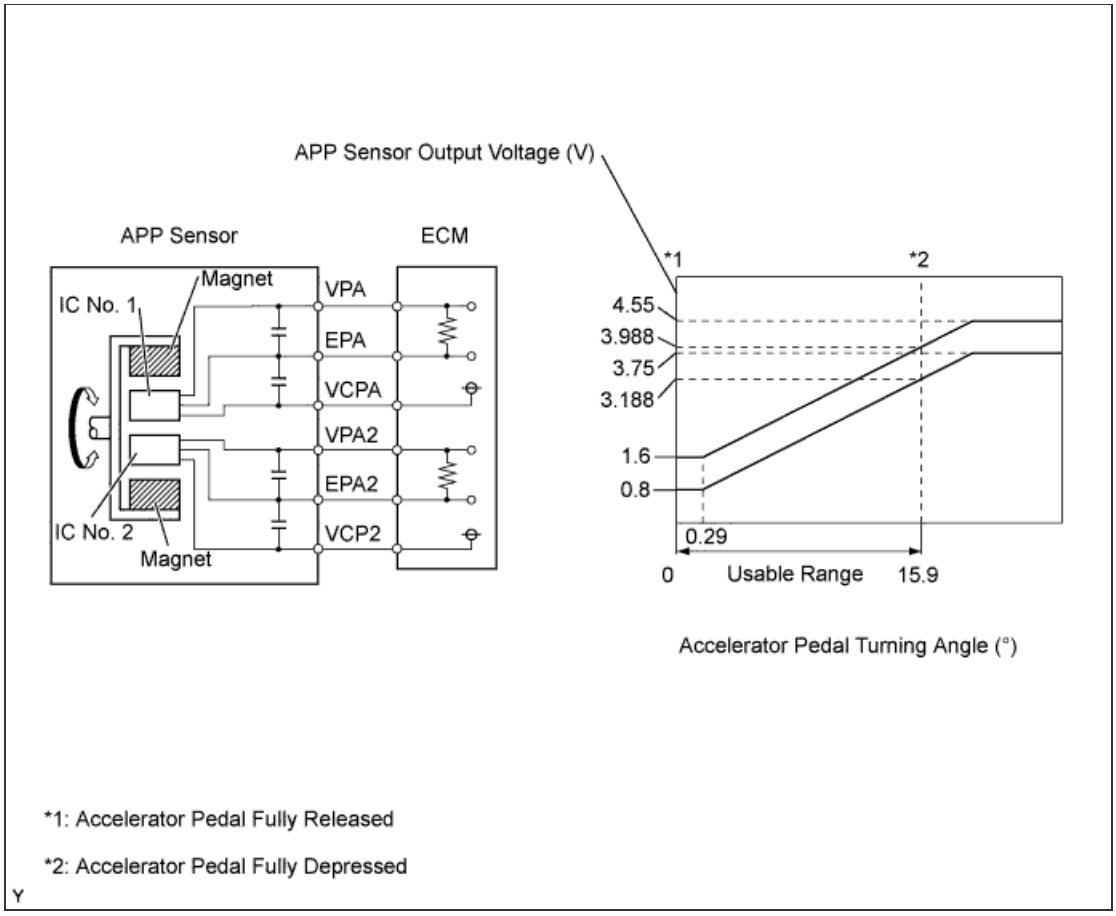
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

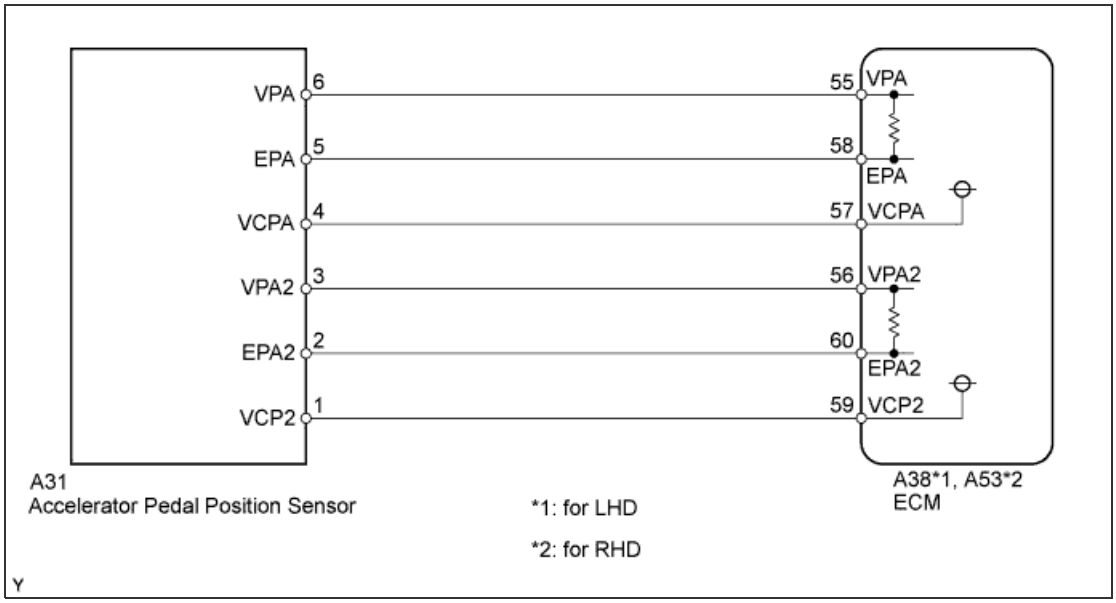
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

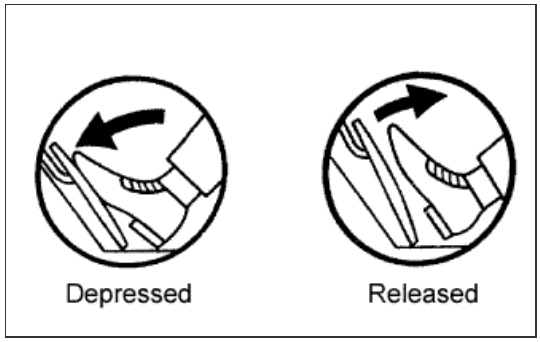
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

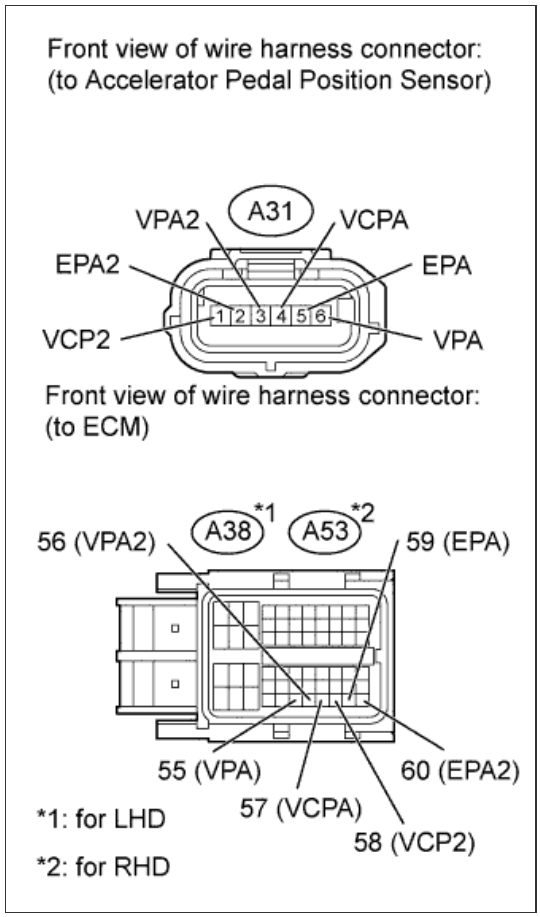
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

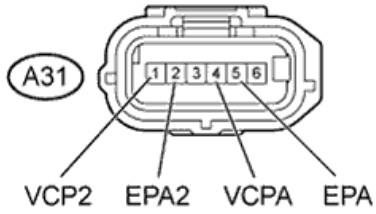
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

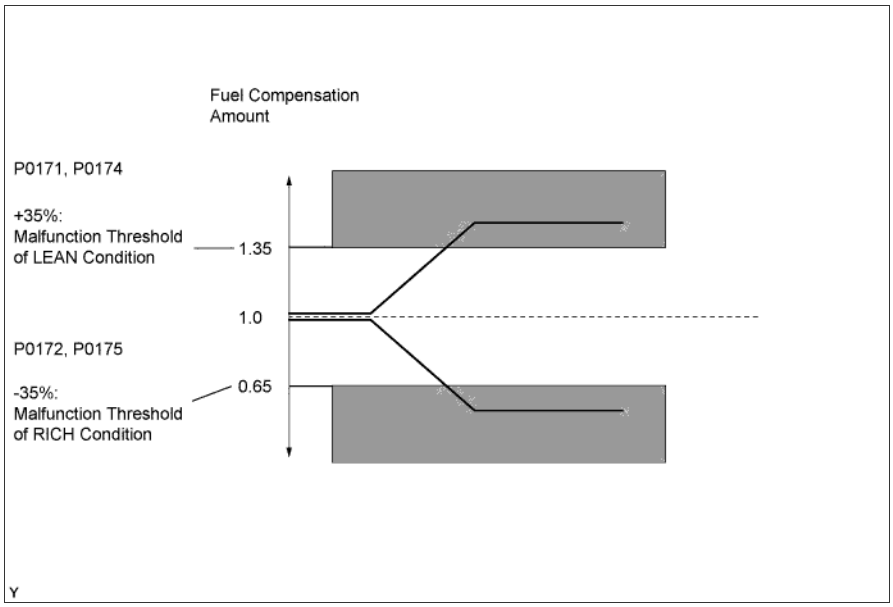
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

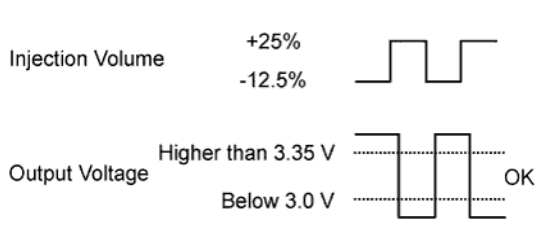
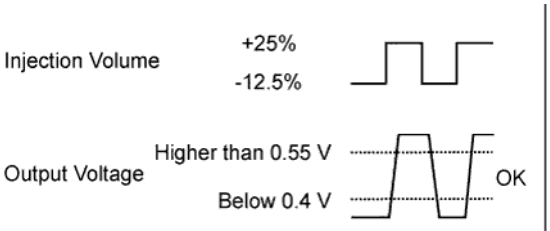
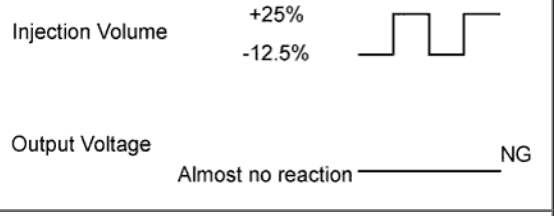
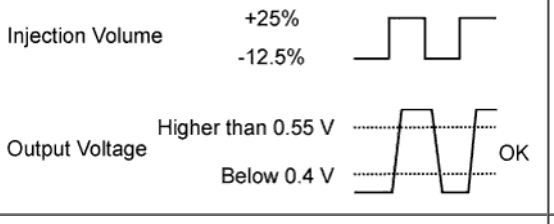
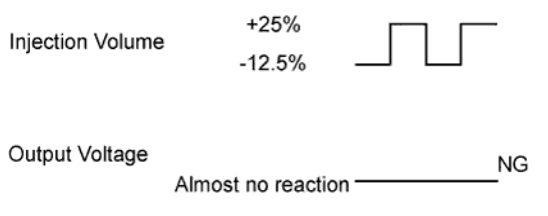
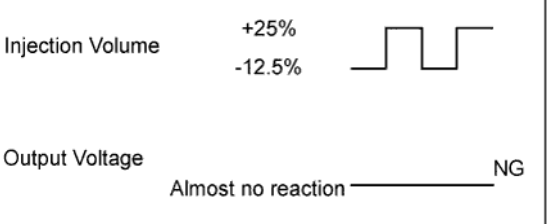
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

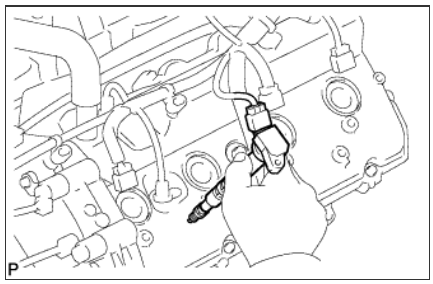
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

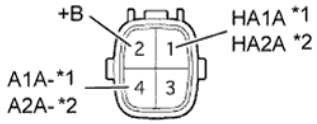
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

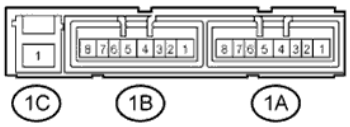
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

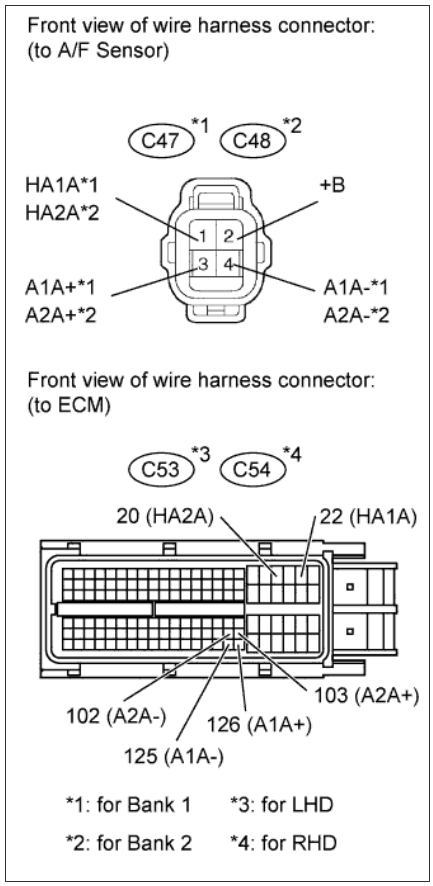
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

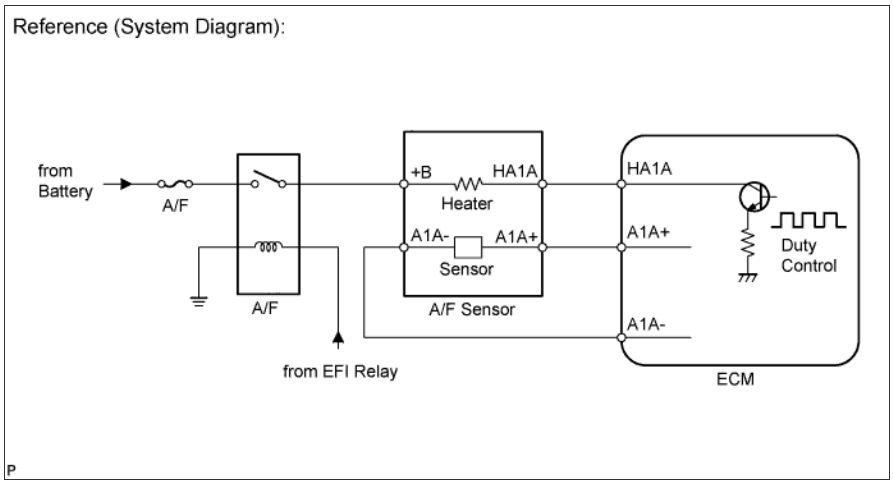
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

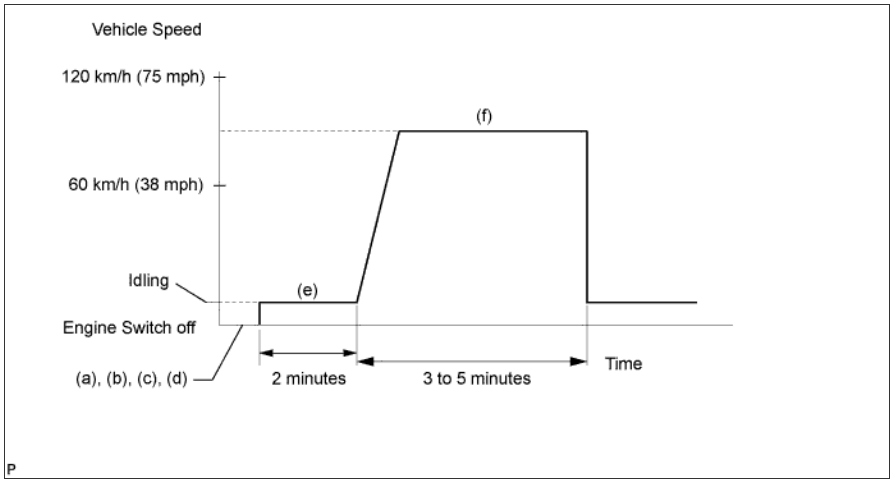
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

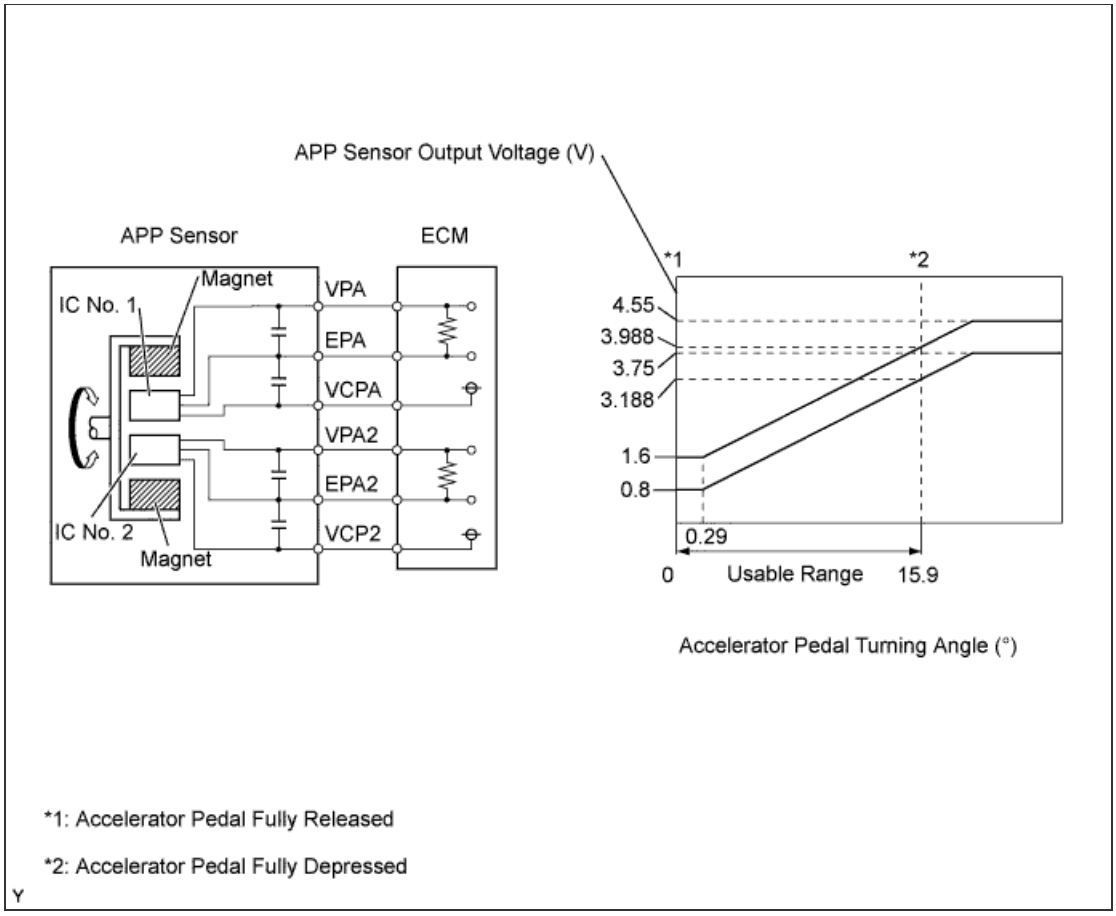
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

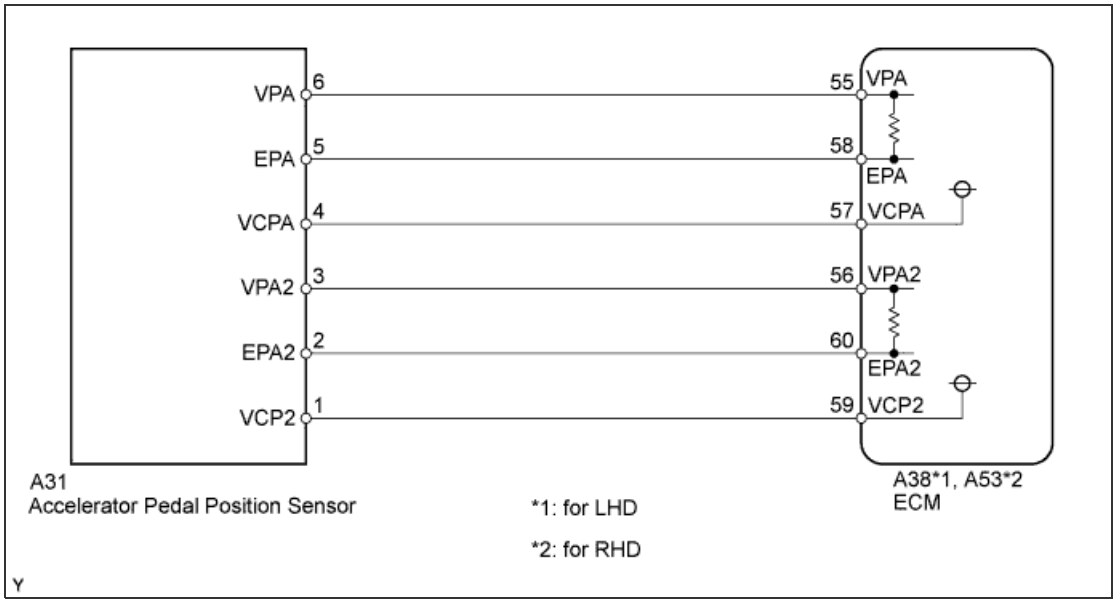
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

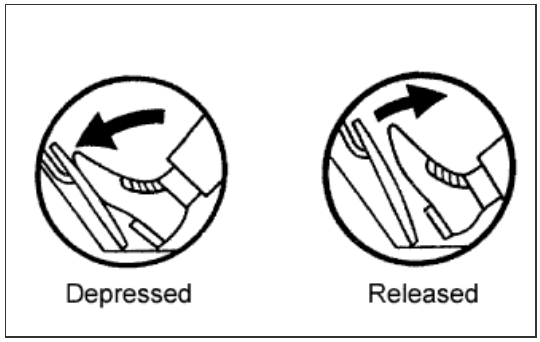
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

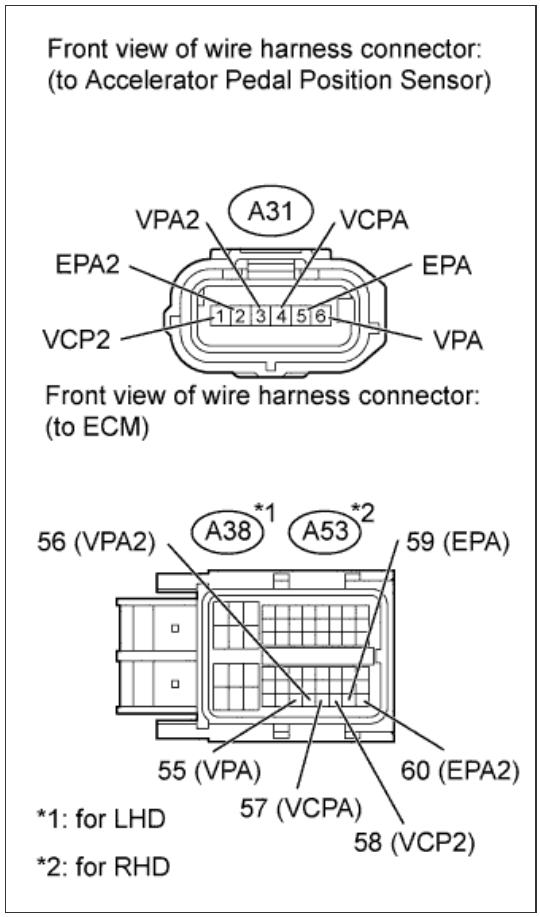
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

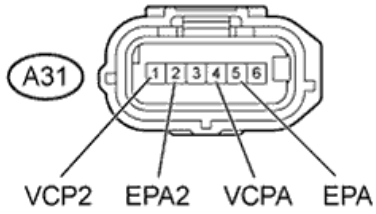
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

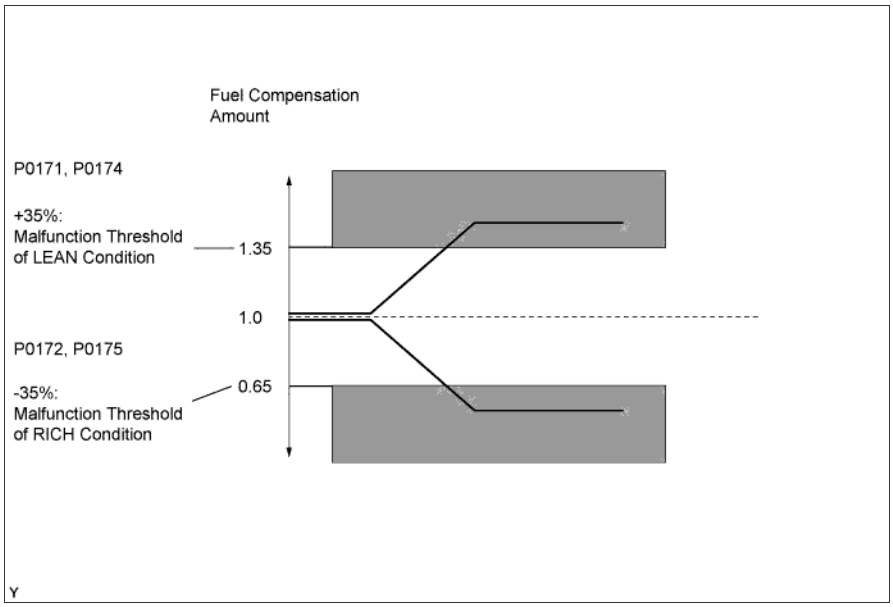
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

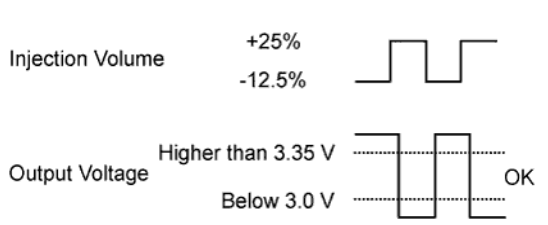
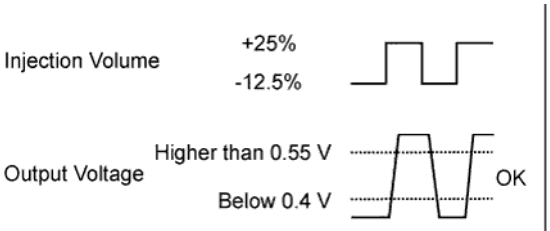
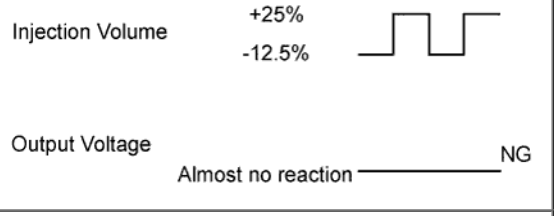
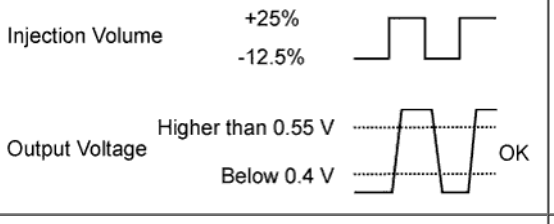
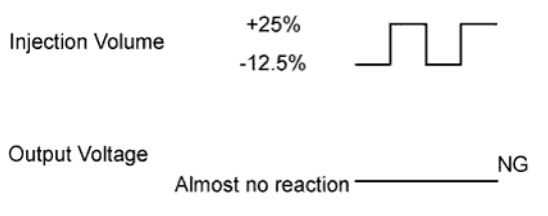
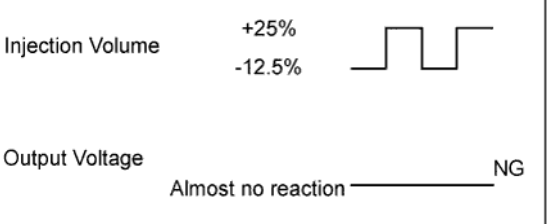
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

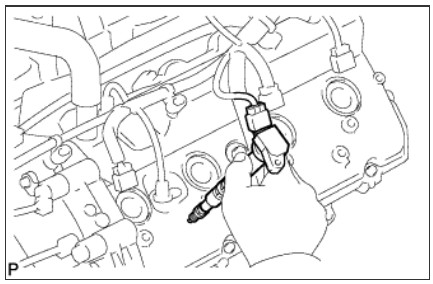
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

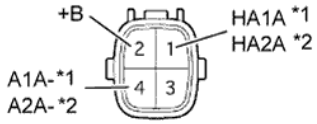
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

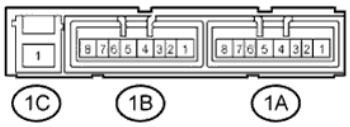
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

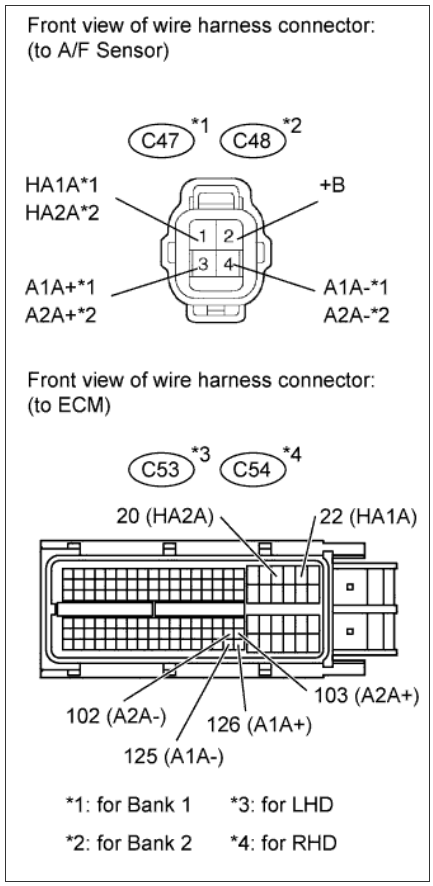
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

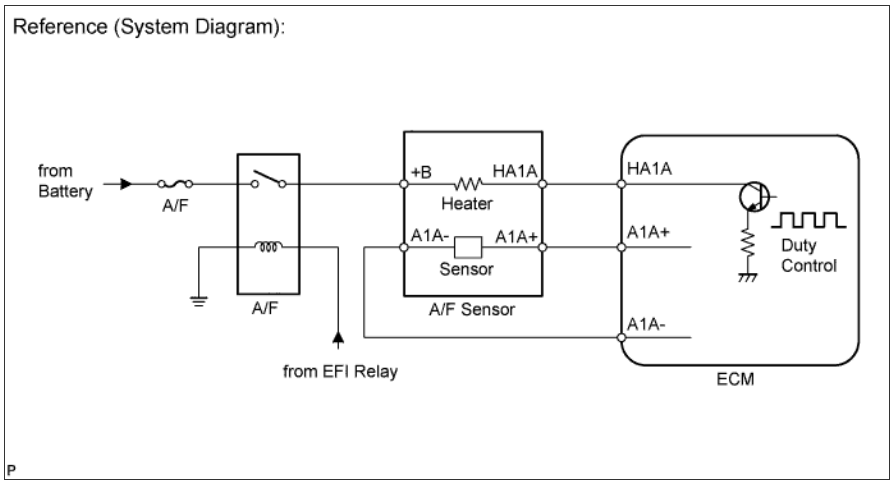
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

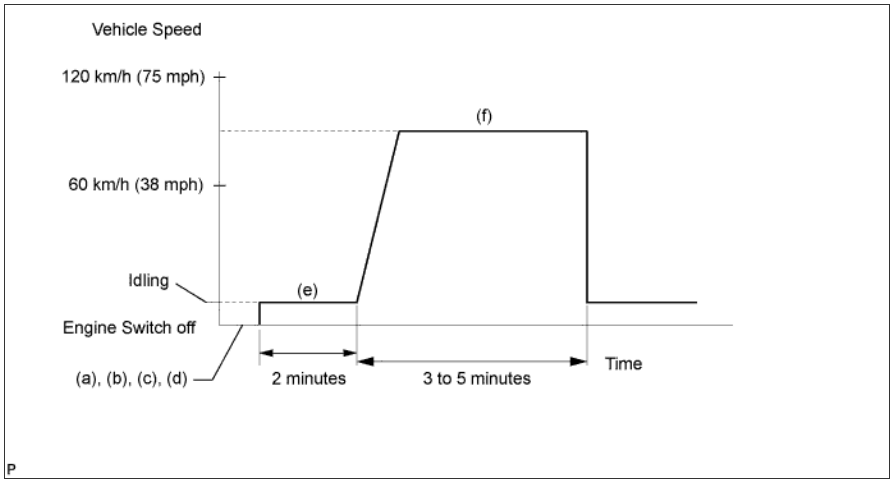
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

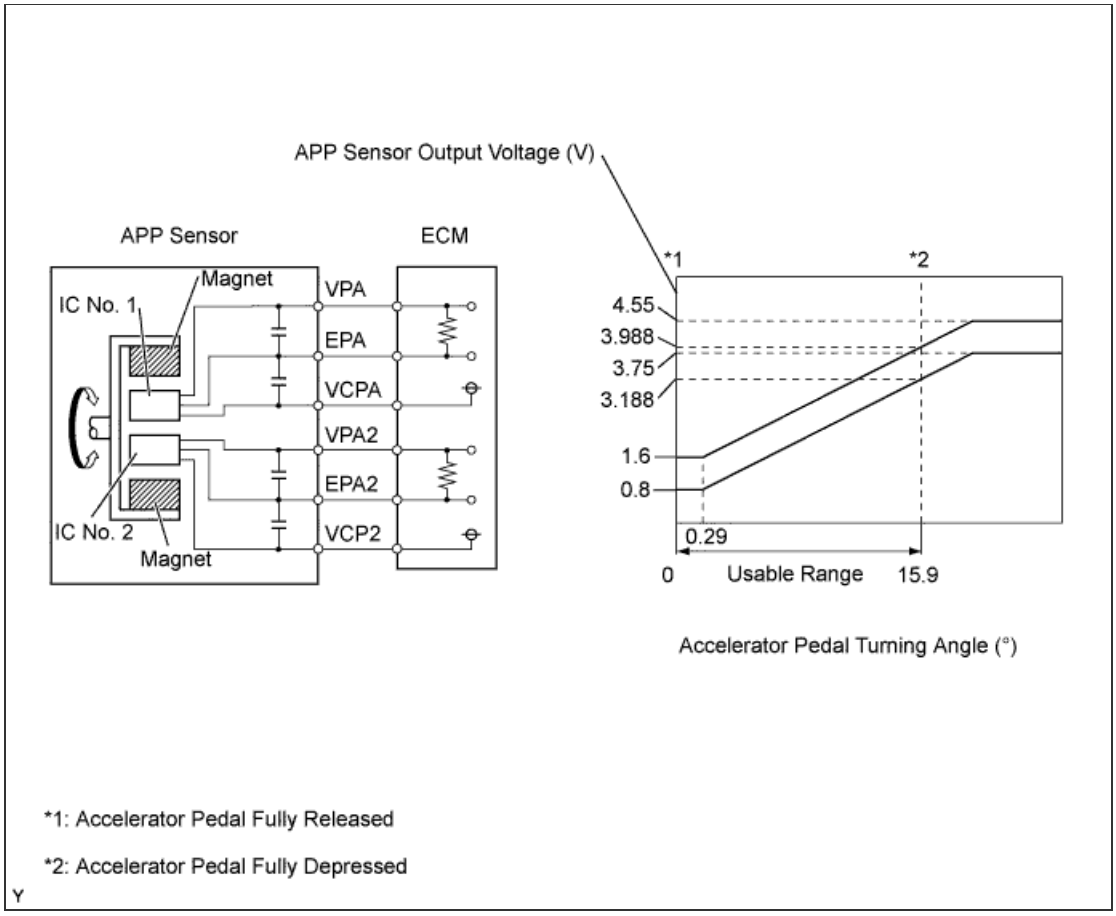
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

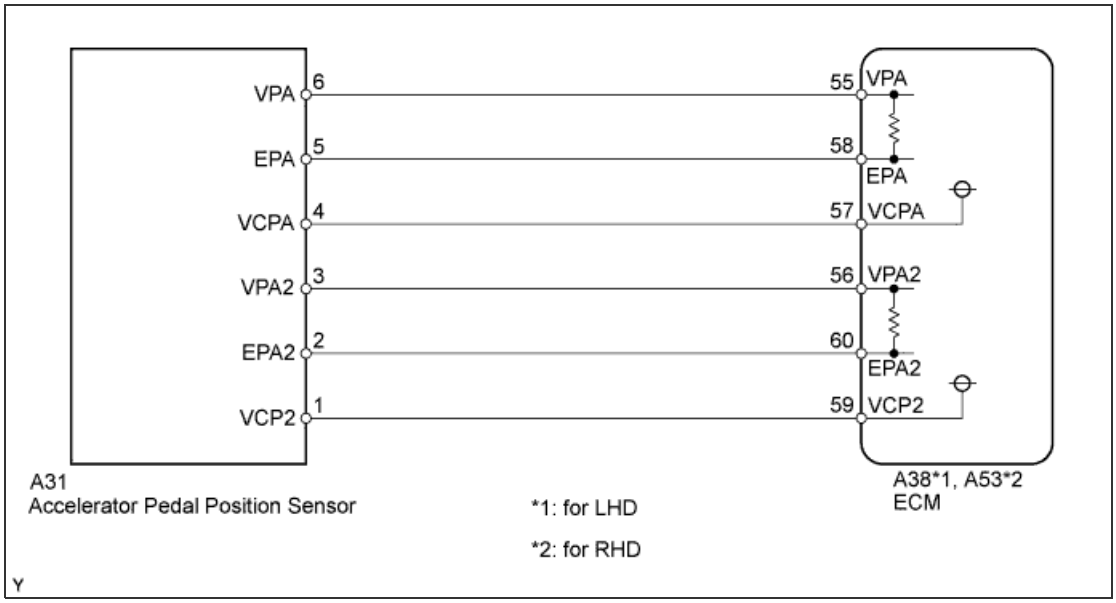
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

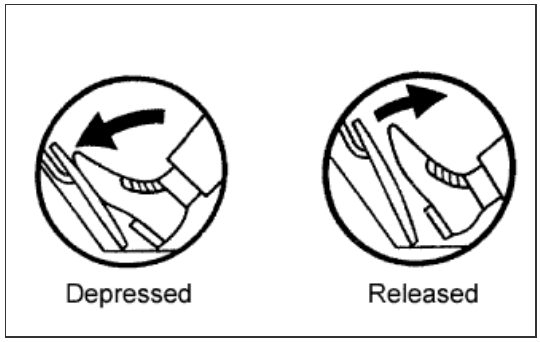
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

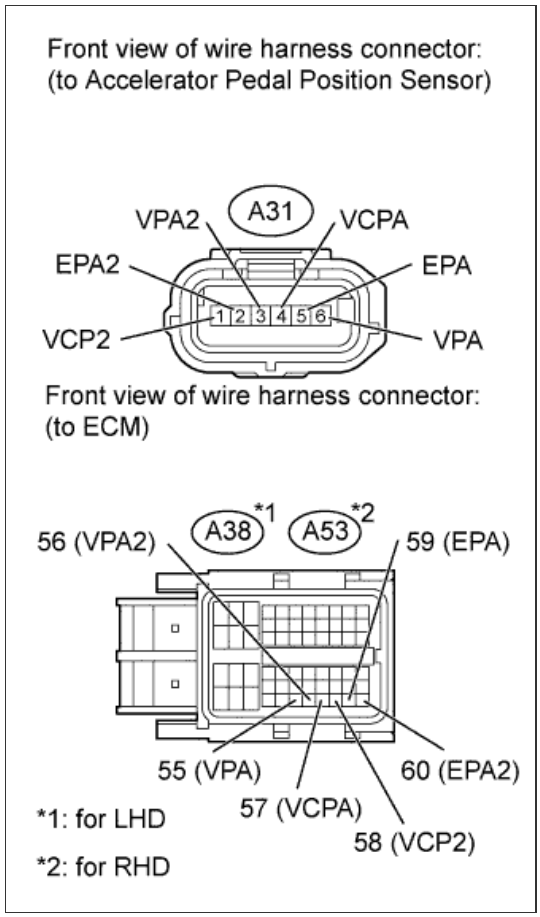
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

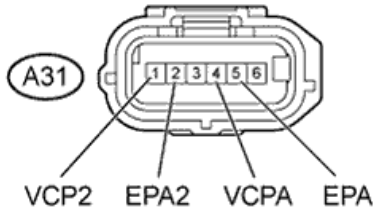
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

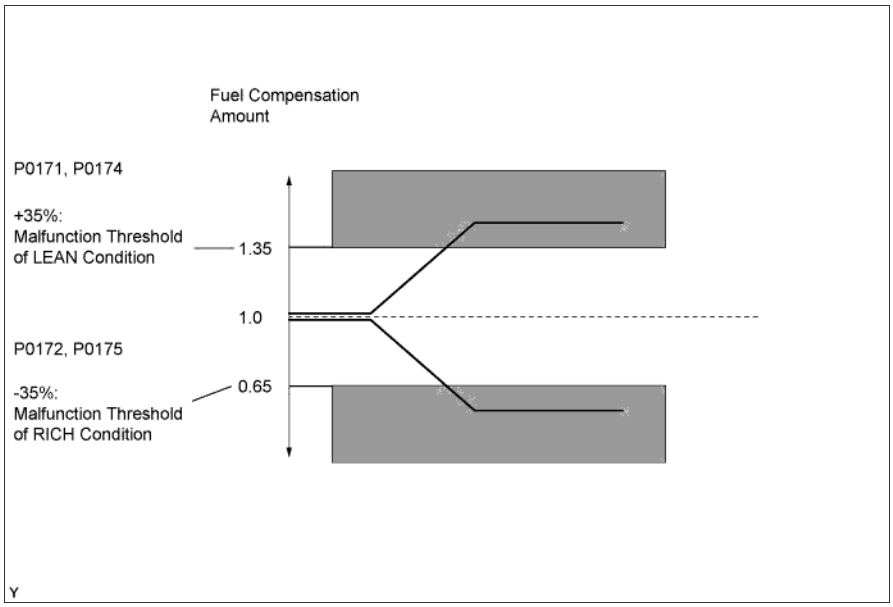
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

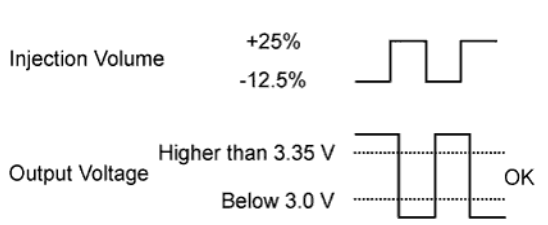
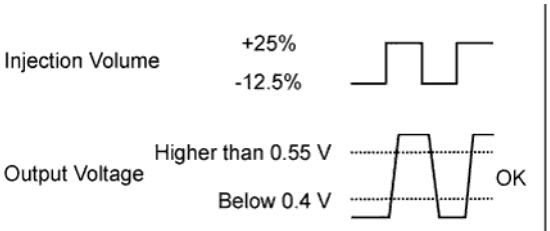
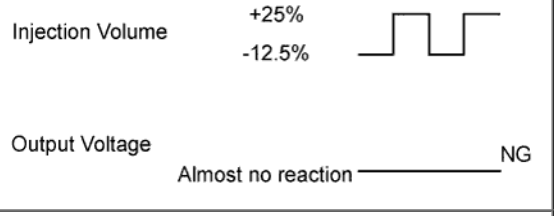
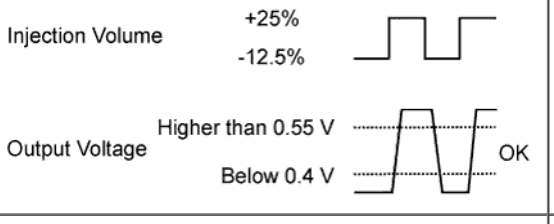
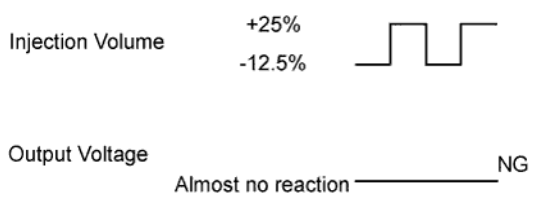
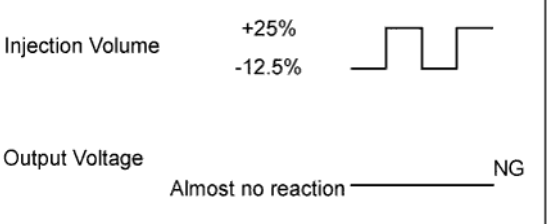
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

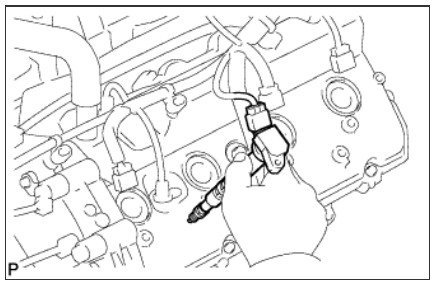
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

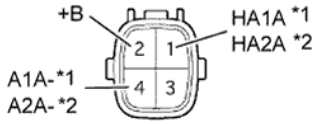
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

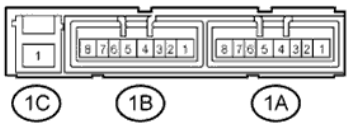
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

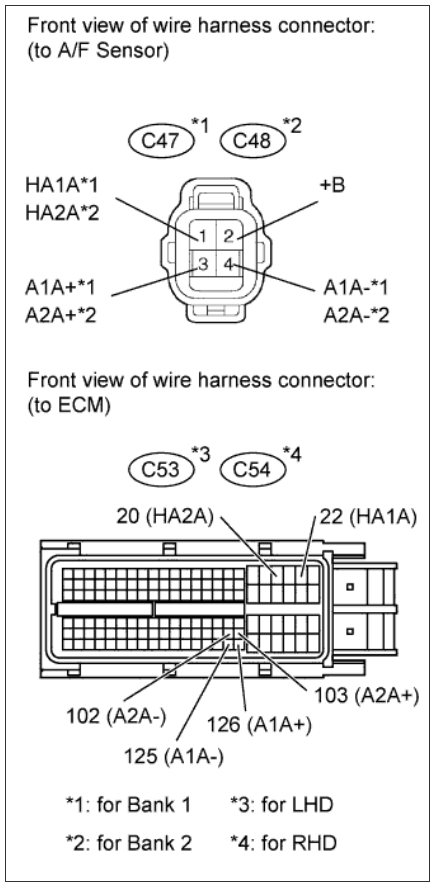
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

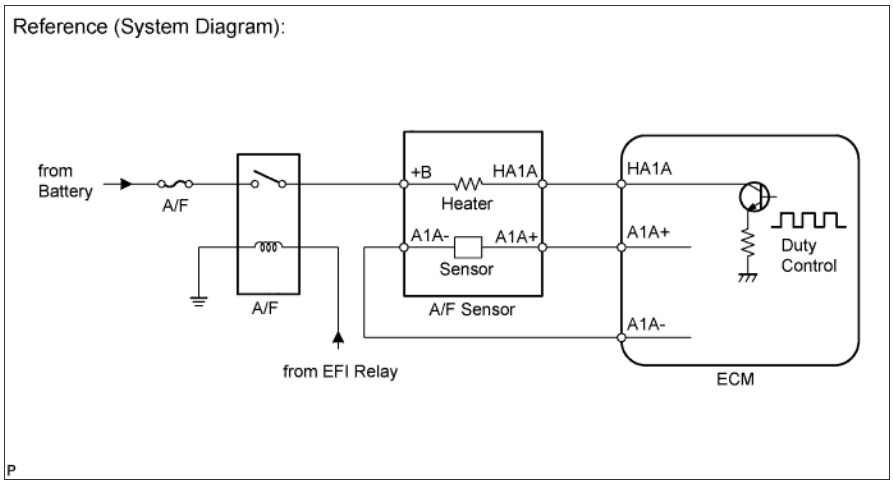
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

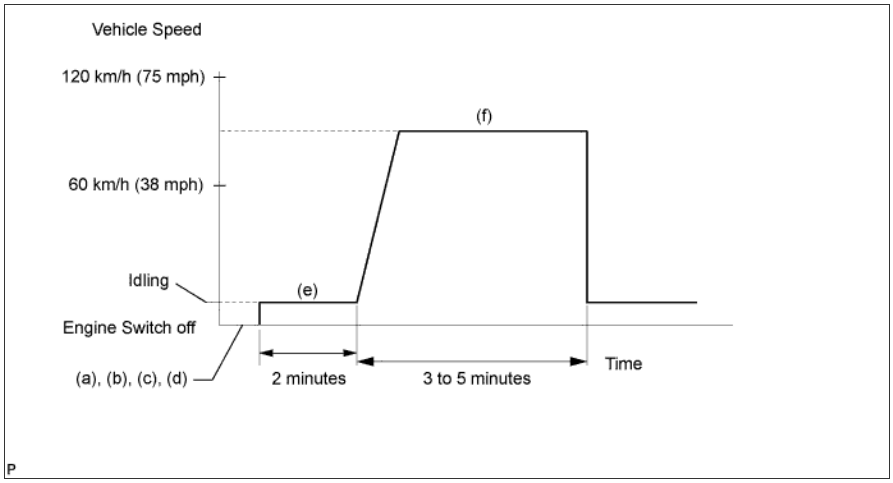
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

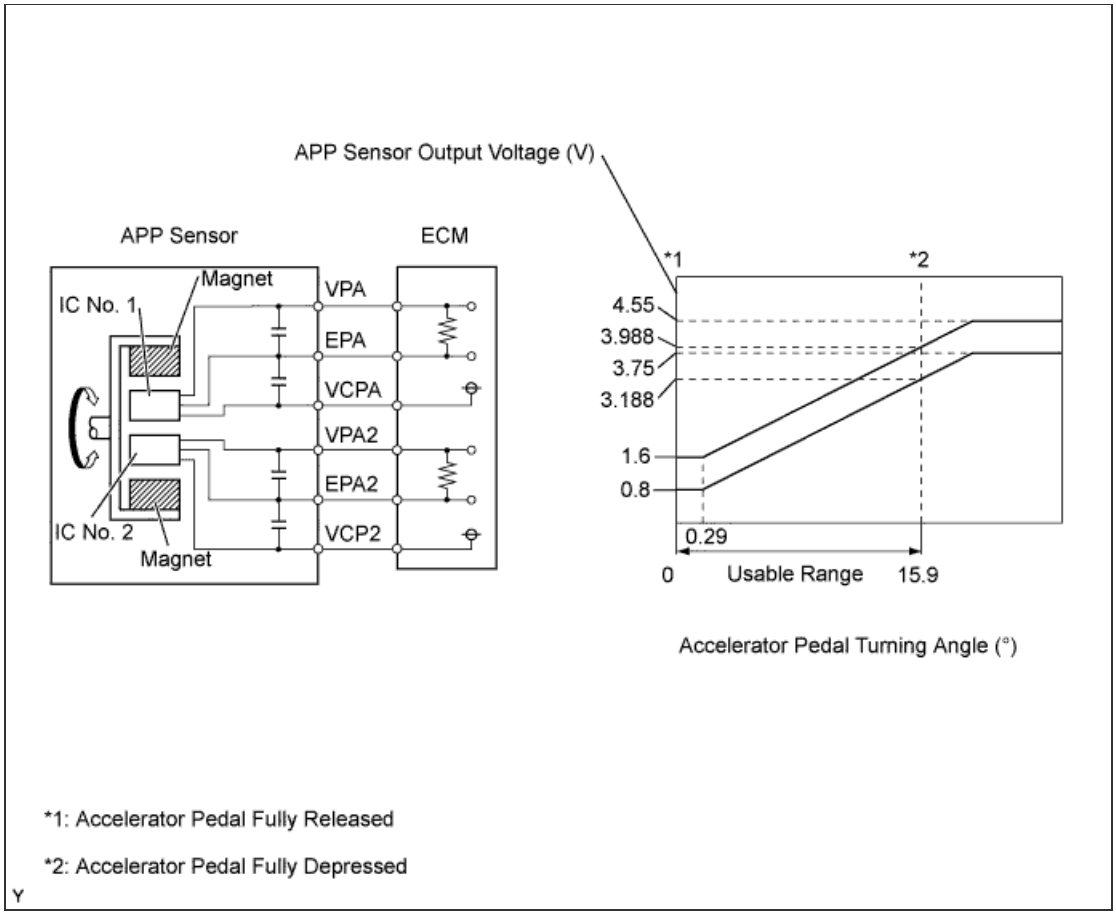
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

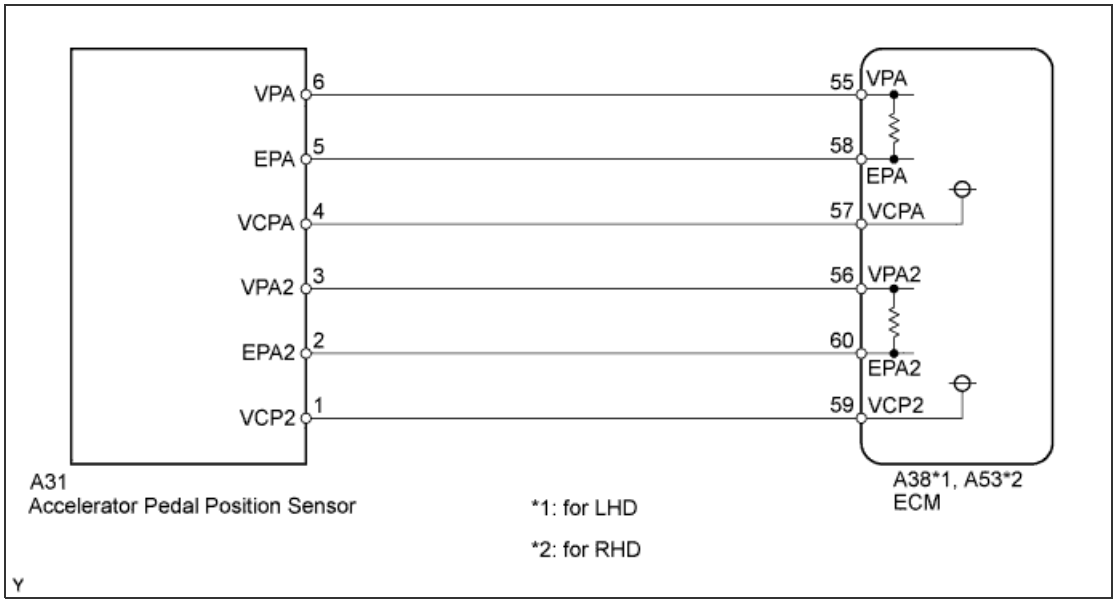
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

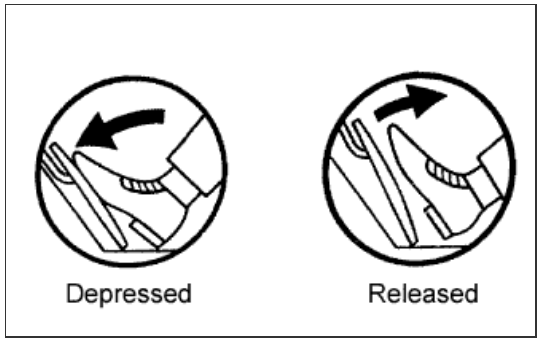
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

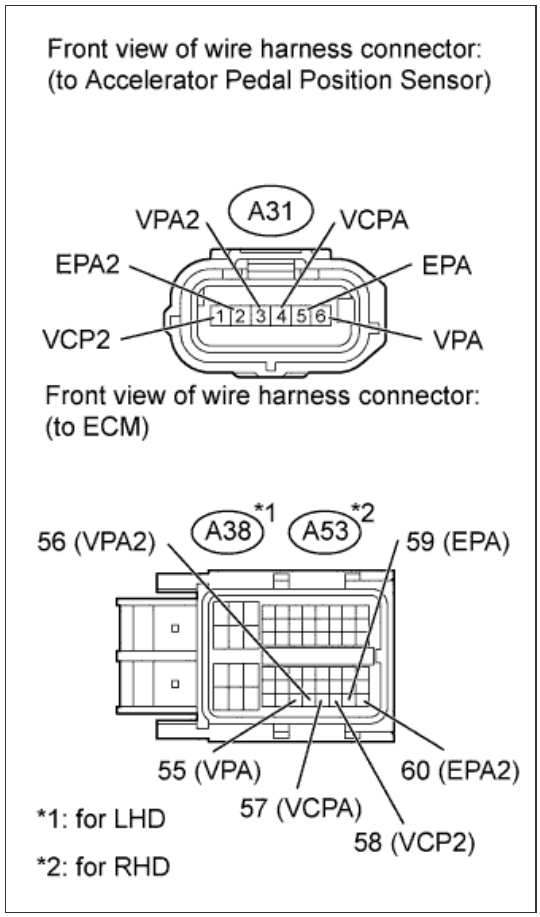
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

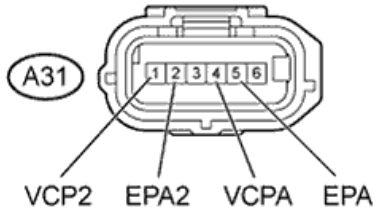
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

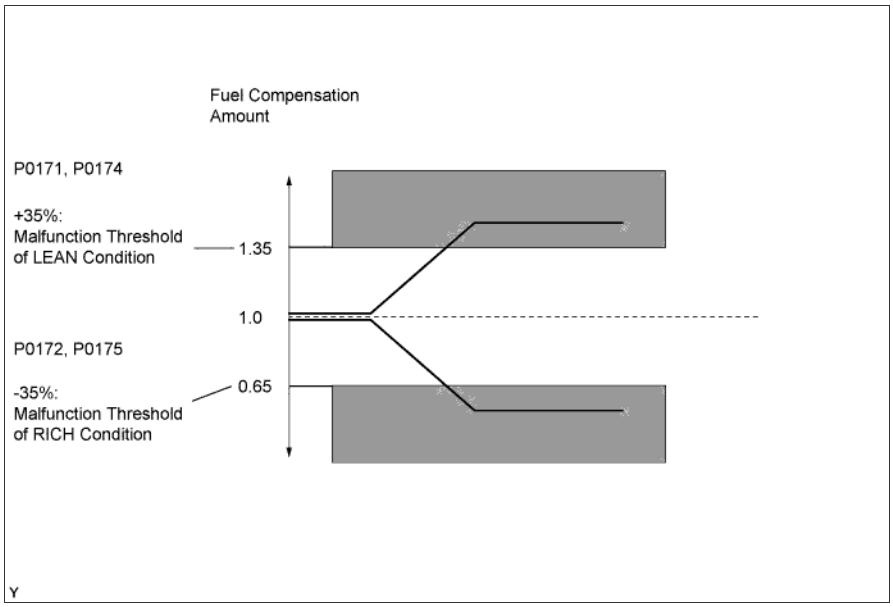
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

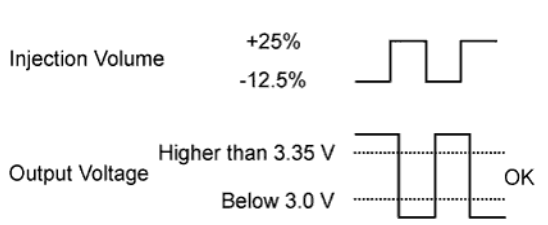
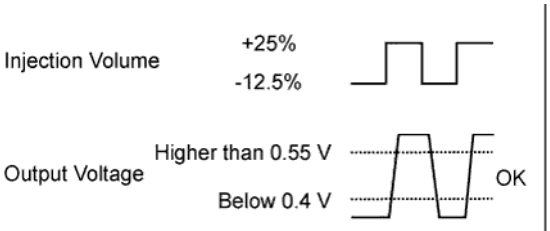
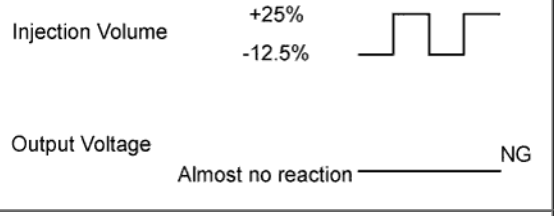
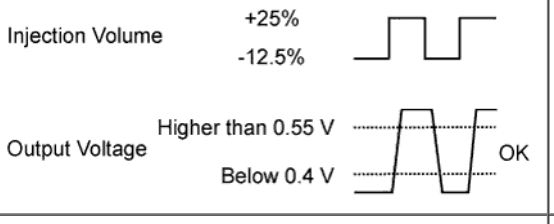
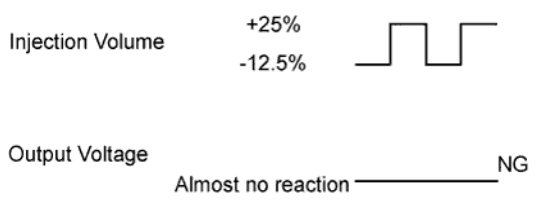
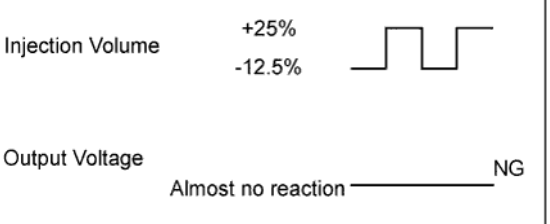
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

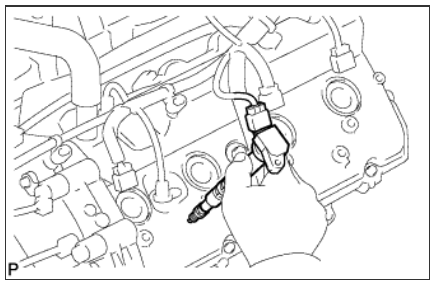
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

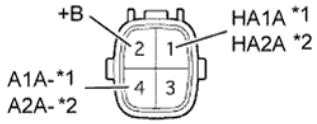
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

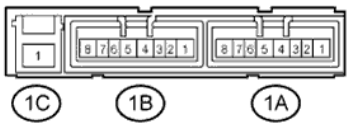
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

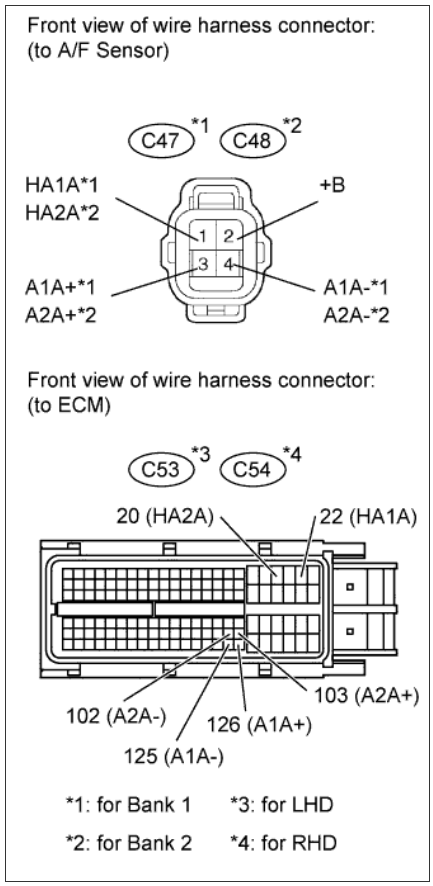
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

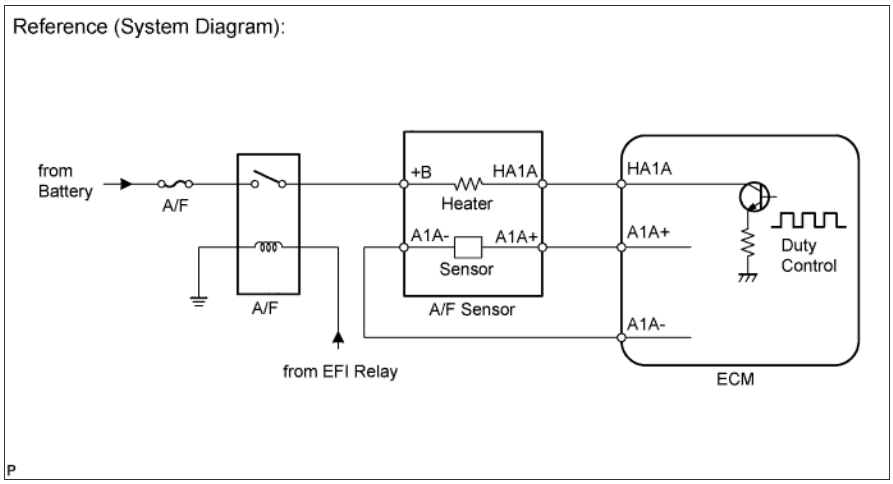
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

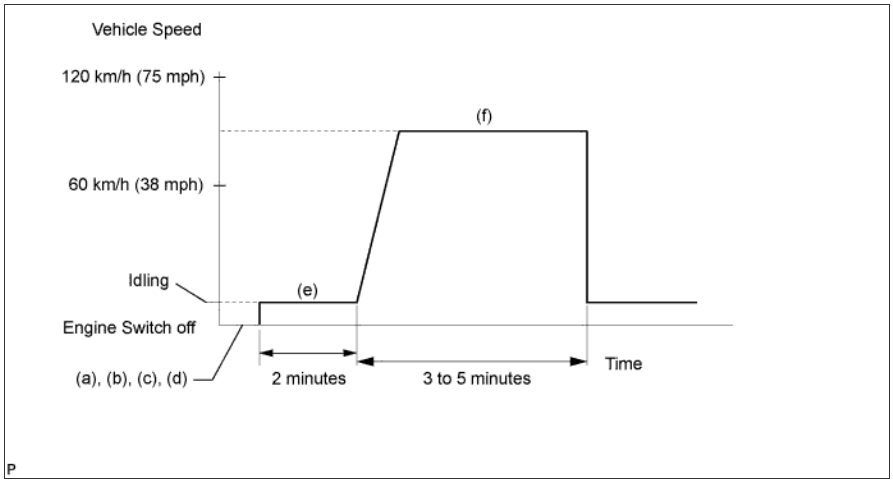
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

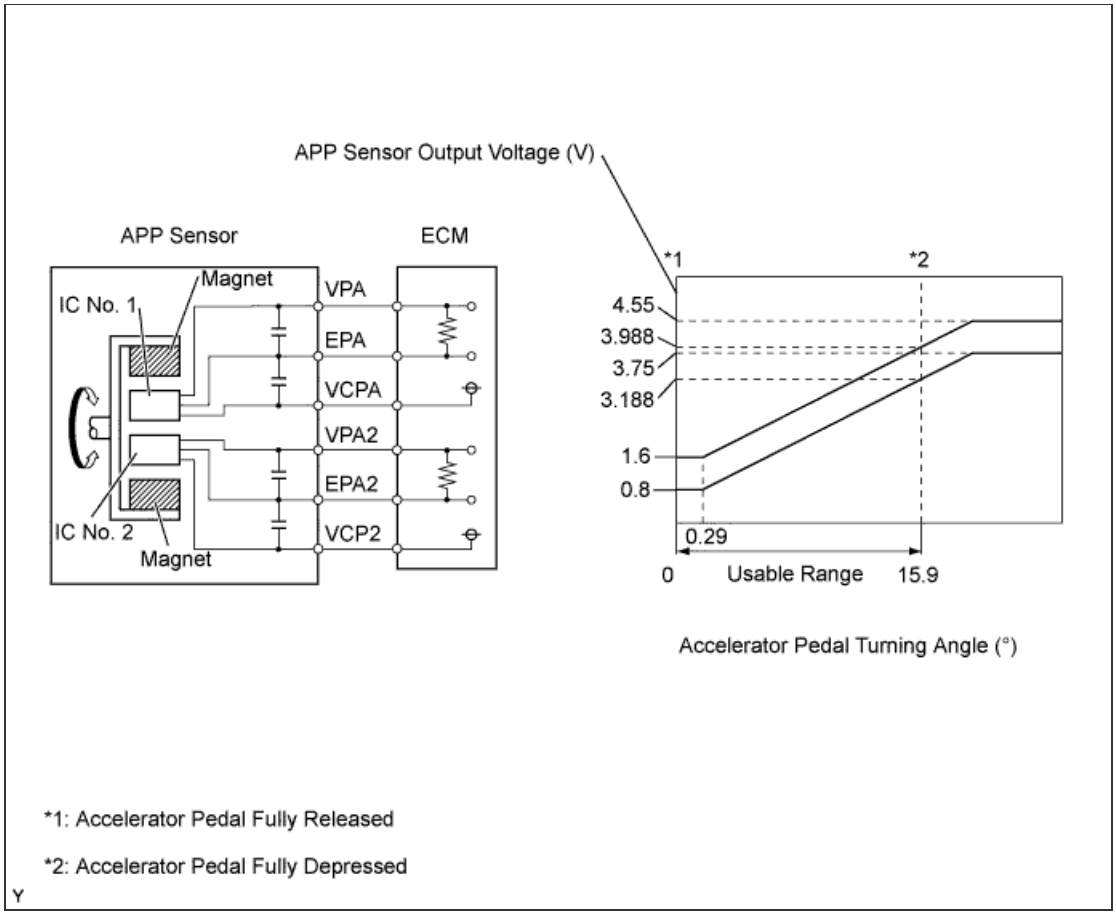
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

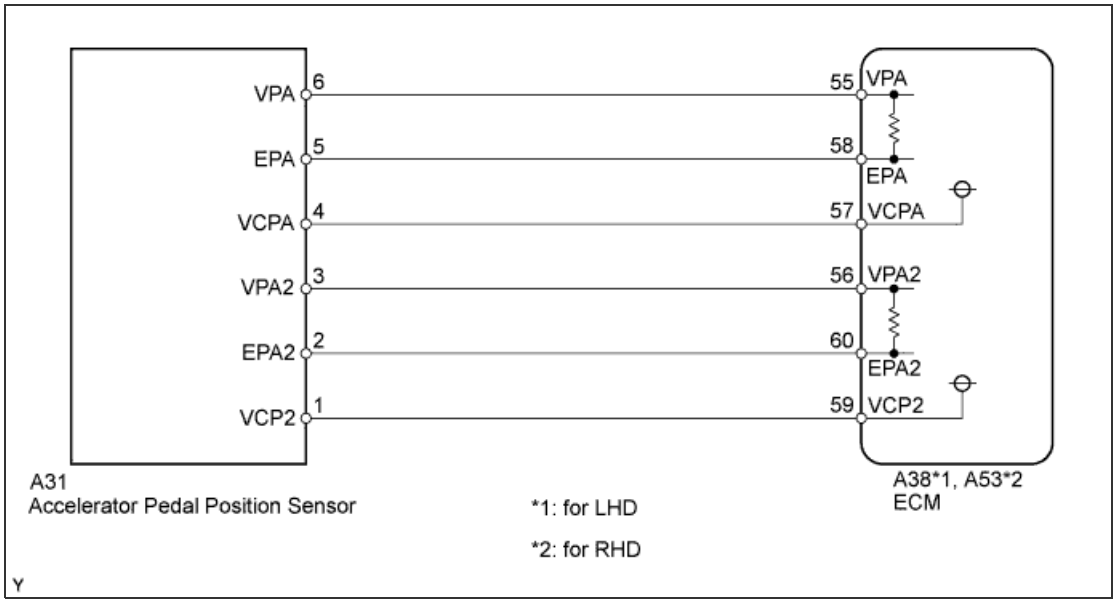
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

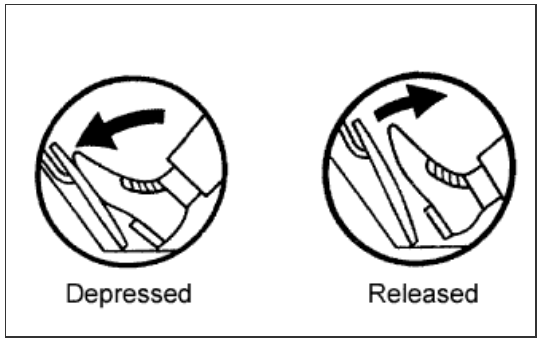
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

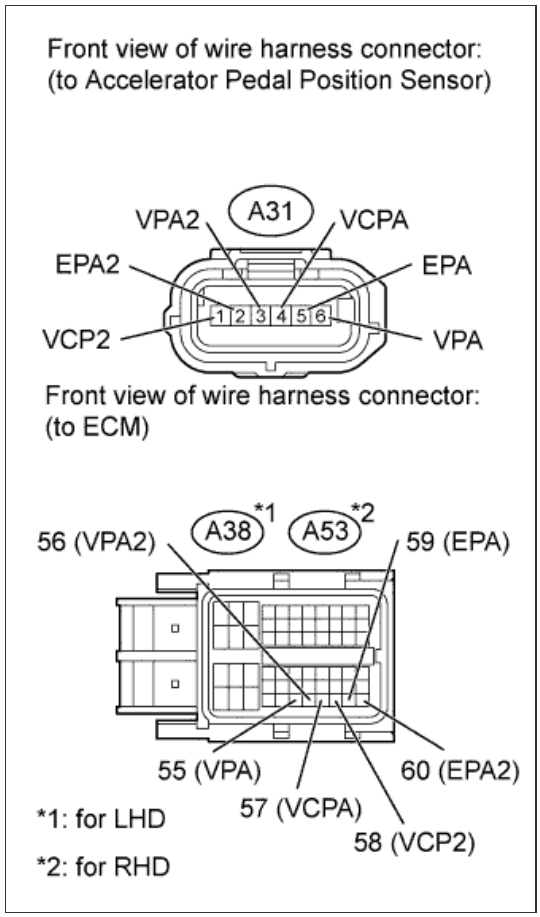
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

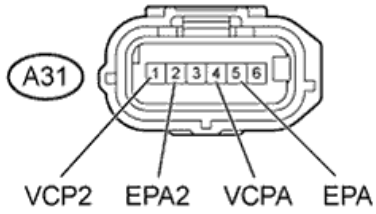
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

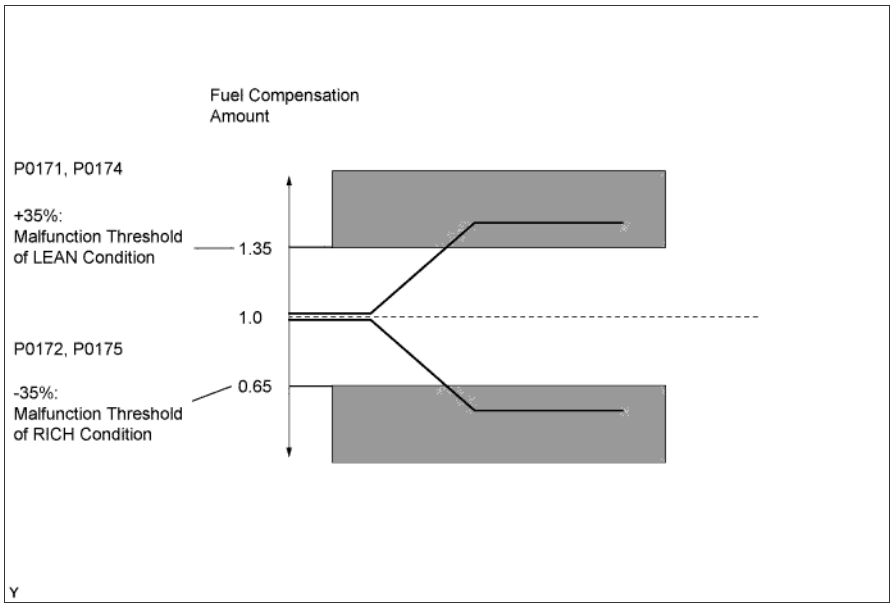
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

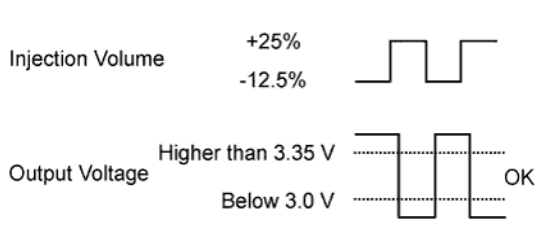
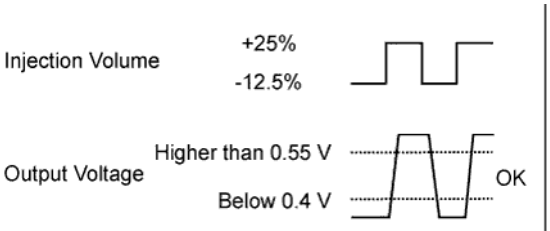
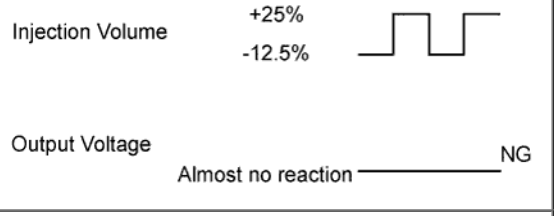
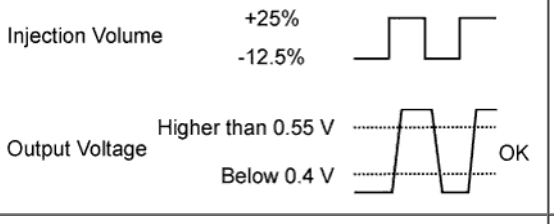
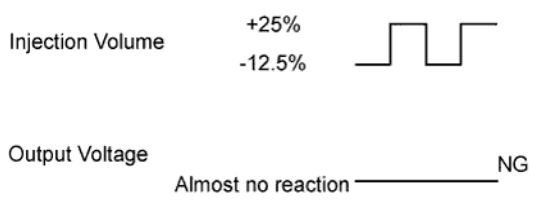
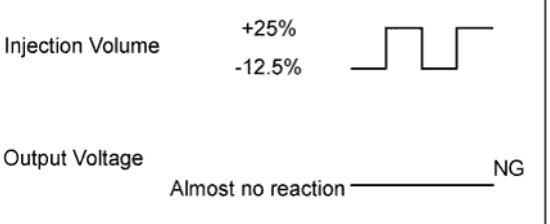
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

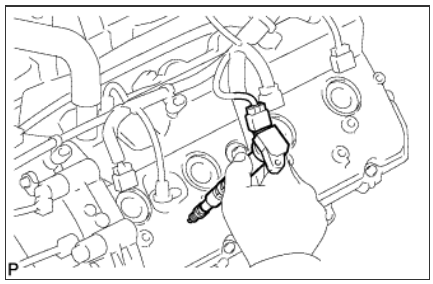
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

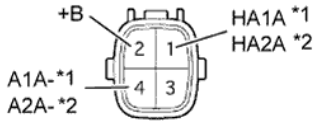
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

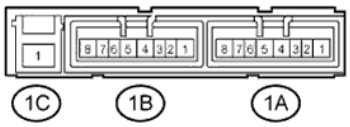
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

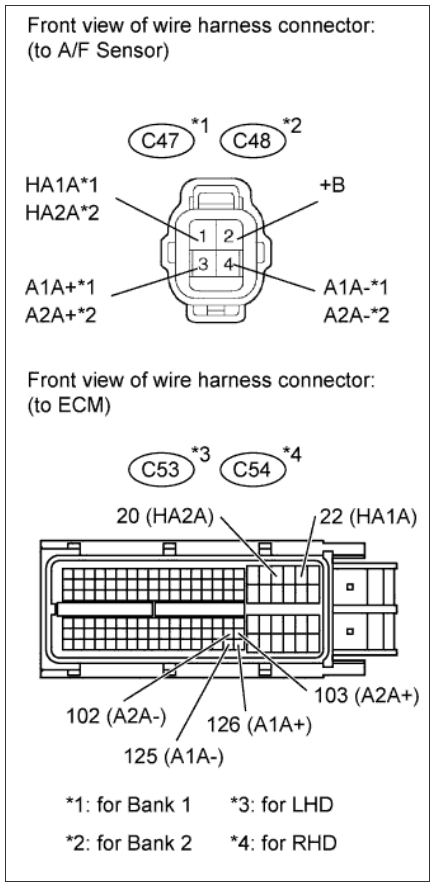
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

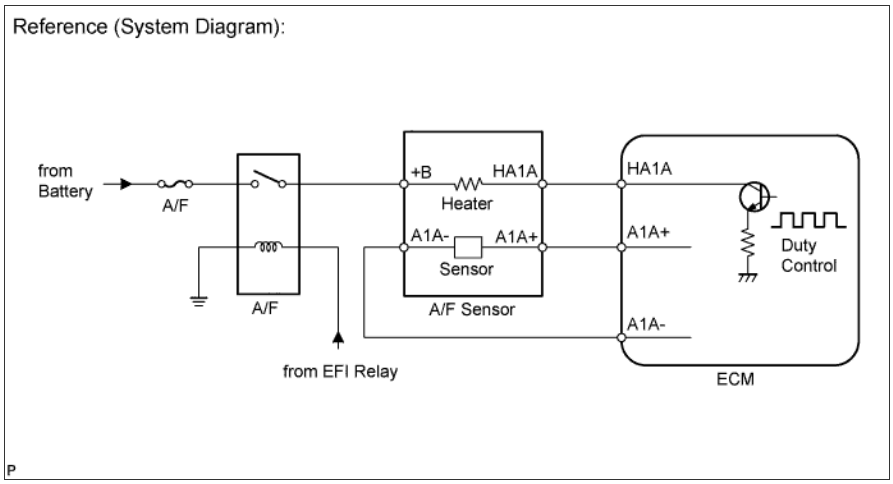
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

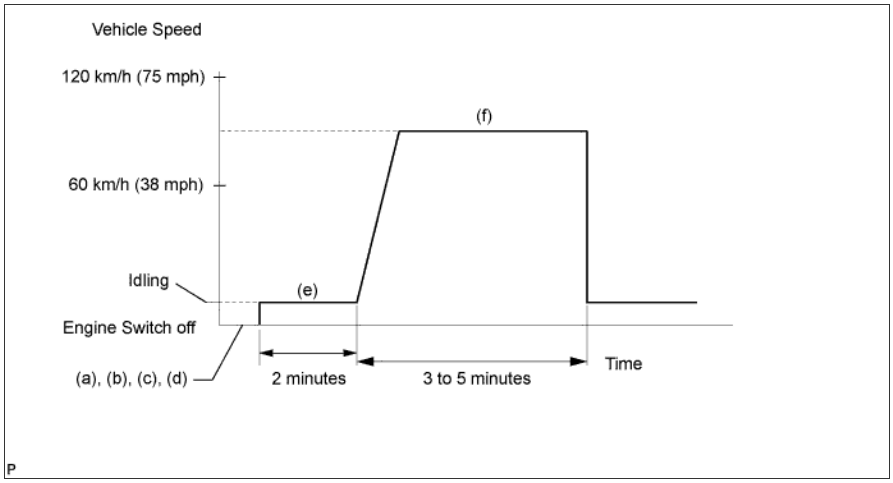
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

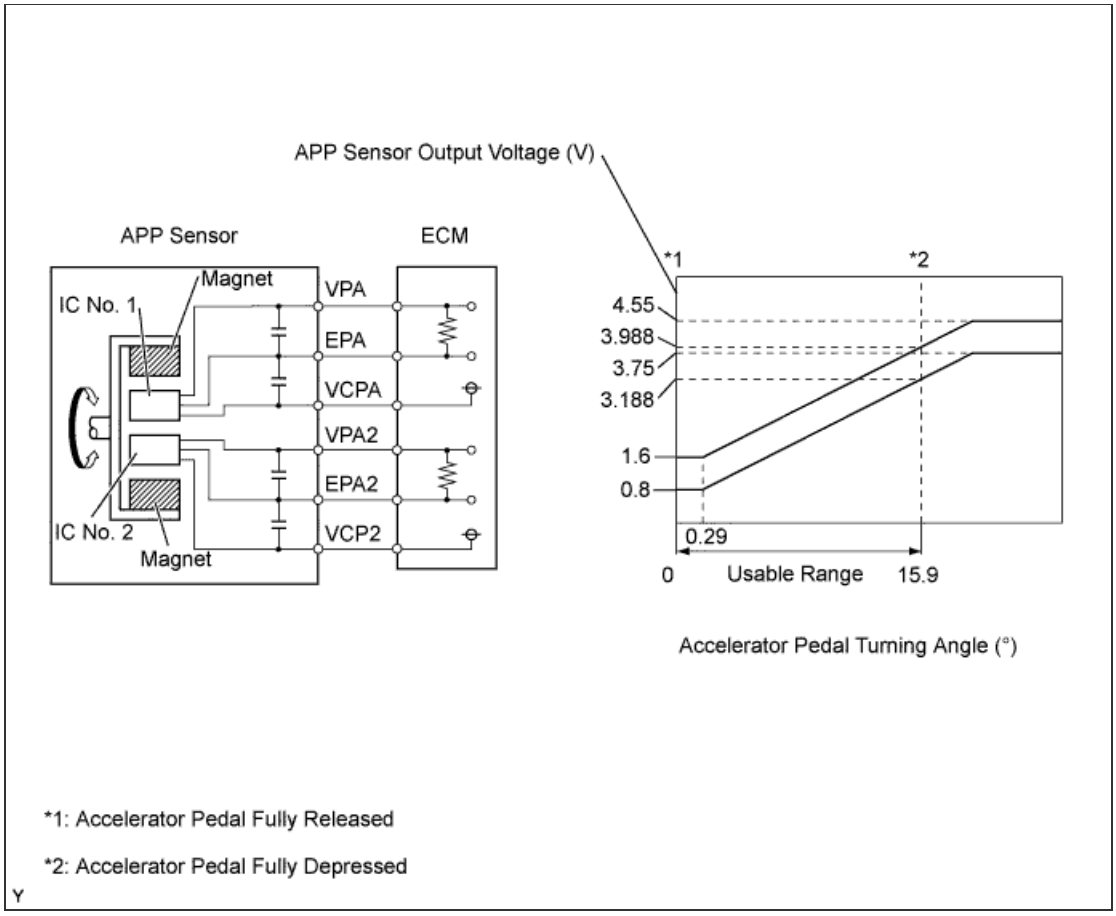
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

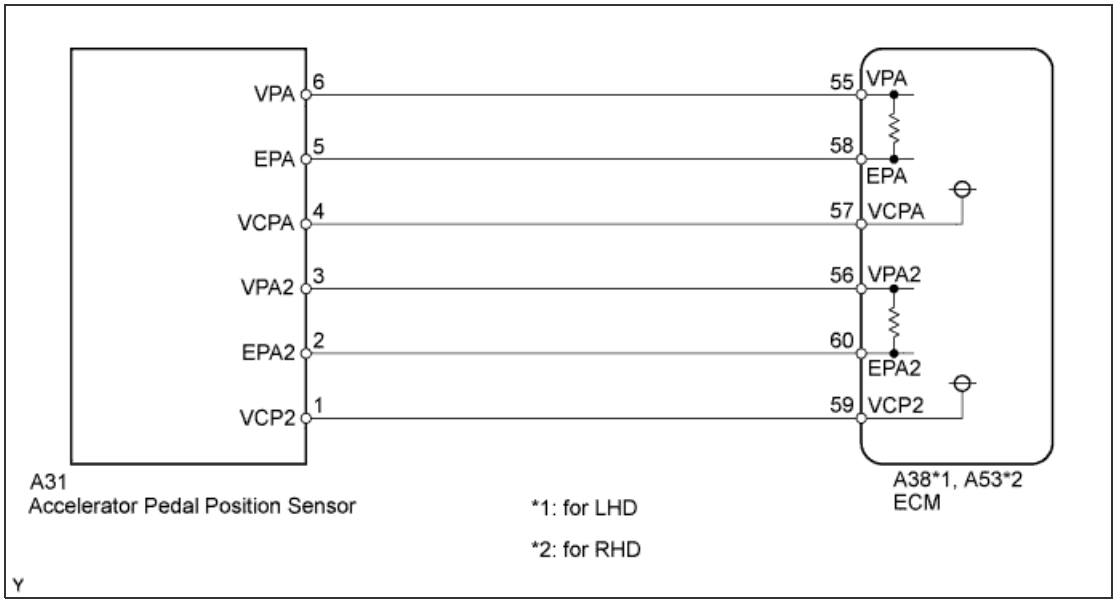
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

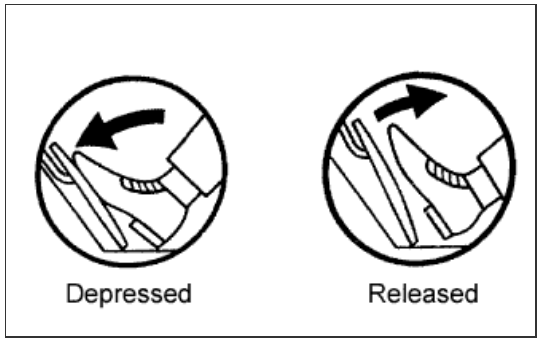
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

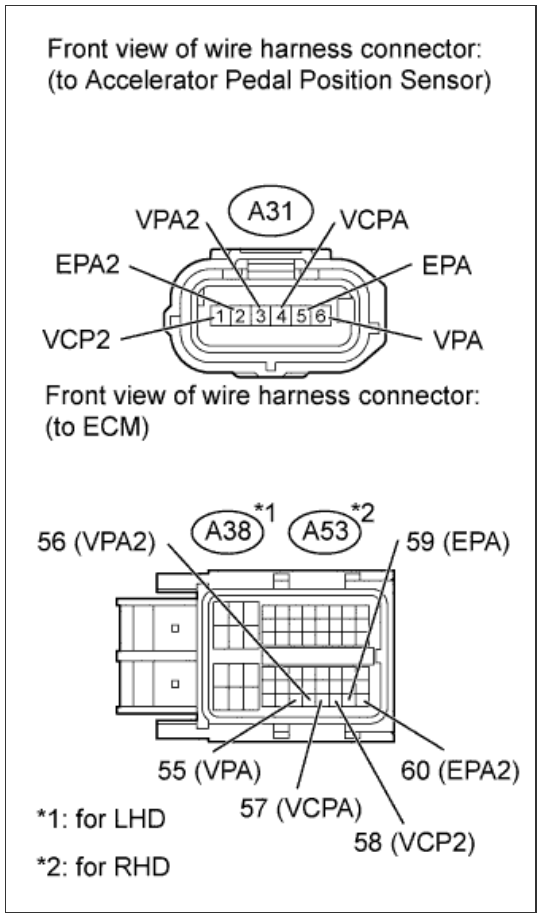
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

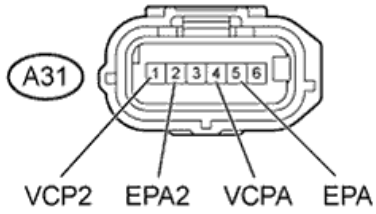
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

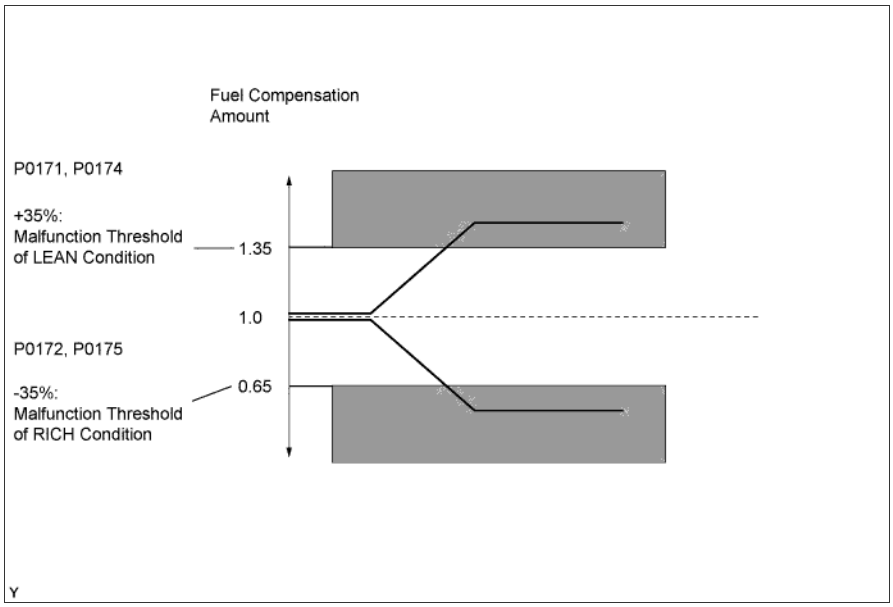
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

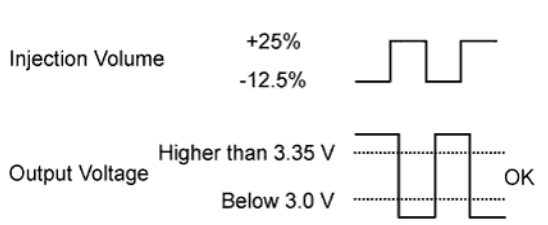
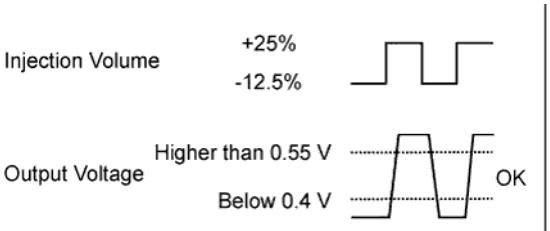
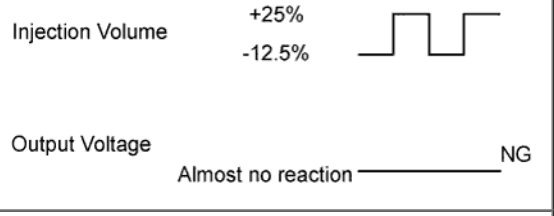
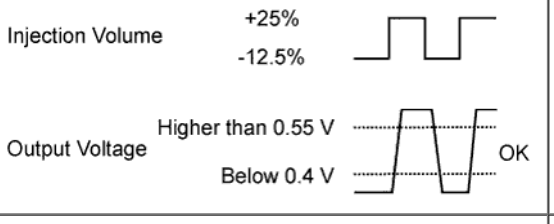
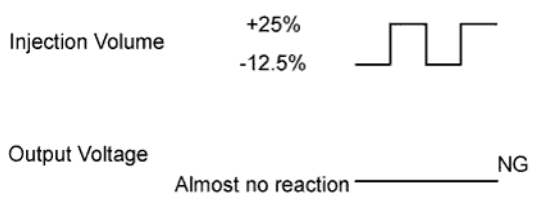
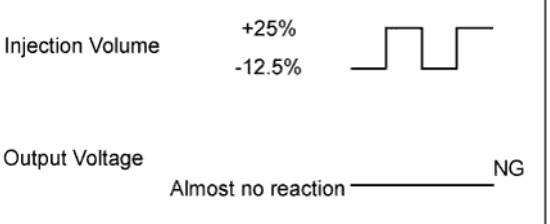
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

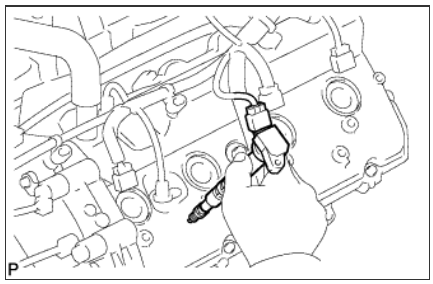
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

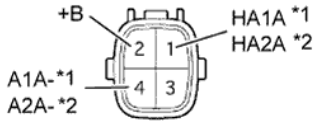
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

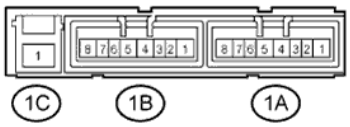
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

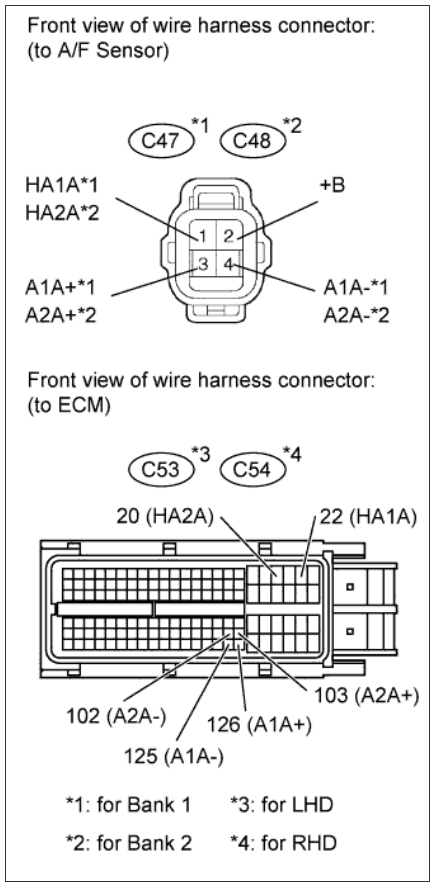
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

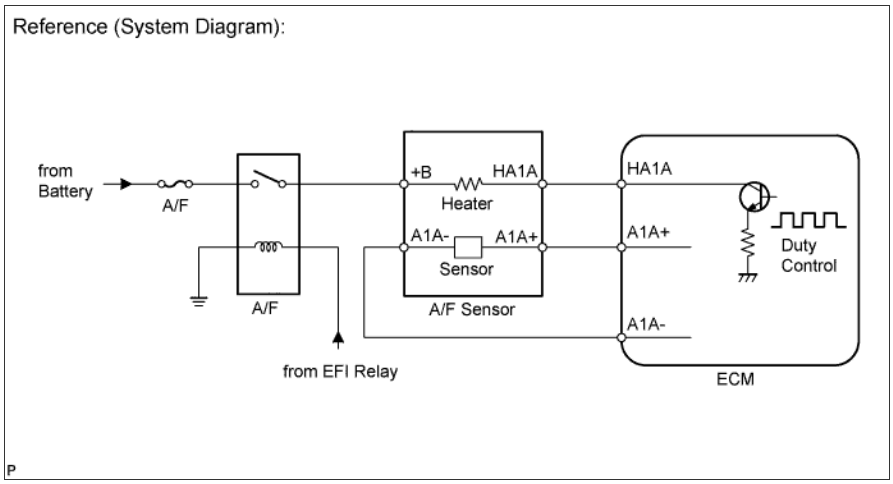
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

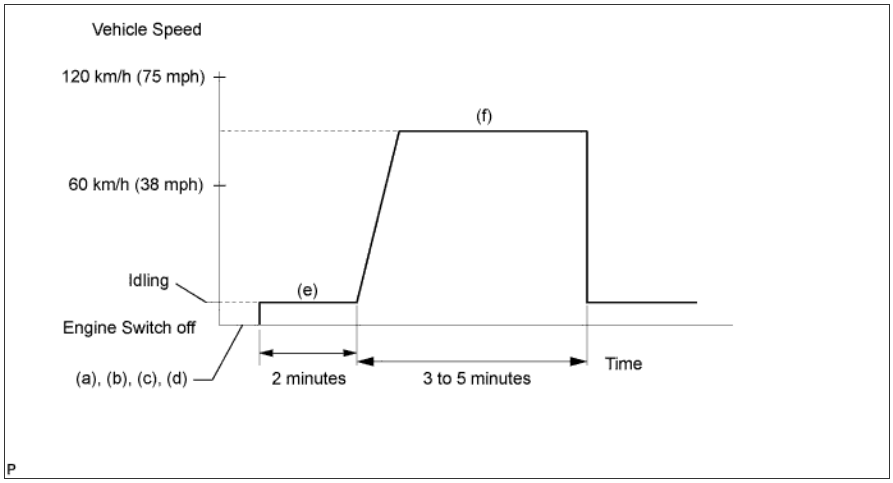
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

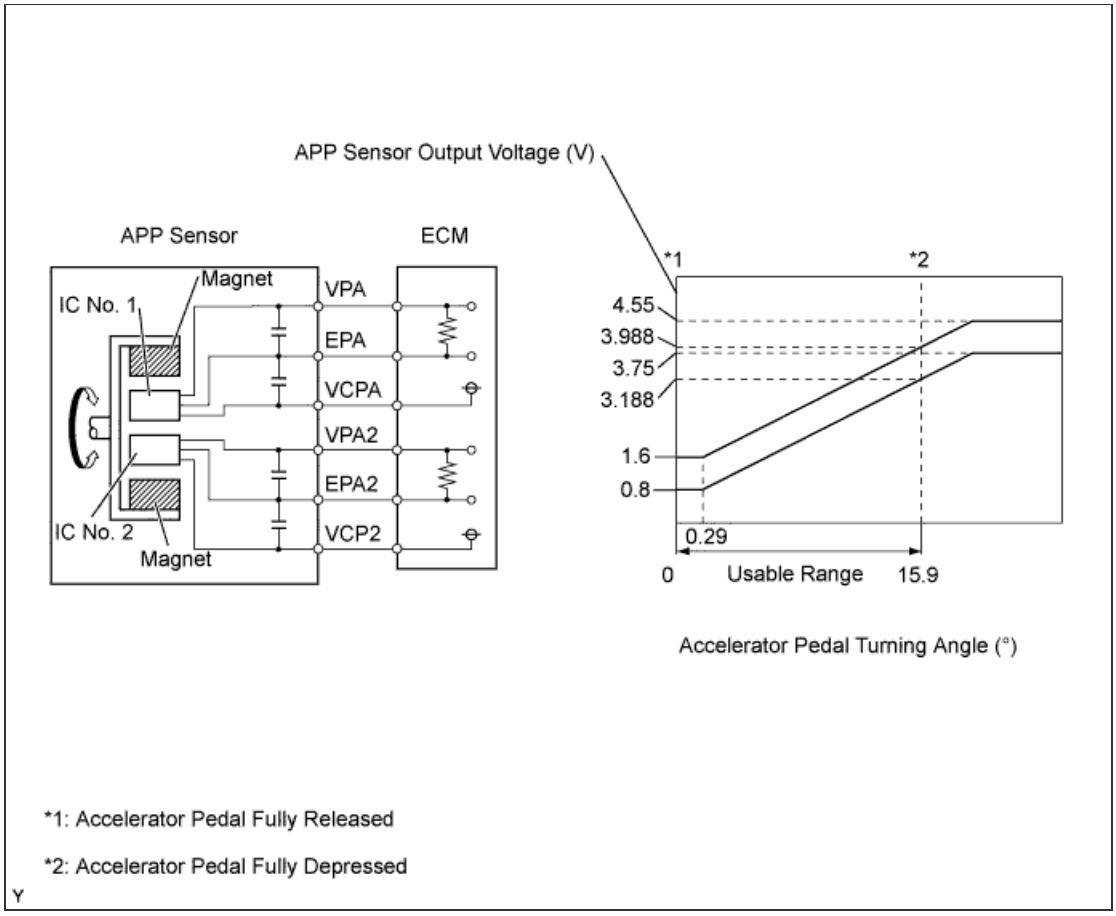
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

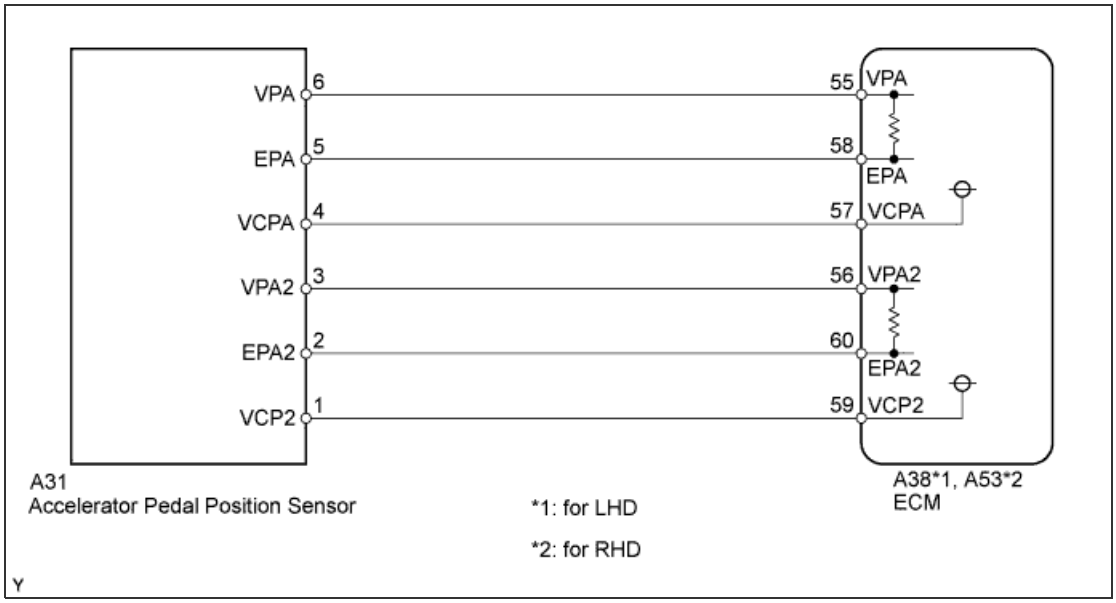
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

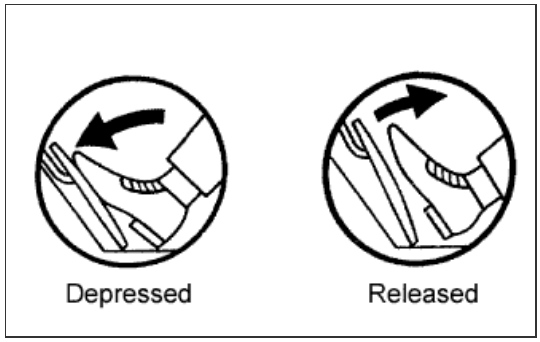
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

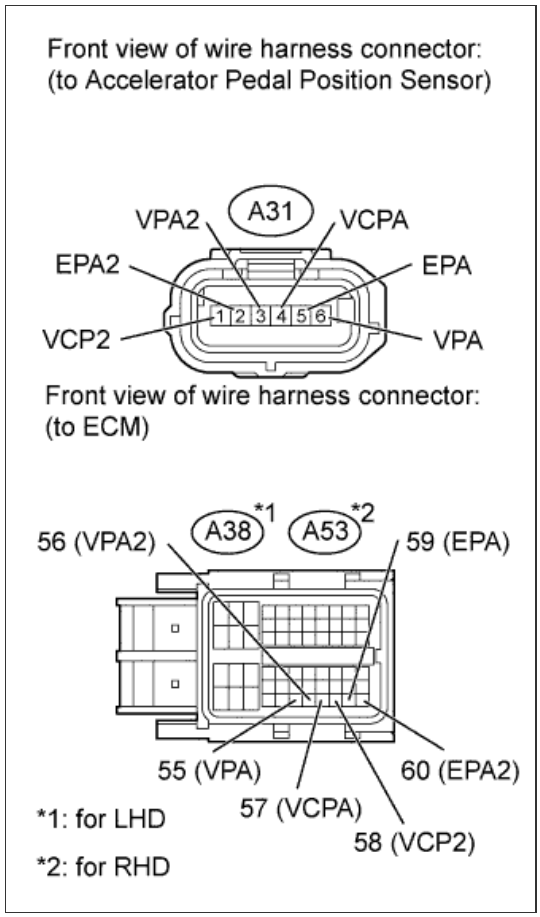
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

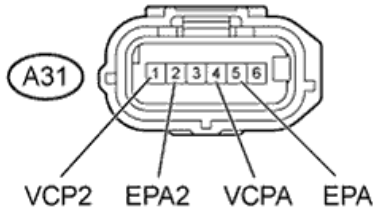
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

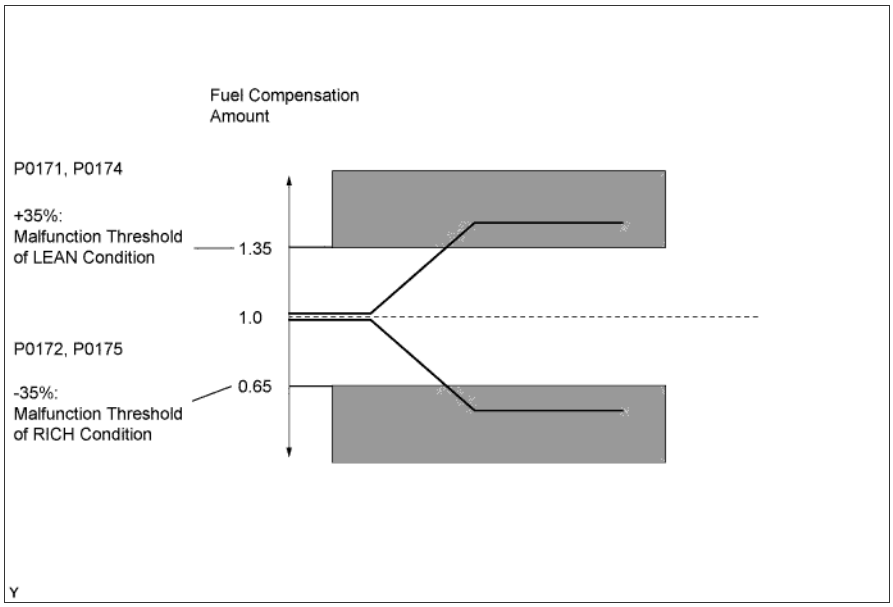
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

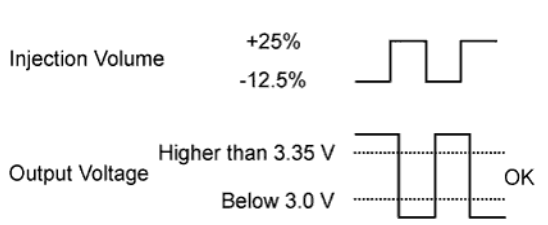
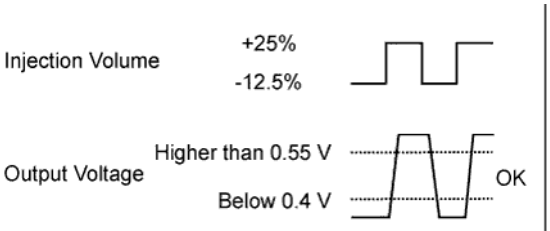
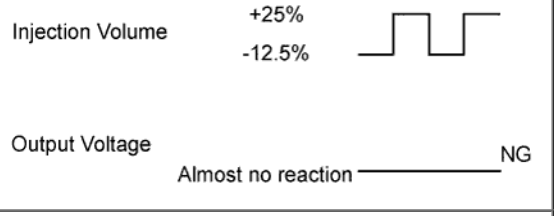
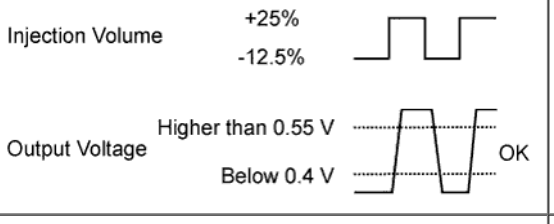
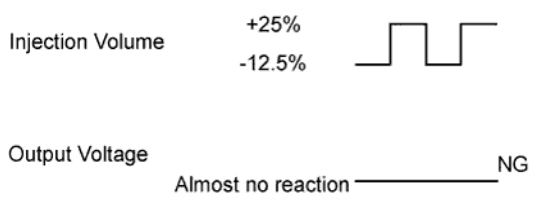
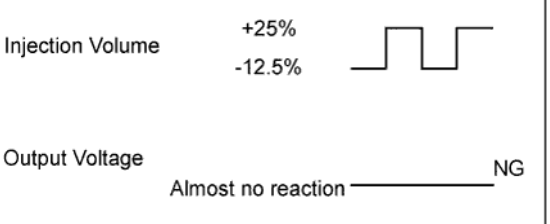
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

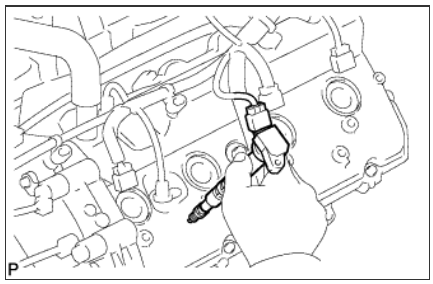
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

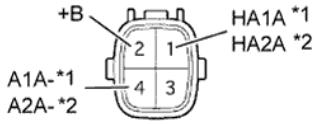
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

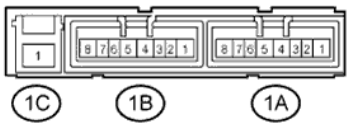
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

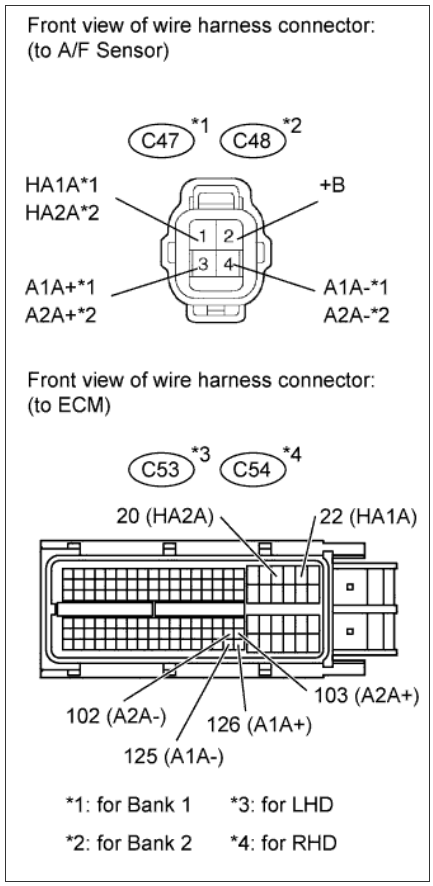
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

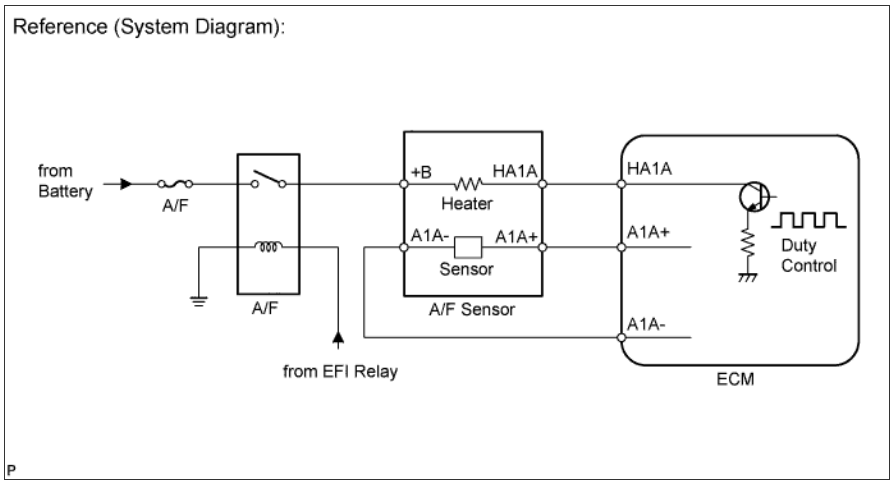
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

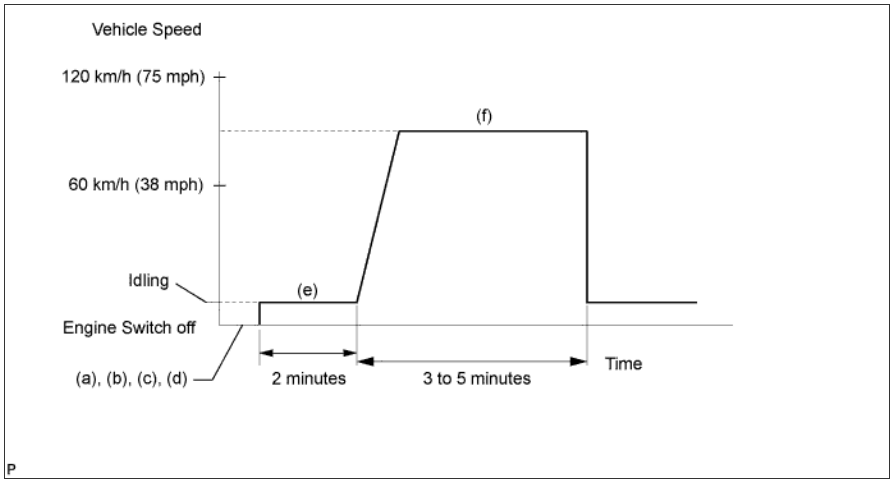
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2120 Throttle / Pedal Position Sensor / Switch "D" Circuit

DTC P2122 Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input

DTC P2123 Throttle / Pedal Position Sensor / Switch "D" Circuit High Input

DTC P2125 Throttle / Pedal Position Sensor / Switch "E" Circuit

DTC P2127 Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input

DTC P2128 Throttle / Pedal Position Sensor / Switch "E" Circuit High Input

DTC P2138 Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation

for Preparation Click here

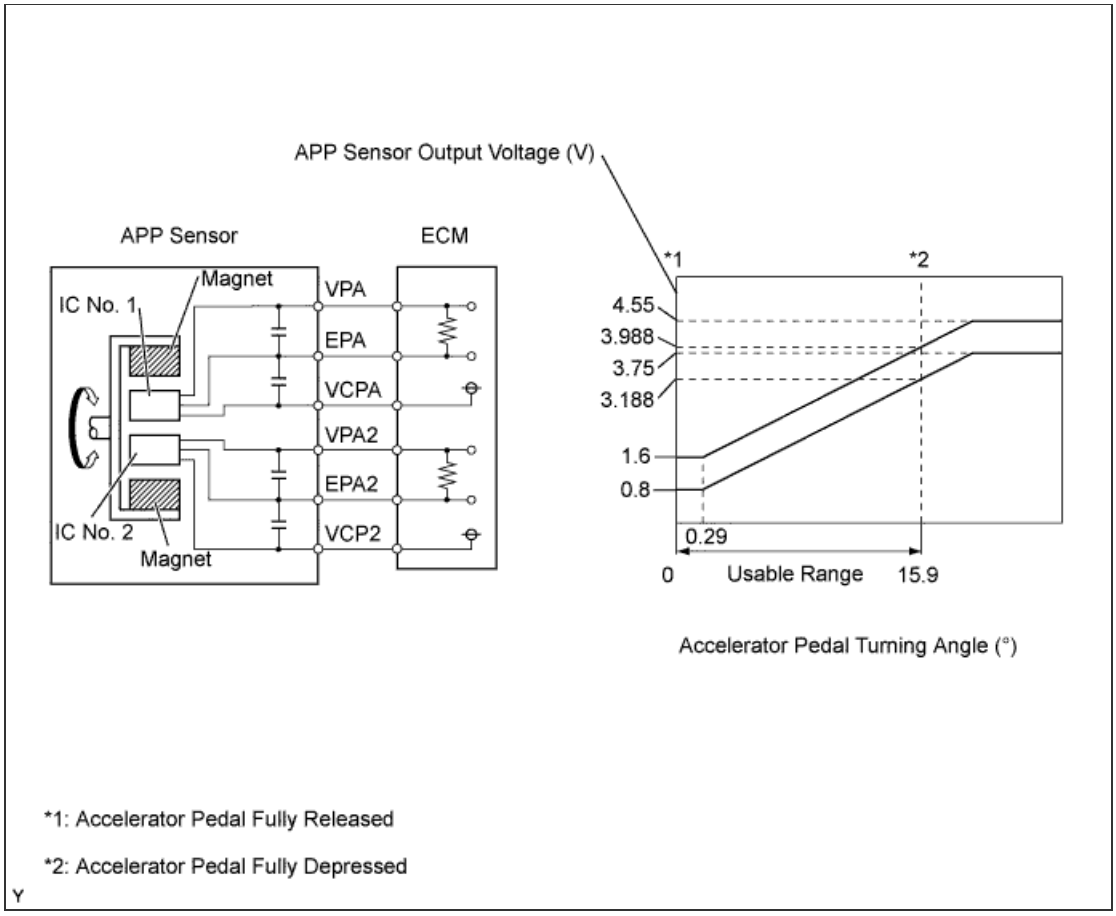
DESCRIPTION

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

The APP sensor is mounted on the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). This sensor is a non-contact type and uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds. The voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0.5 V and 4.5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.

The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC Code	DTC Detection Condition	Trouble Area
P2120	VPA fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM

P2122	VPA is 0.4 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or higher for 2.0 seconds or more (1 trip detection logic).	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond the upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic).	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when the accelerator pedal is fully released (1 trip detection logic).	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or higher. (b) VPA is between 0.4 V and 3.45 V.	• APP sensor • Open in EPA2 circuit • ECM
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) The difference between VPA and VPA2 is 0.02 V or less. (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less.	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:

When any of these DTCs is output, check the APP sensor voltage by entering the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

Trouble Area	Accelerator Position No. 1 When AP Released	Accelerator Position No. 2 When AP Released	Accelerator Position No. 1 When AP Depressed	Accelerator Position No. 2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 4.7 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 4.7 V

HINT:

- **Accelerator pedal positions are expressed as voltages.**
- **AP stands for Accelerator Pedal.**

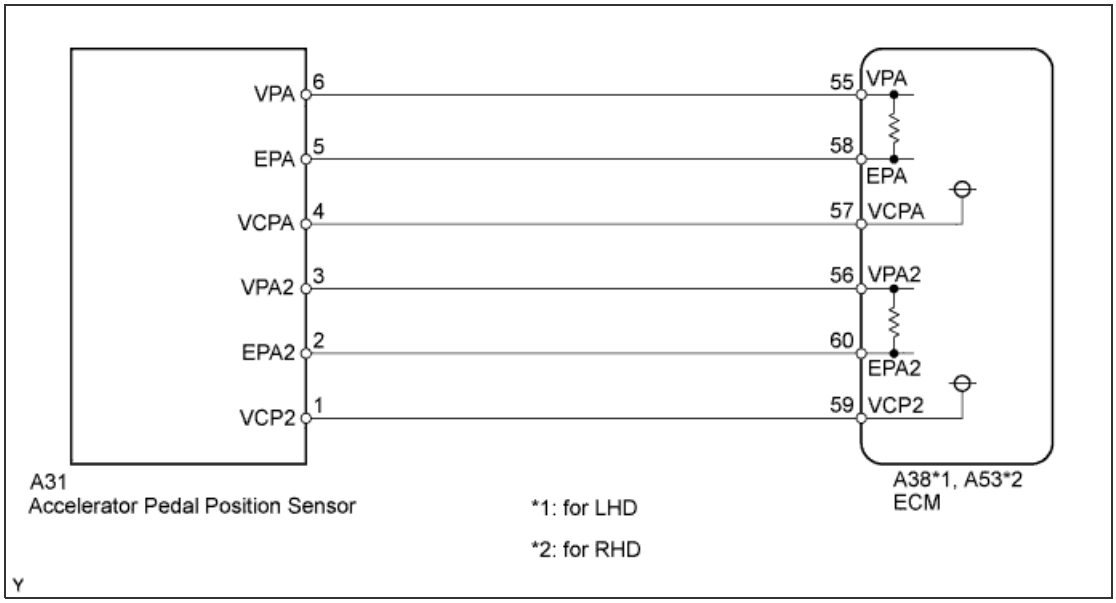
MONITOR DESCRIPTION

When either output voltage of VPA or VPA2 deviates from the standard range, or the difference between the output voltages of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and stores DTC(s).
Example:
When the output voltage of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is stored.
If the malfunction is not repaired successfully, a DTC is stored 2 seconds after the engine is next started.

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 is stored, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.
Fail-safe mode continues until a pass condition is detected, and the engine switch is turned off.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **These DTCs relate to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

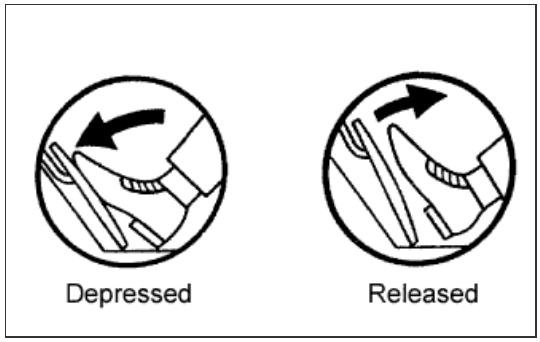
1.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the value displayed on the tester.



Standard Voltage:

Accelerator Pedal Operation	Accelerator Position No. 1	Accelerator Position No. 2
Released → Depressed → Released	0.5 to 4.5 V	1.2 to 4.7 V
	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V	Difference between Accelerator Position No. 1 and Accelerator Position No. 2 is higher than 0.02 V

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 5

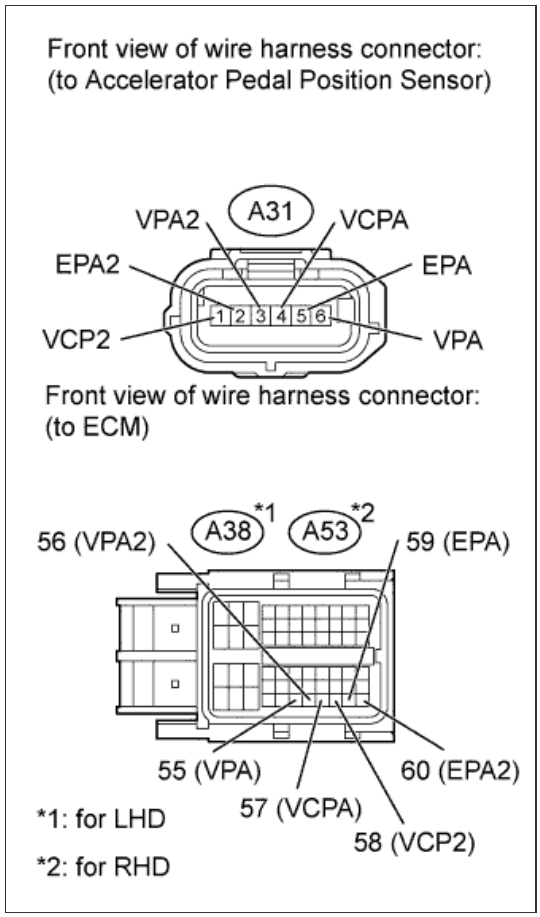
A

2.CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)

a. Disconnect the A31 accelerator pedal position (APP) sensor connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A38-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A38-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A38-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A38-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A38-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A38-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A38-55 (VPA) - body ground	Always	10 kΩ or higher
A31-5 (EPA) or A38-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A38-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A38-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A38-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A38-59 (VCP2) - body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A31-6 (VPA) - A53-55 (VPA)	Always	Below 1 Ω
A31-5 (EPA) - A53-58 (EPA)	Always	Below 1 Ω
A31-4 (VCPA) - A53-57 (VCPA)	Always	Below 1 Ω
A31-3 (VPA2) - A53-56 (VPA2)	Always	Below 1 Ω
A31-2 (EPA2) - A53-60 (EPA2)	Always	Below 1 Ω
A31-1 (VCP2) - A53-59 (VCP2)	Always	Below 1 Ω
A31-6 (VPA) or A53-55 (VPA) - body ground	Always	10 kΩ or higher

A31-5 (EPA) or A53-58 (EPA) - body ground	Always	10 kΩ or higher
A31-4 (VCPA) or A53-57 (VCPA) - body ground	Always	10 kΩ or higher
A31-3 (VPA2) or A53-56 (VPA2) - body ground	Always	10 kΩ or higher
A31-2 (EPA2) or A53-60 (EPA2) - body ground	Always	10 kΩ or higher
A31-1 (VCP2) or A53-59 (VCP2) - body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK ECM (VCPA AND VCP2 VOLTAGE)

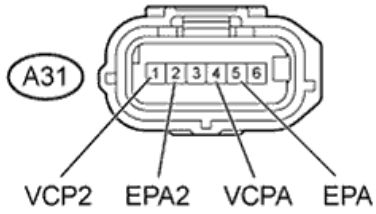
a. Disconnect the A31 APP sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A31-4 (VCPA) - A31-5 (EPA)	Engine switch on (IG)	4.5 to 5.5 V
A31-1 (VCP2) - A31-2 (EPA2)	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to APP Sensor)



NG → REPLACE ECM (Click here)

OK

4.REPLACE ACCELERATOR PEDAL ASSEMBLY

a. Replace the accelerator pedal assembly (Click here).

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL POSITION SENSOR DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128, and/or P2138 are output	A

No DTC is output	B

B → SYSTEM OK

A → REPLACE ECM (Click here)

DTC P0171 System Too Lean (Bank 1)

DTC P0172 System Too Rich (Bank 1)

DTC P0174 System Too Lean (Bank 2)

DTC P0175 System Too Rich (Bank 2)

for Preparation Click here

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and the long-term fuel trims.
The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air Fuel ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.
Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

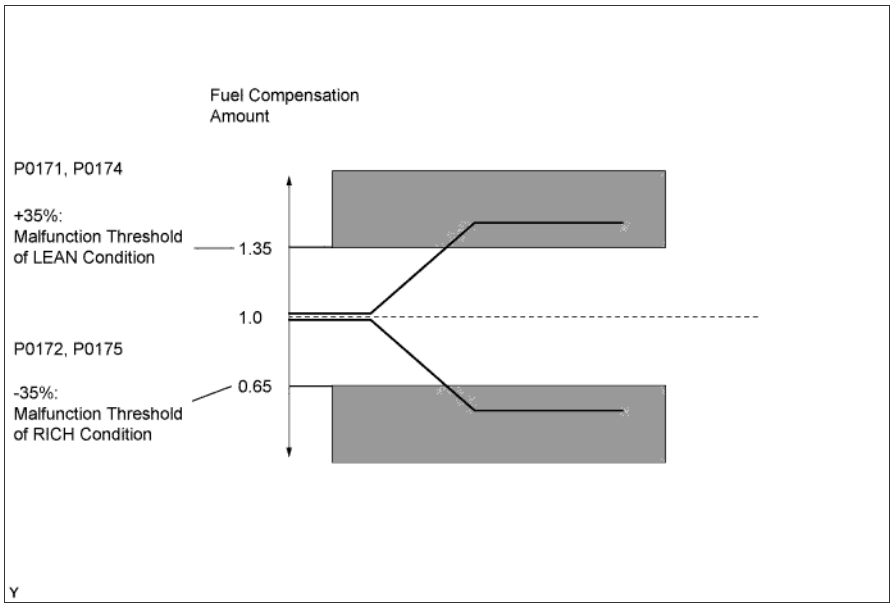
DTC Code	DTC Detection Condition	Trouble Area
P0171 P0174	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the lean side (2 trip detection logic).	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With a warm engine and stable air-fuel ratio feedback, the fuel trim is considerably in error to the rich side (2 trip detection logic).	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • ECM

HINT:

- **When DTC P0171 or P0174 is stored, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is stored, the actual air-fuel ratio is on the rich side.**
- **If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be stored. The MIL is then illuminated.**
- **When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is higher than 75°C [167°F]), the system is functioning normally.**

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction threshold, the ECM interprets this as a fault in the fuel system and stores DTC(s).
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.



WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P0171, P0172, P0174 and P0175 are for Euro-OBD only.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P0171, P0172, P0174 or P0175 is output	A
P0171, P0172, P0174 or P0175 and other DTCs are output	B

HINT:

If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the tester on.

c. Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.

e. Perform the Control the Injection Volume for A/F Sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

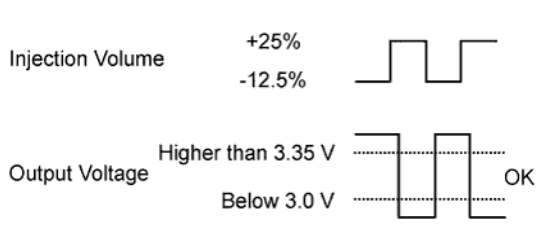
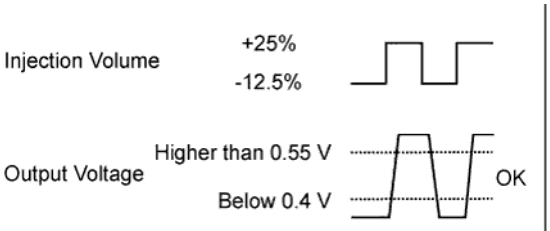
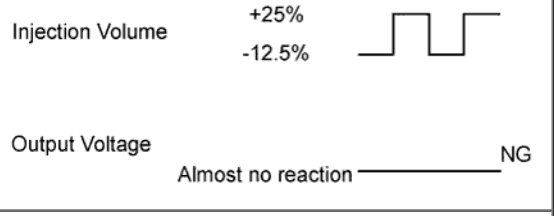
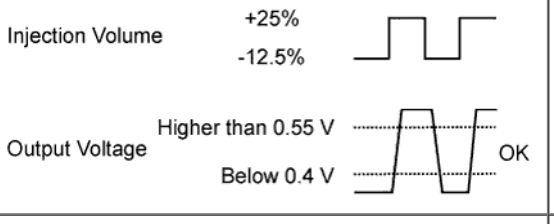
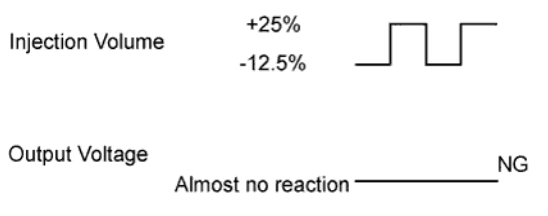
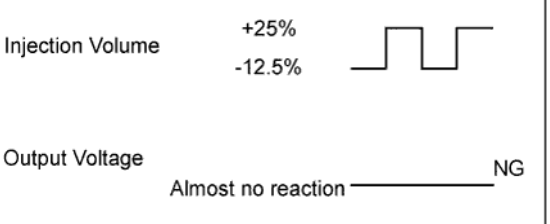
f. Monitor the output voltages of A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

Result:
The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Below 3.0 V
-12.5% = Lean output:
Higher than 3.35 V

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area

1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / Data List / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

5.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections (Click here).

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

6.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

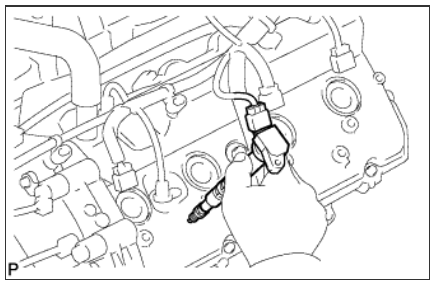
OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

7.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.



CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → REPAIR OR REPLACE IGNITION SYSTEM (Click here)

OK

8.CHECK FOR EXHAUST GAS LEAK

a. Check for exhaust gas leakage.

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

10.INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

a. Check the injection volume (Click here).

NG → REPLACE FUEL INJECTOR (Click here)

OK

11.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

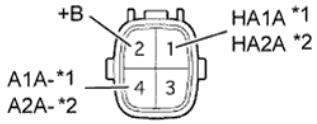
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition

1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

12.INSPECT INTEGRATION RELAY (A/F RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

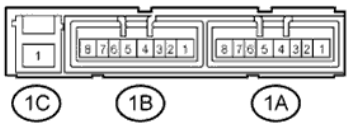
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION RELAY

OK

13.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

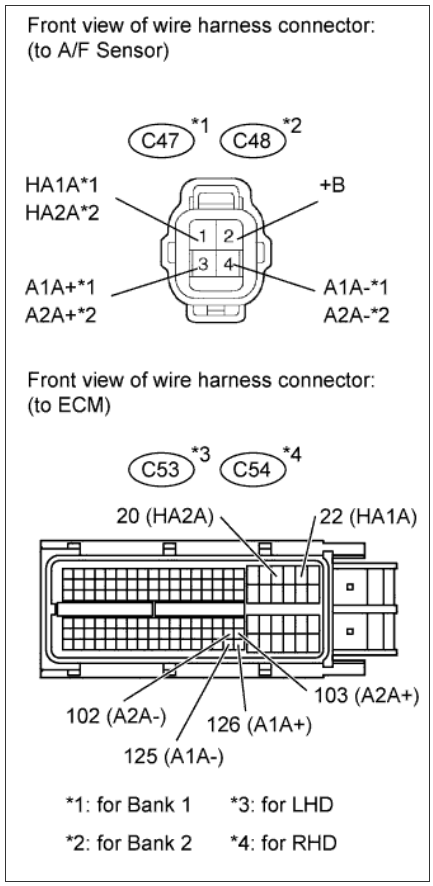
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

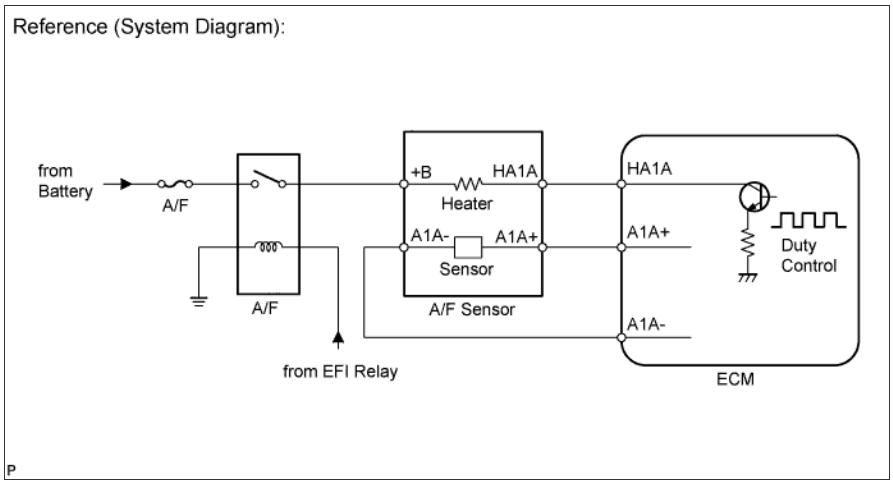
Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

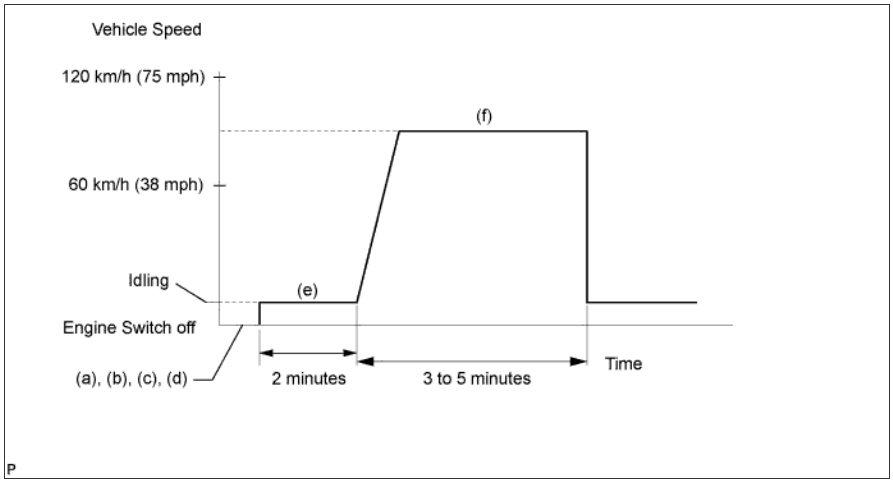
OK

14.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

15.PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG) and turn the tester on.
(c) Clear DTCs (Click here).
(d) Switch the ECM from normal mode to check mode using the tester (Click here).
(e) Start the engine and warm it up with all the accessories switched off.
(f) Drive the vehicle at between 60 km/h and 120 km/h (38 mph and 75 mph) and at an engine speed of between 1400 rpm and 3200 rpm for 3 to 5 minutes.

HINT:

If the system is still malfunctioning, the MIL will be illuminated during step (f).

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16.CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

a. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

b. Read DTCs.

Result

Result	Proceed to
No DTC is output	A
P0171, P0172, P0174 or P0175 is output	B

B

REPLACE ECM (Click here)

A

END

DTC P2121 Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance

for Preparation Click here

DESCRIPTION

HINT:

Refer to DTC P2120 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2121	The difference between VPA and VPA2 is below 0.4 V, or higher than 1.2 V for 0.5 seconds (1 trip detection logic).	• **Accelerator Pedal Position (APP) sensor** • **ECM**

MONITOR DESCRIPTION

When the difference between the output voltages of VPA and VPA2 deviates from the standard, the ECM determines that the Accelerator Pedal Position (APP) sensor is malfunctioning. The ECM turns on the MIL and the DTC is stored.

FAIL-SAFE

The Accelerator Pedal Position (APP) sensor has two (main and sub) sensor circuits. If a malfunction occurs in either of the sensor circuits, the ECM detects the abnormal signal voltage difference between the two sensor circuits and switches to limp mode. In limp mode, the functioning circuit is used to calculate the accelerator pedal opening angle to allow the vehicle to continue driving. If both circuits malfunction, the ECM regards the opening angle of the accelerator pedal as being fully closed. In this case, the throttle valve remains closed as if the engine is idling.
If a pass condition is detected and then the engine switch is turned off, the fail-safe operation stops and the system returns to a normal condition.

WIRING DIAGRAM

Refer to DTC P2120 (Click here).

INSPECTION PROCEDURE

HINT:

- **This DTC relates to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2121)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2121 is output	A
P2121 and other DTCs are output	B

HINT:

If any DTCs other than P2121 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

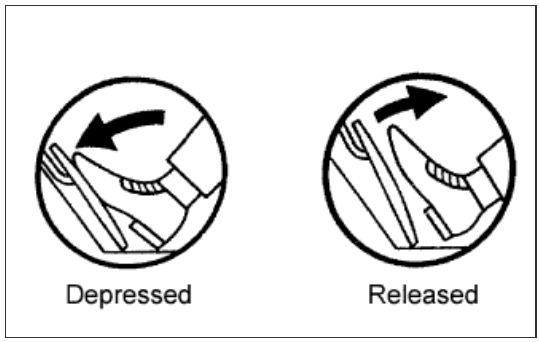
b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the values displayed on the tester.

Standard Voltage:

Accelerator Pedal Operations	Accelerator Position No. 1	Accelerator Position No. 2
Released	0.5 to 1.1 V	1.2 to 2.0 V
Depressed	2.6 to 4.5 V	3.4 to 4.7 V



NG → Go to step 3

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

3.REPLACE ACCELERATOR PEDAL

a. Replace the accelerator pedal assembly (Click here).

NEXT

4.CHECK WHETHER DTC OUTPUT RECURS (DTC P2121)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2121 is output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P0230 Fuel Pump Primary Circuit

for Preparation Click here

DESCRIPTION

When a malfunction in the fuel pump circuit is detected, DTC P0230 is stored.
The fuel pump circuit consists of the ECM, fuel pump and fuel pump ECU (which operates the fuel pump). Based on the engine output, the ECM determines the fuel pump speed. The speed is then converted to a duty signal and sent to the fuel pump ECU. Based on the signal sent from the ECM, the fuel pump ECU adjusts the fuel pump operation speed between 3 settings. The fuel pump ECU also has a self-diagnosis function. Based on the fuel pump circuit condition, the fuel pump ECU outputs a diagnostic signal (DI) to the ECM, and the ECM determines if there is a malfunction in the fuel pump circuit.

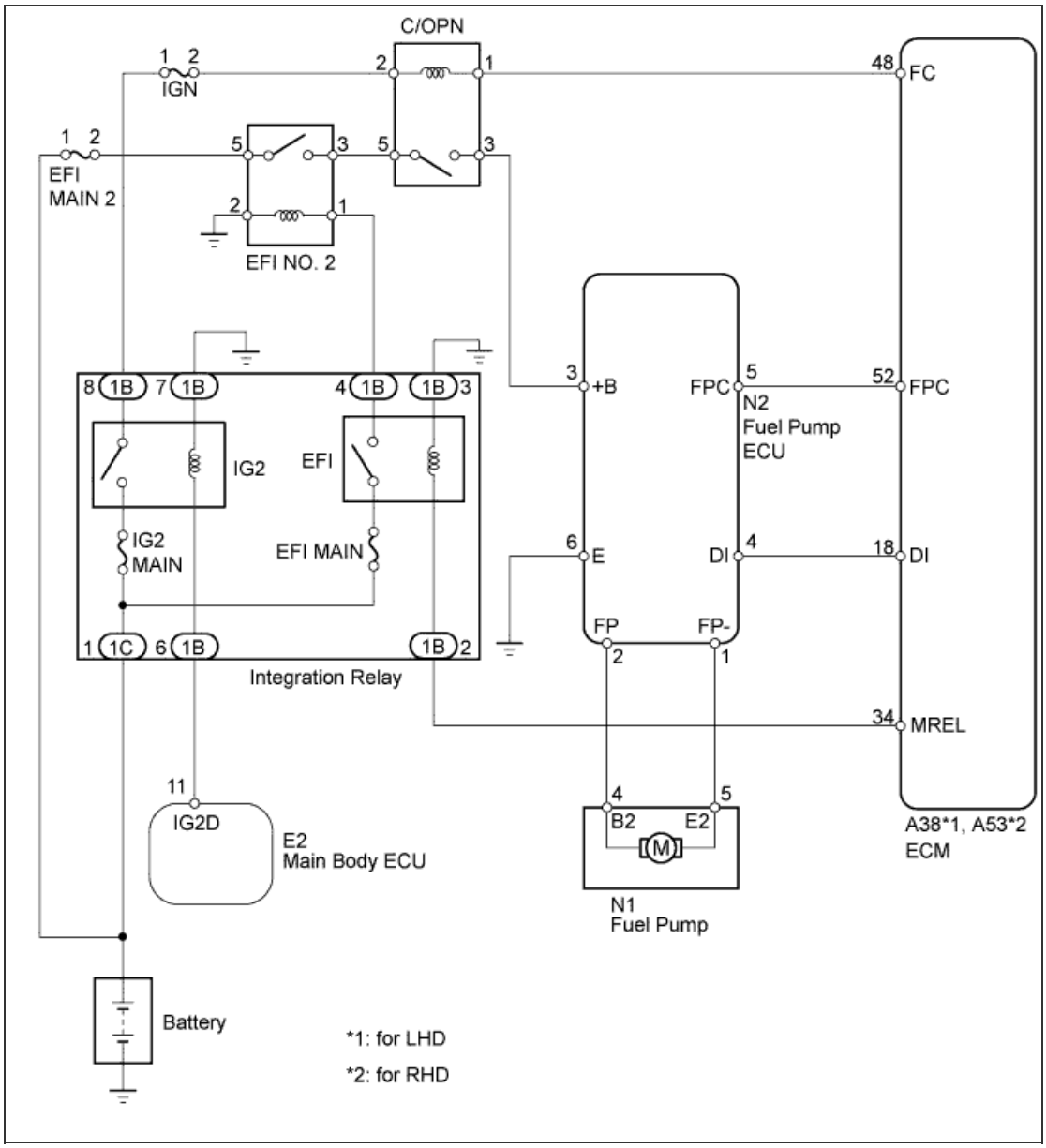
DTC Code	DTC Detection Condition	Trouble Area

P0230	When either condition below is met (1 trip detection logic):
	• When the fuel pump is operating:
	  ◦ The remaining fuel is 17 liters or more.
	  ◦ The DI terminal output is low.
	• When the fuel pump is not operating:
	  ◦ The DI terminal output is high.
		• Open or short in fuel pump circuit
		• Fuel pump
		• Fuel pump ECU
		• ECM

MONITOR DESCRIPTION

To monitor the fuel pump circuit, the ECM checks the fuel pump control signal (FPC) and diagnostic signal (DI). The FPC voltage varies between approximately 0 V to approximately 12 V (duty signal). Based on the condition of the fuel pump ECU malfunction, the DI voltage varies between approximately 0 V and approximately 12 V. The ECM then compares the variance of the FPC voltage and DI voltage, and determines if the fuel pump circuit is malfunctioning. When the ECM determines that the fuel pump circuit is malfunctioning, a DTC is stored immediately.

WIRING DIAGRAM



INSPECTION PROCEDURE

This troubleshooting procedure is based on the premise that the engine is started. If the engine is not started, proceed to the Problem Symptoms Table (Click here).

1.CHECK FOR DTC (B1500)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Body Electrical / Combination Meter / DTC.

e. Read the DTC.

Result

Result	Proceed to
DTC B1500 is not output	A
DTC B1500 is output	B

B → GO TO DTC B1500 (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (FUEL PUMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

d. Check whether operating sounds can be heard while operating the fuel pump using the tester.

OK:

Operating sounds can be heard from fuel pump.

NG → Go to step 6

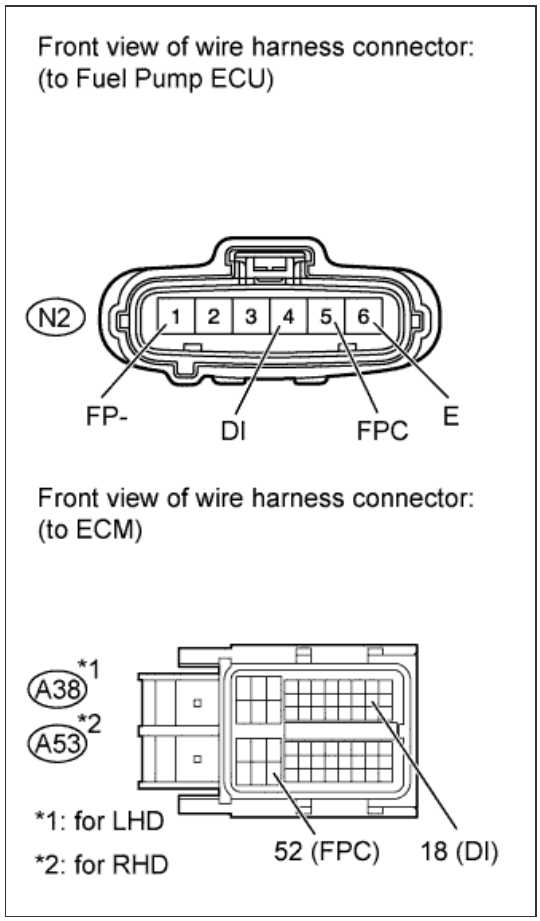
OK

3.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω

N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

5.CONFIRM WHETHER DTC OUTPUT RECURS

a. Check that there are 17 liters or more of fuel remaining.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Clear DTCs (Click here).

f. Crank the engine for 15 seconds.

g. Idle it for 1 minute.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read the DTCs.

Result

Result	Proceed to
DTC is not output	A
DTC P0230 is output	B

B → REPLACE ECM (**Click here**)

A

END

6.INSPECT CIRCUIT OPENING RELAY (C/OPN)

a. Inspect circuit opening relay (C/OPN) (Click here).

NG → REPLACE CIRCUIT OPENING RELAY (C/OPN)

OK

7.INSPECT CIRCUIT OPENING RELAY (POWER SOURCE VOLTAGE)

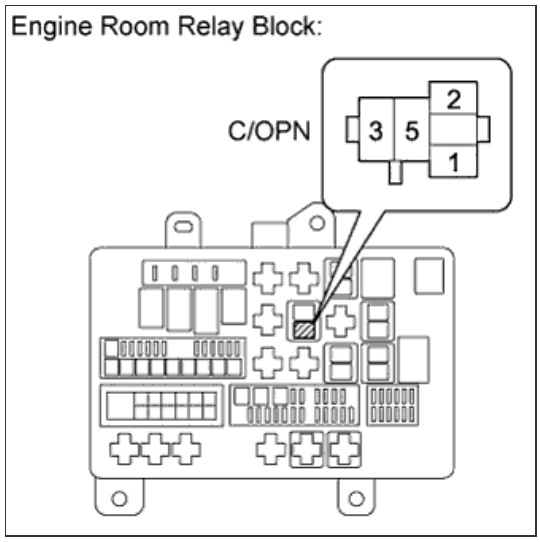
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Turn the engine switch on (IG).

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C/OPN relay (2) - Body ground	Engine switch on (IG)	11 to 14 V
C/OPN relay (5) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 14

OK

8.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY (C/OPN) - ECM, FUEL PUMP ECU)

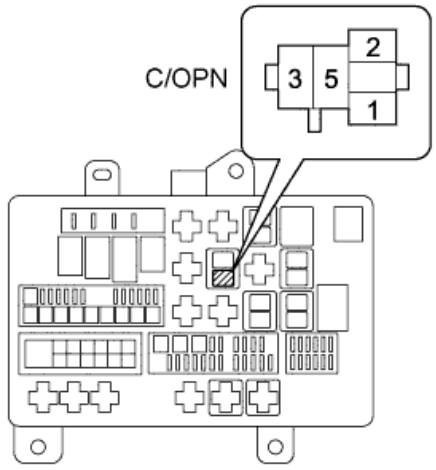
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Disconnect the A38 or A53 ECM connector.

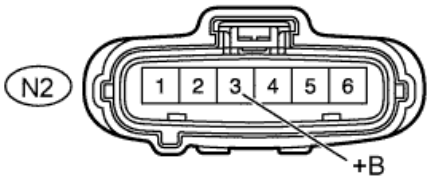
c. Disconnect the N2 fuel pump ECU connector.

d. Measure the resistance according to the value(s) in the table below.

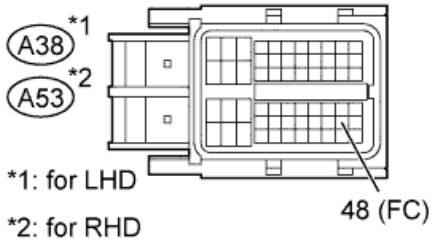
Engine Room Relay Block:



Front view of wire harness connector:
(to Fuel Pump ECU)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A38-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A38-48 (FC) - Body ground	Always	10 kΩ or higher
C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A53-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A53-48 (FC) - Body ground	Always	10 kΩ or higher

C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.CHECK HARNESS AND CONNECTOR (FUEL PUMP - FUEL PUMP ECU)

a. Disconnect the N1 fuel pump connector.

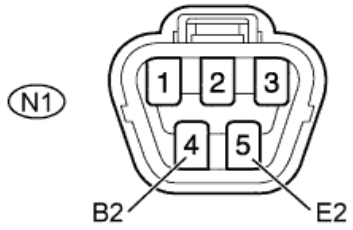
b. Disconnect the N2 fuel pump ECU connector.

c. Measure the resistance according to the value(s) in the table below.

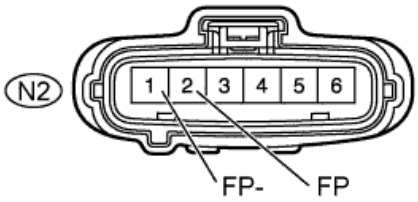
Standard Resistance:

Tester Connection	Condition	Specified Condition
N1-4 (B2) - N2-2 (FP)	Always	Below 1 Ω
N1-5 (E2) - N2-1 (FP-)	Always	Below 1 Ω
N1-4 (B2) or N2-2 (FP) - Body ground	Always	10 kΩ or higher
N1-5 (E2) or N2-1 (FP-) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Fuel Pump)



Front view of wire harness connector:
(to Fuel Pump ECU)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.INSPECT FUEL PUMP

a. Inspect the fuel pump (Click here).

NG → REPLACE FUEL PUMP (**Click here**)

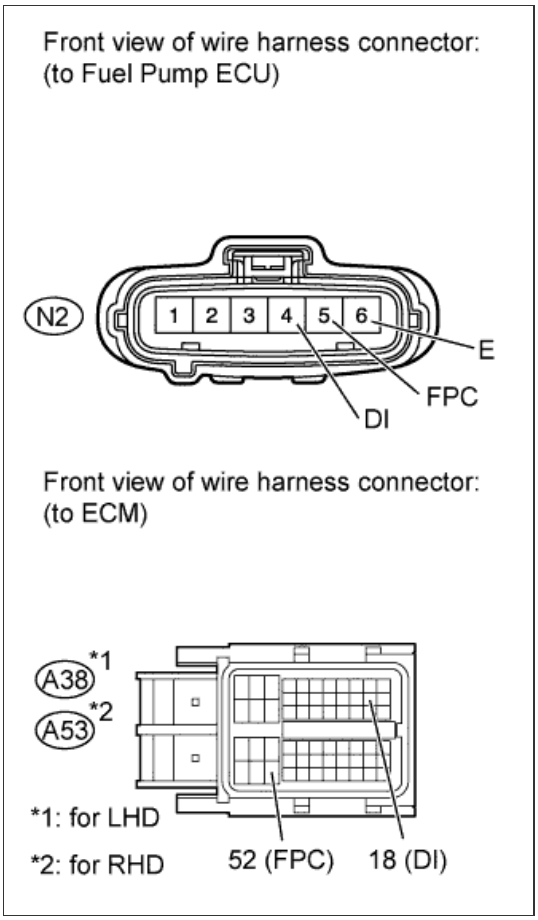
OK

11.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

12.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

13.CONFIRM WHETHER DTC OUTPUT RECURS

a. Check that there is 17 liters or more of fuel remaining.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Clear DTCs (Click here).

f. Crank the engine for 15 seconds.

g. Idle it for 1 minute.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read the DTCs.

Result

Result	Proceed to
DTC is not output	A
DTC P0230 is output	B

B → REPLACE ECM (Click here)

A

END

14.CHECK HARNESS AND CONNECTOR (C/OPN RELAY - EFI NO. 2 RELAY, IGN FUSE)

a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

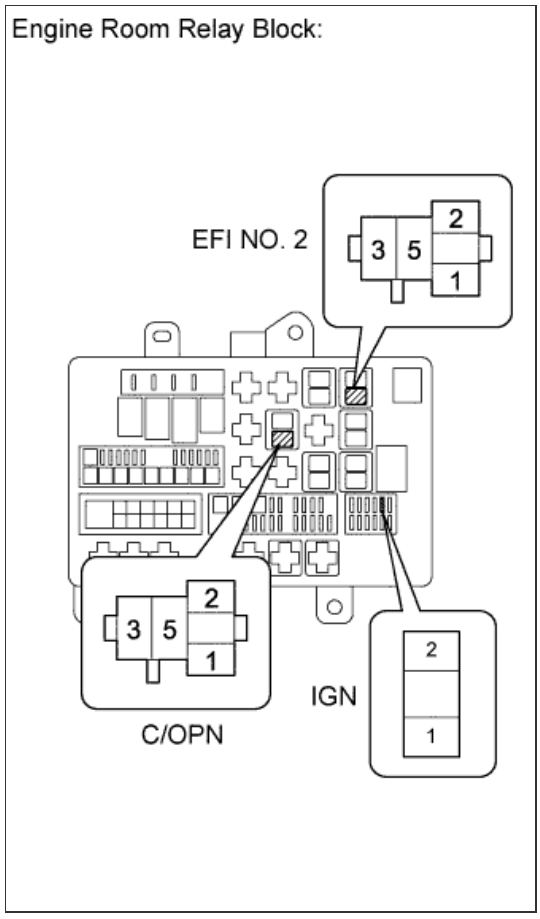
b. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

c. Remove the IGN fuse from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C/OPN relay (2) - IGN fuse (2)	Always	Below 1 Ω
C/OPN relay (5) - EFI NO. 2 relay (3)	Always	Below 1 Ω
C/OPN relay (2) or IGN fuse (2) - Body ground	Always	10 kΩ or higher
C/OPN relay (5) or EFI NO. 2 relay (3) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

15.INSPECT EFI NO. 2 RELAY (EFI NO. 2)

a. Inspect the EFI NO. 2 relay (EFI NO. 2) (Click here).

NG → REPLACE EFI NO. 2 RELAY (EFI NO. 2)

OK

16.CHECK HARNESS AND CONNECTOR (EFI NO. 2 RELAY - INTEGRATION RELAY, BATTERY, BODY GROUND)

a. Remove the EFI MAIN 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN 2 fuse	Always	Below 1 Ω

c. Reinstall the EFI MAIN 2 fuse.

d. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

e. Remove the integration relay from the engine room relay block.

f. Disconnect the 1B integration relay connector.

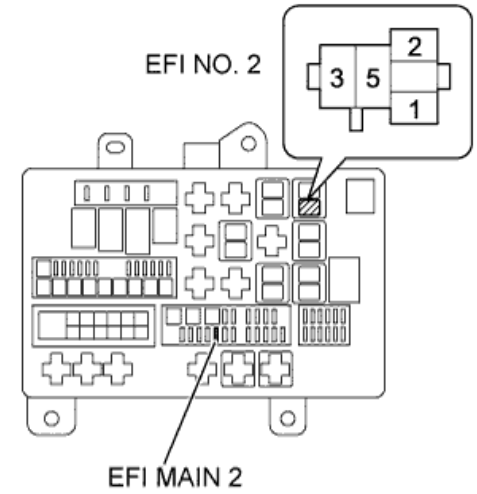
g. Disconnect the cable from the battery positive (+) terminal.

h. Measure the resistance according to the value(s) in the table below.

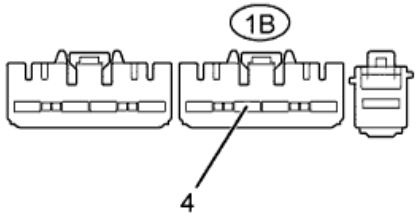
Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 relay (1) - 1B-4	Always	Below 1 Ω
EFI NO. 2 relay (5) - Positive (+) battery cable	Always	Below 1 Ω
EFI NO. 2 relay (2) - Body ground	Always	Below 1 Ω
EFI NO. 2 relay (1) or 1B-4 - Body ground	Always	10 kΩ or higher
EFI NO. 2 relay (5) or Positive (+) battery cable - Body ground	Always	10 kΩ or higher

Engine Room Relay Block:



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO ECM POWER SOURCE CIRCUIT (Click here)

DTC P2121 Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance

for Preparation Click here

DESCRIPTION

HINT:

Refer to DTC P2120 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2121	The difference between VPA and VPA2 is below 0.4 V, or higher than 1.2 V for 0.5 seconds (1 trip detection logic).	• **Accelerator Pedal Position (APP) sensor** • **ECM**

MONITOR DESCRIPTION

When the difference between the output voltages of VPA and VPA2 deviates from the standard, the ECM determines that the Accelerator Pedal Position (APP) sensor is malfunctioning. The ECM turns on the MIL and the DTC is stored.

FAIL-SAFE

The Accelerator Pedal Position (APP) sensor has two (main and sub) sensor circuits. If a malfunction occurs in either of the sensor circuits, the ECM detects the abnormal signal voltage difference between the two sensor circuits and switches to limp mode. In limp mode, the functioning circuit is used to calculate the accelerator pedal opening angle to allow the vehicle to continue driving. If both circuits malfunction, the ECM regards the opening angle of the accelerator pedal as being fully closed. In this case, the throttle valve remains closed as if the engine is idling.
If a pass condition is detected and then the engine switch is turned off, the fail-safe operation stops and the system returns to a normal condition.

WIRING DIAGRAM

Refer to DTC P2120 (Click here).

INSPECTION PROCEDURE

HINT:

- **This DTC relates to the Accelerator Pedal Position (APP) sensor.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2121)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2121 is output	A
P2121 and other DTCs are output	B

HINT:

If any DTCs other than P2121 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

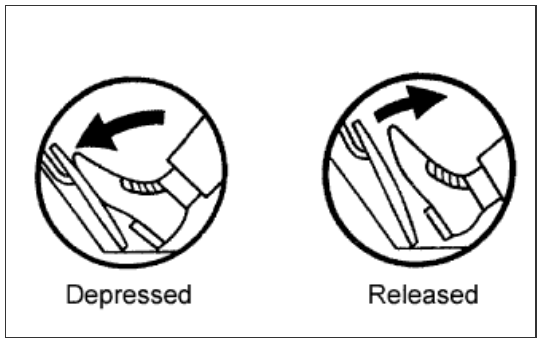
b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

d. Read the values displayed on the tester.

Standard Voltage:

Accelerator Pedal Operations	Accelerator Position No. 1	Accelerator Position No. 2
Released	0.5 to 1.1 V	1.2 to 2.0 V
Depressed	2.6 to 4.5 V	3.4 to 4.7 V



NG → Go to step 3

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

3.REPLACE ACCELERATOR PEDAL

a. Replace the accelerator pedal assembly (Click here).

NEXT

4.CHECK WHETHER DTC OUTPUT RECURS (DTC P2121)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 15 seconds.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
P2121 is output	A
No DTC is output	B

B → SYSTEM OK

A

REPLACE ECM (Click here)

DTC P0230 Fuel Pump Primary Circuit

for Preparation Click here

DESCRIPTION

When a malfunction in the fuel pump circuit is detected, DTC P0230 is stored.
The fuel pump circuit consists of the ECM, fuel pump and fuel pump ECU (which operates the fuel pump). Based on the engine output, the ECM determines the fuel pump speed. The speed is then converted to a duty signal and sent to the fuel pump ECU. Based on the signal sent from the ECM, the fuel pump ECU adjusts the fuel pump operation speed between 3 settings. The fuel pump ECU also has a self-diagnosis function. Based on the fuel pump circuit condition, the fuel pump ECU outputs a diagnostic signal (DI) to the ECM, and the ECM determines if there is a malfunction in the fuel pump circuit.

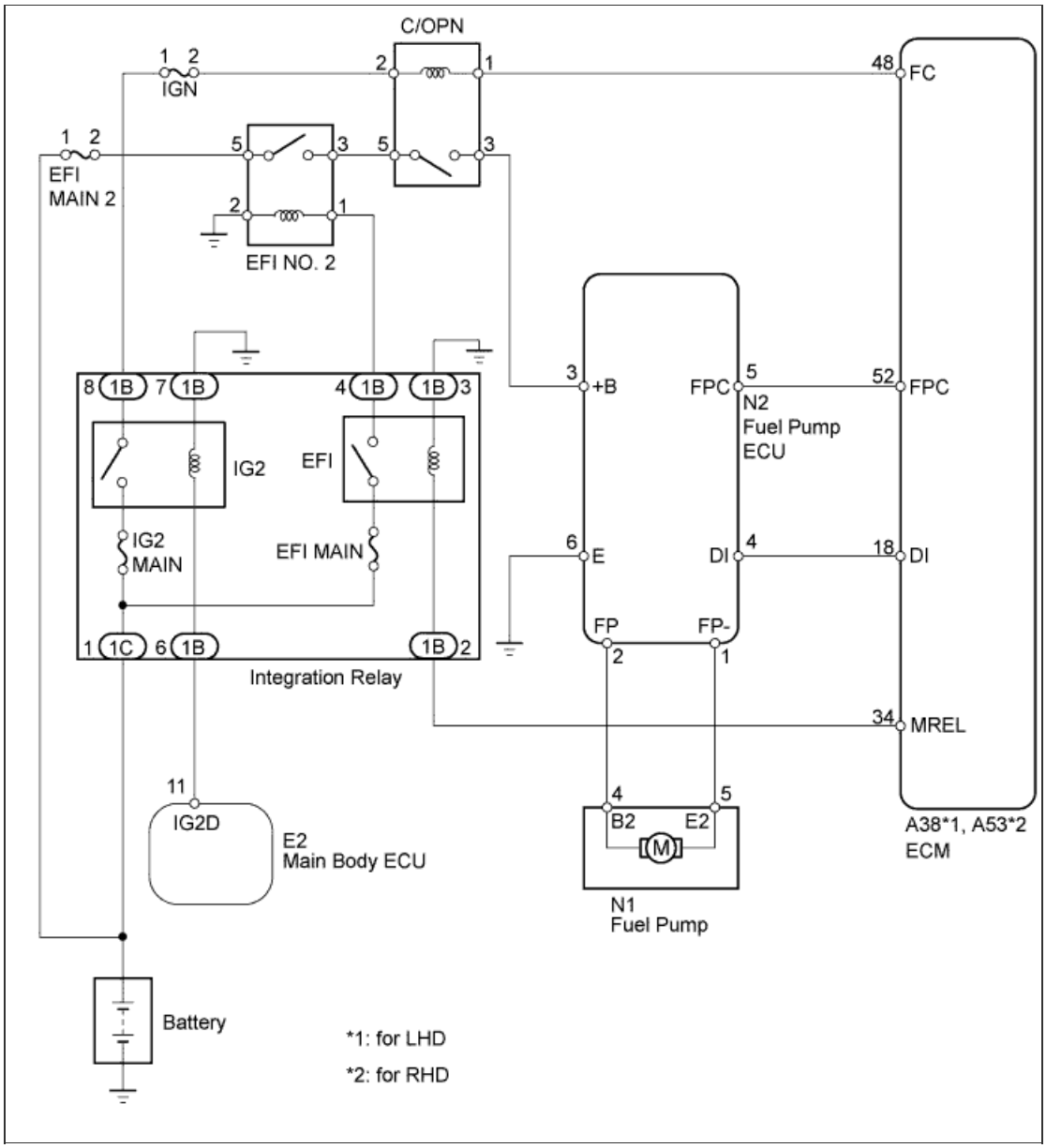
DTC Code	DTC Detection Condition	Trouble Area

P0230	When either condition below is met (1 trip detection logic):
	• When the fuel pump is operating:
	  ◦ The remaining fuel is 17 liters or more.
	  ◦ The DI terminal output is low.
	• When the fuel pump is not operating:
	  ◦ The DI terminal output is high.
		• Open or short in fuel pump circuit
		• Fuel pump
		• Fuel pump ECU
		• ECM

MONITOR DESCRIPTION

To monitor the fuel pump circuit, the ECM checks the fuel pump control signal (FPC) and diagnostic signal (DI). The FPC voltage varies between approximately 0 V to approximately 12 V (duty signal). Based on the condition of the fuel pump ECU malfunction, the DI voltage varies between approximately 0 V and approximately 12 V. The ECM then compares the variance of the FPC voltage and DI voltage, and determines if the fuel pump circuit is malfunctioning. When the ECM determines that the fuel pump circuit is malfunctioning, a DTC is stored immediately.

WIRING DIAGRAM



INSPECTION PROCEDURE

This troubleshooting procedure is based on the premise that the engine is started. If the engine is not started, proceed to the Problem Symptoms Table (Click here).

1.CHECK FOR DTC (B1500)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Body Electrical / Combination Meter / DTC.

e. Read the DTC.

Result

Result	Proceed to
DTC B1500 is not output	A
DTC B1500 is output	B

B → GO TO DTC B1500 (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (FUEL PUMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

d. Check whether operating sounds can be heard while operating the fuel pump using the tester.

OK:

Operating sounds can be heard from fuel pump.

NG → Go to step 6

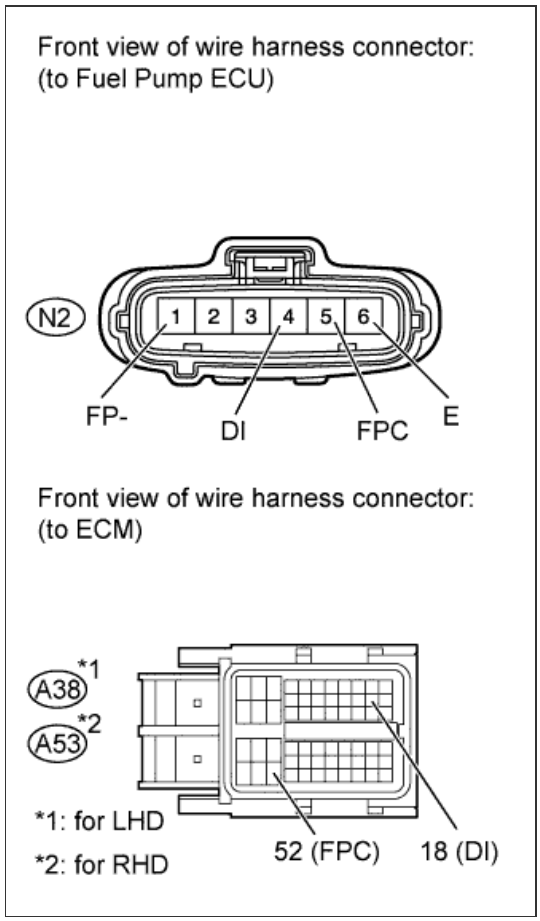
OK

3.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω

N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

5.CONFIRM WHETHER DTC OUTPUT RECURS

a. Check that there are 17 liters or more of fuel remaining.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Clear DTCs (Click here).

f. Crank the engine for 15 seconds.

g. Idle it for 1 minute.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read the DTCs.

Result

Result	Proceed to
DTC is not output	A
DTC P0230 is output	B

B → REPLACE ECM (**Click here**)

A

END

6.INSPECT CIRCUIT OPENING RELAY (C/OPN)

a. Inspect circuit opening relay (C/OPN) (Click here).

NG → REPLACE CIRCUIT OPENING RELAY (C/OPN)

OK

7.INSPECT CIRCUIT OPENING RELAY (POWER SOURCE VOLTAGE)

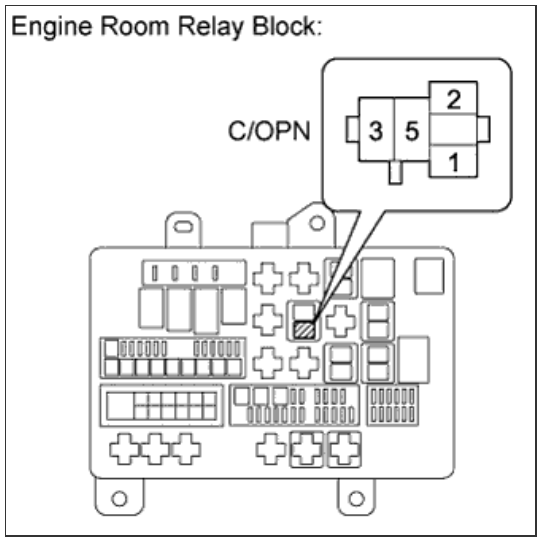
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Turn the engine switch on (IG).

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C/OPN relay (2) - Body ground	Engine switch on (IG)	11 to 14 V
C/OPN relay (5) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 14

OK

8.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY (C/OPN) - ECM, FUEL PUMP ECU)

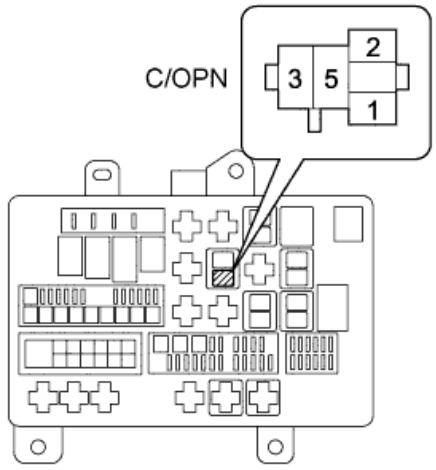
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Disconnect the A38 or A53 ECM connector.

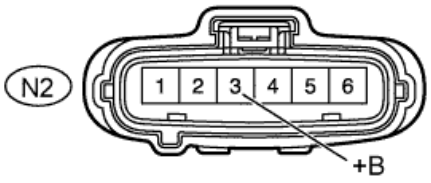
c. Disconnect the N2 fuel pump ECU connector.

d. Measure the resistance according to the value(s) in the table below.

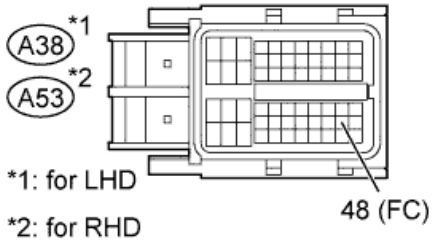
Engine Room Relay Block:



Front view of wire harness connector:
(to Fuel Pump ECU)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A38-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A38-48 (FC) - Body ground	Always	10 kΩ or higher
C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A53-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A53-48 (FC) - Body ground	Always	10 kΩ or higher

C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.CHECK HARNESS AND CONNECTOR (FUEL PUMP - FUEL PUMP ECU)

a. Disconnect the N1 fuel pump connector.

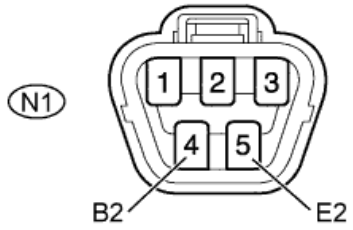
b. Disconnect the N2 fuel pump ECU connector.

c. Measure the resistance according to the value(s) in the table below.

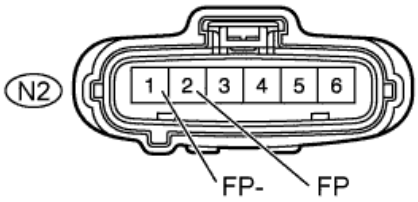
Standard Resistance:

Tester Connection	Condition	Specified Condition
N1-4 (B2) - N2-2 (FP)	Always	Below 1 Ω
N1-5 (E2) - N2-1 (FP-)	Always	Below 1 Ω
N1-4 (B2) or N2-2 (FP) - Body ground	Always	10 kΩ or higher
N1-5 (E2) or N2-1 (FP-) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Fuel Pump)



Front view of wire harness connector:
(to Fuel Pump ECU)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.INSPECT FUEL PUMP

a. Inspect the fuel pump (Click here).

NG → REPLACE FUEL PUMP (**Click here**)

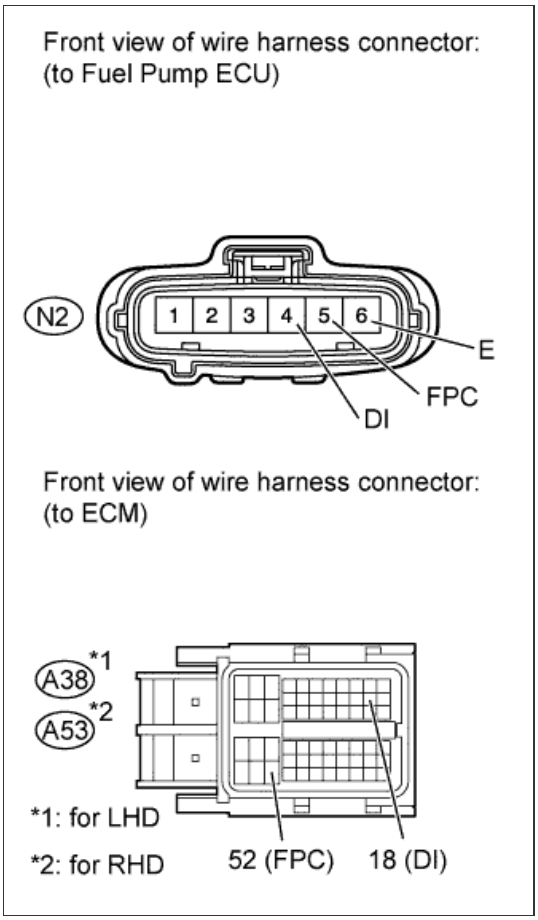
OK

11.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

12.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

13.CONFIRM WHETHER DTC OUTPUT RECURS

a. Check that there is 17 liters or more of fuel remaining.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Clear DTCs (Click here).

f. Crank the engine for 15 seconds.

g. Idle it for 1 minute.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read the DTCs.

Result

Result	Proceed to
DTC is not output	A
DTC P0230 is output	B

B → REPLACE ECM (Click here)

A

END

14.CHECK HARNESS AND CONNECTOR (C/OPN RELAY - EFI NO. 2 RELAY, IGN FUSE)

a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

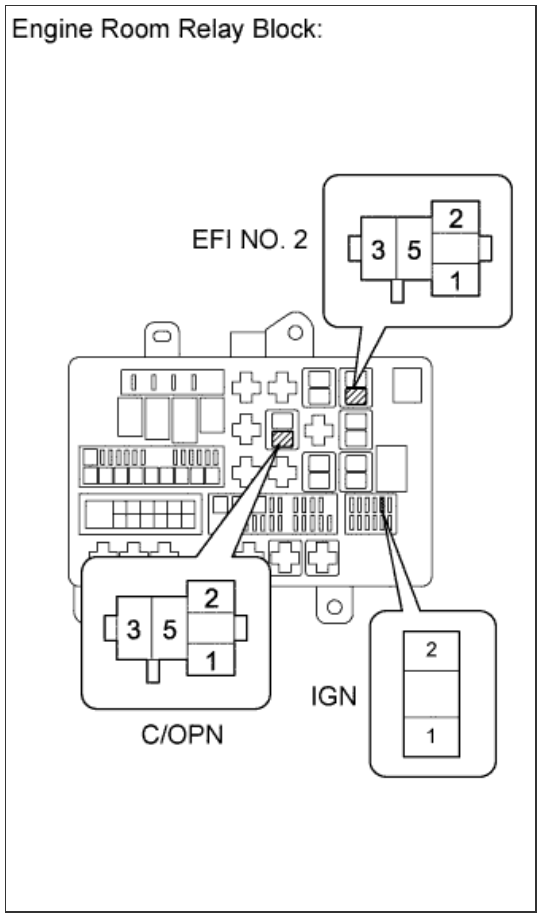
b. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

c. Remove the IGN fuse from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C/OPN relay (2) - IGN fuse (2)	Always	Below 1 Ω
C/OPN relay (5) - EFI NO. 2 relay (3)	Always	Below 1 Ω
C/OPN relay (2) or IGN fuse (2) - Body ground	Always	10 kΩ or higher
C/OPN relay (5) or EFI NO. 2 relay (3) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

15.INSPECT EFI NO. 2 RELAY (EFI NO. 2)

a. Inspect the EFI NO. 2 relay (EFI NO. 2) (Click here).

NG → REPLACE EFI NO. 2 RELAY (EFI NO. 2)

OK

16.CHECK HARNESS AND CONNECTOR (EFI NO. 2 RELAY - INTEGRATION RELAY, BATTERY, BODY GROUND)

a. Remove the EFI MAIN 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN 2 fuse	Always	Below 1 Ω

c. Reinstall the EFI MAIN 2 fuse.

d. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

e. Remove the integration relay from the engine room relay block.

f. Disconnect the 1B integration relay connector.

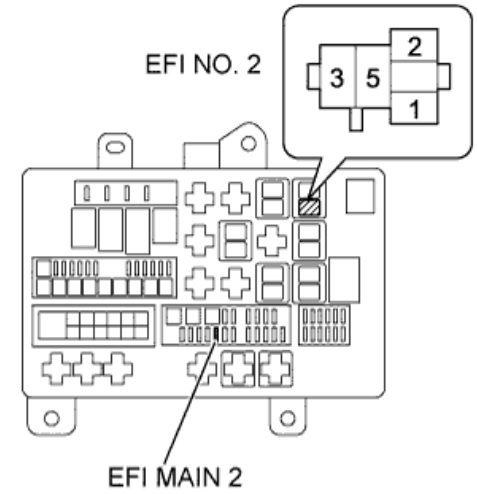
g. Disconnect the cable from the battery positive (+) terminal.

h. Measure the resistance according to the value(s) in the table below.

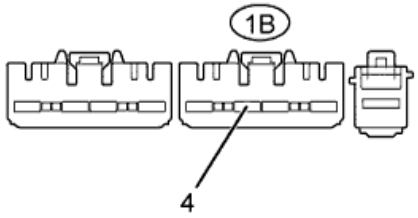
Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 relay (1) - 1B-4	Always	Below 1 Ω
EFI NO. 2 relay (5) - Positive (+) battery cable	Always	Below 1 Ω
EFI NO. 2 relay (2) - Body ground	Always	Below 1 Ω
EFI NO. 2 relay (1) or 1B-4 - Body ground	Always	10 kΩ or higher
EFI NO. 2 relay (5) or Positive (+) battery cable - Body ground	Always	10 kΩ or higher

Engine Room Relay Block:



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO ECM POWER SOURCE CIRCUIT (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

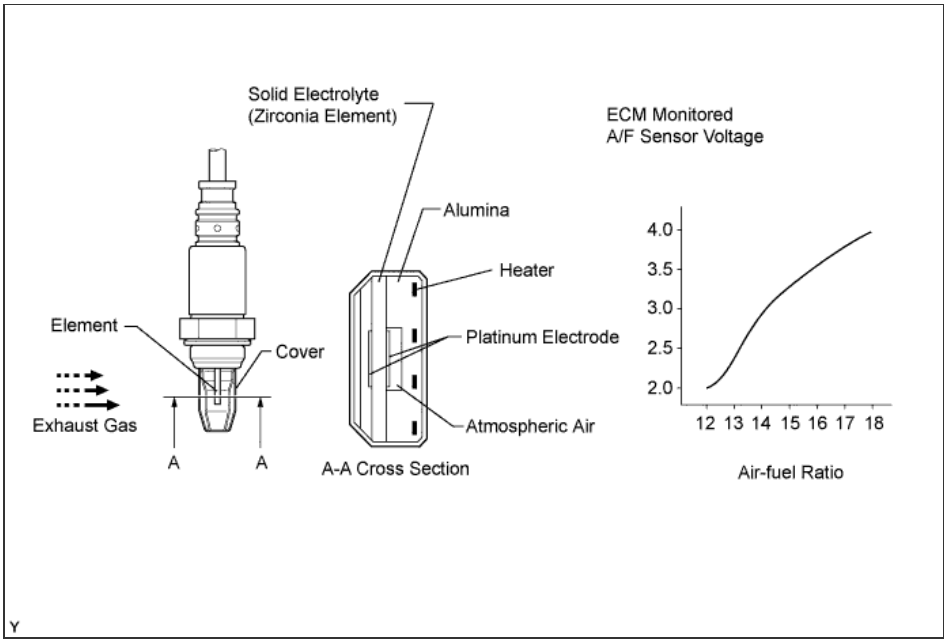
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

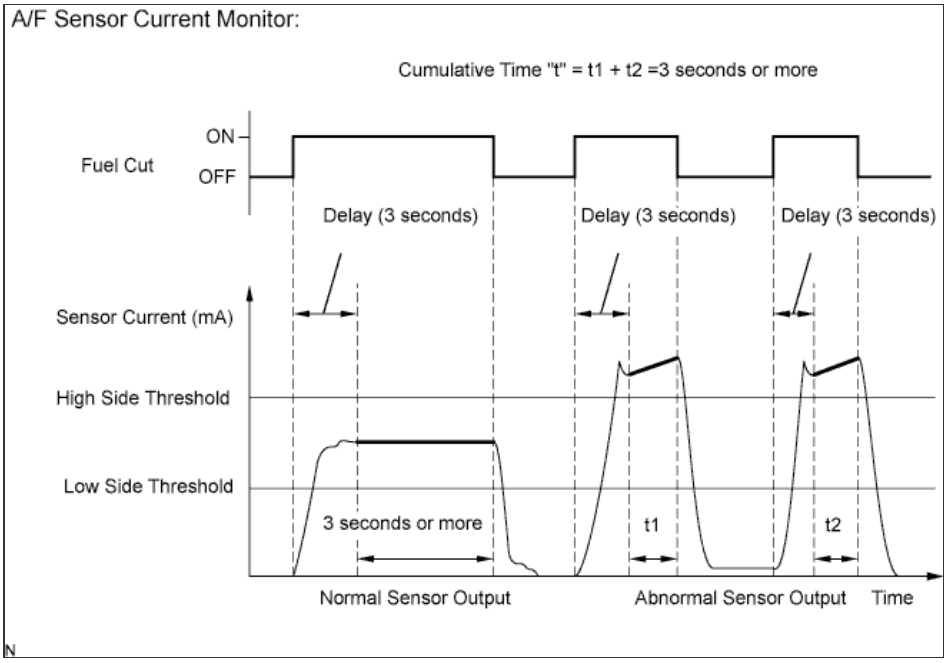
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

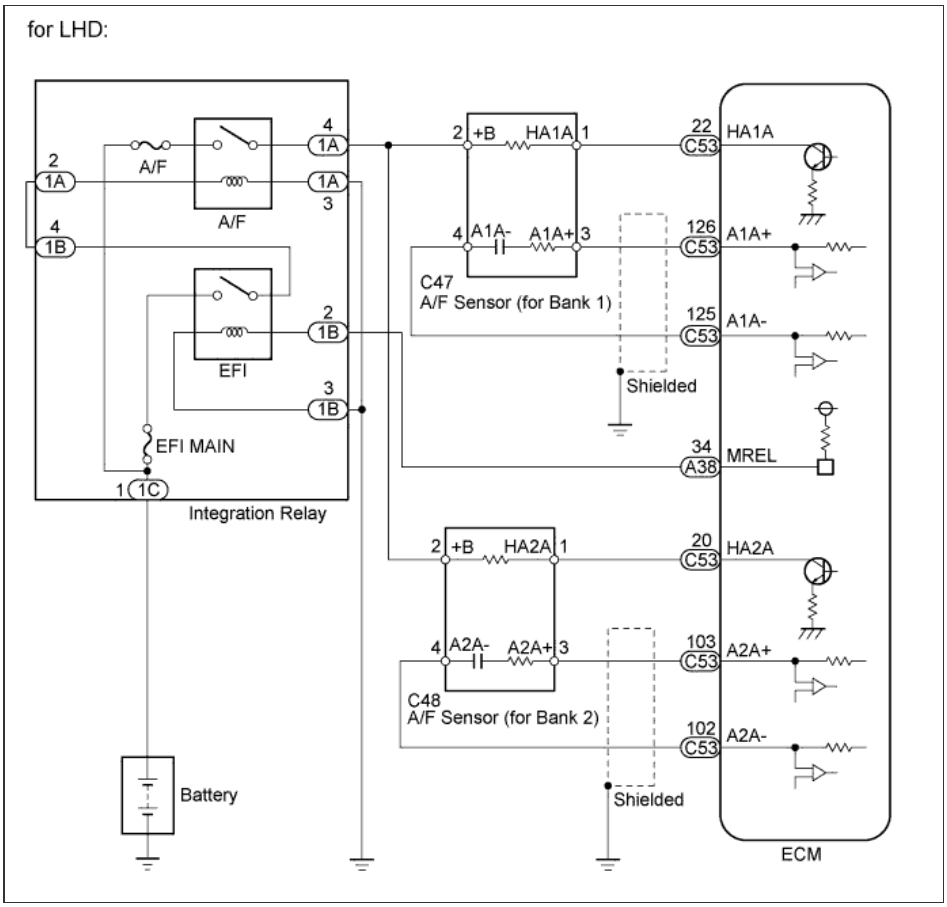
Sensor current detection monitor

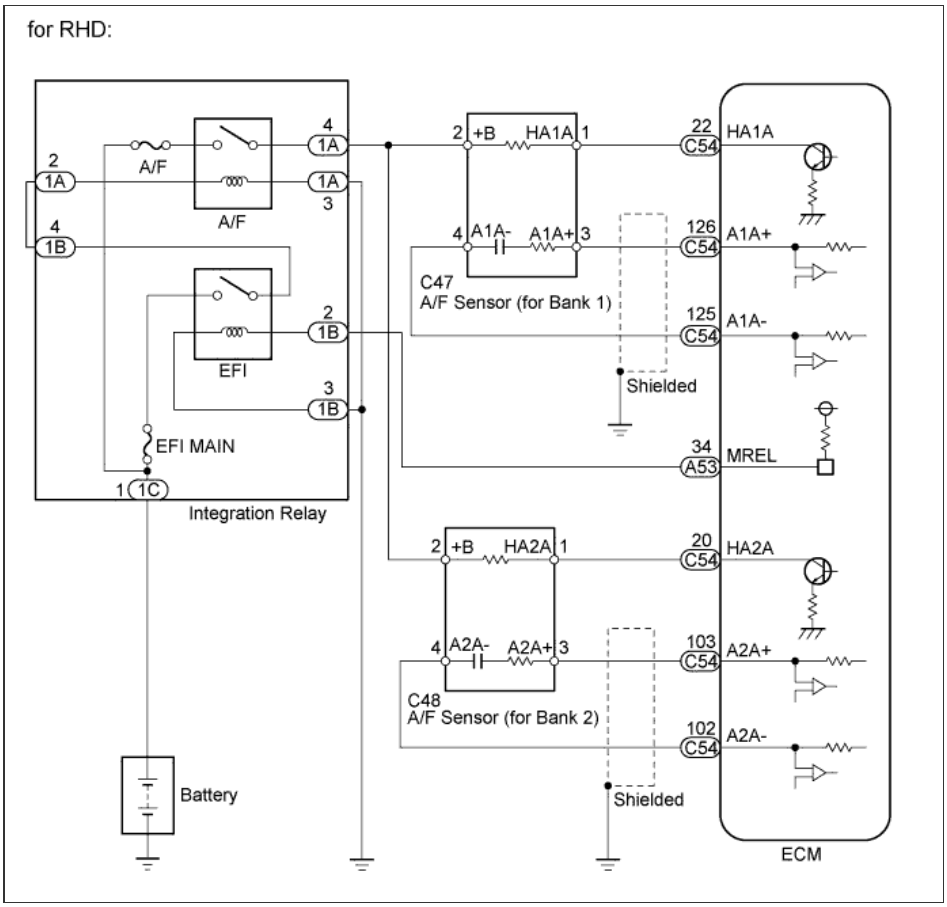
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





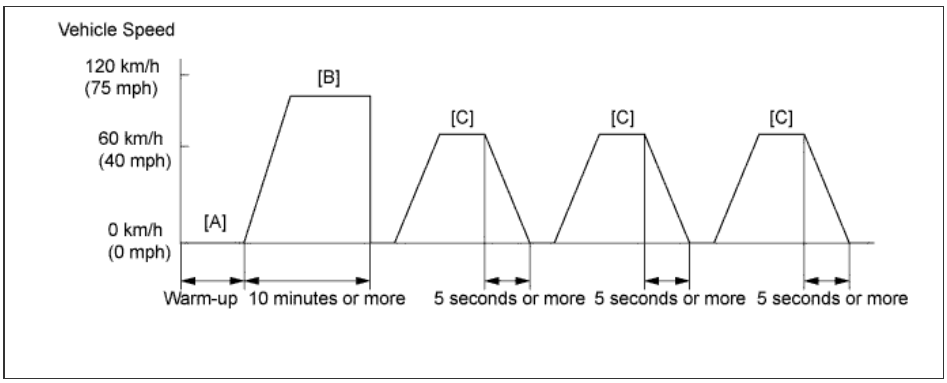
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

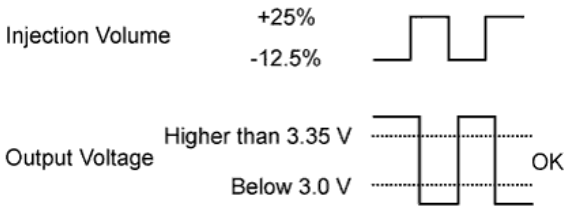
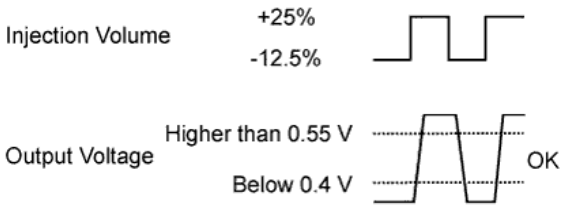
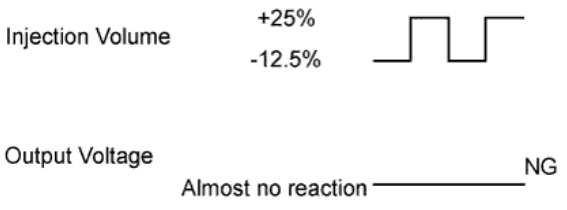
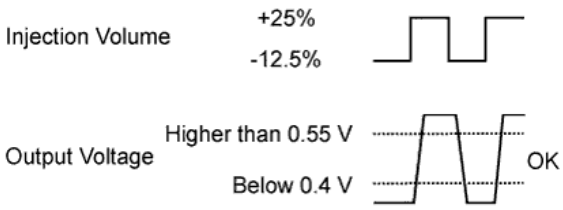
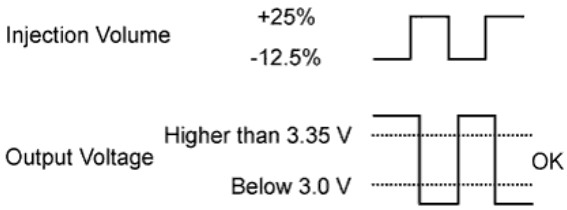
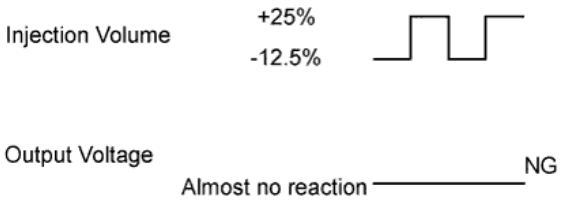
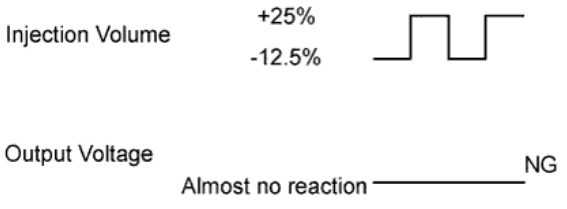
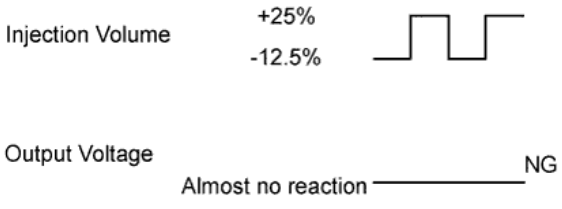
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

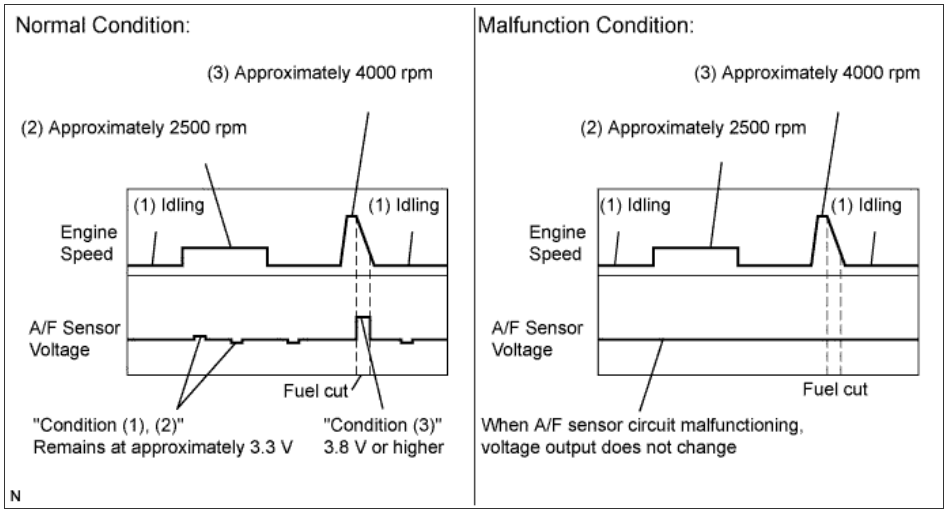
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

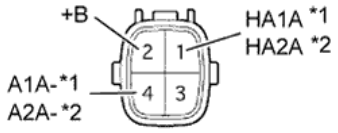
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

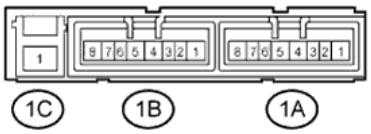
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

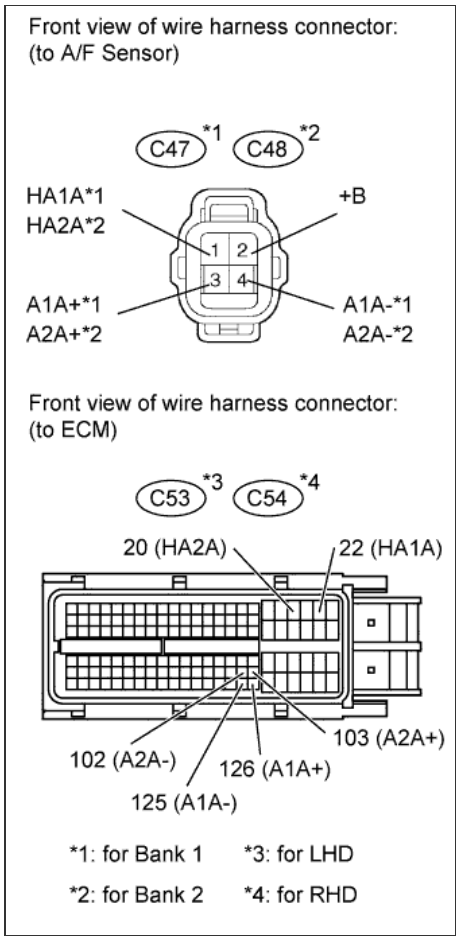
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

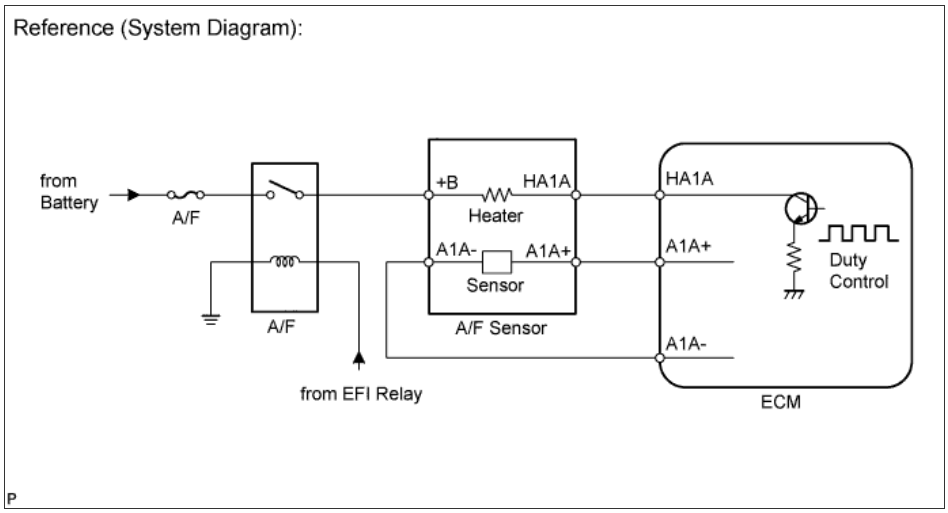
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0230 Fuel Pump Primary Circuit

for Preparation Click here

DESCRIPTION

When a malfunction in the fuel pump circuit is detected, DTC P0230 is stored.
The fuel pump circuit consists of the ECM, fuel pump and fuel pump ECU (which operates the fuel pump). Based on the engine output, the ECM determines the fuel pump speed. The speed is then converted to a duty signal and sent to the fuel pump ECU. Based on the signal sent from the ECM, the fuel pump ECU adjusts the fuel pump operation speed between 3 settings. The fuel pump ECU also has a self-diagnosis function. Based on the fuel pump circuit condition, the fuel pump ECU outputs a diagnostic signal (DI) to the ECM, and the ECM determines if there is a malfunction in the fuel pump circuit.

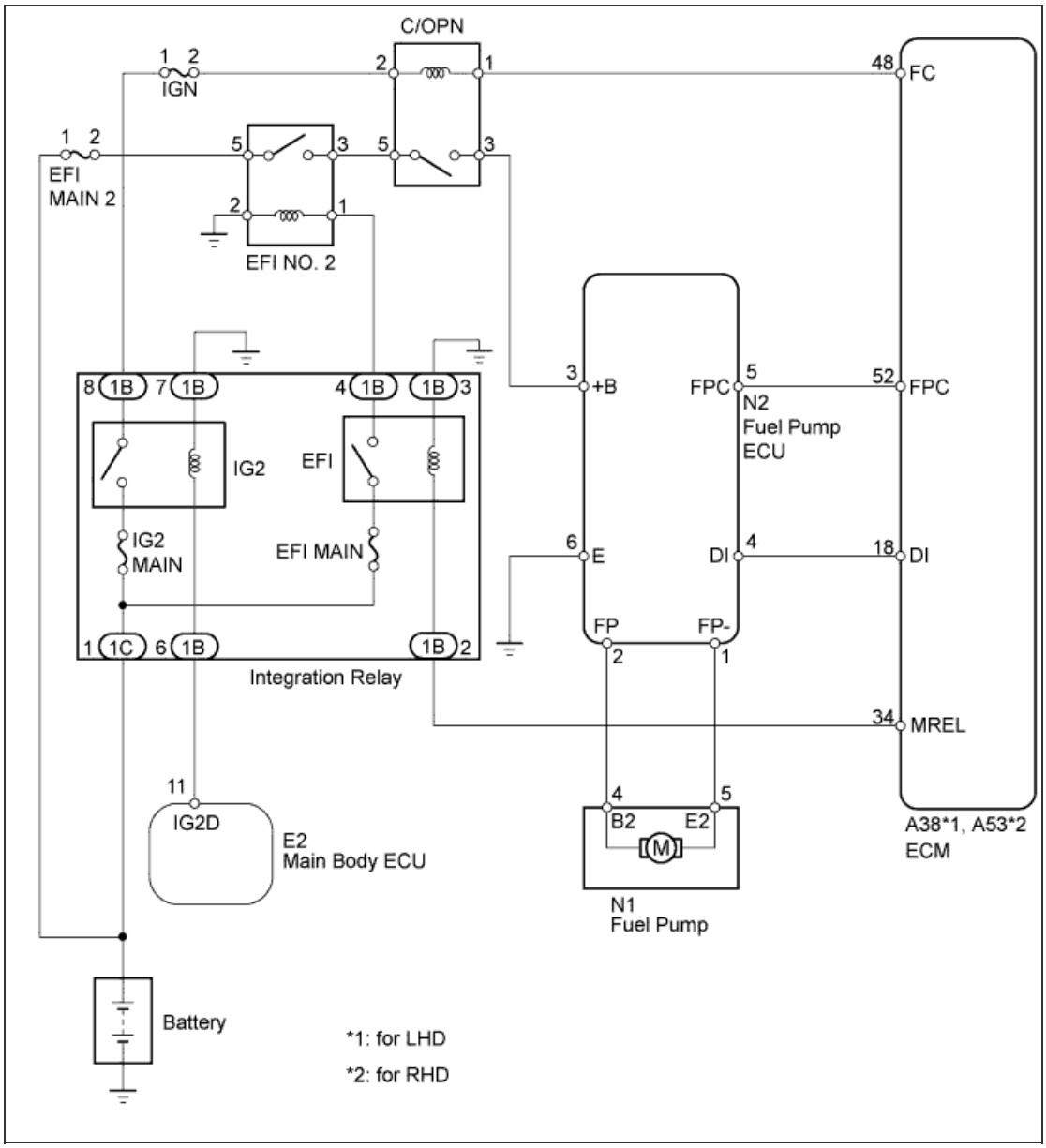
DTC Code	DTC Detection Condition	Trouble Area

P0230	When either condition below is met (1 trip detection logic):
	• When the fuel pump is operating:
	  ◦ The remaining fuel is 17 liters or more.
	  ◦ The DI terminal output is low.
	• When the fuel pump is not operating:
	  ◦ The DI terminal output is high.
		• Open or short in fuel pump circuit
		• Fuel pump
		• Fuel pump ECU
		• ECM

MONITOR DESCRIPTION

To monitor the fuel pump circuit, the ECM checks the fuel pump control signal (FPC) and diagnostic signal (DI). The FPC voltage varies between approximately 0 V to approximately 12 V (duty signal). Based on the condition of the fuel pump ECU malfunction, the DI voltage varies between approximately 0 V and approximately 12 V. The ECM then compares the variance of the FPC voltage and DI voltage, and determines if the fuel pump circuit is malfunctioning. When the ECM determines that the fuel pump circuit is malfunctioning, a DTC is stored immediately.

WIRING DIAGRAM



INSPECTION PROCEDURE

This troubleshooting procedure is based on the premise that the engine is started. If the engine is not started, proceed to the Problem Symptoms Table (Click here).

1.CHECK FOR DTC (B1500)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Body Electrical / Combination Meter / DTC.

e. Read the DTC.

Result

Result	Proceed to
DTC B1500 is not output	A
DTC B1500 is output	B

B → GO TO DTC B1500 (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (FUEL PUMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

d. Check whether operating sounds can be heard while operating the fuel pump using the tester.

OK:

Operating sounds can be heard from fuel pump.

NG → Go to step 6

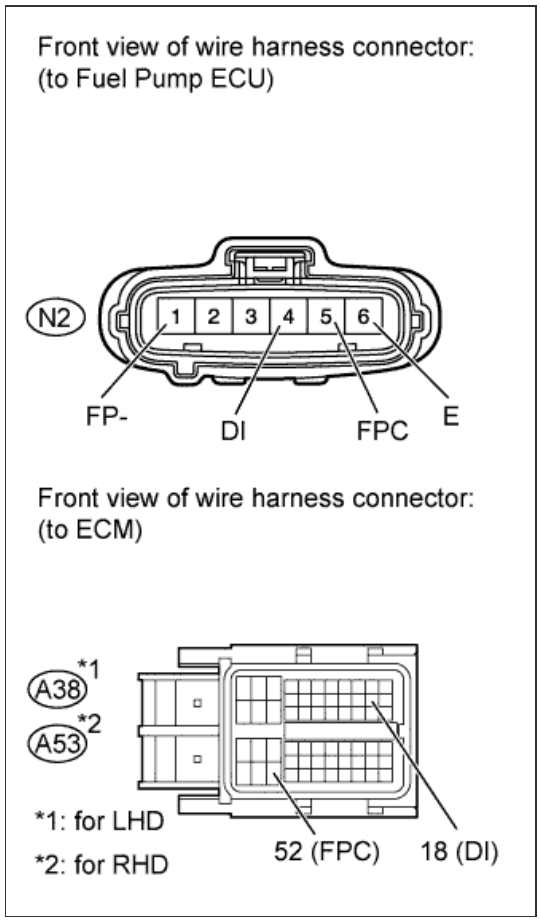
OK

3.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω

N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

5.CONFIRM WHETHER DTC OUTPUT RECURS

a. Check that there are 17 liters or more of fuel remaining.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Clear DTCs (Click here).

f. Crank the engine for 15 seconds.

g. Idle it for 1 minute.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read the DTCs.

Result

Result	Proceed to
DTC is not output	A
DTC P0230 is output	B

B → REPLACE ECM (**Click here**)

A

END

6.INSPECT CIRCUIT OPENING RELAY (C/OPN)

a. Inspect circuit opening relay (C/OPN) (Click here).

NG → REPLACE CIRCUIT OPENING RELAY (C/OPN)

OK

7.INSPECT CIRCUIT OPENING RELAY (POWER SOURCE VOLTAGE)

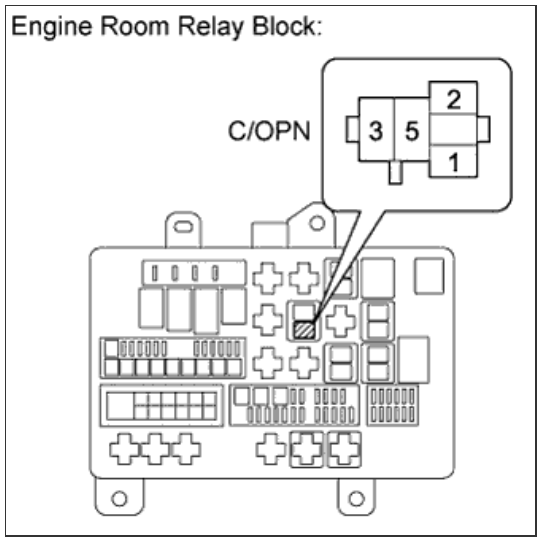
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Turn the engine switch on (IG).

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C/OPN relay (2) - Body ground	Engine switch on (IG)	11 to 14 V
C/OPN relay (5) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 14

OK

8.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY (C/OPN) - ECM, FUEL PUMP ECU)

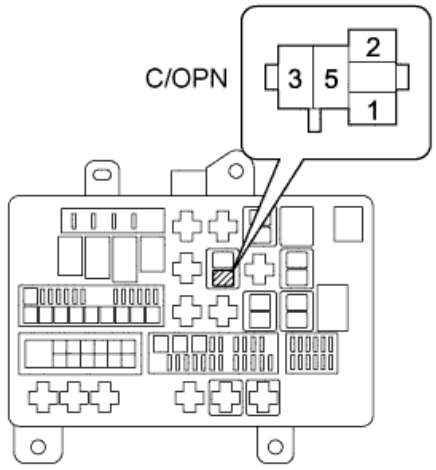
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Disconnect the A38 or A53 ECM connector.

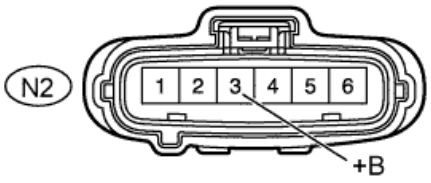
c. Disconnect the N2 fuel pump ECU connector.

d. Measure the resistance according to the value(s) in the table below.

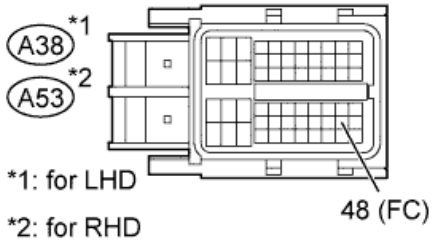
Engine Room Relay Block:



Front view of wire harness connector:
(to Fuel Pump ECU)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A38-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A38-48 (FC) - Body ground	Always	10 kΩ or higher
C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A53-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A53-48 (FC) - Body ground	Always	10 kΩ or higher

C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.CHECK HARNESS AND CONNECTOR (FUEL PUMP - FUEL PUMP ECU)

a. Disconnect the N1 fuel pump connector.

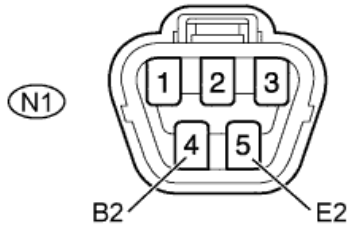
b. Disconnect the N2 fuel pump ECU connector.

c. Measure the resistance according to the value(s) in the table below.

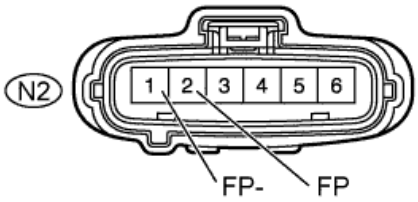
Standard Resistance:

Tester Connection	Condition	Specified Condition
N1-4 (B2) - N2-2 (FP)	Always	Below 1 Ω
N1-5 (E2) - N2-1 (FP-)	Always	Below 1 Ω
N1-4 (B2) or N2-2 (FP) - Body ground	Always	10 kΩ or higher
N1-5 (E2) or N2-1 (FP-) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Fuel Pump)



Front view of wire harness connector:
(to Fuel Pump ECU)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.INSPECT FUEL PUMP

a. Inspect the fuel pump (Click here).

NG → REPLACE FUEL PUMP (**Click here**)

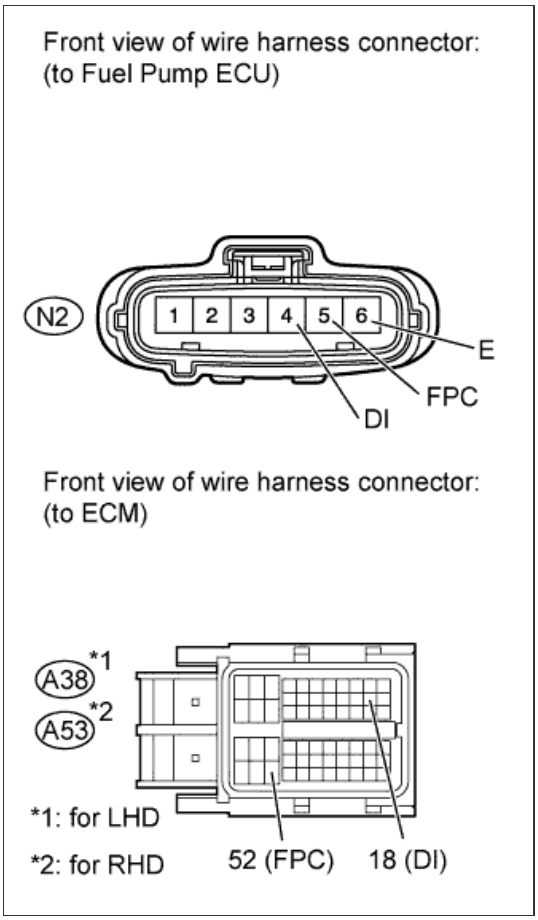
OK

11.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

12.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

13.CONFIRM WHETHER DTC OUTPUT RECURS

a. Check that there is 17 liters or more of fuel remaining.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

d. Turn the tester on.

e. Clear DTCs (Click here).

f. Crank the engine for 15 seconds.

g. Idle it for 1 minute.

h. Enter the following menus: Powertrain / Engine and ECT / DTC.

i. Read the DTCs.

Result

Result	Proceed to
DTC is not output	A
DTC P0230 is output	B

B → REPLACE ECM (Click here)

A

END

14.CHECK HARNESS AND CONNECTOR (C/OPN RELAY - EFI NO. 2 RELAY, IGN FUSE)

a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

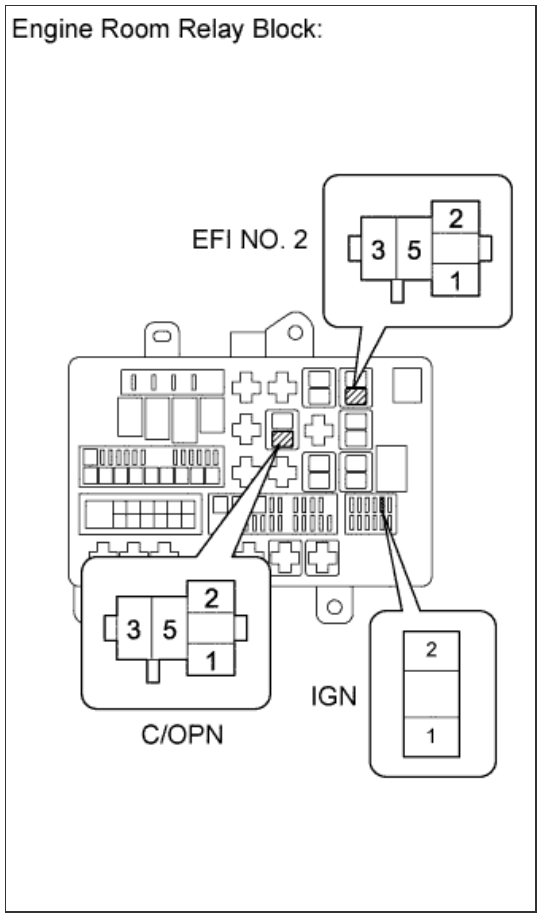
b. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

c. Remove the IGN fuse from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C/OPN relay (2) - IGN fuse (2)	Always	Below 1 Ω
C/OPN relay (5) - EFI NO. 2 relay (3)	Always	Below 1 Ω
C/OPN relay (2) or IGN fuse (2) - Body ground	Always	10 kΩ or higher
C/OPN relay (5) or EFI NO. 2 relay (3) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

15.INSPECT EFI NO. 2 RELAY (EFI NO. 2)

a. Inspect the EFI NO. 2 relay (EFI NO. 2) (Click here).

NG → REPLACE EFI NO. 2 RELAY (EFI NO. 2)

OK

16.CHECK HARNESS AND CONNECTOR (EFI NO. 2 RELAY - INTEGRATION RELAY, BATTERY, BODY GROUND)

a. Remove the EFI MAIN 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN 2 fuse	Always	Below 1 Ω

c. Reinstall the EFI MAIN 2 fuse.

d. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

e. Remove the integration relay from the engine room relay block.

f. Disconnect the 1B integration relay connector.

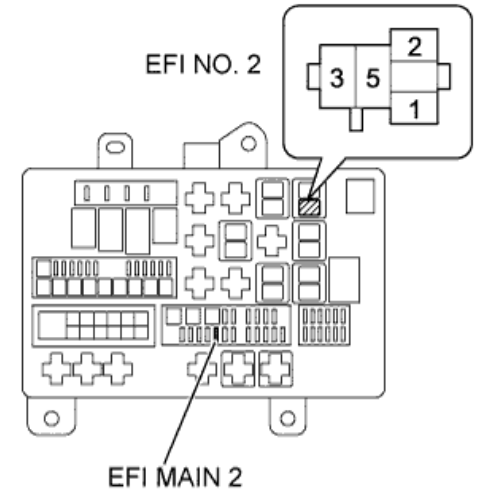
g. Disconnect the cable from the battery positive (+) terminal.

h. Measure the resistance according to the value(s) in the table below.

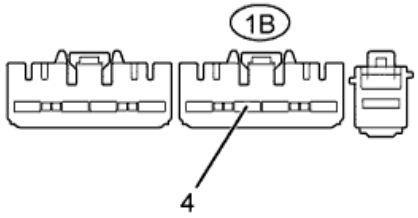
Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 relay (1) - 1B-4	Always	Below 1 Ω
EFI NO. 2 relay (5) - Positive (+) battery cable	Always	Below 1 Ω
EFI NO. 2 relay (2) - Body ground	Always	Below 1 Ω
EFI NO. 2 relay (1) or 1B-4 - Body ground	Always	10 kΩ or higher
EFI NO. 2 relay (5) or Positive (+) battery cable - Body ground	Always	10 kΩ or higher

Engine Room Relay Block:



Front view of wire harness connector:
(to Integration Relay)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO ECM POWER SOURCE CIRCUIT (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

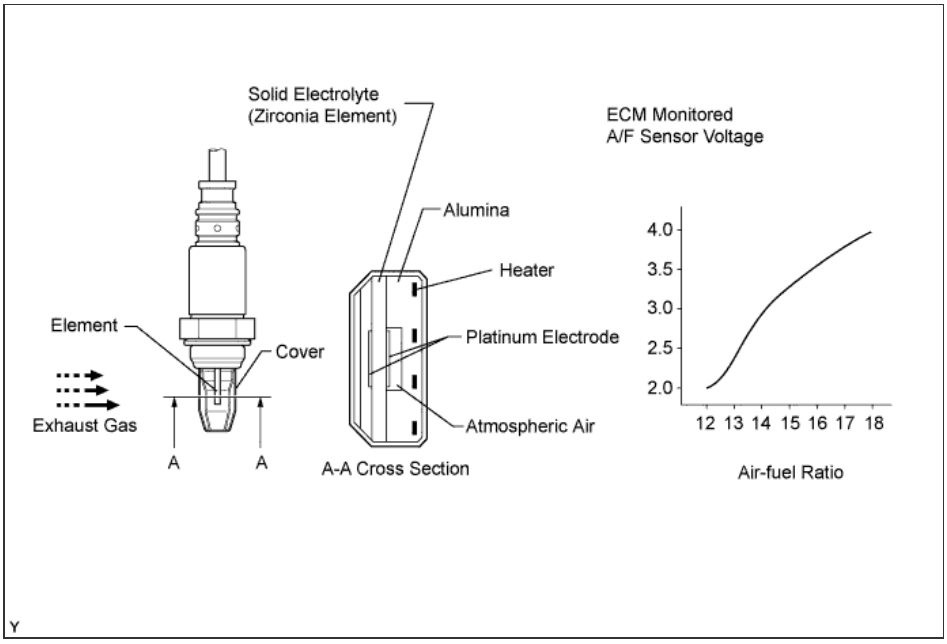
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

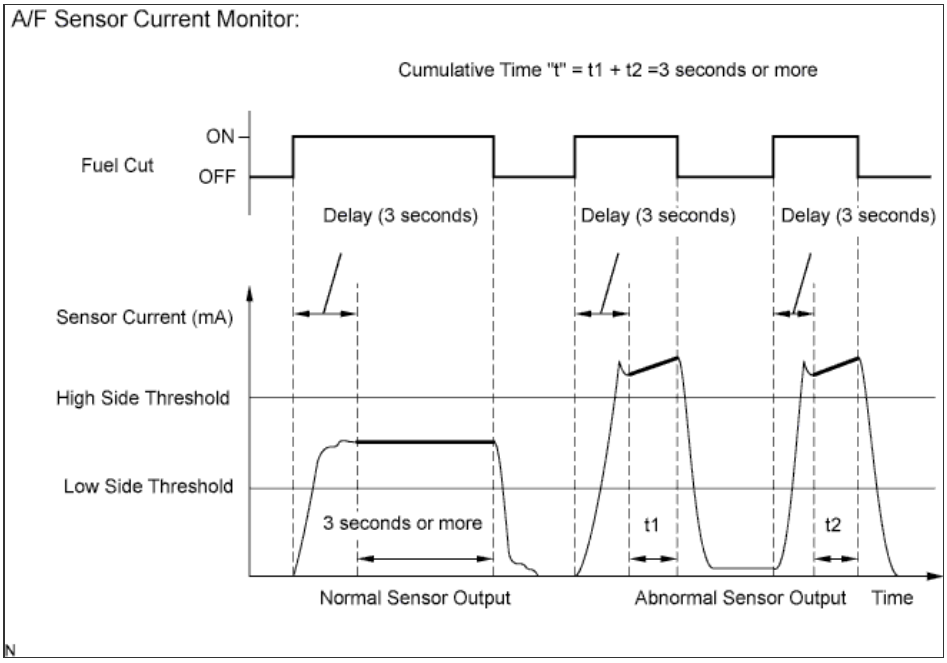
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

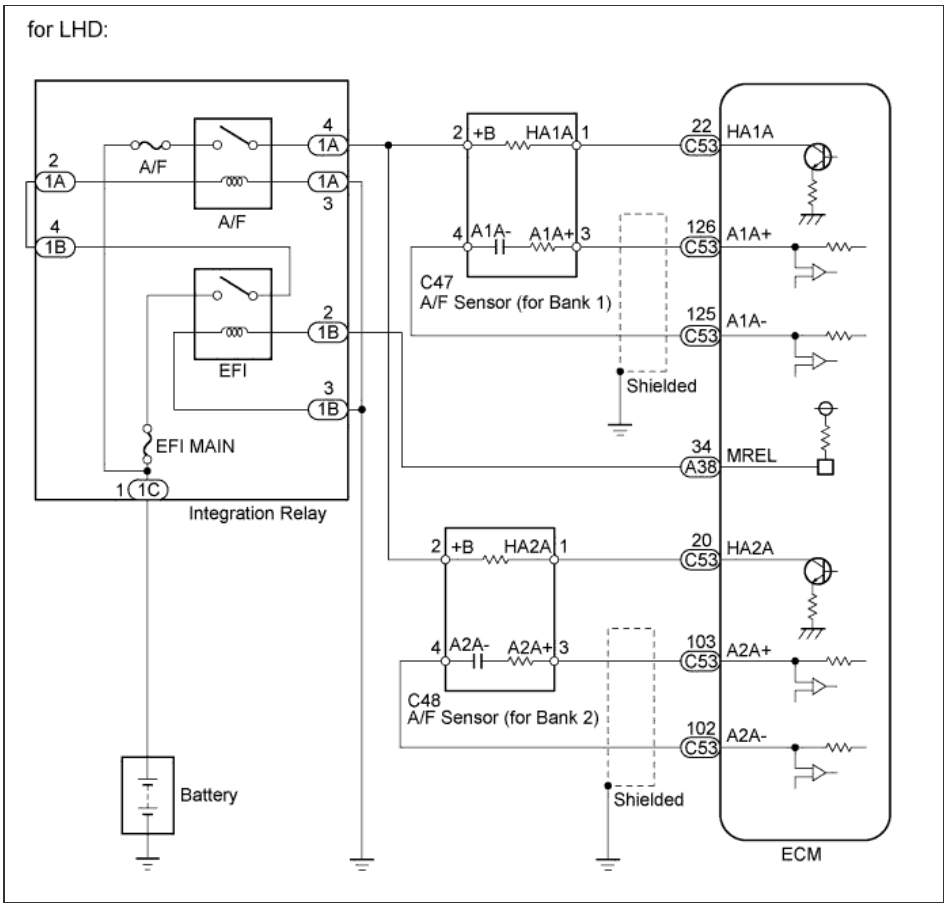
Sensor current detection monitor

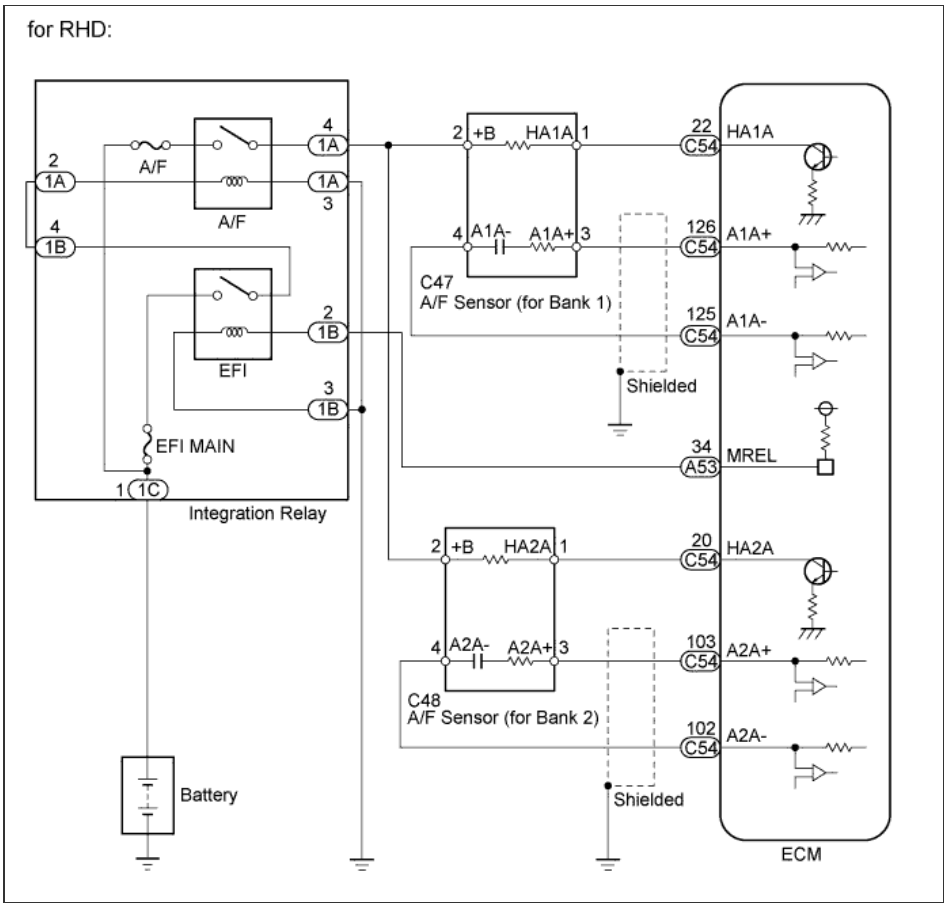
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





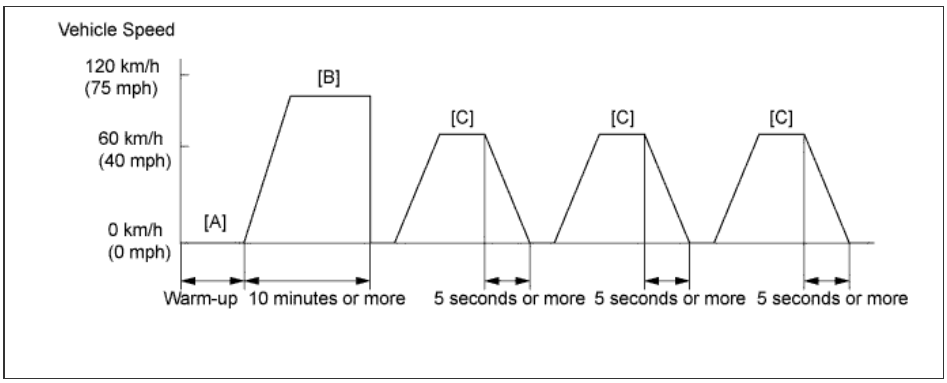
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

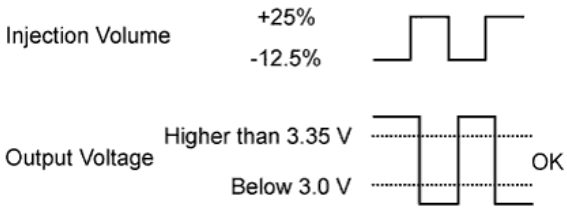
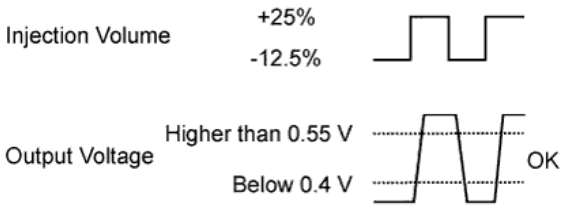
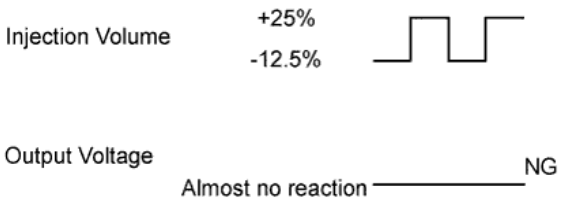
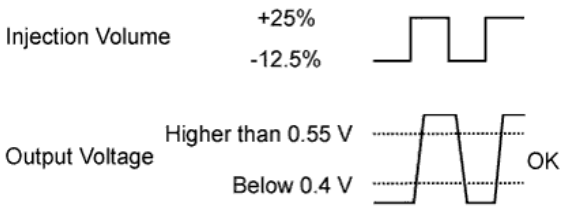
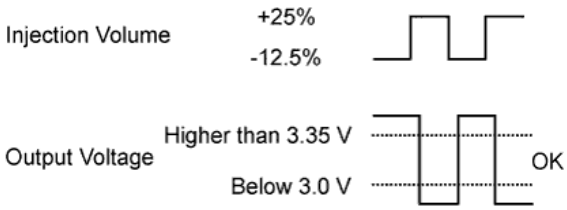
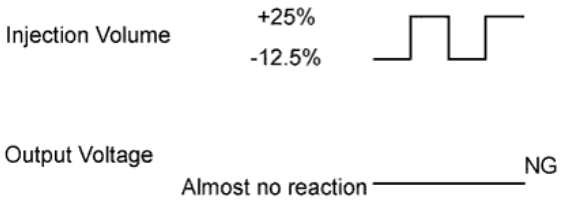
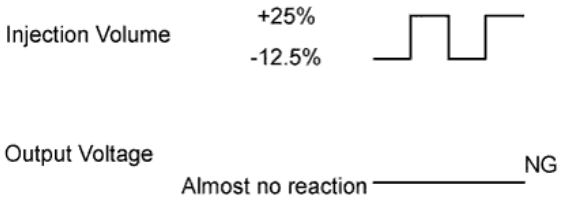
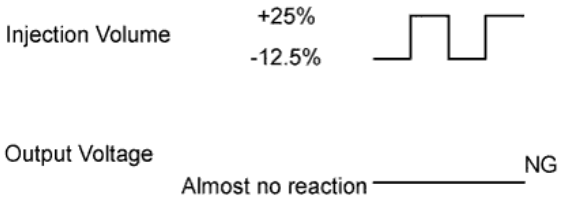
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

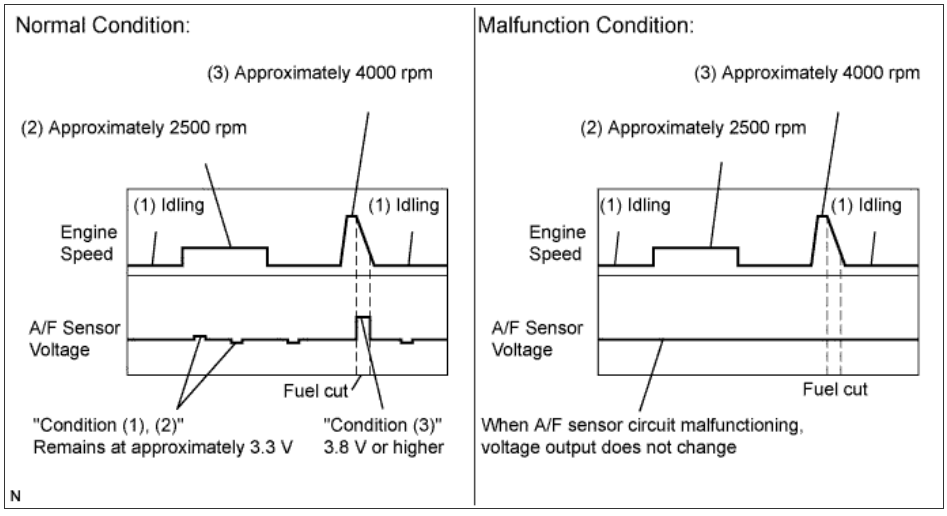
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

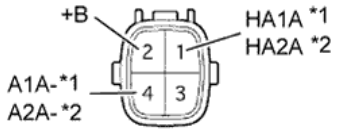
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

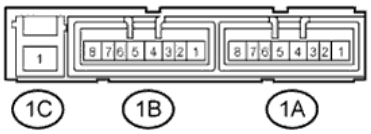
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

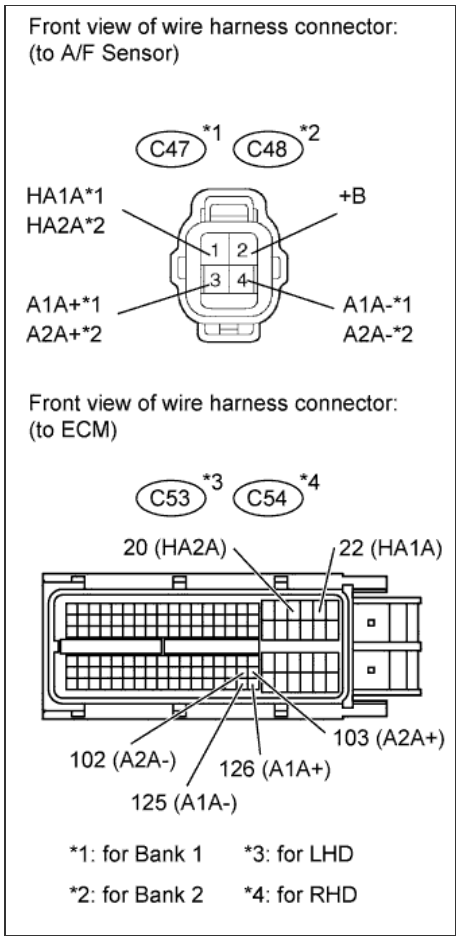
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

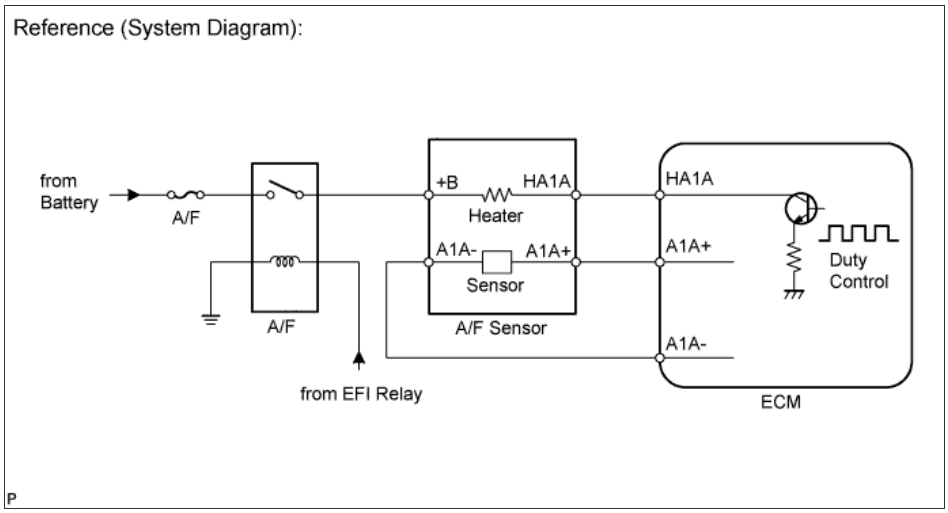
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

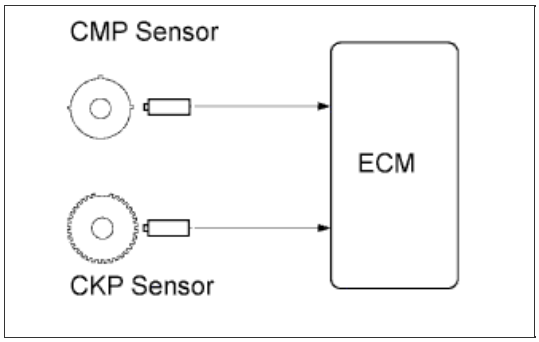
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

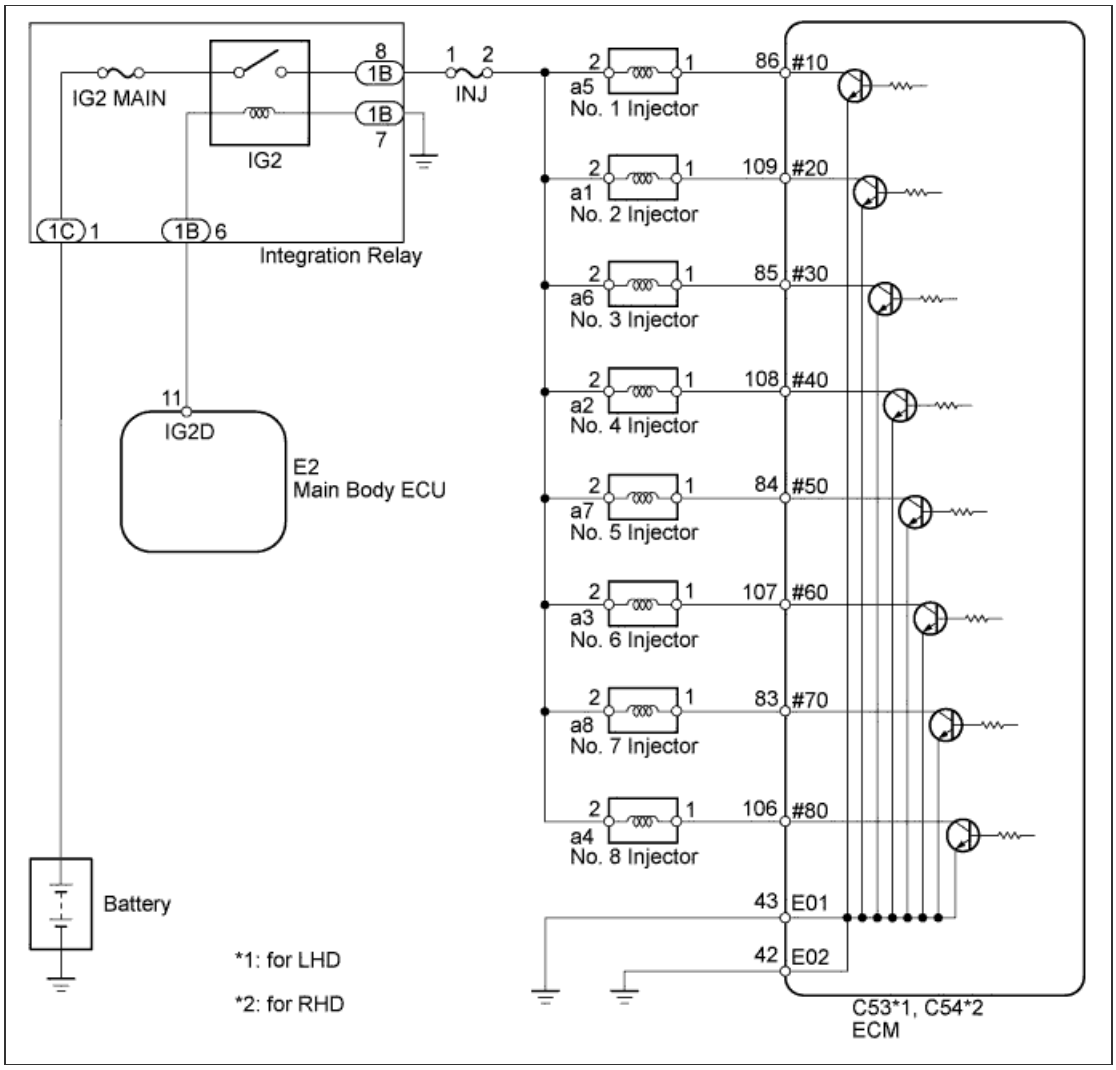
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

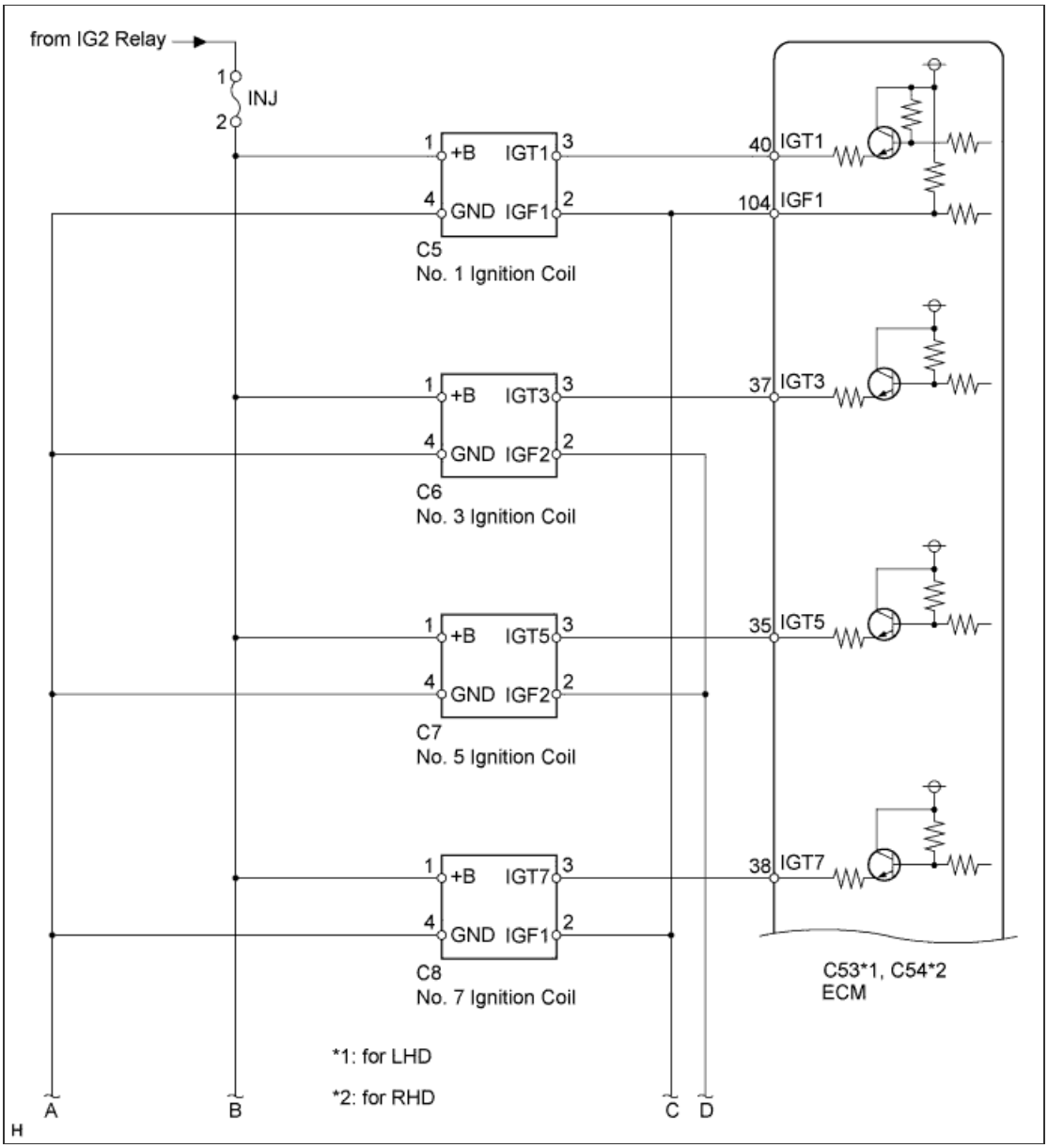
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

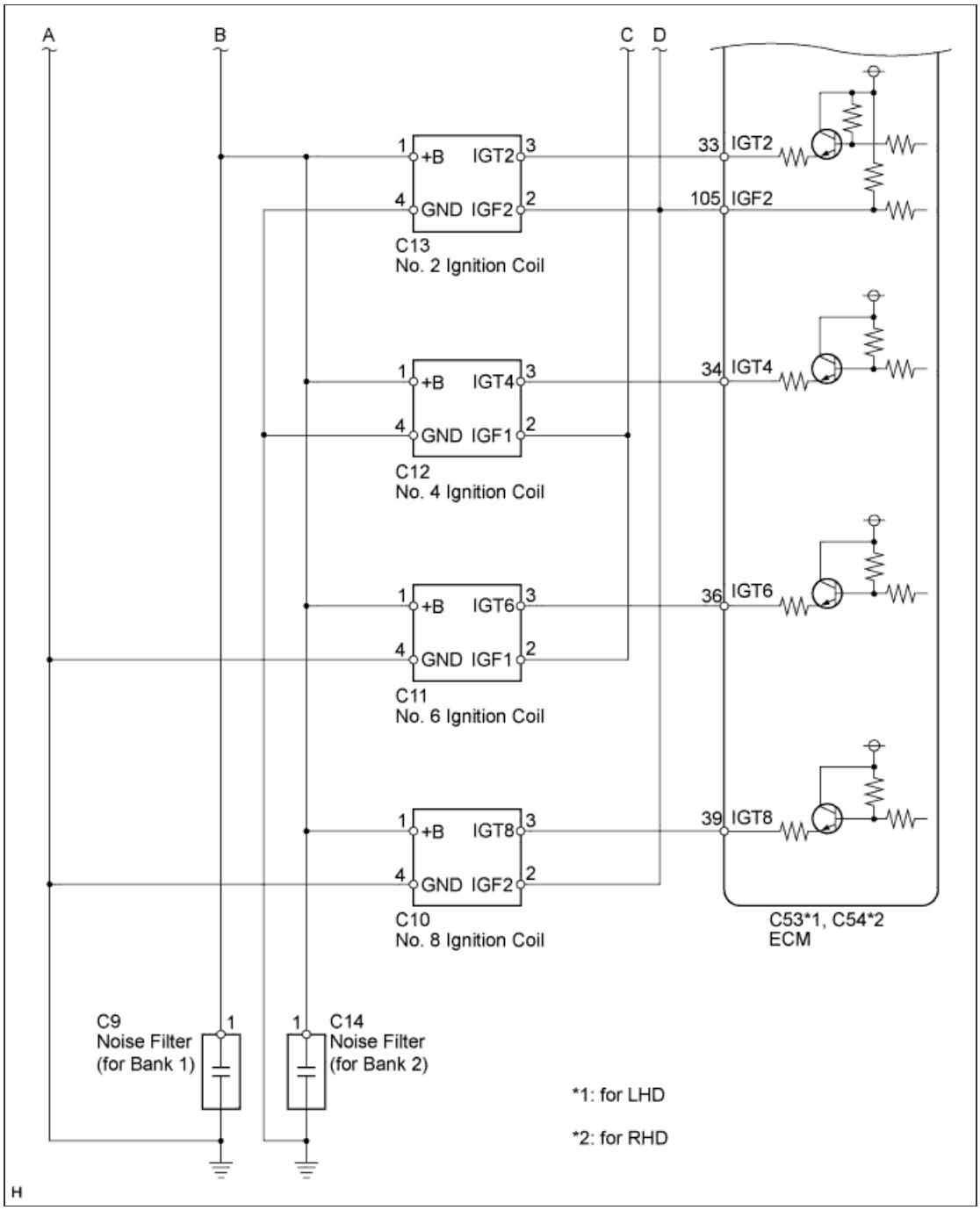
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

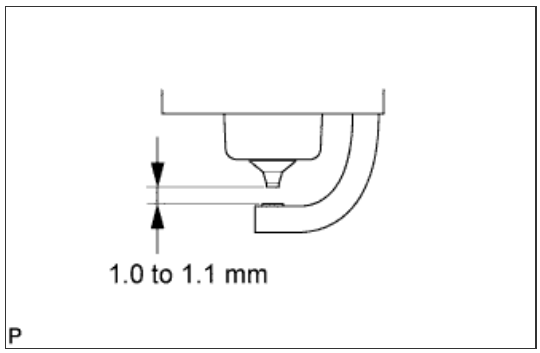
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

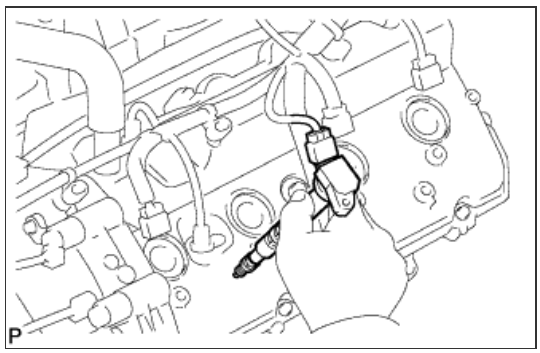
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

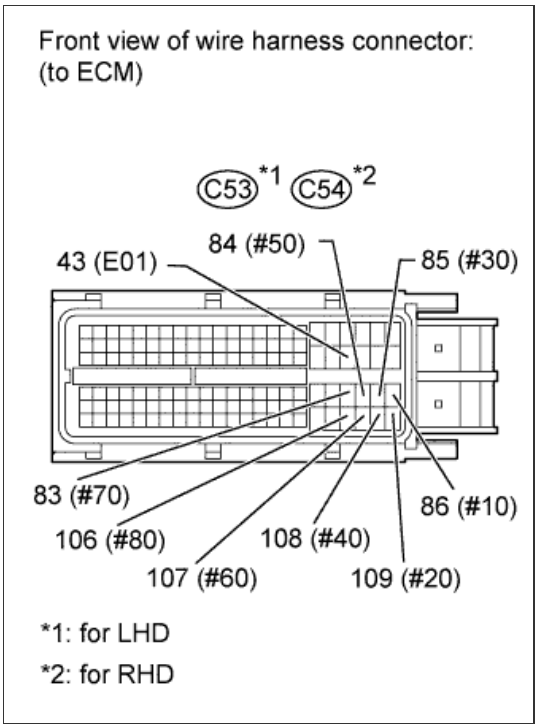
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

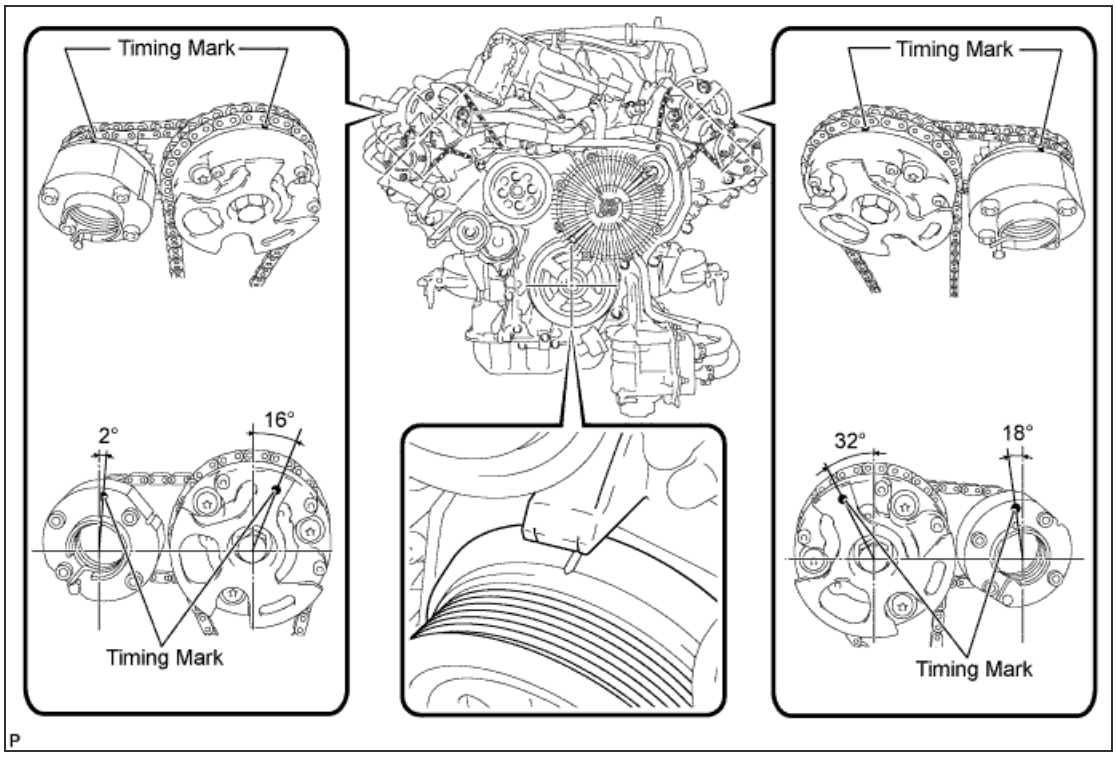
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

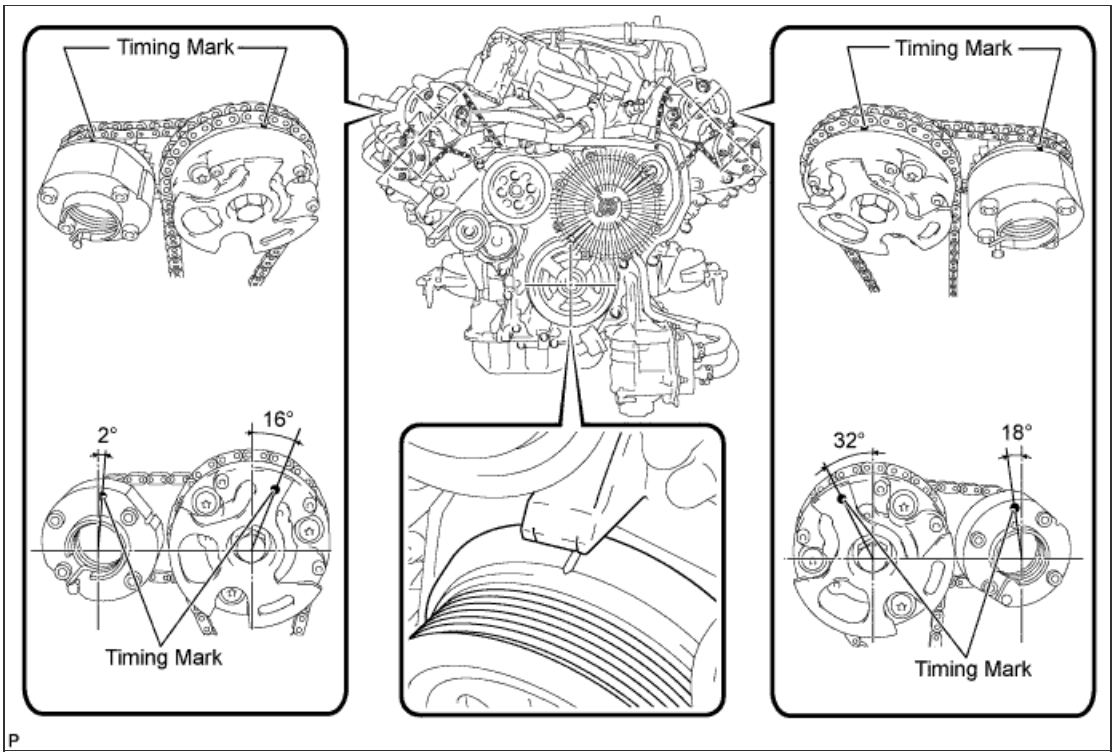
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

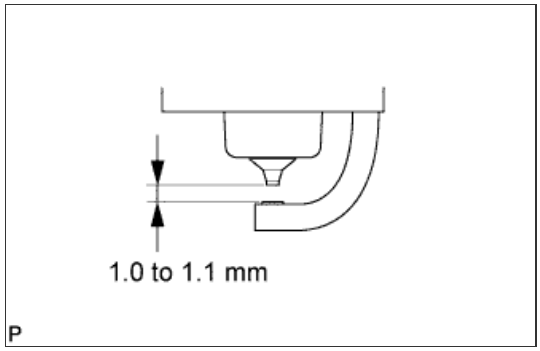
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

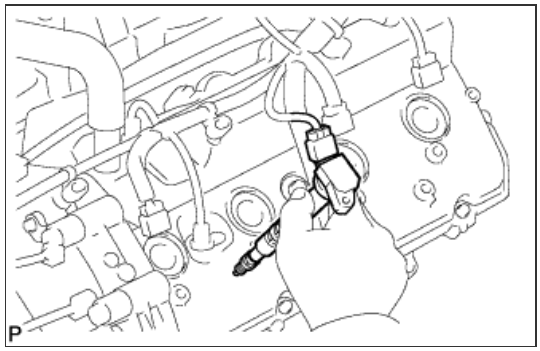
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

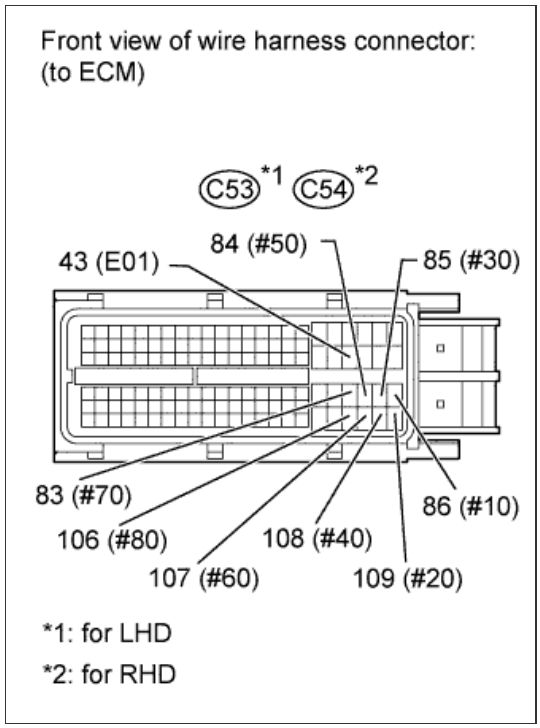
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

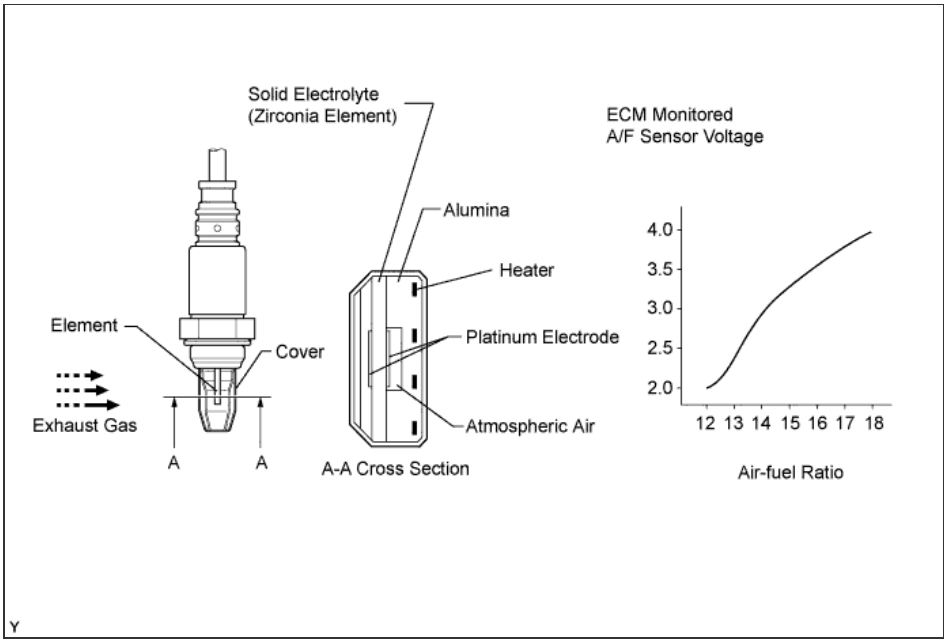
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

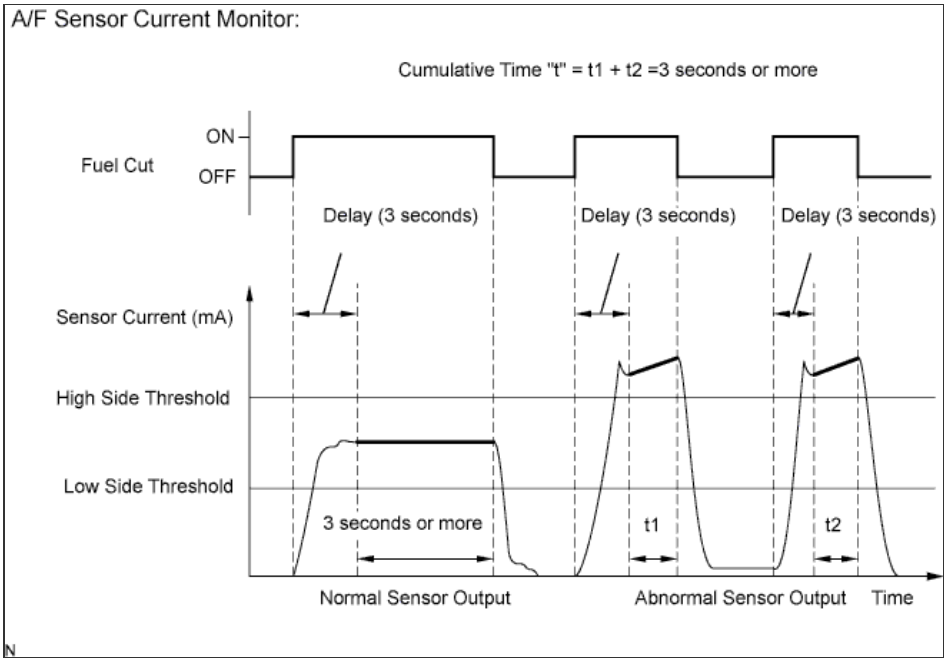
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

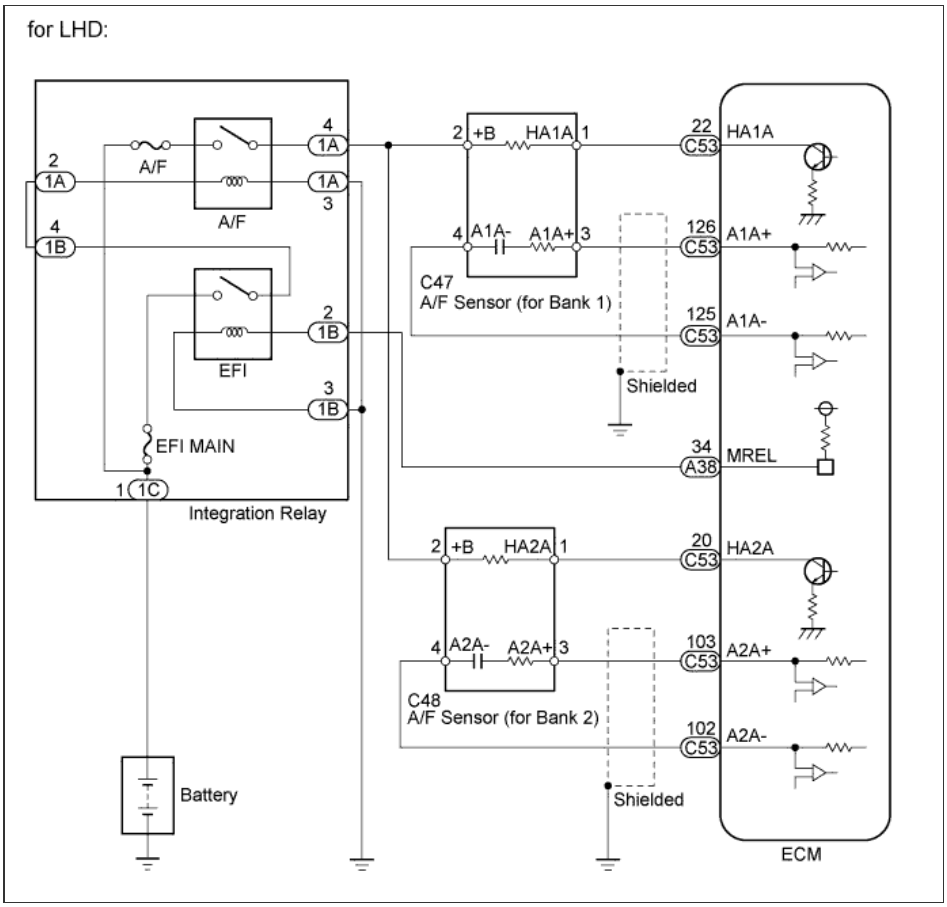
Sensor current detection monitor

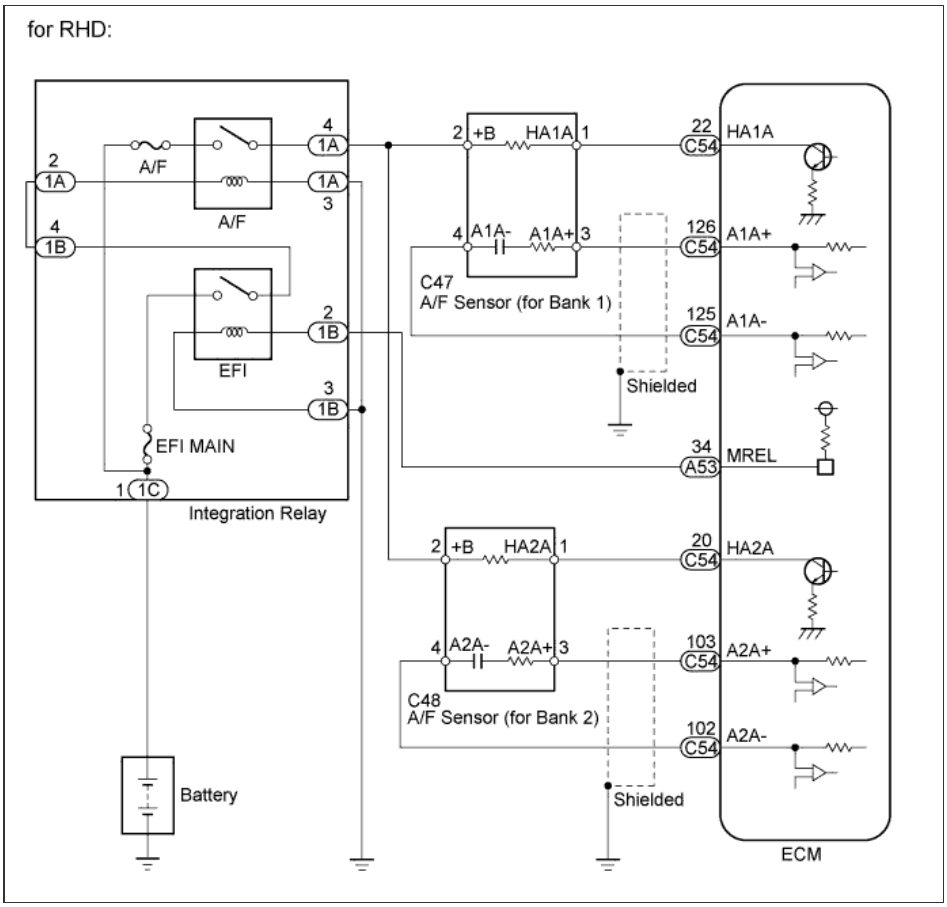
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





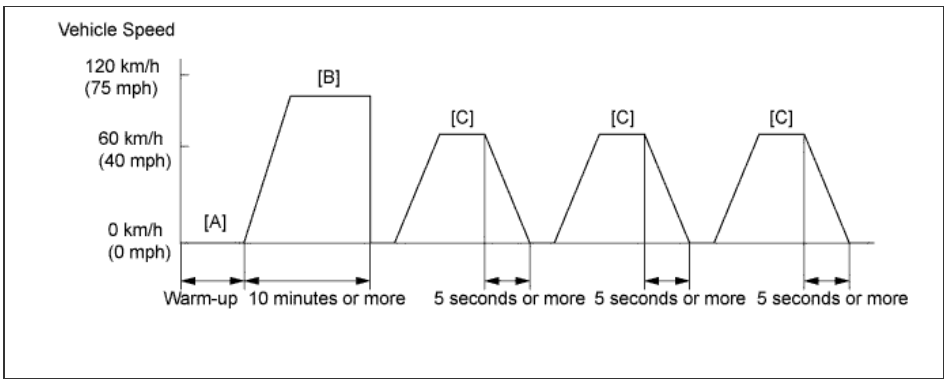
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

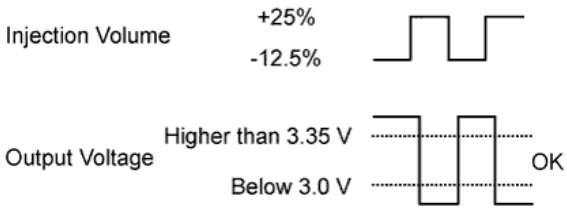
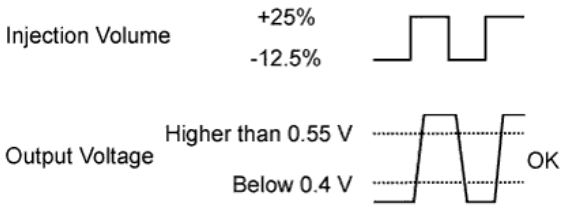
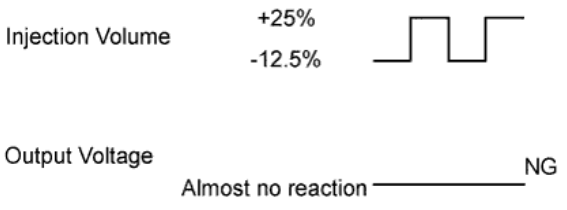
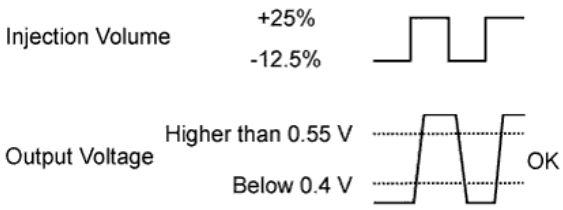
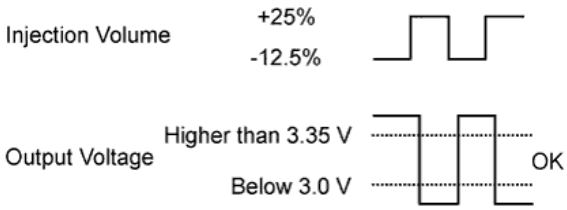
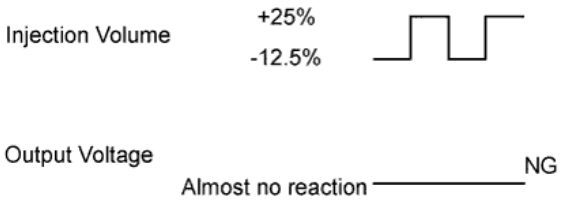
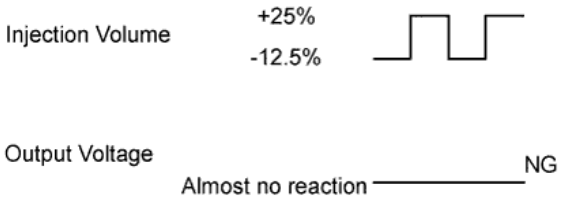
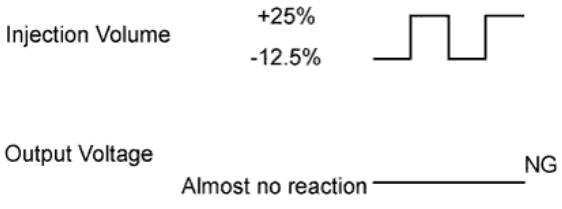
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

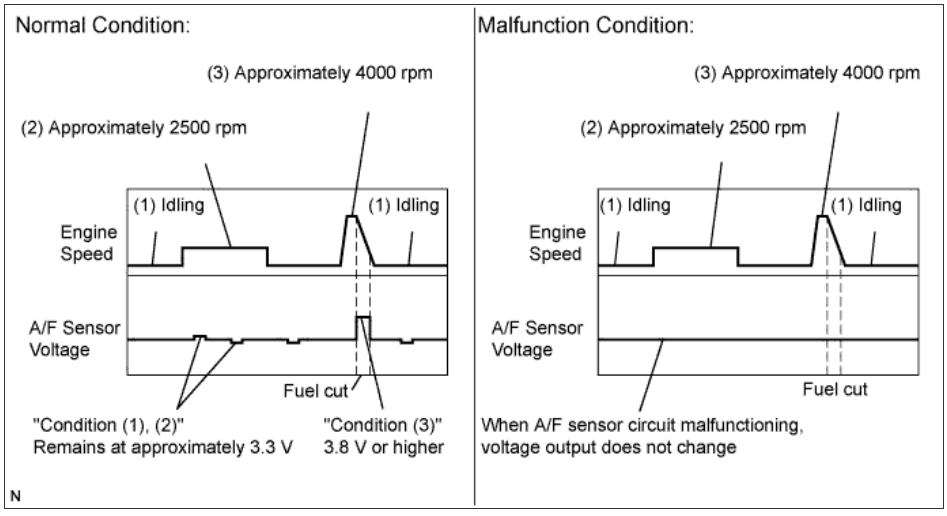
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

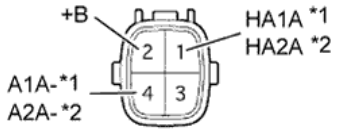
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

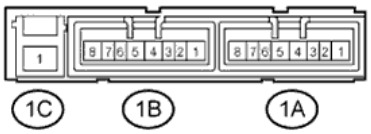
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

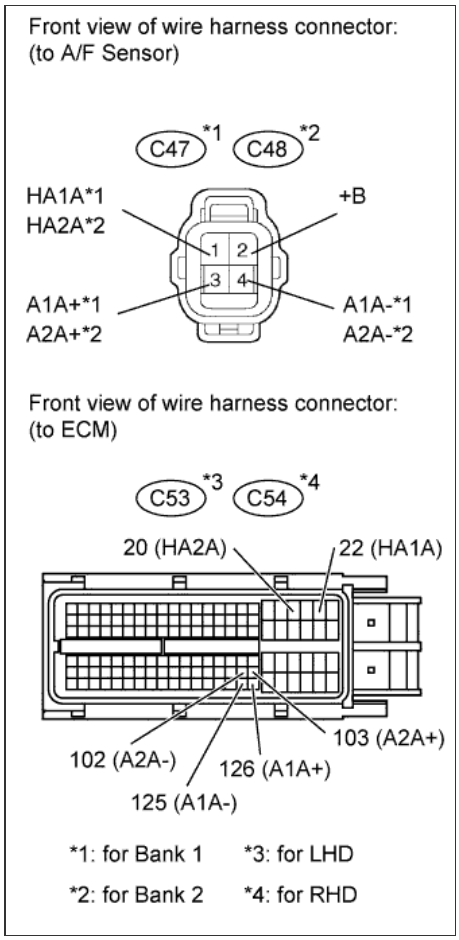
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

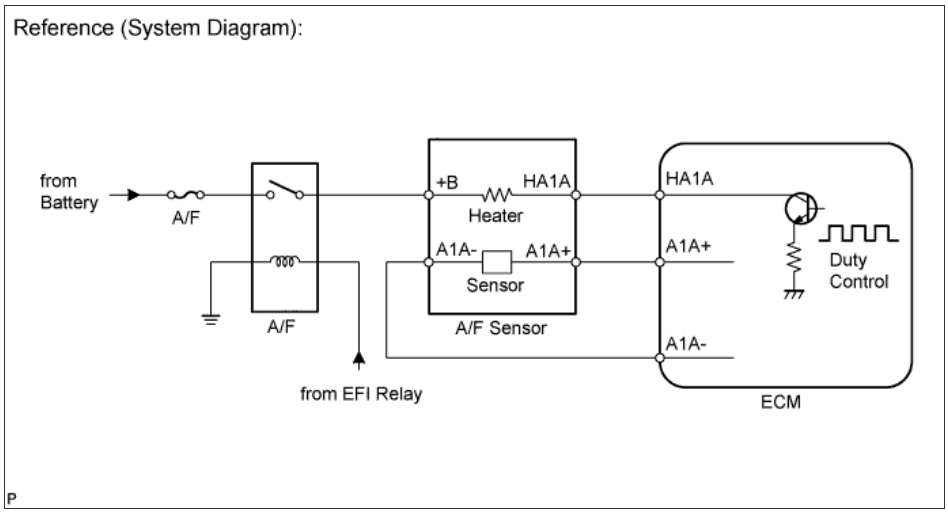
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

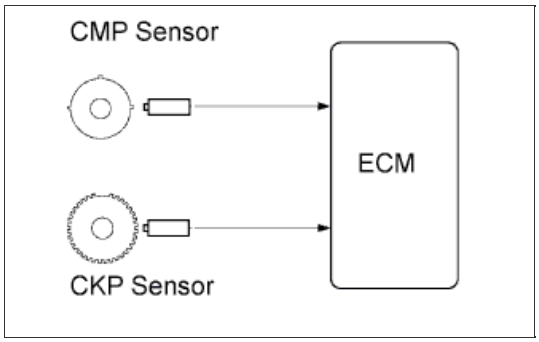
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

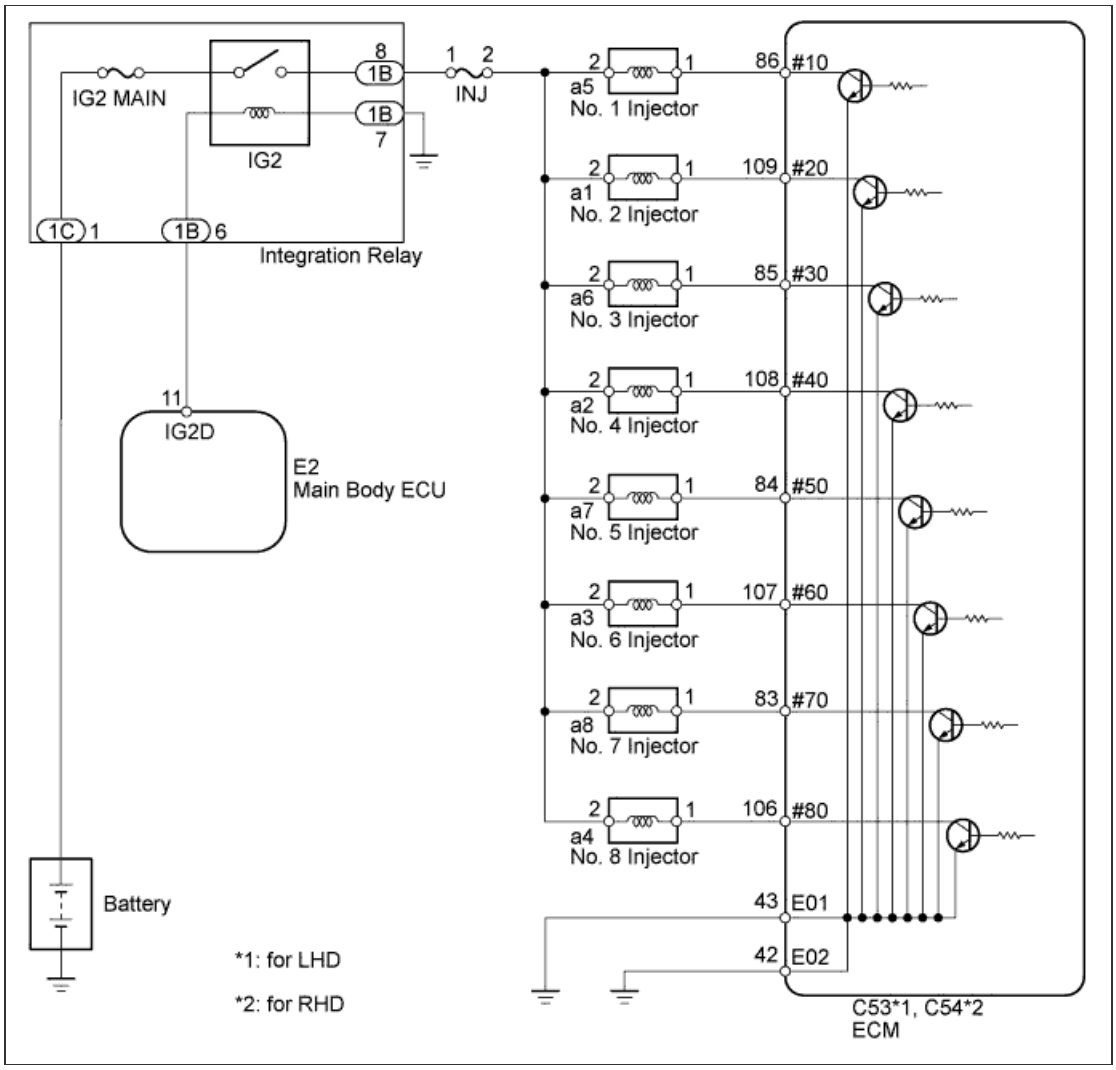
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

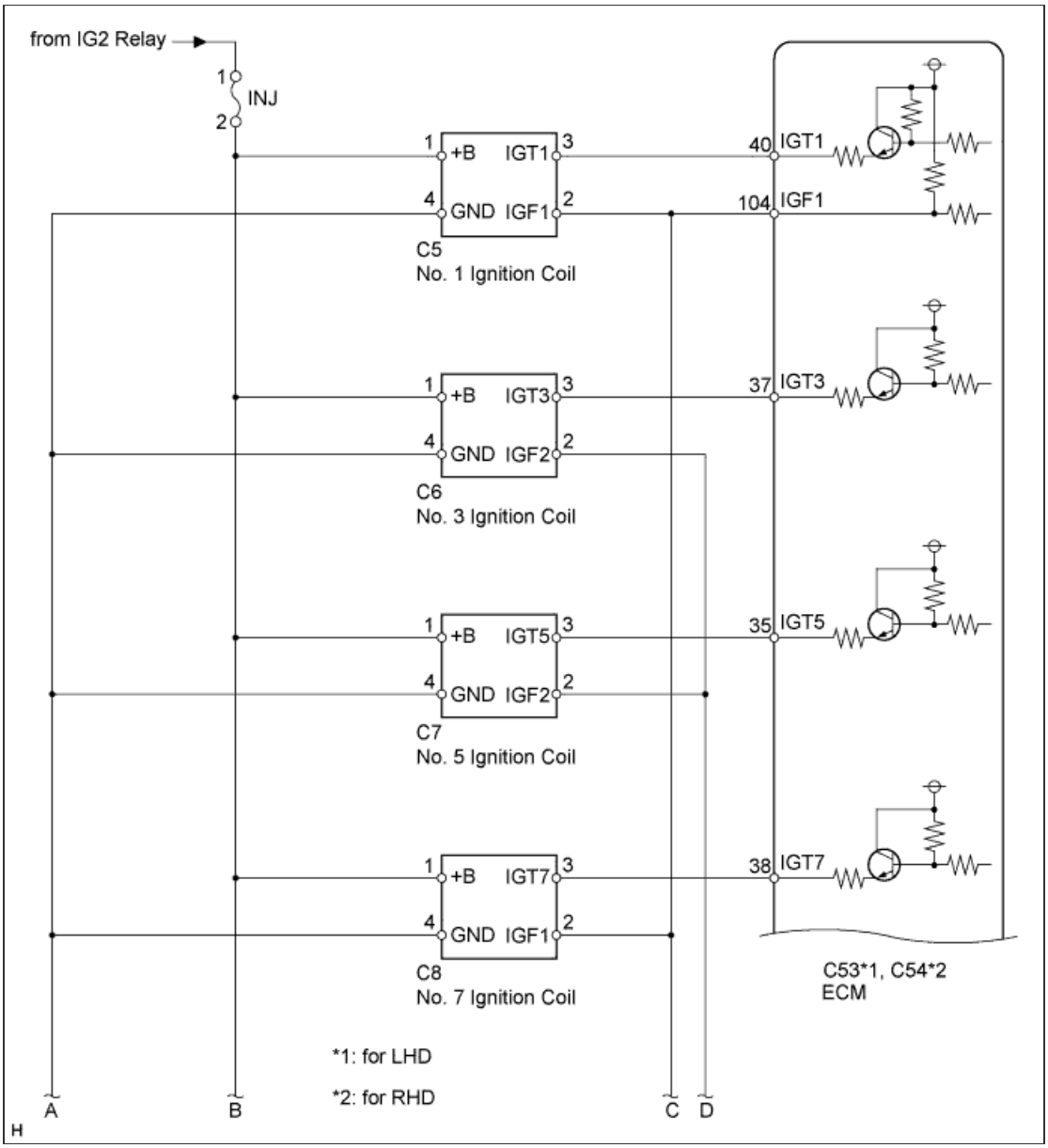
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

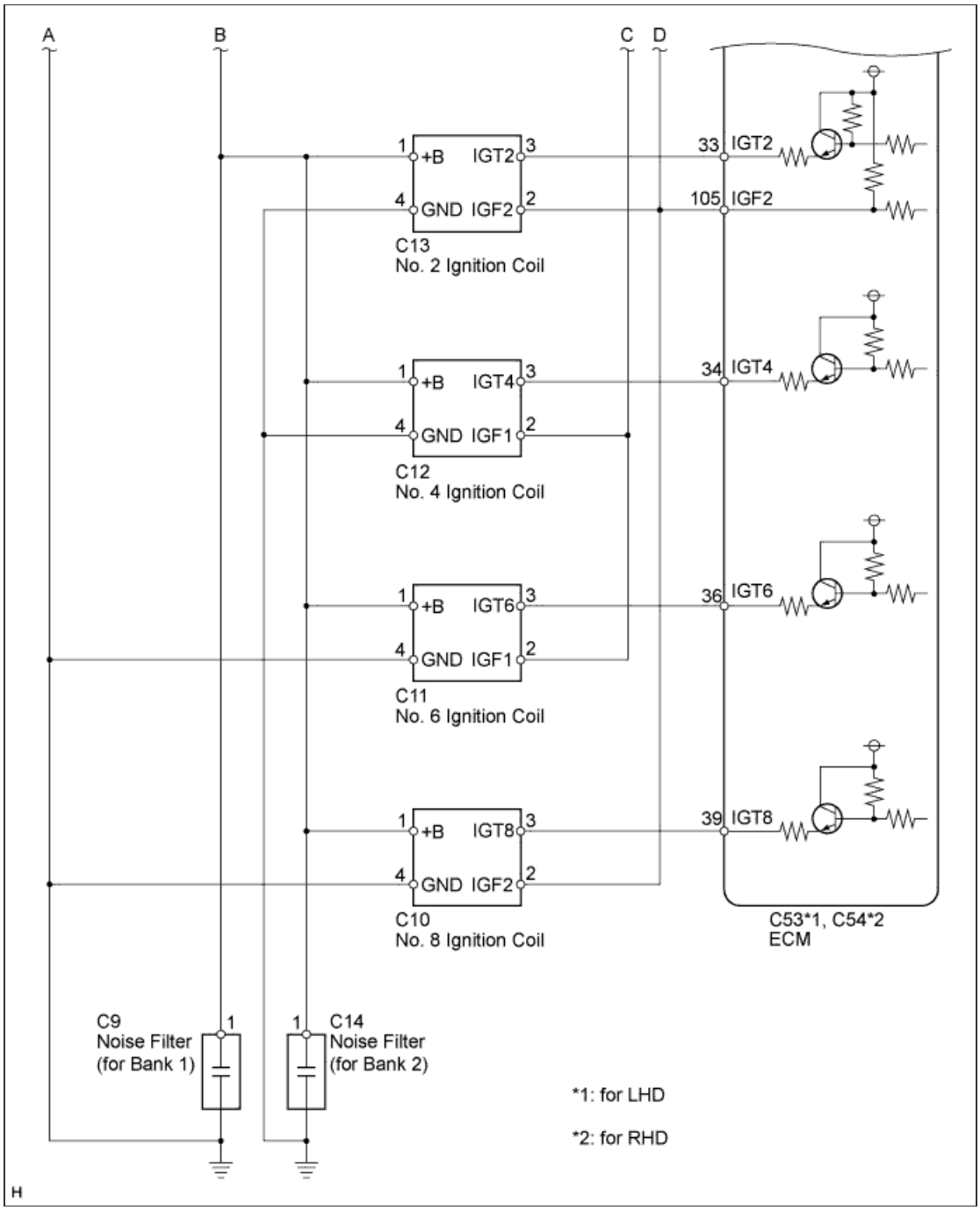
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

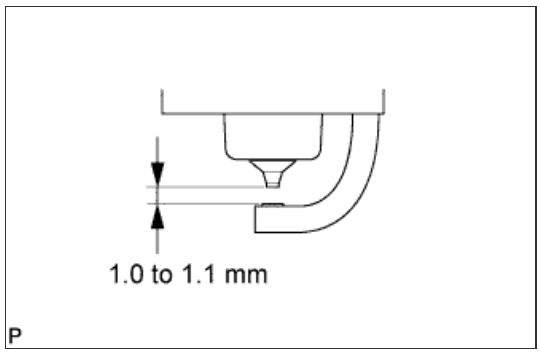
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

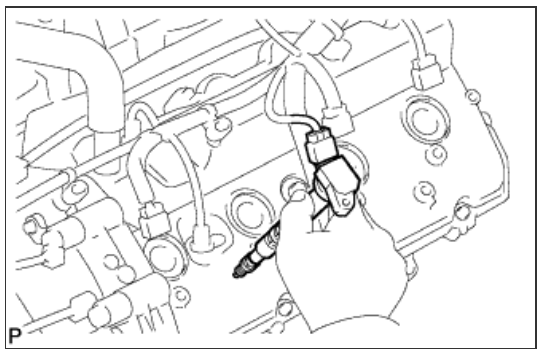
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

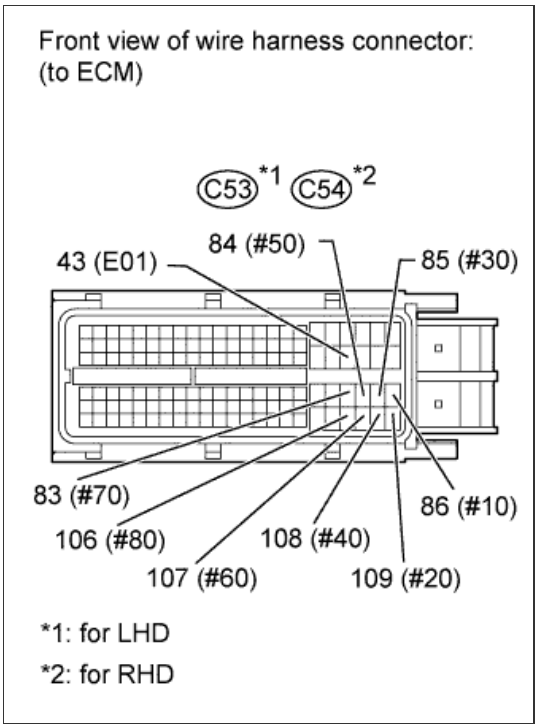
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

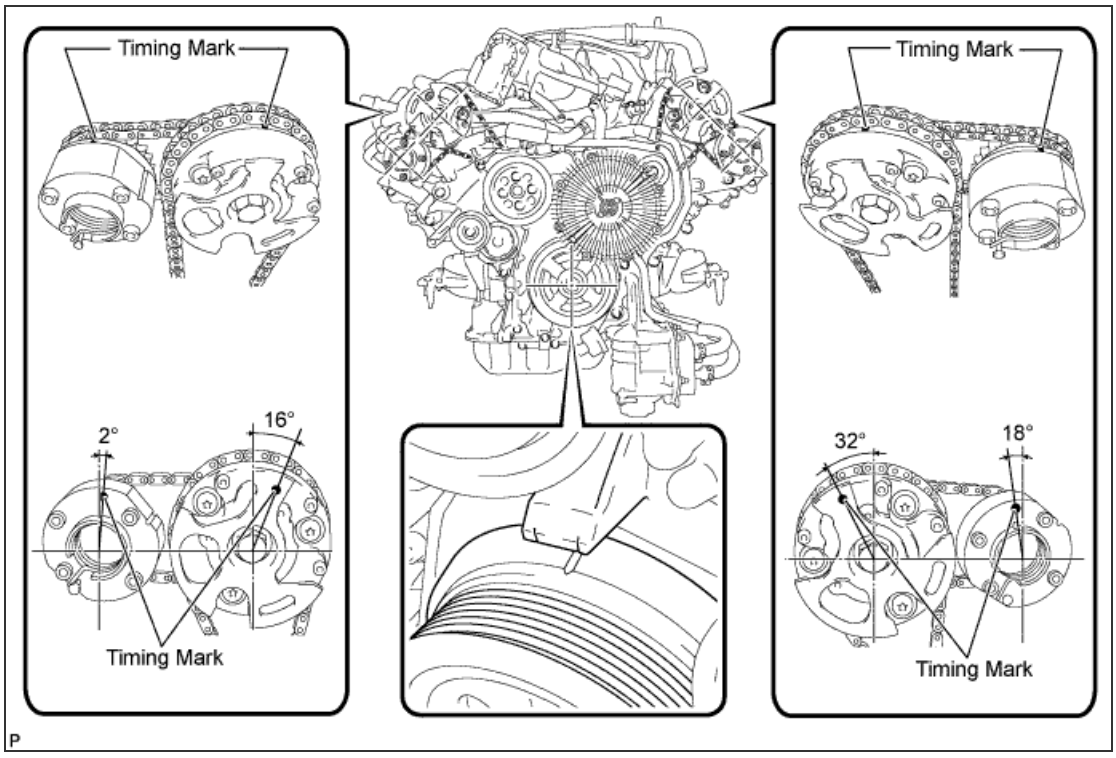
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

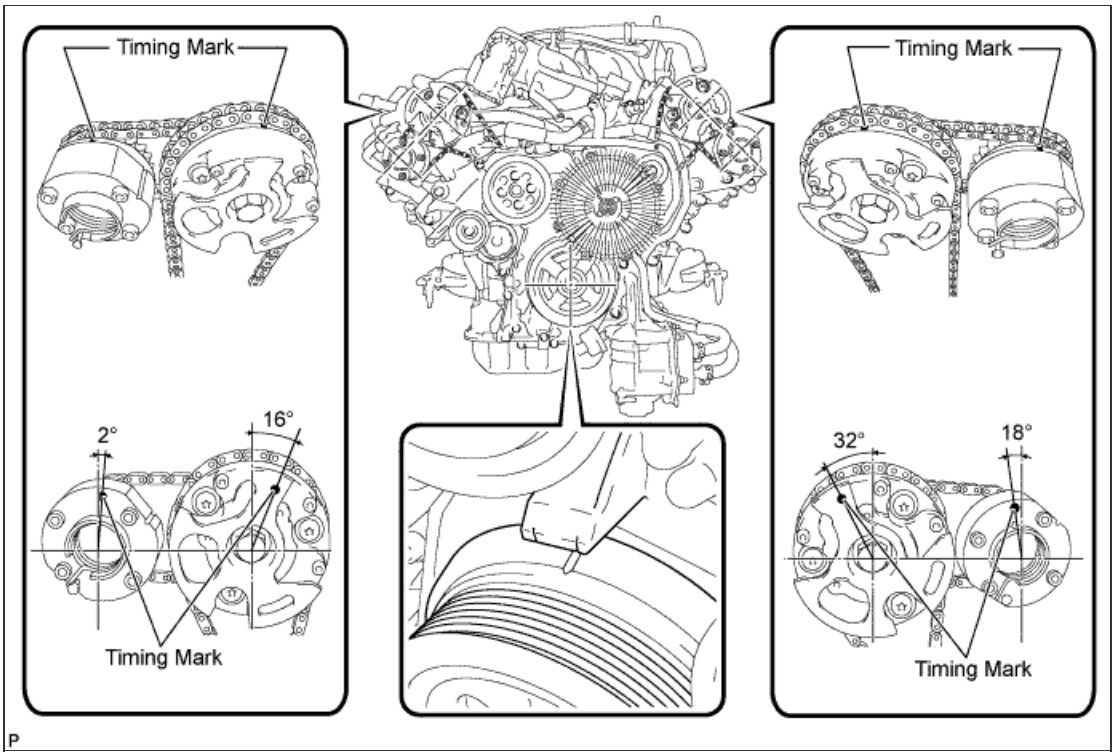
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

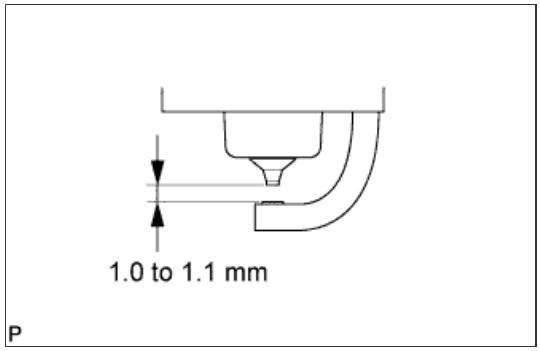
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

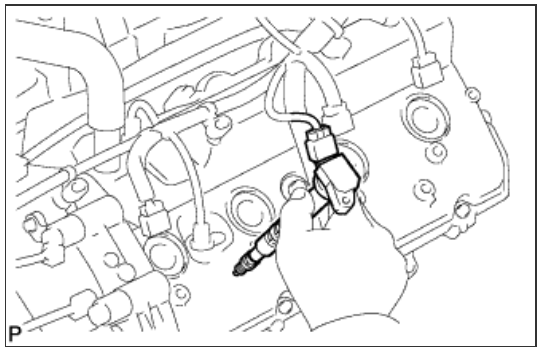
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

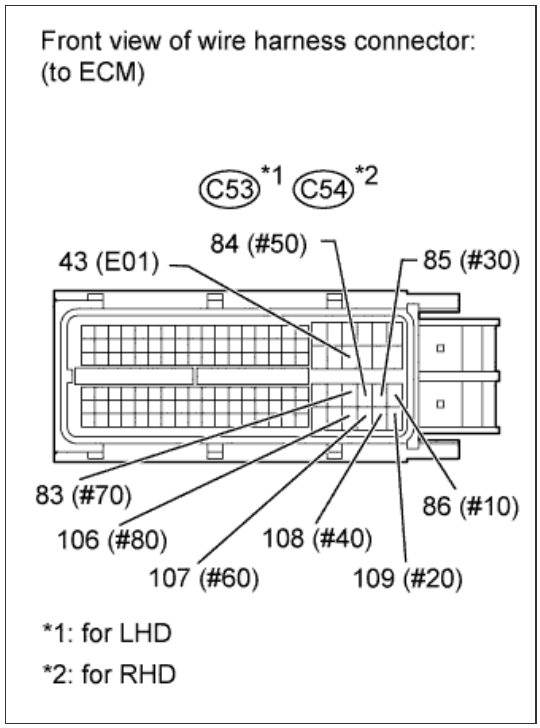
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

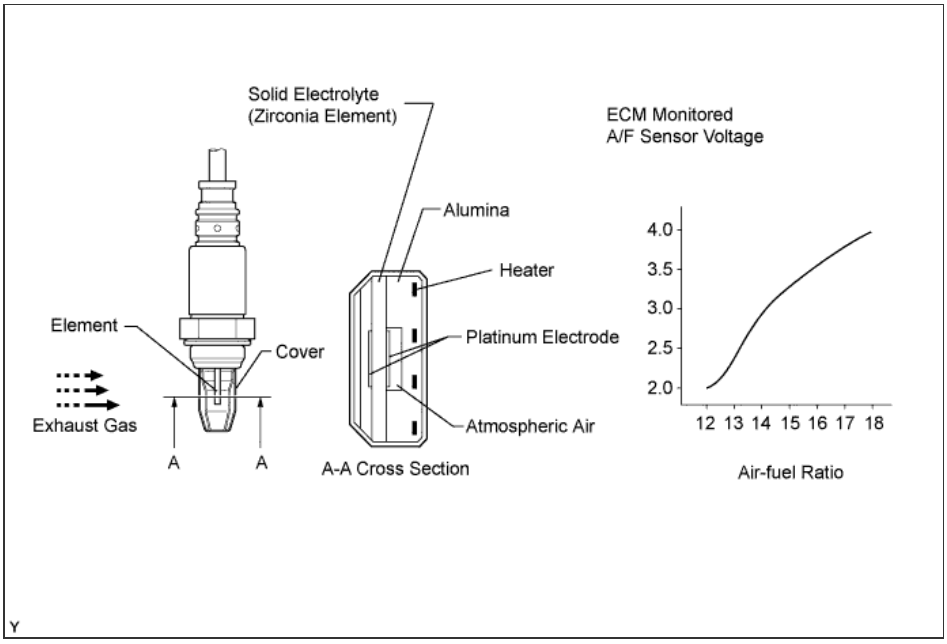
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

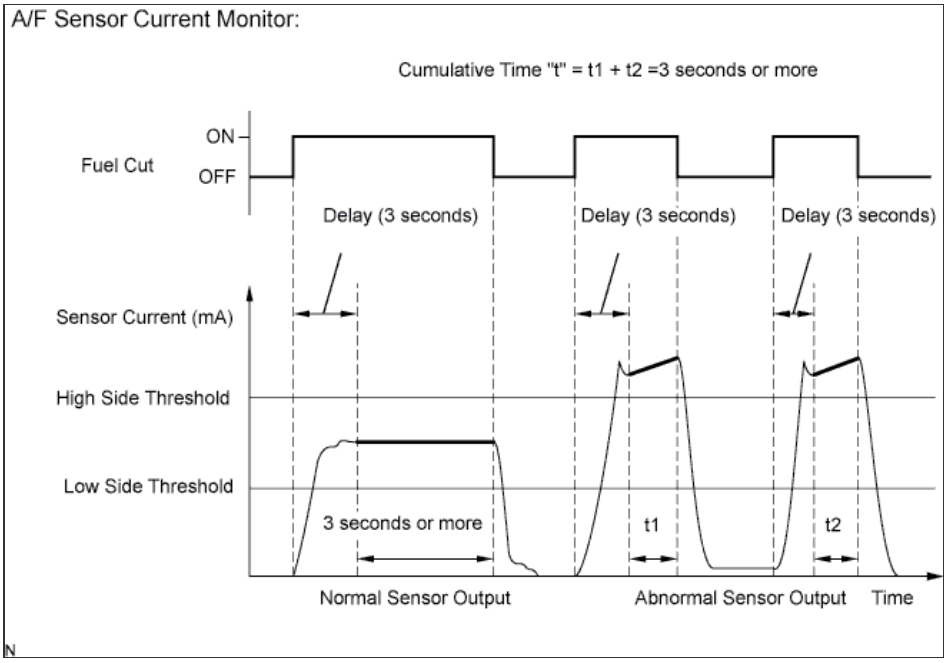
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

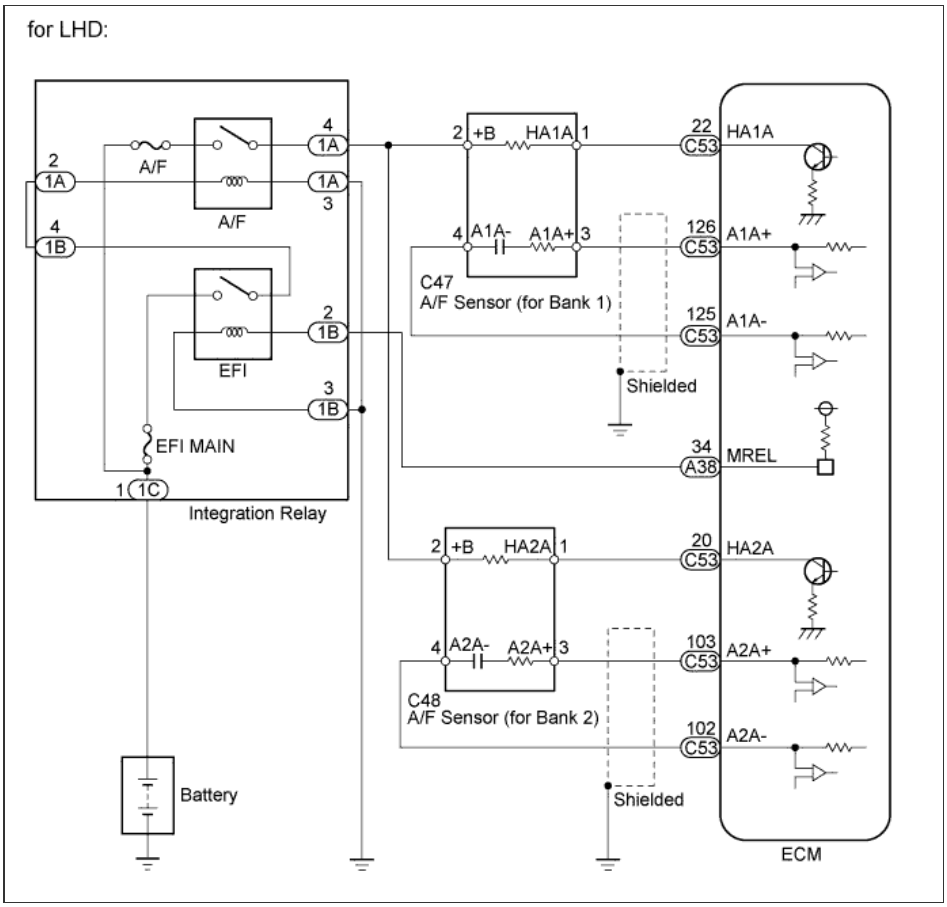
Sensor current detection monitor

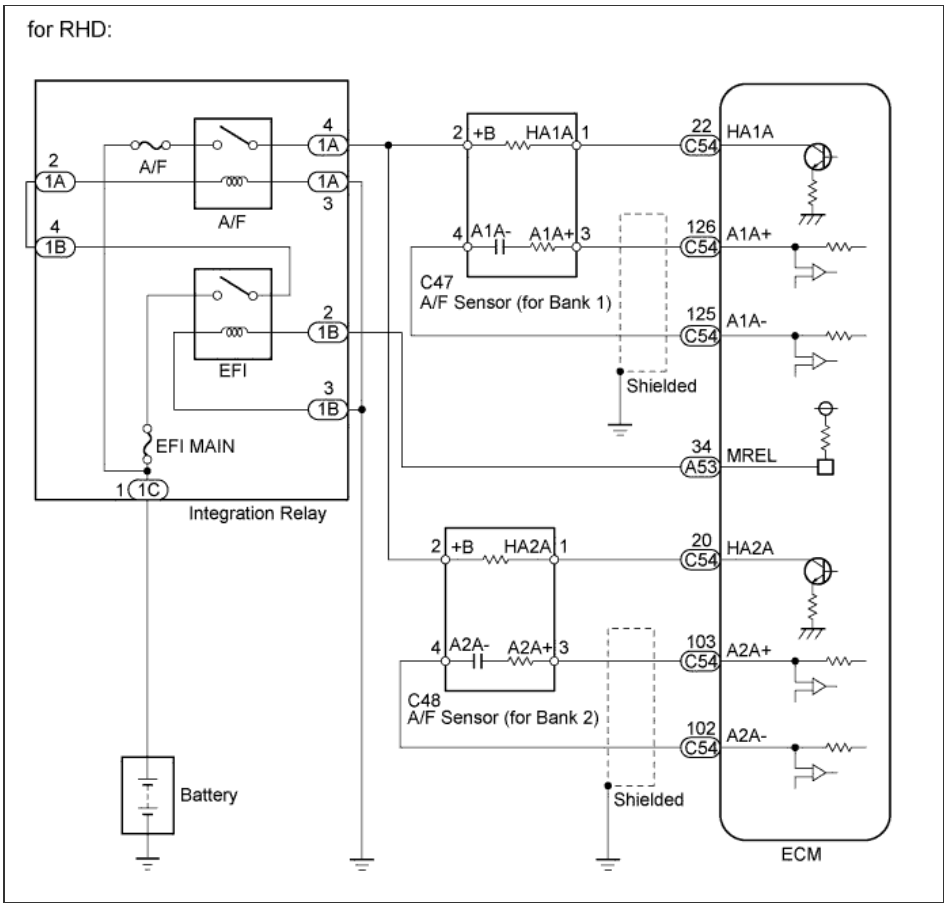
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





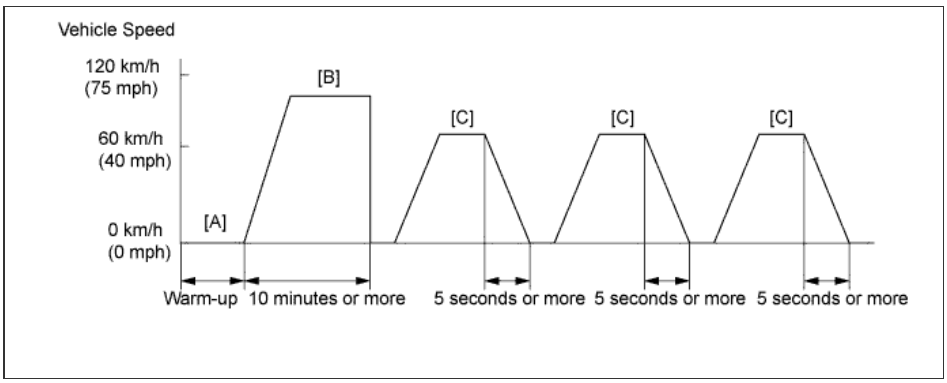
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

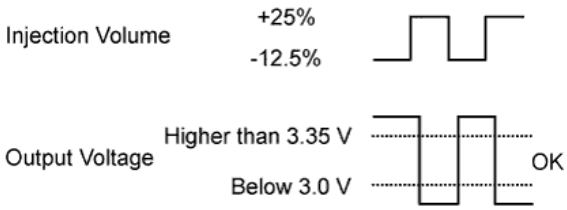
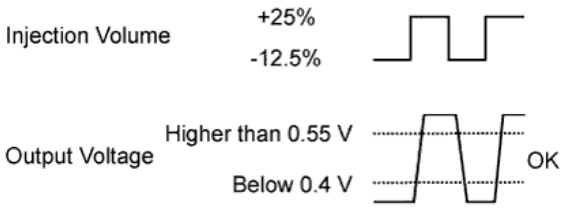
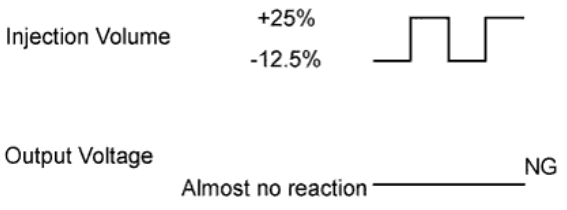
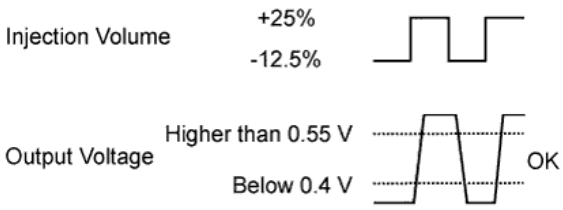
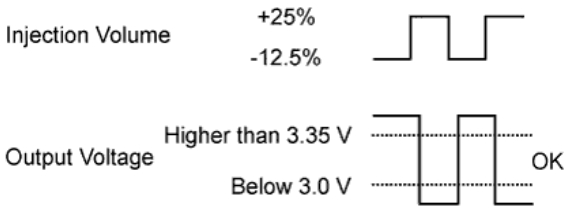
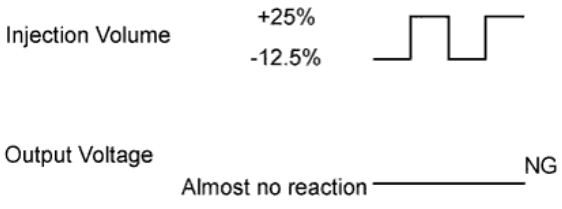
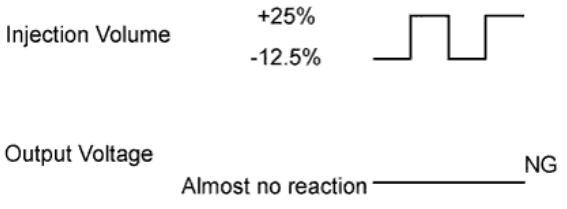
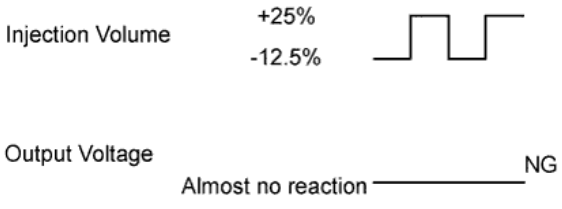
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

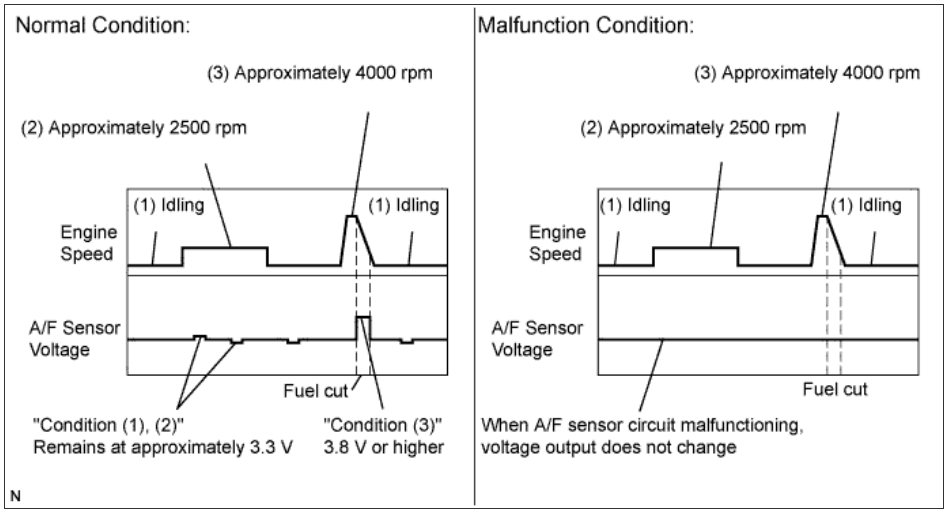
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

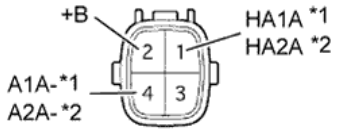
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

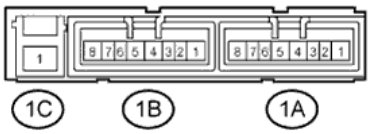
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

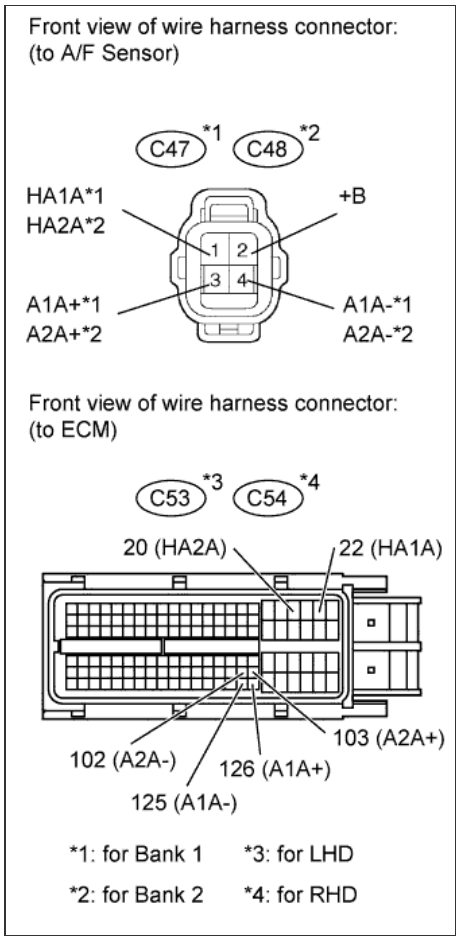
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

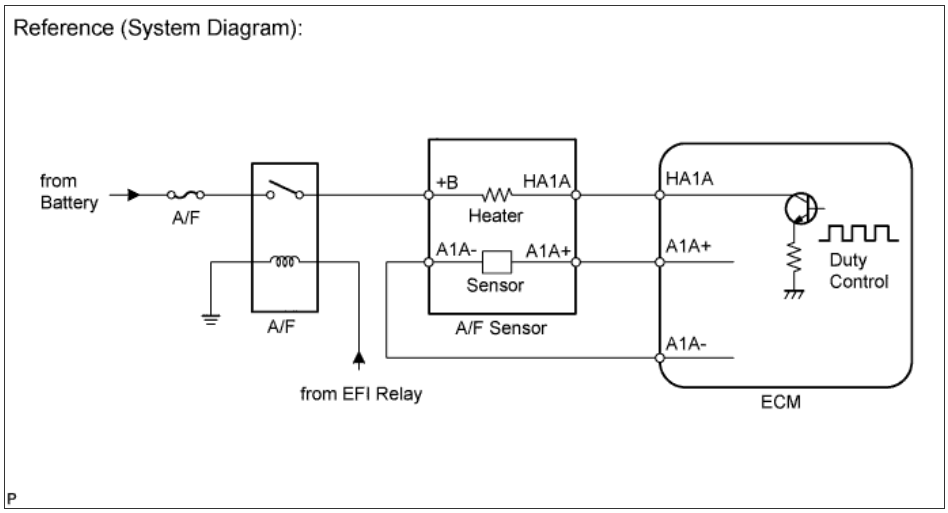
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

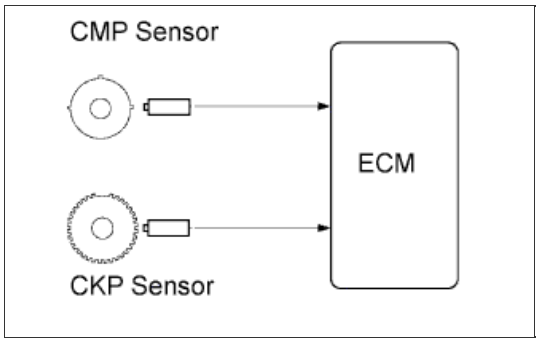
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

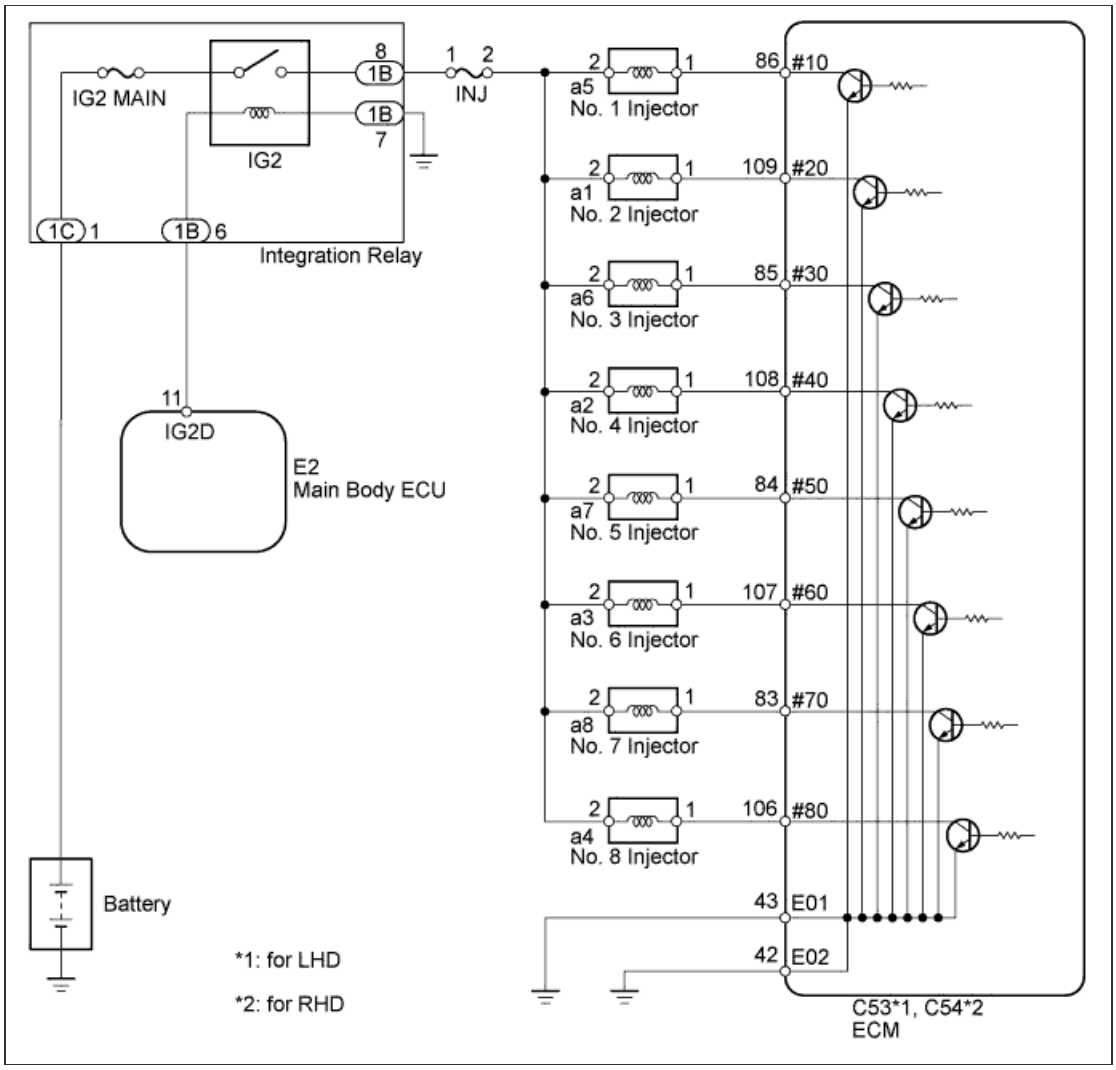
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

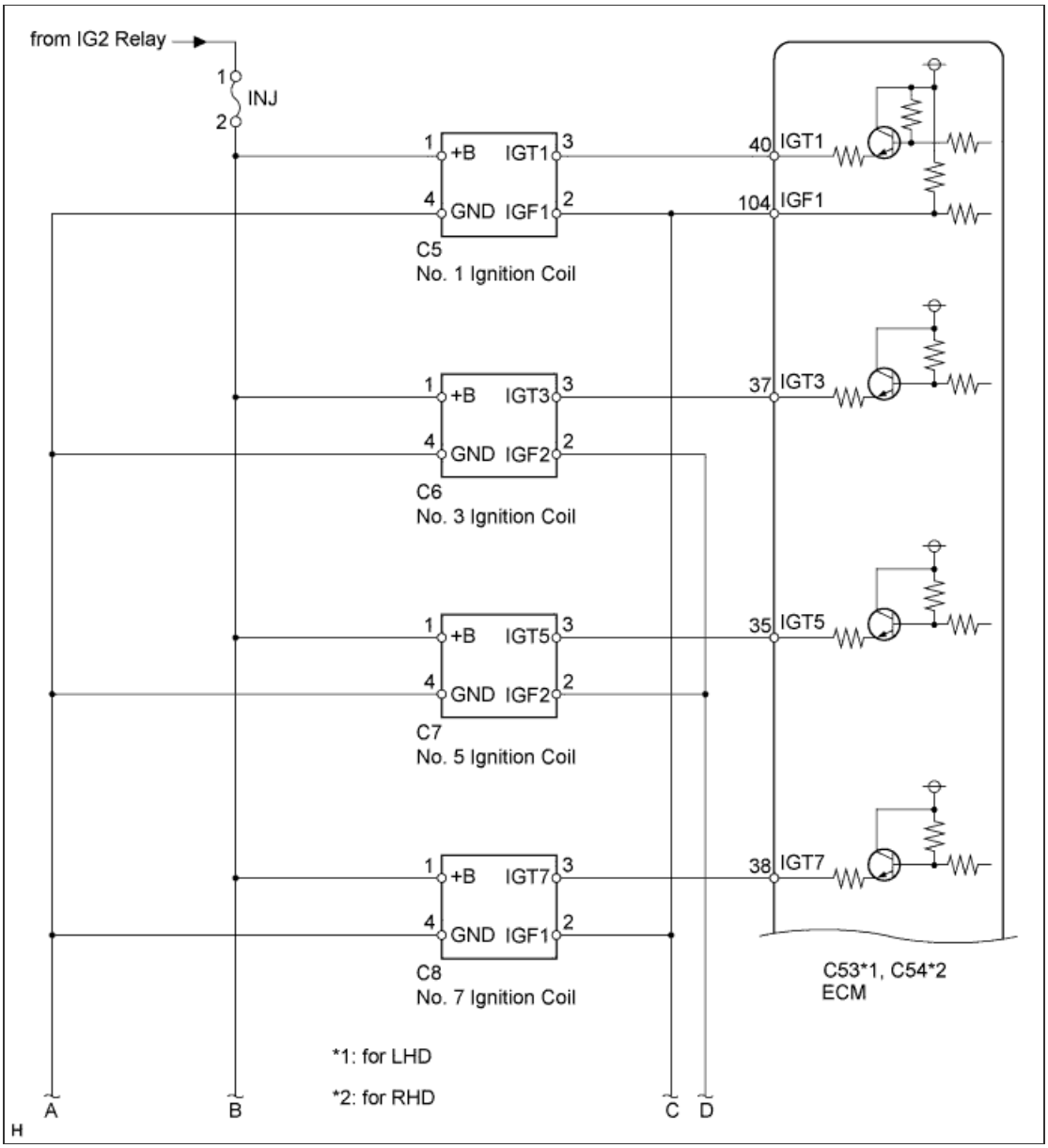
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

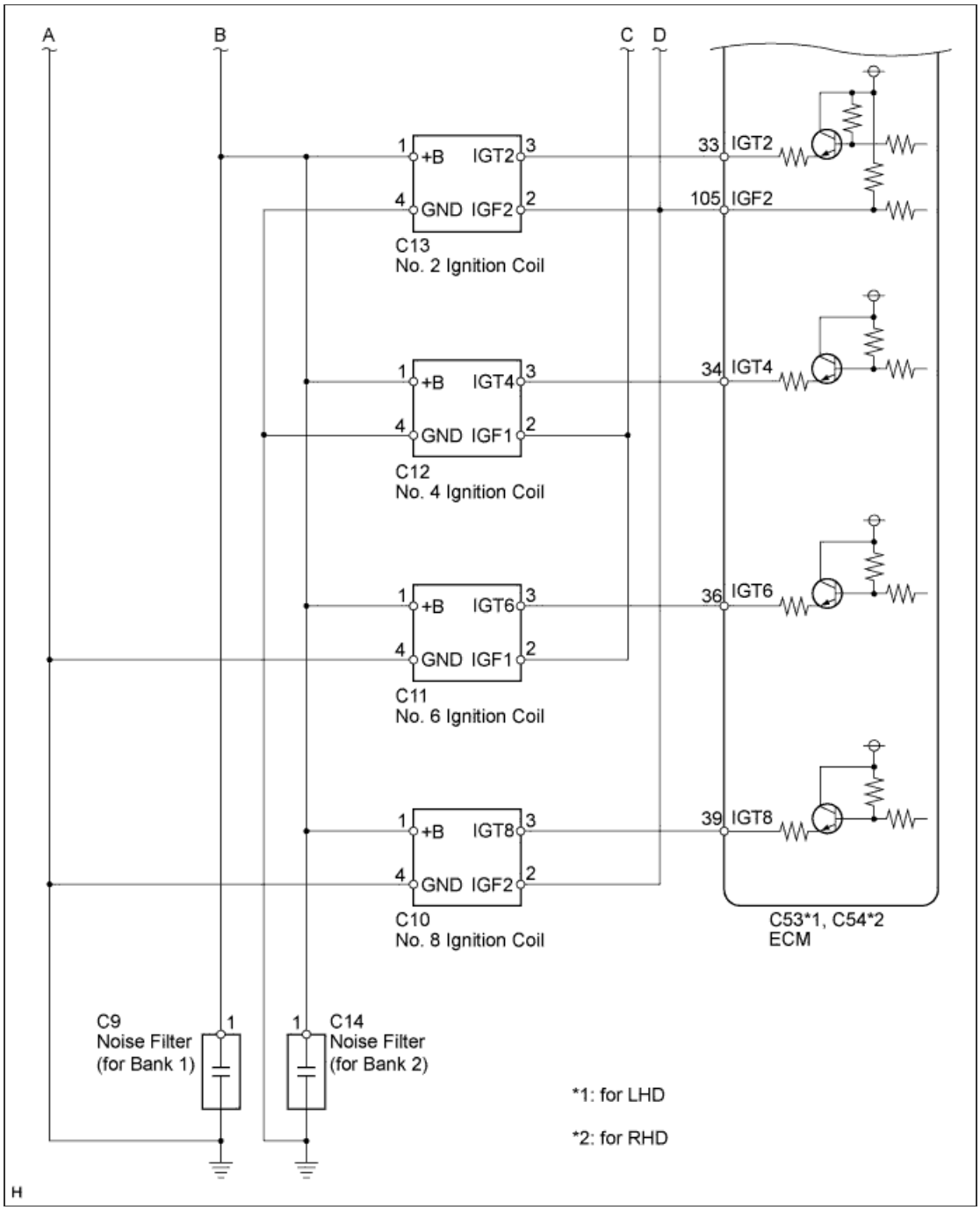
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

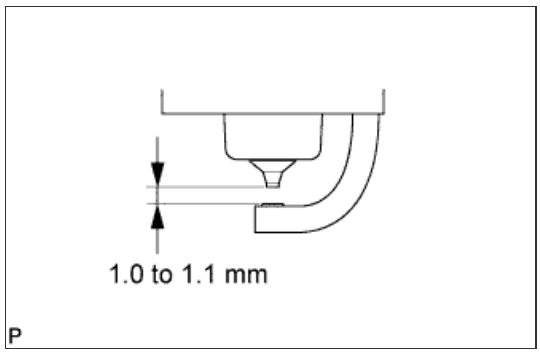
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

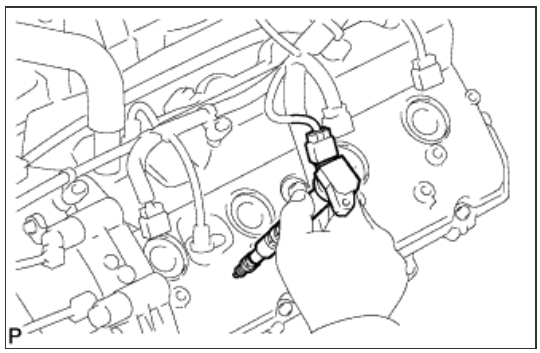
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

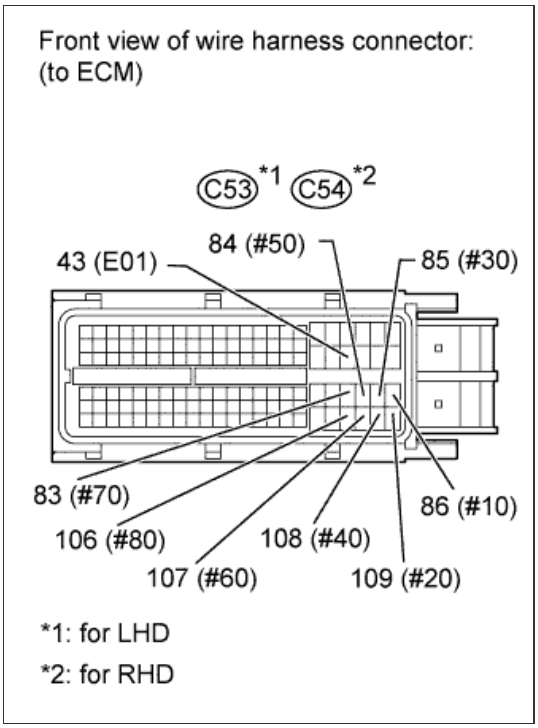
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

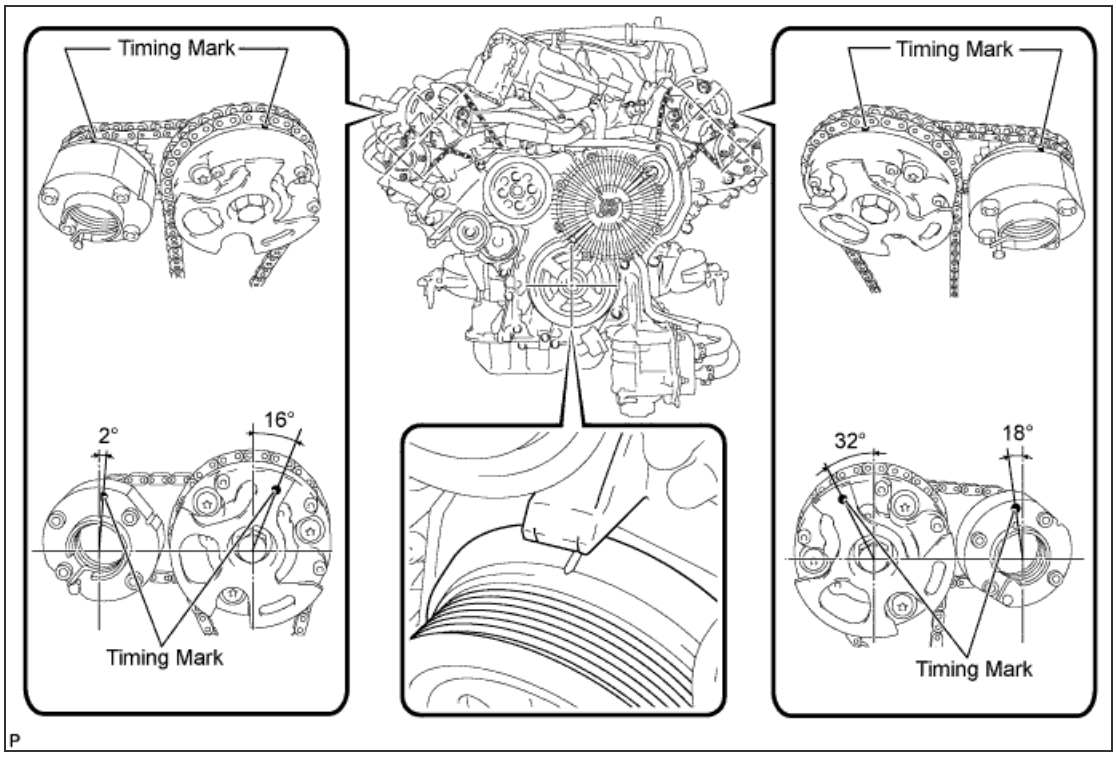
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

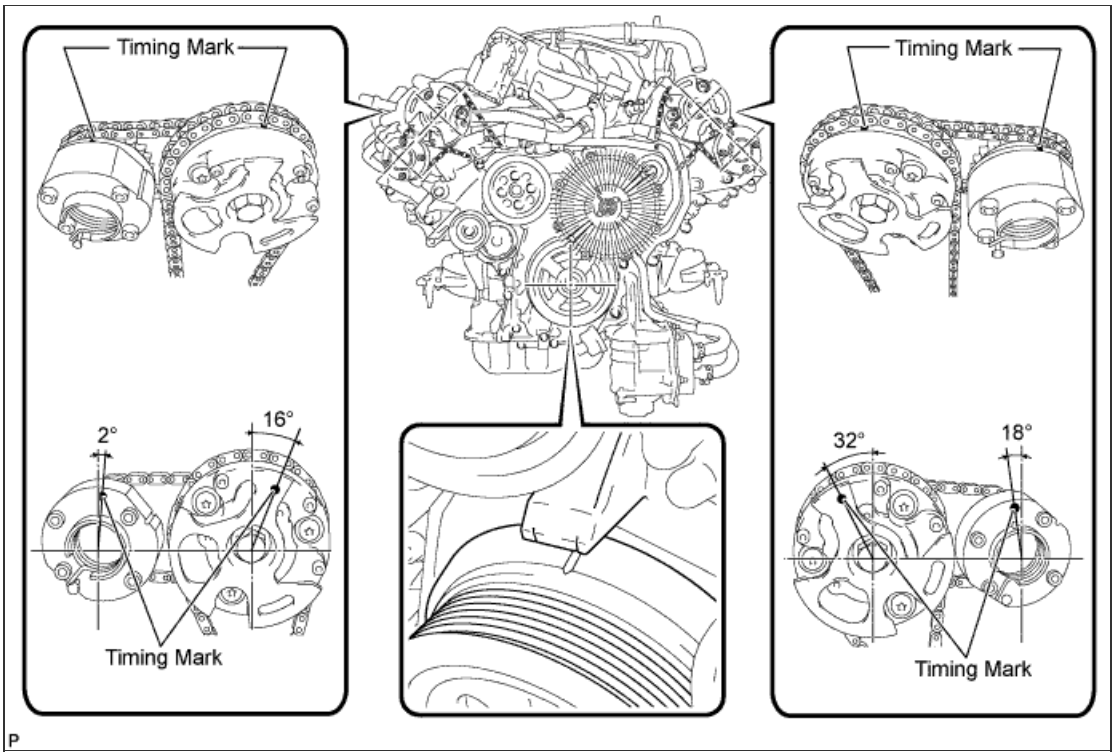
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

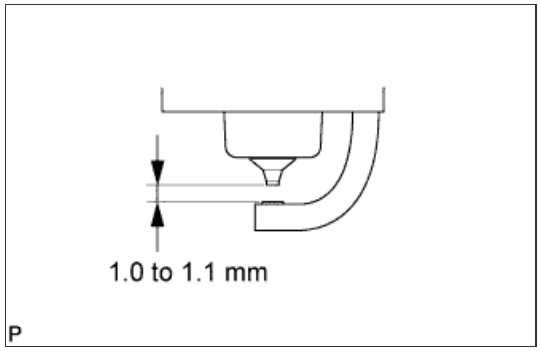
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

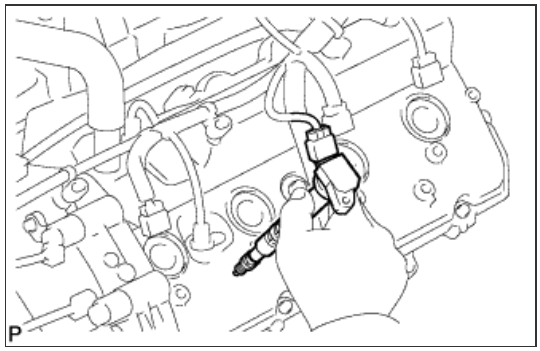
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

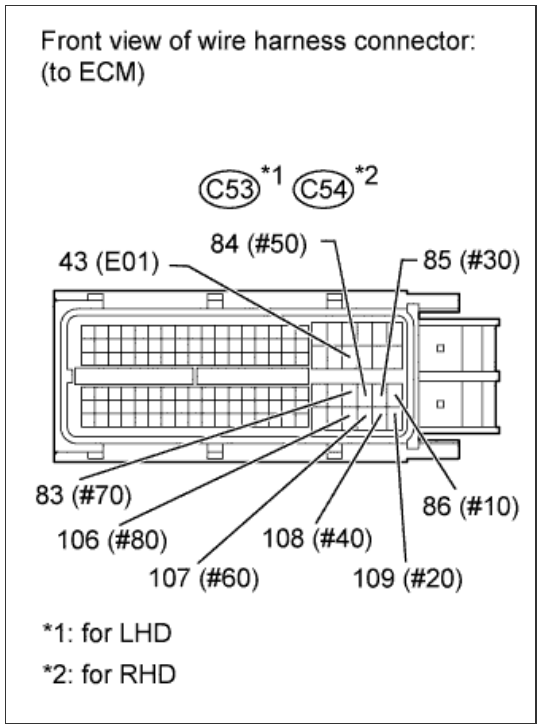
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

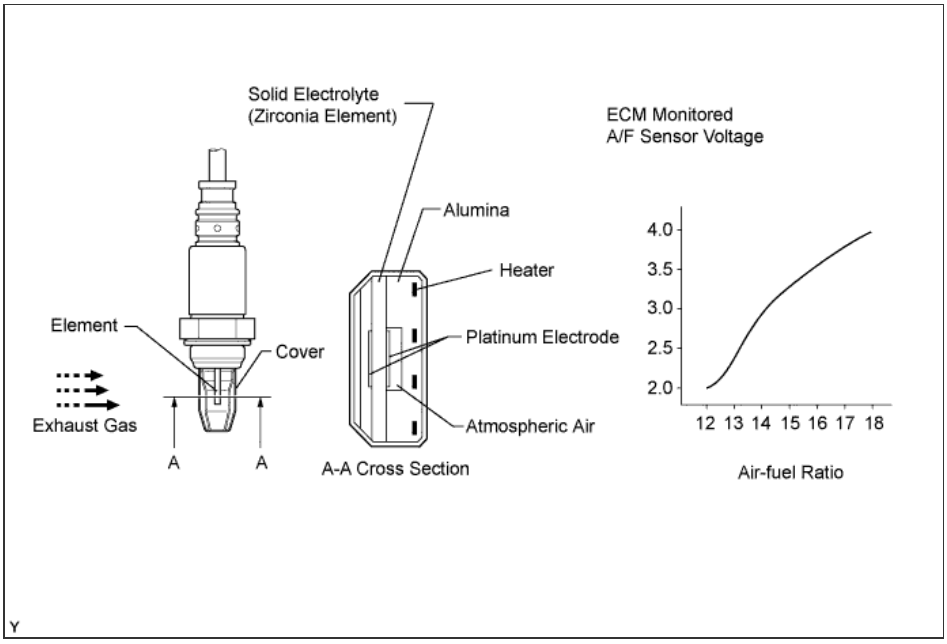
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

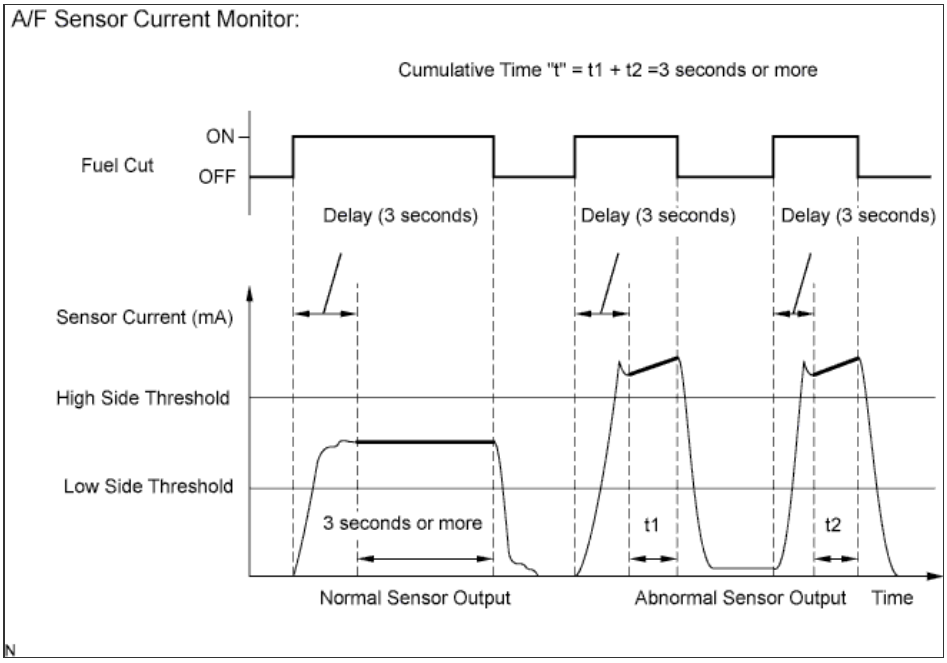
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

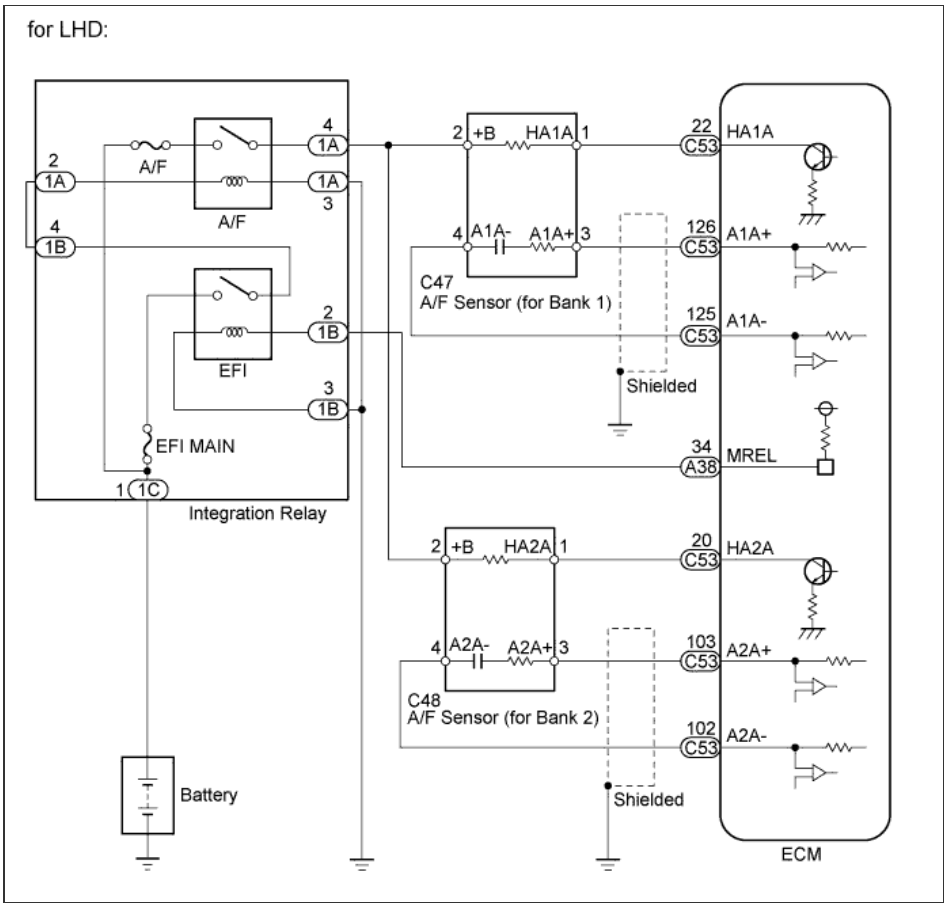
Sensor current detection monitor

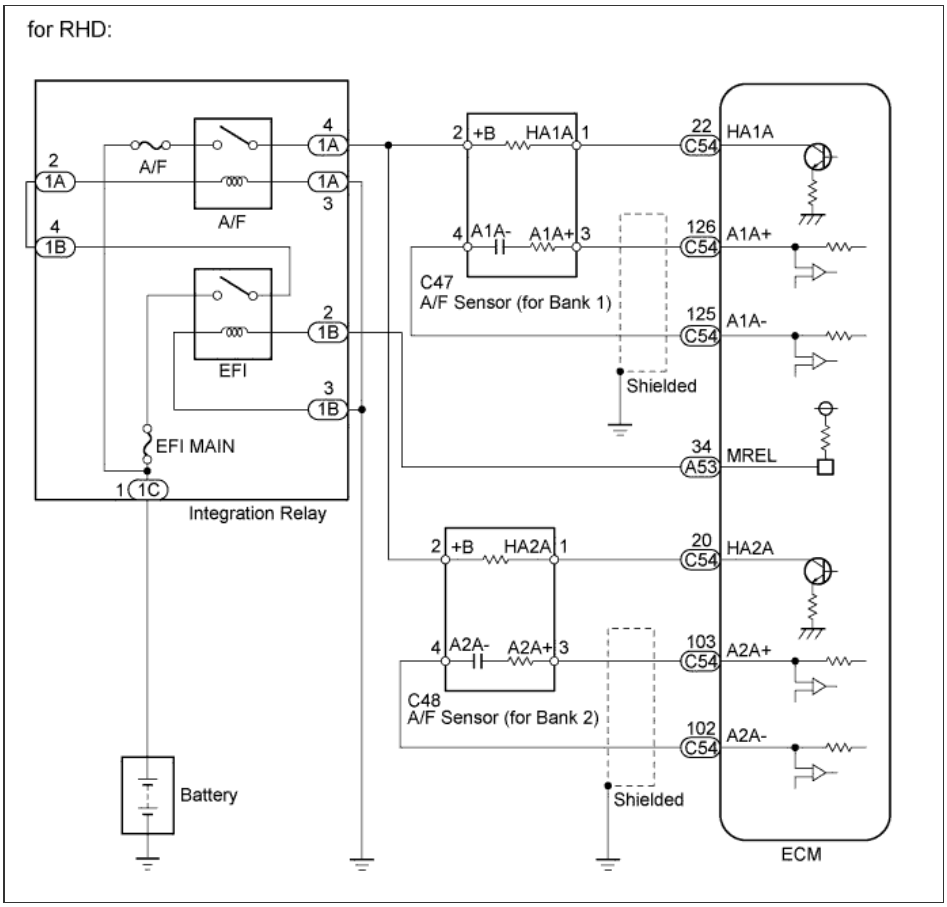
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





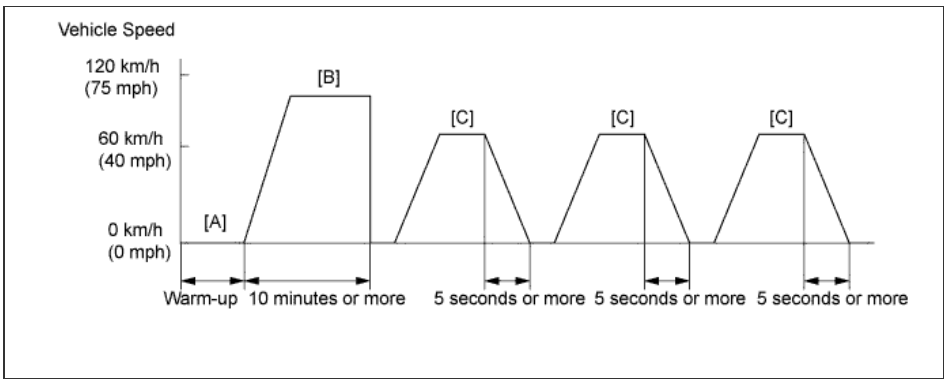
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

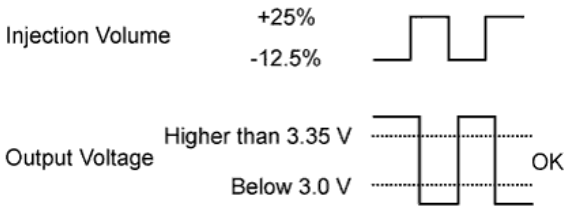
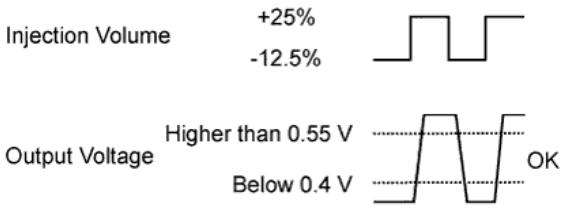
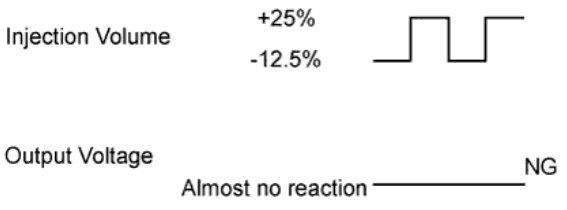
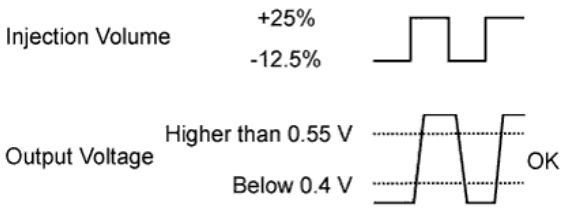
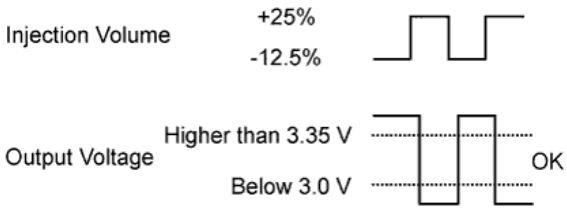
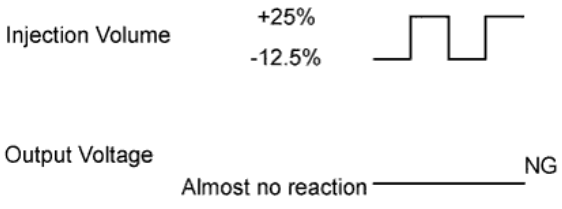
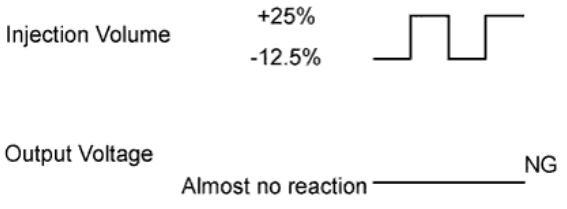
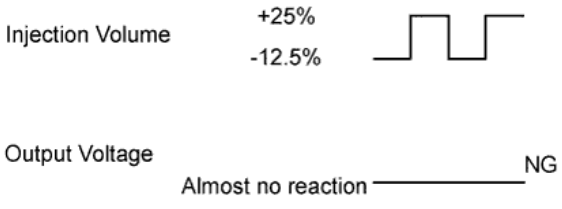
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

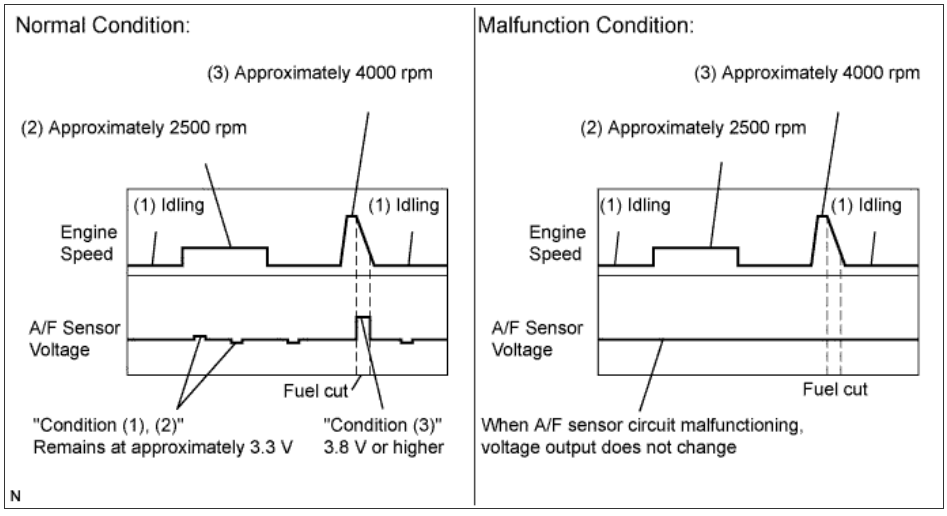
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

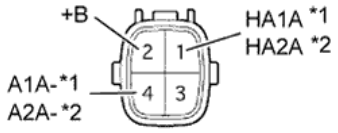
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

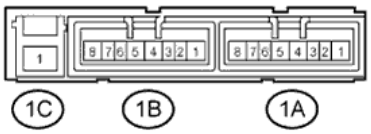
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

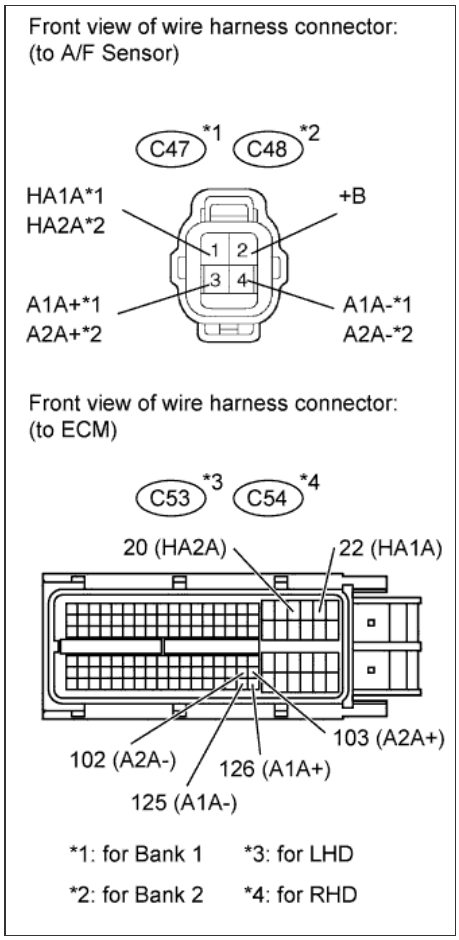
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

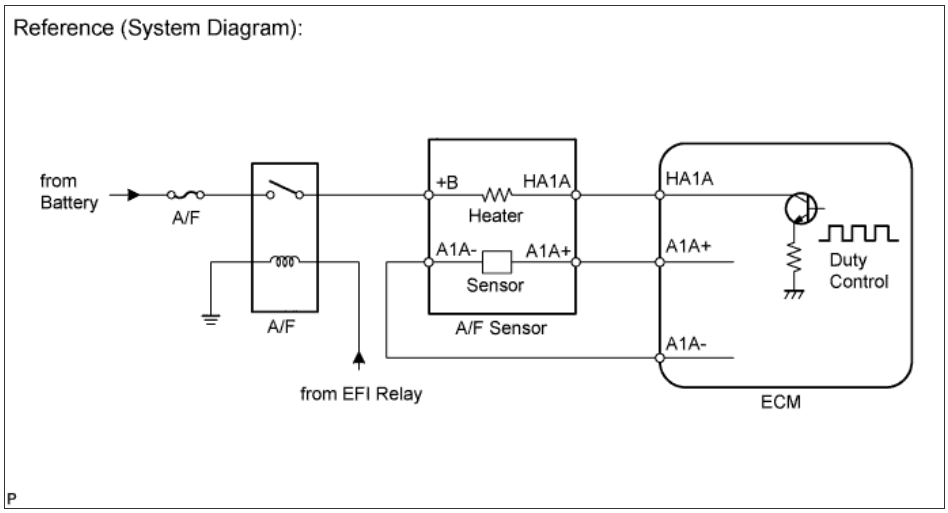
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

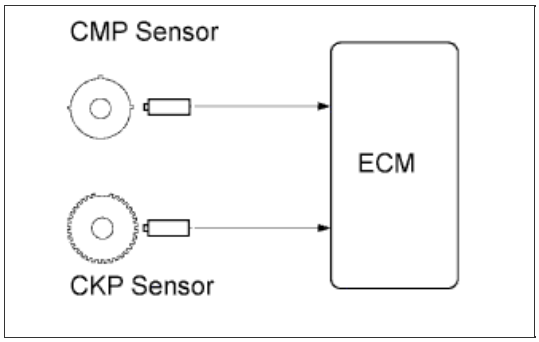
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

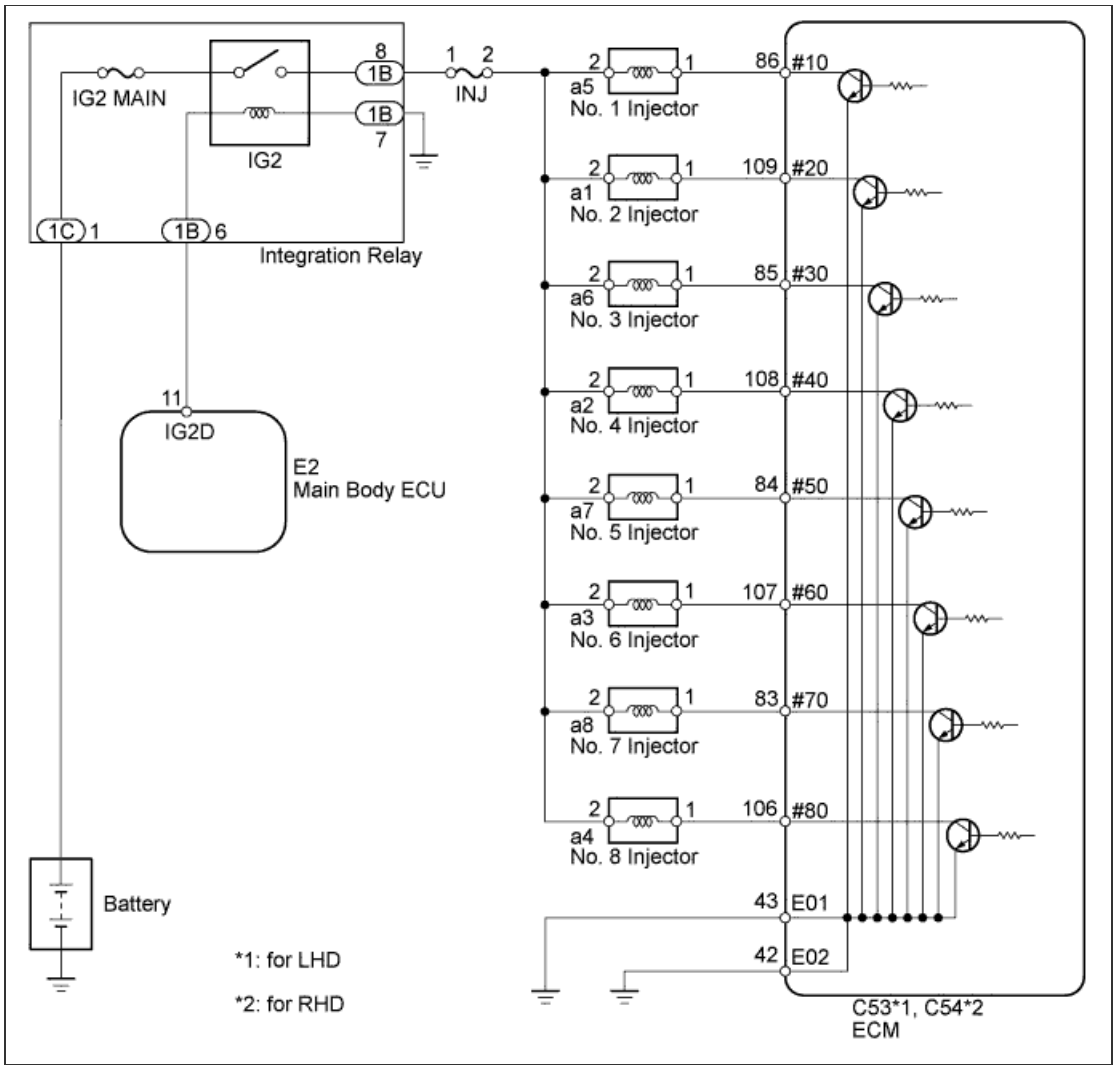
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

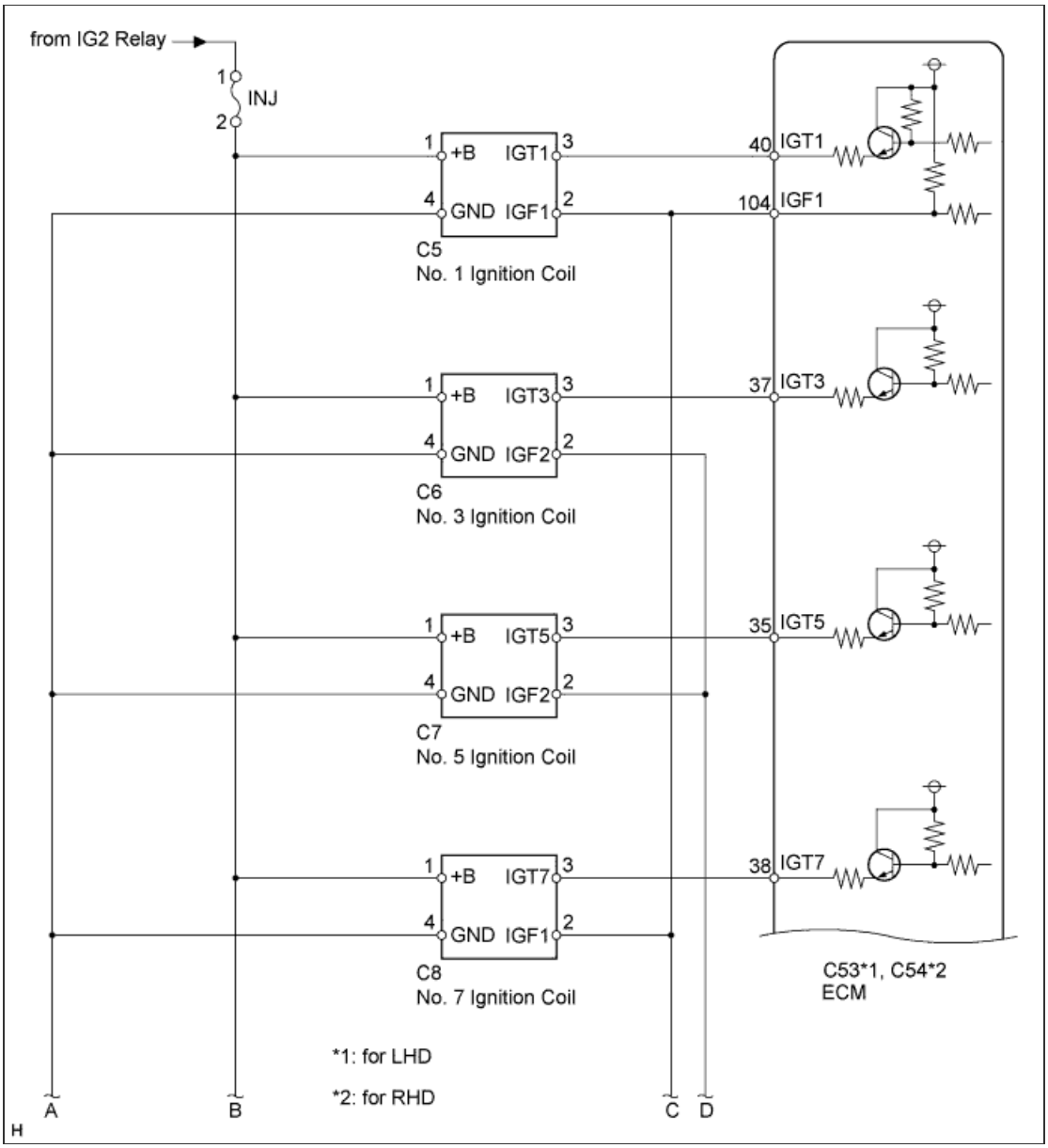
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

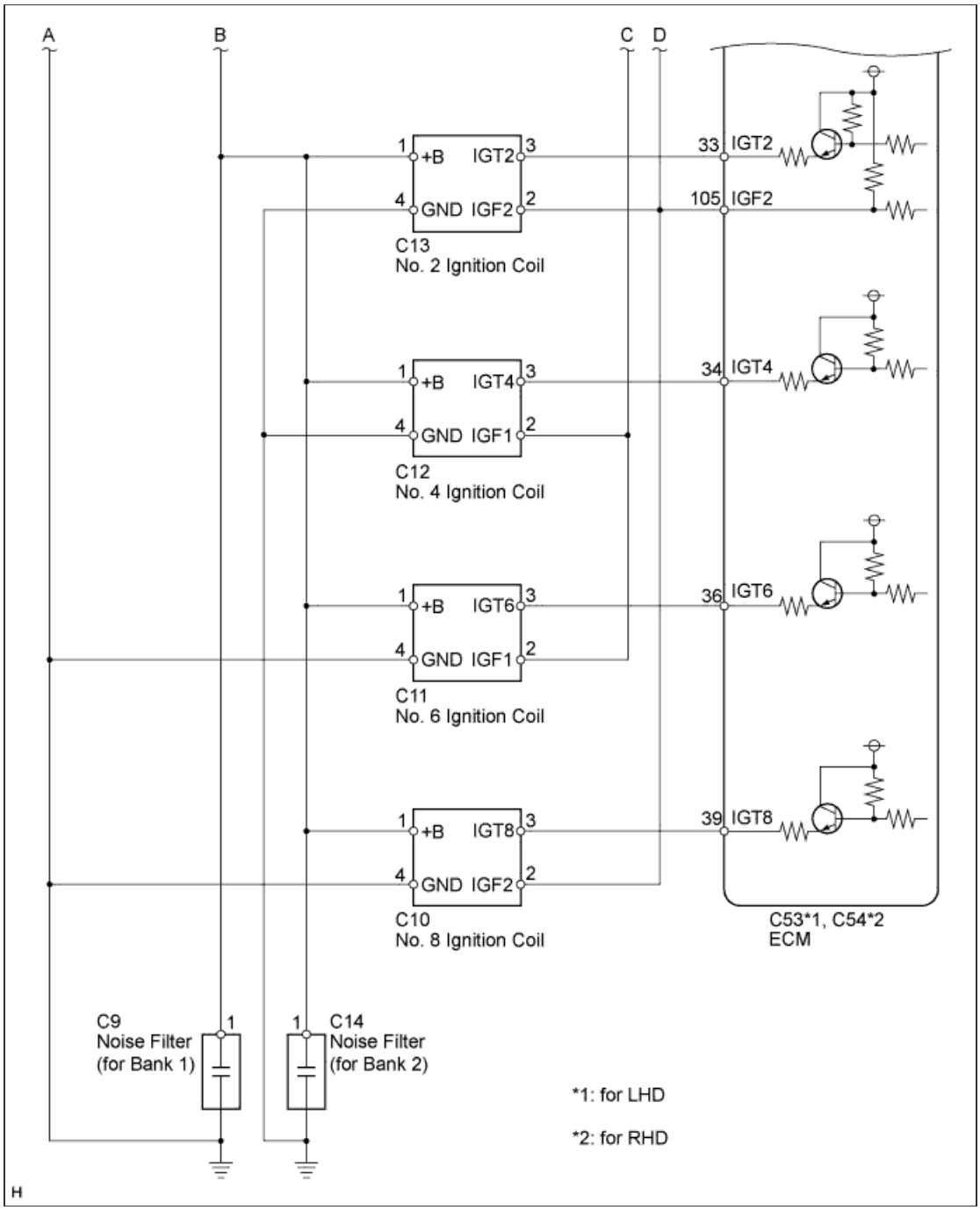
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

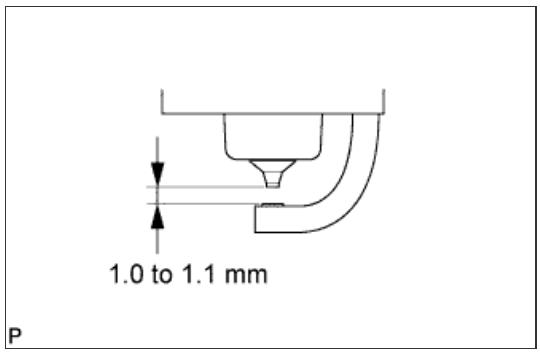
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

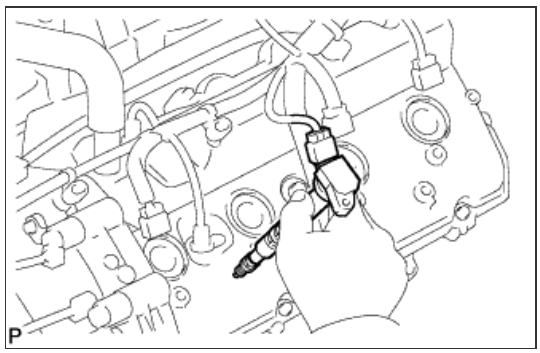
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

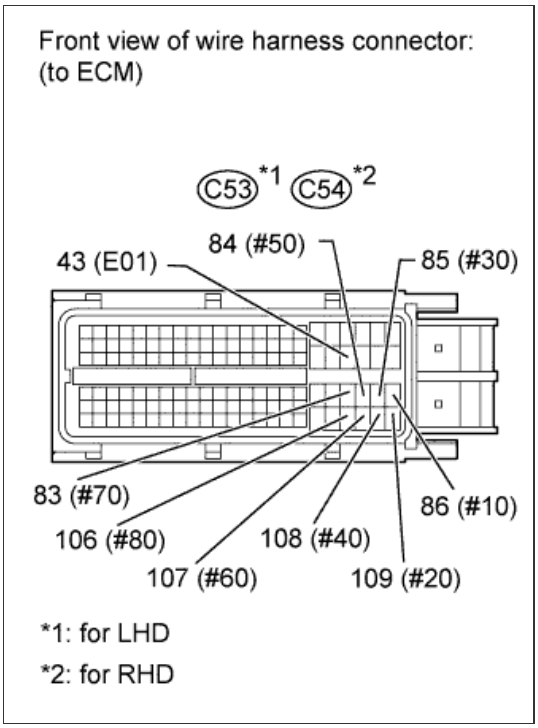
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

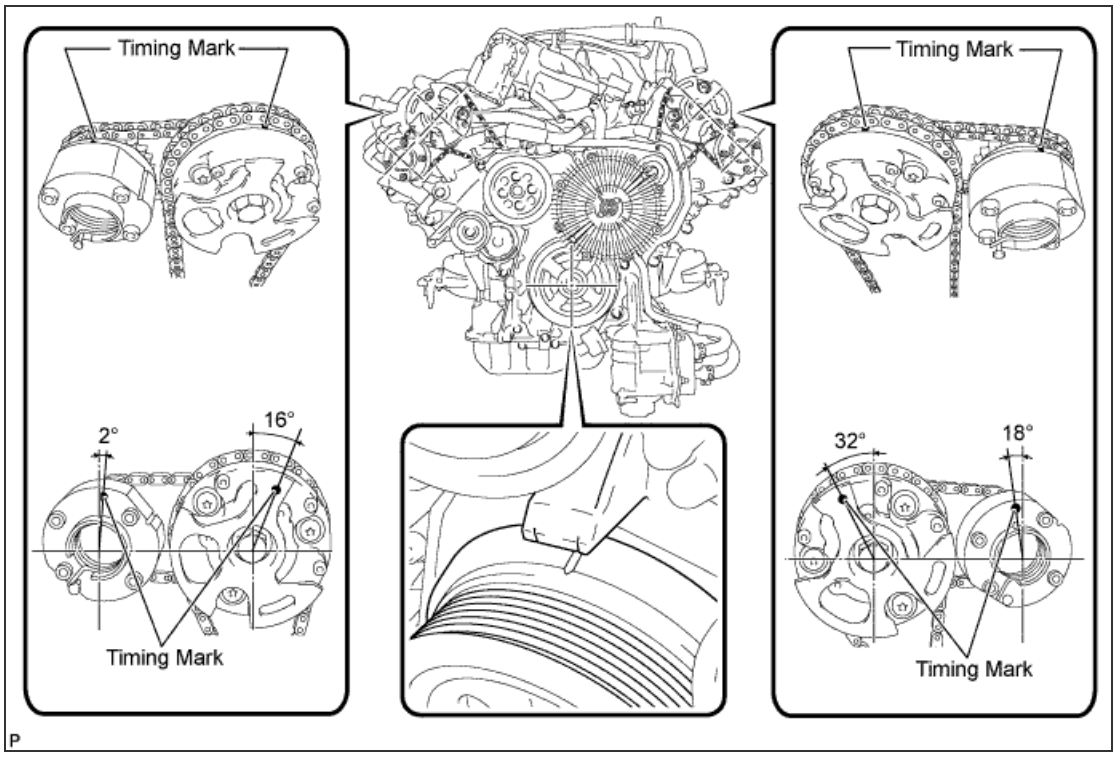
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

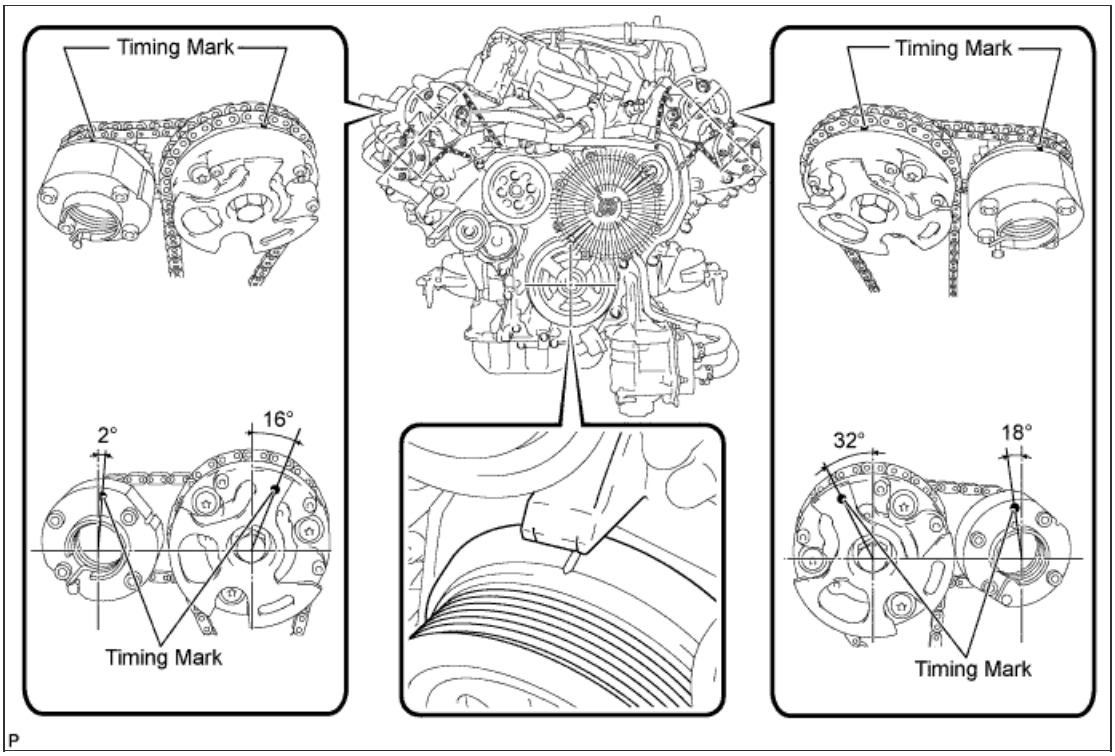
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

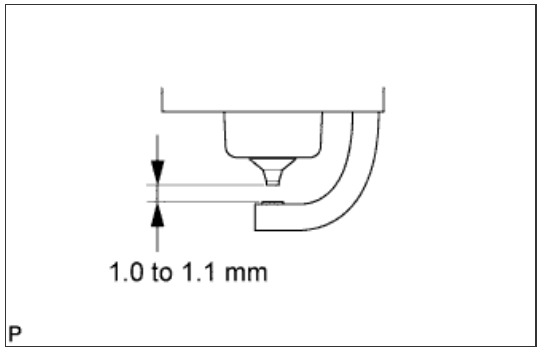
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

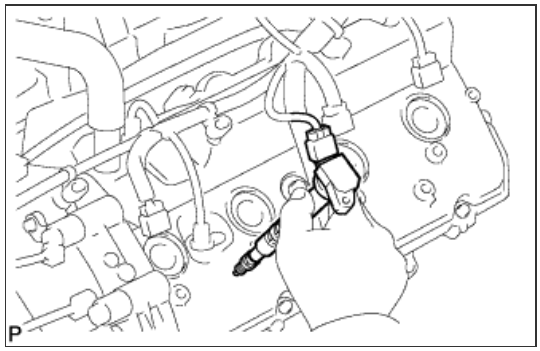
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

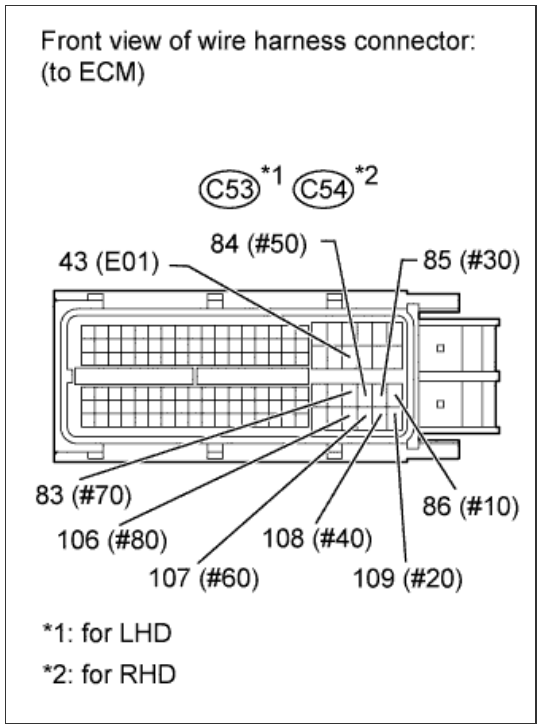
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

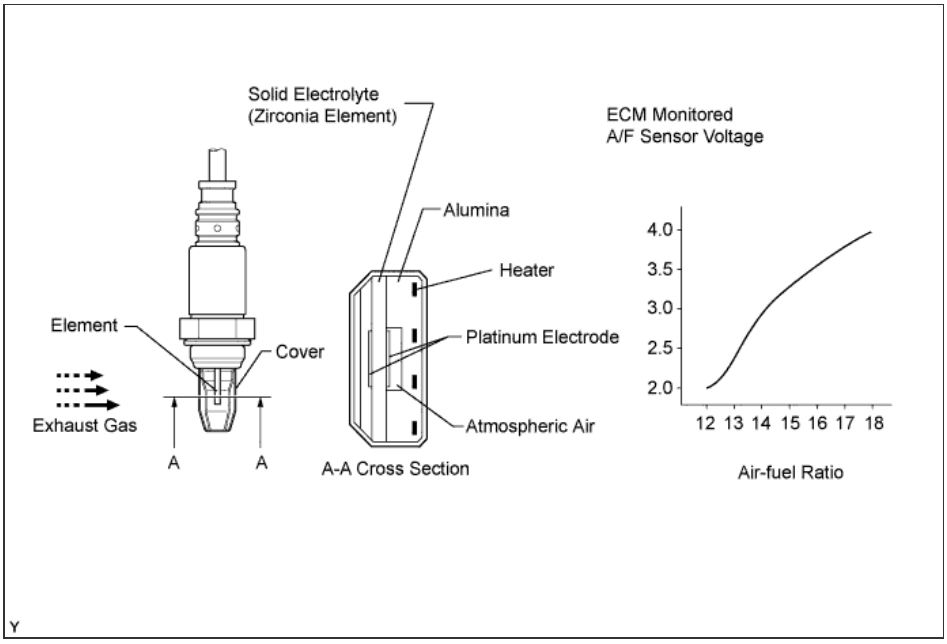
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

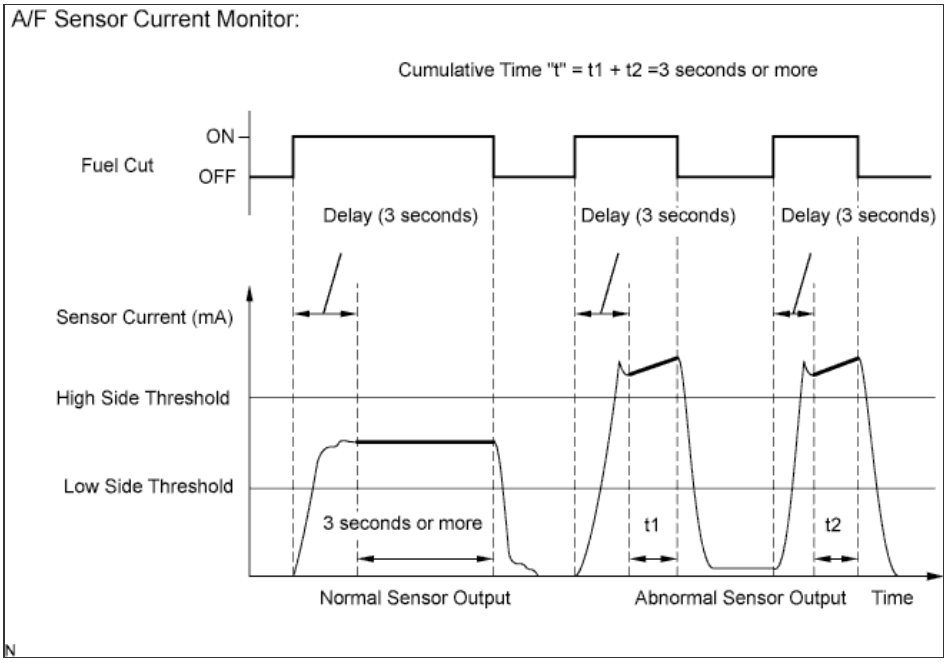
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

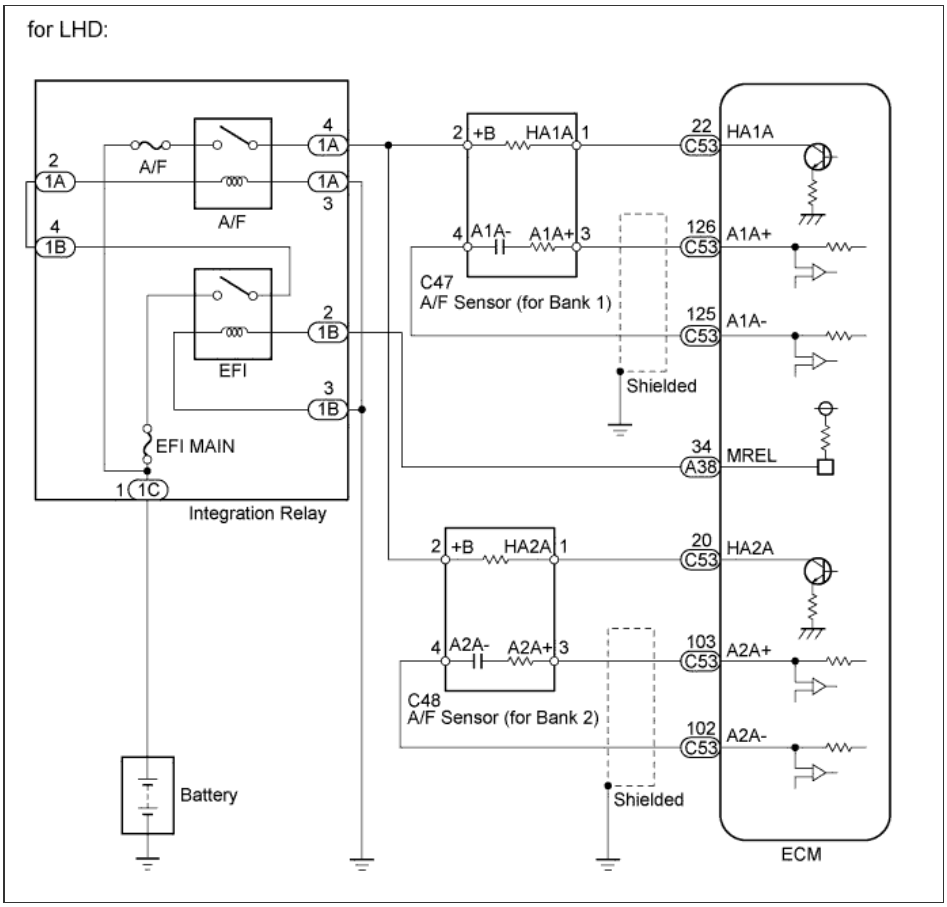
Sensor current detection monitor

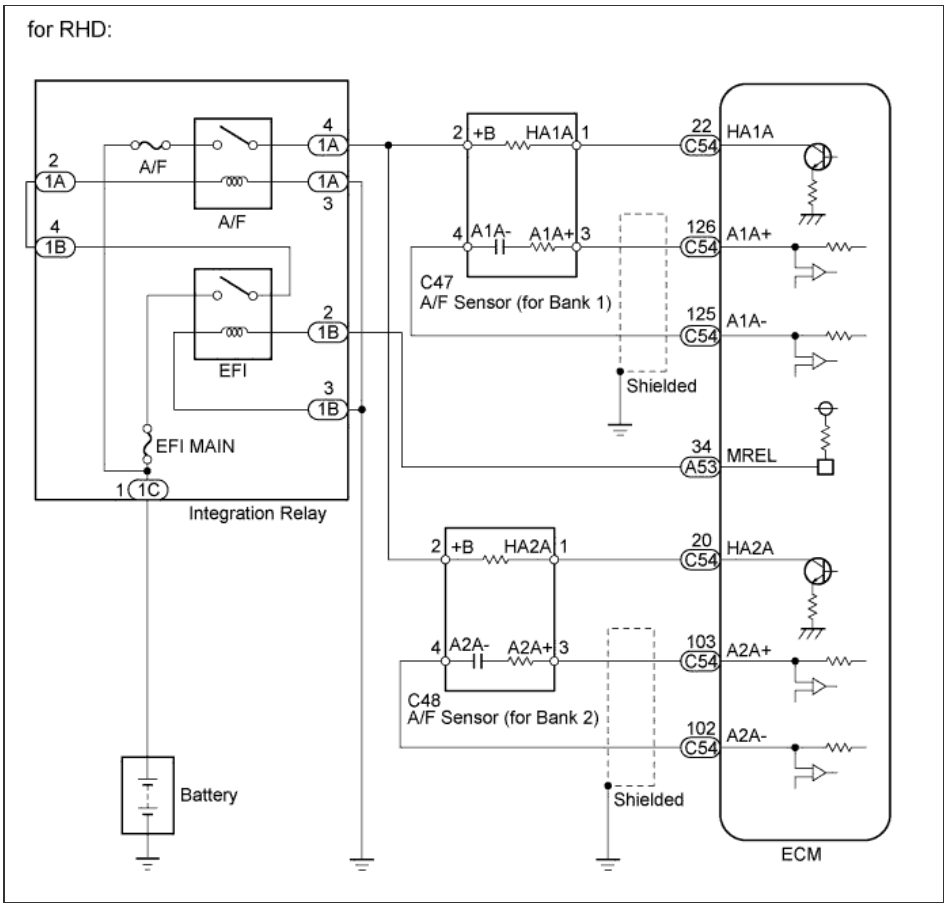
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





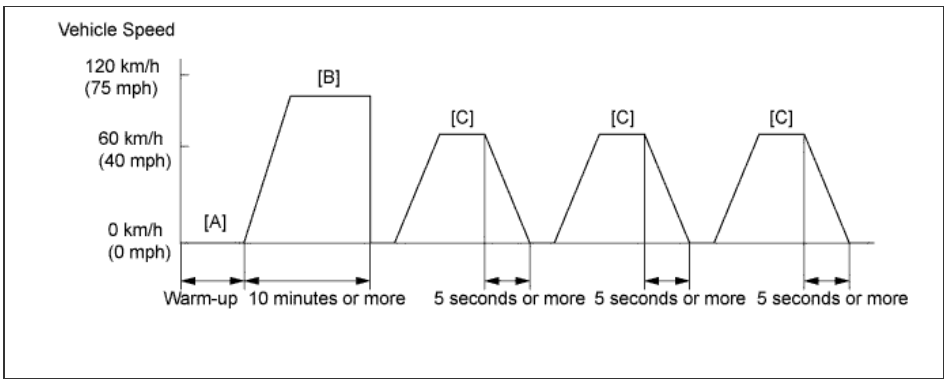
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

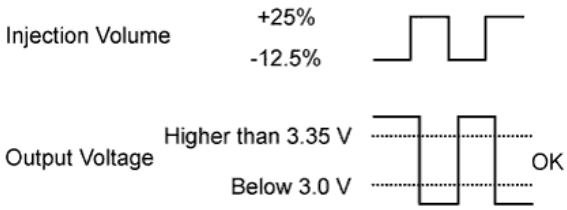
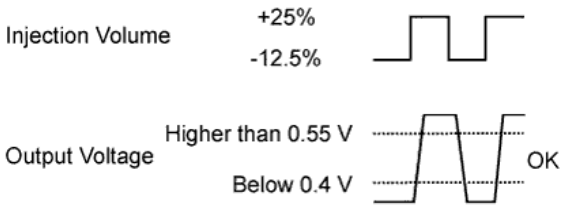
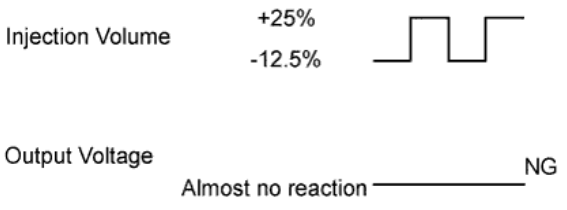
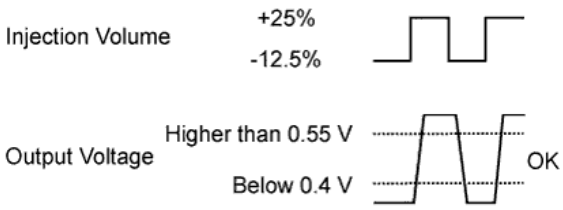
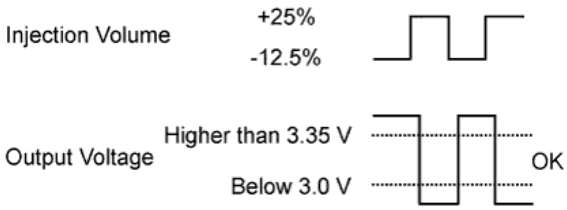
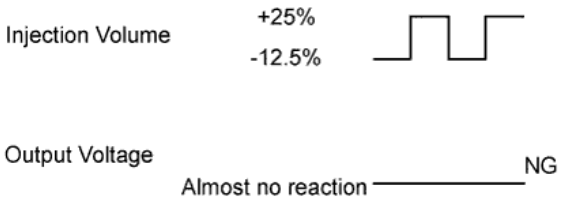
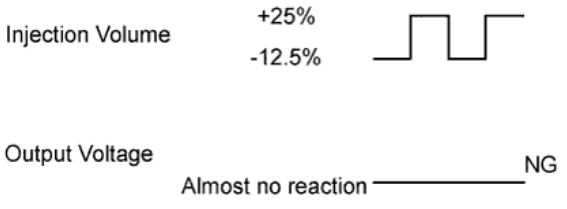
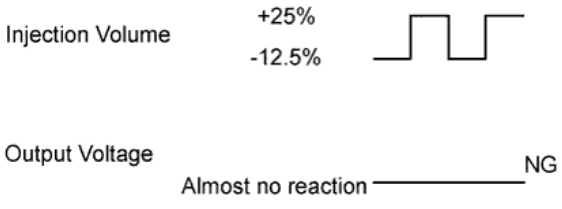
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

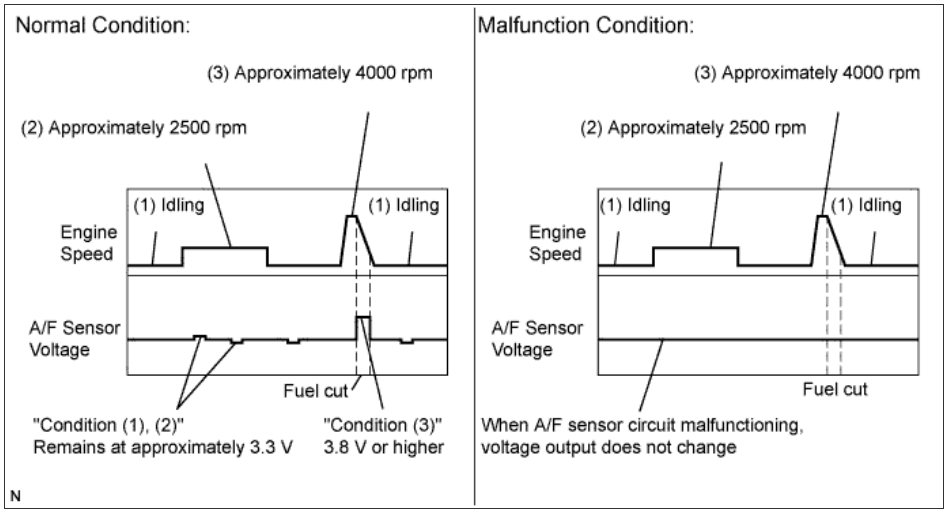
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

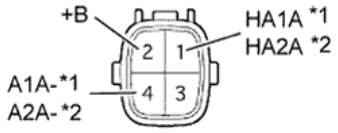
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

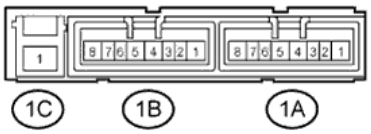
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

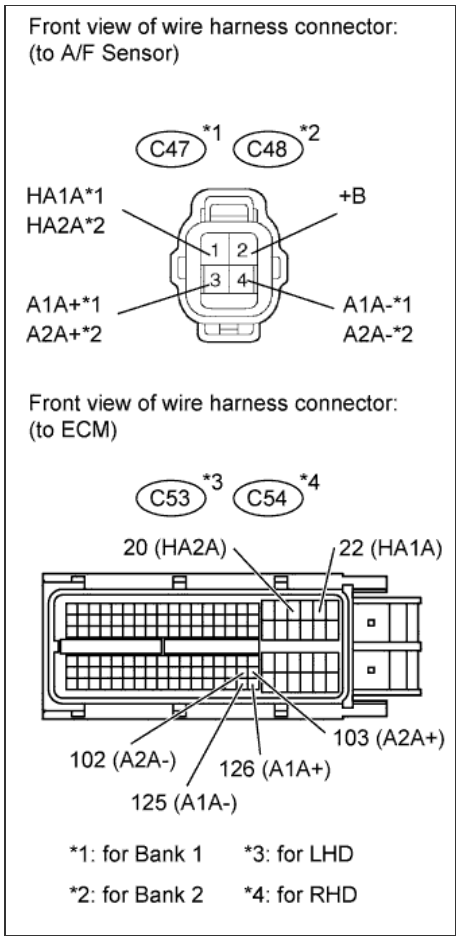
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

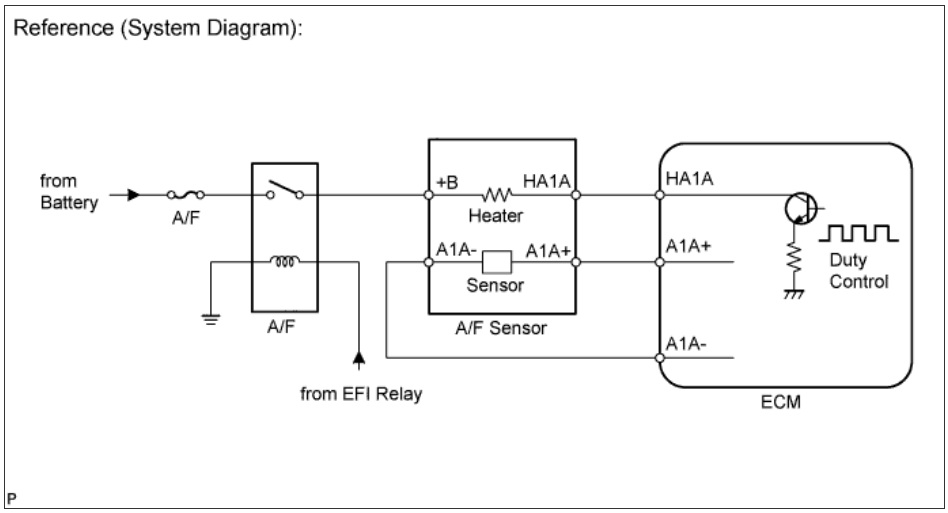
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

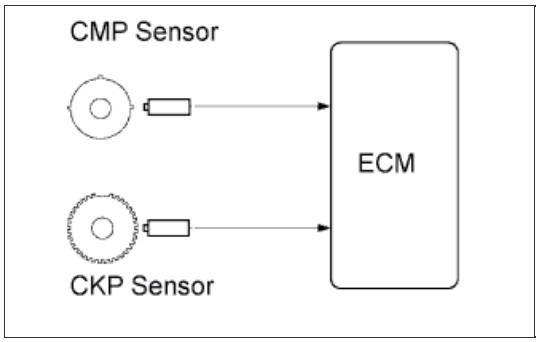
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

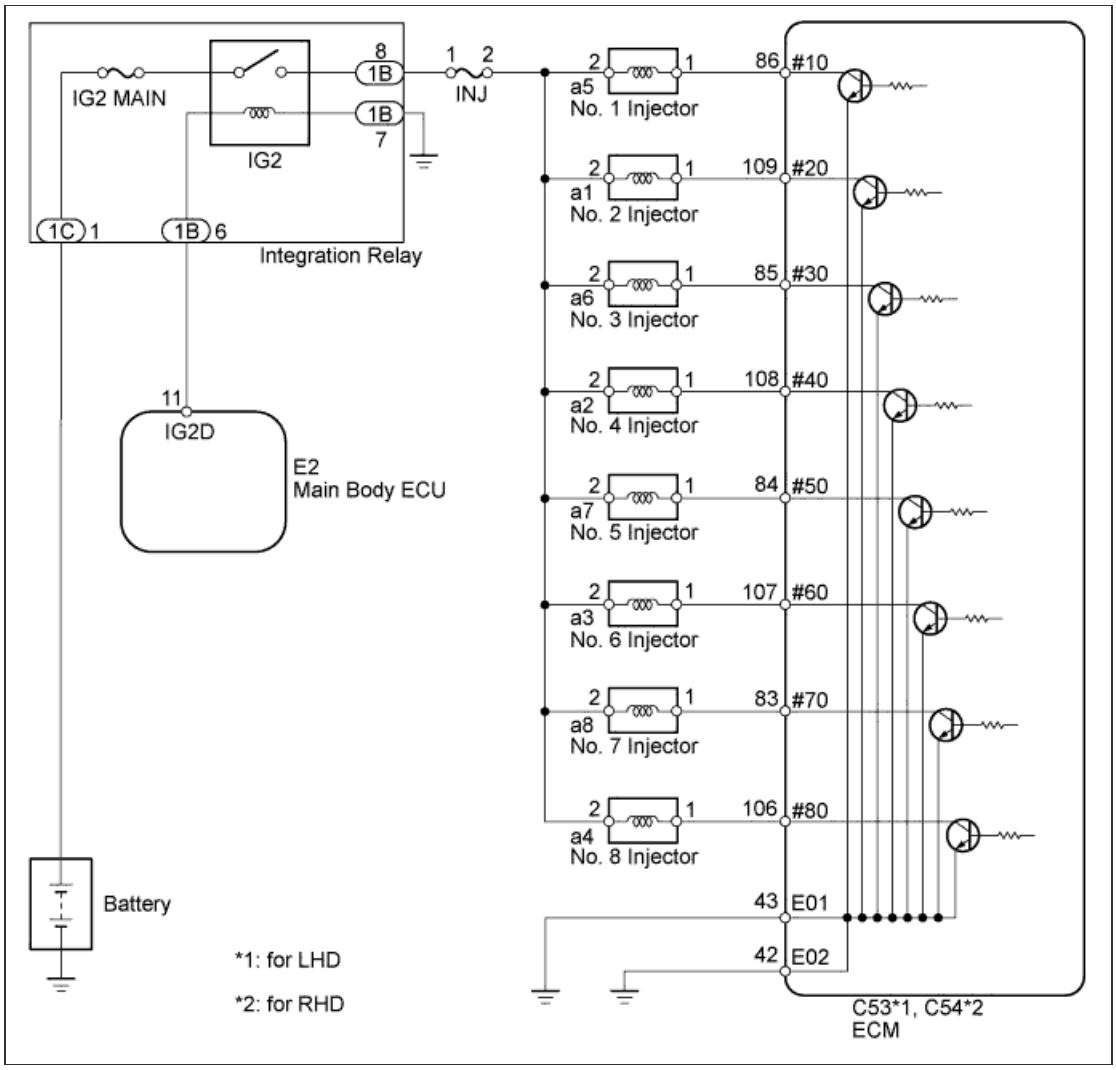
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

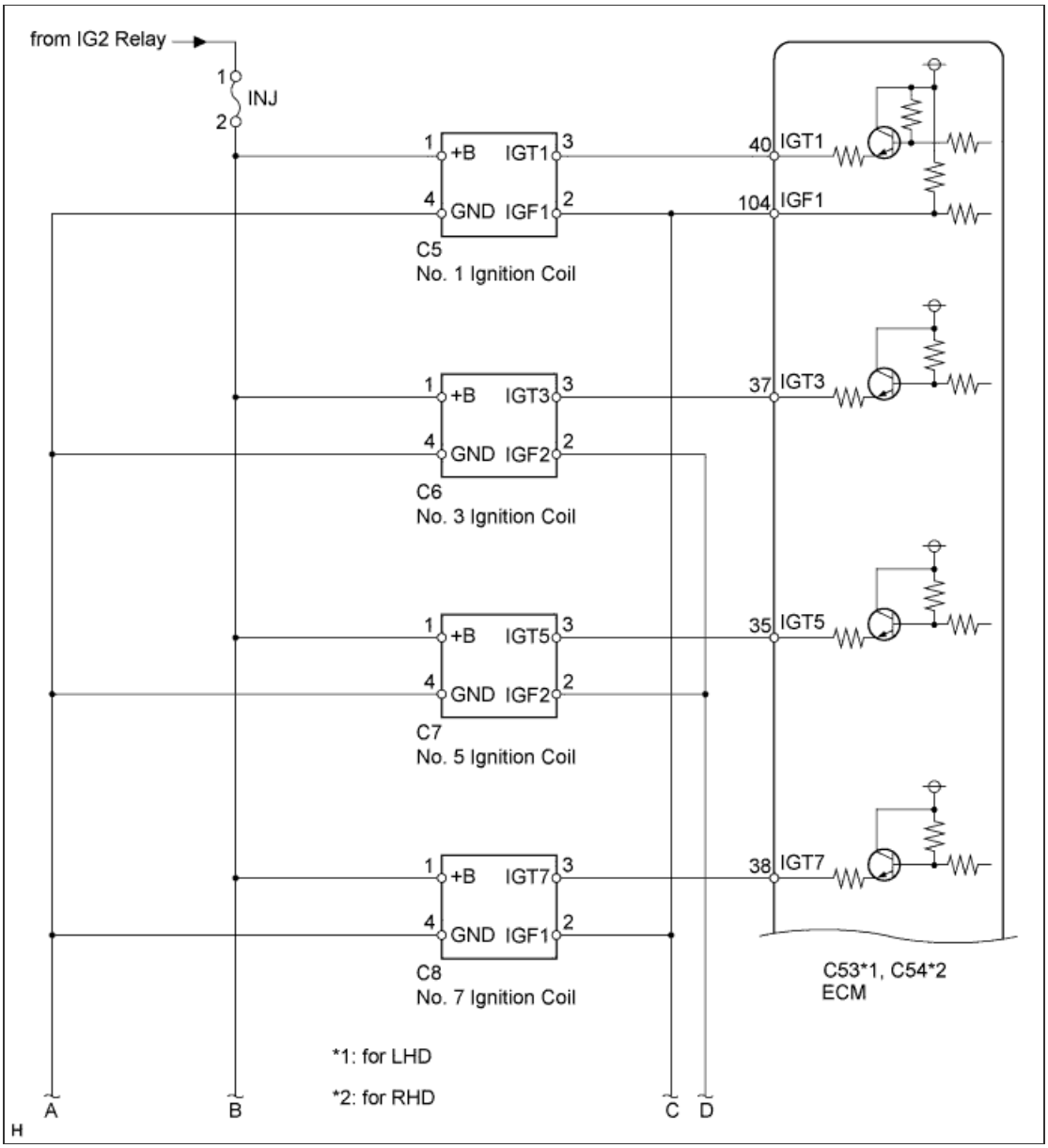
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

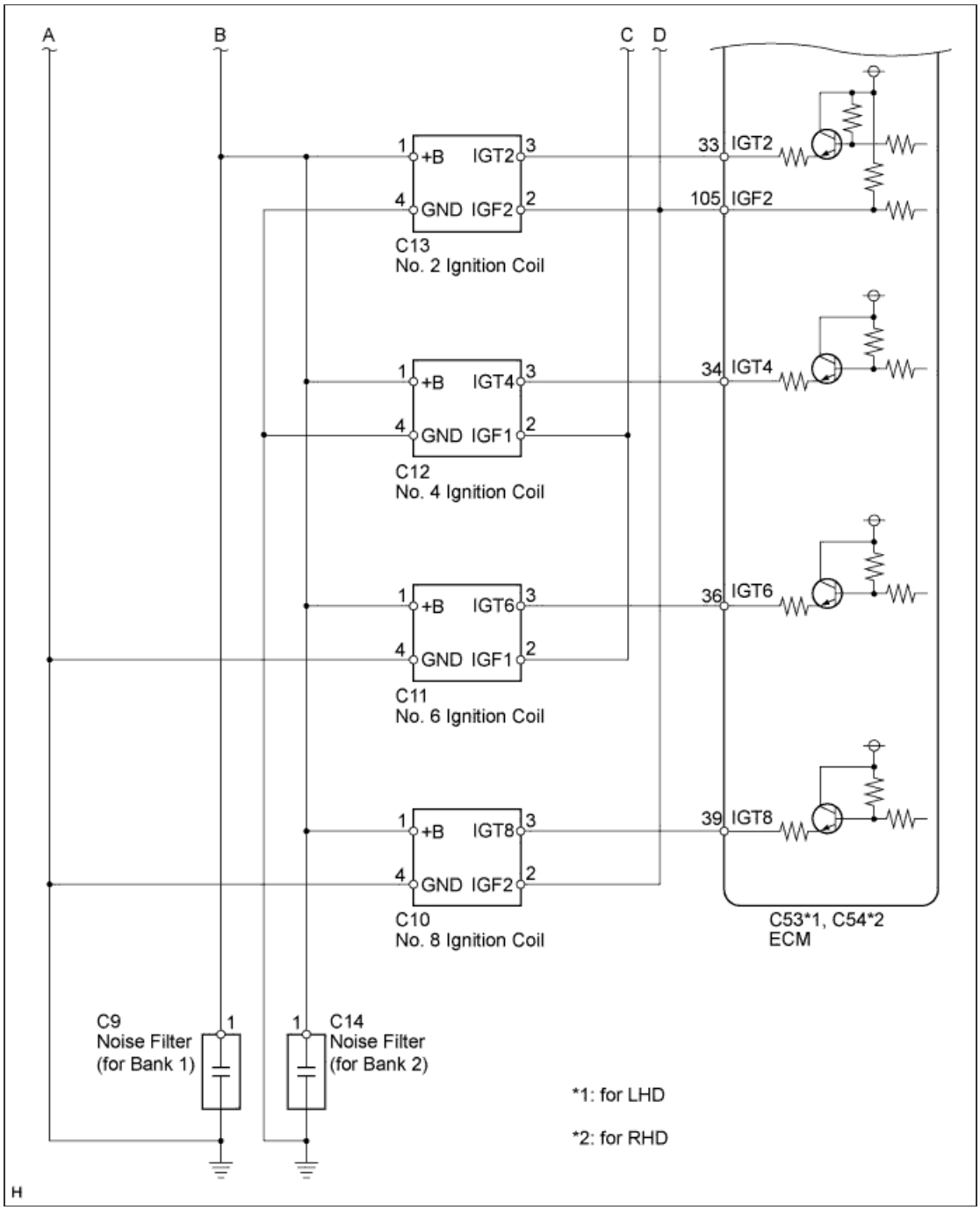
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

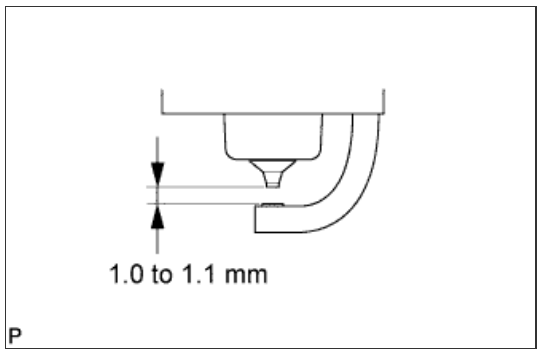
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

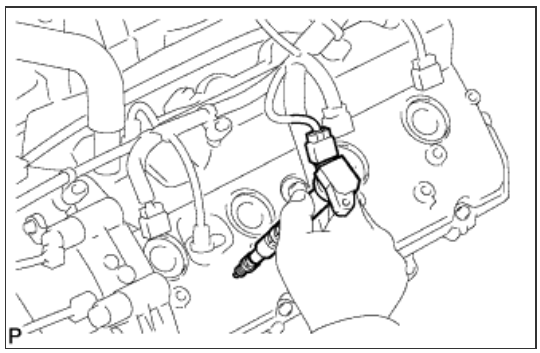
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

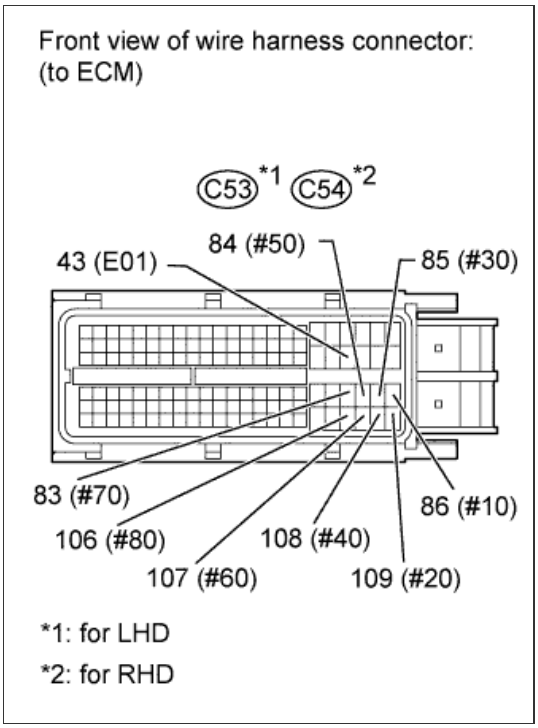
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

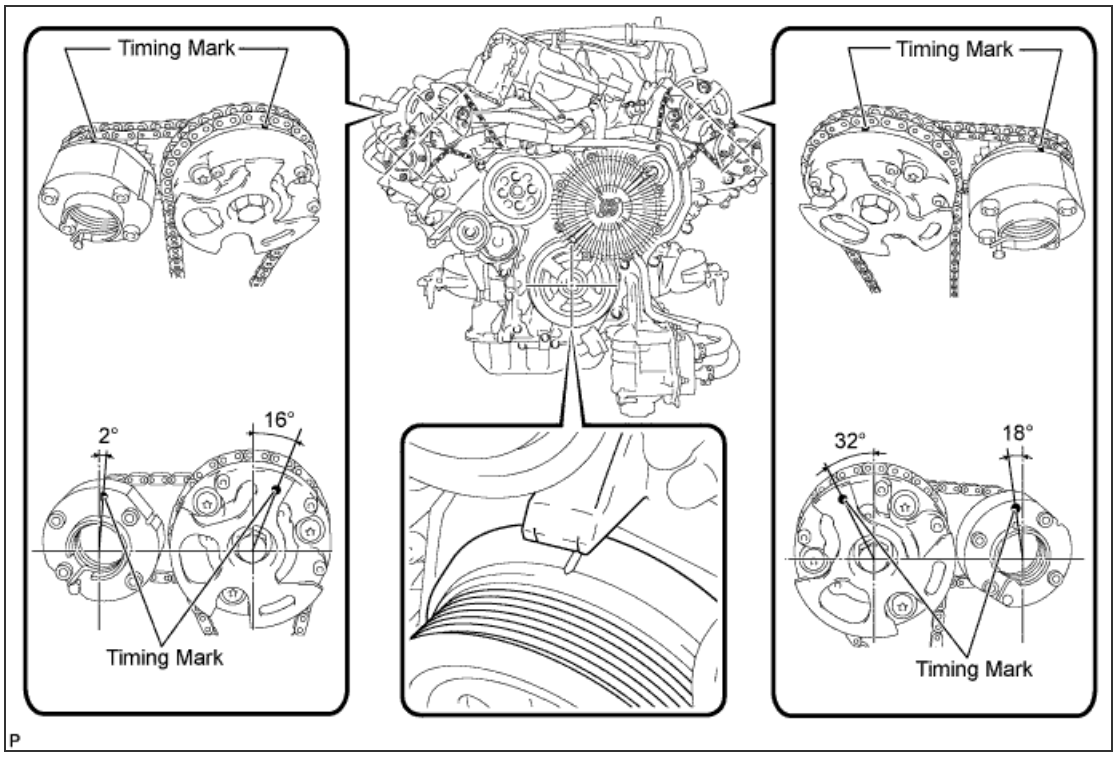
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

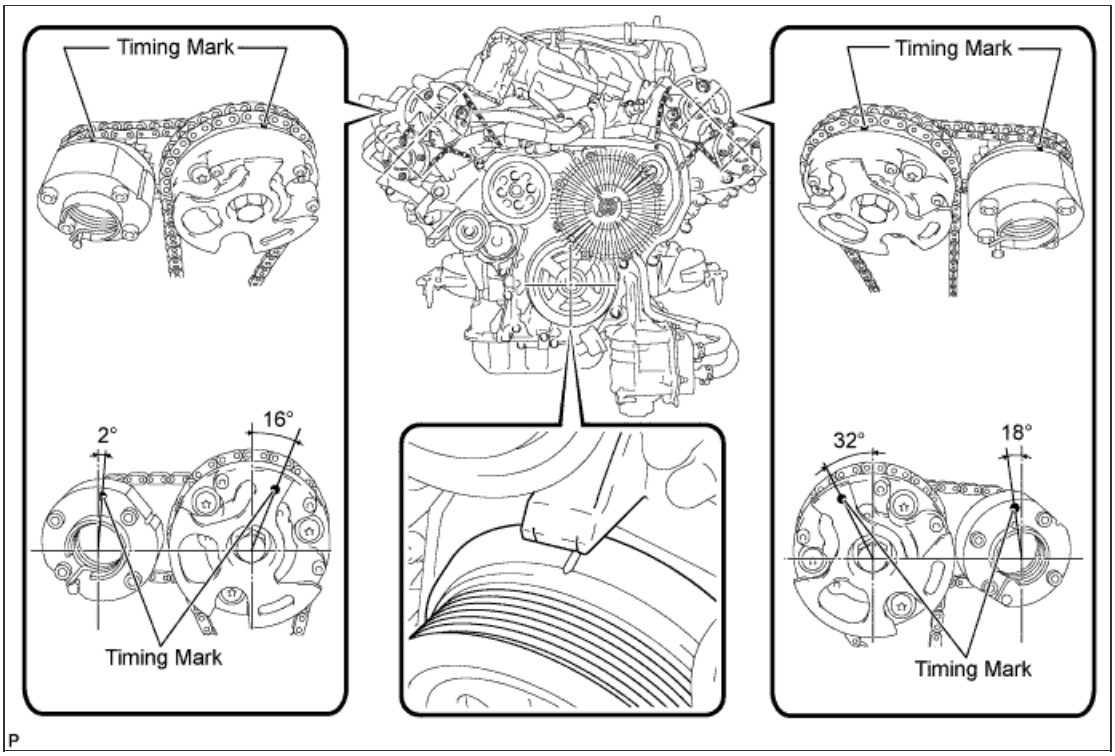
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

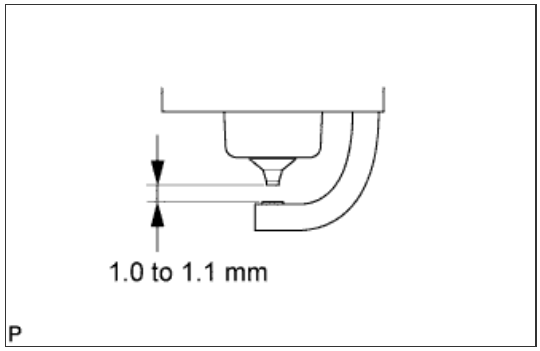
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

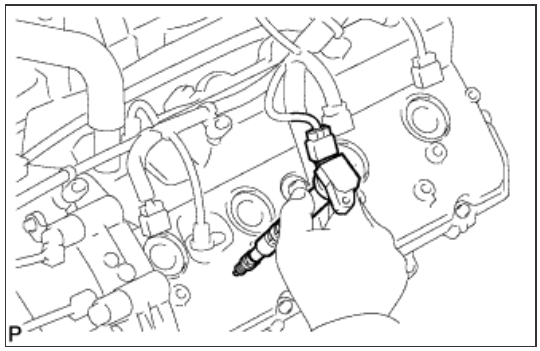
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

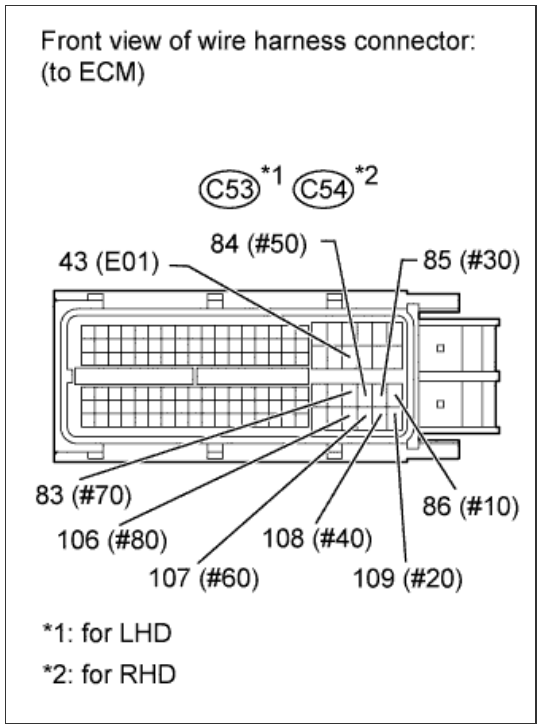
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

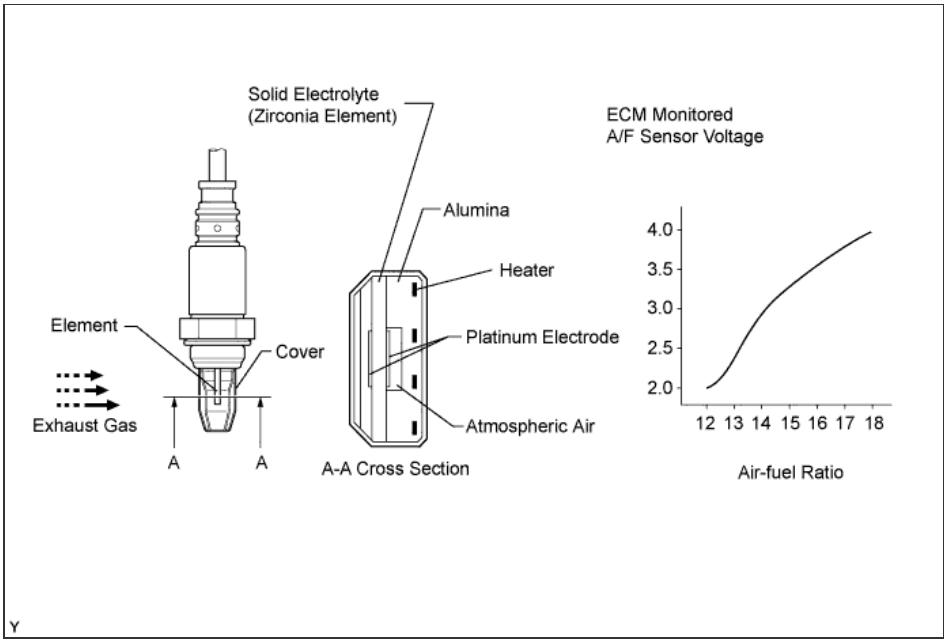
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

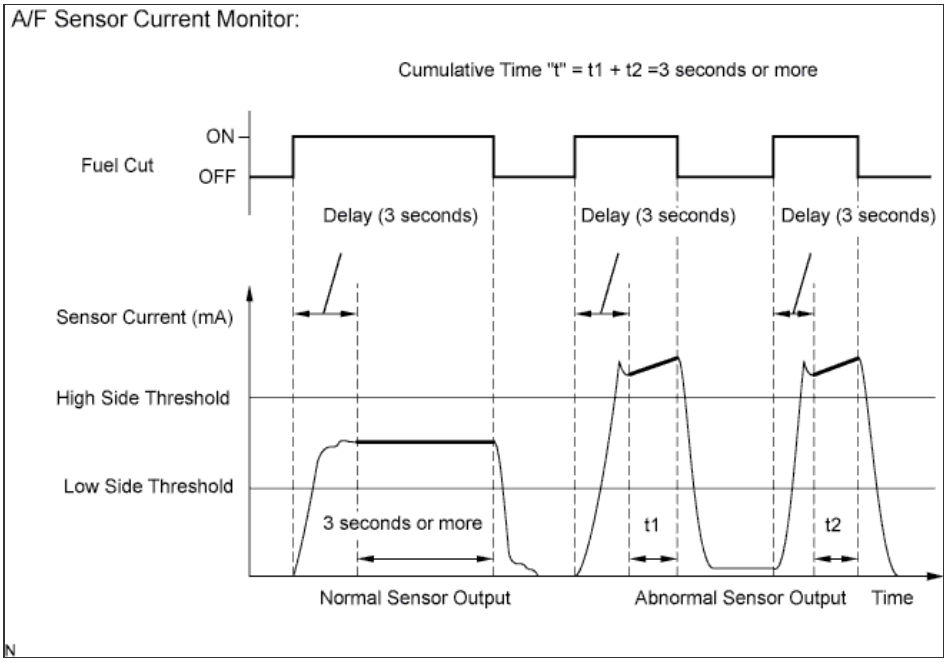
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

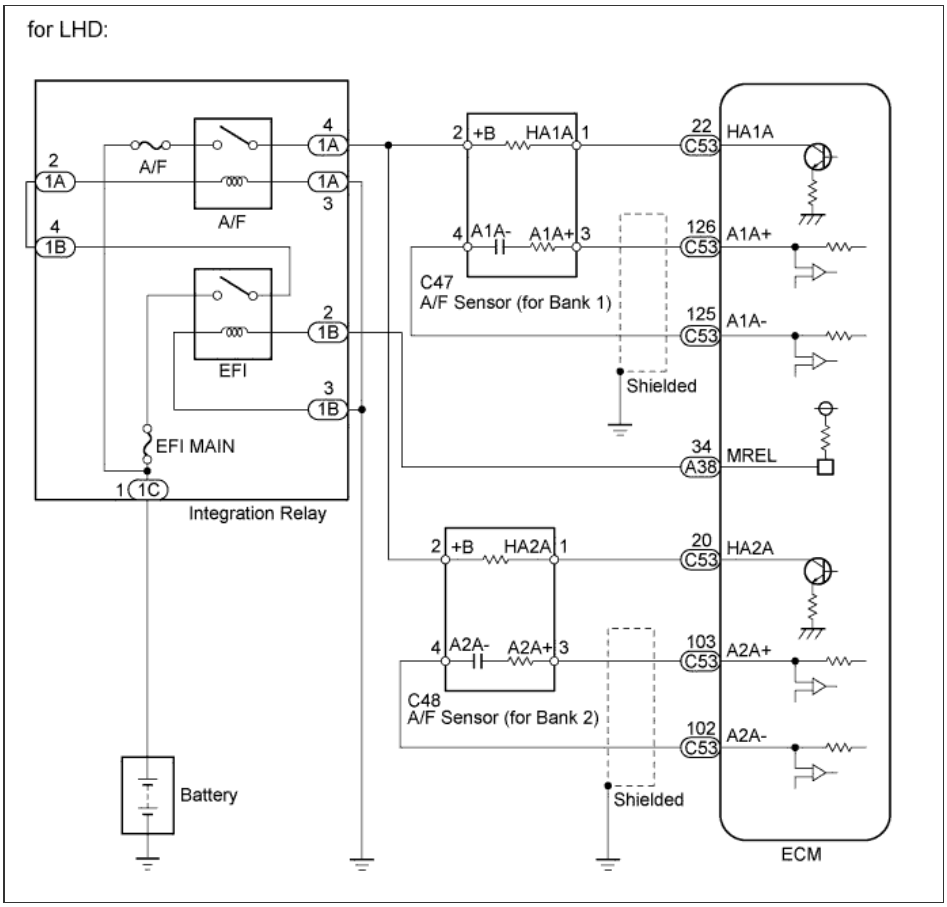
Sensor current detection monitor

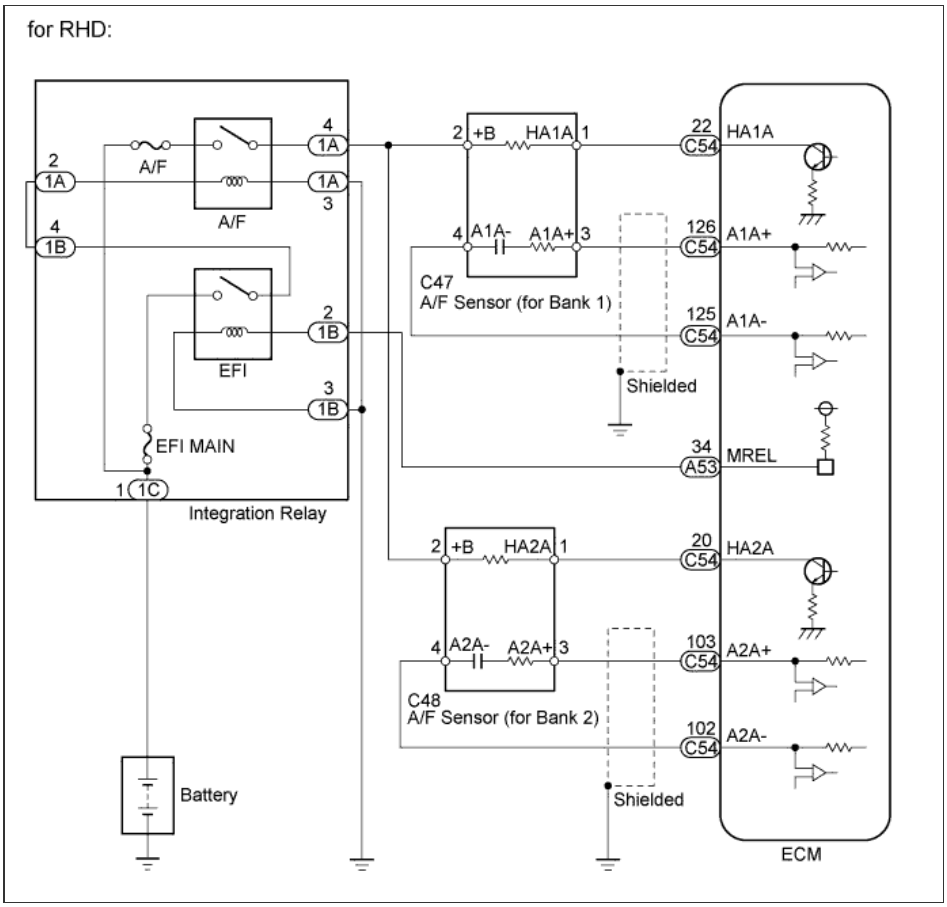
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





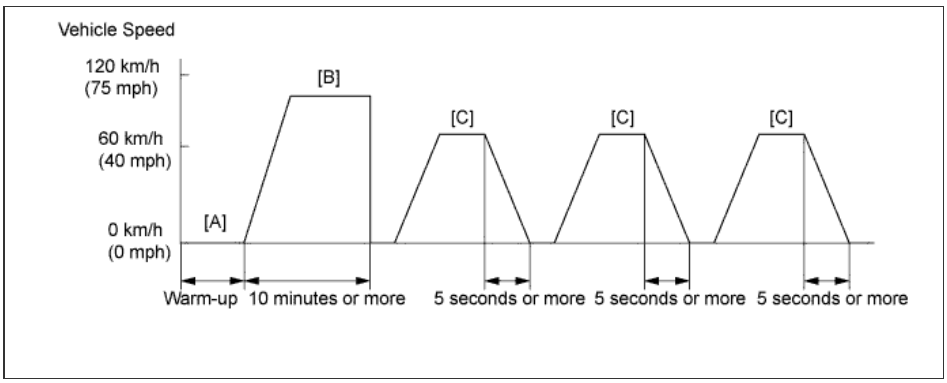
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

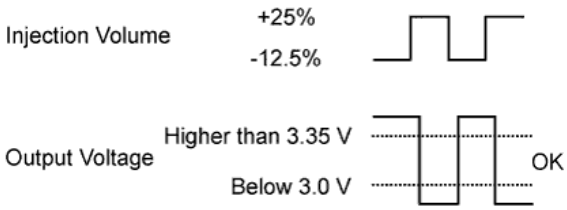
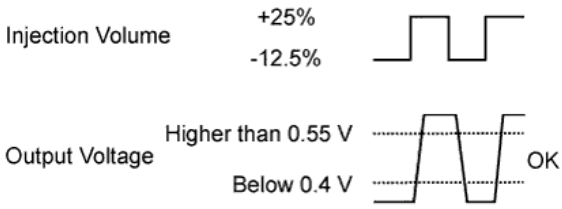
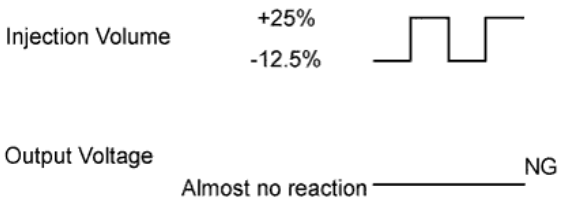
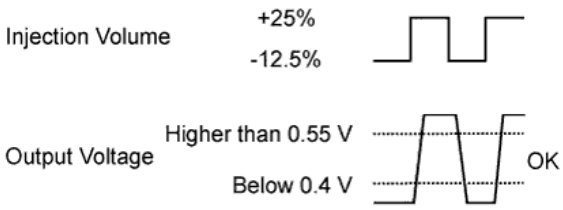
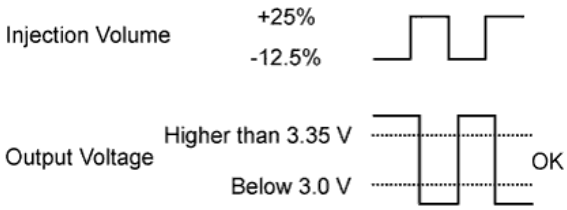
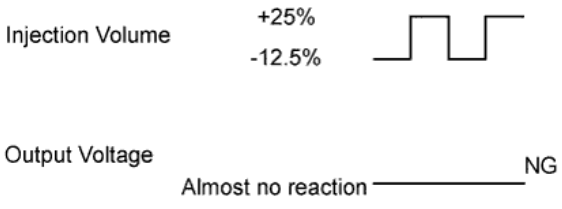
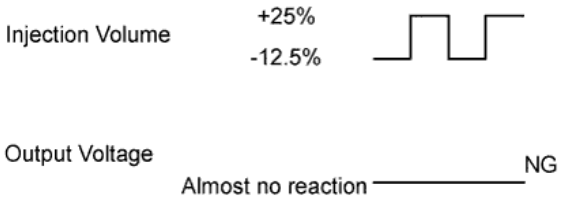
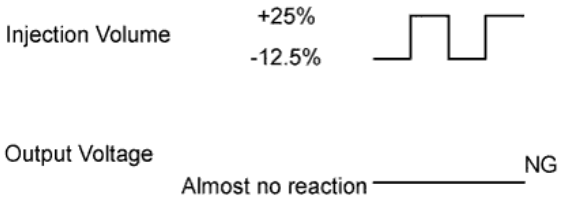
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

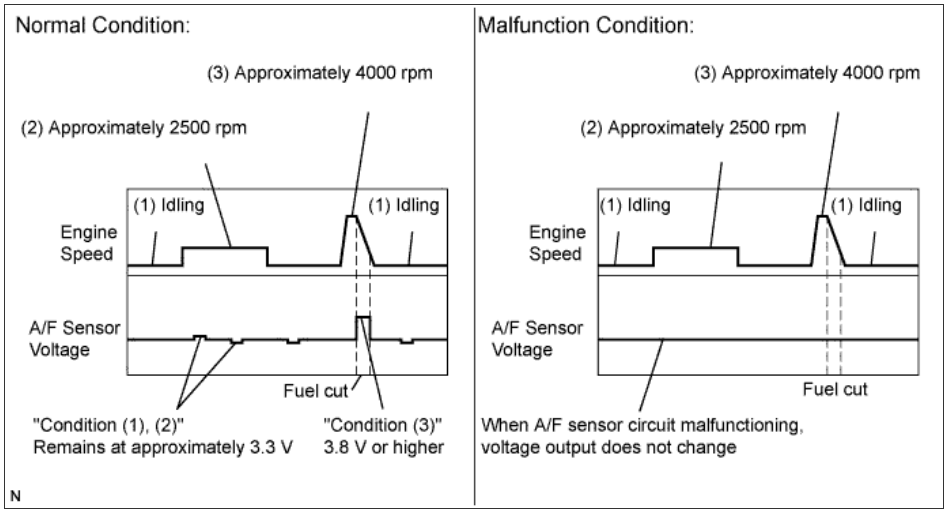
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

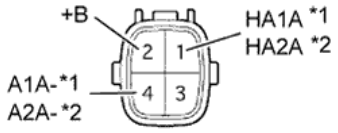
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

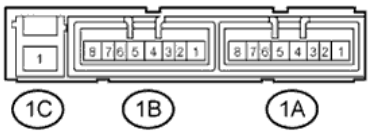
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

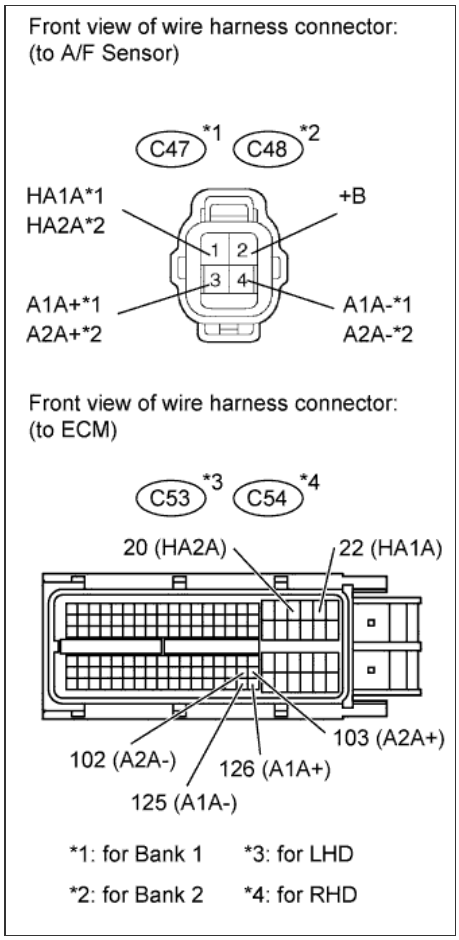
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

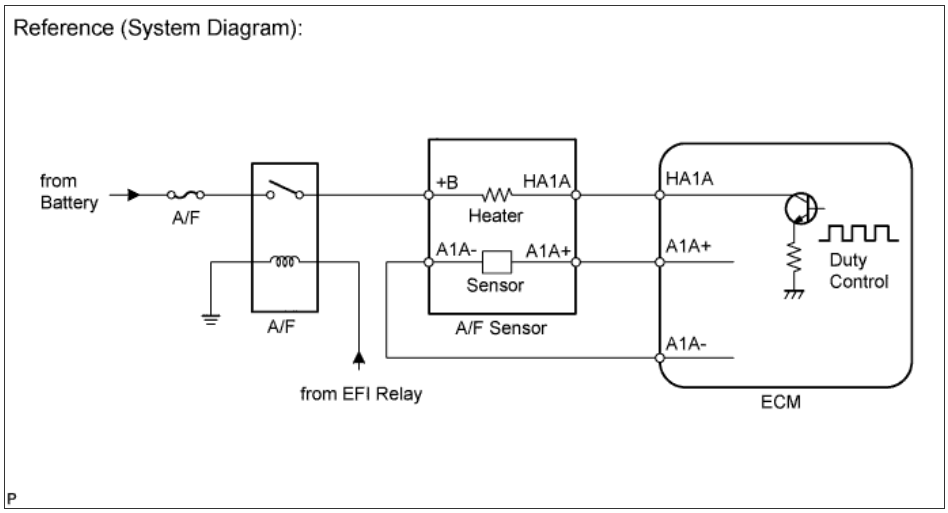
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

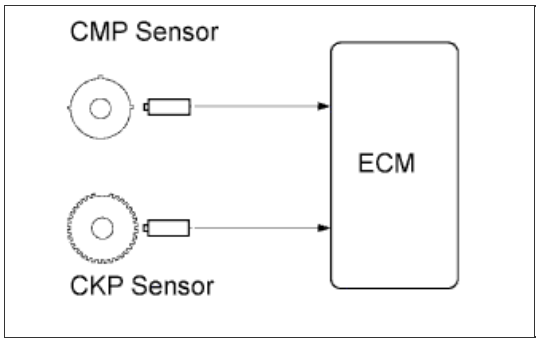
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

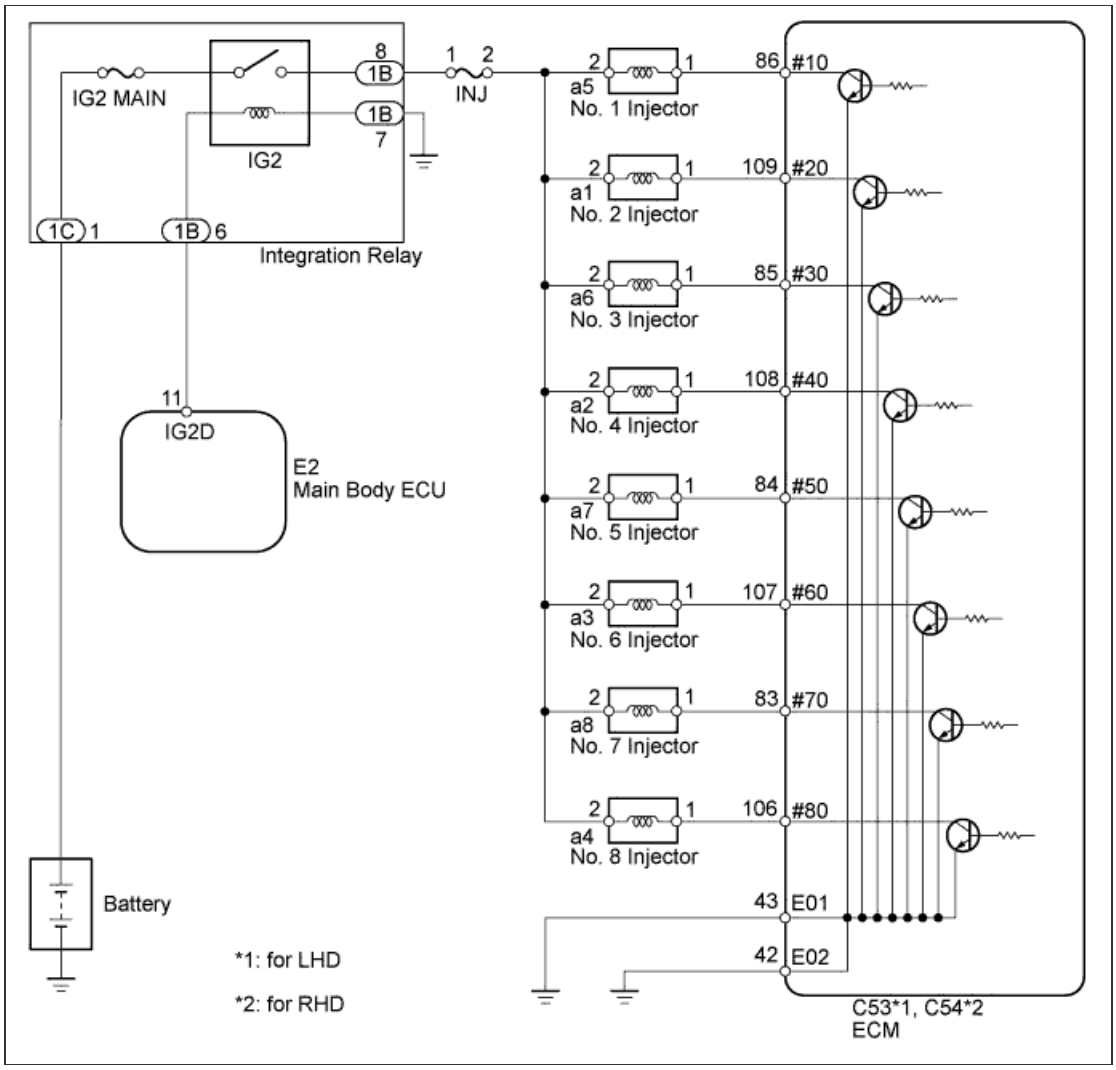
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

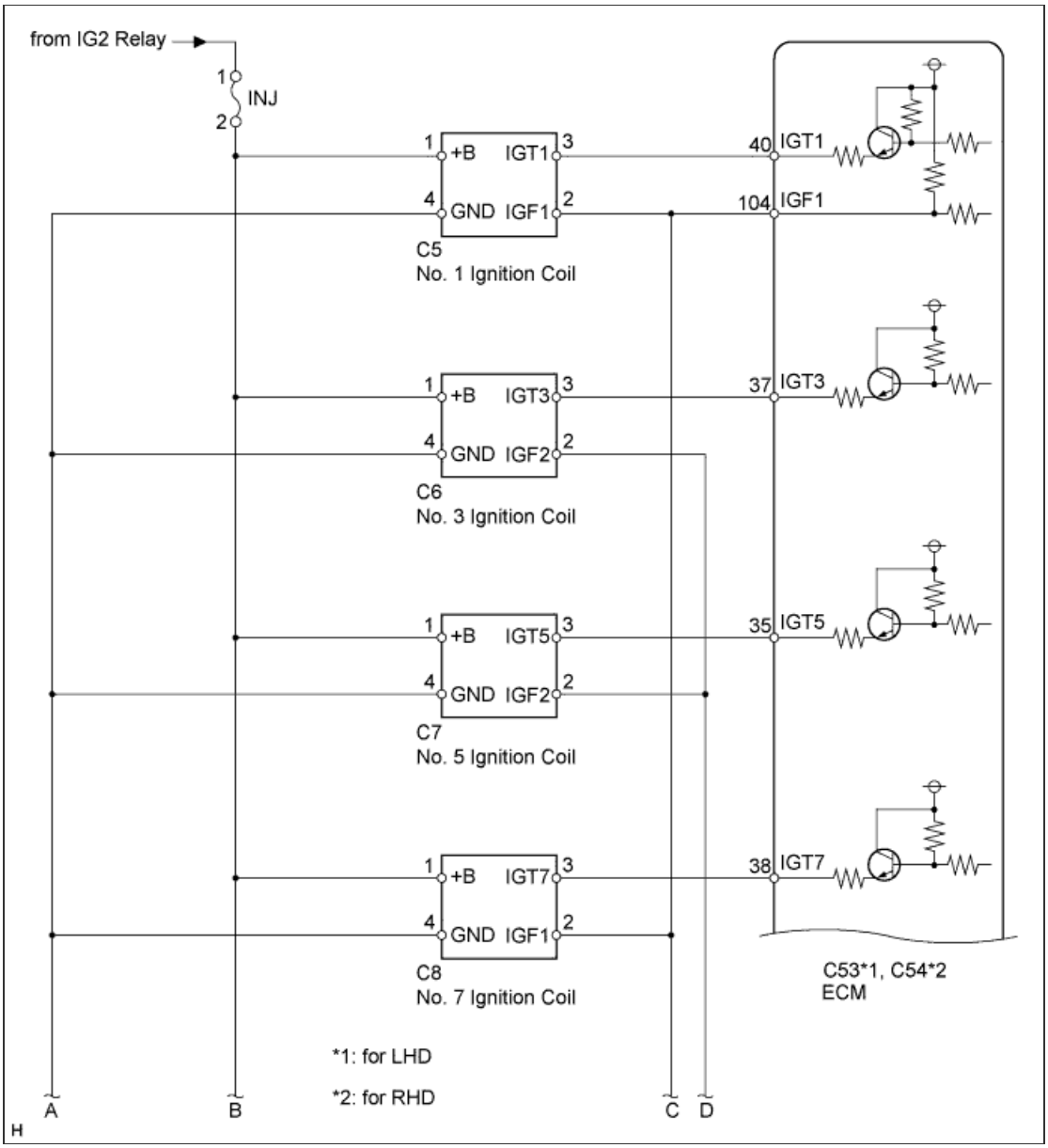
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

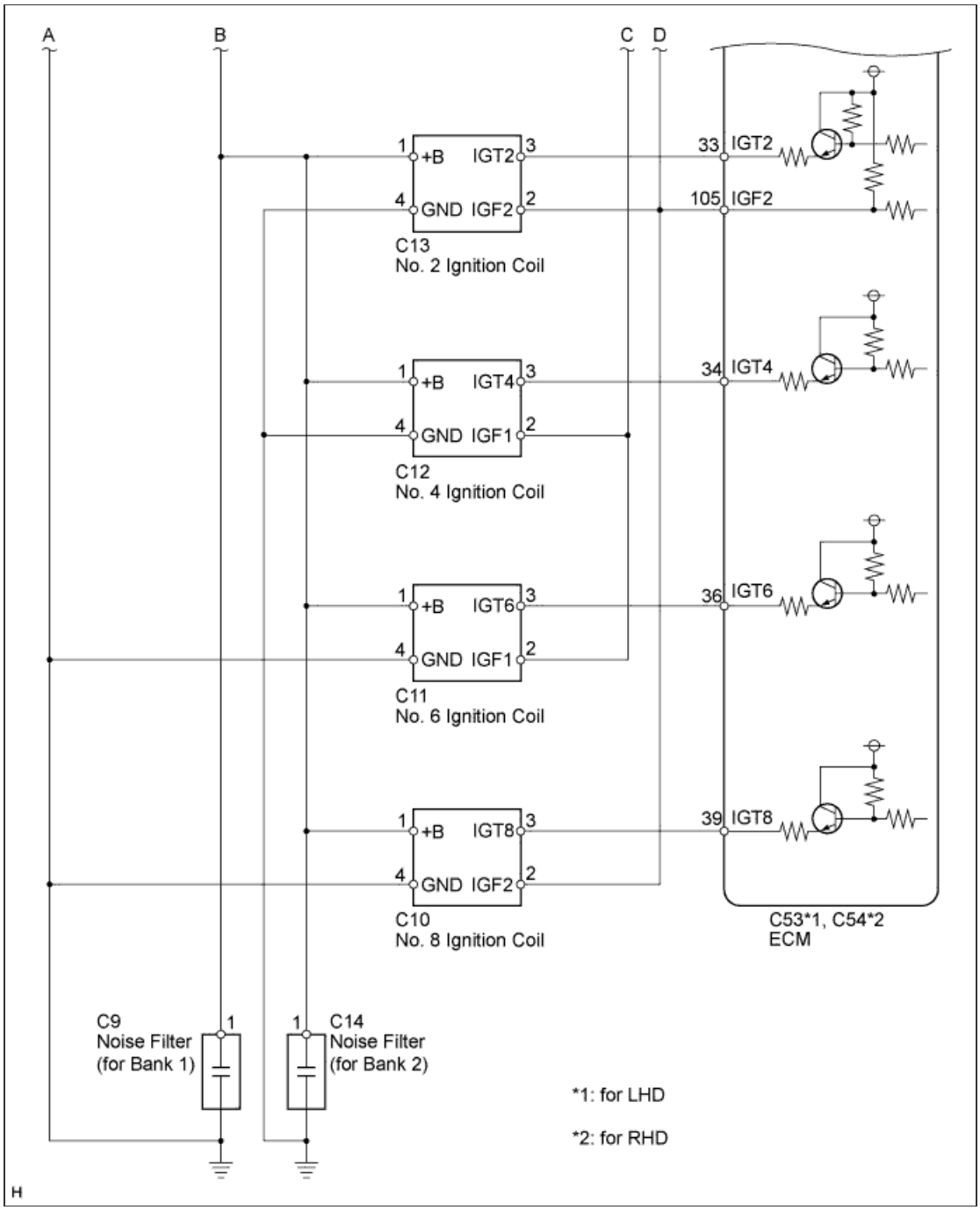
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

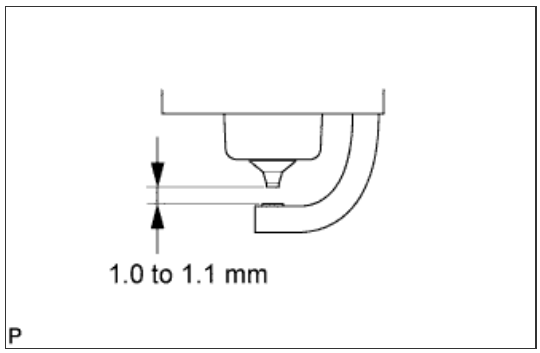
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

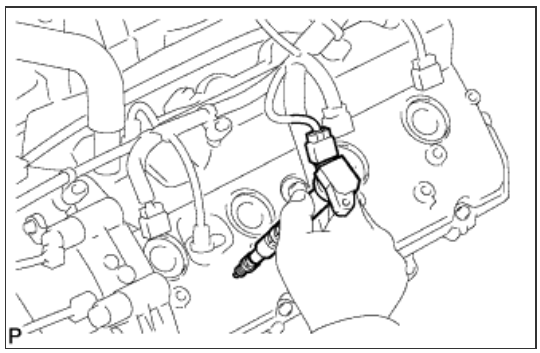
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

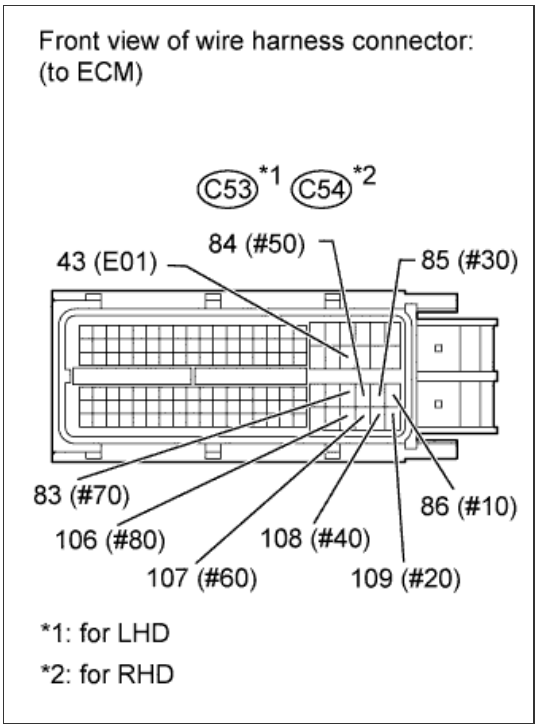
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

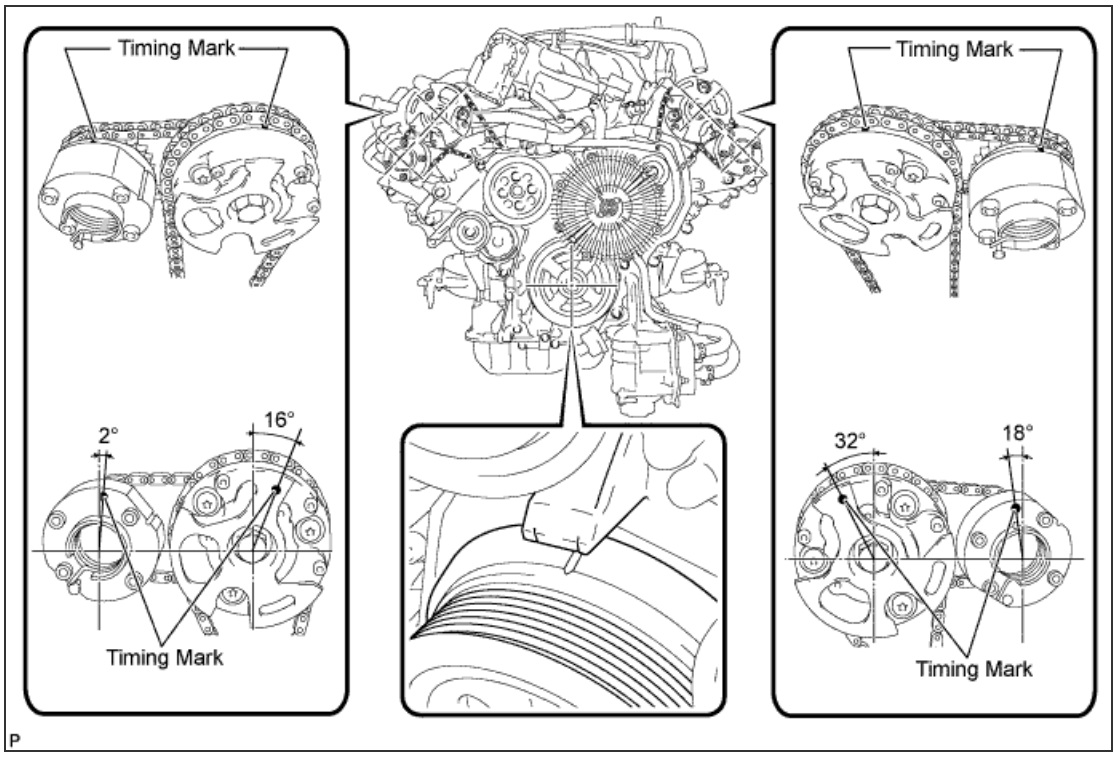
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

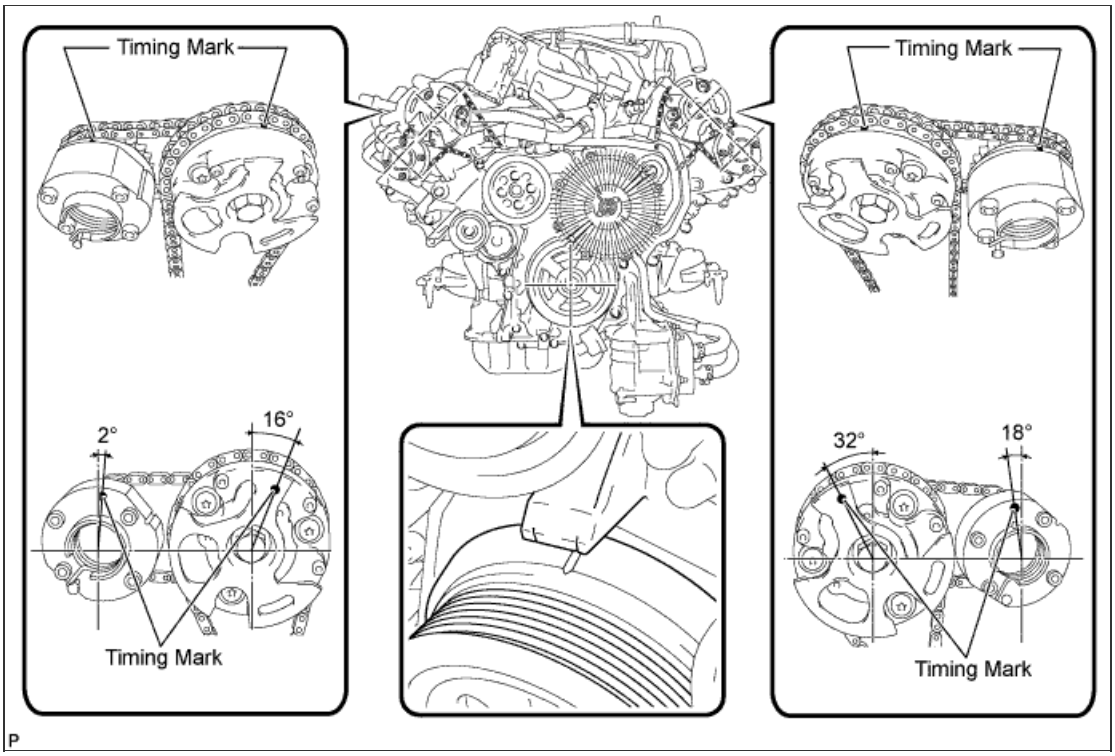
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

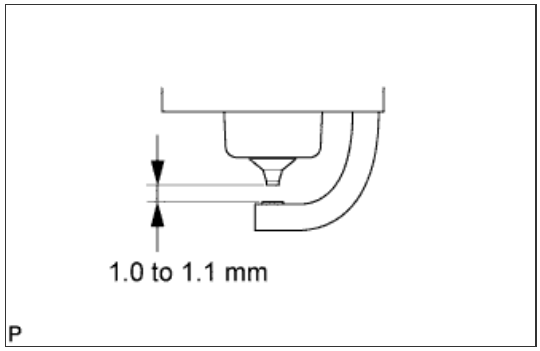
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

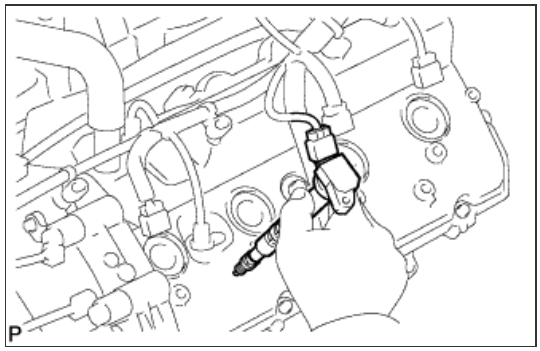
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

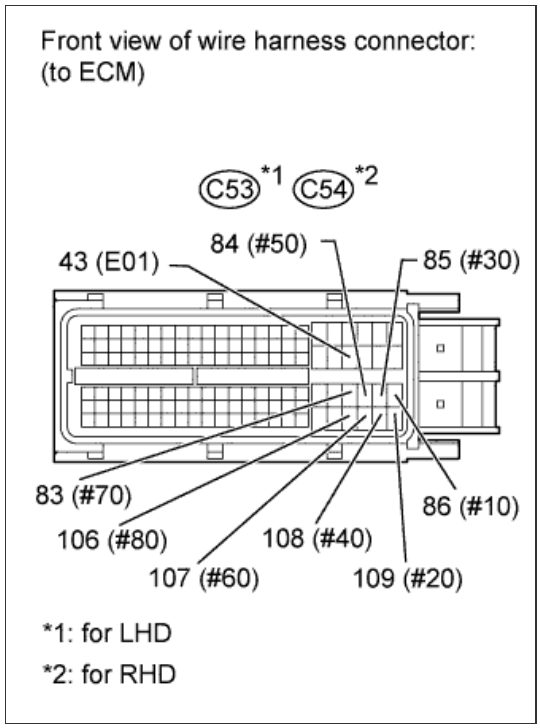
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2195 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC P2196 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

DTC P2197 Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC P2198 Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

for Preparation Click here

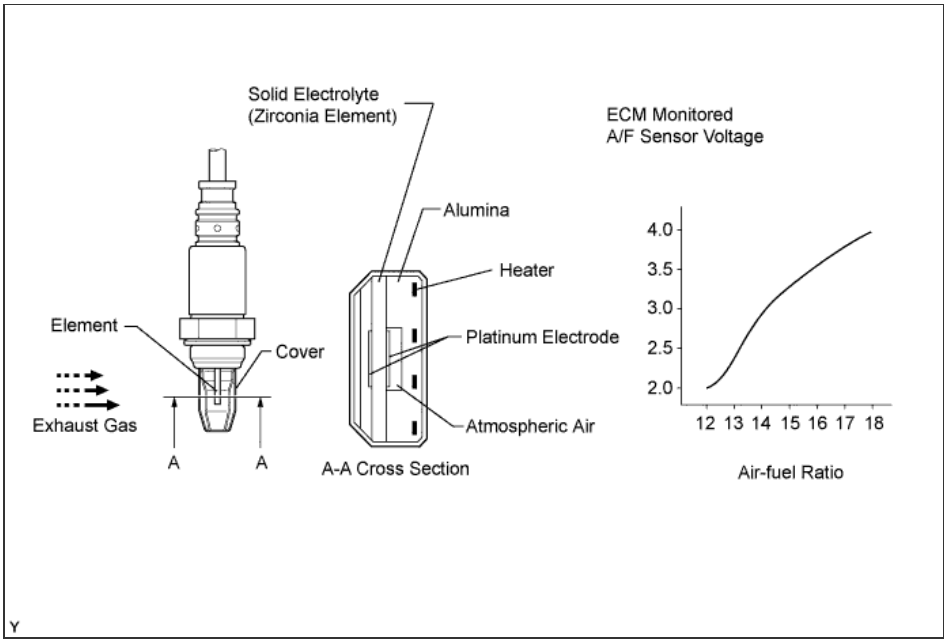
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor in order to facilitate accurate air-fuel ratio detection. In addition, the sensor and heater portions are the narrow type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC Code	DTC Detection Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The Air Fuel ratio (A/F) sensor voltage is higher than 3.8 V for 5 seconds. (b) The Heated Oxygen (HO2) sensor voltage is 0.21 V or higher.	• Open or short in Air Fuel ratio (A/F) sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is 3.6 mA or higher for 3 seconds (2 trip detection logic).	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 5 seconds or more (2 trip detection logic): (a) The A/F sensor voltage is below 2.8 V for 5 seconds. (b) The HO2 sensor voltage is below 0.59 V.	• Open or short in A/F sensor (for Sensor 1) circuit • A/F sensor (for Sensor 1) • A/F sensor heater (for Sensor 1) • Integration relay • A/F sensor heater and integration relay circuits • Air induction system • Fuel pressure • Fuel injector • ECM
	While the fuel cut operation is performed (during vehicle deceleration), the A/F sensor current is below 1.4 mA for 3 seconds (2 trip detection logic).	• A/F sensor • ECM

HINT:

- **DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.**
- **DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

- **When either of these DTCs is stored, check the A/F sensor output voltage by entering the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.**
- **Short-term fuel trim values can also be read using the intelligent tester.**
- **The ECM regulates the voltages at the A1A+ and A1A- or A2A+ and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.**
- **If the A/F sensor is malfunctioning, the ECM stores DTC P2195, P2196, P2197 or P2198.**

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and stores DTC(s).

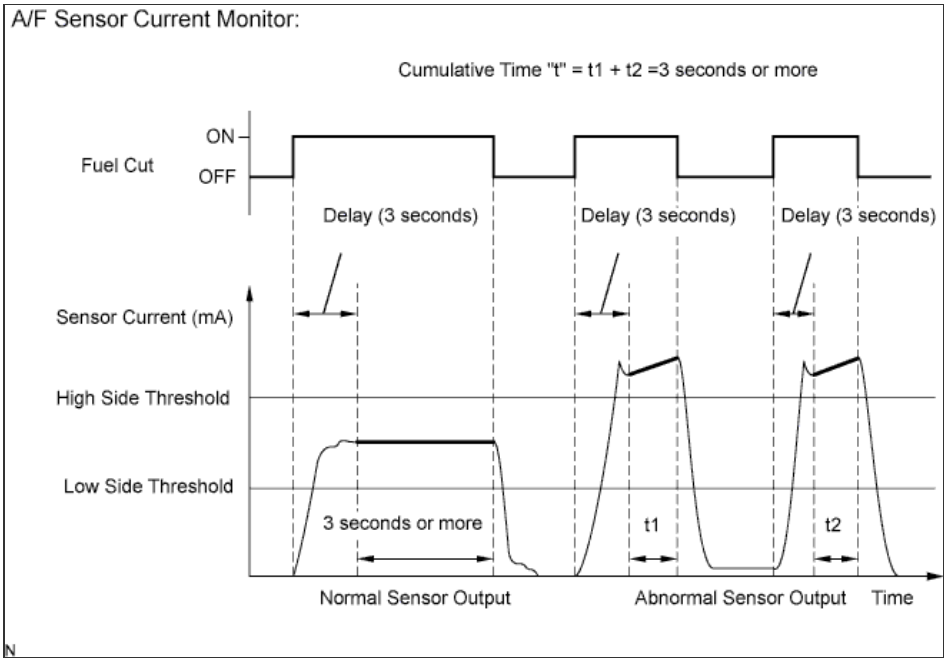
Example:

If the A/F sensor output voltage is below 2.8 V (very rich condition) for 5 seconds, despite the rear HO2 sensor output voltage being below 0.59 V, the ECM stores DTC P2196 or P2198. Alternatively, if the A/F sensor output voltage is higher than 3.8 V (very lean condition) for 5 seconds despite the rear HO2 sensor output voltage being 0.21 V or higher, DTC P2195 or P2197 is stored.

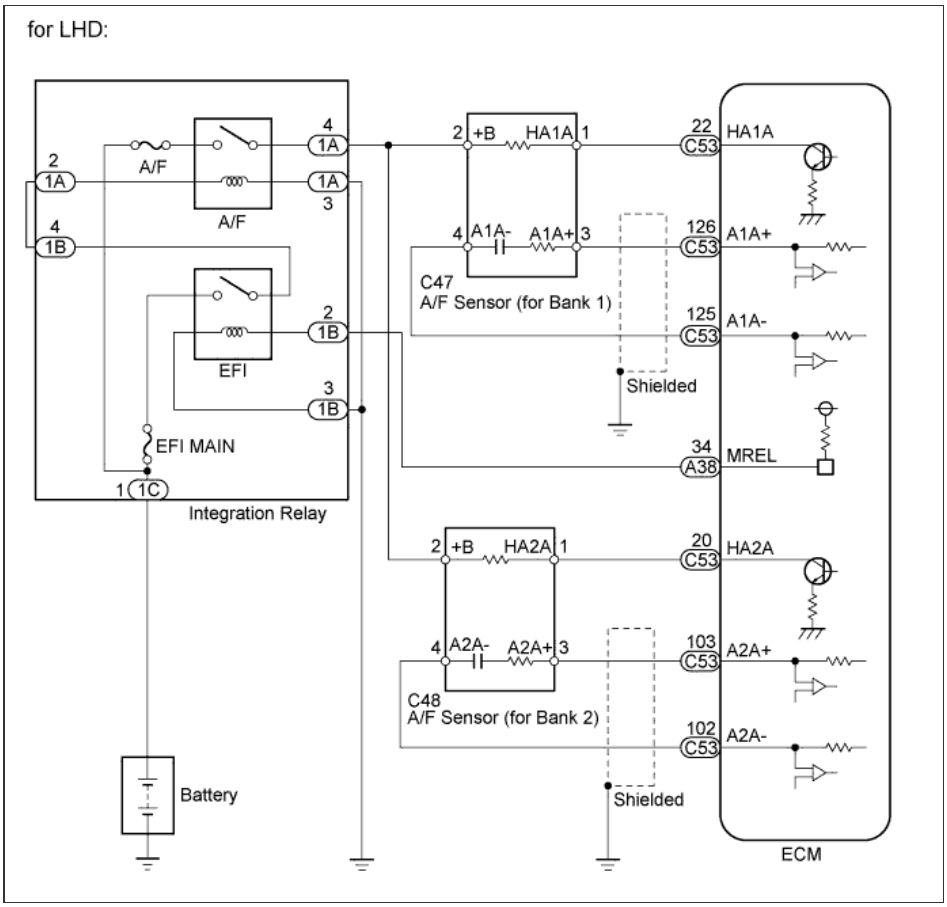
Sensor current detection monitor

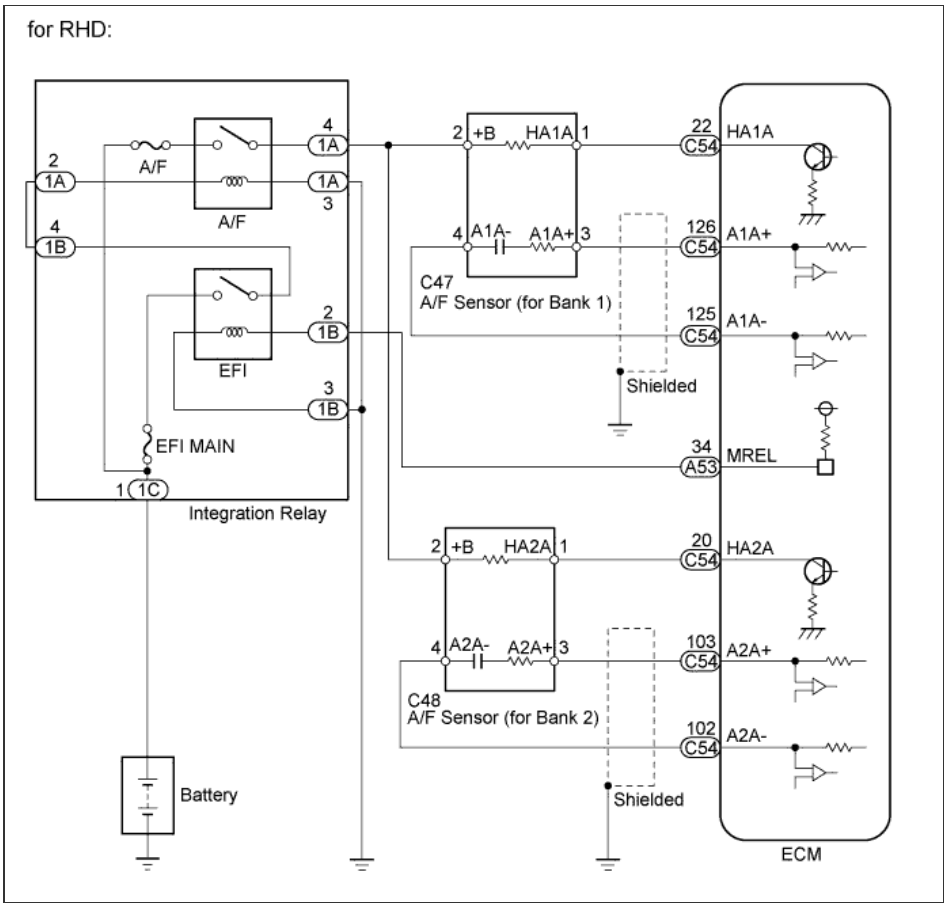
A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or higher for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and stores DTC P2195 or P2197 (high-side stuck). If the A/F sensor output is below 1.4 mA for more than 3 seconds of cumulative time, the ECM stores DTC P2196 or P2198 (low-side stuck).



WIRING DIAGRAM





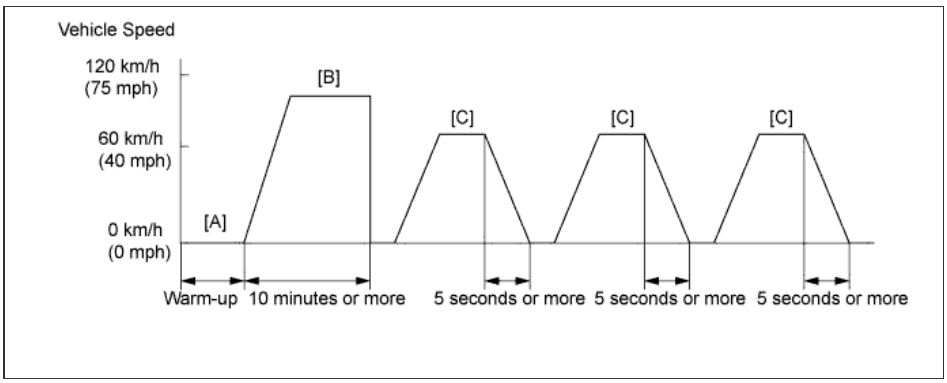
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Start the engine.
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].
6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2195, P2196, P2197 and P2198.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

INSPECTION PROCEDURE

HINT:

- **DTC P2195, P2196, P2197 and P2198 are for Euro-OBD only.**
- **Although the DTC titles say oxygen sensor, these DTCs relate to the Air Fuel ratio (A/F) sensor.**
- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 may be stored when the air-fuel ratio is stuck rich or lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **When viewed from the rear of the engine assembly, Bank 1 is on the right side and Bank 2 is on the left side.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F Sensor function provided in the Active Test. The Control the Injection Volume for A/F Sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F Sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(e) Perform the Control the Injection Volume for A/F Sensor operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

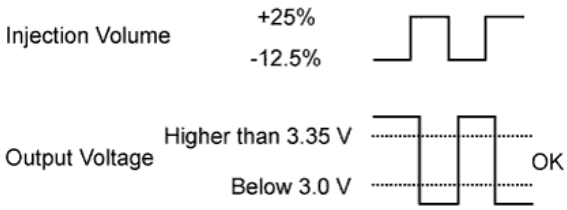
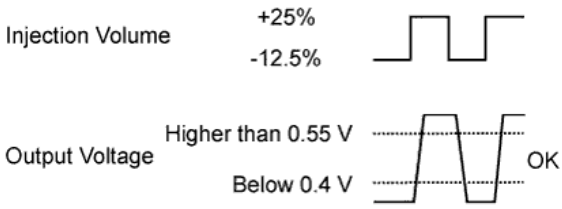
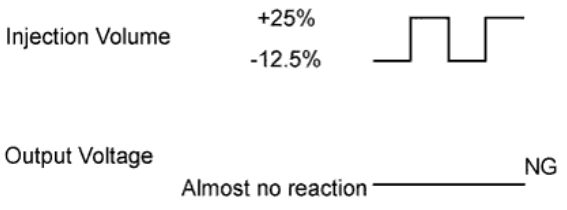
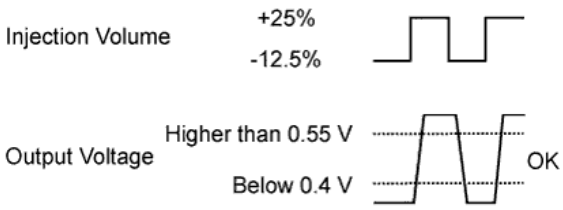
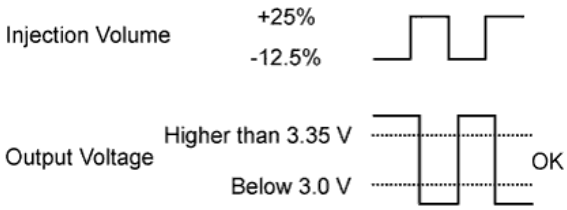
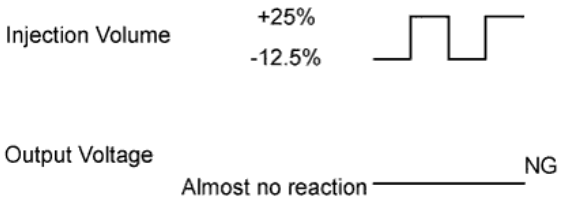
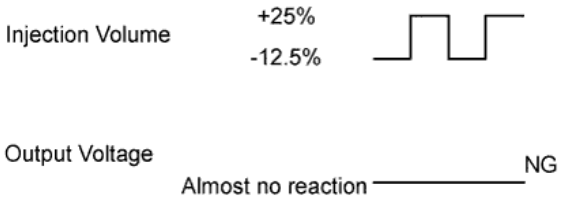
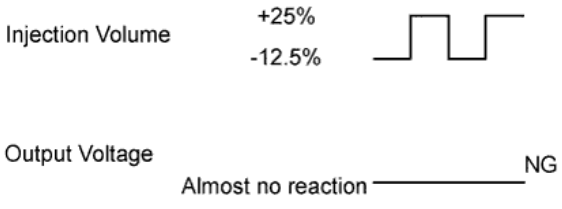
- **The Control the Injection Volume for A/F Sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **The sensors react in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor (for Sensor 2) output has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
P2195, P2196, P2197 or P2198 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (Click here)**

A

2.READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the vehicle to drive in accordance with the drive pattern described in the Confirmation Driving Pattern.

f. Enter the following menus: Powertrain / Engine and ECT / Data List / Monitor Status.

g. Check that the status of O2S (A/FS) Monitor is Complete.
If the status is still Incomplete, drive the vehicle according to the driving pattern again.

HINT:

- **Complete indicates that the component is functioning normally.**
- **Incomplete indicates that the component is malfunctioning.**

h. Enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / AFS B1 S1 or AFS B2 S1.

i. Check the test value of the A/F sensor output current during fuel cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or higher, and below 3.6 mA)	A
Outside normal range (Below 1.4 mA, or 3.6 mA or higher)	B

B → Go to step 20

A

3.READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Start the engine.

c. Turn the tester on.

d. Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.

e. On the tester, enter the following menus: Powertrain / Engine and ECT / Data List / A/F Control System / Snapshot / AFS B1 S1 or AFS B2 S1 and Engine Speed.

f. Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:

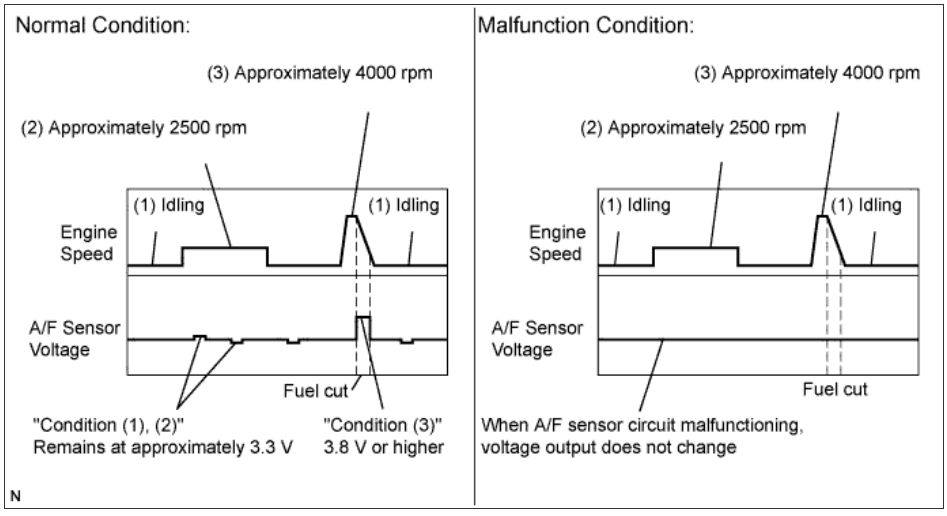
(1) While idling (check for at least 30 seconds).
(2) At an engine speed of approximately 2500 rpm (without any sudden changes in engine speed).
(3) Raise the engine speed to 4000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

Standard Voltage:

Condition	A/F Sensor Voltage Variation	Reference
(1) and (2)	Remains at approximately 3.3 V	3.1 V to 3.5 V
(3)	Increases to 3.8 V or higher	This occurs during engine deceleration (when fuel cut performed)

HINT:

- **For more information, see the diagrams below.**



- **If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, the**

A/F sensor may have an open circuit (this will also happen if the A/F sensor heater has an open circuit).

- If the output voltage of the A/F sensor remains at either approximately 3.8 V or higher, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven at more than 16 km/h (10 mph) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

NG → Go to step 10

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
P2195, P2196, P2197 or P2198 is output	A
No DTC is output	B

B → END

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

9.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK FOR INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

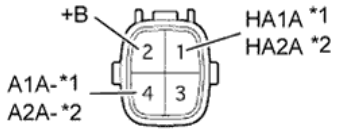
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected:
(A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

11.INSPECT INTEGRATION NO.1 RELAY (A/F)

a. Remove the integration relay from the engine room relay block.

b. Inspect the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

iii. Reinstall the A/F fuse.

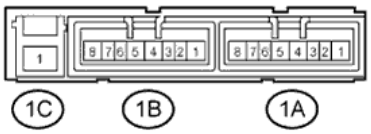
c. Inspect the integration relay (A/F).

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	No battery voltage applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage applied to terminals 1A-2 and 1A-3	Below 1 Ω

Component without harness connected:
(Integration Relay)



NG → REPLACE INTEGRATION NO.1 RELAY (A/F)

OK

12.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

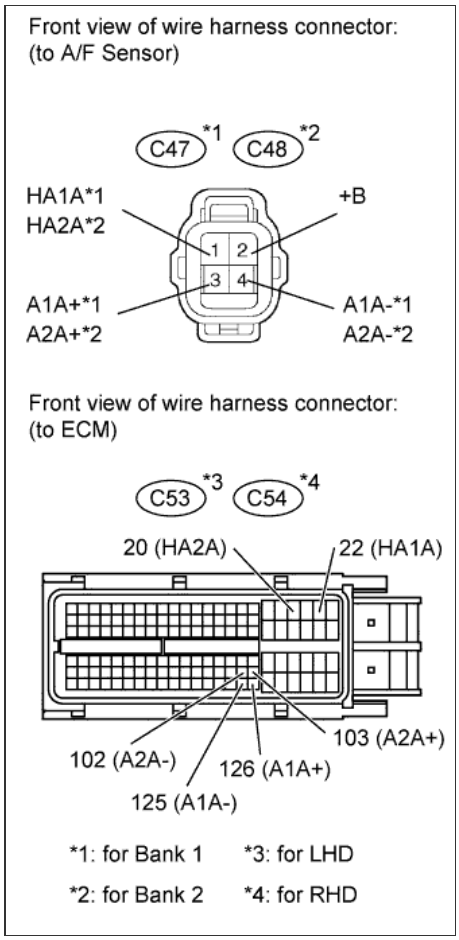
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

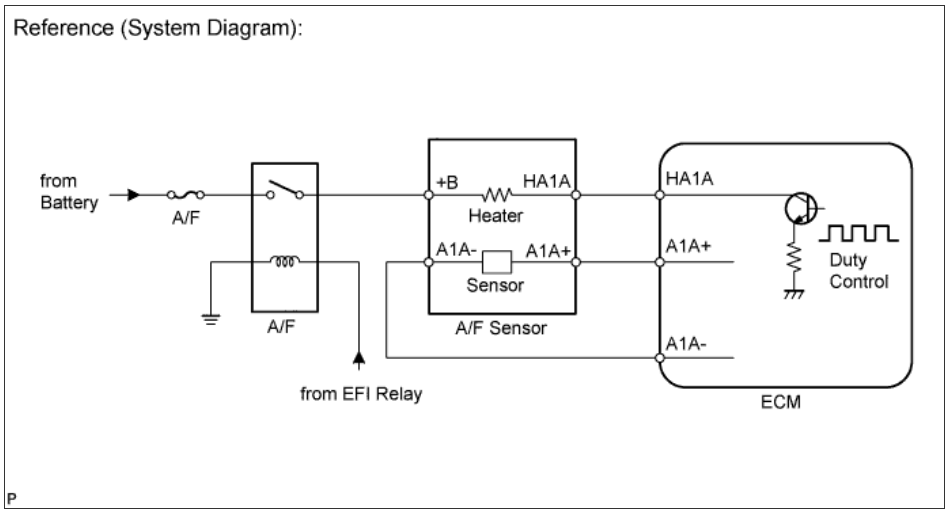
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω

C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

13.CHECK AIR INDUCTION SYSTEM

a. Check the air induction system for vacuum leakage (Click here).

OK:

No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (**Click here**)

OK

14.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

15.INSPECT FUEL INJECTOR ASSEMBLY

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (**Click here**)

OK

16.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

17.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18.CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN (Click here)

A

19.CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → CHECK INTERMITTENT PROBLEMS (Click here)

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

21.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22.CHECK WHETHER DTC OUTPUT RECURS

a. Read DTCs using the intelligent tester.

b. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

c. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2195, P2196, P2197 or P2198 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

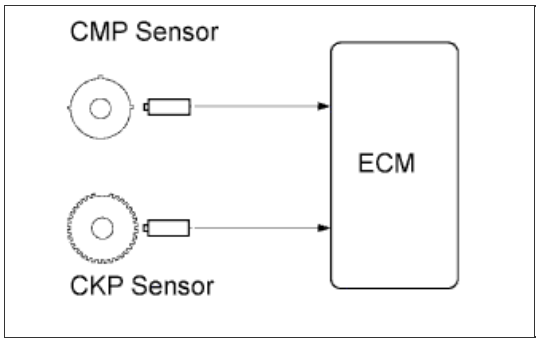
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

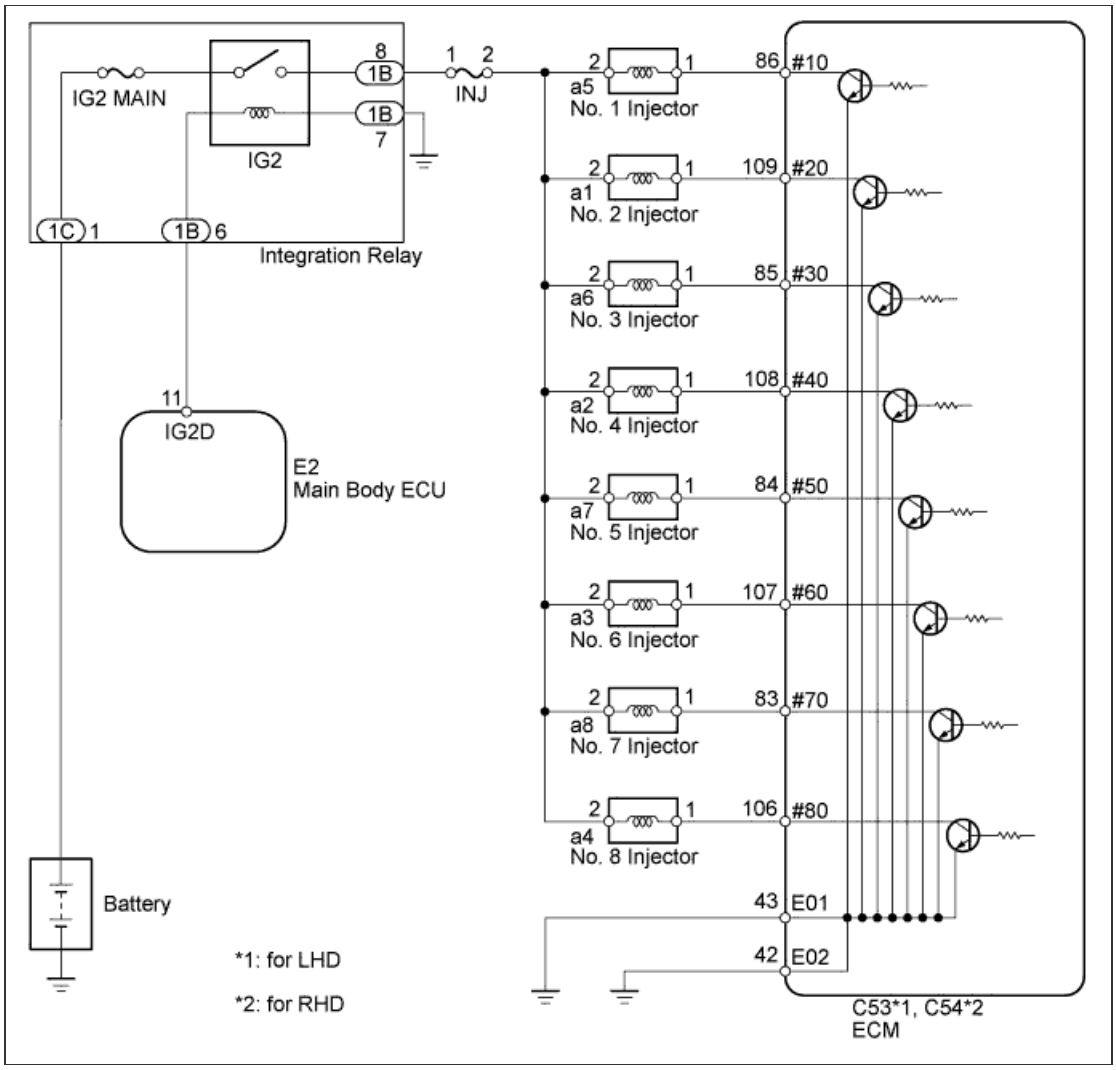
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

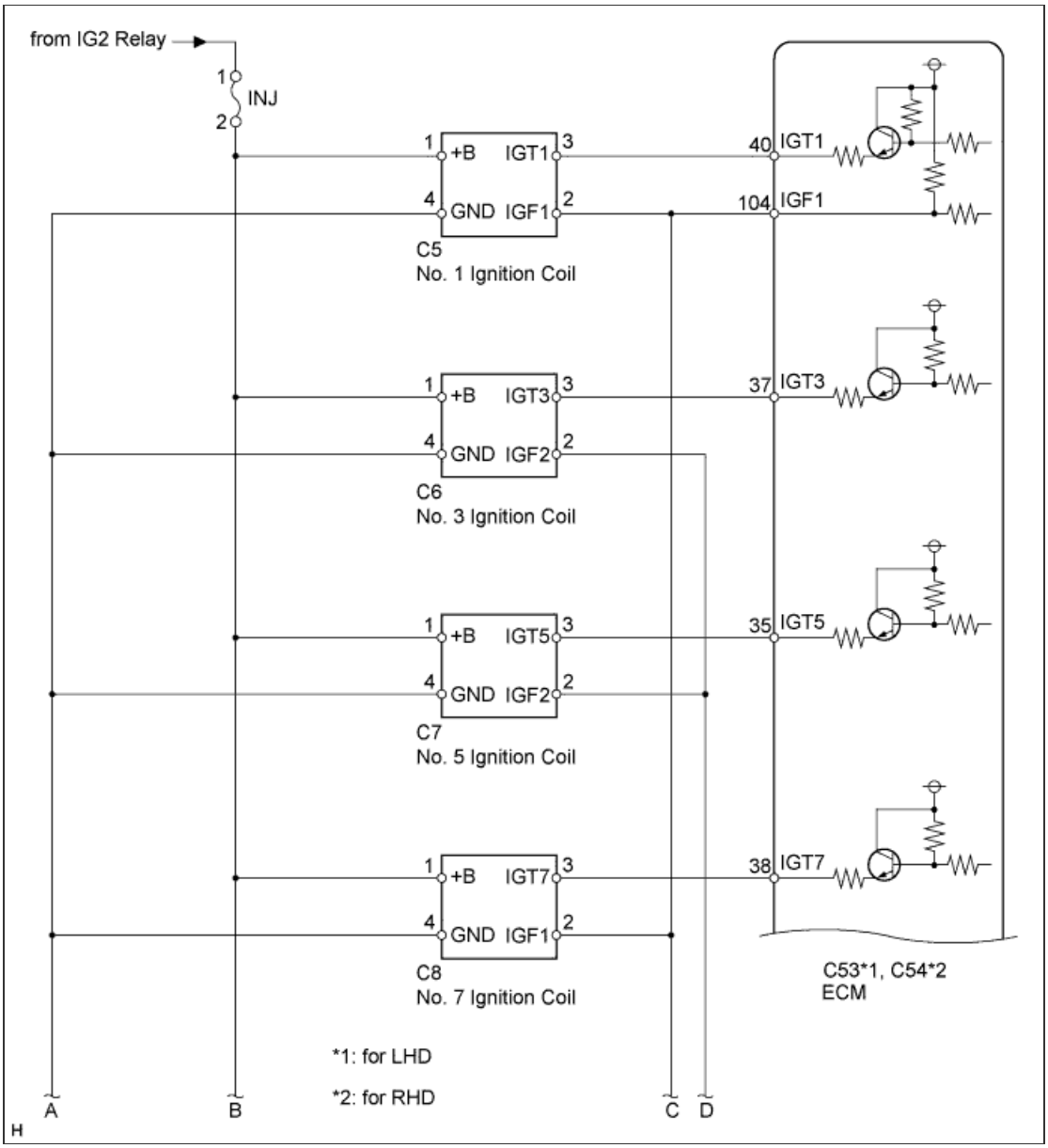
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

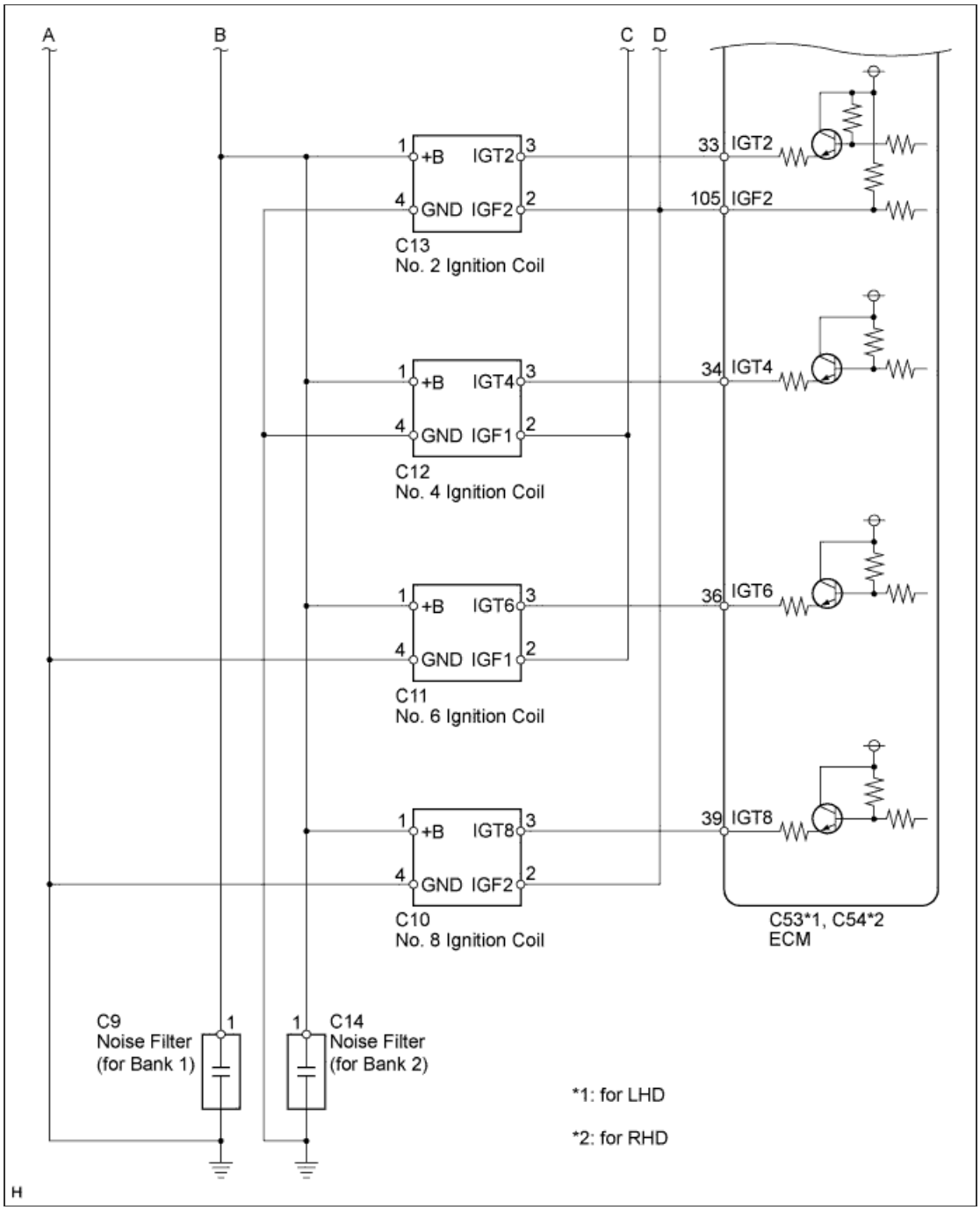
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

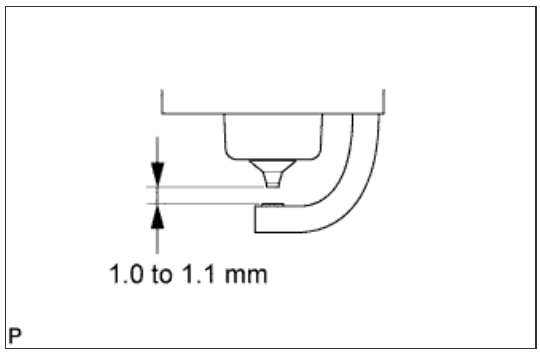
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

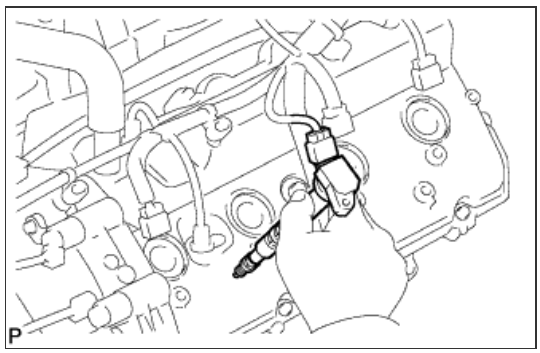
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

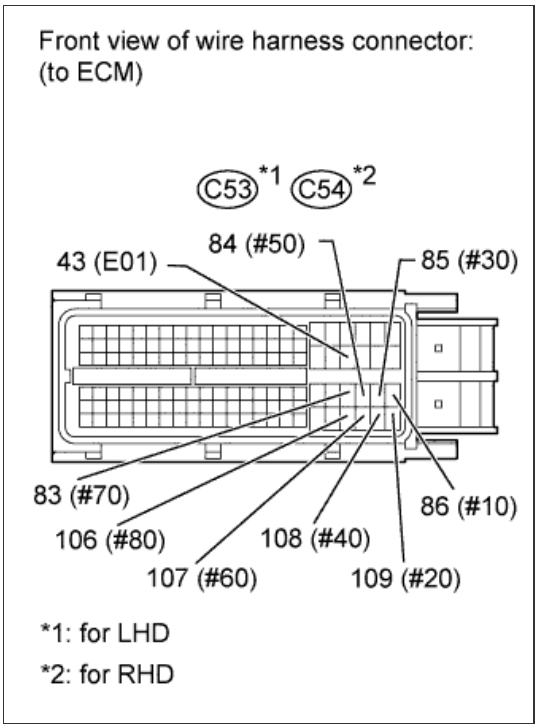
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

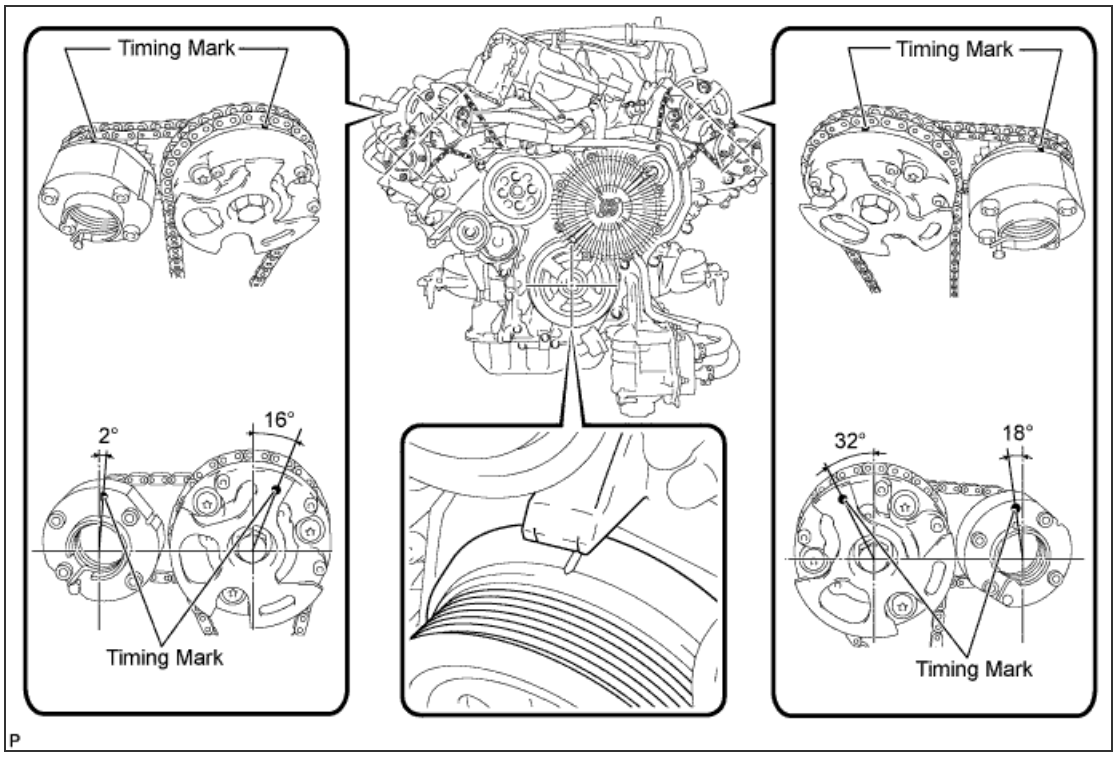
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

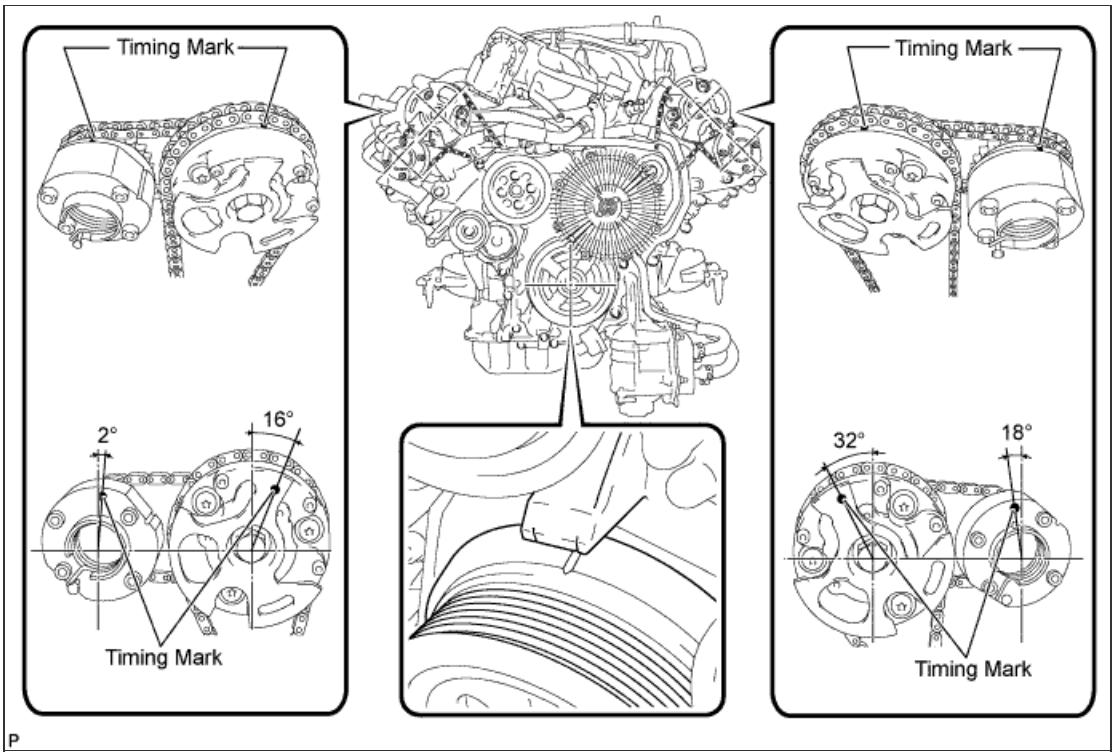
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

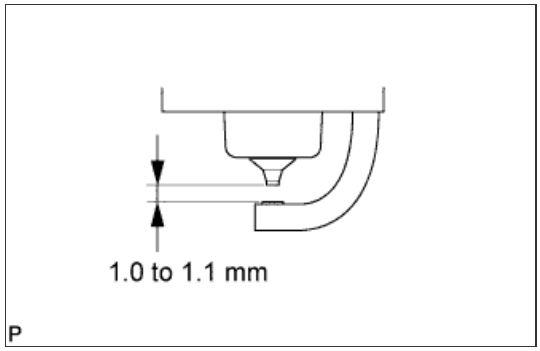
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

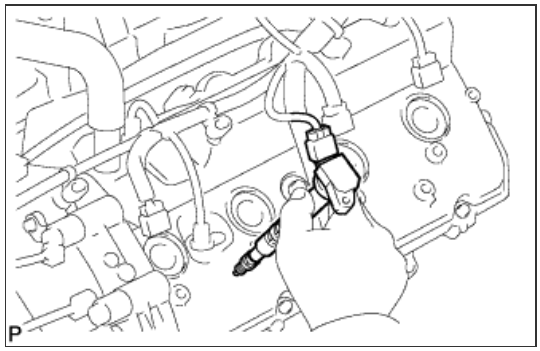
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

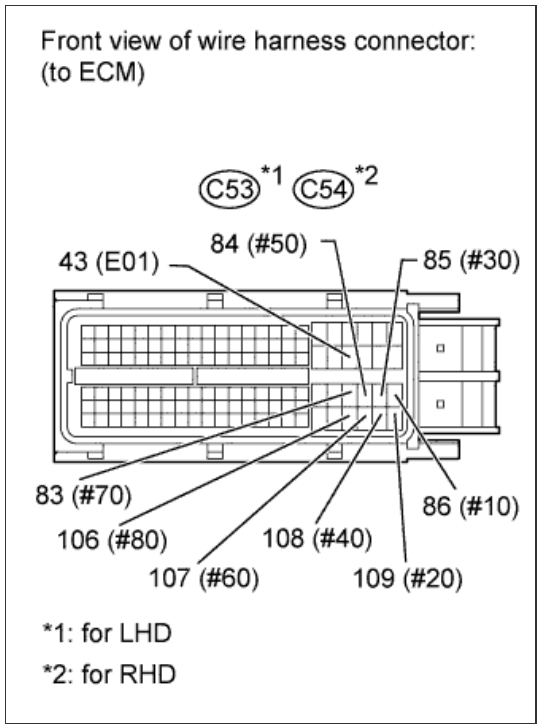
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

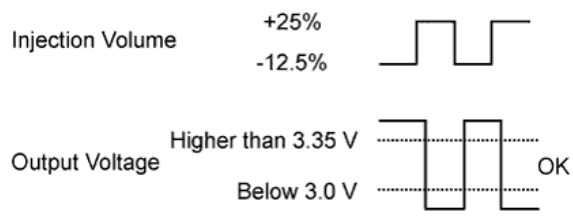
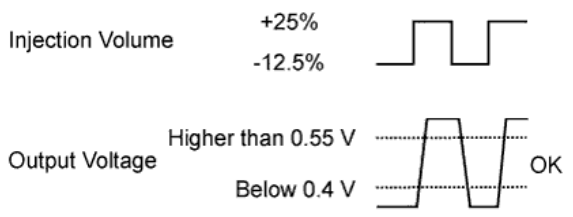
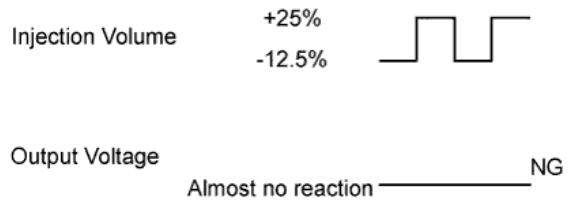
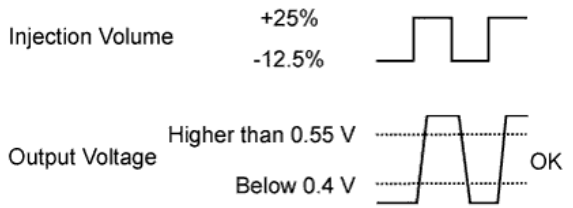
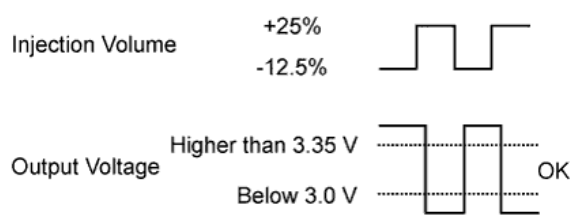
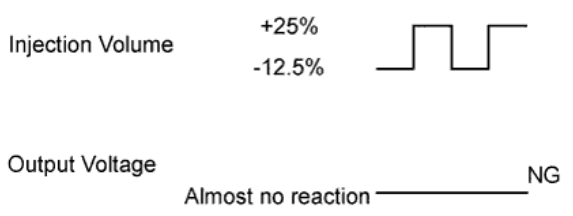
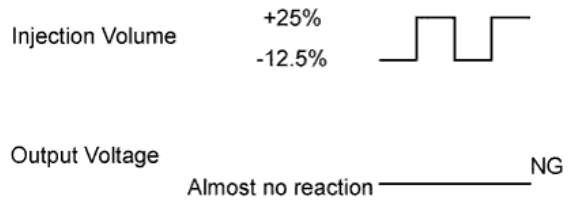
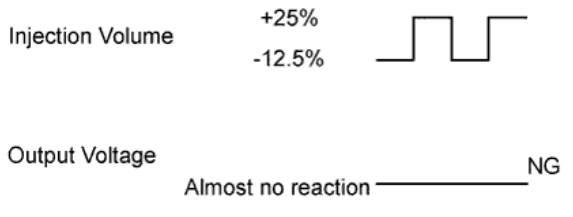
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

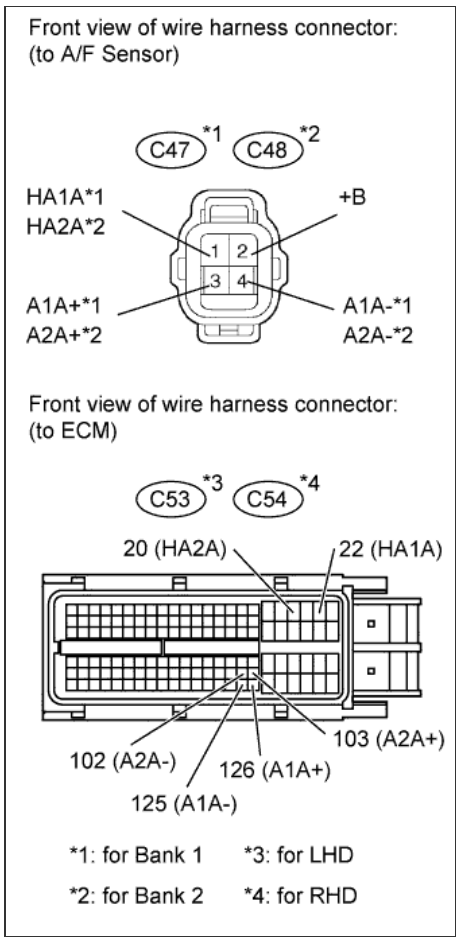
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

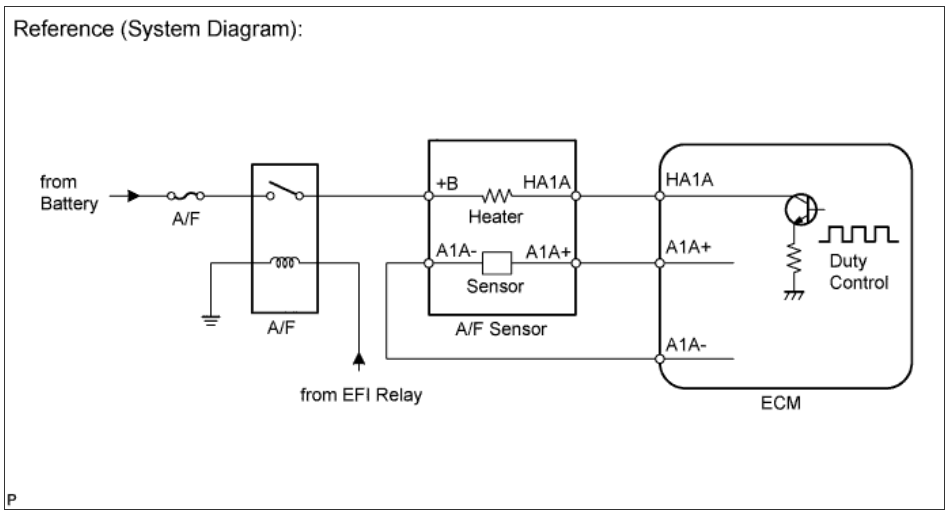
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

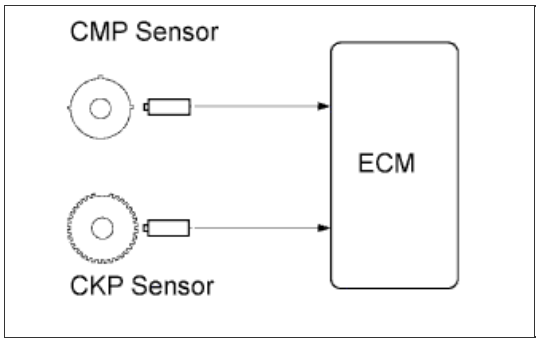
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

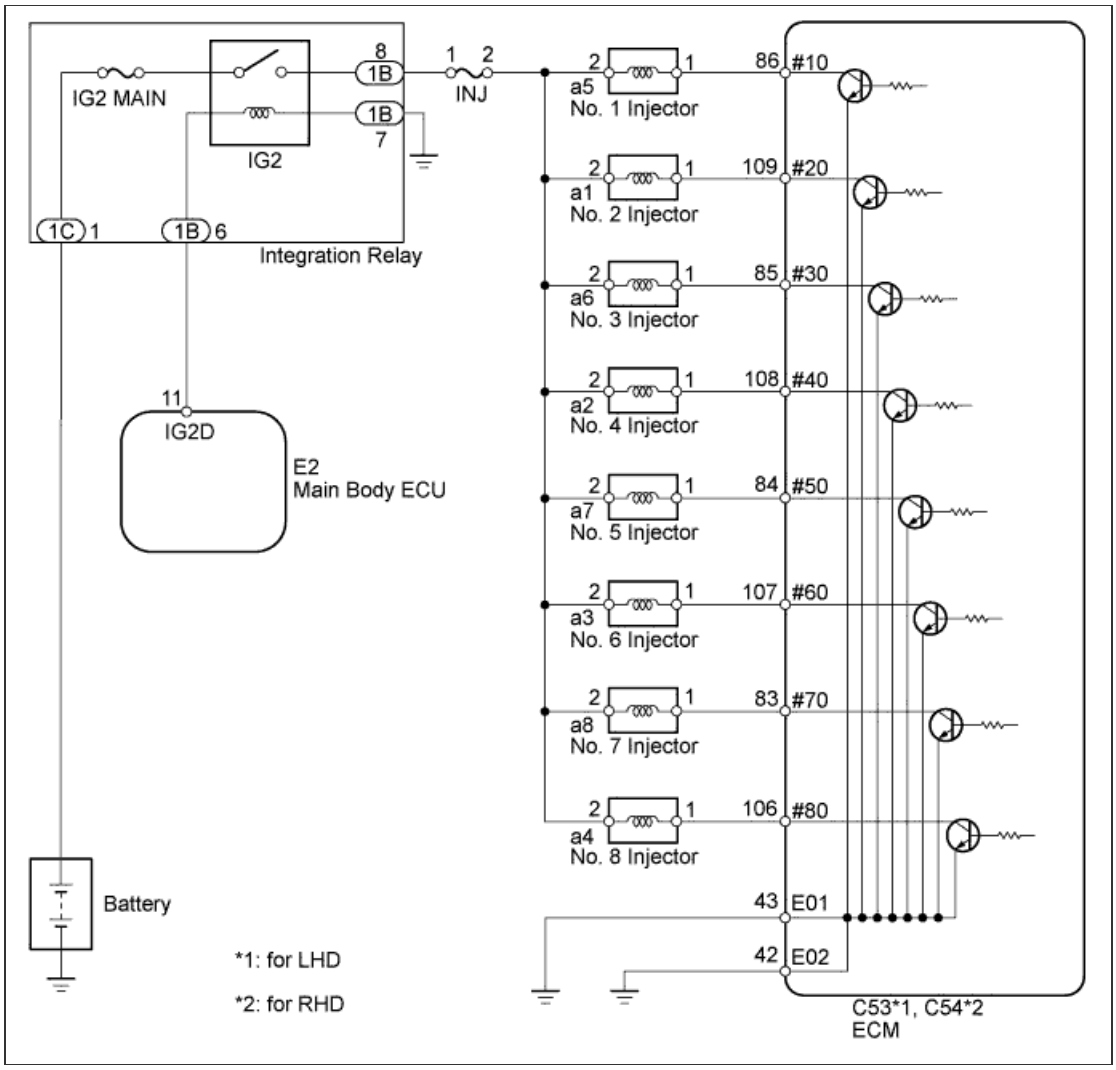
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

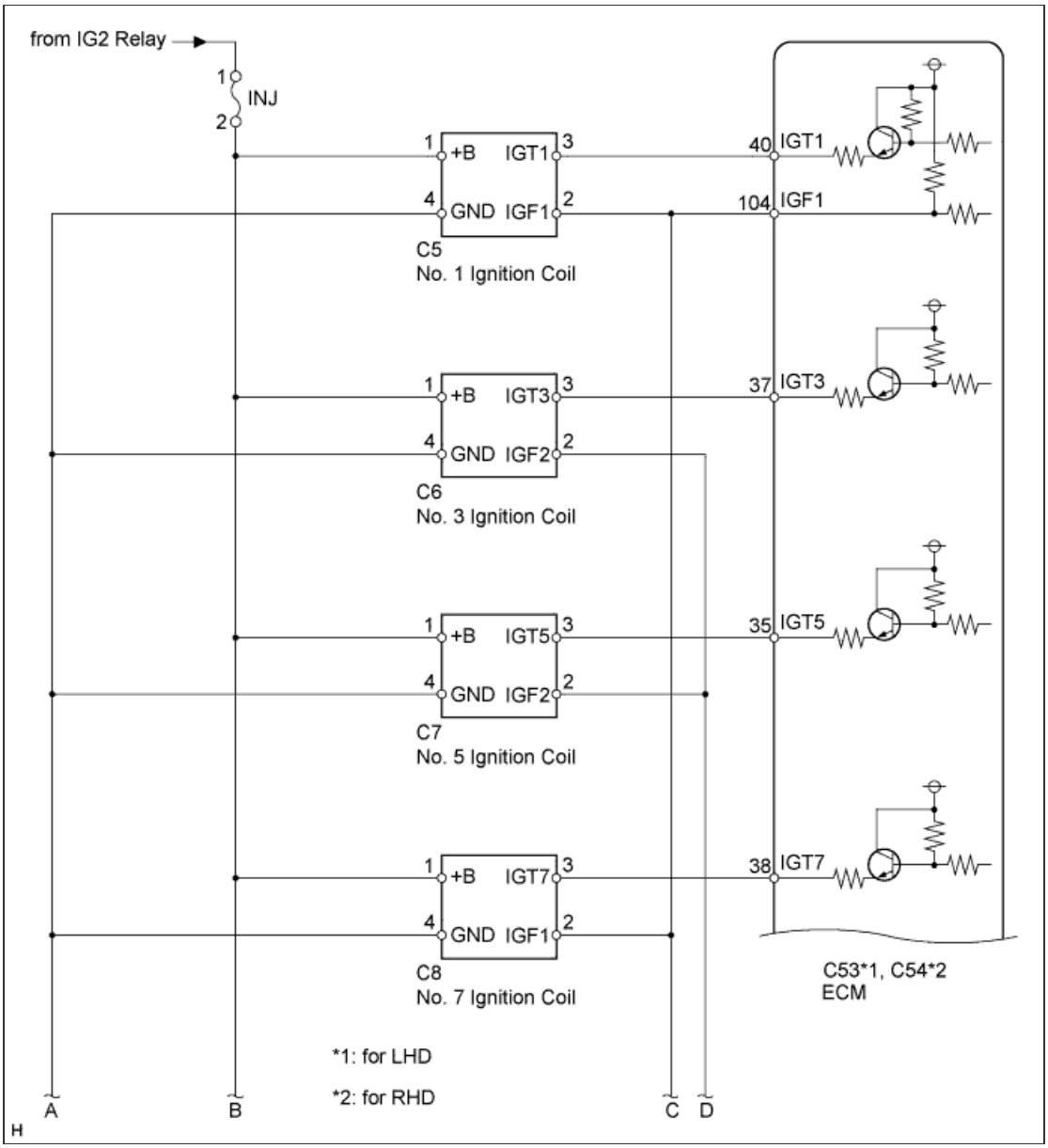
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

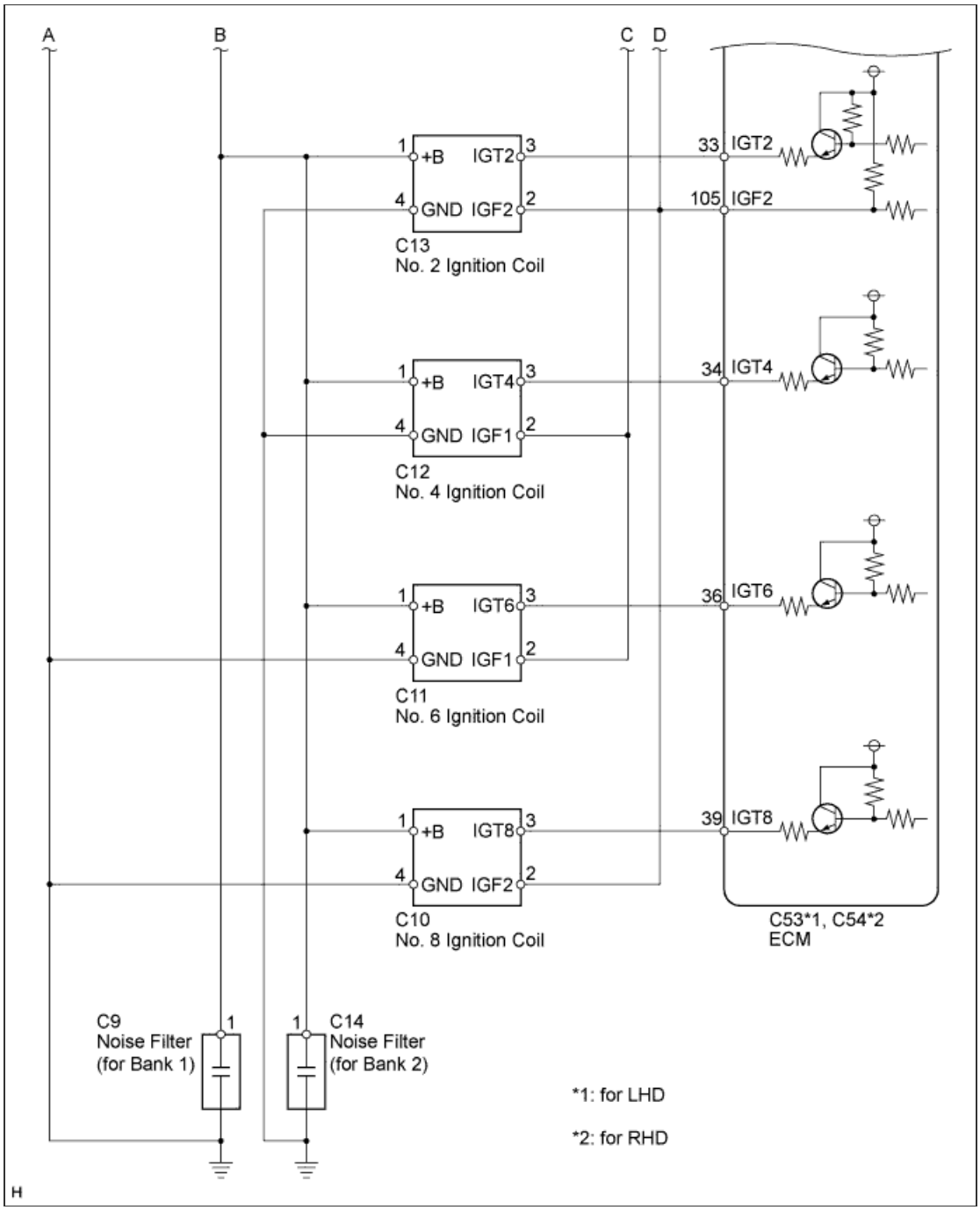
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

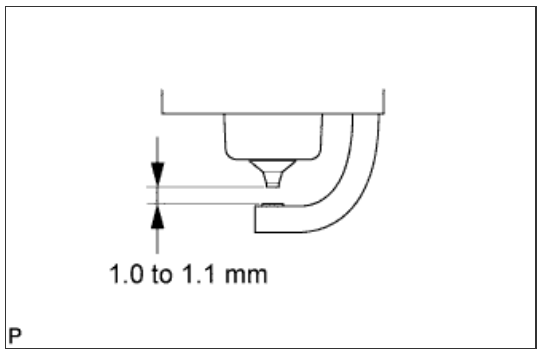
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

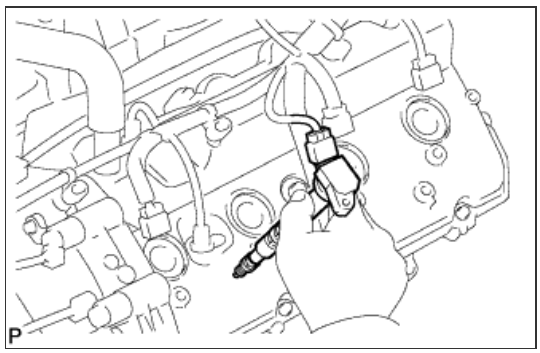
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

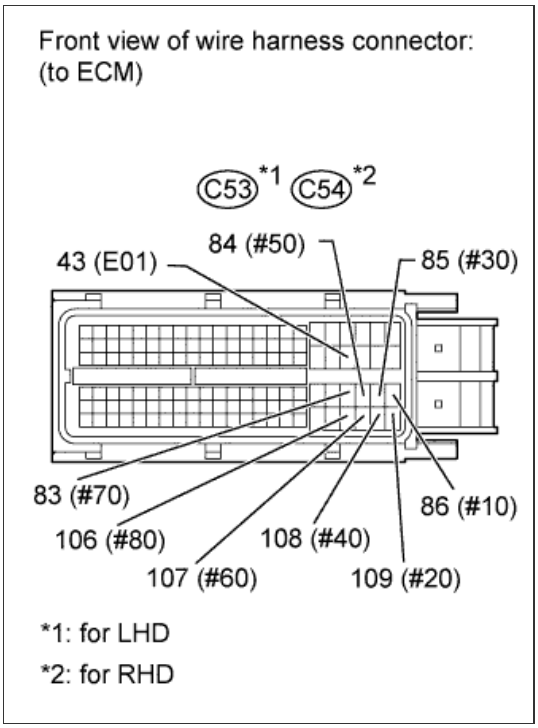
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

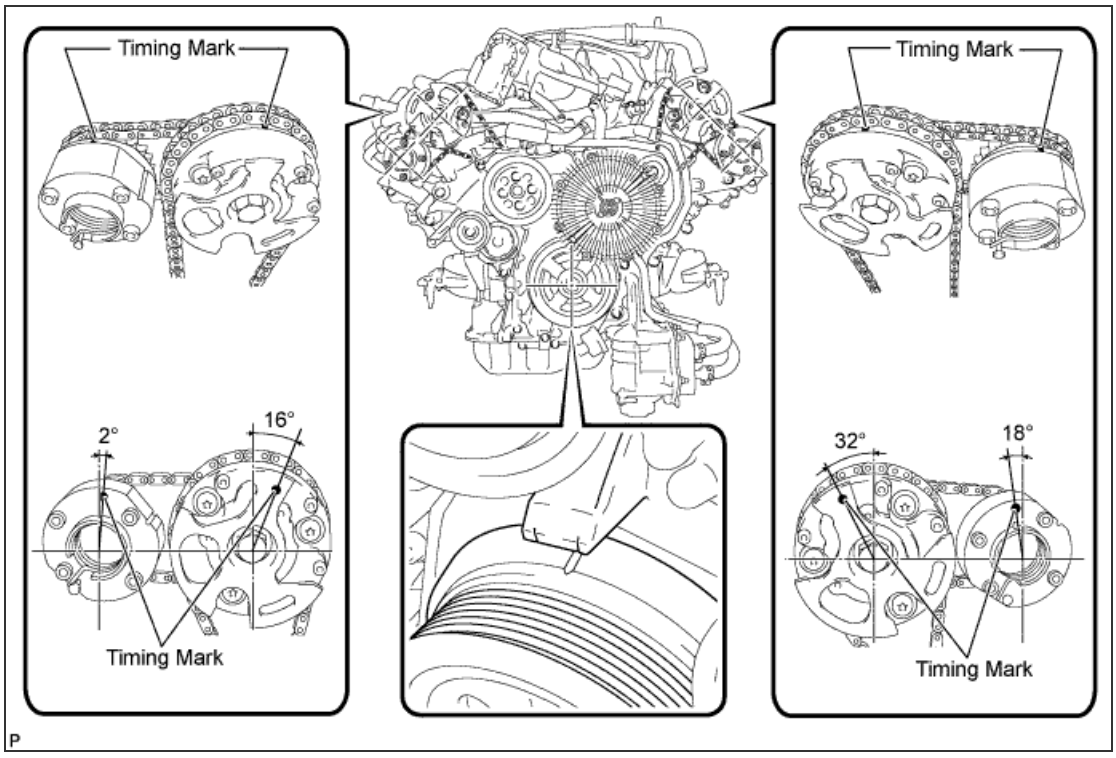
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

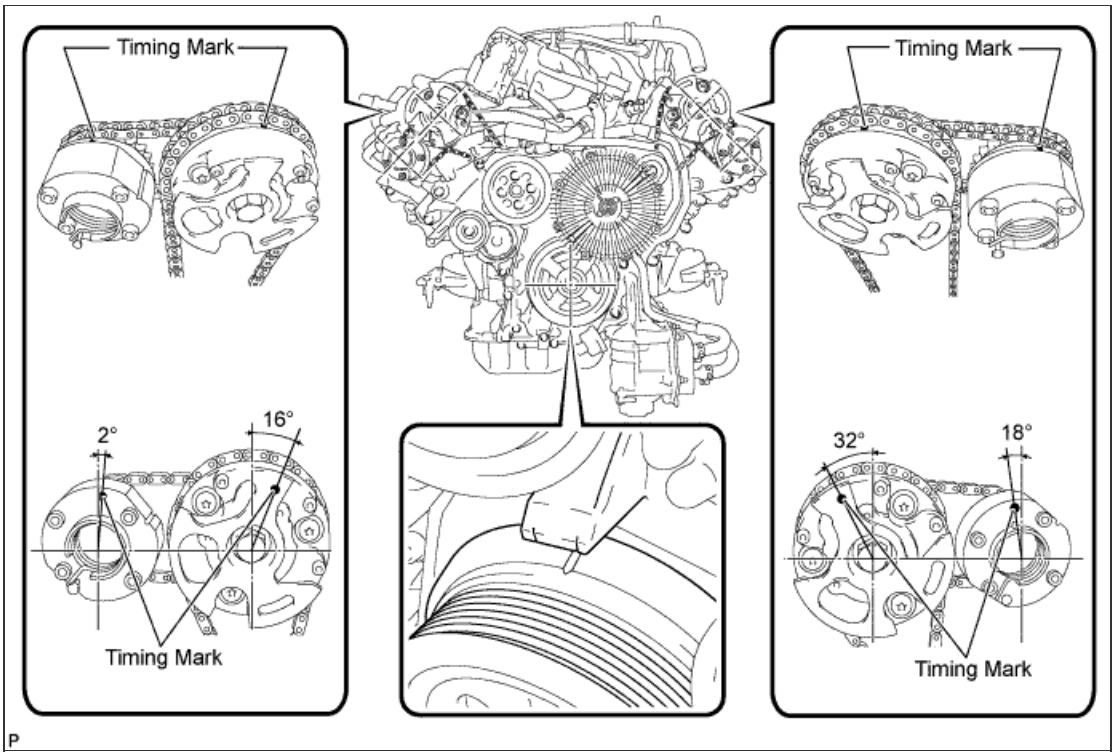
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

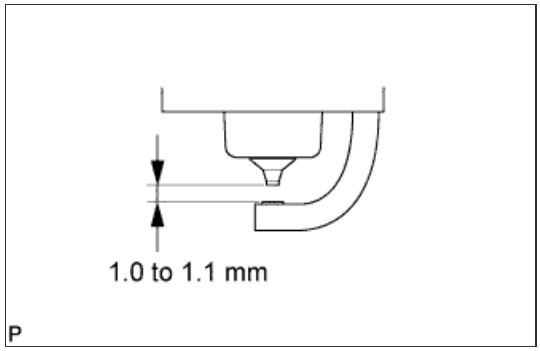
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

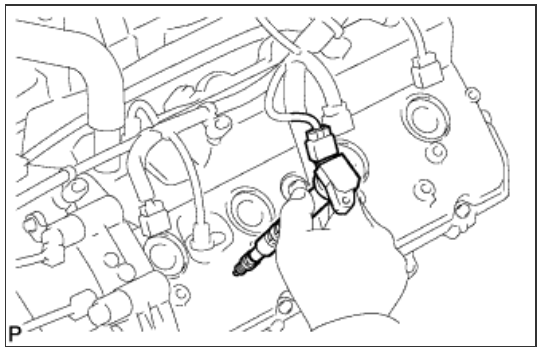
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

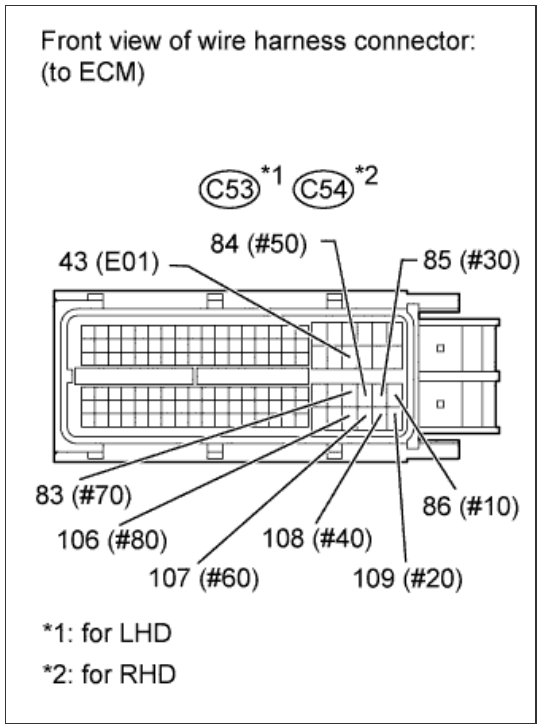
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

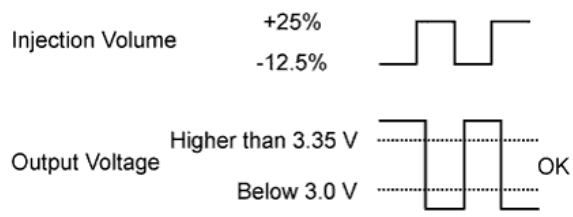
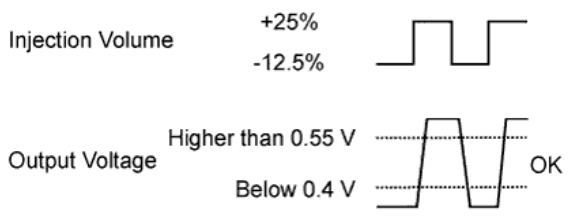
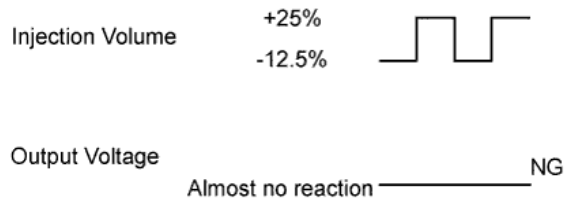
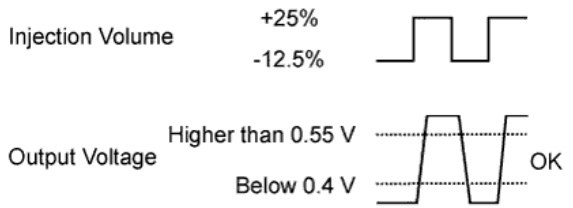
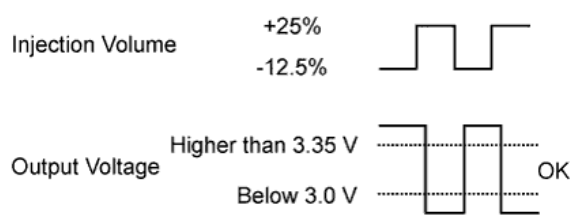
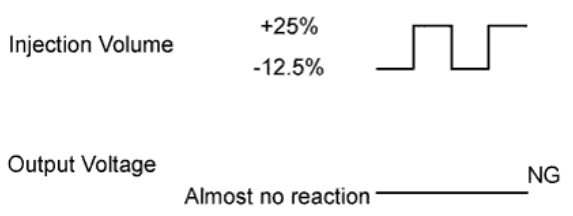
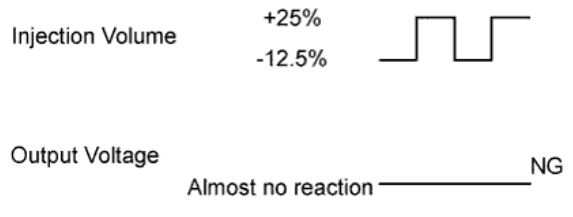
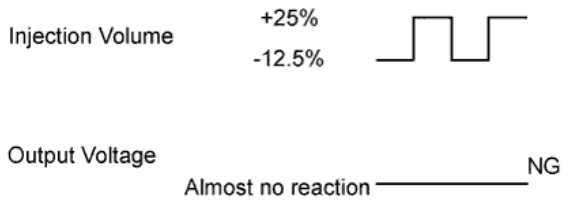
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

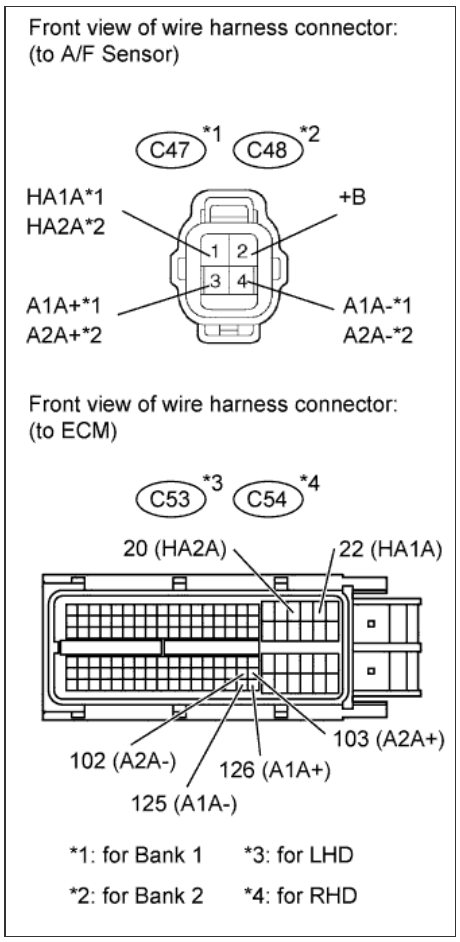
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

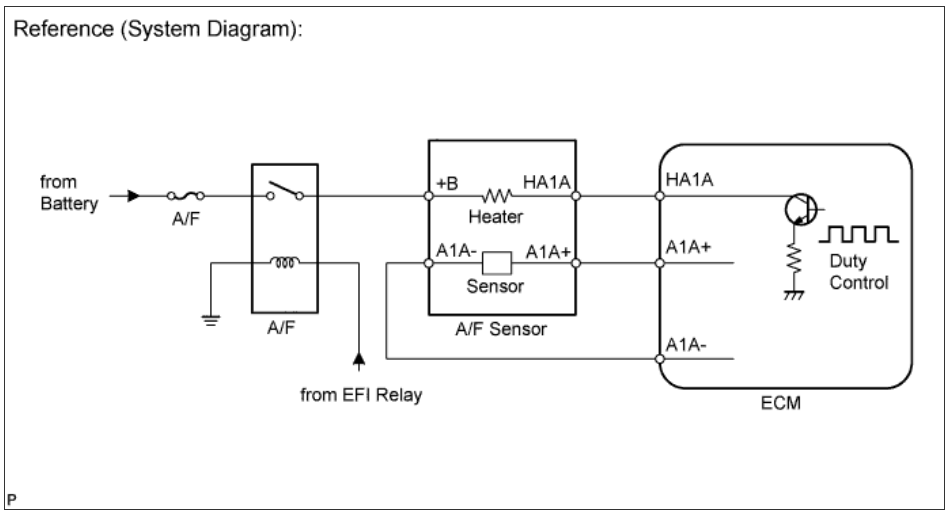
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

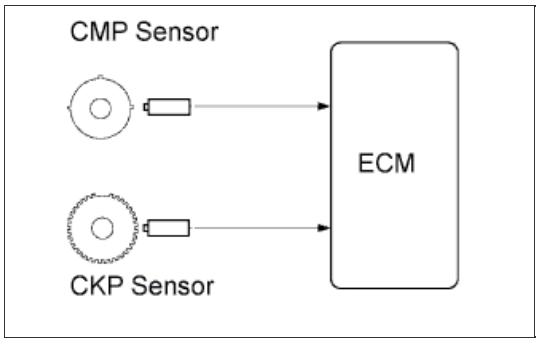
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

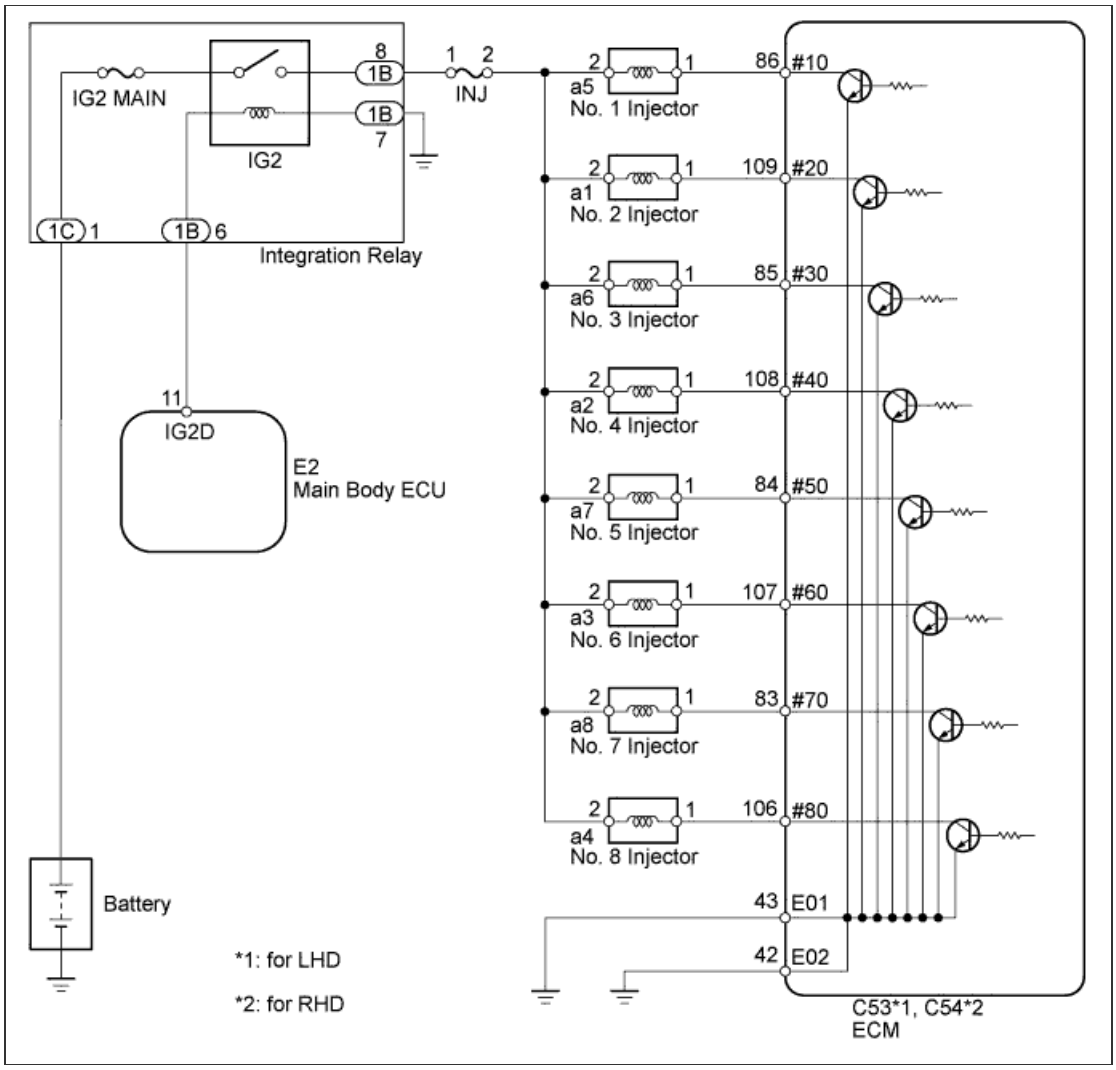
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

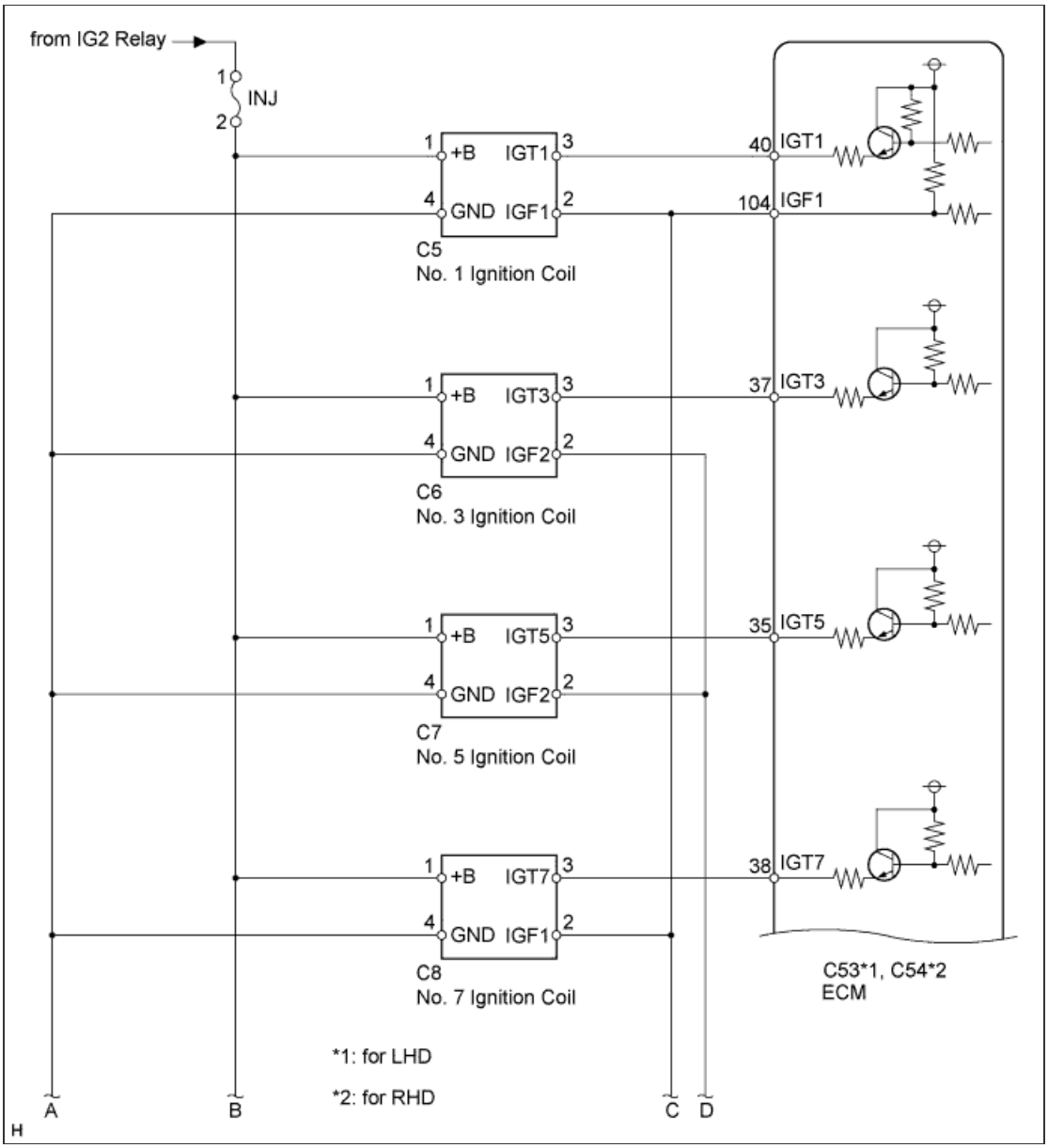
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

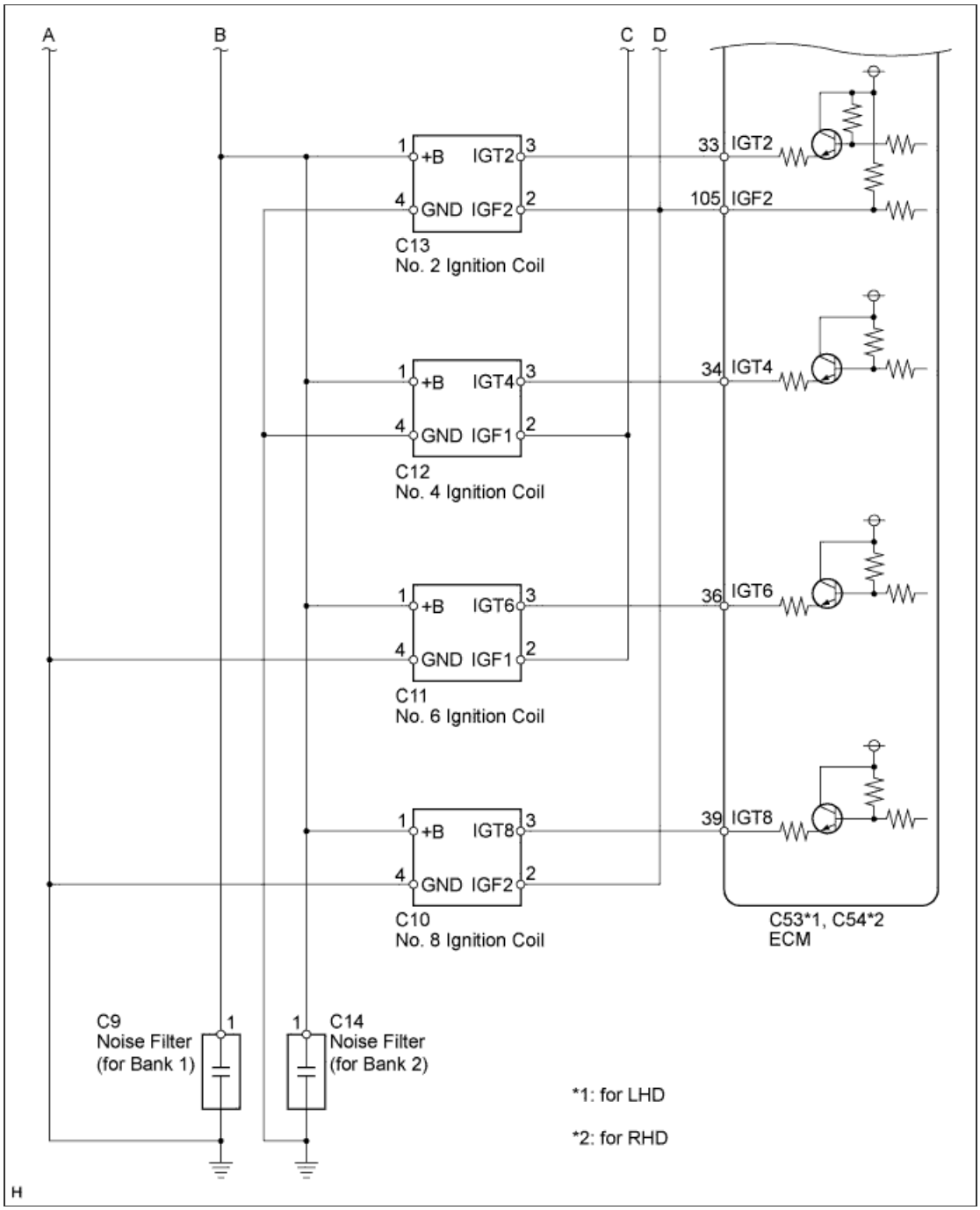
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

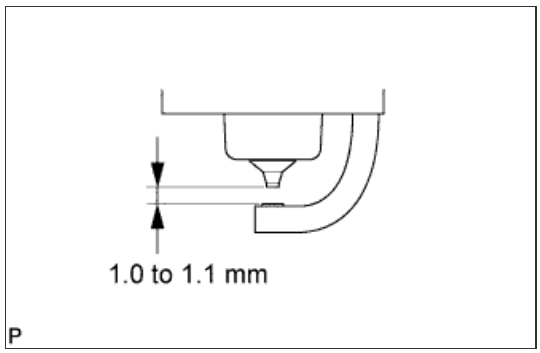
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

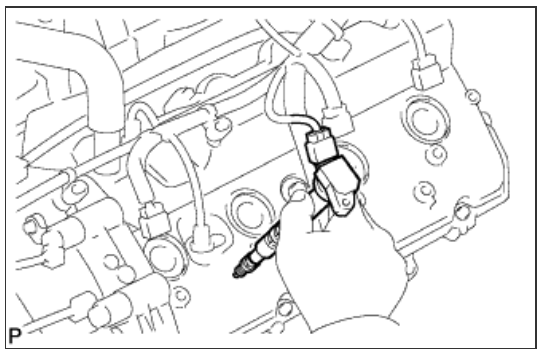
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

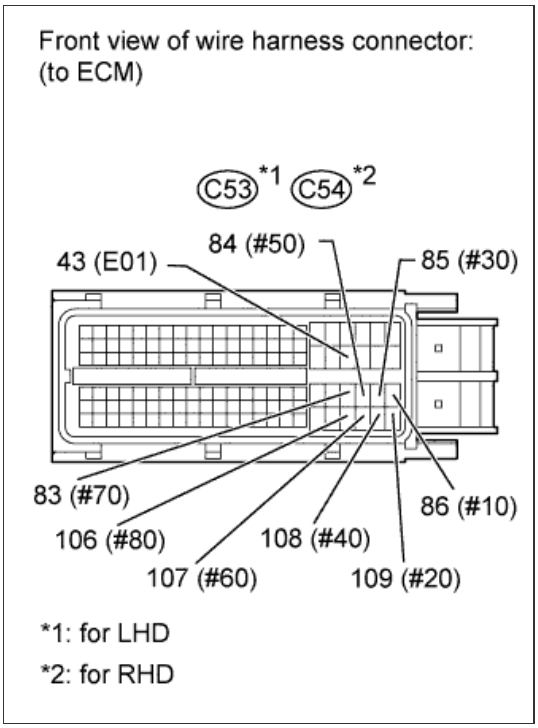
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

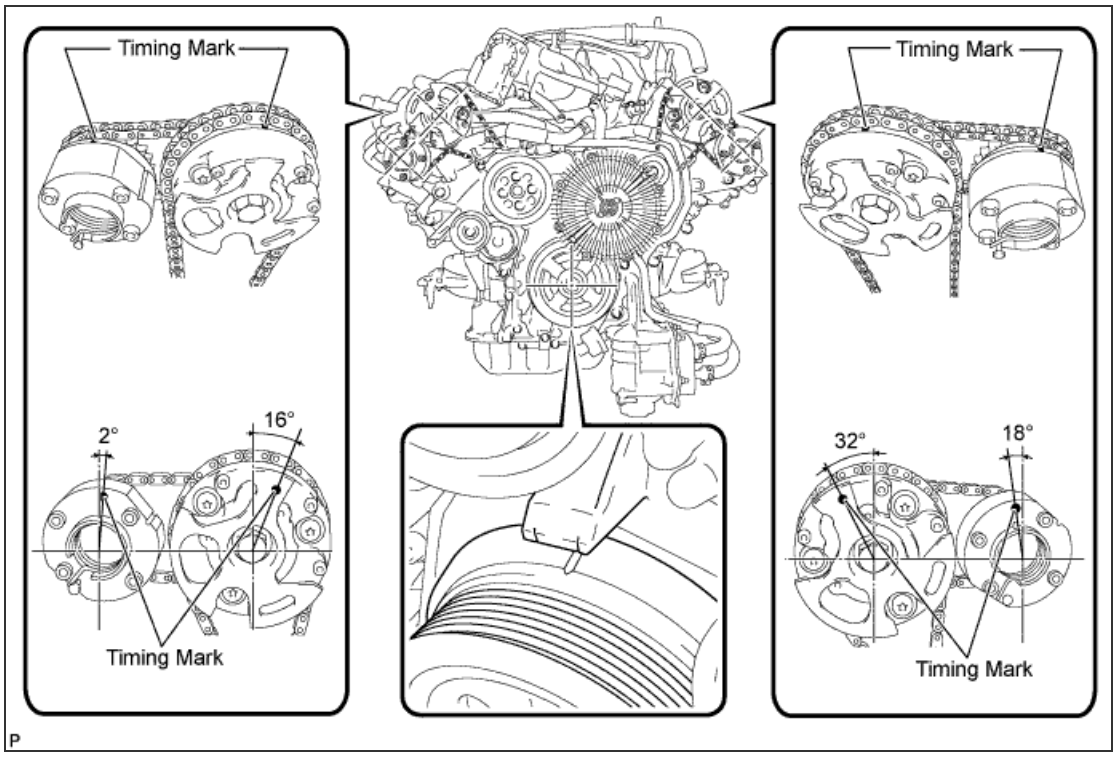
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

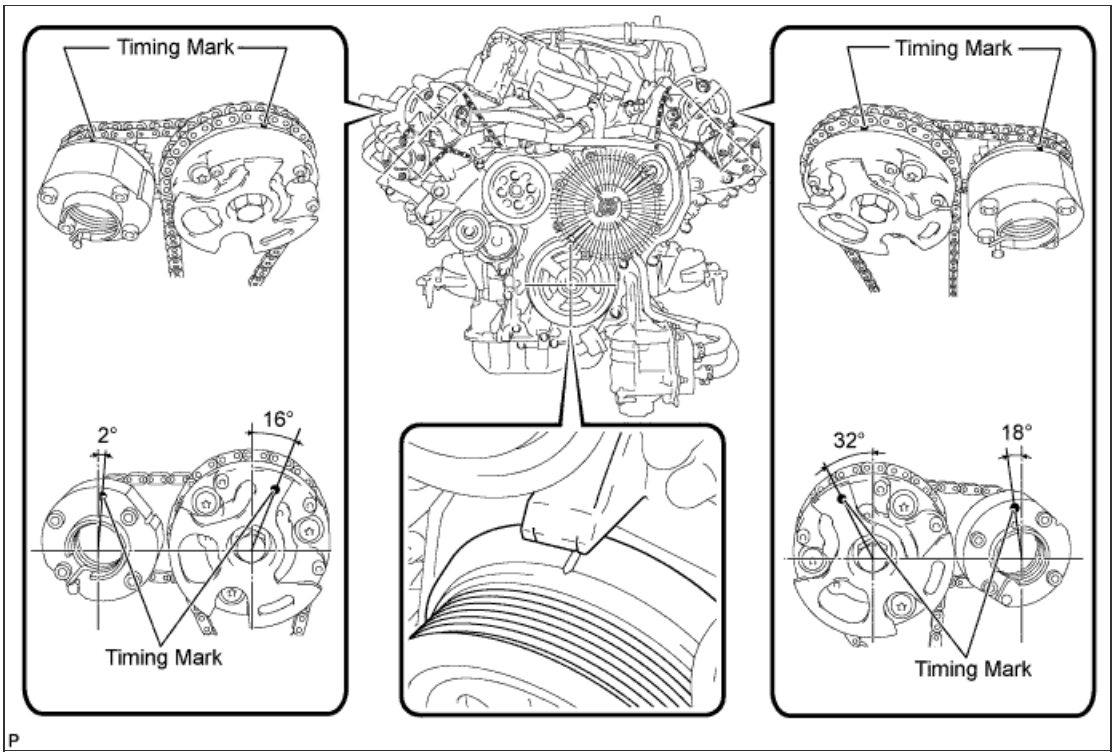
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

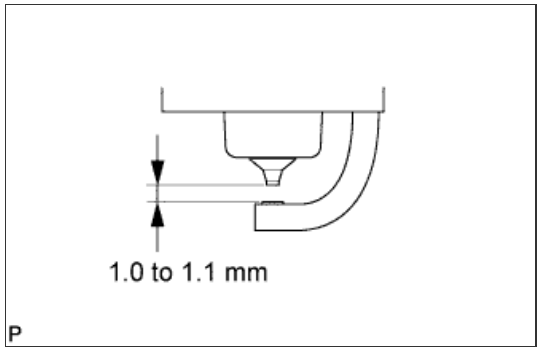
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

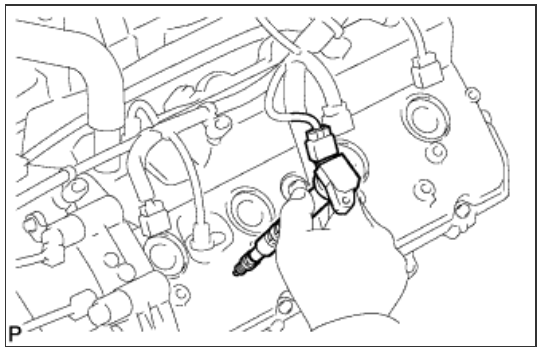
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

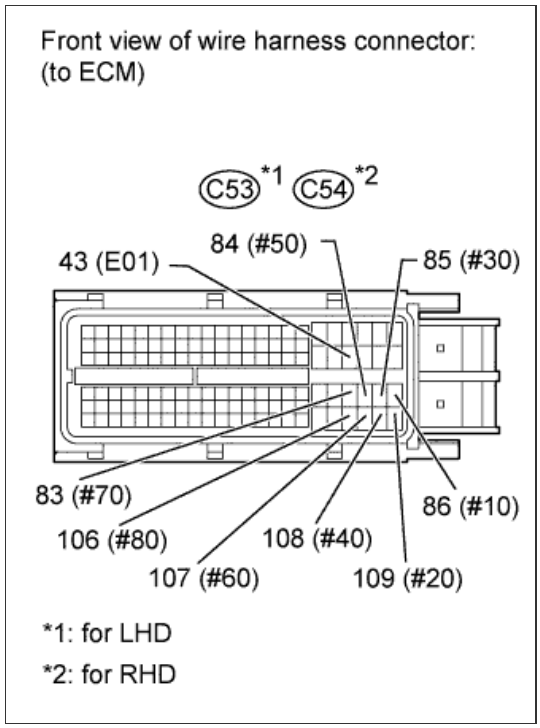
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

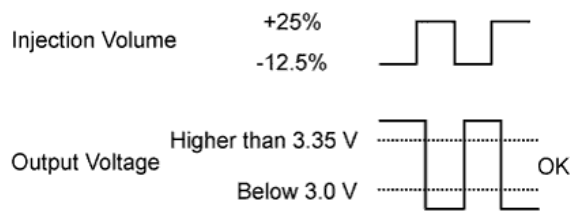
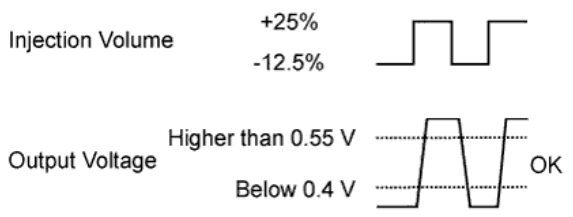
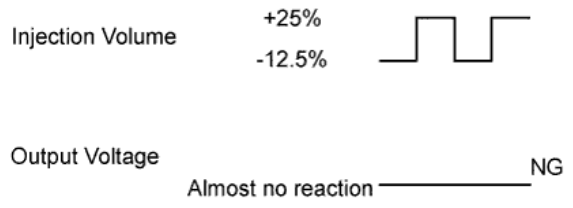
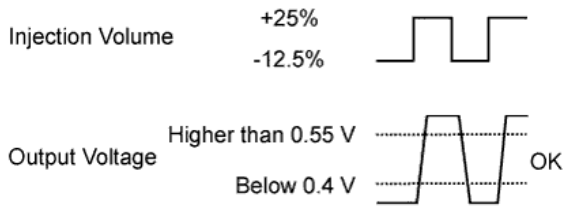
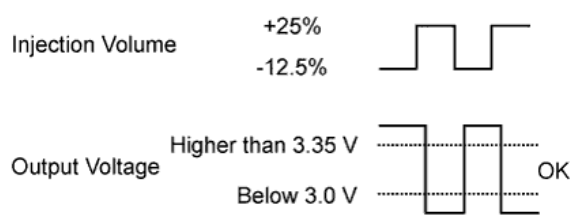
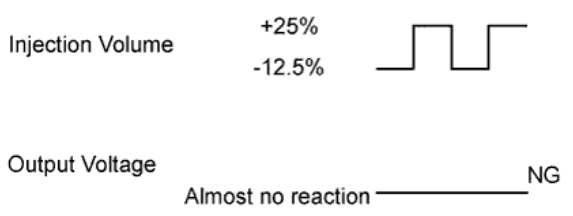
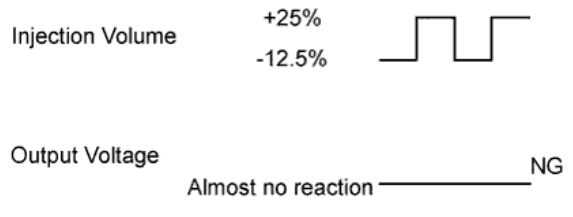
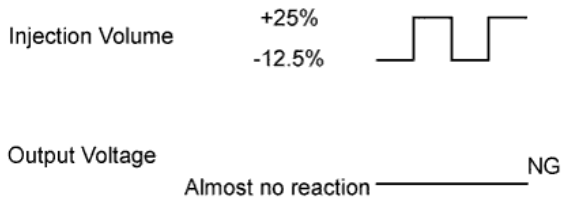
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

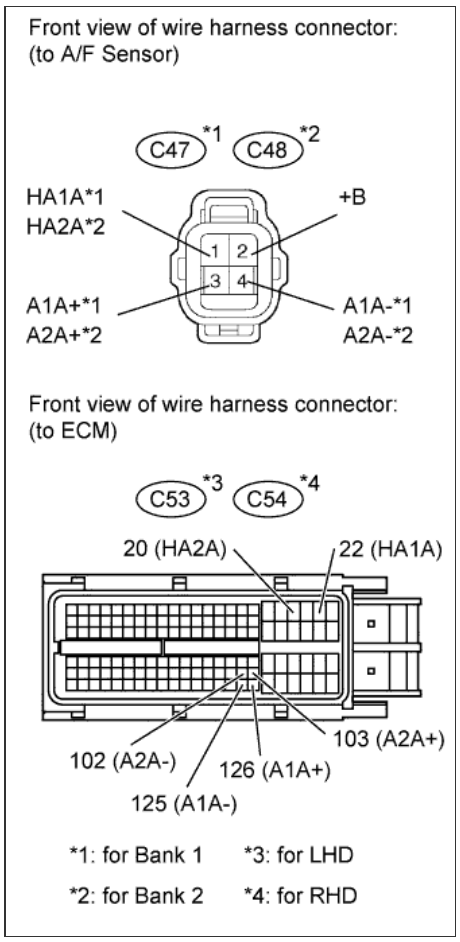
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

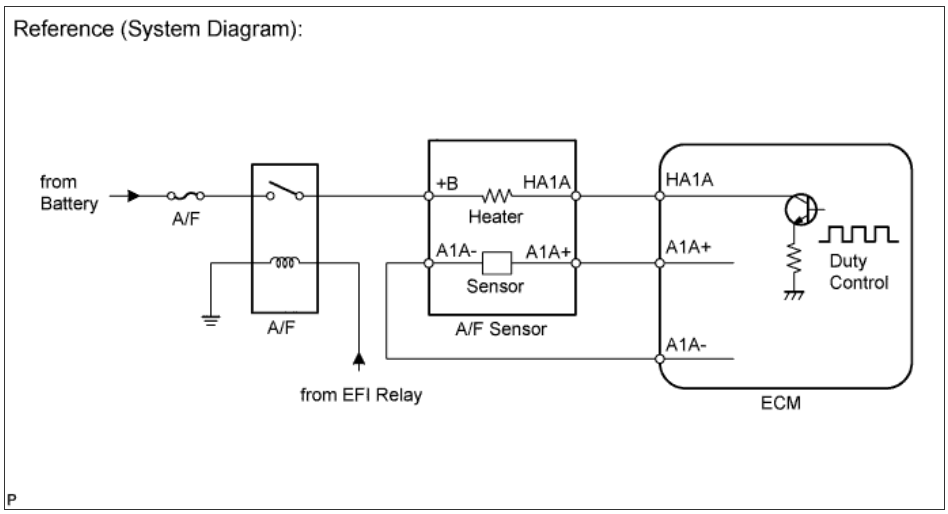
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

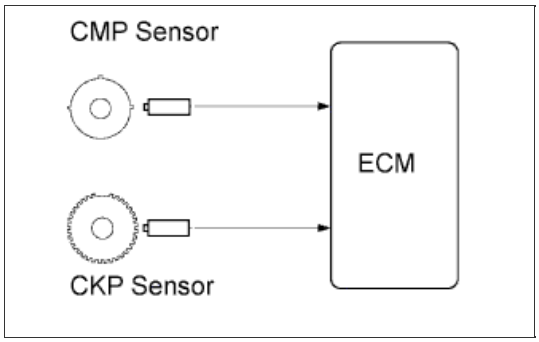
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

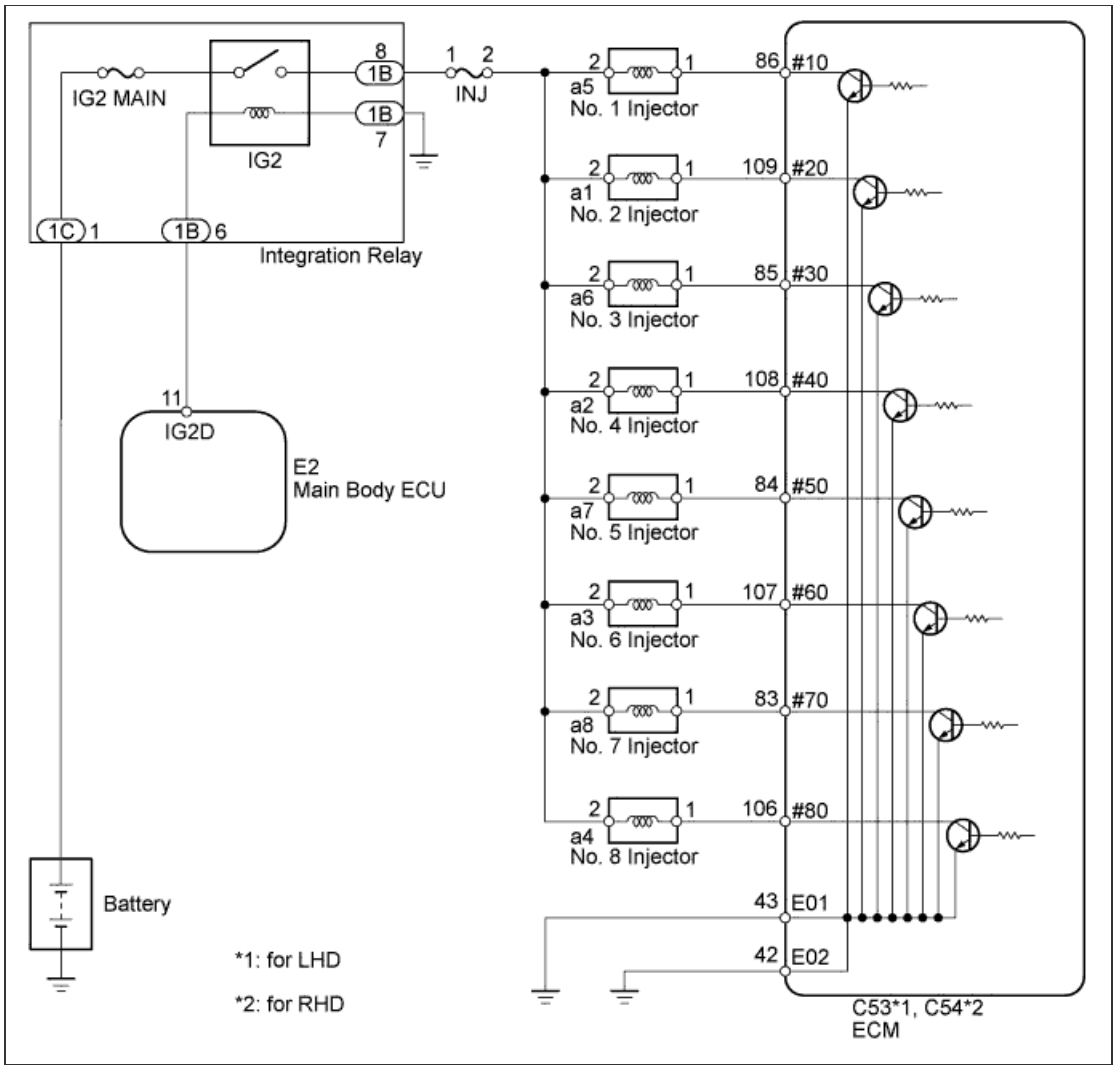
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

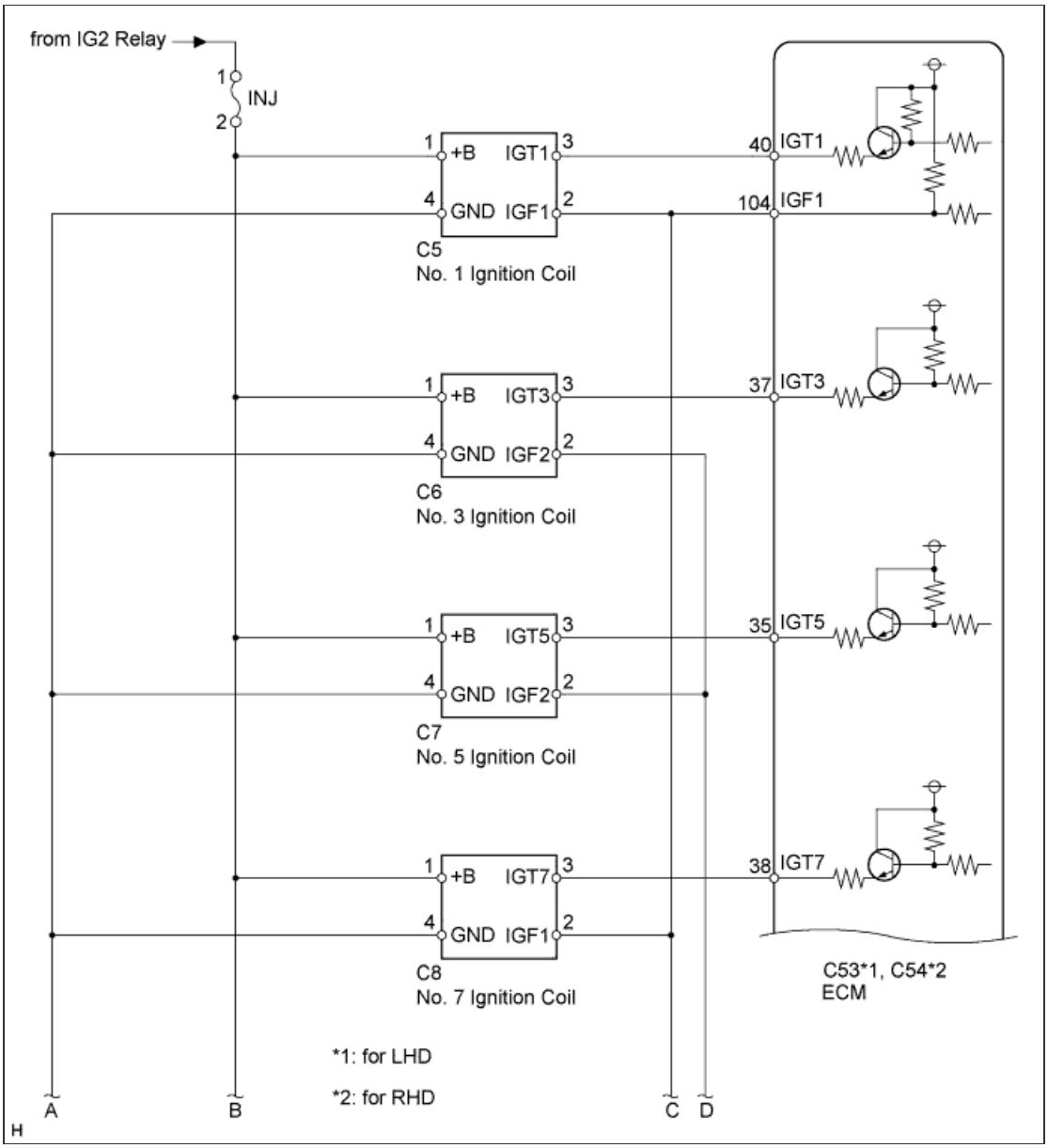
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

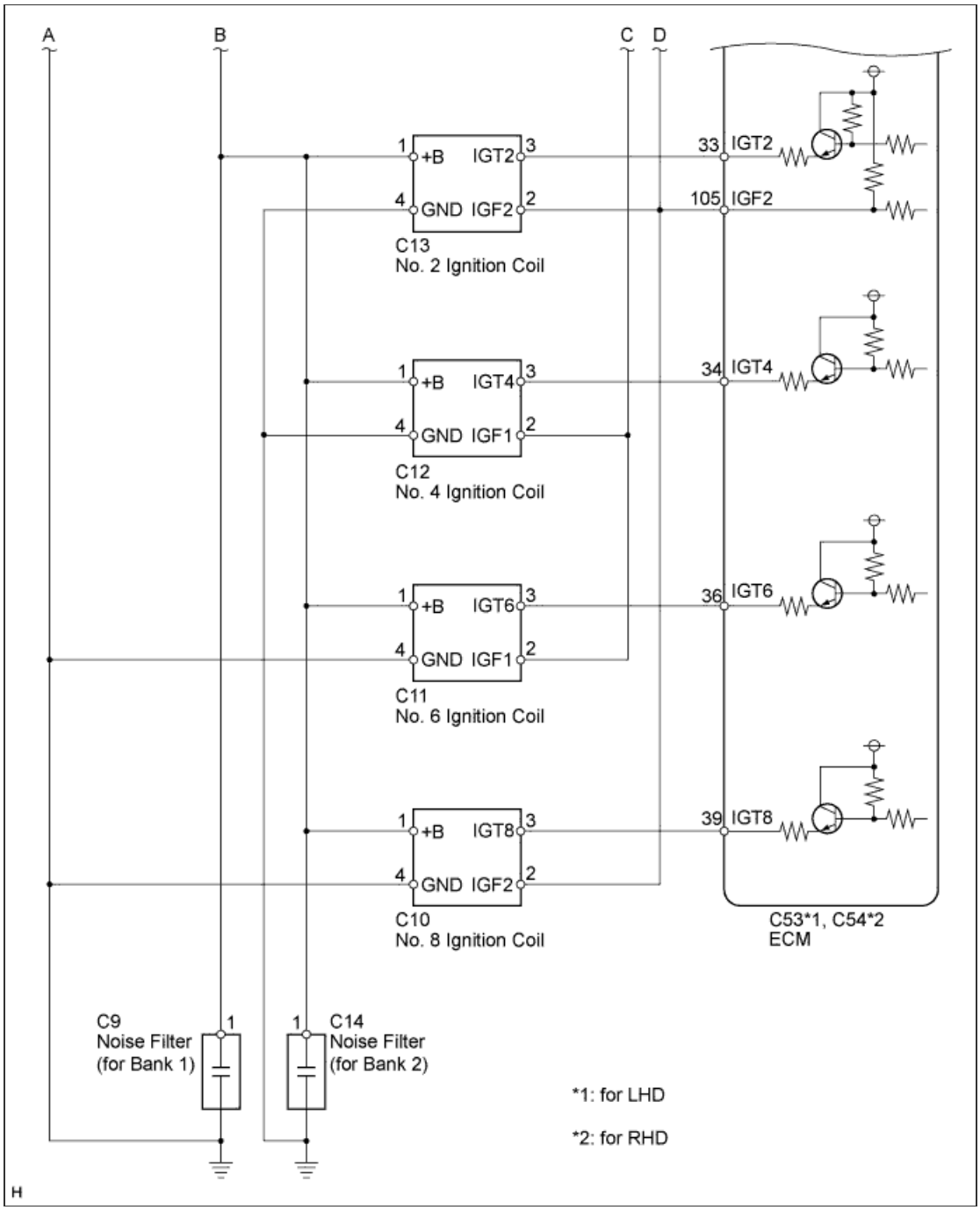
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

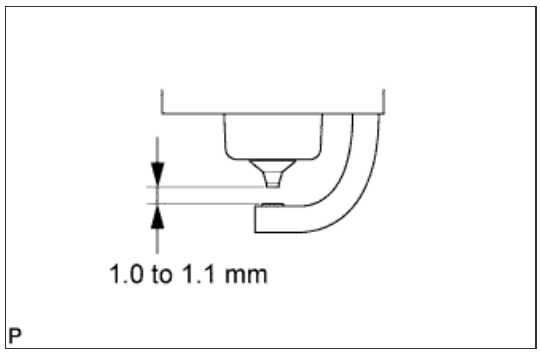
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

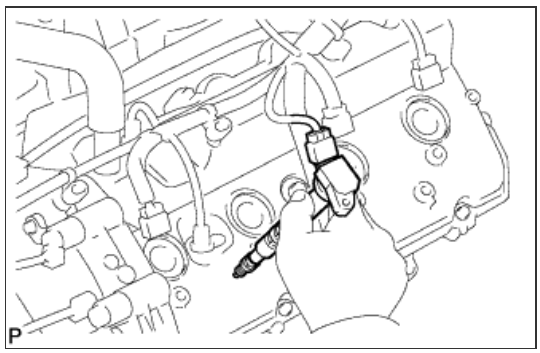
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

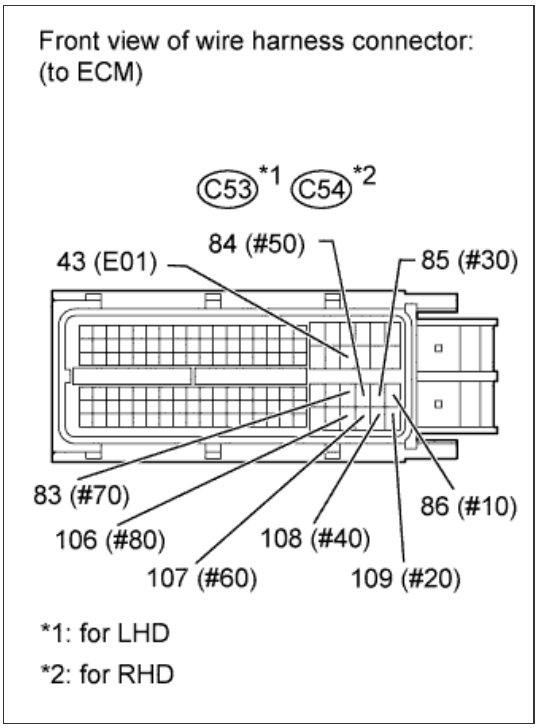
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

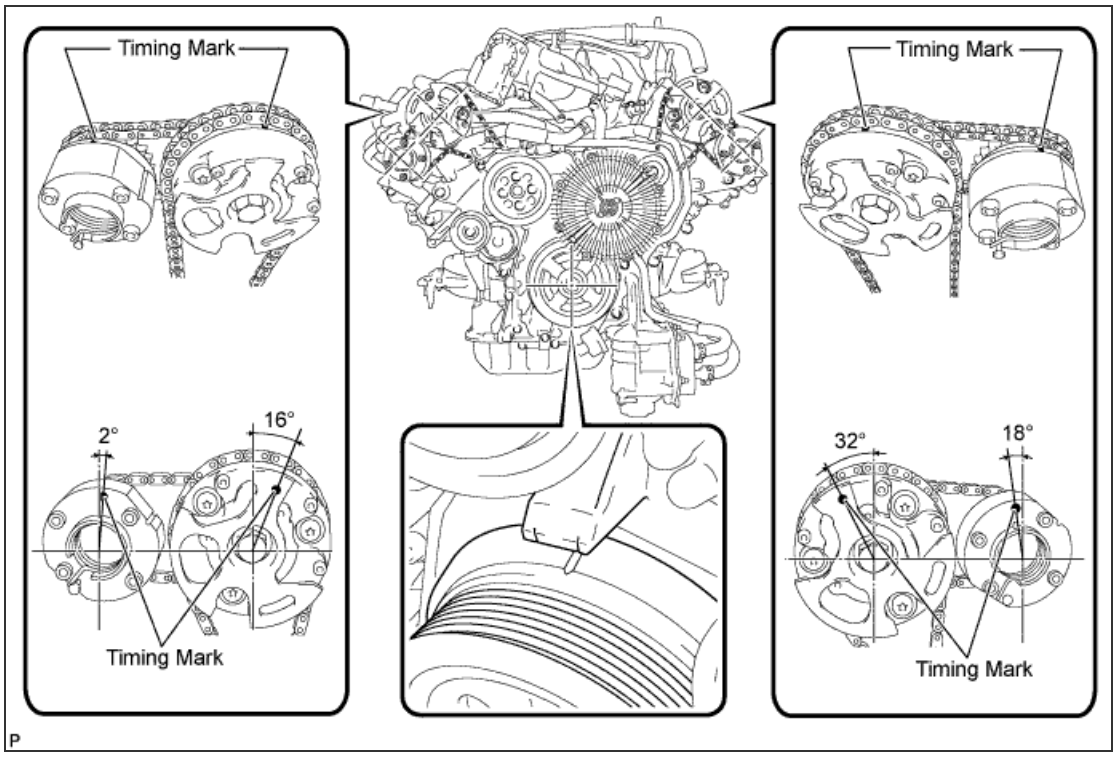
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

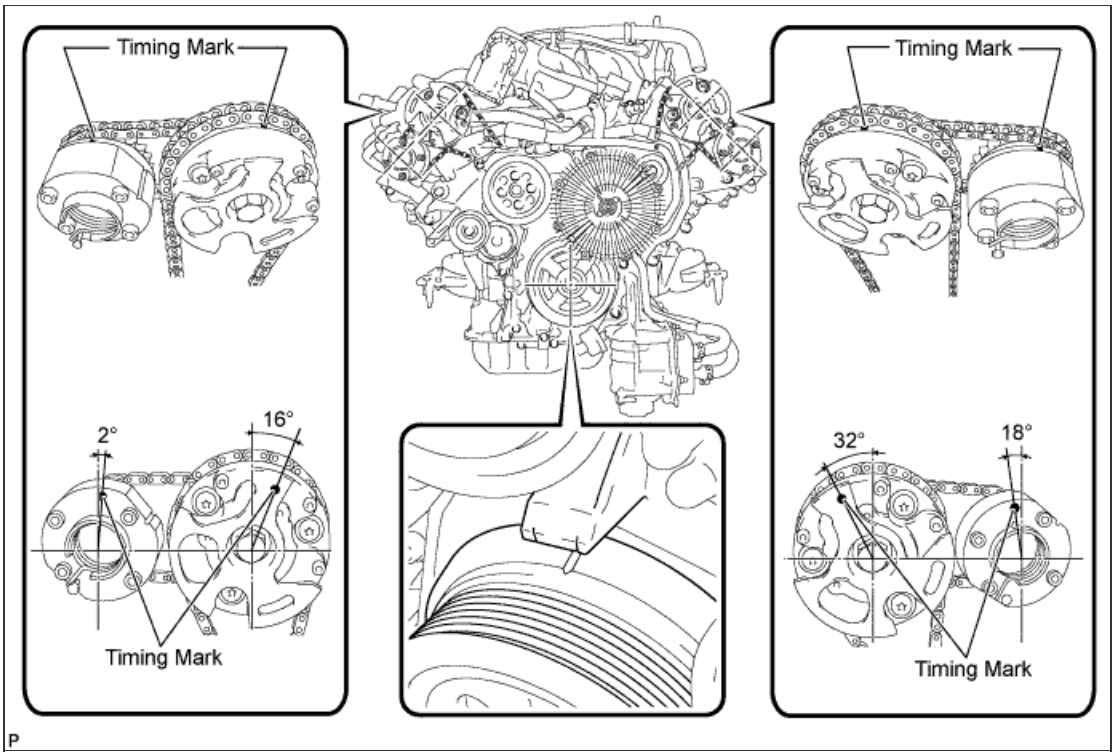
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

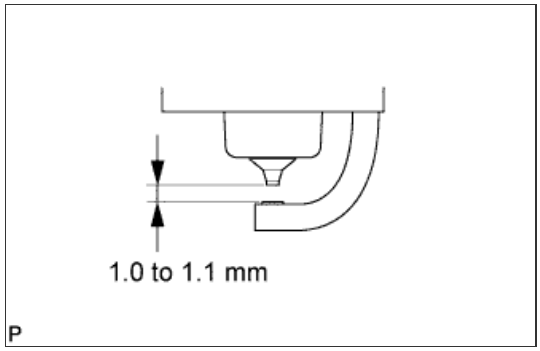
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

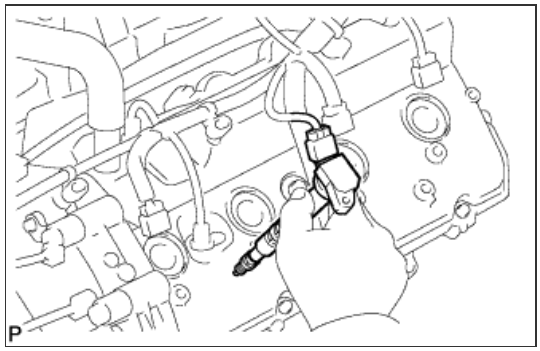
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

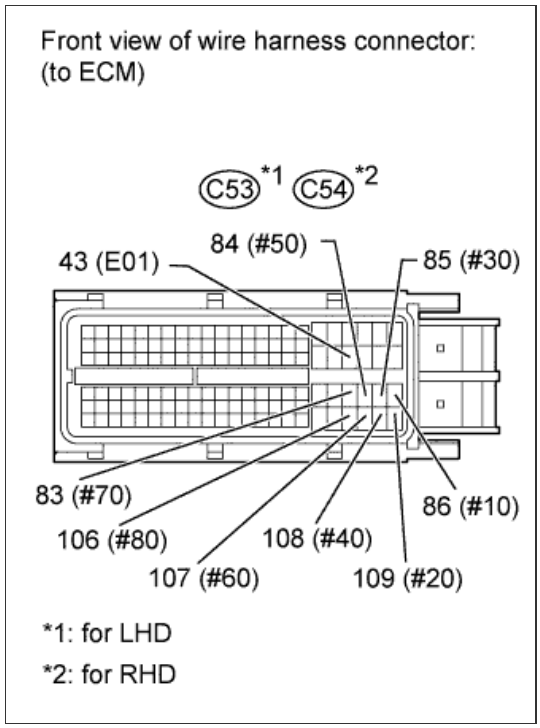
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

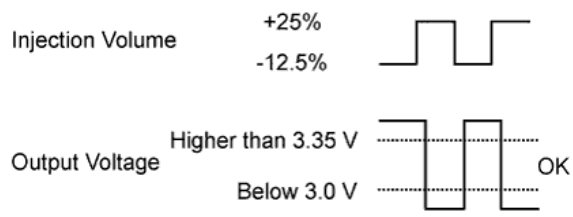
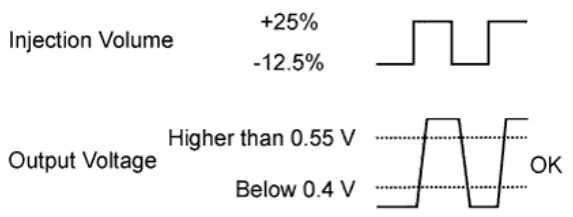
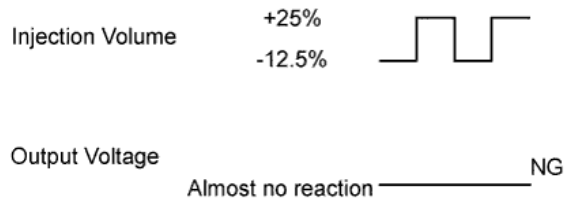
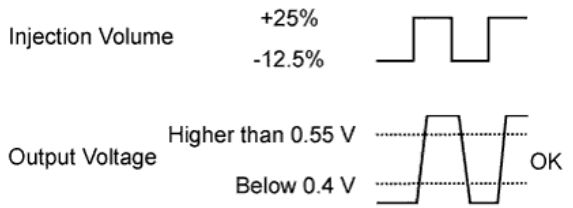
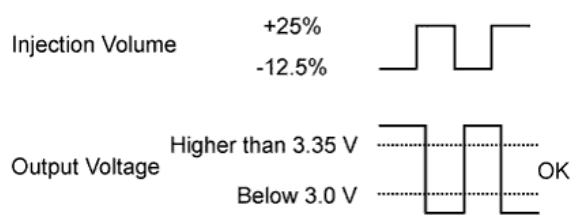
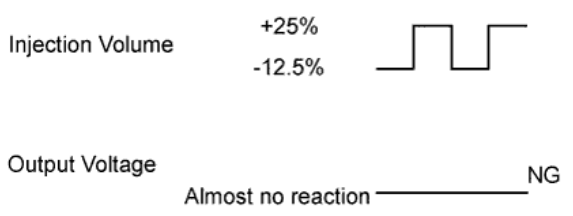
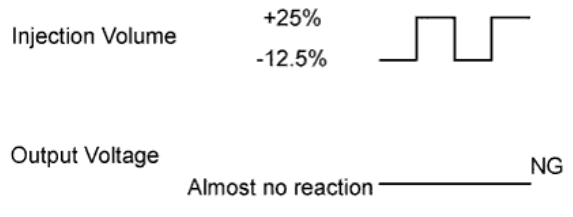
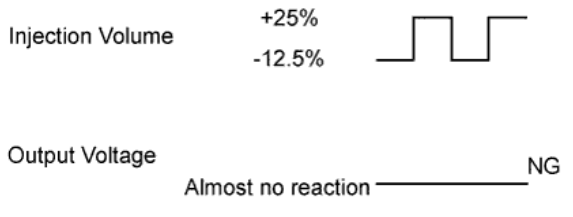
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

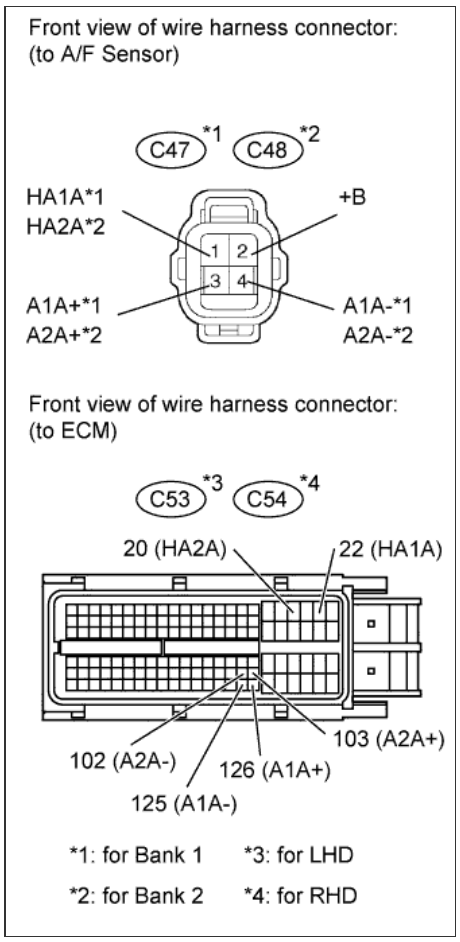
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

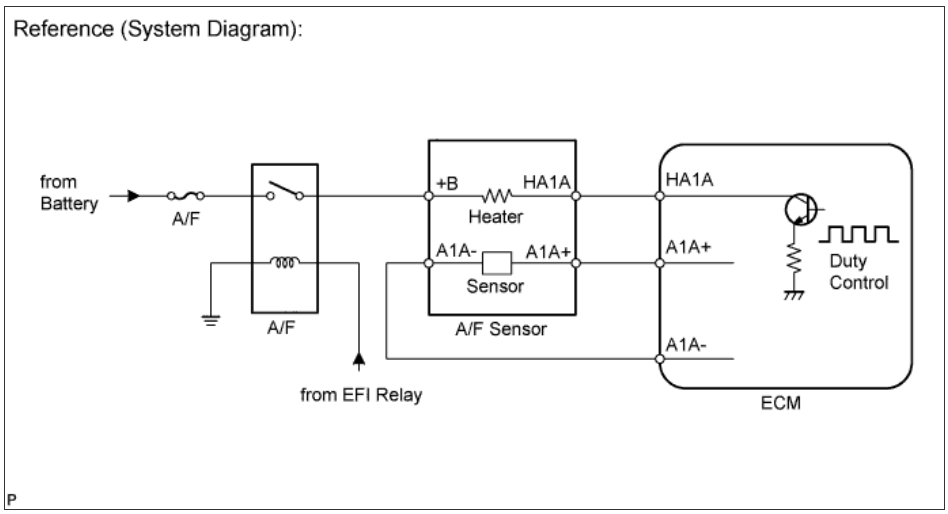
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

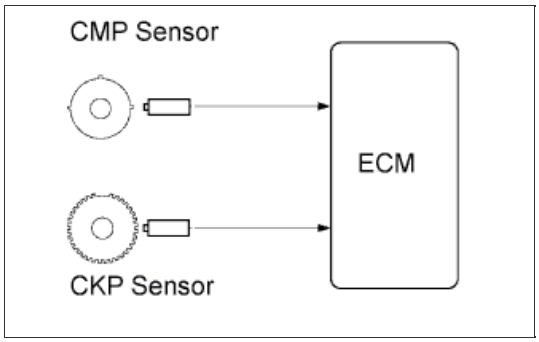
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

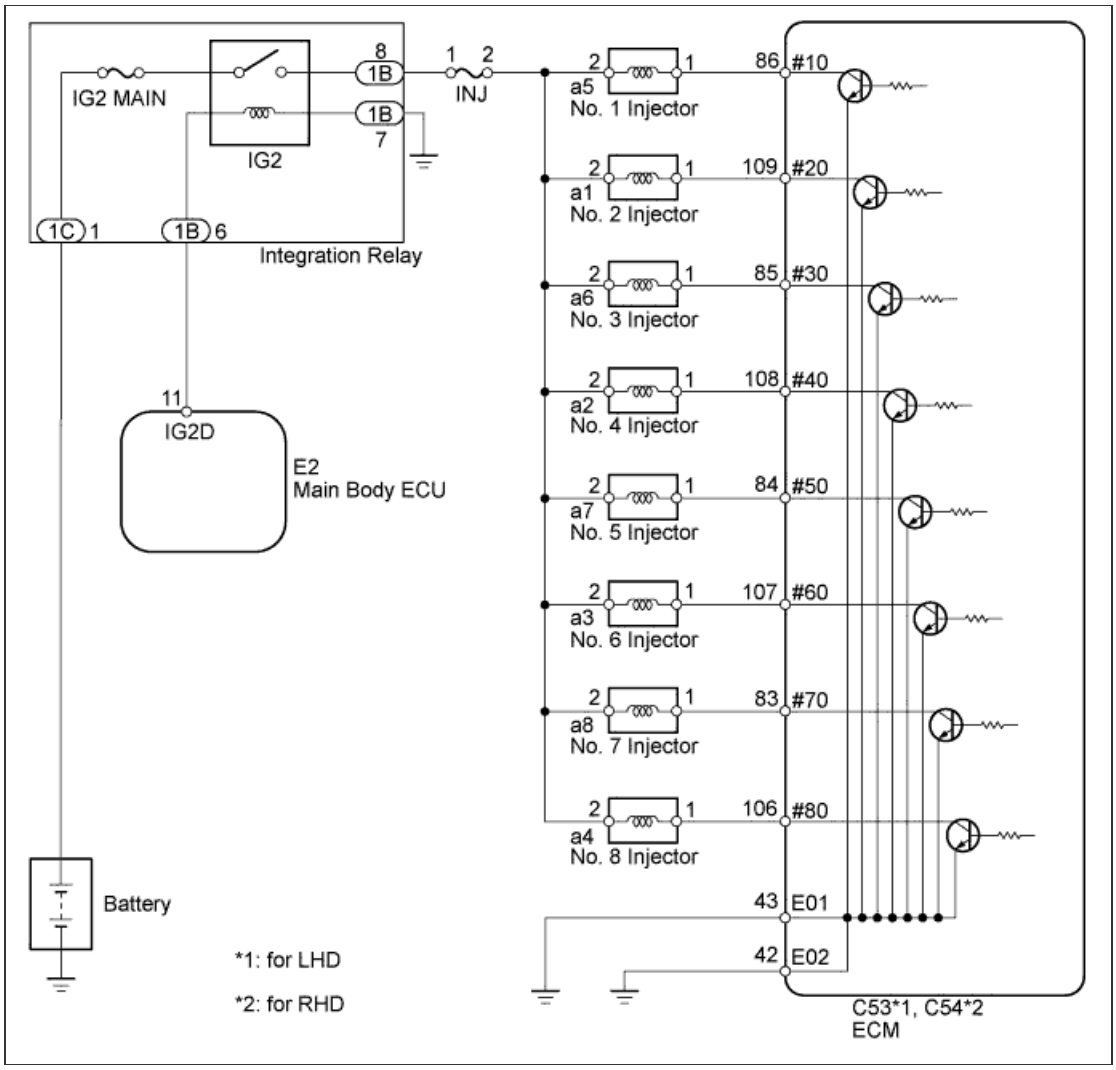
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

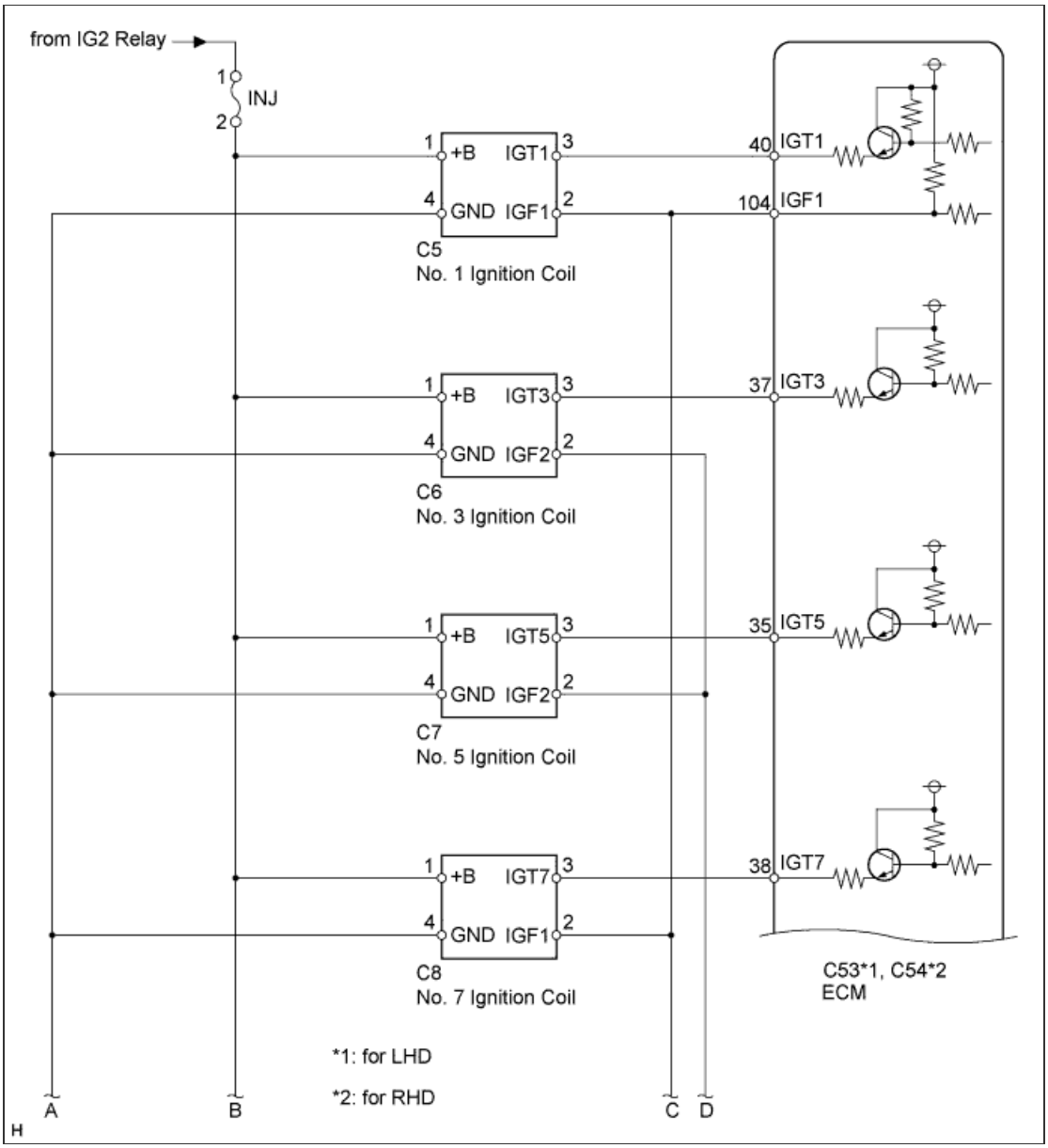
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

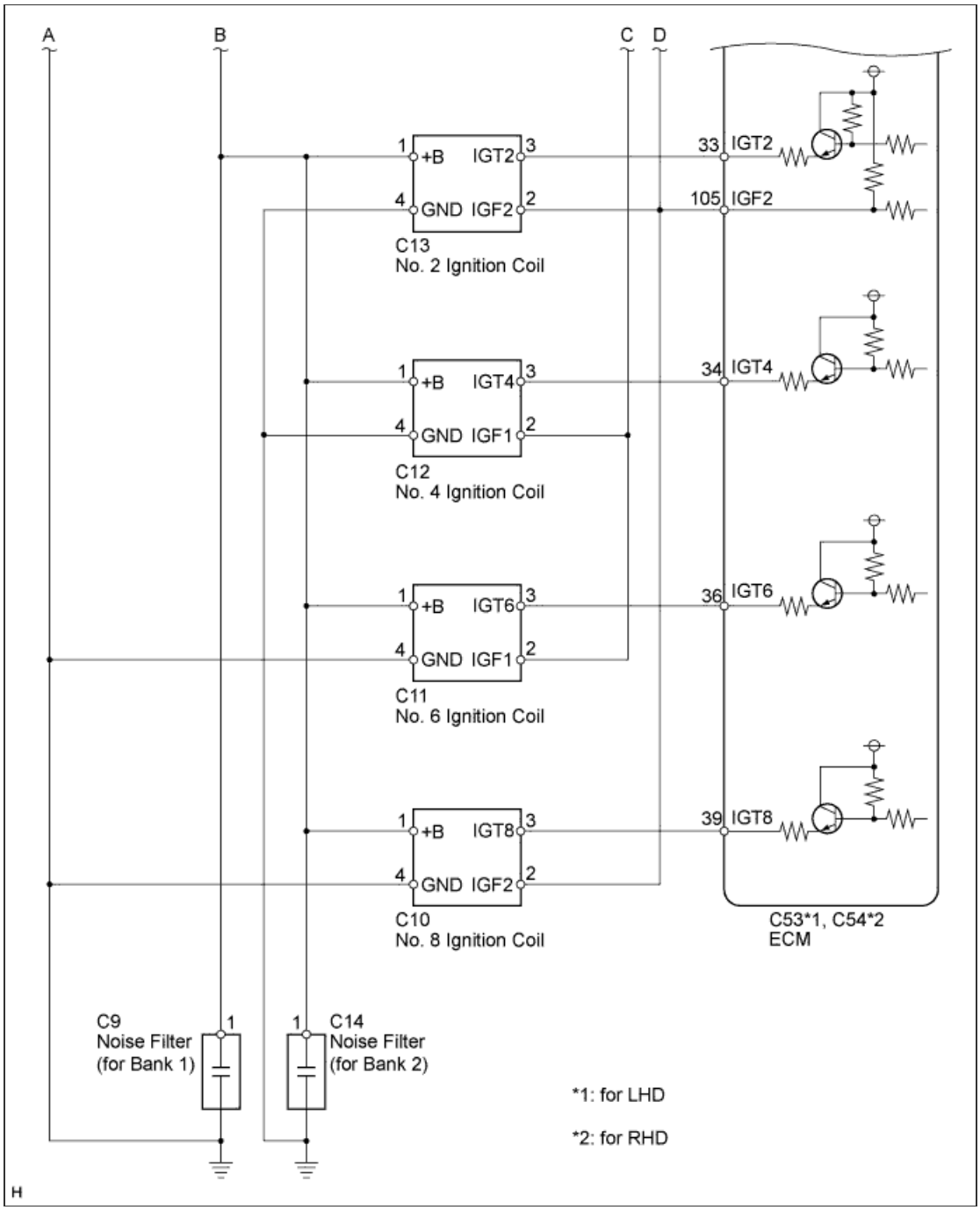
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

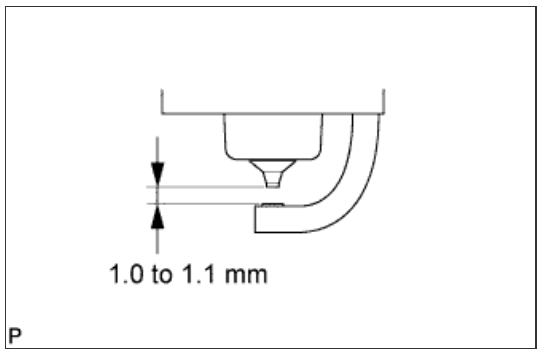
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

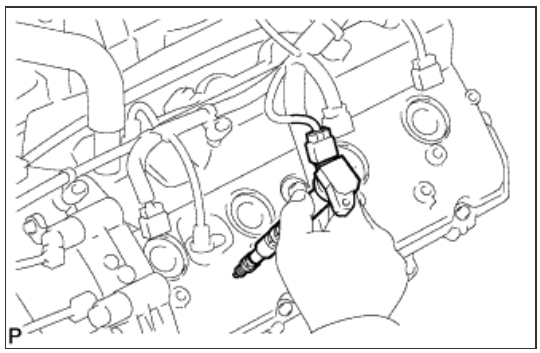
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

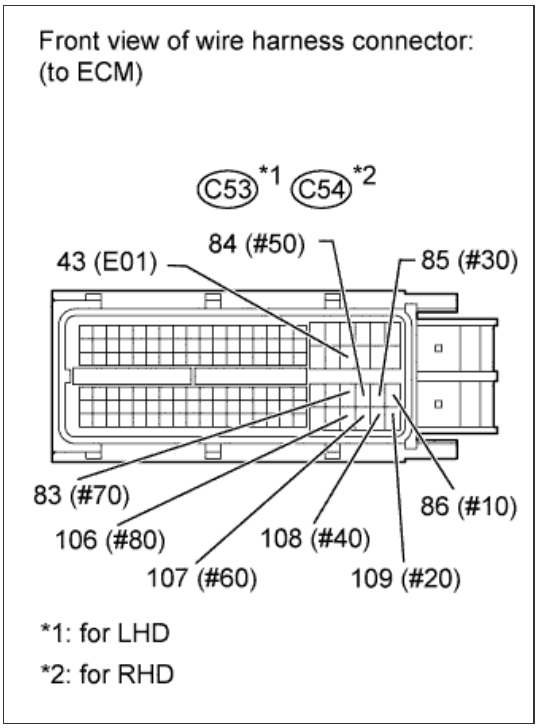
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

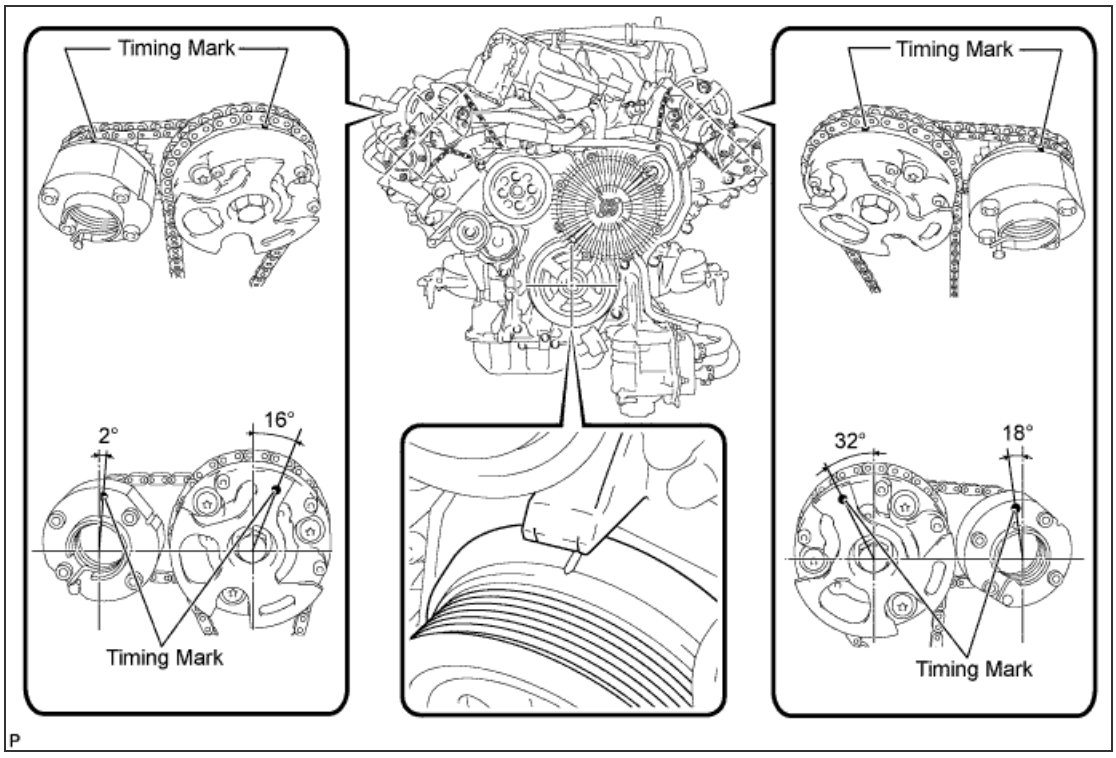
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

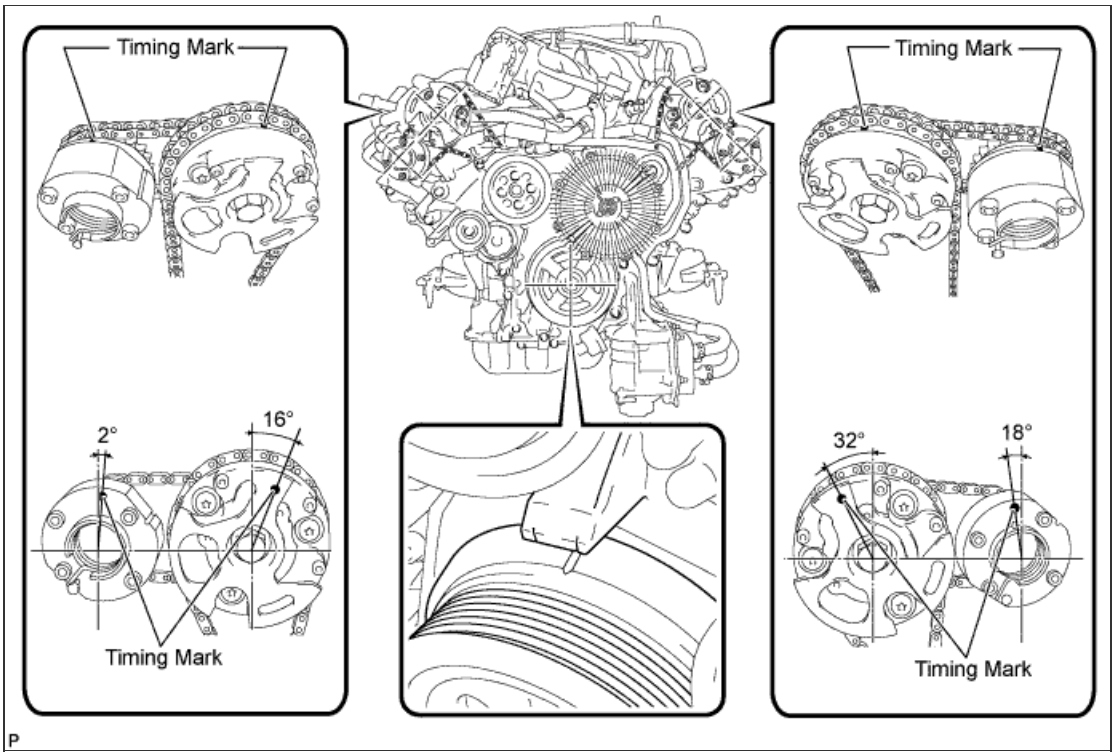
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

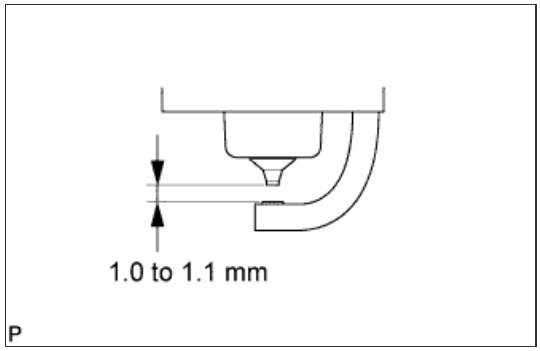
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

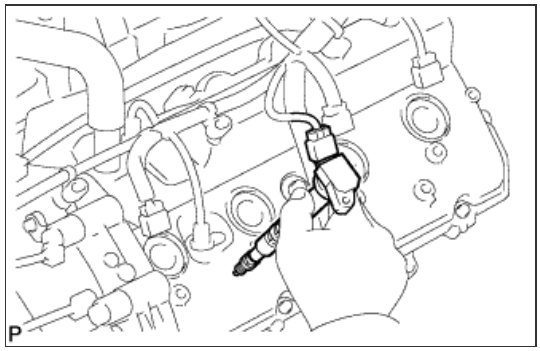
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

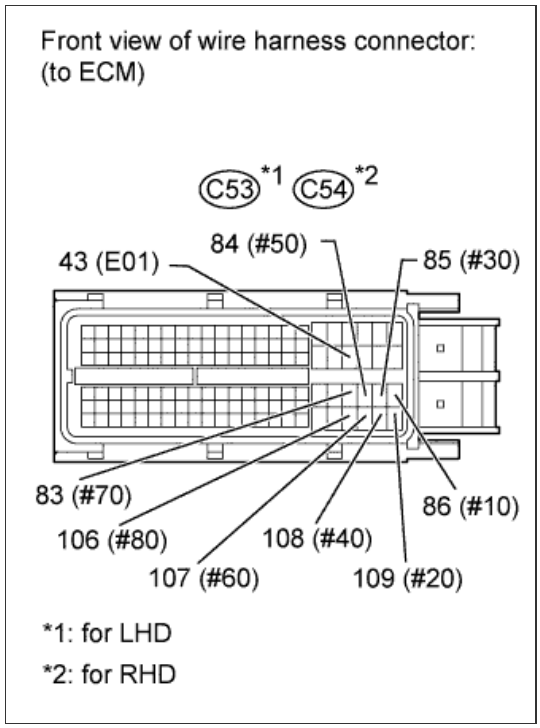
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

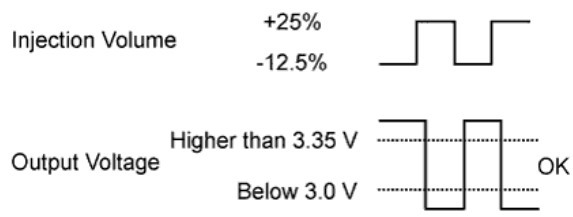
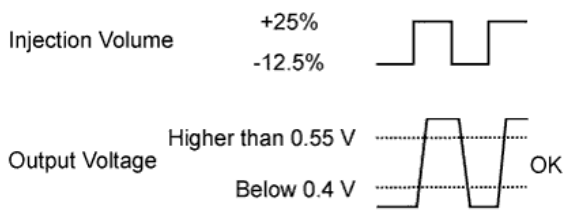
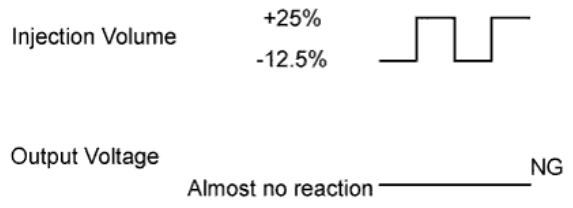
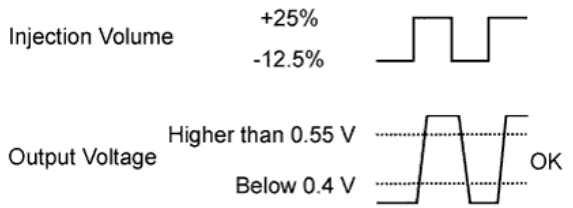
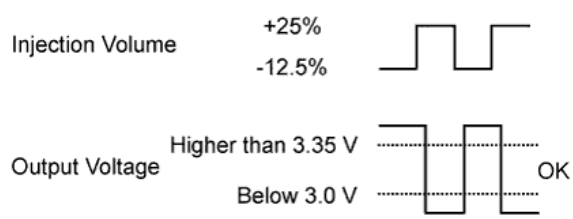
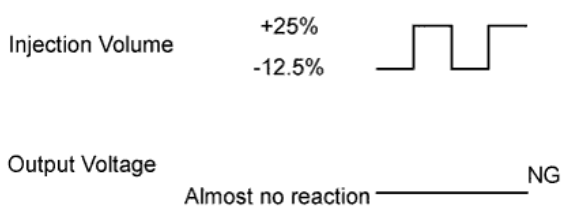
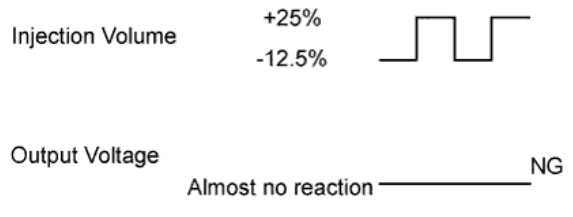
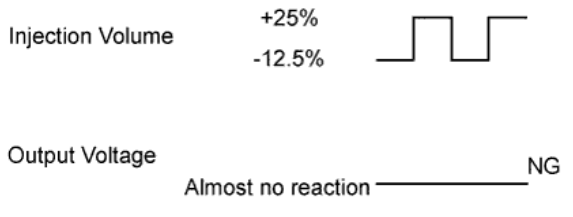
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

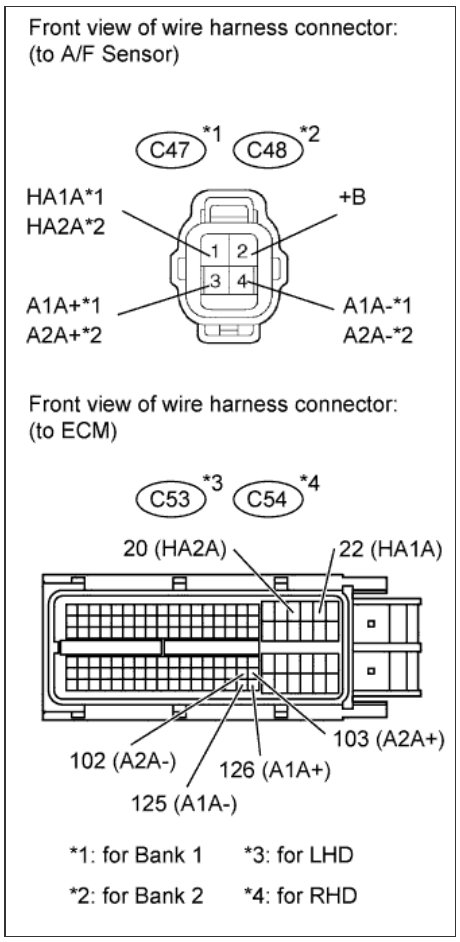
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

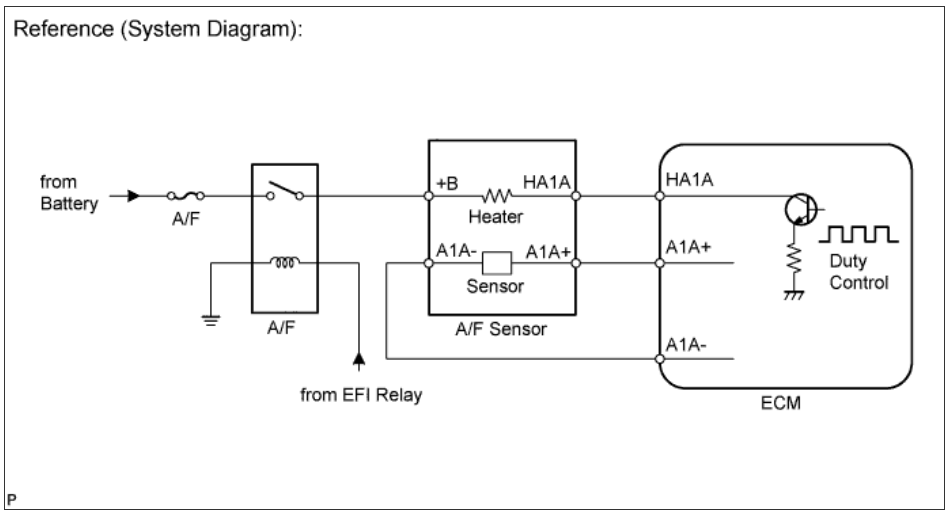
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

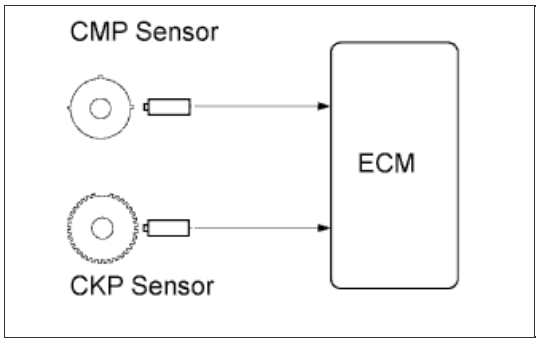
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

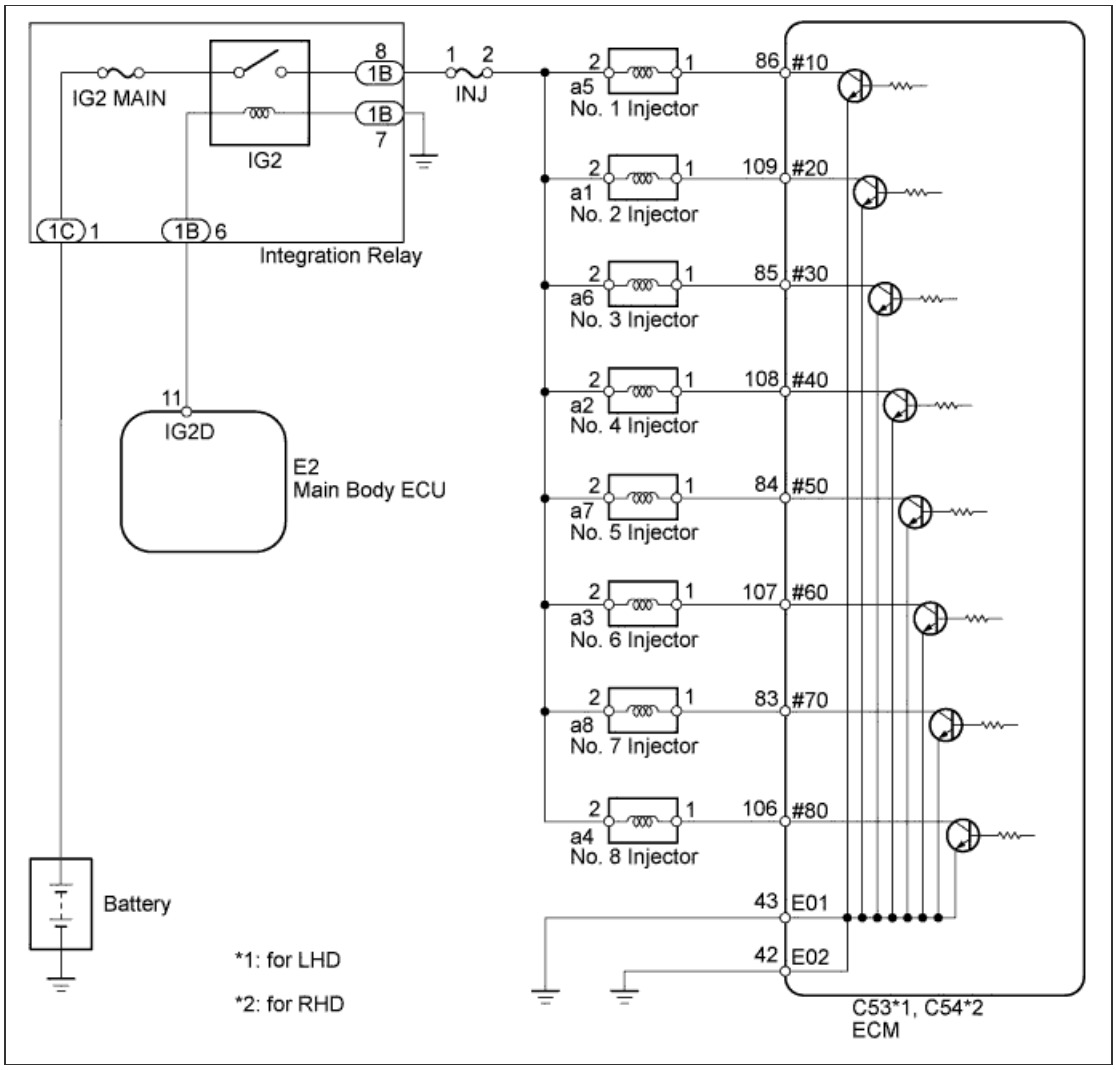
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

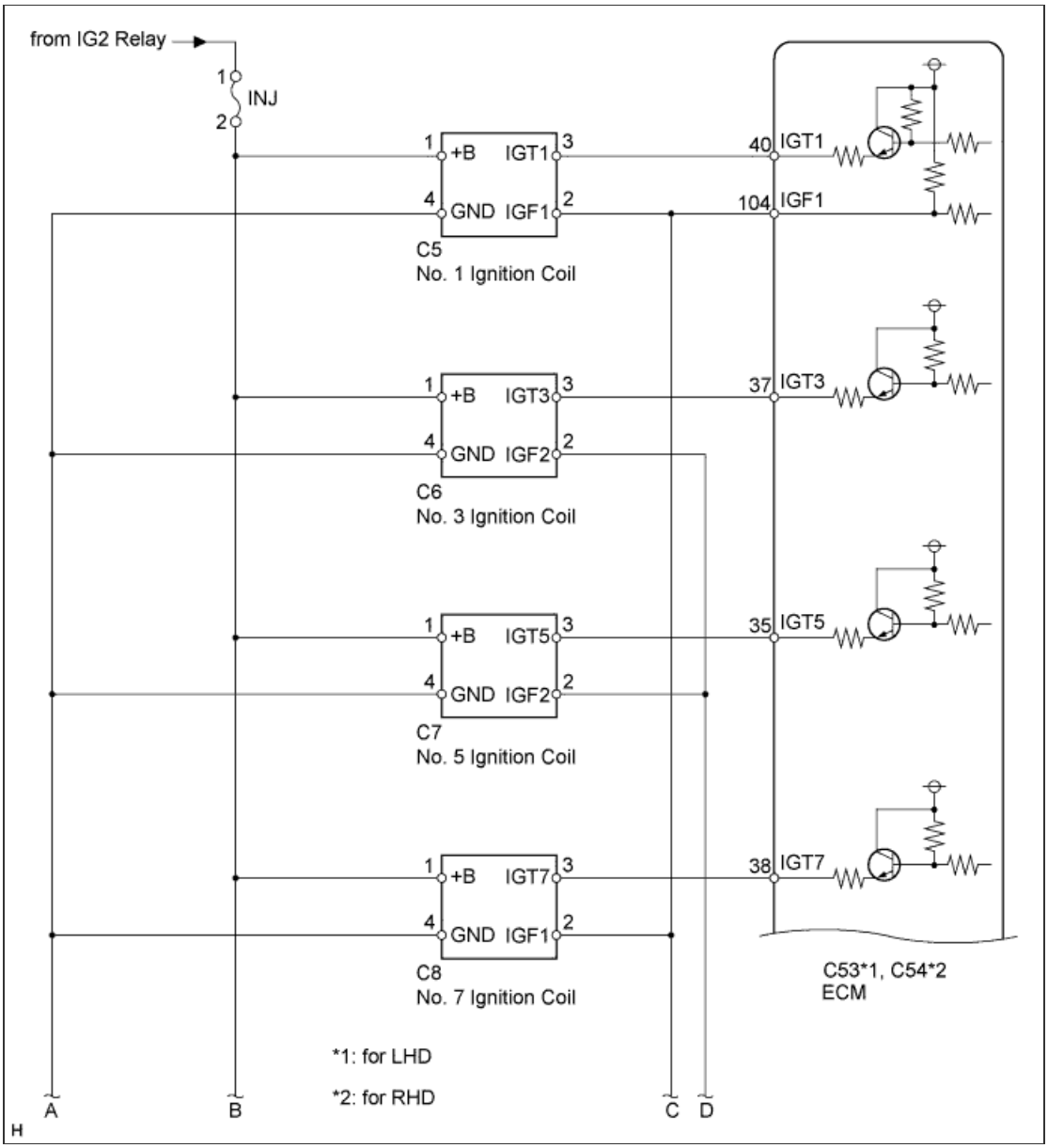
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

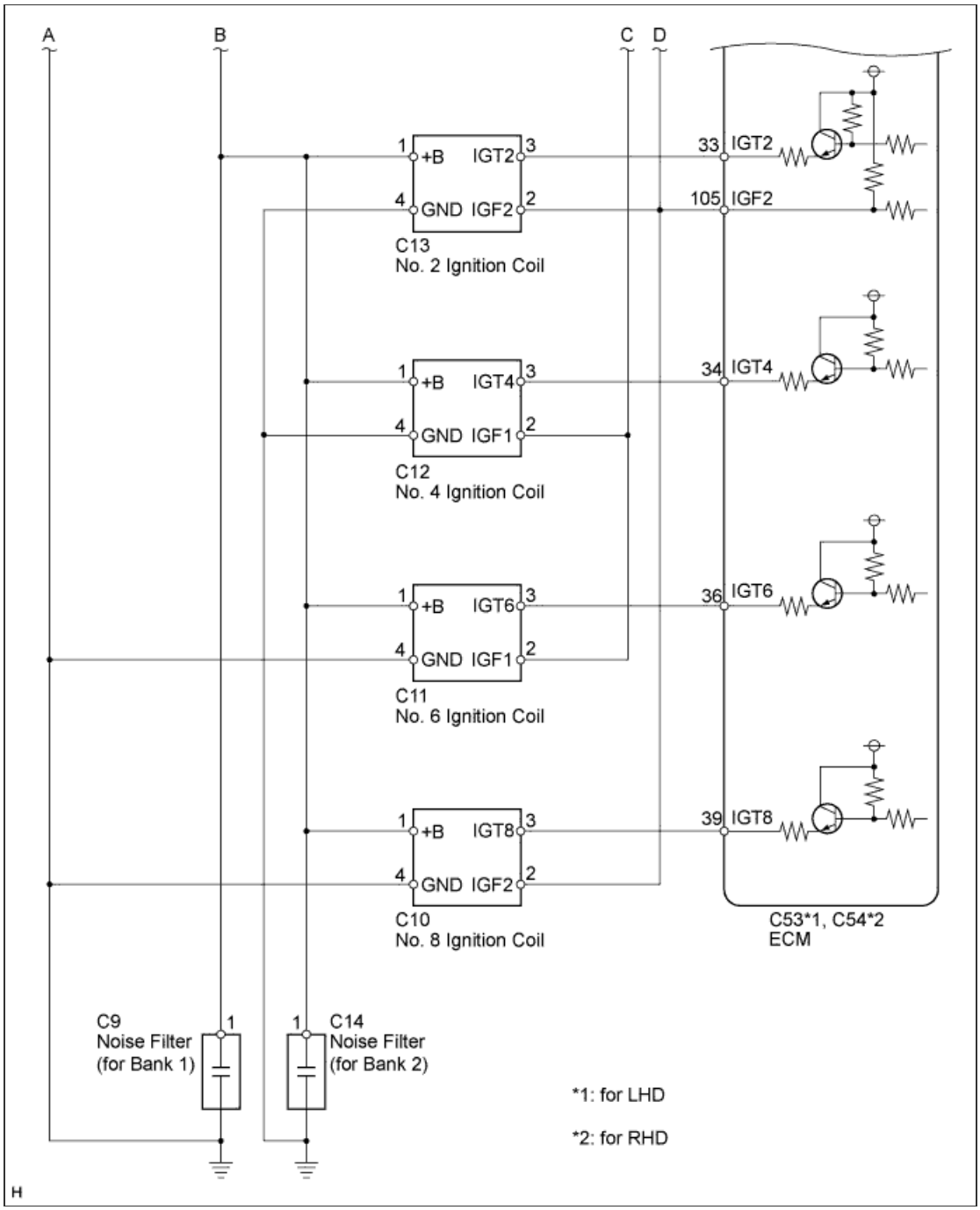
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

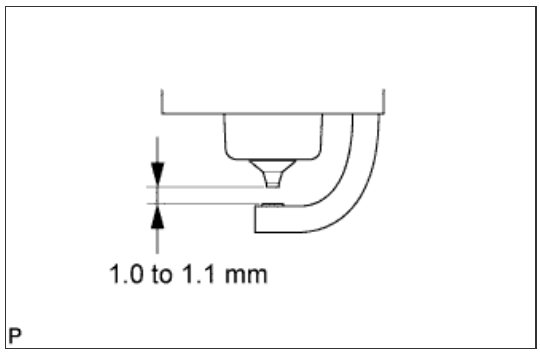
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

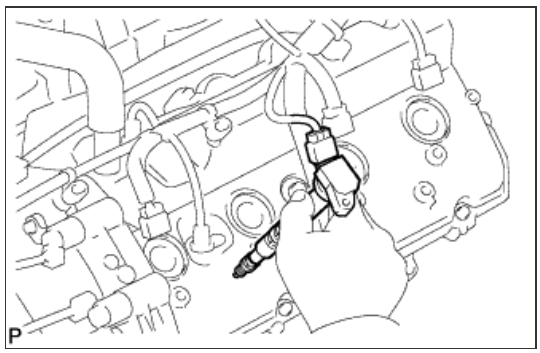
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

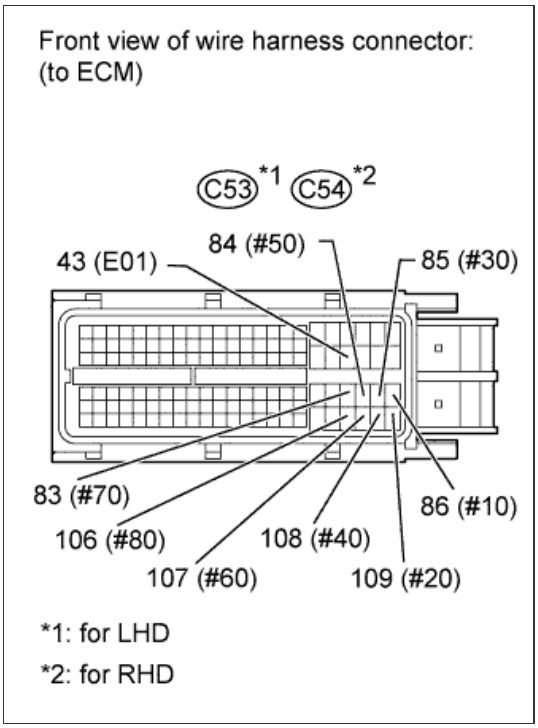
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

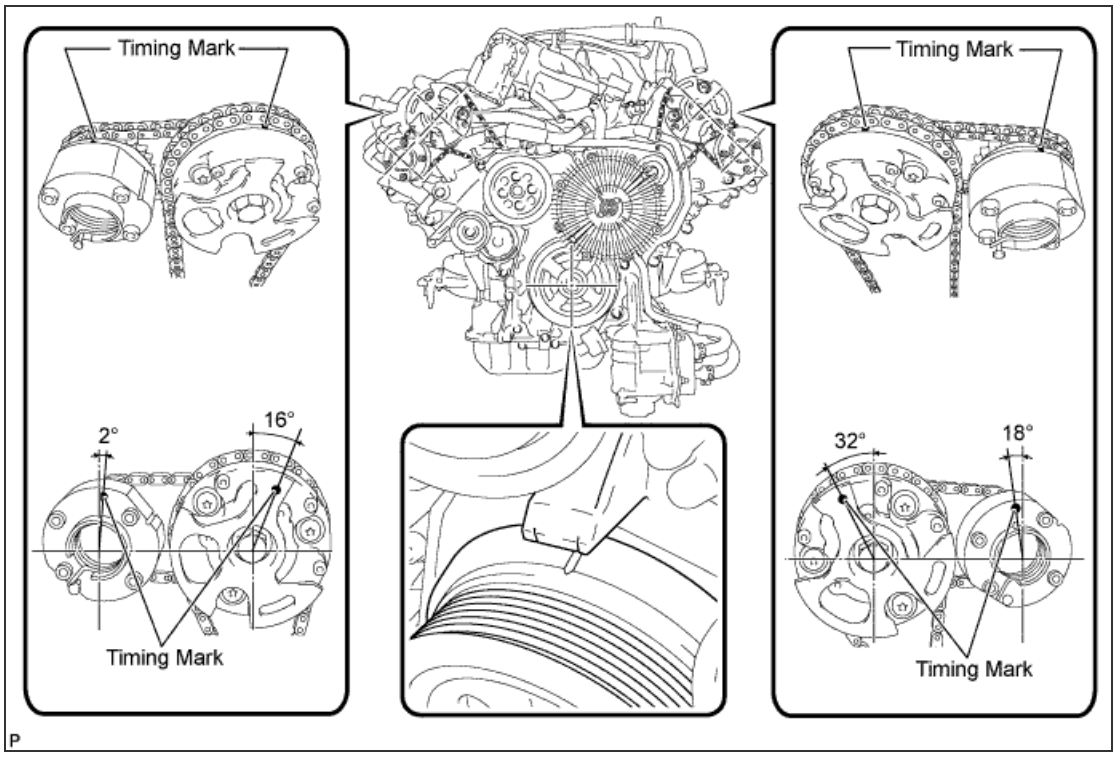
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

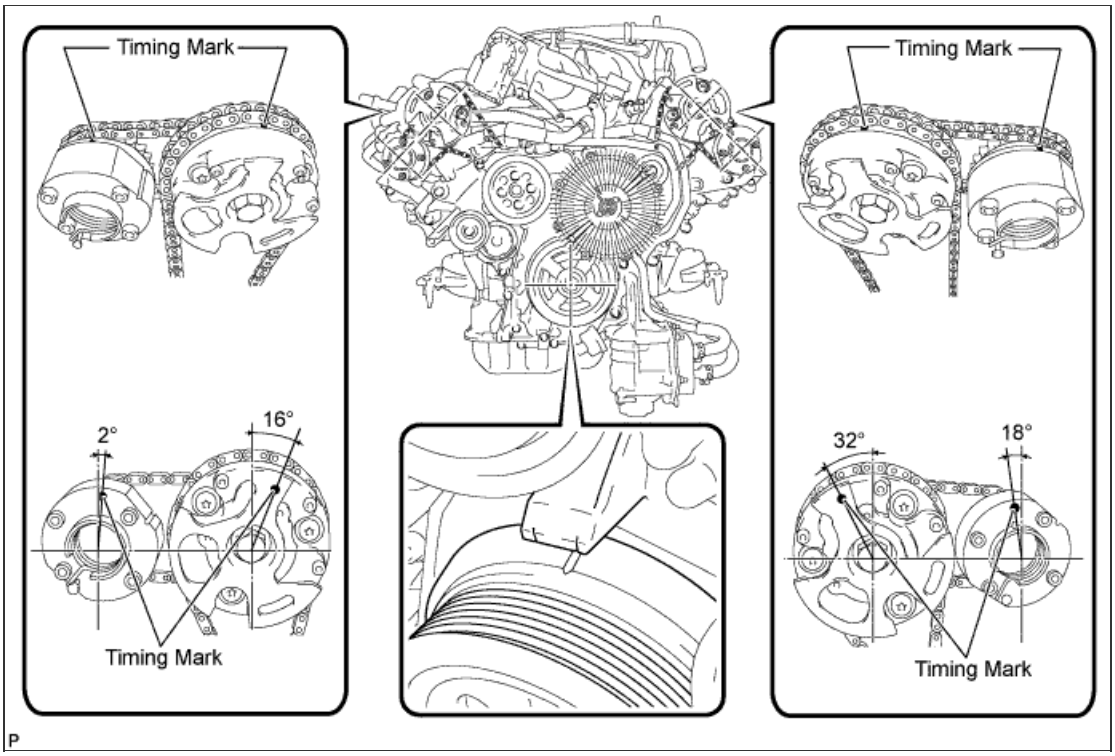
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

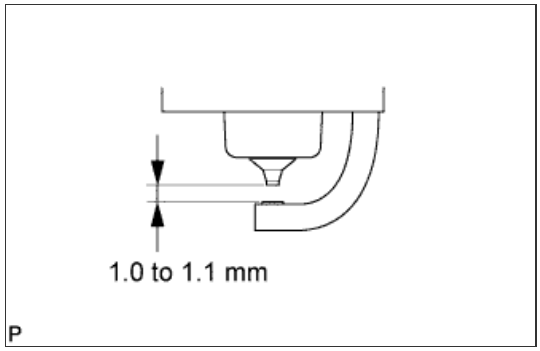
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

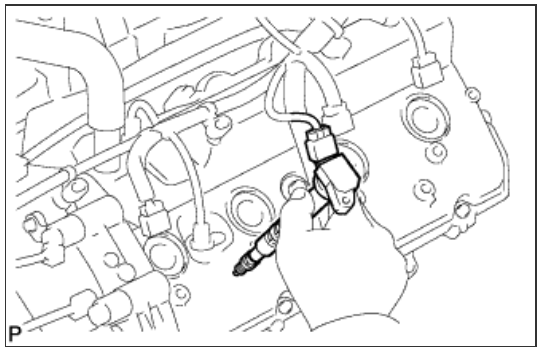
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

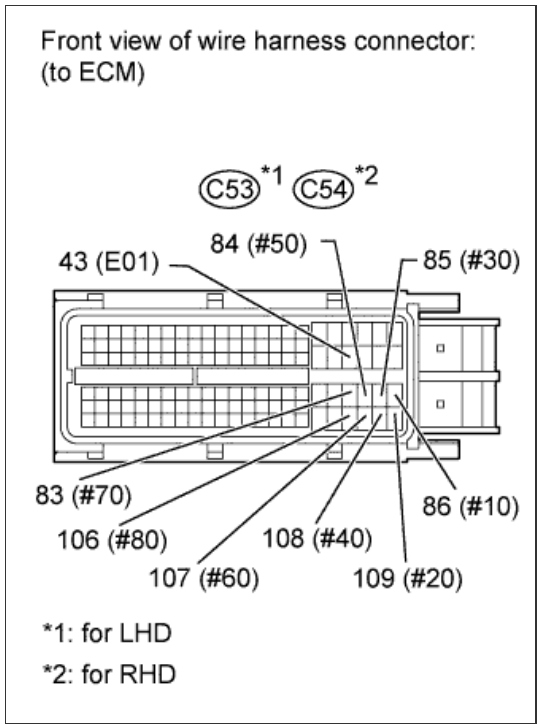
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

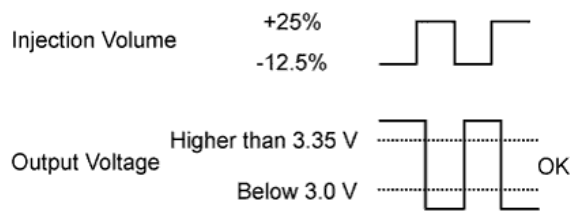
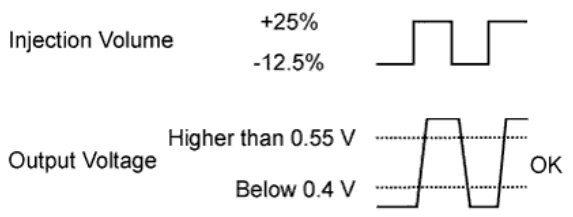
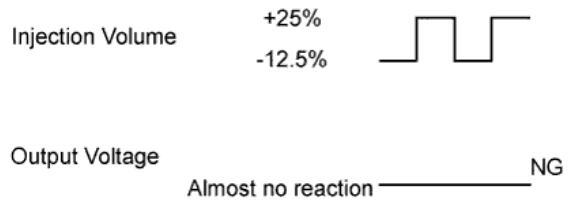
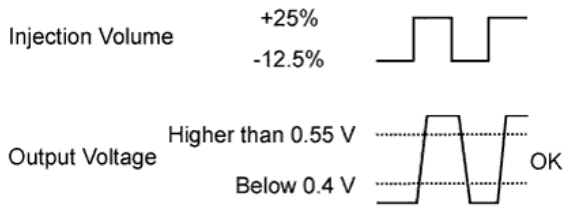
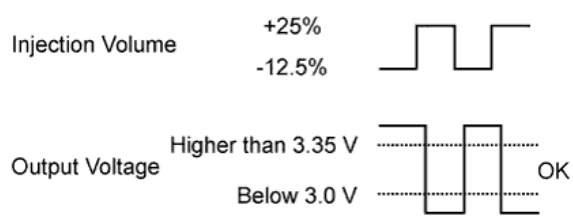
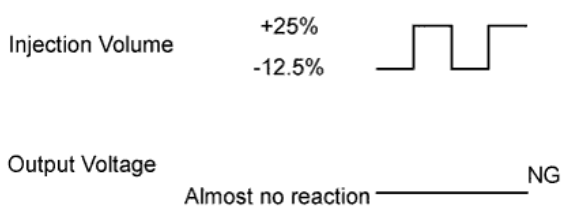
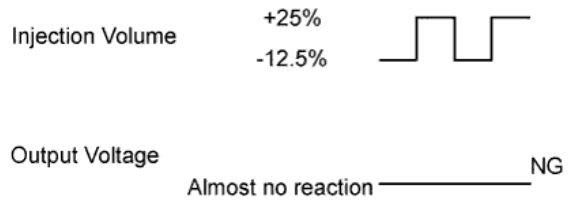
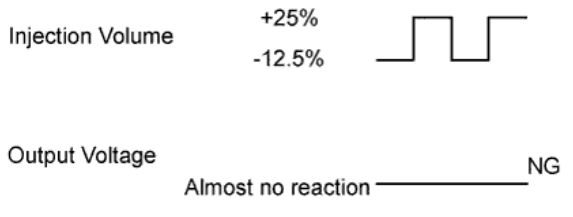
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

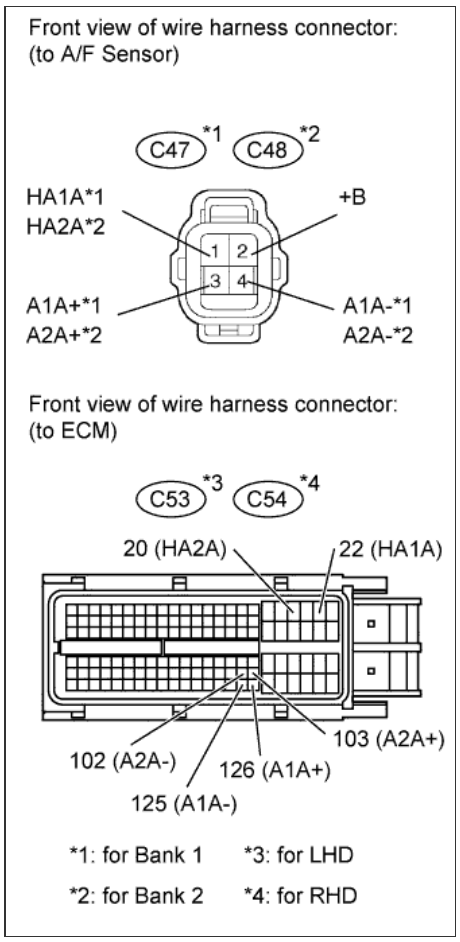
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

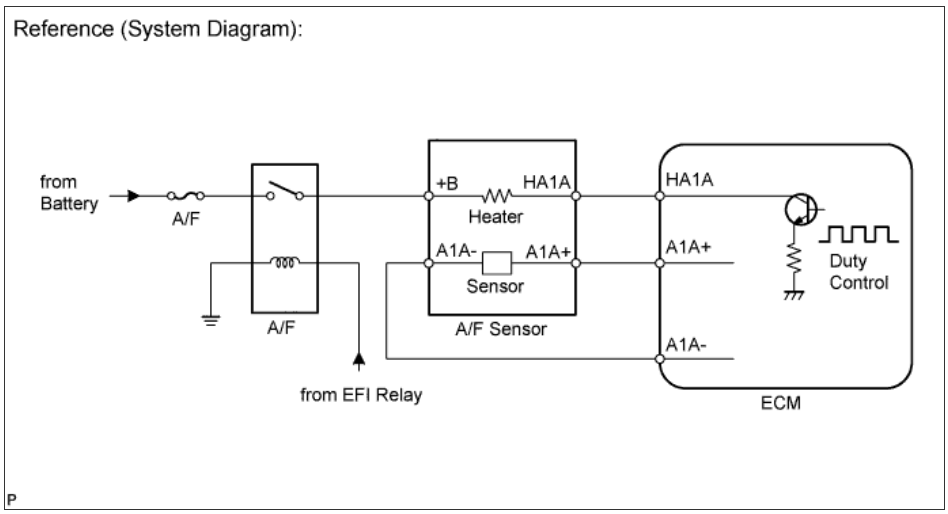
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

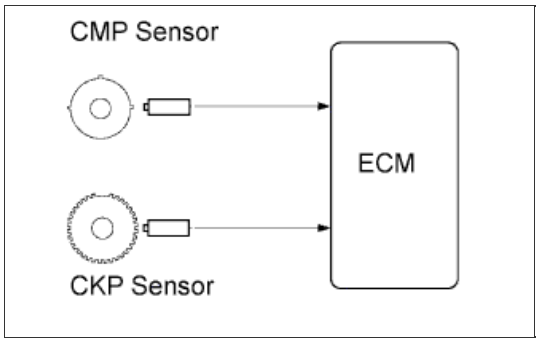
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

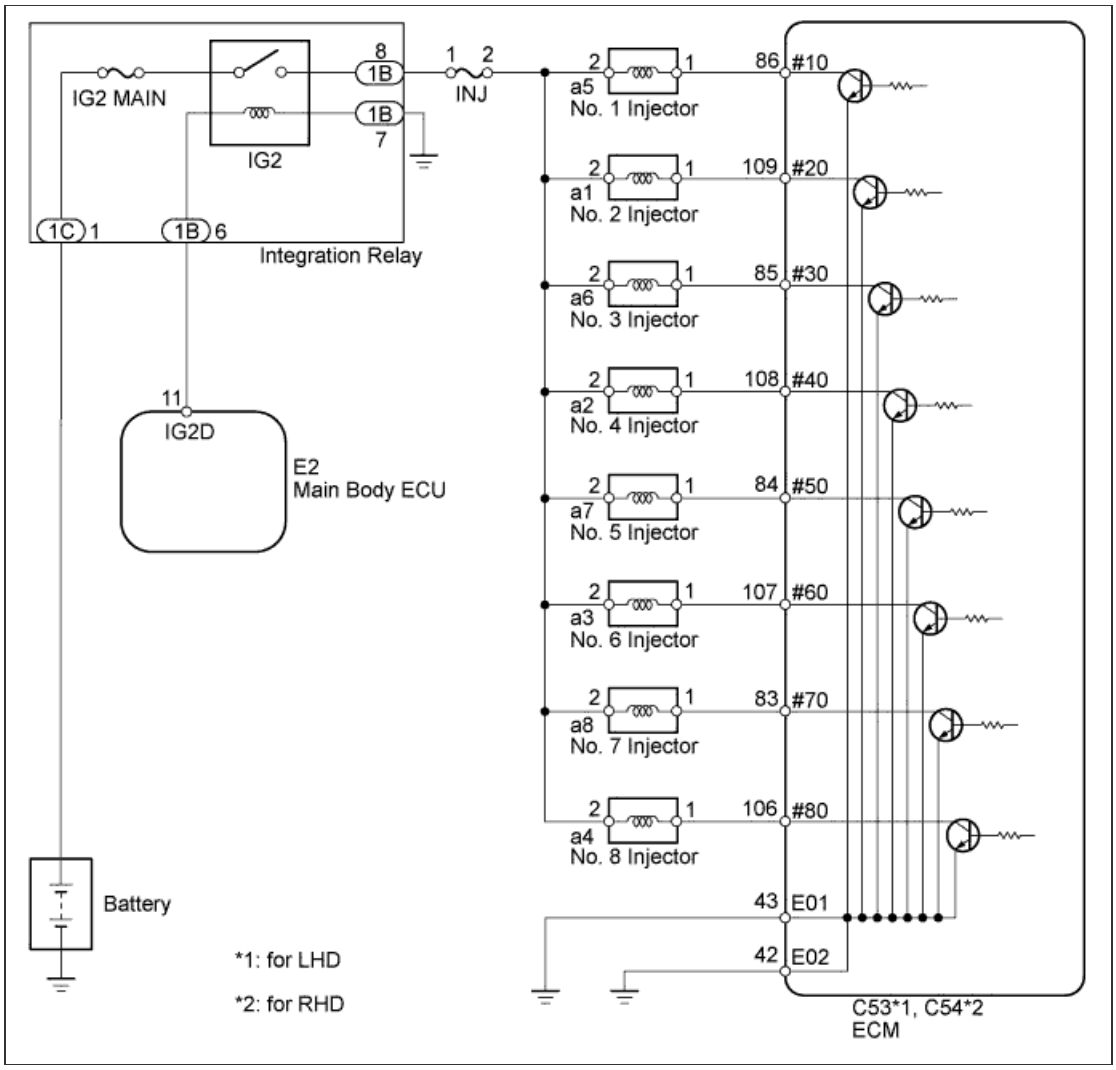
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

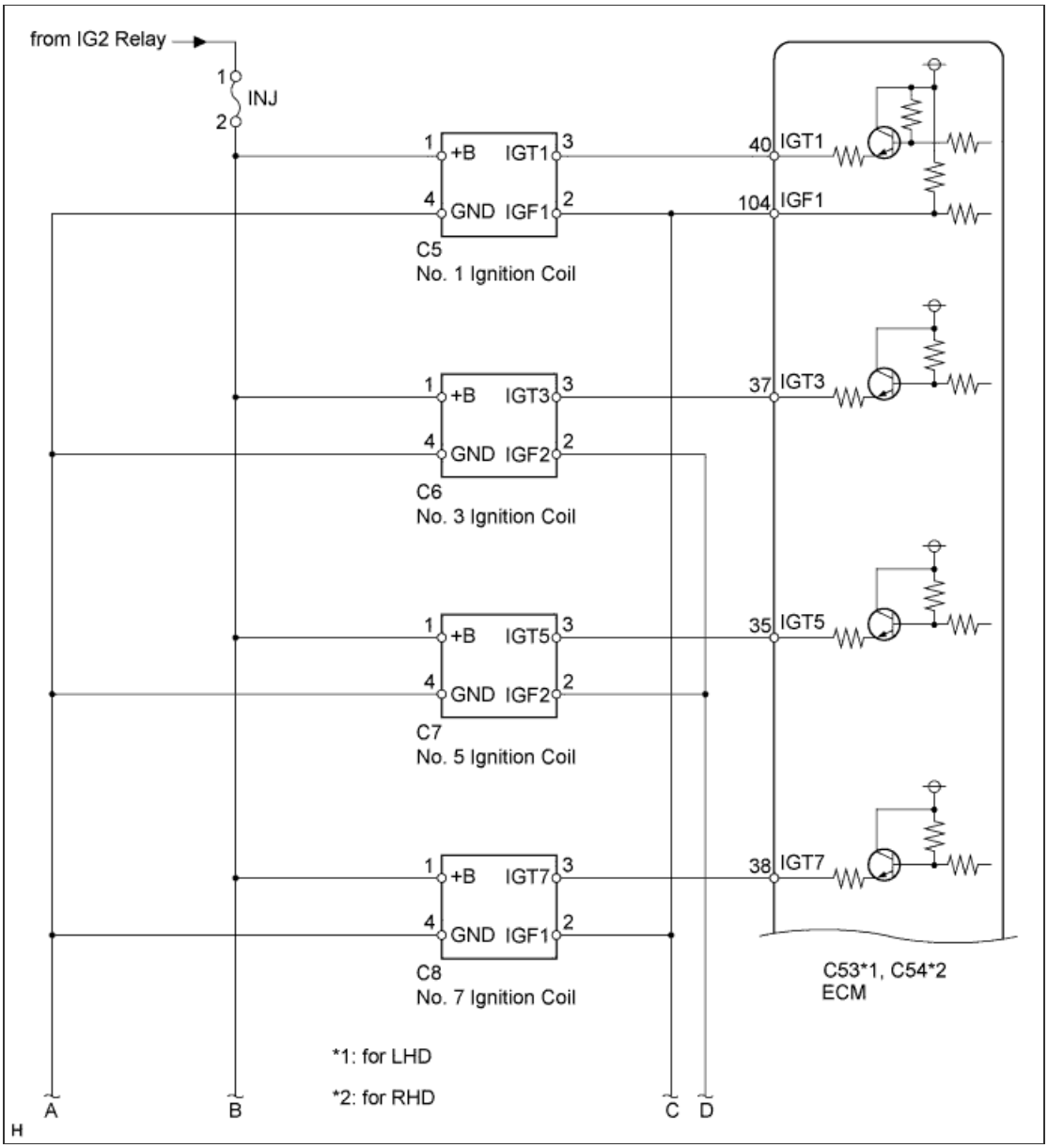
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

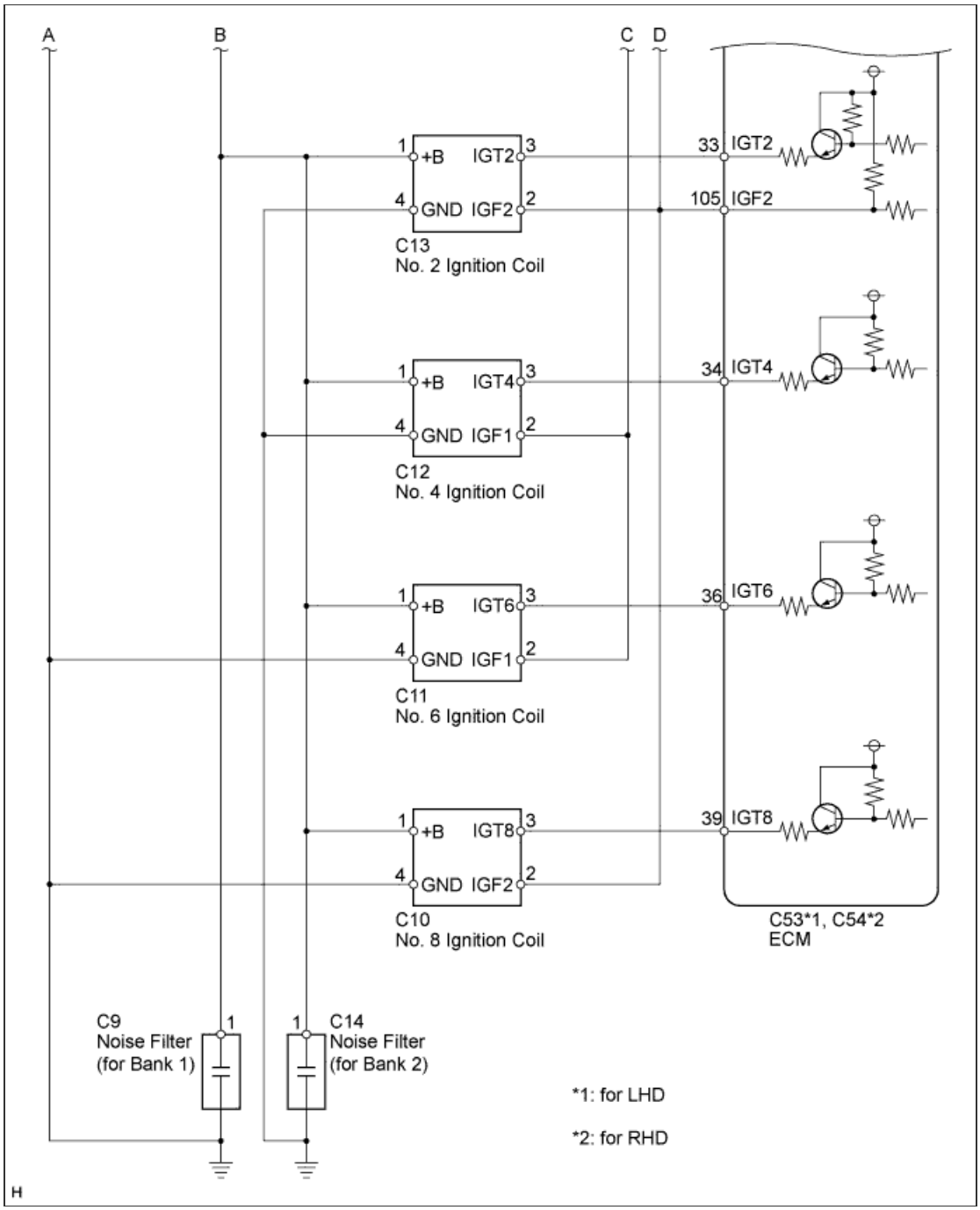
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

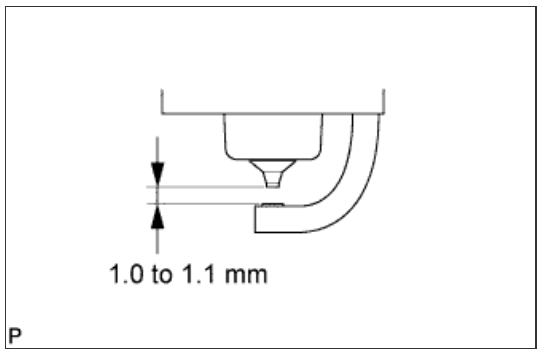
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

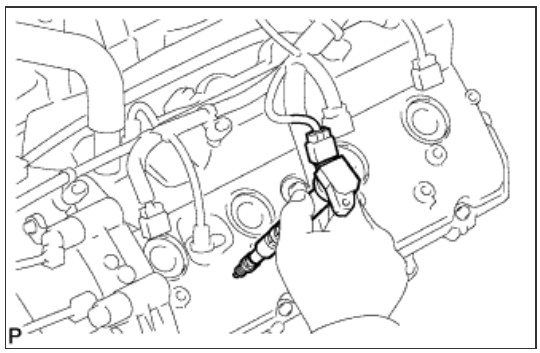
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

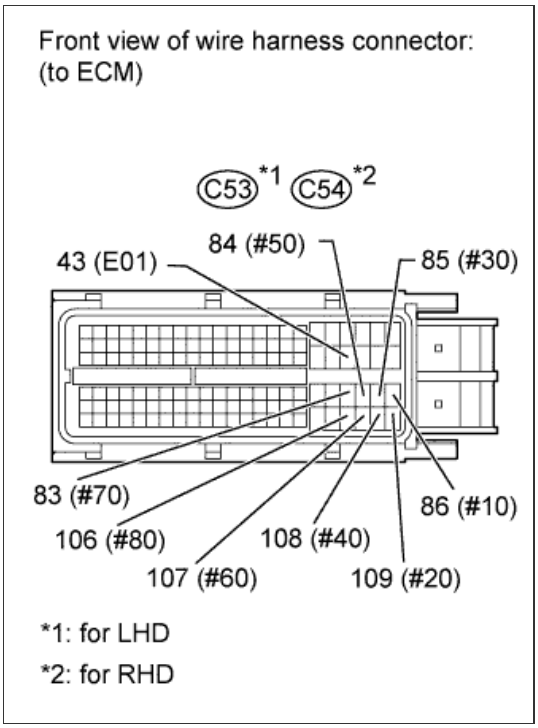
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

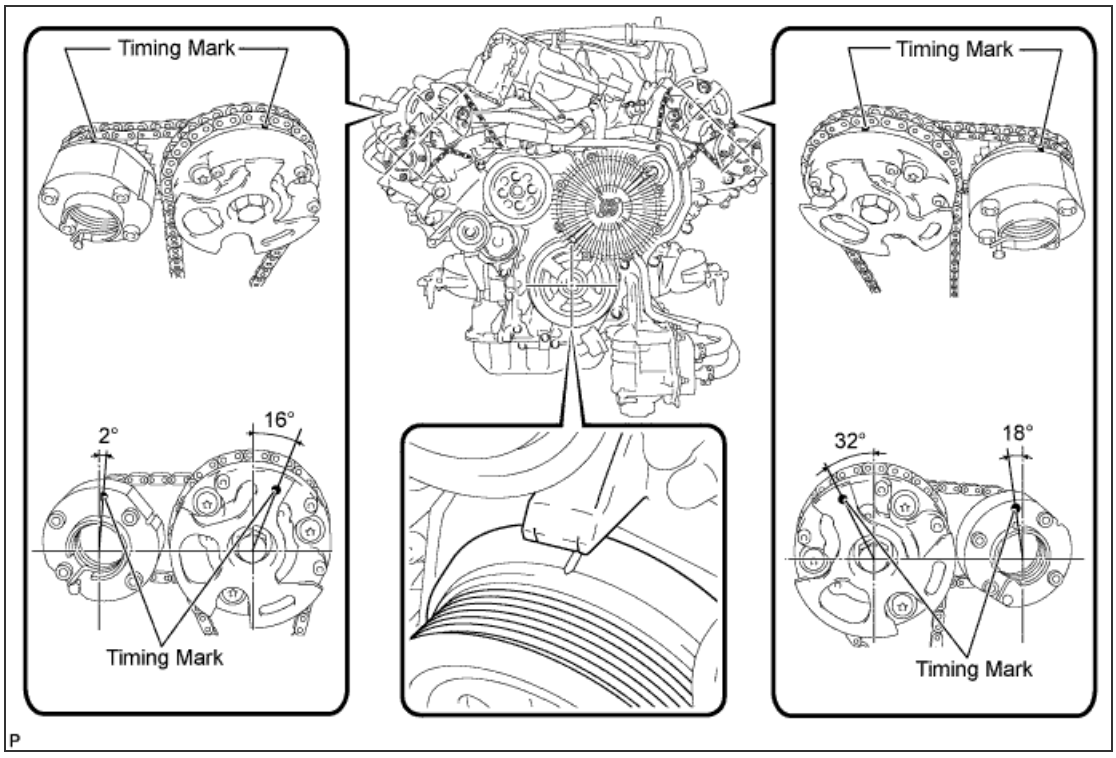
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

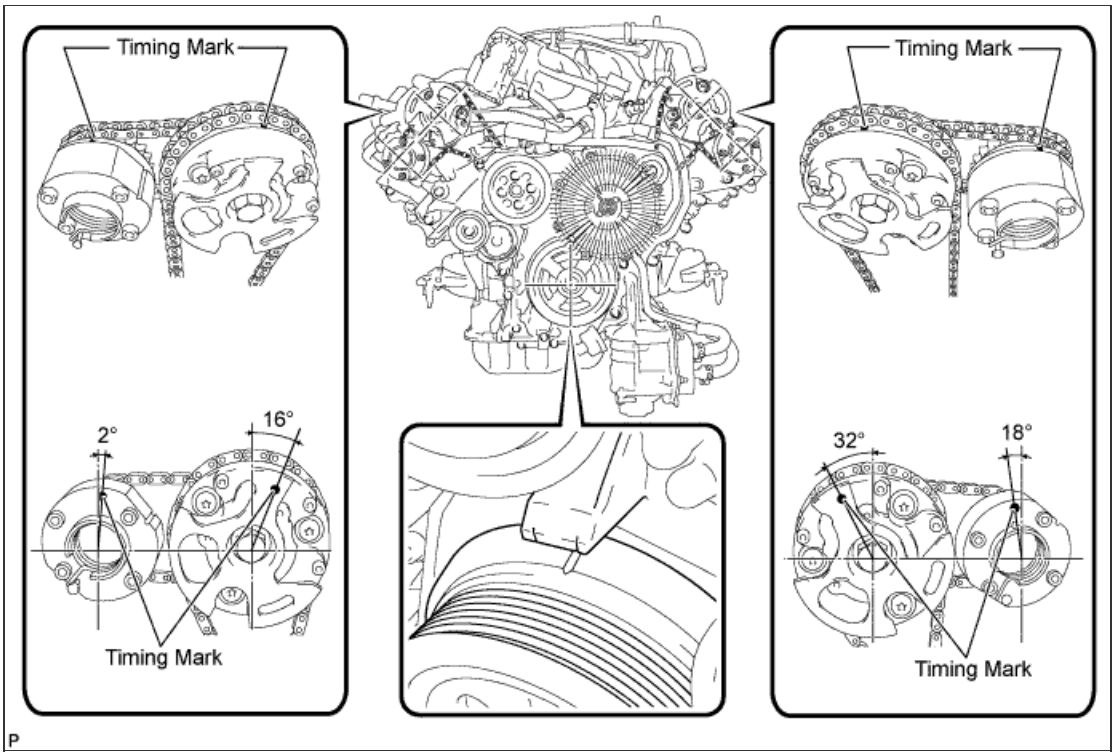
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

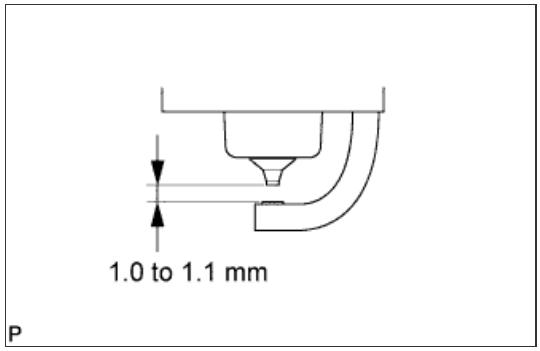
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

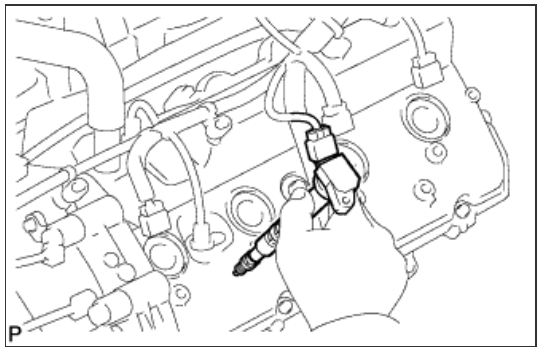
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

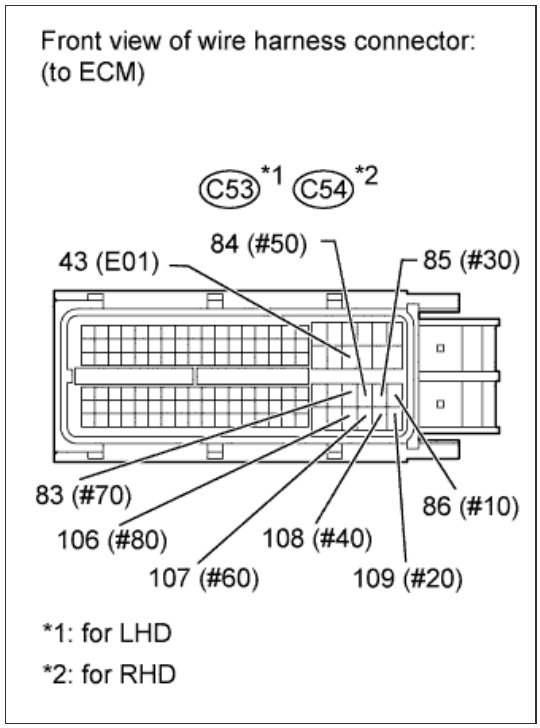
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

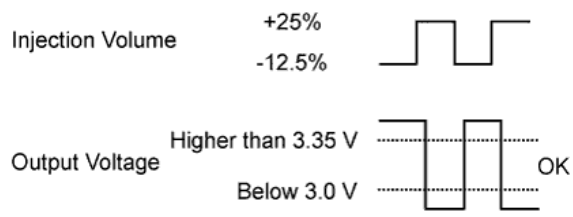
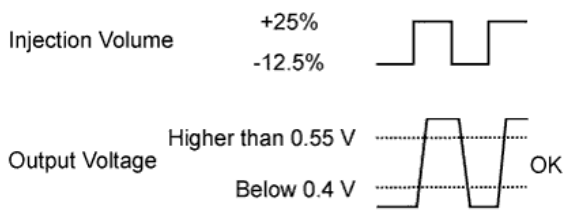
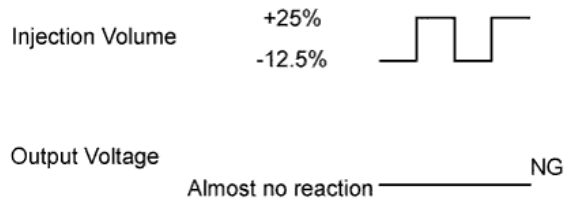
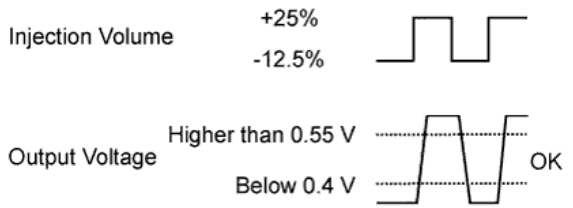
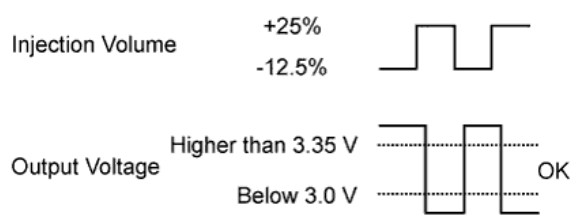
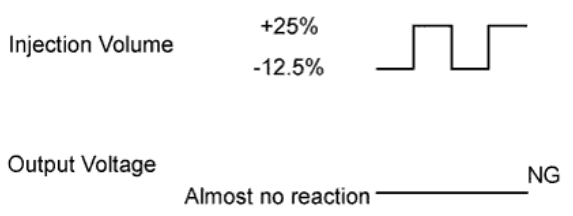
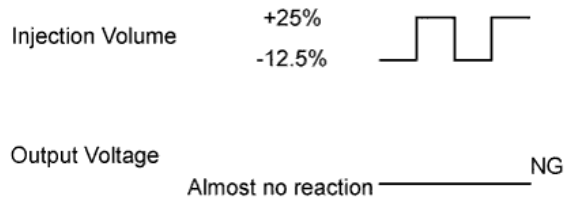
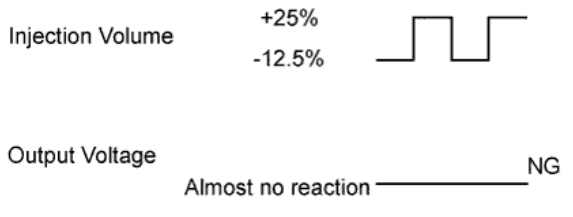
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

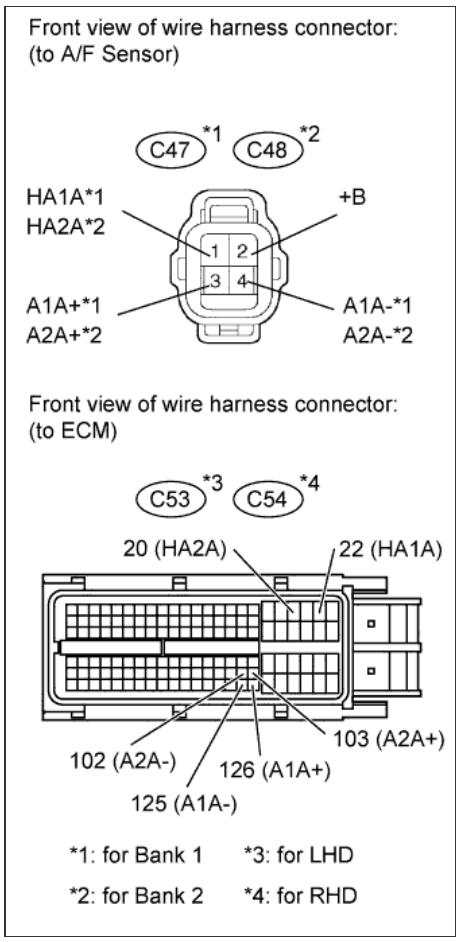
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

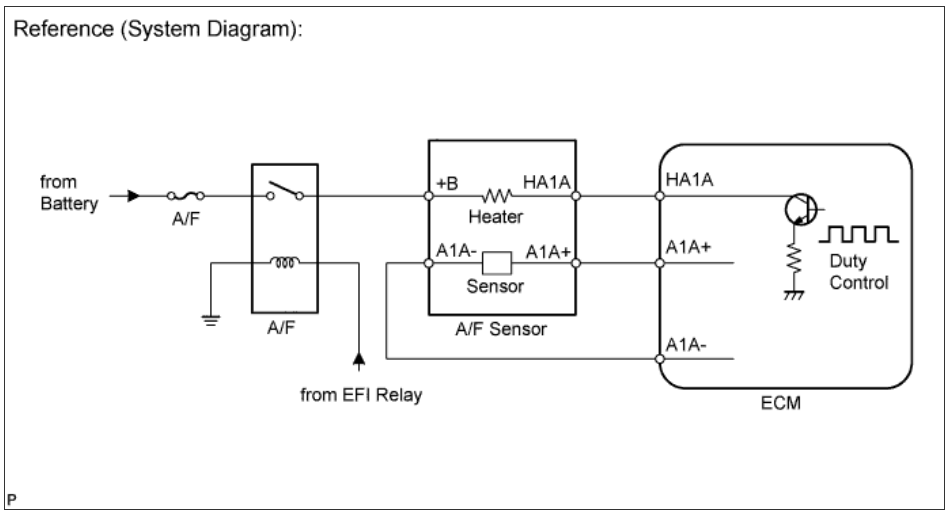
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

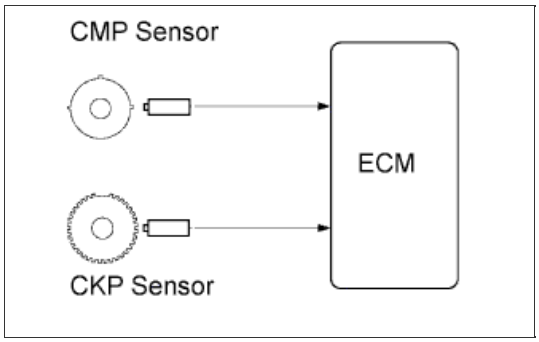
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

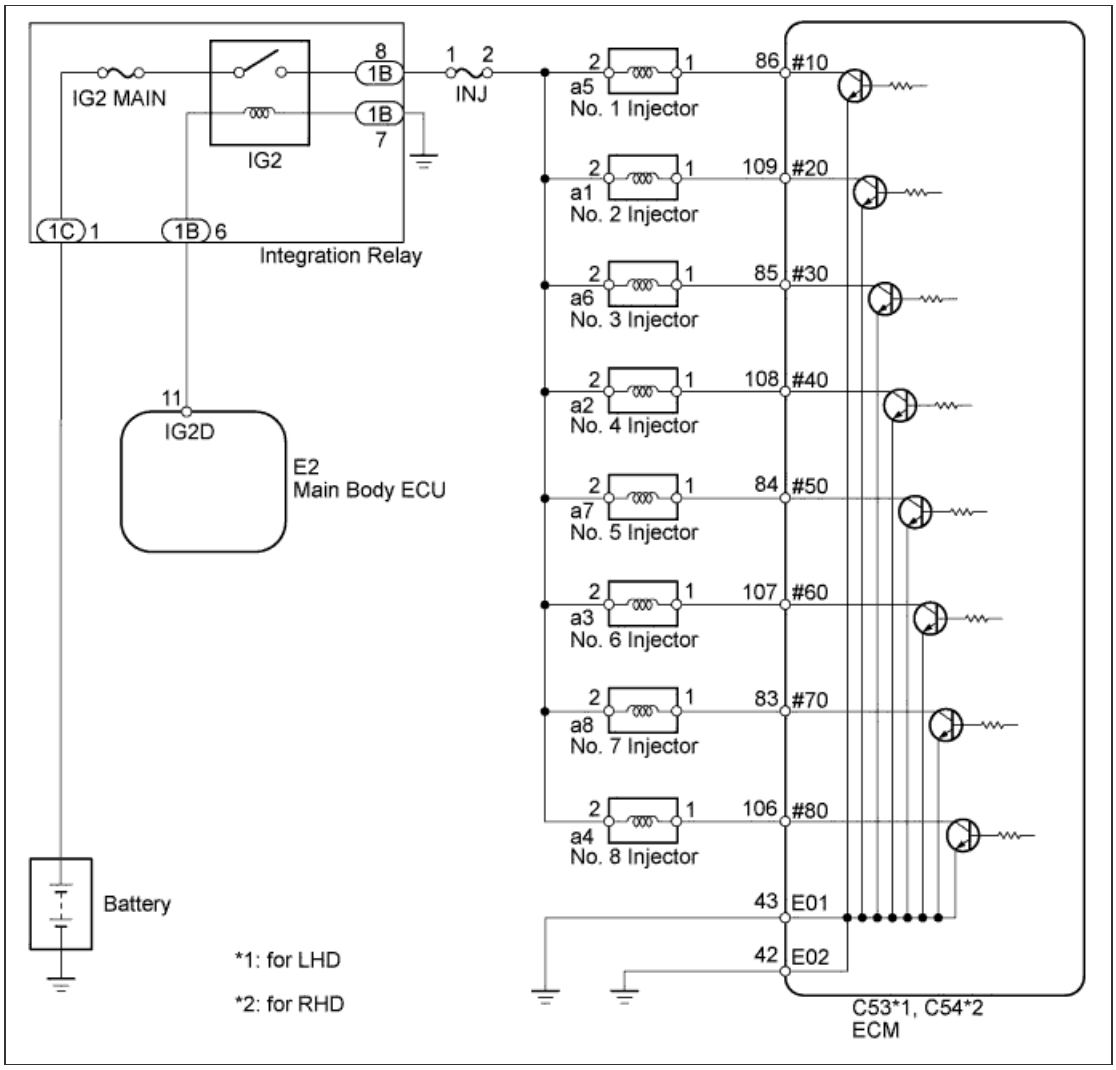
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

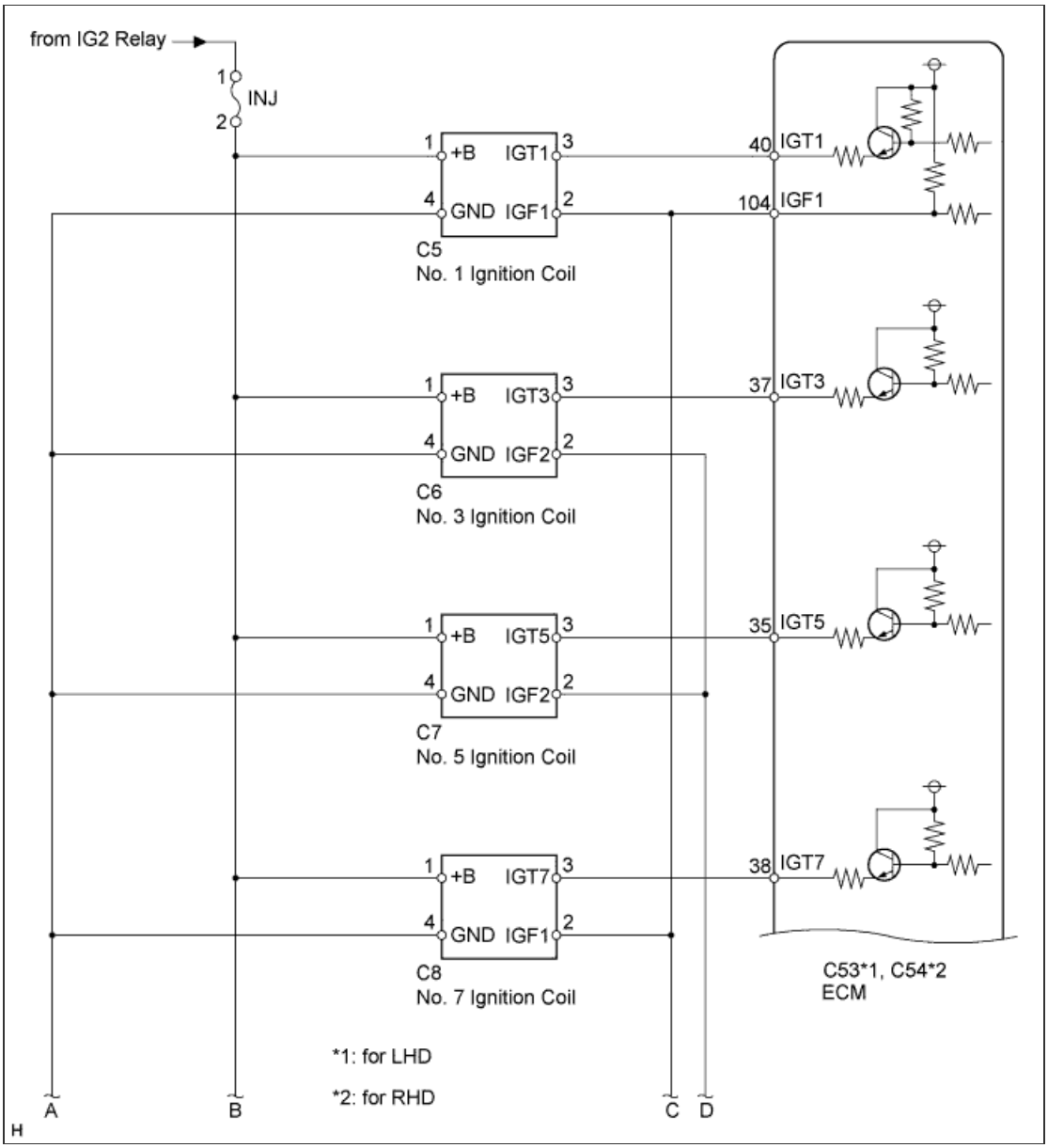
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

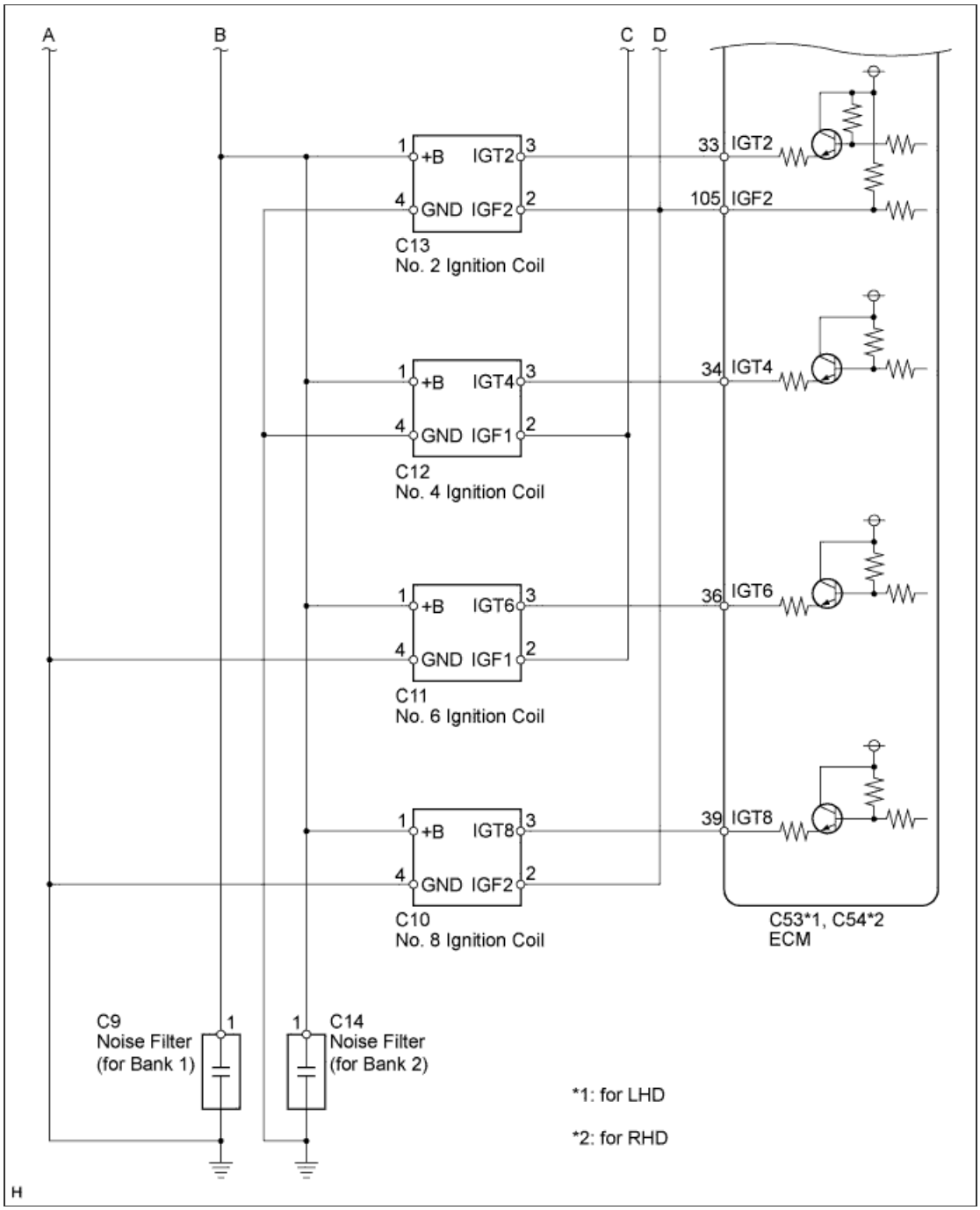
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

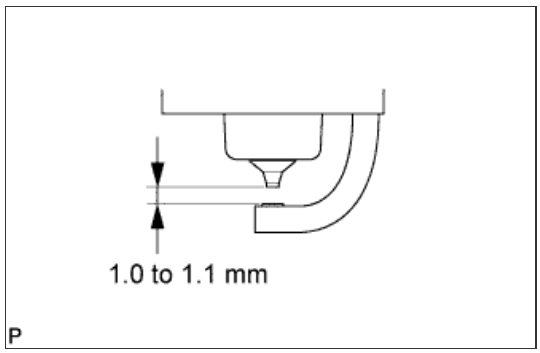
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

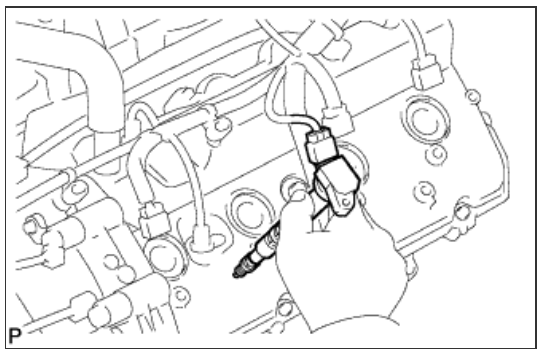
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

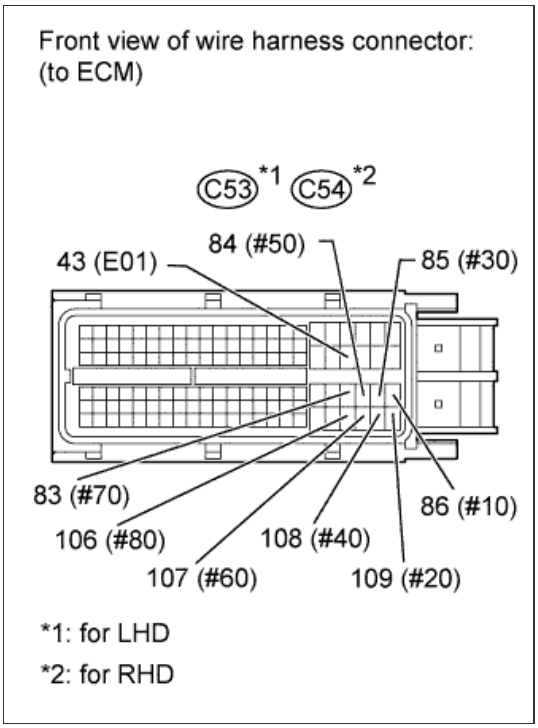
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

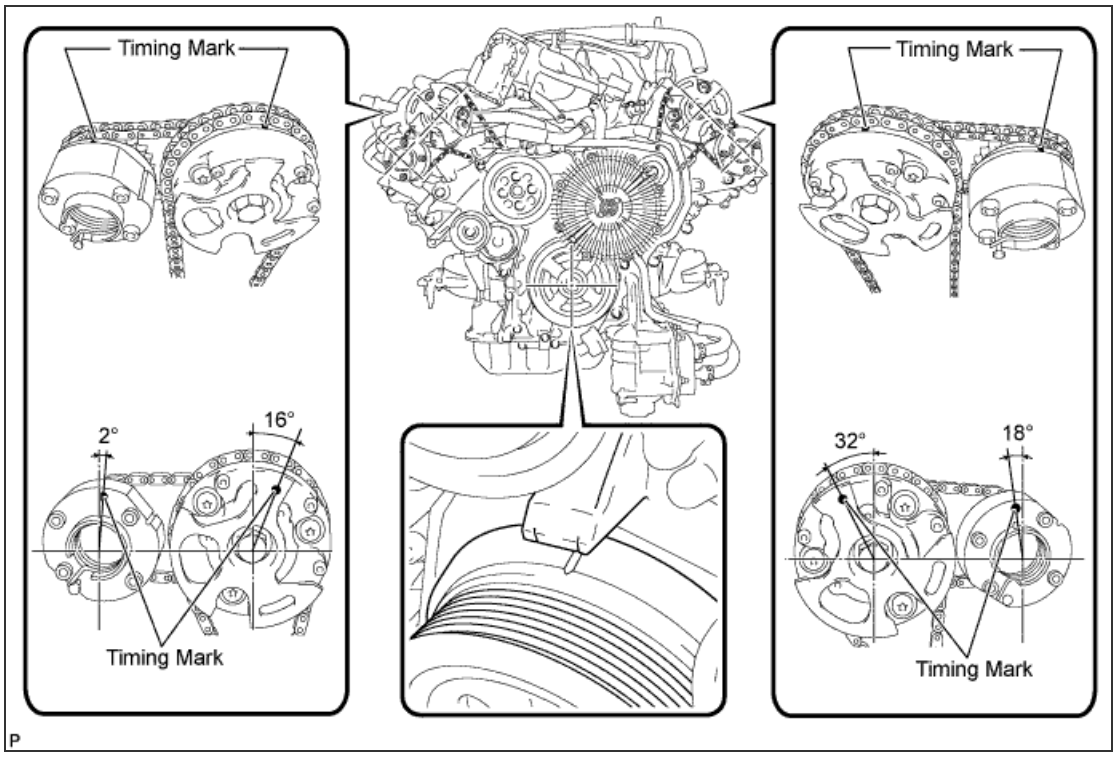
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

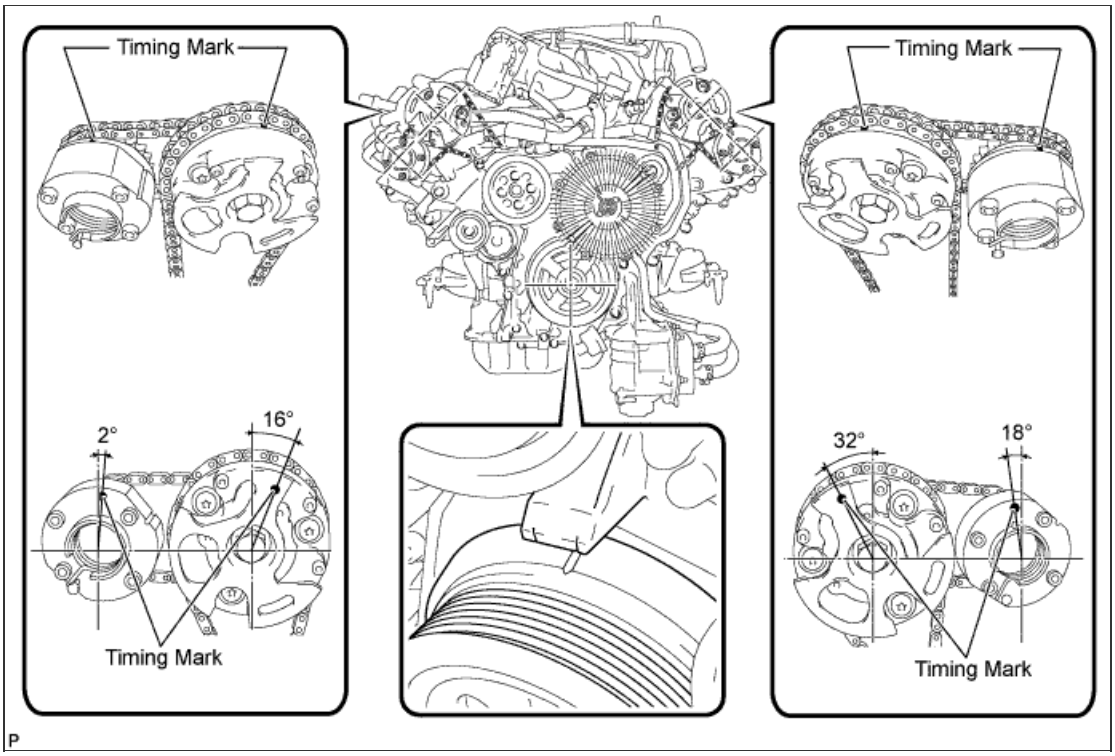
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

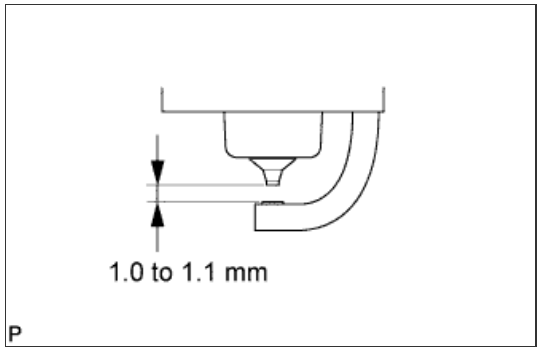
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

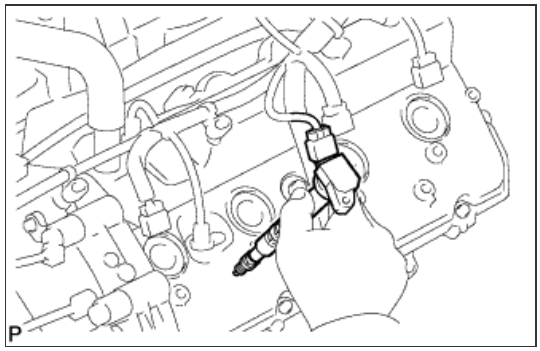
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

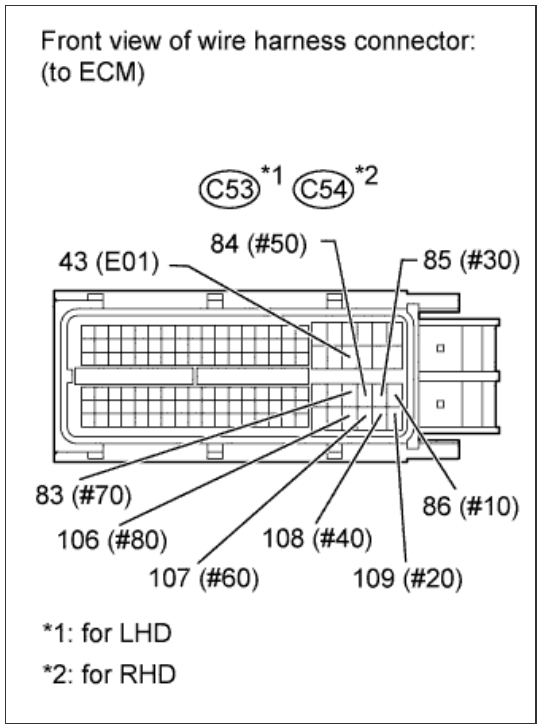
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

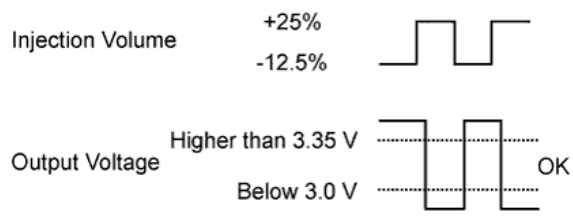
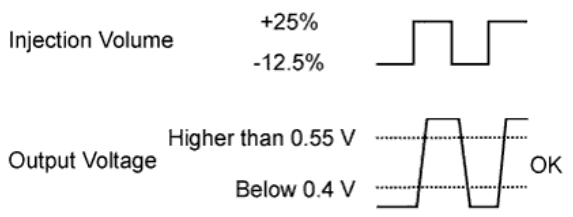
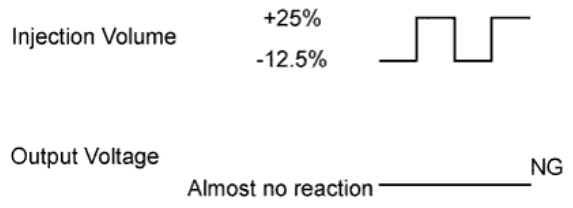
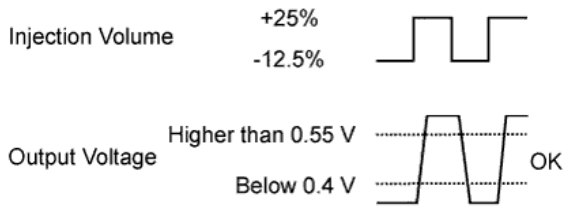
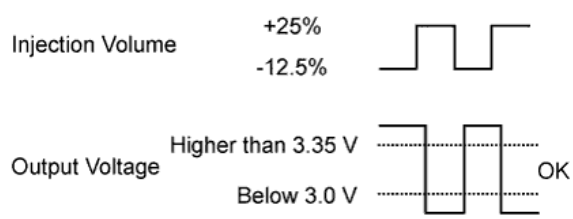
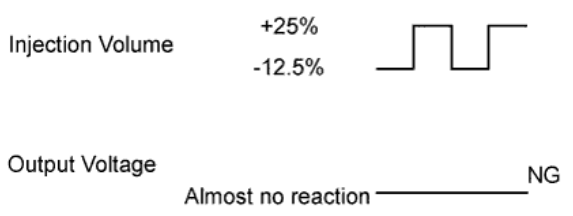
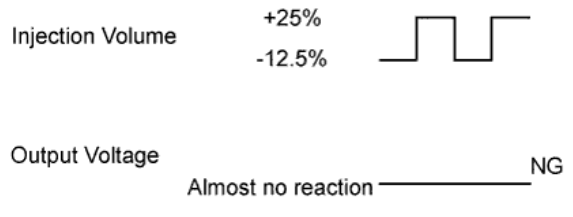
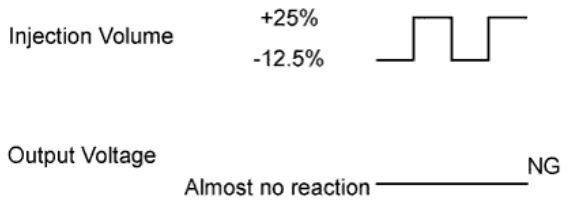
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

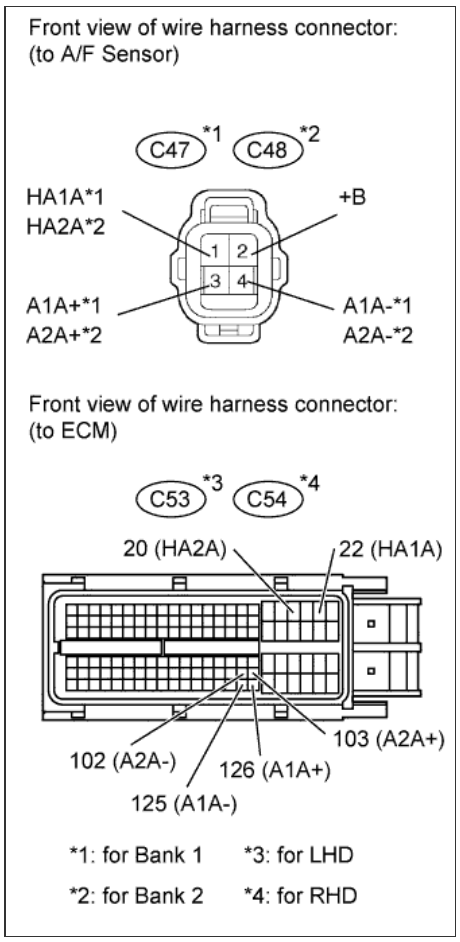
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

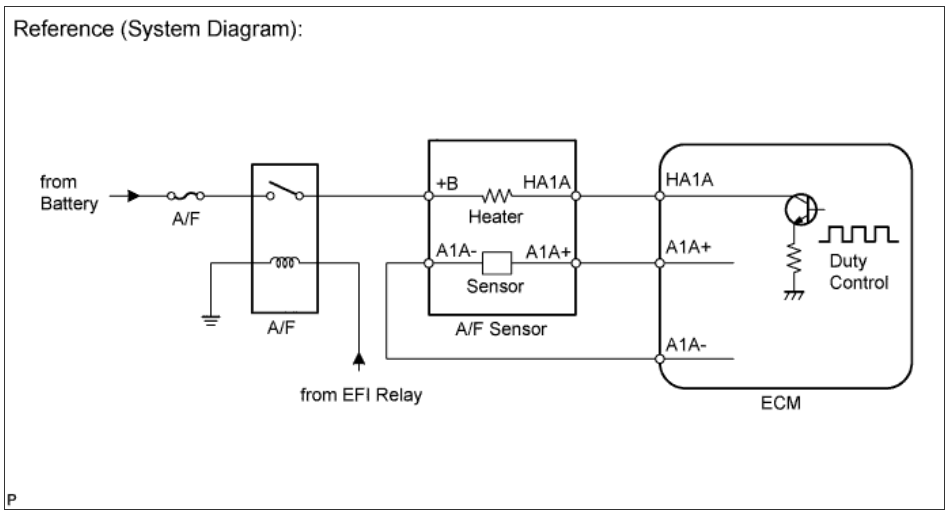
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

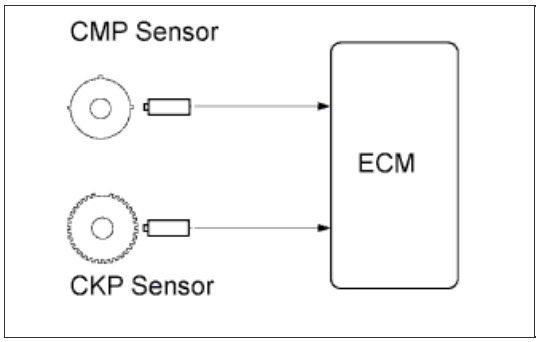
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

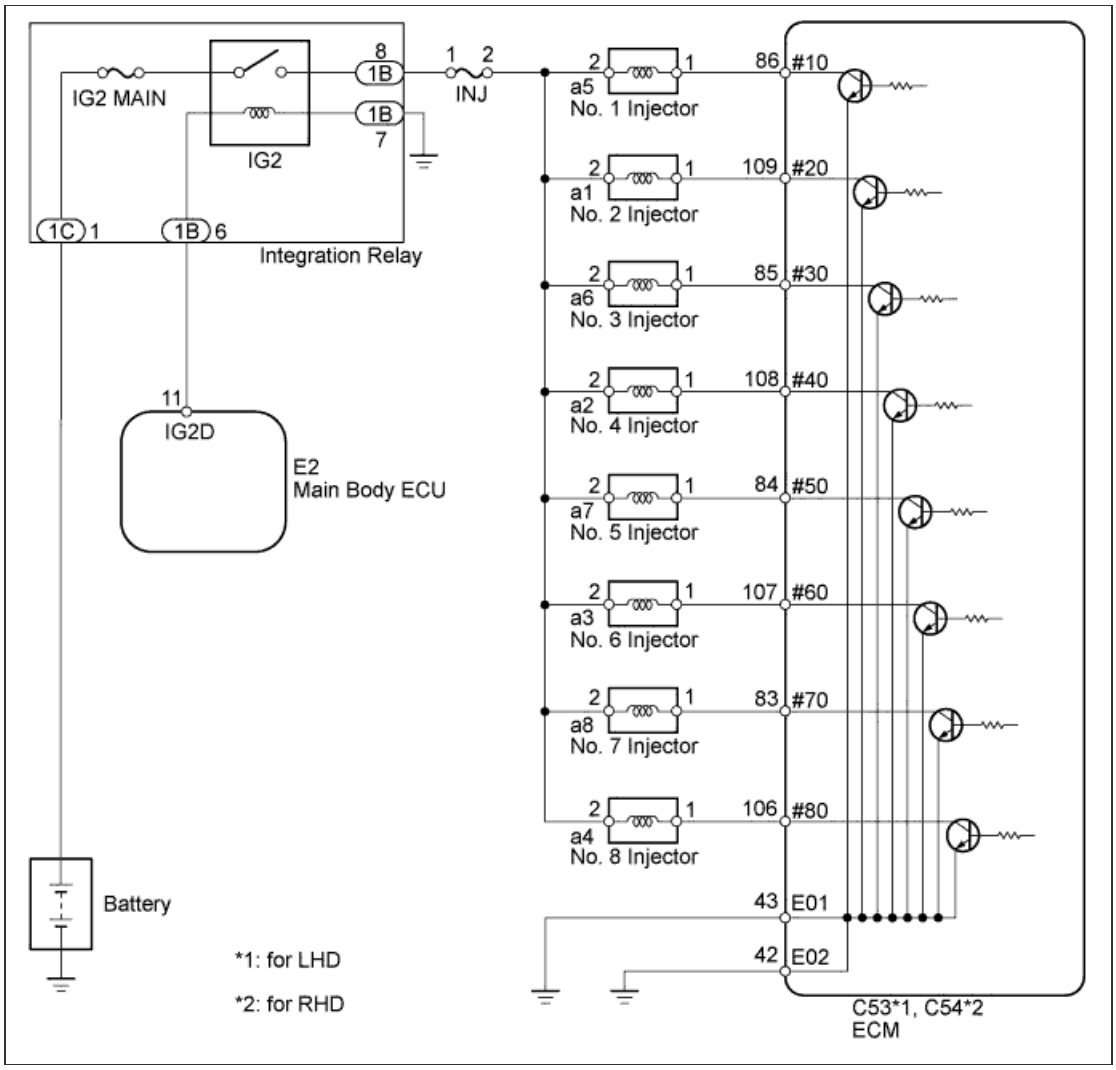
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

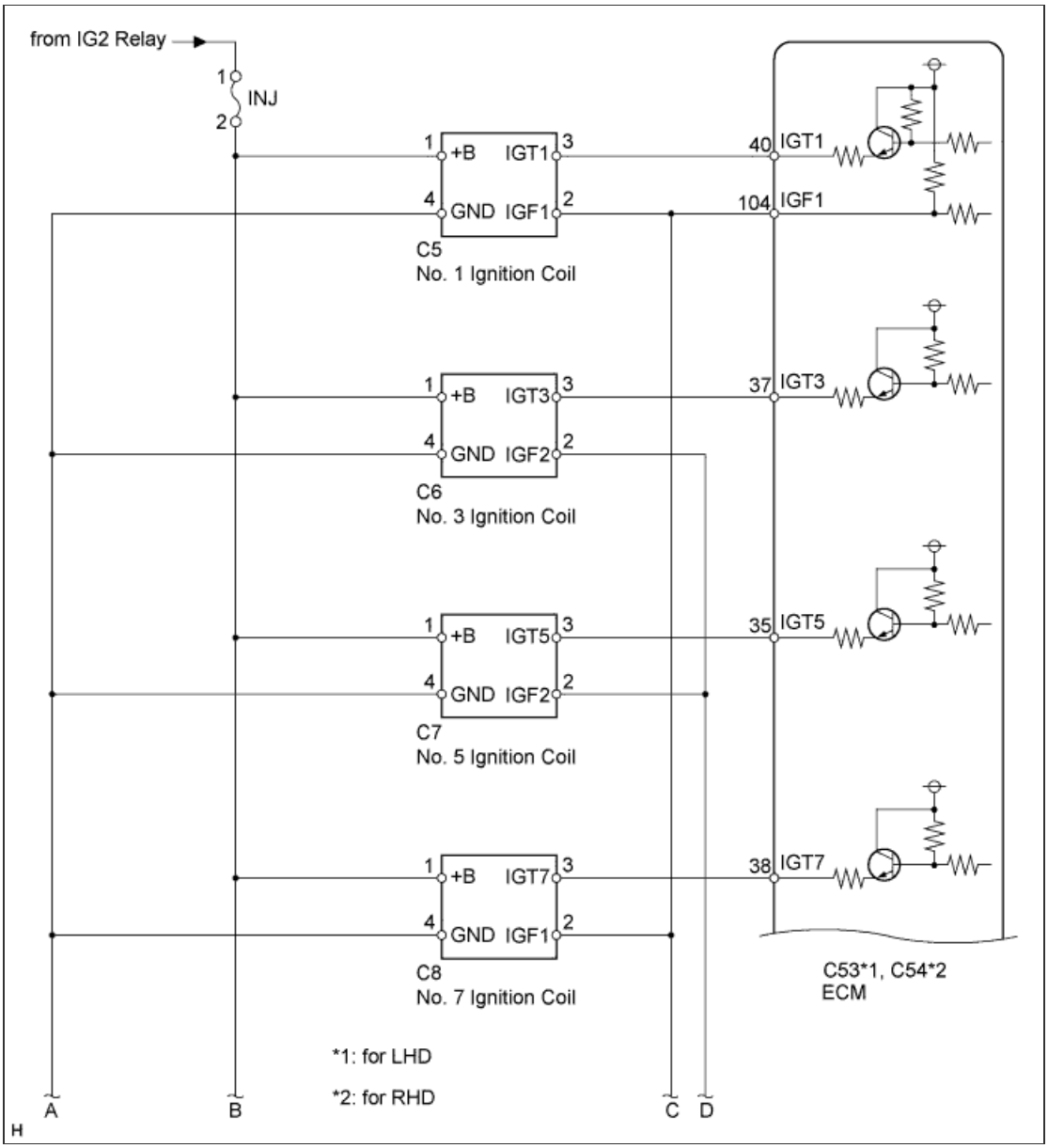
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

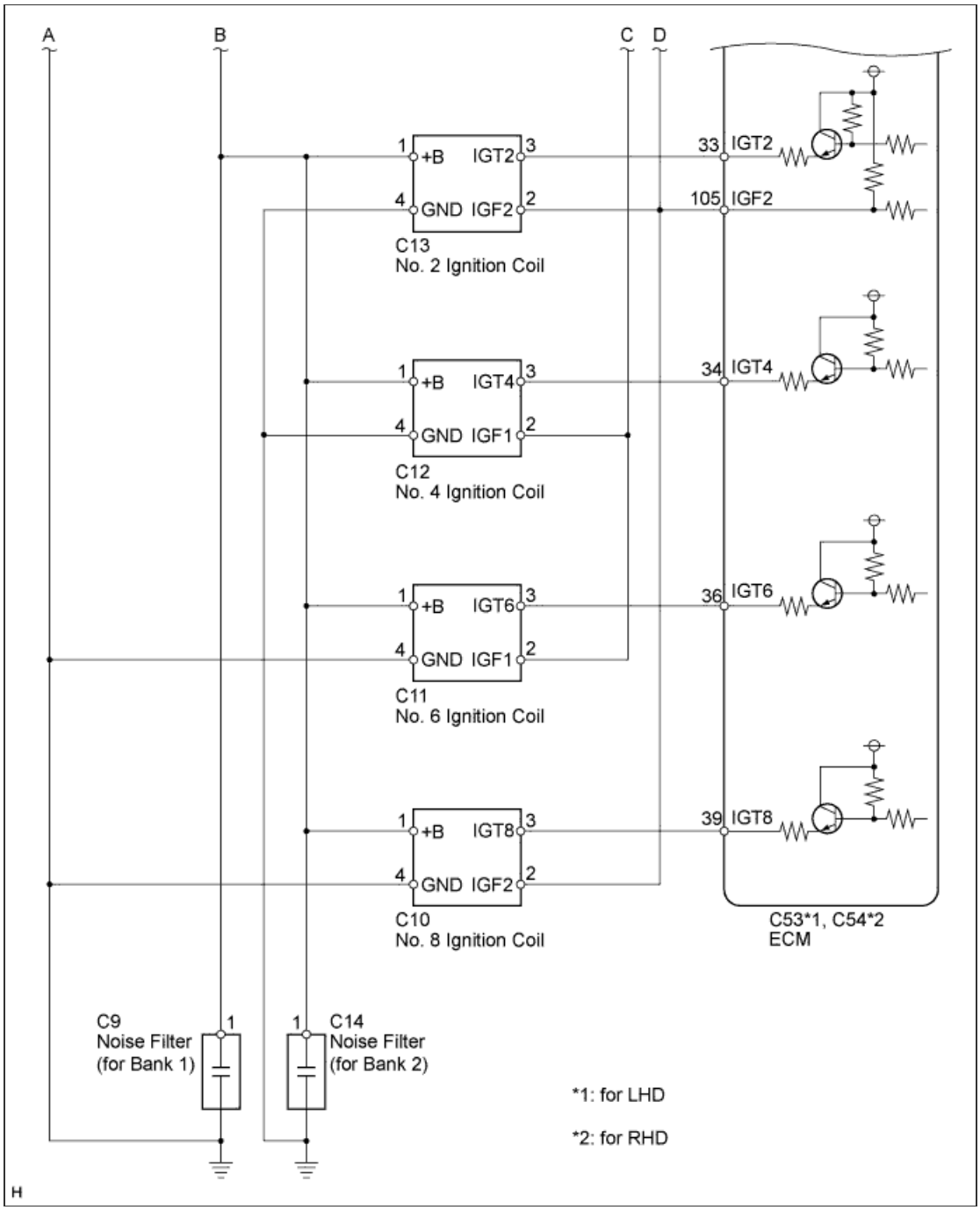
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

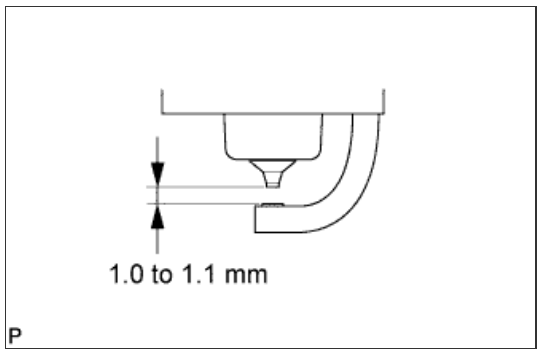
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

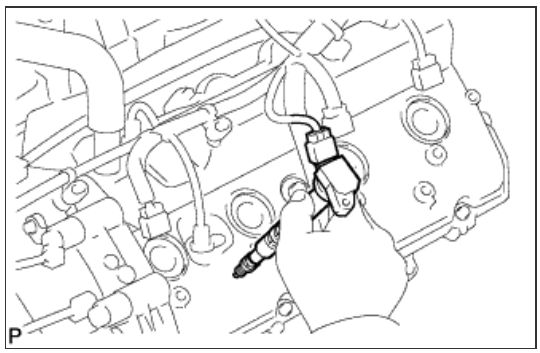
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

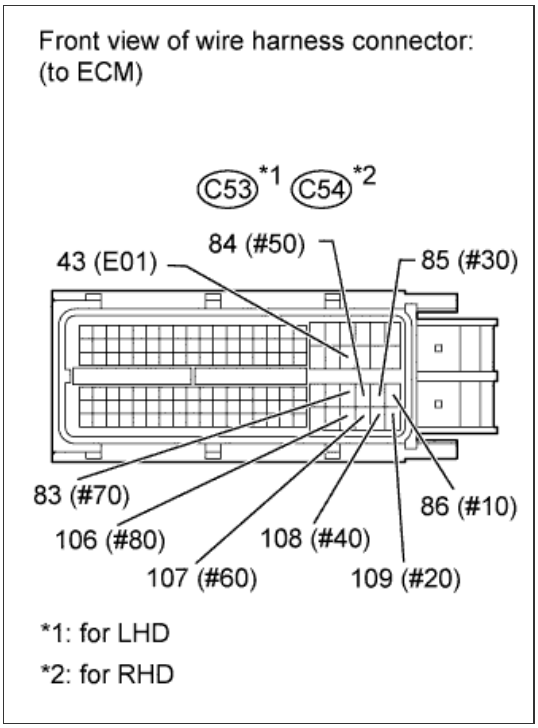
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

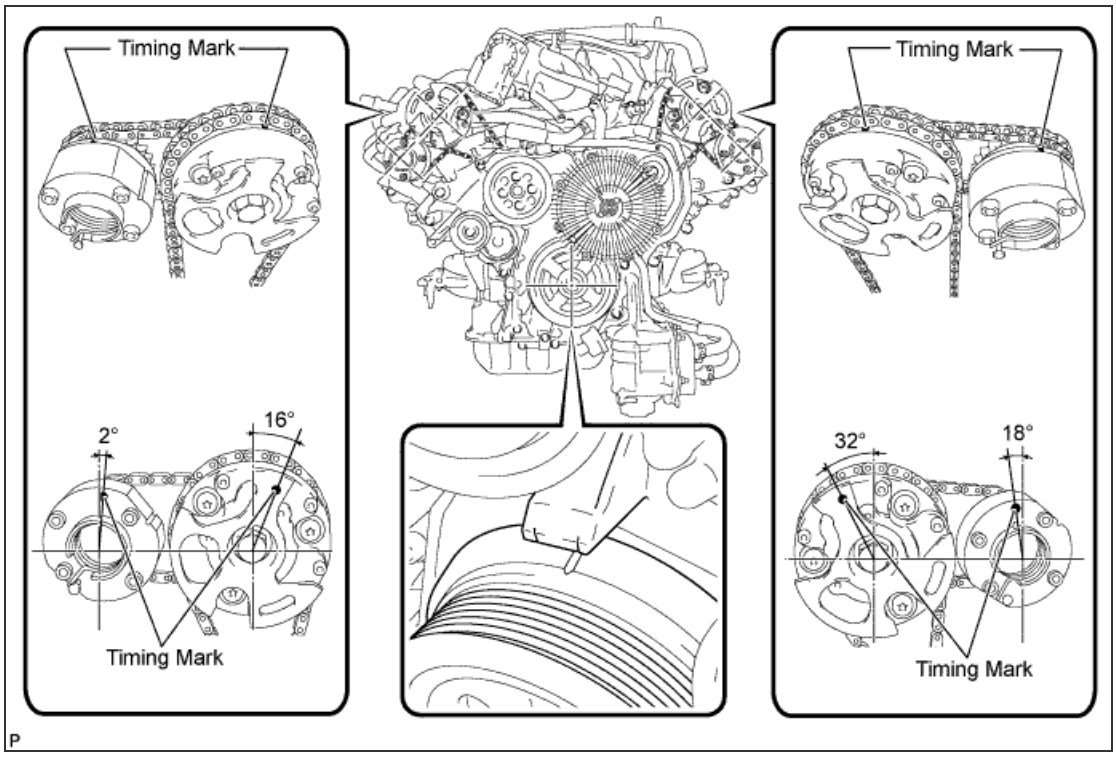
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

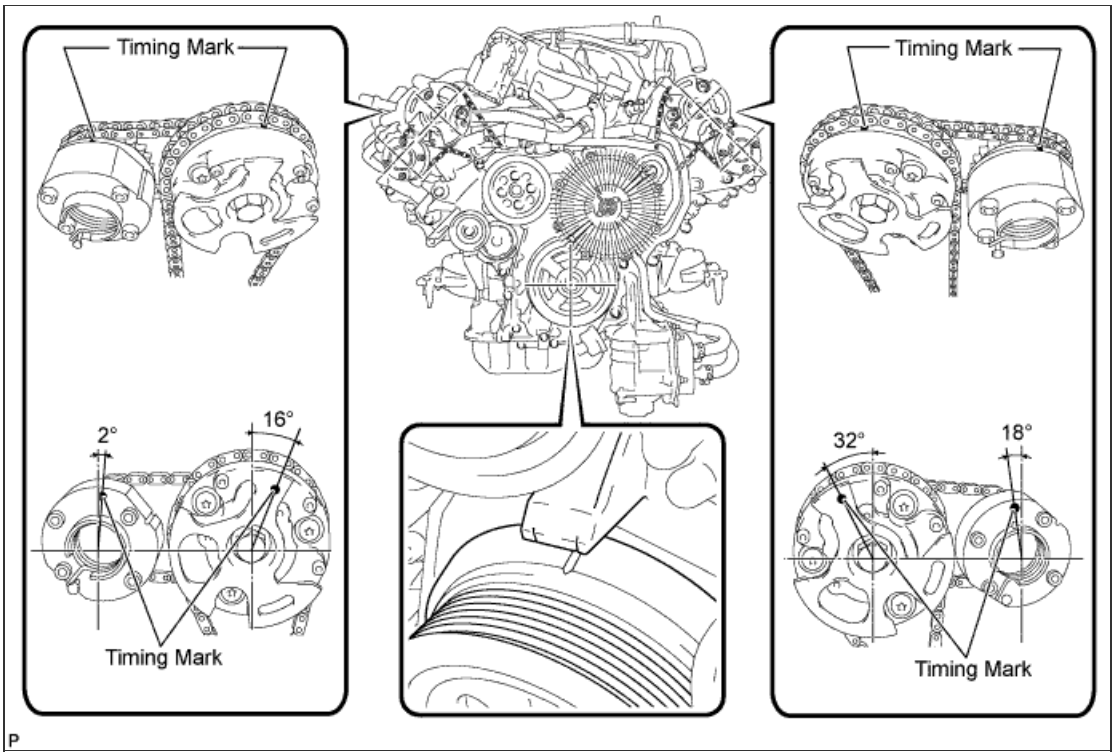
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

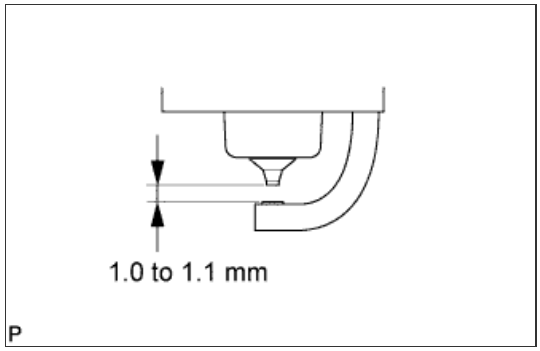
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

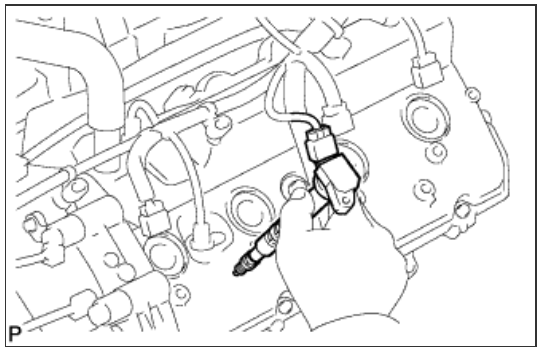
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

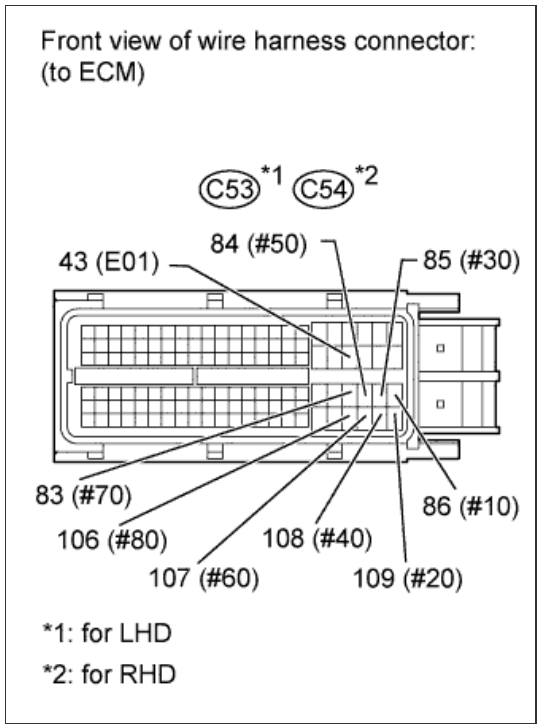
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

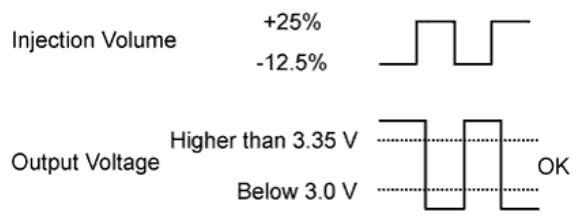
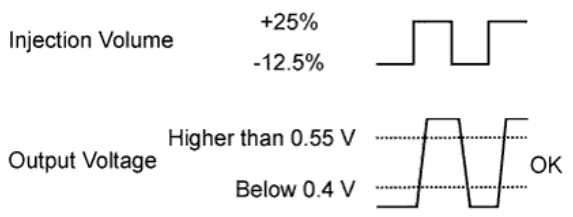
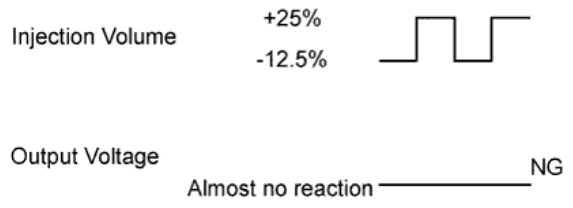
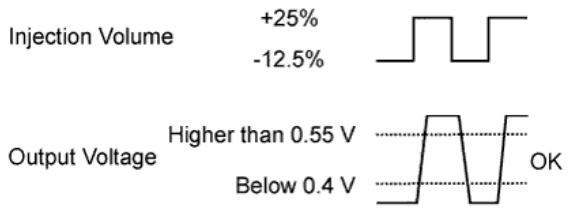
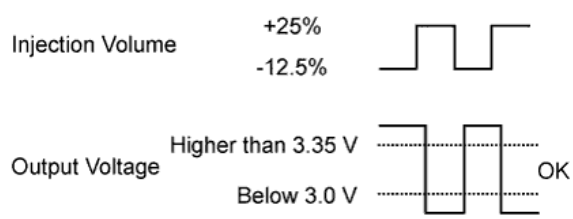
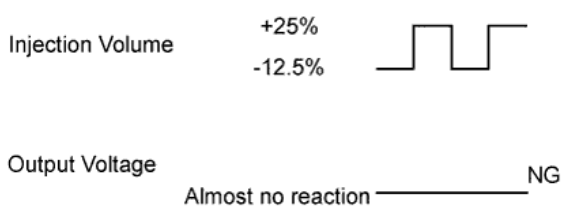
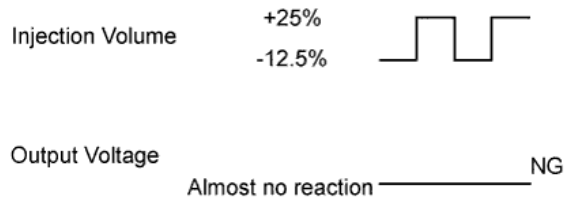
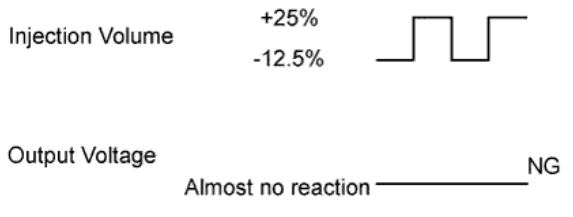
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

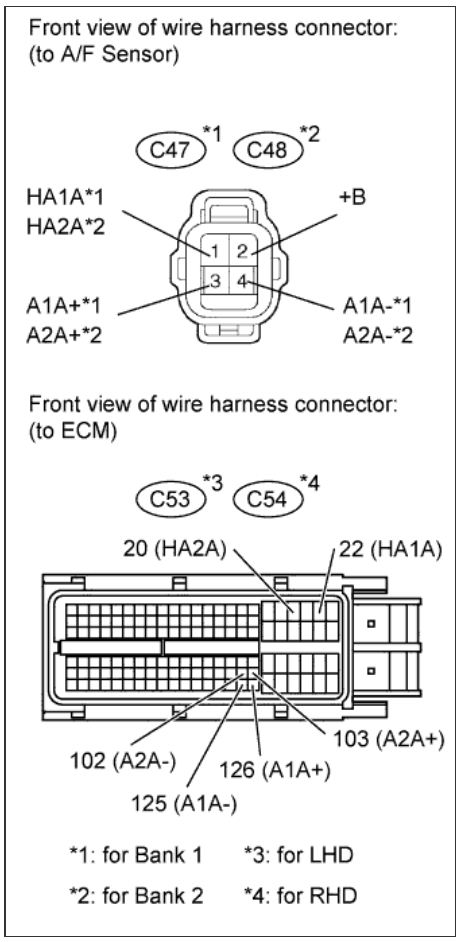
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

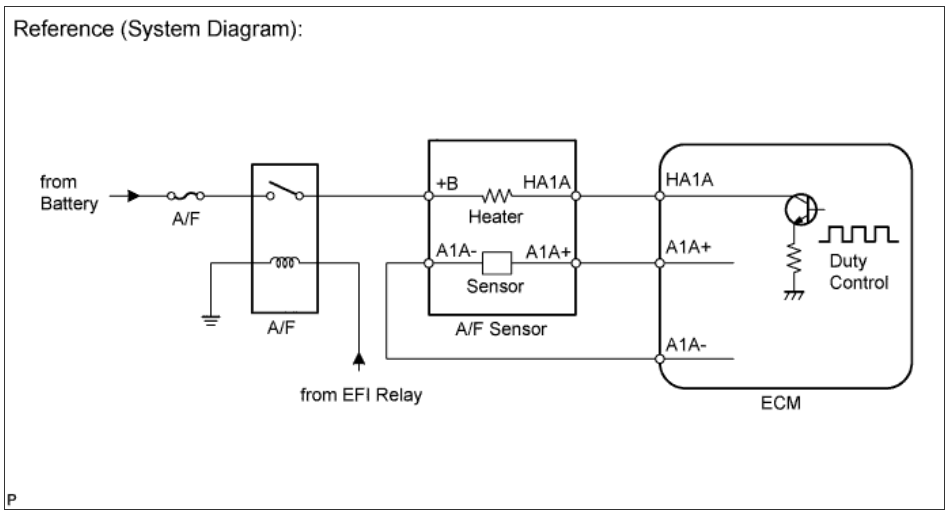
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

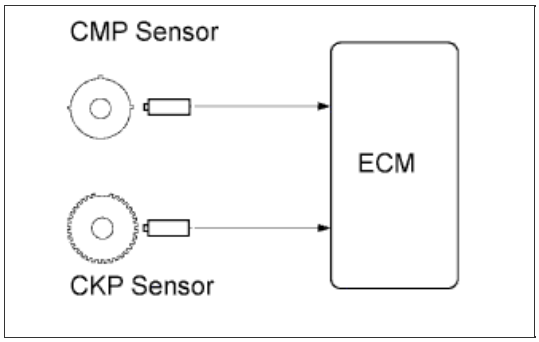
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

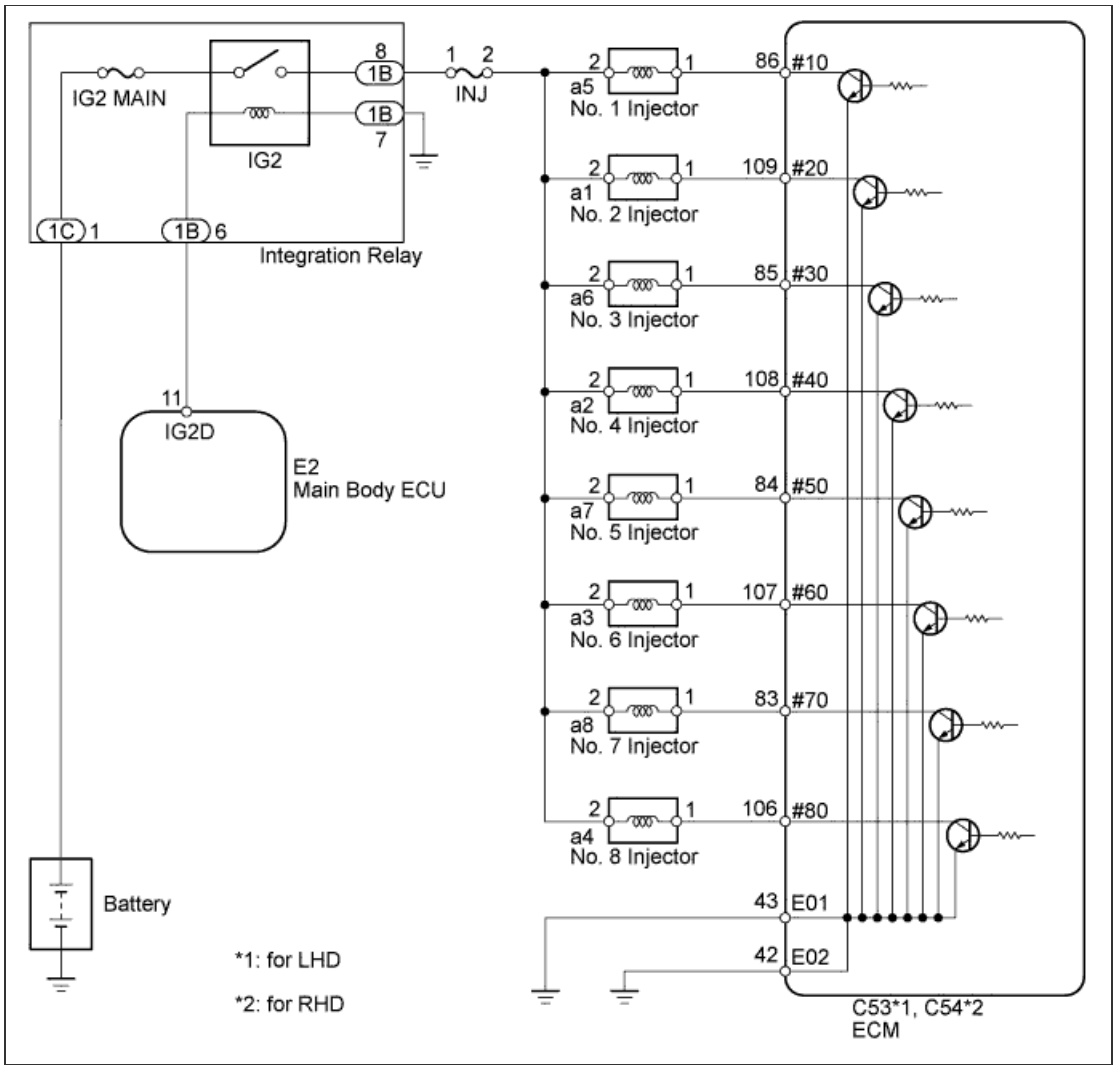
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

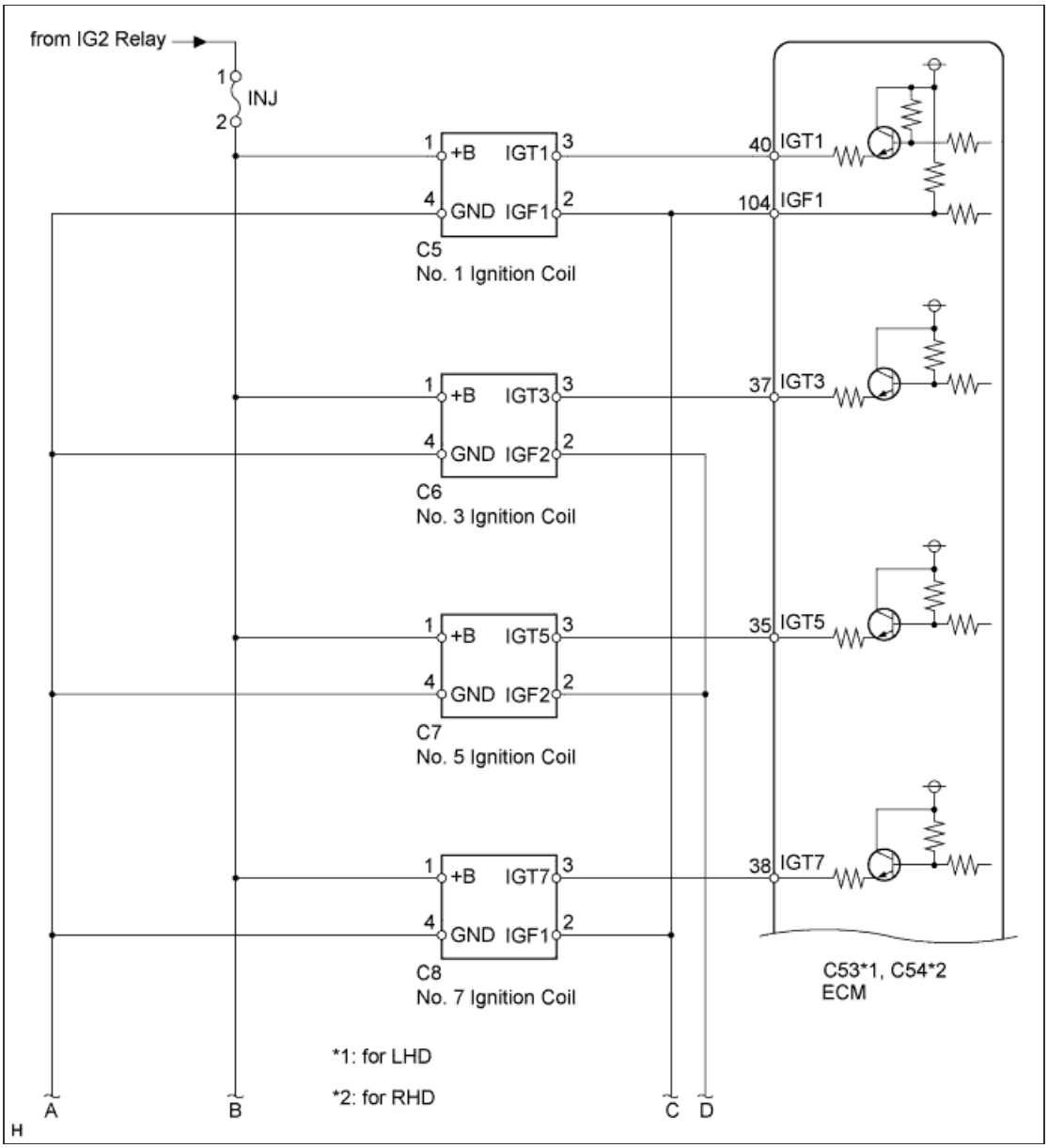
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

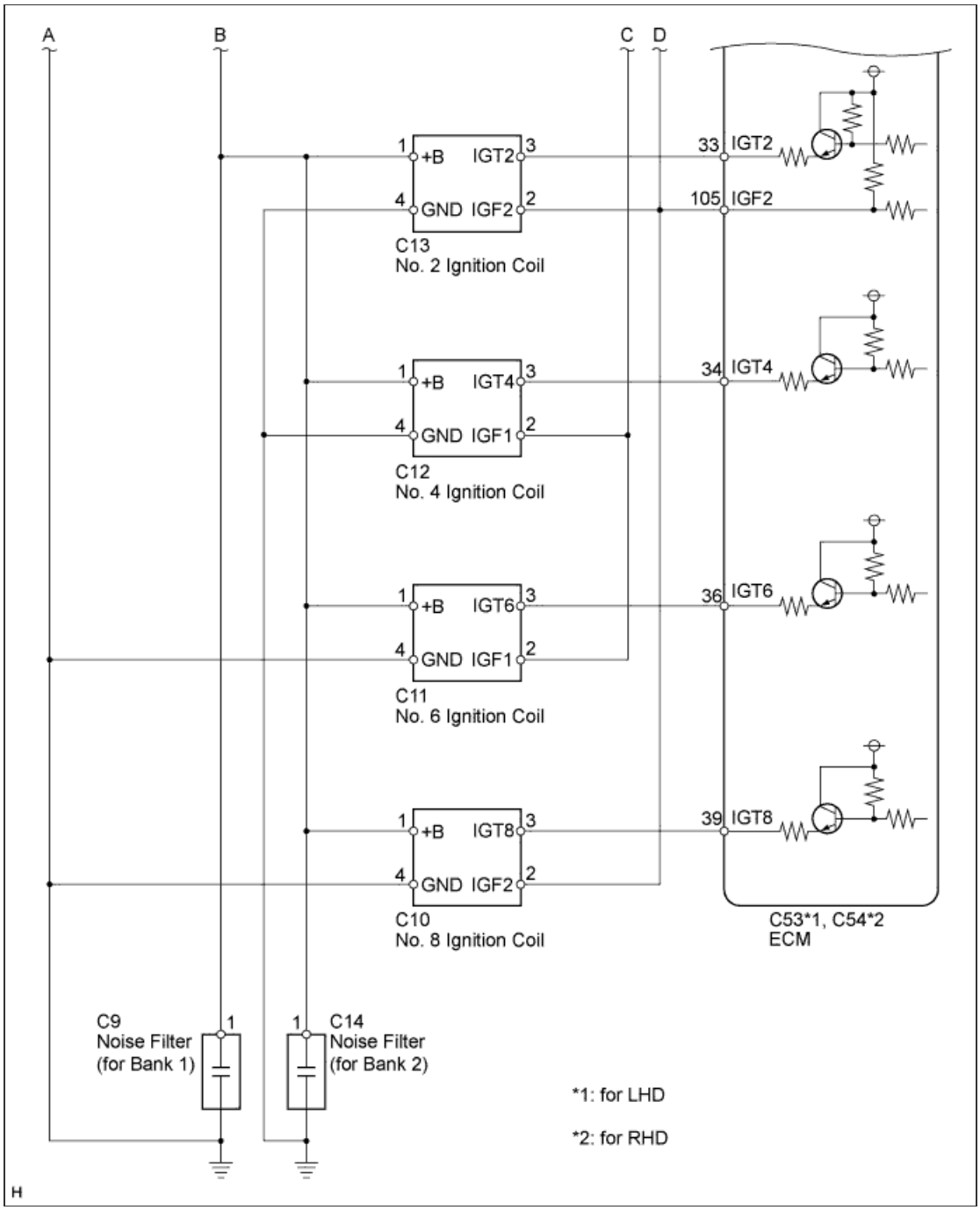
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

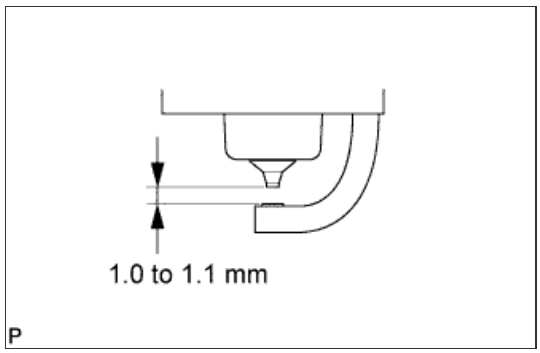
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

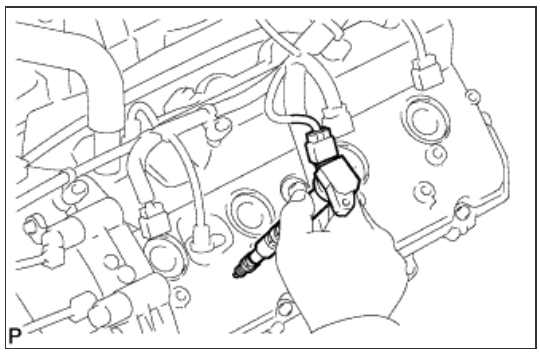
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

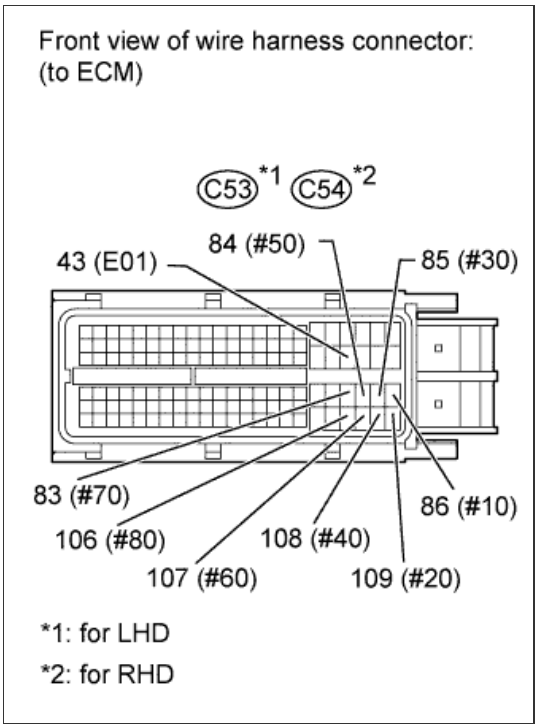
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

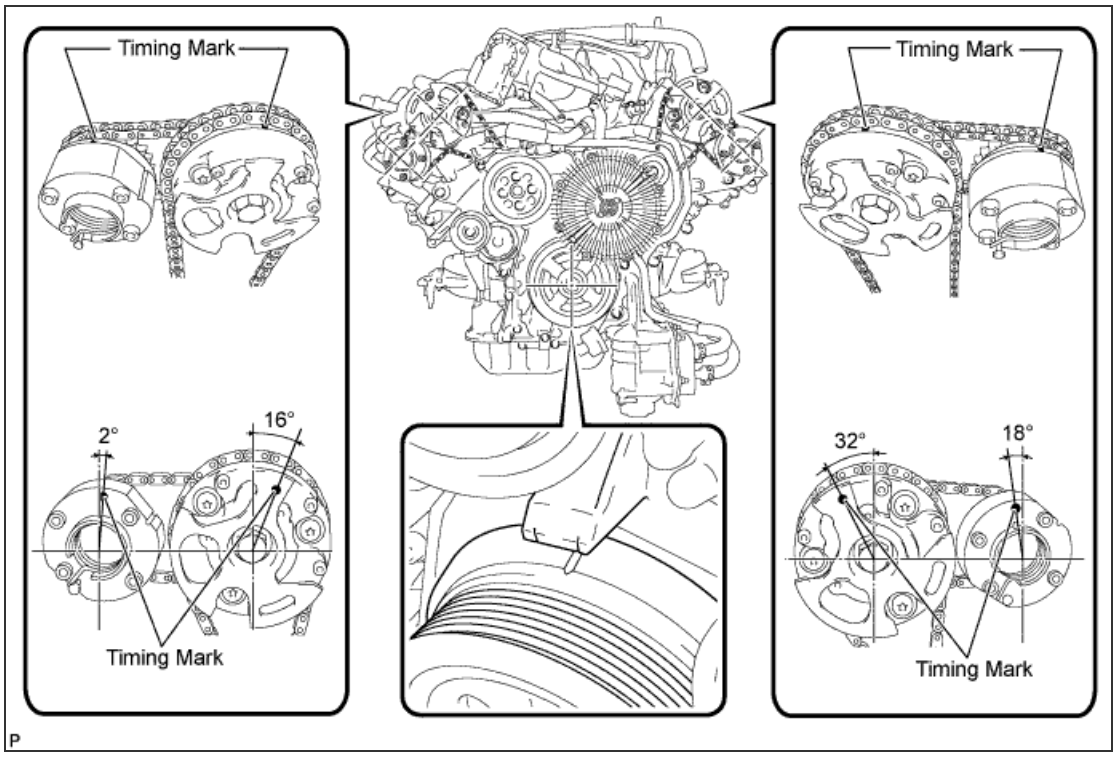
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

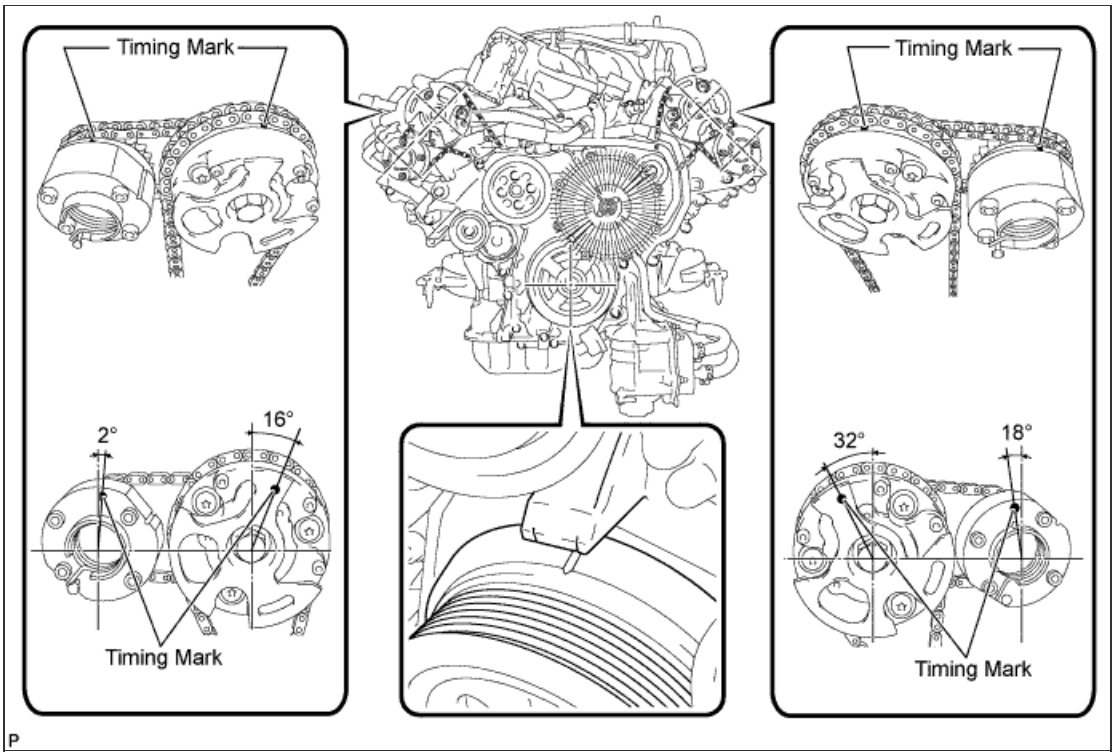
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

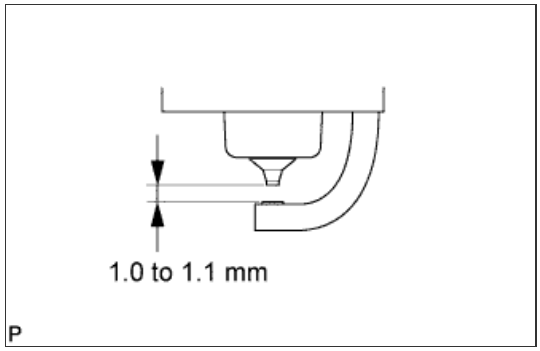
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

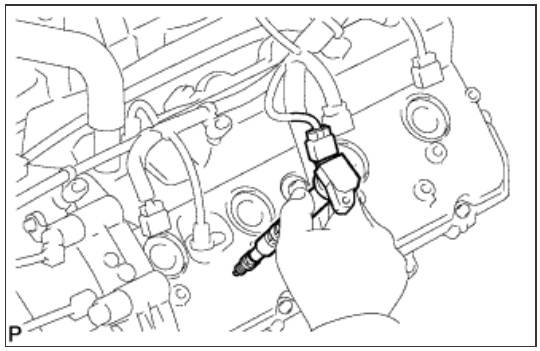
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

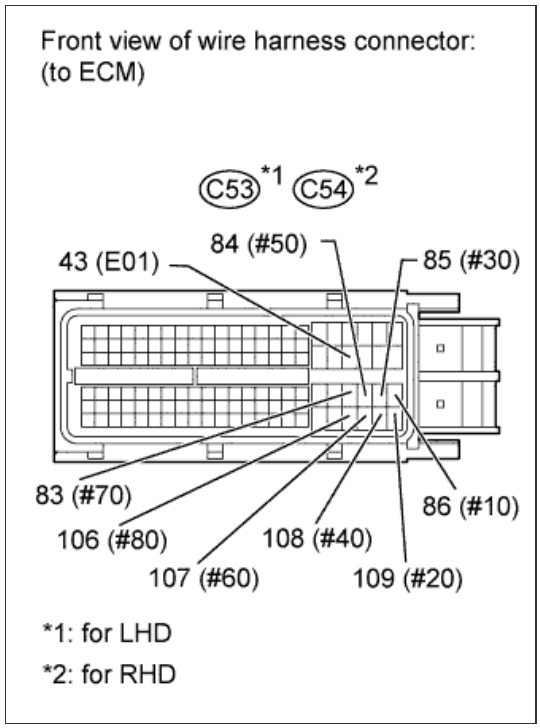
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

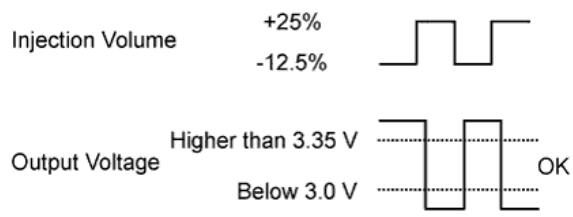
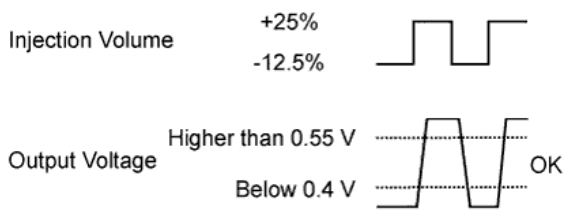
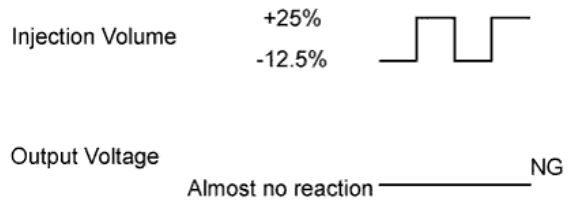
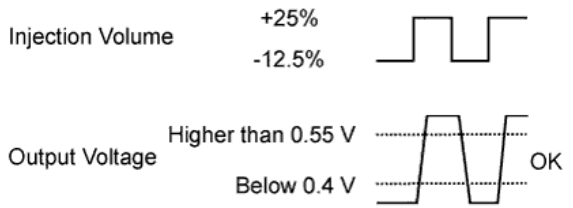
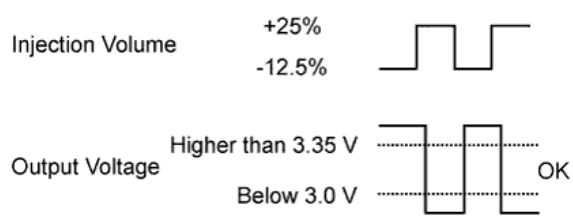
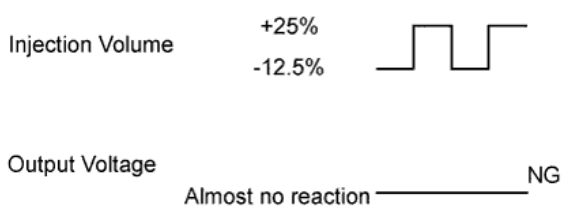
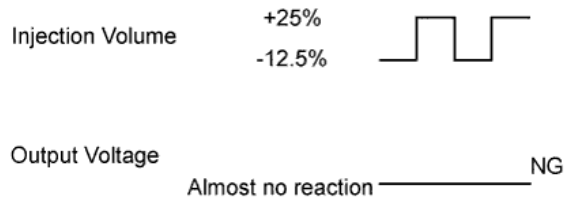
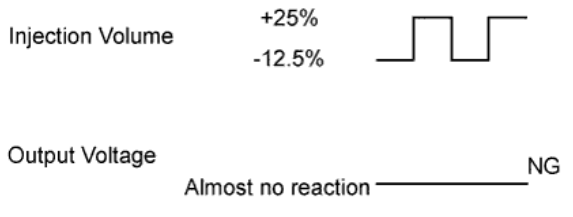
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

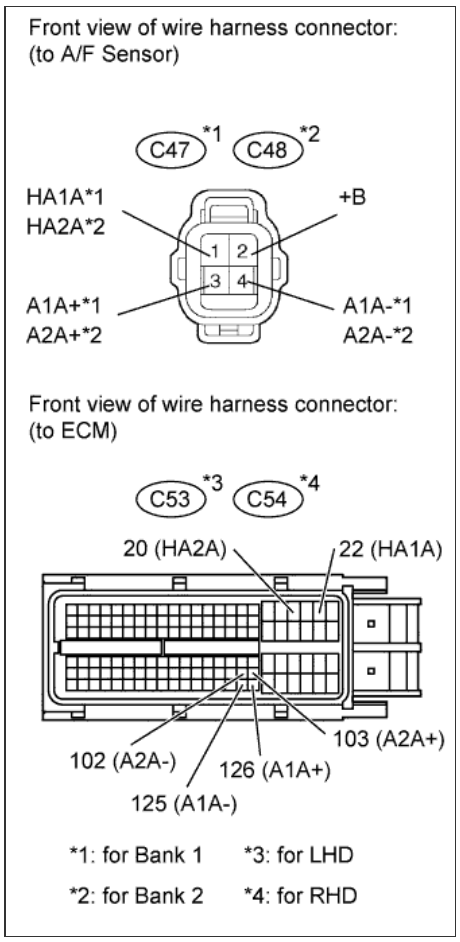
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

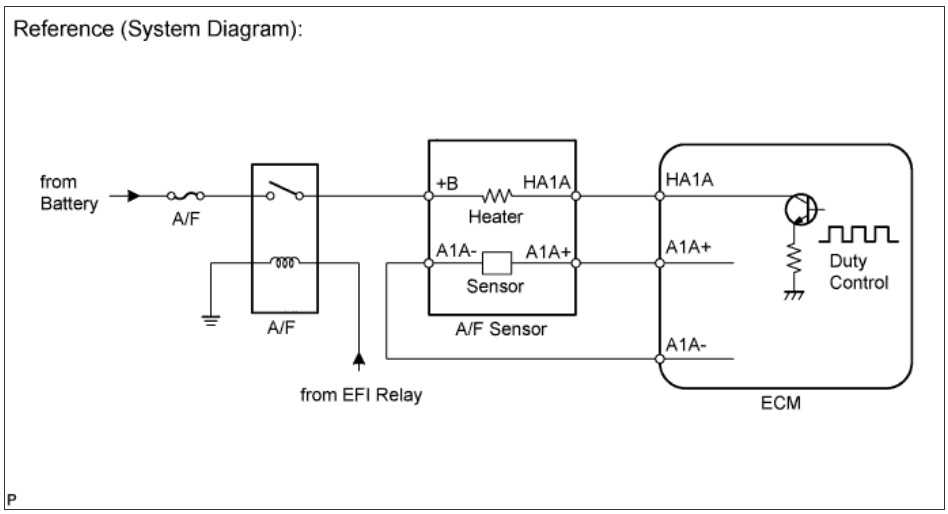
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

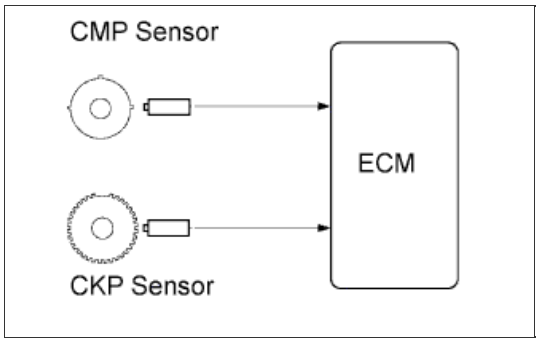
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

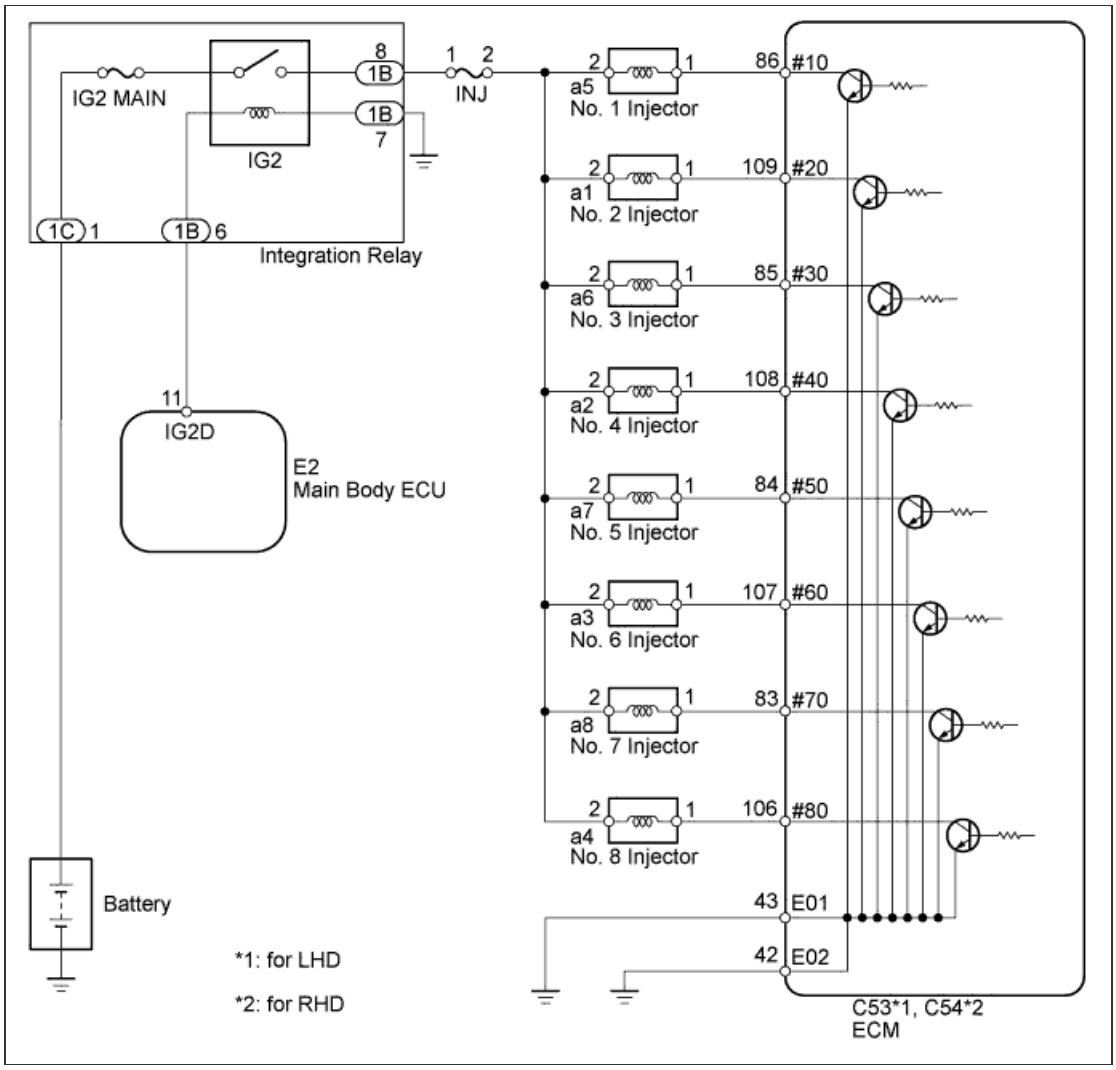
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

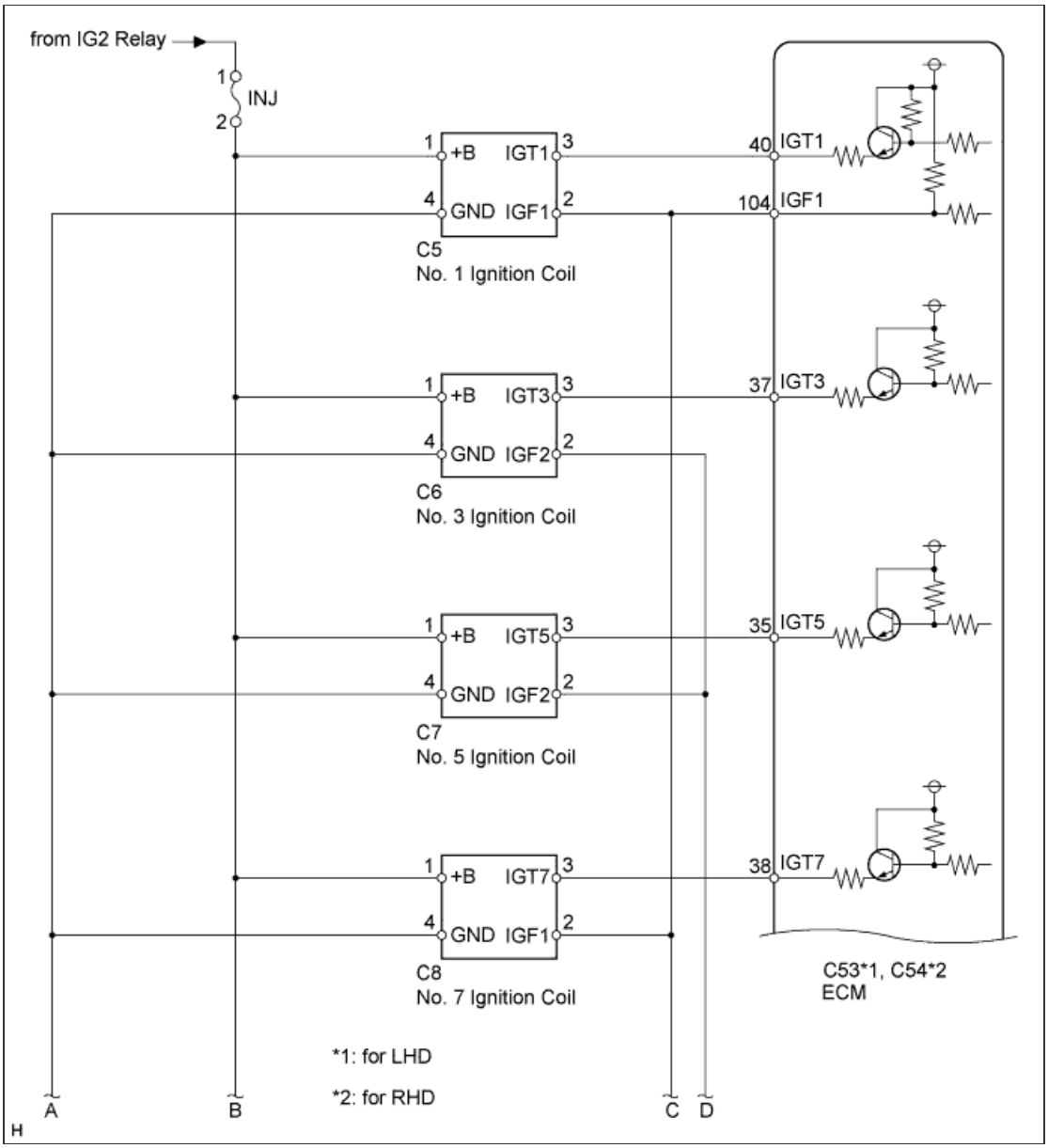
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

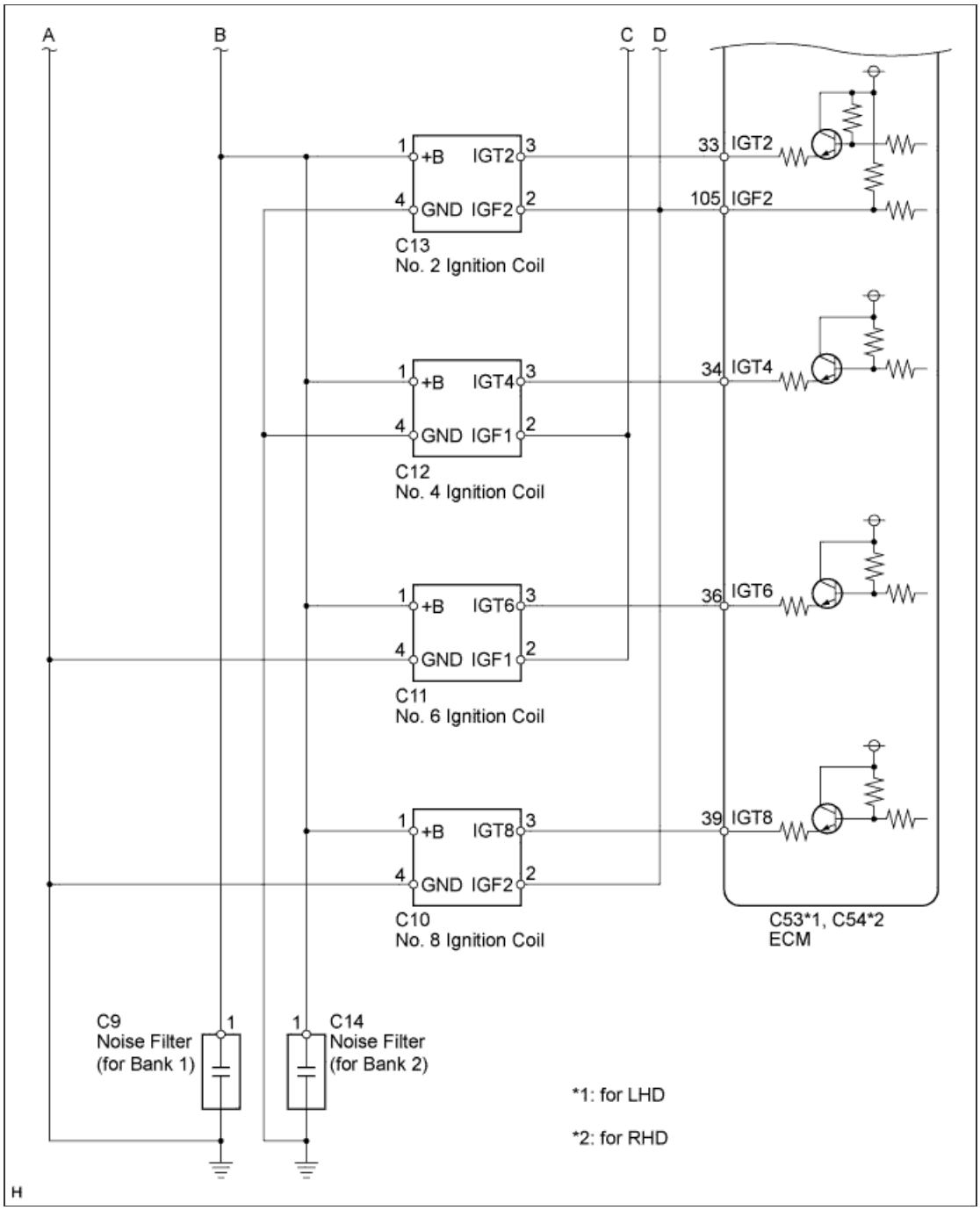
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

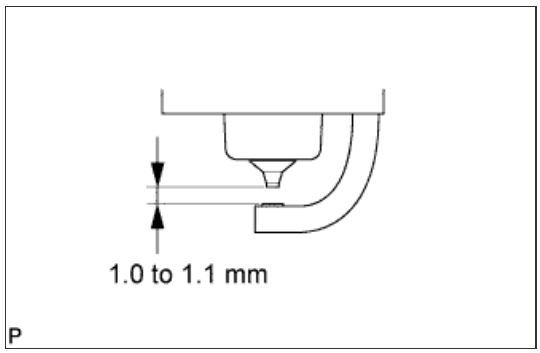
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

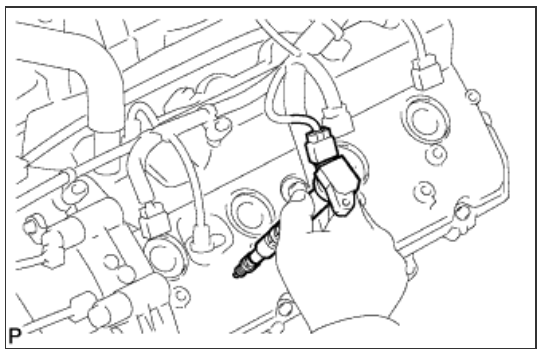
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

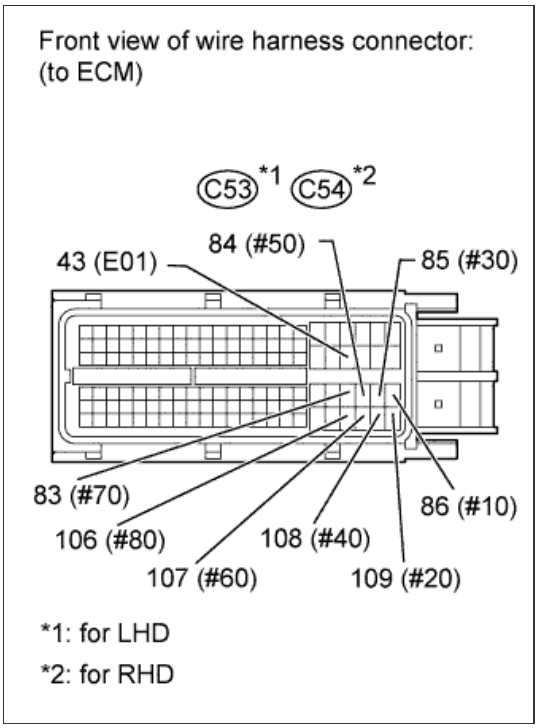
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

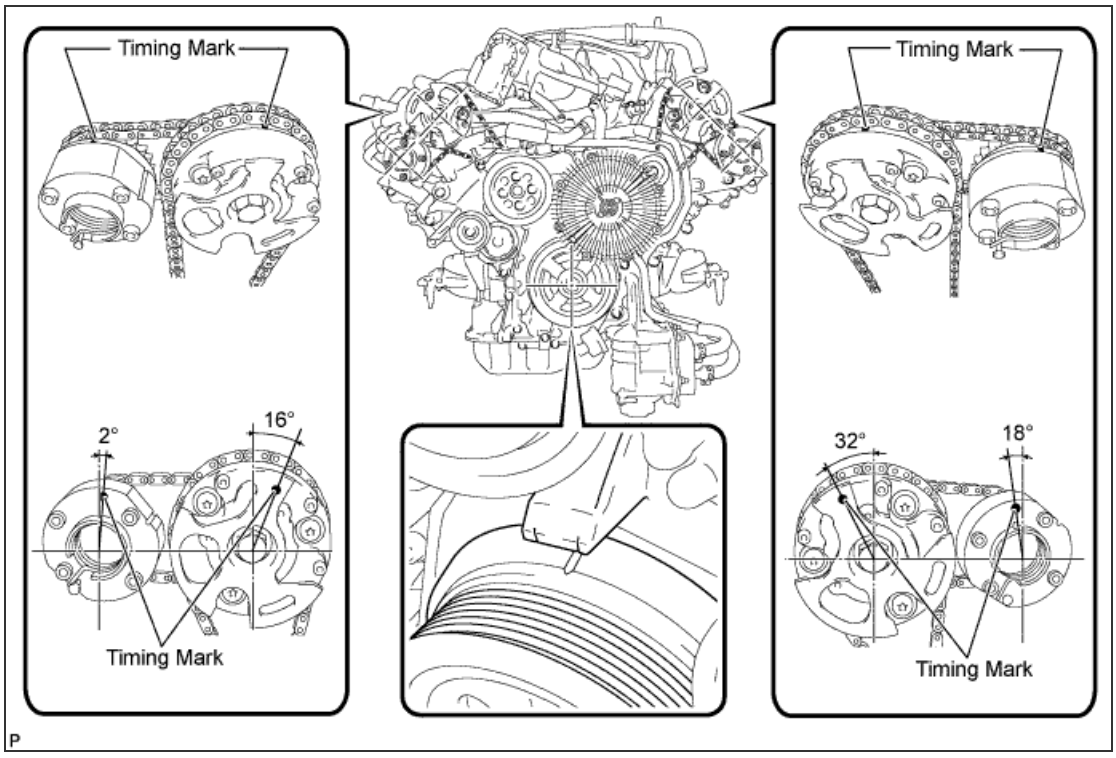
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

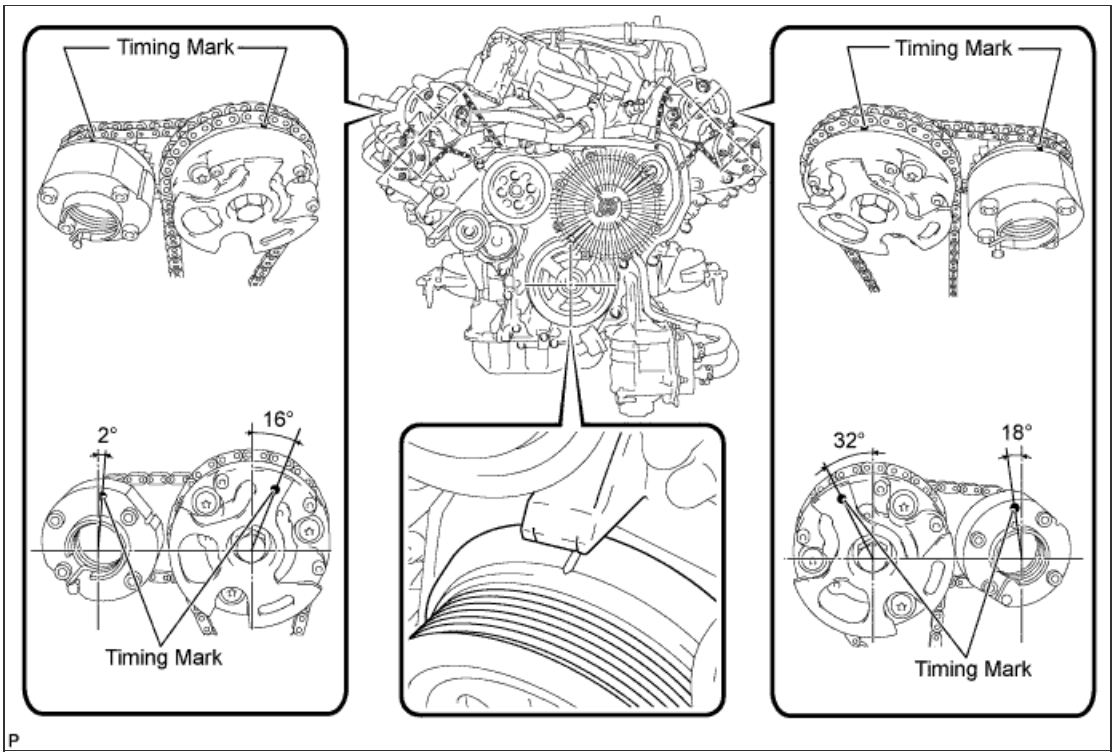
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

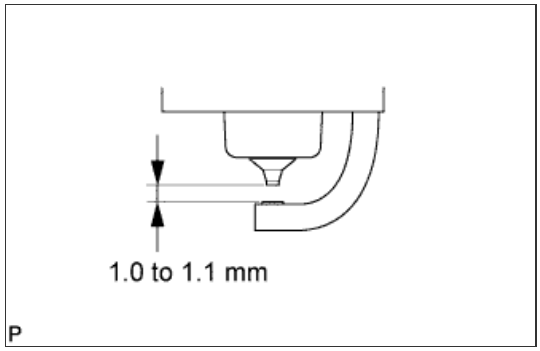
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

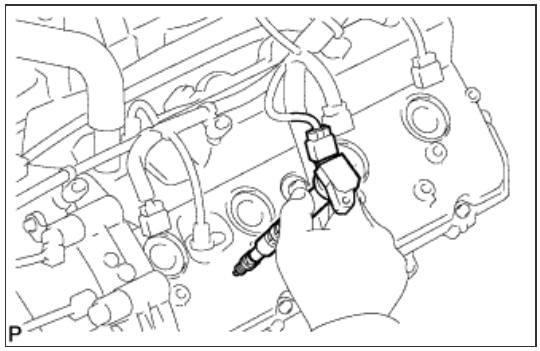
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

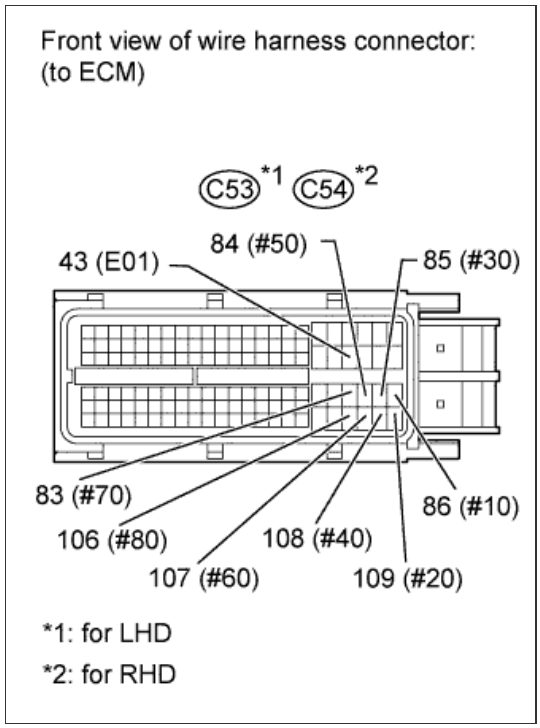
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

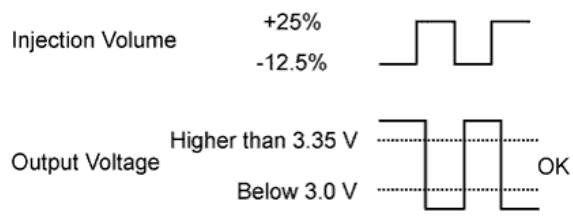
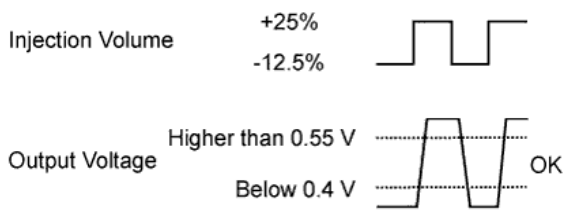
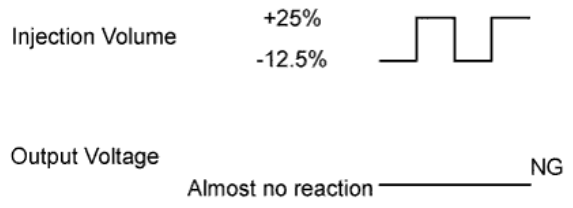
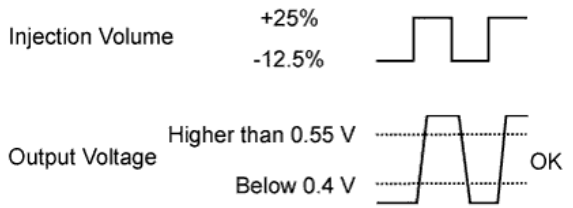
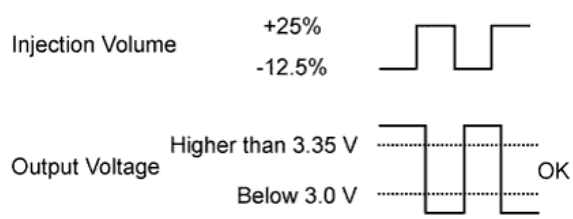
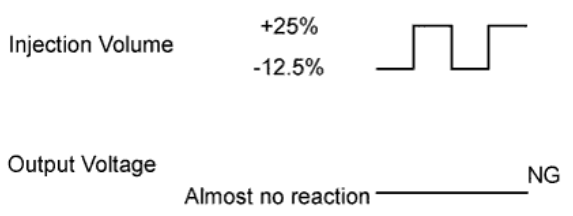
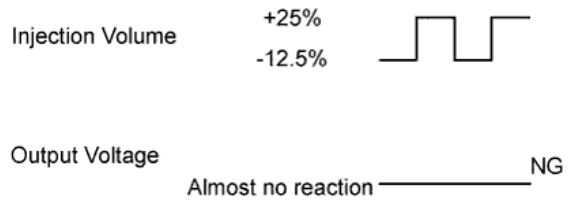
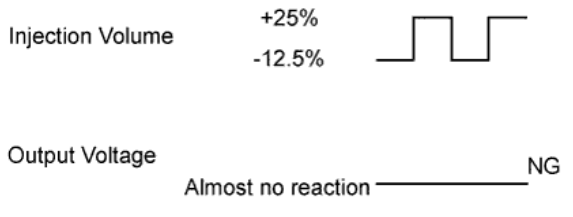
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

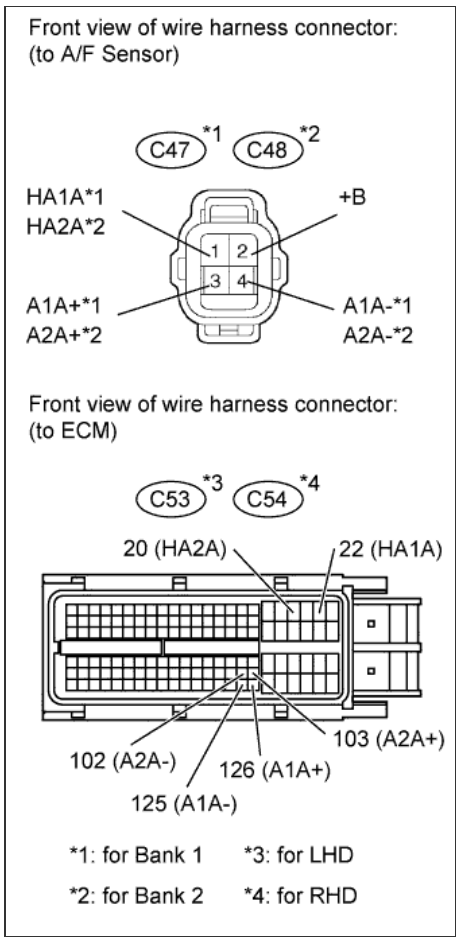
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

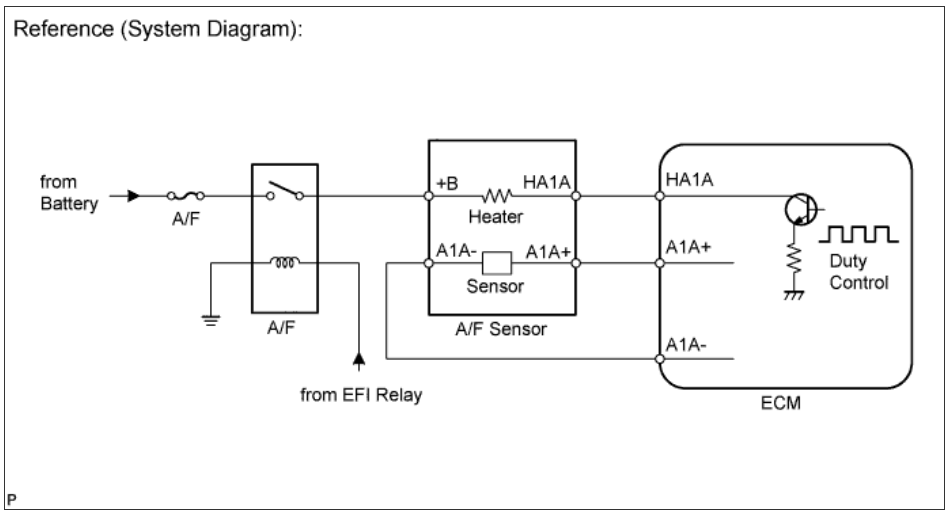
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0300 Random / Multiple Cylinder Misfire Detected

DTC P0301 Cylinder 1 Misfire Detected

DTC P0302 Cylinder 2 Misfire Detected

DTC P0303 Cylinder 3 Misfire Detected

DTC P0304 Cylinder 4 Misfire Detected

DTC P0305 Cylinder 5 Misfire Detected

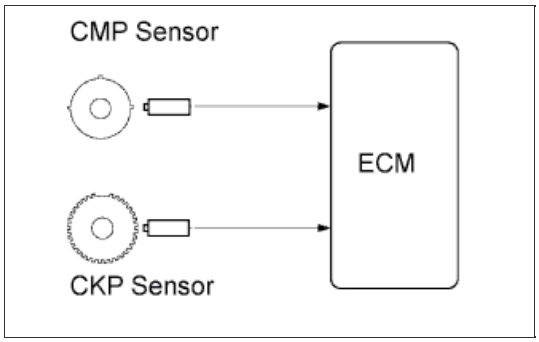
DTC P0306 Cylinder 6 Misfire Detected

DTC P0307 Cylinder 7 Misfire Detected

DTC P0308 Cylinder 8 Misfire Detected

for Preparation Click here

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent these increases in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the MIL blinks. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted as when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire rate exceeds the threshold level, the ECM illuminates the MIL and stores DTC(s).

DTC Code	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinders occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Fuel injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM
P0301 P0302 P0303 P0304 P0305 P0306 P0307 P0308	Misfiring of a specific cylinder occurs and one of the following conditions below is detected (2 trip detection logic): • A high temperature misfire occurs in the Three-Way Catalytic Converter (TWC) (MIL blinks). • An emission deterioration misfire occurs (MIL illuminates).	

HINT:

When multiple DTCs for misfiring cylinders are stored, but DTC P0300 is not stored, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only stored when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION

The ECM illuminates the MIL and stores a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

- Within the first 1000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs once.
- An excessive misfiring rate (approximately 30 to 110 misfires per 1000 crankshaft revolutions) occurs a total of 4 times.

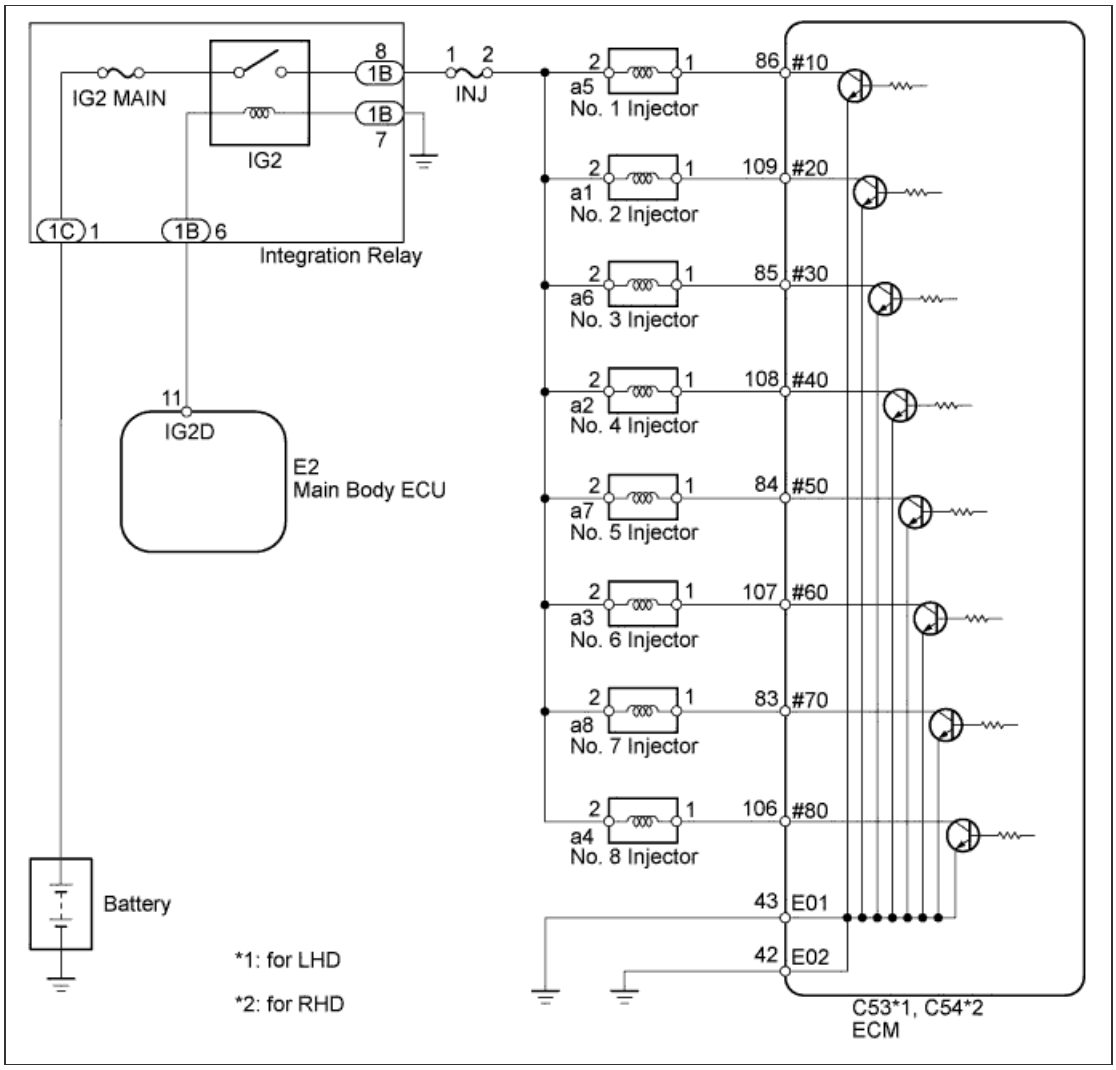
The ECM flashes the MIL and stores DTC(s) when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

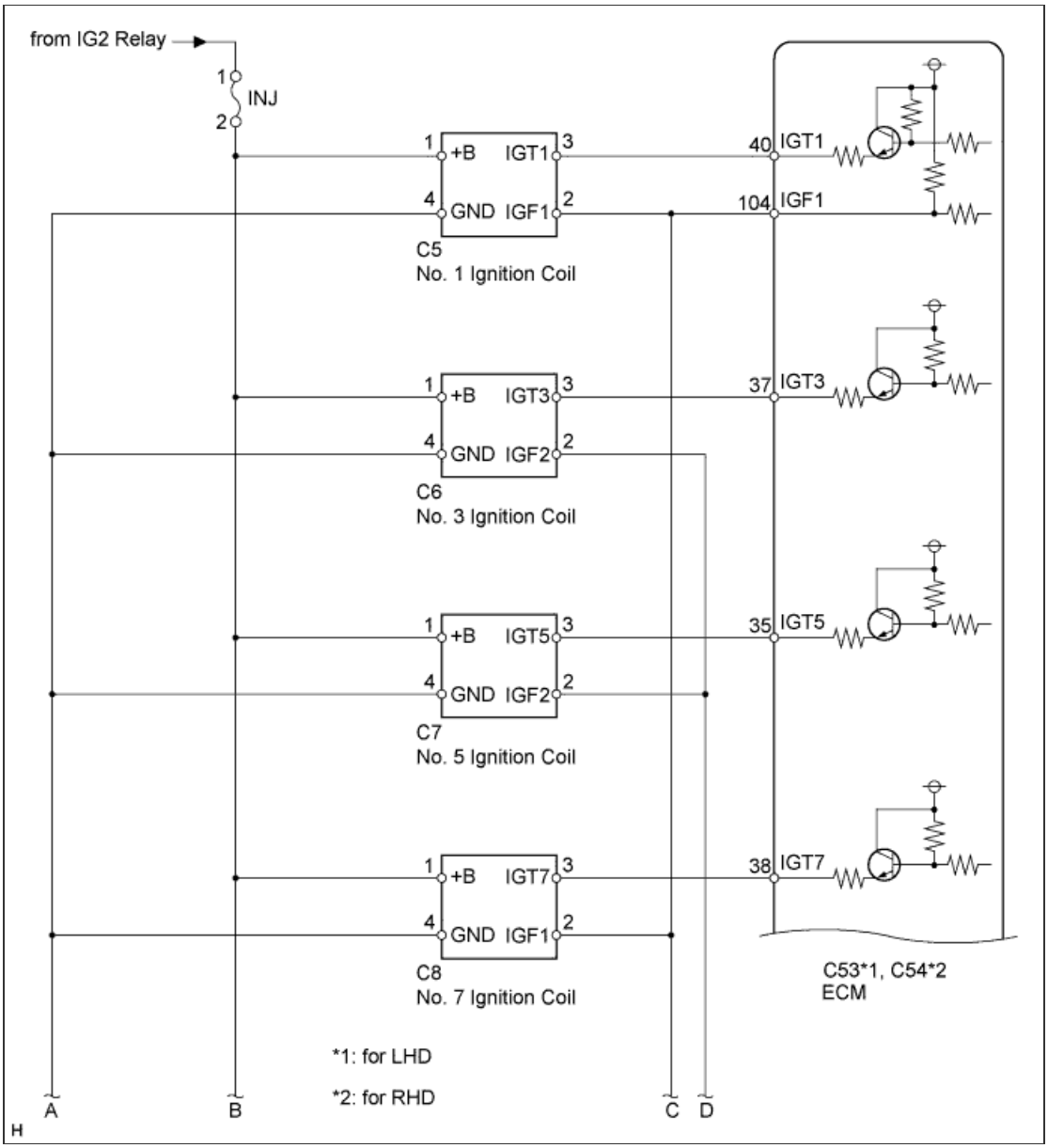
- At a high engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs once.
- At a normal engine speed, a catalyst damage misfire, which monitored every 200 crankshaft revolutions, occurs 3 times.

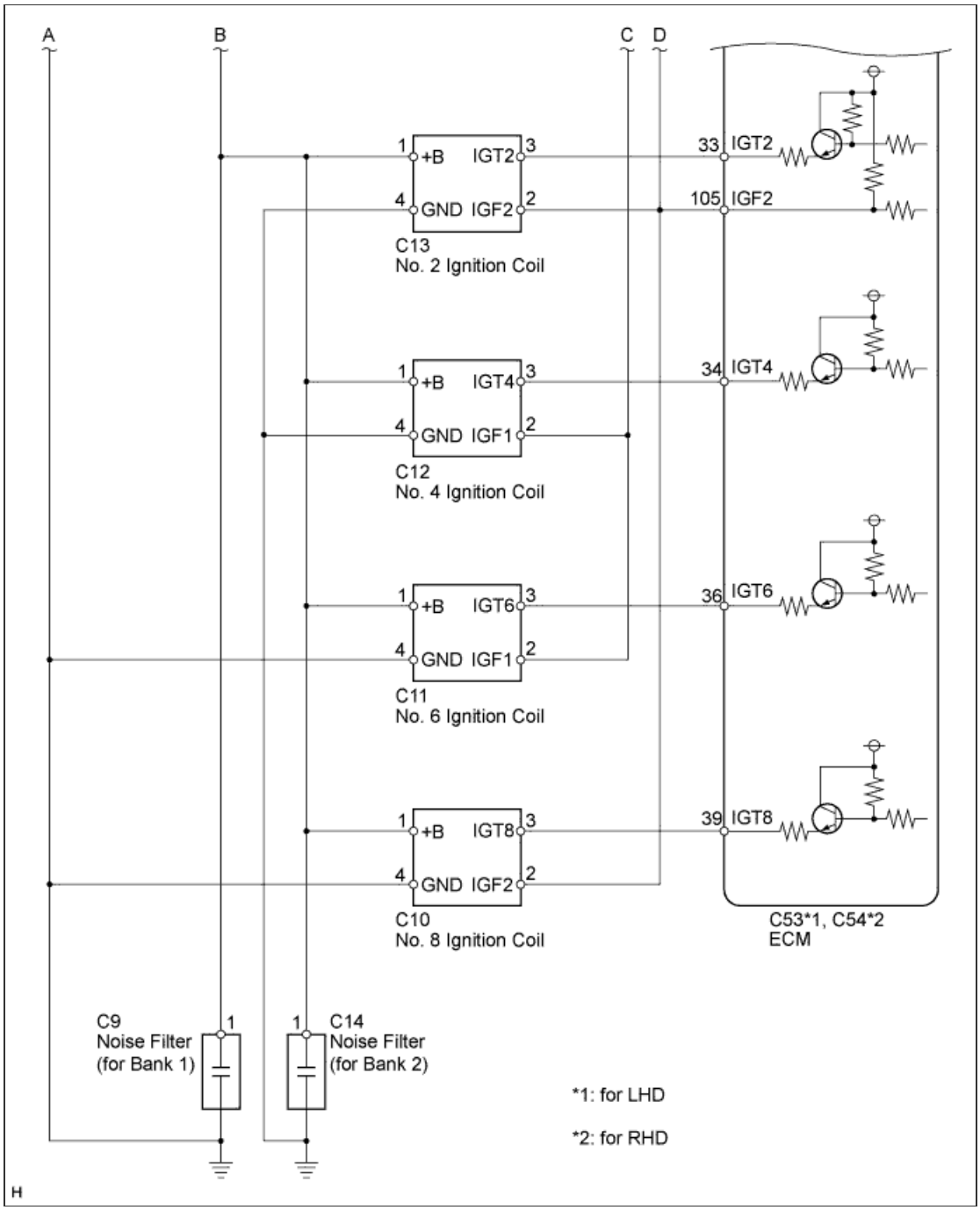
HINT:

If a catalyst damage misfire occurs, the ECM informs the driver by flashing the MIL.

WIRING DIAGRAM




from IG2 Relay
1
INJ
2
1
+B
IGT1
3
4
GND
IGF1
2
C5
No. 1 Ignition Coil
1
+B
IGT3
3
4
GND
IGF2
2
C6
No. 3 Ignition Coil
1
+B
IGT5
3
4
GND
IGF2
2
C7
No. 5 Ignition Coil
1
+B
IGT7
3
4
GND
IGF1
2
C8
No. 7 Ignition Coil
40
IGT1
104
IGF1
37
IGT3
35
IGT5
38
IGT7
C53*1, C54*2
ECM
*1: for LHD
*2: for RHD
A
B
C
D
H



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (Click here).
6. Read the misfire counts of each cylinder (cylinder No. 1 to No. 8) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine speed and engine load, shown in Misfire RPM and Misfire Load in the Data List.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, with the Misfire RPM and Misfire Load in the Data List.

Engine Speed	Duration
Idling	3.5 minutes or more
1000	3 minutes or more
2000	1.5 minutes or more
3000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

   HINT:

   Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be cleared.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- **DTC P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are for Euro-OBD only.**
- **If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**
- **If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.**
- **If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:**
  1. **The fuel level is low.**
  2. **Improper fuel is used.**
  3. **The spark plugs are dirty.**
- **After finishing repairs, check that no misfires occur in each cylinder (cylinder No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7 and No. 8).**
- **Be sure to confirm that no misfiring cylinder DTCs are output again by conducting the confirmation driving pattern after the repairs.**
- **For 6 and 8 cylinder engines, the ECM intentionally does not store the specific misfiring cylinder DTCs at high engine speed. If misfires only occur during high engine speed driving, only DTC P0300 is stored.**
  In the event of DTC P0300 being present, perform the following operations:
  1. **Clear the DTC (Click here).**
  2. **Start the engine and conduct the confirmation driving pattern.**
  3. **Read the misfiring rates of each cylinder or DTC(s) using the intelligent tester.**
  4. **Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.**
  5. **After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not output.**
- **When either Short FT #1, Long FT #1, Short FT #2 or Long FT #2 in the freeze frame data is outside the range of +/-20%, the air-fuel ratio may be rich (-20% or less) or lean (+20% or more).**
- **When the Coolant Temp in the freeze frame data is below 75°C (167°F), the misfires occurred only while warming up the engine.**
- **An extremely imbalanced drive wheel which causes body vibration may cause misfire DTCs to be detected.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE CODES)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 are output	A
P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and/or P0308 and other DTCs are output	B

HINT:

If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307 and P0308 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

a. Connect the intelligent tester the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Misfire RPM and Misfire Load.

d. Read and note the Misfire RPM and Misfire Load values.

HINT:

The Misfire RPM and Misfire Load values indicate the vehicle conditions under which the misfire occurred.

NEXT

3.CHECK PCV HOSE CONNECTIONS

a. Check the PCV hose connections.

OK:
PCV hose is connected correctly and is not damaged.

NG → REPAIR OR REPLACE PCV HOSE (Click here)

OK

4.READ VALUE USING INTELLIGENT TESTER (MISFIRE COUNT)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Enter the following menus: Powertrain / Engine and ECT / Data List / Misfire / Cylinder #1 Misfire Count, #2, #3, #4, #5, #6, #7 and #8.

f. Allow the engine to idle.

g. Read each value for Cylinder #1 Misfire Count to #8 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:

i. Move the shift lever to D.

ii. Check the Cylinder #1 Misfire Count to #8.

iii. If misfire counts are still not displayed, perform procedure "A" and "B" and then check the misfire counts again.

h. Drive the vehicle with the Misfire RPM and Misfire Load noted in the "Read Value Using tester (Misfire RPM and Misfire Load)" procedures above (Procedure "A").

i. Read the Cylinder #1 Misfire Count to #8 or DTCs displayed on the tester (Procedure "B").

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:

- **If it is difficult to reproduce misfires for each cylinder, check the Data List item called Misfire Margin. Try to find vehicle driving conditions that lower the Misfire Margin value. Values above 30% are considered normal.**
- **If the freeze frame data record of the ECT is below 75°C (167°F), the misfire may be detected only when the engine is cold.**
- **If the freeze frame data record of the Engine Run Time is below 120 seconds, the misfire may be detected immediately after the engine is started.**

B → Go to step 15

A

5.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

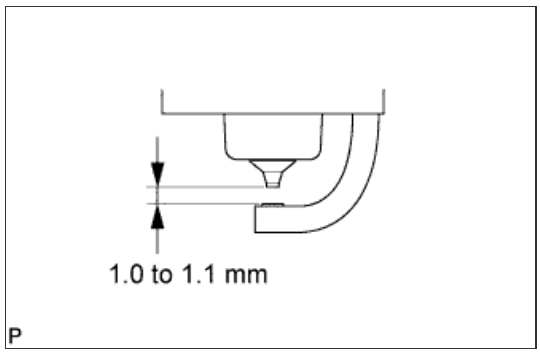
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

6.CHECK FOR SPARKS AND IGNITION

a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

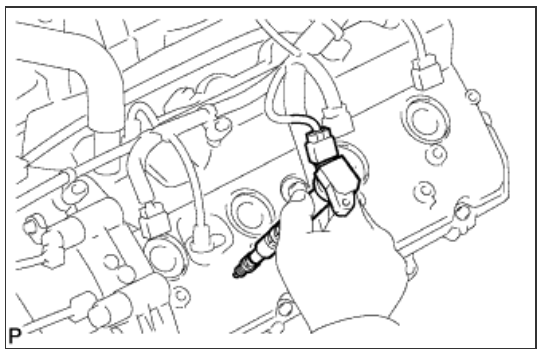
d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.



NG → Go to step 25

OK

7.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

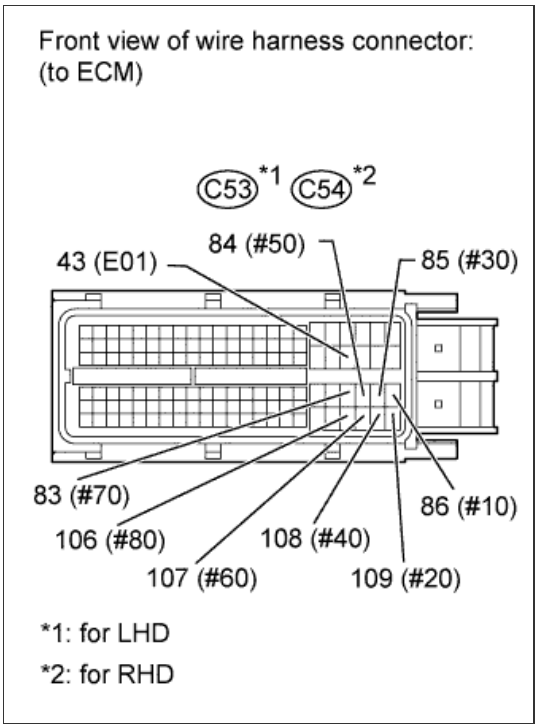
NG → REPAIR ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

OK

8.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

9.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

10.CHECK AIR INDUCTION SYSTEM

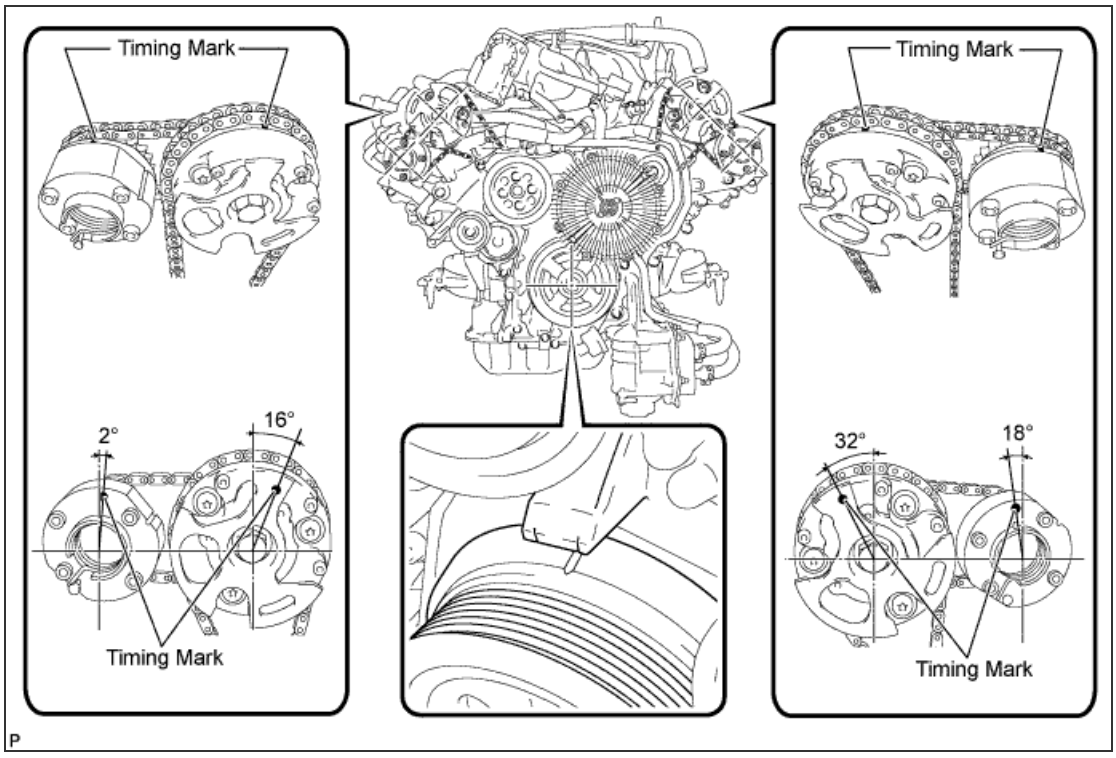
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

11.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

12.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

13.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

14.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

REPLACE ECM (Click here)

15.CHECK AIR INDUCTION SYSTEM

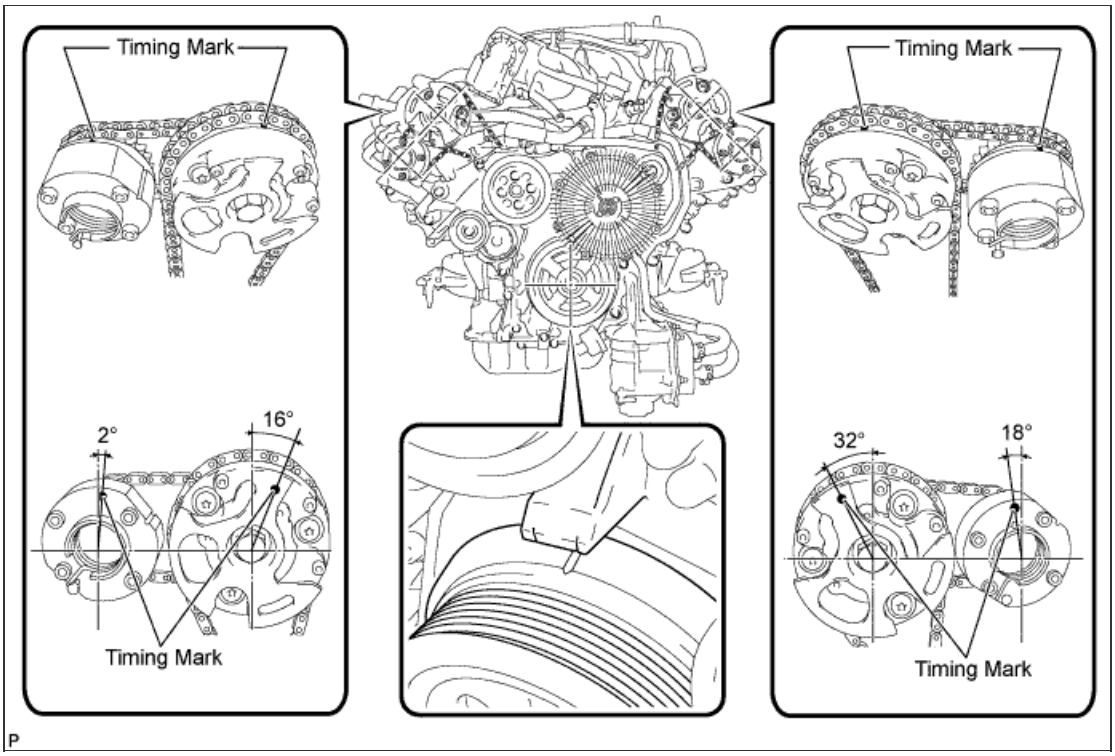
a. Check the air induction system for vacuum leakage (Click here).

OK:
No leakage from air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM (Click here)

OK

16.CHECK VALVE TIMING



a. Remove the cylinder head cover LH and RH.

b. Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.

c. Check that the timing marks of the camshaft timing gears and camshaft timing exhaust gears are at the positions shown in the illustration.

OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.

NG → ADJUST VALVE TIMING (Click here)

OK

17.CHECK FUEL PRESSURE

a. Check the fuel pressure (Click here).

NG → CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER

OK

18.READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Coolant Temp.

d. Read the Coolant Temp twice, when the engine is both cold and warmed up.

Standard:
With cold engine: Same as ambient air temperature.
With warm engine: Between 75°C and 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR (Click here)

OK

19.INSPECT MASS AIR FLOW METER

a. Inspect the mass air flow meter (Click here).

NG → REPLACE MASS AIR FLOW METER (Click here)

OK

20.CHECK SPARK PLUG

a. Remove the ignition coil and the spark plug of the misfiring cylinder (Click here).

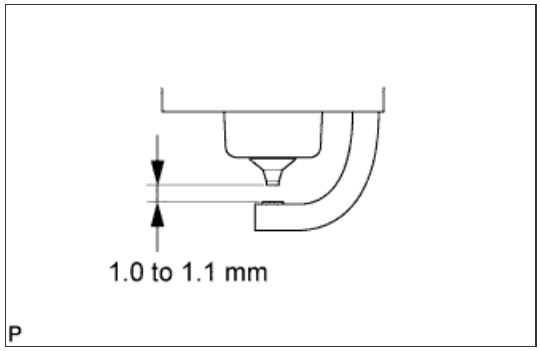
b. Measure the spark plug electrode gap.

Standard gap:
1.0 to 1.1 mm (0.0394 to 0.0433 in.)

c. Check the electrode for carbon deposits.

Recommended Spark Plug:

Manufacturer	Product
DENSO	SK20HR11



NOTICE:

If the electrode gap is larger than standard, replace the spark plug. Do not adjust the electrode gap.

NG → REPLACE SPARK PLUG (Click here)

OK

21.CHECK FOR SPARKS AND IGNITION

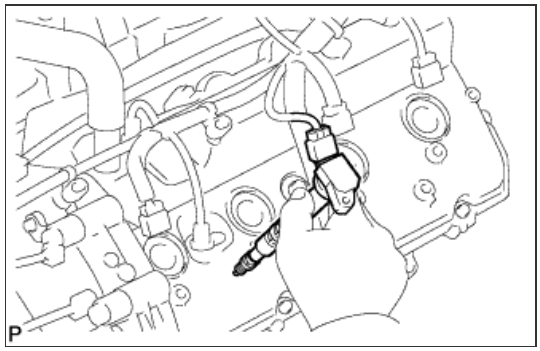
a. Disconnect the injector connectors to prevent the engine from starting.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.



b. Remove the ignition coil from the cylinder head (Click here).

c. Install the spark plug onto the ignition coil.

d. Attach the spark plug assembly to the cylinder head.

e. Crank the engine for less than 2 seconds and check the spark.

OK:
Sparks jump across electrode gap.

f. Install the ignition coil.

g. Reconnect the injector connectors.

NG → Go to step 25

OK

22.CHECK CYLINDER COMPRESSION PRESSURE

a. Measure the cylinder compression pressure of the misfiring cylinder (Click here).

→ REPAIR ENGINE TO DETERMINE CAUSE OF LOW

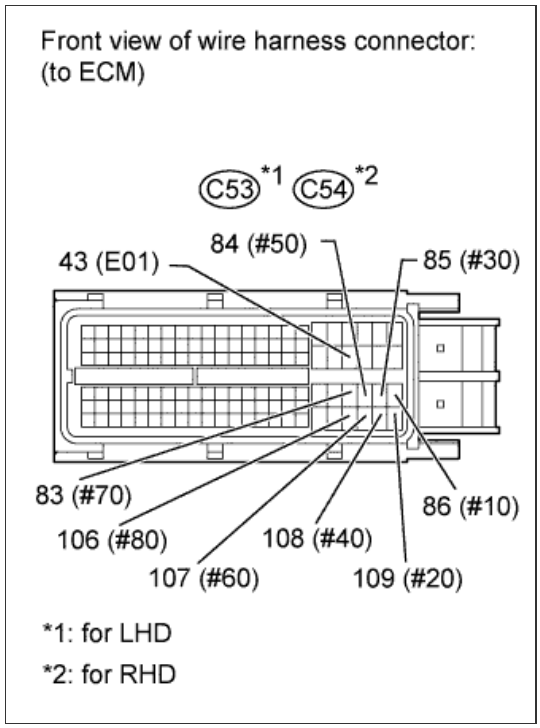
NG → COMPRESSION

OK

23.INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50, #60, #70 AND/OR #80 VOLTAGE)

a. Disconnect the C53 or C54 ECM connector.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
C53-86 (#10) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-109 (#20) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-85 (#30) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-108 (#40) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-84 (#50) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-107 (#60) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-83 (#70) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V
C53-106 (#80) - C53-43 (E01)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
C54-86 (#10) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-109 (#20) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-85 (#30) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-108 (#40) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-84 (#50) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-107 (#60) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

C54-83 (#70) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V
C54-106 (#80) - C54-43 (E01)	Engine switch on (IG)	11 to 14 V

NG → GO TO FUEL INJECTOR CIRCUIT (Click here)

OK

24.CHECK FUEL INJECTOR OF MISFIRING CYLINDER

a. Check the injector injection [whether fuel volume is high or low, and whether injection pattern is poor] (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

REPLACE ECM (Click here)

25.CHANGE TO SPARK PLUG

a. Change the installed spark plug to a spark plug that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:
Sparks jump across electrode gap.

NG → Go to step 26

OK

REPLACE SPARK PLUG (Click here)

26.CHANGE TO NORMAL IGNITION COIL AND CHECK SPARK OF MISFIRING CYLINDER

a. Change the ignition coil to an ignition coil that functions normally.

b. Perform a spark test.

CAUTION:

Always disconnect all injector connectors.

NOTICE:

Do not crank the engine for more than 2 seconds.

i. Install the spark plug to the ignition coil and connect the ignition coil connector.

ii. Disconnect the injector connector.

iii. Ground the spark plug.

iv. Check if sparks occur while the engine is being cranked.

OK:

Sparks jump across electrode gap.

NG → REPLACE ECM (Click here)

OK

REPLACE IGNITION COIL (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

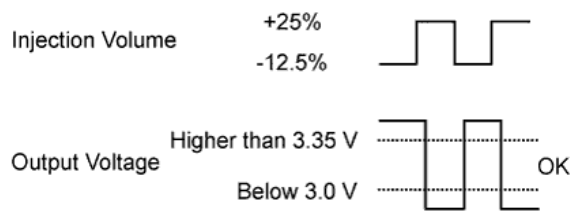
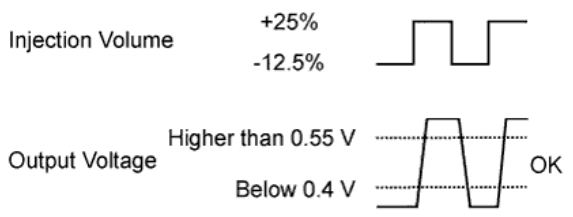
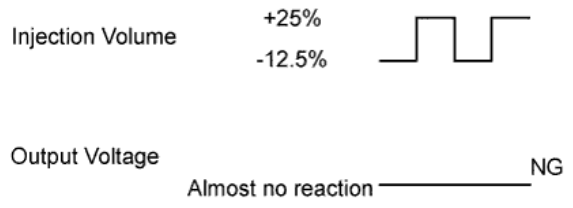
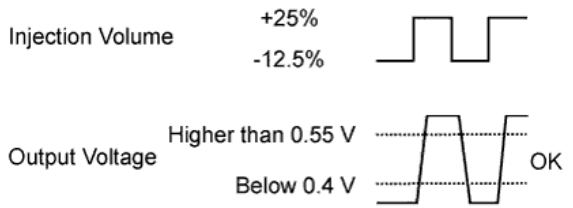
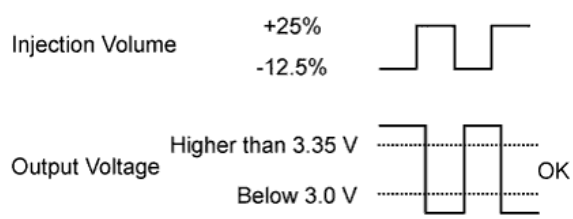
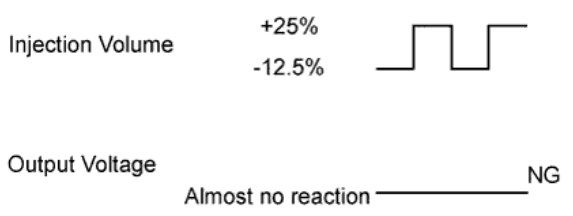
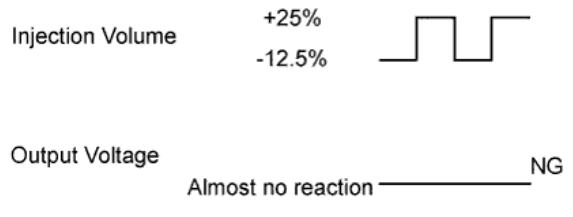
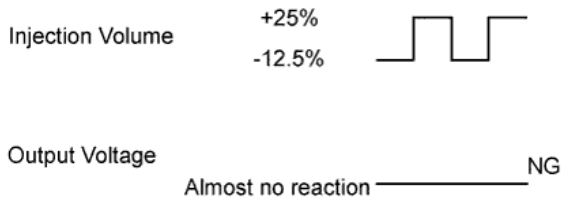
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

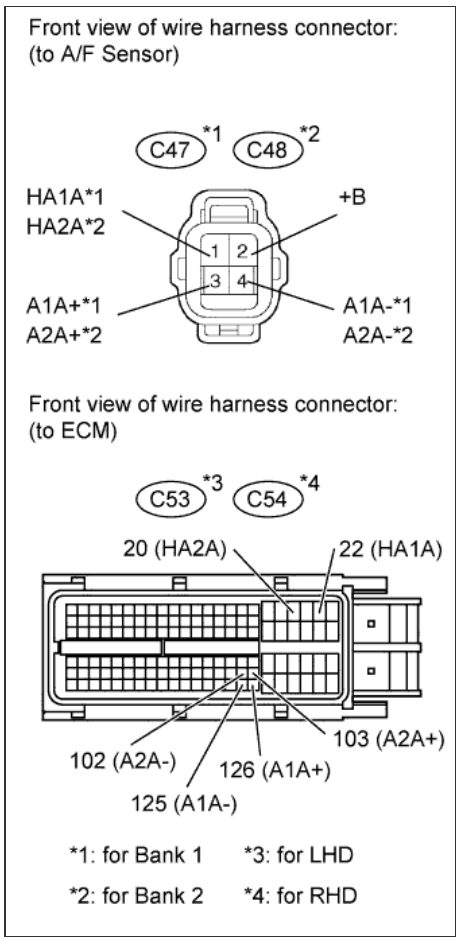
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

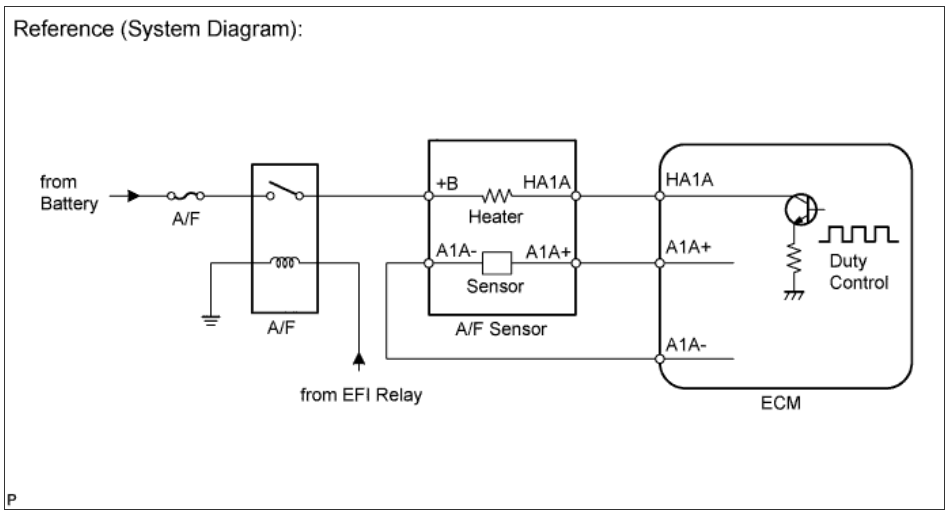
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

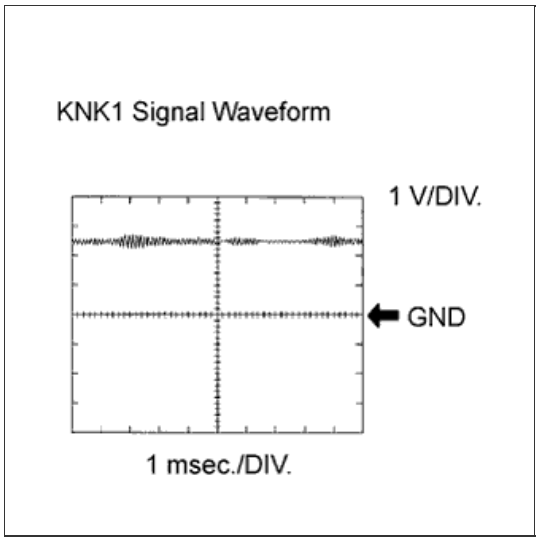
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

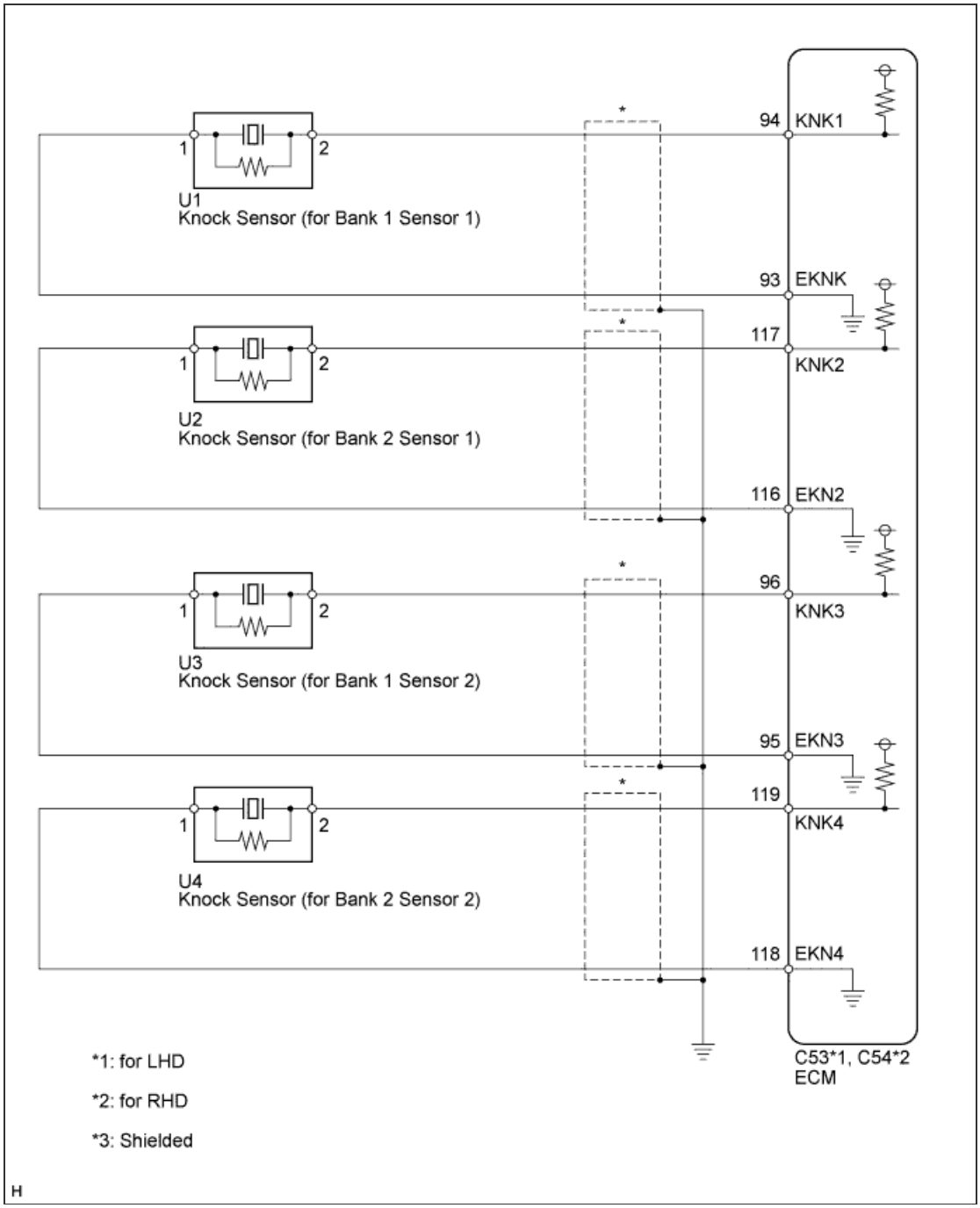
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

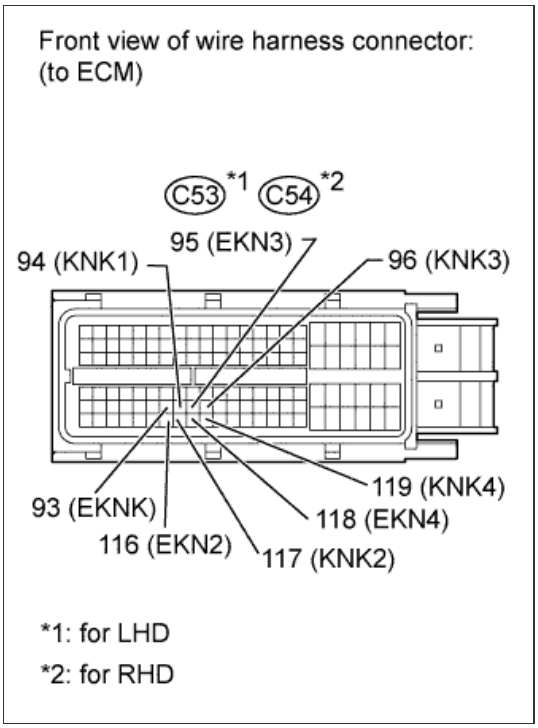
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

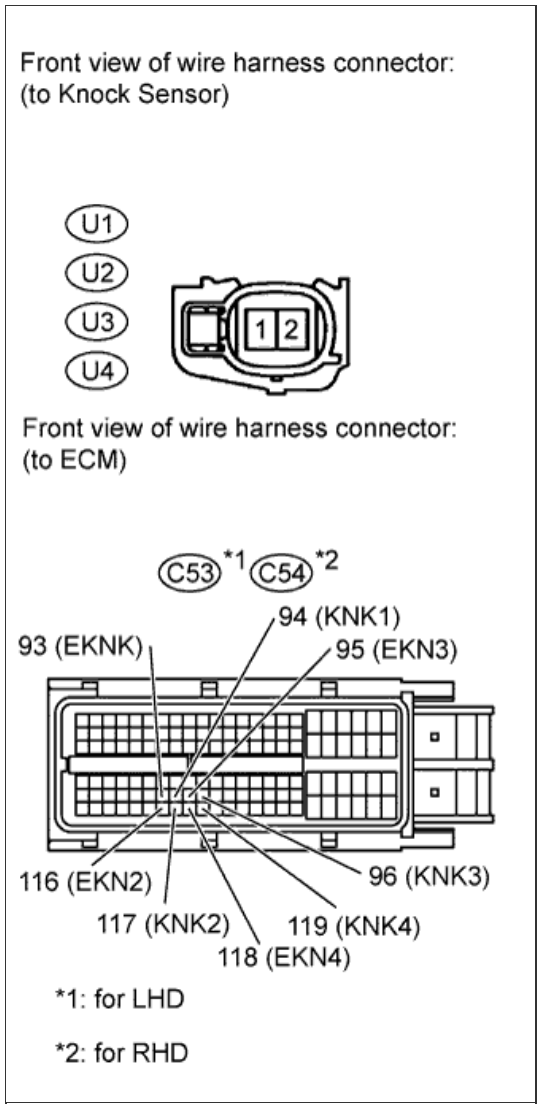
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

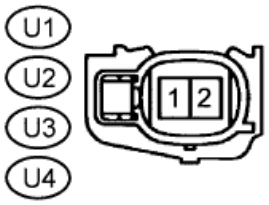
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

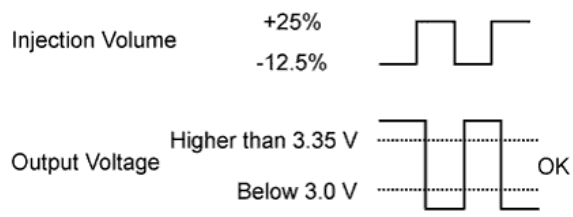
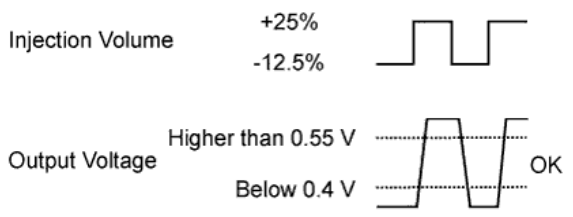
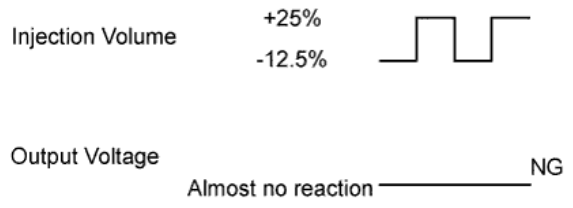
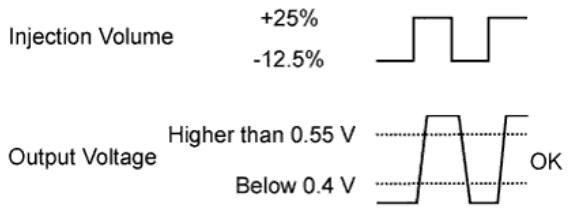
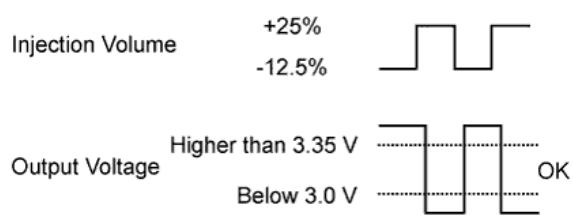
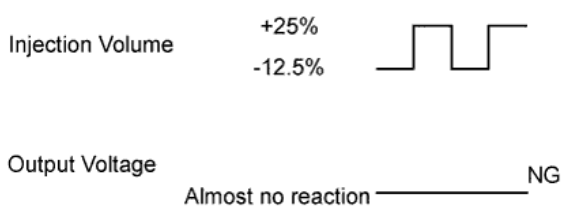
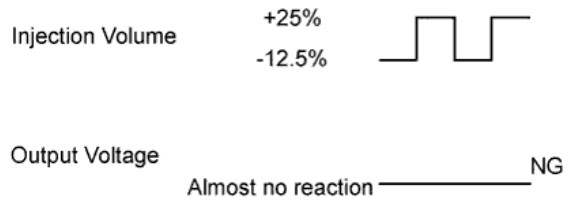
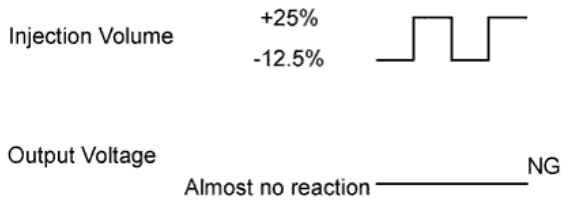
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

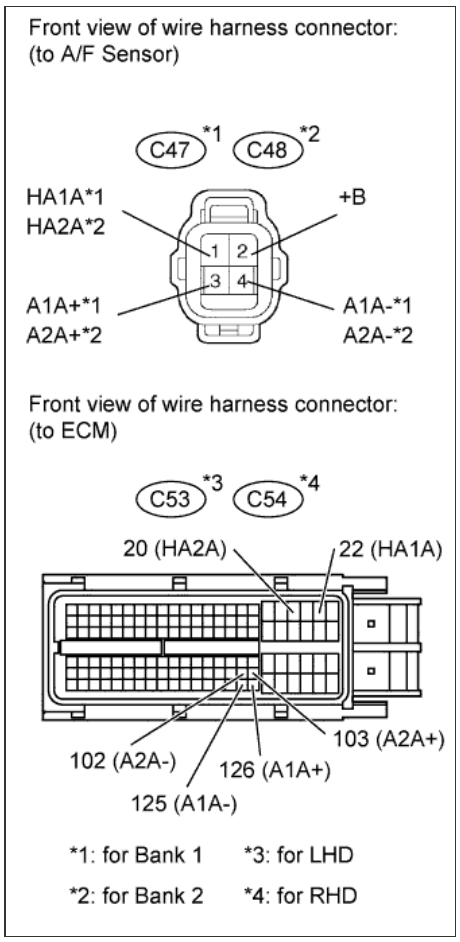
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

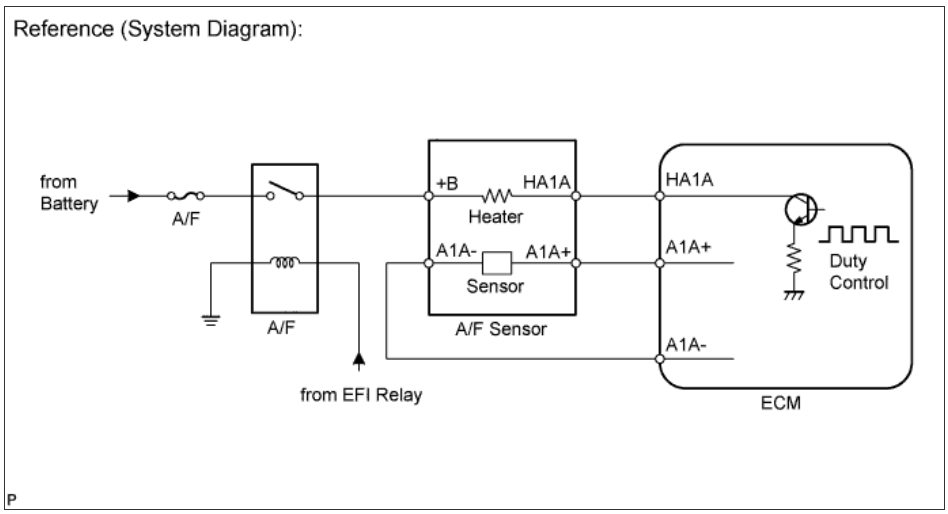
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

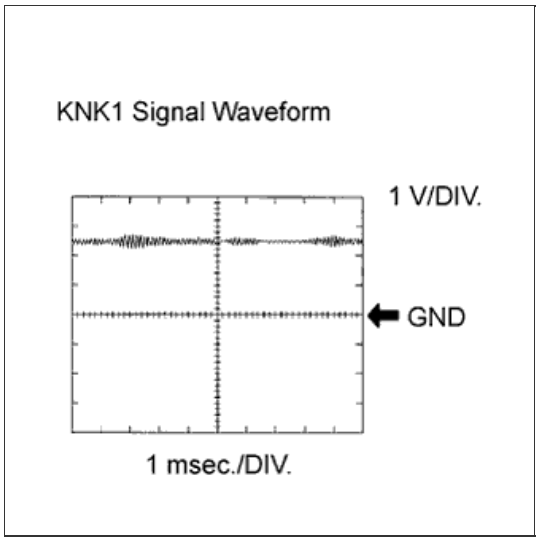
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

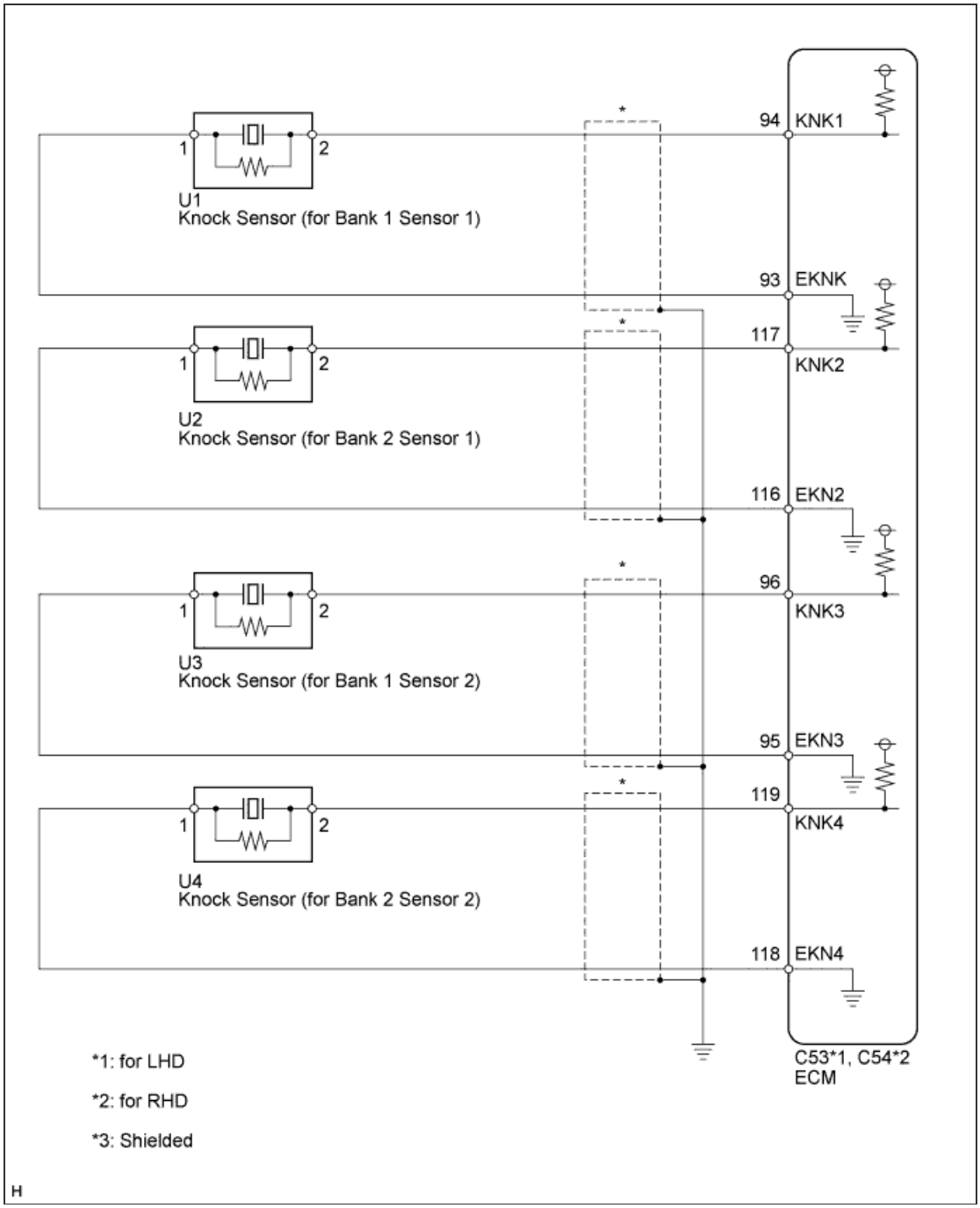
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

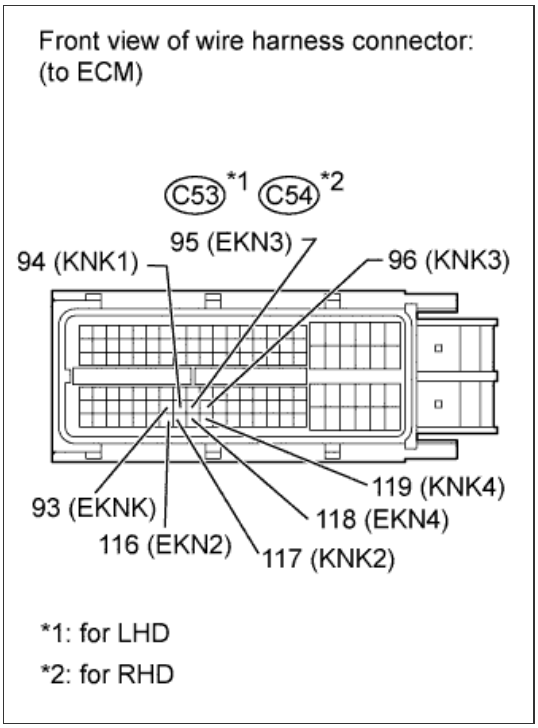
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

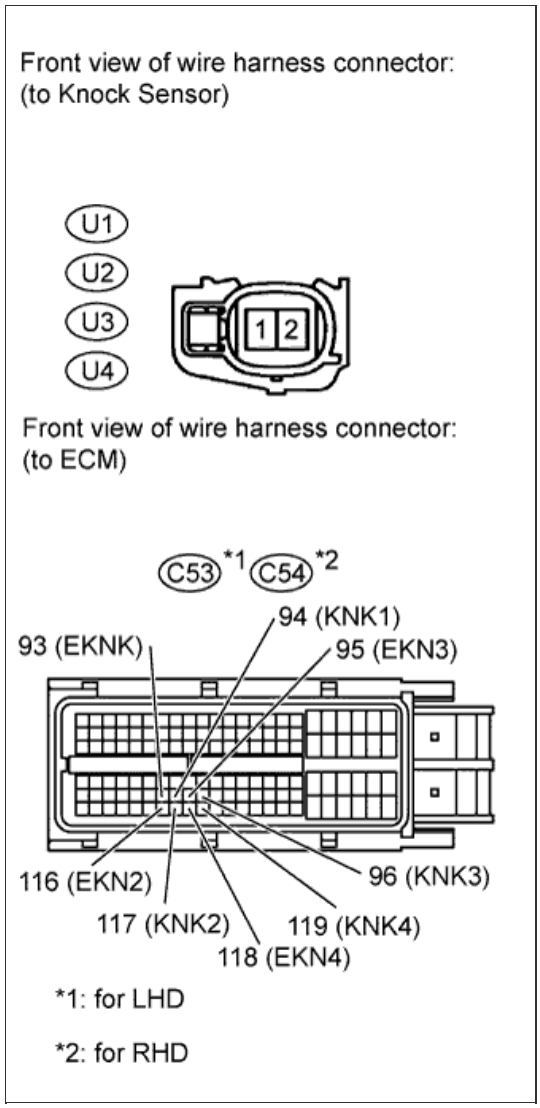
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

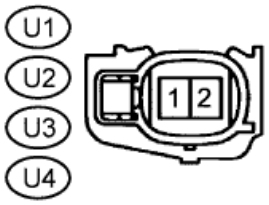
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

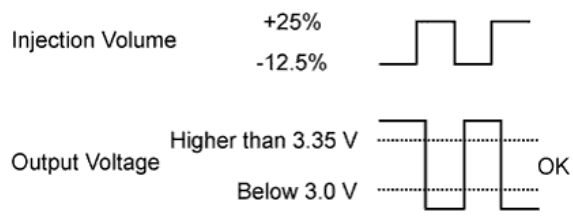
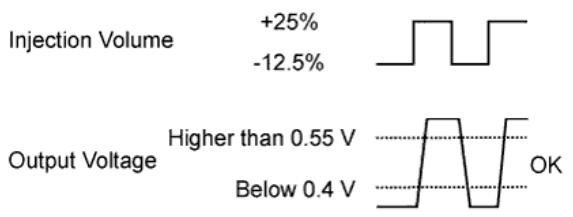
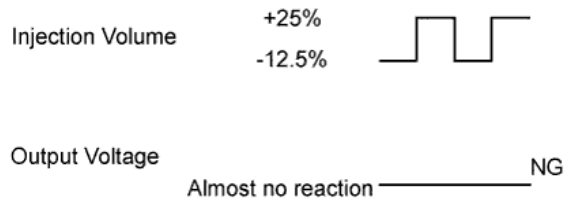
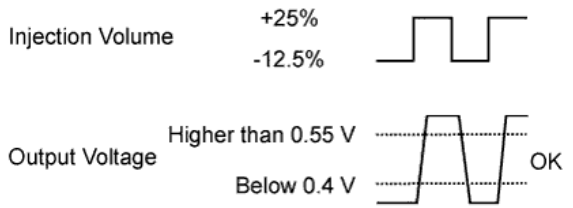
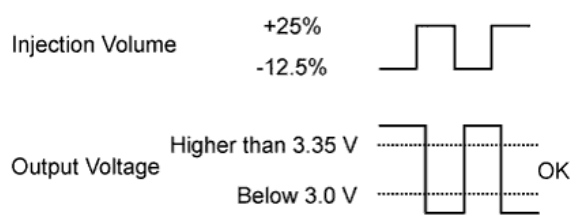
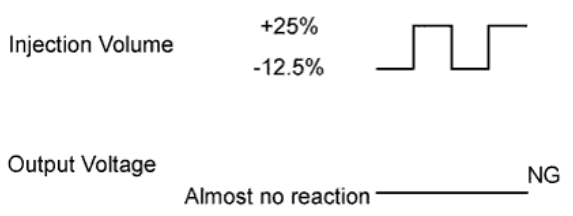
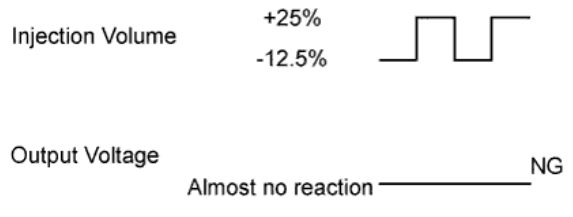
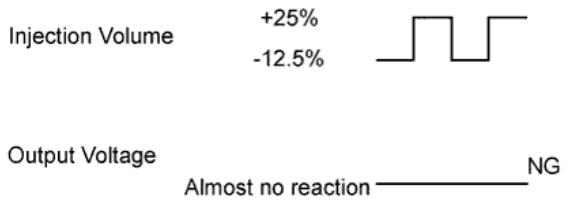
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

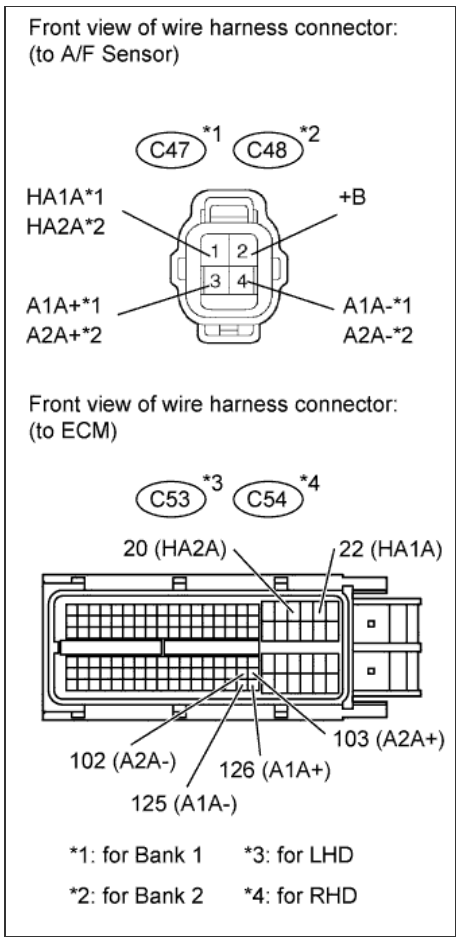
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

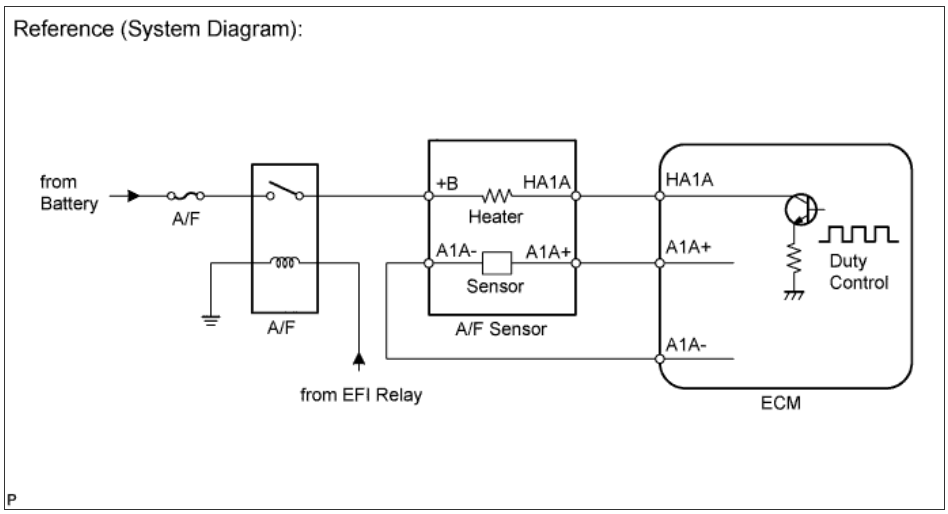
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

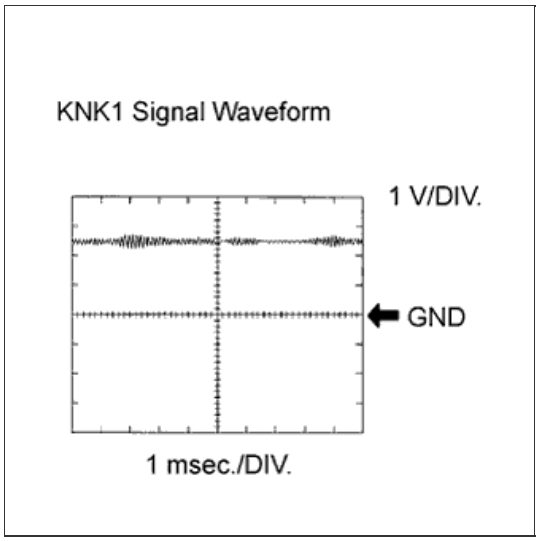
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

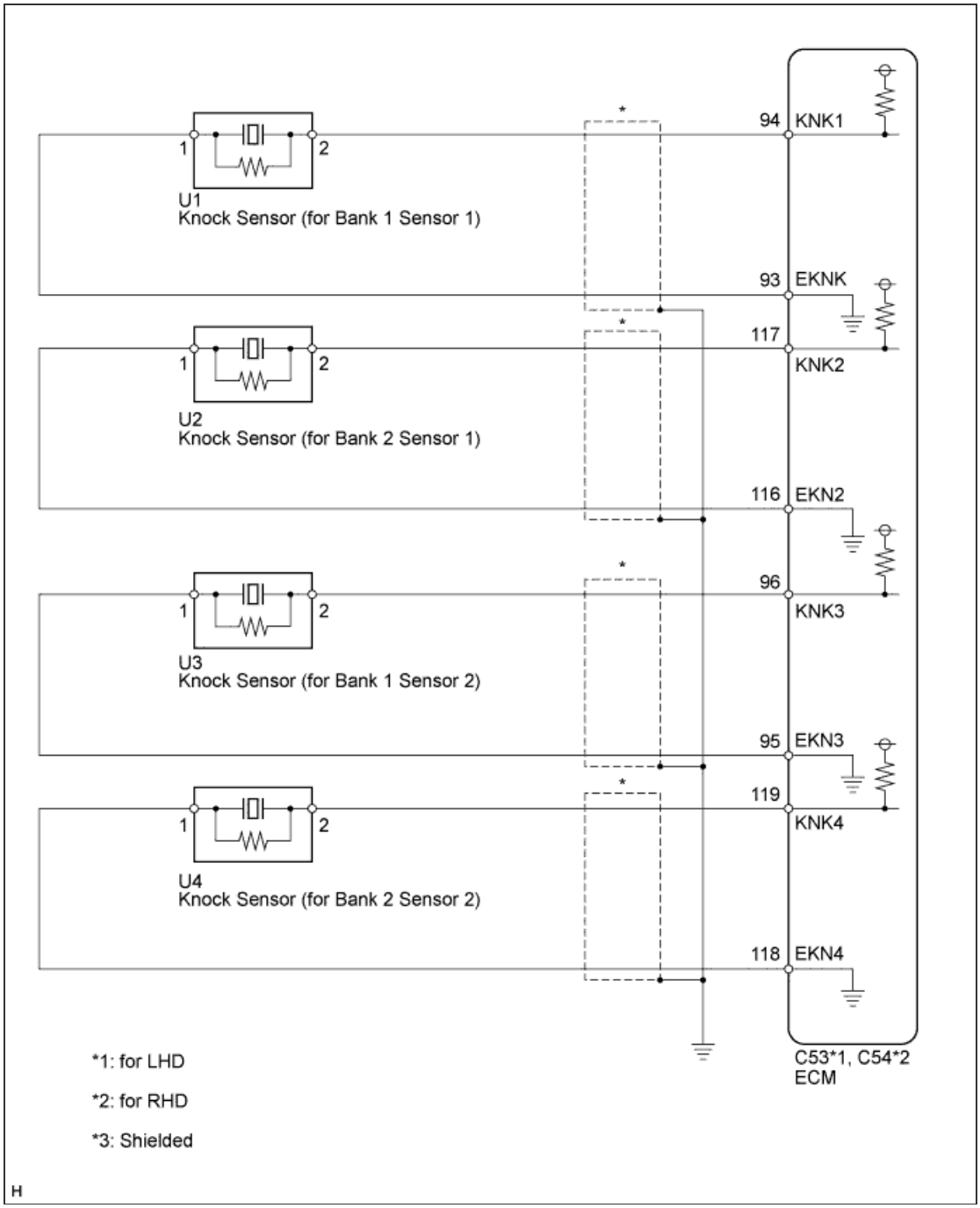
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

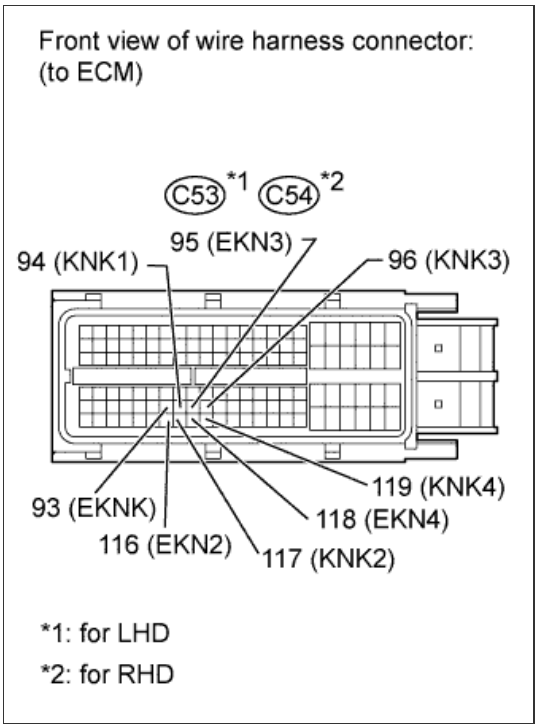
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

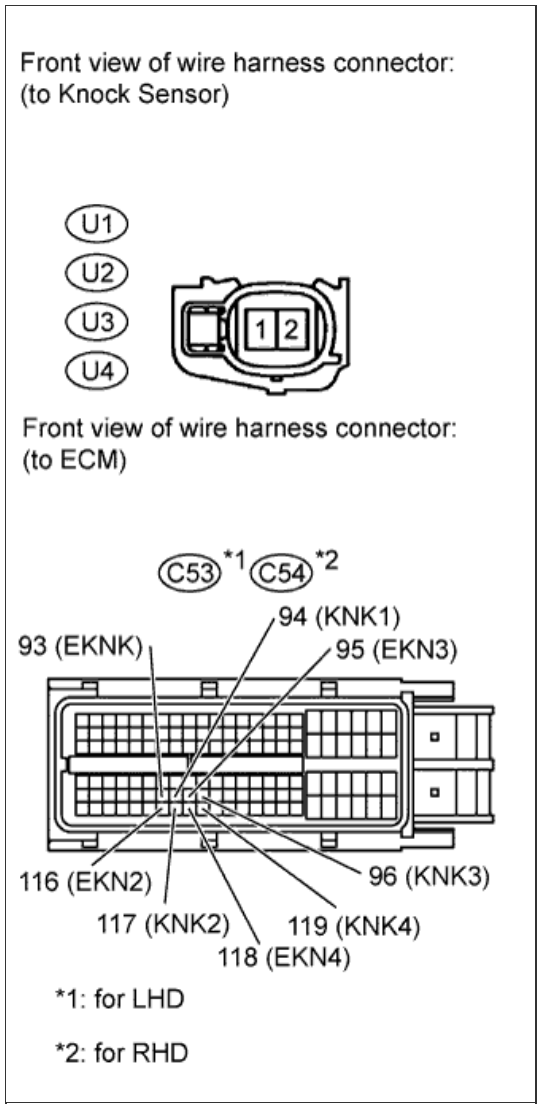
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

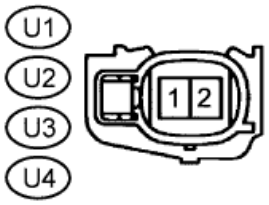
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

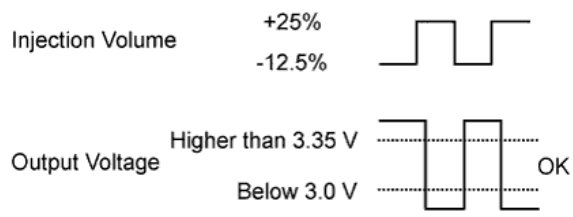
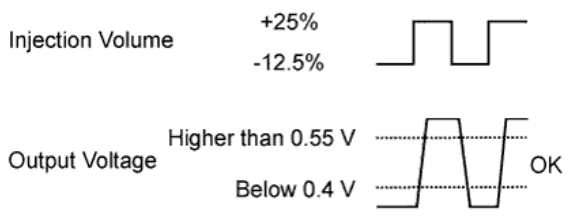
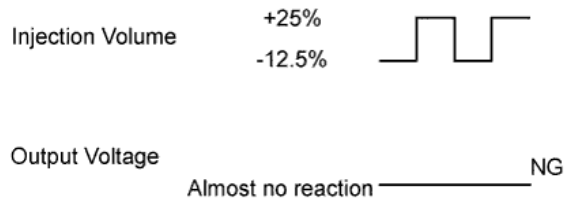
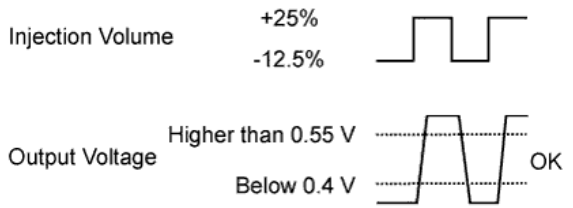
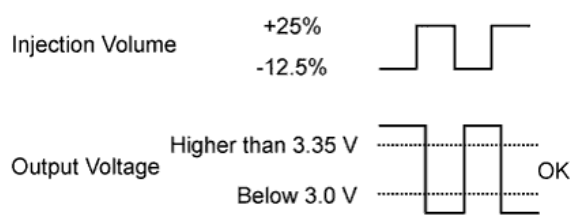
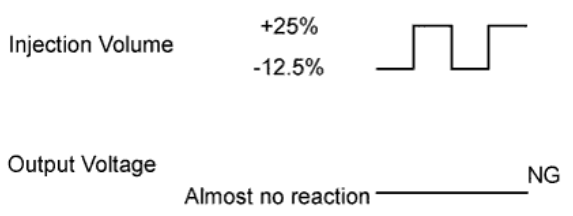
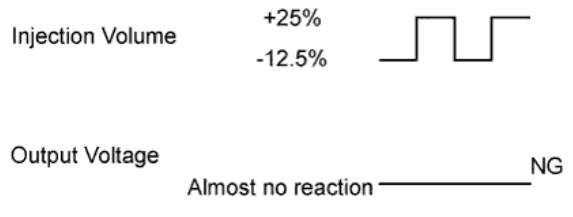
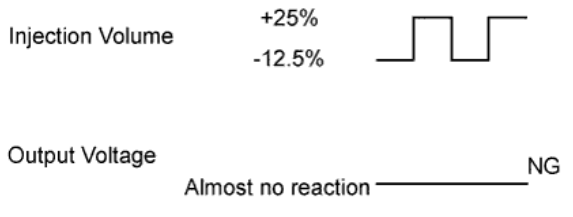
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

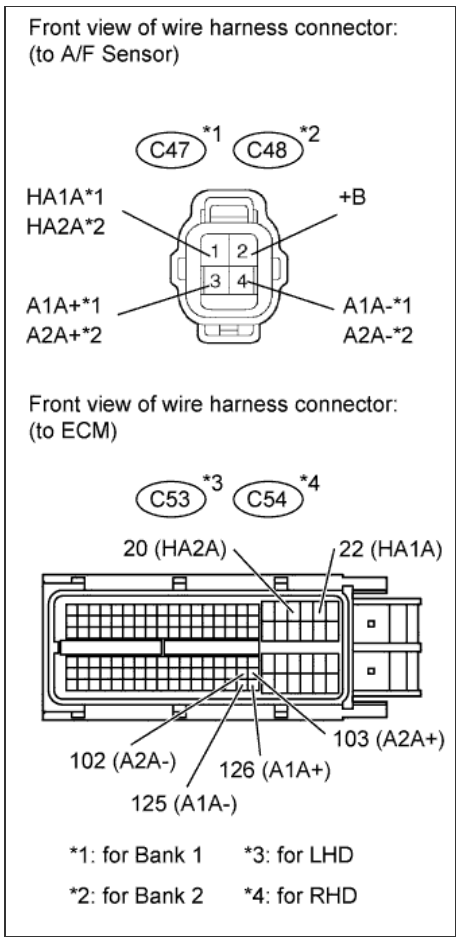
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

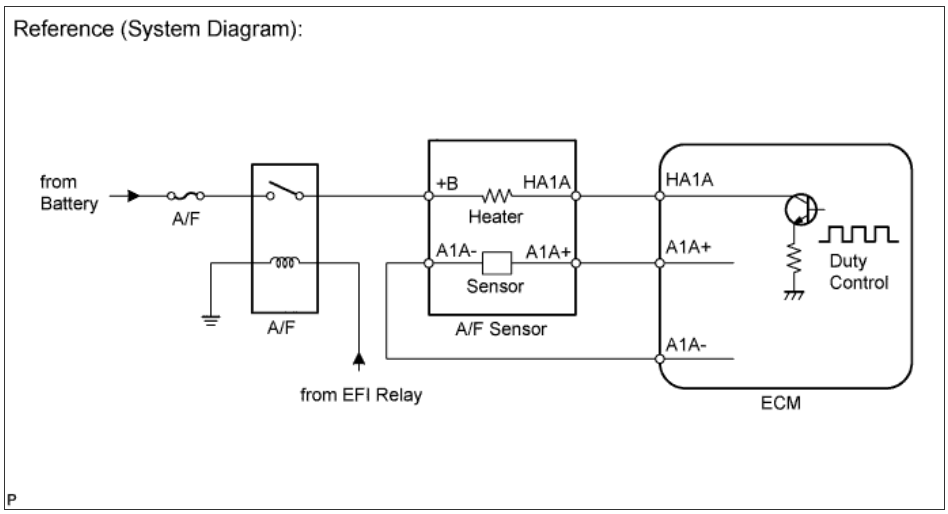
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

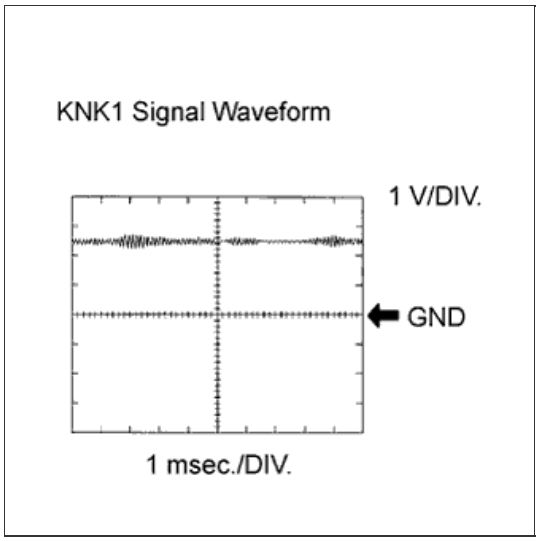
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

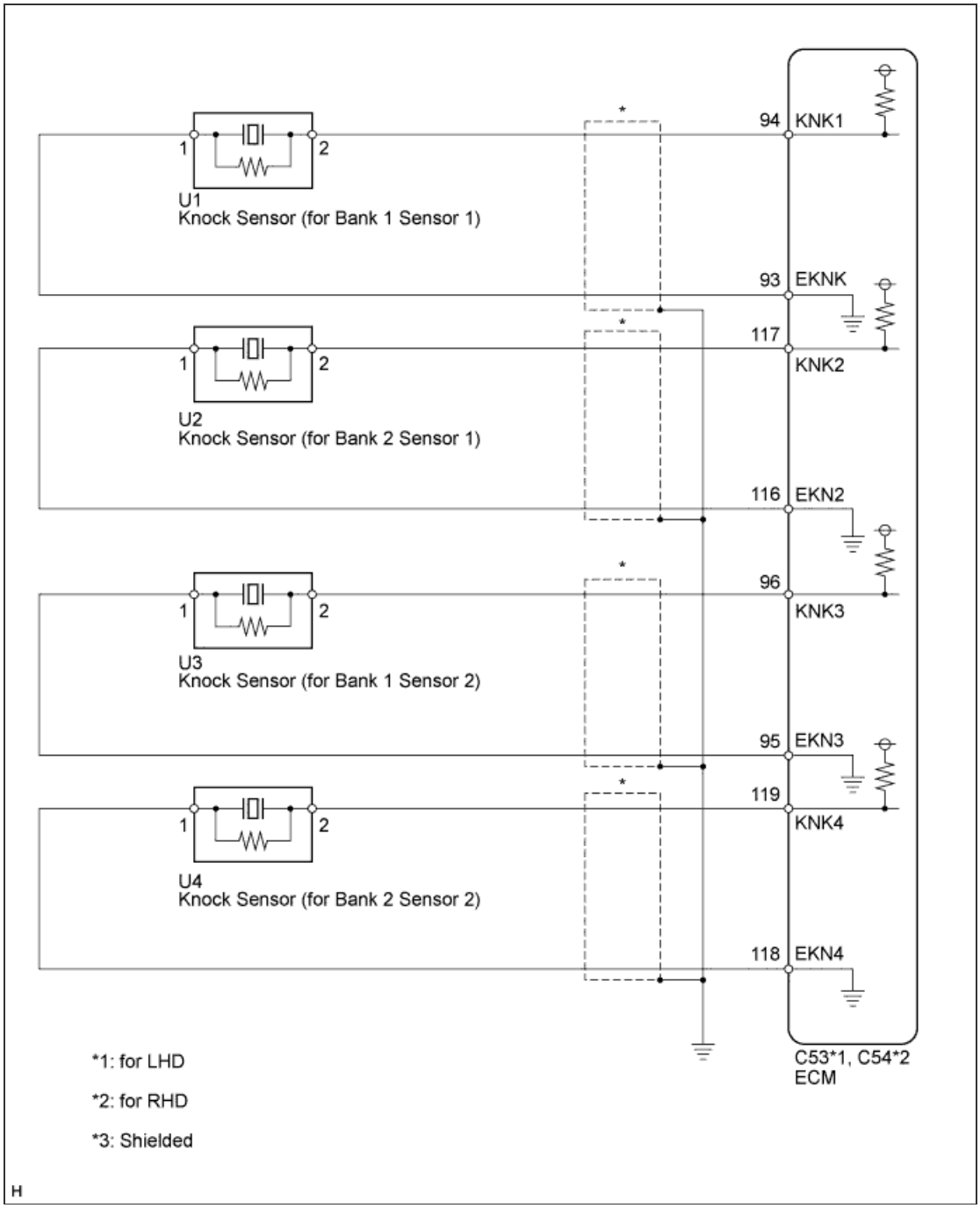
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

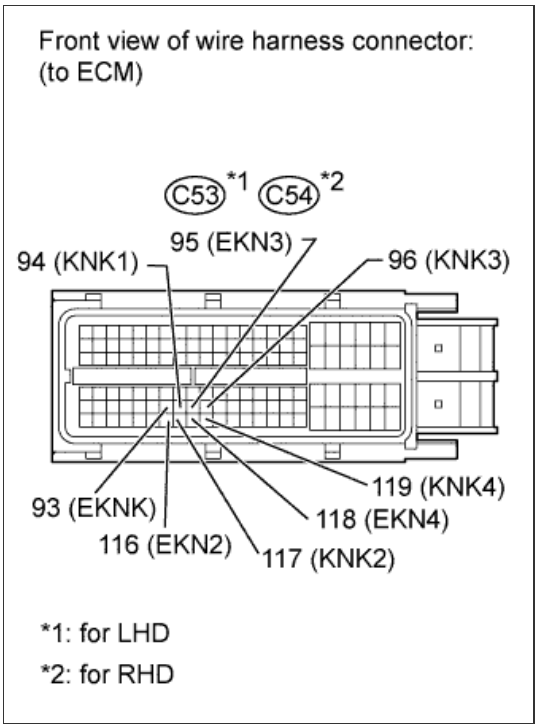
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

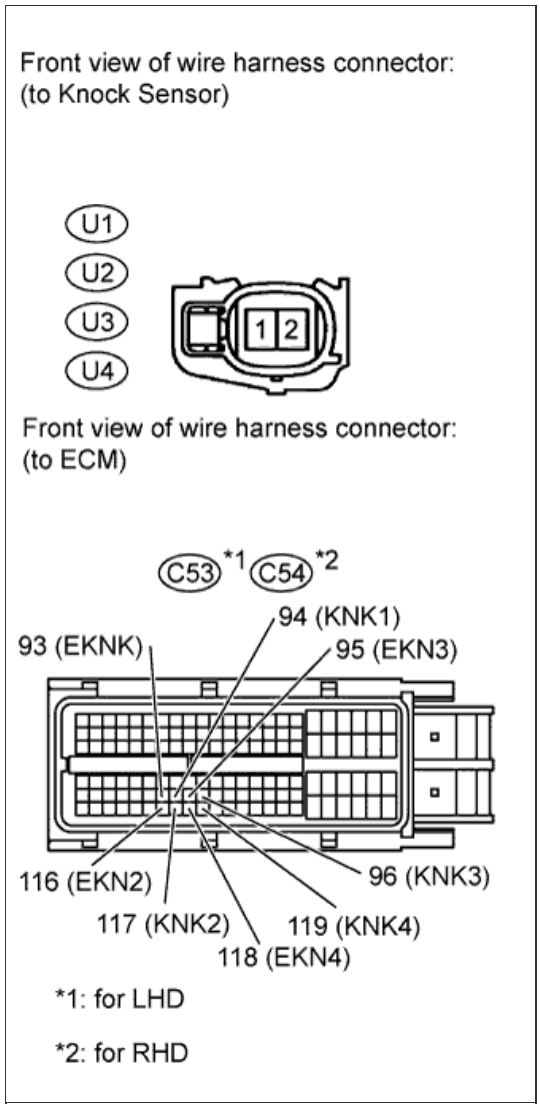
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

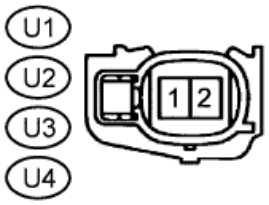
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

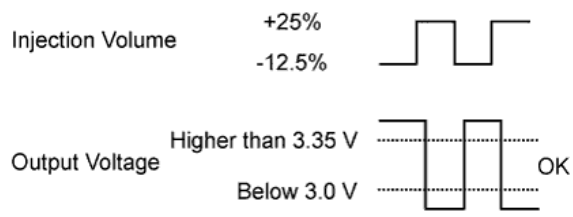
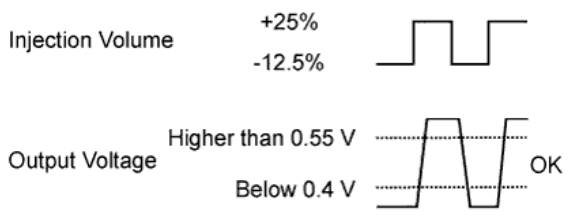
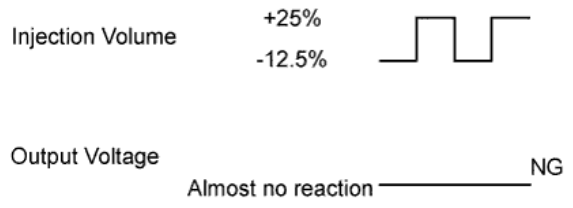
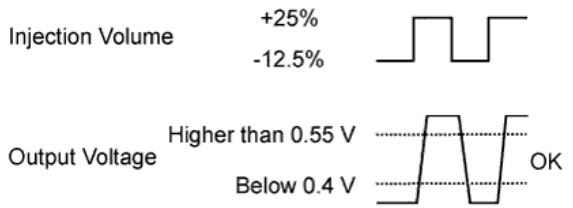
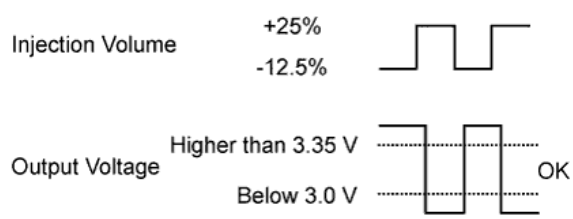
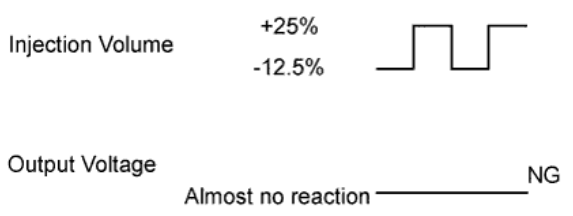
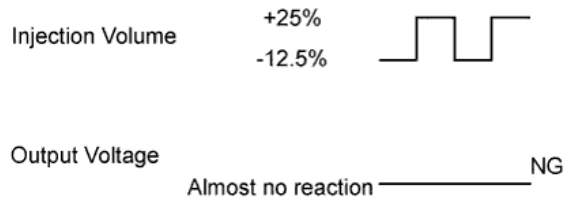
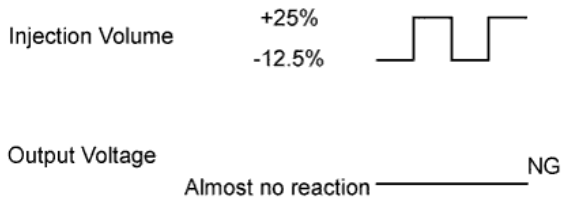
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

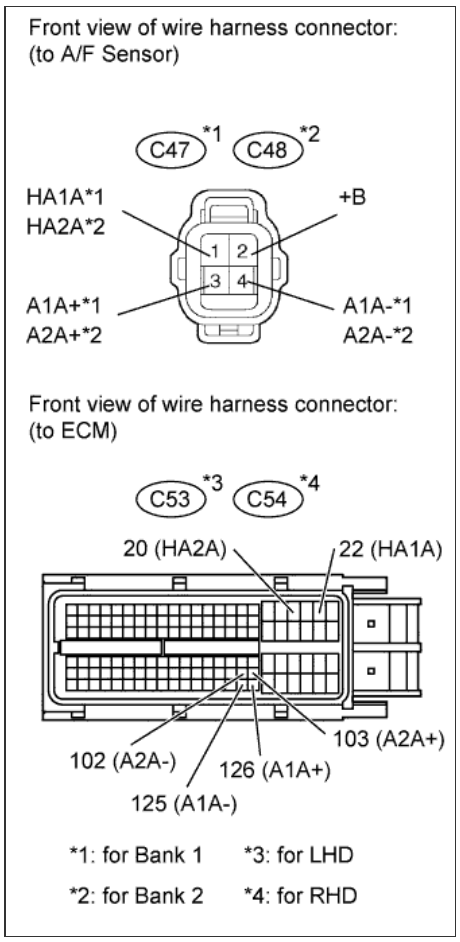
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

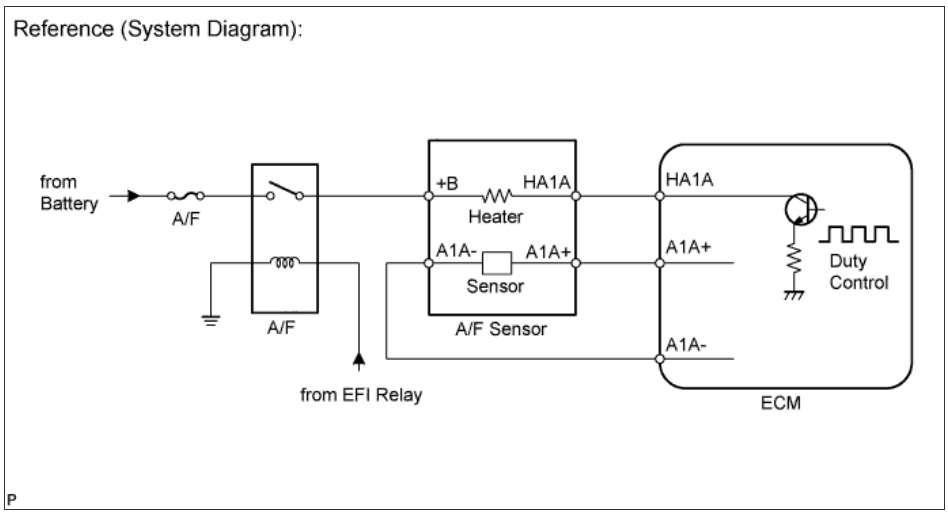
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

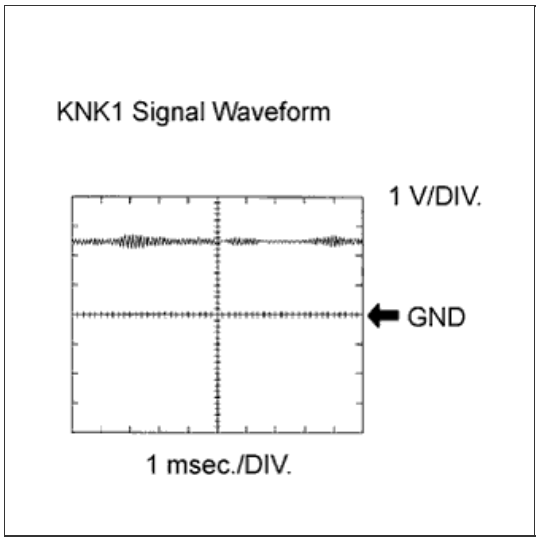
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

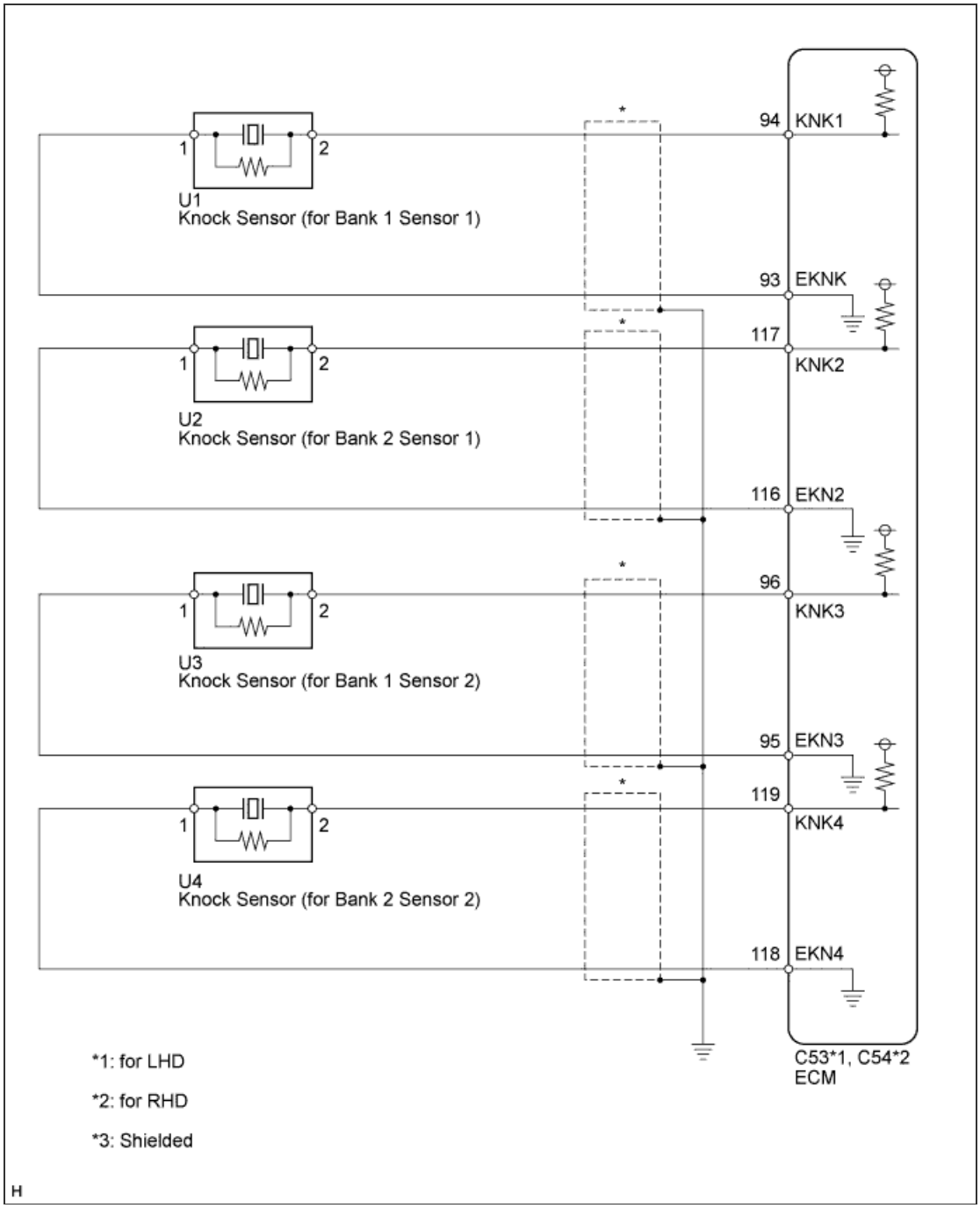
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

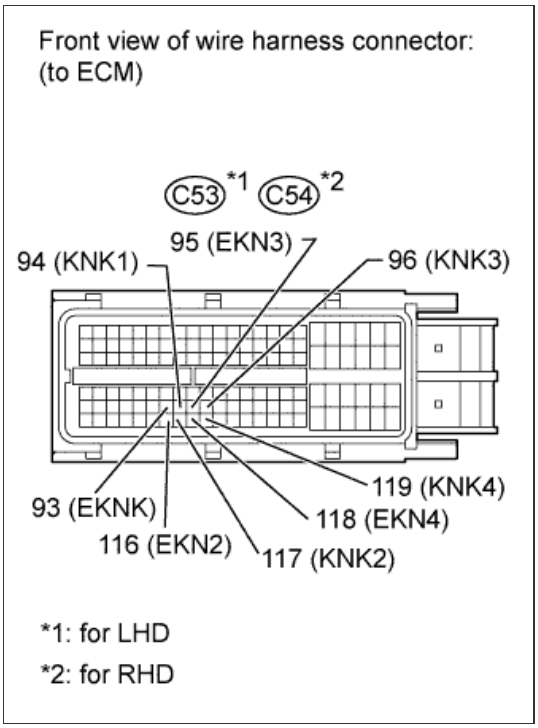
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

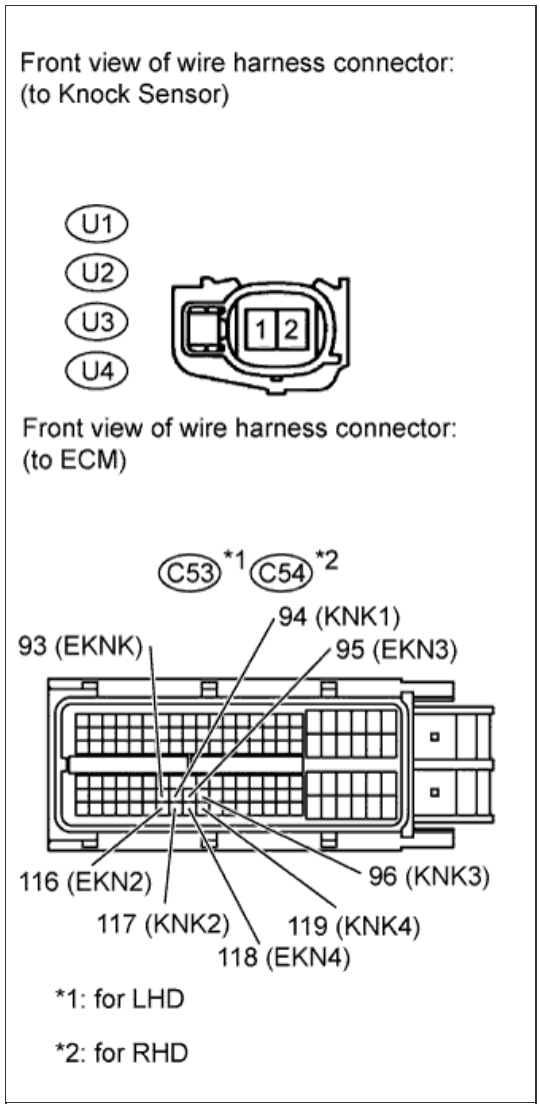
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

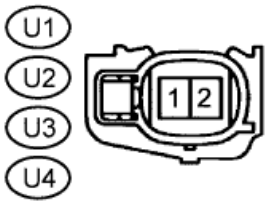
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

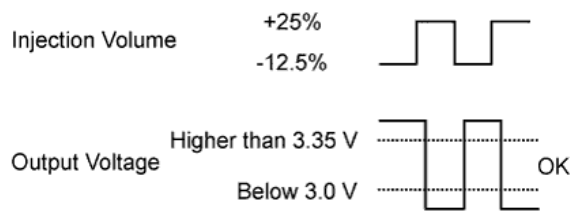
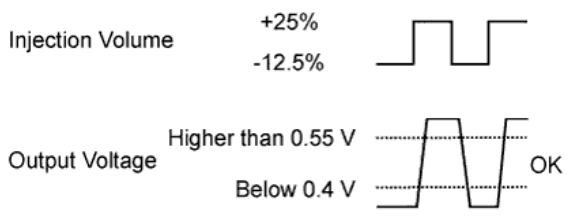
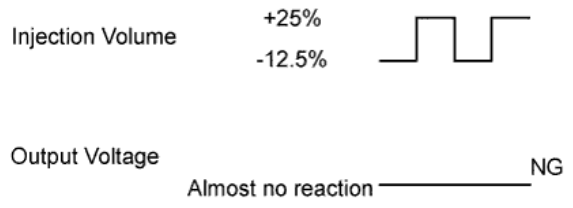
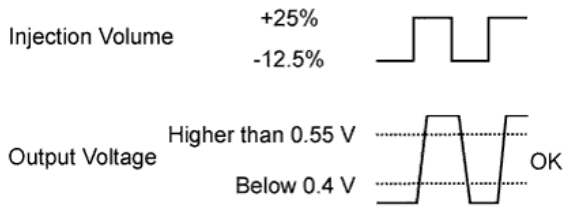
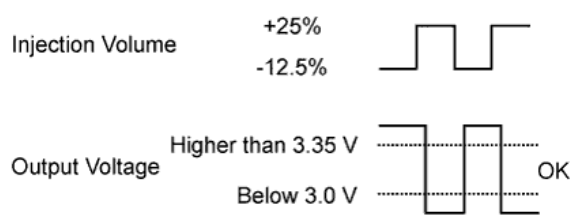
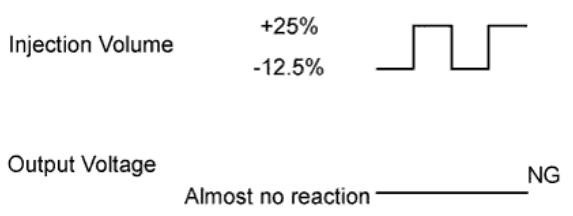
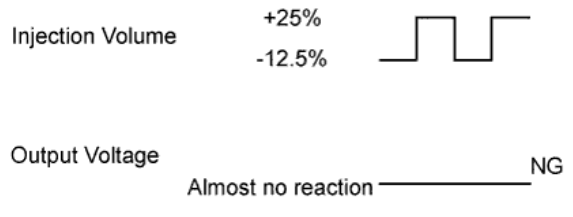
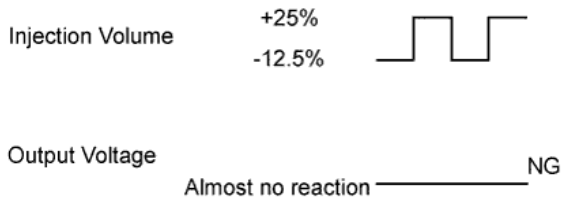
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

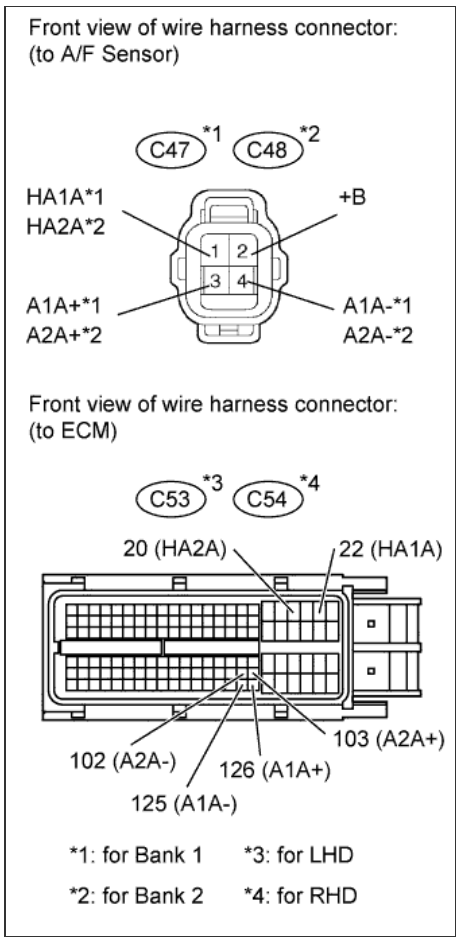
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

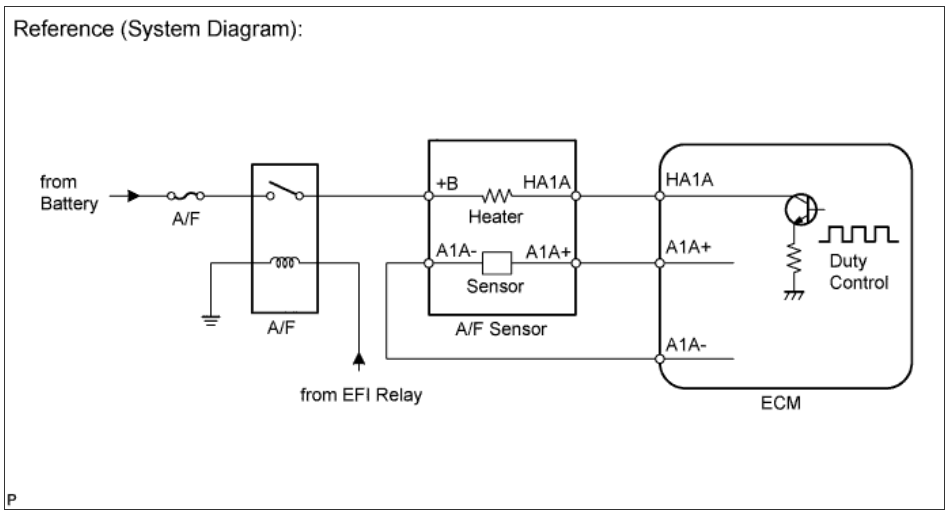
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

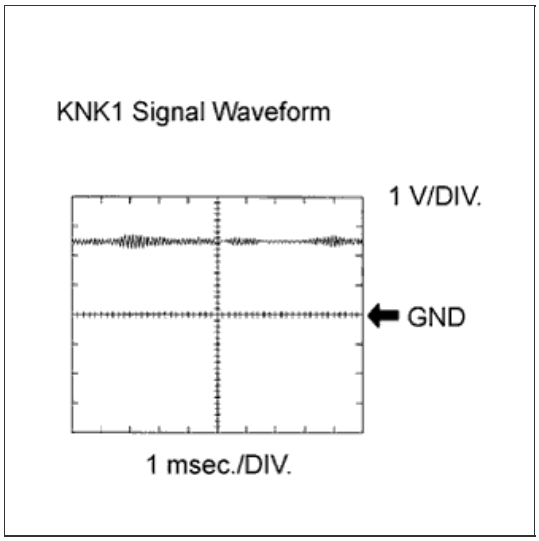
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

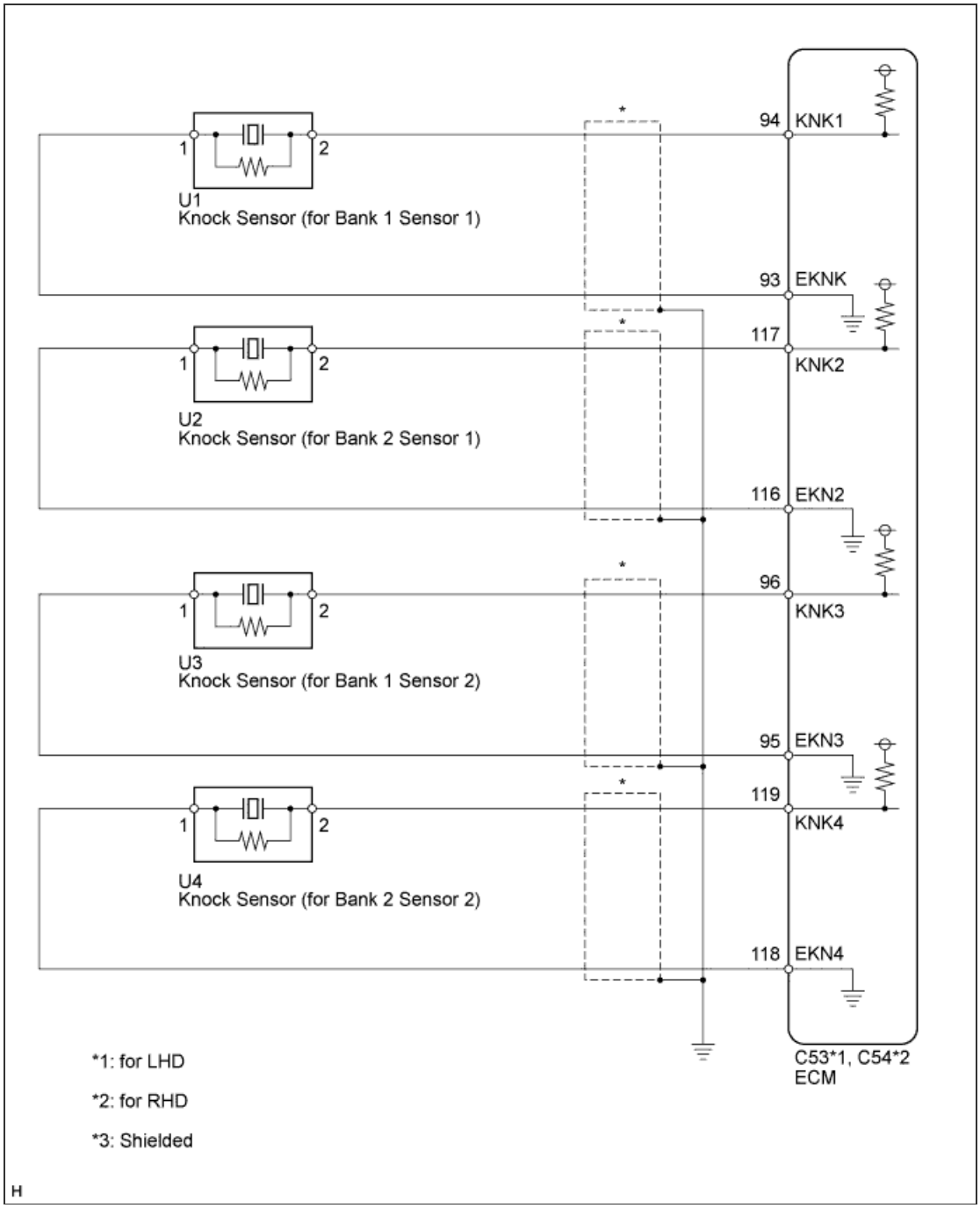
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

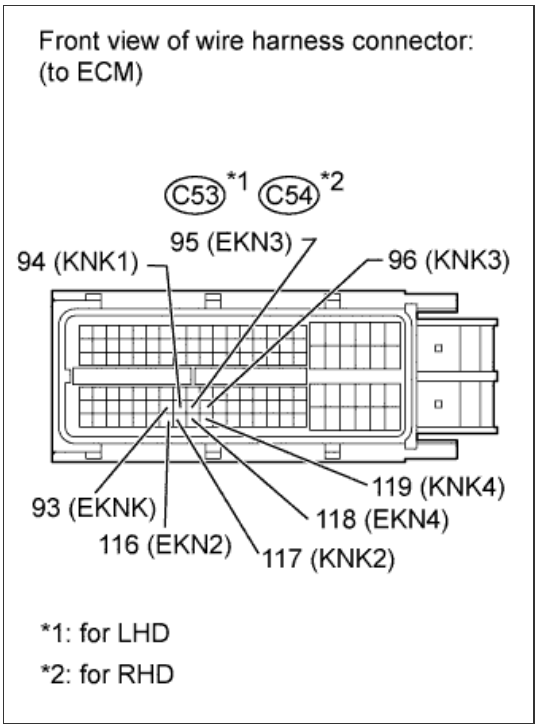
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

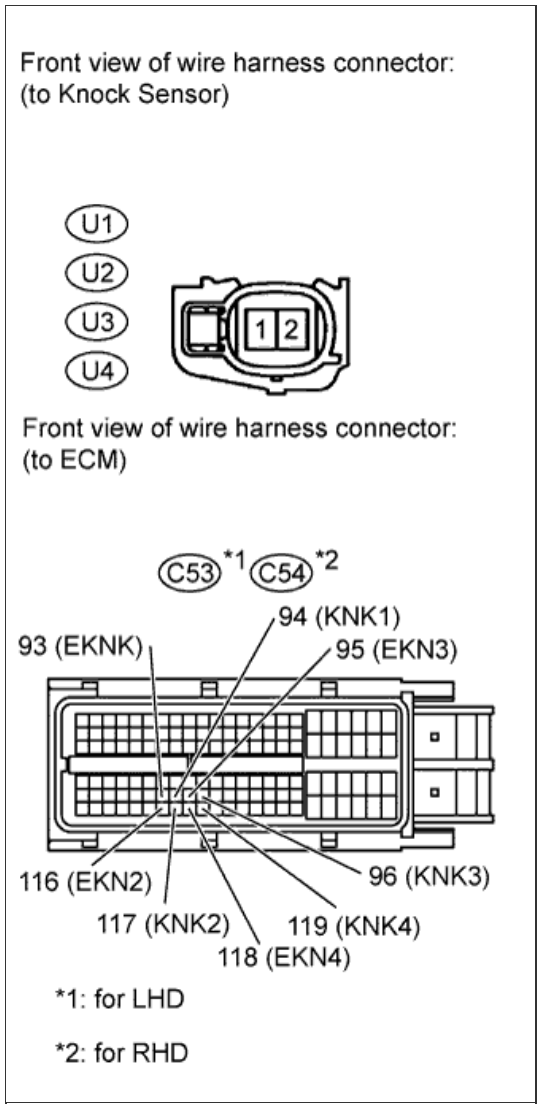
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

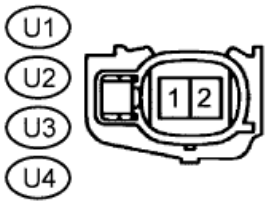
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

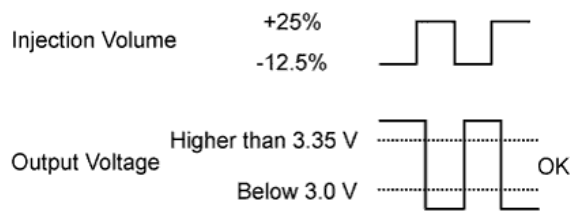
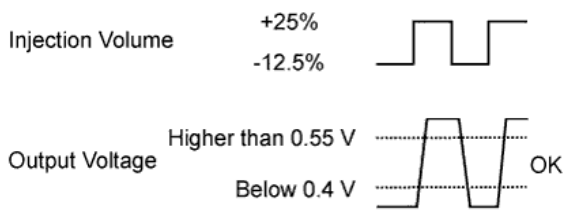
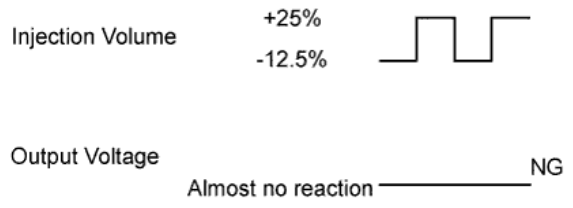
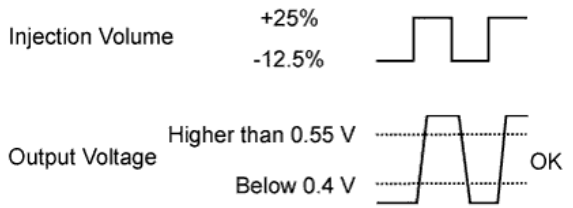
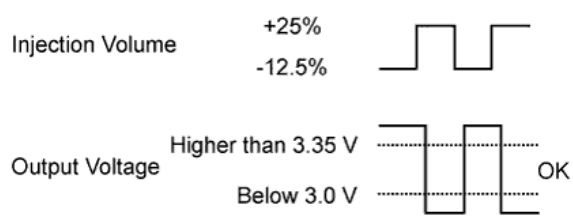
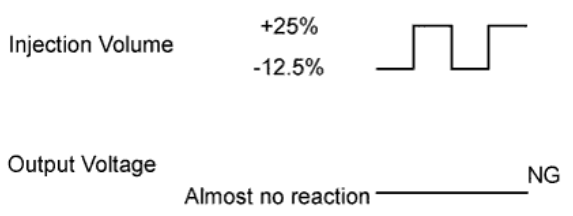
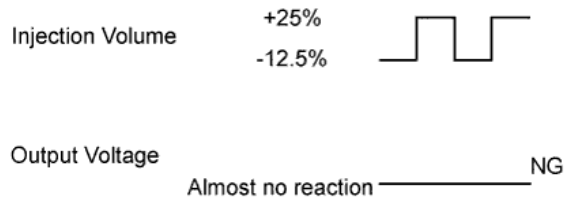
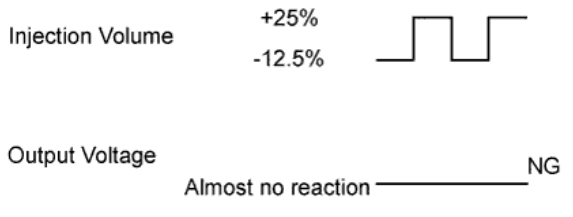
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

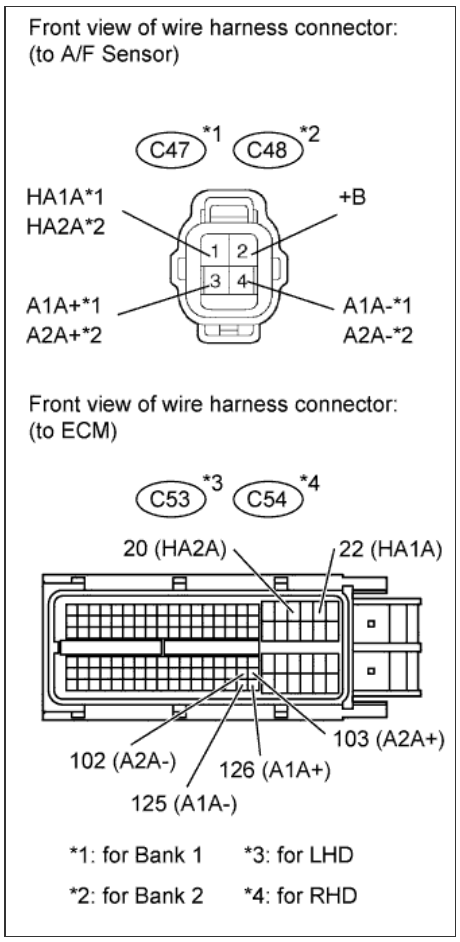
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

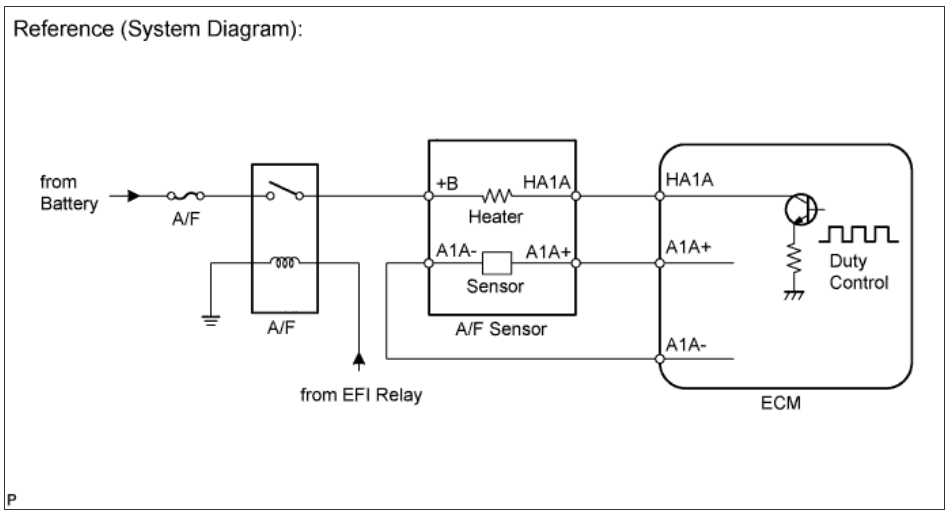
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

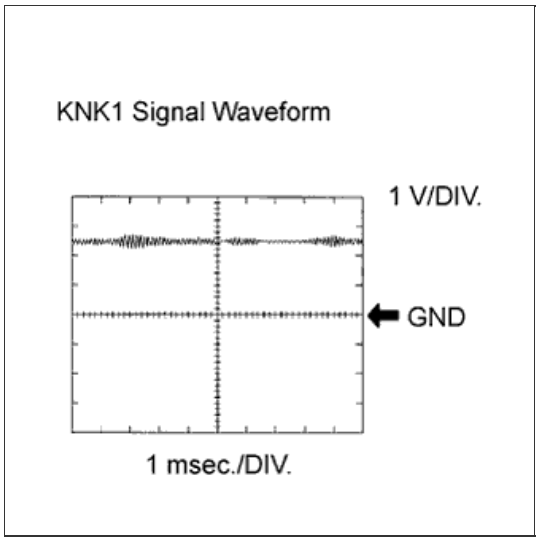
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

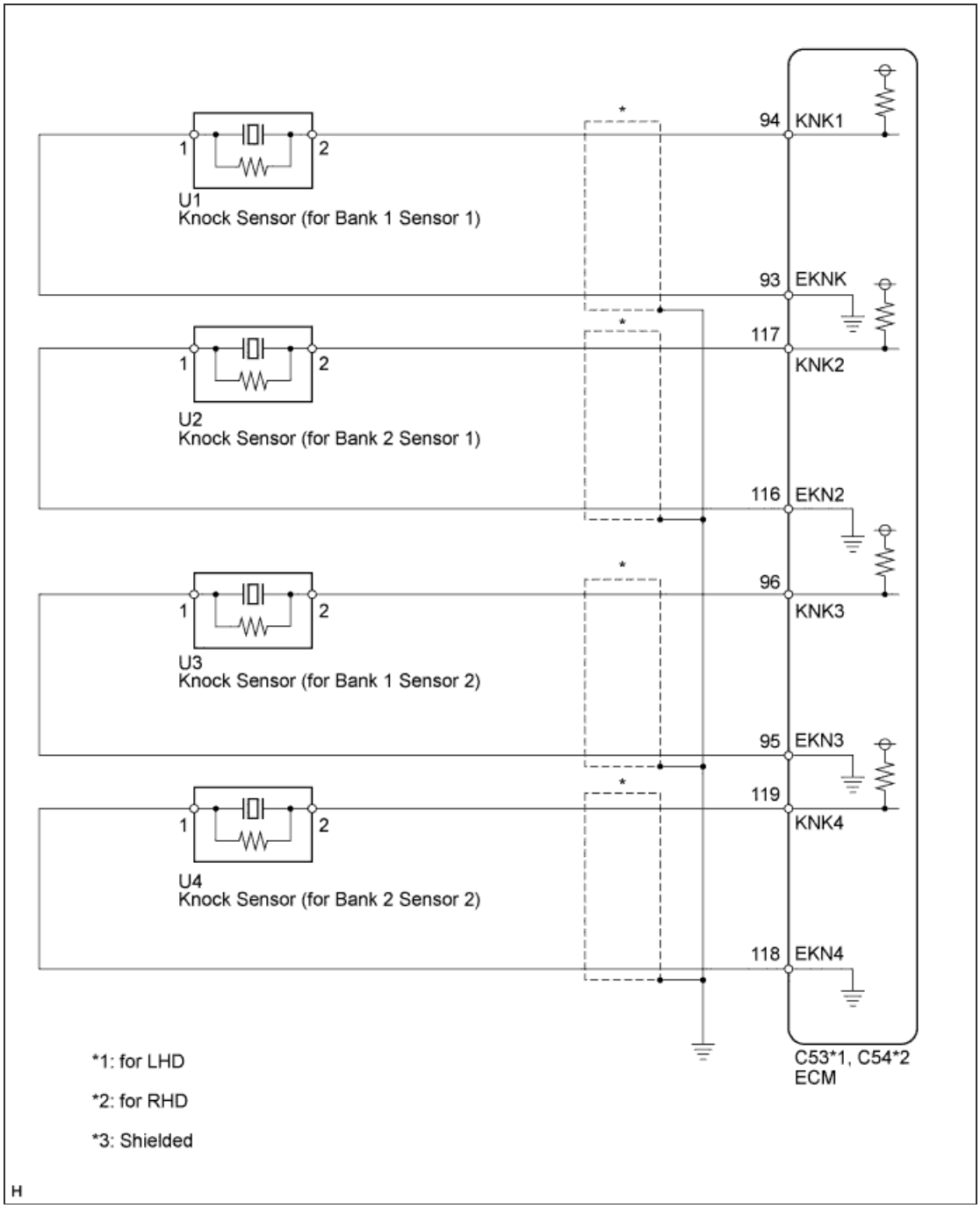
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

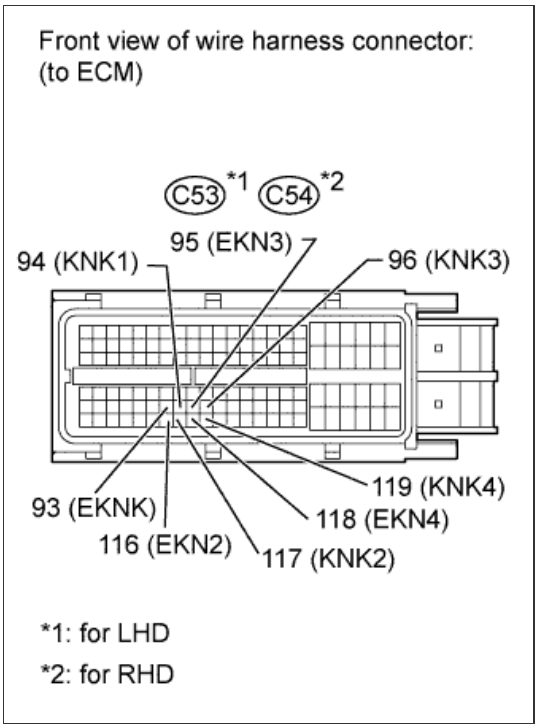
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

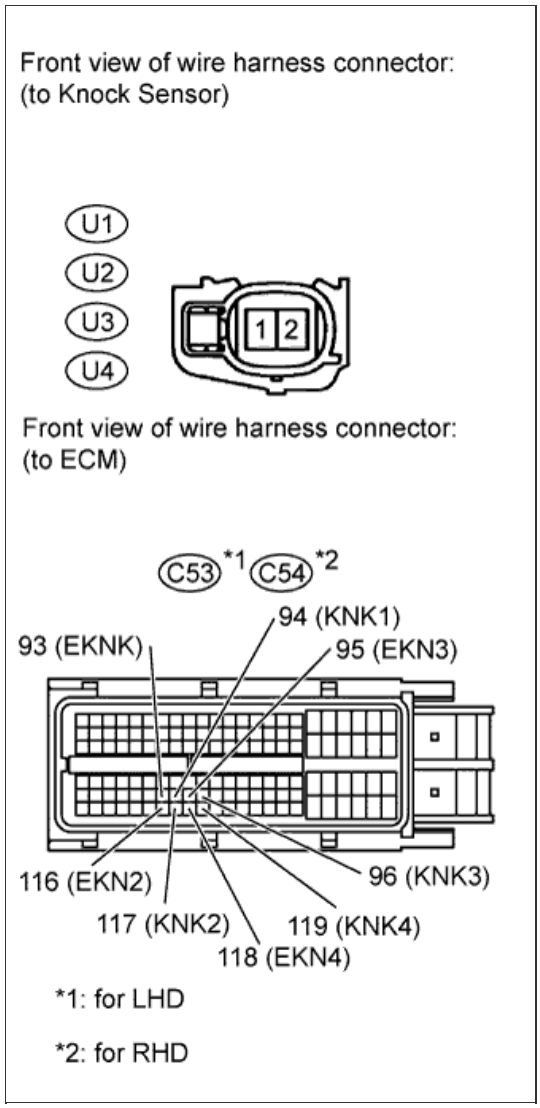
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

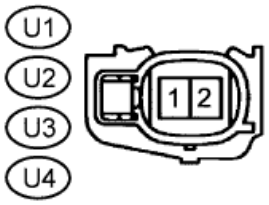
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

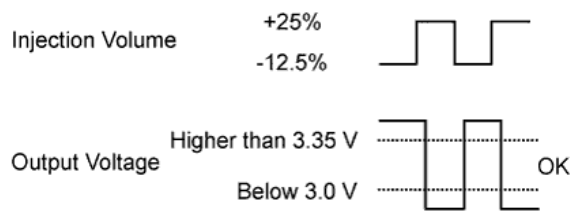
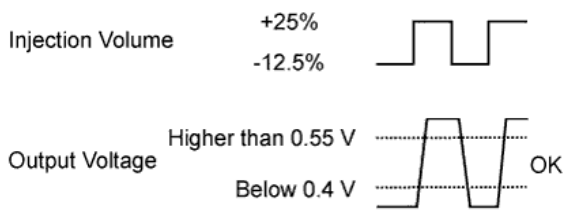
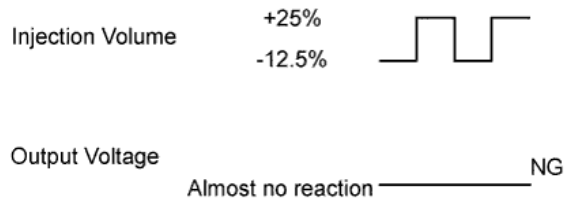
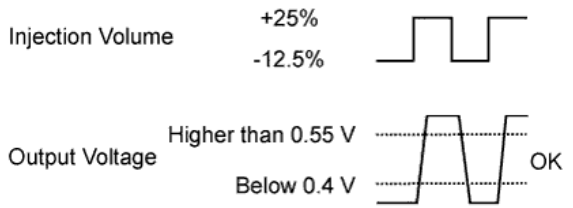
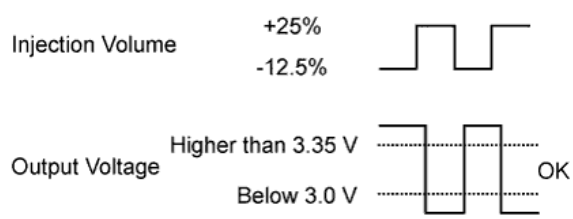
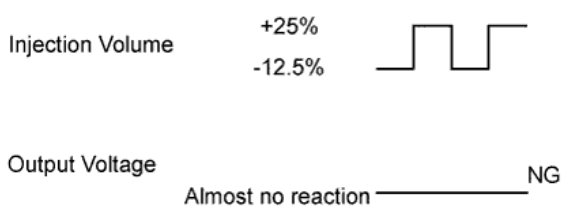
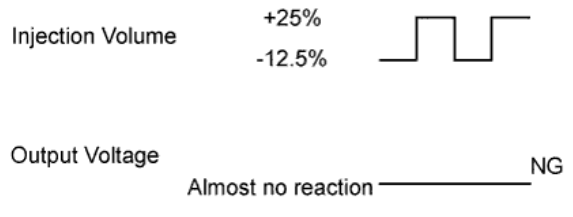
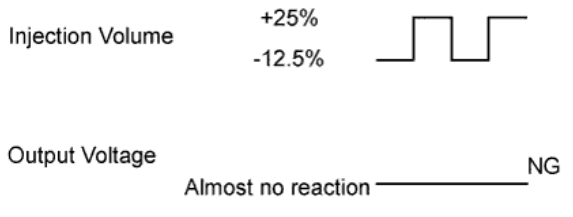
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

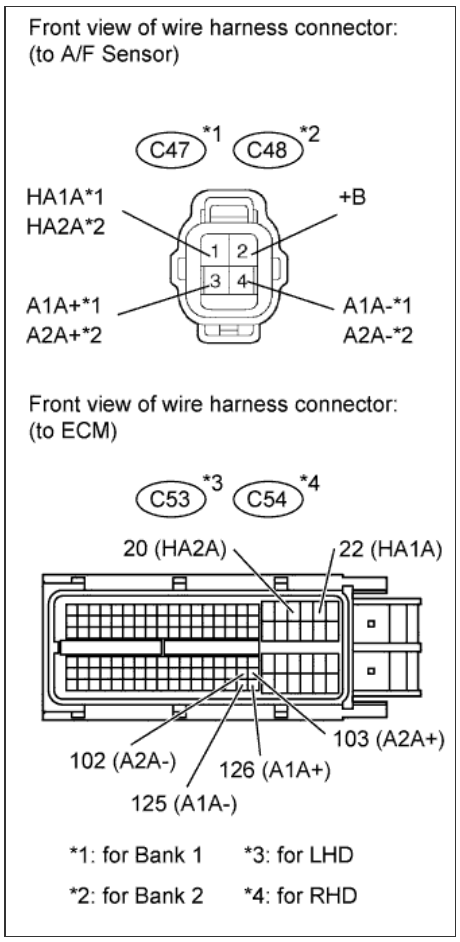
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

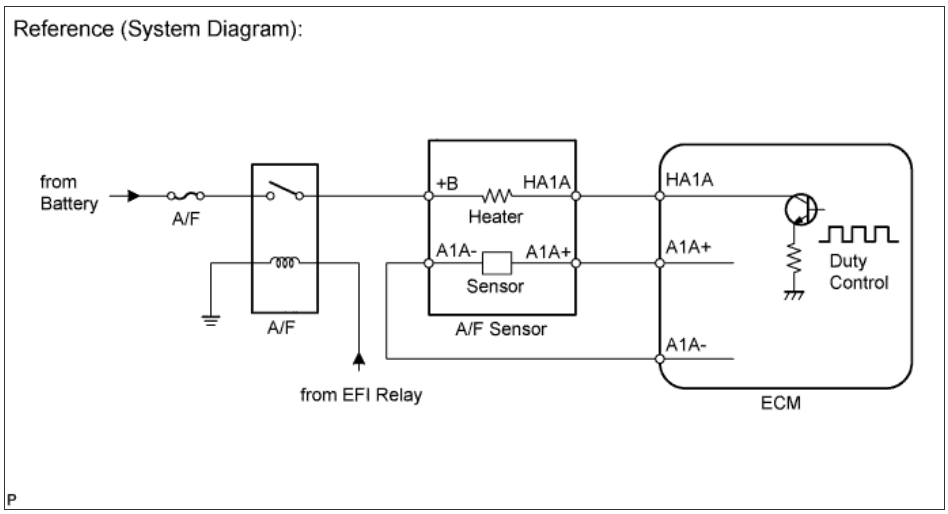
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

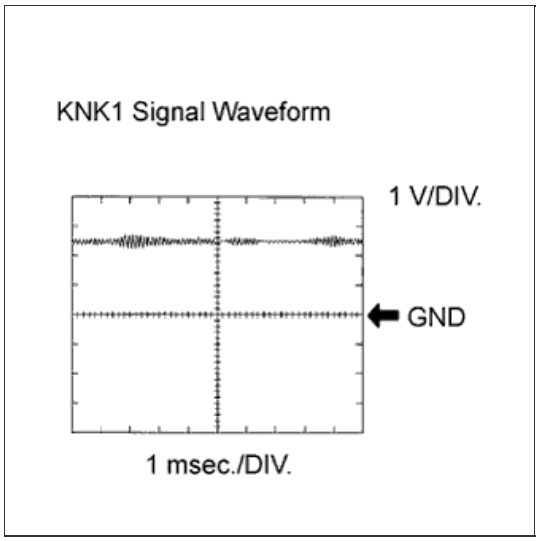
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

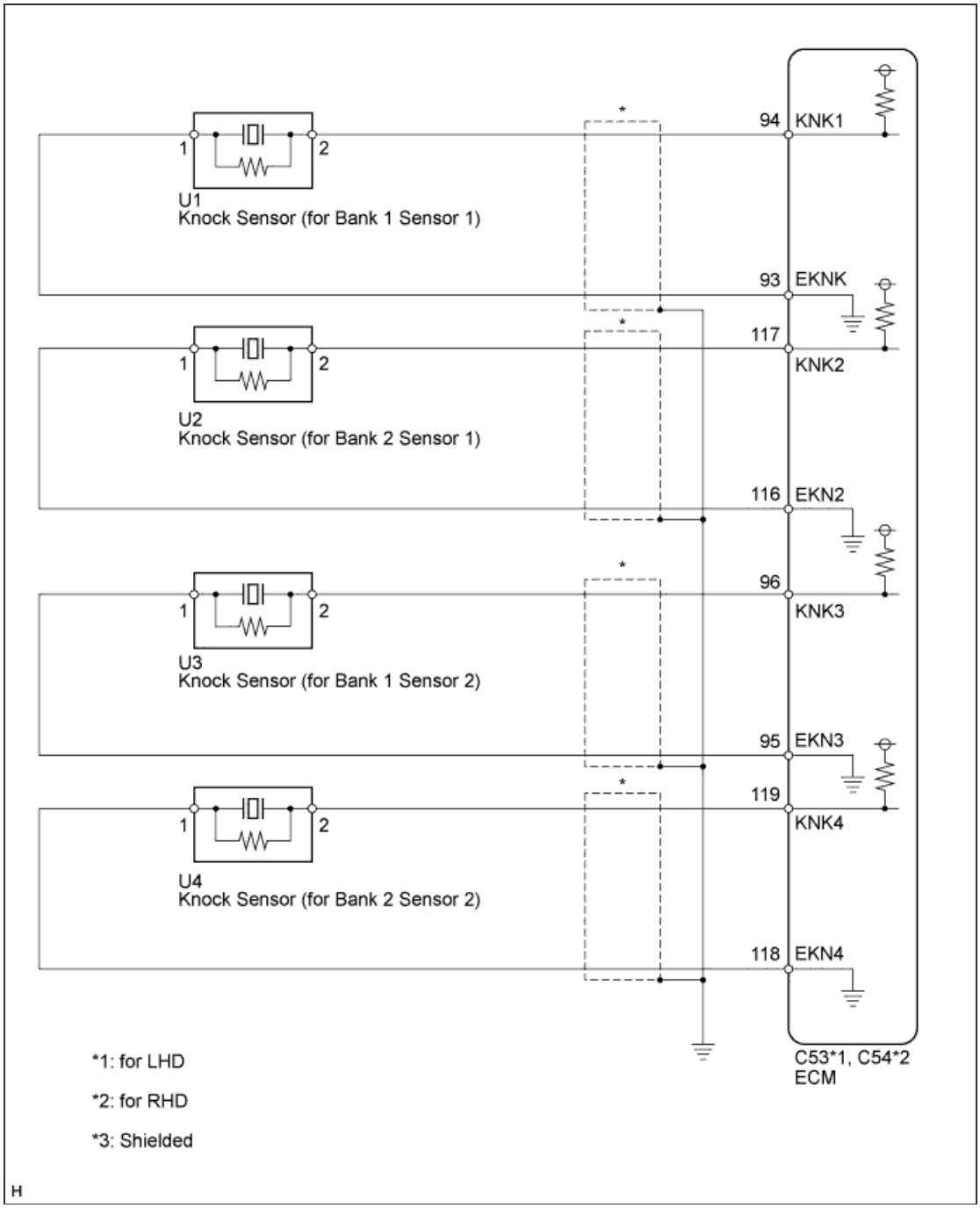
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

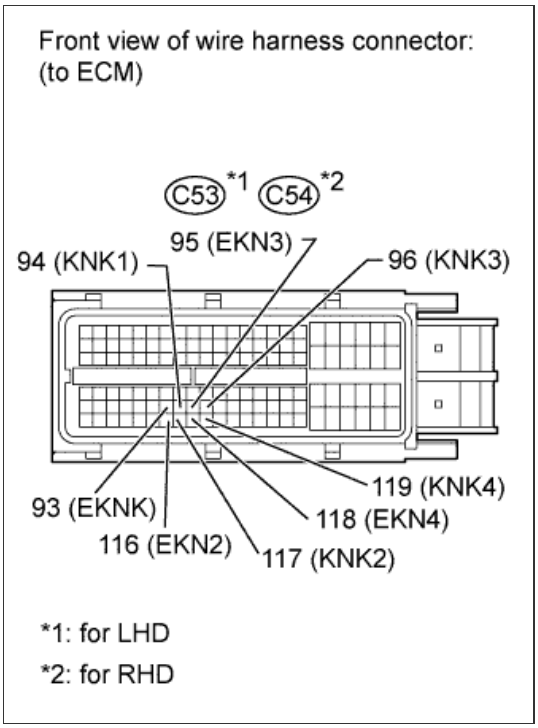
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

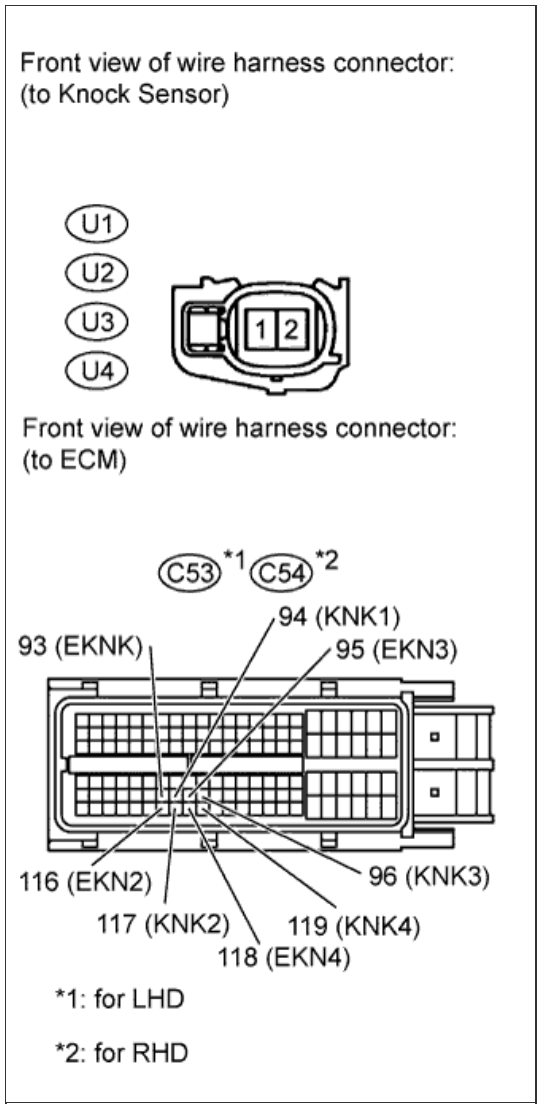
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

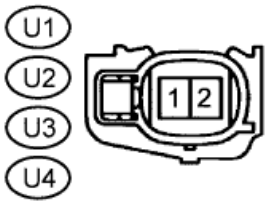
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1)

DTC P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1)

DTC P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

for Preparation Click here

DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2237 P2240	An open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the A/F sensor while the engine is running (2 trip detection logic).	• Open in Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) circuit • Air Fuel ratio (A/F) sensor (for Bank 1, 2 Sensor 1) • ECM
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) The A1A+/A2A+ voltage is 0.5 V or less. (b) (A1A+/A2A+) - (A1A-/A2A-) = 0.1 V or less. • Case 2: The A/F sensor admittance is below 0.022 1/Ω (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2239 P2242	The A1A+/A2A+ voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2252 P2255	The A1A-/A2A- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM
P2253 P2256	The A1A-/A2A- voltage is higher than 4.5 V for 5.0 seconds or more (2 trip detection logic).	• Open or short in A/F sensor (for Bank 1, 2 Sensor 1) circuit • A/F sensor (for Bank 1, 2 Sensor 1) • ECM

HINT:

- **DTCs P2237, P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.**
- **DTCs P2240, P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**

MONITOR DESCRIPTION

These DTCs are stored when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops.
To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch on (IG), and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is outside of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in the next driving cycle, the MIL is illuminated and a DTC is stored.
The Air Fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

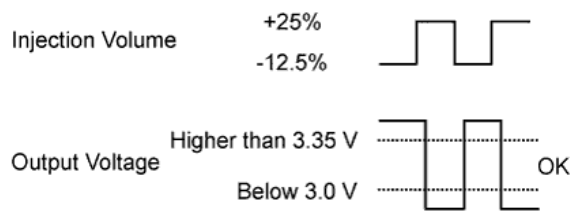
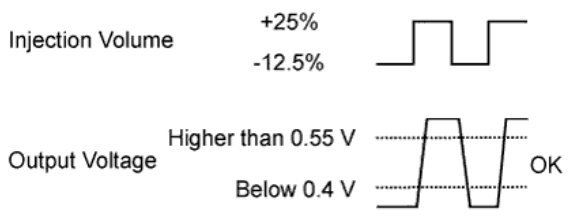
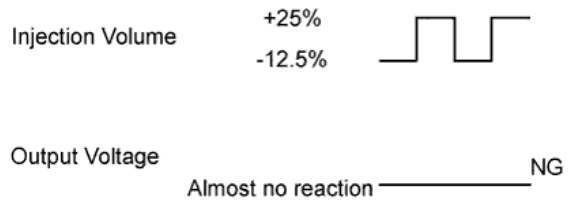
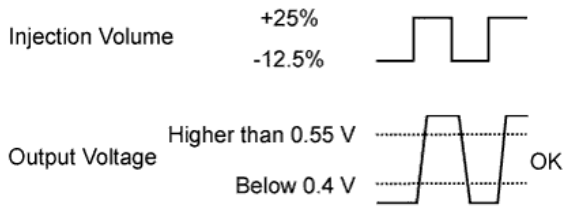
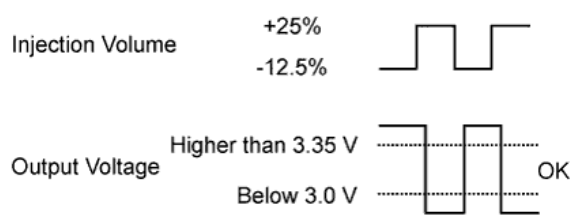
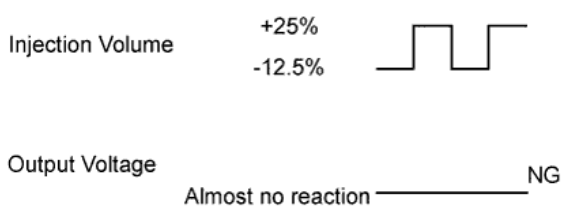
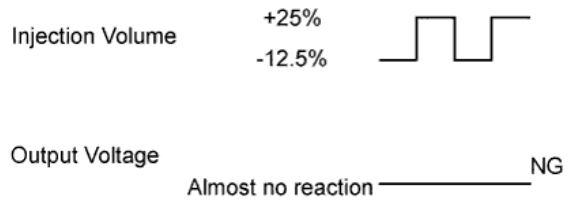
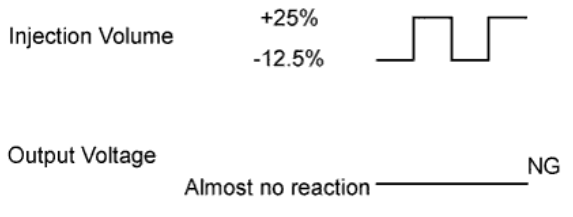
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4			• Fuel injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.

To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1.CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

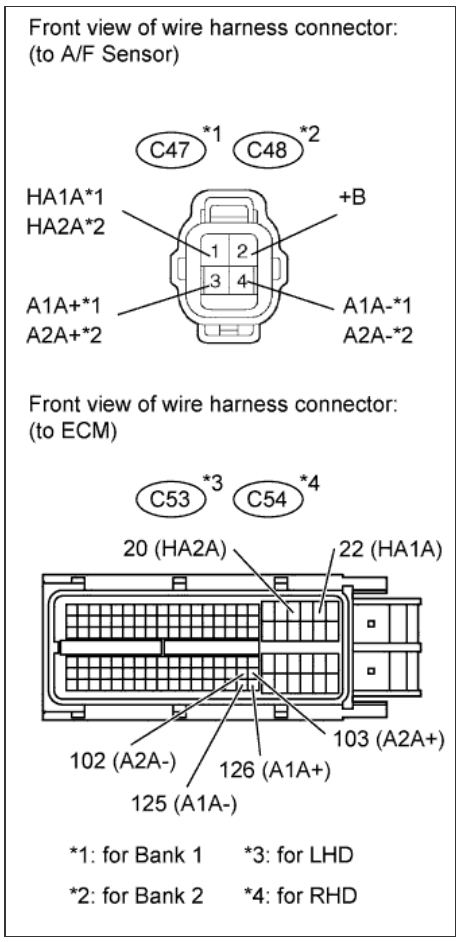
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

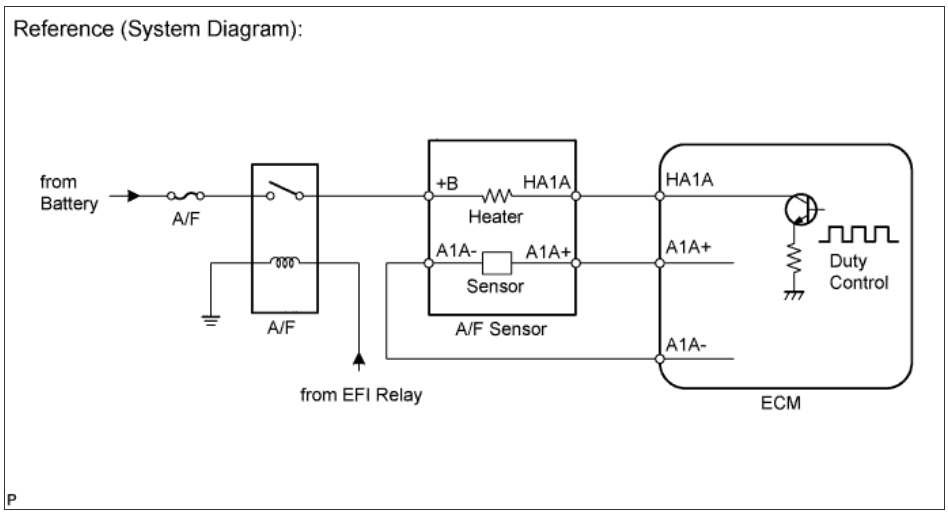
for LHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

3.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Clear DTCs (Click here).

d. Start the engine.

e. Allow the engine to idle for 5 minutes or more.

f. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

g. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256 is output	B

B → REPLACE ECM (Click here)

A

END

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

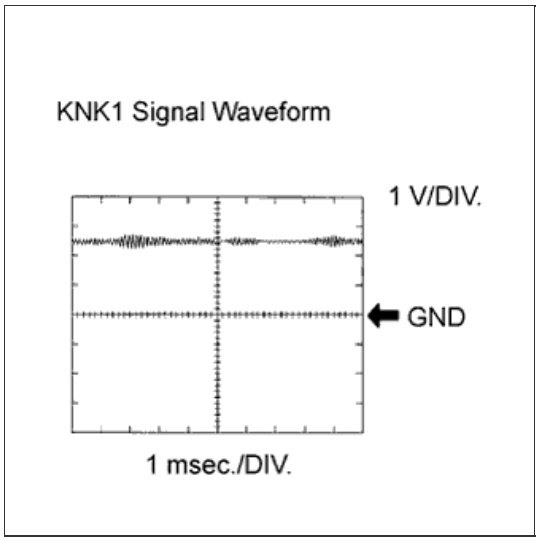
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

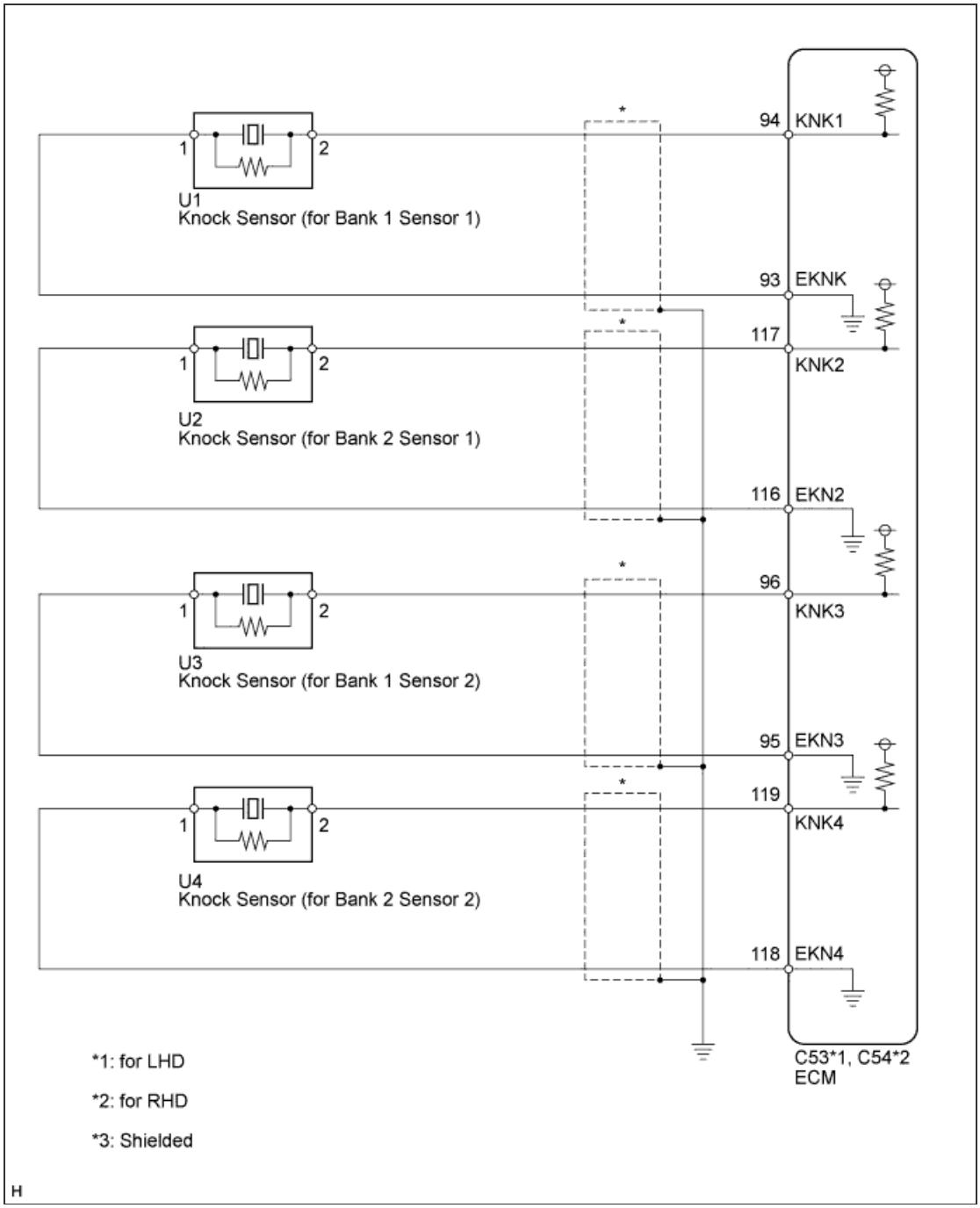
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

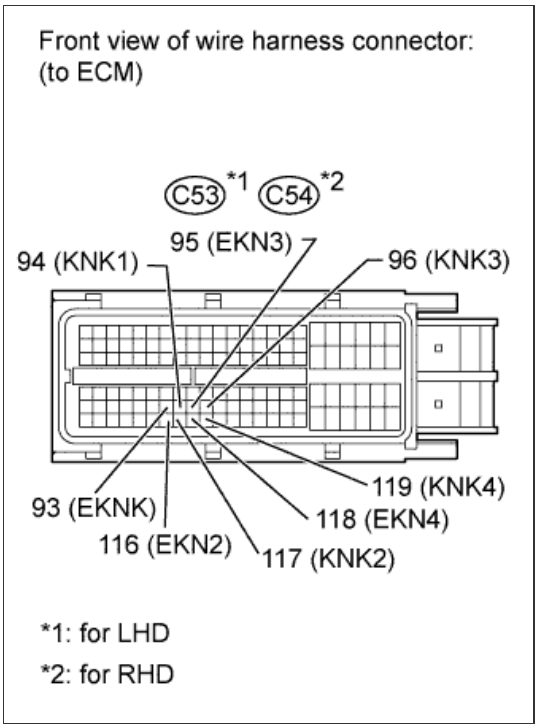
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

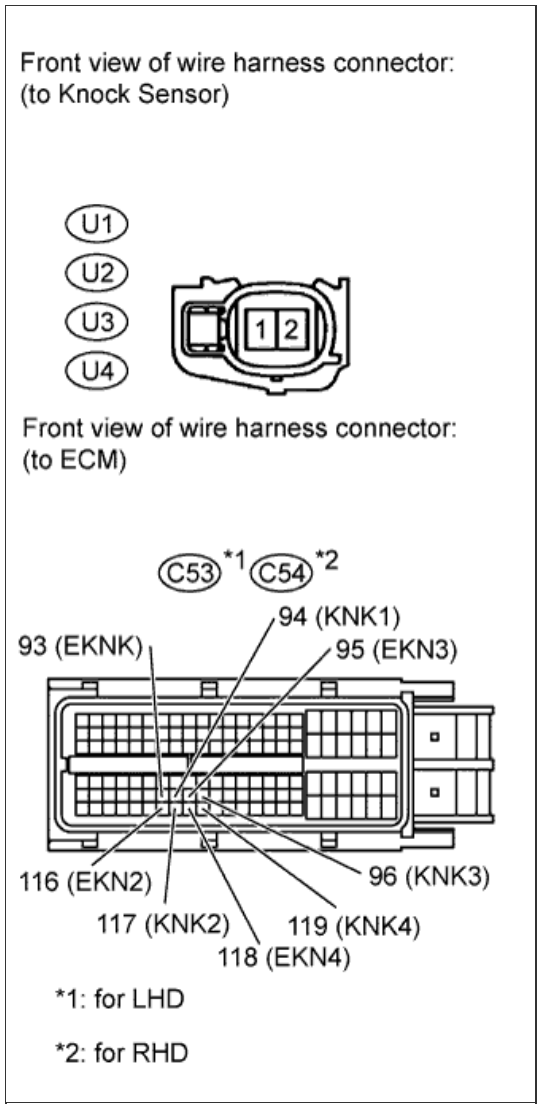
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

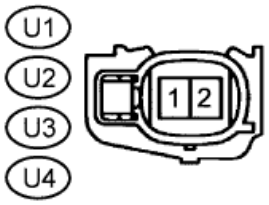
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2431 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1

DTC P2432 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1

DTC P2433 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1

DTC P2436 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2

DTC P2437 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2

DTC P2438 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2

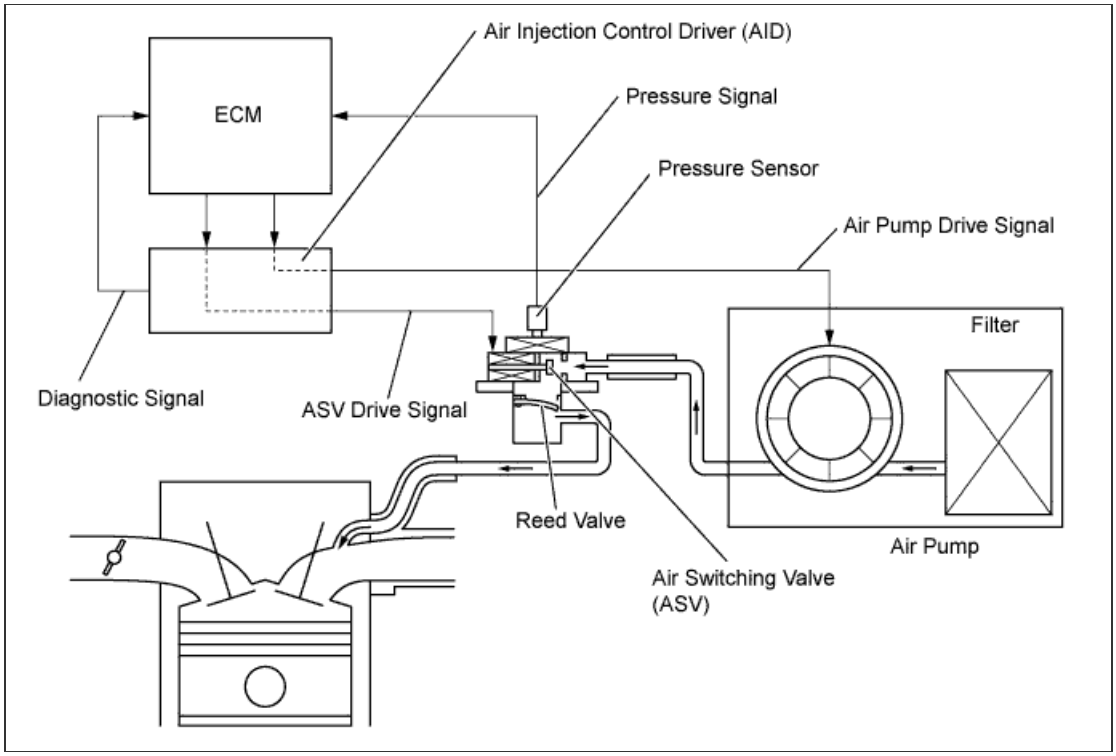
for Preparation Click here

DESCRIPTION

The Secondary Air injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

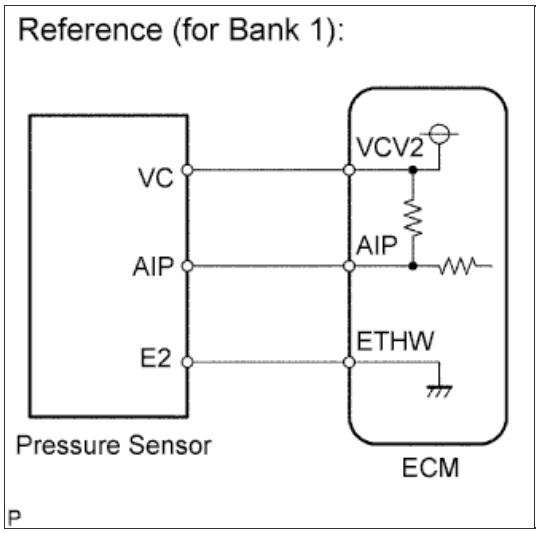
HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P2431 P2436	The pressure sensor indicates below 45.6 kPa (342 mmHg), or higher than 135 kPa (1013 mmHg) (2 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2432 P2437	While the engine is running, the voltage output of the pressure sensor remains below 0.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2433 P2438	While the engine is running, the voltage output of the pressure sensor remains higher than 4.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM

MONITOR DESCRIPTION



The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the air switching valve in the secondary air injection system.
If there is a defect in the sensor or the sensor circuit, the voltage level deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the pressure sensor or circuit and stores DTC(s).

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

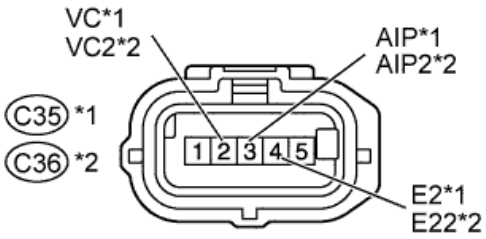
1.CHECK HARNESS AND CONNECTOR (PRESSURE SENSOR - ECM)

a. Disconnect the C35 or C36 pressure sensor connector.

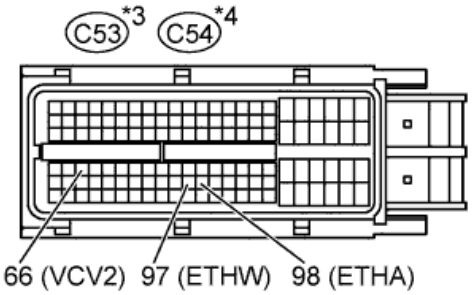
b. Disconnect the A38 and C53 or A53 and C54 ECM connectors.

c. Measure the resistance according to the value(s) in the table below.

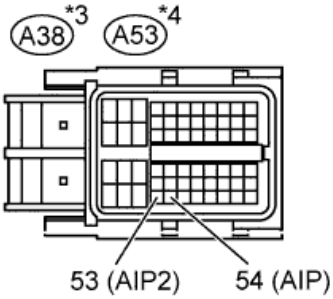
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to ECM)



*1: for Bank 1

*2: for Bank 2

*3: for LHD

*4: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A38-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C53-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A38-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C53-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C53-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A38-54 (AIP) - Body	Always	10 kΩ or

ground		higher
C35-2 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A38-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A53-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C54-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A53-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C54-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C54-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A53-54 (AIP) - Body ground	Always	10 kΩ or higher
C35-2 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A53-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

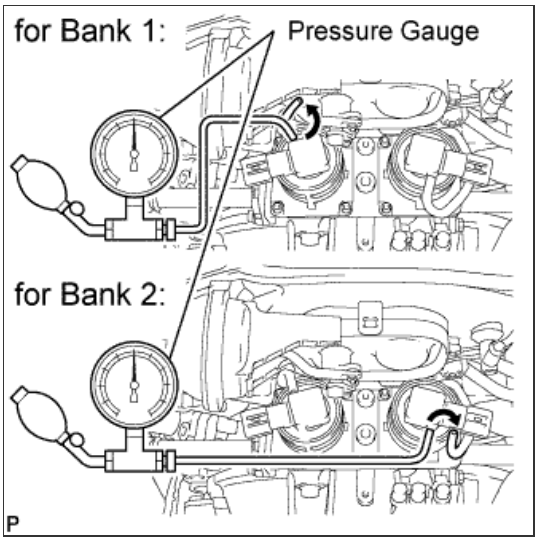
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

REPLACE ECM (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

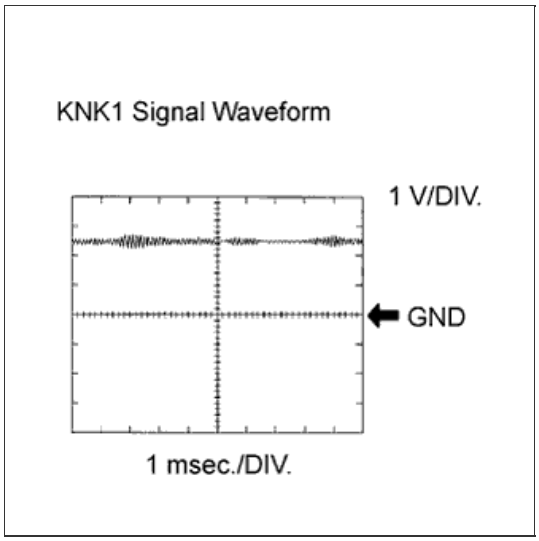
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

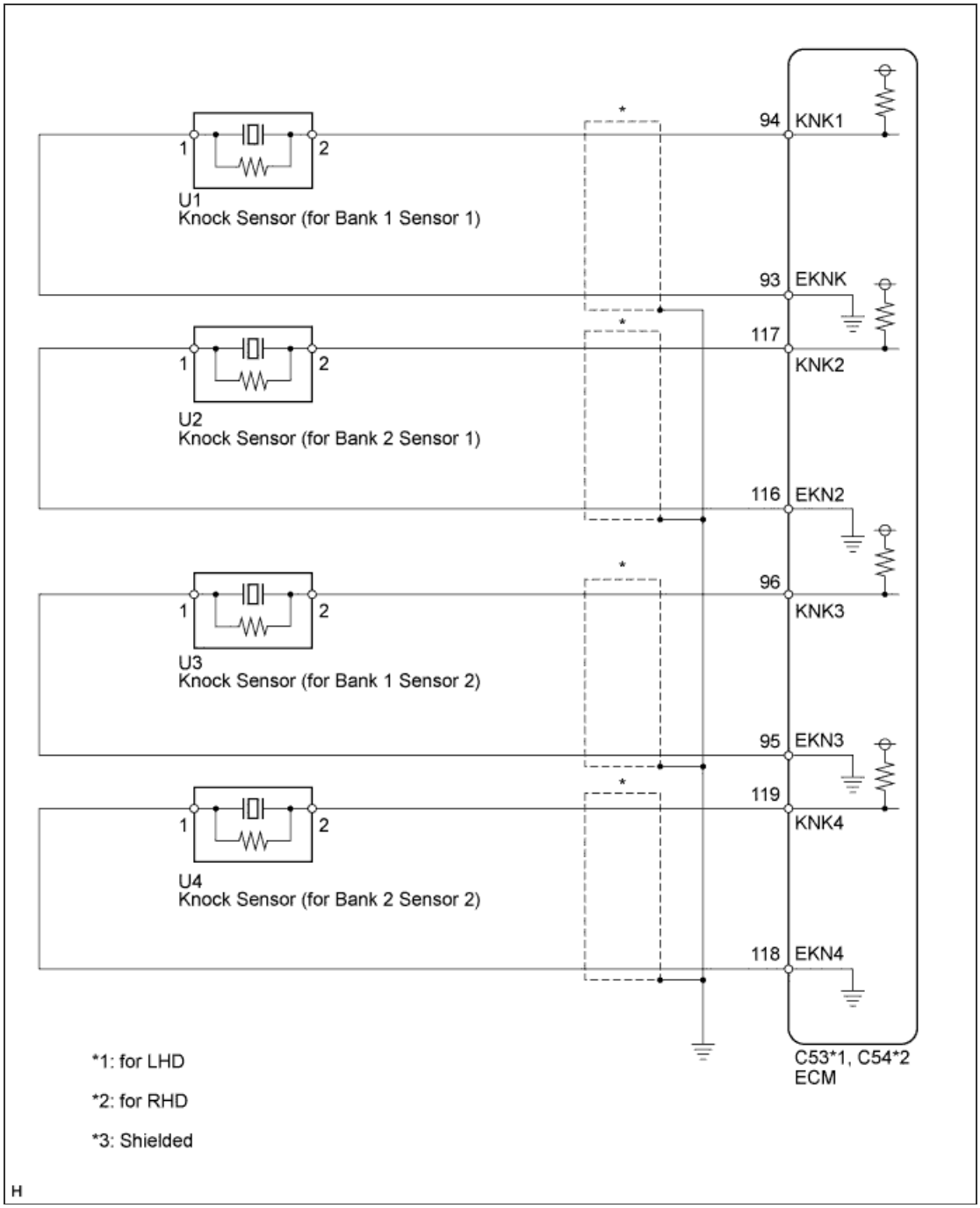
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

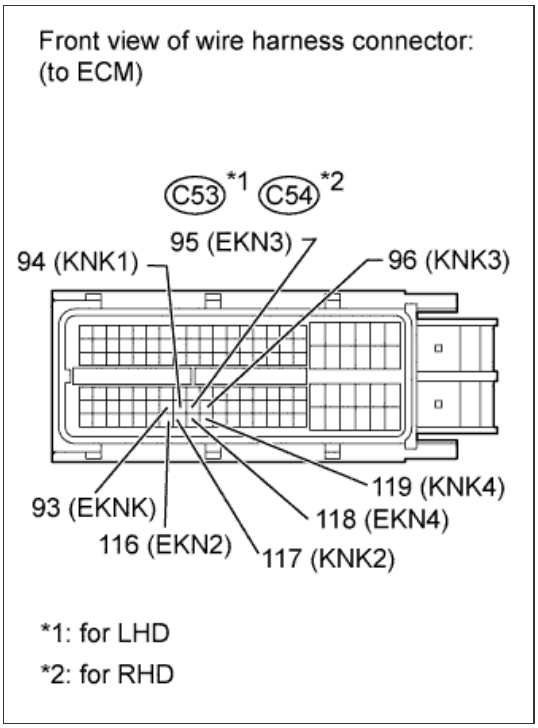
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

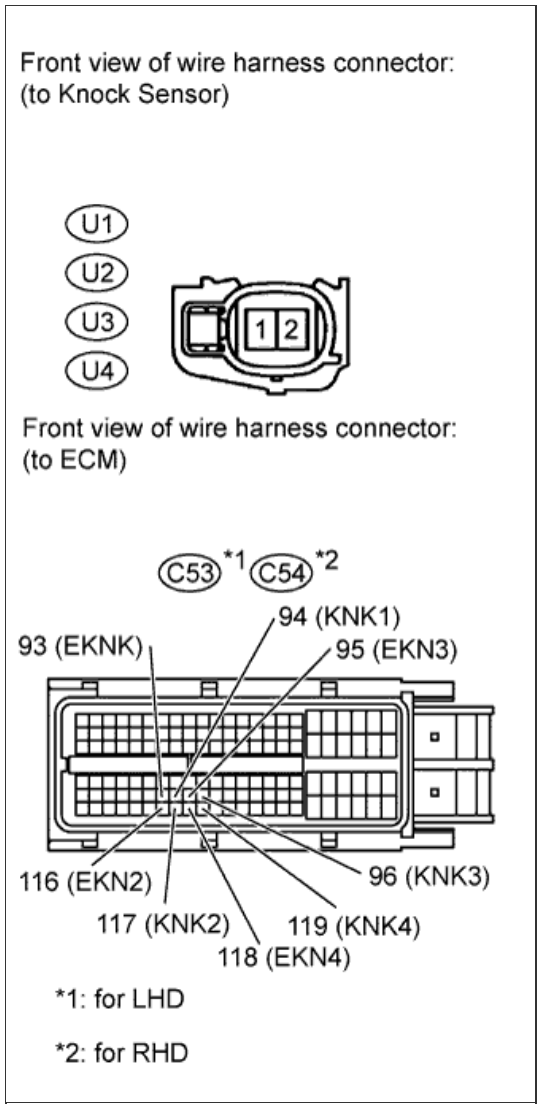
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

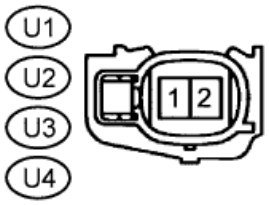
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2431 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1

DTC P2432 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1

DTC P2433 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1

DTC P2436 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2

DTC P2437 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2

DTC P2438 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2

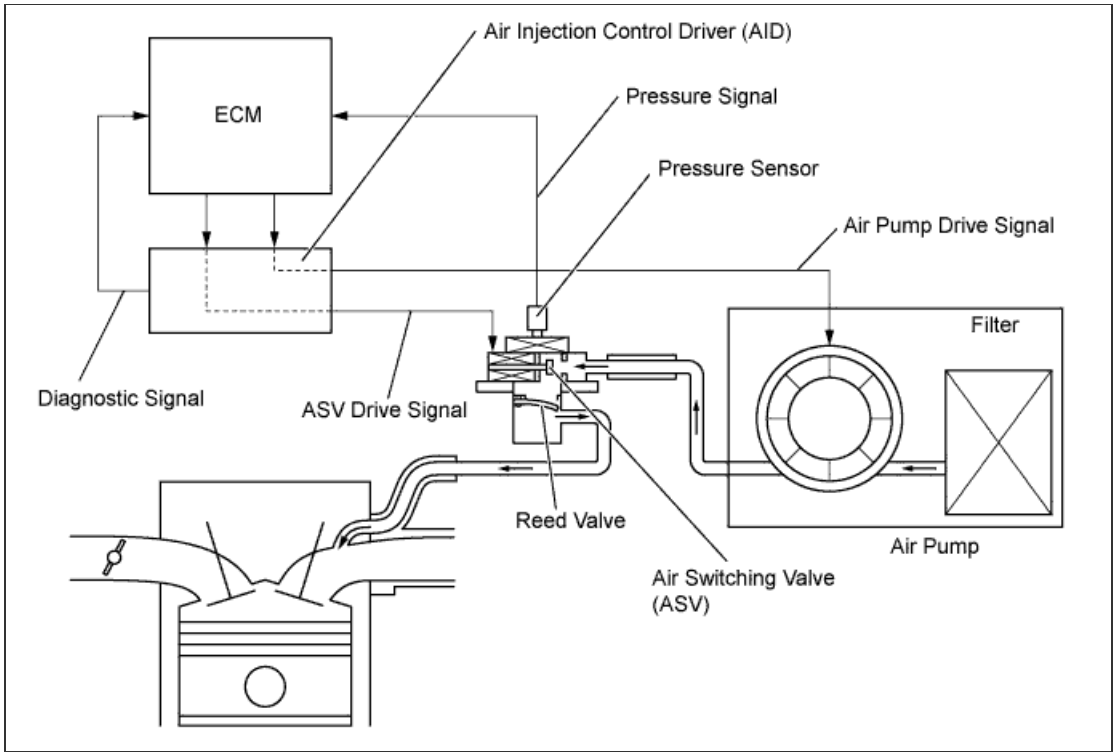
for Preparation Click here

DESCRIPTION

The Secondary Air injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

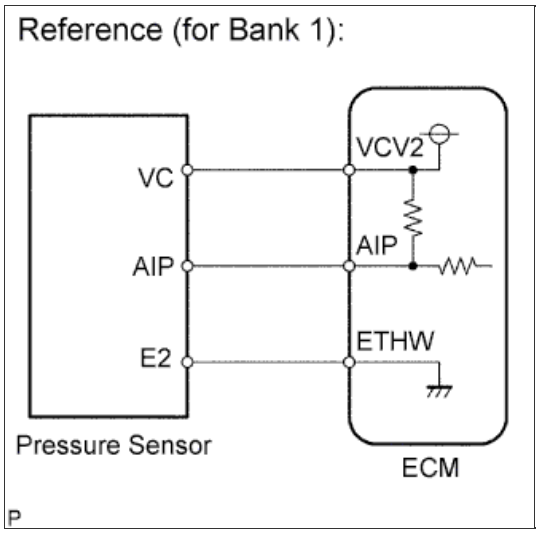
HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P2431 P2436	The pressure sensor indicates below 45.6 kPa (342 mmHg), or higher than 135 kPa (1013 mmHg) (2 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2432 P2437	While the engine is running, the voltage output of the pressure sensor remains below 0.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2433 P2438	While the engine is running, the voltage output of the pressure sensor remains higher than 4.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM

MONITOR DESCRIPTION



The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the air switching valve in the secondary air injection system.
If there is a defect in the sensor or the sensor circuit, the voltage level deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the pressure sensor or circuit and stores DTC(s).

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

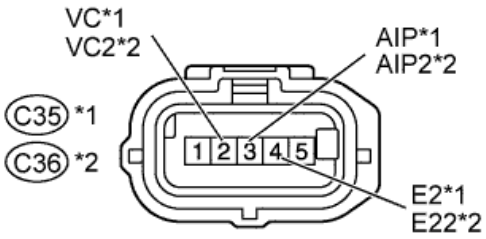
1.CHECK HARNESS AND CONNECTOR (PRESSURE SENSOR - ECM)

a. Disconnect the C35 or C36 pressure sensor connector.

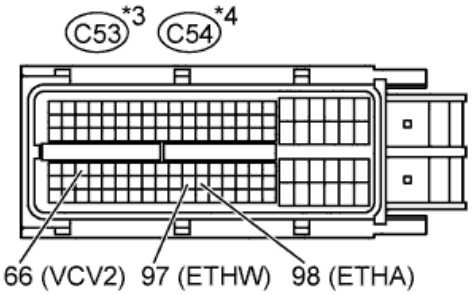
b. Disconnect the A38 and C53 or A53 and C54 ECM connectors.

c. Measure the resistance according to the value(s) in the table below.

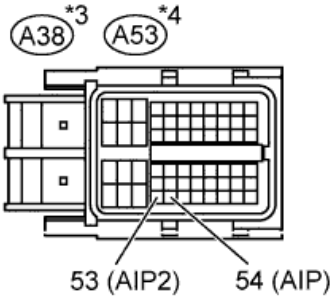
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to ECM)



*1: for Bank 1

*2: for Bank 2

*3: for LHD

*4: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A38-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C53-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A38-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C53-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C53-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A38-54 (AIP) - Body	Always	10 kΩ or

ground		higher
C35-2 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A38-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A53-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C54-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A53-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C54-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C54-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A53-54 (AIP) - Body ground	Always	10 kΩ or higher
C35-2 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A53-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

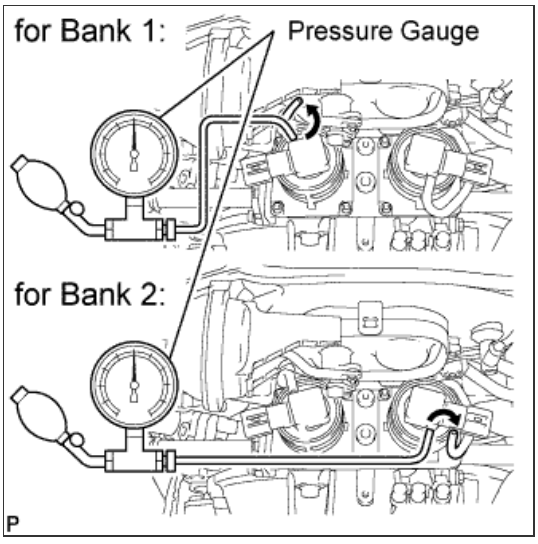
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

REPLACE ECM (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

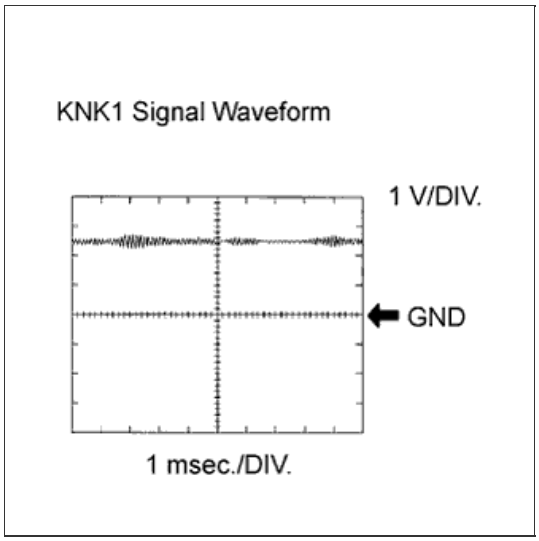
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

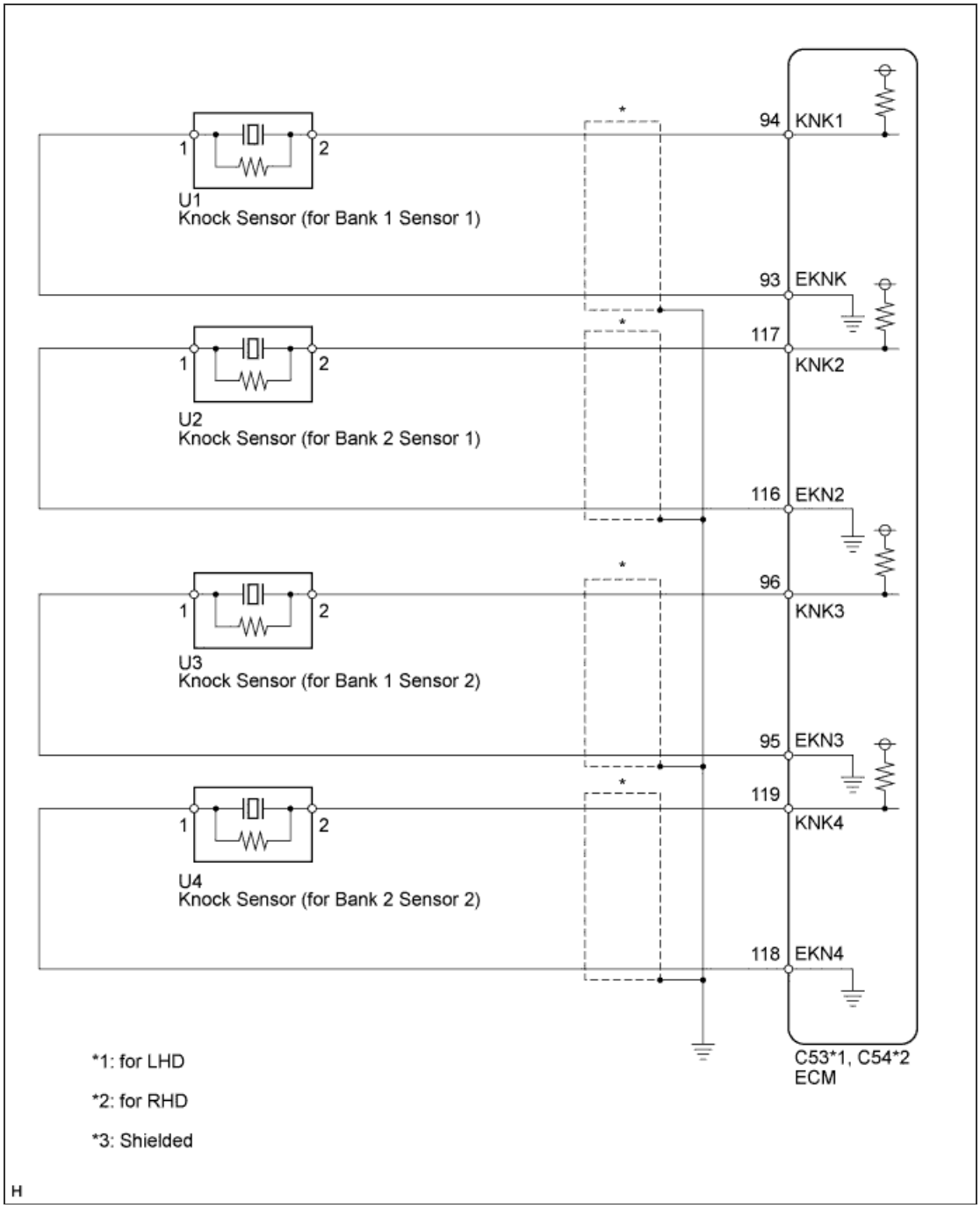
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

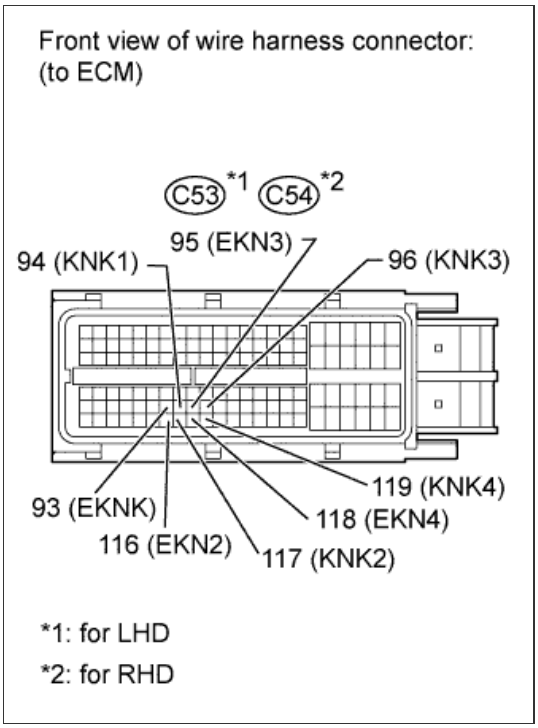
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

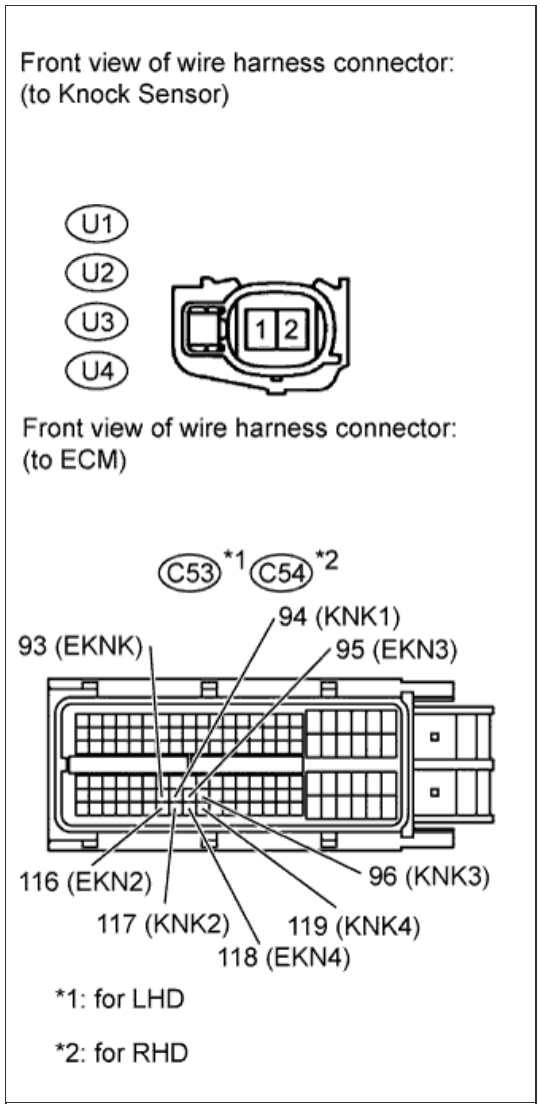
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

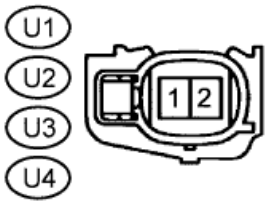
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2431 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1

DTC P2432 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1

DTC P2433 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1

DTC P2436 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2

DTC P2437 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2

DTC P2438 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2

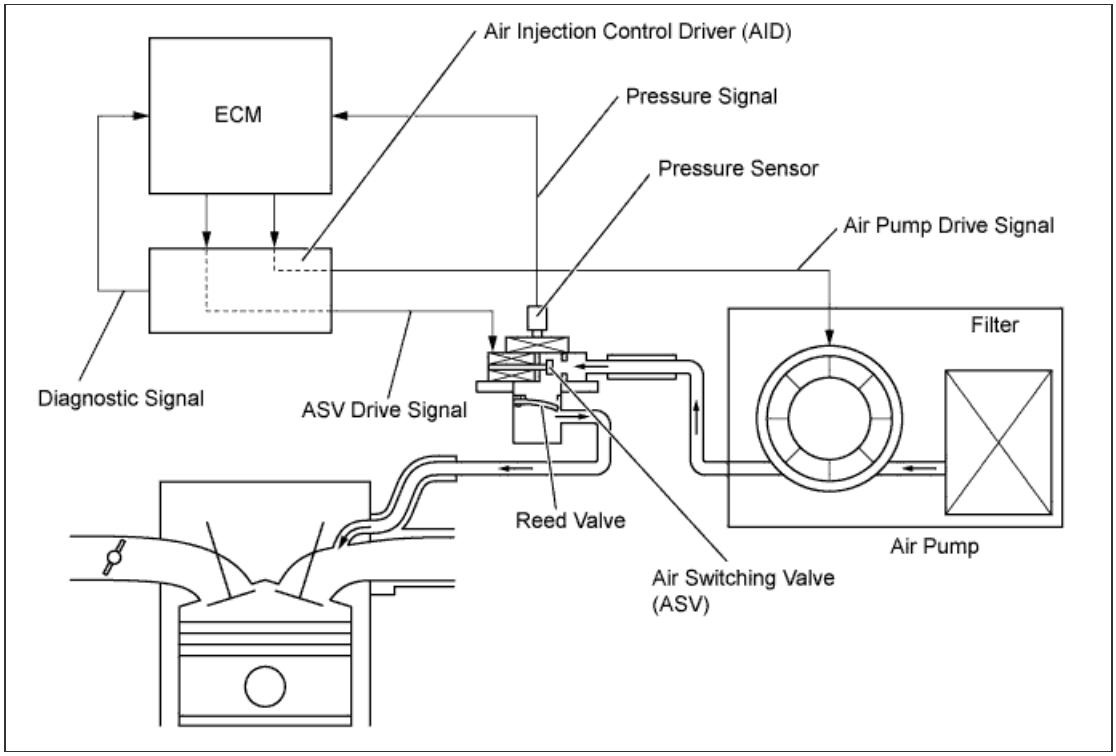
for Preparation Click here

DESCRIPTION

The Secondary Air injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

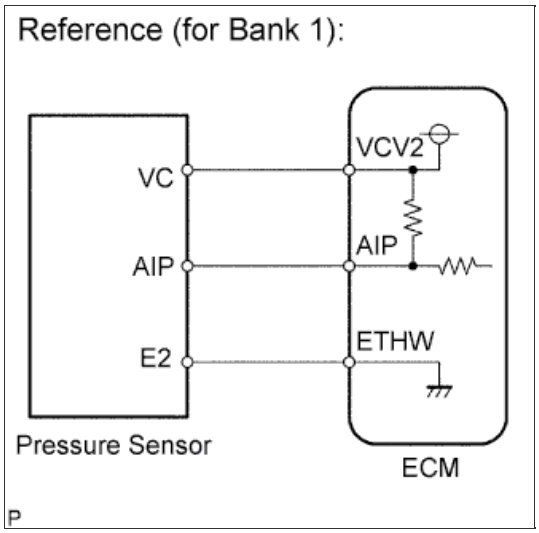
HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P2431 P2436	The pressure sensor indicates below 45.6 kPa (342 mmHg), or higher than 135 kPa (1013 mmHg) (2 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2432 P2437	While the engine is running, the voltage output of the pressure sensor remains below 0.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2433 P2438	While the engine is running, the voltage output of the pressure sensor remains higher than 4.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM

MONITOR DESCRIPTION



The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the air switching valve in the secondary air injection system.
If there is a defect in the sensor or the sensor circuit, the voltage level deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the pressure sensor or circuit and stores DTC(s).

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

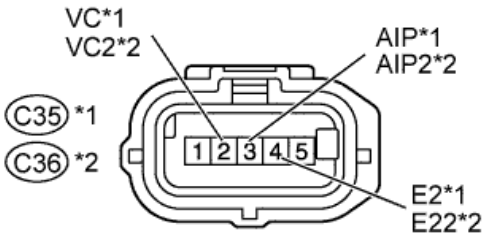
1.CHECK HARNESS AND CONNECTOR (PRESSURE SENSOR - ECM)

a. Disconnect the C35 or C36 pressure sensor connector.

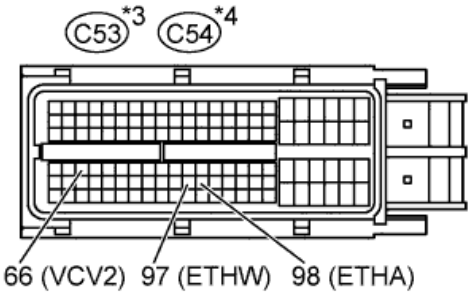
b. Disconnect the A38 and C53 or A53 and C54 ECM connectors.

c. Measure the resistance according to the value(s) in the table below.

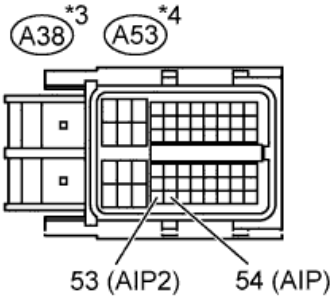
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to ECM)



*1: for Bank 1

*2: for Bank 2

*3: for LHD

*4: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A38-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C53-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A38-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C53-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C53-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A38-54 (AIP) - Body	Always	10 kΩ or

ground		higher
C35-2 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A38-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A53-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C54-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A53-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C54-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C54-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A53-54 (AIP) - Body ground	Always	10 kΩ or higher
C35-2 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A53-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

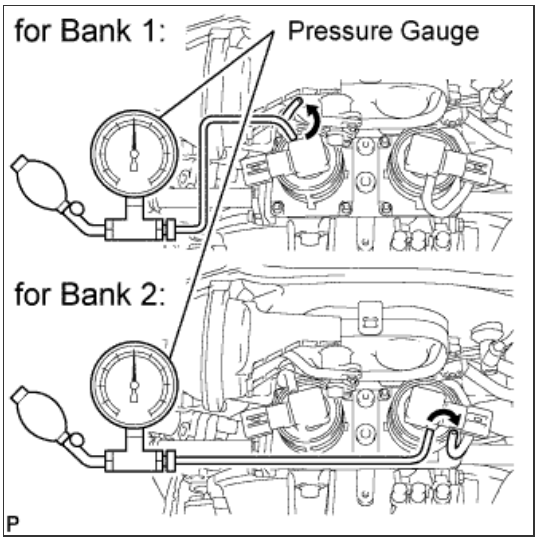
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

REPLACE ECM (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

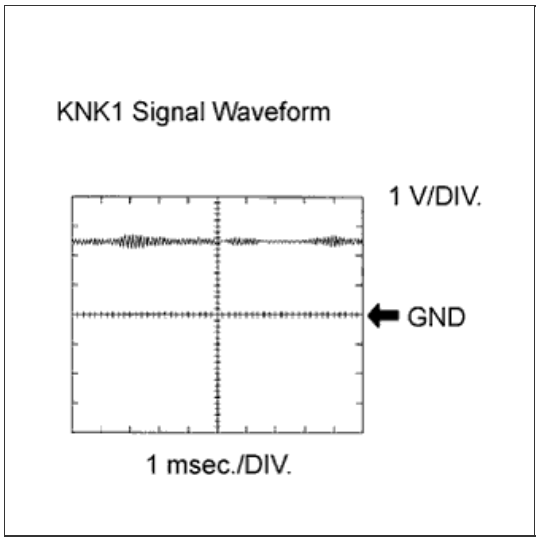
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

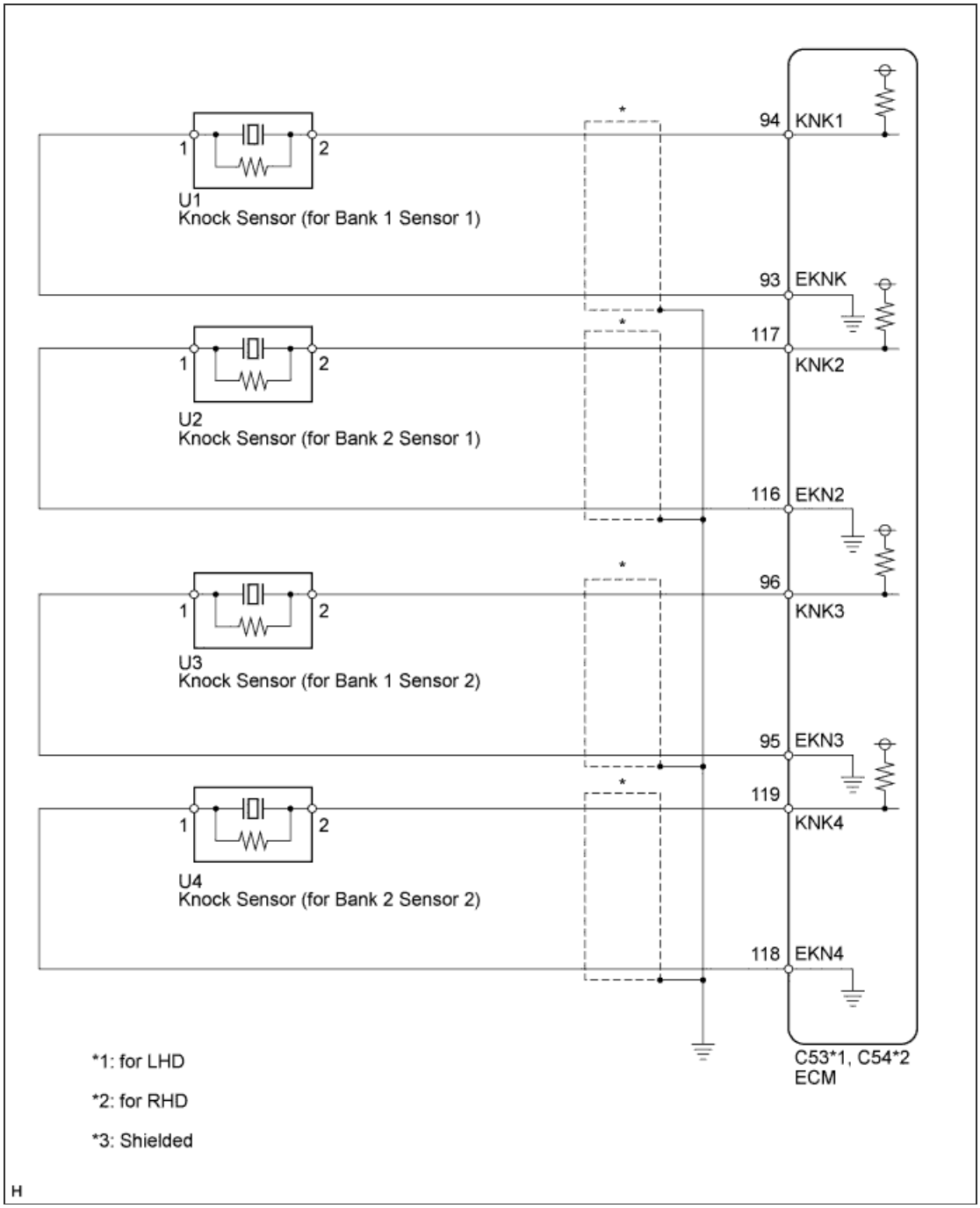
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

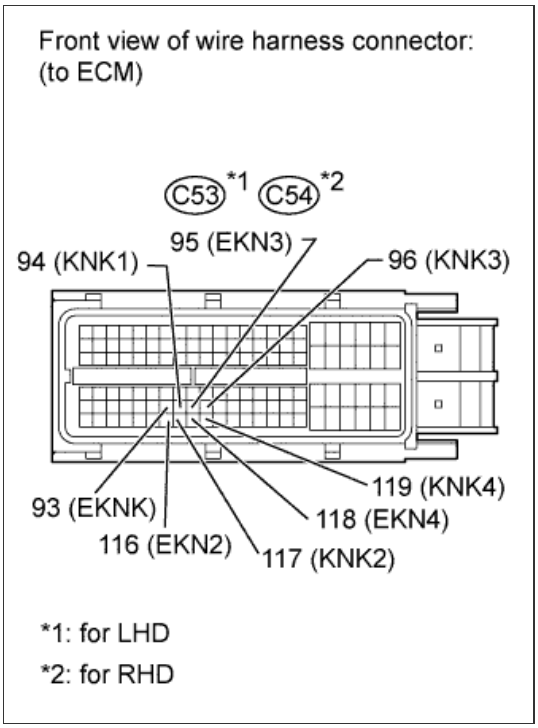
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

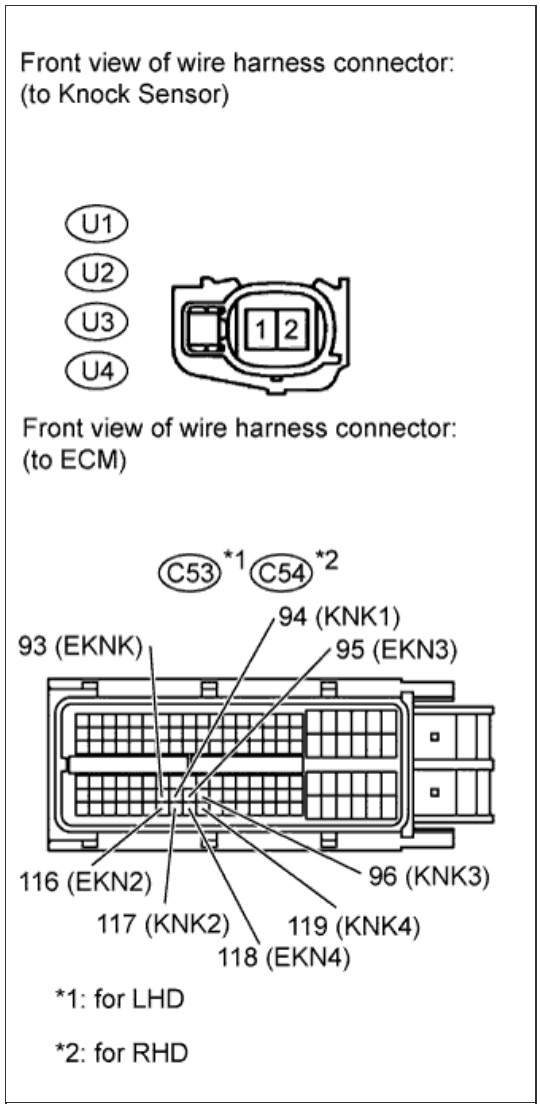
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

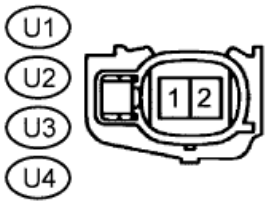
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2431 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1

DTC P2432 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1

DTC P2433 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1

DTC P2436 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2

DTC P2437 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2

DTC P2438 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2

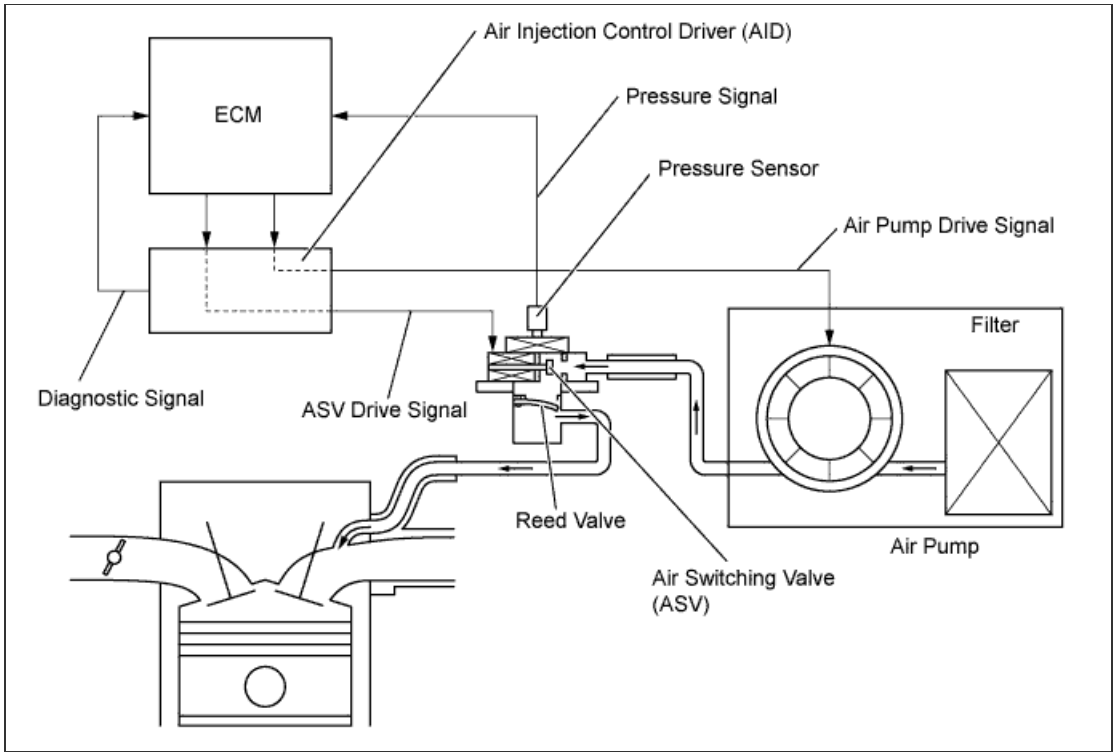
for Preparation Click here

DESCRIPTION

The Secondary Air injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

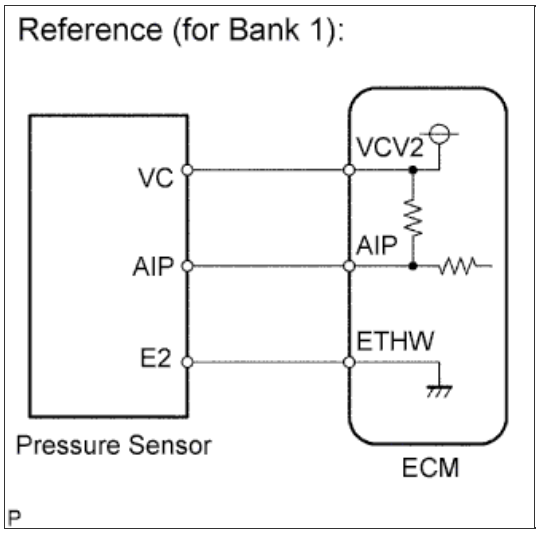
HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P2431 P2436	The pressure sensor indicates below 45.6 kPa (342 mmHg), or higher than 135 kPa (1013 mmHg) (2 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2432 P2437	While the engine is running, the voltage output of the pressure sensor remains below 0.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2433 P2438	While the engine is running, the voltage output of the pressure sensor remains higher than 4.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM

MONITOR DESCRIPTION



The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the air switching valve in the secondary air injection system.
If there is a defect in the sensor or the sensor circuit, the voltage level deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the pressure sensor or circuit and stores DTC(s).

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

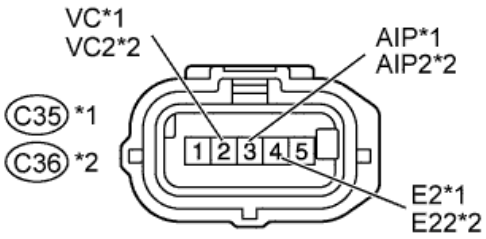
1.CHECK HARNESS AND CONNECTOR (PRESSURE SENSOR - ECM)

a. Disconnect the C35 or C36 pressure sensor connector.

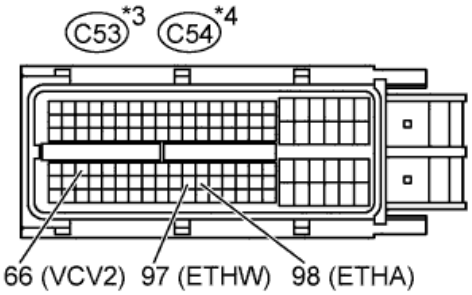
b. Disconnect the A38 and C53 or A53 and C54 ECM connectors.

c. Measure the resistance according to the value(s) in the table below.

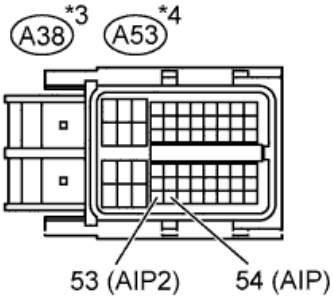
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to ECM)



*1: for Bank 1

*2: for Bank 2

*3: for LHD

*4: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A38-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C53-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A38-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C53-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C53-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A38-54 (AIP) - Body	Always	10 kΩ or

ground		higher
C35-2 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A38-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A53-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C54-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A53-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C54-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C54-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A53-54 (AIP) - Body ground	Always	10 kΩ or higher
C35-2 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A53-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

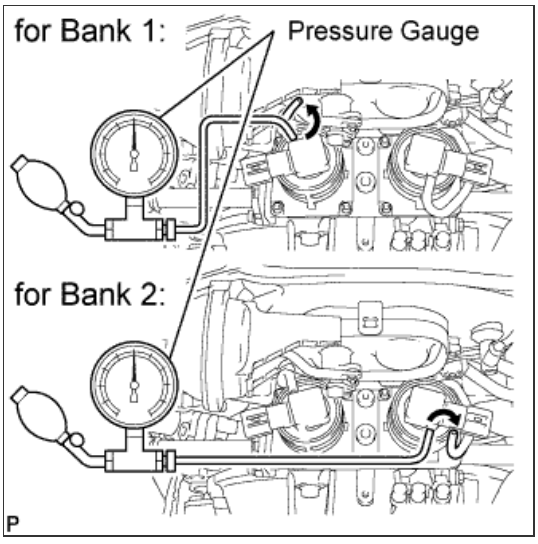
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

REPLACE ECM (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

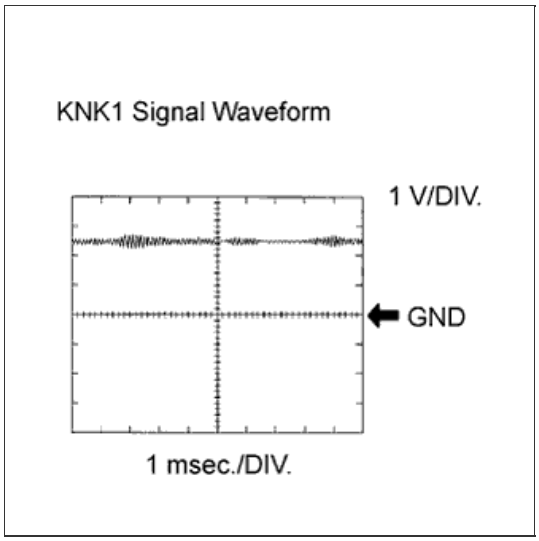
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

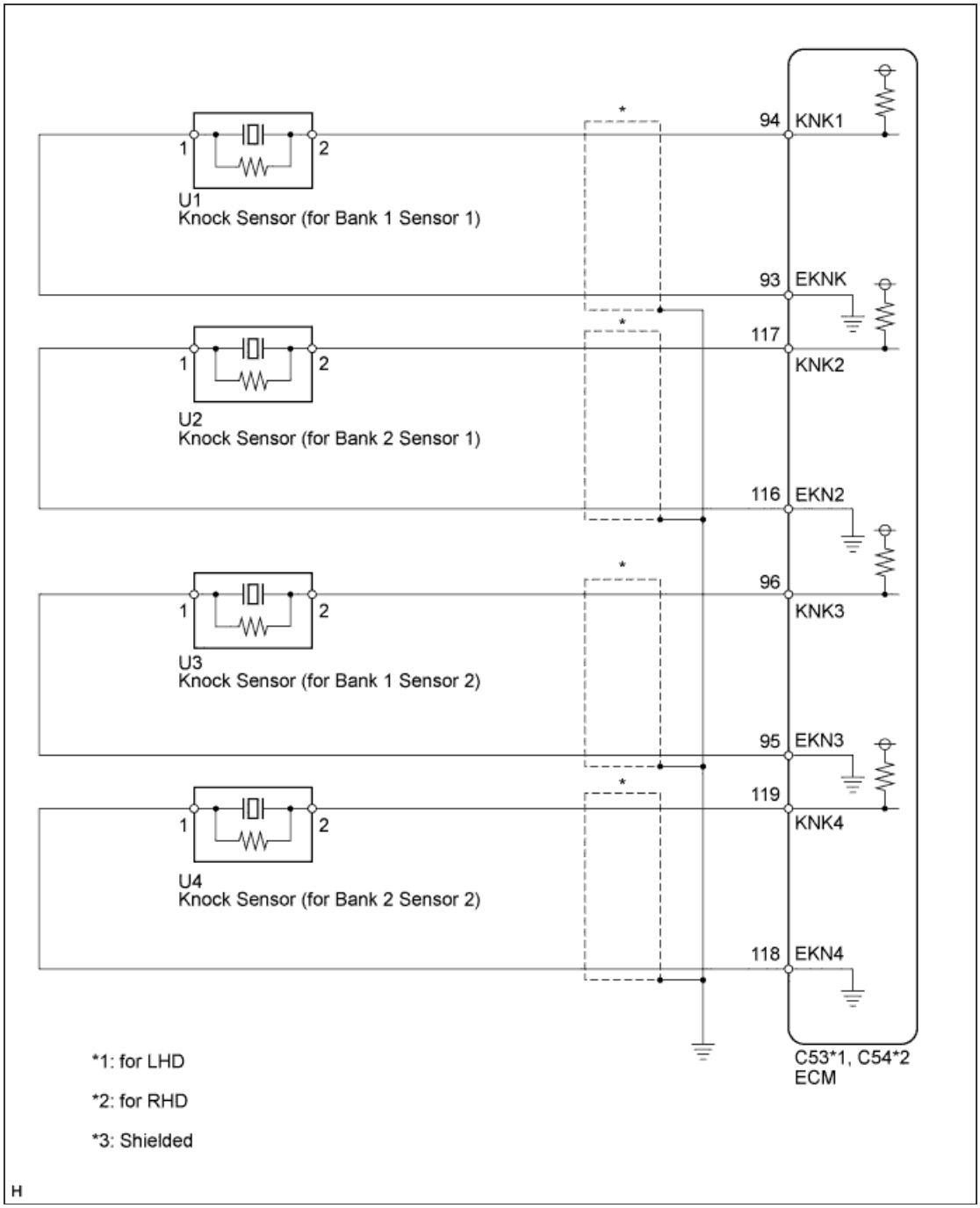
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

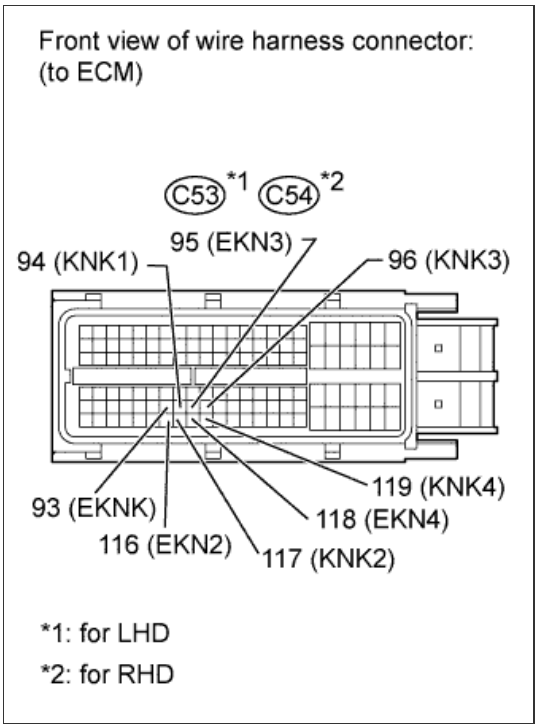
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

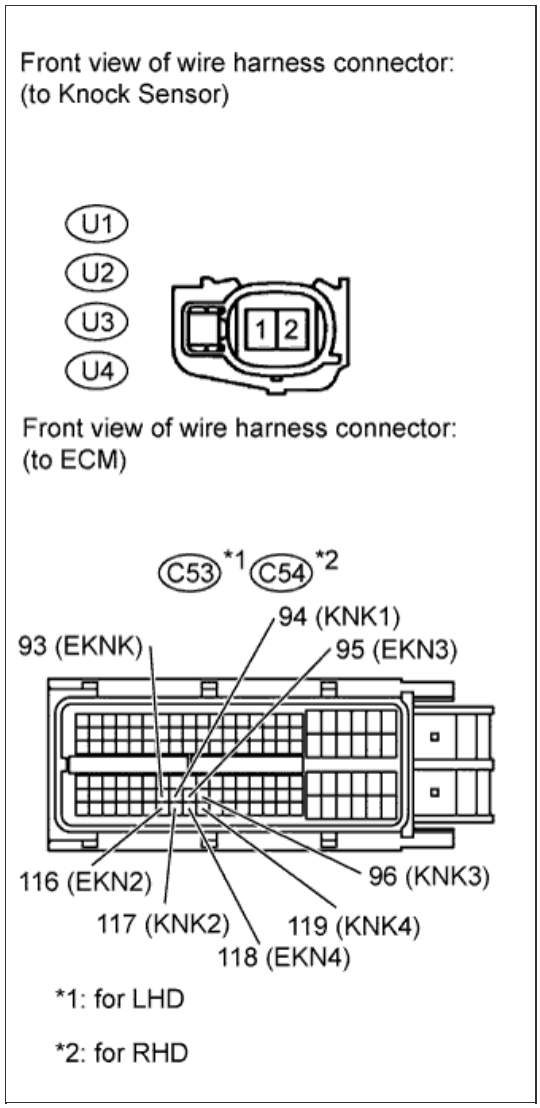
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

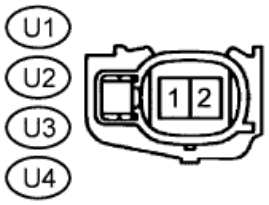
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2431 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1

DTC P2432 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1

DTC P2433 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1

DTC P2436 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2

DTC P2437 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2

DTC P2438 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2

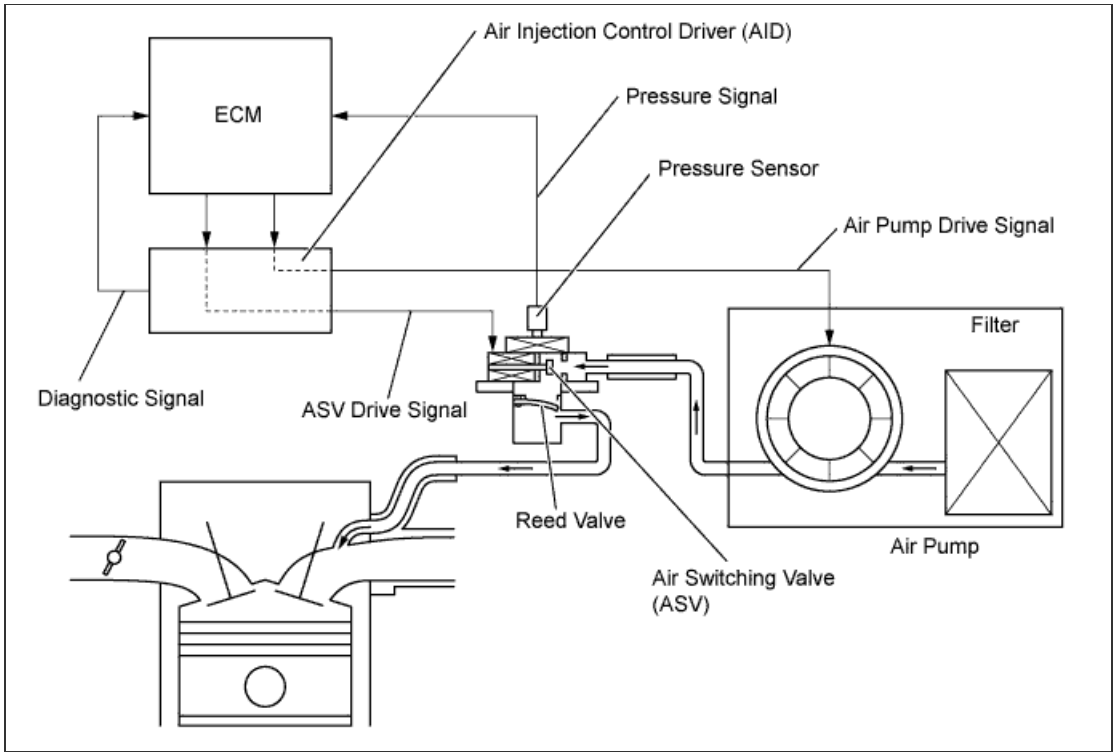
for Preparation Click here

DESCRIPTION

The Secondary Air injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

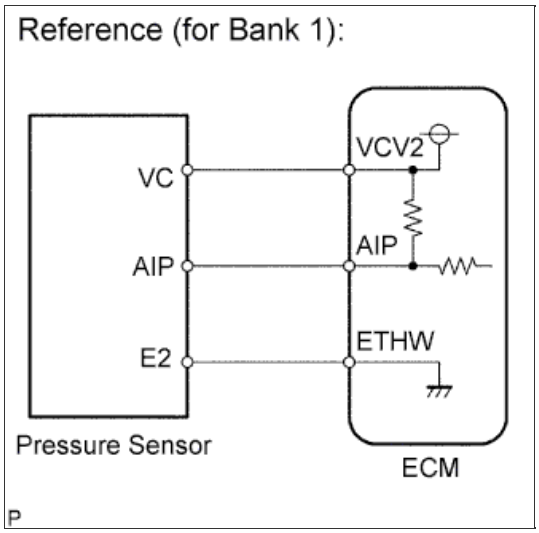
HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P2431 P2436	The pressure sensor indicates below 45.6 kPa (342 mmHg), or higher than 135 kPa (1013 mmHg) (2 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2432 P2437	While the engine is running, the voltage output of the pressure sensor remains below 0.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2433 P2438	While the engine is running, the voltage output of the pressure sensor remains higher than 4.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM

MONITOR DESCRIPTION



The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the air switching valve in the secondary air injection system.
If there is a defect in the sensor or the sensor circuit, the voltage level deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the pressure sensor or circuit and stores DTC(s).

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

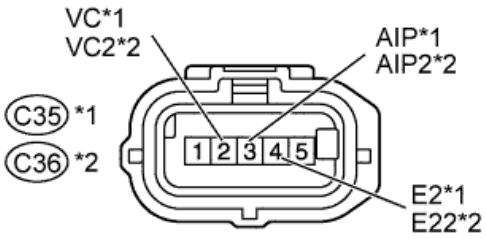
1.CHECK HARNESS AND CONNECTOR (PRESSURE SENSOR - ECM)

a. Disconnect the C35 or C36 pressure sensor connector.

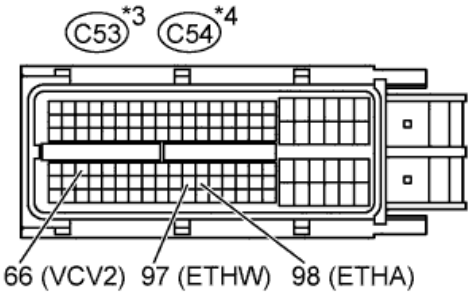
b. Disconnect the A38 and C53 or A53 and C54 ECM connectors.

c. Measure the resistance according to the value(s) in the table below.

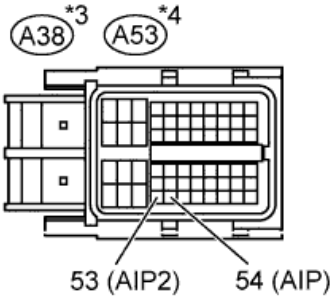
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to ECM)



*1: for Bank 1

*2: for Bank 2

*3: for LHD

*4: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A38-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C53-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A38-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C53-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C53-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A38-54 (AIP) - Body	Always	10 kΩ or

ground		higher
C35-2 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A38-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A53-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C54-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A53-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C54-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C54-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A53-54 (AIP) - Body ground	Always	10 kΩ or higher
C35-2 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A53-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

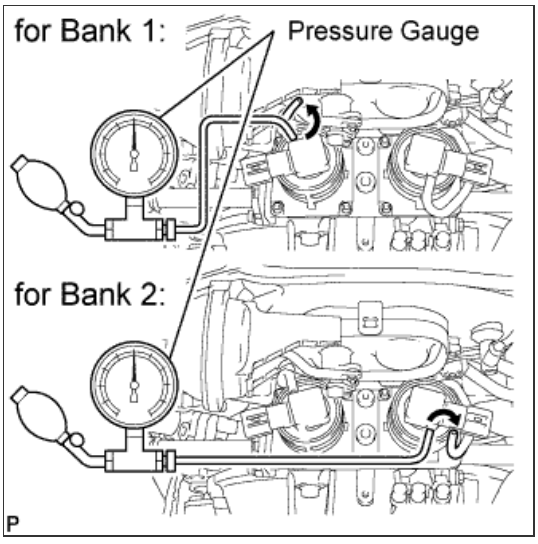
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

REPLACE ECM (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

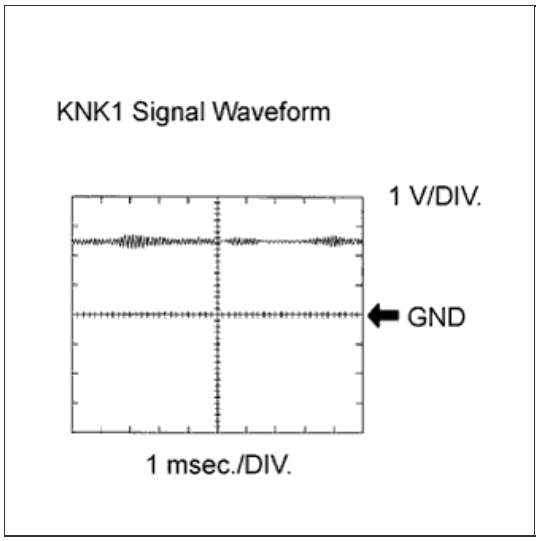
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

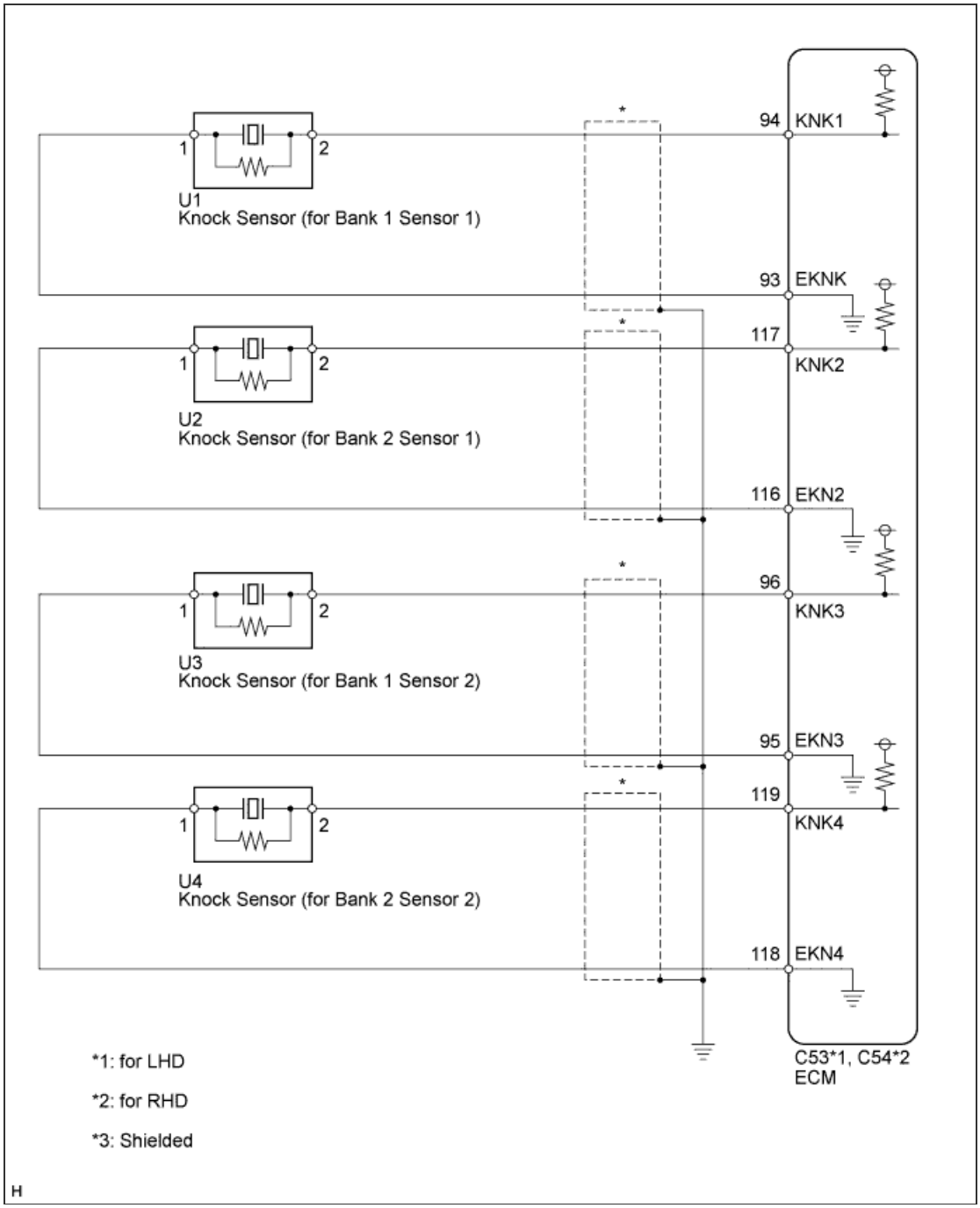
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

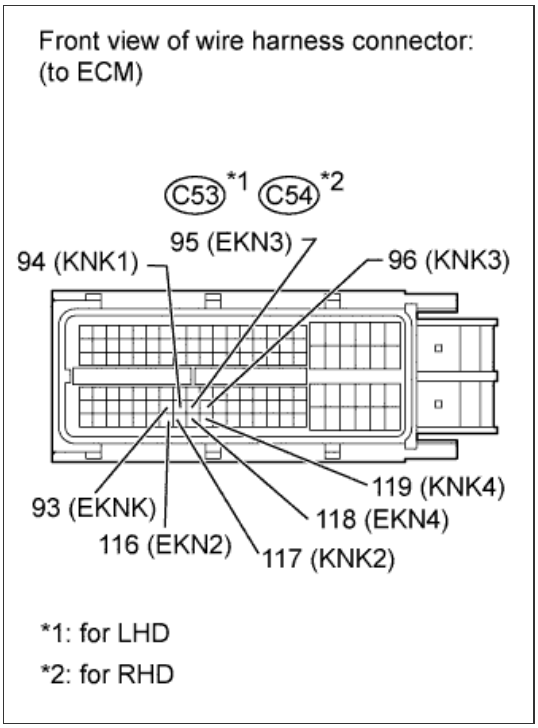
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

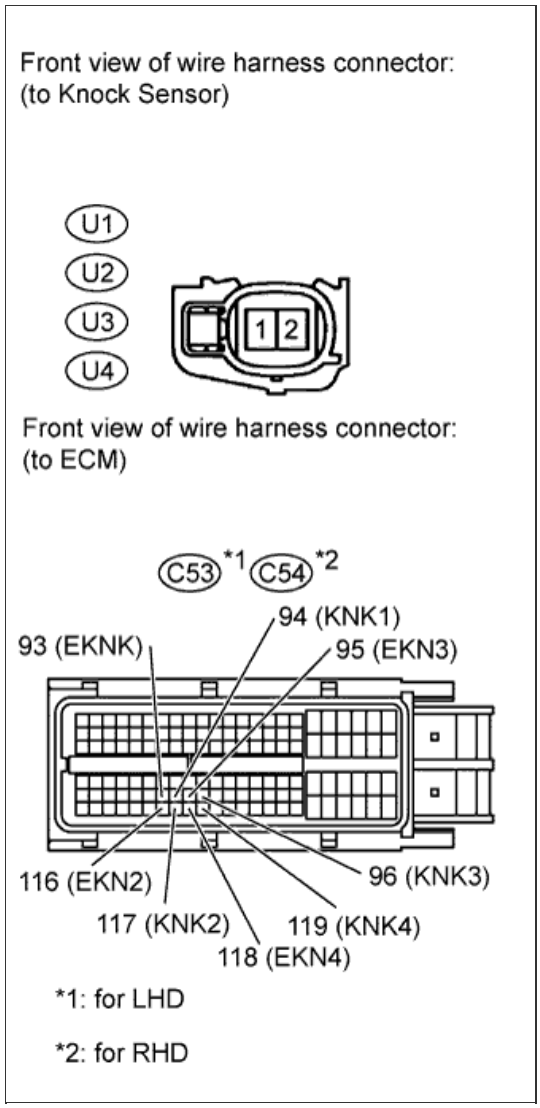
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

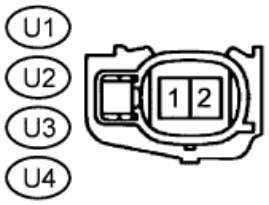
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2431 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank1

DTC P2432 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank1

DTC P2433 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank1

DTC P2436 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Range / Performance Bank 2

DTC P2437 Secondary Air Injection System Air Flow / Pressure Sensor Circuit Low Bank 2

DTC P2438 Secondary Air Injection System Air Flow / Pressure Sensor Circuit High Bank 2

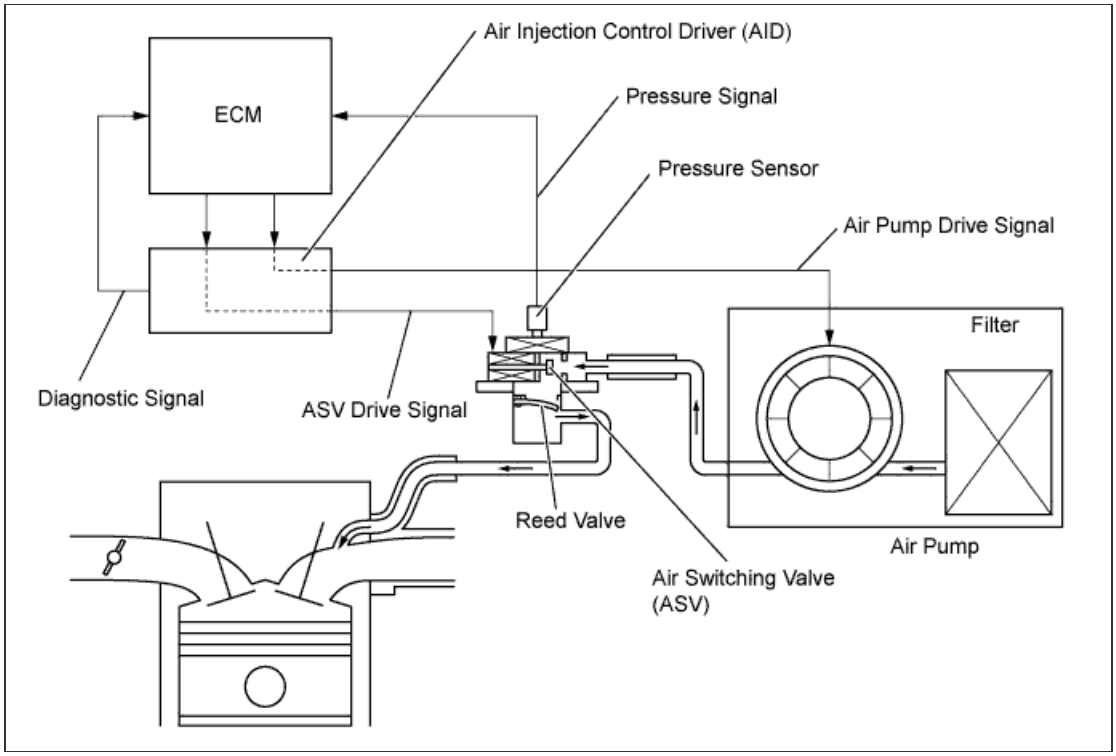
for Preparation Click here

DESCRIPTION

The Secondary Air injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after a cold engine start, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits a pressure signal to the ECM.
The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

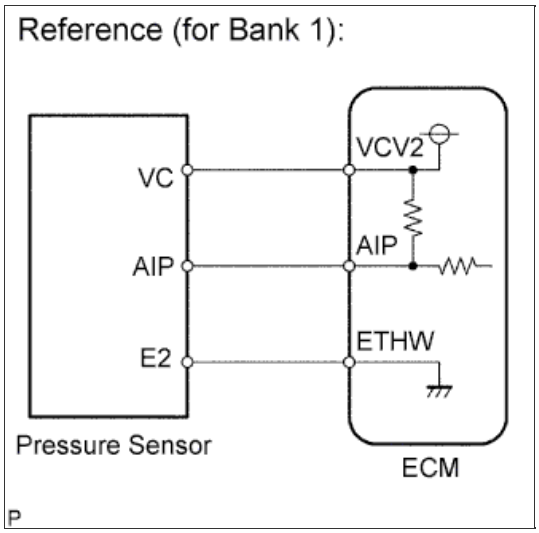
HINT:

As a large current is required to drive the air pump and ASV, an AID is installed to this system.



DTC Code	DTC Detection Condition	Trouble Area
P2431 P2436	The pressure sensor indicates below 45.6 kPa (342 mmHg), or higher than 135 kPa (1013 mmHg) (2 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2432 P2437	While the engine is running, the voltage output of the pressure sensor remains below 0.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM
P2433 P2438	While the engine is running, the voltage output of the pressure sensor remains higher than 4.5 V (1 trip detection logic).	• Pressure sensor • Open or short in pressure sensor circuit • ECM

MONITOR DESCRIPTION



The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the air switching valve in the secondary air injection system.
If there is a defect in the sensor or the sensor circuit, the voltage level deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the pressure sensor or circuit and stores DTC(s).

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

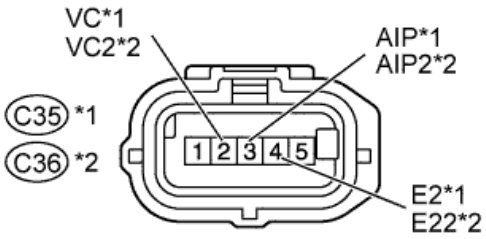
1.CHECK HARNESS AND CONNECTOR (PRESSURE SENSOR - ECM)

a. Disconnect the C35 or C36 pressure sensor connector.

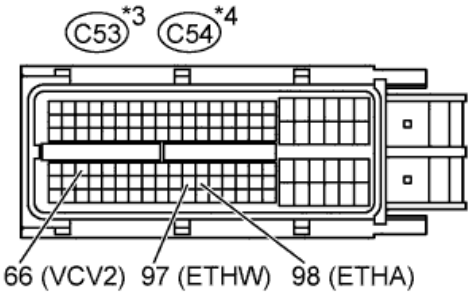
b. Disconnect the A38 and C53 or A53 and C54 ECM connectors.

c. Measure the resistance according to the value(s) in the table below.

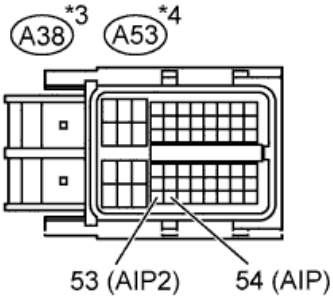
Front view of wire harness connector:
(to Air Switching Valve)



Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to ECM)



*1: for Bank 1

*2: for Bank 2

*3: for LHD

*4: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A38-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C53-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A38-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C53-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C53-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A38-54 (AIP) - Body	Always	10 kΩ or

ground		higher
C35-2 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A38-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C35-3 (AIP) - A53-54 (AIP)	Always	Below 1 Ω
C35-2 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C35-4 (E2) - C54-98 (ETHA)	Always	Below 1 Ω
C36-3 (AIP2) - A53-53 (AIP2)	Always	Below 1 Ω
C36-2 (VC2) - C54-66 (VCV2)	Always	Below 1 Ω
C36-4 (E22) - C54-97 (ETHW)	Always	Below 1 Ω
C35-3 (AIP) or A53-54 (AIP) - Body ground	Always	10 kΩ or higher
C35-2 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C36-3 (AIP2) or A53-53 (AIP2) - Body ground	Always	10 kΩ or higher
C36-2 (VC2) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

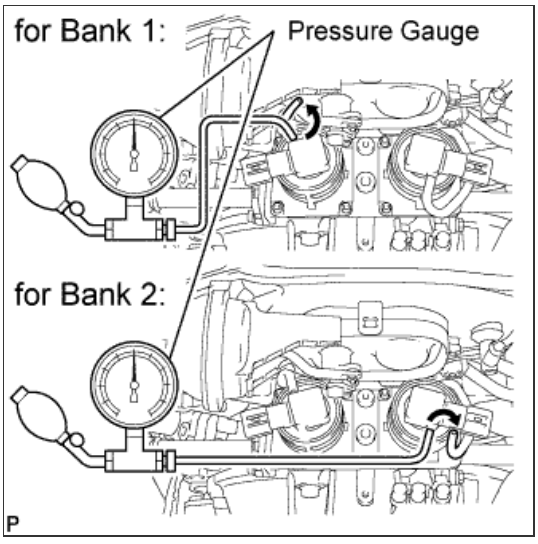
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

REPLACE ECM (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

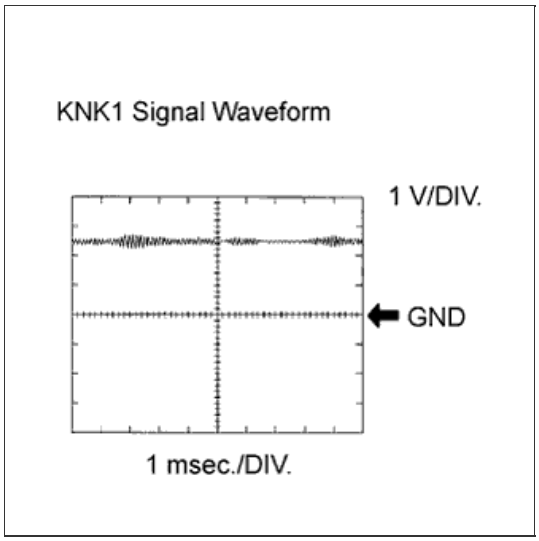
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

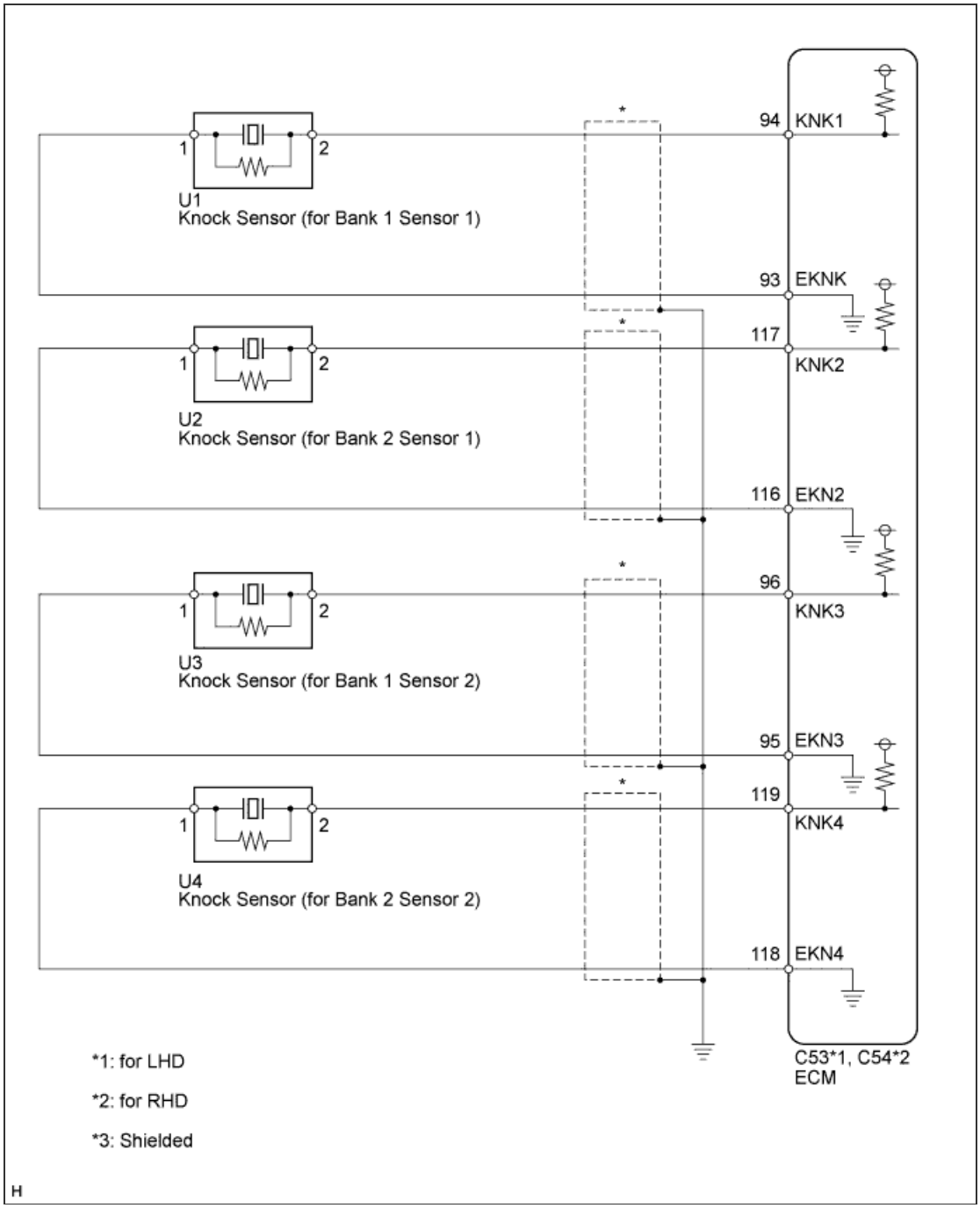
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

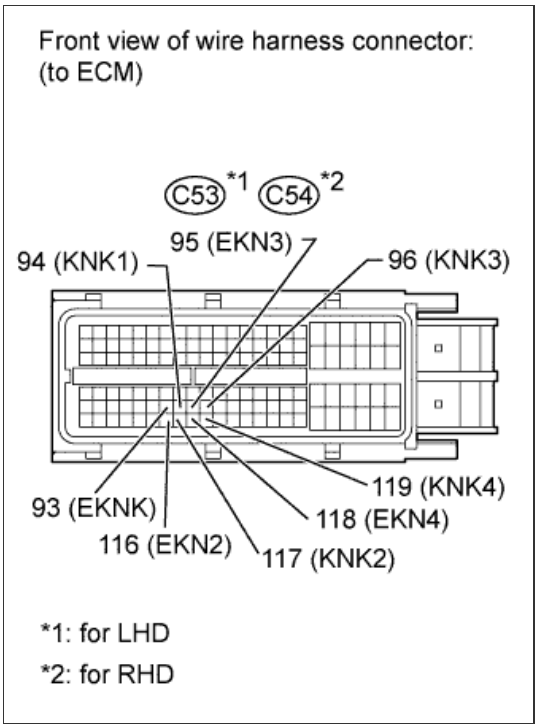
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

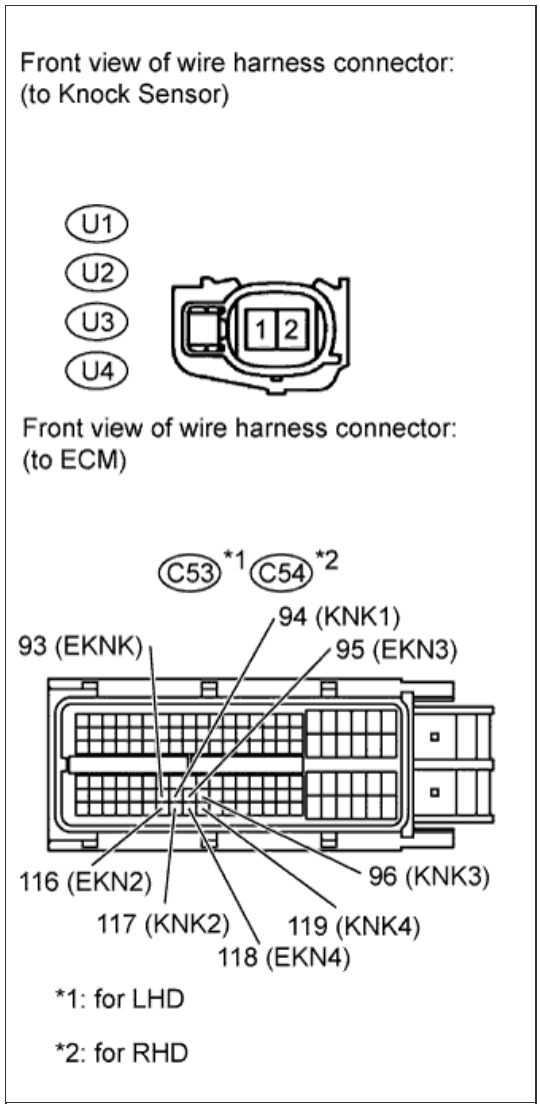
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

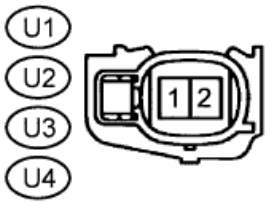
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

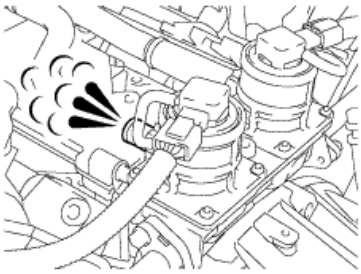
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

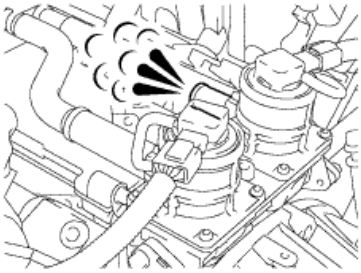
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

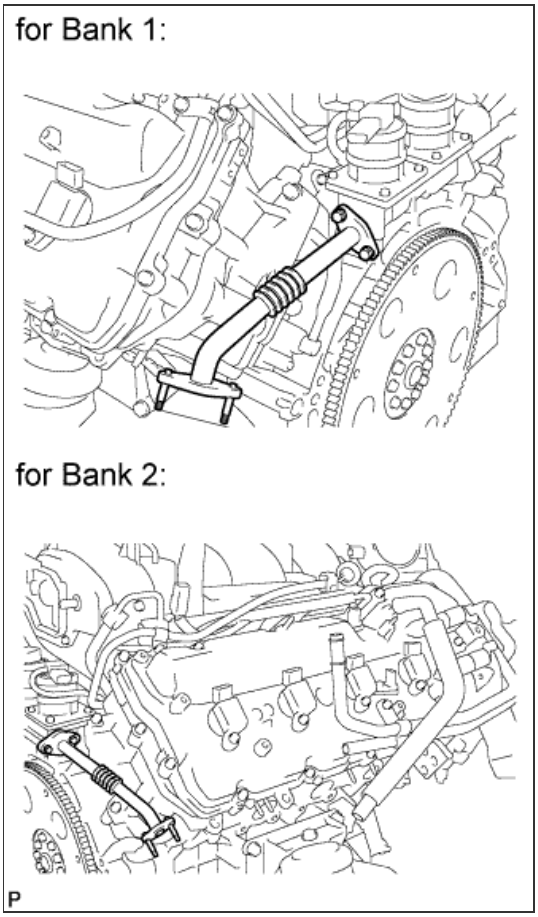
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

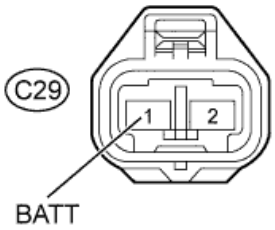
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

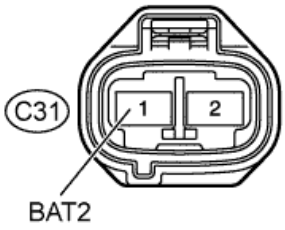
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

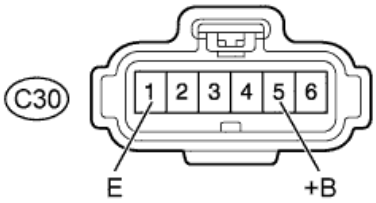
Front view of wire harness connector:
(to AID for Bank 1)



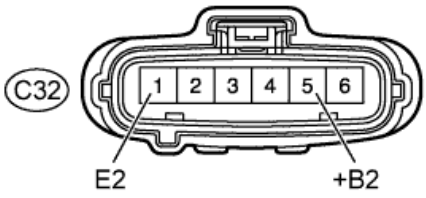
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

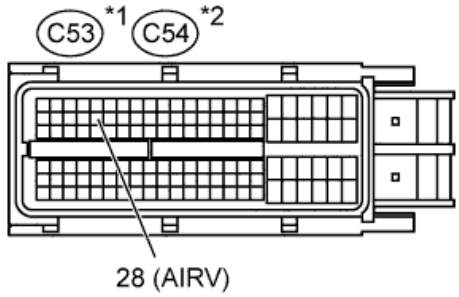
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

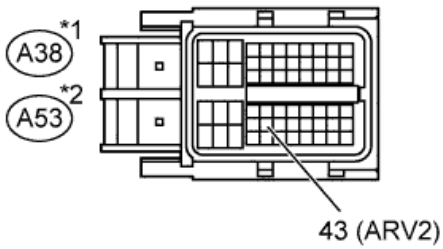
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

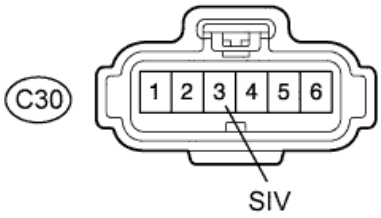
Front view of wire harness connector:
(to ECM)



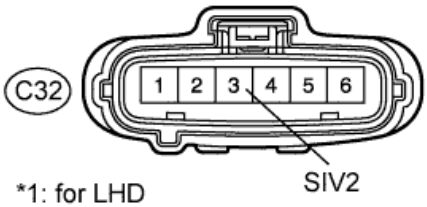
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

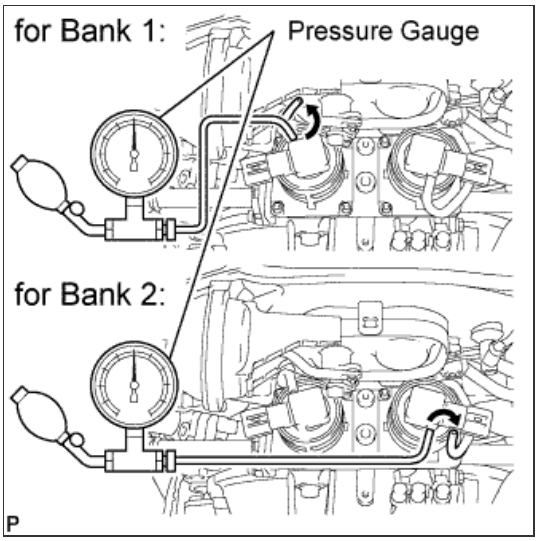
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0327 Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC P0328 Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC P032C Knock Sensor 3 Circuit Low

DTC P032D Knock Sensor 3 Circuit High

DTC P0332 Knock Sensor 2 Circuit Low Input (Bank 2)

DTC P0333 Knock Sensor 2 Circuit High Input (Bank 2)

DTC P033C Knock Sensor 4 Circuit Low Input

DTC P033D Knock Sensor 4 Circuit High Input

for Preparation Click here

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed.
The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

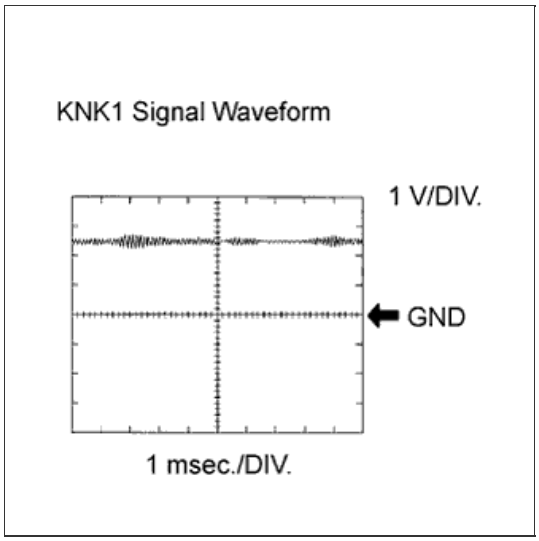
DTC Code	DTC Detection Condition	Trouble Area
P0327	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0328	The output voltage of the knock sensor (for Bank 1 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 1) circuit • Knock sensor (for Bank 1 Sensor 1) • ECM
P0332	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P0333	The output voltage of the knock sensor (for Bank 2 Sensor 1) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor1) circuit • Knock sensor (for Bank 2 Sensor 1) • ECM
P032C	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P032D	The output voltage of the knock sensor (for Bank 1 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 1 Sensor 2) circuit • Knock sensor (for Bank 1 Sensor 2) • ECM
P033C	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 0.5 V or less (1 trip detection logic).	• Short in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2)

		• ECM
P033D	The output voltage of the knock sensor (for Bank 2 Sensor 2) is 4.5 V or higher (1 trip detection logic).	• Open in knock sensor (for Bank 2 Sensor 2) circuit • Knock sensor (for Bank 2 Sensor 2) • ECM

HINT:

When any of DTCs P0327, P0328, P0332, P0333, P032C, P032D, P033C and P033D is stored, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the engine switch is turned off.

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-117 (KNK2) - C53-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-96 (KNK3) - C53-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C53-119 (KNK4) - C53-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

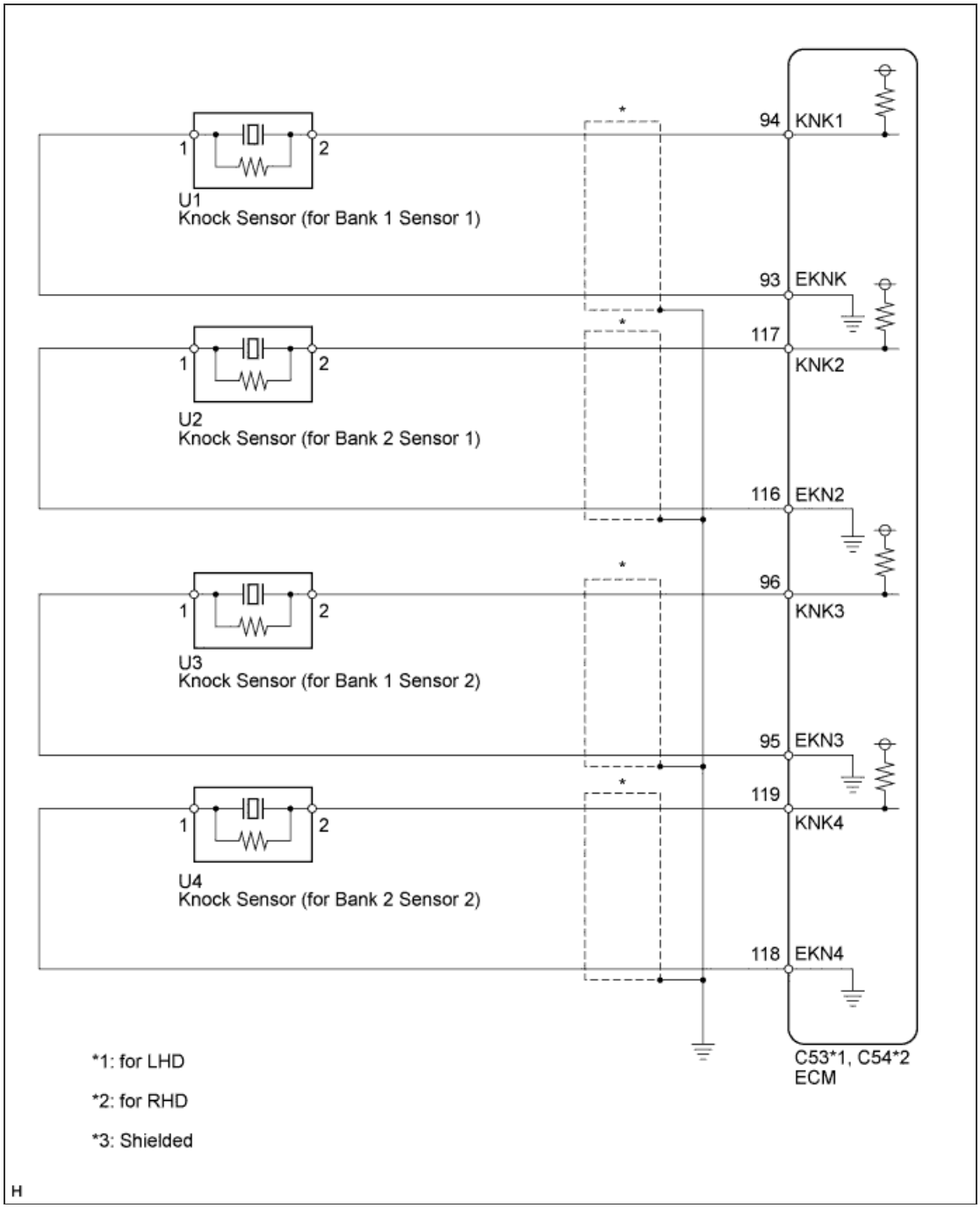
for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-117 (KNK2) - C54-116 (EKN2)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-96 (KNK3) - C54-95 (EKN3)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown
C54-119 (KNK4) - C54-118 (EKN4)	0.01 to 10 V/DIV. 0.01 to 10 msec./DIV.	Keep engine speed at 4000 rpm with warm engine	The correct waveform is as shown

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

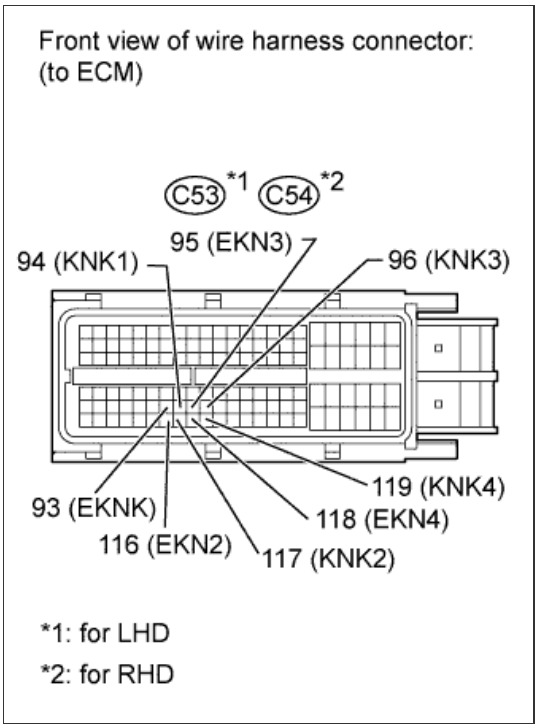
HINT:

- **DTCs P0327 and P0328 are for the bank 1 sensor 1 knock sensor circuit.**
- **DTCs P032C and P032D are for the bank 1 sensor 2 knock sensor circuit.**
- **DTCs P0332 and P0333 are for the bank 2 sensor 1 knock sensor circuit.**
- **DTCs P033C and P033D are for the bank 2 sensor 2 knock sensor circuit.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.INSPECT KNOCK SENSOR

a. Disconnect the C53 or C54 ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-94 (KNK1) - C53-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C53-117 (KNK2) - C53-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C53-96 (KNK3) - C53-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C53-119 (KNK4) - C53-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

for RHD

Tester Connection	Condition	Specified Condition
C54-94 (KNK1) - C54-93 (EKNK)	20°C (68°F)	120 to 280 kΩ
C54-117 (KNK2) - C54-116 (EKN2)	20°C (68°F)	120 to 280 kΩ
C54-96 (KNK3) - C54-95 (EKN3)	20°C (68°F)	120 to 280 kΩ
C54-119 (KNK4) - C54-118 (EKN4)	20°C (68°F)	120 to 280 kΩ

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 3

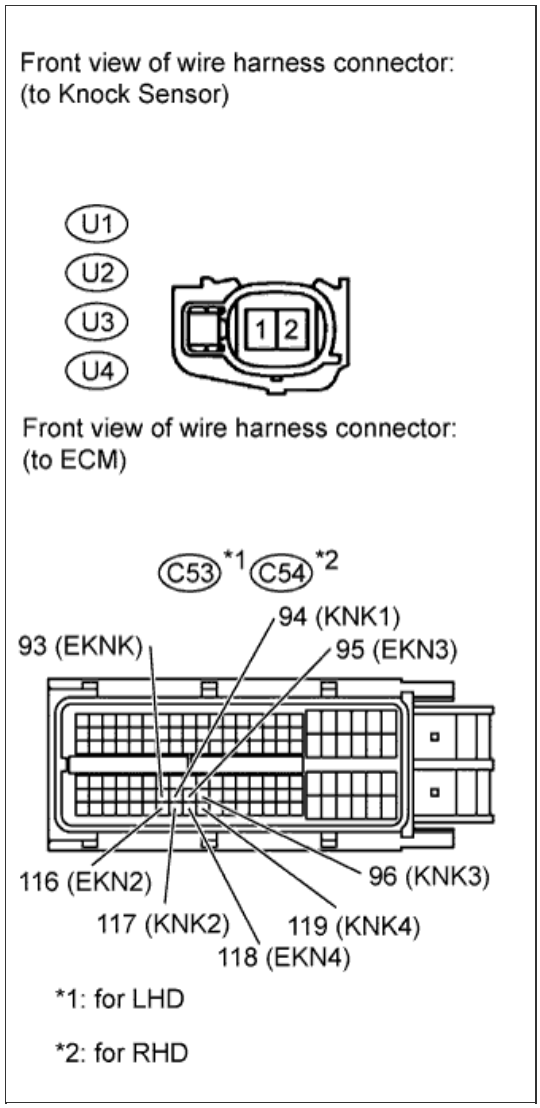
A

2.CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)

a. Disconnect the C53 or C54 ECM connector.

b. Disconnect the U1, U2, U3 or U4 knock sensor connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
U1-2 - C53-94 (KNK1)	Always	Below 1 Ω
U1-1 - C53-93 (EKNK)	Always	Below 1 Ω
U2-2 - C53-117 (KNK2)	Always	Below 1 Ω
U2-1 - C53-116 (EKN2)	Always	Below 1 Ω
U3-2 - C53-96 (KNK3)	Always	Below 1 Ω
U3-1 - C53-95 (EKN3)	Always	Below 1 Ω
U4-2 - C53-119 (KNK4)	Always	Below 1 Ω
U4-1 - C53-118 (EKN4)	Always	Below 1 Ω
U1-2 or C53-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C53-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C53-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C53-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C53-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C53-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C53-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C53-118 (EKN4) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
U1-2 - C54-94 (KNK1)	Always	Below 1 Ω
U1-1 - C54-93 (EKNK)	Always	Below 1 Ω
U2-2 - C54-117 (KNK2)	Always	Below 1 Ω
U2-1 - C54-116 (EKN2)	Always	Below 1 Ω
U3-2 - C54-96 (KNK3)	Always	Below 1 Ω
U3-1 - C54-95 (EKN3)	Always	Below 1 Ω
U4-2 - C54-119 (KNK4)	Always	Below 1 Ω
U4-1 - C54-118 (EKN4)	Always	Below 1 Ω
U1-2 or C54-94 (KNK1) - Body ground	Always	10 kΩ or higher
U1-1 or C54-93 (EKNK) - Body ground	Always	10 kΩ or higher
U2-2 or C54-117 (KNK2) - Body ground	Always	10 kΩ or higher
U2-1 or C54-116 (EKN2) - Body ground	Always	10 kΩ or higher
U3-2 or C54-96 (KNK3) - Body ground	Always	10 kΩ or higher
U3-1 or C54-95 (EKN3) - Body ground	Always	10 kΩ or higher
U4-2 or C54-119 (KNK4) - Body ground	Always	10 kΩ or higher
U4-1 or C54-118 (EKN4) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (Click here)

3.INSPECT ECM

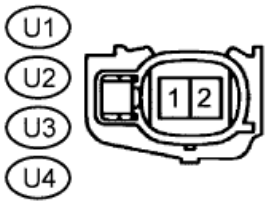
a. Disconnect the U1, U2, U3 or U4 knock sensor connectors.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Engine switch on (IG)	4.5 to 5.5 V

Front view of wire harness connector:
(to Knock Sensor)



NG → REPLACE ECM (Click here)

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

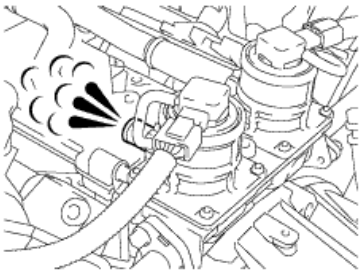
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

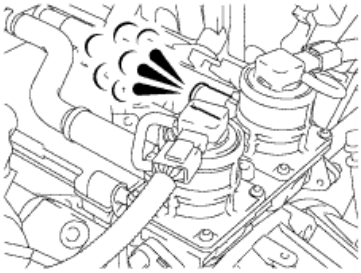
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

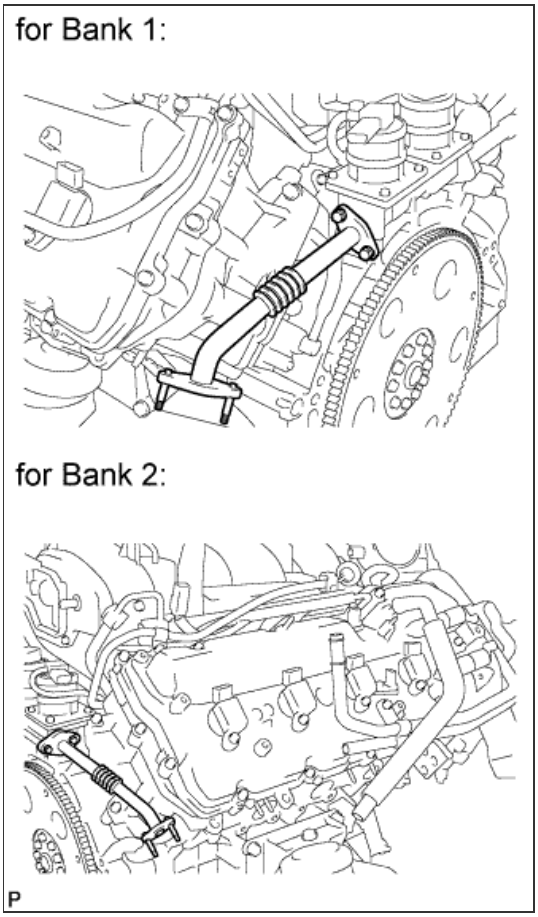
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

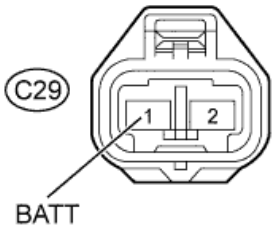
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

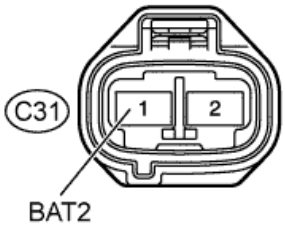
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

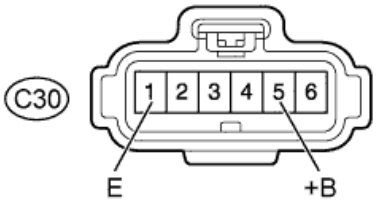
Front view of wire harness connector:
(to AID for Bank 1)



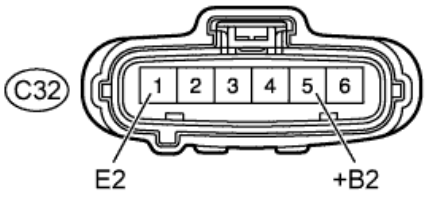
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

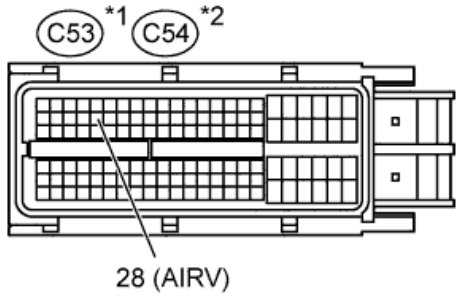
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

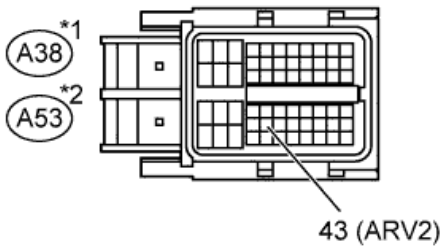
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

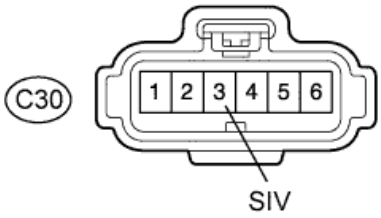
Front view of wire harness connector:
(to ECM)



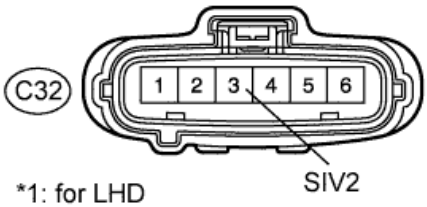
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

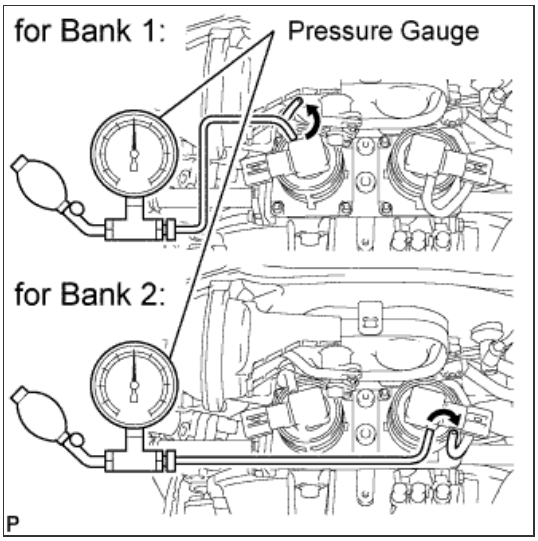
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

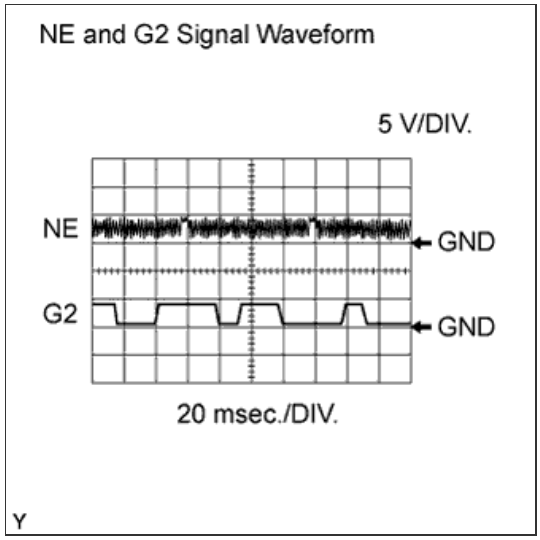
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

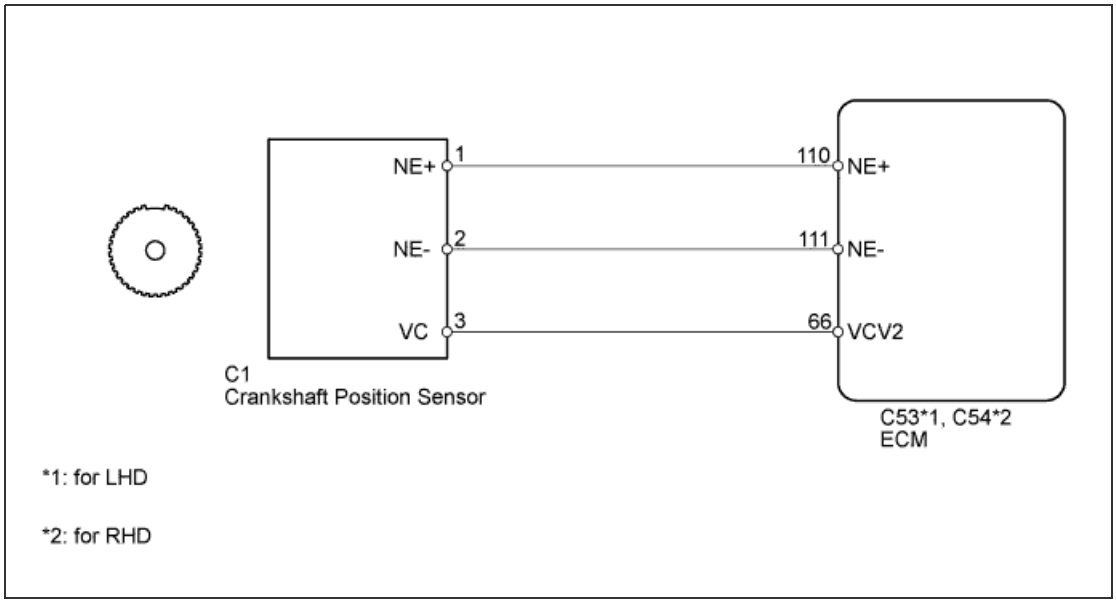
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

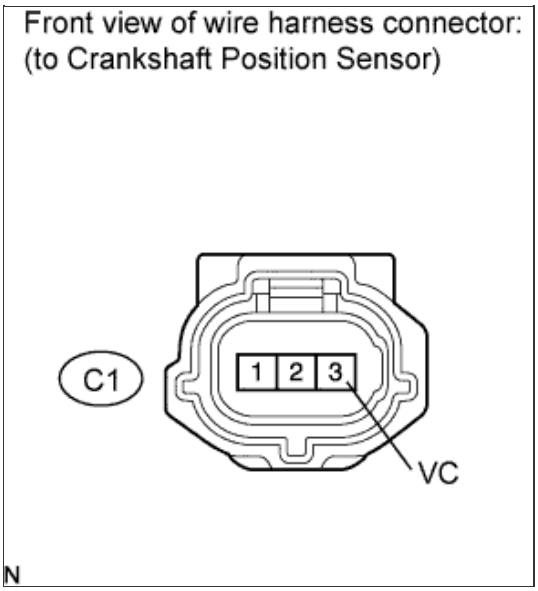
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

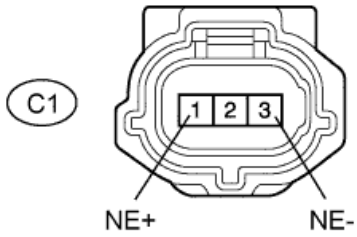
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

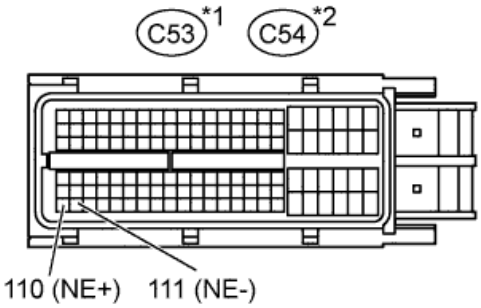
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

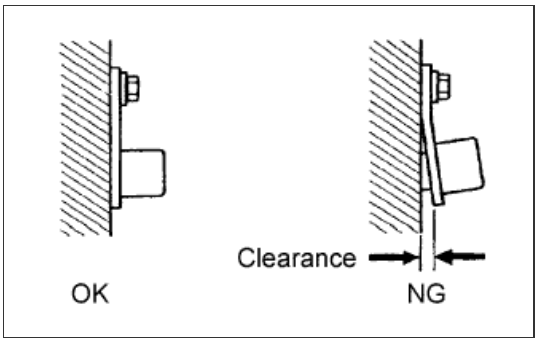
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

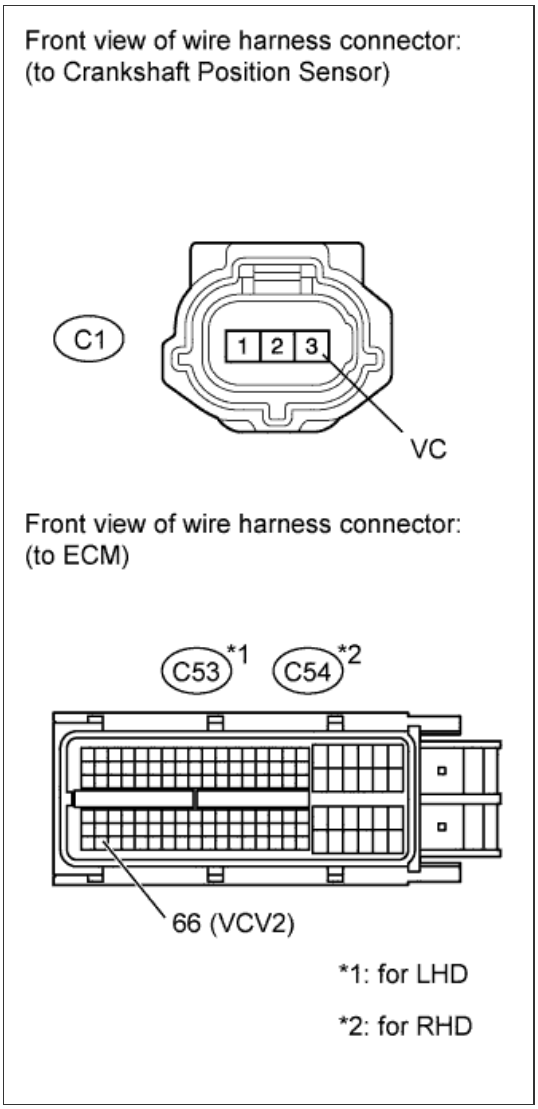
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

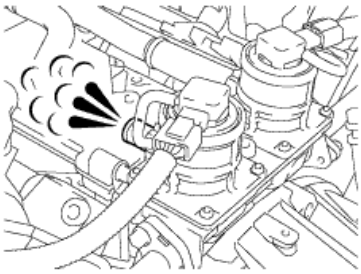
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

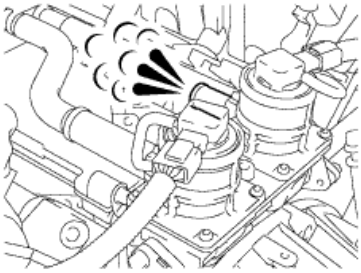
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

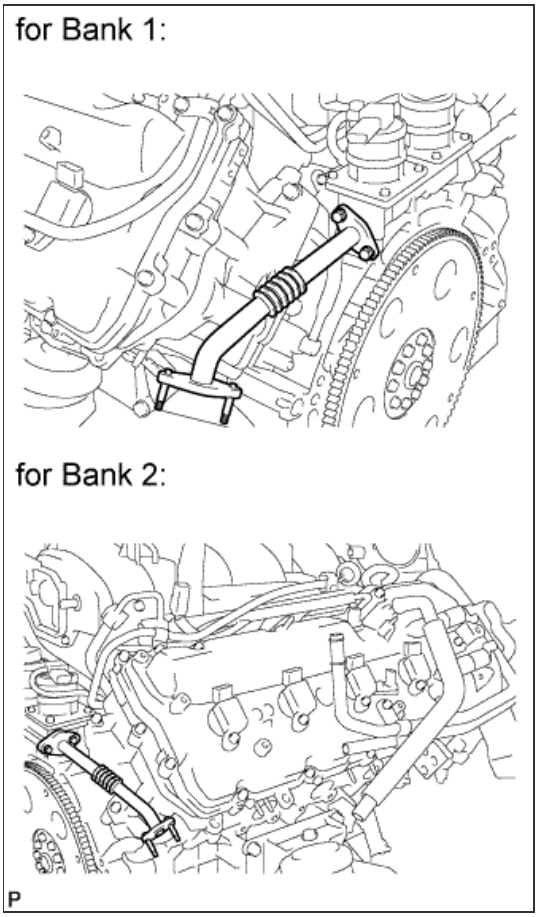
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

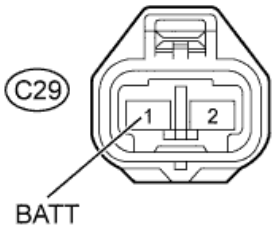
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

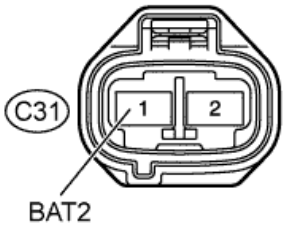
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

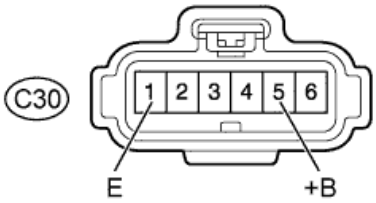
Front view of wire harness connector:
(to AID for Bank 1)



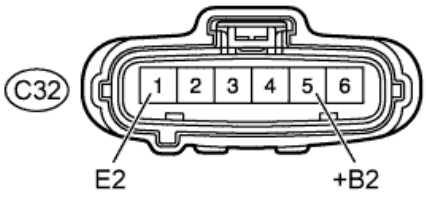
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

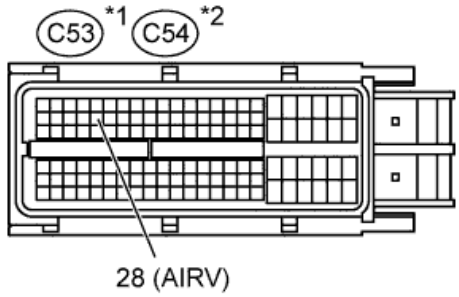
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

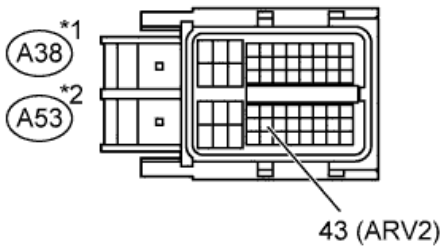
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

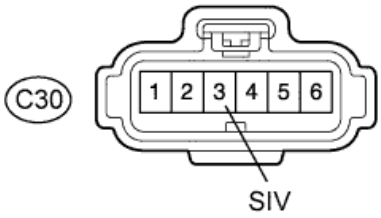
Front view of wire harness connector:
(to ECM)



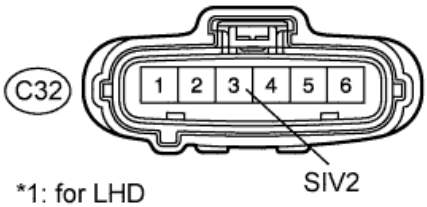
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

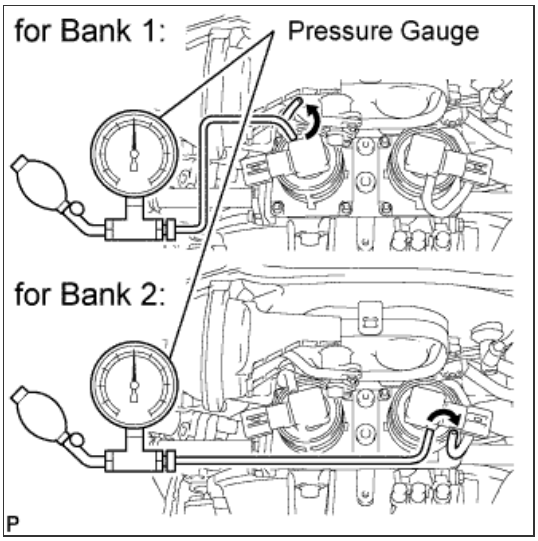
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

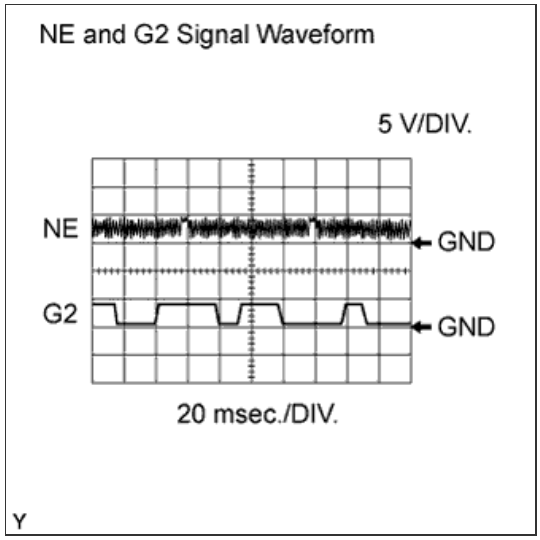
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

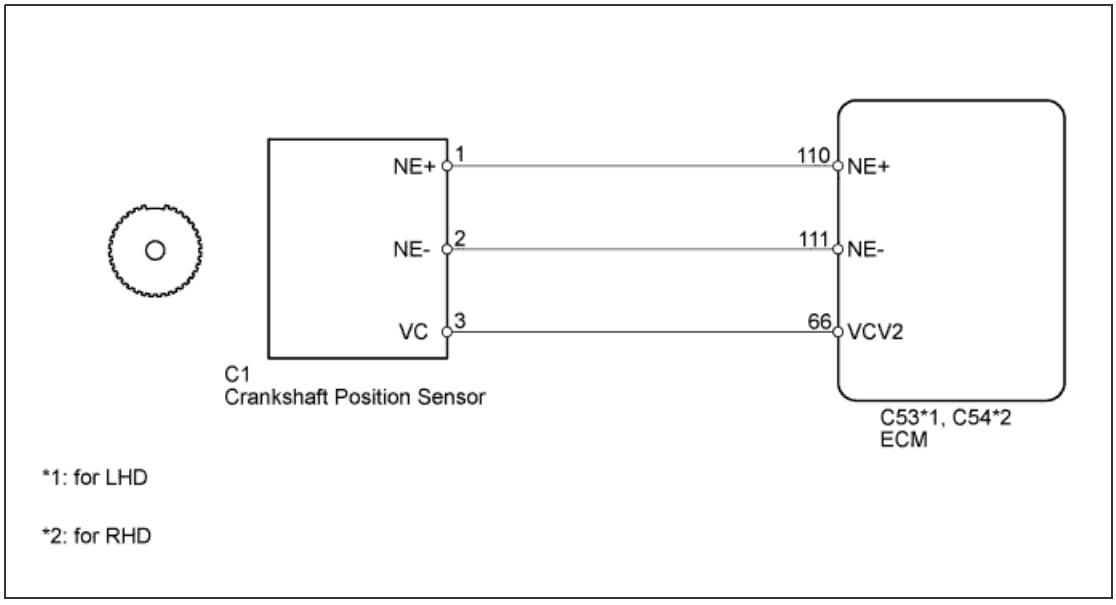
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

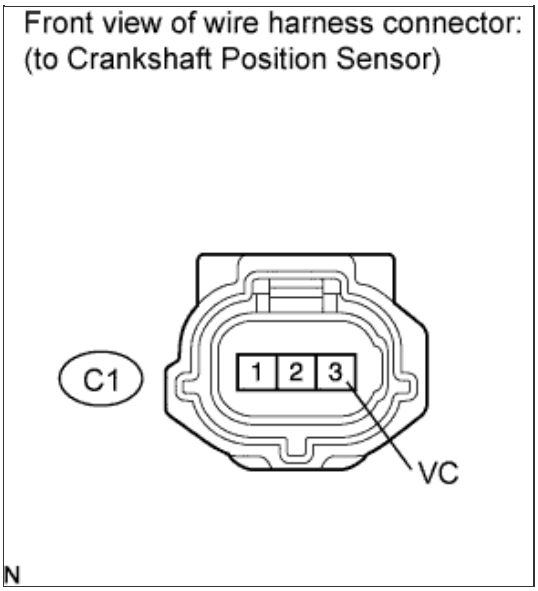
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

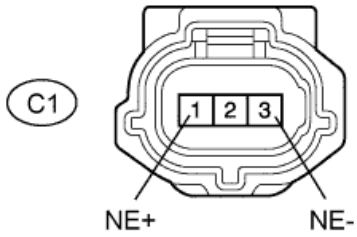
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

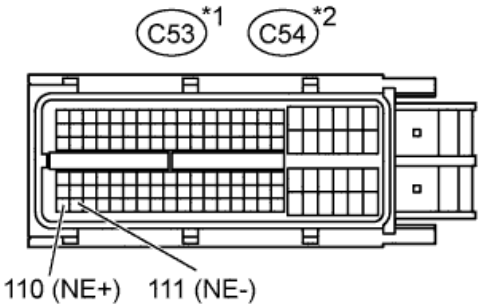
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

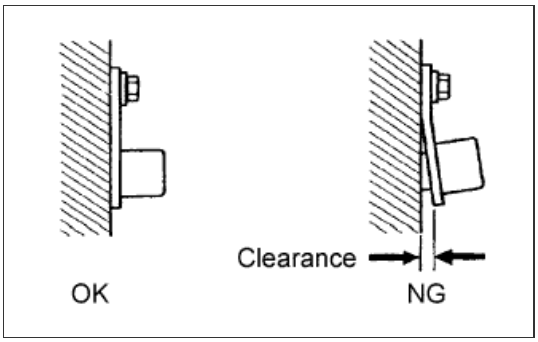
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

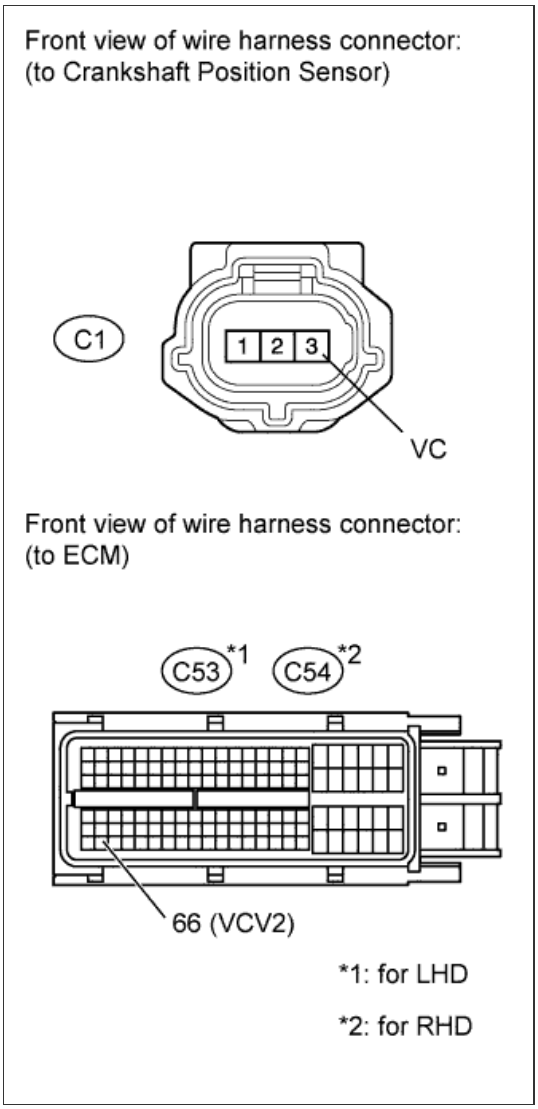
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

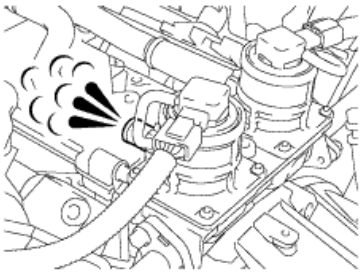
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

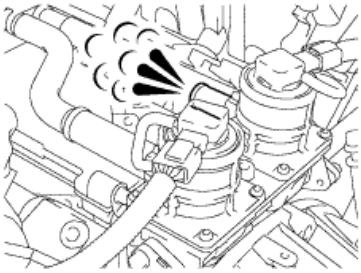
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

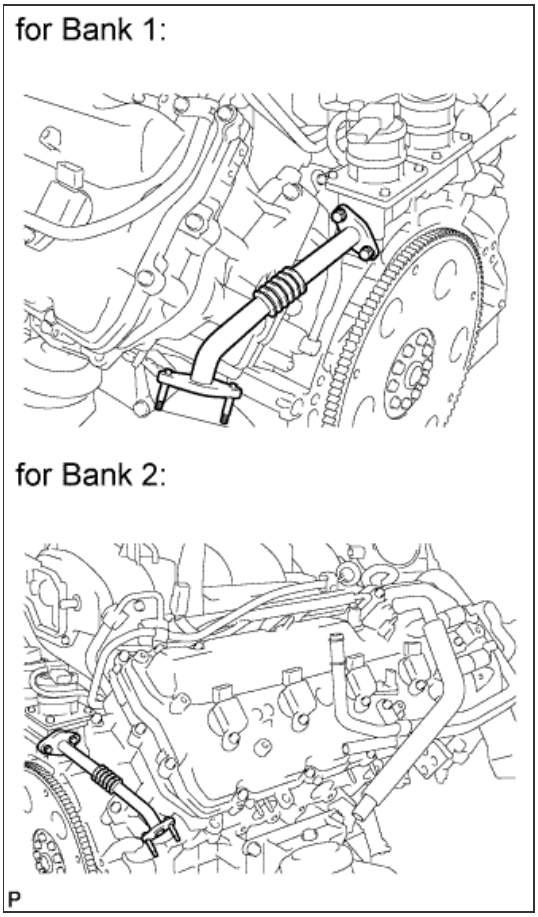
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

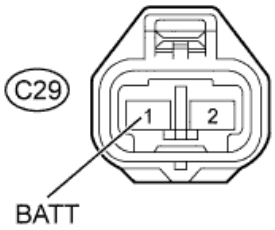
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

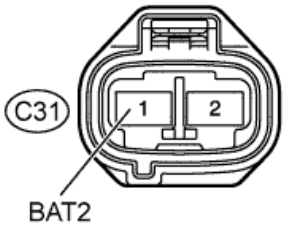
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

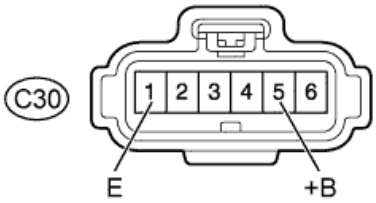
Front view of wire harness connector:
(to AID for Bank 1)



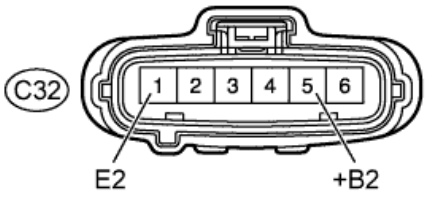
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

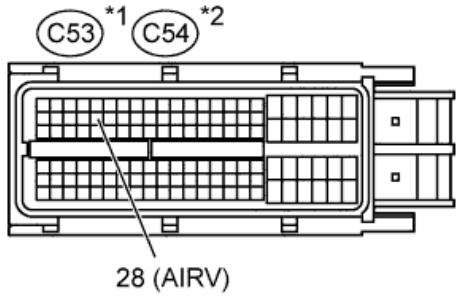
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

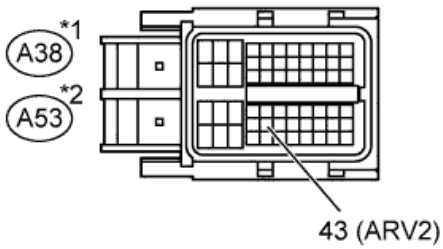
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

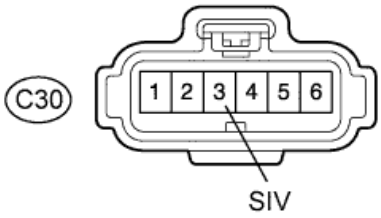
Front view of wire harness connector:
(to ECM)



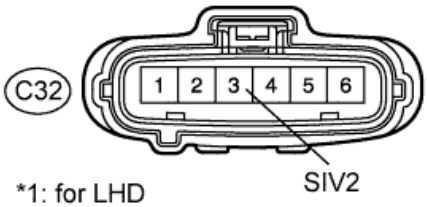
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

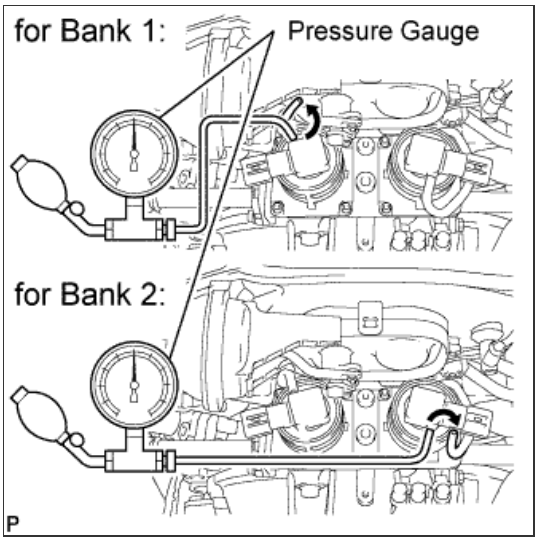
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

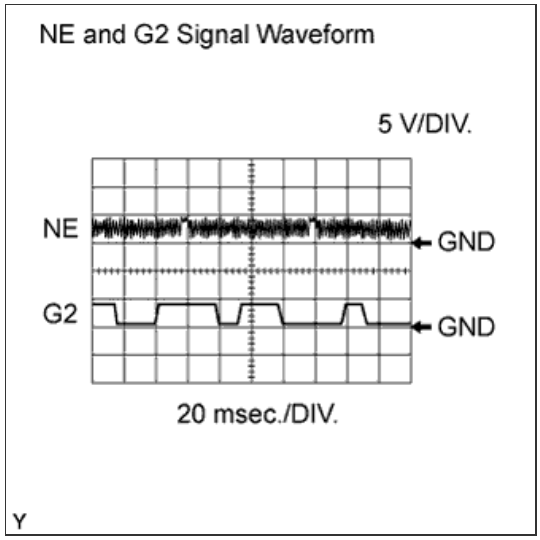
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

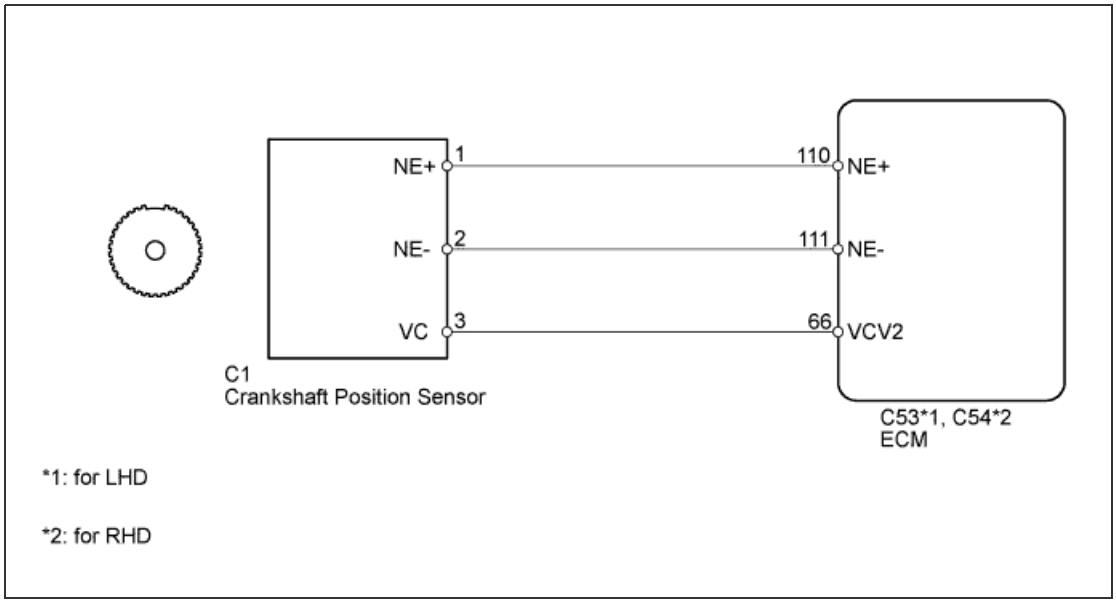
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

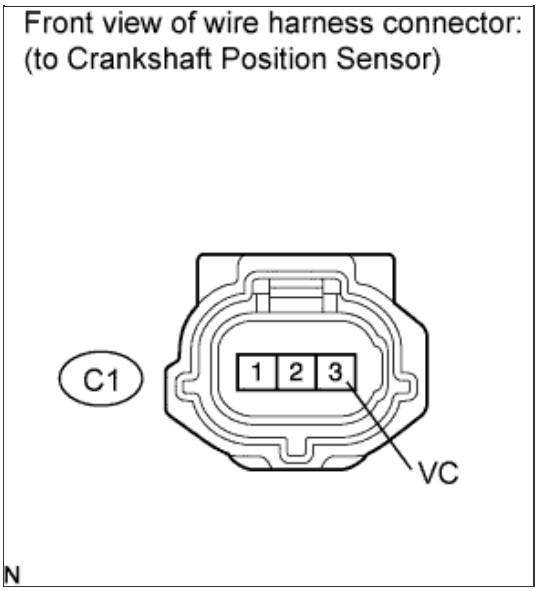
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

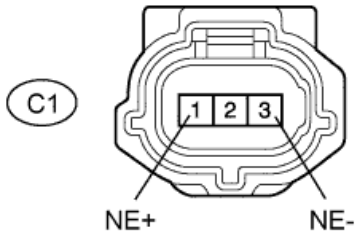
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

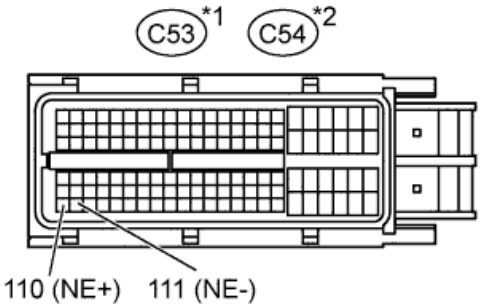
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

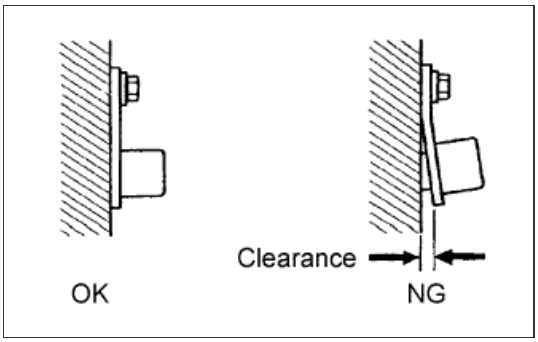
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

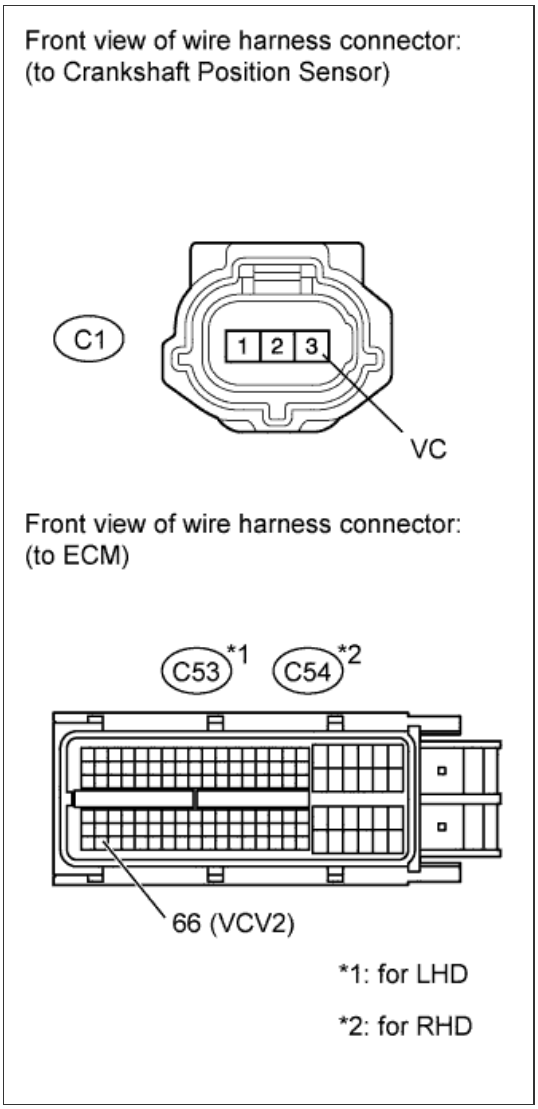
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

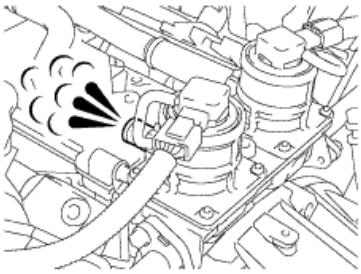
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

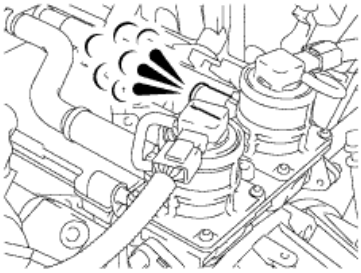
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

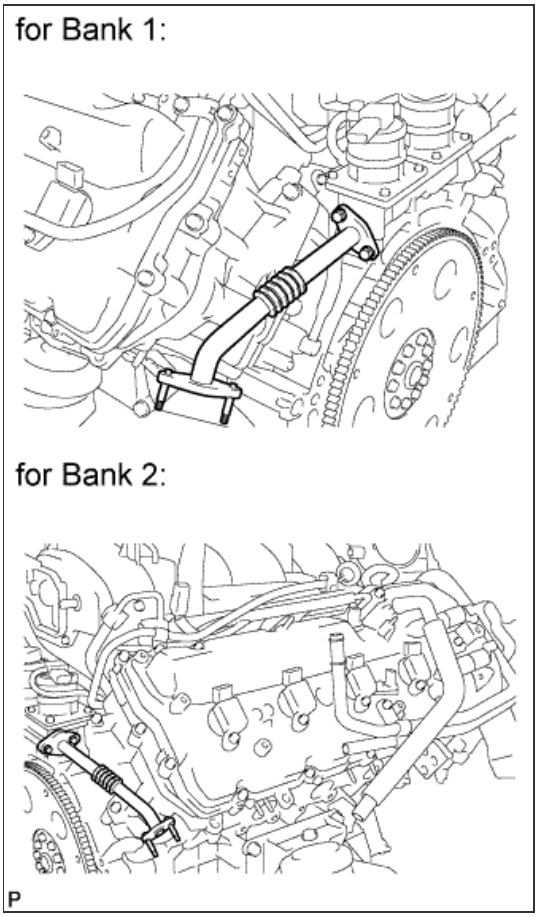
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

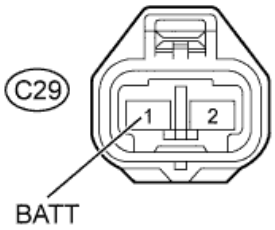
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

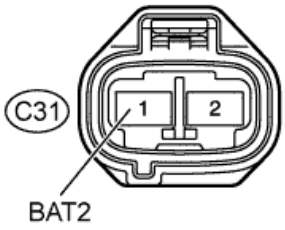
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

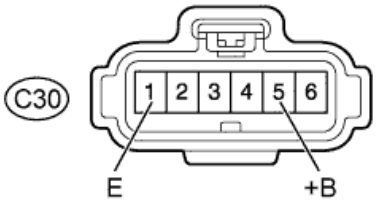
Front view of wire harness connector:
(to AID for Bank 1)



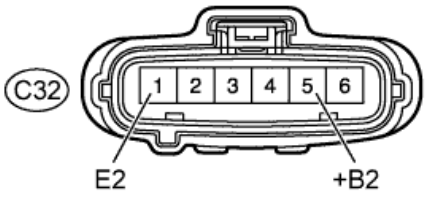
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

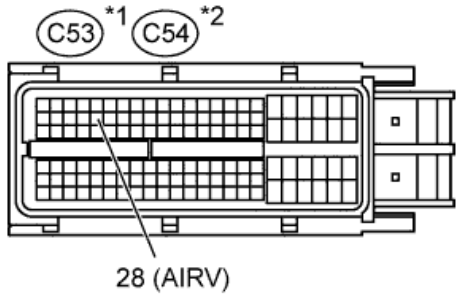
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

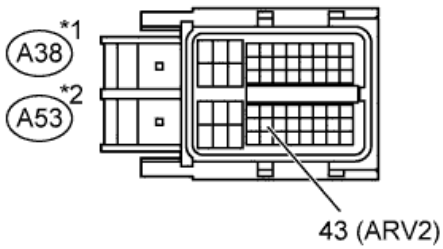
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

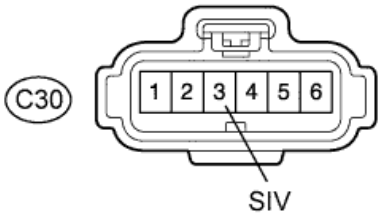
Front view of wire harness connector:
(to ECM)



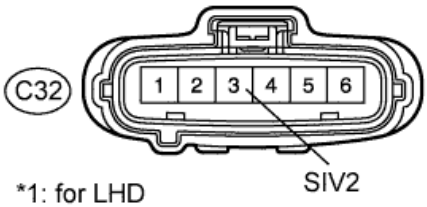
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

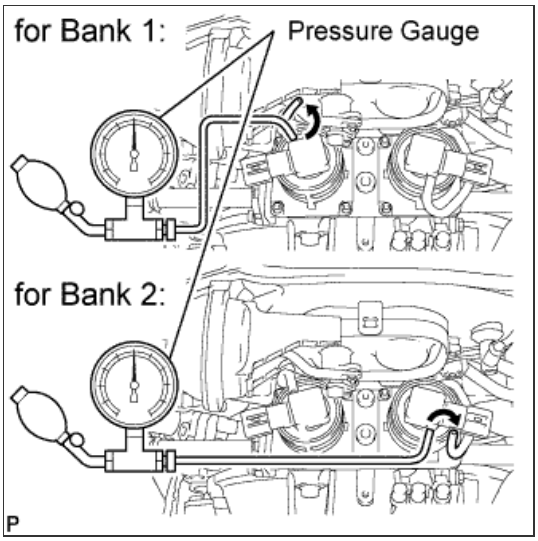
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

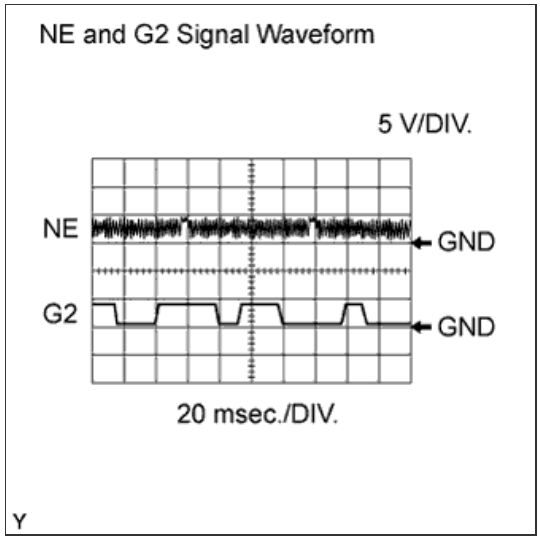
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

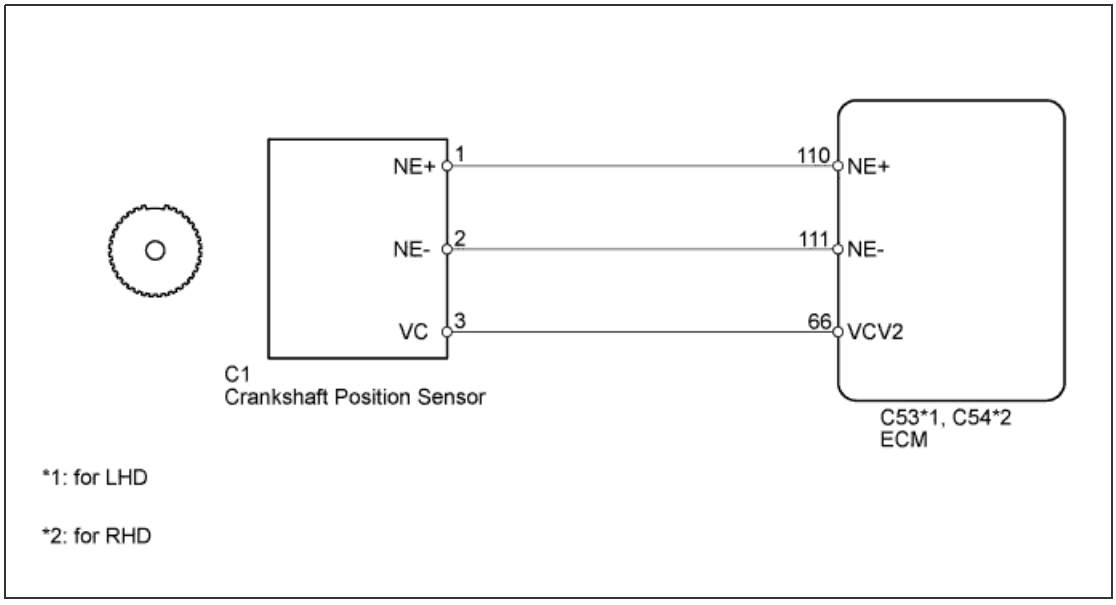
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

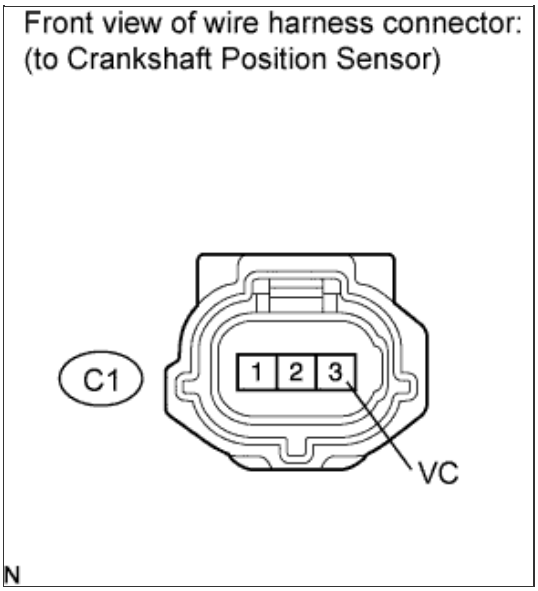
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

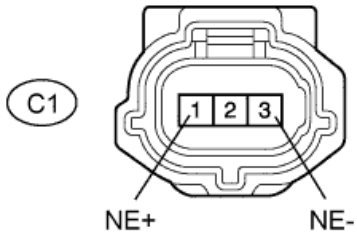
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

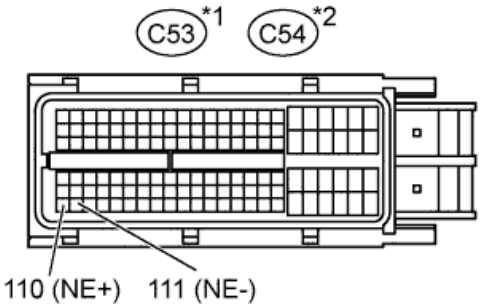
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

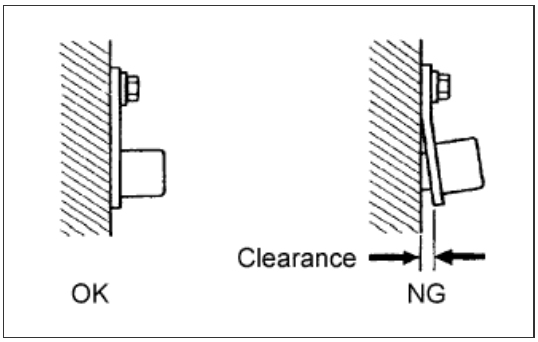
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

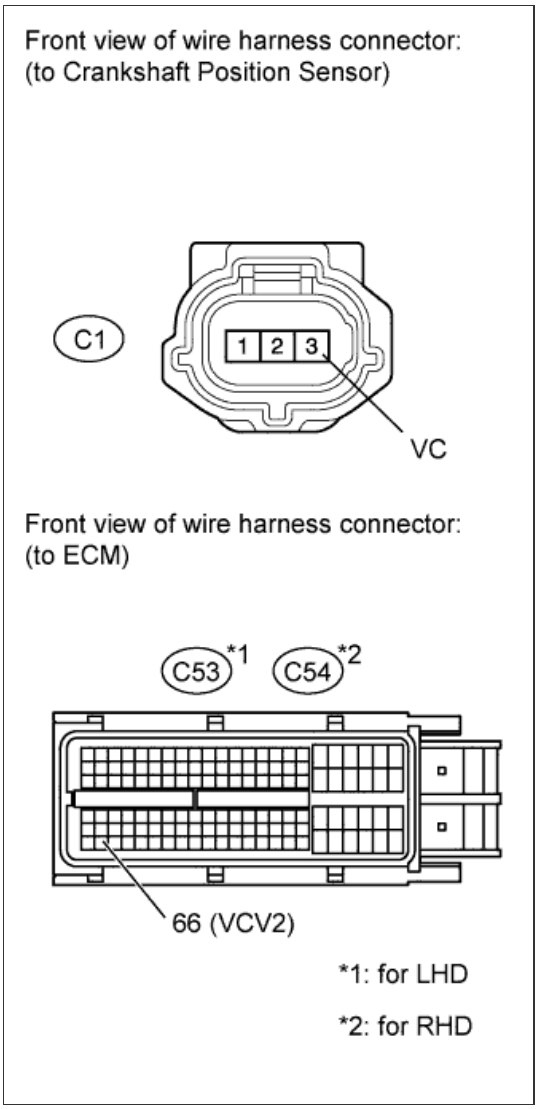
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

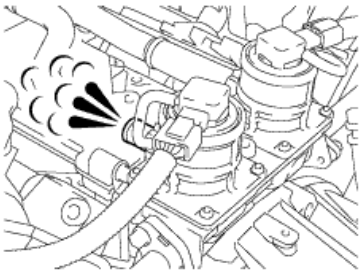
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

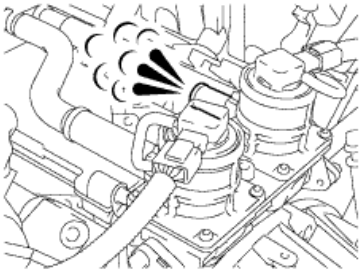
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

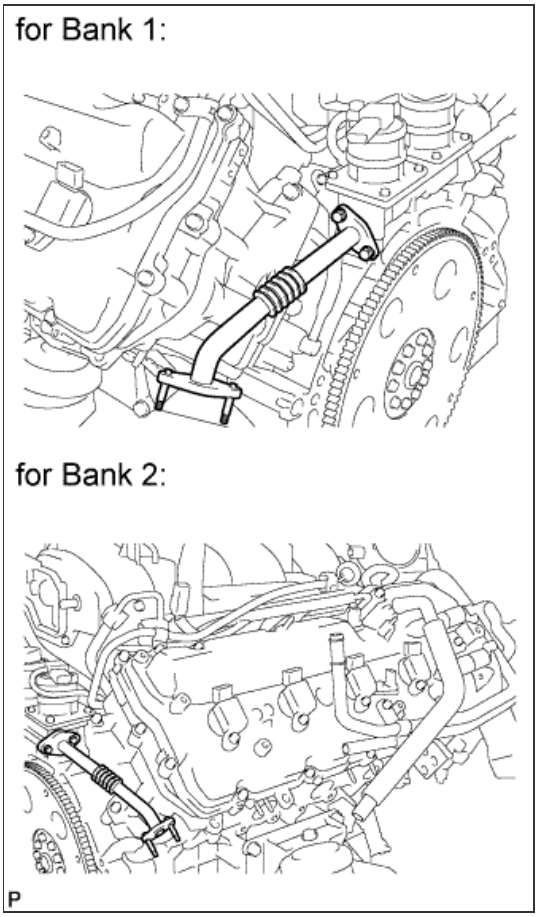
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

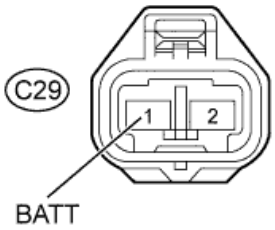
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

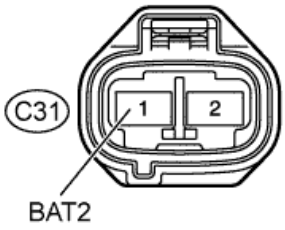
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

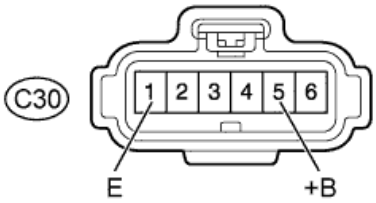
Front view of wire harness connector:
(to AID for Bank 1)



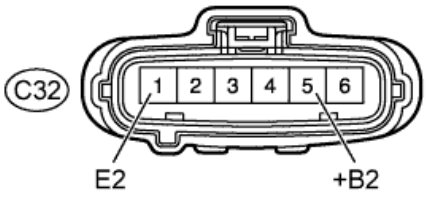
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

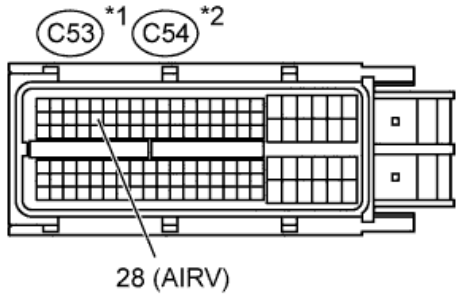
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

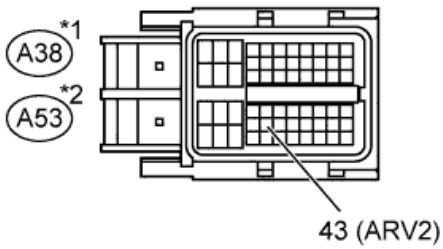
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

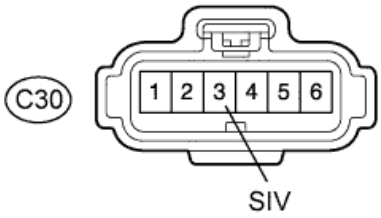
Front view of wire harness connector:
(to ECM)



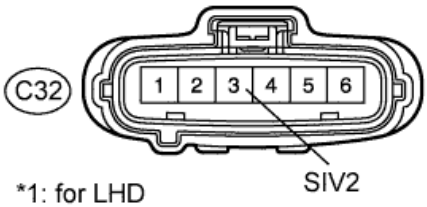
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

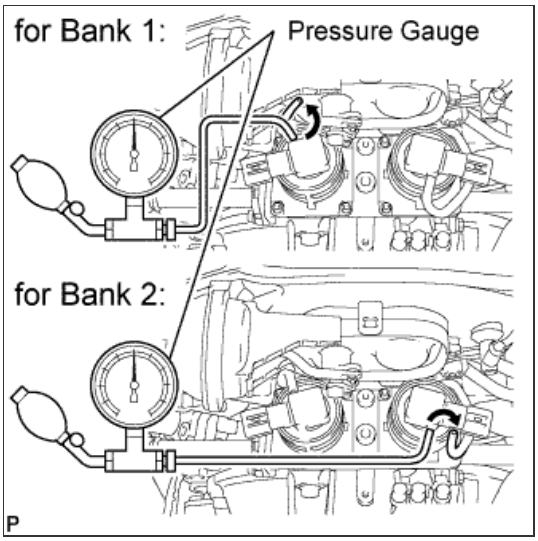
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

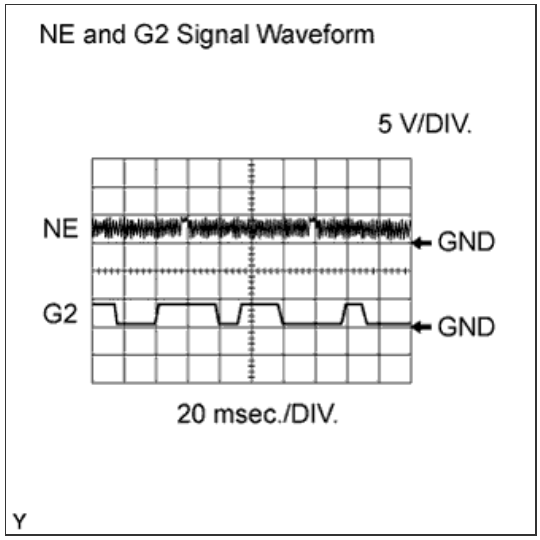
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

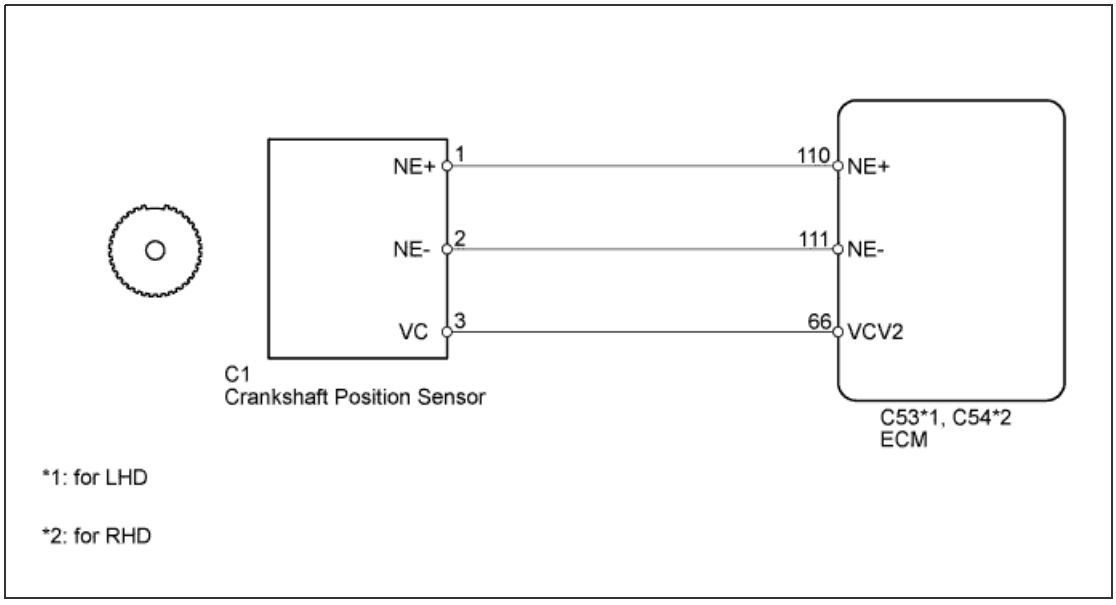
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

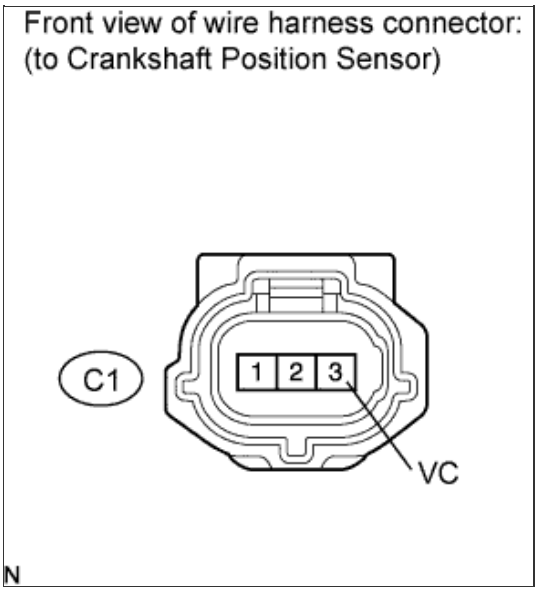
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

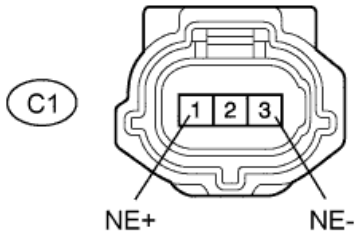
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

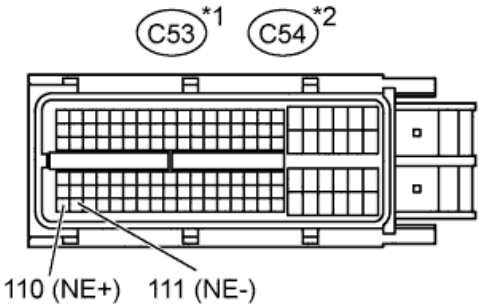
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

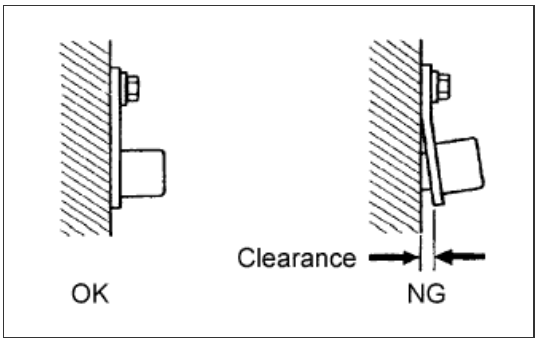
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

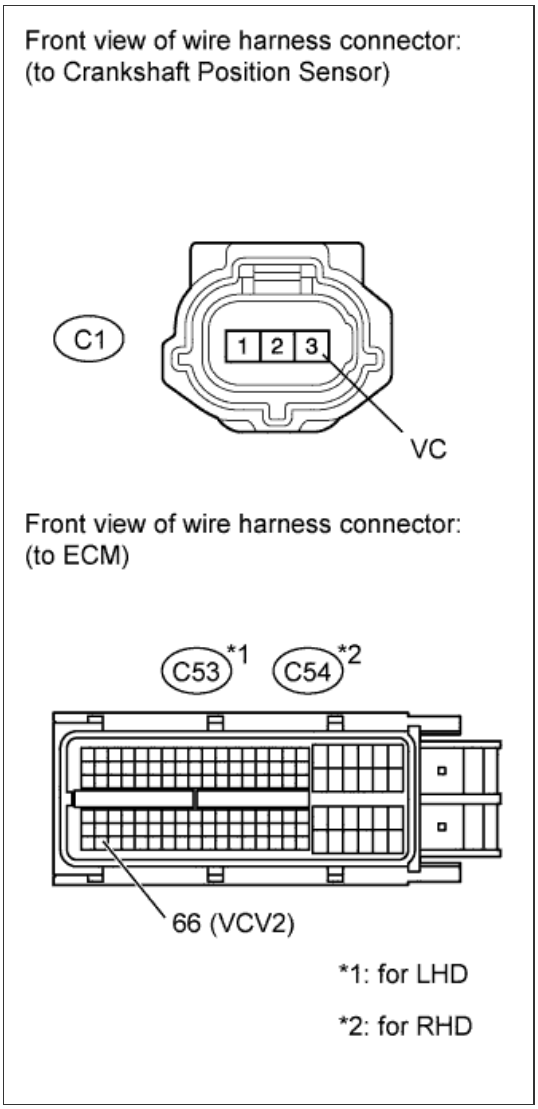
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

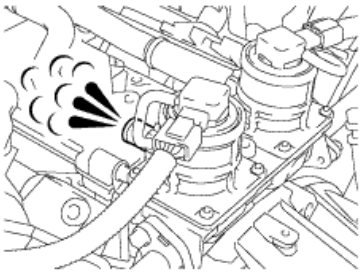
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

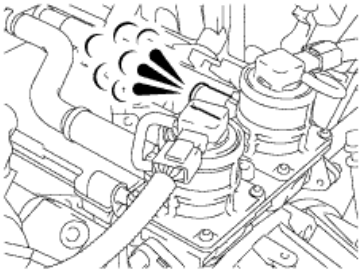
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

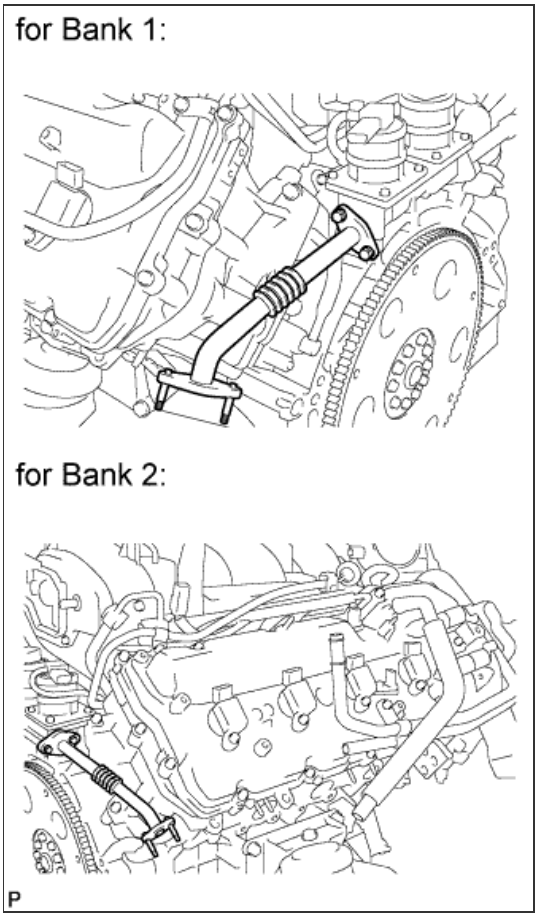
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

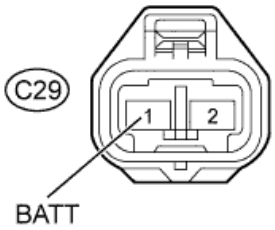
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

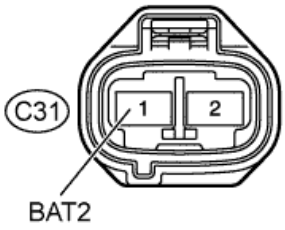
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

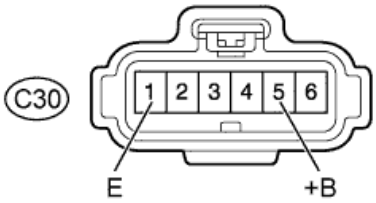
Front view of wire harness connector:
(to AID for Bank 1)



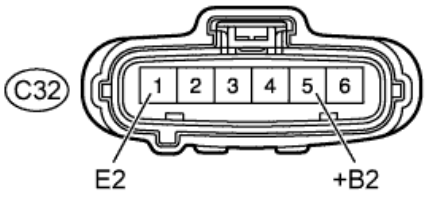
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

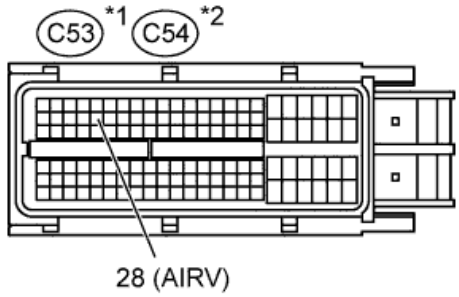
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

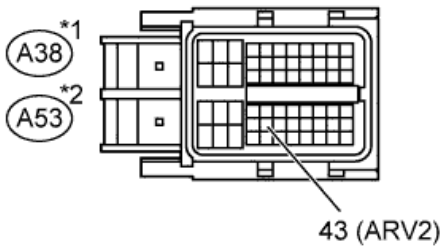
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

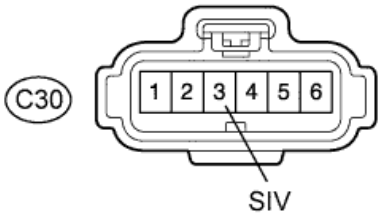
Front view of wire harness connector:
(to ECM)



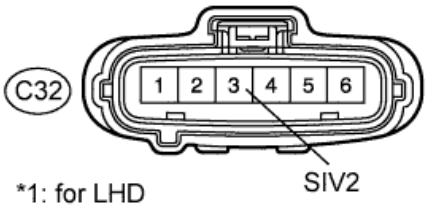
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

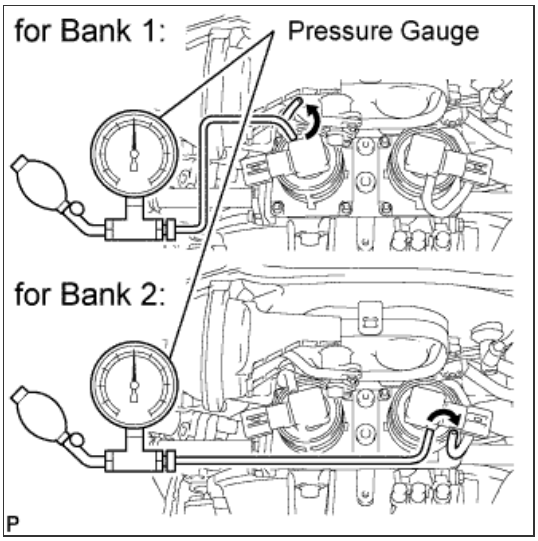
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

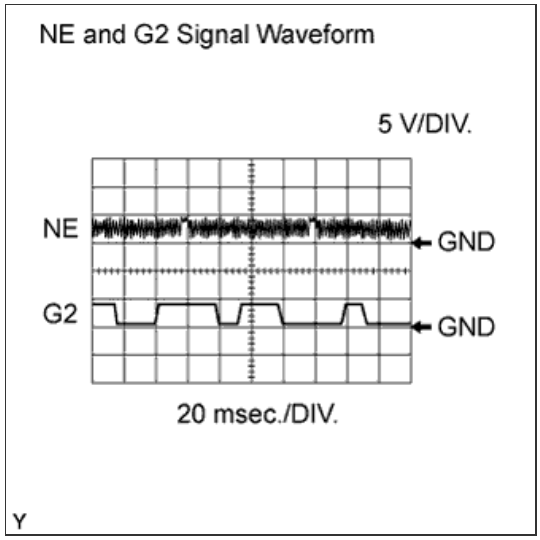
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

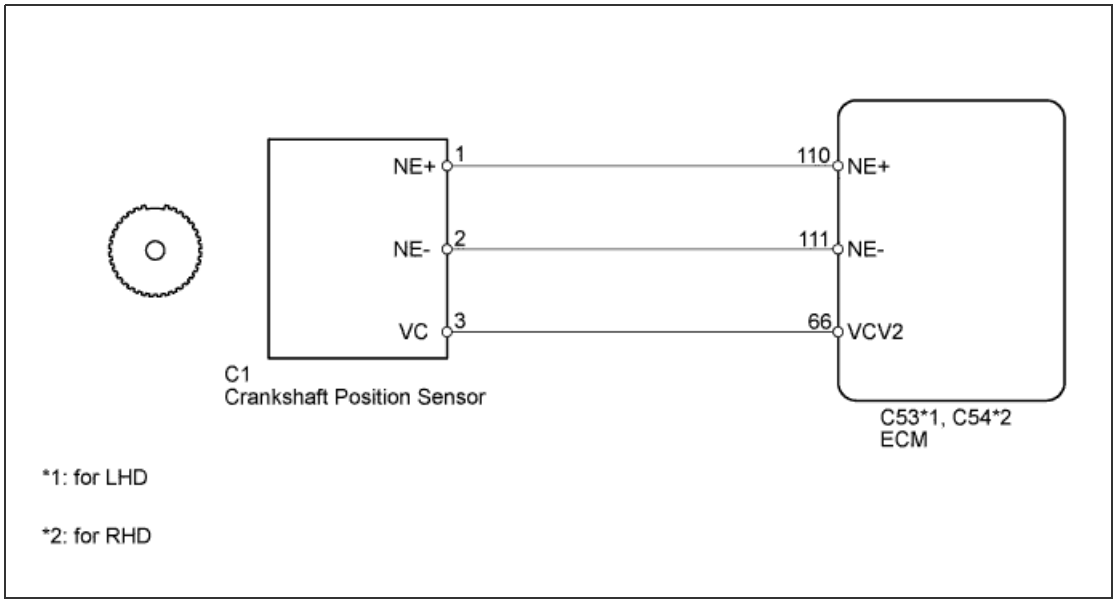
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

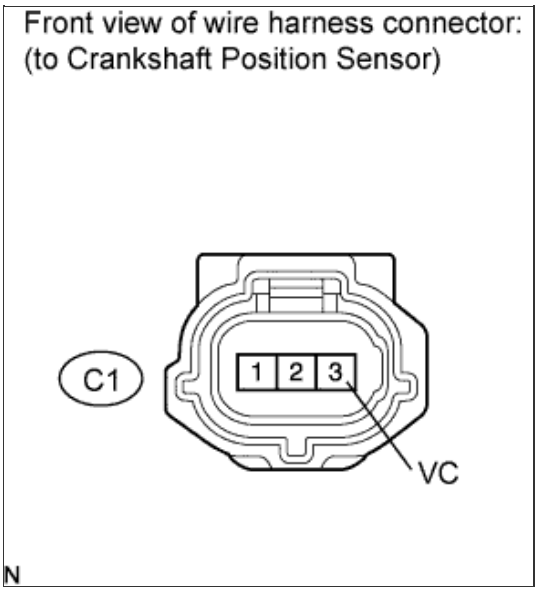
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

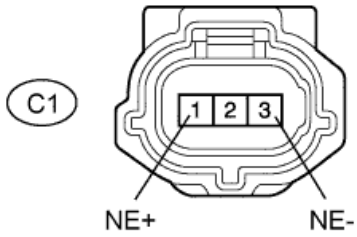
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

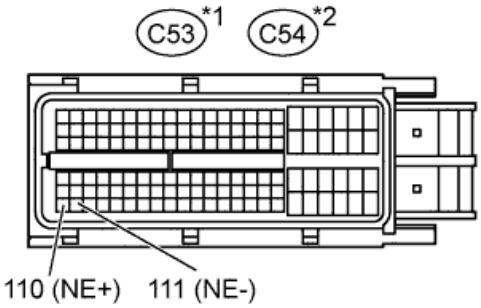
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

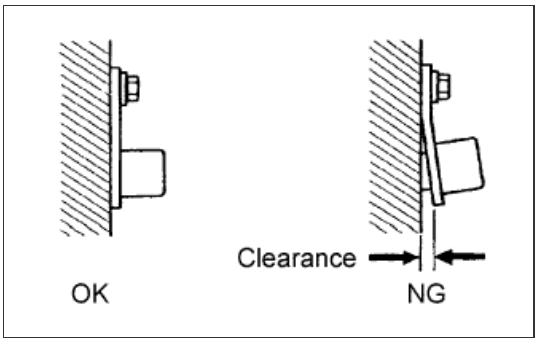
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

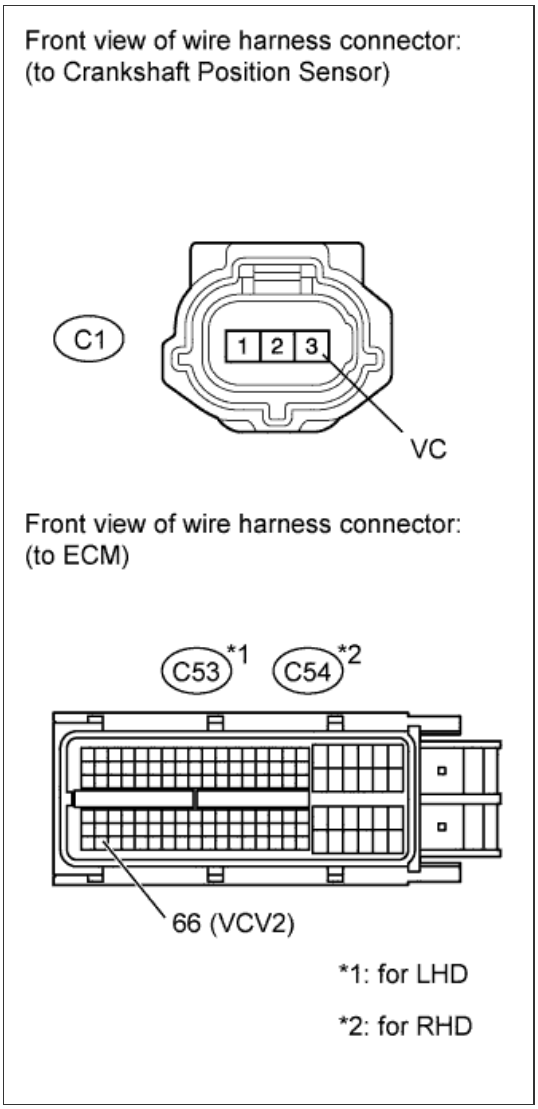
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2440 Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC P2441 Secondary Air Injection System Switching Valve Stuck Close Bank1

DTC P2442 Secondary Air Injection System Switching Valve Stuck Open Bank 2

DTC P2443 Secondary Air Injection System Switching Valve Stuck Closed Bank 2

for Preparation Click here

DESCRIPTION

Refer to DTC P0412 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2440 P2442	The pressure sensor detects pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to close, while the engine is running (1 trip detection logic).	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441 P2443	The pressure sensor detects no pulsation of the exhaust gas despite the ECM commanding the Air Switching Valve (ASV) to open, while the engine is running (2 trip detection logic).	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:

Air switching valve normal operation:

When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.

When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output

Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
Case 2	Case 8	Air pump stuck OFF	P2445 or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the intelligent tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

9. Turn the engine switch off.

   NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2440, P2441, P2442 and/or P2443 are output	A
P2440, P2441, P2442 and/or P2443 and P0412 and/or P0415 are output	B
P2440, P2441, P2442 and/or P2443 and other DTCs (except P0412 and P0415) are output	C

If any DTCs other than P0412, P0415, P2440, P2441, P2442 and/or P2443 are output, troubleshoot those DTCs first.

B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE (P0412 AND P0415) (Click here)**

C → **GO TO DTC CHART (Click here)**

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER

a. Visual check

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Disconnect the No. 1 air hose.

iv. Connect the intelligent tester to the DLC3.

v. Turn the engine switch on (IG) and turn the tester on.

vi. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.

vii. Start the engine.

viii. Perform the AIR system intrusive operation while the engine is idling.

ix. Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned on.

CAUTION:

To avoid the danger of being burned by the exhaust gas, bring your

hand close to the valve port slowly.

x. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: ON, ASV1: CLOSE, AIR PUMP 2: ON, ASV2: CLOSE.

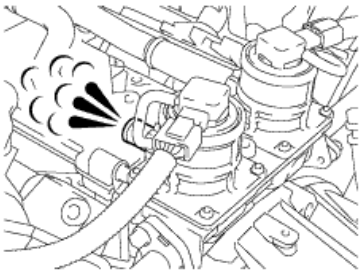
xi. Check that the exhaust gas does not pulsate when the ASV is turned off.

xii. Turn the engine switch off.

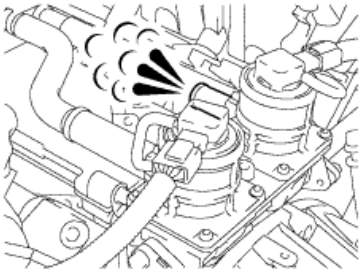
NOTICE:

- **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

for Bank 1:



for Bank 2:



P

Standard:

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

b. Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the Utility.
Perform Secondary Air Injection Check operation under Manual Mode.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

i. Start the engine and warm it up.

ii. Turn the engine switch off.

iii. Connect the intelligent tester to the DLC3.

iv. Turn the engine switch on (IG) and turn the tester on.

v. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

vi. Start the engine after the intelligent tester initialization is finished.

vii. Perform the AIR system intrusive operation while the engine is idling.

viii. Check that the air-fuel ratio and pressure in the secondary air injection system passage (Pulsation) displayed on the tester indicate the conditions shown in the table below.

ix. Turn the engine switch off.

OK:

AIR System Operation	Pulsation Condition (ECM Calculation)	Air-Fuel Ratio (Reference)
AIR PUMP: ON, ASV: OPEN	20 kPa or higher	18 or more
AIR PUMP: OFF, ASV: CLOSE	Below 30 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

Reference:
If the air pump operation is confirmed as normal (Click here), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

Result

Result	Proceed to
NG	A
OK	B

B → Go to step 9

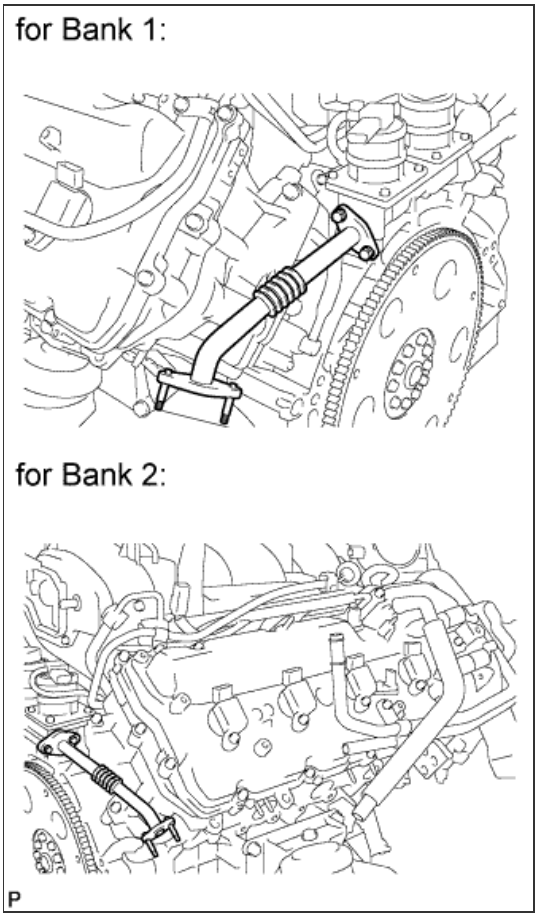
A

3.INSPECT AIR TUBE (BLOCKAGES AND LEAKAGES)

a. Check that the No. 2 and No. 3 air tubes are securely connected to both the exhaust manifold and the air switching valve.

b. Inspect the air tube for blockages and damage.

OK:
No blockages and damage on intake pipe.



NG → REPLACE AIR TUBE (Click here)

OK

4.INSPECT AIR SWITCHING VALVE

a. Inspect the air switching valve (Click here).

NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

5.INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

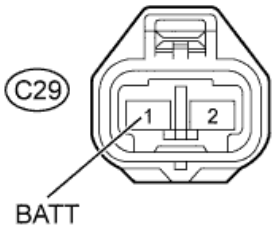
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

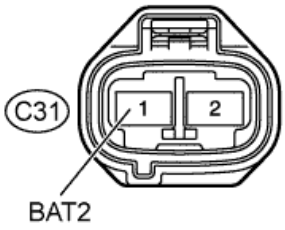
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

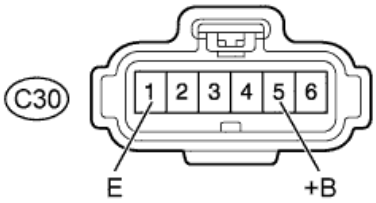
Front view of wire harness connector:
(to AID for Bank 1)



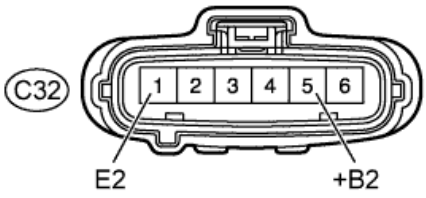
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

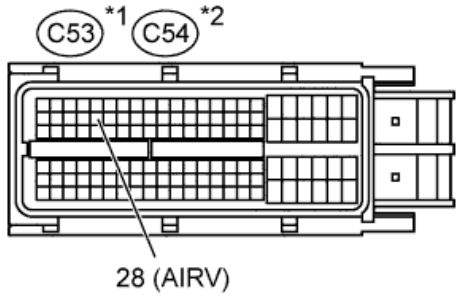
6.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the A38, A53, C53 or C54 ECM connector.

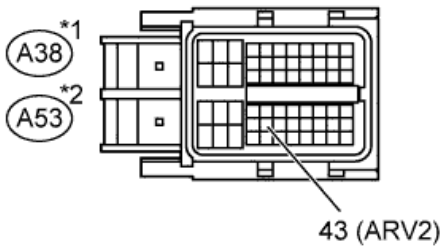
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

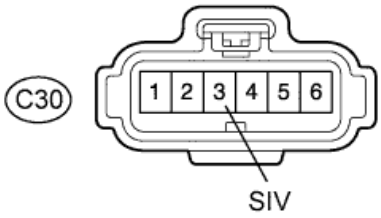
Front view of wire harness connector:
(to ECM)



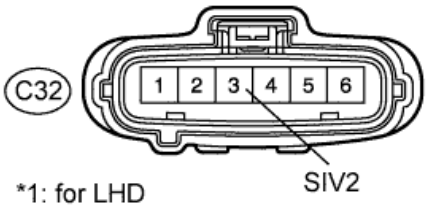
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω
A38-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-28 (AIRV) - C30-3 (SIV)	Always	Below 1 Ω

A53-43 (ARV2) - C32-3 (SIV2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2440, P2441, P2442 AND/OR P2443)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

9.INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

OK:
No blockage and no deformation in vacuum hose.

NG → REPAIR OR REPLACE VACUUM HOSE

OK

10.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

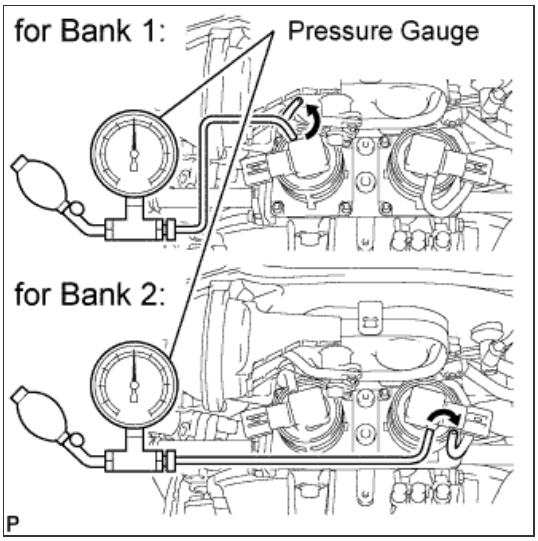
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK → CHECK FOR INTERMITTENT PROBLEMS (Click here)

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

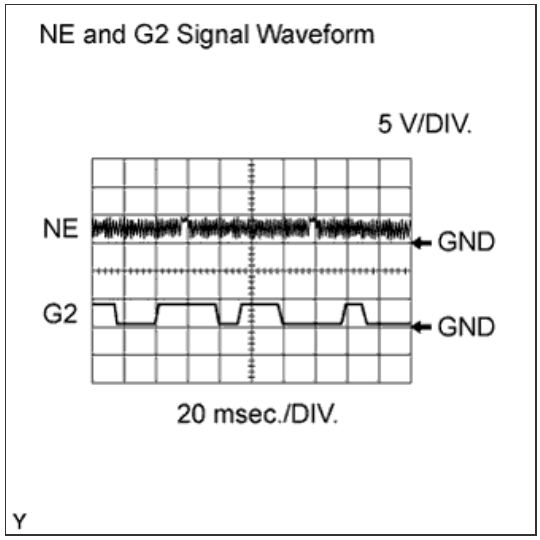
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

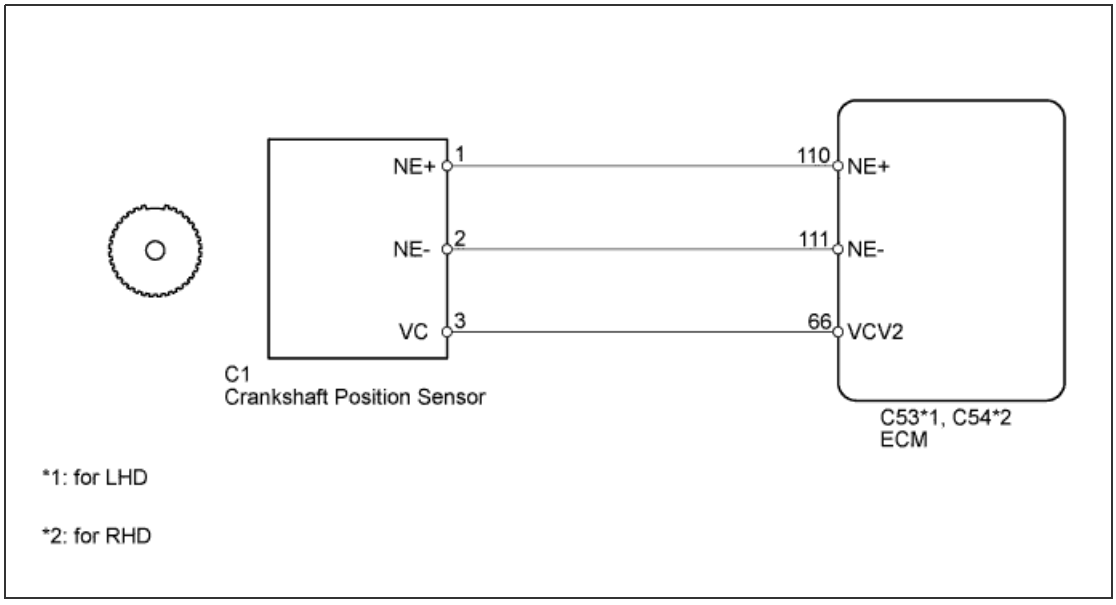
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

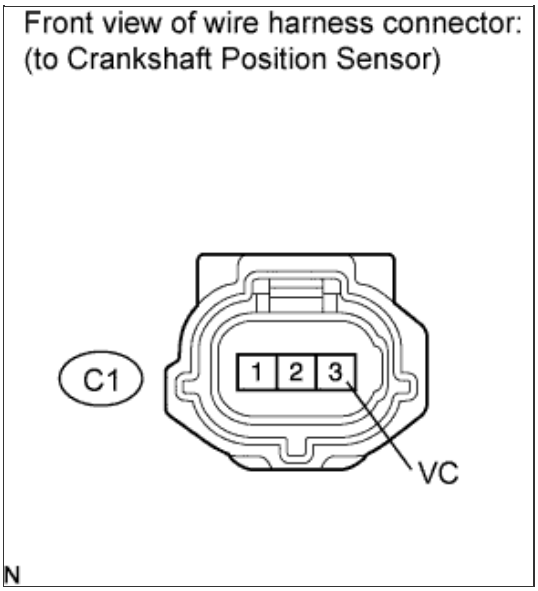
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

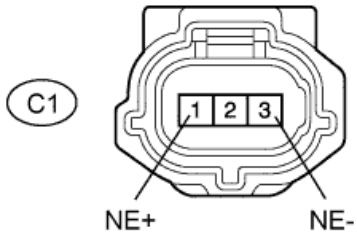
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

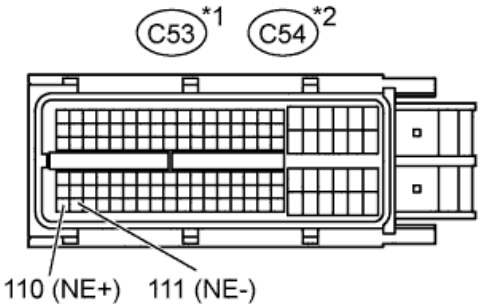
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

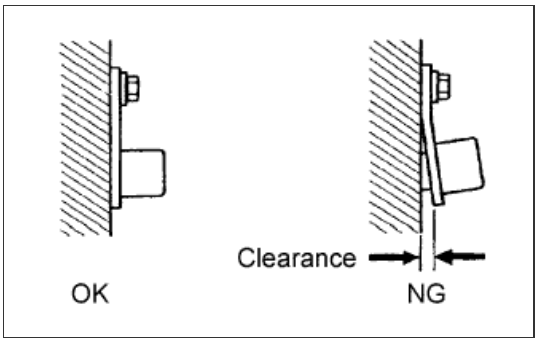
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

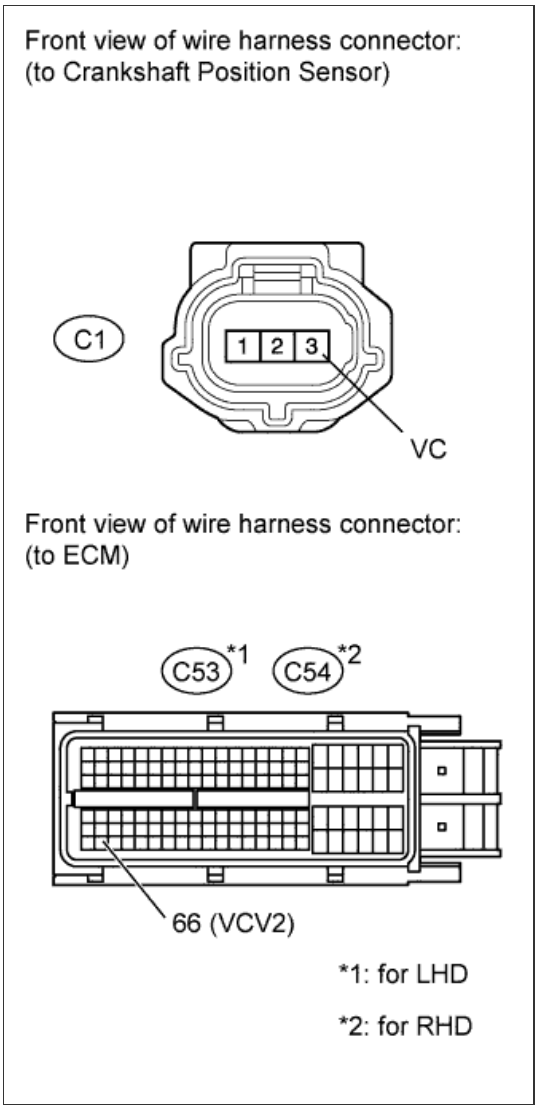
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

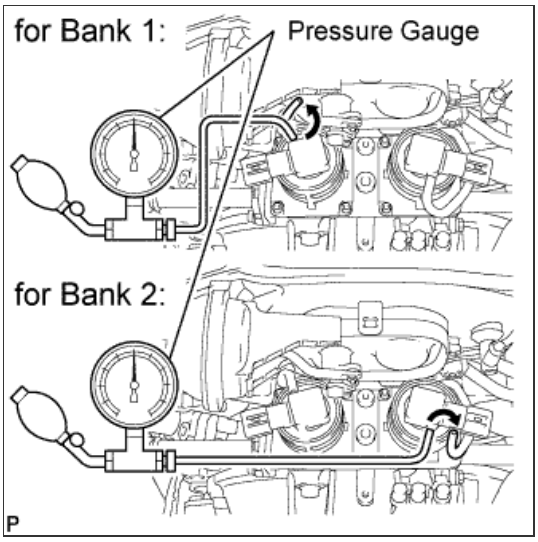
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

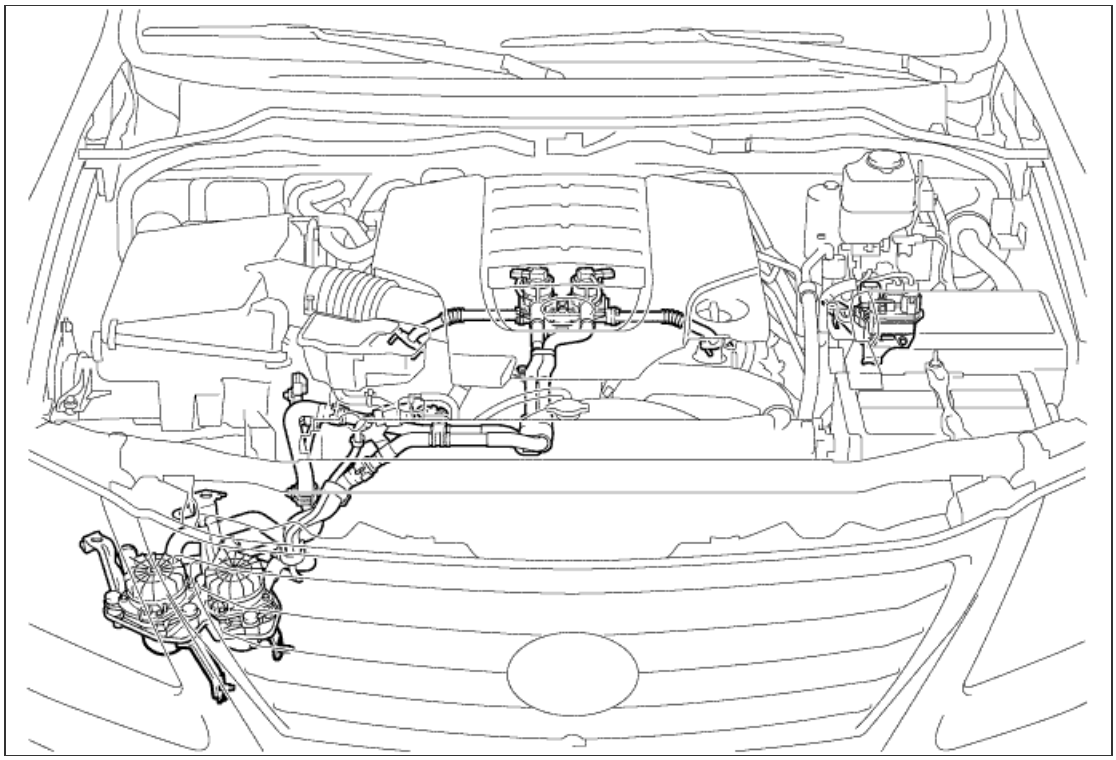
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

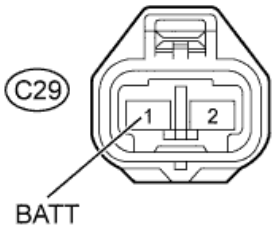
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

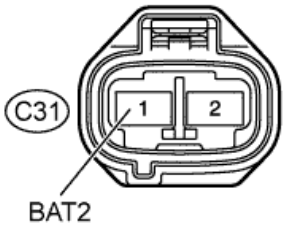
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

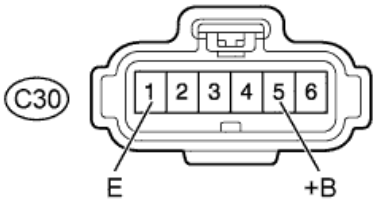
Front view of wire harness connector:
(to AID for Bank 1)



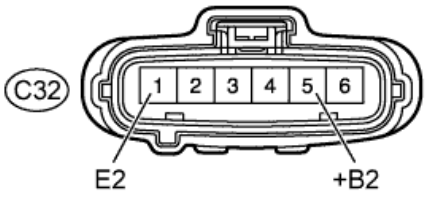
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

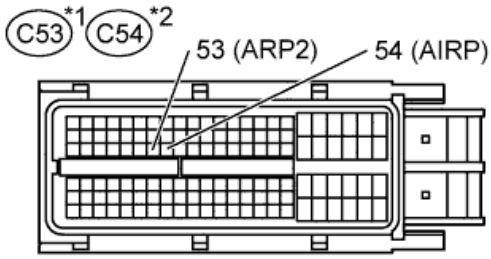
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

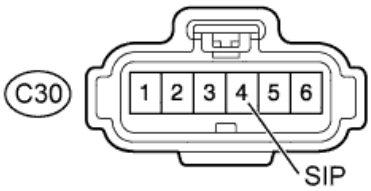
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

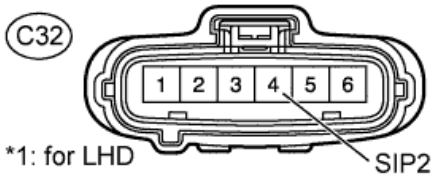
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0335 Crankshaft Position Sensor "A" Circuit

DTC P0337 Crankshaft Position Sensor "A" Circuit Low Input

DTC P0338 Crankshaft Position Sensor "A" Circuit High Input

DTC P0339 Crankshaft Position Sensor "A" Circuit Intermittent

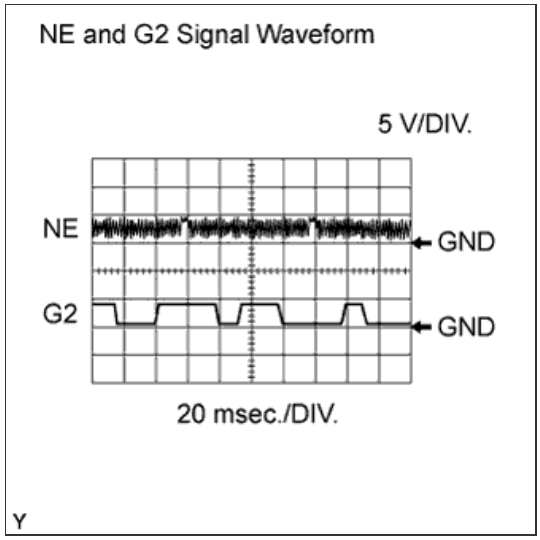
for Preparation Click here

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a crankshaft position sensor plate and Magnetic Resistance Element (MRE) type sensor. The crankshaft position sensor plate has 34 teeth at 10° intervals (2 teeth are missing for detecting top dead center), and is installed to the rear end of the crankshaft. The crankshaft position sensor outputs 34 rotation signals per crankshaft revolution. The ECM uses the G2 signal to distinguish between the cylinders, and uses the NE signal to detect the crankshaft position and engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0335	• No Crankshaft Position (CKP) sensor signal is sent to the ECM while cranking (1 trip detection logic). • No CKP sensor signal is sent to the ECM at an engine speed of 600 rpm or more (1 trip detection logic).	• Open or short in Crankshaft Position (CKP) sensor circuit • CKP sensor • CKP sensor plate • ECM
P0337	The output voltage of the CKP sensor is 0.3 V or less for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0338	The output voltage of the CKP sensor is 4.7 V or higher for 4 seconds (1 trip detection logic).	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal is sent to the ECM for 0.05 seconds or more (1 trip detection logic): (a) The engine speed is 1000 rpm or more. (b) The starter signal is OFF. (c) 3 seconds or more have elapsed since the starter signal was switched from ON to OFF.	• Open or short in CKP sensor circuit • CKP sensor • CKP sensor plate • ECM

Reference: Inspection using an oscilloscope.



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

C53-90 (G2) - C53-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-90 (G2) - C54-89 (G2-)	5 V/DIV., 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

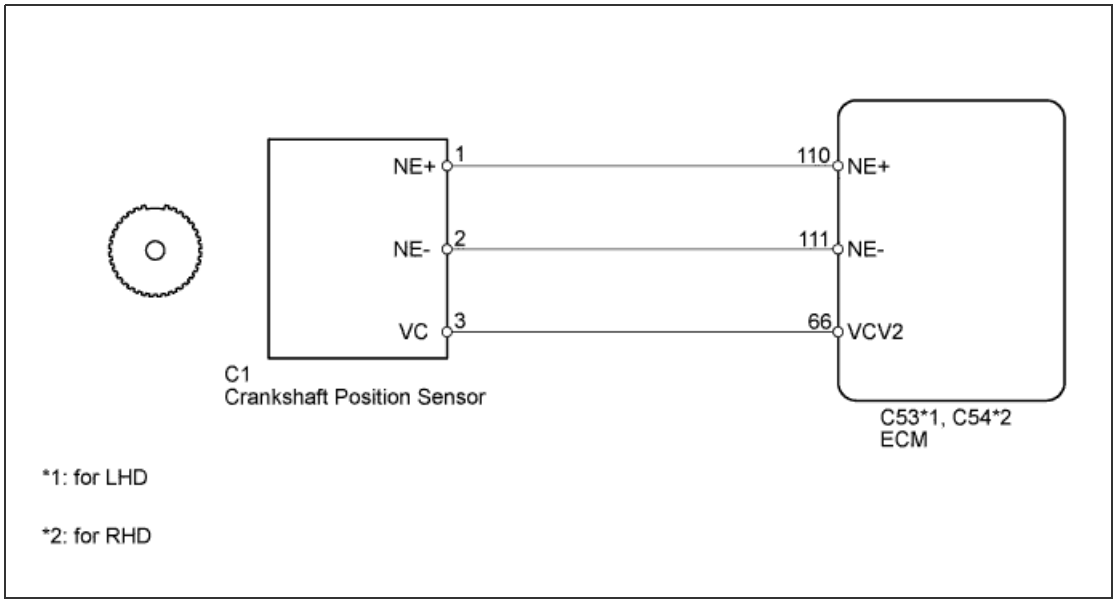
HINT:

G2 stands for the camshaft position sensor signal, and NE stands for the crankshaft position sensor signal.

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor. When the sensor output voltage remains at below 0.3 V, or higher than 4.7 V for more than 4 seconds, the ECM stores DTC(s).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- **If no problem is found by this diagnostic troubleshooting procedure, check for problems by referring to the engine mechanical section.**
- **The engine speed can be checked by using the intelligent tester. To check, follow the procedures below:**
  1. **Connect the tester to the DLC3.**
  2. **Start the engine.**
  3. **Turn the tester on.**
  4. **Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.**
     The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as less than the actual engine speed, if the CKP sensor output voltage is insufficient.
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.READ VALUE USING INTELLIGENT TESTER (ENGINE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Engine Speed.

d. Start the engine.

e. Read the values displayed on the tester while the engine is running.

Standard:
Correct values are displayed.

HINT:

- **To check the engine speed change, display the graph on the intelligent tester.**
- **If the engine does not start, check the engine speed while cranking.**
- **If the engine speed indicated on the intelligent tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.**

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS (Click here)

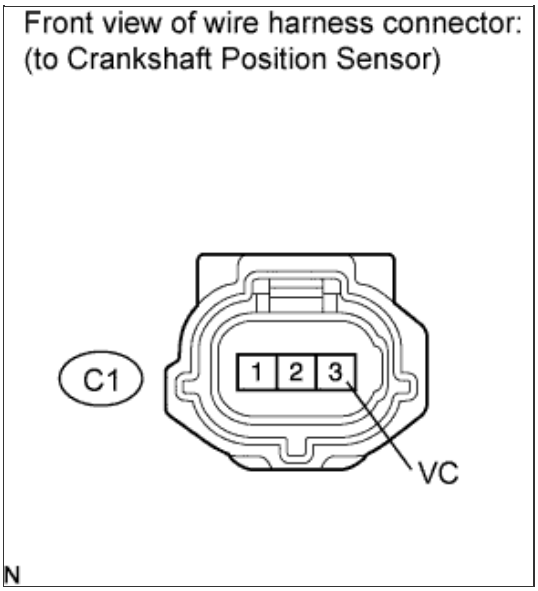
2.INSPECT CRANKSHAFT POSITION SENSOR (SENSOR POWER SOURCE)

a. Disconnect the C1 crankshaft position sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C1-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → Go to step 8

OK

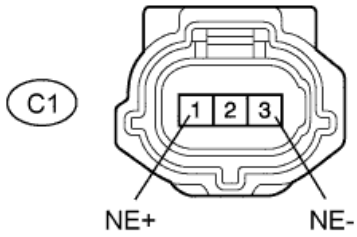
3.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

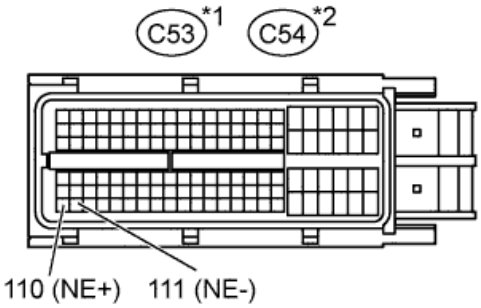
b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Crankshaft Position Sensor)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C53-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C53-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C53-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C53-111 (NE-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-1 (NE+) - C54-110 (NE+)	Always	Below 1 Ω
C1-2 (NE-) - C54-111 (NE-)	Always	Below 1 Ω
C1-1 (NE+) or C54-110 (NE+) - Body ground	Always	10 kΩ or higher
C1-2 (NE-) or C54-111 (NE-) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

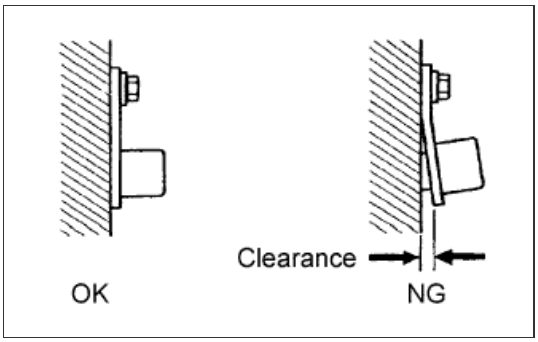
OK

4.CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)

a. Check the crankshaft position sensor installation.

OK:

Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

5.CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

a. Check the teeth of the sensor plate.

OK:

Sensor plate does not have any cracks or deformation.

NG → REPLACE CRANKSHAFT POSITION SENSOR PLATE (Click here)

OK

6.REPLACE CRANKSHAFT POSITION SENSOR

a. Replace the crankshaft position sensor (Click here).

NEXT

7.CHECK WHETHER DTC OUTPUT RECURS (DTC P0335, P0337, P0338 AND/OR P0339)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs (Click here).

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0335, P0337, P0338 and/or P0339	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

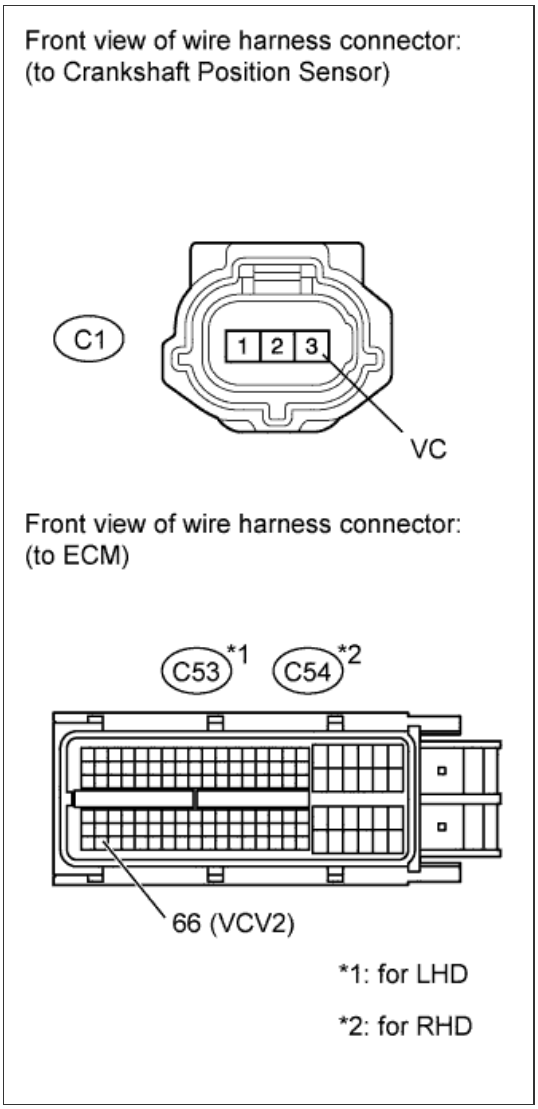
END

8.CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)

a. Disconnect the C1 crankshaft position sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C53-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C53-66 (VCV2) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C1-3 (VC) - C54-66 (VCV2)	Always	Below 1 Ω
C1-3 (VC) or C54-66 (VCV2) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

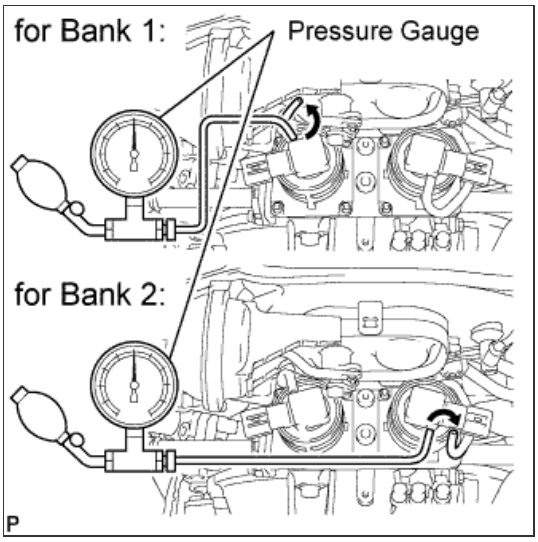
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

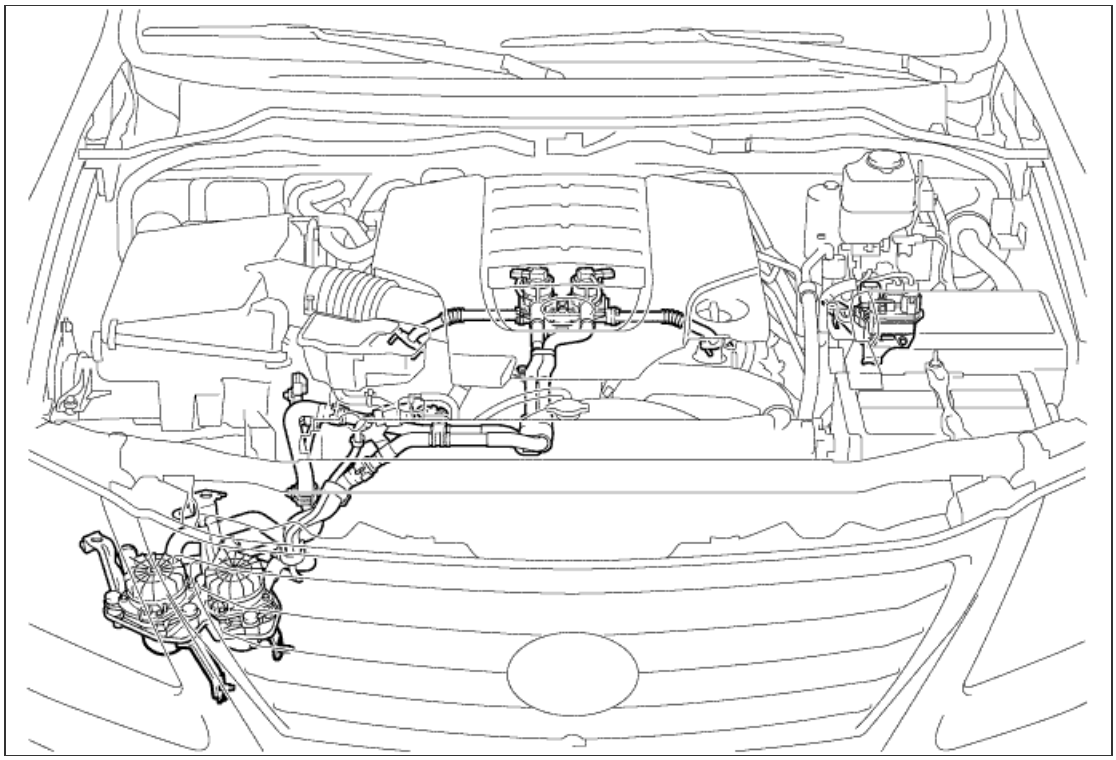
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

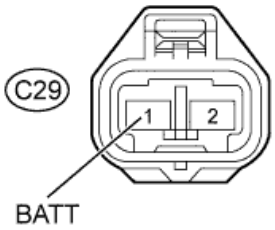
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

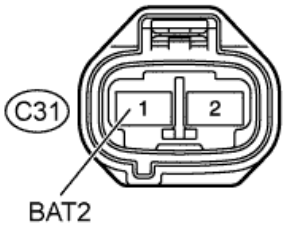
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

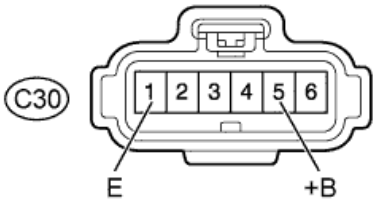
Front view of wire harness connector:
(to AID for Bank 1)



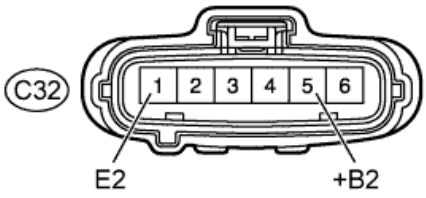
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

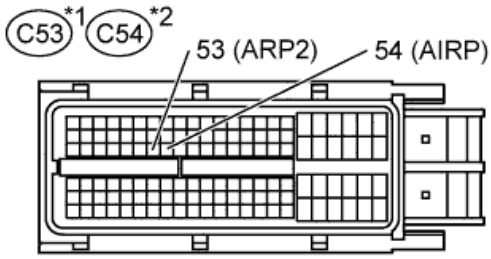
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

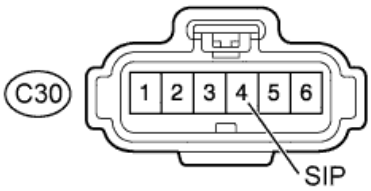
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

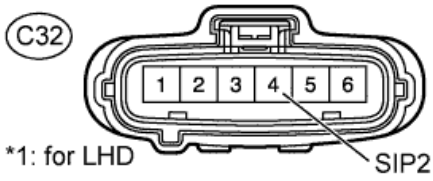
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

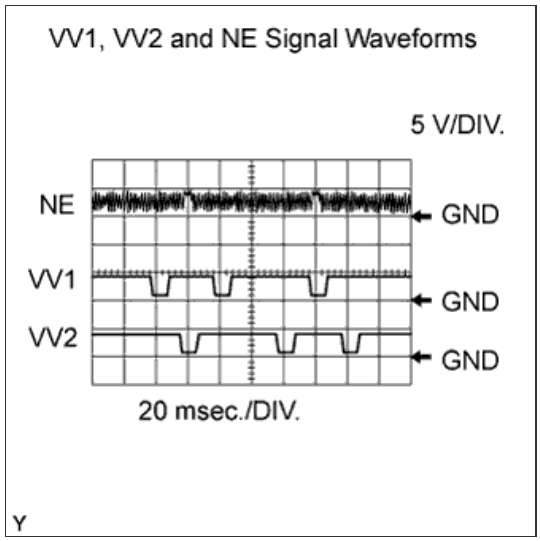
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

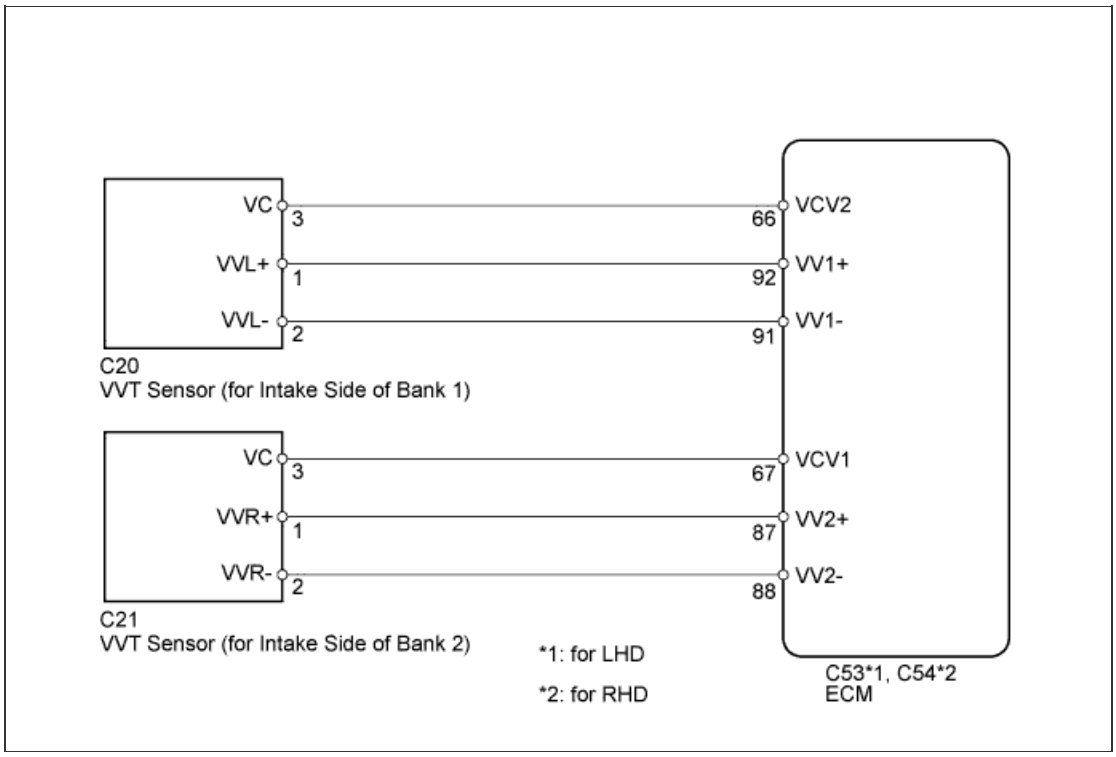
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

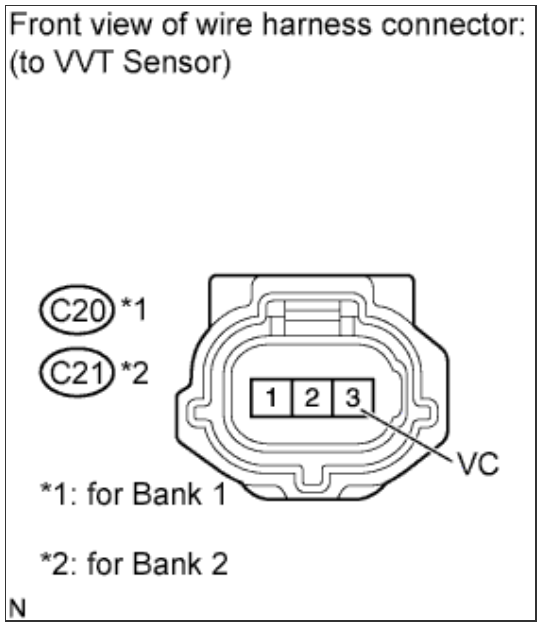
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

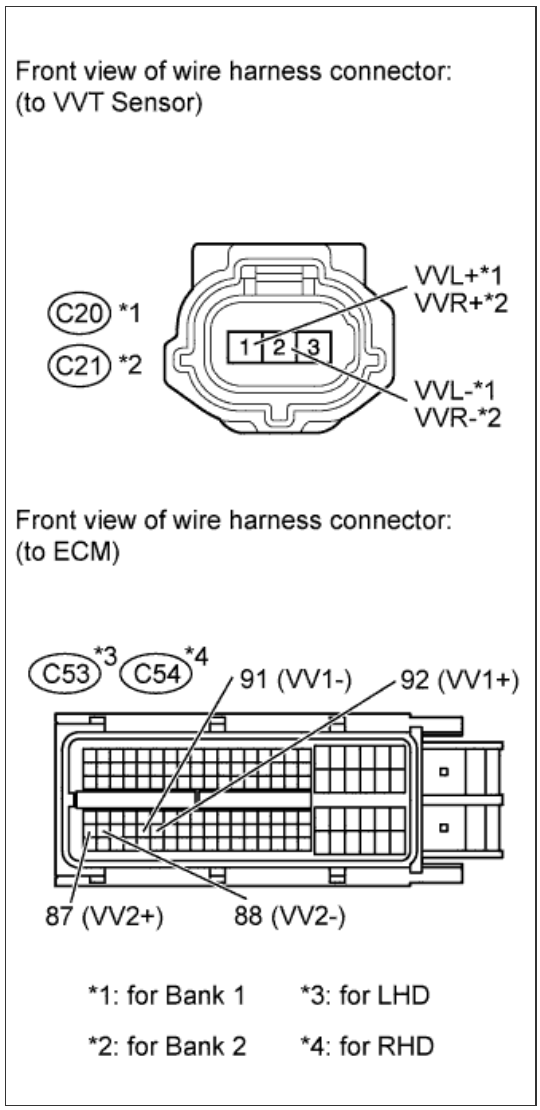
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

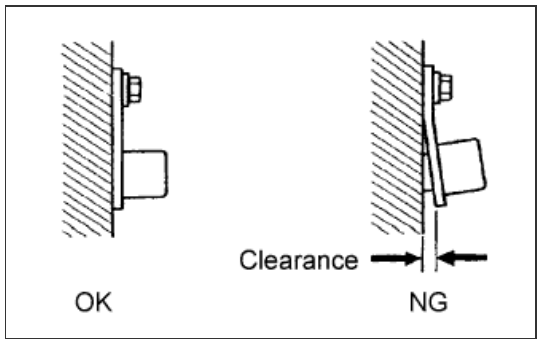
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

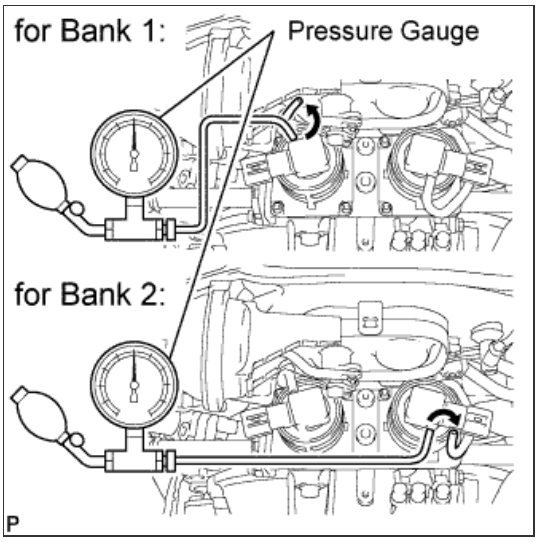
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

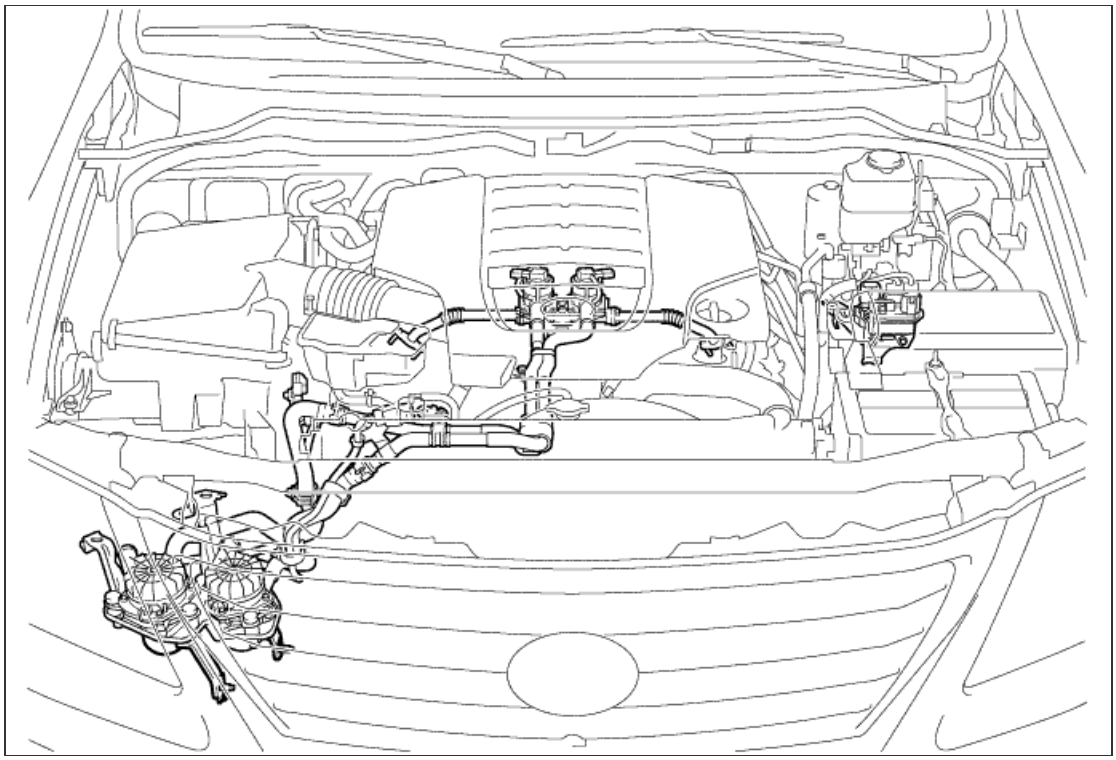
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

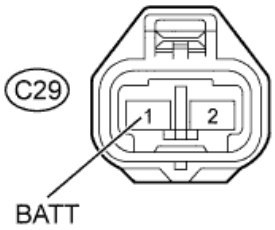
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

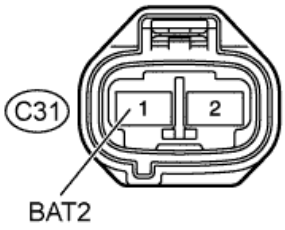
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

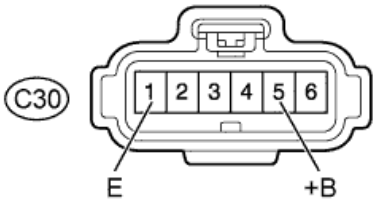
Front view of wire harness connector:
(to AID for Bank 1)



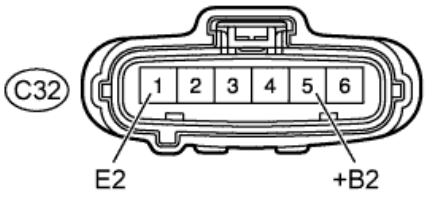
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

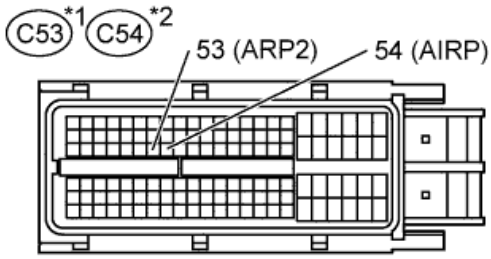
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

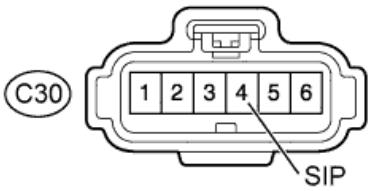
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

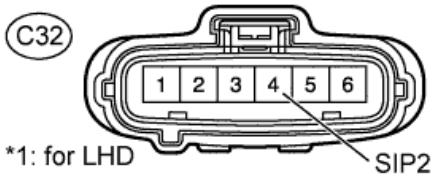
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

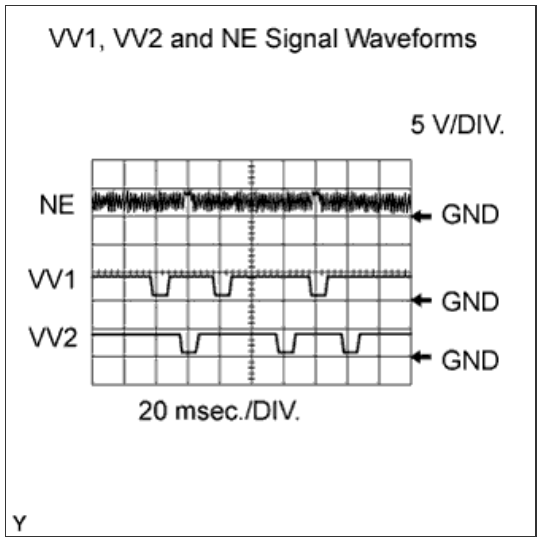
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

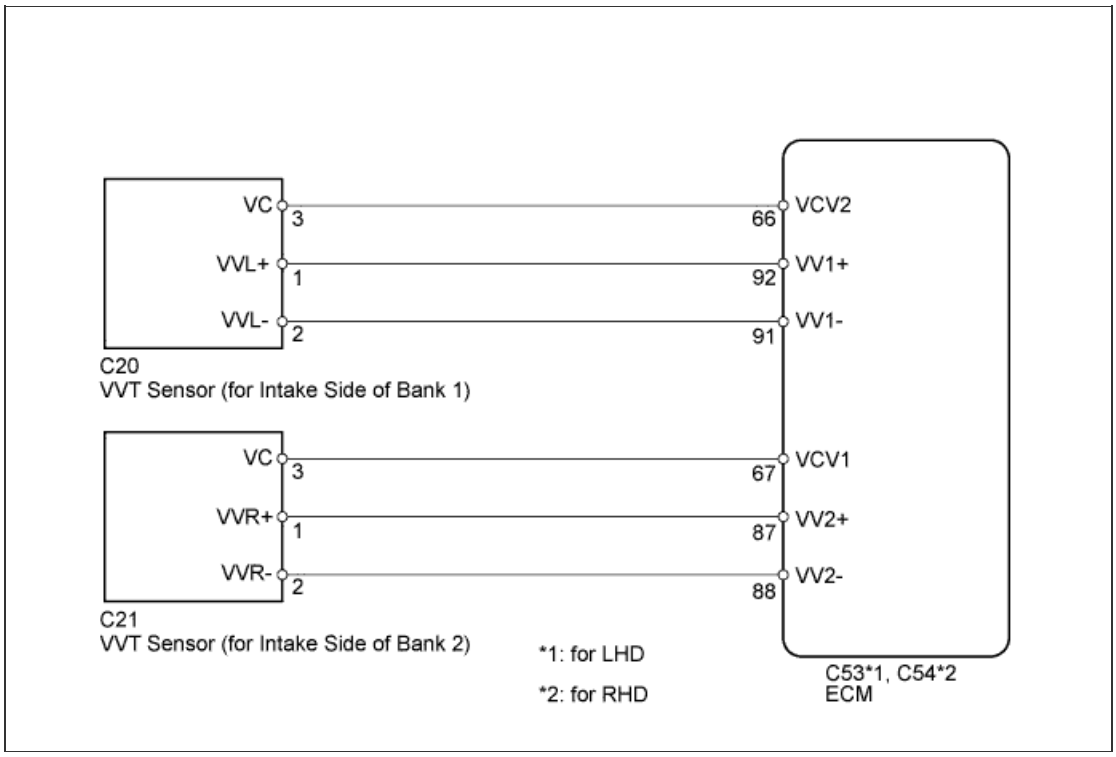
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

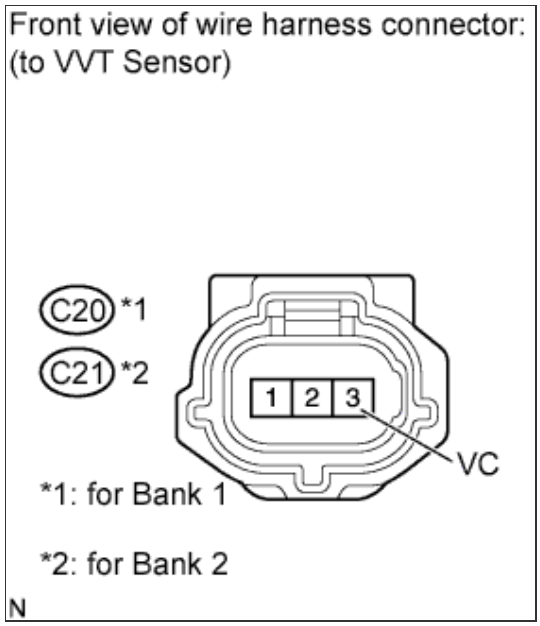
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

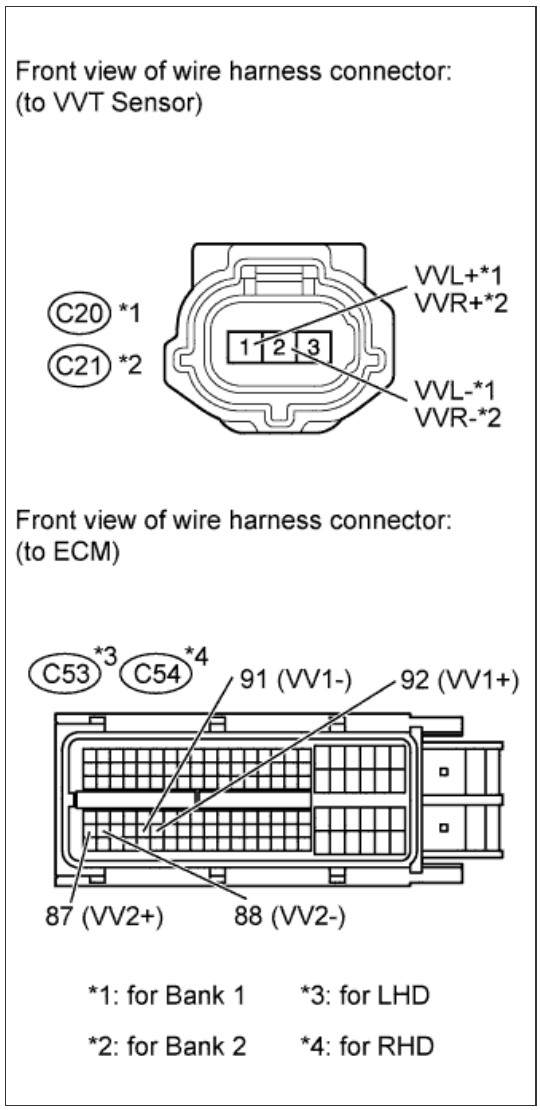
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

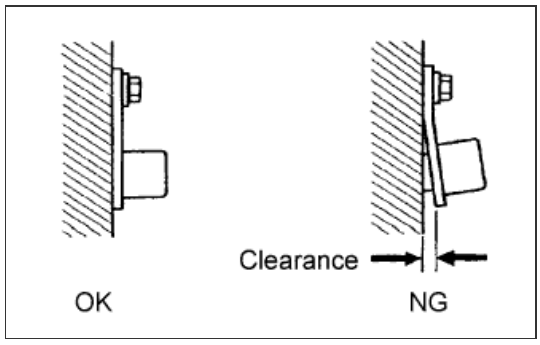
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

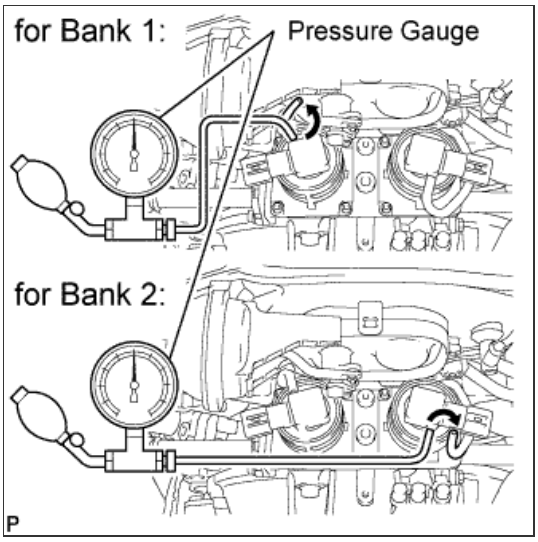
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

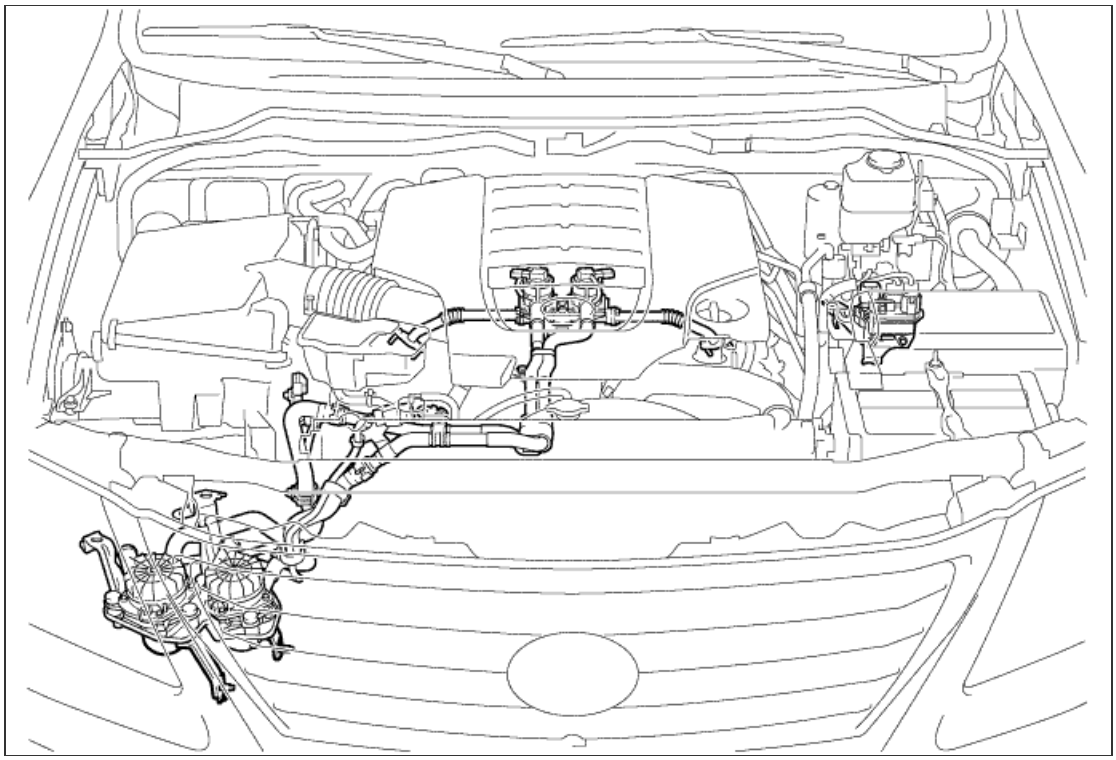
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

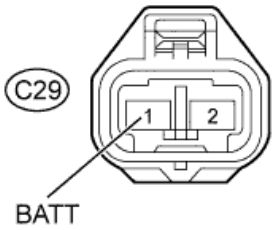
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

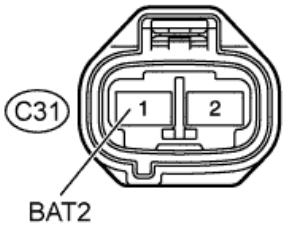
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

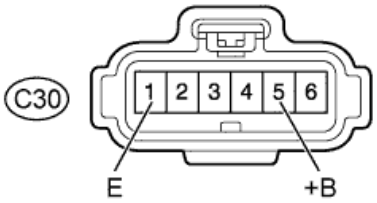
Front view of wire harness connector:
(to AID for Bank 1)



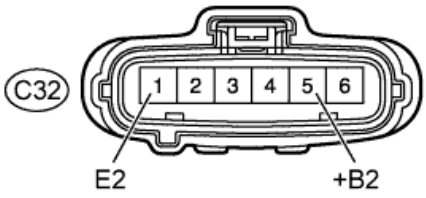
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

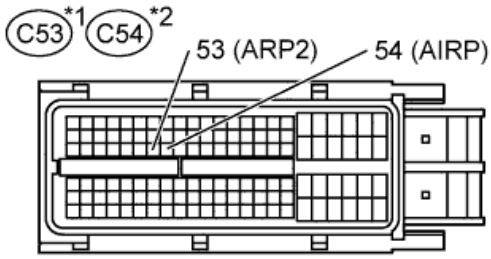
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

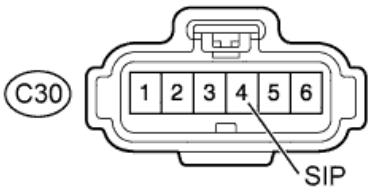
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

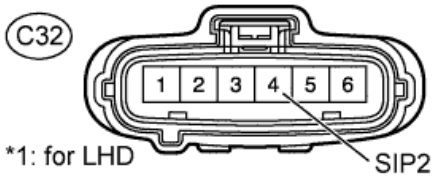
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

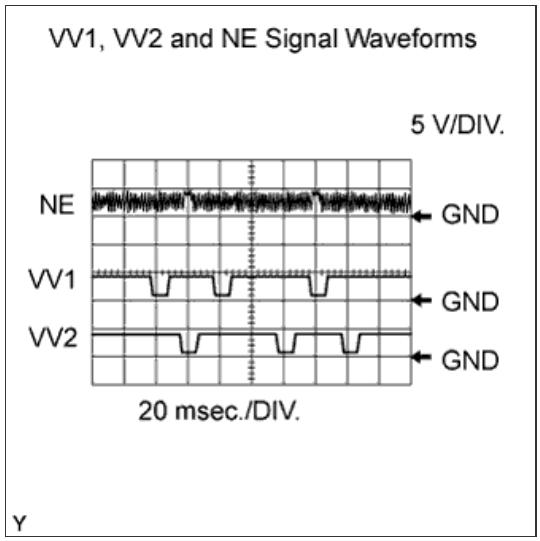
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

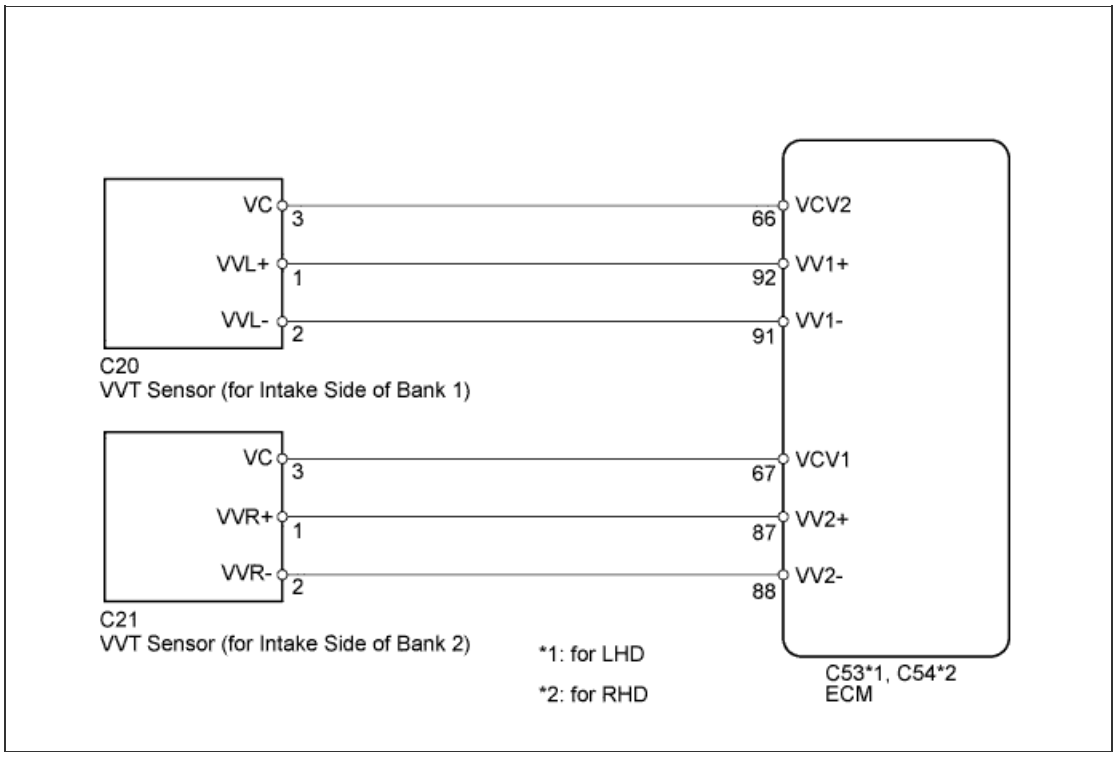
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

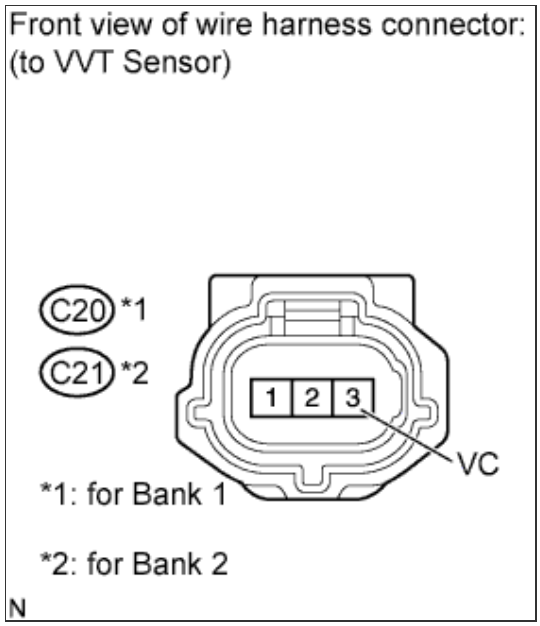
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

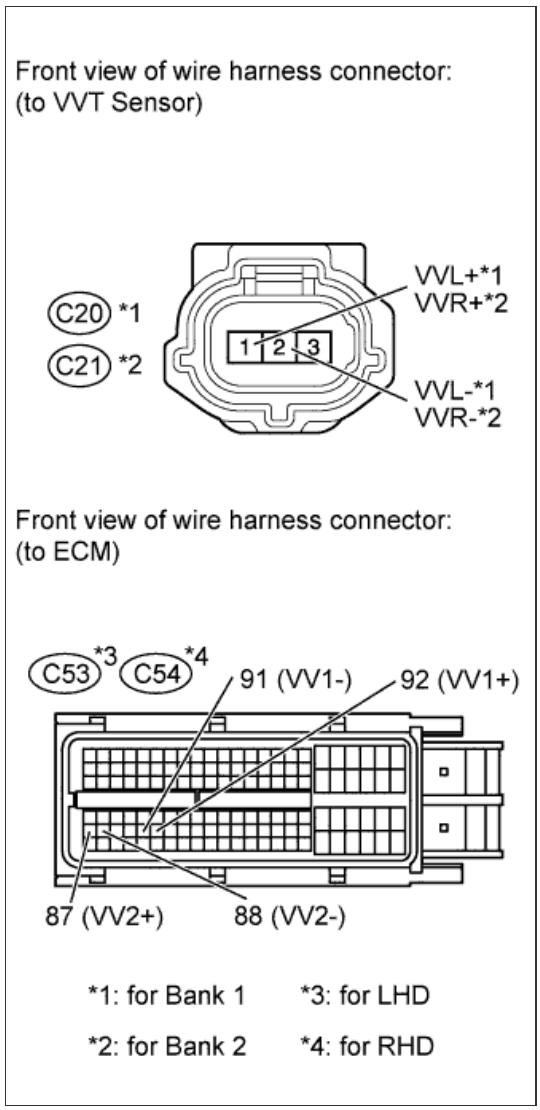
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

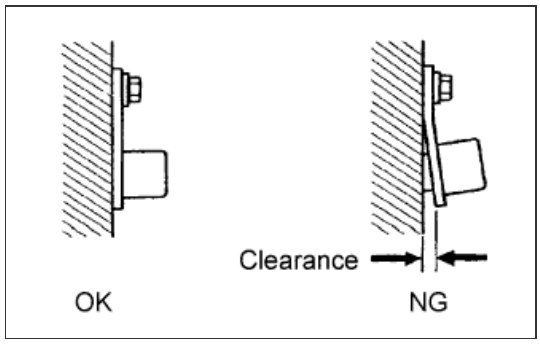
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

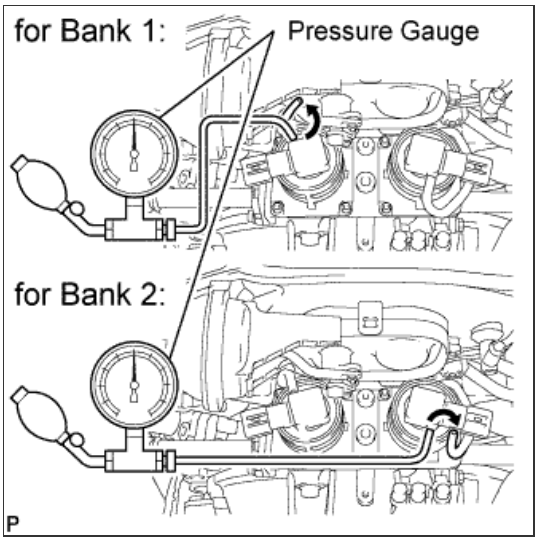
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

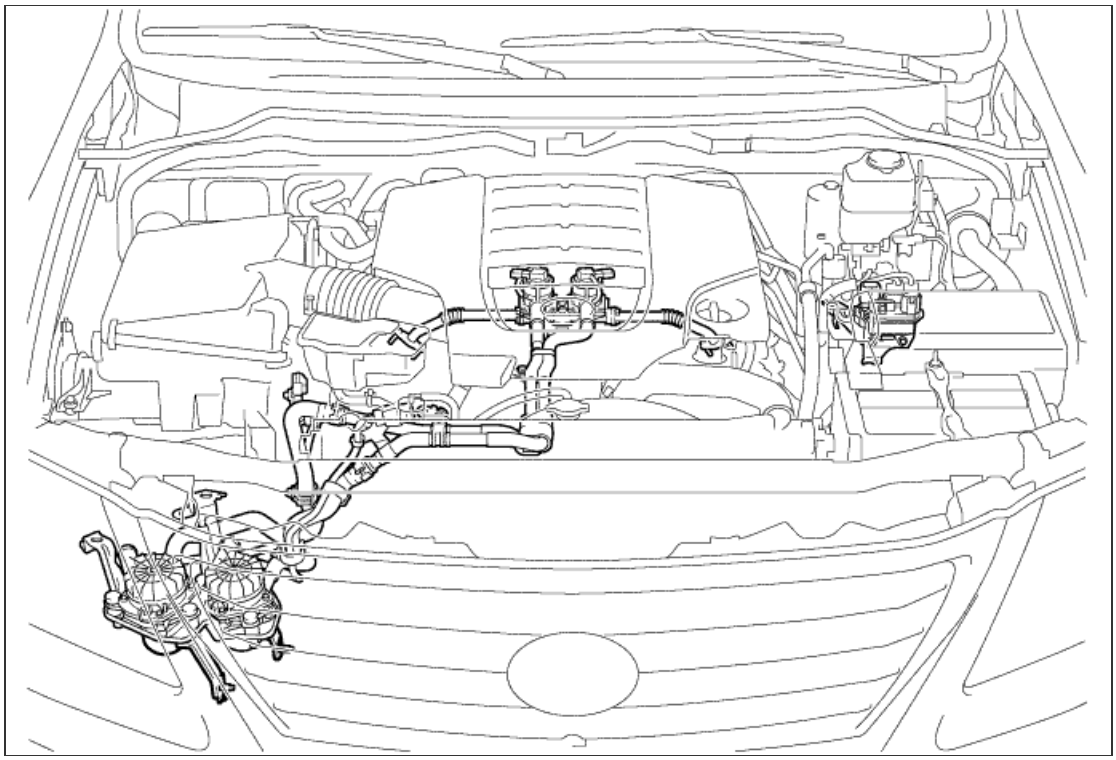
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

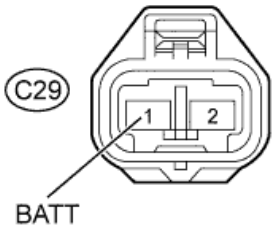
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

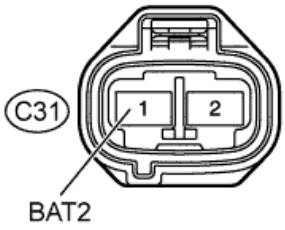
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

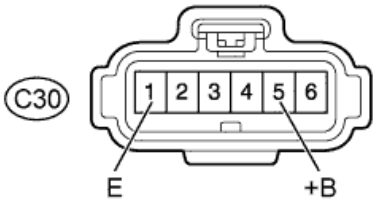
Front view of wire harness connector:
(to AID for Bank 1)



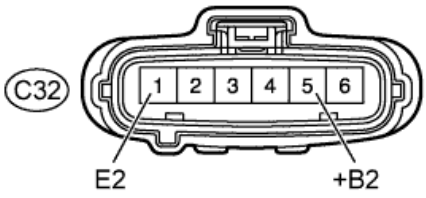
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

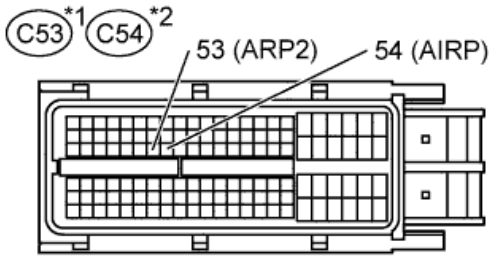
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

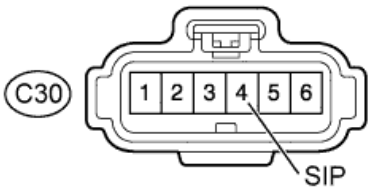
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

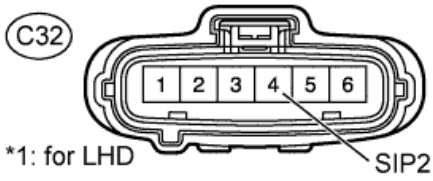
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

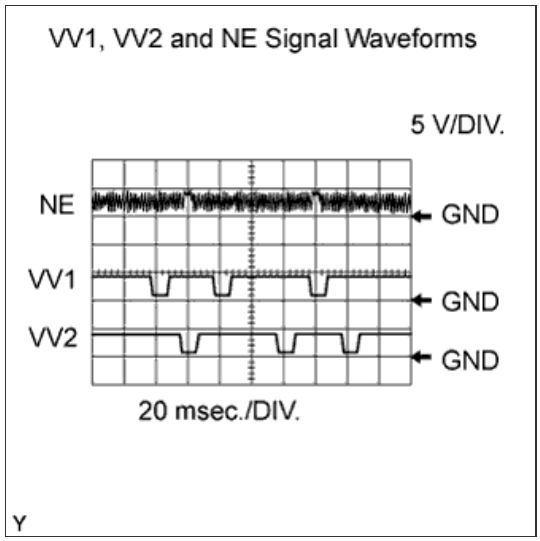
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

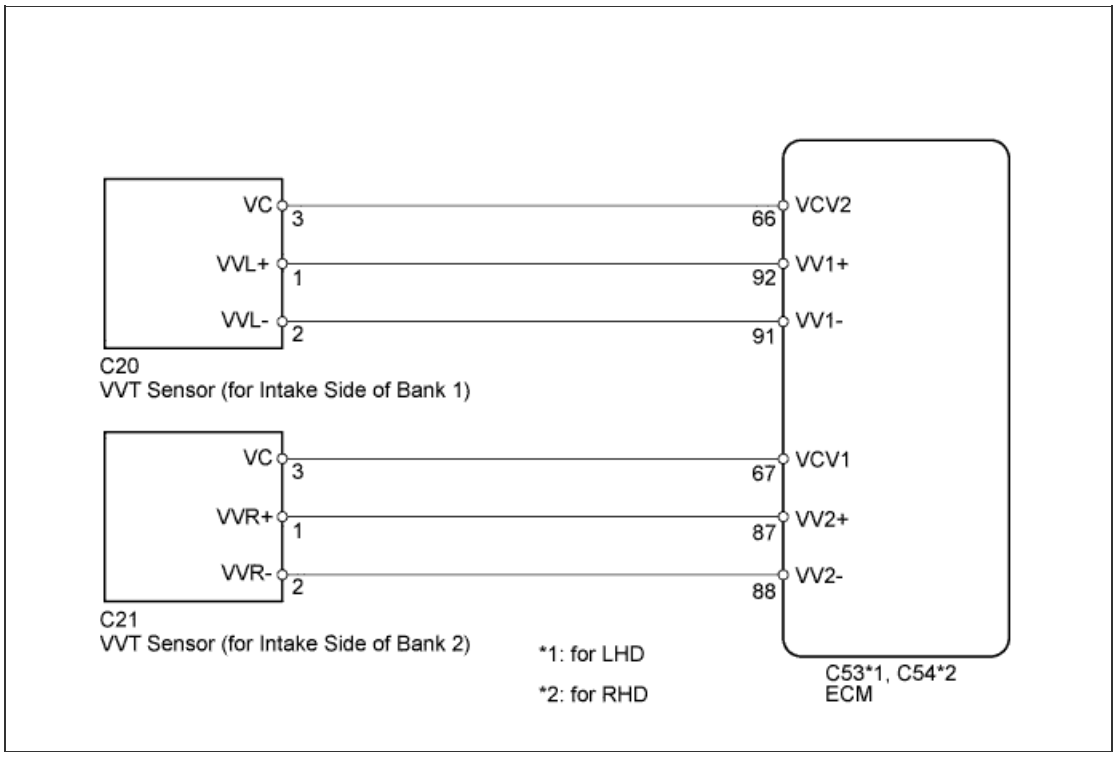
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

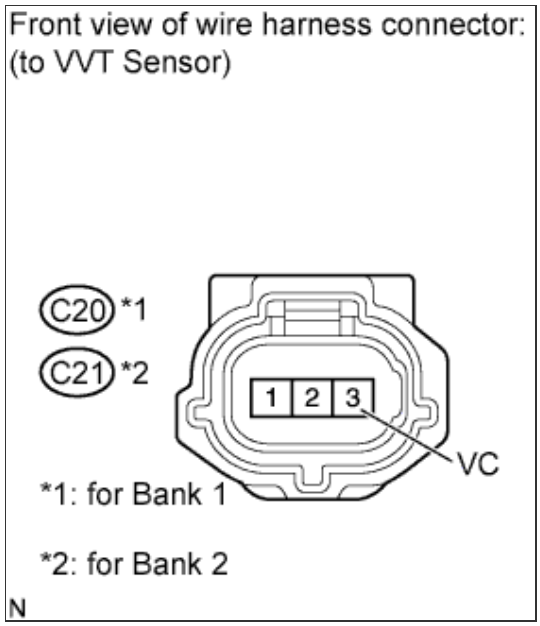
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

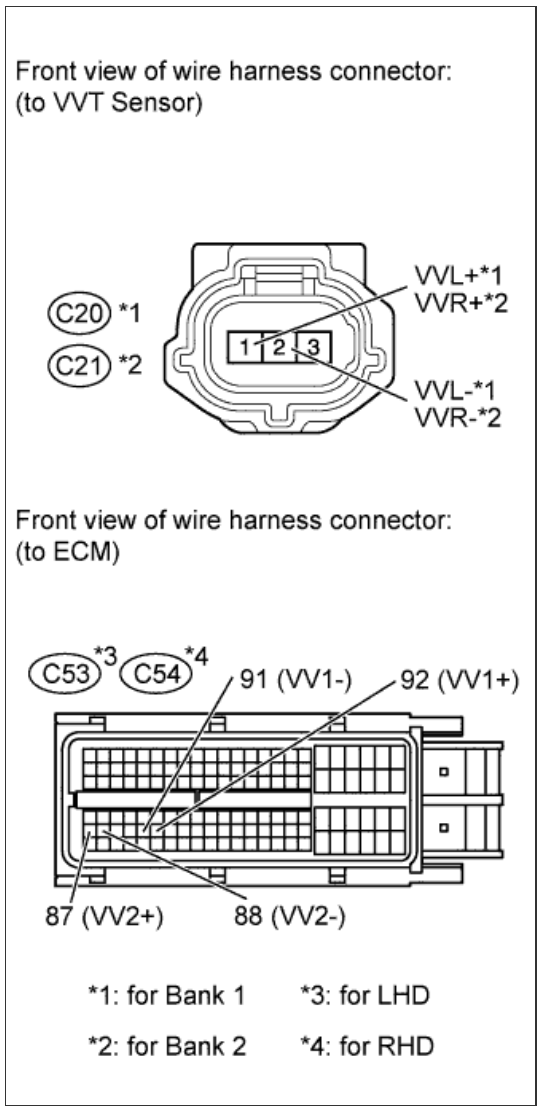
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

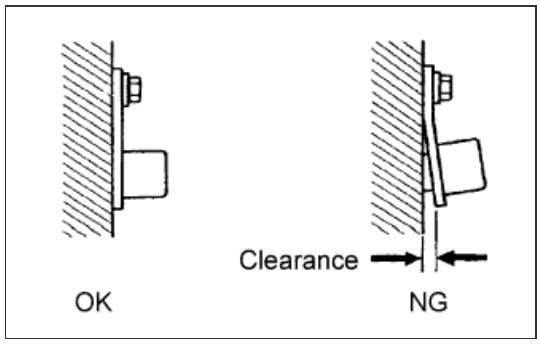
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

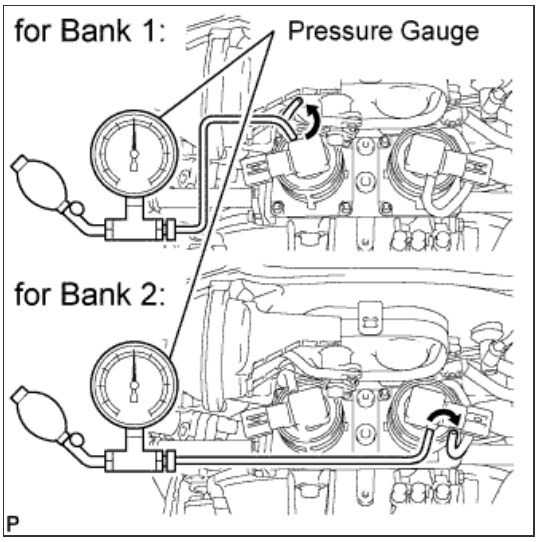
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

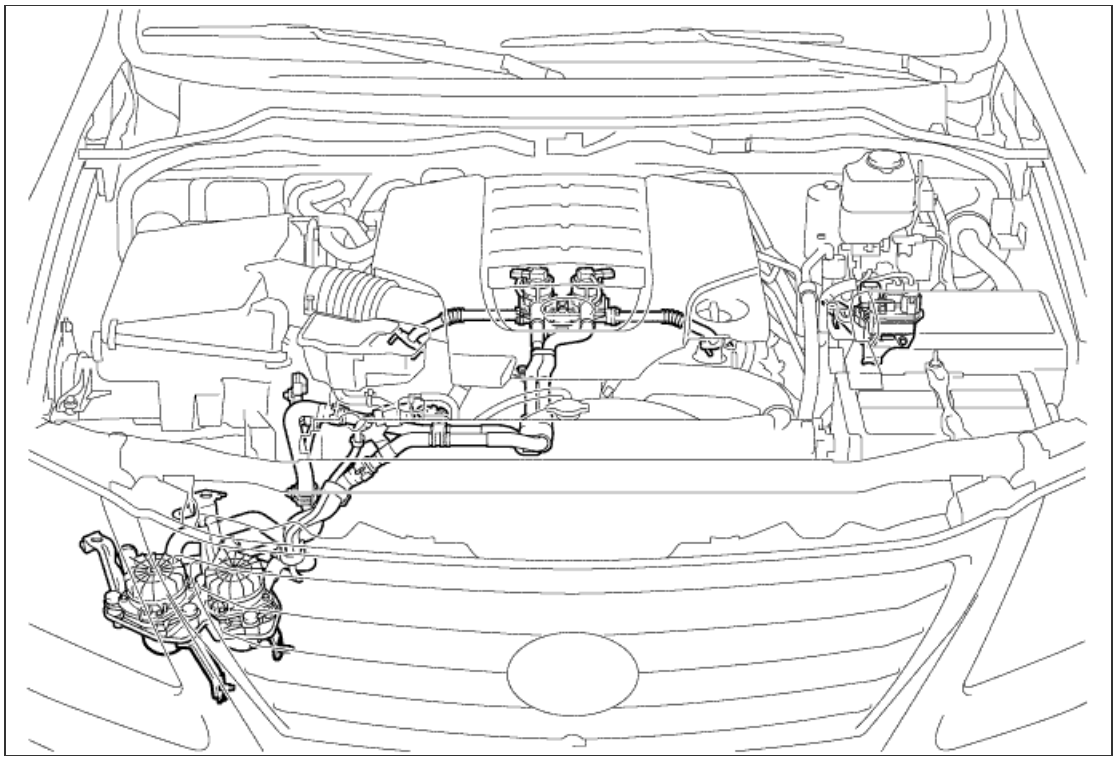
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

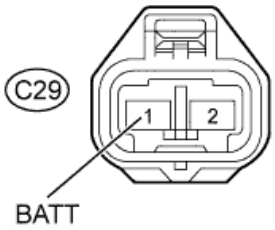
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

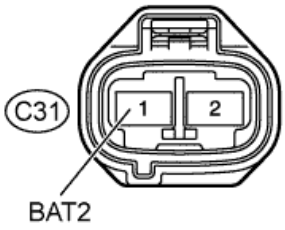
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

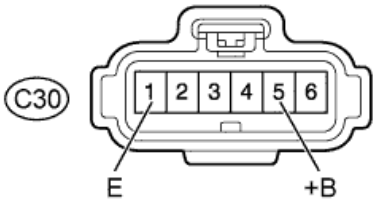
Front view of wire harness connector:
(to AID for Bank 1)



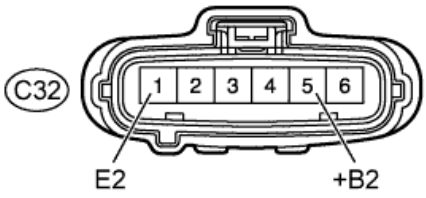
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

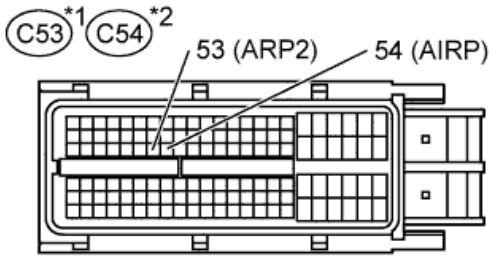
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

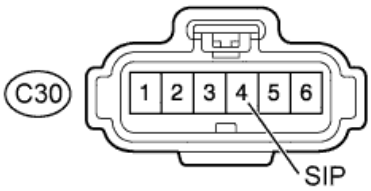
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

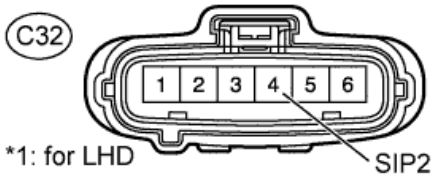
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

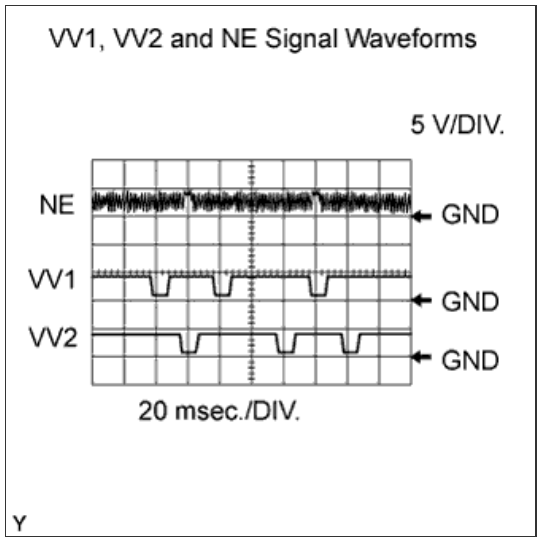
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

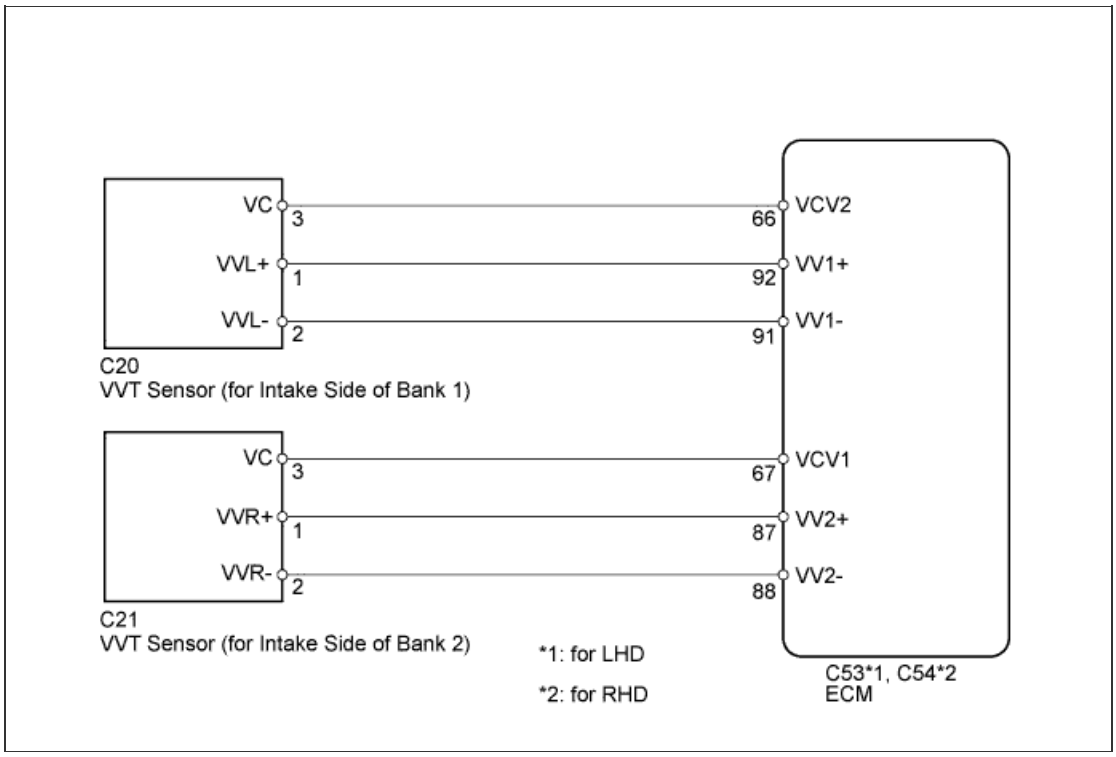
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

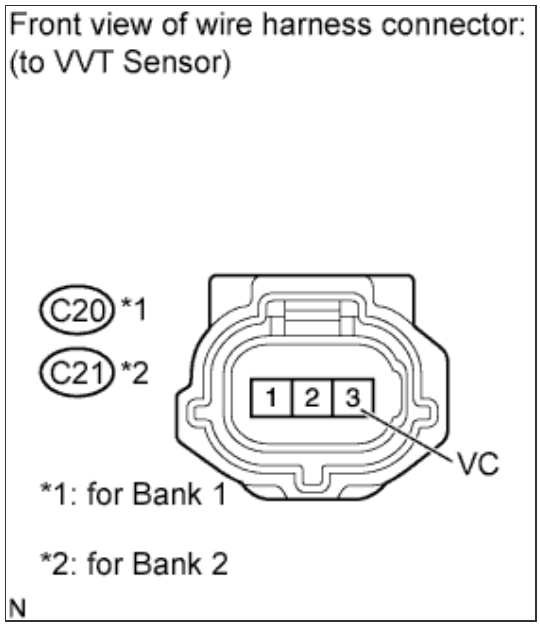
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

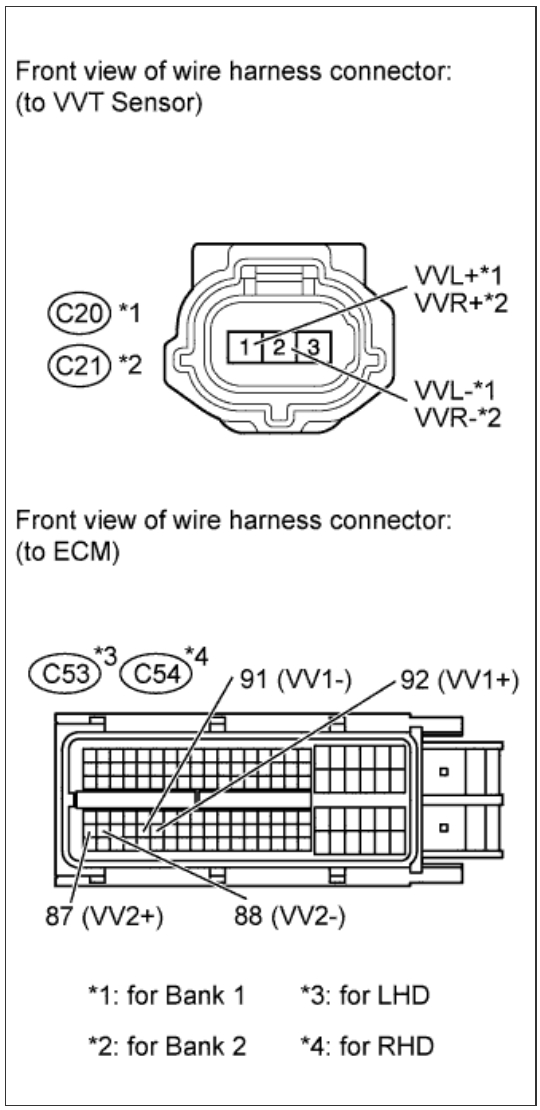
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

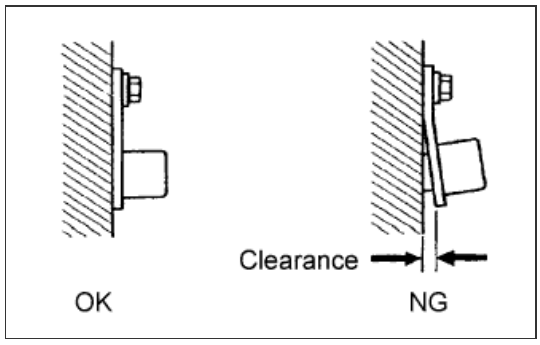
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

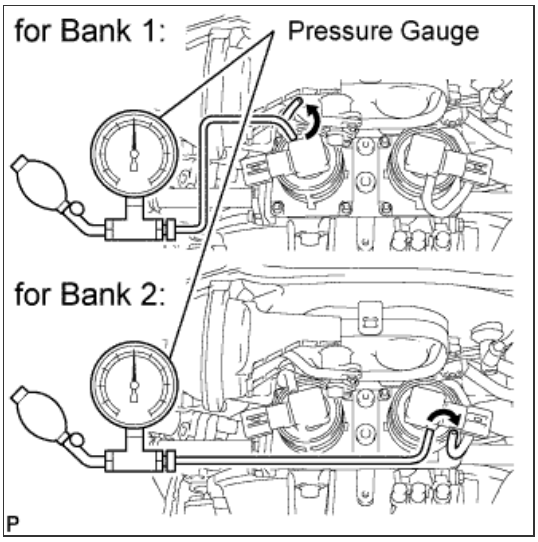
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

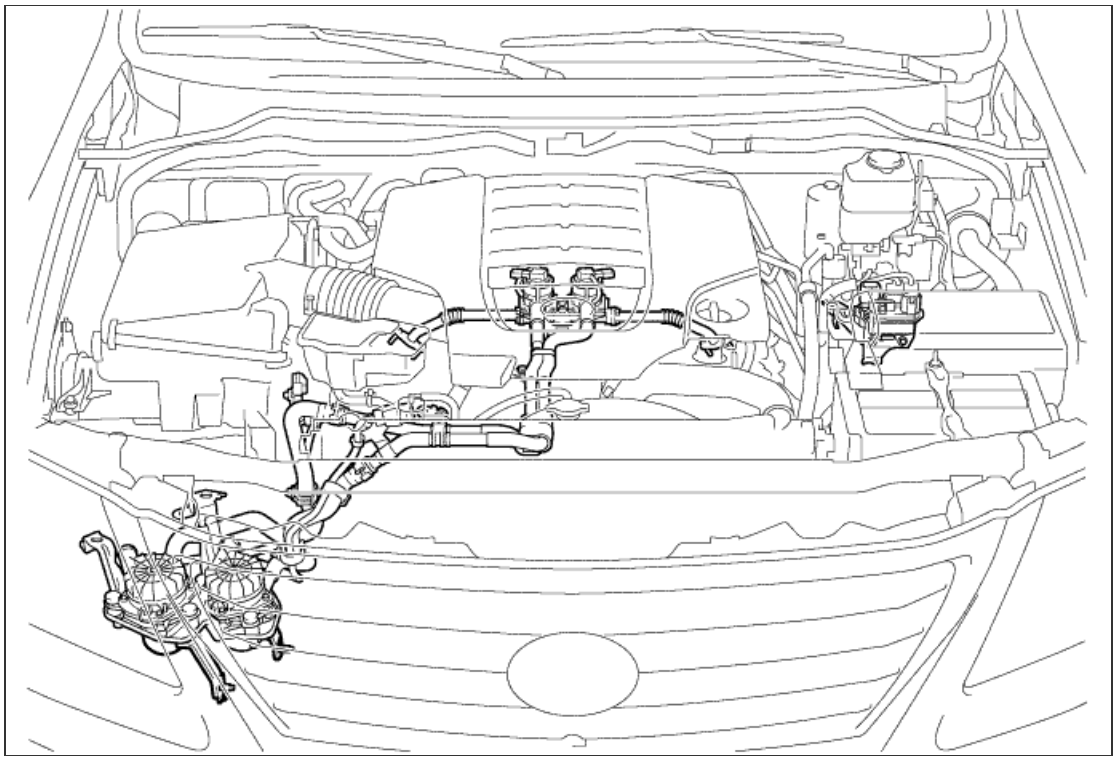
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

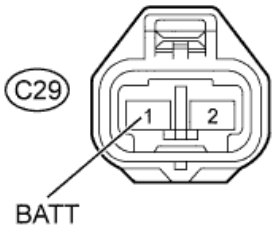
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

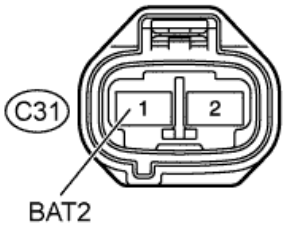
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

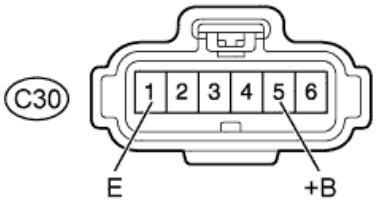
Front view of wire harness connector:
(to AID for Bank 1)



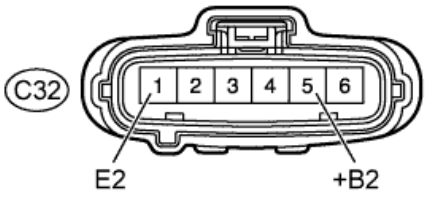
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

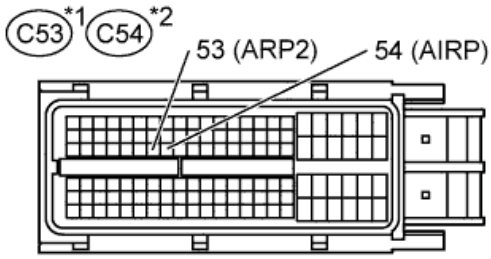
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

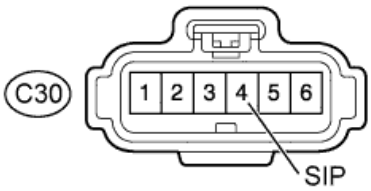
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

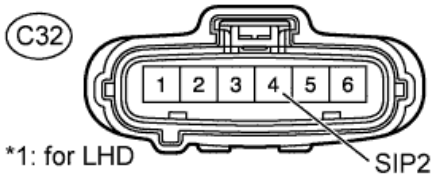
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

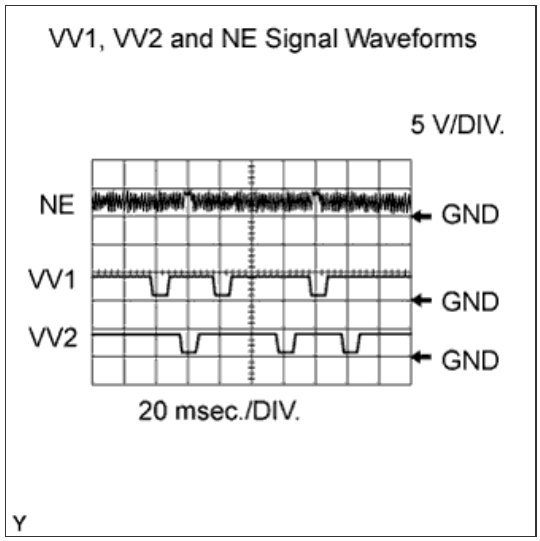
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

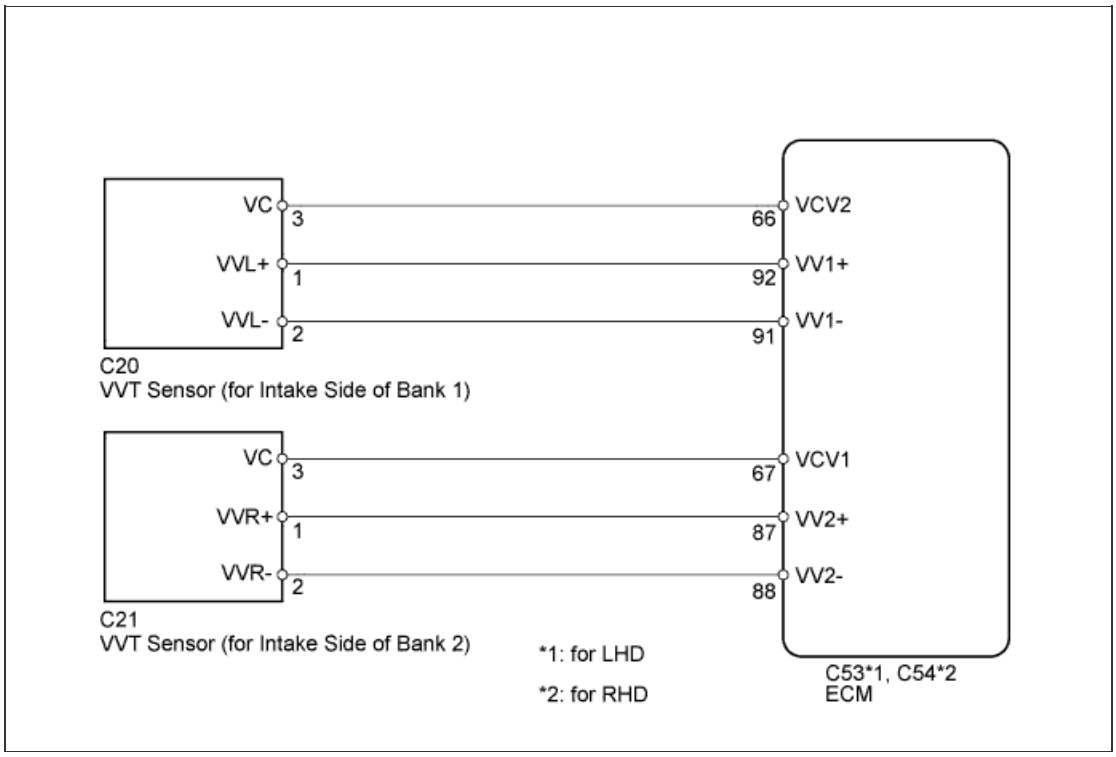
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

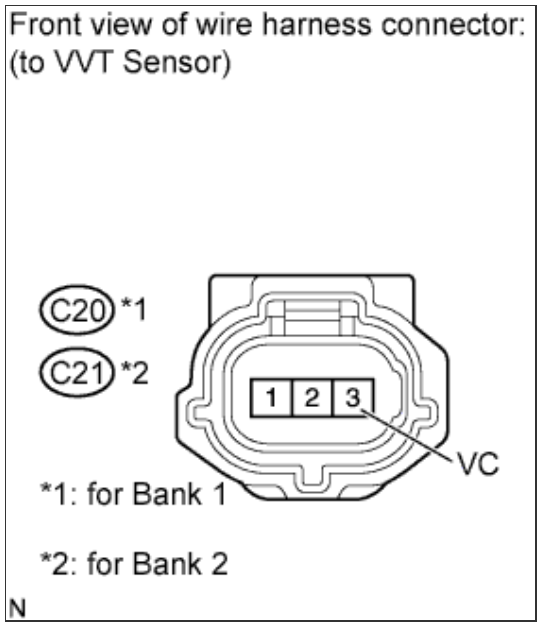
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

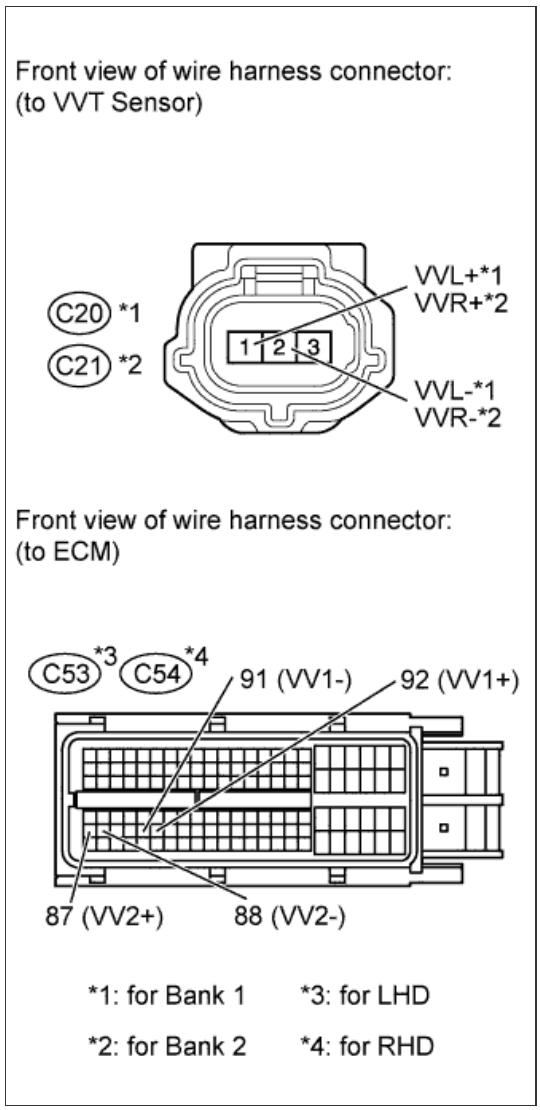
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

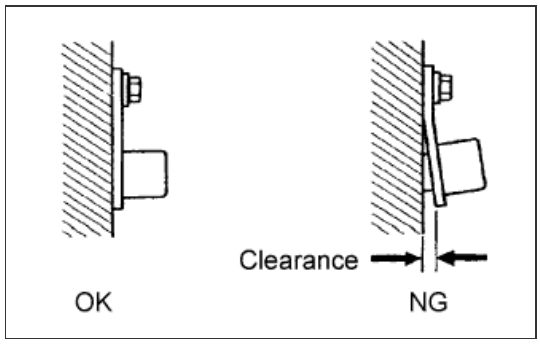
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2444 Secondary Air Injection System Pump Stuck On Bank1

DTC P2445 Secondary Air Injection System Pump Stuck Off Bank1

DTC P2446 Secondary Air Injection System Pump Stuck On Bank 2

DTC P2447 Secondary Air Injection System Pump Stuck Off Bank 2

for Preparation Click here

DESCRIPTION

Refer to P2440 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2444 P2446	The secondary air pressure is higher than 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn off (2 trip detection logic).	• Short in air pump circuit • Open or short in pressure sensor circuit • Pressure sensor • Air Injection Control Driver (AID) • ECM
P2445 P2447	The secondary air pressure is below 2.4 kPa (18 mmHg) despite the ECM commanding the air pump to turn on (2 trip detection logic).	• Air pump • Open in air pump circuit • Air injection system piping • Vacuum hose (pressure sensor - air switching valve) • Pressure sensor • Open or short in pressure sensor circuit • Air Injection Control Driver (AID) • ECM

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor located on the Air Switching Valve (ASV) of the Secondary Air Injection (AIR) system. The sensor measures the pressure in the secondary air passage and transmits a signal to the ECM.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the AIR system, illuminates the MIL and stores DTC(s):

- The pressure indicated by the pressure sensor does not reach threshold levels despite the ECM turning on the air pump.
- The pressure indicated by the pressure sensor exceeds threshold levels despite the ECM turning off the air pump.

WIRING DIAGRAM

Refer to DTC P0412 (Click here).

INSPECTION PROCEDURE

HINT:

Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and stores DTC(s). Soon after a cold engine start, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.

The following 8 patterns are AIR system pressure conditions in the AIR system passage.

Pressure Condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 5:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 6:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation detected

Pressure Condition in Secondary Air Injection System Case 7:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.4 kPa or higher
Pulsation Detection	Exhaust gas pulsation not detected

Pressure Condition in Secondary Air Injection System Case 8:

Air Pump	OFF
Air Switching Valve	Close
Pressure	Below 2.4 kPa
Pulsation Detection	Exhaust gas pulsation not detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.

HINT:

The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

HINT:

- **In case 3 and 7, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).**
- **In case 1, the average pressure is approximately 3 to 11 kPa. The value of 2.4 kPa indicated in the table above is a threshold for detecting pump malfunctions.**

Detected Conditions while AIR Operating: Air Pump ON, ASV Open	Detected Conditions while AIR not Operating: Air Pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 8	Normal	-
Case 1	Case 6	ASV stuck open	P2440 or P2442
Case 1	Case 7	Air pump stuck ON	P2444 or P2446
			P2445

Case 2	Case 8	Air pump stuck OFF	or P2447
Case 3	Case 8	ASV stuck closed	P2441 or P2443
Case 1	Case 5	ASV stuck open and air pump stuck ON	P2440 and P2444 or P2442 and P2446
Case 2	Case 6	ASV stuck open and air pump stuck OFF	P2440 and P2445 or P2442 and P2447
Case 3	Case 7	ASV stuck closed and air pump stuck ON	P2441 and P2444 or P2443 and P2446
Case 4	Case 8	ASV stuck closed and air pump stuck OFF	P2441 and P2445 or P2443 and P2447

HINT:

- **If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.**
- **By using the intelligent tester to perform the Secondary Air Injection Check operation in the Utility, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, Pending Codes also can be checked by performing Utility / Secondary Air Injection Check / Automatic Mode after the repair.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

System Check:
The pressure in the secondary air passage can be checked using the intelligent tester.

1. Start the engine and warm it up.
2. Turn the engine switch off.
3. Connect the tester to the DLC3.
4. Turn the engine switch on (IG) and turn the tester on.
5. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1 CLOSE, AIR PUMP 2: OFF, ASV2 CLOSE.

   HINT:

   When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

6. Start the engine.
7. Perform the AIR system intrusive operation while the engine is idling.
8. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester indicate the conditions shown in the table below.

   Standard:

Operations	AIR PUMP	ASV	PRESSURE*1	PULSATION*2
AIR PUMP: ON, ASV: OPEN	ON	OPEN	2.4 kPa or higher	20 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	CLOSE	Below 2.4 kPa	Below 30 kPa

   *1:
   Average pumping pressure (gauge pressure). The pressure should be 2.4 kPa or higher when the AIR system operates.
   *2:
   The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
9. Turn the engine switch off.

   NOTICE:

   - **This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds.**
     Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
     While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
     If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
   - **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system**

from overheating.

- When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.
- Turn the engine switch off when the Secondary Air Injection Check operation finishes.

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2444, P2445, P2446 AND/OR P2447)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Read DTCs.

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
P2444, P2445, P2446 and/or P2447 and P0418 and/or P0419 are output	B
P2444, P2445, P2446 and/or P2447 and other DTCs (except P0418 and P0419) are output	C

If any DTCs other than P0418, P0419, P2444, P2445, P2446 and/or P2447 are output, troubleshoot those DTCs first.

B → GO TO AIR PUMP INSPECTION PROCEDURE (Click here)

C → GO TO DTC CHART (Click here)

A

2.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (SECONDARY AIR INJECTION SYSTEM OPERATION)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Manual Mode / AIR PUMP 1: ON, ASV1: OPEN, AIR PUMP 2: ON, ASV2: OPEN and AIR PUMP 1: OFF, ASV1: CLOSE, AIR PUMP 2: OFF, ASV2: CLOSE.

HINT:

When Manual Mode is selected, the intelligent tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AIR PUMP and ASV operation can be selected.

f. Start the engine.

g. Perform the AIR system intrusive operation while the engine is idling.

h. Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) status displayed on the tester indicate the conditions shown in the table below.

Standard:

Operation	AIR PUMP	ASV	PRESSURE*
AIR PUMP: ON, ASV: OPEN	ON	ON	2.4 kPa or higher
AIR PUMP: OFF, ASV: CLOSE	OFF	OFF	Below 2.4 kPa

*: Average pumping pressure. The pressure should be 2.4 kPa or higher when the AIR system operates.

i. Turn the engine switch off.

NOTICE:

- This Secondary Air Injection Check only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).

If an ERROR is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.

- **Performing the Secondary Air Injection Check repeatedly may cause damage to the AIR system. If necessary, leave an interval of several minutes between system check operations to prevent the system from overheating.**
- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → **Go to step 4**

OK

3.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2247)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the Secondary Air Injection Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

Result

Result	Proceed to
P2444, P2445, P2446 and/or P2447 are output	A
No pending DTC is output	B

B → **CHECK FOR INTERMITTENT PROBLEMS (Click here)**

A

4.CHECK VACUUM HOSES (PRESSURE SENSOR - AIR SWITCHING VALVE)

a. Check the vacuum hose connections with the pressure sensor and ASV.

b. Inspect the vacuum hose for blockages and damage.

OK:

Vacuum hose has no blockages or damage.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

5.INSPECT AIR SWITCHING VALVE (PRESSURE SENSOR)

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Air pump pressure (absolute) and Air Pump2 Pressure (Absolute).

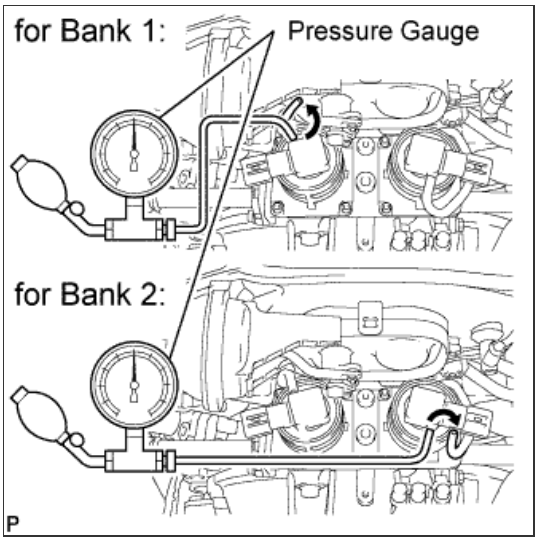
e. Check that the pressure displayed on the tester fluctuates when applying the pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

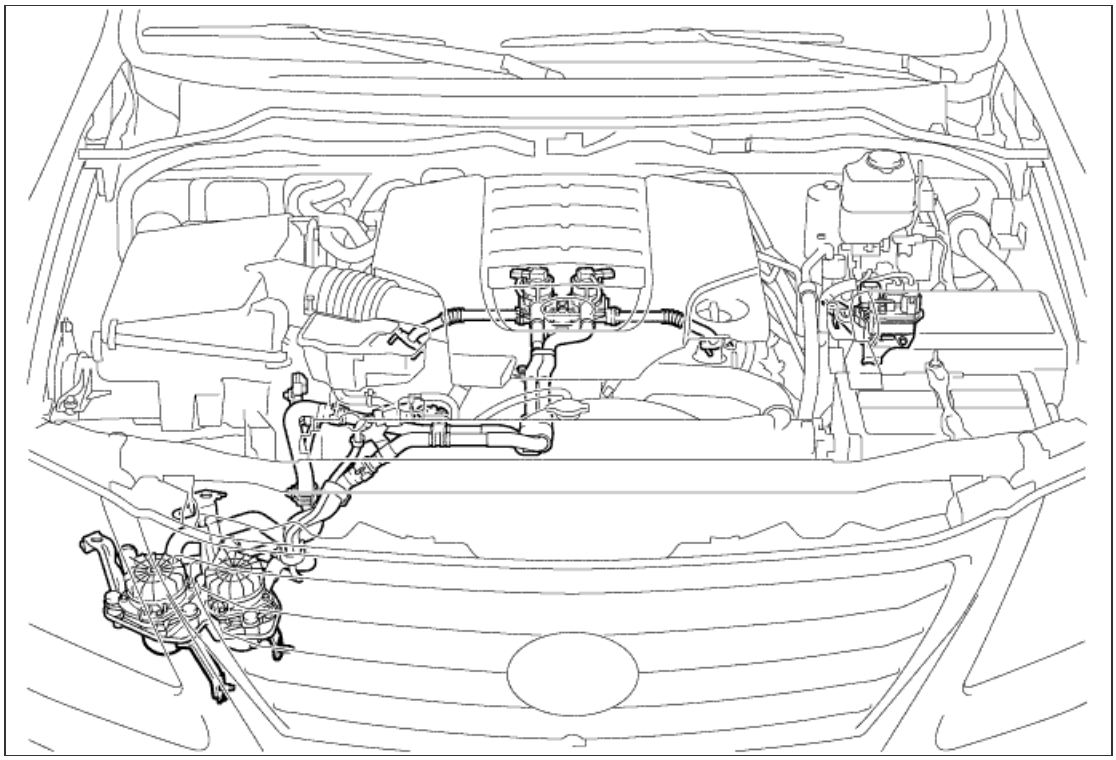
The tester displays the air pump pressure as absolute pressure.



NG → REPLACE AIR SWITCHING VALVE (Click here)

OK

6.CHECK AIR INJECTION SYSTEM PIPE CONNECTIONS



a. Check that all the pipes and hoses between the air pump and ASV are securely connected.

b. Inspect the pipes and hoses for blockages and damage.

OK:

AIR system piping has no blockages or damage.

NG → REPAIR OR REPLACE AIR INJECTION SYSTEM PIPING

OK

7.INSPECT AIR PUMP

a. Disconnect the C33 or C34 air pump connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 1	20°C (68°F)	0.44 to 1 Ω

If the result is not as specified, replace the air pump.

HINT:

To check the air pump operation, use the Secondary Air Injection Check function described in the Utility.

Component without harness connected:
(Air Pump)



NG → REPLACE AIR PUMP (Click here)

OK

8.INSPECT AIR INJECTION CONTROL DRIVER (AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT)

a. Disconnect the C29 and C30 or C31 and C32 air injection control driver (AID) connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

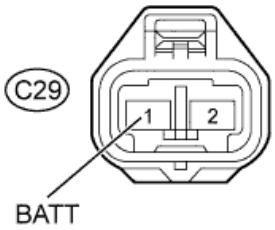
Tester Connection	Condition	Specified Condition
C30-1 (E) - Body ground	Always	Below 1 Ω
C32-1 (E2) - Body ground	Always	Below 1 Ω

c. Measure the voltage according to the value(s) in the table below.

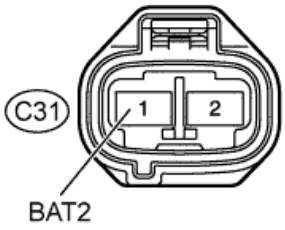
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C29-1 (BATT) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C30-5 (+B) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C31-1 (BAT2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)
C32-5 (+B2) - Body ground	Engine switch on (IG)	11 to 14 V (near battery voltage)

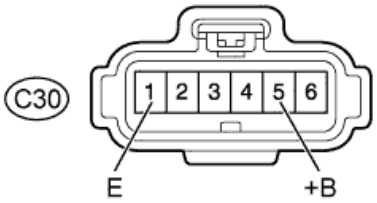
Front view of wire harness connector:
(to AID for Bank 1)



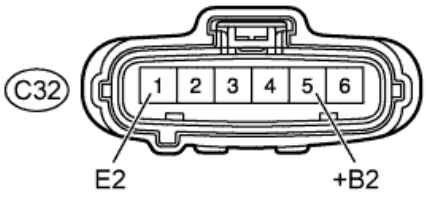
Front view of wire harness connector:
(to AID for Bank 2)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



NG → REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT

OK

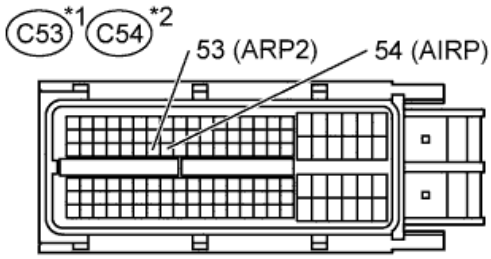
9.CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)

a. Disconnect the C53 or C54 ECM connector.

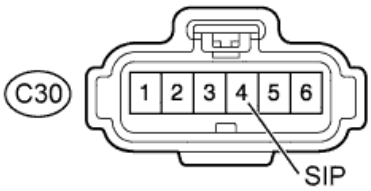
b. Disconnect the C30 or C32 AID connector.

c. Measure the resistance according to the value(s) in the table below.

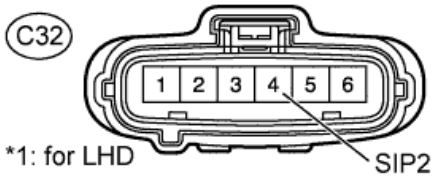
Front view of wire harness connector:
(to ECM)



Front view of wire harness connector:
(to AID for Bank 1)



Front view of wire harness connector:
(to AID for Bank 2)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C53-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-54 (AIRP) - C30-4 (SIP)	Always	Below 1 Ω
C54-53 (ARP2) - C32-4 (SIP2)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

10.REPLACE AIR INJECTION CONTROL DRIVER

a. Replace the air injection control driver (Click here).

NEXT

11.CHECK WHETHER DTC OUTPUT RECURS (DTC P2444, P2445, P2446 AND/OR P2447)

a. Start the engine and warm it up.

b. Turn the engine switch off.

c. Connect the intelligent tester to the DLC3.

d. Turn the engine switch on (IG) and turn the tester on.

e. Clear DTCs (if output) (Click here).

f. Enter the following menus: Powertrain / Engine and ECT / Utility / Secondary Air Injection Check / Automatic Mode.

g. Start the engine after the intelligent tester initialization is finished.

h. Perform the System Check operation by pressing Next.

i. After operating the AIR system, perform the following to confirm the AIR system pending codes: Press the Exit button.

j. Check pending DTCs.

k. Turn the engine switch off.

OK:
No pending DTC is output.

NOTICE:

- **When performing the Secondary Air Injection Check operation after the battery cable has been reconnected, wait for 7 minutes with the engine switch turned on (IG) or the engine running.**
- **Turn the engine switch off when the Secondary Air Injection Check operation finishes.**

NG → REPLACE ECM (Click here)

OK

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

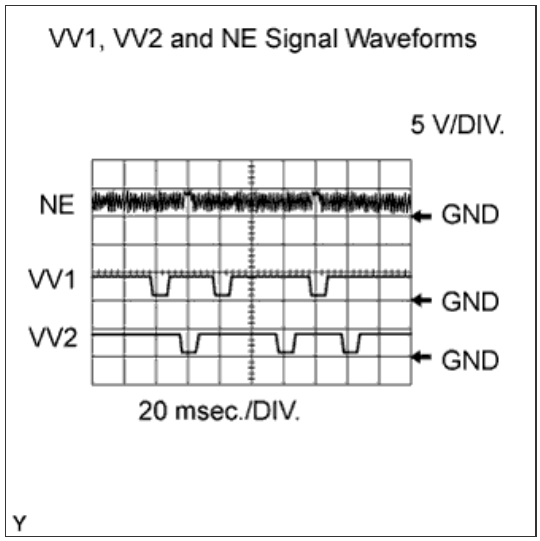
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

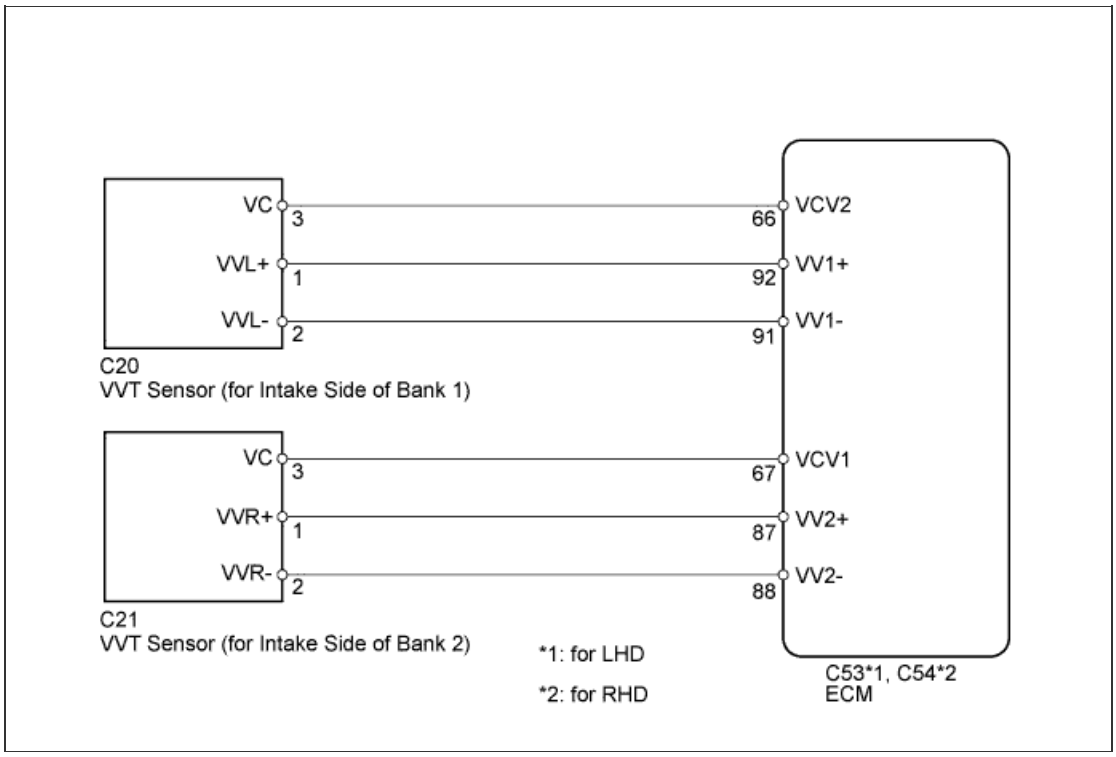
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

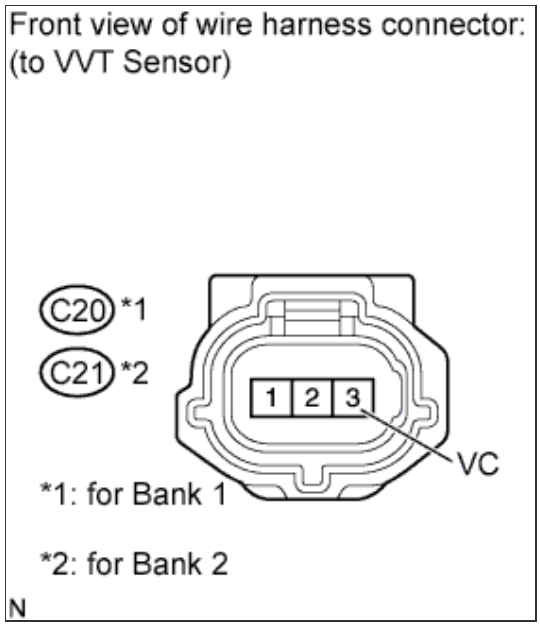
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

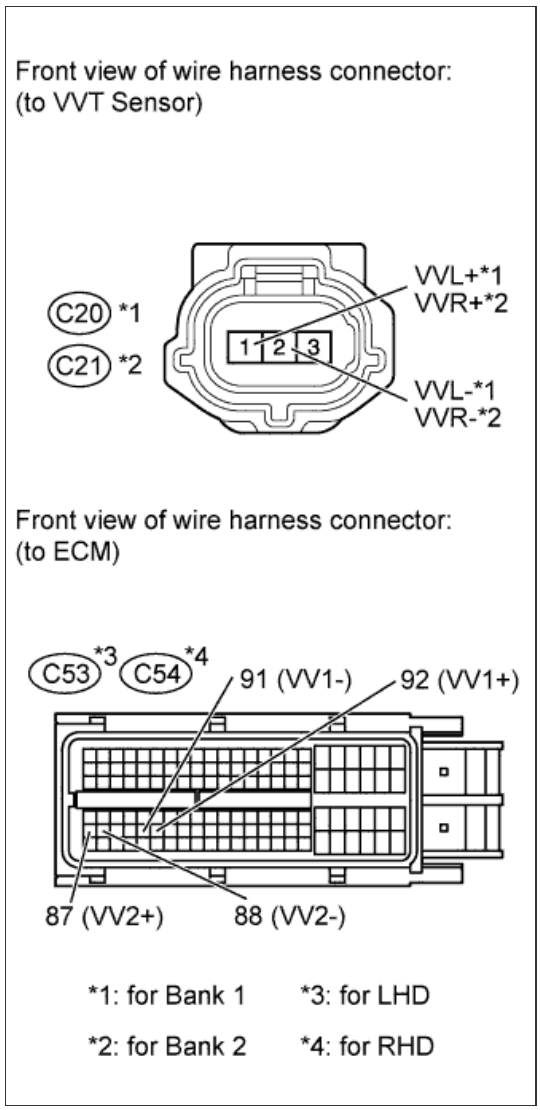
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

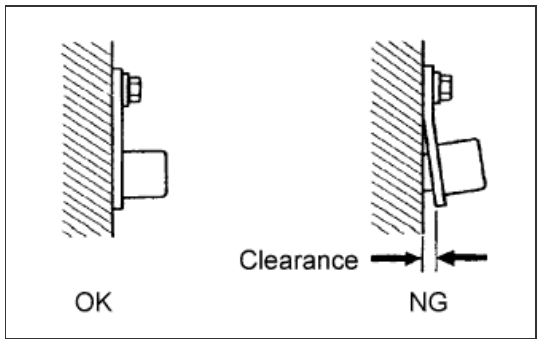
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2A00 A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC P2A03 A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)

for Preparation Click here

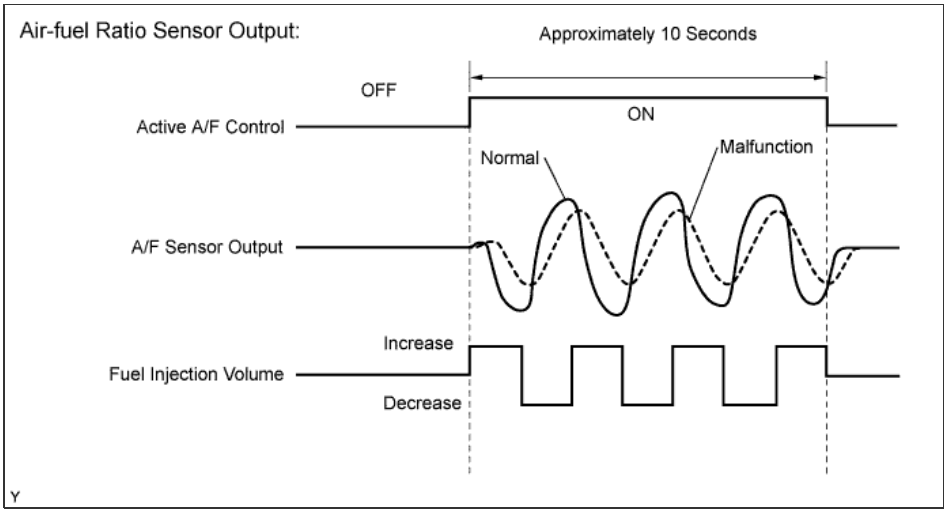
DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2A00	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in Air Fuel ratio (A/F) (for Bank 1) sensor circuit • A/F sensor (for Bank 1) • ECM
P2A03	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in A/F sensor (for Bank 2) circuit • A/F sensor (for Bank 2) • ECM

MONITOR DESCRIPTION

After the engine is warmed up, the ECM performs air-fuel ratio feedback control to maintain the air-fuel ratio at the stoichiometric level. In addition, active A/F control is performed for approximately 10 seconds after the preconditions are met in order to measure the A/F sensor response rate. During active A/F control, the ECM forcibly increases and decreases the injection volume a certain amount, based on the stoichiometric air-fuel ratio learned during normal air-fuel ratio control, and measures the A/F sensor response rate. The ECM receives a signal from the A/F sensor while performing active A/F control and uses it to calculate the A/F sensor response rate deterioration level.
If the A/F sensor response rate deterioration level is less than the threshold, the ECM interprets this as a malfunction and stores DTC(s).



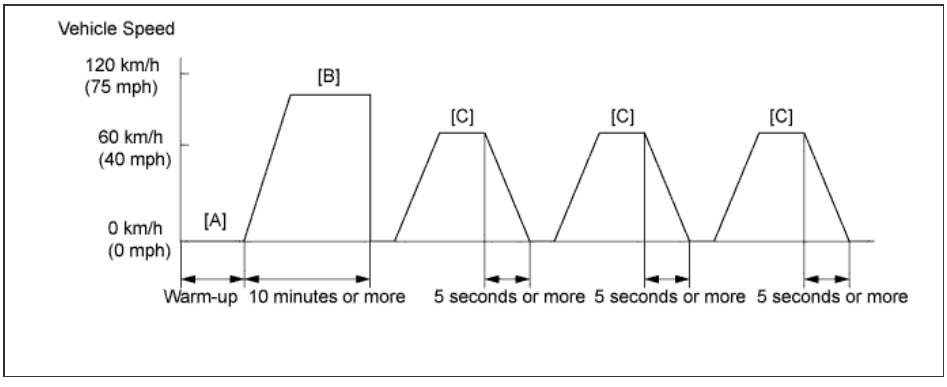
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].

6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2A00 and P2A03.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P2A00 and P2A03 are for Euro-OBD only.**
- **Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.**
- **The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.**

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

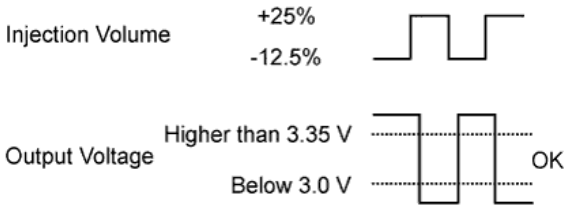
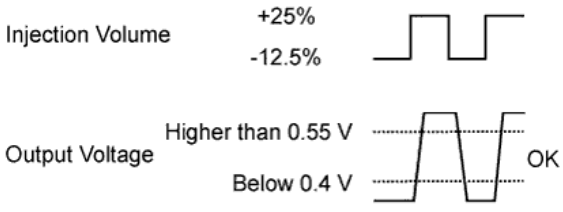
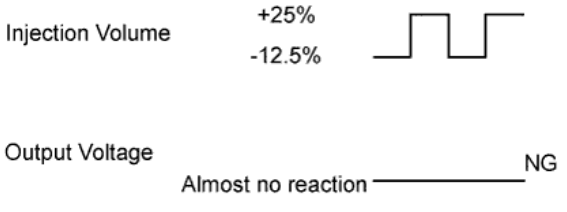
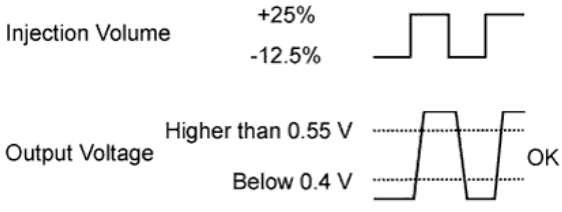
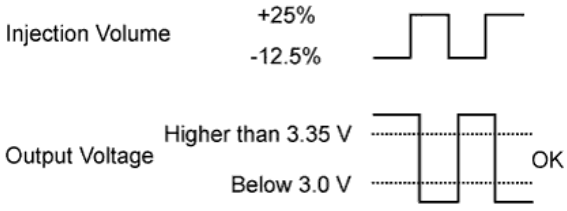
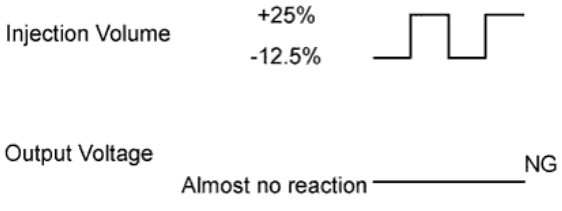
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
			• Fuel

4	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	• injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 indicates malfunctions related to the bank 1 A/F sensor.**
- **DTC P2A03 indicates malfunctions related to the bank 2 A/F sensor.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**
- **DTC P2A00 or P2A03 may be stored when the air-fuel ratio is stuck rich or lean.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 are output	A
P2A00 and/or P2A03 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

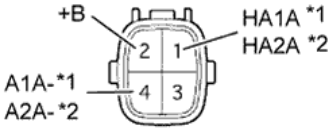
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected: (A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

3.CHECK HARNESS AND CONNECTOR (ECM - AIR FUEL RATIO SENSOR)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

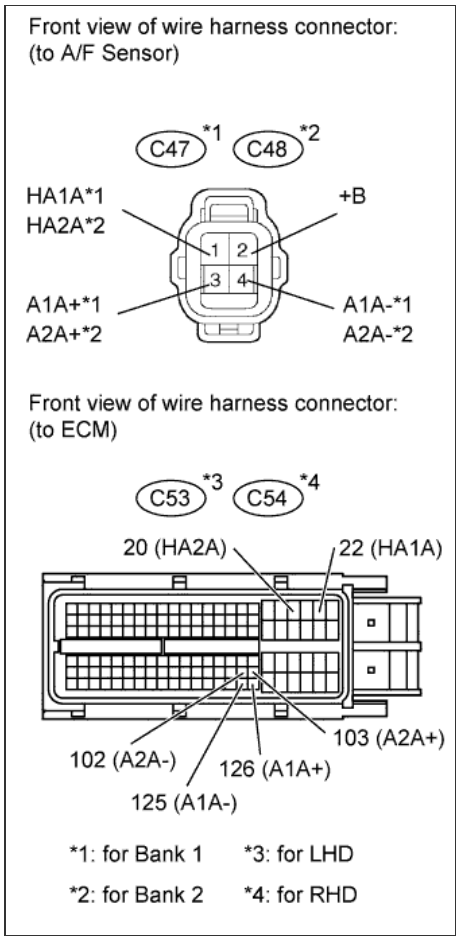
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

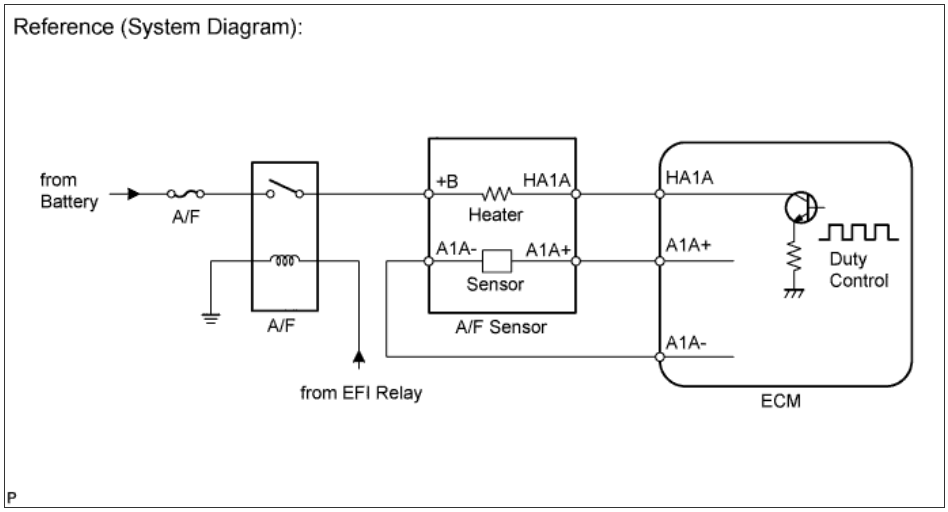
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher

C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 is output	A
No DTC is output	B

B → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2A00 and/or P2A03 are output	B

B → REPLACE ECM (Click here)

A

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

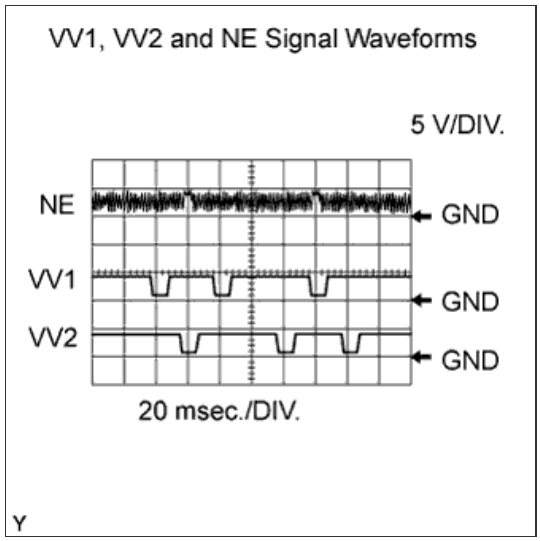
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

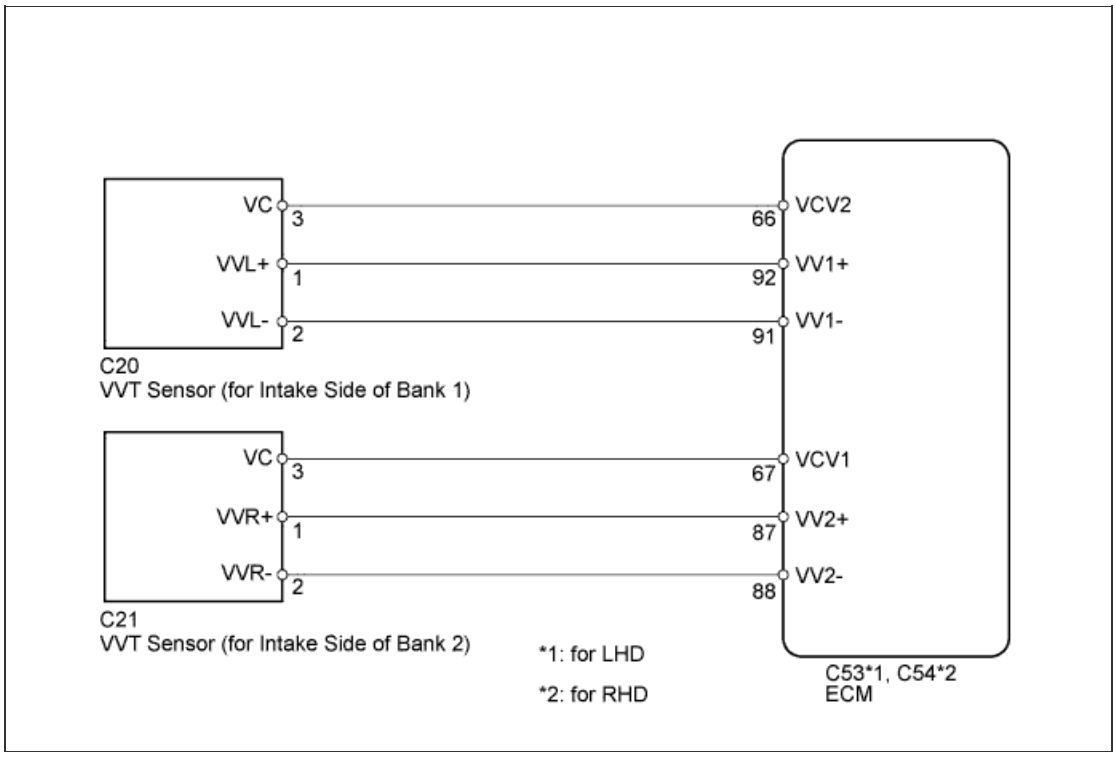
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

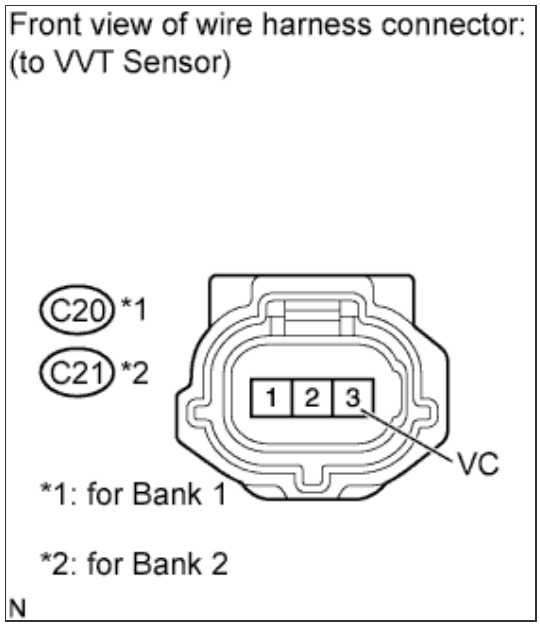
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

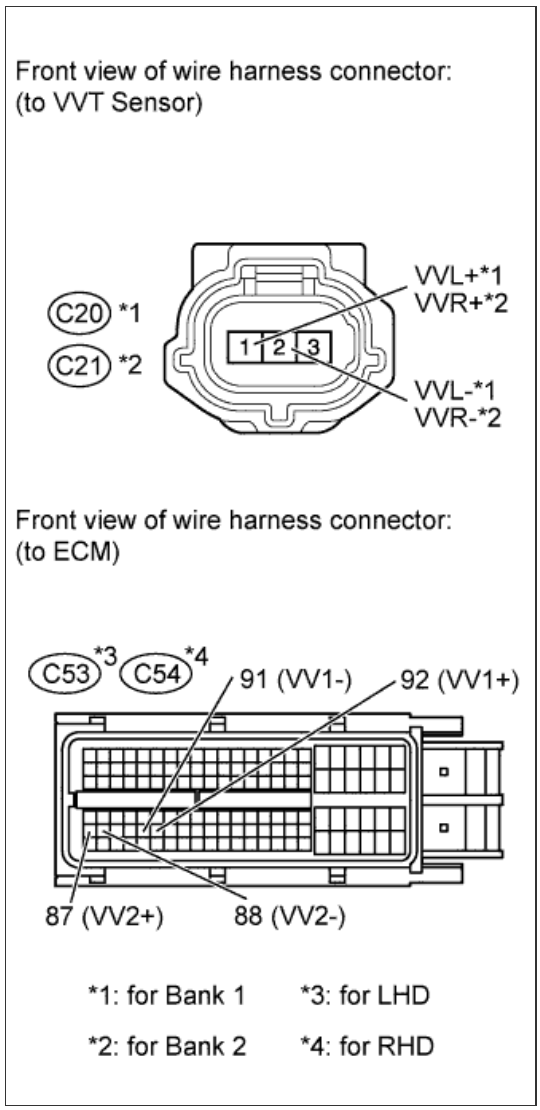
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

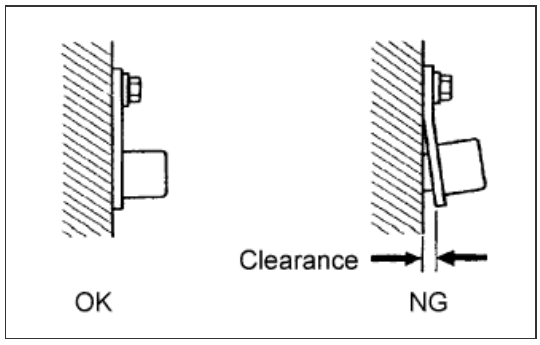
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2A00 A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC P2A03 A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)

for Preparation Click here

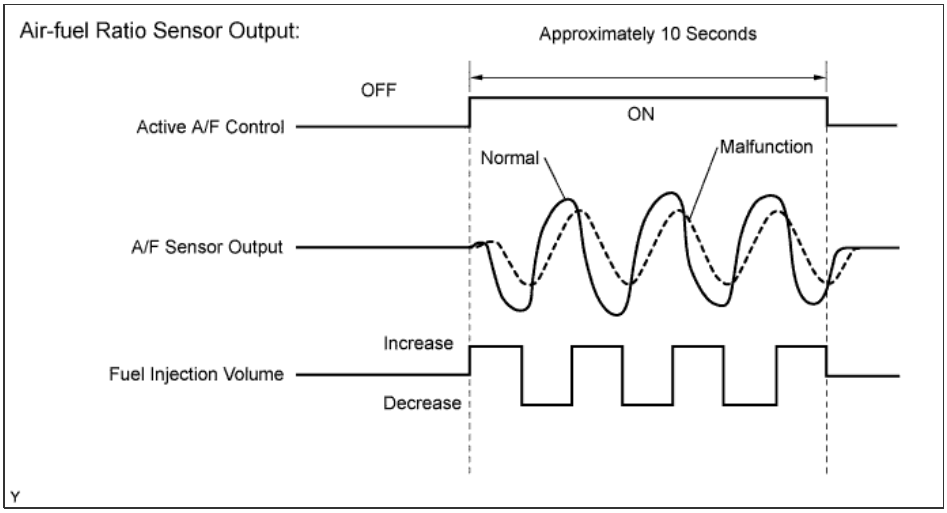
DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2A00	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in Air Fuel ratio (A/F) (for Bank 1) sensor circuit • A/F sensor (for Bank 1) • ECM
P2A03	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in A/F sensor (for Bank 2) circuit • A/F sensor (for Bank 2) • ECM

MONITOR DESCRIPTION

After the engine is warmed up, the ECM performs air-fuel ratio feedback control to maintain the air-fuel ratio at the stoichiometric level. In addition, active A/F control is performed for approximately 10 seconds after the preconditions are met in order to measure the A/F sensor response rate. During active A/F control, the ECM forcibly increases and decreases the injection volume a certain amount, based on the stoichiometric air-fuel ratio learned during normal air-fuel ratio control, and measures the A/F sensor response rate. The ECM receives a signal from the A/F sensor while performing active A/F control and uses it to calculate the A/F sensor response rate deterioration level.
If the A/F sensor response rate deterioration level is less than the threshold, the ECM interprets this as a malfunction and stores DTC(s).



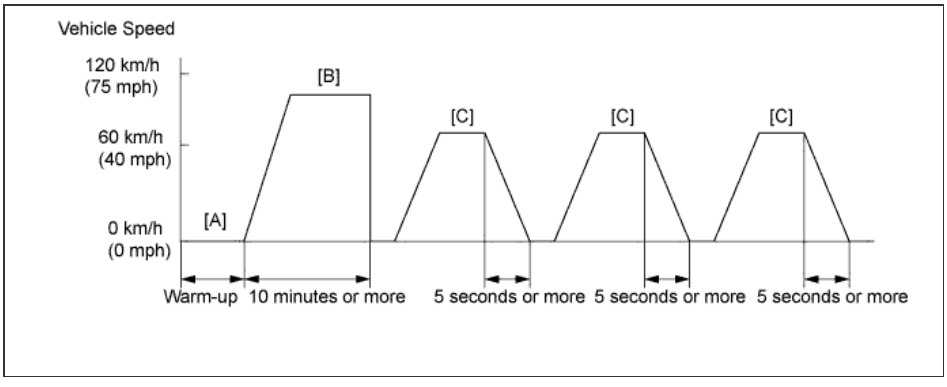
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].

6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2A00 and P2A03.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P2A00 and P2A03 are for Euro-OBD only.**
- **Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.**
- **The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.**

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

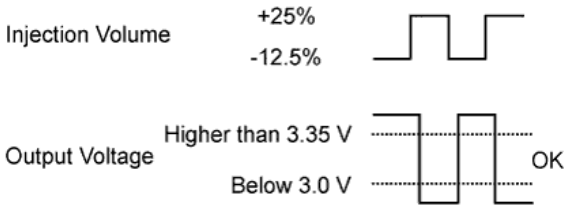
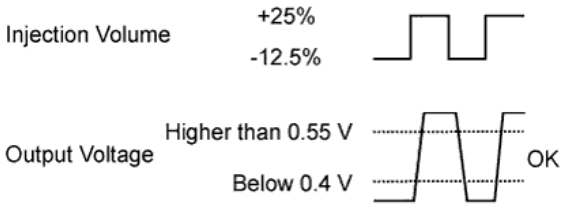
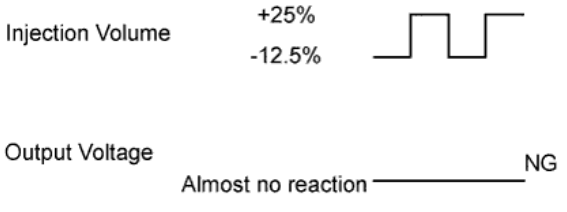
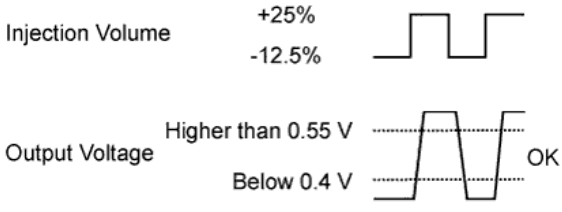
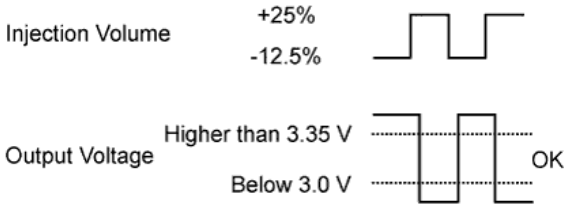
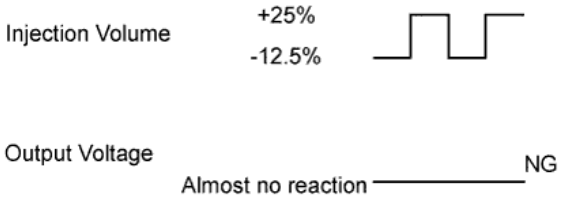
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
			• Fuel

4	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	• injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 indicates malfunctions related to the bank 1 A/F sensor.**
- **DTC P2A03 indicates malfunctions related to the bank 2 A/F sensor.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**
- **DTC P2A00 or P2A03 may be stored when the air-fuel ratio is stuck rich or lean.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 are output	A
P2A00 and/or P2A03 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

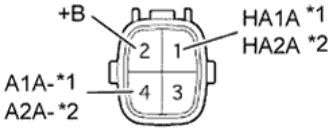
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected: (A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

3.CHECK HARNESS AND CONNECTOR (ECM - AIR FUEL RATIO SENSOR)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

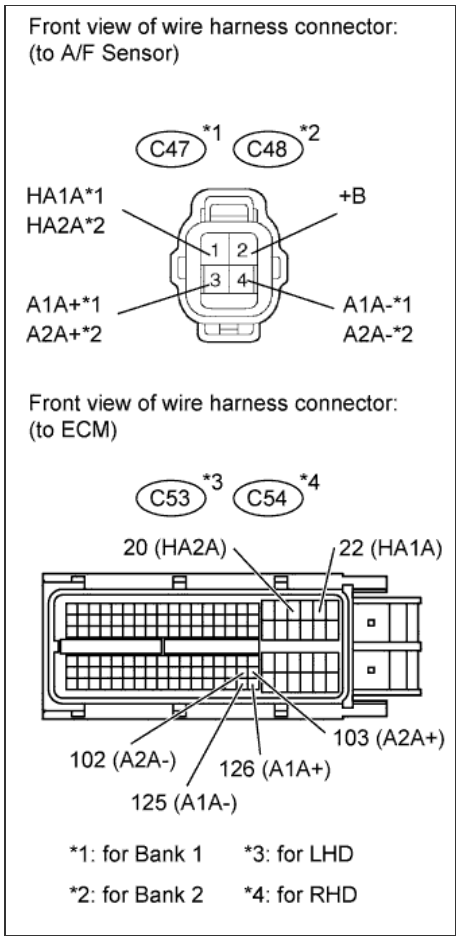
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

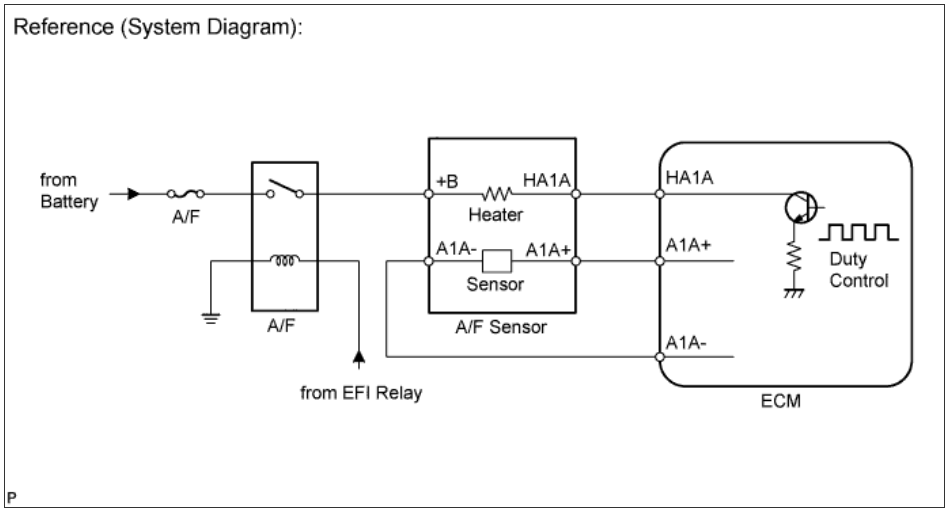
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher

C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 is output	A
No DTC is output	B

B → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2A00 and/or P2A03 are output	B

B → REPLACE ECM (Click here)

A

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

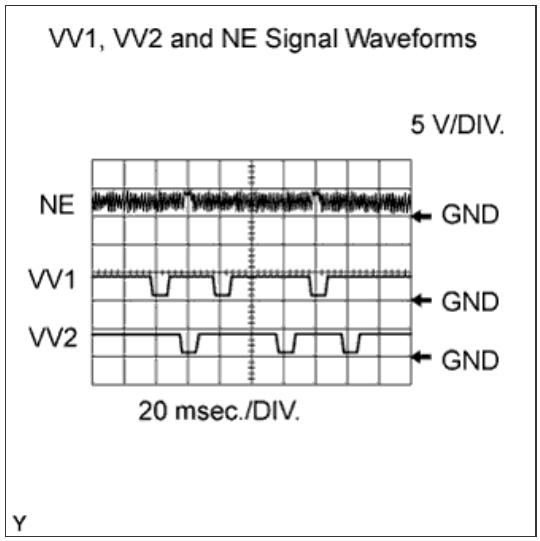
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

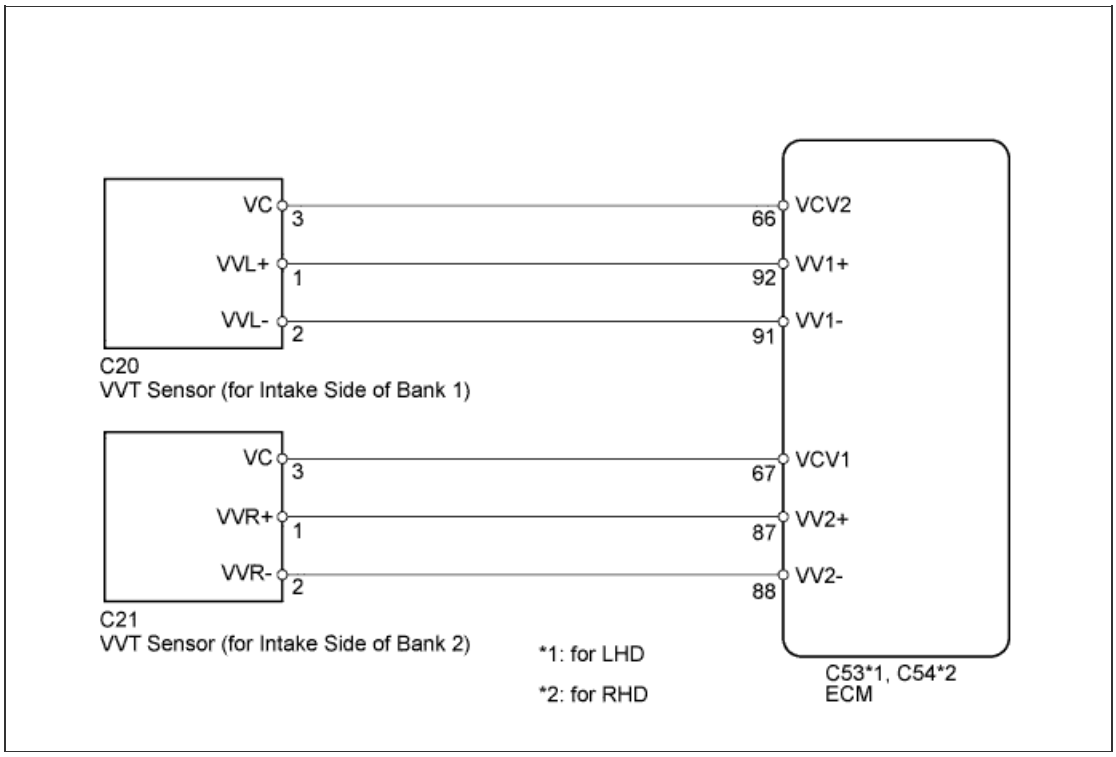
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

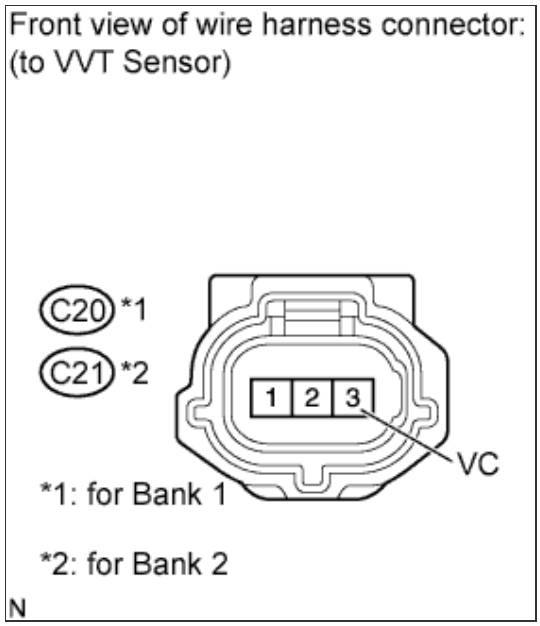
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

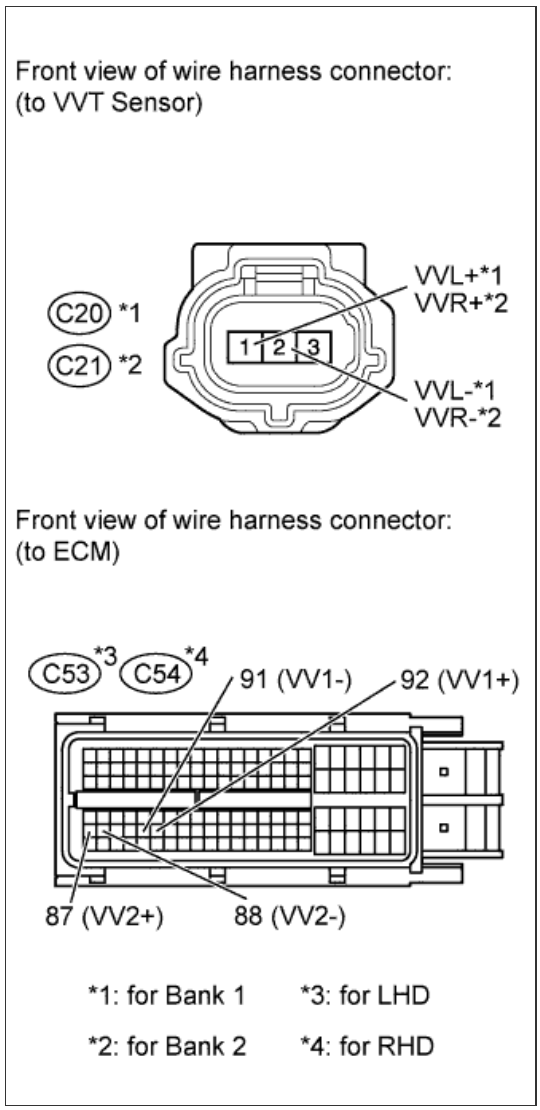
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

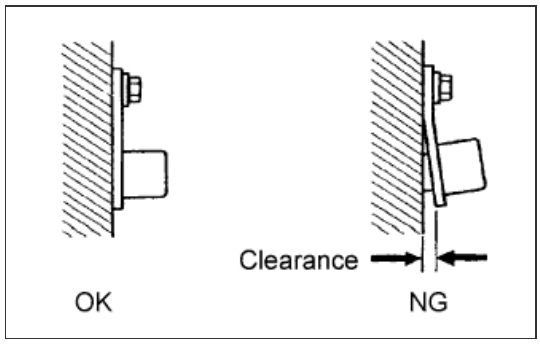
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2A00 A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC P2A03 A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)

for Preparation Click here

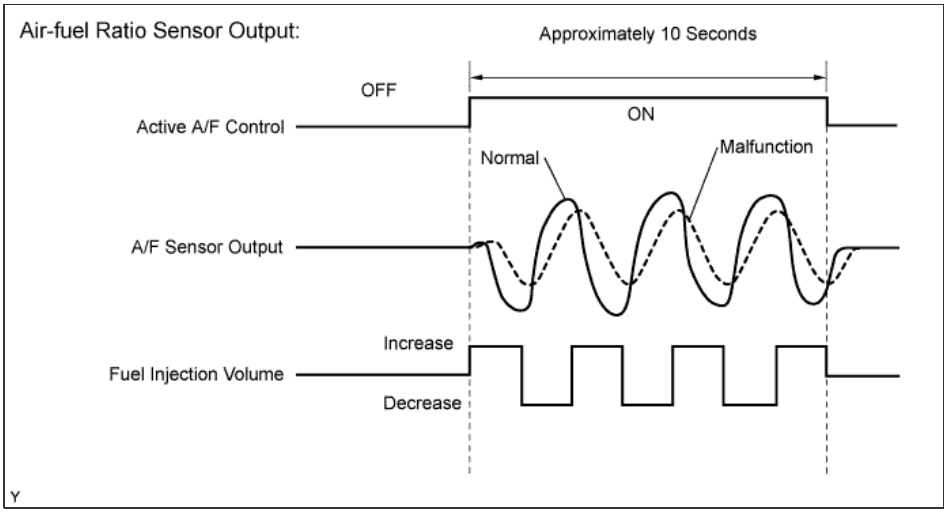
DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2A00	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in Air Fuel ratio (A/F) (for Bank 1) sensor circuit • A/F sensor (for Bank 1) • ECM
P2A03	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in A/F sensor (for Bank 2) circuit • A/F sensor (for Bank 2) • ECM

MONITOR DESCRIPTION

After the engine is warmed up, the ECM performs air-fuel ratio feedback control to maintain the air-fuel ratio at the stoichiometric level. In addition, active A/F control is performed for approximately 10 seconds after the preconditions are met in order to measure the A/F sensor response rate. During active A/F control, the ECM forcibly increases and decreases the injection volume a certain amount, based on the stoichiometric air-fuel ratio learned during normal air-fuel ratio control, and measures the A/F sensor response rate. The ECM receives a signal from the A/F sensor while performing active A/F control and uses it to calculate the A/F sensor response rate deterioration level.
If the A/F sensor response rate deterioration level is less than the threshold, the ECM interprets this as a malfunction and stores DTC(s).



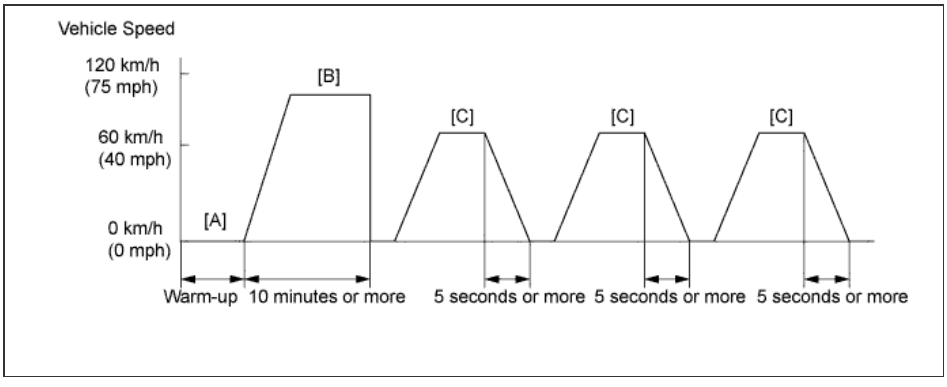
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].

6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2A00 and P2A03.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P2A00 and P2A03 are for Euro-OBD only.**
- **Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.**
- **The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.**

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

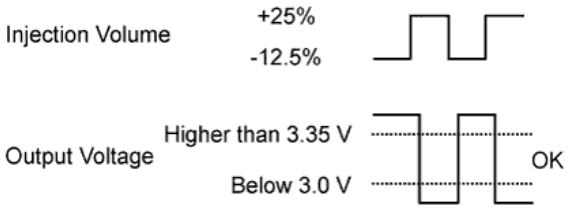
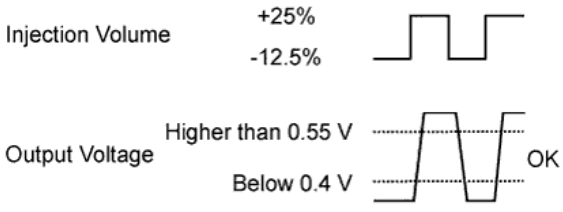
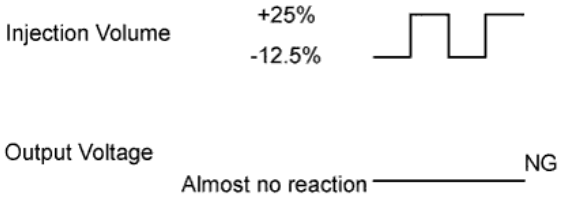
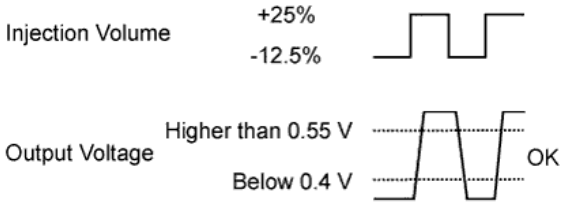
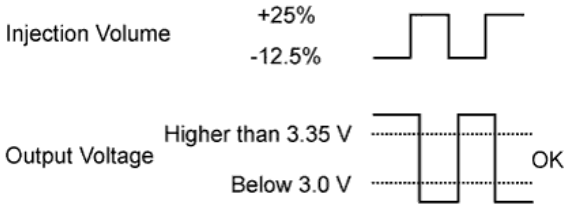
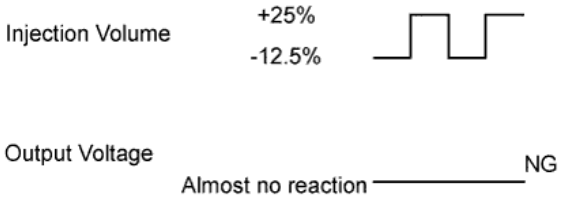
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
			• Fuel

4	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	• injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 indicates malfunctions related to the bank 1 A/F sensor.**
- **DTC P2A03 indicates malfunctions related to the bank 2 A/F sensor.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**
- **DTC P2A00 or P2A03 may be stored when the air-fuel ratio is stuck rich or lean.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 are output	A
P2A00 and/or P2A03 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

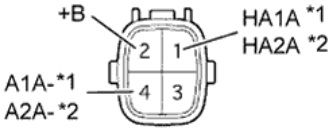
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected: (A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

3.CHECK HARNESS AND CONNECTOR (ECM - AIR FUEL RATIO SENSOR)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

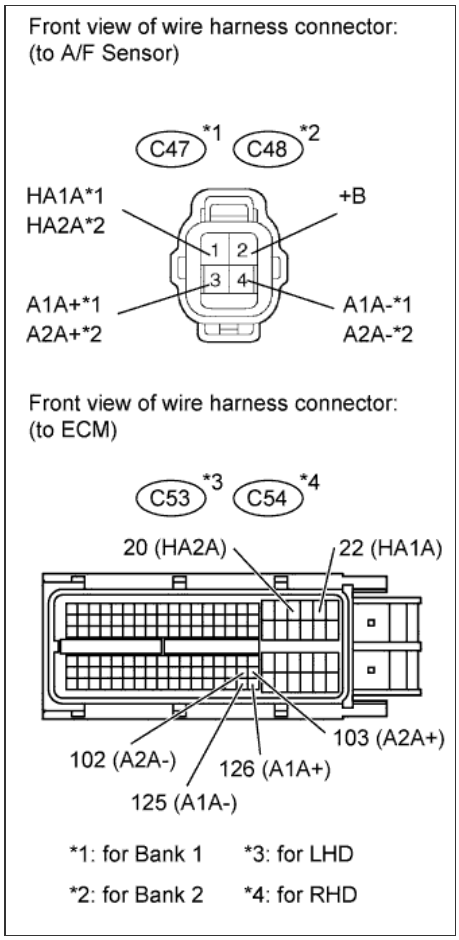
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

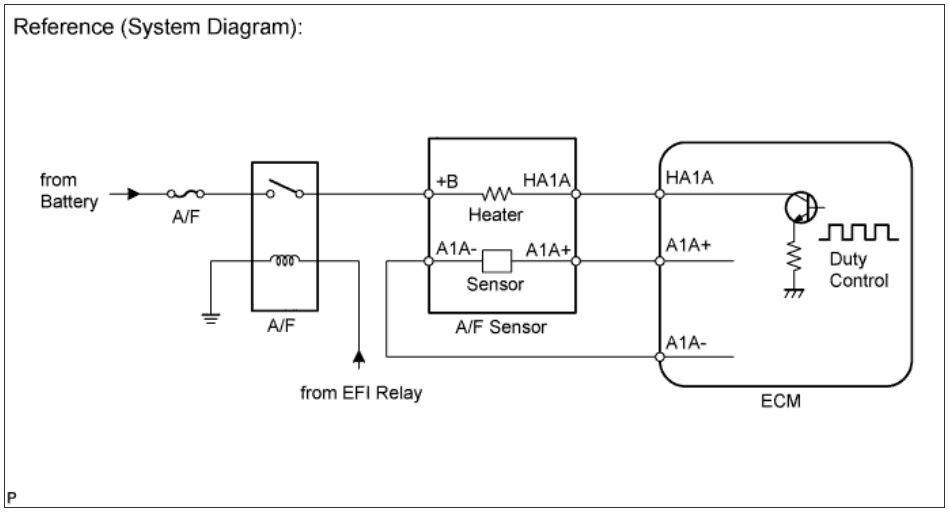
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher

C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 is output	A
No DTC is output	B

B → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2A00 and/or P2A03 are output	B

B → REPLACE ECM (Click here)

A

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

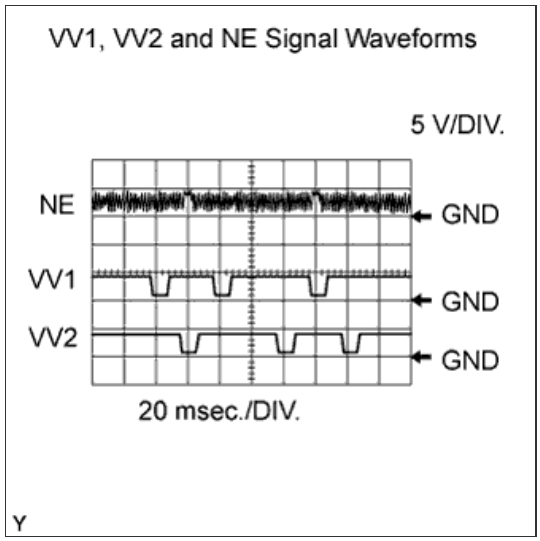
for Preparation Click here

DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

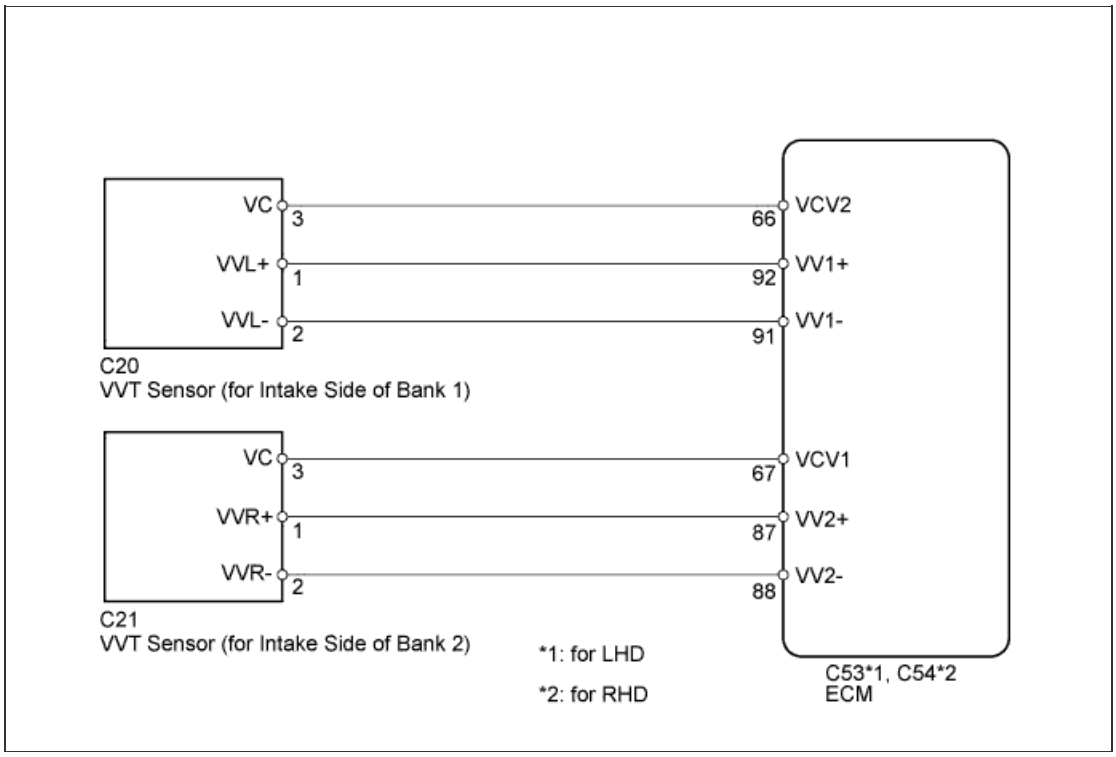
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

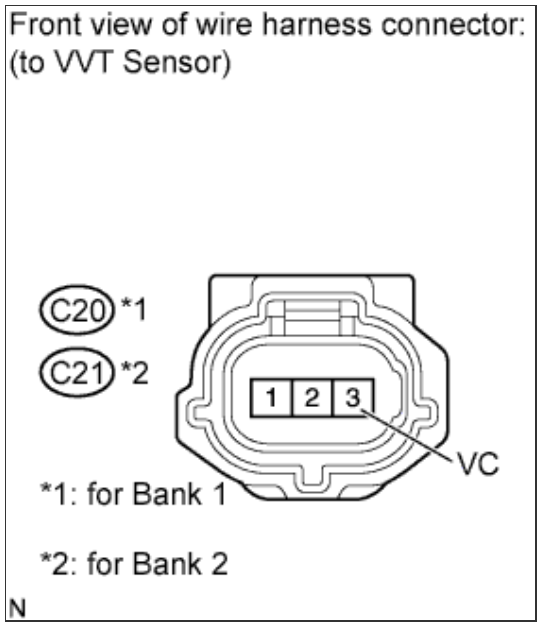
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

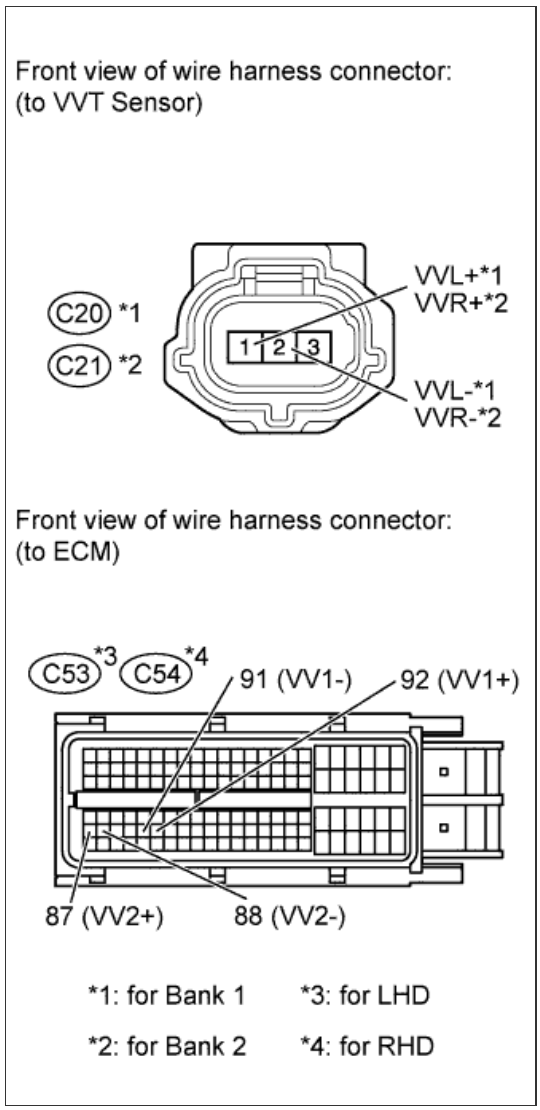
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

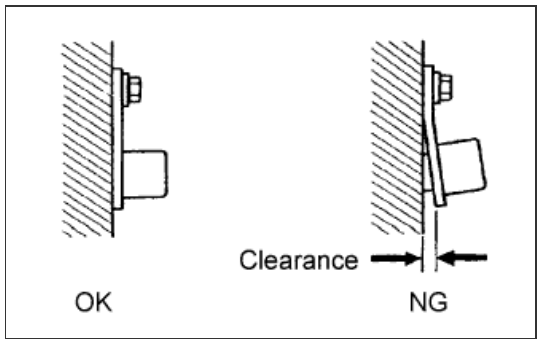
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

END

DTC P2A00 A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC P2A03 A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)

for Preparation Click here

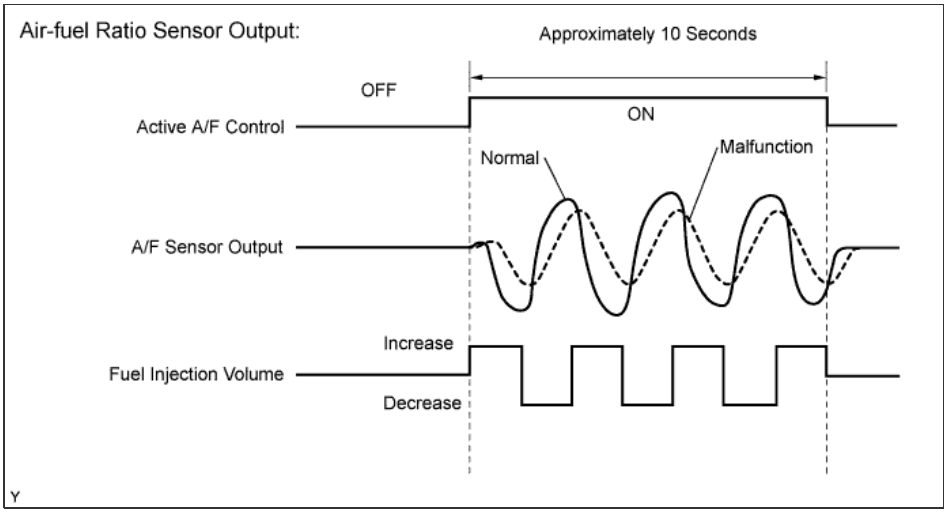
DESCRIPTION

Refer to DTC P2195 (Click here).

DTC Code	DTC Detection Condition	Trouble Area
P2A00	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in Air Fuel ratio (A/F) (for Bank 1) sensor circuit • A/F sensor (for Bank 1) • ECM
P2A03	The calculated value of the Air Fuel ratio (A/F) sensor response rate deterioration level is less than the threshold (2 trip detection logic).	• Open or short in A/F sensor (for Bank 2) circuit • A/F sensor (for Bank 2) • ECM

MONITOR DESCRIPTION

After the engine is warmed up, the ECM performs air-fuel ratio feedback control to maintain the air-fuel ratio at the stoichiometric level. In addition, active A/F control is performed for approximately 10 seconds after the preconditions are met in order to measure the A/F sensor response rate. During active A/F control, the ECM forcibly increases and decreases the injection volume a certain amount, based on the stoichiometric air-fuel ratio learned during normal air-fuel ratio control, and measures the A/F sensor response rate. The ECM receives a signal from the A/F sensor while performing active A/F control and uses it to calculate the A/F sensor response rate deterioration level.
If the A/F sensor response rate deterioration level is less than the threshold, the ECM interprets this as a malfunction and stores DTC(s).



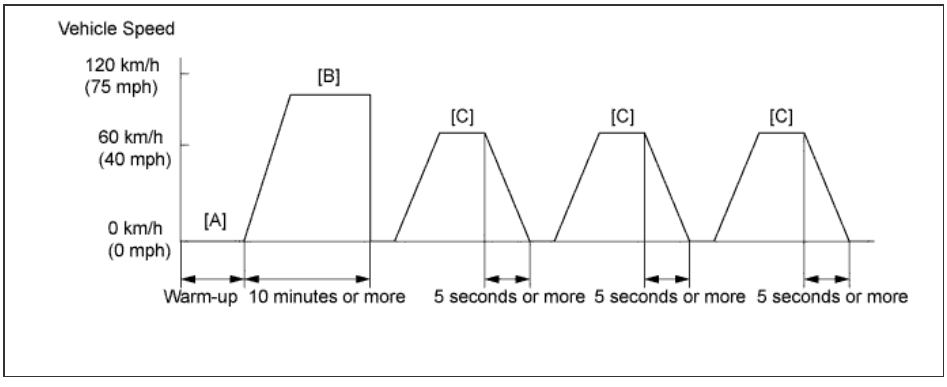
CONFIRMATION DRIVING PATTERN

HINT:

- **This confirmation driving pattern is used in the "Perform Confirmation Driving Pattern" procedure of the following diagnostic troubleshooting procedure.**
- **Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor (the catalyst monitor is performed simultaneously). This is very useful for verifying the completion of a repair.**

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.



1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Warm-up the engine until the engine coolant temperature is 75°C (167°F) or higher [A].
4. Drive the vehicle at between 60 km/h and 120 km/h (40 mph and 75 mph) for at least 10 minutes [B].
5. Drive the vehicle at 60 km/h (40 mph) or more and decelerate the vehicle for 5 seconds or more. Perform this 3 times [C].

6. Turn the tester on.
7. Enter the following menus: Powertrain / Engine and ECT / Utility / All Readiness.
8. Input DTCs: P2A00 and P2A03.
9. Check the DTC monitor is NORMAL. If the DTC monitor is INCOMPLETE, perform the drive pattern adding the vehicle speed and using the second gear to decelerate the vehicle.

WIRING DIAGRAM

Refer to DTC P2195 (Click here).

INSPECTION PROCEDURE

HINT:

- **DTC P2A00 and P2A03 are for Euro-OBD only.**
- **Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the Active Test. The Control the Injection Volume for A/F sensor function can help to determine whether the Air Fuel ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.**
- **The following instructions describe how to conduct the Control the Injection Volume for A/F sensor operation using the intelligent tester.**

(a) Connect the tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2500 rpm for approximately 90 seconds.
(d) Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
(e) Perform the Active Test operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2) displayed on the tester.

HINT:

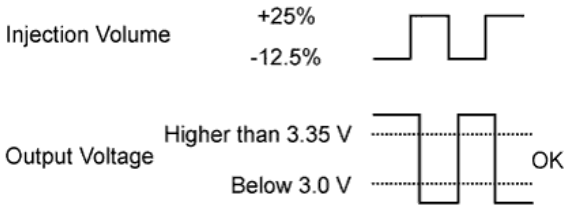
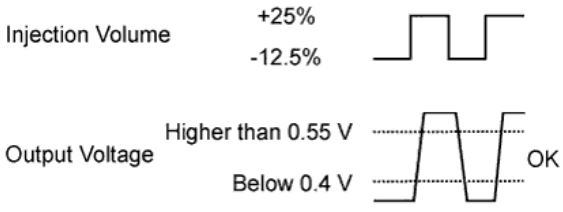
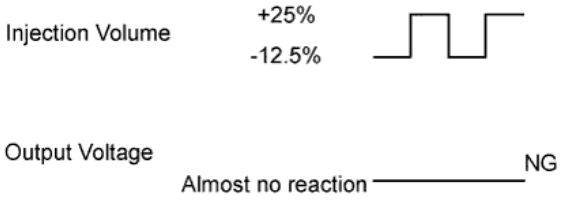
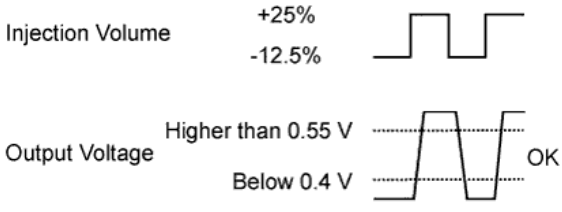
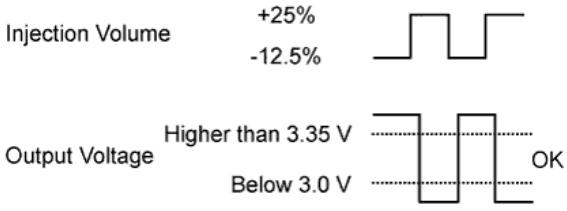
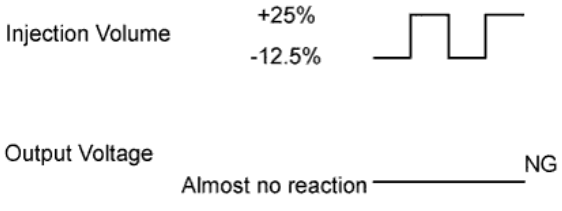
- **The Control the Injection Volume for A/F sensor operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.**
- **Each sensor reacts in accordance with increases and decreases in the fuel injection volume.**

Standard:

Display Item (Sensor)	Injection Volume	Status	Voltage
AFS B1 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B1 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4
AFS B2 S1 (A/F)	+25%	Rich	Below 3.0
	-12.5%	Lean	Higher than 3.35
O2S B2 S2 (HO2)	+25%	Rich	Higher than 0.55
	-12.5%	Lean	Below 0.4

NOTICE:

The A/F sensor has an output delay of a few seconds and the HO2 sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
1			-
2			• A/F sensor • A/F sensor heater • A/F sensor circuit
3			• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
			• Fuel

4	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	Injection Volume +25% -12.5%  Output Voltage Almost no reaction ——— NG	• injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)

Following the Control the Injection Volume for A/F Sensor procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors. To display the graph, enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor / A/F Control System / AFS B1 S1 and O2S B1 S2 or AFS B2 S1 and O2S B2 S2.

HINT:

- **Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.**
- **DTC P2A00 indicates malfunctions related to the bank 1 A/F sensor.**
- **DTC P2A03 indicates malfunctions related to the bank 2 A/F sensor.**
- **Bank 1 refers to the bank that includes the No. 1 cylinder.**
- **Bank 2 refers to the bank that includes the No. 2 cylinder.**
- **DTC P2A00 or P2A03 may be stored when the air-fuel ratio is stuck rich or lean.**
- **A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.**
- **A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.**
- **Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.**

1.CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / DTC.

e. Read DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 are output	A
P2A00 and/or P2A03 and other DTCs are output	B

HINT:

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (Click here)

A

2.INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

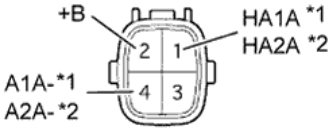
a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA1A) - 4 (A1A-)	Always	10 kΩ or higher
1 (HA2A) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 4 (A2A-)	Always	10 kΩ or higher

Component without harness connected: (A/F Sensor)



*1: for Bank 1

*2: for Bank 2

NG → REPLACE AIR FUEL RATIO SENSOR (Click here)

OK

3.CHECK HARNESS AND CONNECTOR (ECM - AIR FUEL RATIO SENSOR)

a. Disconnect the C47 or C48 Air Fuel ratio (A/F) sensor connector.

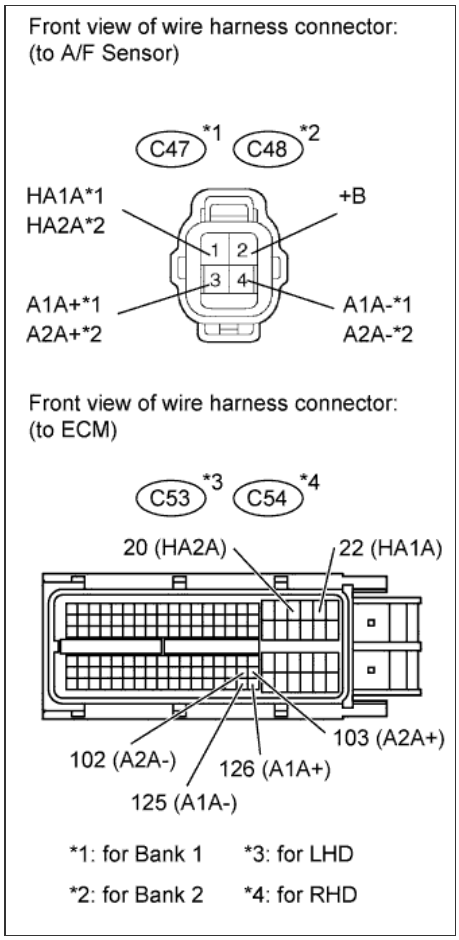
b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C47-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V
C48-2 (+B) - Body ground	Engine switch on (IG)	11 to 14 V

c. Turn the engine switch off.

d. Disconnect the C53 or C54 ECM connector.



e. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

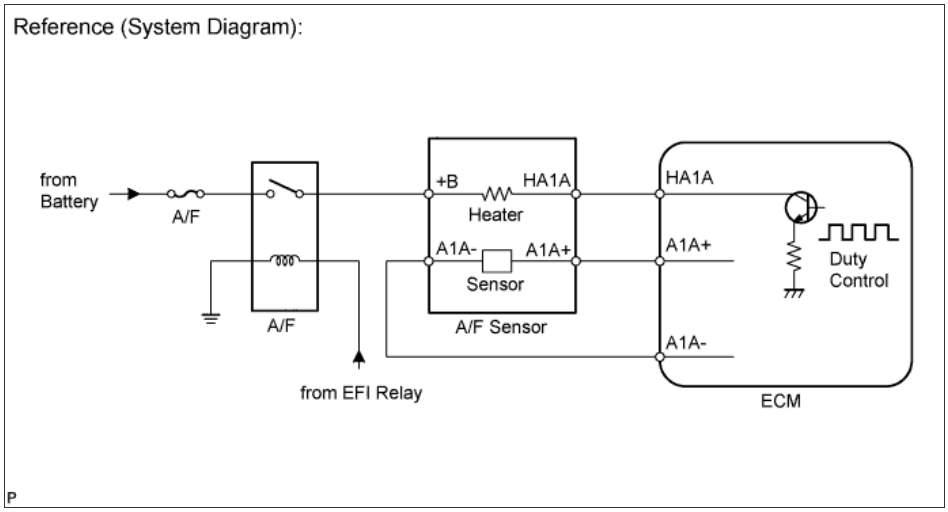
Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C53-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C53-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C53-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C53-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C53-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C53-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C53-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C53-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C53-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C53-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C53-103 (A2A+) - Body ground	Always	10 kΩ or higher

C48-4 (A2A-) or C53-102 (A2A-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C47-1 (HA1A) - C54-22 (HA1A)	Always	Below 1 Ω
C47-3 (A1A+) - C54-126 (A1A+)	Always	Below 1 Ω
C47-4 (A1A-) - C54-125 (A1A-)	Always	Below 1 Ω
C48-1 (HA2A) - C54-20 (HA2A)	Always	Below 1 Ω
C48-3 (A2A+) - C54-103 (A2A+)	Always	Below 1 Ω
C48-4 (A2A-) - C54-102 (A2A-)	Always	Below 1 Ω
C47-1 (HA1A) or C54-22 (HA1A) - Body ground	Always	10 kΩ or higher
C47-3 (A1A+) or C54-126 (A1A+) - Body ground	Always	10 kΩ or higher
C47-4 (A1A-) or C54-125 (A1A-) - Body ground	Always	10 kΩ or higher
C48-1 (HA2A) or C54-20 (HA2A) - Body ground	Always	10 kΩ or higher
C48-3 (A2A+) or C54-103 (A2A+) - Body ground	Always	10 kΩ or higher
C48-4 (A2A-) or C54-102 (A2A-) - Body ground	Always	10 kΩ or higher

Reference (System Diagram):



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
P2A00 and/or P2A03 is output	A
No DTC is output	B

B → CHECK FOR INTERMITTENT PROBLEMS (Click here)

A

6.REPLACE AIR FUEL RATIO SENSOR

a. Replace the air fuel ratio sensor (Click here).

NEXT

7.PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8.CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC / Pending.

d. Read pending DTCs.

Result

Result	Proceed to
No DTC is output	A
P2A00 and/or P2A03 are output	B

B → REPLACE ECM (Click here)

A

END

DTC P0340 Camshaft Position Sensor Circuit Malfunction

DTC P0342 Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)

DTC P0343 Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)

DTC P0345 Camshaft Position Sensor "A" Circuit (Bank 2)

DTC P0347 Camshaft Position Sensor "A" Circuit Low Input (Bank 2)

DTC P0348 Camshaft Position Sensor "A" Circuit High Input (Bank 2)

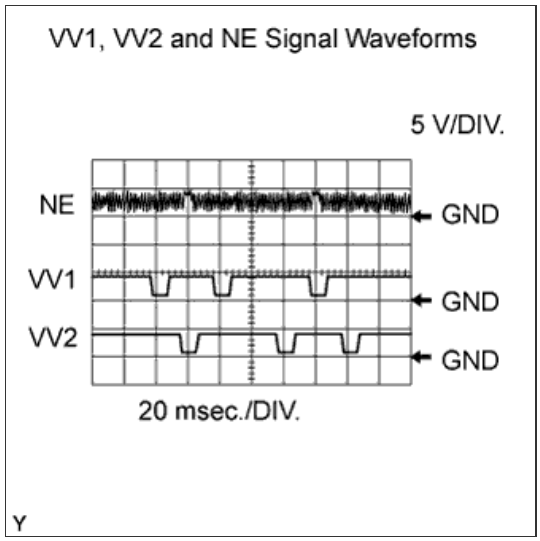
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DESCRIPTION

The intake camshaft Variable Valve Timing (VVT) sensor (VV1, 2 signal) consists of a magnet and MRE (Magnetic Resistance Element).
The intake camshaft has 3 teeth on its outer circumference. When the intake camshaft rotates, changes occur in the air gaps between the teeth and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the intake camshaft rotation data into pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.
The crankshaft position sensor plate has 34 teeth. The crankshaft position sensor generates 34 signals for each revolution. Based on a combination of the VVT signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

DTC Code	DTC Detection Condition	Trouble Area
P0340 P0345	When either condition below is met: • The input voltage to the ECM remains at below 0.3 V or higher than 4.7 V for 4 seconds when 2 or more seconds have elapsed after turning the engine switch on (IG) (1 trip detection logic). • No VVT sensor (for intake side of Bank 1, 2) signal is sent to the ECM during cranking (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0342 P0347	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is below 0.3 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM
P0343 P0348	The output voltage of the VVT sensor (for intake side of Bank 1, 2) is higher than 4.7 V for 4 seconds (1 trip detection logic).	• Open or short in VVT sensor (for intake side) circuit • VVT sensor (for intake side) • Intake camshaft (for Bank 1, 2) • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



Standard:

for LHD

Tester Connection	Tool Setting	Condition	Specified Condition
C53-110 (NE+) - C53-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-92 (VV1+) - C53-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C53-87 (VV2+) - C53-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

for RHD

Tester Connection	Tool Setting	Condition	Specified Condition
C54-110 (NE+) - C54-111 (NE-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-92 (VV1+) - C54-91 (VV1-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown
C54-87 (VV2+) - C54-88 (VV2-)	5 V/DIV. 20 msec./DIV.	Cranking or idling	The correct waveform is as shown

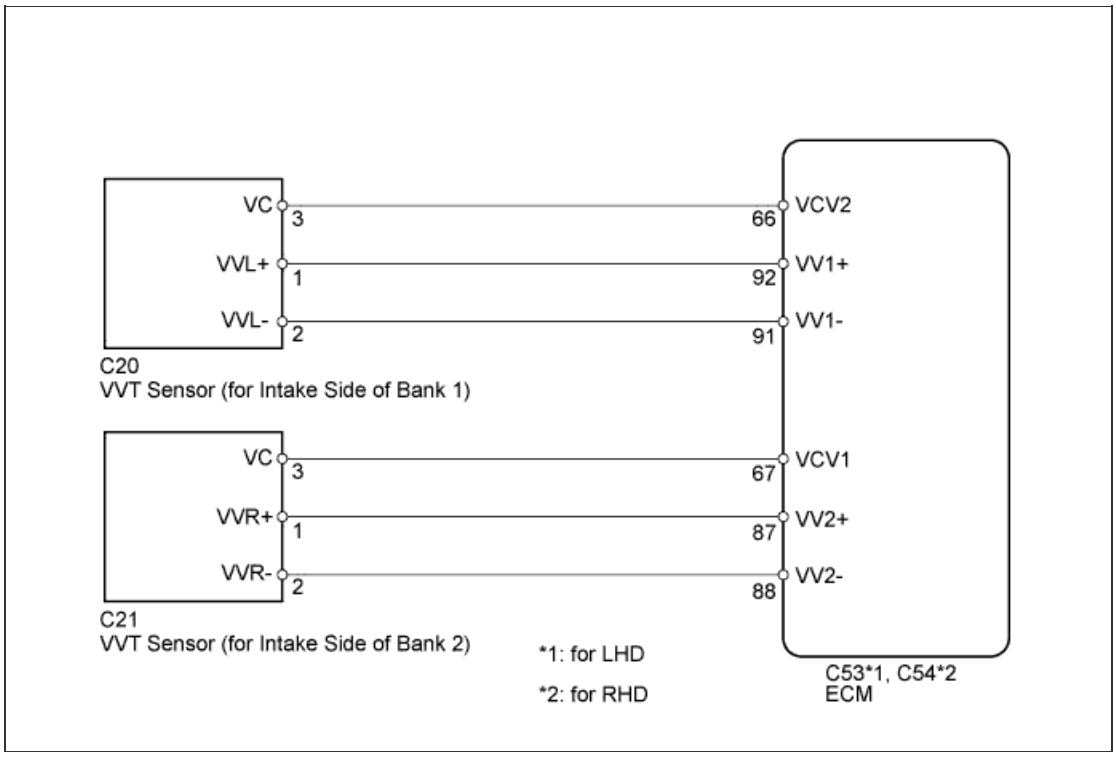
HINT:

VV1+ and VV2+ stand for the VVT sensor (for intake side) signal, and NE+ stands for the CKP sensor signal.

MONITOR DESCRIPTION

If no signal is transmitted by the VVT sensor despite the engine revolving, or the rotations of the camshaft and the crankshaft are not synchronized, the ECM interprets this as a malfunction of the sensor.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

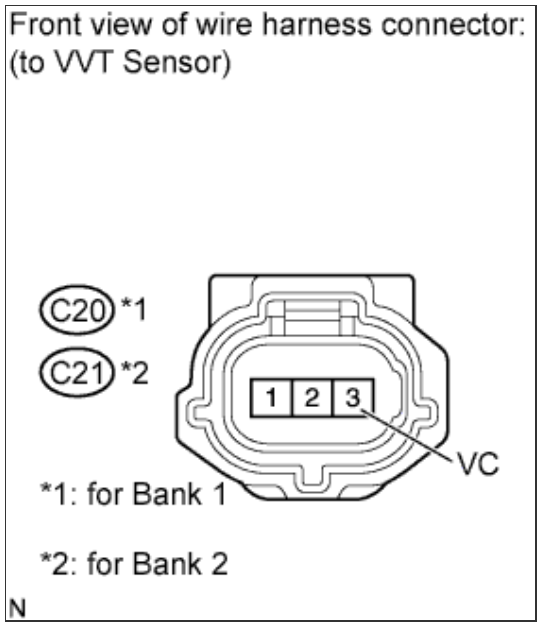
1.CHECK HARNESS AND CONNECTOR (SENSOR POWER SOURCE)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
C20-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V
C21-3 (VC) - Body ground	Engine switch on (IG)	4.5 to 5.0 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

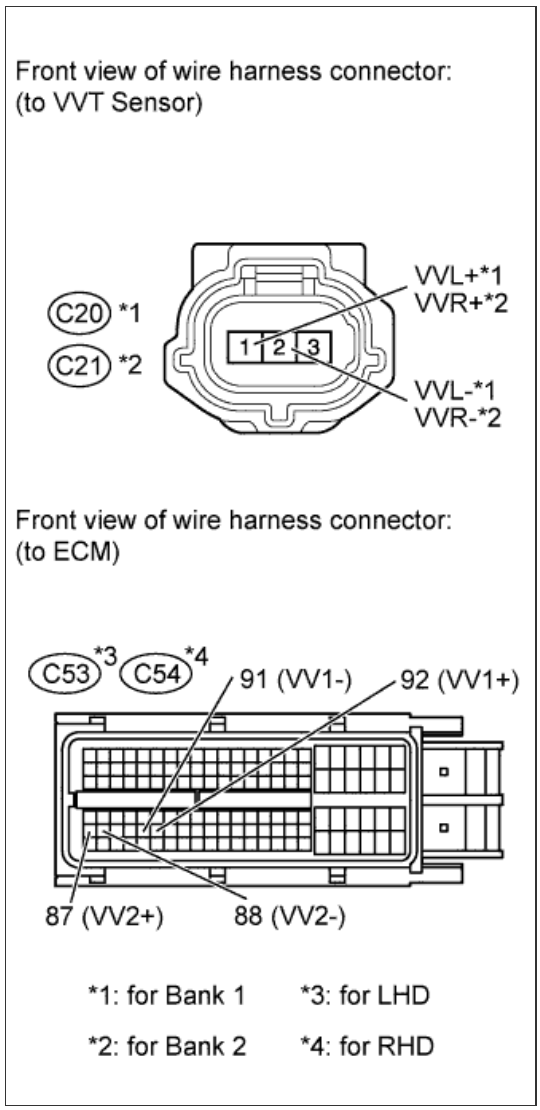
OK

2.CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE SIDE - ECM)

a. Disconnect the C20 or C21 VVT sensor connector.

b. Disconnect the C53 or C54 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C53-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C53-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C53-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C53-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C53-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C53-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C53-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C53-88 (VV2-) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C20-1 (VVL+) - C54-92 (VV1+)	Always	Below 1 Ω
C20-2 (VVL-) - C54-91 (VV1-)	Always	Below 1 Ω
C21-1 (VVR+) - C54-87 (VV2+)	Always	Below 1 Ω
C21-2 (VVR-) - C54-88 (VV2-)	Always	Below 1 Ω
C20-1 (VVL+) or C54-92 (VV1+) - Body ground	Always	10 kΩ or higher
C20-2 (VVL-) or C54-91 (VV1-) - Body ground	Always	10 kΩ or higher
C21-1 (VVR+) or C54-87 (VV2+) - Body ground	Always	10 kΩ or higher
C21-2 (VVR-) or C54-88 (VV2-) - Body ground	Always	10 kΩ or higher

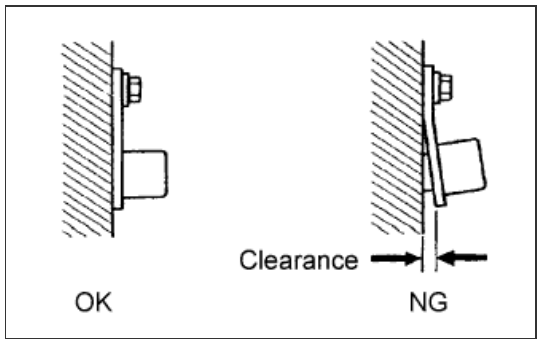
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.CHECK SENSOR INSTALLATION

a. Check the VVT sensor (for intake side) installation.

OK:
Sensor is installed correctly.



NG → SECURELY REINSTALL SENSOR (Click here)

OK

4.CHECK INTAKE CAMSHAFT (TEETH)

a. Check the teeth of the camshaft.

OK:
Teeth do not have any cracks or deformation.

NG → REPLACE INTAKE CAMSHAFT (Click here)

OK

5.REPLACE VVT SENSOR (for Intake Side)

a. Replace the VVT sensor (for Intake Side) (Click here).

NEXT

6.CHECK WHETHER DTC OUTPUT RECURS

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Clear DTCs.

e. Start the engine.

f. Enter the following menus: Powertrain / Engine and ECT / DTC.

g. Read DTCs.

Result

Result	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

HINT:

If the engine does not start, replace the ECM.

B → REPLACE ECM (Click here)

A

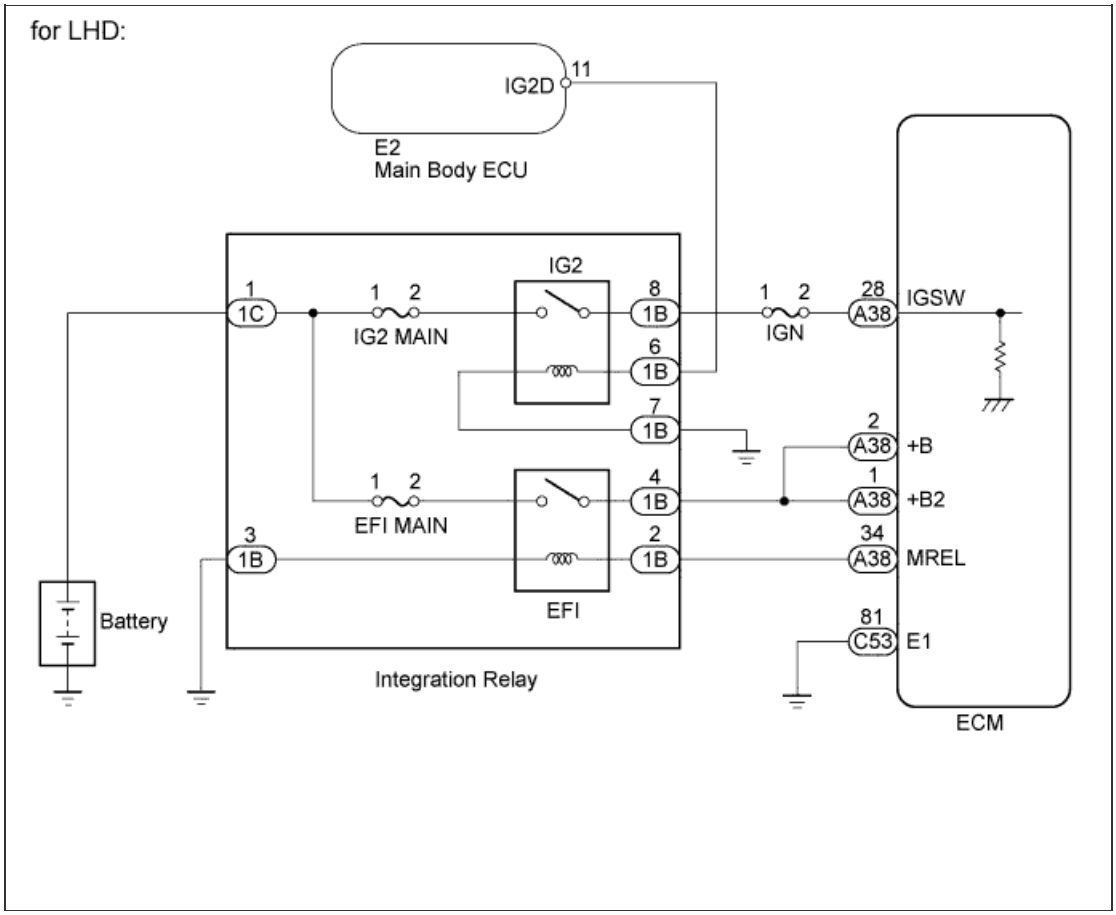
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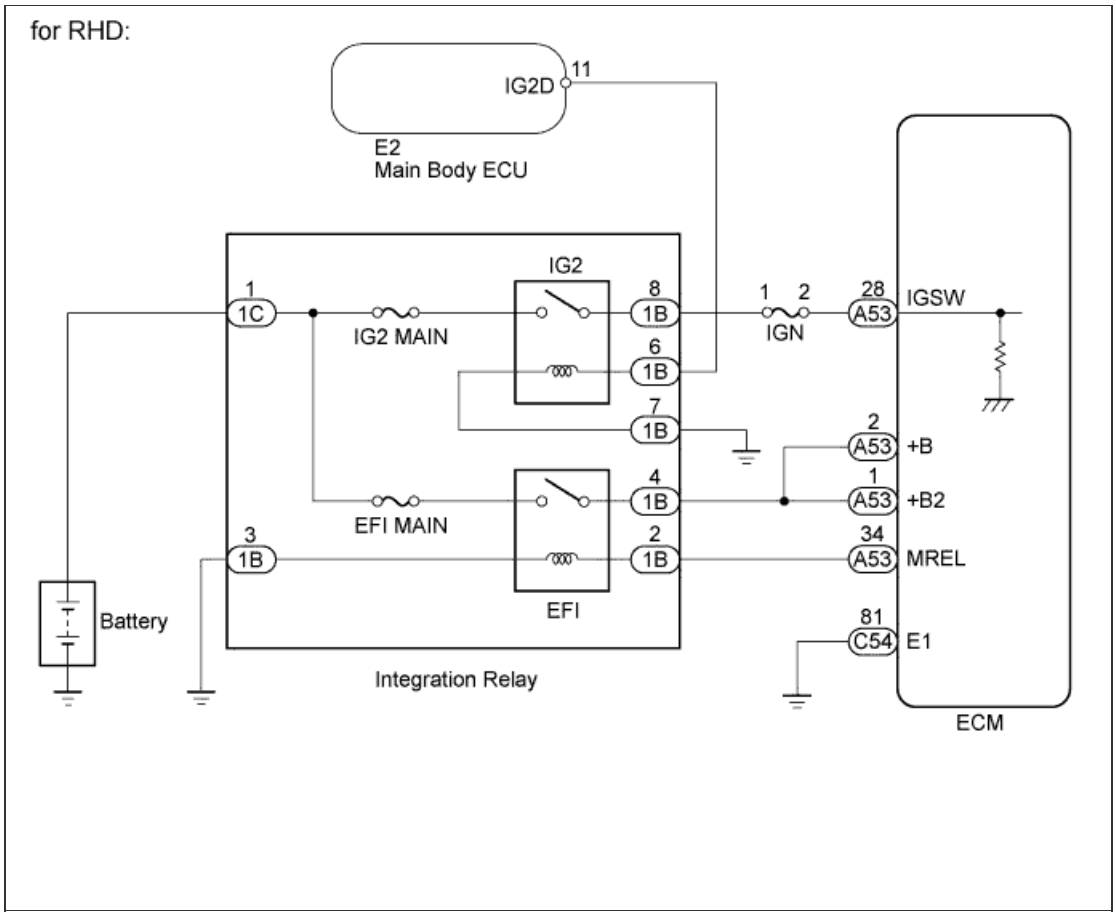
for Preparation Click here

DESCRIPTION

When the engine switch is turned on (IG), battery voltage is applied to the IGSW of the ECM. The output signal from the MREL terminal of the ECM causes a current to flow to the coil, closing the contacts of the integration relay (EFI relay) and supplying power to either terminal +B or +B2 of the ECM.

WIRING DIAGRAM





INSPECTION PROCEDURE

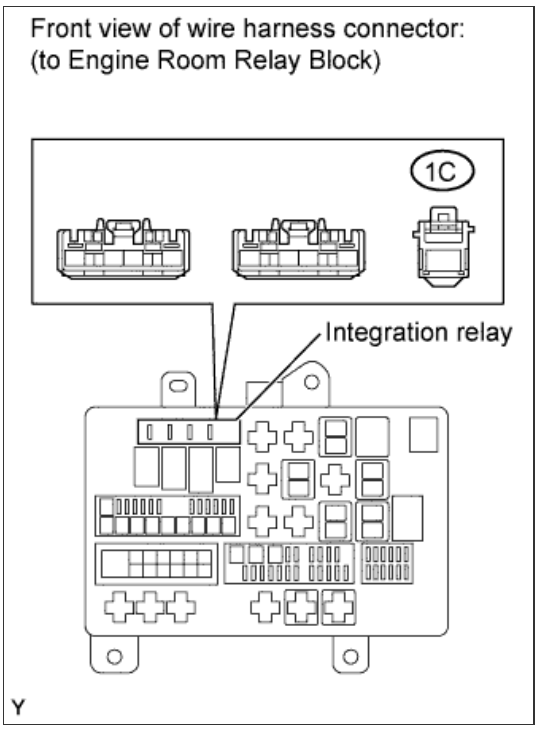
1.INSPECT INTEGRATION NO.1 RELAY (INTEGRATION RELAY - BODY GROUND)

a. Remove the integration relay from the engine room relay block.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
1C-1 - Body ground	Always	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.INSPECT INTEGRATION NO.1 RELAY (EFI AND IG2 RELAY)

a. Remove the integration relay from the engine room relay block.

b. Inspect the EFI MAIN fuse and the IG2 MAIN fuse.

i. Remove the EFI MAIN fuse and IG2 MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

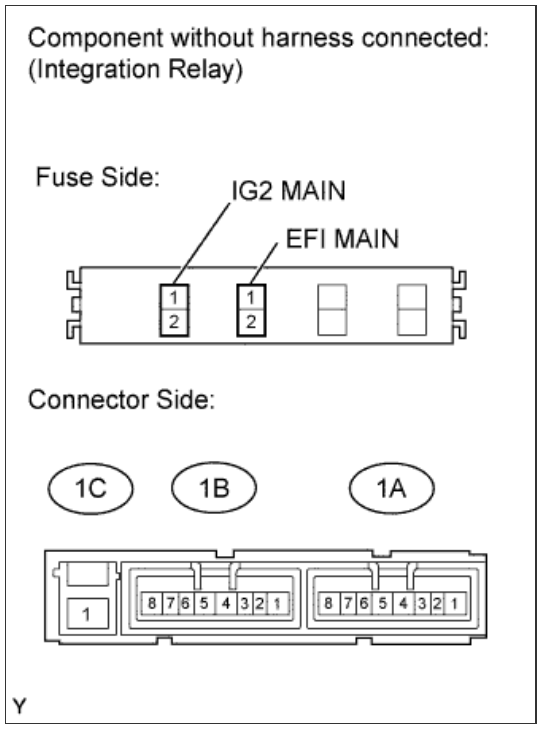
Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω
IG2 MAIN fuse	Always	Below 1 Ω

c. Inspect the EFI relay and the IG2 relay.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	Battery voltage is not applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage is applied to terminals 1B-2 and 1B-3	Below 1 Ω
1C-1 - 1B-8	Battery voltage is not applied to terminals 1B-7 and 1B-6	10 kΩ or higher
	Battery voltage is applied to terminals 1B-7 and 1B-6	Below 1 Ω



NG → REPLACE INTEGRATION NO.1 RELAY

OK

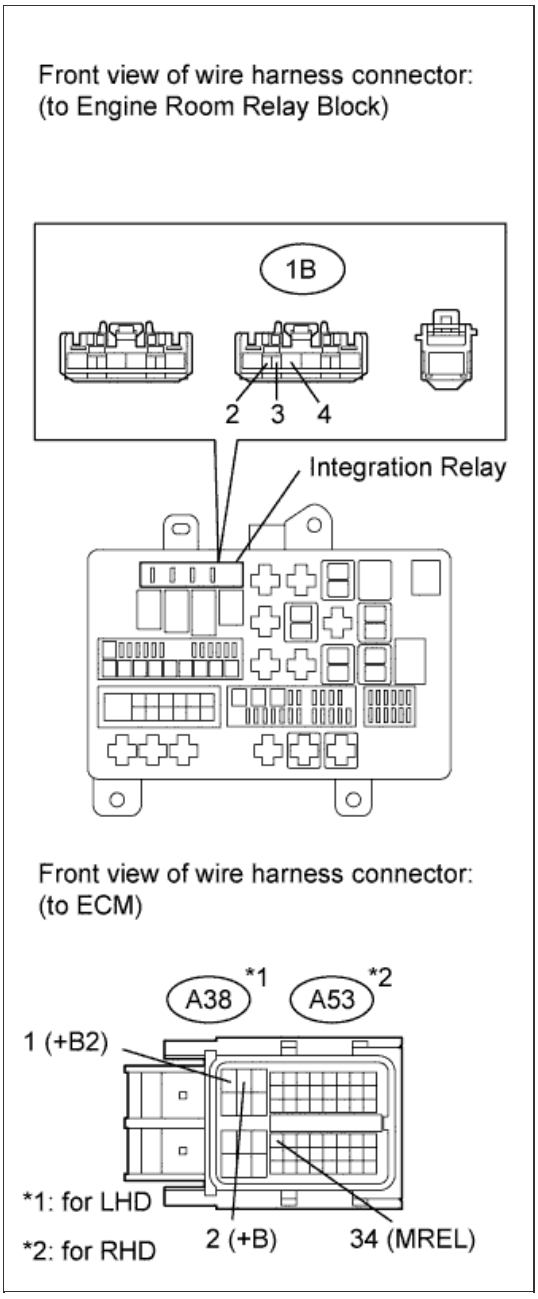
3.CHECK HARNESS AND CONNECTOR (+B, +B2 AND MREL CIRCUIT)

a. Check the harness and the connectors between the integration relay and the ECM.

i. Remove the integration relay from the engine room relay block.

ii. Disconnect the ECM connector.

iii. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A38-34 (MREL) - 1B-2	Always	Below 1 Ω
A38-2 (+B) - 1B-4	Always	Below 1 Ω
A38-1 (+B2) - 1B-4	Always	Below 1 Ω
A38-34 (MREL) or 1B-2 - Body ground	Always	10 kΩ or higher
A38-2 (+B) or 1B-4 - Body ground	Always	10 kΩ or higher
A38-1 (+B2) or 1B-4 - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A53-34 (MREL) - 1B-2	Always	Below 1 Ω
A53-2 (+B) - 1B-4	Always	Below 1 Ω
A53-1 (+B2) - 1B-4	Always	Below 1 Ω
A53-34 (MREL) or 1B-2 - Body ground	Always	10 kΩ or higher
A53-2 (+B) or 1B-4 - Body	Always	10 kΩ or

ground		higher
A53-1 (+B2) or 1B-4 - Body ground	Always	10 kΩ or higher

b. Check the harness and connectors between the integration relay and body ground.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1B-3 - Body ground	Always	Below 1 Ω

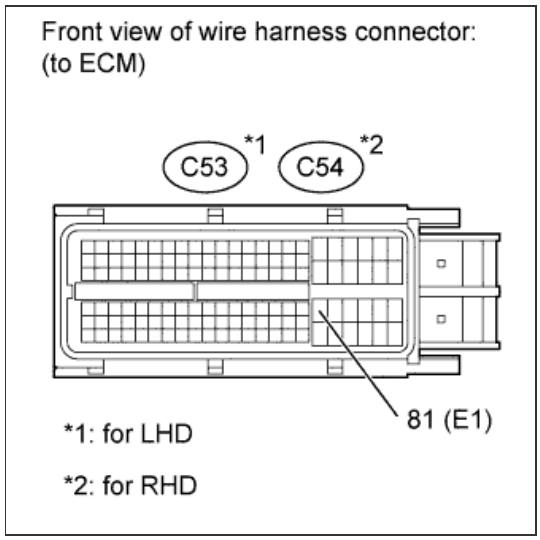
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4.CHECK HARNESS AND CONNECTOR (ECM - BODY GROUND)

a. Disconnect the ECM connector.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-81 (E1) - Body ground	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
C54-81 (E1) - Body ground	Always	Below 1 Ω

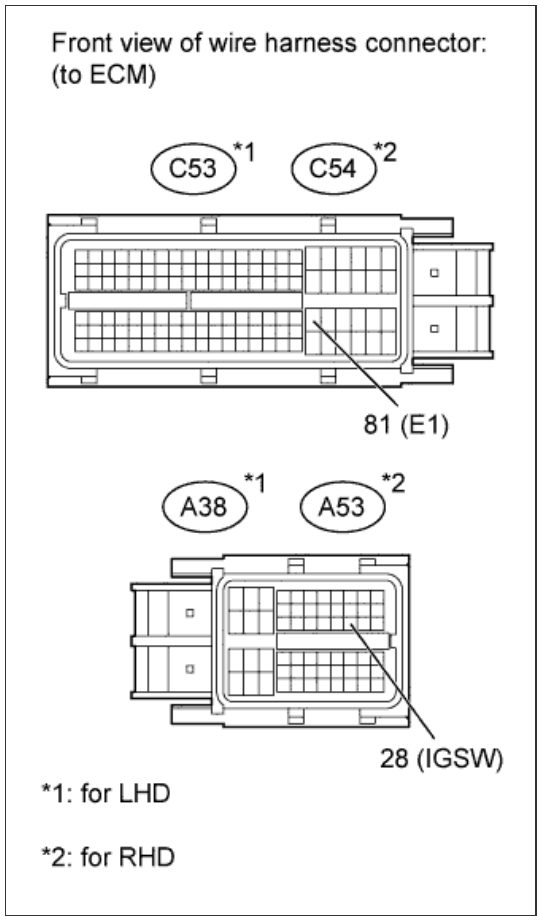
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

5.INSPECT ECM (IGSW VOLTAGE)

a. Disconnect the ECM connectors.

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

for LHD

Tester Connection	Switch Condition	Specified Condition
A38-28 (IGSW) - C53-81 (E1)	Engine switch on (IG)	11 to 14 V

for RHD

Tester Connection	Switch Condition	Specified Condition
A53-28 (IGSW) - C54-81 (E1)	Engine switch on (IG)	11 to 14 V

NG → Go to step 6

OK

REPLACE ECM (Click here)

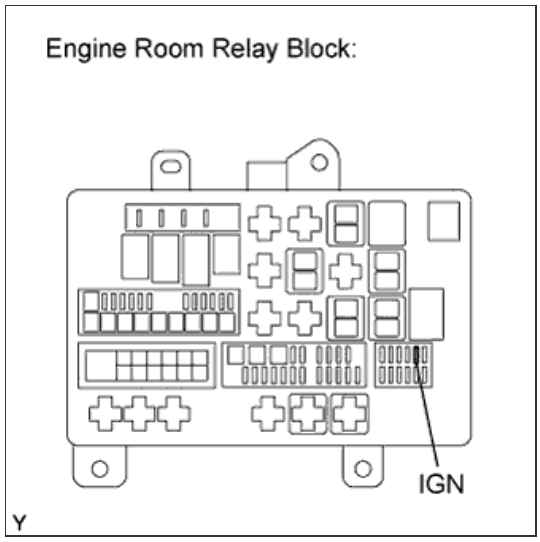
6.INSPECT FUSE (IGN)

a. Remove the IGN fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
IGN fuse	Always	Below 1 Ω



NG → CHECK FOR SHORT IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE

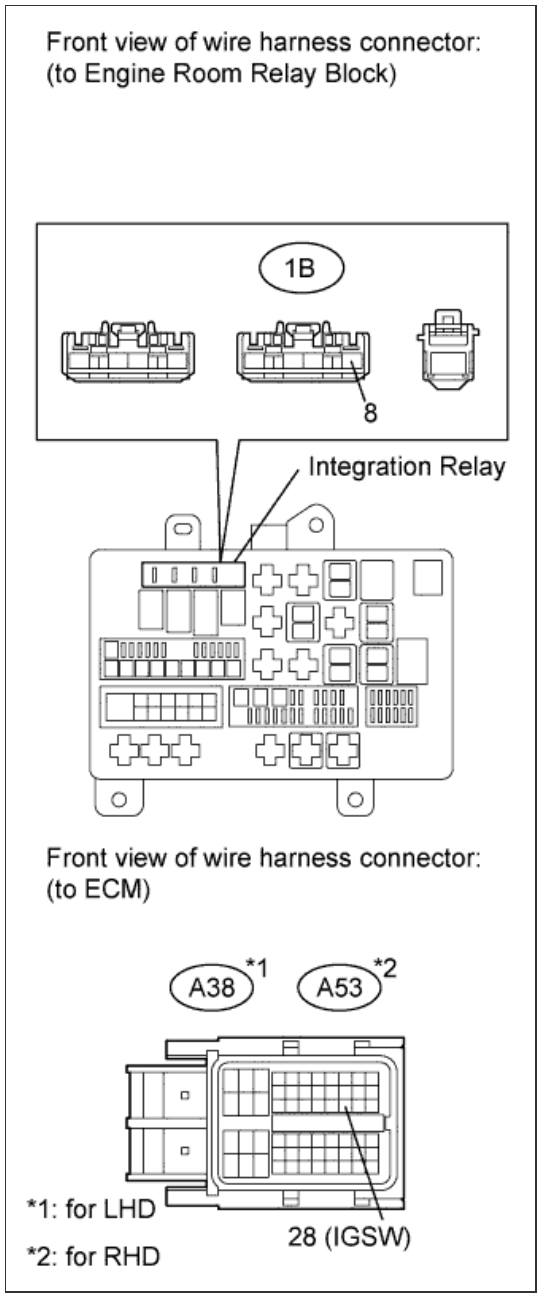
OK

7.CHECK HARNESS AND CONNECTOR (INTEGRATION RELAY - ECM, INTEGRATION RELAY - BODY GROUND)

a. Remove the integration relay from the engine room relay block.

b. Disconnect the ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
1B-8 - A38-28 (IGSW)	Always	Below 1 Ω
1B-8 or A38-28 (IGSW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
1B-8 - A53-28 (IGSW)	Always	Below 1 Ω
1B-8 or A53-28 (IGSW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

8.CHECK HARNESS AND CONNECTOR (MAIN BODY ECU - ENGINE ROOM RELAY BLOCK)

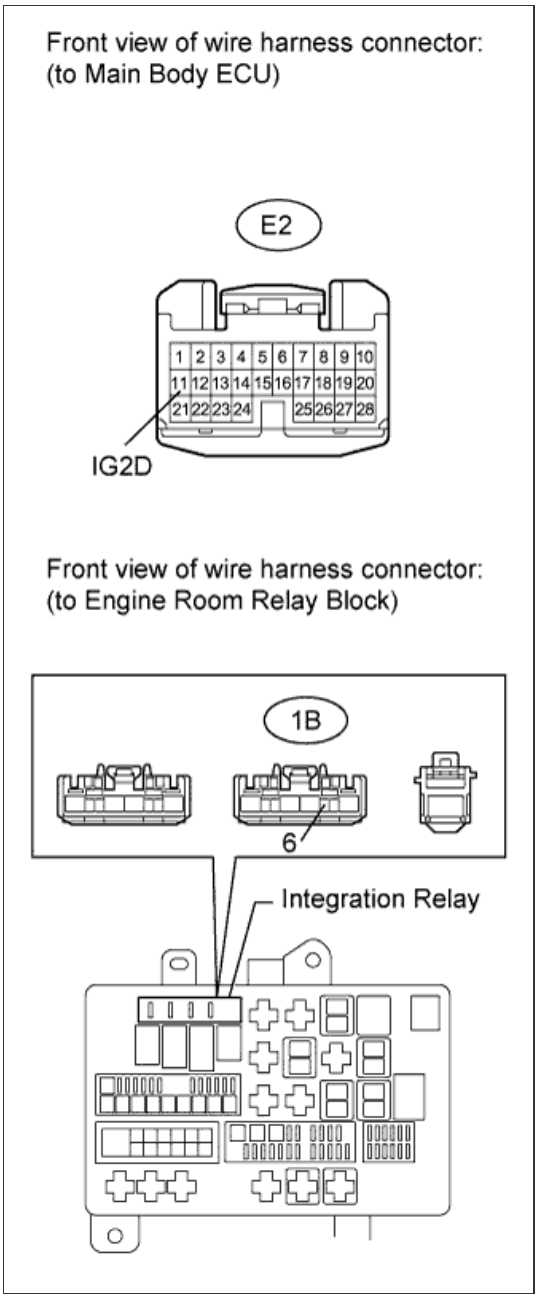
a. Remove the integration relay from the engine room relay block.

b. Disconnect the E2 main body ECU connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
E2-11 (IG2D) - 1B-6	Always	Below 1 Ω
E2-11 (IG2D) or 1B-6 - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.CHECK ENTRY AND START SYSTEM (POWER SOURCE MODE DOES NOT CHANGE)

a. Check the entry and start system (Click here).

NG → REPAIR ENTRY AND START SYSTEM

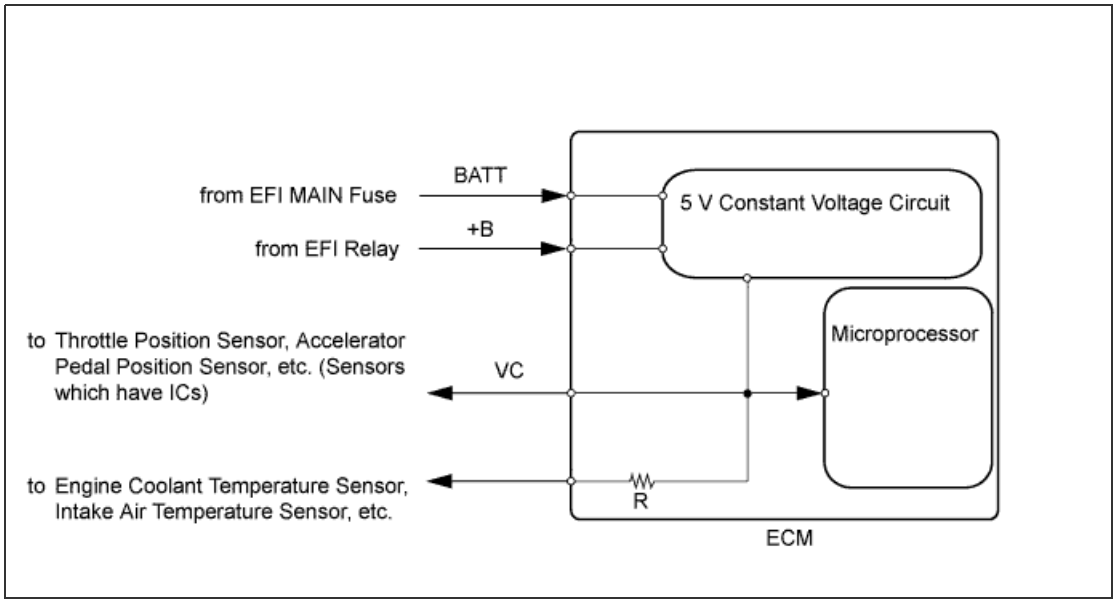
OK

REPLACE ECM (**Click here**)

for Preparation Click here

DESCRIPTION

The ECM constantly generates 5 V power from the battery voltages supplied to the +B (BATT) terminal to operate the microprocessor. The ECM also provides this power to the sensors through the VC output circuit.

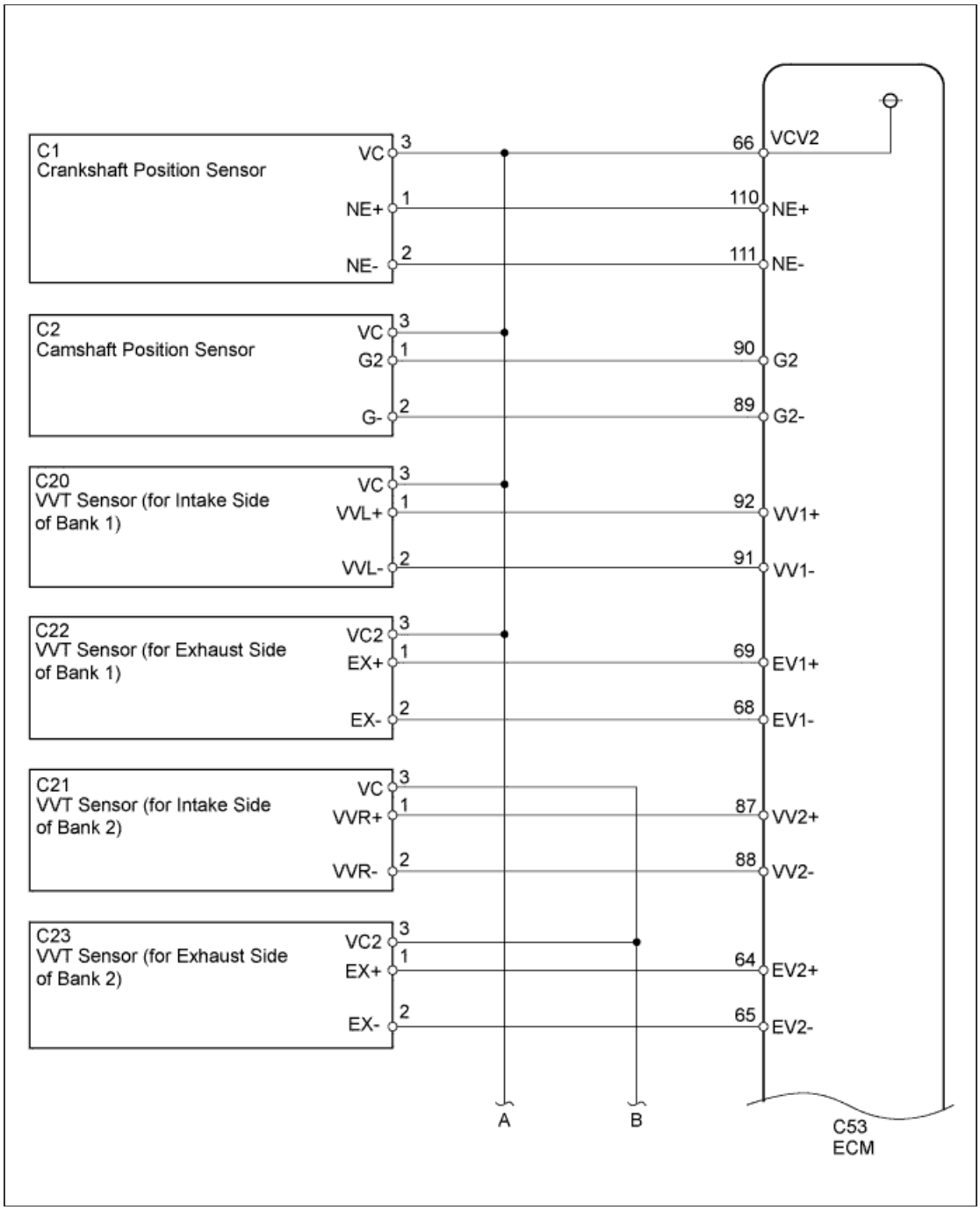


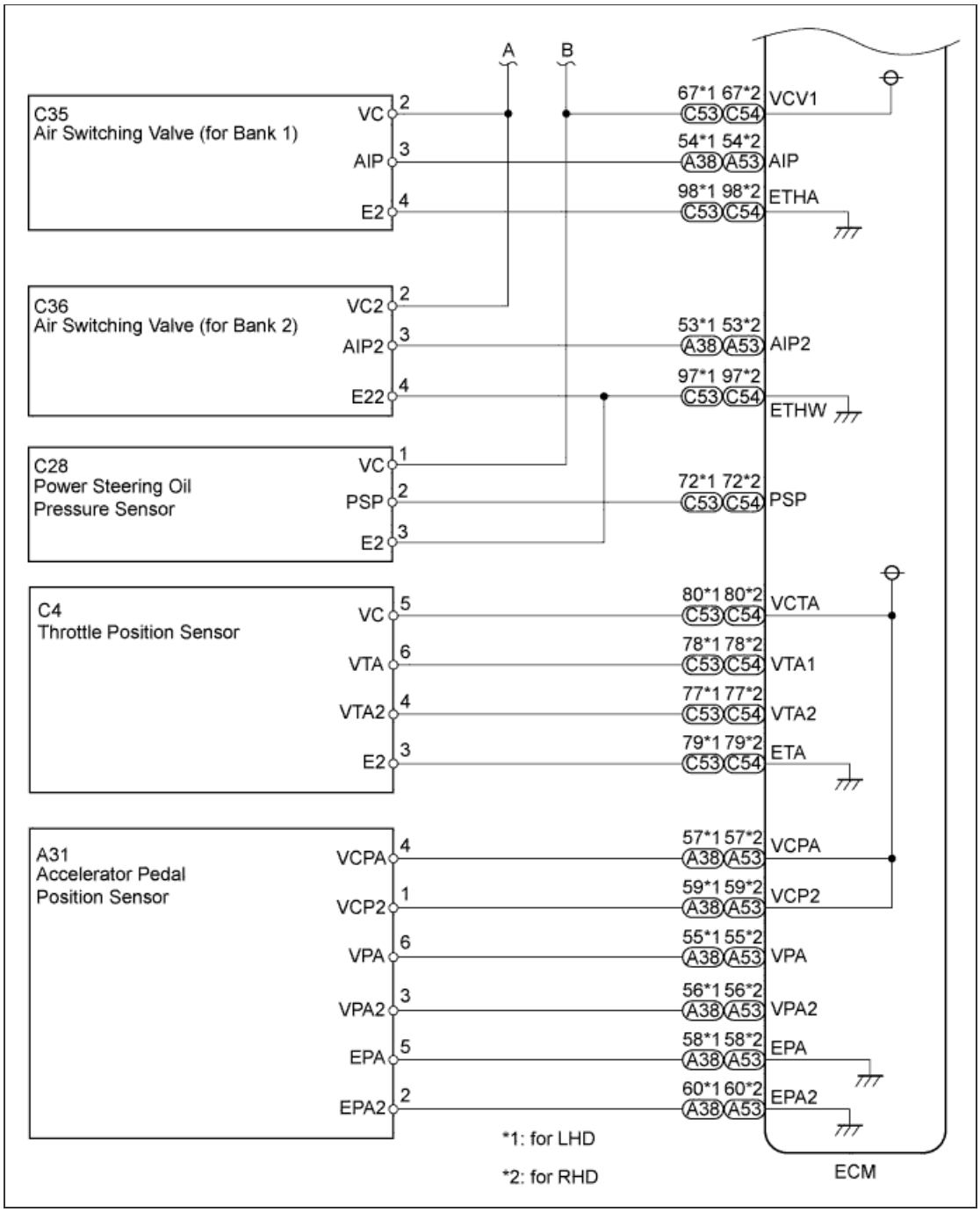
When the VC circuit is short-circuited, the microprocessor in the ECM and sensors that are supplied with power through the VC circuit are inactivated because the power is not supplied from the VC circuit. Under this condition, the system does not start up and the MIL does not illuminate even if the system malfunctions.

HINT:

Under normal conditions, the MIL is illuminated for several seconds when the engine switch is first turned on (IG). The MIL goes off when the engine is started.

WIRING DIAGRAM


C1
Crankshaft Position Sensor
VC
3
NE+
1
NE-
2
C2
Camshaft Position Sensor
VC
3
G2
1
G-
2
C20
VVT Sensor (for Intake Side of Bank 1)
VC
3
VVL+
1
VVL-
2
C22
VVT Sensor (for Exhaust Side of Bank 1)
VC2
3
EX+
1
EX-
2
C21
VVT Sensor (for Intake Side of Bank 2)
VC
3
VVR+
1
VVR-
2
C23
VVT Sensor (for Exhaust Side of Bank 2)
VC2
3
EX+
1
EX-
2
66
VCV2
110
NE+
111
NE-
90
G2
89
G2-
92
VV1+
91
VV1-
69
EV1+
68
EV1-
87
VV2+
88
VV2-
64
EV2+
65
EV2-
A
B
C53
ECM



INSPECTION PROCEDURE

1.CHECK MIL

a. Check that the Malfunction Indicator Lamp (MIL) lights up when turning the engine switch on (IG).

OK:
MIL lights up

NG → Go to step 2

OK

SYSTEM OK

2.CHECK COMMUNICATION BETWEEN INTELLIGENT TESTER AND ECM

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and tester on.

c. Check the communication between the tester and ECM.

Result

Result	Proceed to
Communication is possible	A
Communication is not possible	B

A → GO TO MIL CIRCUIT (Click here)

B

3.CHECK MIL (THROTTLE POSITION SENSOR)

a. Disconnect the C4 throttle body connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE THROTTLE BODY ASSEMBLY (Click here)

B

4.CHECK MIL (ACCELERATOR PEDAL POSITION SENSOR)

a. Disconnect the A31 accelerator pedal position sensor connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE ACCELERATOR PEDAL POSITION SENSOR (Click here)

B

5.CHECK MIL (AIR SWITCHING VALVE for Bank 1)

a. Disconnect the C35 air switching valve connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE AIR SWITCHING VALVE (Click here)

B

6.CHECK MIL (AIR SWITCHING VALVE for Bank 2)

a. Disconnect the C36 air switching valve connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE AIR SWITCHING VALVE (Click here)

B

7.CHECK MIL (POWER STEERING OIL PRESSURE SENSOR)

a. Disconnect the C28 power steering oil pressure sensor connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE POWER STEERING OIL PRESSURE SENSOR (Click here)

B

8.CHECK MIL (CAMSHAFT POSITION SENSOR)

a. Disconnect the C2 camshaft position sensor connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE CAMSHAFT POSITION SENSOR (Click here)

B

9.CHECK MIL (CRANKSHAFT POSITION SENSOR)

a. Disconnect the C1 crankshaft position sensor connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE CRANKSHAFT POSITION SENSOR (Click here)

B

10.CHECK MIL (VVT SENSOR for Intake Side of Bank 1)

a. Disconnect the C20 VVT sensor (for Intake Side of Bank 1) connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE VVT SENSOR (for Intake Side of Bank 1) (Click here)

B

11.CHECK MIL (VVT SENSOR for Exhaust Side of Bank 1)

a. Disconnect the C22 VVT sensor (for Exhaust Side of Bank 1) connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE VVT SENSOR (for Exhaust Side of Bank 1) (Click here)

B

12.CHECK MIL (VVT SENSOR for Intake Side of Bank 2)

a. Disconnect the C21 VVT sensor (for Intake Side of Bank 2) connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A → REPLACE VVT SENSOR (for Intake Side of Bank 2) (Click here)

B

13.CHECK MIL (VVT SENSOR for Exhaust Side of Bank 2)

a. Disconnect the C23 VVT sensor (for Exhaust Side of Bank 2) connector.

b. Turn the engine switch on (IG).

c. Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

A

REPLACE VVT SENSOR (for Exhaust Side of Bank 2) (Click here)

B

14.CHECK HARNESS AND CONNECTOR

a. Disconnect the C4 throttle body connector.

b. Disconnect the A31 accelerator pedal position sensor connector.

c. Disconnect the C35 air switching valve connector.

d. Disconnect the C36 air switching valve connector.

e. Disconnect the C28 power steering oil pressure sensor connector.

f. Disconnect the C2 camshaft position sensor connector.

g. Disconnect the C1 crankshaft position sensor connector.

h. Disconnect the C20 VVT sensor (for Intake Side of Bank 1) connector.

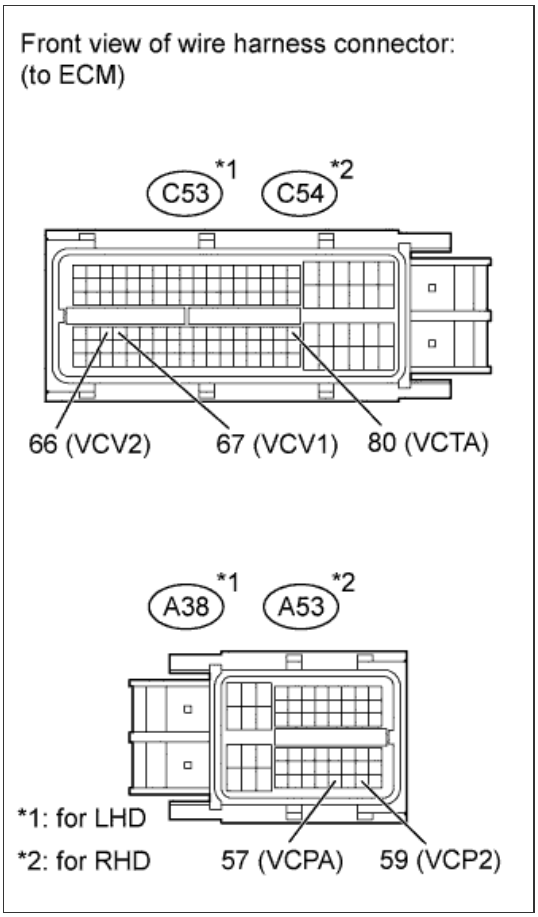
i. Disconnect the C22 VVT sensor (for Exhaust Side of Bank 1) connector.

j. Disconnect the C21 VVT sensor (for Intake Side of Bank 2) connector.

k. Disconnect the C23 VVT sensor (for Exhaust Side of Bank 2) connector.

l. Disconnect the ECM connectors.

m. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C53-80 (VCTA) - Body ground	Always	10 kΩ or higher
A38-57 (VCPA) - Body		

ground	Always	10 kΩ or higher
A38-59 (VCP2) - Body ground	Always	10 kΩ or higher
C53-66 (VCV2) - Body ground	Always	10 kΩ or higher
C53-67 (VCV1) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C54-80 (VCTA) - Body ground	Always	10 kΩ or higher
A53-57 (VCPA) - Body ground	Always	10 kΩ or higher
A53-59 (VCP2) - Body ground	Always	10 kΩ or higher
C54-66 (VCV2) - Body ground	Always	10 kΩ or higher
C54-67 (VCV1) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK → REPLACE ECM (Click here)

for Preparation Click here

DESCRIPTION

The fuel pump circuit consists of the ECM, fuel pump and fuel pump ECU (which operates the fuel pump). Based on the engine output, the ECM determines the fuel pump speed. The speed is then converted to a duty signal and sent to the fuel pump ECU. Based on the signal sent from the ECM, the fuel pump ECU adjusts the fuel pump operation speed between 3 settings.

WIRING DIAGRAM

Refer to DTC P0230 (Click here).

INSPECTION PROCEDURE

This troubleshooting procedure is based on the premise that the engine is started. If the engine is not started, proceed to the Problem Symptoms Table (Click here).

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (FUEL PUMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

d. Check whether operating sounds can be heard while operating the fuel pump using the tester.

OK:

Operating sounds can be heard from fuel pump.

NG → Go to step 5

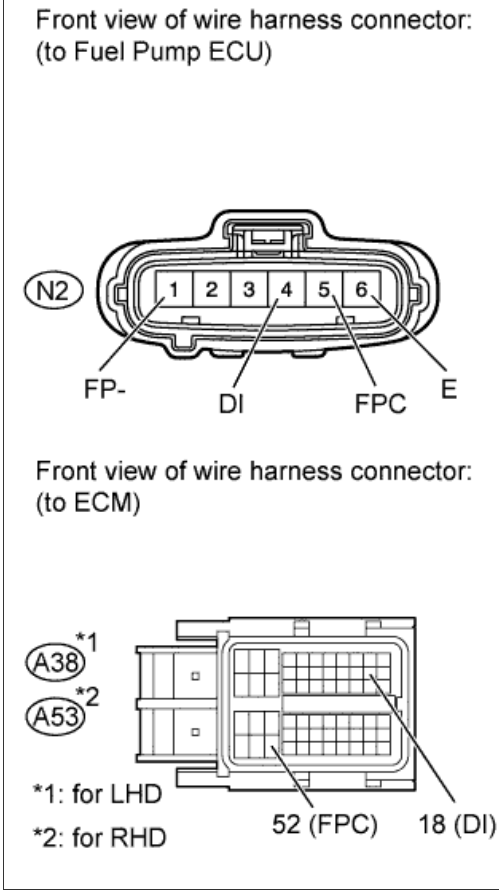
OK

2.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

4.CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

a. Check the fuel pump operation.

OK:
Malfunction has been repaired successfully.

NG → REPLACE ECM (**Click here**)

OK

END

5.INSPECT CIRCUIT OPENING RELAY (C/OPN)

a. Inspect the circuit opening relay (C/OPN) (Click here).

NG → REPLACE CIRCUIT OPENING RELAY (C/OPN)

OK

6.INSPECT CIRCUIT OPENING RELAY (POWER SOURCE VOLTAGE)

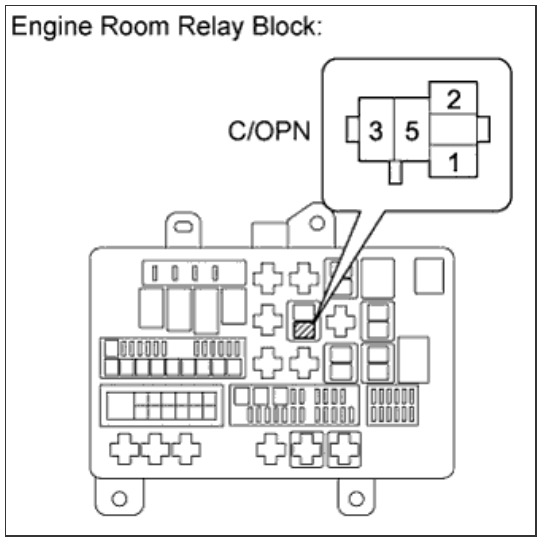
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Turn the engine switch on (IG).

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C/OPN relay (2) - Body ground	Engine switch on (IG)	11 to 14 V
C/OPN relay (5) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 13

OK

7.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY - ECU, FUEL PUMP ECU)

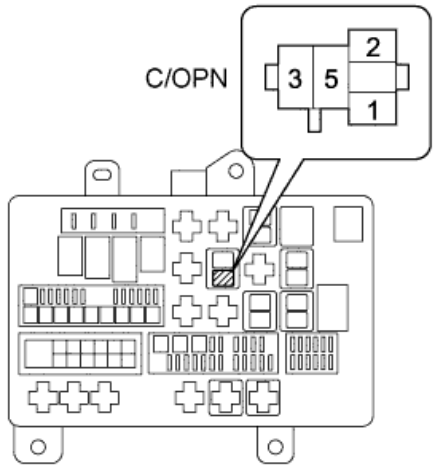
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Disconnect the A38 or A53 ECM connector.

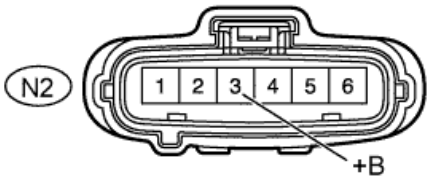
c. Disconnect the N2 fuel pump ECU connector.

d. Measure the resistance according to the value(s) in the table below.

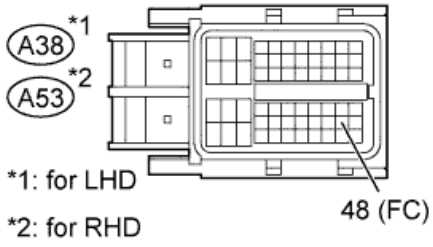
Engine Room Relay Block:



Front view of wire harness connector:
(to Fuel Pump ECU)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A38-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A38-48 (FC) - Body ground	Always	10 kΩ or higher
C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A53-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A53-48 (FC) - Body ground	Always	10 kΩ or higher

C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

8.CHECK HARNESS AND CONNECTOR (FUEL PUMP - FUEL PUMP ECU)

a. Disconnect the N1 fuel pump connector.

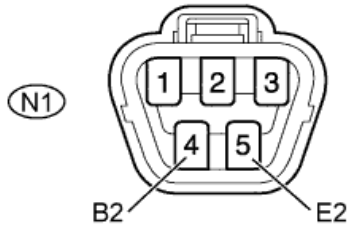
b. Disconnect the N2 fuel pump ECU connector.

c. Measure the resistance according to the value(s) in the table below.

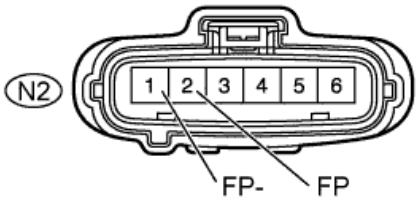
Standard Resistance:

Tester Connection	Condition	Specified Condition
N1-4 (B2) - N2-2 (FP)	Always	Below 1 Ω
N1-5 (E2) - N2-1 (FP-)	Always	Below 1 Ω
N1-4 (B2) or N2-2 (FP) - Body ground	Always	10 kΩ or higher
N1-5 (E2) or N2-1 (FP-) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Fuel Pump)



Front view of wire harness connector:
(to Fuel Pump ECU)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.INSPECT FUEL PUMP

a. Inspect the fuel pump (Click here).

NG → REPLACE FUEL PUMP (**Click here**)

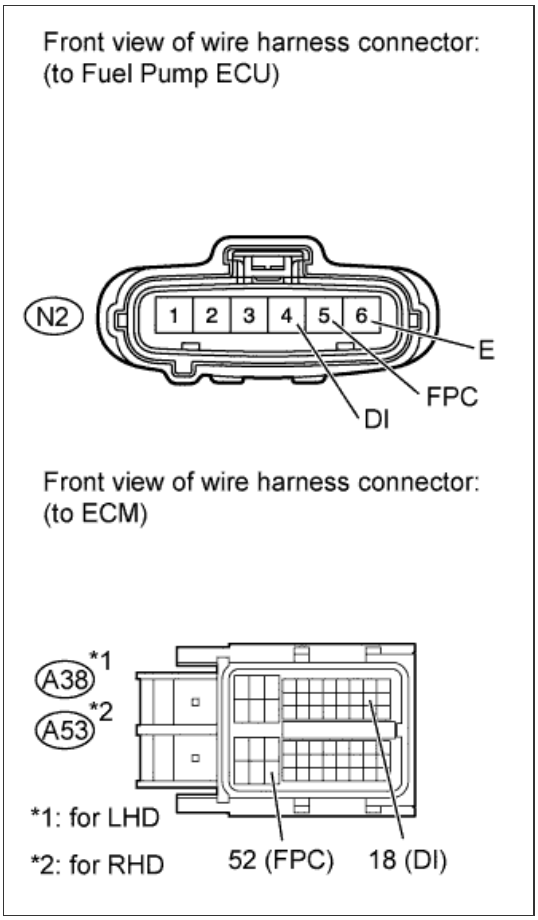
OK

10.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

11.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

12.CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

a. Check the fuel pump operation.

OK:
Malfunction has been repaired successfully.

NG → REPLACE ECM (Click here)

OK ↓

END

13.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY - EFI NO. 2 RELAY, IGN FUSE)

a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

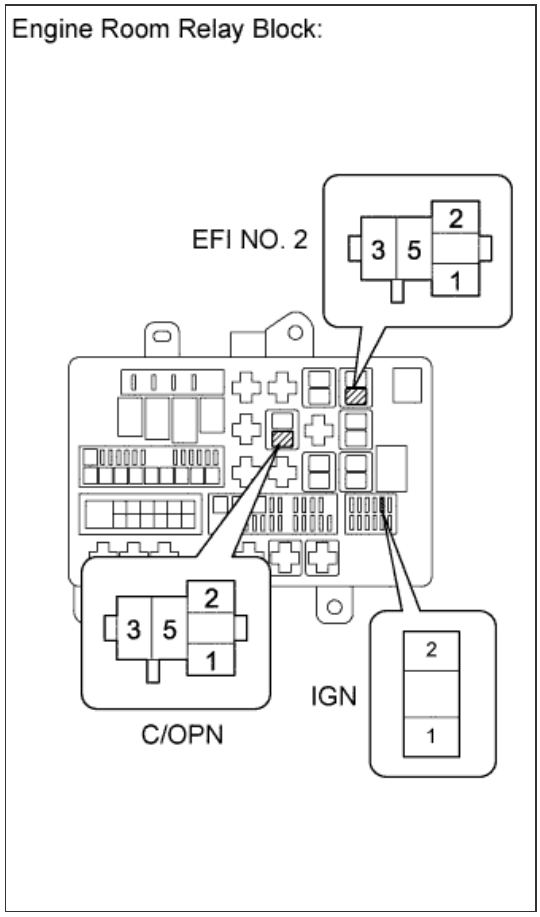
b. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

c. Remove the IGN fuse from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C/OPN relay (2) - IGN fuse (2)	Always	Below 1 Ω
C/OPN relay (5) - EFI NO. 2 relay (3)	Always	Below 1 Ω
C/OPN relay (2) or IGN fuse (2) - Body ground	Always	10 kΩ or higher
C/OPN relay (5) or EFI NO. 2 relay (3) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK ↓

14.INSPECT EFI NO. 2 RELAY (EFI NO. 2)

a. Inspect the EFI NO. 2 relay (EFI NO. 2) (Click here).

NG → REPLACE EFI NO. 2 RELAY (EFI NO. 2)

OK ↓

15.CHECK HARNESS AND CONNECTOR (EFI NO. 2 RELAY - INTEGRATION RELAY, BATTERY AND BODY GROUND)

a. Remove the EFI MAIN 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN 2 fuse	Always	Below 1 Ω

c. Reinstall the EFI MAIN 2 fuse.

d. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

e. Remove the integration relay from the engine room relay block.

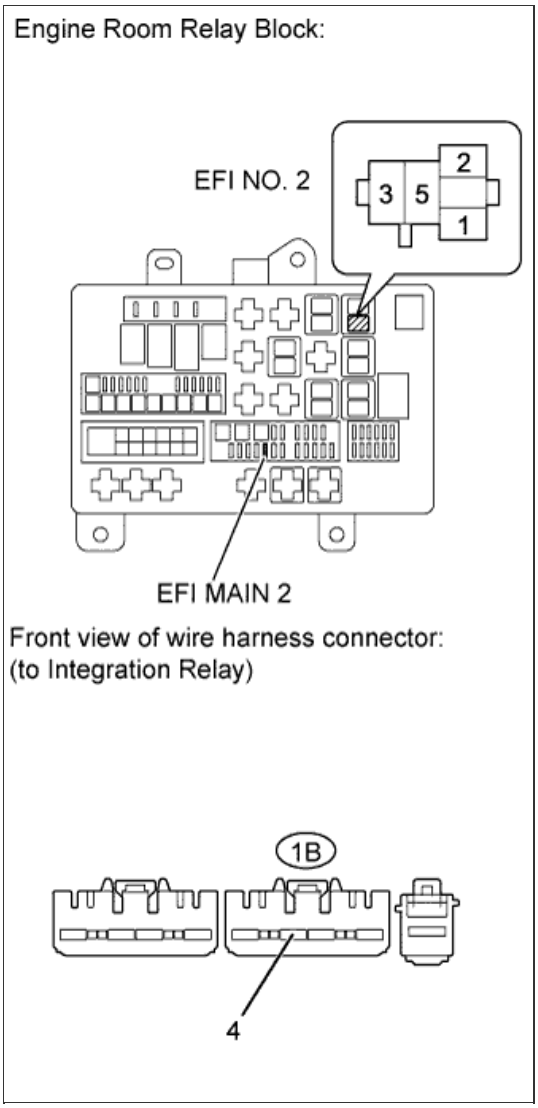
f. Disconnect the 1B integration relay connector.

g. Disconnect the cable from the battery positive (+) terminal.

h. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 relay (1) - 1B-4	Always	Below 1 Ω
EFI NO. 2 relay (5) - Positive (+) battery cable	Always	Below 1 Ω
EFI NO. 2 relay (2) - Body ground	Always	Below 1 Ω
EFI NO. 2 relay (1) or 1B-4 - Body ground	Always	10 kΩ or higher
EFI NO. 2 relay (5) or Positive (+) battery cable - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO ECM POWER SOURCE CIRCUIT (Click here)

for Preparation Click here

DESCRIPTION

The fuel pump circuit consists of the ECM, fuel pump and fuel pump ECU (which operates the fuel pump). Based on the engine output, the ECM determines the fuel pump speed. The speed is then converted to a duty signal and sent to the fuel pump ECU. Based on the signal sent from the ECM, the fuel pump ECU adjusts the fuel pump operation speed between 3 settings.

WIRING DIAGRAM

Refer to DTC P0230 (Click here).

INSPECTION PROCEDURE

This troubleshooting procedure is based on the premise that the engine is started. If the engine is not started, proceed to the Problem Symptoms Table (Click here).

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (FUEL PUMP)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

d. Check whether operating sounds can be heard while operating the fuel pump using the tester.

OK:

Operating sounds can be heard from fuel pump.

NG → Go to step 5

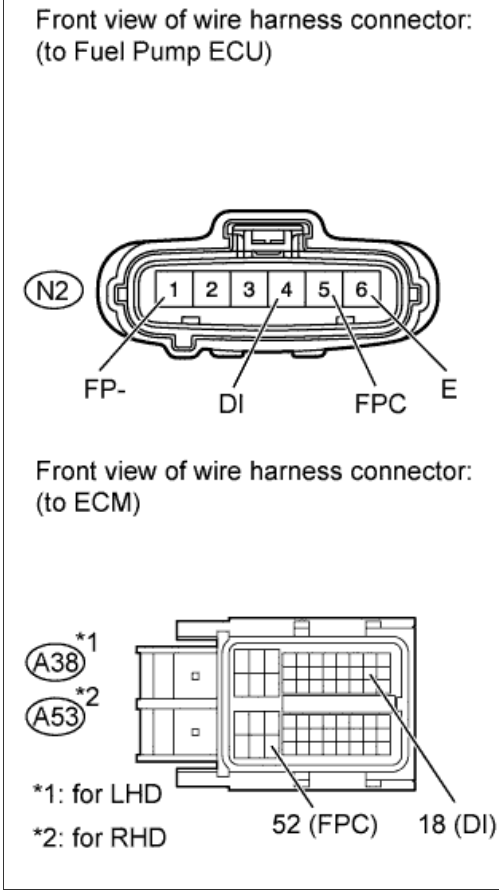
OK

2.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-1 (FP-) - Body ground	Always	10 kΩ or higher
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

4.CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

a. Check the fuel pump operation.

OK:
Malfunction has been repaired successfully.

NG → REPLACE ECM (**Click here**)

OK

END

5.INSPECT CIRCUIT OPENING RELAY (C/OPN)

a. Inspect the circuit opening relay (C/OPN) (Click here).

NG → REPLACE CIRCUIT OPENING RELAY (C/OPN)

OK

6.INSPECT CIRCUIT OPENING RELAY (POWER SOURCE VOLTAGE)

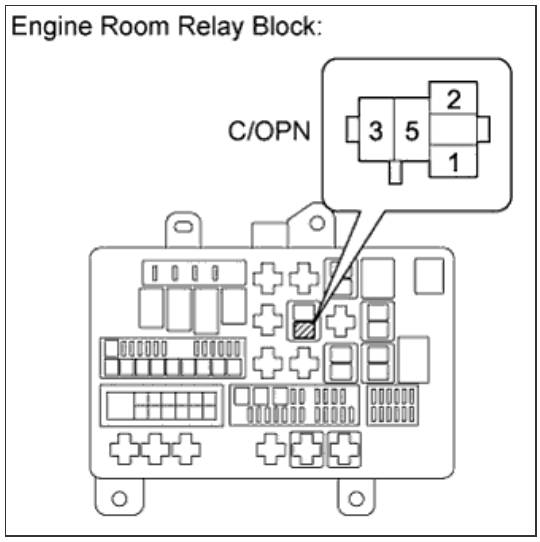
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Turn the engine switch on (IG).

c. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
C/OPN relay (2) - Body ground	Engine switch on (IG)	11 to 14 V
C/OPN relay (5) - Body ground	Engine switch on (IG)	11 to 14 V



NG → Go to step 13

OK

7.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY - ECU, FUEL PUMP ECU)

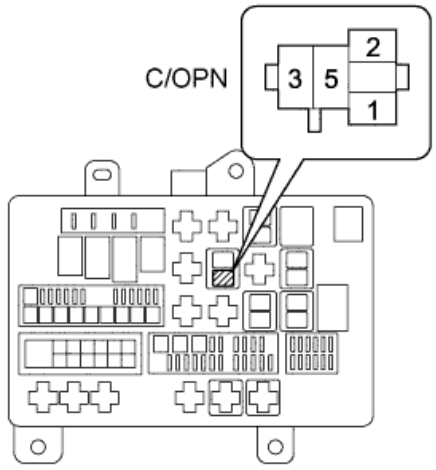
a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

b. Disconnect the A38 or A53 ECM connector.

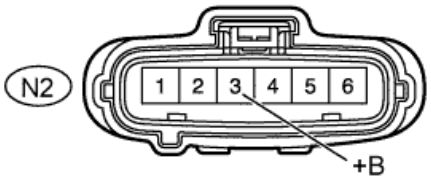
c. Disconnect the N2 fuel pump ECU connector.

d. Measure the resistance according to the value(s) in the table below.

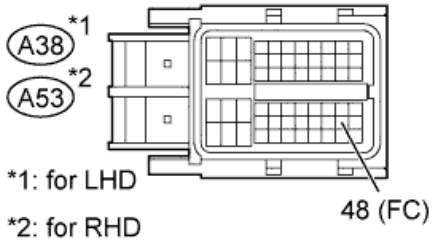
Engine Room Relay Block:



Front view of wire harness connector:
(to Fuel Pump ECU)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A38-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A38-48 (FC) - Body ground	Always	10 kΩ or higher
C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C/OPN relay (1) - A53-48 (FC)	Always	Below 1 Ω
C/OPN relay (3) - N2-3 (+B)	Always	Below 1 Ω
C/OPN relay (1) or A53-48 (FC) - Body ground	Always	10 kΩ or higher

C/OPN relay (3) or N2-3 (+B) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

8.CHECK HARNESS AND CONNECTOR (FUEL PUMP - FUEL PUMP ECU)

a. Disconnect the N1 fuel pump connector.

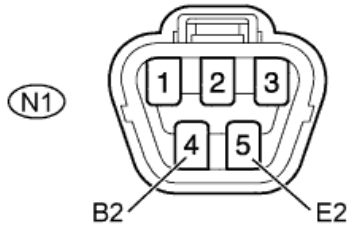
b. Disconnect the N2 fuel pump ECU connector.

c. Measure the resistance according to the value(s) in the table below.

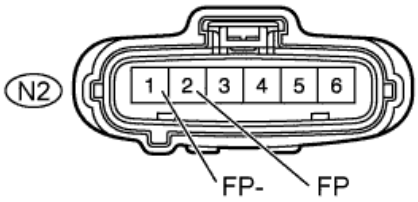
Standard Resistance:

Tester Connection	Condition	Specified Condition
N1-4 (B2) - N2-2 (FP)	Always	Below 1 Ω
N1-5 (E2) - N2-1 (FP-)	Always	Below 1 Ω
N1-4 (B2) or N2-2 (FP) - Body ground	Always	10 kΩ or higher
N1-5 (E2) or N2-1 (FP-) - Body ground	Always	10 kΩ or higher

Front view of wire harness connector:
(to Fuel Pump)



Front view of wire harness connector:
(to Fuel Pump ECU)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.INSPECT FUEL PUMP

a. Inspect the fuel pump (Click here).

NG → REPLACE FUEL PUMP (**Click here**)

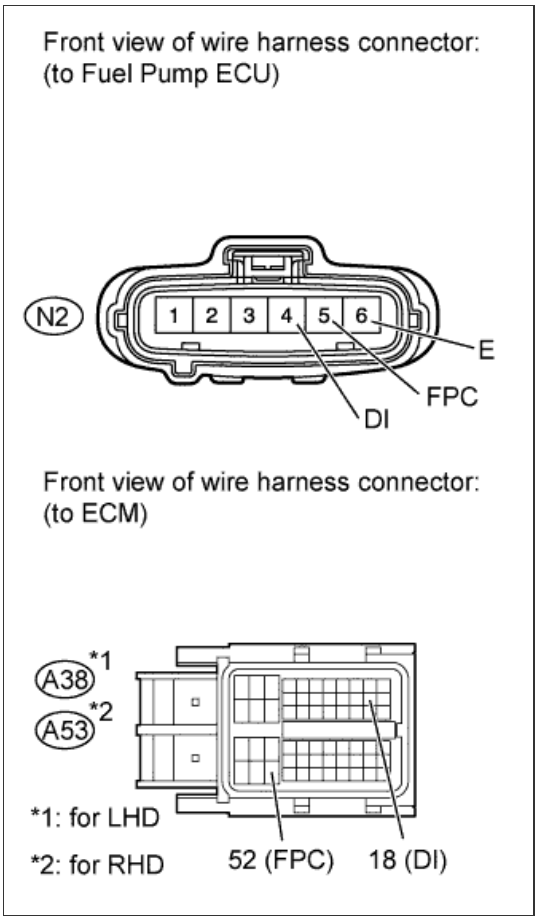
OK

10.CHECK HARNESS AND CONNECTOR (FUEL PUMP ECU - ECM, BODY GROUND)

a. Disconnect the N2 fuel pump ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A38-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A38-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A38-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A38-18 (DI) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
N2-5 (FPC) - A53-52 (FPC)	Always	Below 1 Ω
N2-4 (DI) - A53-18 (DI)	Always	Below 1 Ω
N2-6 (E) - Body ground	Always	Below 1 Ω
N2-5 (FPC) or A53-52 (FPC) - Body ground	Always	10 kΩ or higher
N2-4 (DI) or A53-18 (DI) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

11.REPLACE FUEL PUMP ECU

a. Replace the fuel pump ECU (Click here).

NEXT

12.CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

a. Check the fuel pump operation.

OK:
Malfunction has been repaired successfully.

NG → REPLACE ECM (Click here)

OK ↓

END

13.CHECK HARNESS AND CONNECTOR (CIRCUIT OPENING RELAY - EFI NO. 2 RELAY, IGN FUSE)

a. Remove the circuit opening relay (C/OPN) from the engine room relay block.

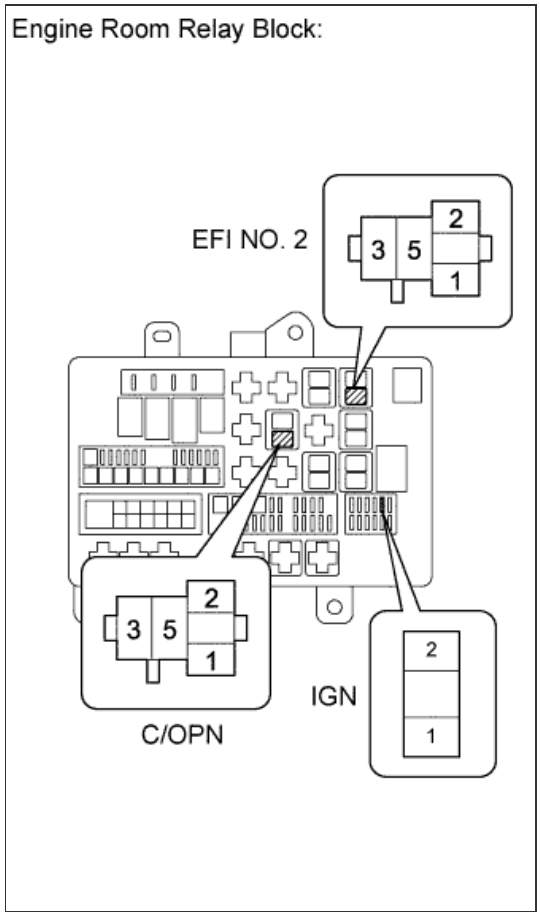
b. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

c. Remove the IGN fuse from the engine room relay block.

d. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
C/OPN relay (2) - IGN fuse (2)	Always	Below 1 Ω
C/OPN relay (5) - EFI NO. 2 relay (3)	Always	Below 1 Ω
C/OPN relay (2) or IGN fuse (2) - Body ground	Always	10 kΩ or higher
C/OPN relay (5) or EFI NO. 2 relay (3) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK ↓

14.INSPECT EFI NO. 2 RELAY (EFI NO. 2)

a. Inspect the EFI NO. 2 relay (EFI NO. 2) (Click here).

NG → REPLACE EFI NO. 2 RELAY (EFI NO. 2)

OK ↓

15.CHECK HARNESS AND CONNECTOR (EFI NO. 2 RELAY - INTEGRATION RELAY, BATTERY AND BODY GROUND)

a. Remove the EFI MAIN 2 fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN 2 fuse	Always	Below 1 Ω

c. Reinstall the EFI MAIN 2 fuse.

d. Remove the EFI NO. 2 relay (EFI NO. 2) from the engine room relay block.

e. Remove the integration relay from the engine room relay block.

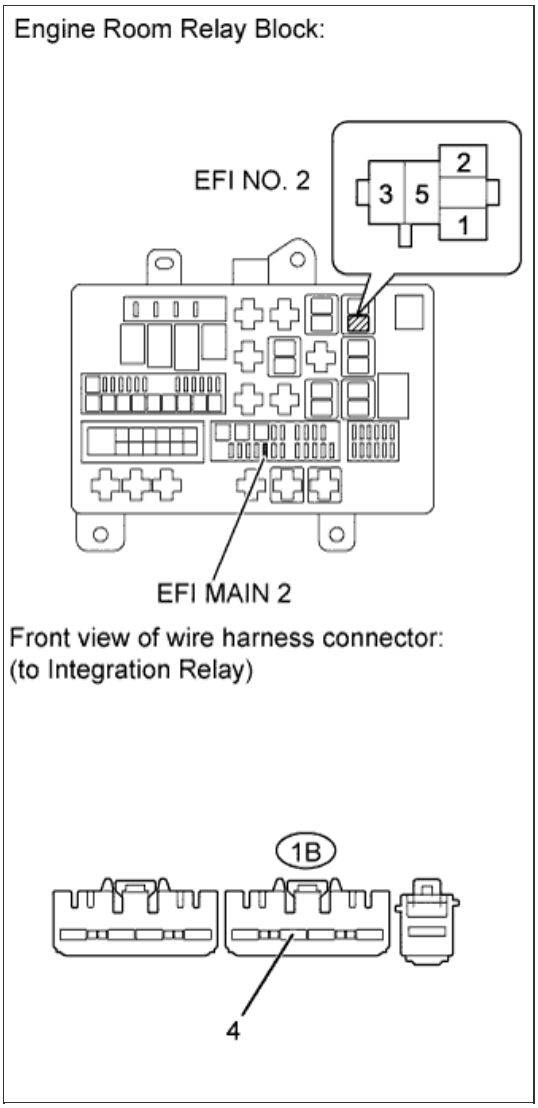
f. Disconnect the 1B integration relay connector.

g. Disconnect the cable from the battery positive (+) terminal.

h. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI NO. 2 relay (1) - 1B-4	Always	Below 1 Ω
EFI NO. 2 relay (5) - Positive (+) battery cable	Always	Below 1 Ω
EFI NO. 2 relay (2) - Body ground	Always	Below 1 Ω
EFI NO. 2 relay (1) or 1B-4 - Body ground	Always	10 kΩ or higher
EFI NO. 2 relay (5) or Positive (+) battery cable - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO ECM POWER SOURCE CIRCUIT (Click here)

for Preparation Click here

DESCRIPTION

The fuel injectors are located on the intake manifold. They inject fuel into the cylinders based on the signals from the ECM.

WIRING DIAGRAM

Refer to DTC P0300 (Click here).

INSPECTION PROCEDURE

1.CHECK INJECTOR ASSEMBLY (POWER SOURCE)

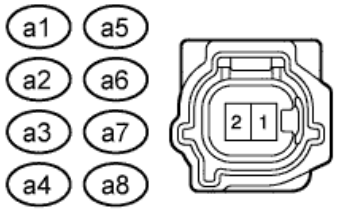
a. Disconnect the fuel injector connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Cylinder	Tester Connection	Switch Condition	Specified Condition
No. 1	a5-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 2	a1-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 3	a6-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 4	a2-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 5	a7-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 6	a3-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 7	a8-2 - Ground	Engine switch on (IG)	11 to 14 V
No. 8	a4-2 - Ground	Engine switch on (IG)	11 to 14 V

Front view of wire harness connector:
(to Injector)



NG → Go to step 4

OK

2.INSPECT FUEL INJECTOR ASSEMBLY

a. Inspect the fuel injector (Click here).

NG → REPLACE FUEL INJECTOR ASSEMBLY (Click here)

OK

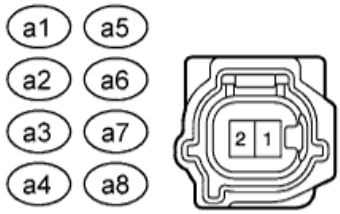
3.CHECK HARNESS AND CONNECTOR (FUEL INJECTOR ASSEMBLY - ECM)

a. Disconnect the fuel injector connector.

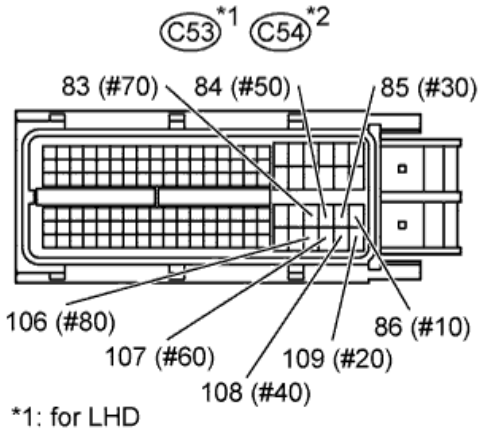
b. Disconnect the C53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Injector)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Cylinder	Tester Connection	Condition	Specified Condition
No. 1	a5-1 - Body ground	Always	10 kΩ or higher
	a5-1 - C53-86 (#10)	Always	Below 1 Ω
No. 2	a1-1 - Body ground	Always	10 kΩ or higher
	a1-1 - C53-109 (#20)	Always	Below 1 Ω
No. 3	a6-1 - Body ground	Always	10 kΩ or higher
	a6-1 - C53-85 (#30)	Always	Below 1 Ω
No. 4	a2-1 - Body ground	Always	10 kΩ or higher
	a2-1 - C53-108 (#40)	Always	Below 1 Ω
No. 5	a7-1 - Body ground	Always	10 kΩ or higher
	a7-1 - C53-84 (#50)	Always	Below 1 Ω
No. 6	a3-1 - Body ground	Always	10 kΩ or higher
	a3-1 - C53-107 (#60)	Always	Below 1 Ω
No. 7	a8-1 - Body ground	Always	10 kΩ or higher
	a8-1 - C53-83 (#70)	Always	Below 1 Ω
No. 8	a4-1 - Body ground	Always	10 kΩ or higher
	a4-1 - C53-106 (#80)	Always	Below 1 Ω

for RHD

Cylinder	Tester Connection	Condition	Specified Condition

No. 1	a5-1 - Body ground	Always	10 kΩ or higher
	a5-1 - C54-86 (#10)	Always	Below 1 Ω
No. 2	a1-1 - Body ground	Always	10 kΩ or higher
	a1-1 - C54-109 (#20)	Always	Below 1 Ω
No. 3	a6-1 - Body ground	Always	10 kΩ or higher
	a6-1 - C54-85 (#30)	Always	Below 1 Ω
No. 4	a2-1 - Body ground	Always	10 kΩ or higher
	a2-1 - C54-108 (#40)	Always	Below 1 Ω
No. 5	a7-1 - Body ground	Always	10 kΩ or higher
	a7-1 - C54-84 (#50)	Always	Below 1 Ω
No. 6	a3-1 - Body ground	Always	10 kΩ or higher
	a3-1 - C54-107 (#60)	Always	Below 1 Ω
No. 7	a8-1 - Body ground	Always	10 kΩ or higher
	a8-1 - C54-83 (#70)	Always	Below 1 Ω
No. 8	a4-1 - Body ground	Always	10 kΩ or higher
	a4-1 - C54-106 (#80)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

4.INSPECT FUSE (INJ, IG2 MAIN)

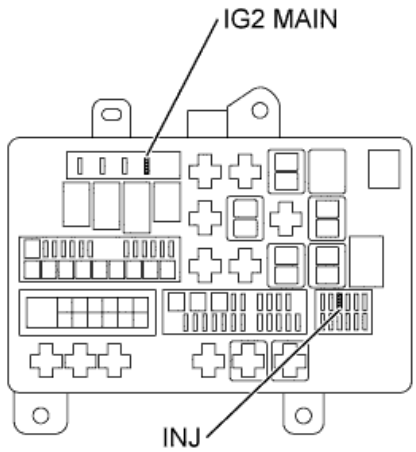
a. Remove the INJ fuse and IG2 MAIN fuse from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
INJ fuse	Always	Below 1 Ω
IG2 MAIN fuse	Always	Below 1 Ω

Engine Room Relay Block:



NG → CHECK FOR SHORT IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE

OK

5.INSPECT INTEGRATION NO.1 RELAY (IG2)

a. Inspect the integration relay (IG2) (Click here).

NG → REPLACE INTEGRATION NO.1 RELAY

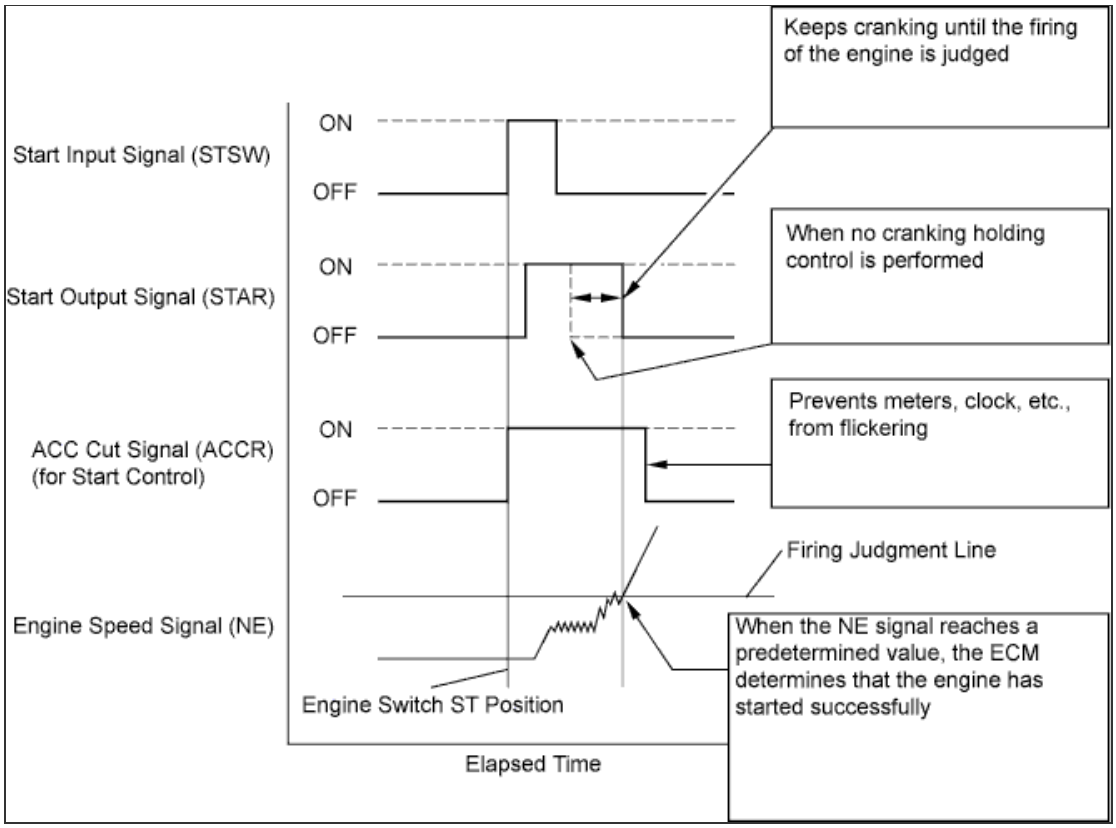
OK

REPAIR OR REPLACE HARNESS OR CONNECTOR (INTEGRATION RELAY - FUEL INJECTOR ASSEMBLY)

for Preparation Click here

DESCRIPTION

The cranking holding control system provides current to the starter when the ECM detects the engine switch start signal (STSW). When the ECM performs a firing judgment, the system cuts current to the starter. When an ECM receives the STSW signal, it turns on the ACC cut, which prevents flickering of the combination meter, clock, audio system, etc. Also, the ECM sends a signal to the ECM STAR terminal. Then the STAR output signal travels through the Park/Neutral Position (PNP) switch to the starter relay, causing the starter to activate.
When the engine is cranking, the starter operation signal is sent to the ECM STA terminal.



WIRING DIAGRAM

Refer to DTC P0617 (Click here).

INSPECTION PROCEDURE

1.CHECK CRANKING

a. Check the cranking of the engine.

Result

Result	Proceed to
Cranking possible and holding control operates	A
Does not crank	B
Cranking possible but holding control does not operate	C

B → Go to step 2

C → Go to step 11

A

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

2.READ VALUE USING INTELLIGENT TESTER (STARTER SIGNAL)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Starter Signal.

e. Check the value displayed on the tester when the engine switch is turned to the START.

Standard:

Engine Switch Position	Display (Starter Signal)
On (IG)	OFF
START	ON

NG → Go to step 7

OK

3.INSPECT STARTER RELAY (ST)

a. Inspect the starter relay (ST) (Click here).

NG → REPLACE STARTER RELAY

OK

4.CHECK HARNESS AND CONNECTOR (STARTER RELAY - PNP SWITCH)

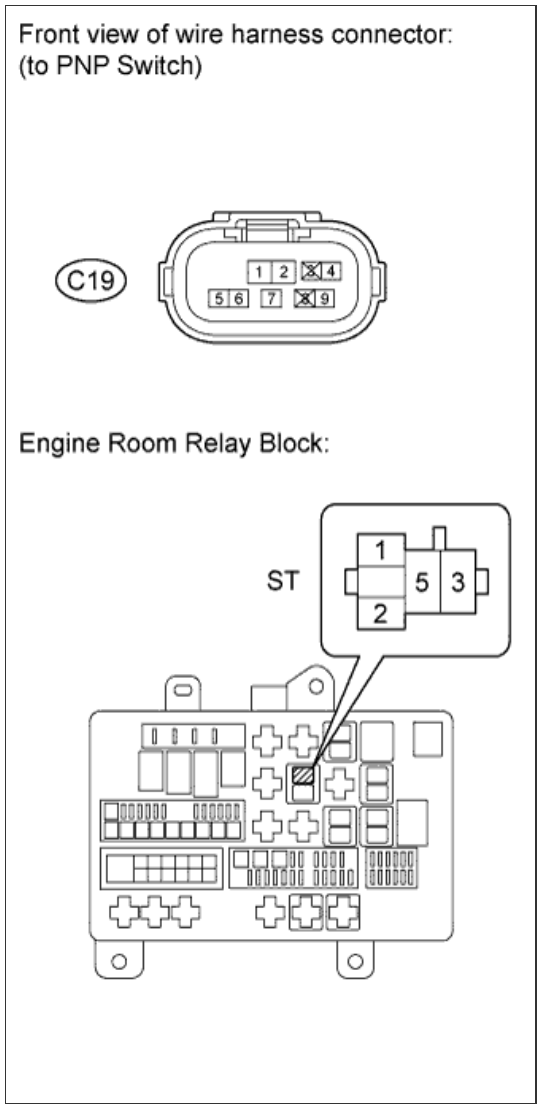
a. Remove the starter relay (ST) from the engine room relay block.

b. Disconnect the C19 PNP switch.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
ST relay (1) - C19-5	Always	Below 1 Ω
ST relay (1) or C19-5 - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

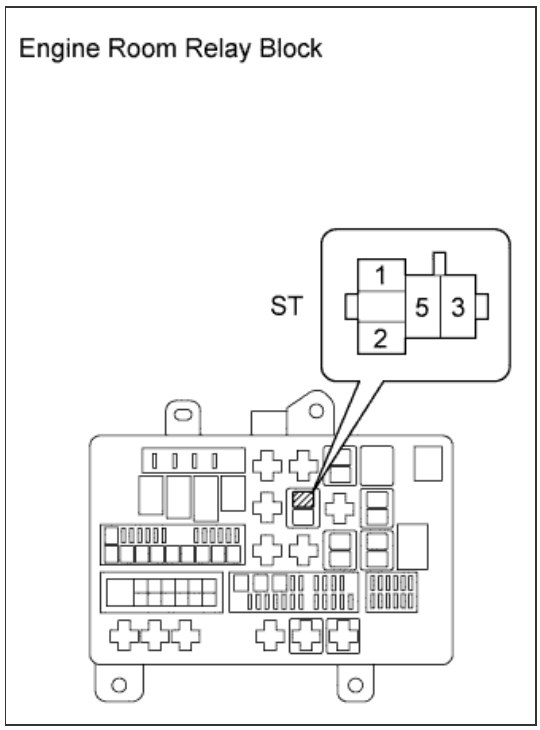
5.CHECK STARTER RELAY (POWER SOURCE)

a. Remove the ST relay from the engine room relay block.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
ST relay (2) - ST relay (5)	Always	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR (STARTER RELAY (ST) - BATTERY, BODY GROUND)

OK

6.INSPECT STARTER

a. Inspect the starter (Click here).

NG → REPAIR OR REPLACE STARTER (Click here)

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR (STARTER - STARTER RELAY (ST), BATTERY)

7.INSPECT STARTER CUT RELAY (ST CUT)

a. Inspect the starter cut relay (ST CUT) (Click here).

NG → REPLACE STARTER CUT RELAY

OK

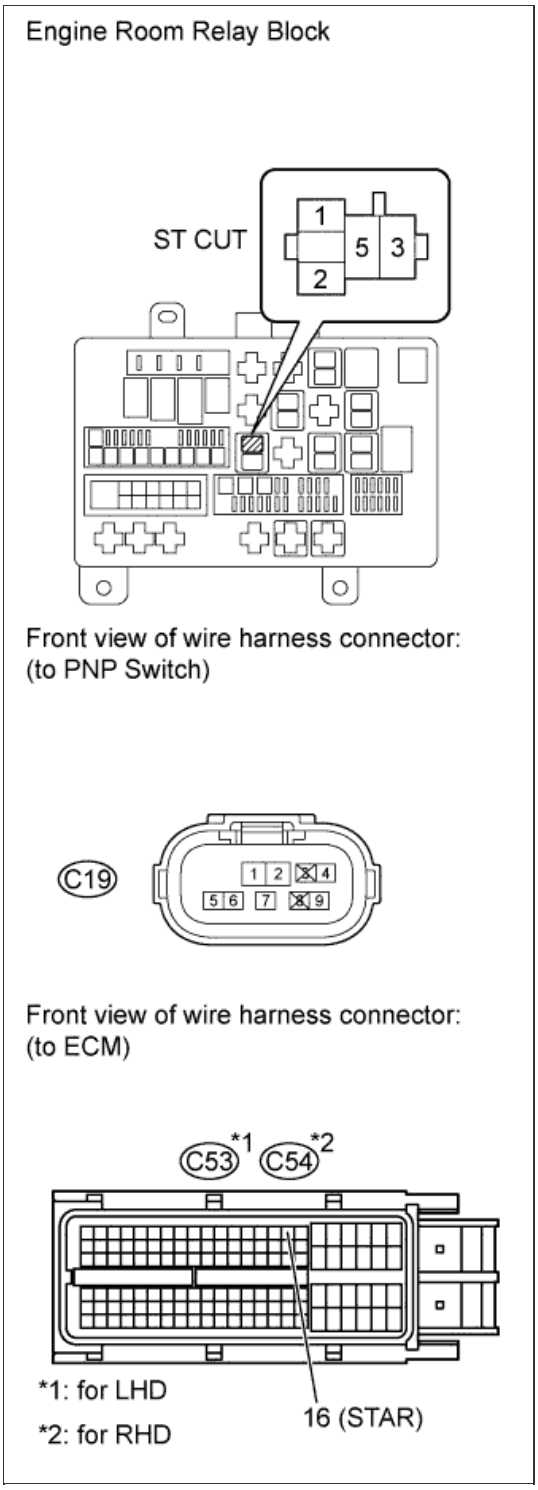
8.CHECK HARNESS AND CONNECTOR (ST CUT RELAY - PNP SWITCH, ECM)

a. Remove the starter cut relay (ST CUT) from the engine room relay block.

b. Disconnect the C19 PNP switch connector.

c. Disconnect the C53 or C54 ECM connector.

d. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C53-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C53-16 (STAR) - Body ground	Always	10 kΩ or higher
ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C54-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C54-16 (STAR) - Body ground	Always	10 kΩ or higher

ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.INSPECT PARK/NEUTRAL POSITION SWITCH

a. Inspect the park/neutral position switch (Click here).

NG → REPLACE PARK/NEUTRAL POSITION SWITCH (Click here)

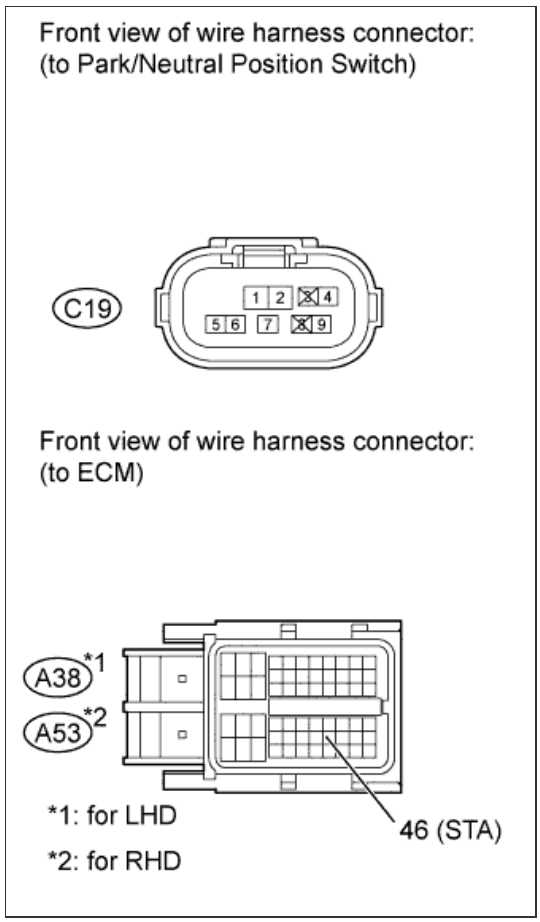
OK

10.CHECK HARNESS AND CONNECTOR (PNP SWITCH - ECM)

a. Disconnect the C19 PNP switch connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C19-5 - A38-46 (STA)	Always	Below 1 Ω
C19-5 or A38-46 (STA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C19-5 - A53-46 (STA)	Always	Below 1 Ω
C19-5 or A53-46 (STA) - Body ground	Always	10 kΩ or higher

Result

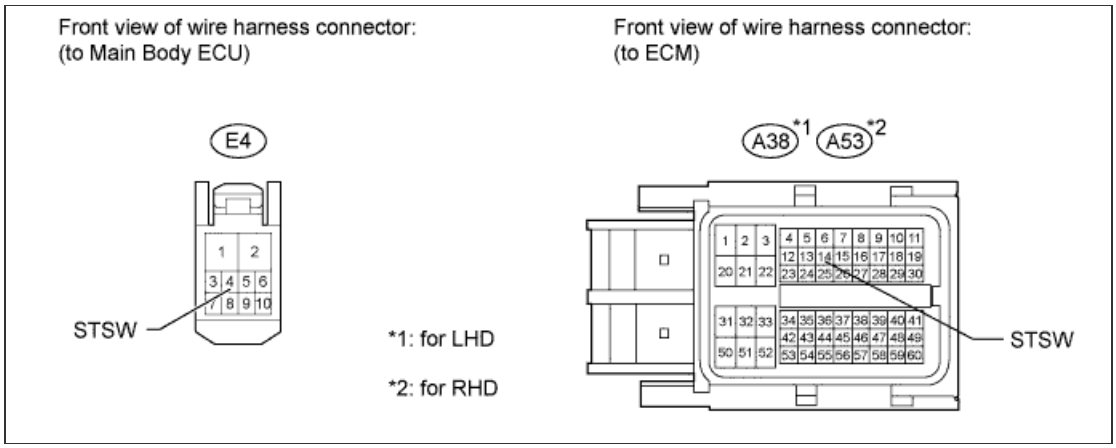
Result	Proceed to
NG	A
OK	B

B → Go to step 13

A

REPAIR OR REPLACE HARNESS OR CONNECTOR

11.CHECK HARNESS AND CONNECTOR (MAIN BODY ECU - ECM)



a. Disconnect the E4 main body ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E4-4 (STSW) - A38-14 (STSW)	Always	Below 1 Ω
E4-4 (STSW) or A38-14 (STSW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
E4-4 (STSW) - A53-14 (STSW)	Always	Below 1 Ω
E4-4 (STSW) or A53-14 (STSW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

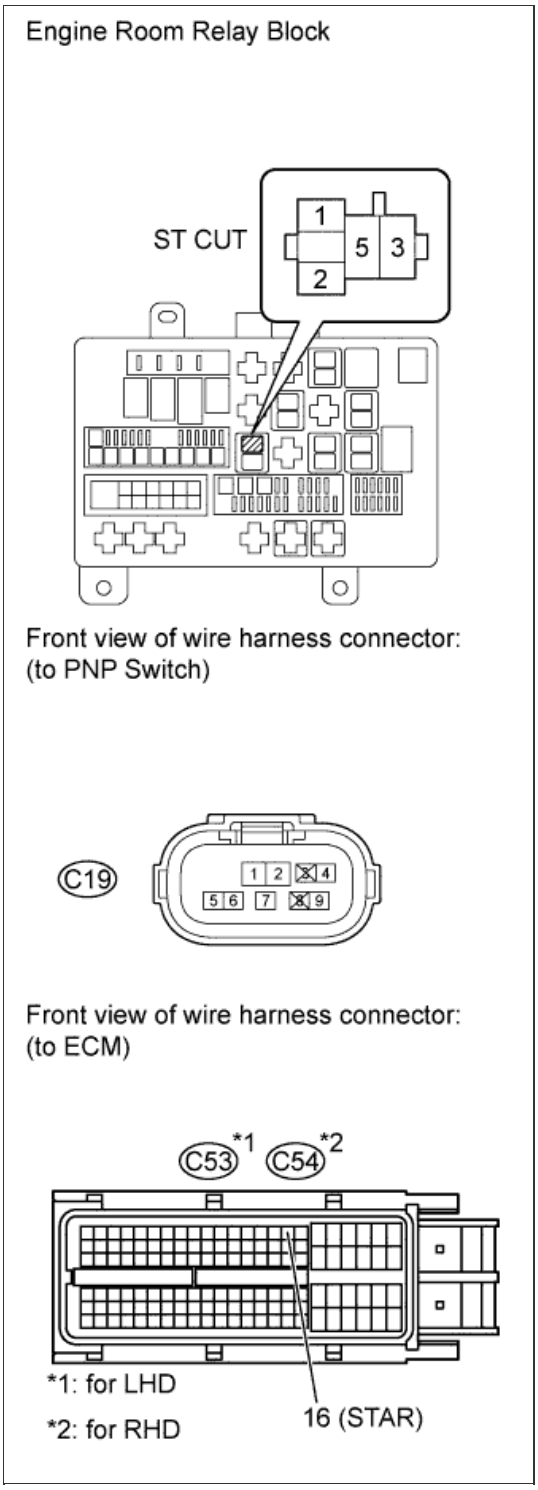
12.CHECK HARNESS AND CONNECTOR (STARTER CUT RELAY - PNP SWITCH, ECM)

a. Remove the starter cut relay (ST CUT) from the engine room relay block.

b. Disconnect the C19 PNP switch connector.

c. Disconnect the C53 or C54 ECM connector.

d. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C53-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C53-16 (STAR) - Body ground	Always	10 kΩ or higher
ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C54-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C54-16 (STAR) - Body ground	Always	10 kΩ or higher

ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK ↓

REPLACE ECM (**Click here**)

13.REPLACE ECM

a. Replace the ECM (Click here).

NEXT ↓

14.CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

a. Check the starter operation.

OK:
Malfunction has been repaired successfully.

NG → GO TO ENTRY AND START SYSTEM (ENGINE DOES NOT START) (**Click here**)

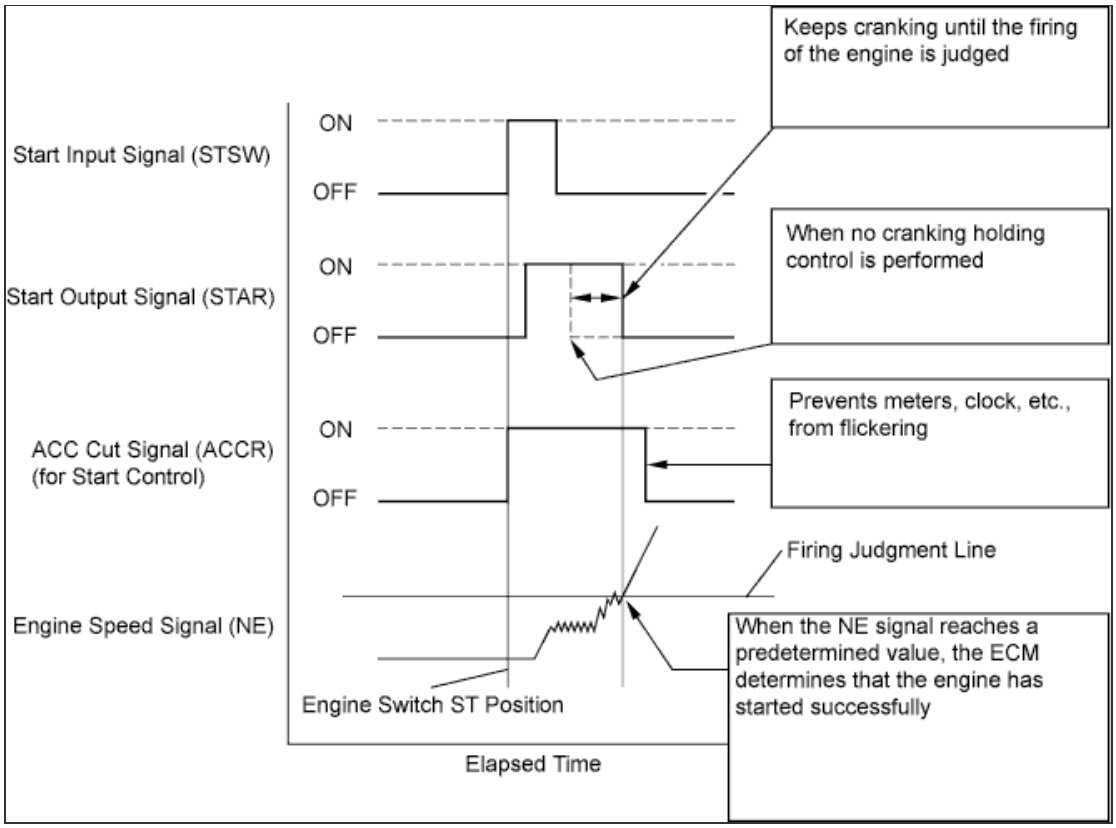
OK ↓

END

for Preparation Click here

DESCRIPTION

The cranking holding control system provides current to the starter when the ECM detects the engine switch start signal (STSW). When the ECM performs a firing judgment, the system cuts current to the starter. When an ECM receives the STSW signal, it turns on the ACC cut, which prevents flickering of the combination meter, clock, audio system, etc. Also, the ECM sends a signal to the ECM STAR terminal. Then the STAR output signal travels through the Park/Neutral Position (PNP) switch to the starter relay, causing the starter to activate.
When the engine is cranking, the starter operation signal is sent to the ECM STA terminal.



WIRING DIAGRAM

Refer to DTC P0617 (Click here).

INSPECTION PROCEDURE

1.CHECK CRANKING

a. Check the cranking of the engine.

Result

Result	Proceed to
Cranking possible and holding control operates	A
Does not crank	B
Cranking possible but holding control does not operate	C

B → Go to step 2

C → Go to step 11

A

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

2.READ VALUE USING INTELLIGENT TESTER (STARTER SIGNAL)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / Starter Signal.

e. Check the value displayed on the tester when the engine switch is turned to the START.

Standard:

Engine Switch Position	Display (Starter Signal)
On (IG)	OFF
START	ON

NG → Go to step 7

OK

3.INSPECT STARTER RELAY (ST)

a. Inspect the starter relay (ST) (Click here).

NG → REPLACE STARTER RELAY

OK

4.CHECK HARNESS AND CONNECTOR (STARTER RELAY - PNP SWITCH)

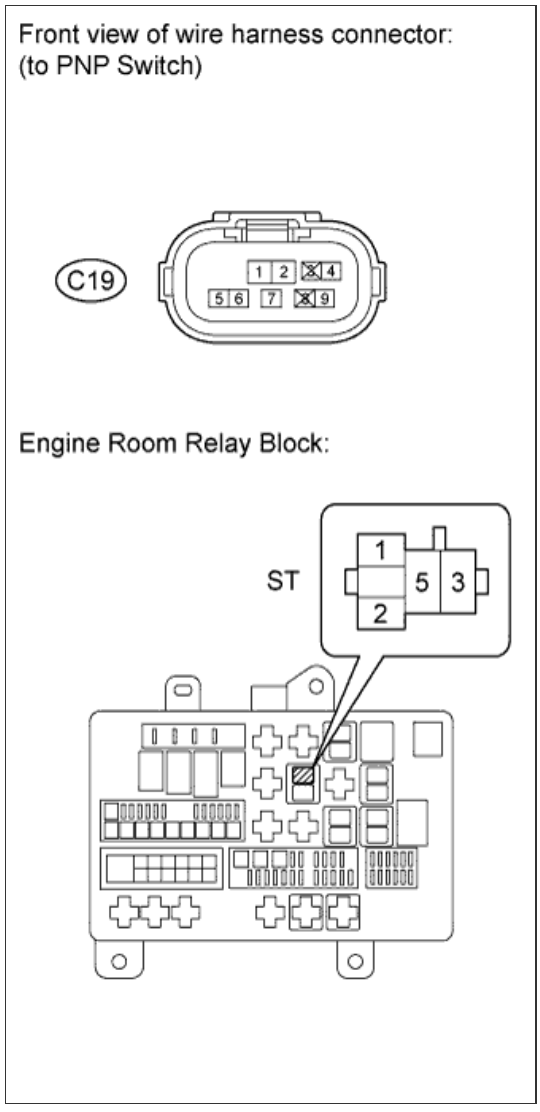
a. Remove the starter relay (ST) from the engine room relay block.

b. Disconnect the C19 PNP switch.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
ST relay (1) - C19-5	Always	Below 1 Ω
ST relay (1) or C19-5 - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

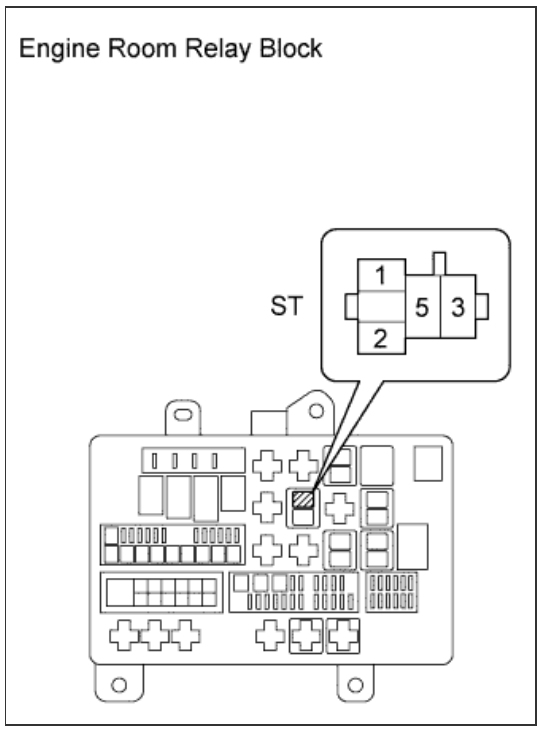
5.CHECK STARTER RELAY (POWER SOURCE)

a. Remove the ST relay from the engine room relay block.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Condition	Specified Condition
ST relay (2) - ST relay (5)	Always	11 to 14 V



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR (STARTER RELAY (ST) - BATTERY, BODY GROUND)

OK

6.INSPECT STARTER

a. Inspect the starter (Click here).

NG → REPAIR OR REPLACE STARTER (Click here)

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR (STARTER - STARTER RELAY (ST), BATTERY)

7.INSPECT STARTER CUT RELAY (ST CUT)

a. Inspect the starter cut relay (ST CUT) (Click here).

NG → REPLACE STARTER CUT RELAY

OK

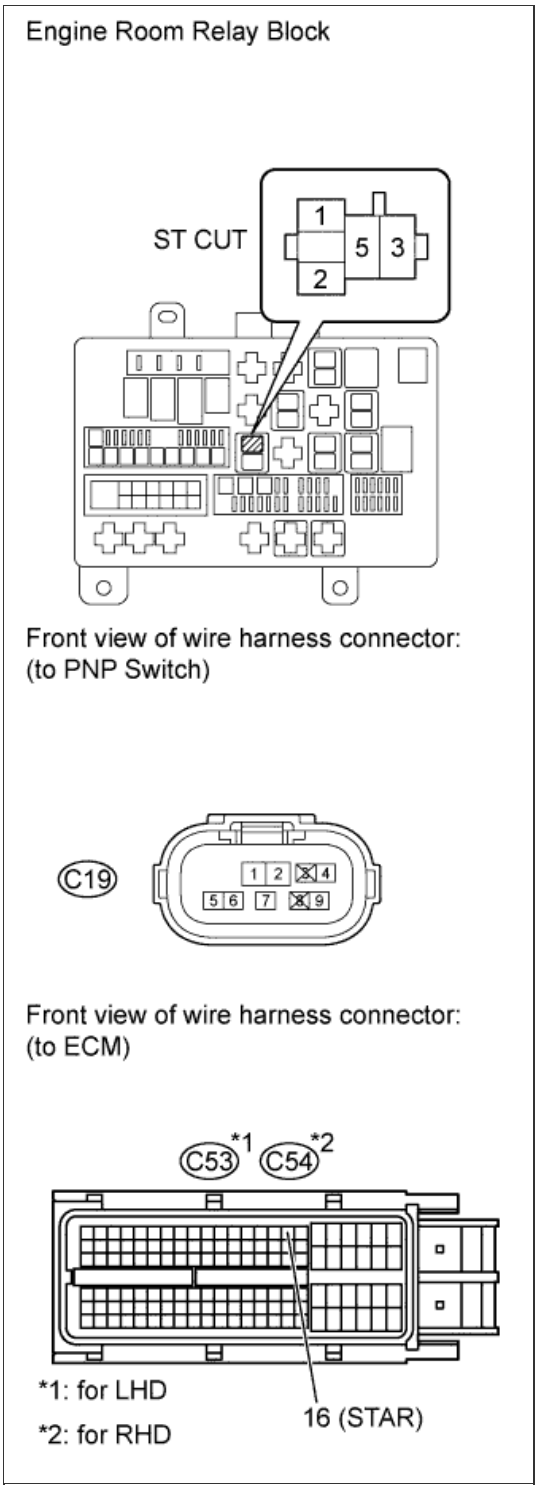
8.CHECK HARNESS AND CONNECTOR (ST CUT RELAY - PNP SWITCH, ECM)

a. Remove the starter cut relay (ST CUT) from the engine room relay block.

b. Disconnect the C19 PNP switch connector.

c. Disconnect the C53 or C54 ECM connector.

d. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C53-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C53-16 (STAR) - Body ground	Always	10 kΩ or higher
ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C54-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C54-16 (STAR) - Body ground	Always	10 kΩ or higher

ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.INSPECT PARK/NEUTRAL POSITION SWITCH

a. Inspect the park/neutral position switch (Click here).

NG → REPLACE PARK/NEUTRAL POSITION SWITCH (Click here)

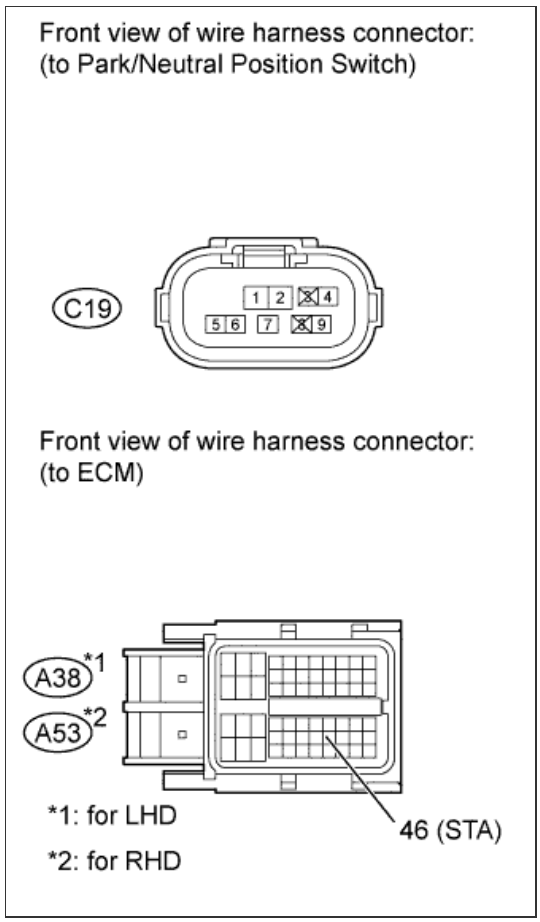
OK

10.CHECK HARNESS AND CONNECTOR (PNP SWITCH - ECM)

a. Disconnect the C19 PNP switch connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
C19-5 - A38-46 (STA)	Always	Below 1 Ω
C19-5 or A38-46 (STA) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
C19-5 - A53-46 (STA)	Always	Below 1 Ω
C19-5 or A53-46 (STA) - Body ground	Always	10 kΩ or higher

Result

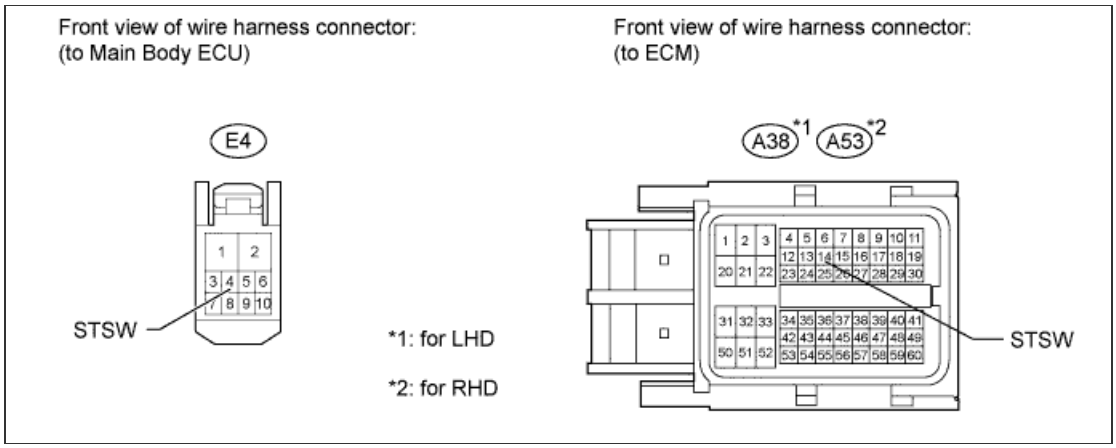
Result	Proceed to
NG	A
OK	B

B → Go to step 13

A

REPAIR OR REPLACE HARNESS OR CONNECTOR

11.CHECK HARNESS AND CONNECTOR (MAIN BODY ECU - ECM)



a. Disconnect the E4 main body ECU connector.

b. Disconnect the A38 or A53 ECM connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E4-4 (STSW) - A38-14 (STSW)	Always	Below 1 Ω
E4-4 (STSW) or A38-14 (STSW) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
E4-4 (STSW) - A53-14 (STSW)	Always	Below 1 Ω
E4-4 (STSW) or A53-14 (STSW) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

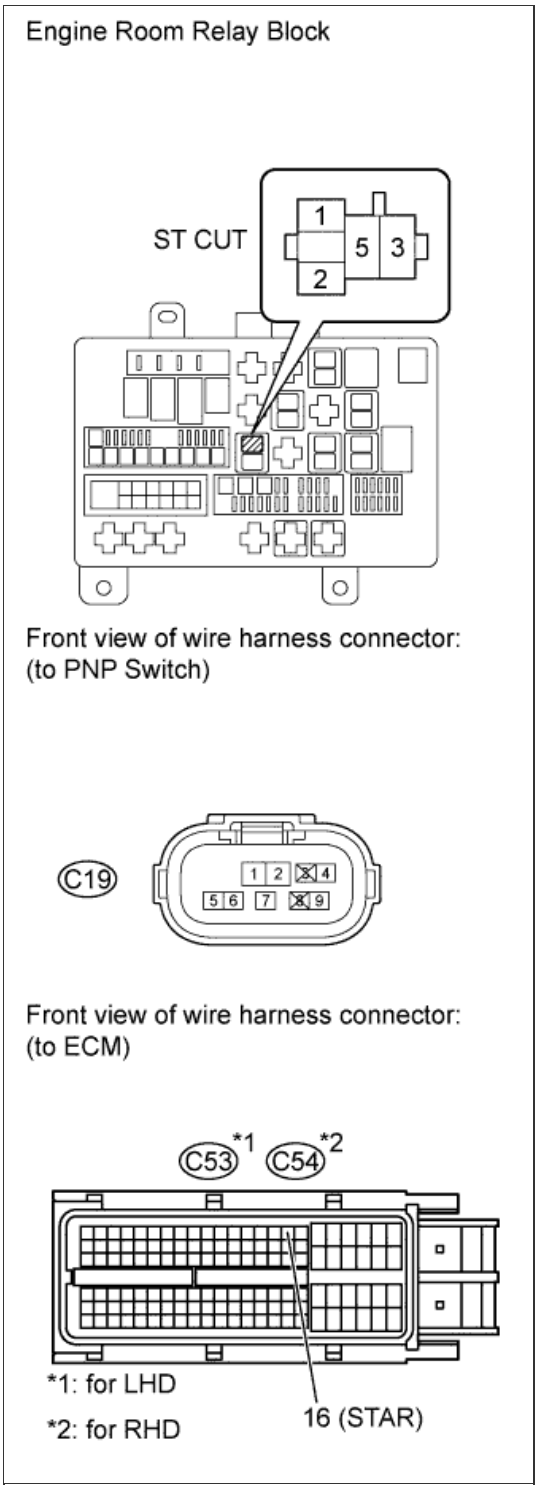
12.CHECK HARNESS AND CONNECTOR (STARTER CUT RELAY - PNP SWITCH, ECM)

a. Remove the starter cut relay (ST CUT) from the engine room relay block.

b. Disconnect the C19 PNP switch connector.

c. Disconnect the C53 or C54 ECM connector.

d. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C53-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C53-16 (STAR) - Body ground	Always	10 kΩ or higher
ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
ST CUT relay (5) - C54-16 (STAR)	Always	Below 1 Ω
ST CUT relay (3) - C19-4	Always	Below 1 Ω
ST CUT relay (5) or C54-16 (STAR) - Body ground	Always	10 kΩ or higher

ST CUT relay (3) or C19-4 - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK ↓

REPLACE ECM (**Click here**)

13.REPLACE ECM

a. Replace the ECM (Click here).

NEXT ↓

14.CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

a. Check the starter operation.

OK:
Malfunction has been repaired successfully.

NG → GO TO ENTRY AND START SYSTEM (ENGINE DOES NOT START) (**Click here**)

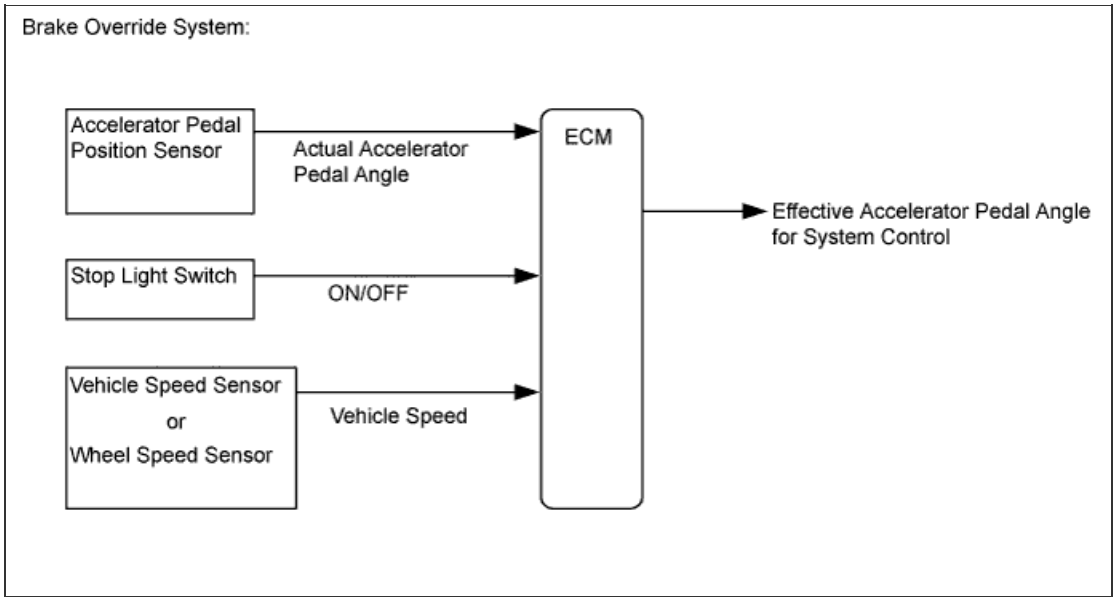
OK ↓

END

for Preparation Click here

DESCRIPTION

When the vehicle is being driven with the accelerator pedal depressed, depressing the brake pedal without releasing the accelerator pedal will activate the brake override system to restrict driving torque. The conditions for activating the brake override system as well as the items that are controlled are explained below.



Activation Conditions:

- Vehicle is running at or above the specified speed.
- The accelerator pedal is depressed beyond a specified level, and then the brake pedal is depressed.

NOTICE:

The vehicle may not enter the brake override system control due to the relation of the accelerator pedal angle and the vehicle's speed.

Items Controlled:

- Driving torque is restricted.

HINT:

During brake override system control, the value for the accelerator pedal angle (which is used for engine control) is forcibly reduced to a specified value. For this reason, the Data List value for Accelerator Position (applied to electronic throttle control) will be replaced with a specified value regardless of the actual accelerator pedal angle (Accel Sens. No. 1 Volt %, Accel Sens. No. 2 Volt %)

Deactivation Conditions:

- When the Stop Light Switch turns OFF or the actual accelerator pedal angle increases or decreases beyond the specified range.

INSPECTION PROCEDURE

Inspection Method

Drive at 10 km/h (6.25 mph), depress the accelerator pedal by 1/2 to 3/4 and keep it in that position. Under these conditions, if the engine speed decreases to 1000 rpm when the brake pedal is depressed, and then the brake override system has been activated.

CAUTION:

When carrying out the inspection, use a place where you are able to carry it out safely and also pay close attention to your surroundings.

Also, when driving make absolutely sure that all road traffic laws, such as speed limits, are observed.

HINT:

- **Under normal conditions, the Accelerator Position value changes in response to the Accel Sens. No. 1 Volt % value. For more information on the numerical values, refer to the Data List (Click here).**
- **If the Data List values of Accelerator Position and Accel Sens. No. 1 Volt % do not match, and the value of Accelerator Position changes but the value of Accel Sens. No. 1 Volt % is constant, this confirms that the brake override system has activated. (Data can be captured relatively easily by using the snapshot function in the Data List. Confirm the data after performing the driving test.)**

NOTICE:

The brake override system restricts driving torque if the brake pedal is depressed when driving with the accelerator pedal depressed. If a customer reports experiencing loss of torque after the accelerator and brake pedals have both been intentionally depressed, explain to the customer that this is not a malfunction, and that the customer should avoid depressing both the accelerator and brake pedals at the same time.

Example: While operating the accelerator pedal, the customer uses their left foot to operate the brake pedal.

1.CHECK DTC OUTPUT

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the intelligent tester on.

c. Enter the following menus: System Select / Health Check.

d. Check DTCs.

Result

Result	Proceed to
No DTC output	A
DTC output	B

B → GO TO DTC CHART

A

2.READ VALUE USING INTELLIGENT TESTER (STOP LIGHT SWITCH AND ST1)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the intelligent tester on.

c. Enter the following menus: Powertrain / Engine / Data List / Stop Light Switch and ST1.

d. Check the Data List indication when the brake pedal is depressed and released.

OK:

Tester Display	Condition	Specified Condition
Stop Light Switch	Brake pedal released	OFF
	Brake pedal depressed	ON
ST1	Brake pedal released	OFF
	Brake pedal depressed	ON

NG → INSPECT STOP LIGHT SWITCH ASSEMBLY (Click here)

OK

3.INSPECT BRAKE PEDAL

a. Inspect and adjust the brake pedal (for LHD) (Click here).

b. Inspect and adjust the brake pedal (for RHD) (Click here).

HINT:

If the stop light switch turns ON too late, the start of brake override system control may be delayed; if it turns ON too soon, brake override system control may begin too early, so conduct inspection of the brake pedal and stop light switch assembly.

Result

Result	Result
OK	A
NG (for LHD)	B
NG (for RHD)	C

B → REPAIR OR REPLACE BRAKE PEDAL (Click here)

C → REPAIR OR REPLACE BRAKE PEDAL (Click here)

A

4.READ VALUE USING INTELLIGENT TESTER (ACCELERATOR PEDAL POSITION SENSOR)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the intelligent tester on.

c. Enter the following menus: Powertrain / Engine / Data List / Accel Sens. No. 1 Volt % and Accel Sens. No. 2 Volt %.

d. Read the value displayed on the intelligent tester.

OK:

Tester Display	Condition	Specified Condition
Accel Sens. No. 1 Volt %	Accelerator Pedal Released → Depressed → Released	Values smoothly change following accelerator pedal operation
Accel Sens. No. 2 Volt %		

HINT:

For numerical values of Accel Sens. No. 1 Volt % and Accel Sens. No. 2 Volt %, refer to the Data List (Click here).

NG → REPLACE ACCELERATOR PEDAL SENSOR ASSEMBLY (Click here)

OK

5.READ VALUE USING INTELLIGENT TESTER (VEHICLE SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the intelligent tester on.

c. Start the engine.

d. Enter the following menus: Powertrain / Engine / Data List / Vehicle Speed.

e. Read the value displayed on the intelligent tester.

Standard:

Tester Display	Condition	Specified Condition
Vehicle Speed	Vehicle stopped, engine running	0 km/h (0 mph)
	Vehicle running at constant speed between 16.1 to 64.4 km/h (10 to 40 mph)	No large fluctuations when driving at a constant speed

CAUTION:

When performing the confirmation driving pattern, obey all speed limits and traffic laws.

HINT:

Data can be captured relatively easily by using the snapshot function in the Data List. Confirm the data after performing the drive test.

NG → GO TO VEHICLE SPEED SENSOR "A" (Click here)

OK

6.READ VALUE USING INTELLIGENT TESTER (FR, FL, RR, RL WHEEL SPEED)

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the intelligent tester on.

c. Start the engine.

d. Enter the following menus: Chassis / ABS/VSC/TRC / Data List / FR Wheel Speed, FL Wheel Speed, RR Wheel Speed and RL Wheel Speed.

e. Read the value displayed on the intelligent tester.

Standard:

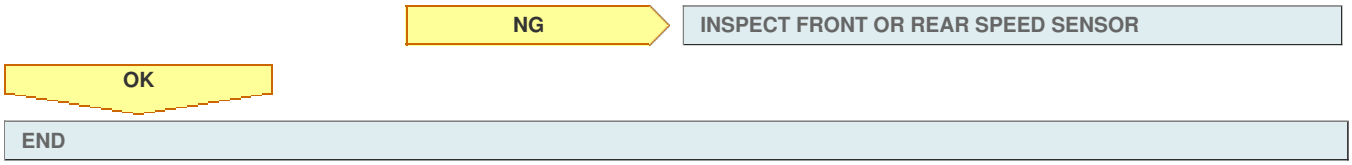
Tester Display	Condition	Specified Condition
FR Wheel Speed FL Wheel Speed RR Wheel Speed RL Wheel Speed	Vehicle stopped, engine running	0 km/h (0 mph)
	Vehicle running at constant speed between 16.1 to 64.4 km/h (10 to 40 mph)	No large fluctuations when driving at a constant speed

CAUTION:

When performing the confirmation driving pattern, obey all speed limits and traffic laws.

HINT:

Data can be captured relatively easily by using the snapshot function in the Data List. Confirm the data after performing the drive test.

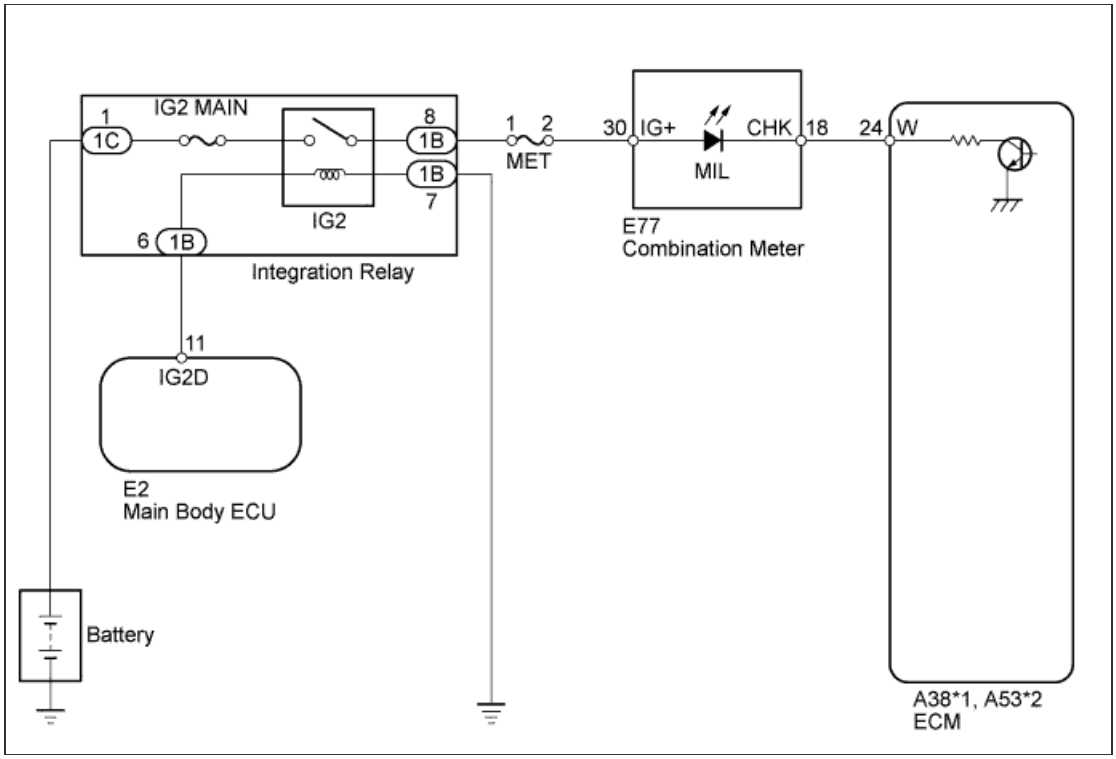


for Preparation Click here

DESCRIPTION

The MIL (Malfunction Indicator Lamp) is used to indicate vehicle malfunction detections by the ECM. When the engine switch is turned on (IG), power is supplied to the MIL circuit, and the ECM provides the circuit ground which illuminates the MIL.
The MIL operation can be checked visually: When the engine switch is first turned on (IG), the MIL should be illuminated and should then turn off when the engine is started. If the MIL remains illuminated or is not illuminated, conduct the following troubleshooting procedure using the intelligent tester.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.CHECK THAT MIL IS ILLUMINATED

a. Perform troubleshooting in accordance with the table below.

Result

Result	Proceed to
MIL remains ON	A
MIL does not illuminate	B

B → Go to step 5

A

2.CHECK WHETHER MIL TURNS OFF

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Check if any DTCs are output. Note down any DTCs.

e. Clear DTCs (Click here).

f. Check if the MIL goes off.

Standard:
MIL goes off

NG → Go to step 3

OK

REPAIR CIRCUITS INDICATED BY OUTPUT DTCS (Click here)

3.CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT IN WIRE HARNESS)

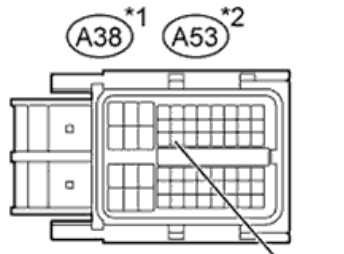
a. Disconnect the A38 or A53 ECM connector.

b. Turn the engine switch on (IG).

c. Check that the MIL is not illuminated.

OK:
MIL is not illuminated.

Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

NG → Go to step 4

OK

REPLACE ECM (Click here)

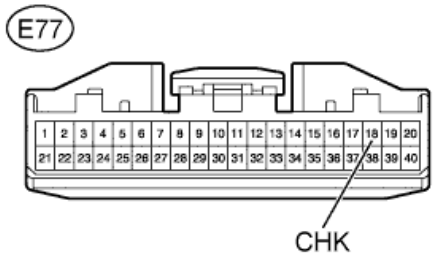
4.CHECK HARNESS AND CONNECTOR (COMBINATION METER - ECM)

a. Disconnect the A38 or A53 ECM connector.

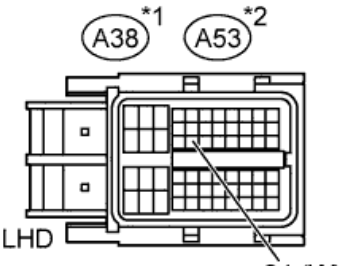
b. Disconnect the E77 combination meter connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Combination Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A38-24 (W) or E77-18 (CHK) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A53-24 (W) or E77-18 (CHK) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK ↓

REPLACE COMBINATION METER ASSEMBLY (Click here)

5.CHECK THAT MIL IS ILLUMINATED

a. Check if the MIL is illuminated when the engine switch is turned on (IG).

OK:
MIL is illuminated.

NG → Go to step 6

OK ↓

SYSTEM OK

6.CHECK THAT ENGINE STARTS

a. Turn the engine switch on (IG).

b. Start the engine.

Result

Result	Proceed to
Engine starts	A
Engine does not start*	B

HINT:

*: The intelligent tester cannot communicate with the ECM.

B → GO TO VC OUTPUT CIRCUIT (Click here)

A ↓

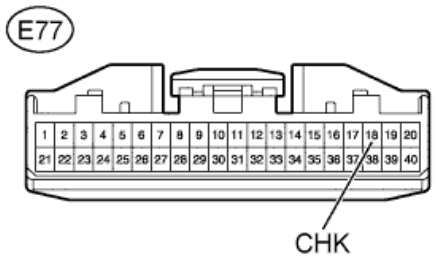
7.CHECK HARNESS AND CONNECTOR (COMBINATION METER - ECM)

a. Disconnect the A38 or A53 ECM connector.

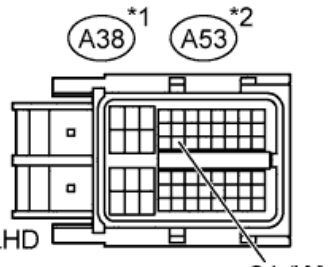
b. Disconnect the E77 combination meter connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Combination Meter)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A38-24 (W) - E77-18 (CHK)	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
A53-24 (W) - E77-18 (CHK)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

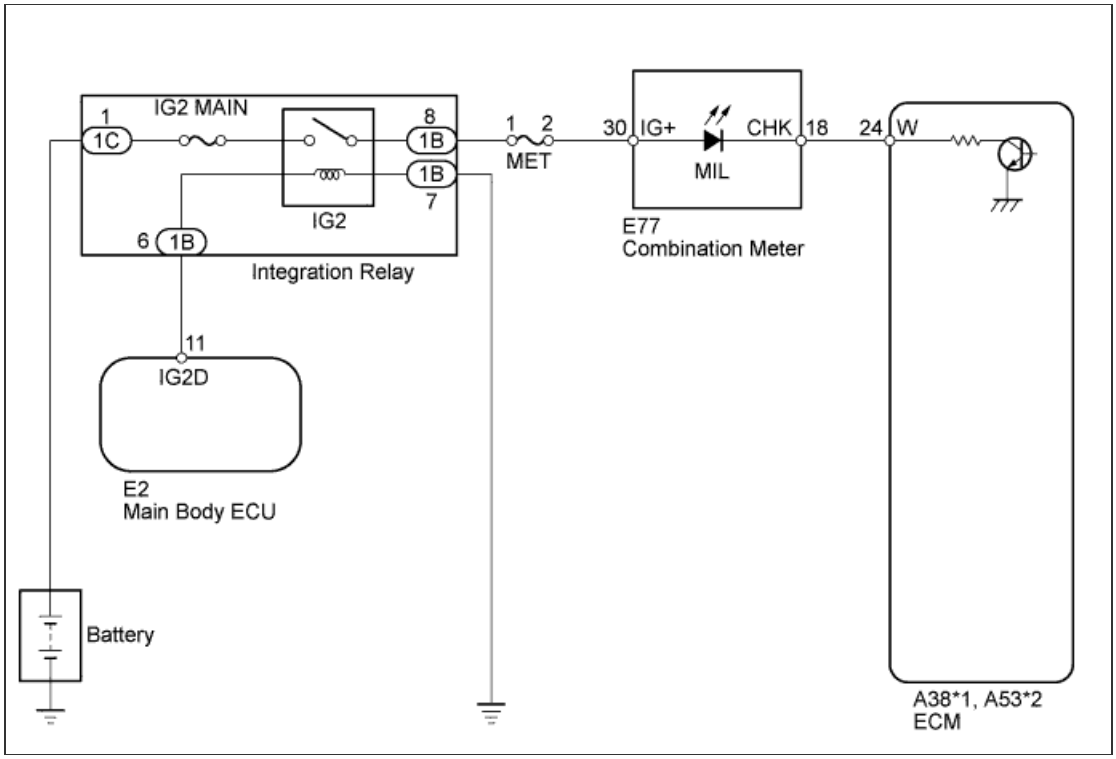
OK → REPLACE COMBINATION METER ASSEMBLY (Click here)

for Preparation Click here

DESCRIPTION

The MIL (Malfunction Indicator Lamp) is used to indicate vehicle malfunction detections by the ECM. When the engine switch is turned on (IG), power is supplied to the MIL circuit, and the ECM provides the circuit ground which illuminates the MIL.
The MIL operation can be checked visually: When the engine switch is first turned on (IG), the MIL should be illuminated and should then turn off when the engine is started. If the MIL remains illuminated or is not illuminated, conduct the following troubleshooting procedure using the intelligent tester.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.CHECK THAT MIL IS ILLUMINATED

a. Perform troubleshooting in accordance with the table below.

Result

Result	Proceed to
MIL remains ON	A
MIL does not illuminate	B

B → Go to step 5

A

2.CHECK WHETHER MIL TURNS OFF

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and turn the tester on.

c. Enter the following menus: Powertrain / Engine and ECT / DTC.

d. Check if any DTCs are output. Note down any DTCs.

e. Clear DTCs (Click here).

f. Check if the MIL goes off.

Standard:
MIL goes off

NG → Go to step 3

OK

REPAIR CIRCUITS INDICATED BY OUTPUT DTCS (Click here)

3.CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT IN WIRE HARNESS)

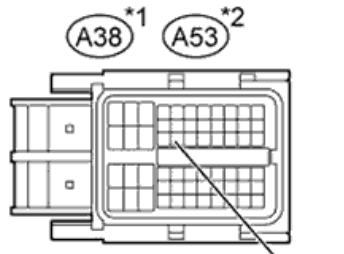
a. Disconnect the A38 or A53 ECM connector.

b. Turn the engine switch on (IG).

c. Check that the MIL is not illuminated.

OK:
MIL is not illuminated.

Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

NG → Go to step 4

OK

REPLACE ECM (Click here)

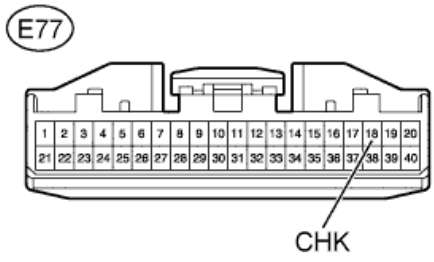
4.CHECK HARNESS AND CONNECTOR (COMBINATION METER - ECM)

a. Disconnect the A38 or A53 ECM connector.

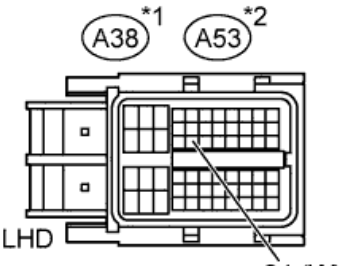
b. Disconnect the E77 combination meter connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Combination Meter)



Front view of wire harness connector:
(to ECM)



*1: for LHD

*2: for RHD

Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A38-24 (W) or E77-18 (CHK) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A53-24 (W) or E77-18 (CHK) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK ↓

REPLACE COMBINATION METER ASSEMBLY (Click here)

5.CHECK THAT MIL IS ILLUMINATED

a. Check if the MIL is illuminated when the engine switch is turned on (IG).

OK:
MIL is illuminated.

NG → Go to step 6

OK ↓

SYSTEM OK

6.CHECK THAT ENGINE STARTS

a. Turn the engine switch on (IG).

b. Start the engine.

Result

Result	Proceed to
Engine starts	A
Engine does not start*	B

HINT:

*: The intelligent tester cannot communicate with the ECM.

B → GO TO VC OUTPUT CIRCUIT (Click here)

A ↓

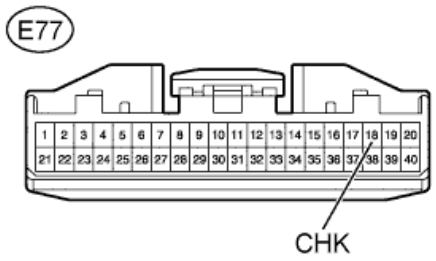
7.CHECK HARNESS AND CONNECTOR (COMBINATION METER - ECM)

a. Disconnect the A38 or A53 ECM connector.

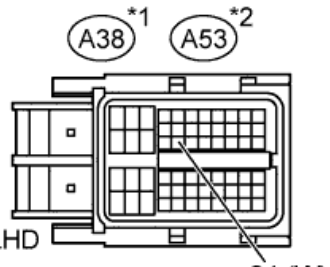
b. Disconnect the E77 combination meter connector.

c. Measure the resistance according to the value(s) in the table below.

Front view of wire harness connector:
(to Combination Meter)



Front view of wire harness connector:
(to ECM)



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A38-24 (W) - E77-18 (CHK)	Always	Below 1 Ω

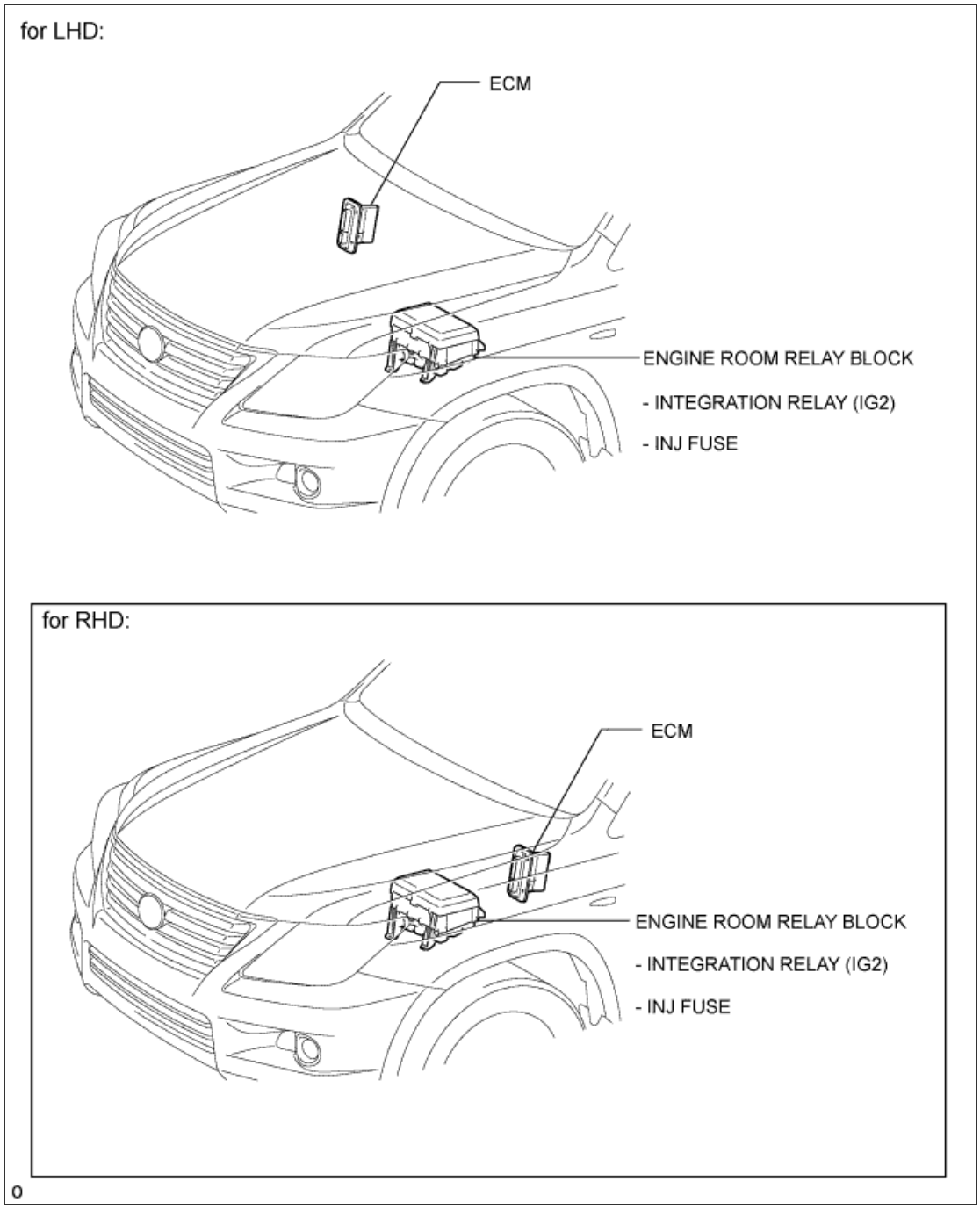
for RHD

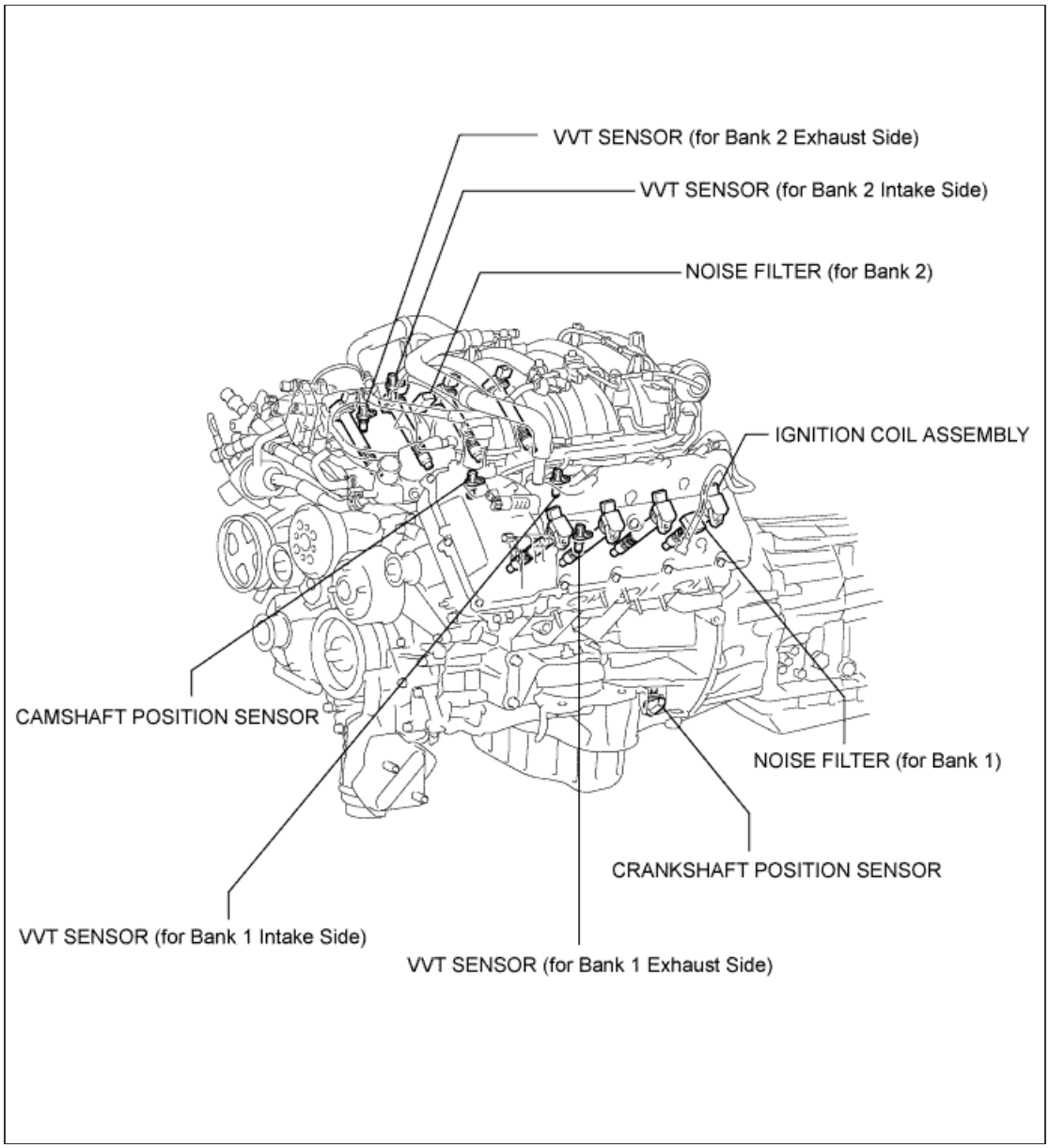
Tester Connection	Condition	Specified Condition
A53-24 (W) - E77-18 (CHK)	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

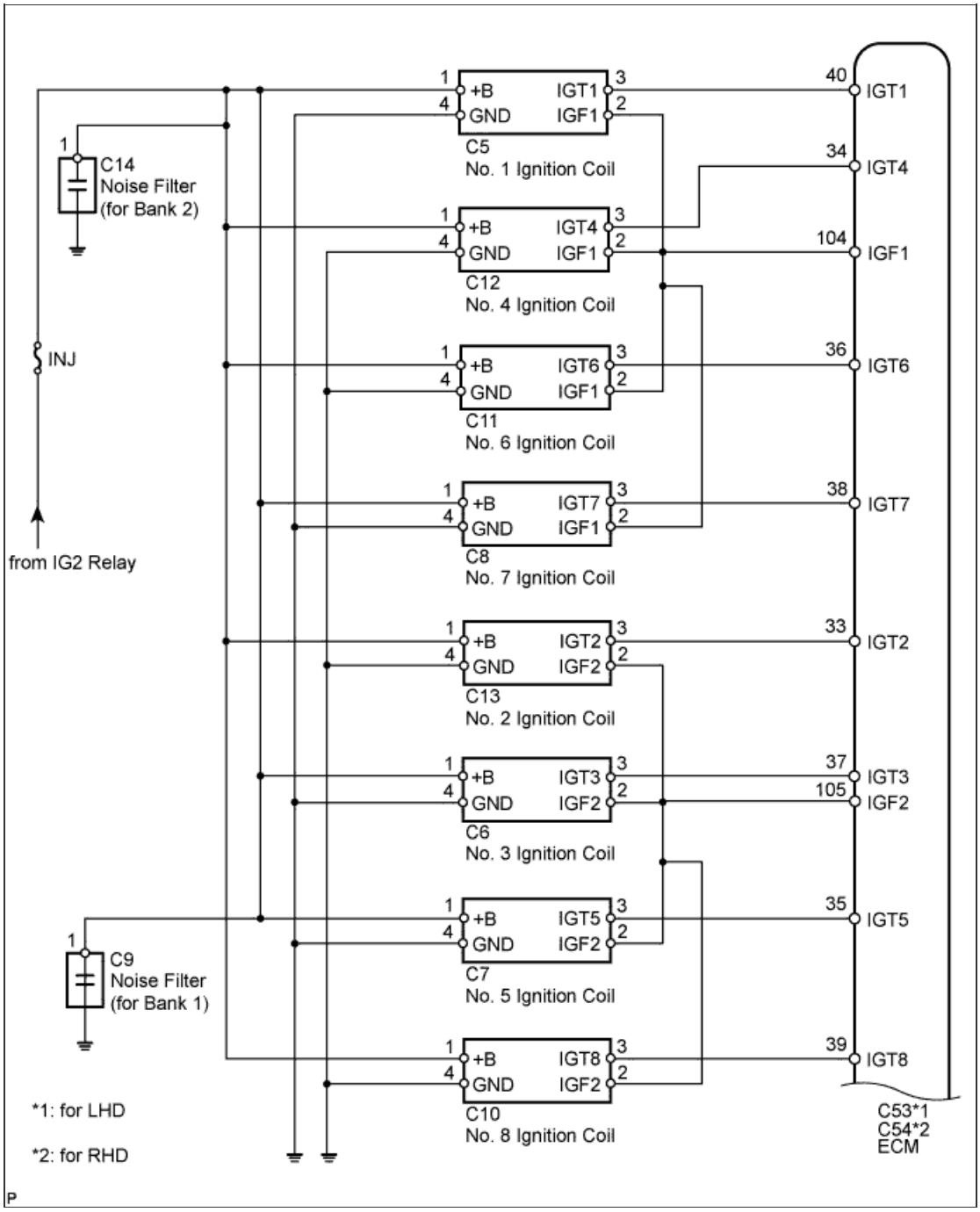
OK → REPLACE COMBINATION METER ASSEMBLY (Click here)

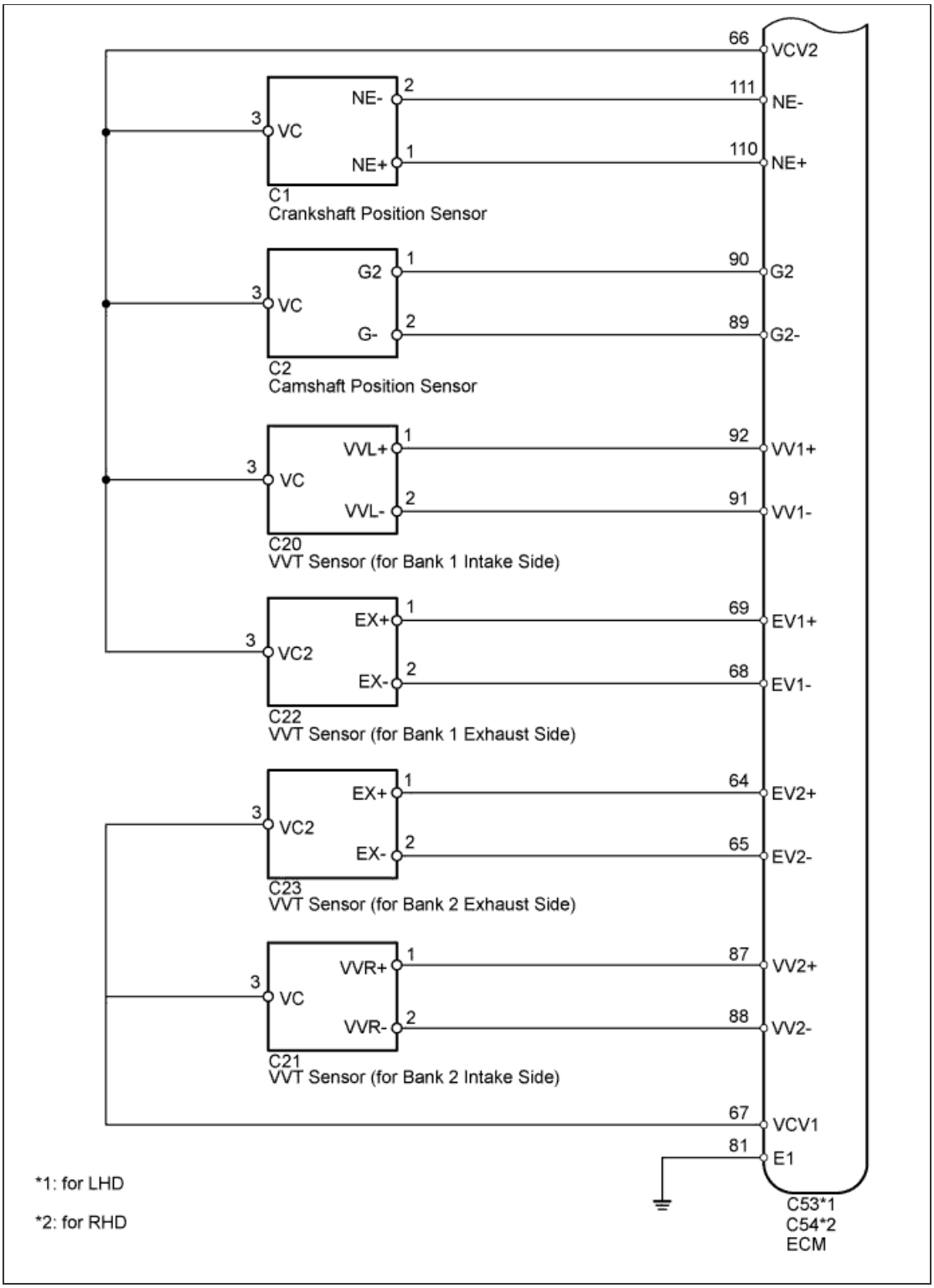
for Preparation Click here




VVT SENSOR (for Bank 2 Exhaust Side)
VVT SENSOR (for Bank 2 Intake Side)
NOISE FILTER (for Bank 2)
IGNITION COIL ASSEMBLY
CAMSHAFT POSITION SENSOR
NOISE FILTER (for Bank 1)
CRANKSHAFT POSITION SENSOR
VVT SENSOR (for Bank 1 Intake Side)
VVT SENSOR (for Bank 1 Exhaust Side)

for Preparation Click here




66
VCV2
NE-
2
111
NE-
3
VC
NE+
1
110
NE+
C1
Crankshaft Position Sensor
G2
1
90
G2
3
VC
G-
2
89
G2-
C2
Camshaft Position Sensor
VVL+
1
92
VV1+
3
VC
VVL-
2
91
VV1-
C20
VVT Sensor (for Bank 1 Intake Side)
EX+
1
69
EV1+
3
VC2
EX-
2
68
EV1-
C22
VVT Sensor (for Bank 1 Exhaust Side)
EX+
1
64
EV2+
3
VC2
EX-
2
65
EV2-
C23
VVT Sensor (for Bank 2 Exhaust Side)
VVR+
1
87
VV2+
3
VC
VVR-
2
88
VV2-
C21
VVT Sensor (for Bank 2 Intake Side)
67
VCV1
81
E1
C53*1
C54*2
ECM
*1: for LHD
*2: for RHD

for Preparation Click here

1. PERFORM SPARK TEST

a. Check for DTCs (Click here).

NOTICE:

If any DTC is output, perform troubleshooting procedures for that DTC.

b. Check if sparks occur.

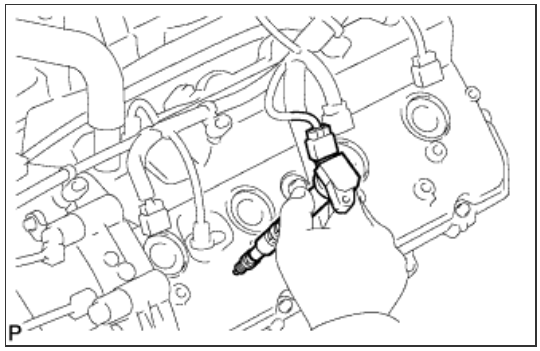
i. Remove the ignition coils and spark plugs (Click here).

ii. Install the spark plug to the ignition coil and connect the ignition coil connector.

iii. Disconnect the 8 injector connectors.

iv. Ground the spark plug.

v. Visually check that sparks occur while the engine is being cranked.



NOTICE:

- **Be sure to ground the spark plug when checking.**
- **If the ignition coil has been struck or dropped, replace it.**
- **Do not crank the engine for more than 2 seconds.**

c. Check that the wire harness side connector of the ignition coil with igniter is securely connected.

Result

Result	Proceed to
NG	Connect securely
OK	Go to next step

d. Perform a spark test on each ignition coil with igniter.

i. If there is a cylinder where sparks do not occur, replace its ignition coil with the ignition coil of a cylinder where sparks occur normally.

ii. Crank the engine and visually check that sparks occur at the cylinder with the normally operating ignition coil.

Result

Result	Proceed to
OK	Replace ignition coil with igniter
NG	Go to next step

e. Check spark plug.

Result

Result	Proceed to
NG	Replace spark plug
OK	Go to next step

f. Check the power supply to the ignition coil with igniter.

i. Turn the engine switch on (IG).

ii. Check that there is battery voltage at the ignition coil positive (+) terminal.

Result

Result	Proceed to

NG	Check wiring between engine switch and ignition coil with igniter
OK	Go to next step

g. Check the VVT sensor for intake side (Click here).

h. Check the VVT sensor for exhaust side (Click here).

i. Check the camshaft position sensor (Click here).

j. Check the crankshaft position sensor (Click here).

k. Check the IGT signal circuit (Click here).

l. Connect the 8 injector connectors.

m. Install the ignition coils and spark plugs (Click here).

2. INSPECT SPARK PLUG

NOTICE:

- **Do not use a wire brush for cleaning.**
- **Do not attempt to adjust the electrode gap of a used spark plug.**

a. Check the electrode.

i. Using a megohmmeter, measure the insulation resistance.

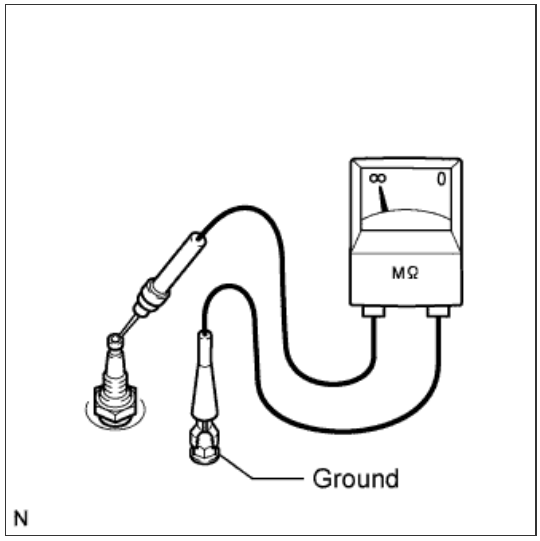
Standard Insulation Resistance:

Tester Connection	Condition	Specified Condition
Spark plug (terminal part) - Body ground	Always	10 MΩ or higher

If the insulation resistance is below the specified range, replace the spark plug.

HINT:

If a megohmmeter is not available, perform the following simple inspection instead.

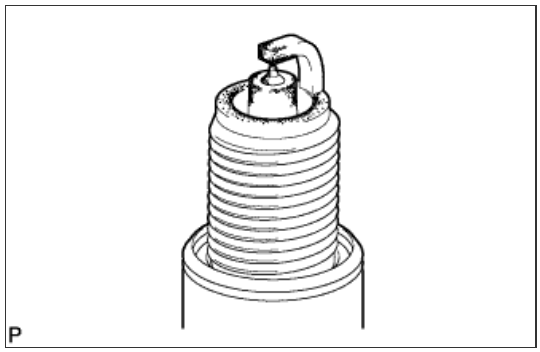


b. Alternative inspection method:

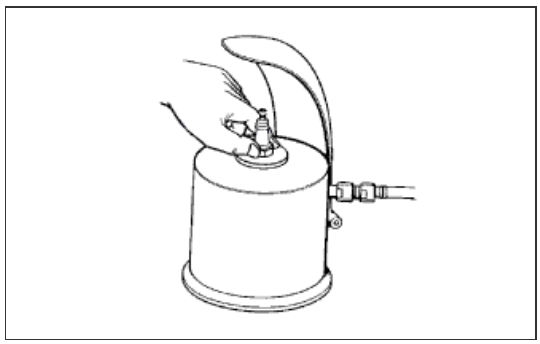
i. Quickly accelerate the engine to 4000 rpm 5 times.

ii. Remove the spark plug.

iii. Visually check the spark plug.
If the electrode is dry, the spark plug is functioning properly. If the electrode is damp, proceed to the next step.



c. Check the spark plug for any damage to its threads and insulator.
If there is any damage, replace the spark plug.



Recommended Spark Plug:

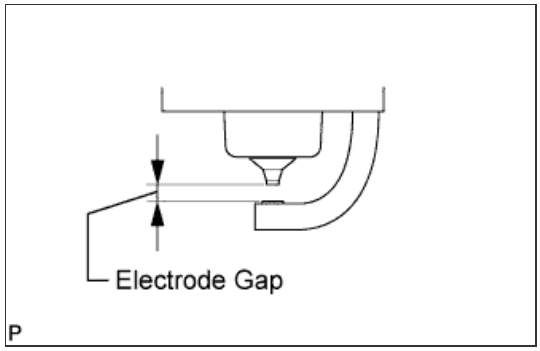
Manufacturer	Type
DENSO made	SK20HR11

HINT:

Maximum electrode gap for a used spark plug: 1.3 mm (0.051 in.).

If the gap is more than the maximum, replace the spark plug.

Electrode gap for a new spark plug: 1.0 to 1.1 mm (0.039 to 0.043 in.).



NOTICE:

If adjusting the gap of a new spark plug, bend only the base of the ground electrode. Do not touch the tip. Never attempt to adjust the gap of a used plug.

If the electrode has traces of wet carbon, allow it to dry and then clean it with a spark plug cleaner.

Standard air pressure:
588 kPa (6.0 kgf/cm^2, 85 psi)

Standard duration:
20 seconds or less

HINT:

Only use the spark plug cleaner when the electrode is free of oil. If the electrode has traces of oil, use gasoline to clean off the oil before using the spark plug cleaner.

for Preparation Click here

1. PERFORM SPARK TEST

a. Check for DTCs (Click here).

NOTICE:

If any DTC is output, perform troubleshooting procedures for that DTC.

b. Check if sparks occur.

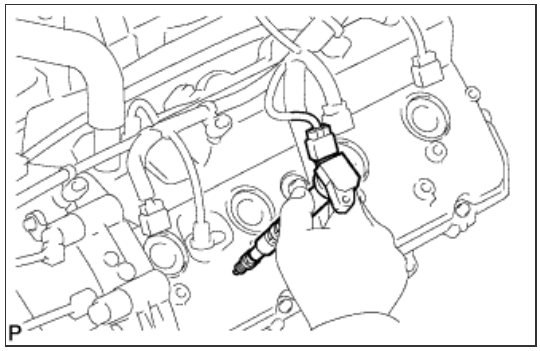
i. Remove the ignition coils and spark plugs (Click here).

ii. Install the spark plug to the ignition coil and connect the ignition coil connector.

iii. Disconnect the 8 injector connectors.

iv. Ground the spark plug.

v. Visually check that sparks occur while the engine is being cranked.



NOTICE:

- **Be sure to ground the spark plug when checking.**
- **If the ignition coil has been struck or dropped, replace it.**
- **Do not crank the engine for more than 2 seconds.**

c. Check that the wire harness side connector of the ignition coil with igniter is securely connected.

Result

Result	Proceed to
NG	Connect securely
OK	Go to next step

d. Perform a spark test on each ignition coil with igniter.

i. If there is a cylinder where sparks do not occur, replace its ignition coil with the ignition coil of a cylinder where sparks occur normally.

ii. Crank the engine and visually check that sparks occur at the cylinder with the normally operating ignition coil.

Result

Result	Proceed to
OK	Replace ignition coil with igniter
NG	Go to next step

e. Check spark plug.

Result

Result	Proceed to
NG	Replace spark plug
OK	Go to next step

f. Check the power supply to the ignition coil with igniter.

i. Turn the engine switch on (IG).

ii. Check that there is battery voltage at the ignition coil positive (+) terminal.

Result

Result	Proceed to

NG	Check wiring between engine switch and ignition coil with igniter
OK	Go to next step

g. Check the VVT sensor for intake side (Click here).

h. Check the VVT sensor for exhaust side (Click here).

i. Check the camshaft position sensor (Click here).

j. Check the crankshaft position sensor (Click here).

k. Check the IGT signal circuit (Click here).

l. Connect the 8 injector connectors.

m. Install the ignition coils and spark plugs (Click here).

2. INSPECT SPARK PLUG

NOTICE:

- **Do not use a wire brush for cleaning.**
- **Do not attempt to adjust the electrode gap of a used spark plug.**

a. Check the electrode.

i. Using a megohmmeter, measure the insulation resistance.

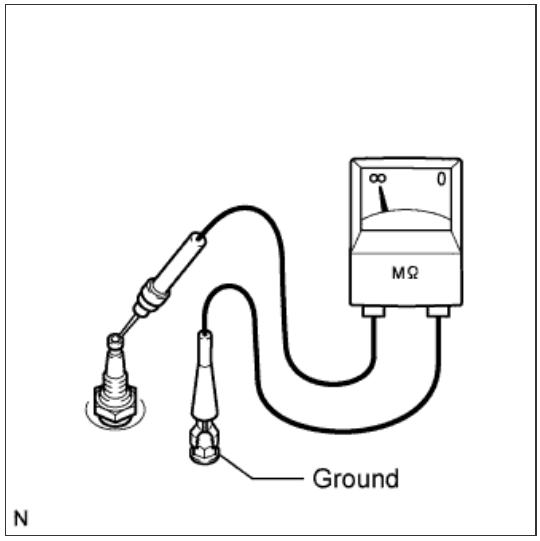
Standard Insulation Resistance:

Tester Connection	Condition	Specified Condition
Spark plug (terminal part) - Body ground	Always	10 MΩ or higher

If the insulation resistance is below the specified range, replace the spark plug.

HINT:

If a megohmmeter is not available, perform the following simple inspection instead.

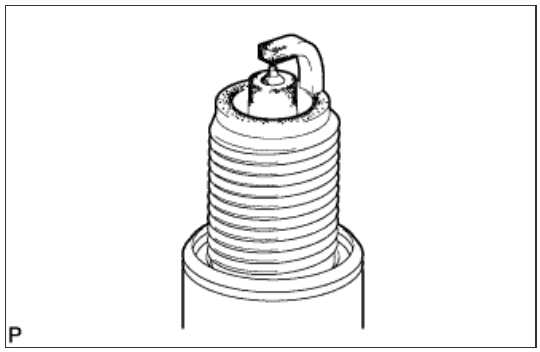


b. Alternative inspection method:

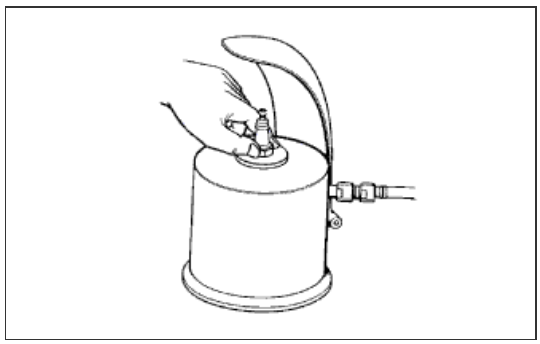
i. Quickly accelerate the engine to 4000 rpm 5 times.

ii. Remove the spark plug.

iii. Visually check the spark plug.
If the electrode is dry, the spark plug is functioning properly. If the electrode is damp, proceed to the next step.



c. Check the spark plug for any damage to its threads and insulator.
If there is any damage, replace the spark plug.



Recommended Spark Plug:

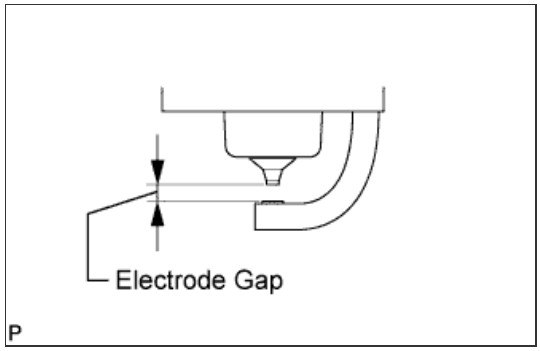
Manufacturer	Type
DENSO made	SK20HR11

HINT:

Maximum electrode gap for a used spark plug: 1.3 mm (0.051 in.).

If the gap is more than the maximum, replace the spark plug.

Electrode gap for a new spark plug: 1.0 to 1.1 mm (0.039 to 0.043 in.).



NOTICE:

If adjusting the gap of a new spark plug, bend only the base of the ground electrode. Do not touch the tip. Never attempt to adjust the gap of a used plug.

If the electrode has traces of wet carbon, allow it to dry and then clean it with a spark plug cleaner.

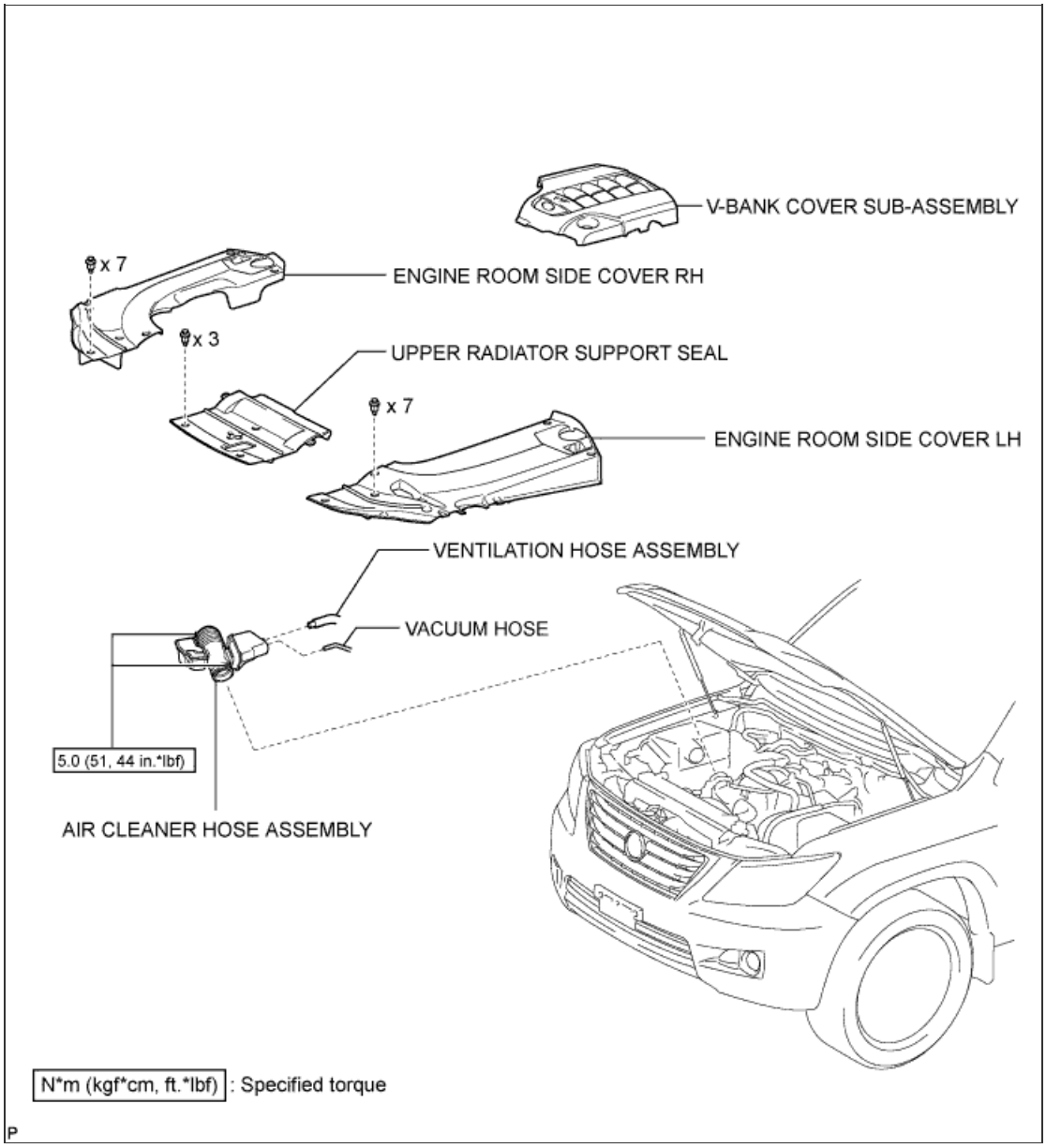
Standard air pressure:
588 kPa (6.0 kgf/cm^2, 85 psi)

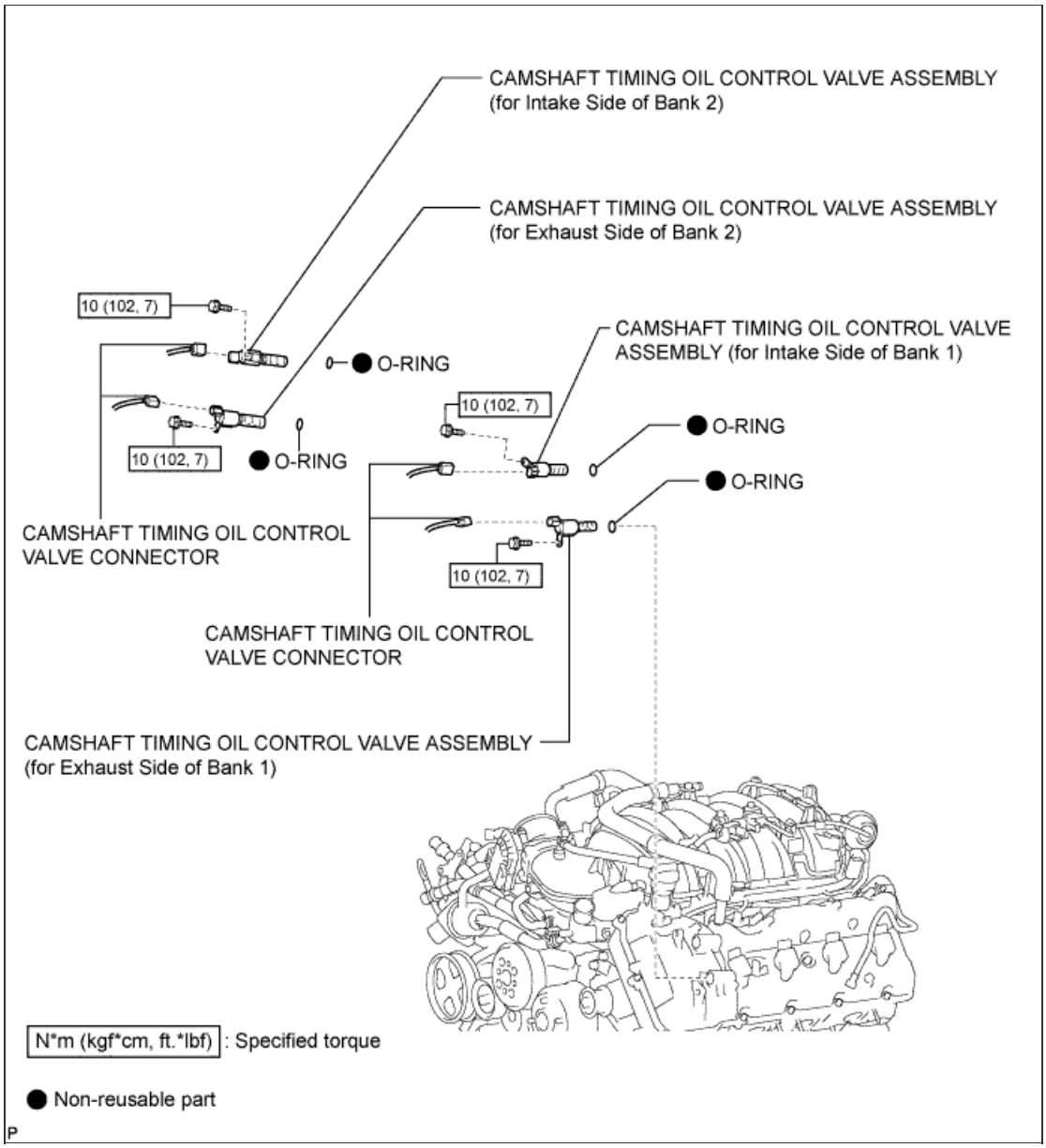
Standard duration:
20 seconds or less

HINT:

Only use the spark plug cleaner when the electrode is free of oil. If the electrode has traces of oil, use gasoline to clean off the oil before using the spark plug cleaner.

for Preparation Click here




CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
(for Intake Side of Bank 2)
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
(for Exhaust Side of Bank 2)
10 (102, 7)
O-RING
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Intake Side of Bank 1)
10 (102, 7)
O-RING
10 (102, 7)
O-RING
O-RING
CAMSHAFT TIMING OIL CONTROL VALVE CONNECTOR
10 (102, 7)
CAMSHAFT TIMING OIL CONTROL VALVE CONNECTOR
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
(for Exhaust Side of Bank 1)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

1. INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

a. Connect the intelligent tester to the DLC3.

b. Start the engine and turn the intelligent tester on.

c. Warm up the engine.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the VVT Linear (Bank 1) or Control the VVT Linear (Bank 2) or Control the VVT System (Bank 1) or Control the VVT System (Bank 2) or Control the VVT Exhaust Linear (Bank 1) or Control the VVT Exhaust Linear (Bank 2).

e. Check the engine speed while operating the Oil Control Valve (OCV) using the intelligent tester.

OK:

Tester Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Soon after OCV switched from OFF to ON, engine idles roughly or stalls

If the result is not as specified, check the oil control valve, wirings and camshaft timing gear.

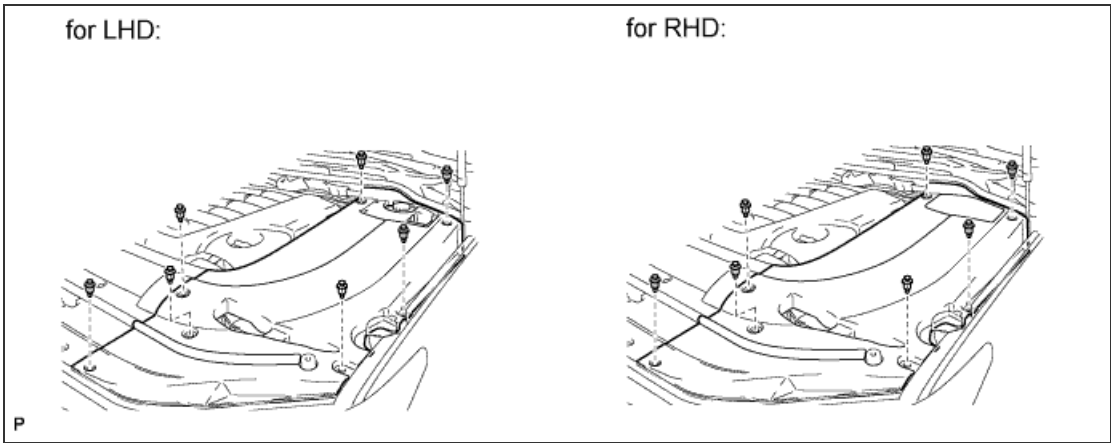
HINT:

- **Control the VVT Linear (Bank 1): Command to activate exhaust and intake side oil control valves of bank 1 (Control range: Between -128 to 127%).**
- **Control the VVT Linear (Bank 2): Command to activate exhaust and intake side oil control valves of bank 2 (Control range: Between -128 to 127%).**
- **Control VVT System (Bank 1): Command to activate oil control valve of bank 1 (Control range: ON/OFF).**
- **Control VVT System (Bank 2): Command to activate oil control valve of bank 2 (Control range: ON/OFF).**
- **Control the VVT Exhaust Linear (Bank 1): Command to activate exhaust side oil control valve of bank 1 (Control range: Between -128 to 127%).**
- **Control the VVT Exhaust Linear (Bank 2): Command to activate exhaust side oil control valve of bank 2 (Control range: Between -128 to 127%).**

for Preparation Click here

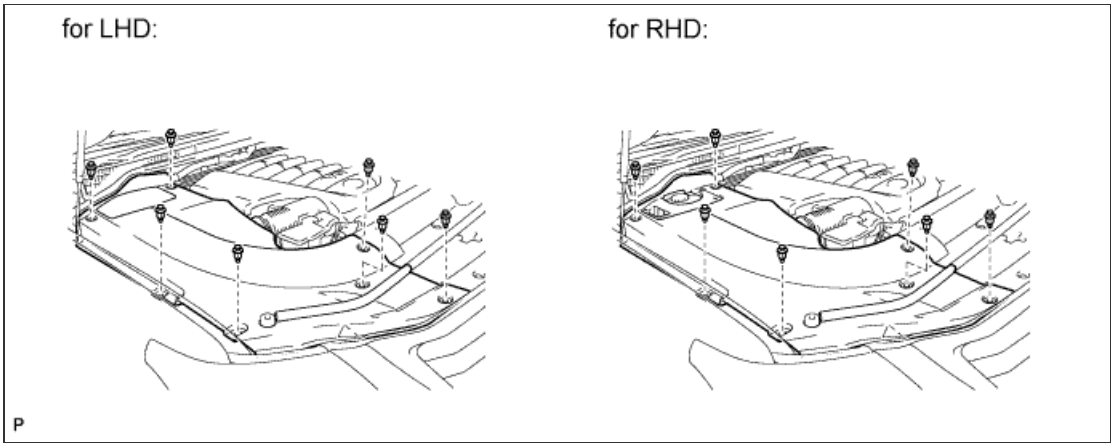
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



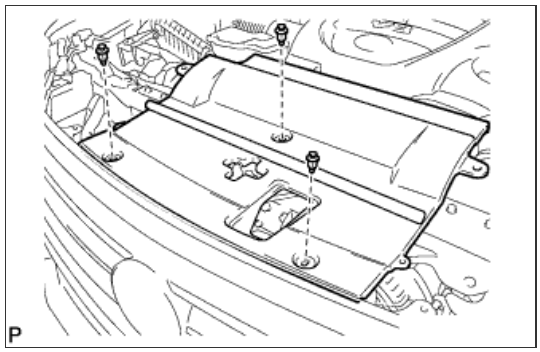
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



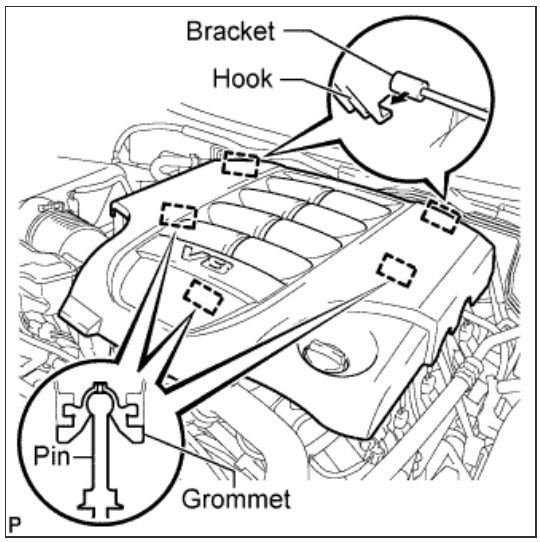
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

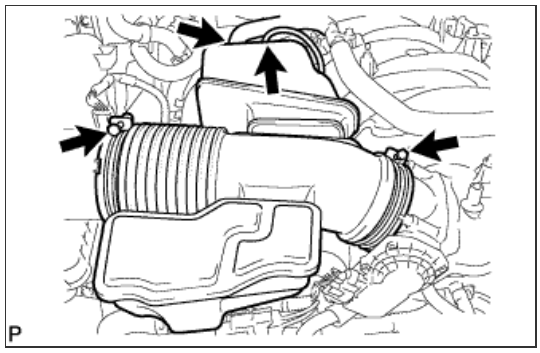


5. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.

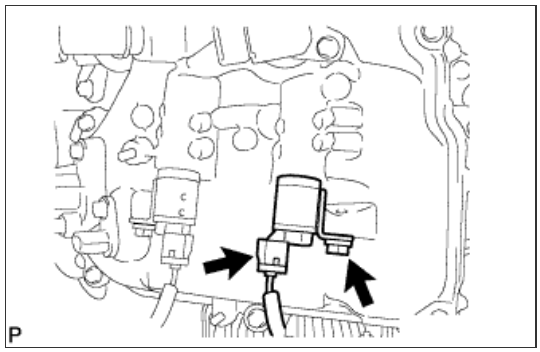


6. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Exhaust Side of Bank 1)

a. Disconnect the oil control valve connector.

b. Remove the bolt and oil control valve.

c. Remove the O-ring from the oil control valve.

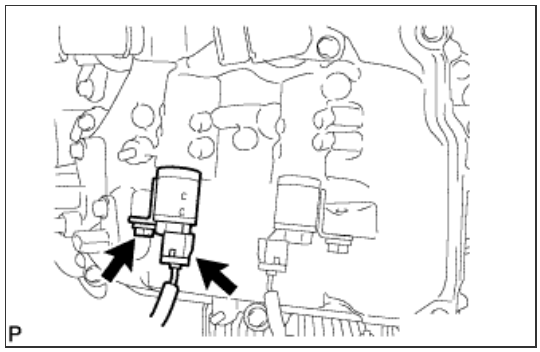


7. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Intake Side of Bank 1)

a. Disconnect the oil control valve connector.

b. Remove the bolt and oil control valve.

c. Remove the O-ring from the oil control valve.

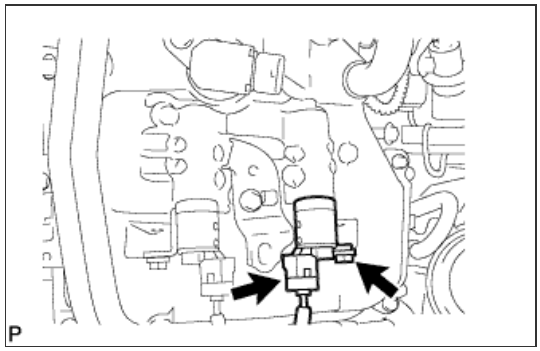


8. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Intake Side of Bank 2)

a. Disconnect the oil control valve connector.

b. Remove the bolt and oil control valve.

c. Remove the O-ring from the oil control valve.

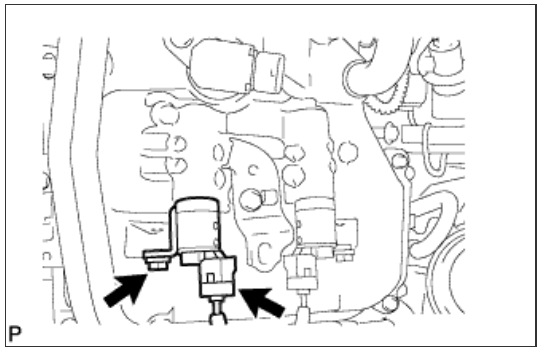


9. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Exhaust Side of Bank 2)

a. Disconnect the oil control valve connector.

b. Remove the bolt and oil control valve.

c. Remove the O-ring from the oil control valve.



for Preparation Click here

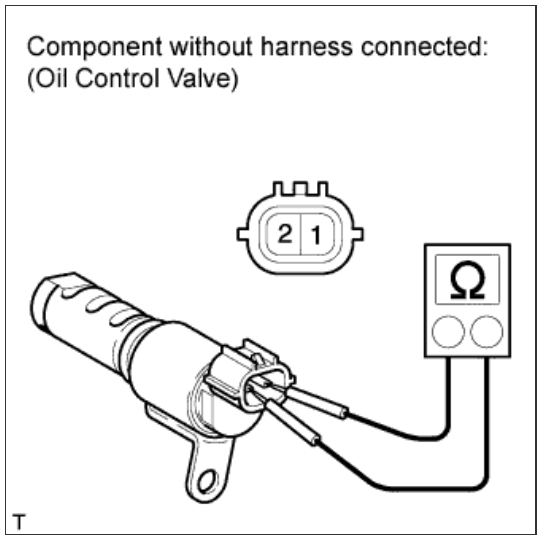
1. INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

If the result is not as specified, replace the oil control valve assembly.

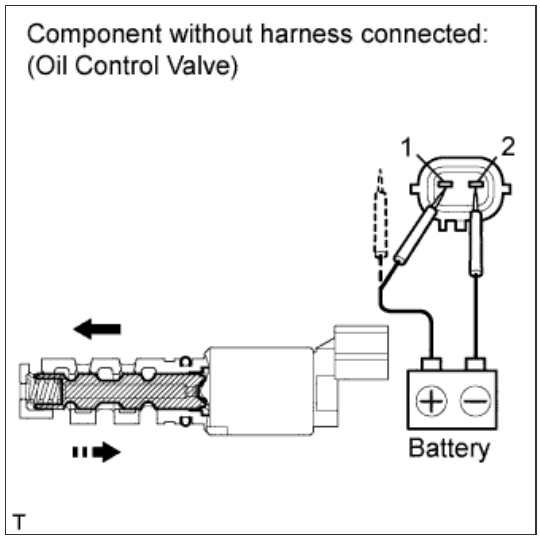


b. Connect the battery positive (+) lead to terminal 1 and the negative (-) lead to terminal 2, and check the movement of the valve.

OK:

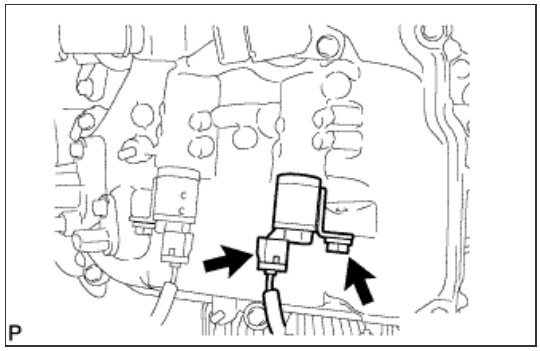
Condition	Specified Condition
Battery positive (+) voltage is applied	Valve moves in left arrow direction shown in the illustration
Battery positive (+) voltage is cut off	Valve moves in right arrow direction shown in the illustration

If the result is not as specified, replace the oil control valve assembly. If the valve cannot return properly because of foreign matter, a small pressure leak in the advanced direction may occur and a DTC may be output.



for Preparation Click here

1. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Exhaust Side of Bank 1)



a. Install a new O-ring to the oil control valve.

b. Apply a light coat of engine oil to the O-ring.

c. Install the oil control valve with the bolt.

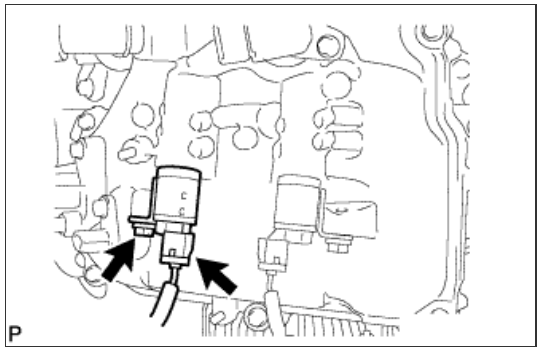
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

- **Do not allow foreign matter to contact the oil seal face of the oil control valve (connecting surface with cylinder head cover).**
- **Be careful that the O-ring is not cracked or moved out of place when installing the oil control valve.**

d. Connect the oil control valve connector.

2. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Intake Side of Bank 1)



a. Install a new O-ring to the oil control valve.

b. Apply a light coat of engine oil to the O-ring.

c. Install the oil control valve with the bolt.

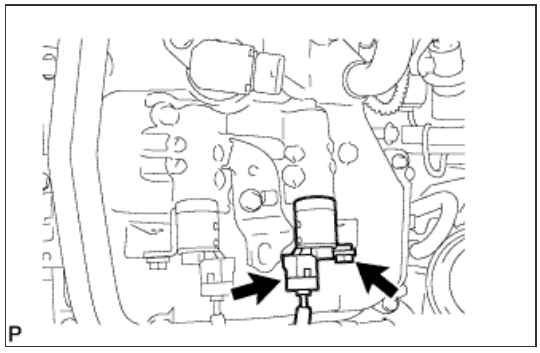
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

- **Do not allow foreign matter to contact the oil seal face of the oil control valve (connecting surface with cylinder head cover).**
- **Be careful that the O-ring is not cracked or moved out of place when installing the oil control valve.**

d. Connect the oil control valve connector.

3. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Intake Side of Bank 2)



a. Install a new O-ring to the oil control valve.

b. Apply a light coat of engine oil to the O-ring.

c. Install the oil control valve with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

- **Do not allow foreign matter to contact the oil seal face of the oil control valve (connecting surface with cylinder head cover).**
- **Be careful that the O-ring is not cracked or moved out of place when installing the oil control valve.**

d. Connect the oil control valve connector.

4. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (for Exhaust Side of Bank 2)

a. Install a new O-ring to the oil control valve.

b. Apply a light coat of engine oil to the O-ring.

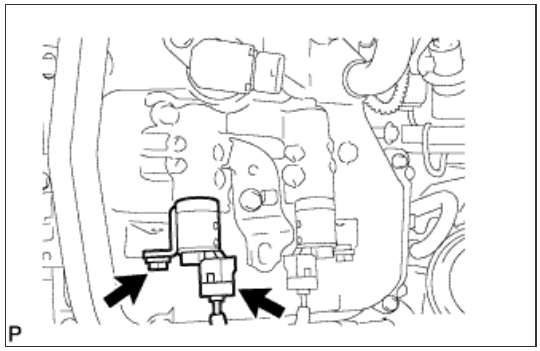
c. Install the oil control valve with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

- **Do not allow foreign matter to contact the oil seal face of the oil control valve (connecting surface with cylinder head cover).**
- **Be careful that the O-ring is not cracked or moved out of place when installing the oil control valve.**

d. Connect the oil control valve connector.



5. INSTALL AIR CLEANER HOSE ASSEMBLY

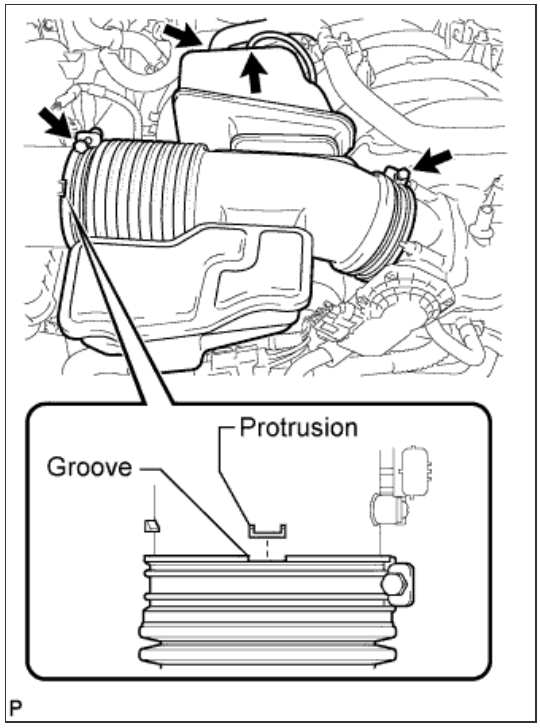
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

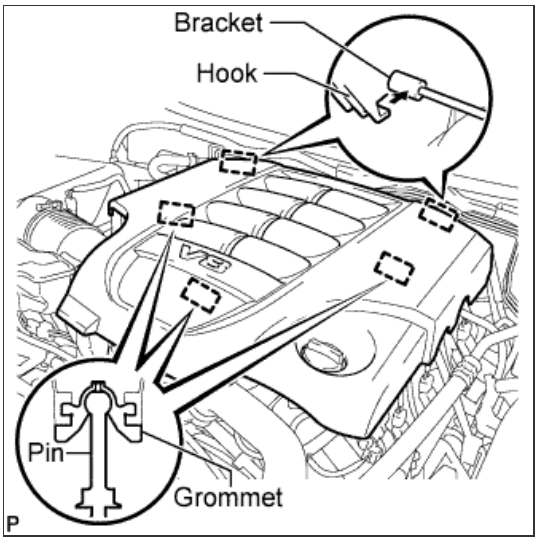
c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



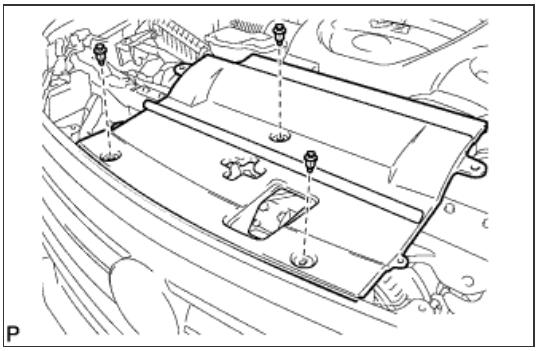
6. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



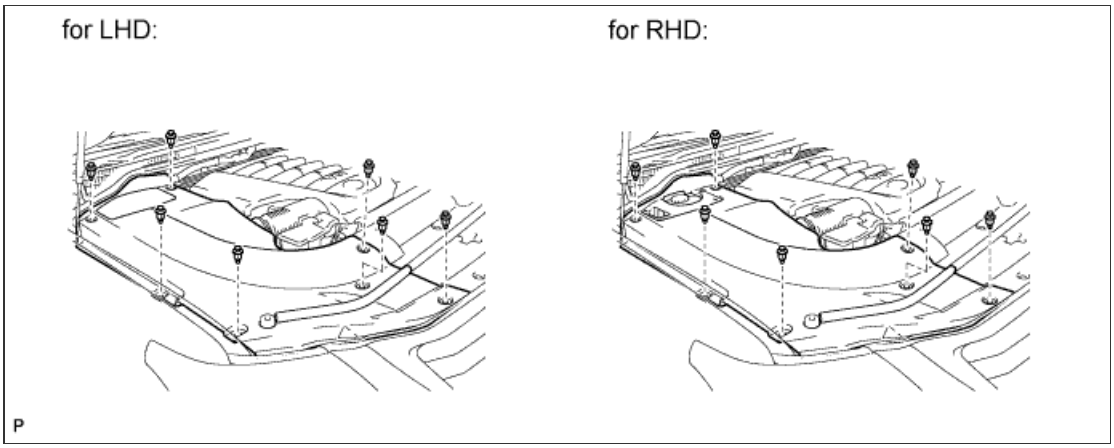
7. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



8. INSTALL ENGINE ROOM SIDE COVER RH

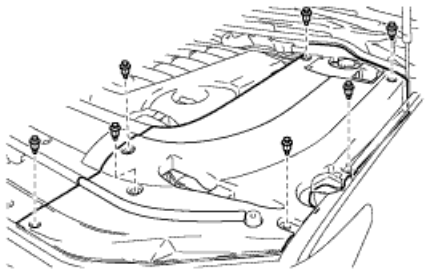
a. Install the engine room side cover with the 7 clips.



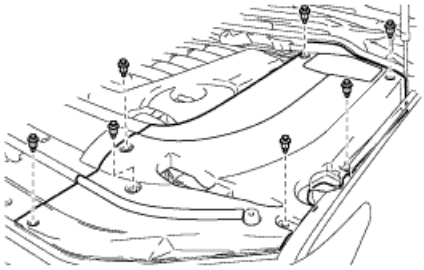
9. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

for LHD:

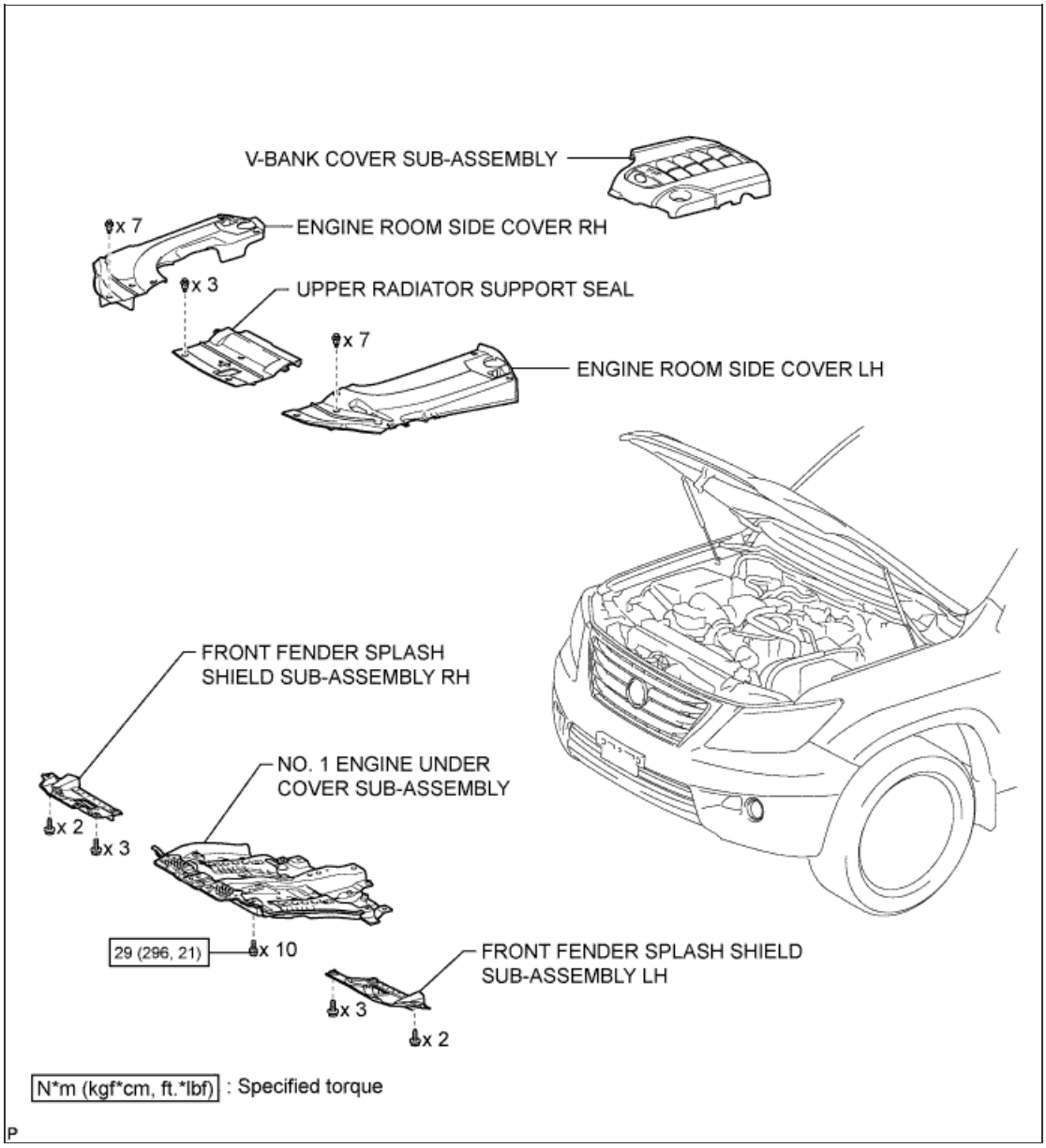


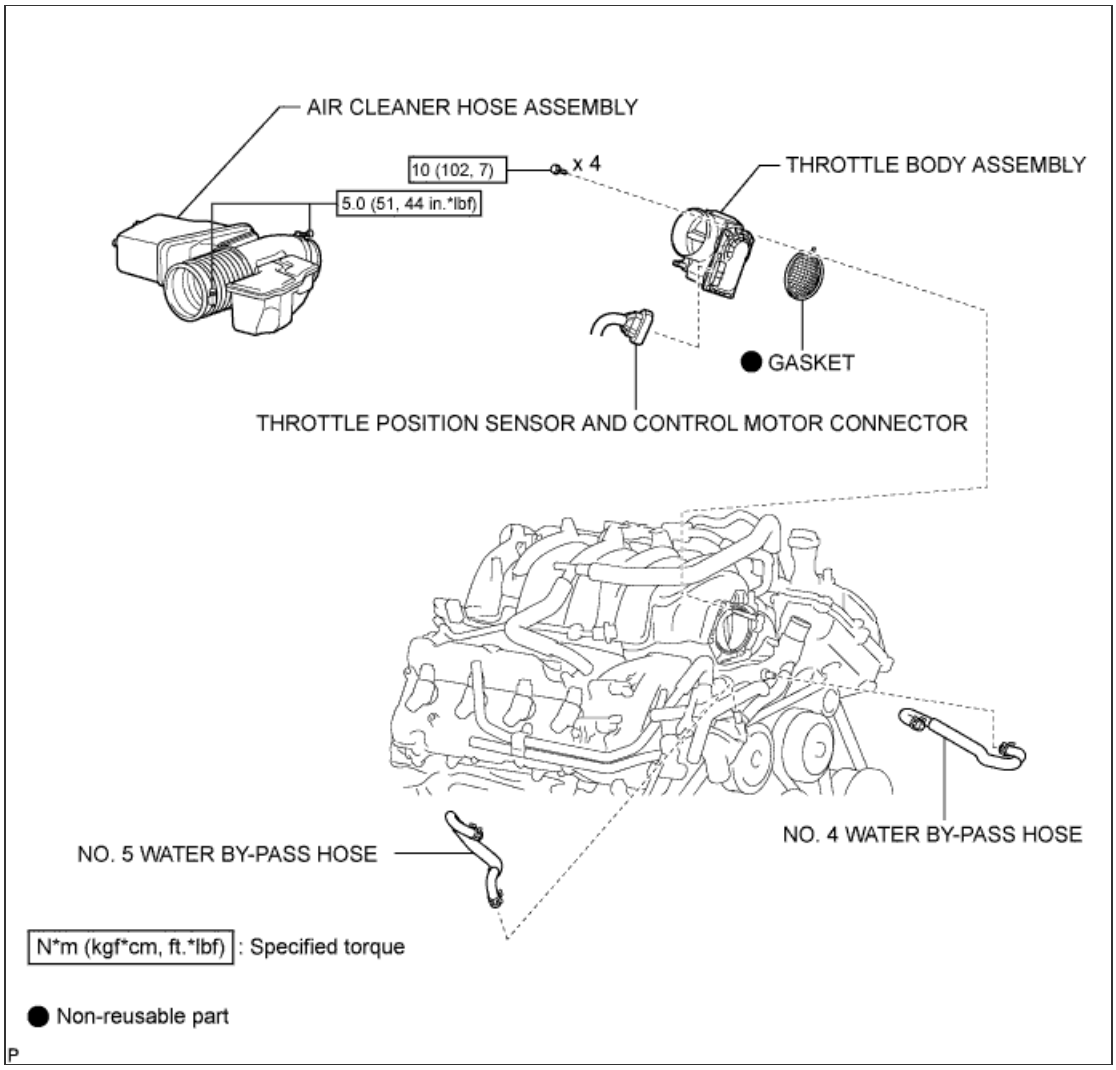
for RHD:



P

for Preparation Click here




AIR CLEANER HOSE ASSEMBLY
10 (102, 7)
x 4
5.0 (51, 44 in.*lbf)
THROTTLE BODY ASSEMBLY
GASKET
THROTTLE POSITION SENSOR AND CONTROL MOTOR CONNECTOR
NO. 5 WATER BY-PASS HOSE
NO. 4 WATER BY-PASS HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

1. CHECK THROTTLE BODY ASSEMBLY

a. Check the throttle control motor operating sounds.

i. Turn the engine switch on (IG).

ii. When depressing the accelerator pedal, check the operating sound of the running motor. Make sure that no friction noises are emitted from the motor.
If friction noise exists, replace the throttle body.

b. Check the throttle position sensor.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch on.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Throttle Sensor Position.

v. Depress the accelerator pedal. When the throttle valve is fully opened, check that the value of "Throttle Sensor Position" is within the specification.

Standard throttle valve opening percentage:
60% or more

HINT:

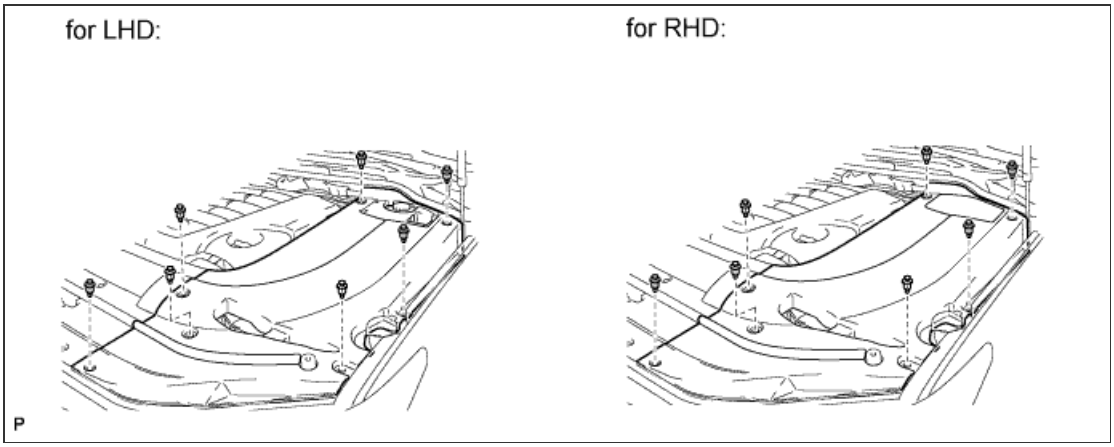
When checking the standard throttle valve opening percentage, the shift lever should be in N.

If the percentage is less than 60%, replace the throttle body assembly.

for Preparation Click here

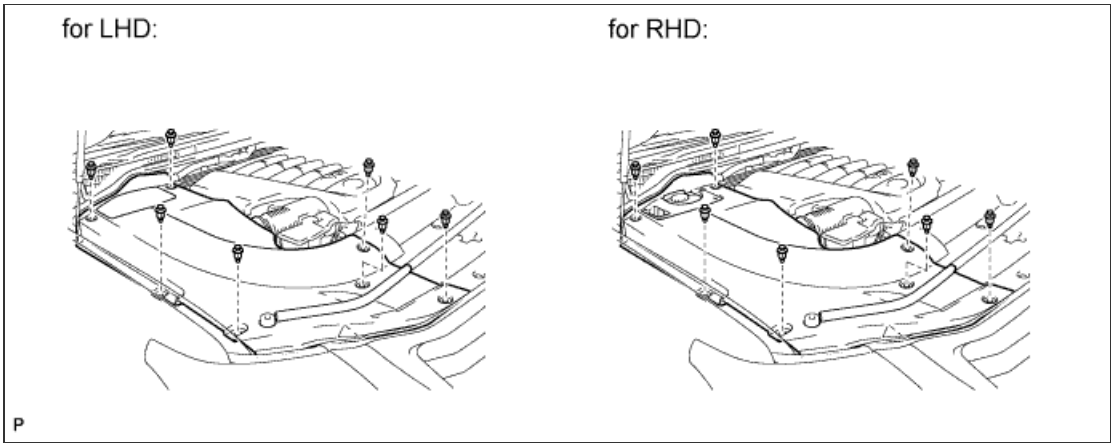
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



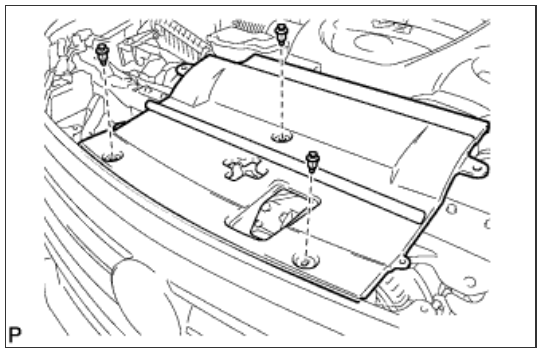
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

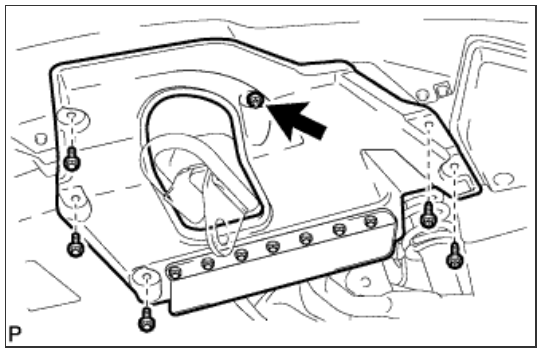
a. Remove the 3 clips and upper radiator support seal.



4. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



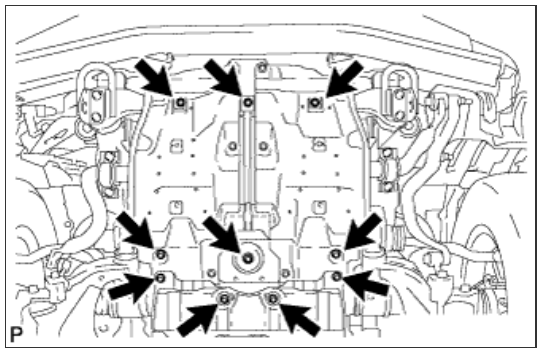
5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

6. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

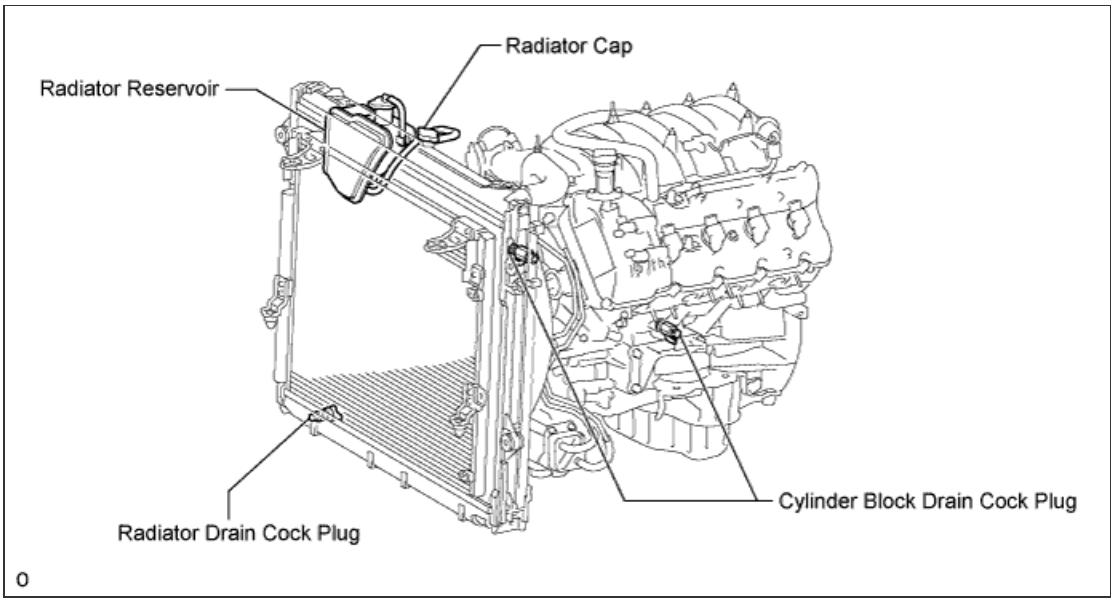
a. Remove the 10 bolts and No. 1 engine under cover.



7. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

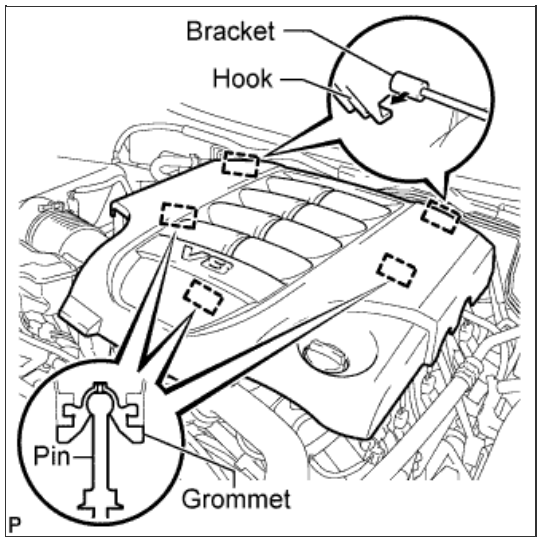
d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

e. Tighten the radiator drain cock plug by hand.

8. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

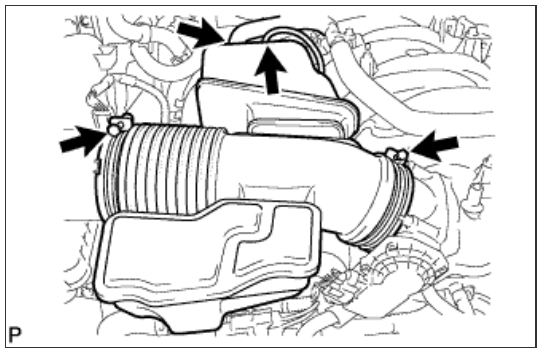


9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

b. Loosen the 2 hose clamps.

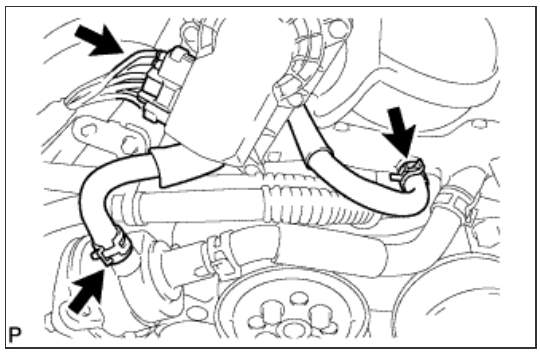
c. Remove the air cleaner hose.



10. REMOVE THROTTLE BODY ASSEMBLY

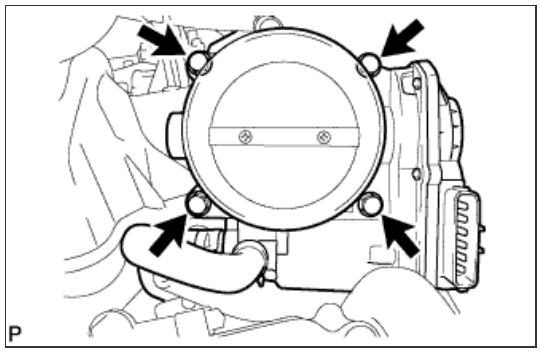
a. Disconnect the 2 water by-pass hoses.

b. Disconnect the throttle position sensor and control motor connector.



c. Remove the 4 bolts, throttle body and gasket.

d. Remove the 2 water by-pass hoses from the throttle body.



for Preparation Click here

1. INSPECT THROTTLE BODY ASSEMBLY

a. Check the throttle valve.

i. Check that the throttle valve opens and closes smoothly.

ii. Check that there is no sludge accumulating around the throttle body.

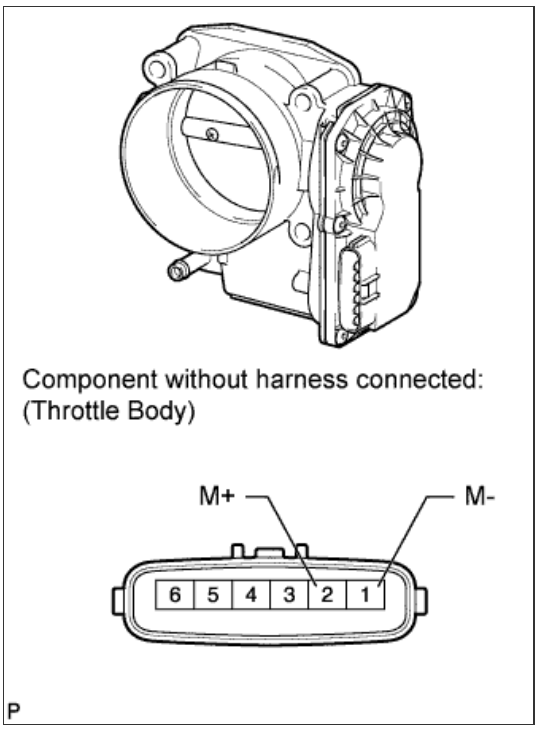
b. Check the throttle control motor.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (M-) - 2 (M+)	20°C (68°F)	0.3 to 100 Ω

If the result is not as specified, replace the throttle body assembly.



for Preparation Click here

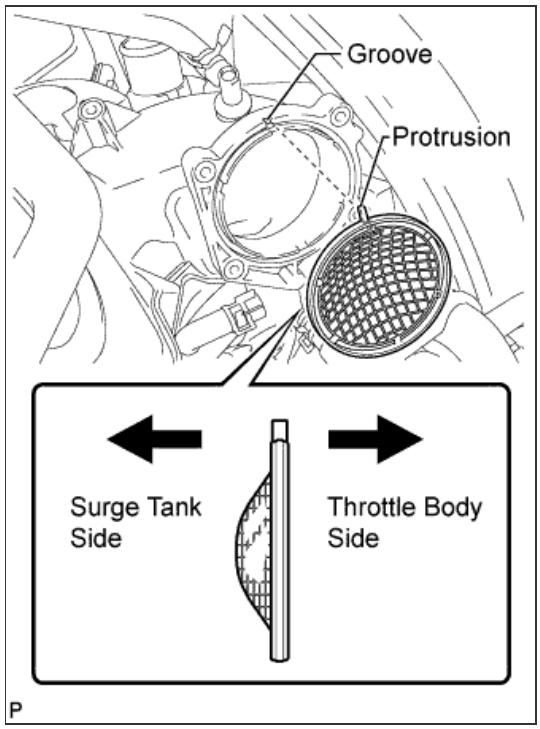
1. INSTALL THROTTLE BODY ASSEMBLY

a. Install the 2 water by-pass hoses to the throttle body.

b. Install a new gasket to the intake air surge tank.

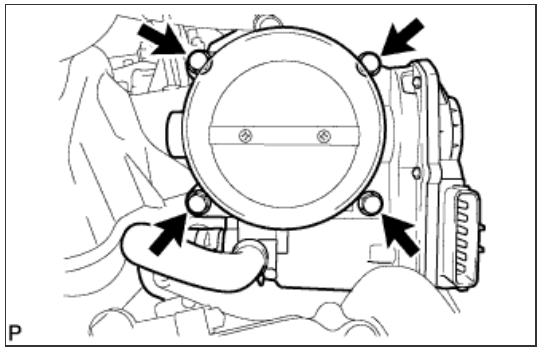
HINT:

Align the protrusion of the gasket with the groove of the intake air surge tank.



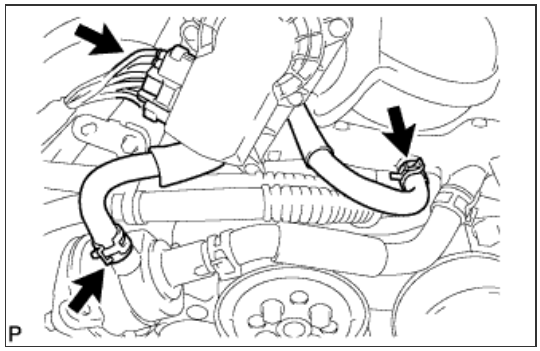
c. Install the throttle body with the 4 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



d. Connect the throttle position sensor and control motor connector.

e. Connect the 2 water by-pass hoses.



2. INSTALL AIR CLEANER HOSE ASSEMBLY

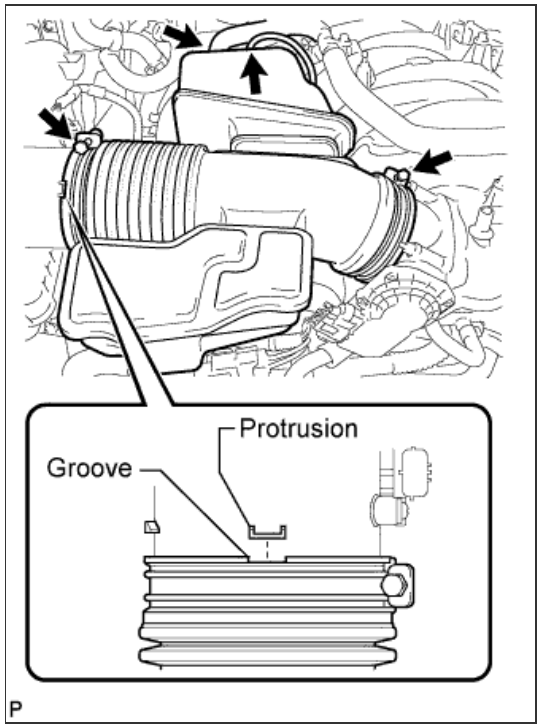
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



3. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

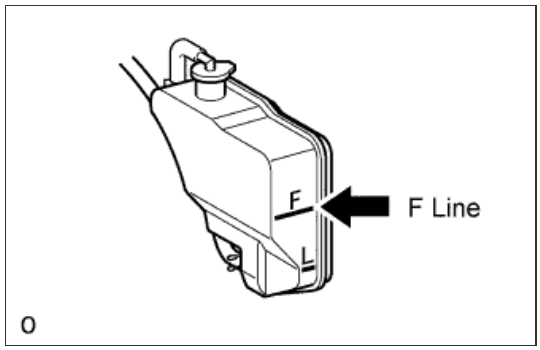
d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

NOTICE:

Switch off the A/C.



g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**

- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

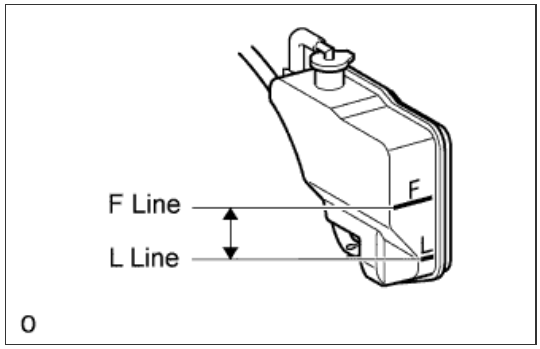
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

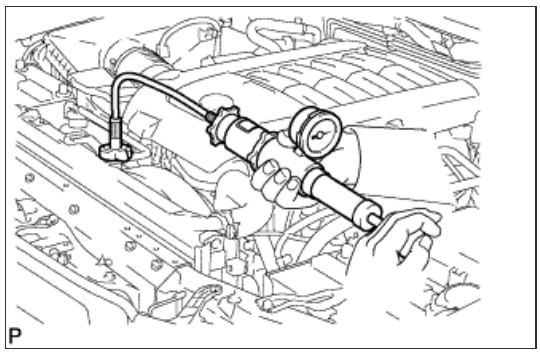


4. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



5. CHECK THROTTLE BODY ASSEMBLY

a. Check the throttle control motor operating sounds.

i. Turn the engine switch on (IG).

ii. When depressing the accelerator pedal, check the operating sound of the running motor. Make sure that no friction noises are emitted from the motor.
If friction noise exists, replace the throttle body.

b. Check the throttle position sensor.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch on.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Throttle Sensor Position.

v. Depress the accelerator pedal. When the throttle valve is fully opened, check that the value of "Throttle Sensor Position" is within

the specification.

Standard throttle valve opening percentage:
60% or more

HINT:

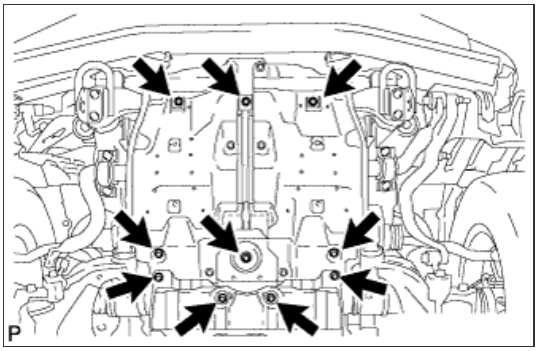
When checking the standard throttle valve opening percentage, the shift lever should be in N.

If the percentage is less than 60%, replace the throttle body assembly.

6. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

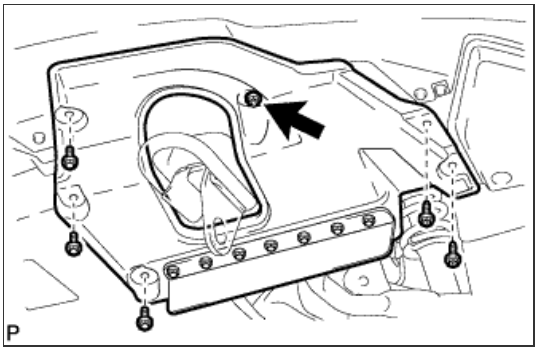
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



7. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



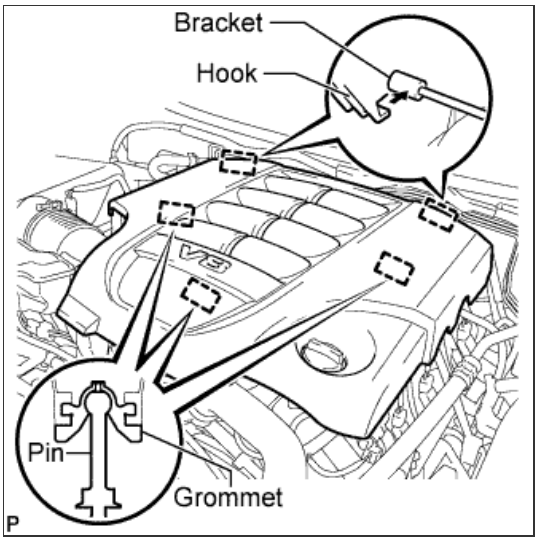
8. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

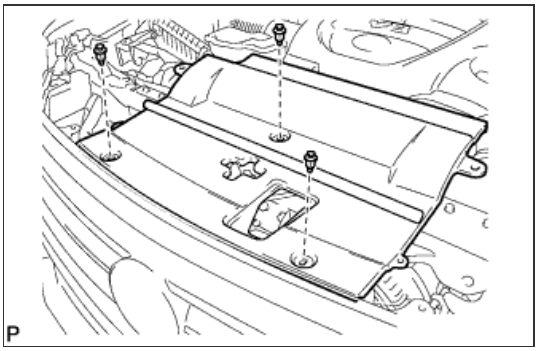
9. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



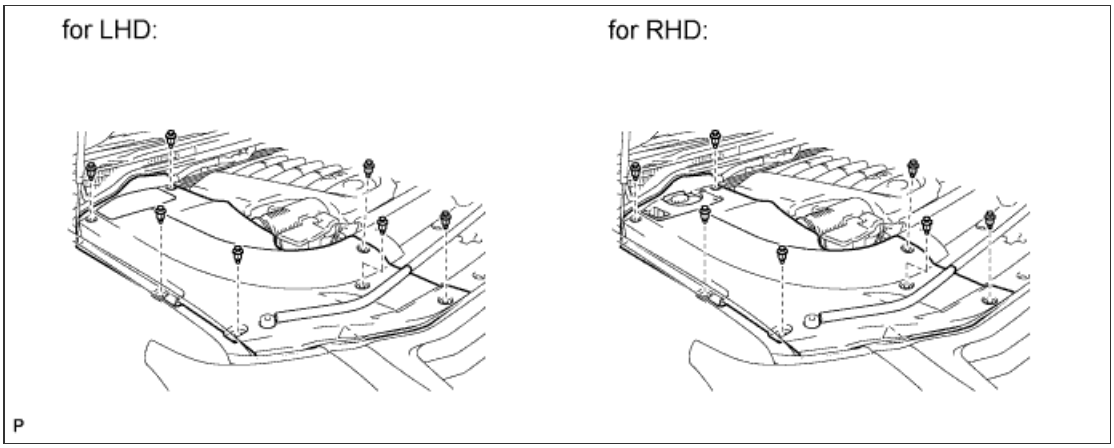
10. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



11. INSTALL ENGINE ROOM SIDE COVER RH

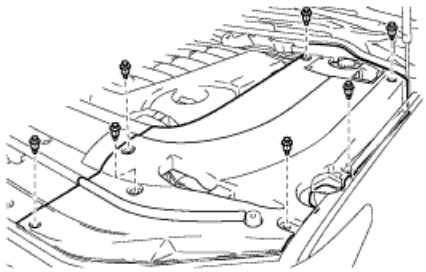
a. Install the engine room side cover with the 7 clips.



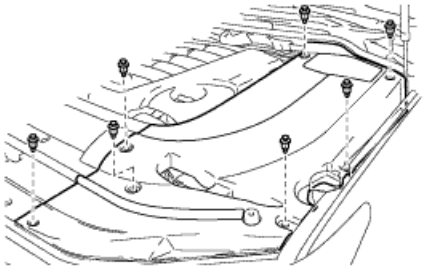
12. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

for LHD:

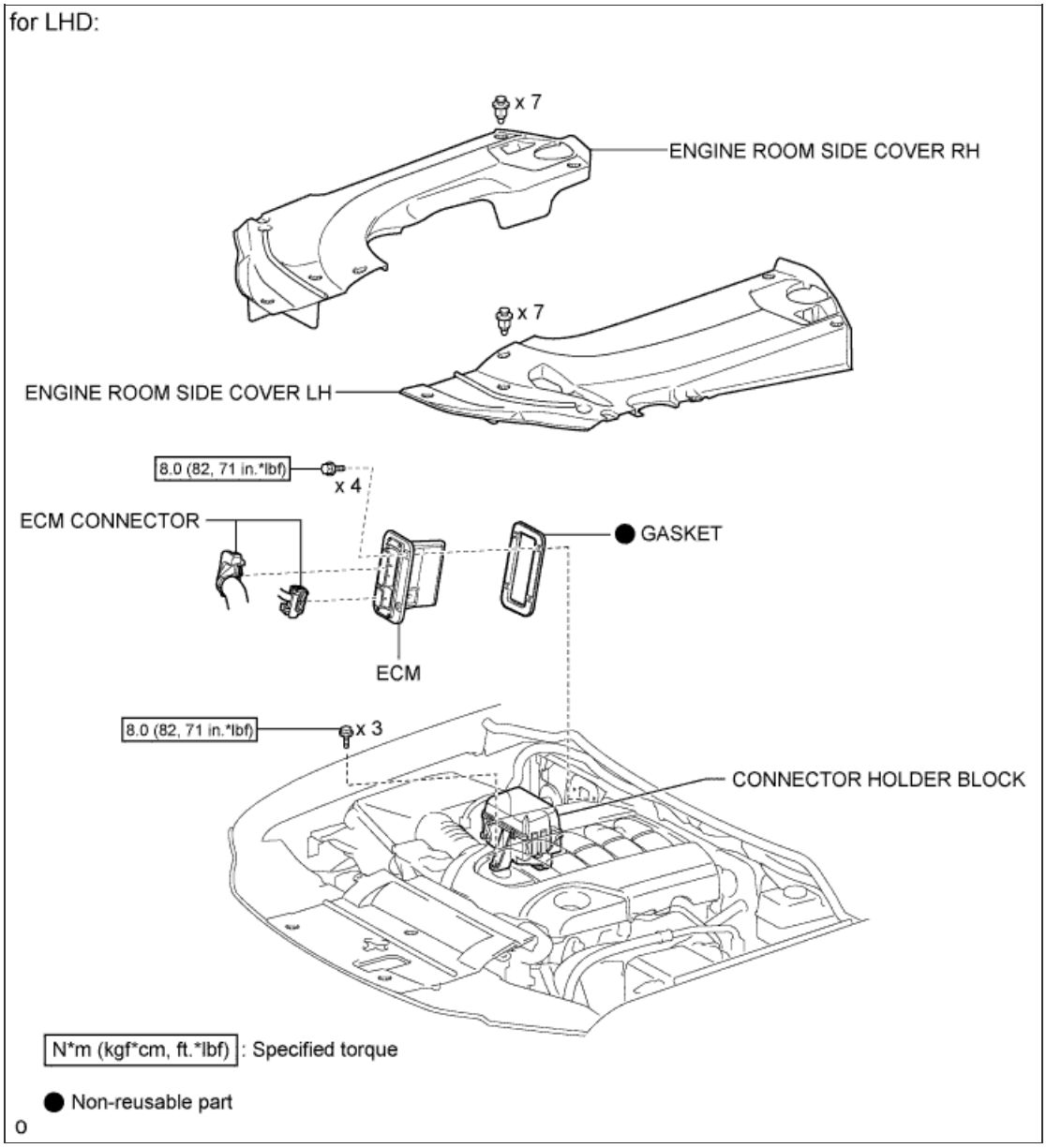


for RHD:

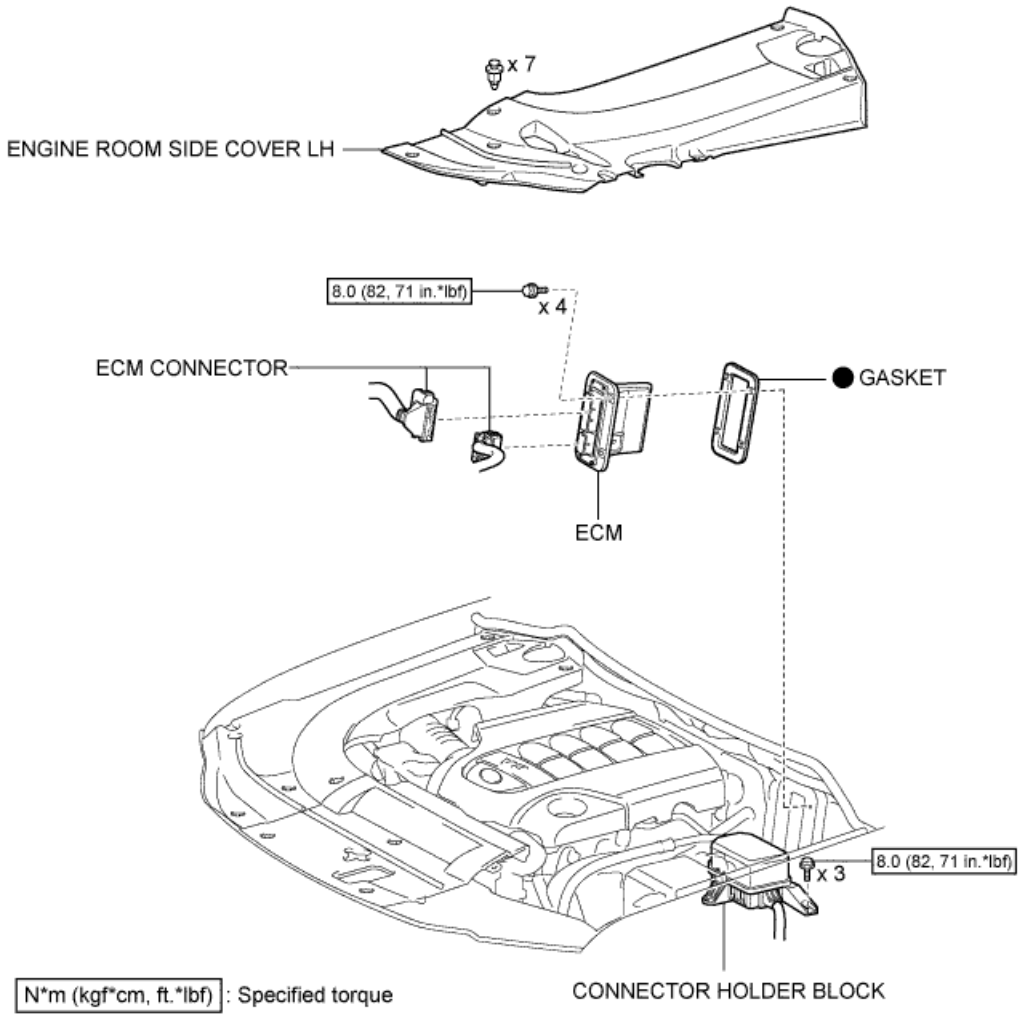


P

for Preparation [Click here]



for RHD:



N*m (kgf*cm, ft.*lbf) : Specified torque

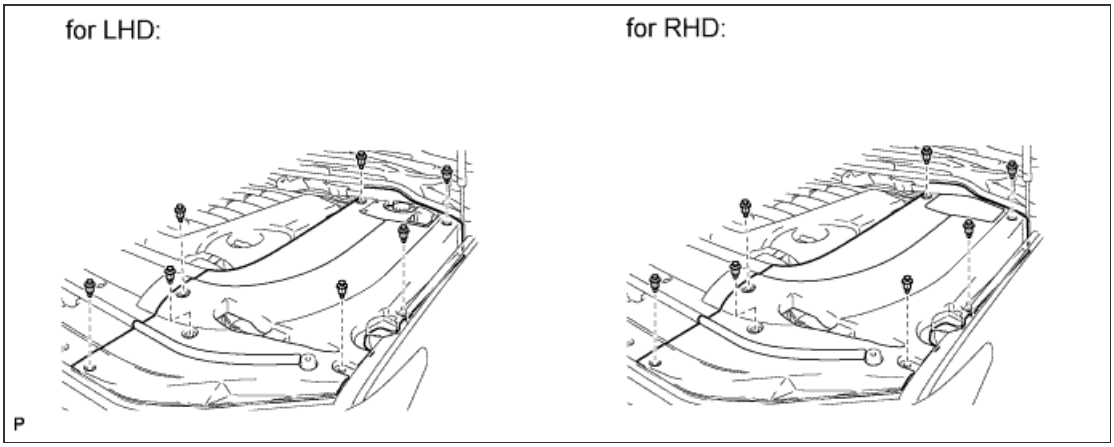
● Non-reusable part

o

for Preparation Click here

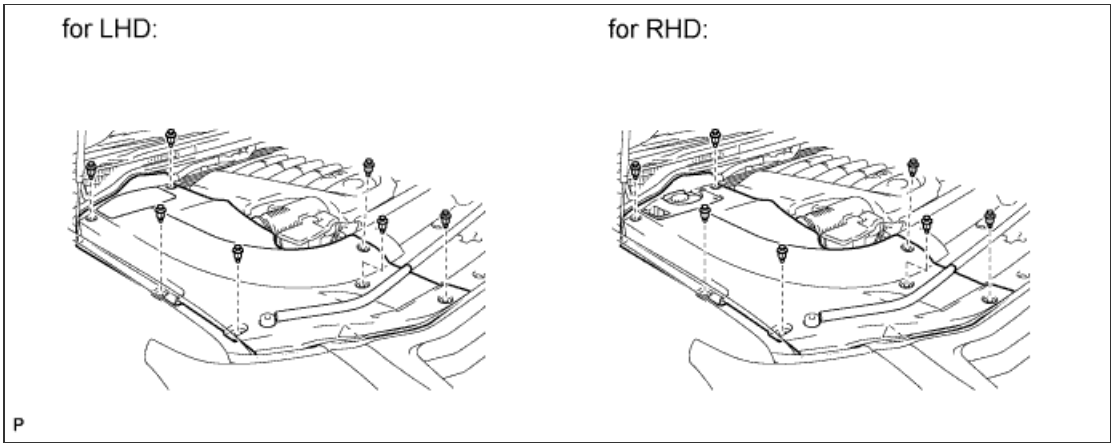
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



2. REMOVE ENGINE ROOM SIDE COVER RH (for LHD)

a. Remove the 7 clips and engine room side cover.



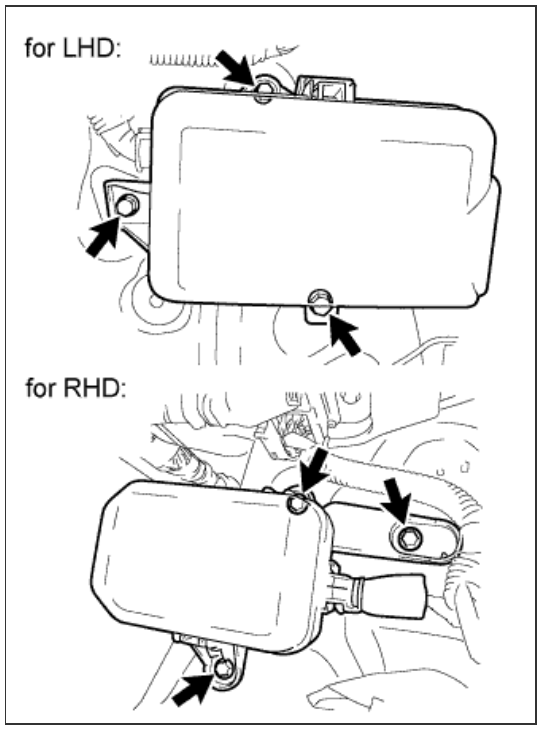
3. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

4. DISCONNECT CONNECTOR HOLDER BLOCK

a. Remove the 3 bolts and move the connector holder block so that the ECM can be removed in the next step.



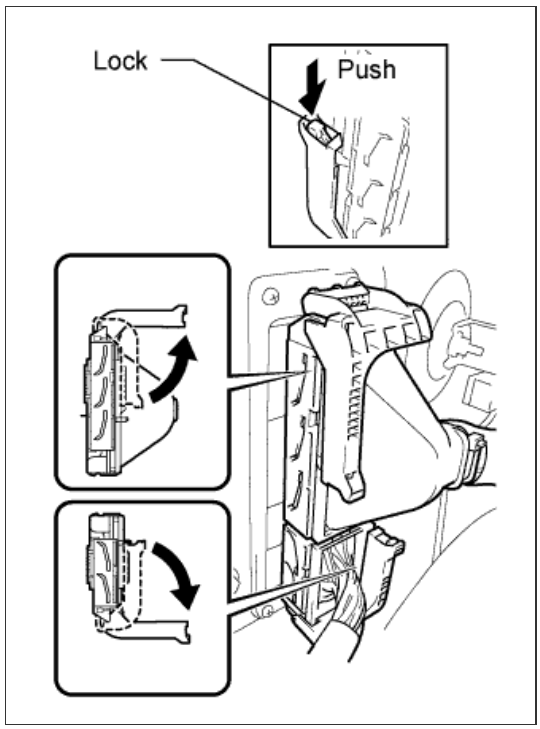
5. REMOVE ECM

a. Raise the 2 levers while pushing the locks on the 2 levers.

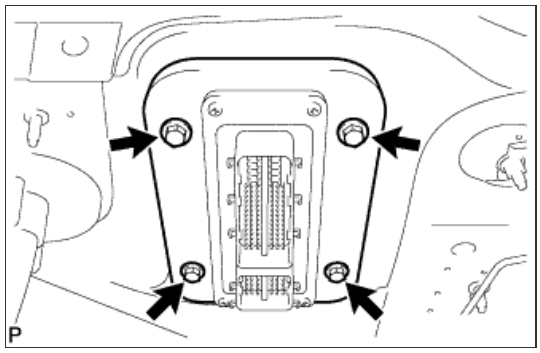
NOTICE:

Make sure that the lock levers are raised 90° as shown in the illustration before disconnecting the connectors. Failure to do this may cause the connectors to break.

b. Disconnect the 2 connectors.

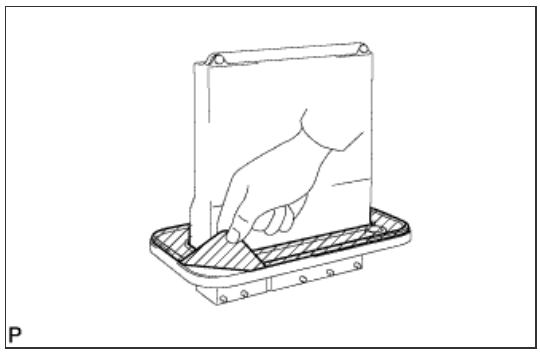


c. Remove the 4 bolts and ECM.



6. REMOVE GASKET

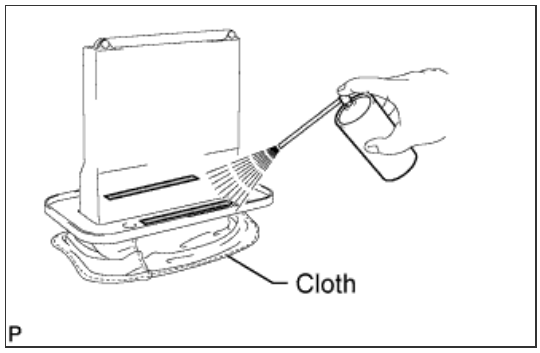
a. Peel off the gasket.



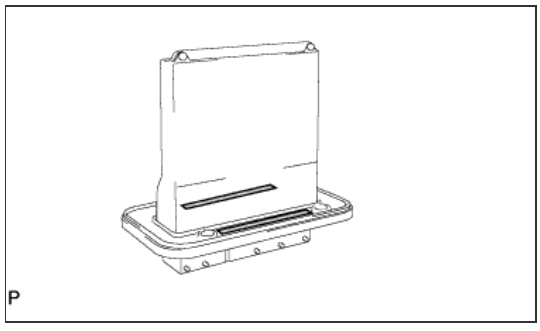
b. Spray gasket remover or equivalent on the remaining tape of the gasket.

NOTICE:

When using gasket remover or equivalent, cover the ECM connectors with a cloth.



c. Remove the tape of the gasket without using bladed objects.



for Preparation Click here

1. INSTALL GASKET

a. Clean the ECM seal surface with non-residue solvent.

b. Attach a new gasket to the ECM.

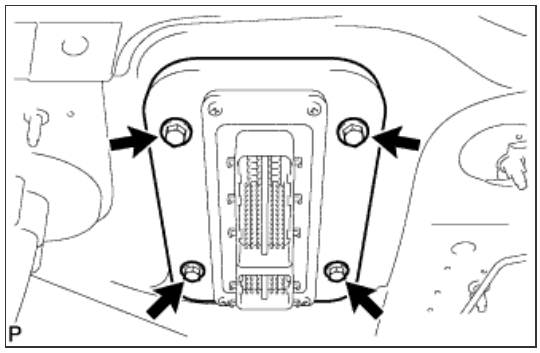
2. INSTALL ECM

a. Install the ECM with the 4 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

NOTICE:

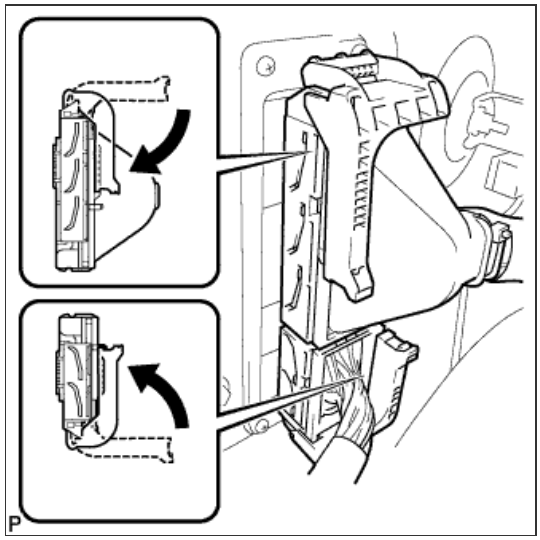
- **Make sure the gasket is not folded or caught on any area of the surrounding part.**
- **Make sure there is no foreign matter caught between the gasket and surrounding part.**
- **Do not damage the gasket.**



b. Connect the 2 ECM connectors and push each lock lever down to lock the ECM connectors.

NOTICE:

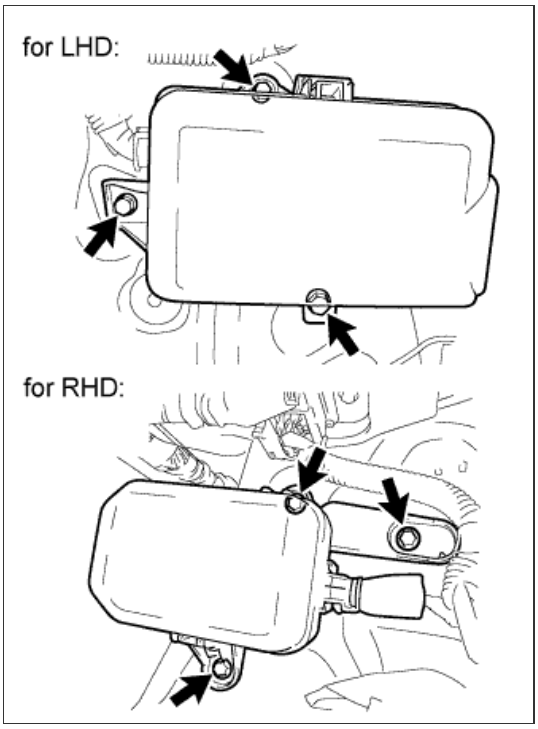
- **Make sure that the lock levers are raised 90° before connecting the ECM connectors. Failure to do this may cause the lock lever and terminals to break.**
- **Do not twist the wire harness when connecting the ECM connectors.**



3. INSTALL CONNECTOR HOLDER BLOCK

a. Install the connector holder block with the 3 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



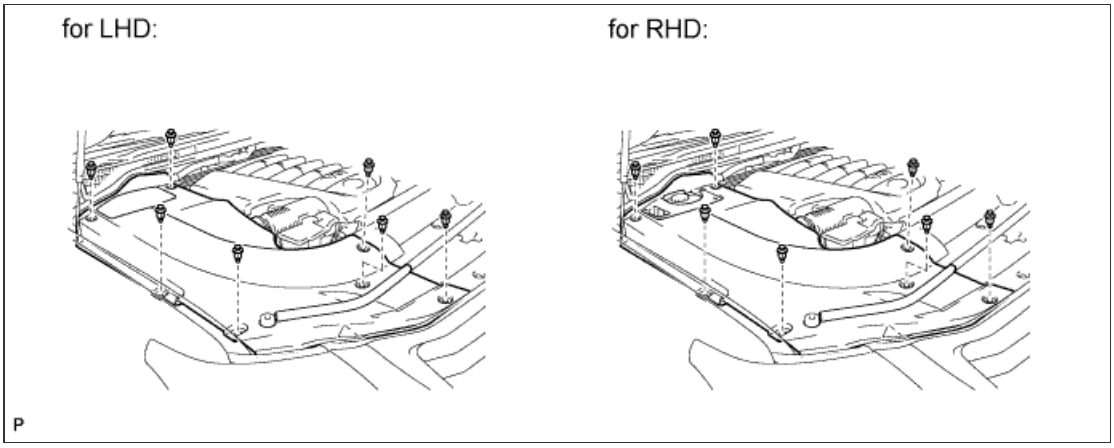
4. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

5. INSTALL ENGINE ROOM SIDE COVER RH (for LHD)

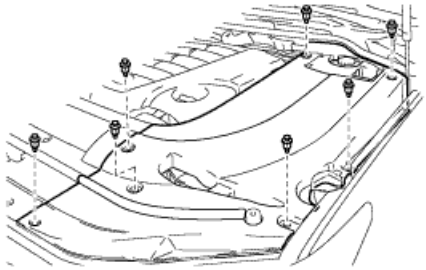
a. Install the engine room side cover with the 7 clips.



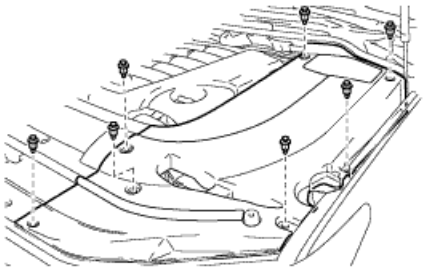
6. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

for LHD:

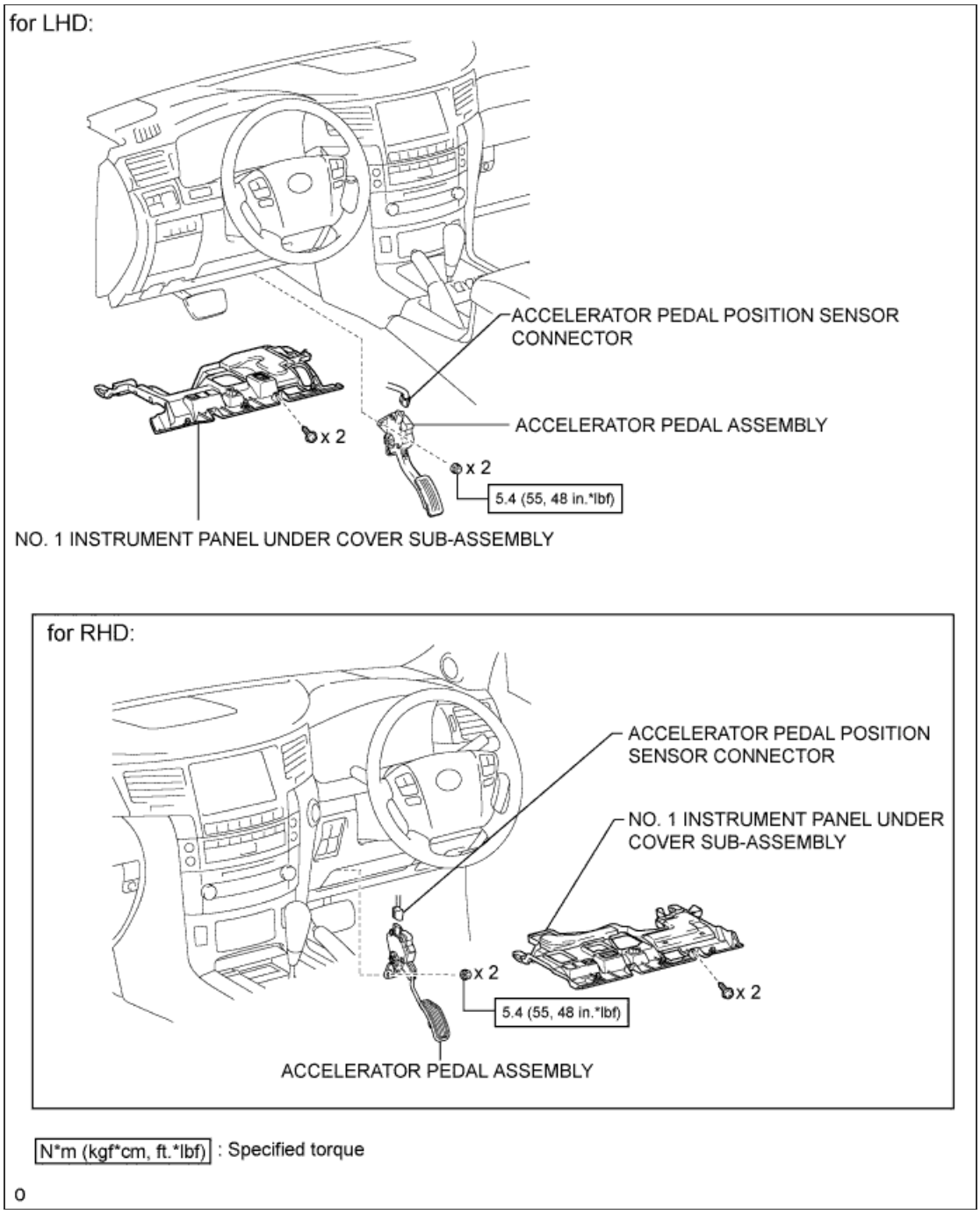


for RHD:



P

for Preparation Click here



o

for Preparation Click here

1. INSPECT ACCELERATOR PEDAL ASSEMBLY

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester main switch on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / ETCS / Accelerator Position No. 1 and Accelerator Position No. 2.

e. Read the value displayed on the intelligent tester.

Standard Voltage:

Accelerator Pedal Operations	Accelerator Position No. 1	Accelerator Position No. 2
Released	0.5 to 1.1 V	1.2 to 2.0 V
Depressed	2.6 to 4.5 V	3.4 to 5.0 V

If the result is not as specified, check the accelerator pedal, wire harness and ECM.

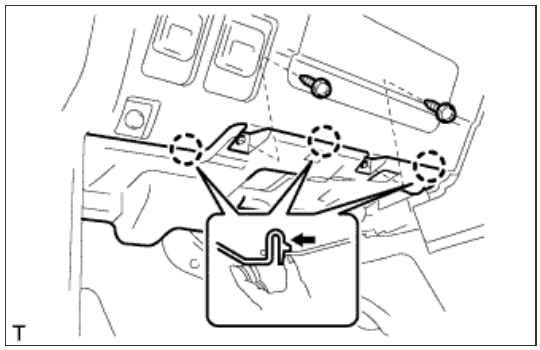
for Preparation Click here

1. REMOVE NO. 1 INSTRUMENT PANEL UNDER COVER SUB-ASSEMBLY

a. Remove the 2 screws.

b. Detach the 3 claws.

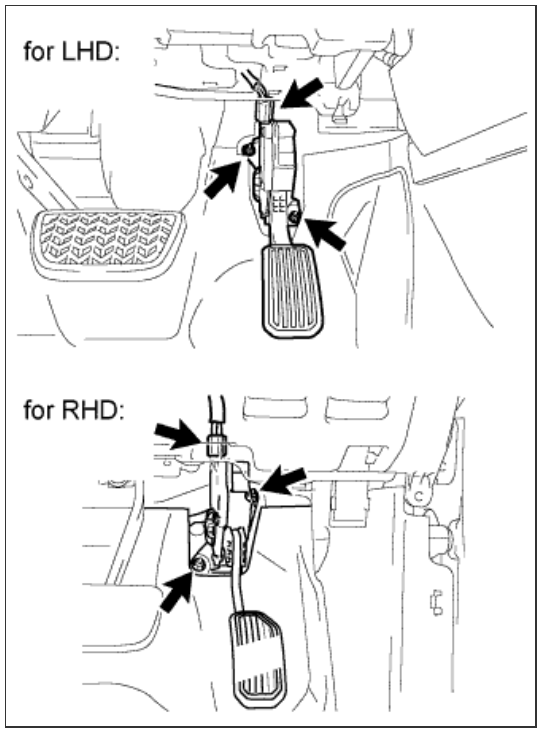
c. Remove the under cover and disconnect the connectors.



2. REMOVE ACCELERATOR PEDAL ASSEMBLY

a. Disconnect the accelerator pedal position sensor connector.

b. Remove the 2 nuts and accelerator pedal.



for Preparation Click here

1. INSTALL ACCELERATOR PEDAL ASSEMBLY

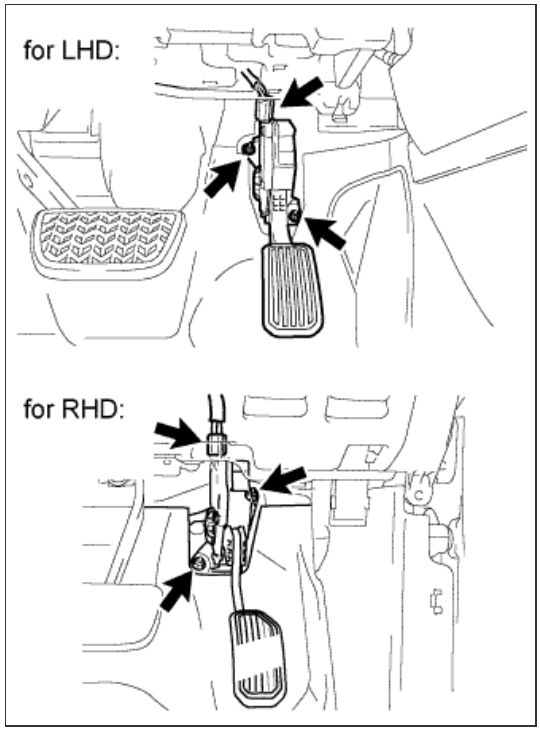
NOTICE:

- **Avoid physical shocks to the accelerator pedal.**
- **Do not disassemble the accelerator pedal.**

a. Install the accelerator pedal with the 2 nuts.

Torque:
5.4 N*m{ 55 kgf*cm , 48 in.*lbf }

b. Connect the accelerator pedal position sensor connector.

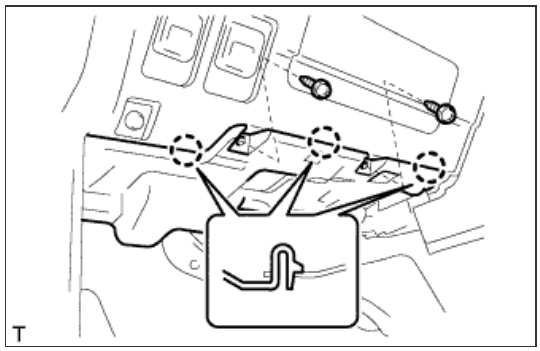


2. INSTALL NO. 1 INSTRUMENT PANEL UNDER COVER SUB-ASSEMBLY

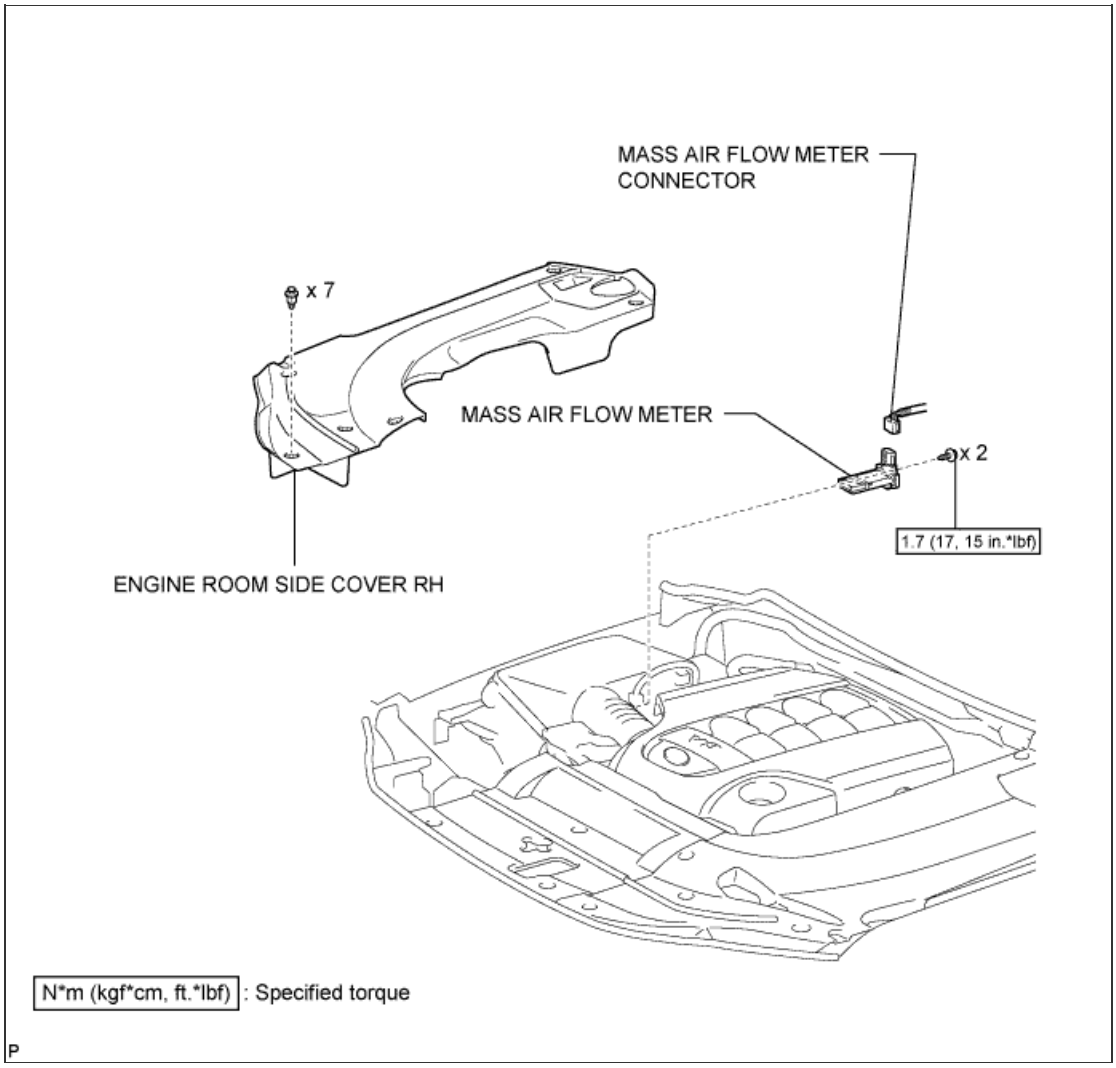
a. Connect the connectors.

b. Attach the 3 claws to install the under cover.

c. Install the 2 screws.



for Preparation Click here



for Preparation Click here

1. CHECK MASS AIR FLOW METER

a. Check the mass air flow value.

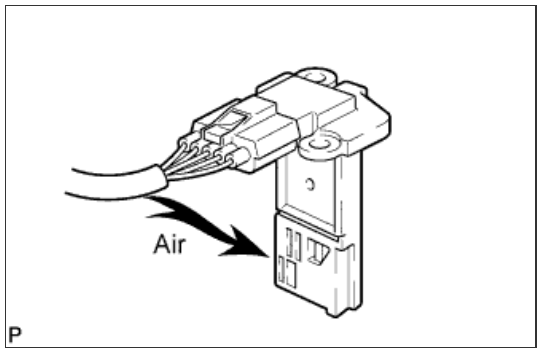
i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch on.

iv. Enter the following menus: Powertrain / Engine / Data List / All Data / MAF.

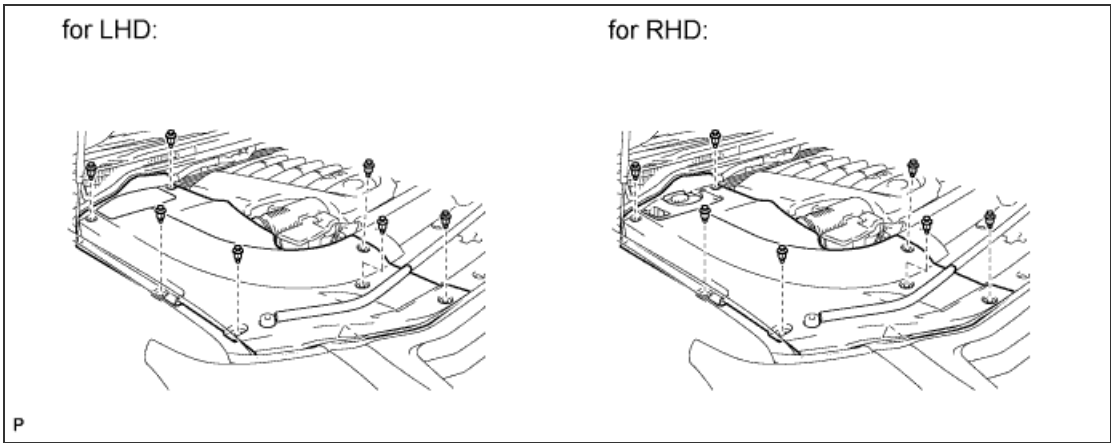
v. Blow air into the MAF meter, and check that the MAF value fluctuates. If the result is not as specified, check the MAF meter (Click here), or wiring and ECM (Click here).



for Preparation Click here

1. REMOVE ENGINE ROOM SIDE COVER RH

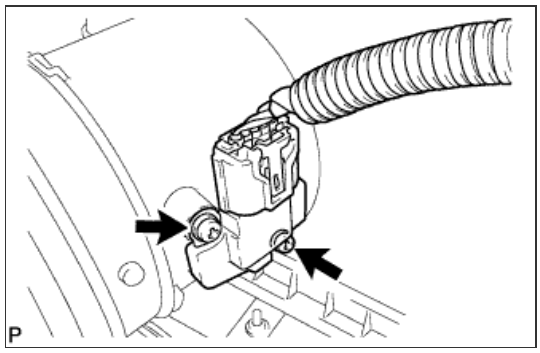
a. Remove the 7 clips and engine room side cover.



2. REMOVE MASS AIR FLOW METER

a. Disconnect the MAF connector.

b. Remove the 2 screws and MAF meter.



for Preparation Click here

1. INSPECT MASS AIR FLOW METER

a. Check the output voltage.

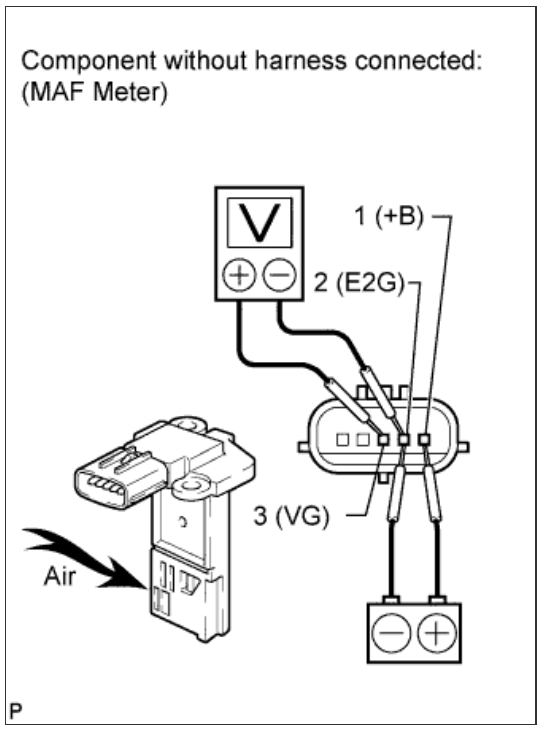
i. Apply battery voltage across terminals 1 (+B) and 2 (E2G).

NOTICE:

While using the battery during inspection, do not bring the positive and negative tester probes too close to each other as a short circuit may occur.

ii. Using a voltmeter, connect the positive (+) tester probe to terminal 3 (VG), and the negative (-) tester probe to terminal 2 (E2G).

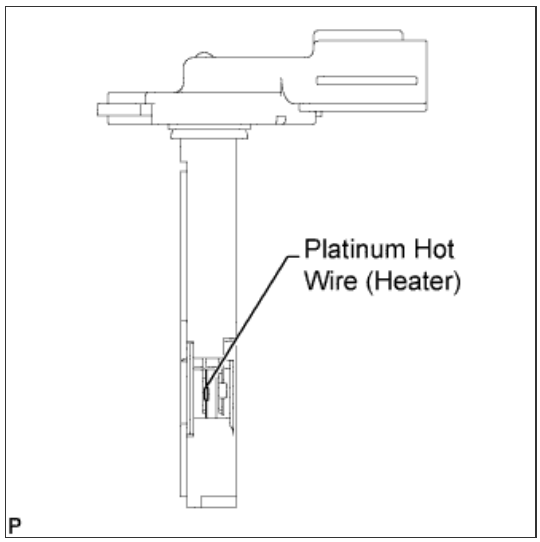
iii. Blow air into the MAF meter and check that the voltage fluctuates.
If the result is not as specified, replace the MAF meter.



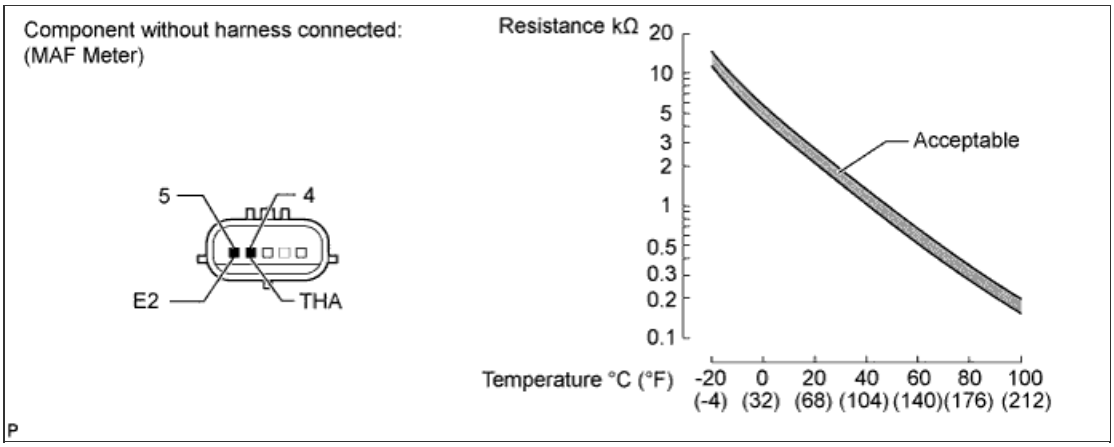
b. Perform a visual check for any foreign matter on the platinum hot wire (heater) of the mass air flow meter shown in the illustration.

OK:
There is no foreign matter.

If the result is not as specified, replace the mass air flow meter.



c. Check the IAT sensor.



i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
4 (THA) - 5 (E2)	-20°C (-4°F)	12.5 to 16.9 kΩ
	20°C (68°F)	2.19 to 2.67 kΩ
	60°C (140°F)	0.50 to 0.68 kΩ

If the result is not as specified, replace the MAF meter.

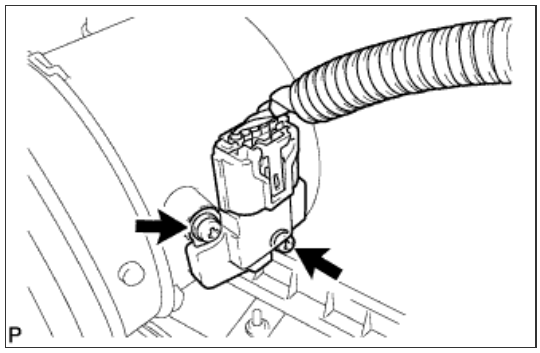
for Preparation Click here

1. INSTALL MASS AIR FLOW METER

a. Install the MAF meter with the 2 screws.

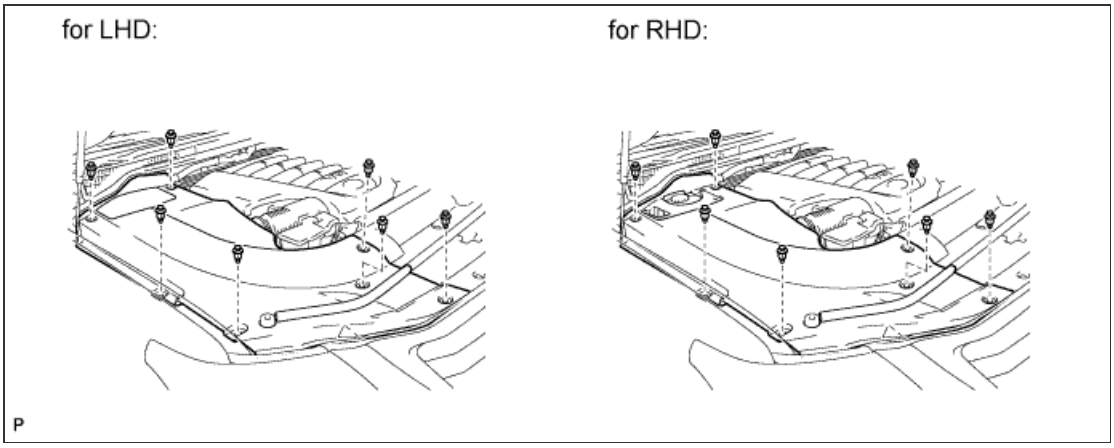
Torque:
1.7 N*m{ 17 kgf*cm , 15 in.*lbf }

b. Connect the MAF connector.

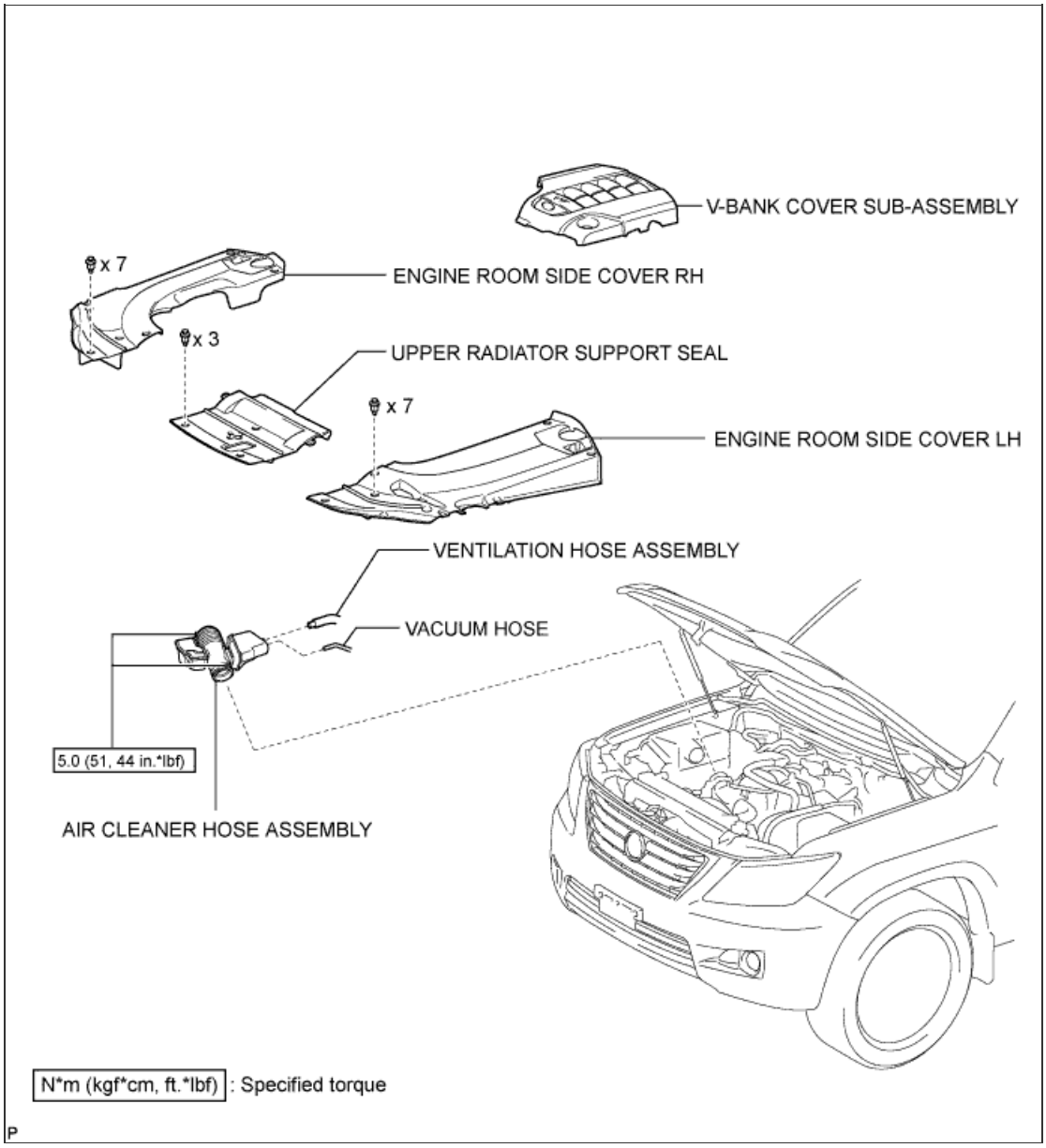


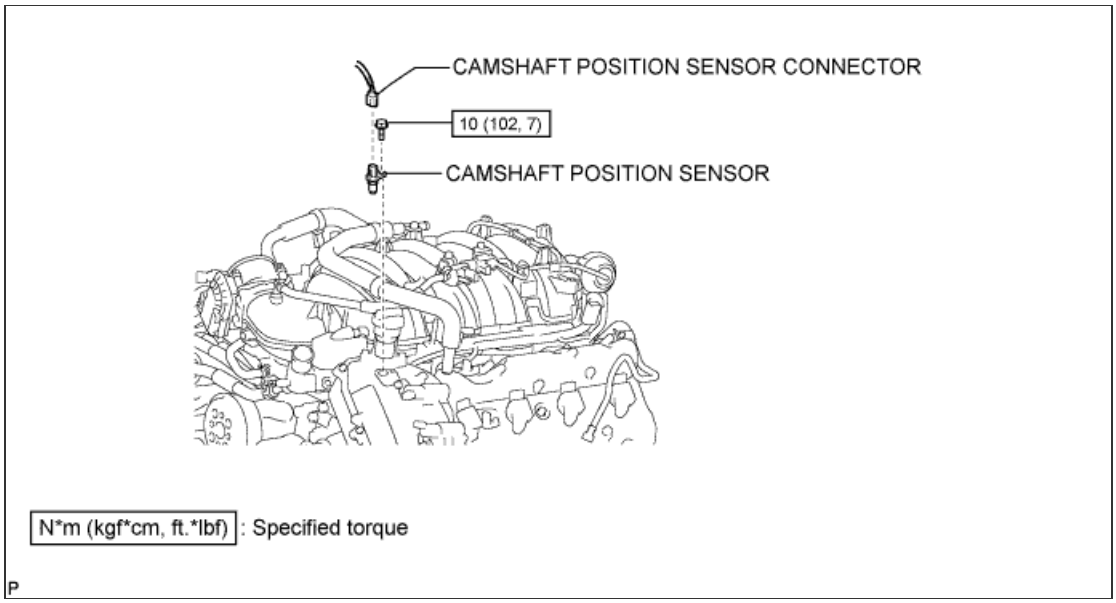
2. INSTALL ENGINE ROOM SIDE COVER RH

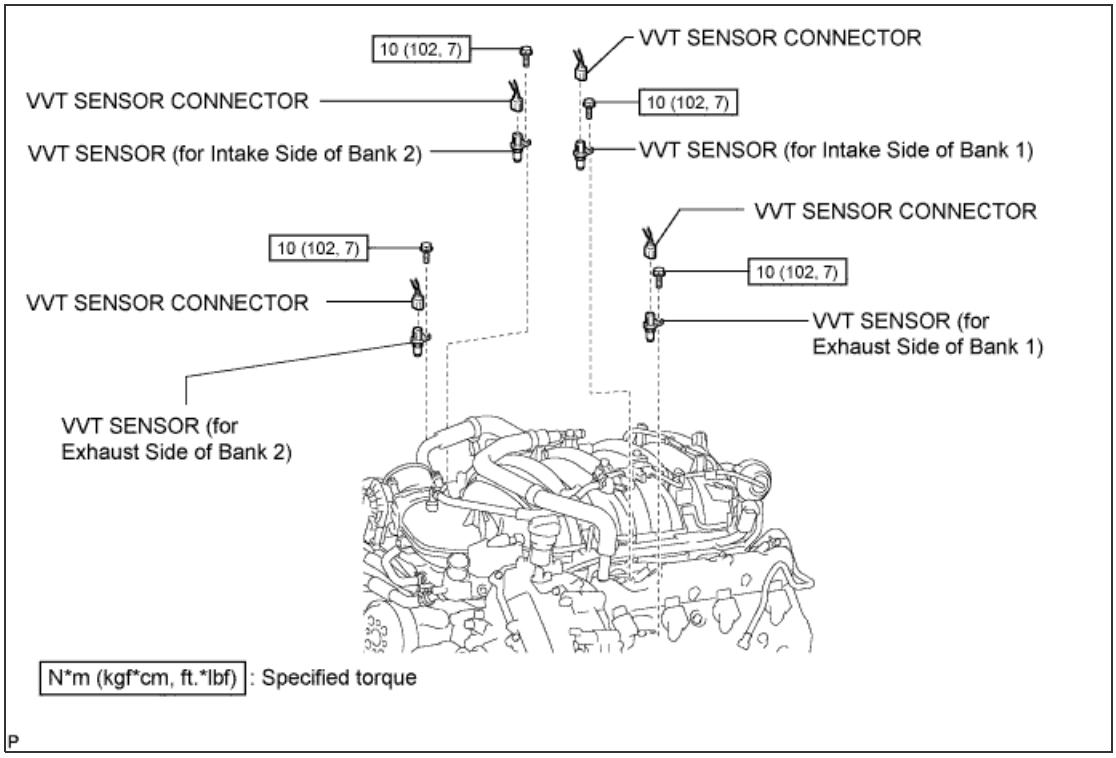
a. Install the engine room side cover with the 7 clips.



for Preparation Click here



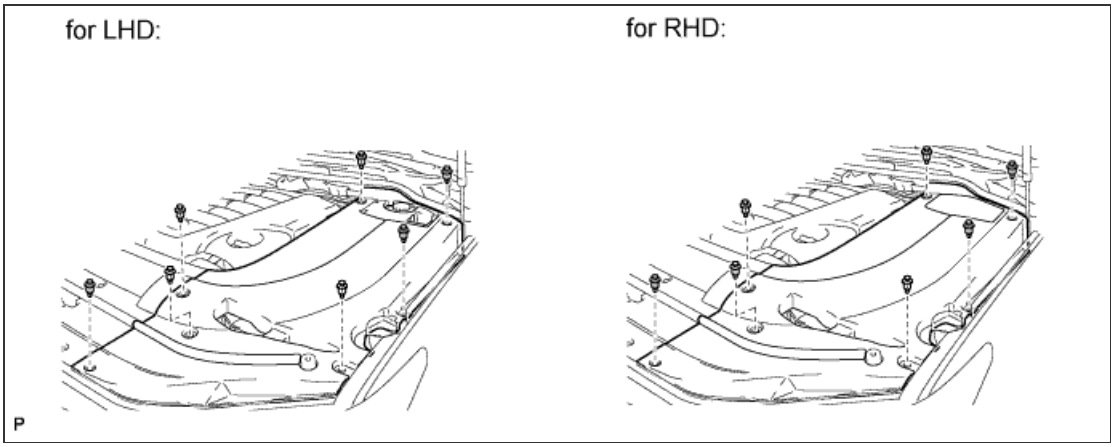

CAMSHAFT POSITION SENSOR CONNECTOR
10 (102, 7)
CAMSHAFT POSITION SENSOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P


10 (102, 7)
VVT SENSOR CONNECTOR
VVT SENSOR (for Intake Side of Bank 2)
VVT SENSOR CONNECTOR
10 (102, 7)
VVT SENSOR (for Intake Side of Bank 1)
VVT SENSOR CONNECTOR
10 (102, 7)
VVT SENSOR (for Exhaust Side of Bank 1)
10 (102, 7)
VVT SENSOR CONNECTOR
VVT SENSOR (for Exhaust Side of Bank 2)
N*m (kgf*cm, ft.*lbf) : Specified torque
P

for Preparation Click here

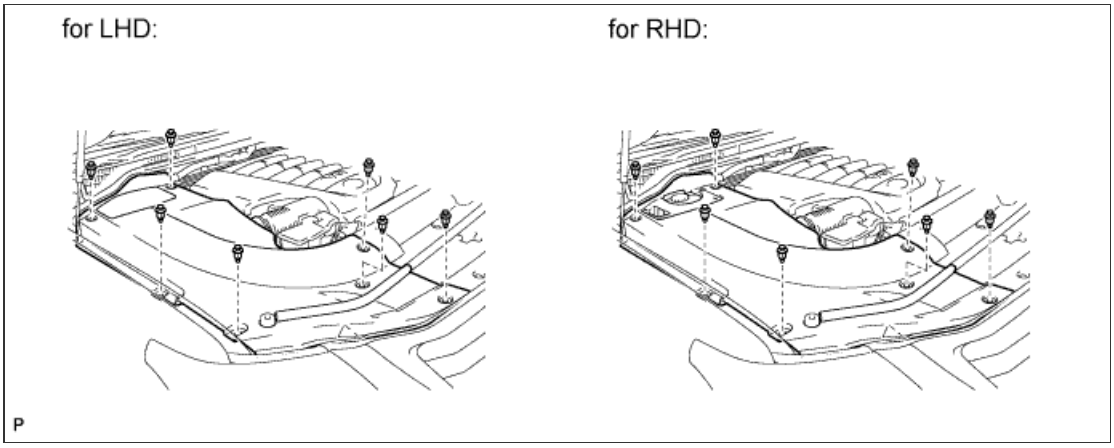
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



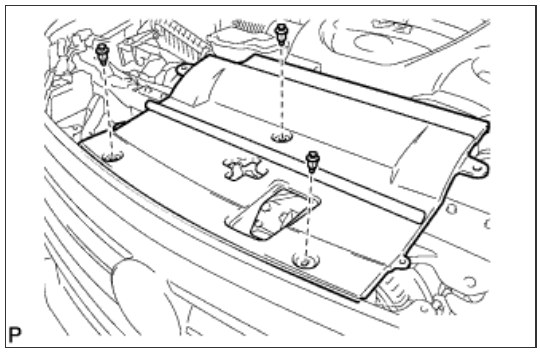
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



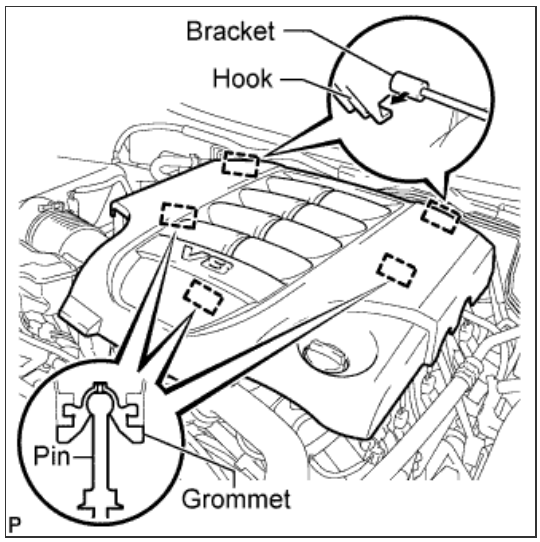
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

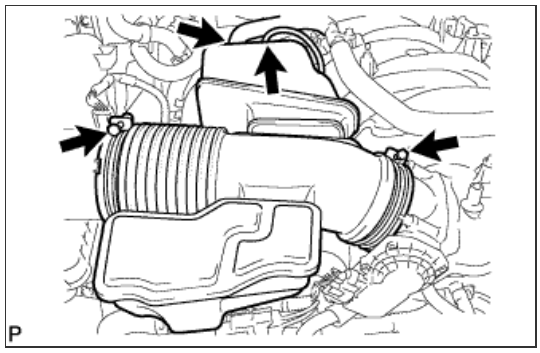


5. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

b. Loosen the 2 hose clamps.

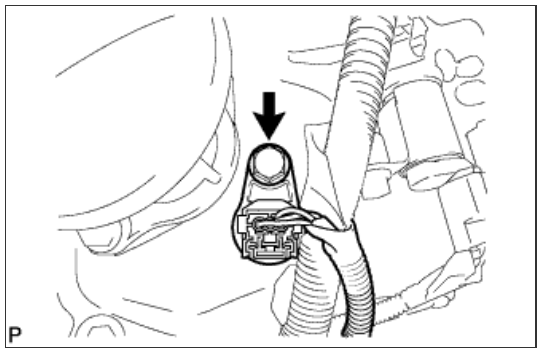
c. Remove the air cleaner hose.



6. REMOVE CAMSHAFT POSITION SENSOR

a. Disconnect the sensor connector.

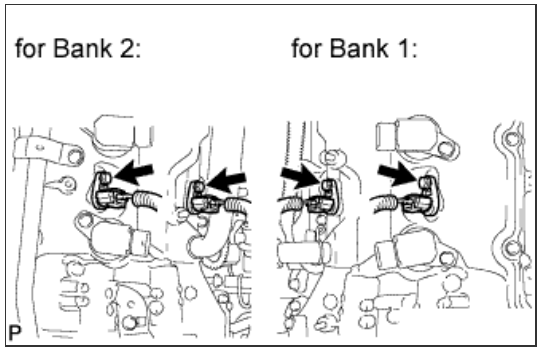
b. Remove the bolt and sensor.



7. REMOVE VVT SENSOR

a. Disconnect the 4 sensor connectors.

b. Remove the 4 bolts and 4 sensors.



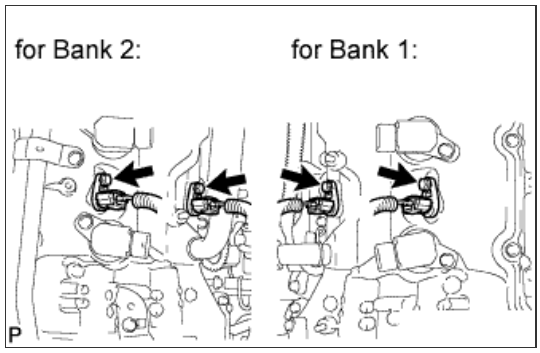
for Preparation Click here

1. INSTALL VVT SENSOR

a. Install the 4 sensors with the 4 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Connect the 4 sensor connectors.

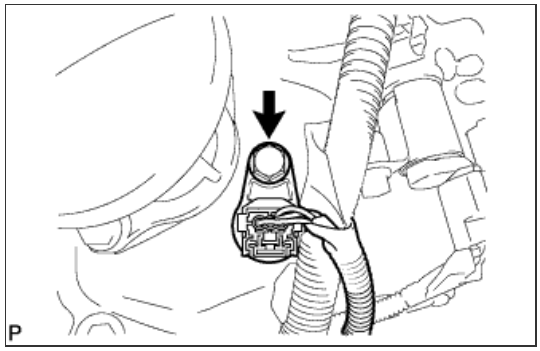


2. INSTALL CAMSHAFT POSITION SENSOR

a. Install the sensor with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Connect the sensor connector.



3. INSTALL AIR CLEANER HOSE ASSEMBLY

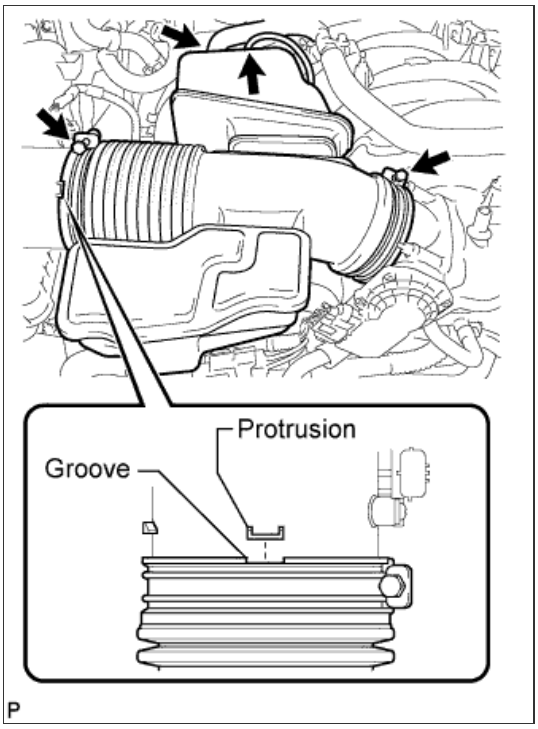
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

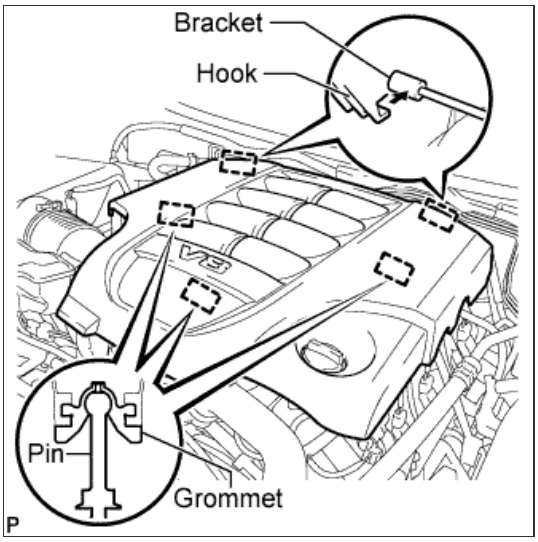
c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



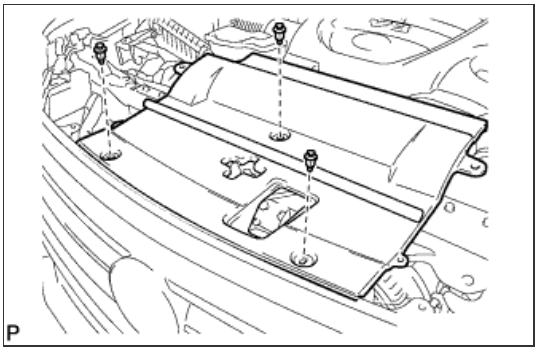
4. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



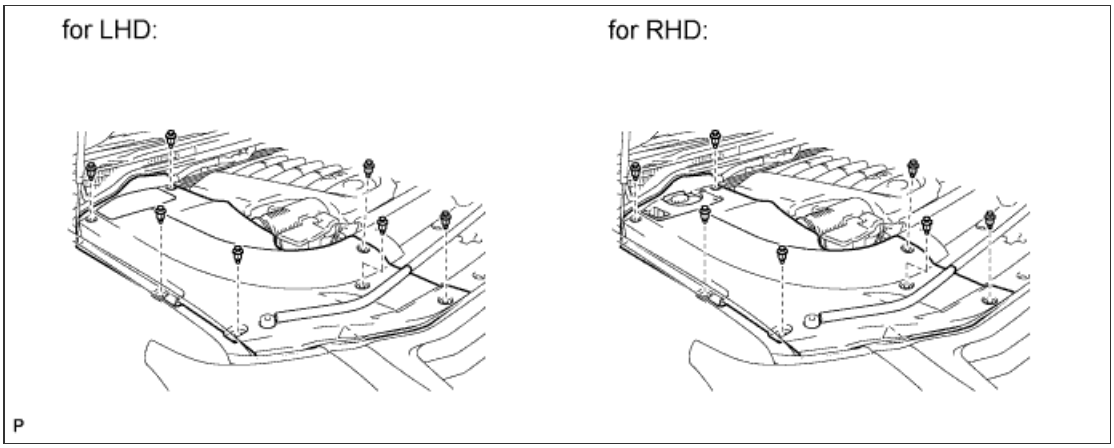
5. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



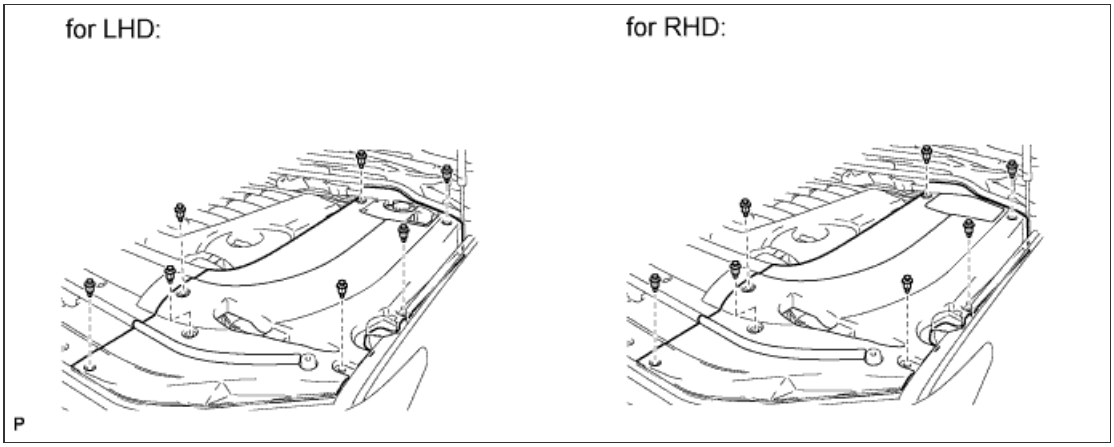
6. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

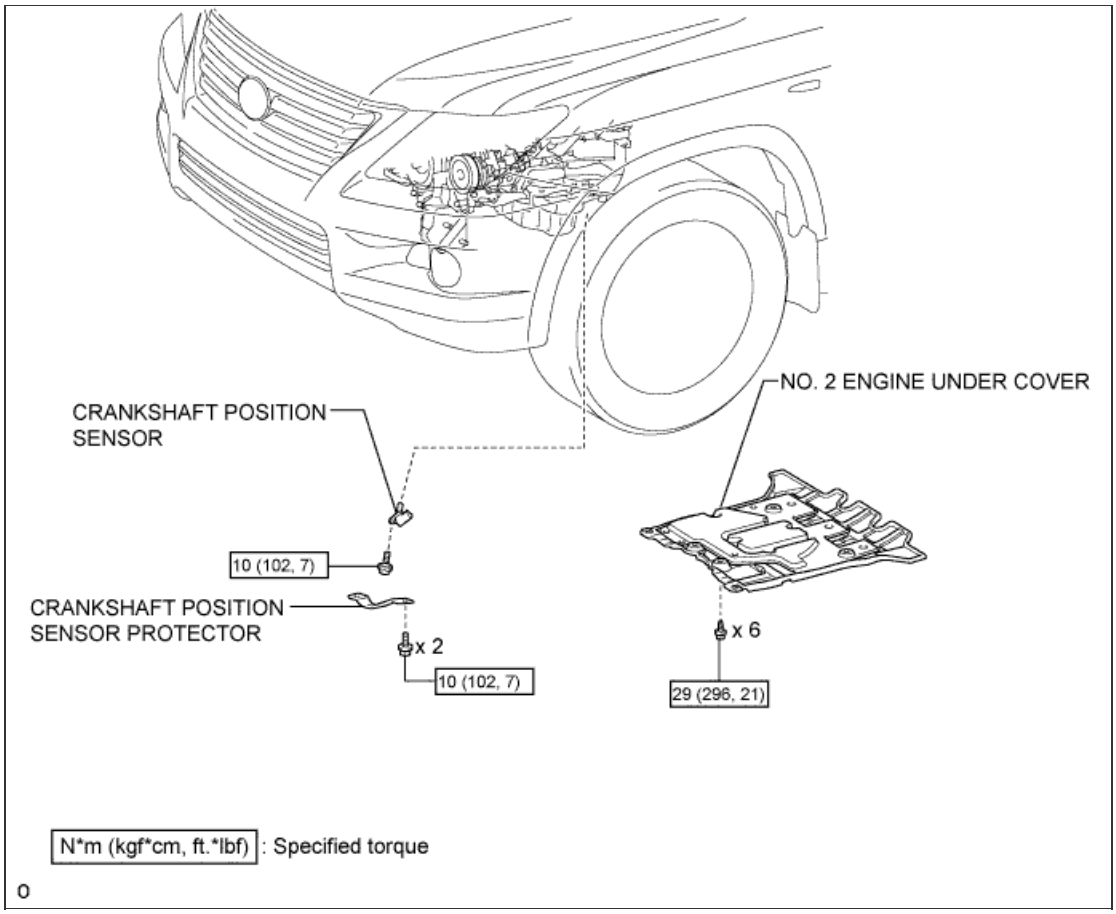


7. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



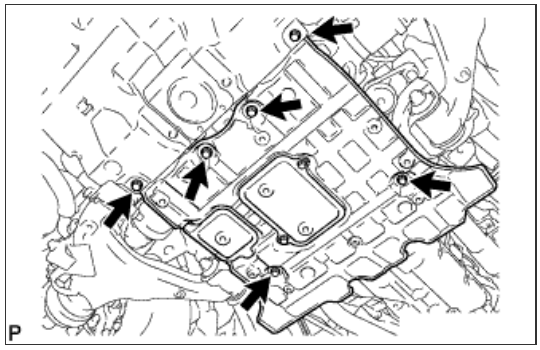
for Preparation Click here



for Preparation Click here

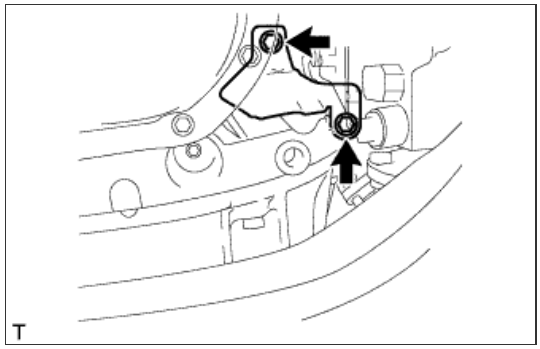
1. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 6 bolts and under cover.



2. REMOVE CRANKSHAFT POSITION SENSOR PROTECTOR

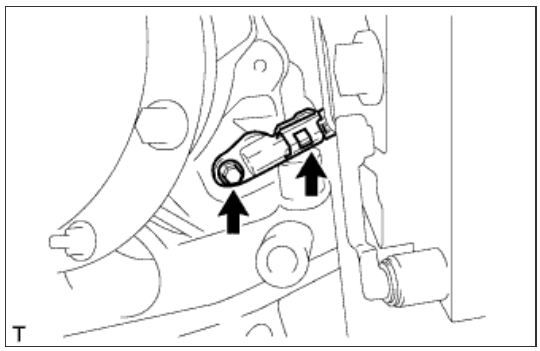
a. Remove the 2 bolts and sensor protector.



3. REMOVE CRANKSHAFT POSITION SENSOR

a. Disconnect the sensor connector.

b. Remove the bolt and sensor.



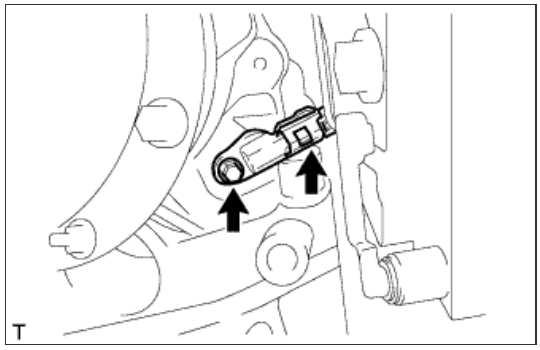
for Preparation Click here

1. INSTALL CRANKSHAFT POSITION SENSOR

a. Install the sensor with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

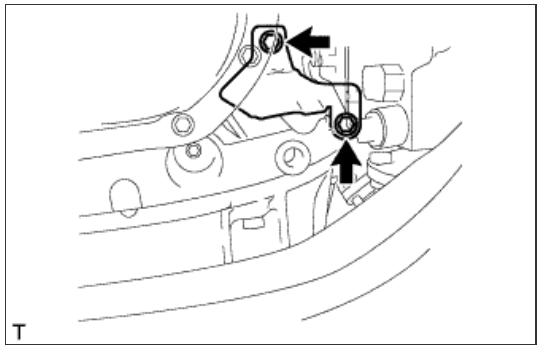
b. Connect the sensor connector.



2. INSTALL CRANKSHAFT POSITION SENSOR PROTECTOR

a. Install the sensor protector with the 2 bolts.

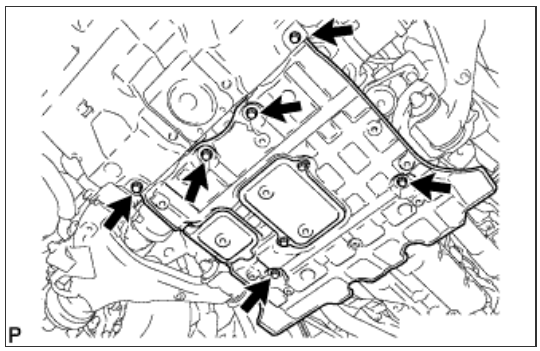
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



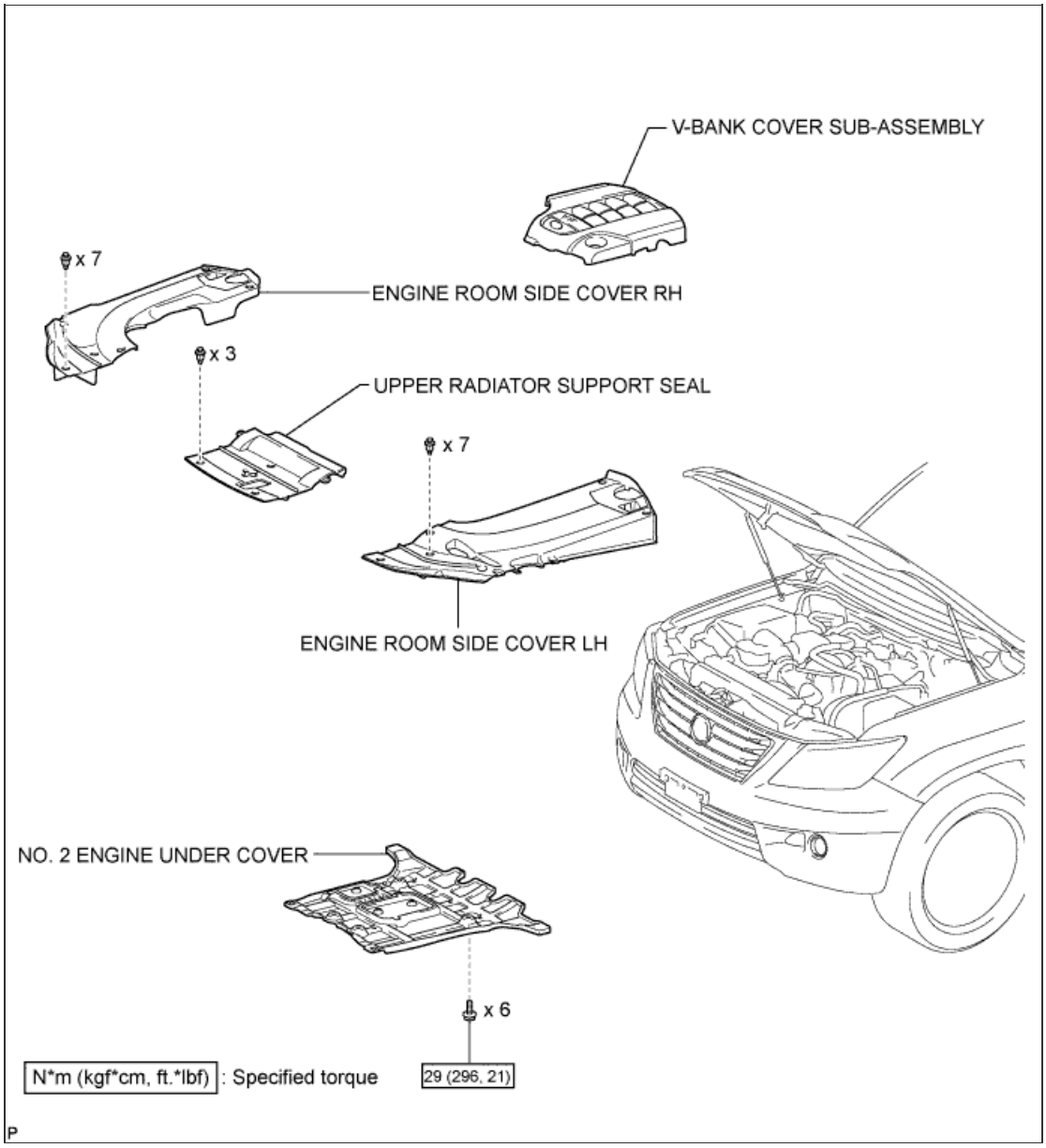
3. INSTALL NO. 2 ENGINE UNDER COVER

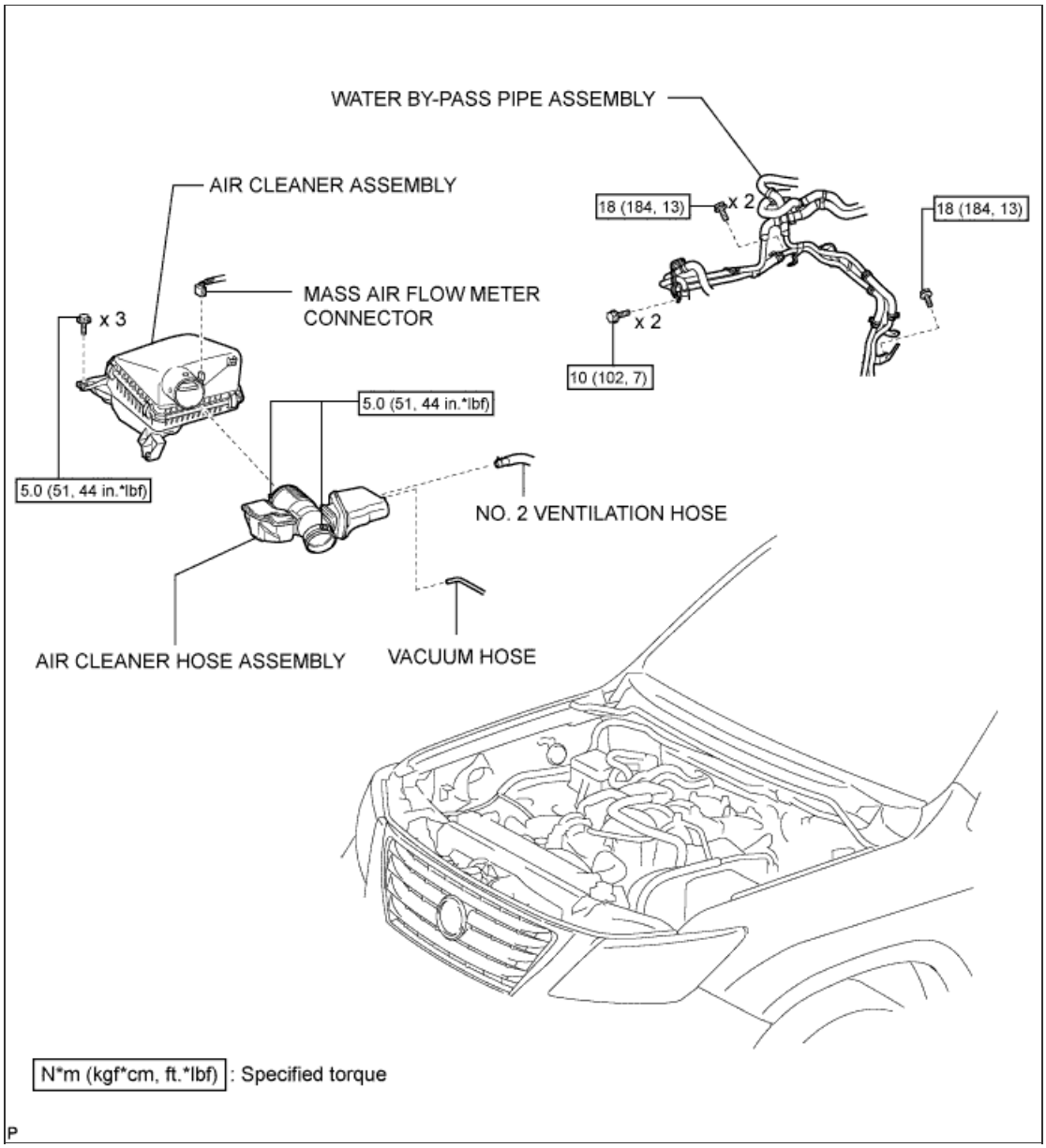
a. Install the under cover with the 6 bolts.

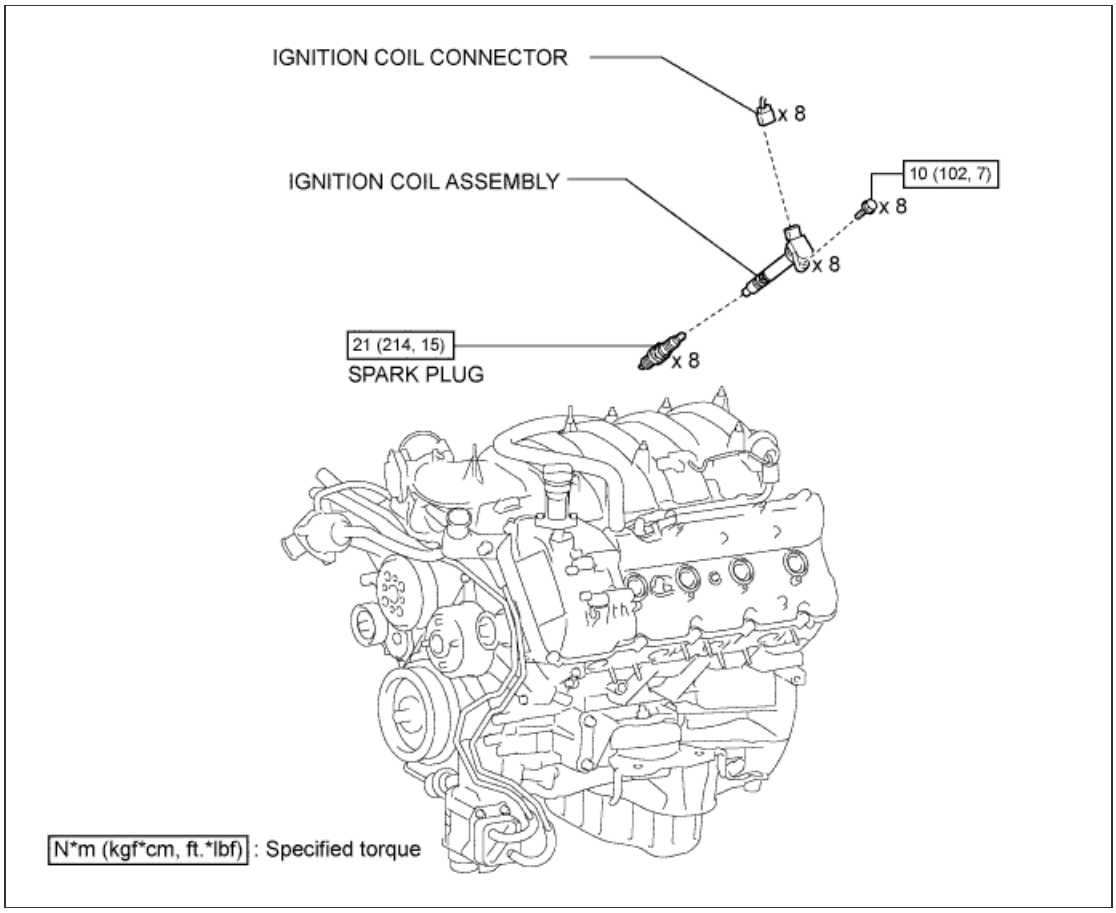
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



for Preparation Click here



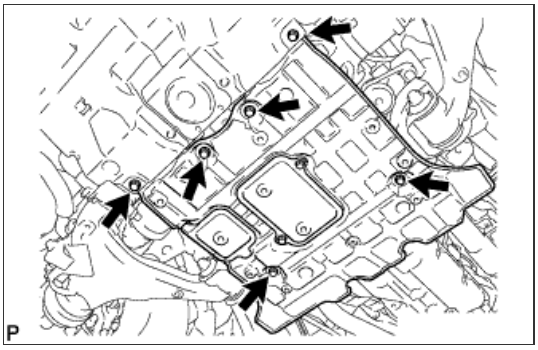

WATER BY-PASS PIPE ASSEMBLY
AIR CLEANER ASSEMBLY
MASS AIR FLOW METER CONNECTOR
x 3
18 (184, 13)
x 2
18 (184, 13)
x 2
10 (102, 7)
5.0 (51, 44 in.*lbf)
5.0 (51, 44 in.*lbf)
NO. 2 VENTILATION HOSE
AIR CLEANER HOSE ASSEMBLY
VACUUM HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P


IGNITION COIL CONNECTOR
x 8
IGNITION COIL ASSEMBLY
10 (102, 7)
x 8
x 8
21 (214, 15)
SPARK PLUG
x 8
N*m (kgf*cm, ft.*lbf) : Specified torque

for Preparation Click here

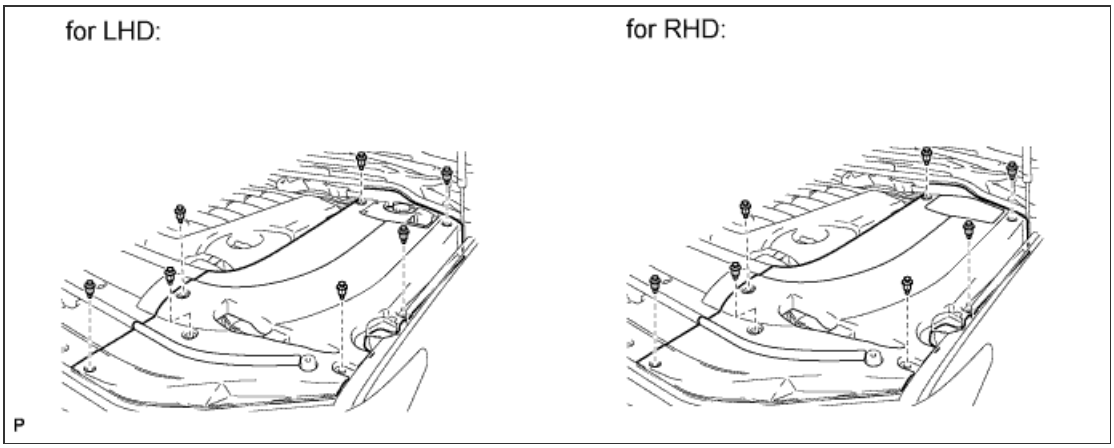
1. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 6 bolts and under cover.



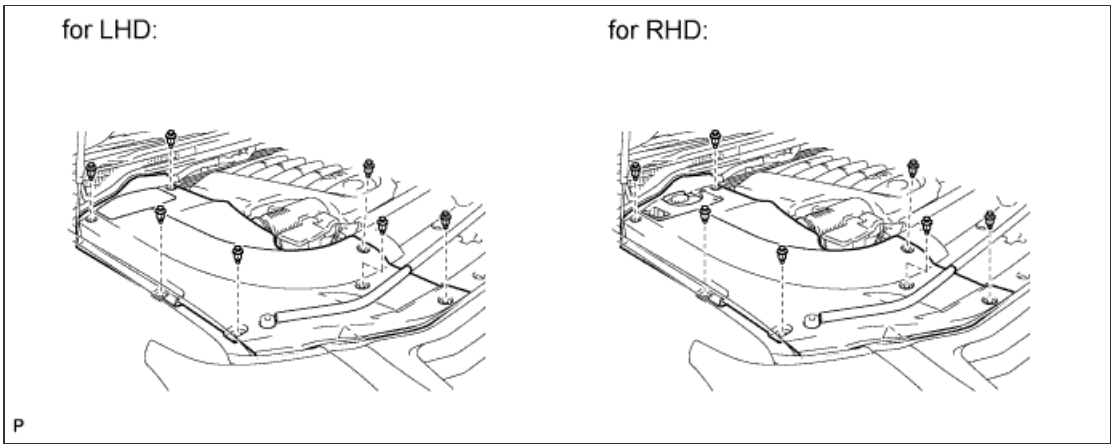
2. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



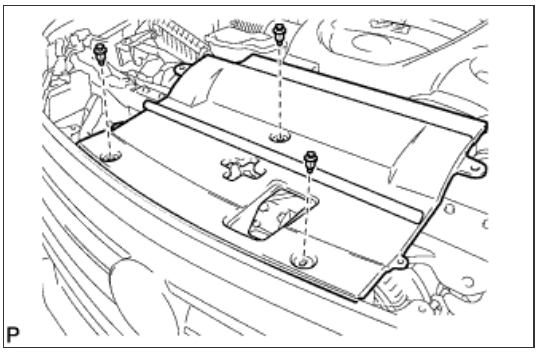
3. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



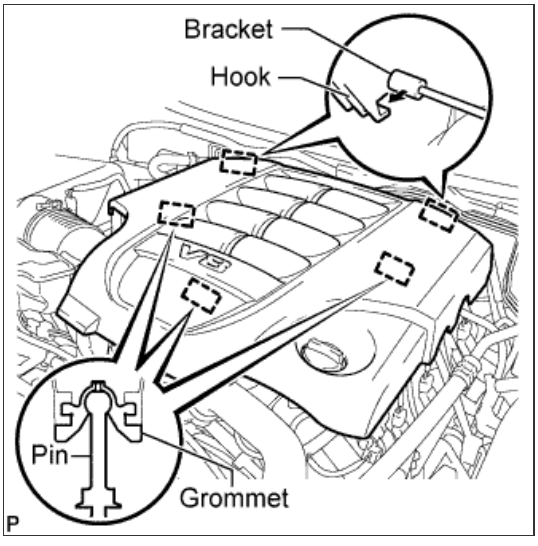
4. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



5. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

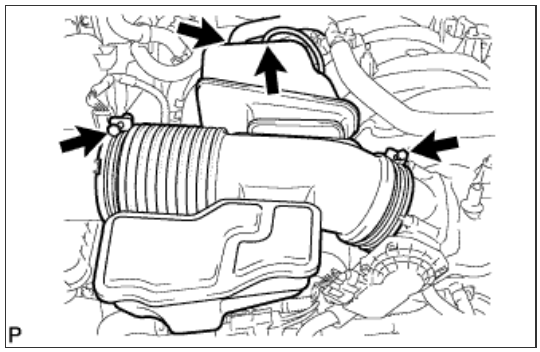


6. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

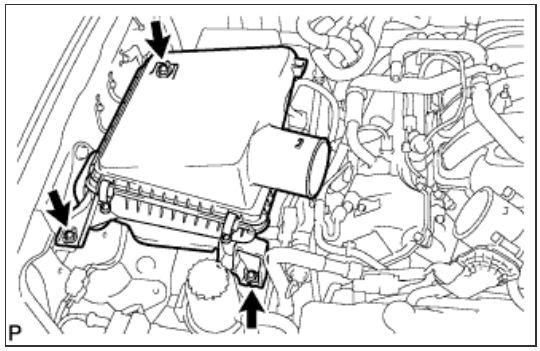
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



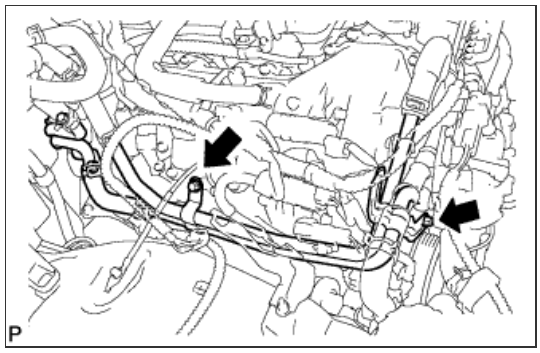
7. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.

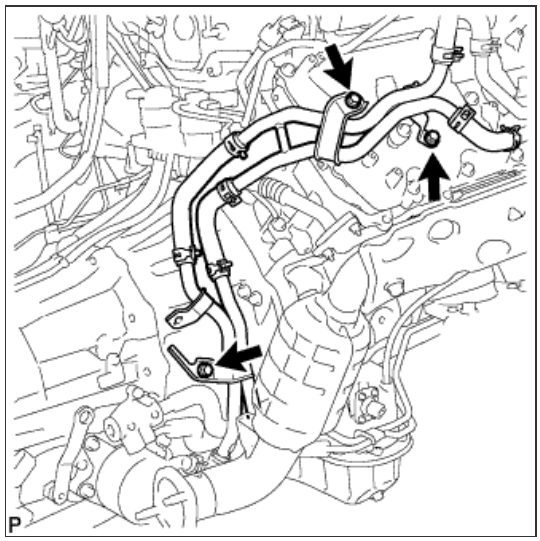


8. DISCONNECT WATER BY-PASS PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the water by-pass pipe from the cylinder head cover and timing chain cover.



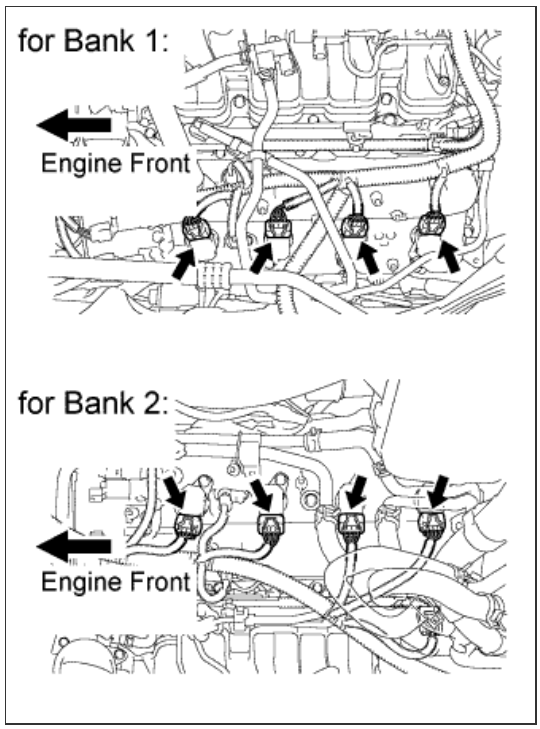
b. Remove the 3 bolts and disconnect the water by-pass pipe from the cylinder head cover.



9. REMOVE IGNITION COIL ASSEMBLY

a. Disconnect the 8 ignition coil connectors.

b. Remove the 8 bolts and 8 ignition coils.



10. REMOVE SPARK PLUG

a. Remove the 8 spark plugs.

for Preparation Click here

1. INSTALL SPARK PLUG

a. Install the 8 spark plugs.

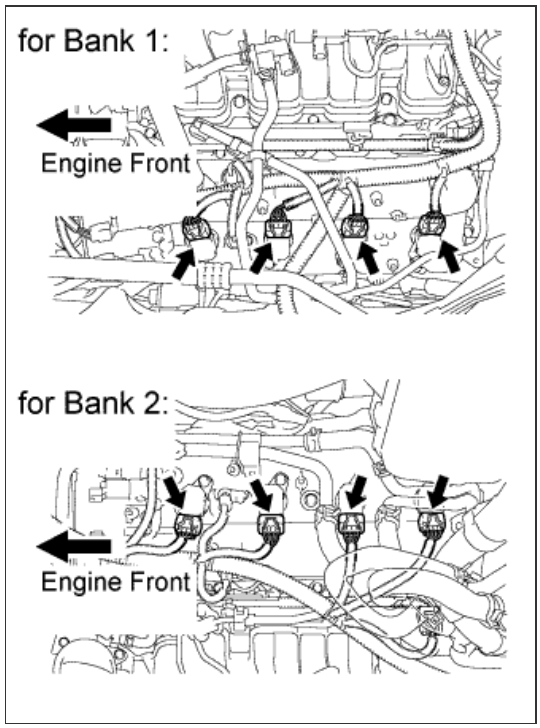
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

2. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

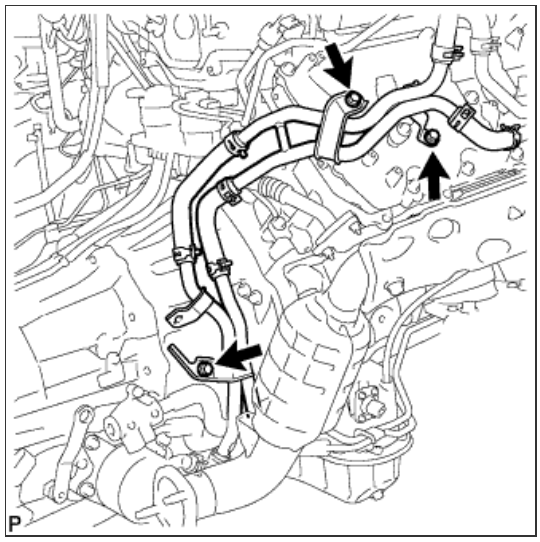
b. Connect the 8 ignition coil connectors.



3. CONNECT WATER BY-PASS PIPE ASSEMBLY

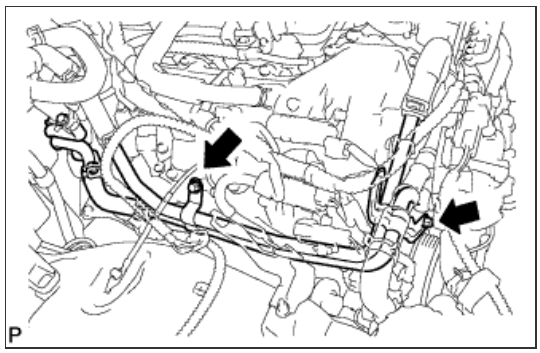
a. Connect the water by-pass pipe to the cylinder head cover and automatic transmission with the 3 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



b. Connect the water by-pass pipe to the cylinder head cover and timing chain cover with the 2 bolts.

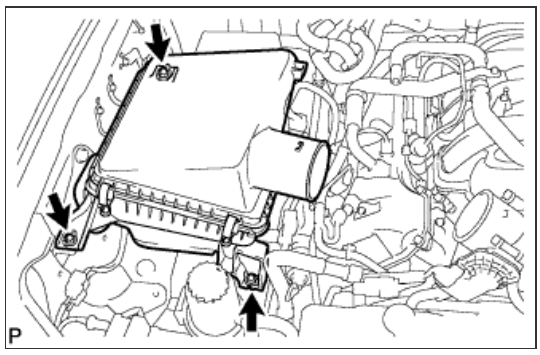
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



4. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



5. INSTALL AIR CLEANER HOSE ASSEMBLY

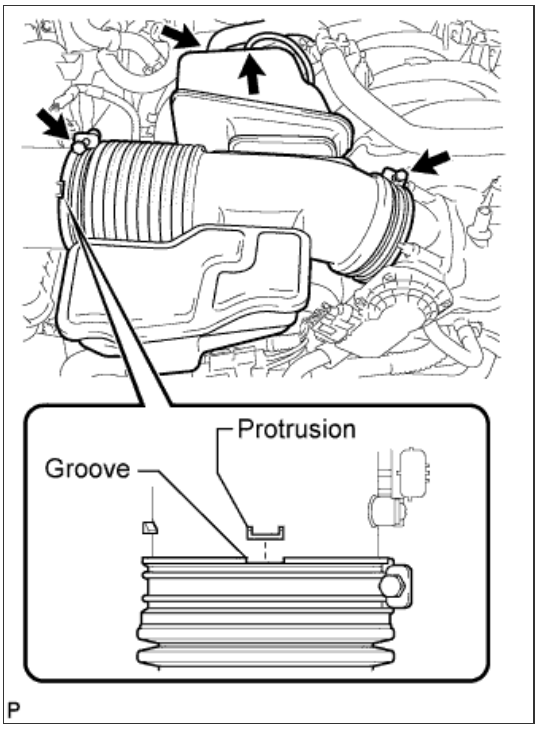
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

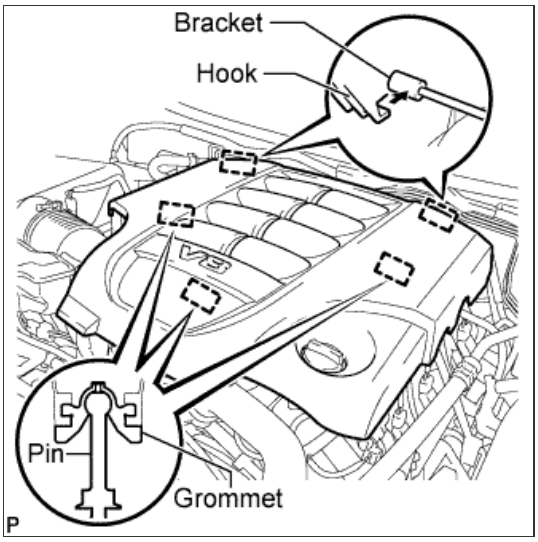
c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



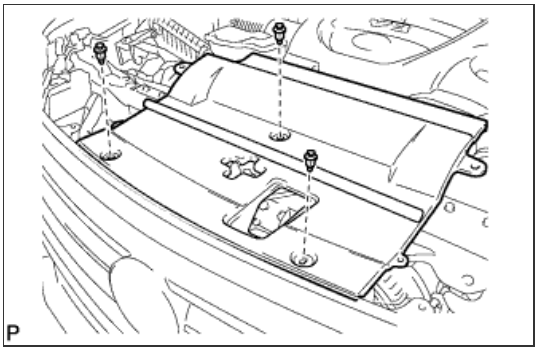
6. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



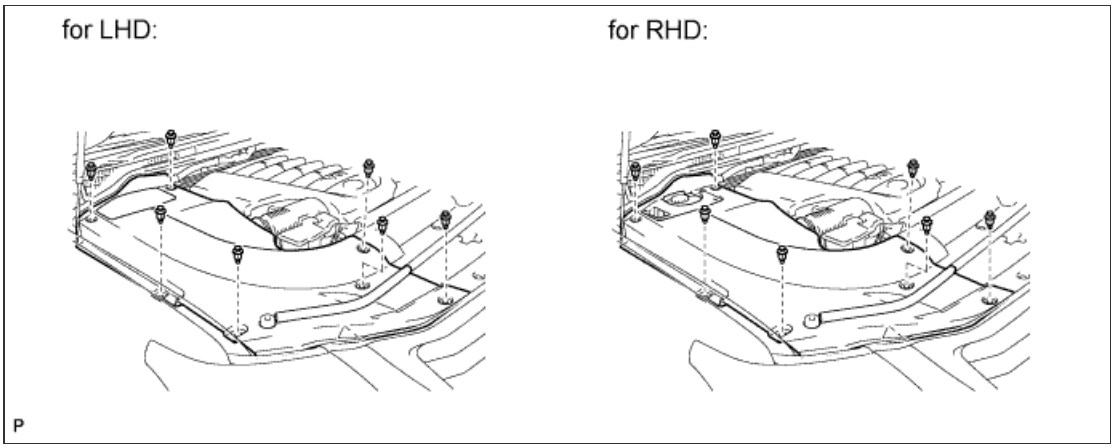
7. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



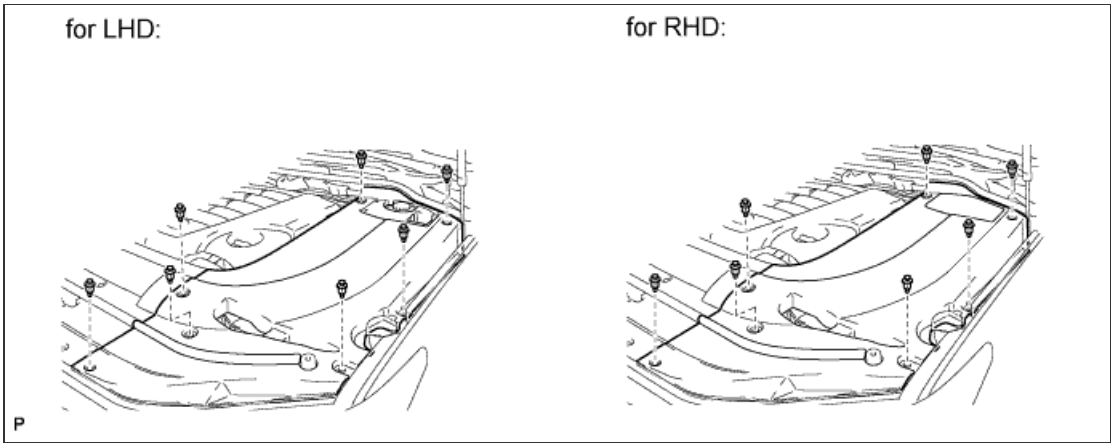
8. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



9. INSTALL ENGINE ROOM SIDE COVER LH

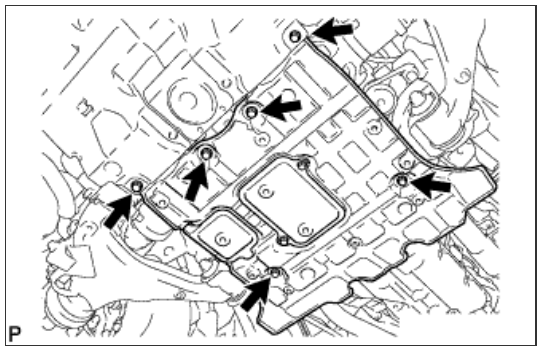
a. Install the engine room side cover with the 7 clips.



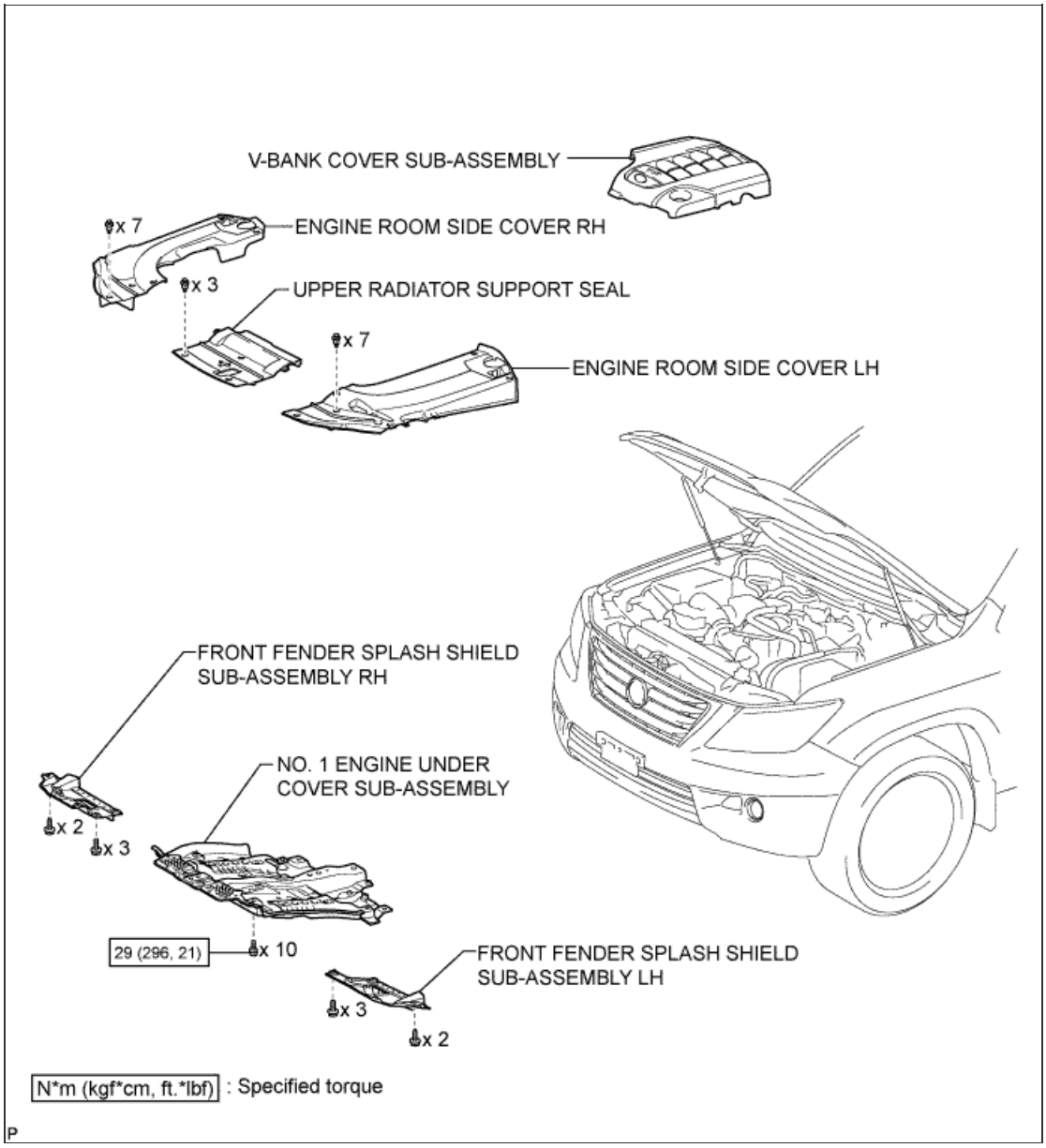
10. INSTALL NO. 2 ENGINE UNDER COVER

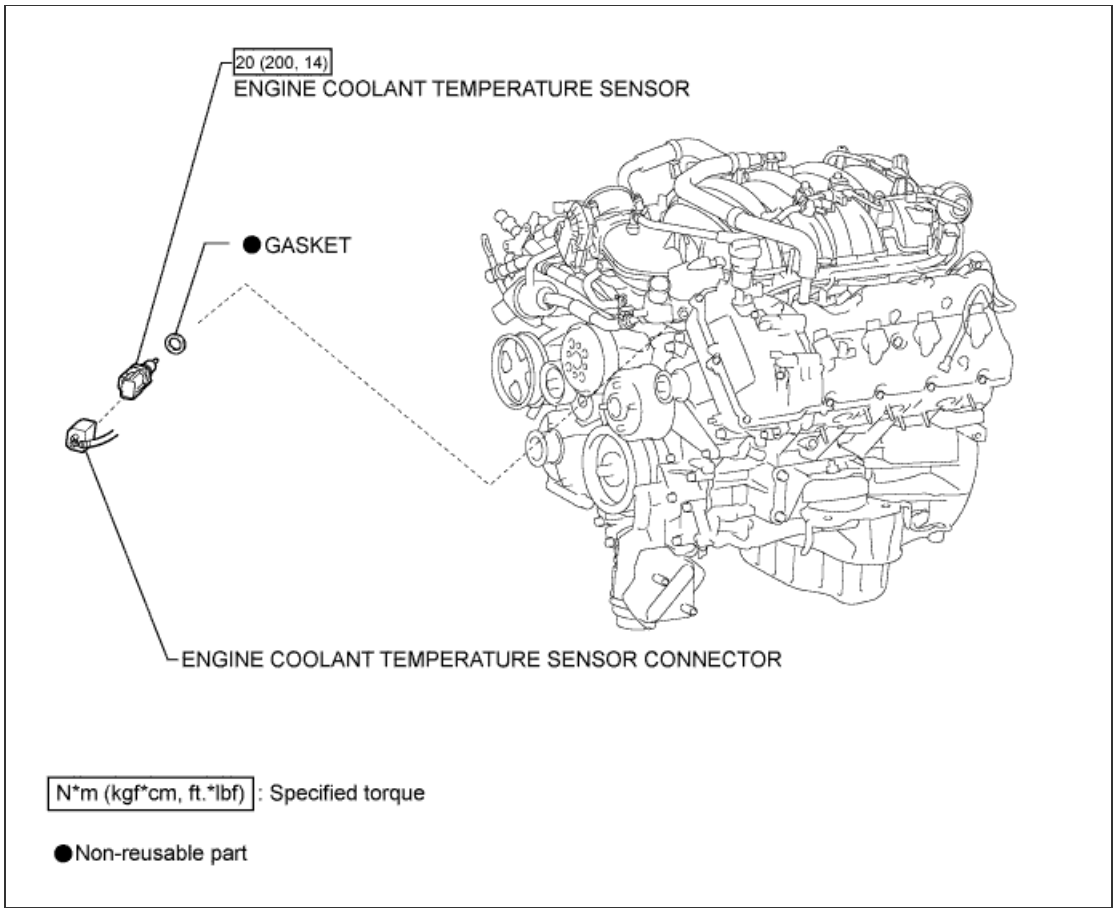
a. Install the under cover with the 6 bolts.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



for Preparation Click here

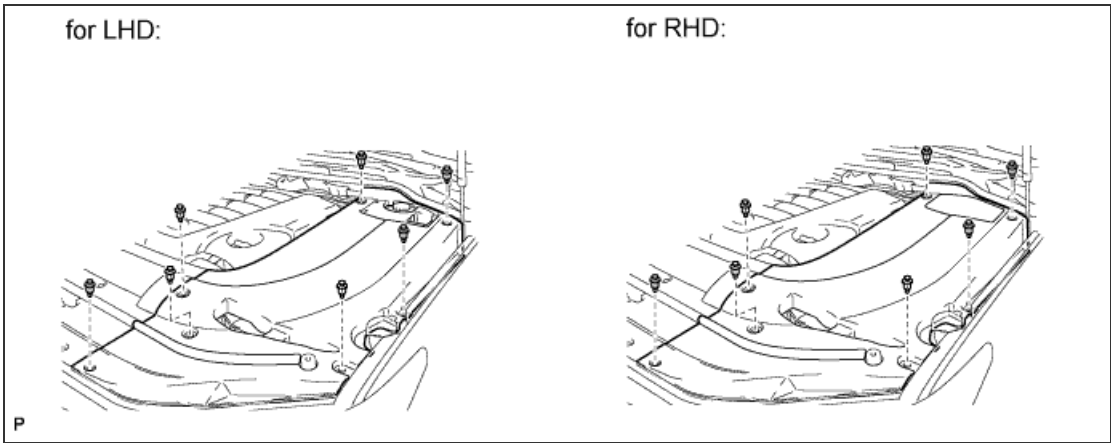



20 (200, 14)
ENGINE COOLANT TEMPERATURE SENSOR
●GASKET
ENGINE COOLANT TEMPERATURE SENSOR CONNECTOR
N*m (kgf*cm, ft.*lbf) : Specified torque
●Non-reusable part

for Preparation Click here

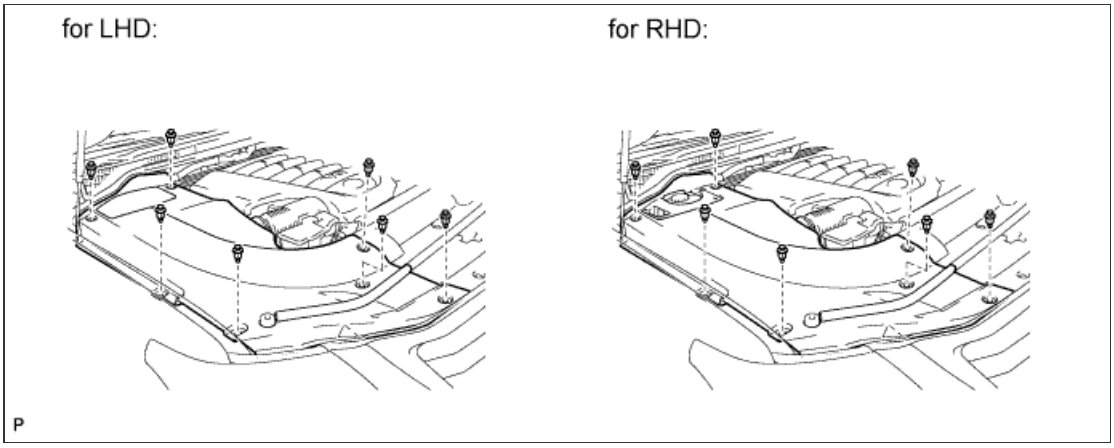
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



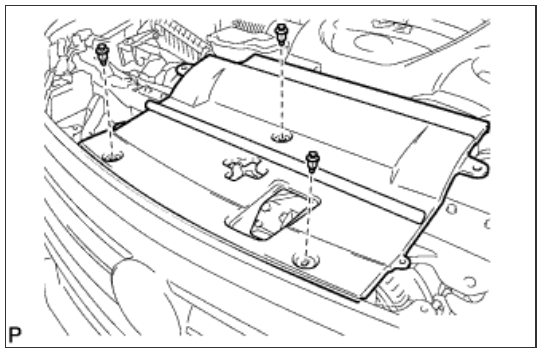
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

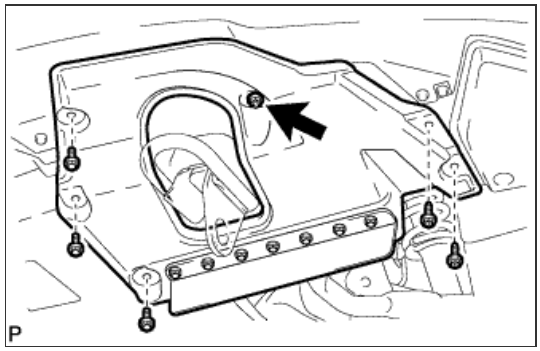
HINT:

Use the same procedures described for the LH side.

5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

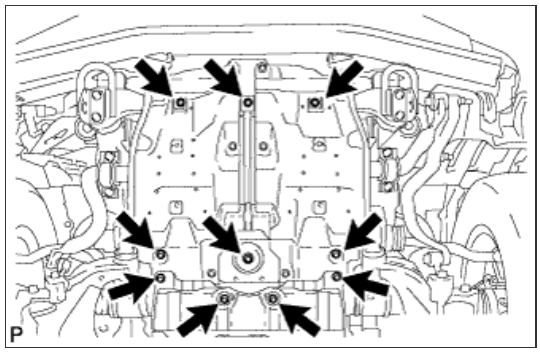
a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



6. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

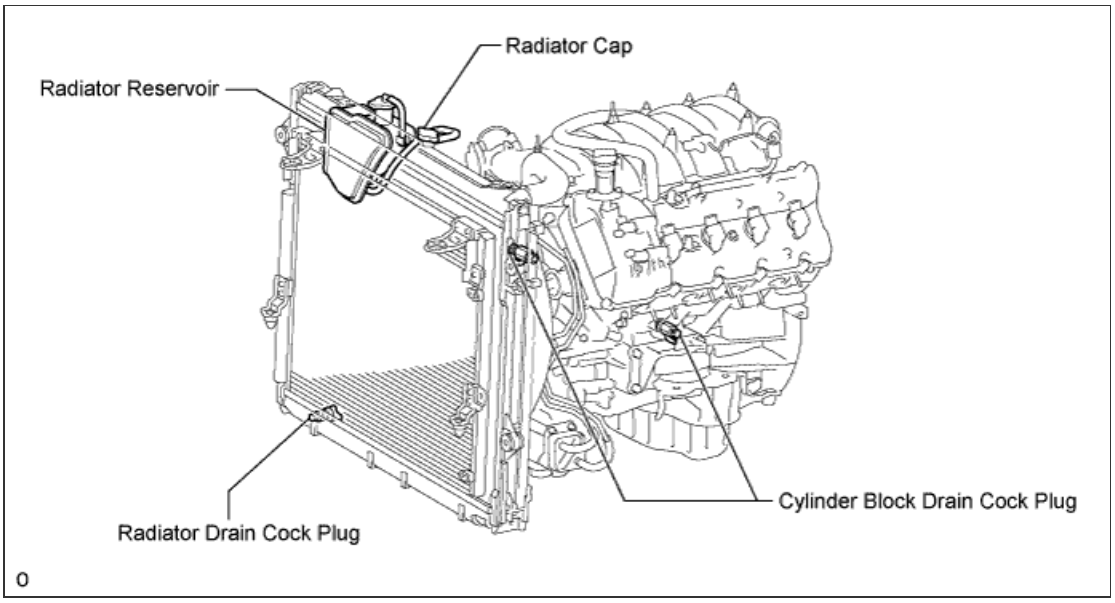
a. Remove the 10 bolts and No. 1 engine under cover.



7. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

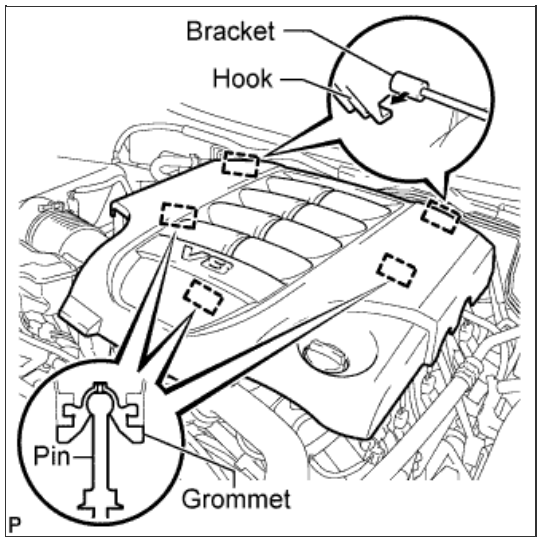
d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

e. Tighten the radiator drain cock plug by hand.

8. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

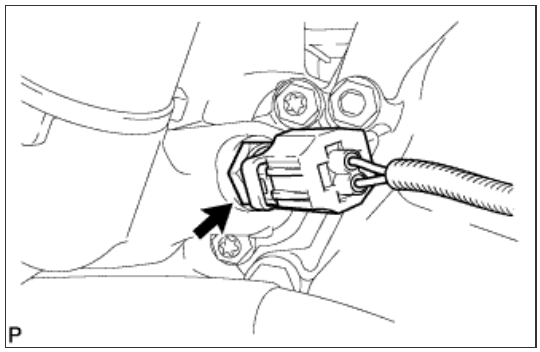


9. REMOVE ENGINE COOLANT TEMPERATURE SENSOR

a. Disconnect the sensor connector.

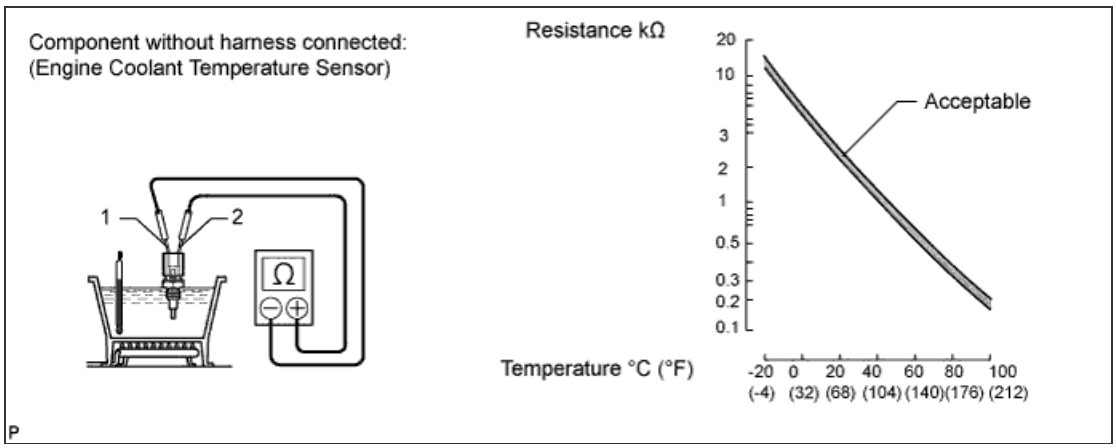
b. Using a 19 mm deep socket wrench, remove the sensor.

c. Remove the gasket from the sensor.



for Preparation Click here

1. INSPECT ENGINE COOLANT TEMPERATURE SENSOR



a. Partially immerse the sensor in water and warm up the water.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	Approx. 20°C (68°F)	2.32 to 2.59 kΩ
1 - 2	Approx. 80°C (176°F)	0.310 to 0.326 kΩ

NOTICE:

When checking the sensor in water, keep the terminals dry. After the check, wipe the sensor dry.

If the result is not as specified, replace the engine coolant temperature sensor.

for Preparation Click here

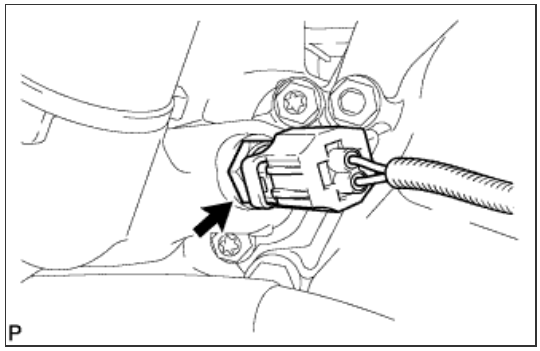
1. INSTALL ENGINE COOLANT TEMPERATURE SENSOR

a. Install a new gasket to the sensor.

b. Using a 19 mm deep socked wrench, install the sensor.

Torque:
20 N*m{ 200 kgf*cm , 14 ft.*lbf }

c. Connect the sensor connector.



2. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

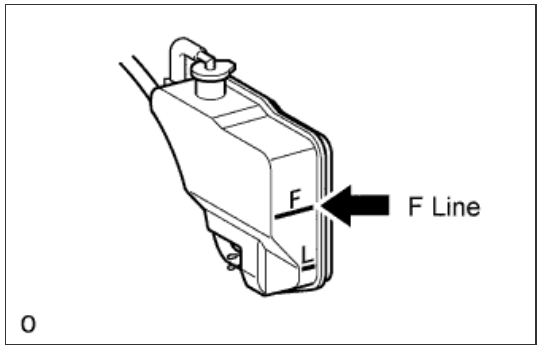
d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

NOTICE:

Switch off the A/C.



g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

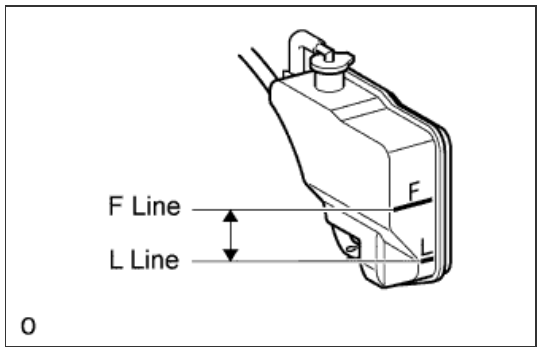
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

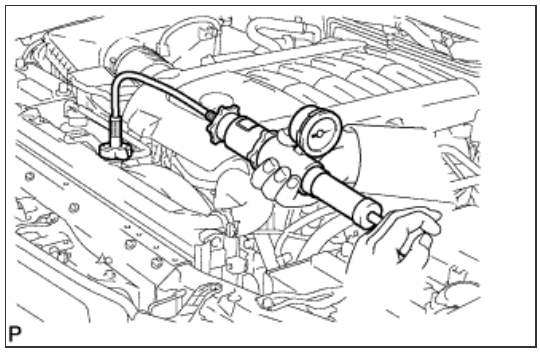


3. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

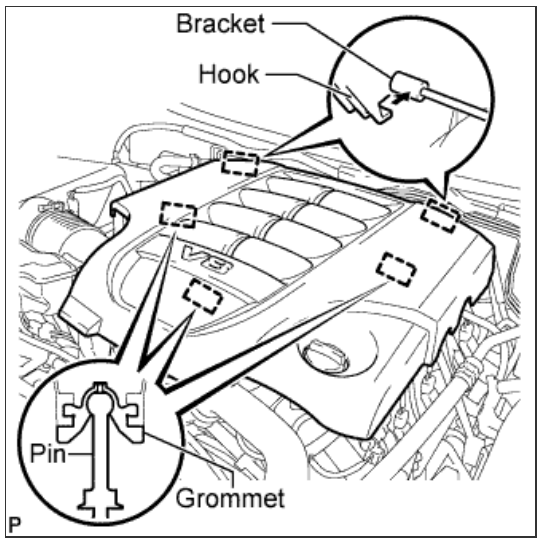
b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



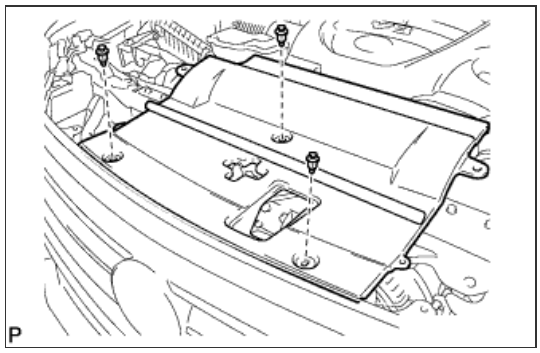
4. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



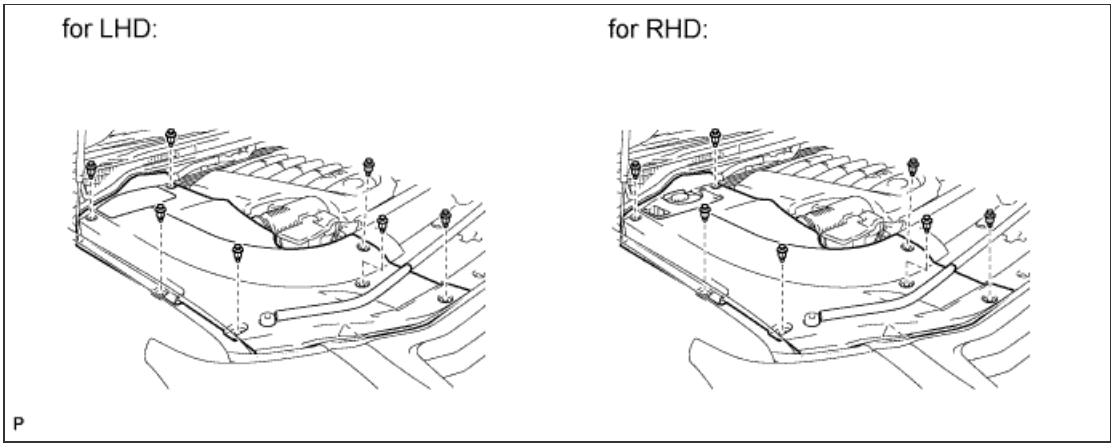
5. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



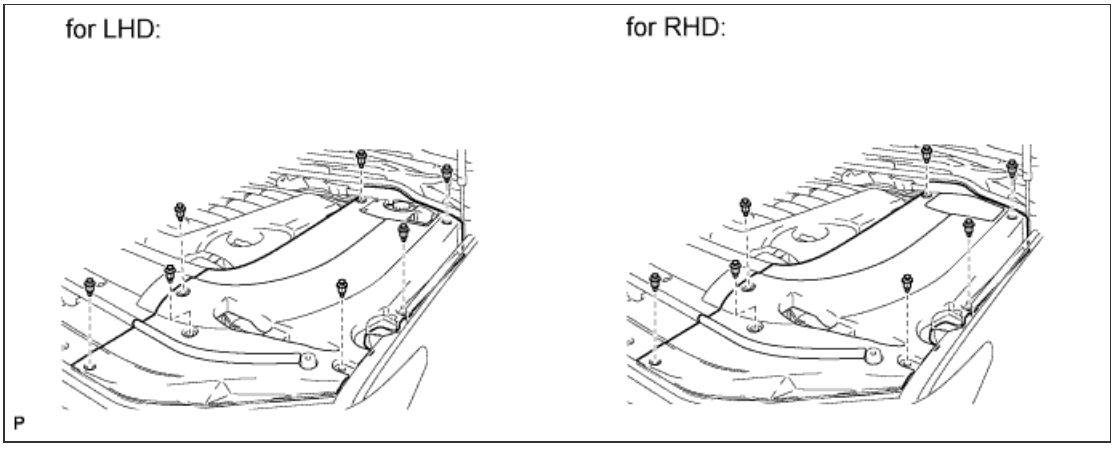
6. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



7. INSTALL ENGINE ROOM SIDE COVER LH

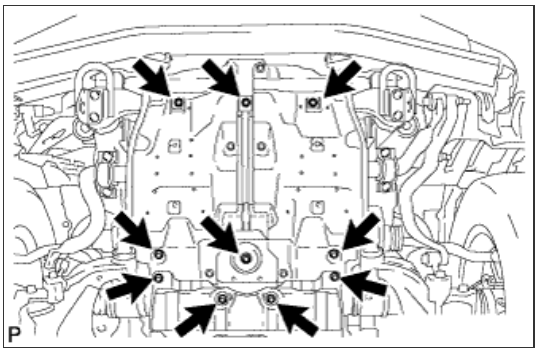
a. Install the engine room side cover with the 7 clips.



8. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

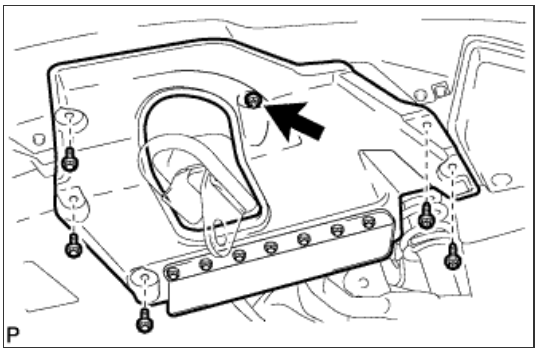
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



9. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.

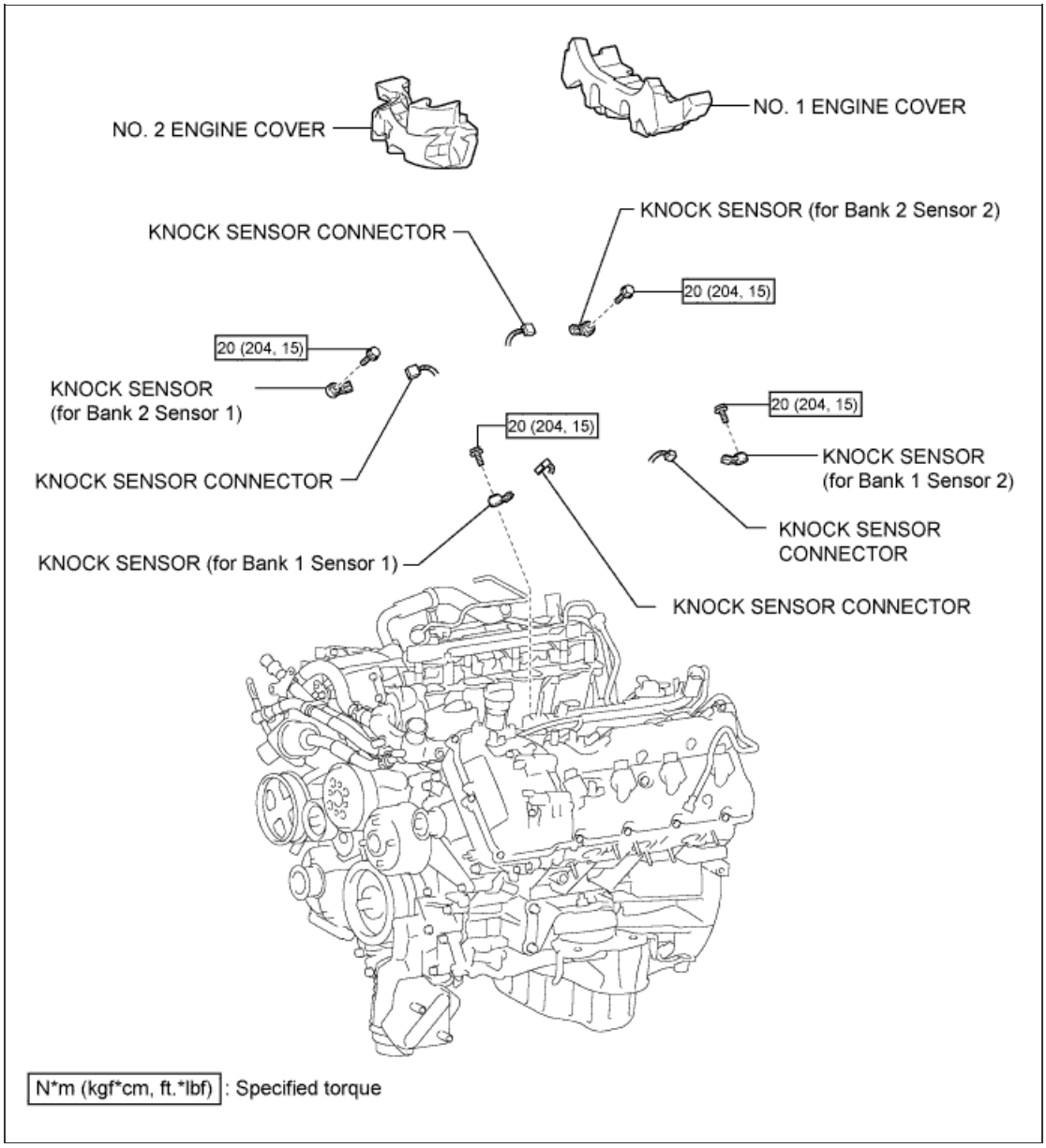


10. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

for Preparation Click here

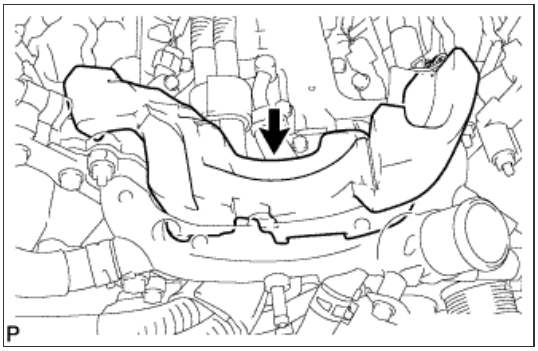


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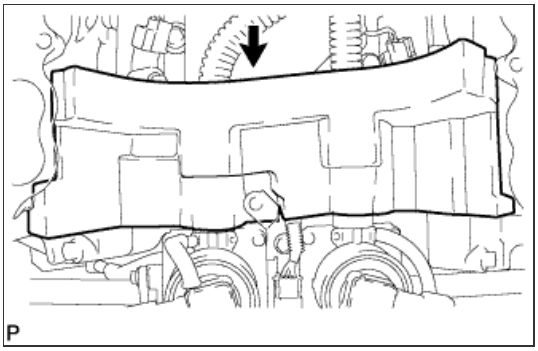
1. REMOVE INTAKE MANIFOLD

a. Remove the intake manifold (Click here).

2. REMOVE NO. 2 ENGINE COVER



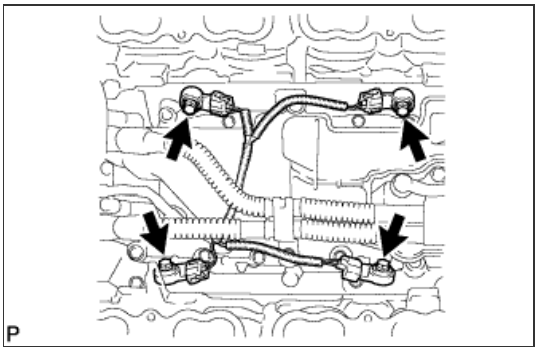
3. REMOVE NO. 1 ENGINE COVER



4. REMOVE KNOCK SENSOR

a. Disconnect the 4 knock sensor connectors.

b. Remove the 4 bolts and 4 knock sensors.



for Preparation Click here

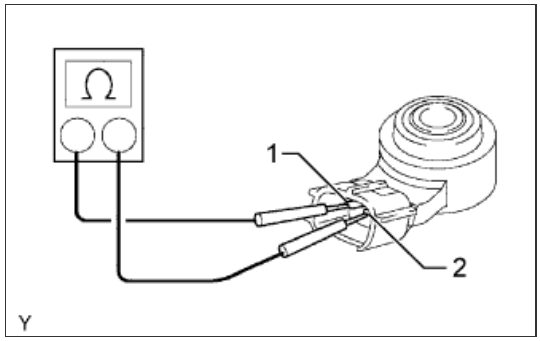
1. INSPECT KNOCK SENSOR

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	120 to 280 kΩ

If the result is not as specified, replace the sensor.



for Preparation Click here

1. INSTALL KNOCK SENSOR

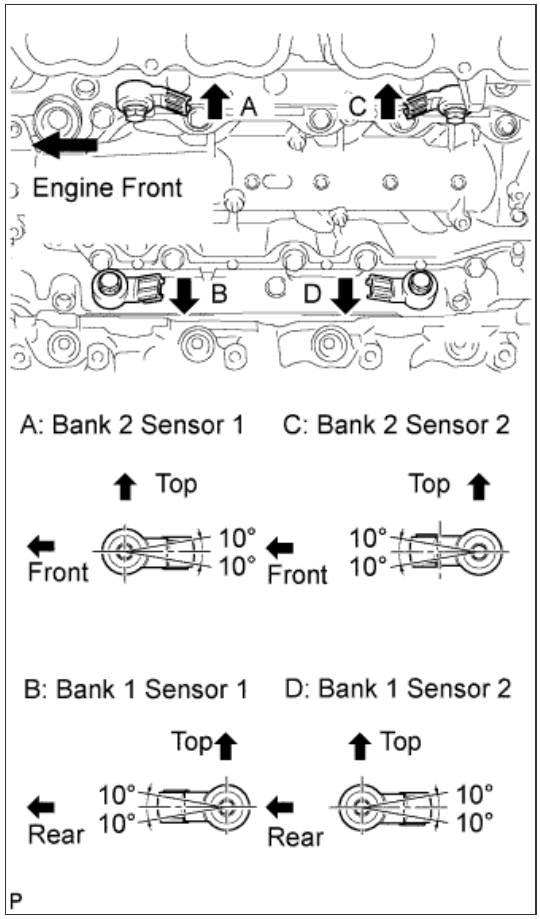
a. Install the 4 sensors with the 4 bolts so that the sensors are angled as shown in the illustration.

Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }

NOTICE:

The acceptable installation angle of the sensor is between 10° upward and downward from the horizontal position.

b. Connect the 4 sensor connectors.



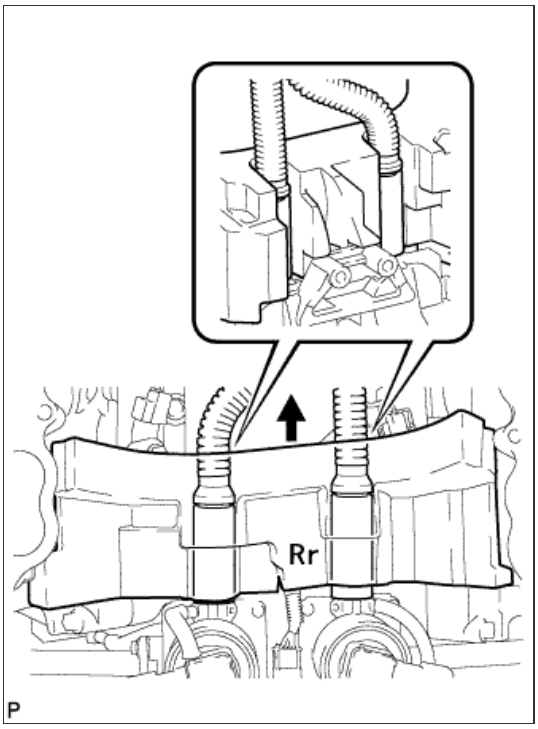
2. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



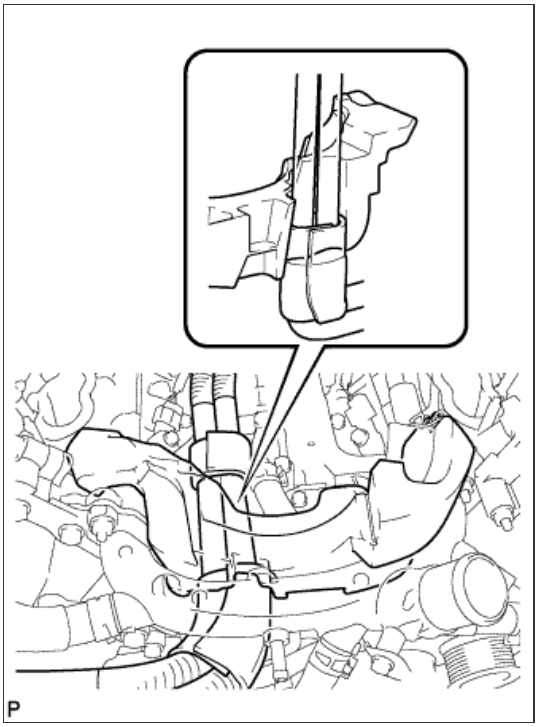
3. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

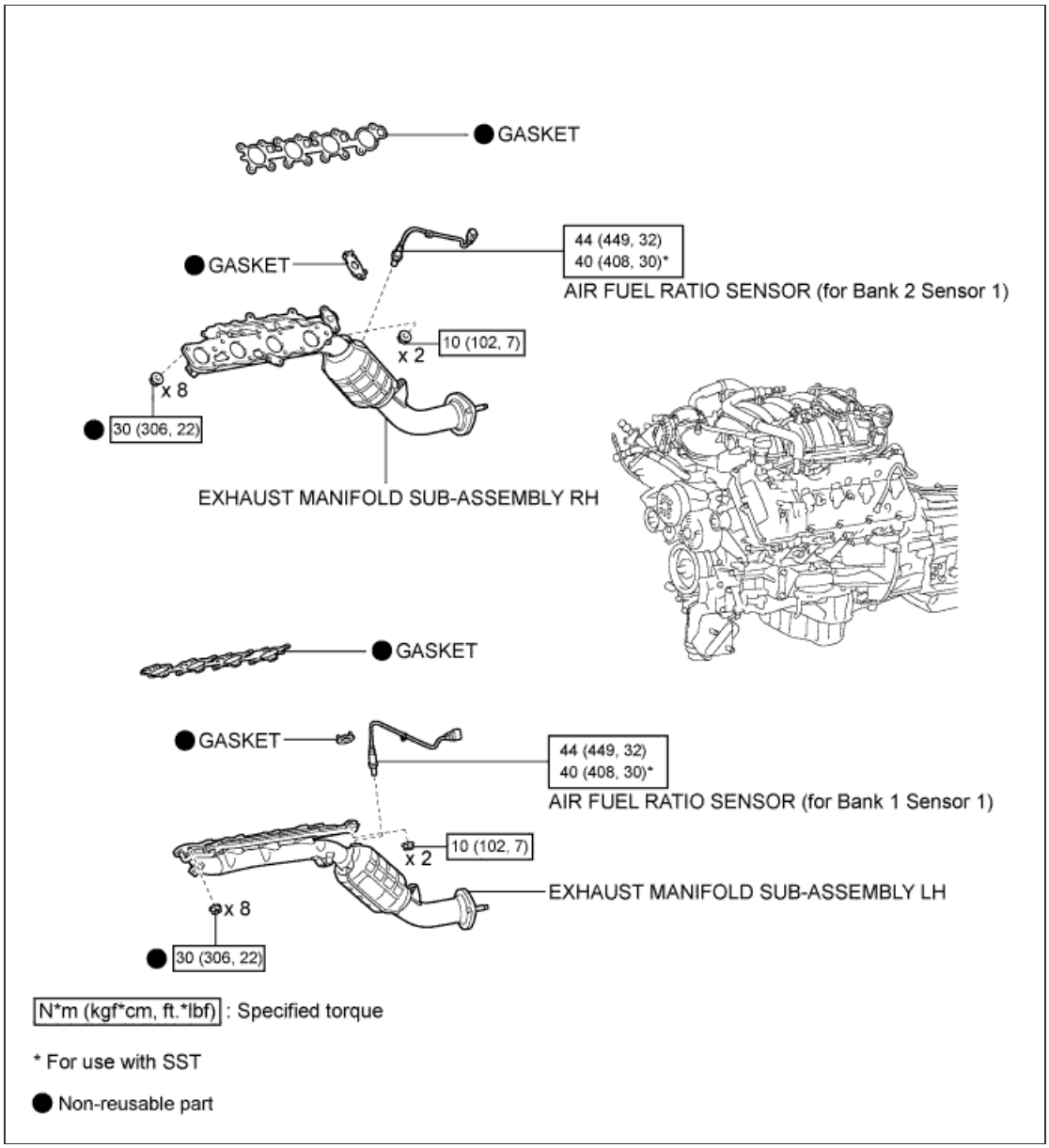
Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.



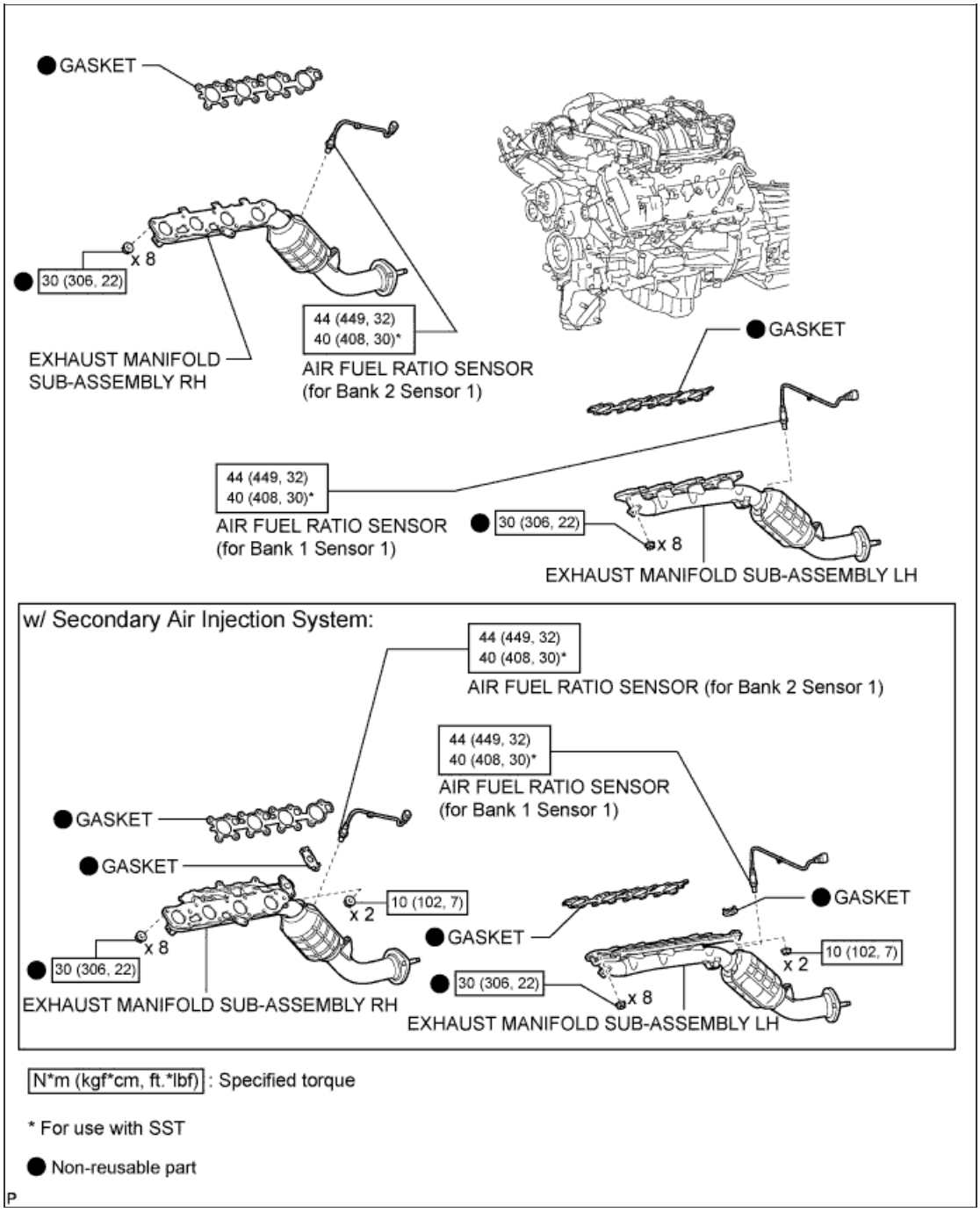
4. INSTALL INTAKE MANIFOLD

a. Install the intake manifold (Click here).

for Preparation Click here



for Preparation Click here



for Preparation Click here

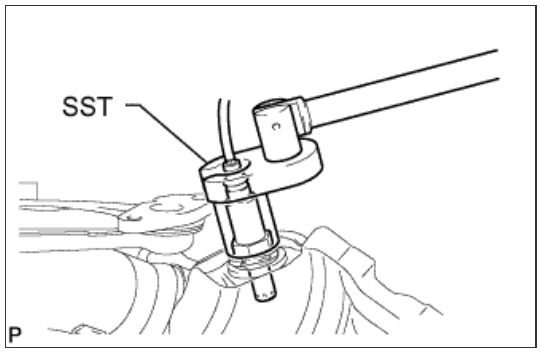
1. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY

a. Remove the exhaust manifold (Click here).

2. REMOVE AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Using SST, remove the sensor.

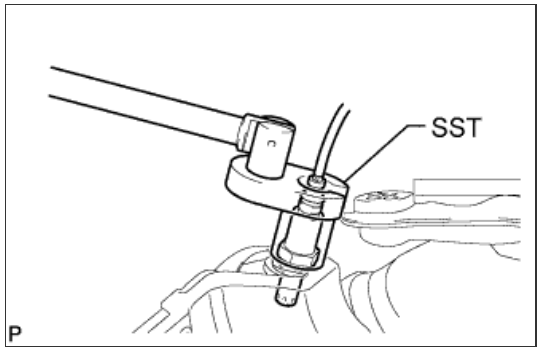
SST
09224-00010



3. REMOVE AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Using SST, remove the sensor.

SST
09224-00010



for Preparation Click here

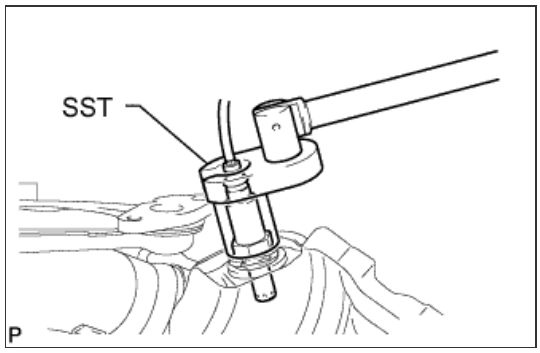
1. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY

(Click here)

2. REMOVE AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Using SST, remove the sensor.

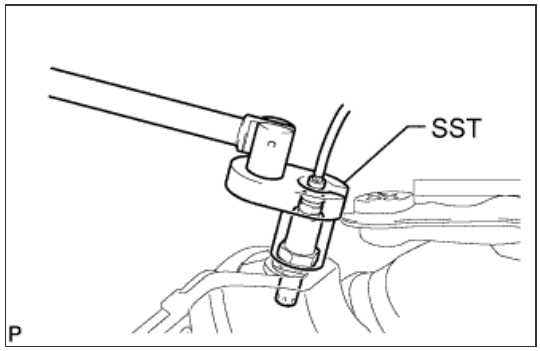
SST
09224-00010



3. REMOVE AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Using SST, remove the sensor.

SST
09224-00010



for Preparation Click here

1. INSPECT AIR FUEL RATIO SENSOR

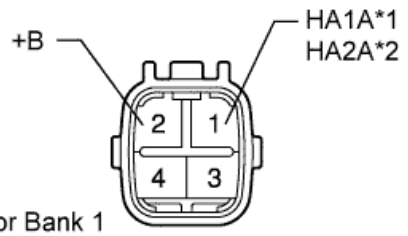
a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HA1A) - 2 (+B) (for Bank 1)	20°C (68°F)	1.8 to 3.4 Ω
1 (HA2A) - 2 (+B) (for Bank 2)		

If the result is not as specified, replace the air fuel ratio sensor.

Component without harness connected:
(Air Fuel Ratio Sensor)



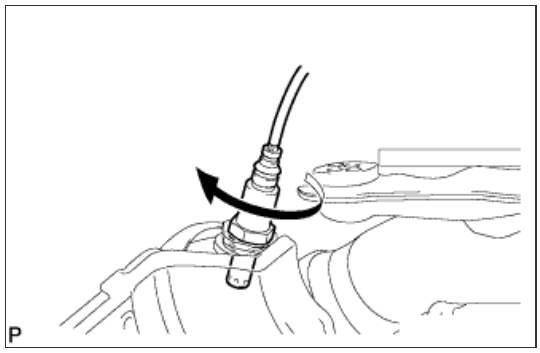
*1: for Bank 1

*2: for Bank 2

for Preparation Click here

1. INSTALL AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



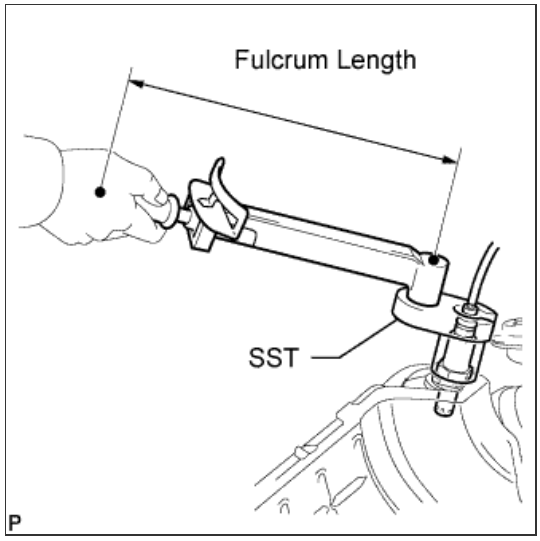
b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

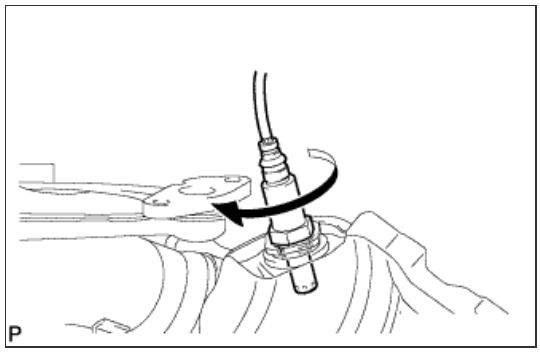
HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



2. INSTALL AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.

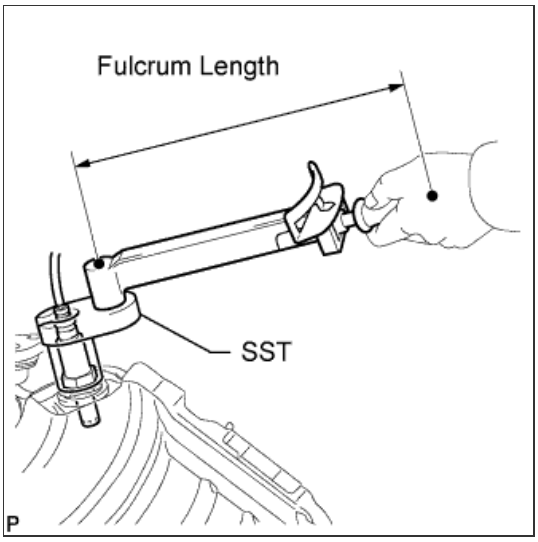


b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:

44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**

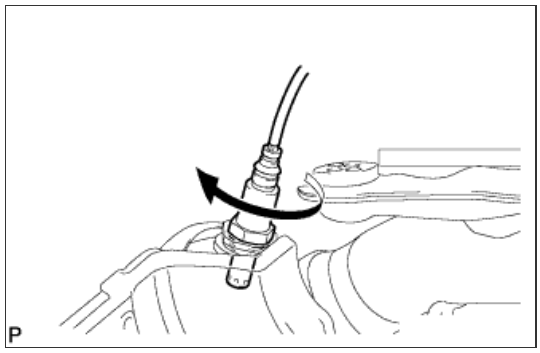
3. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY

a. Install the exhaust manifold (Click here).

for Preparation Click here

1. INSTALL AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



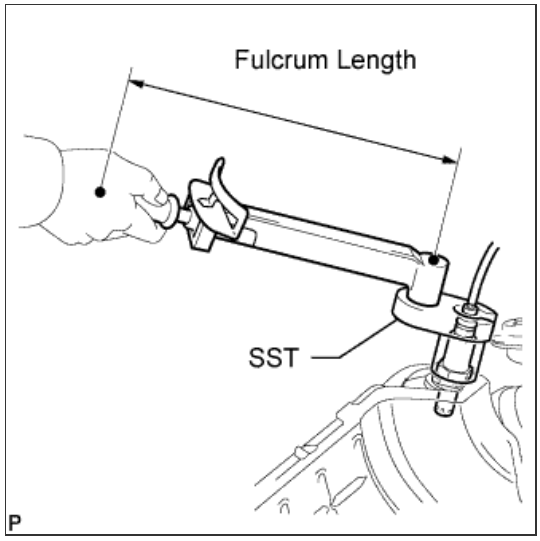
b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

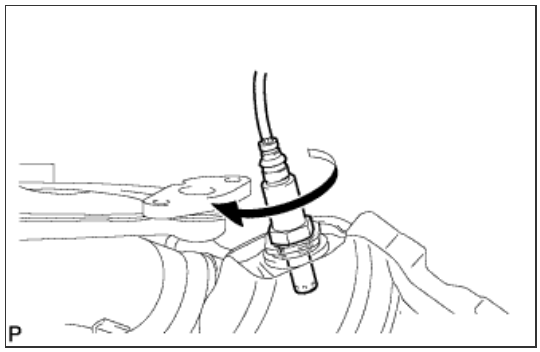
HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



2. INSTALL AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



b. Using SST, tighten the sensor.

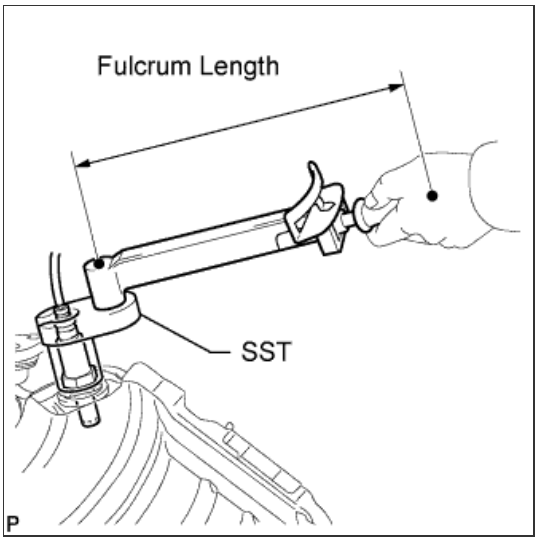
SST
09224-00010

Torque:
without SST:

44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

HINT:

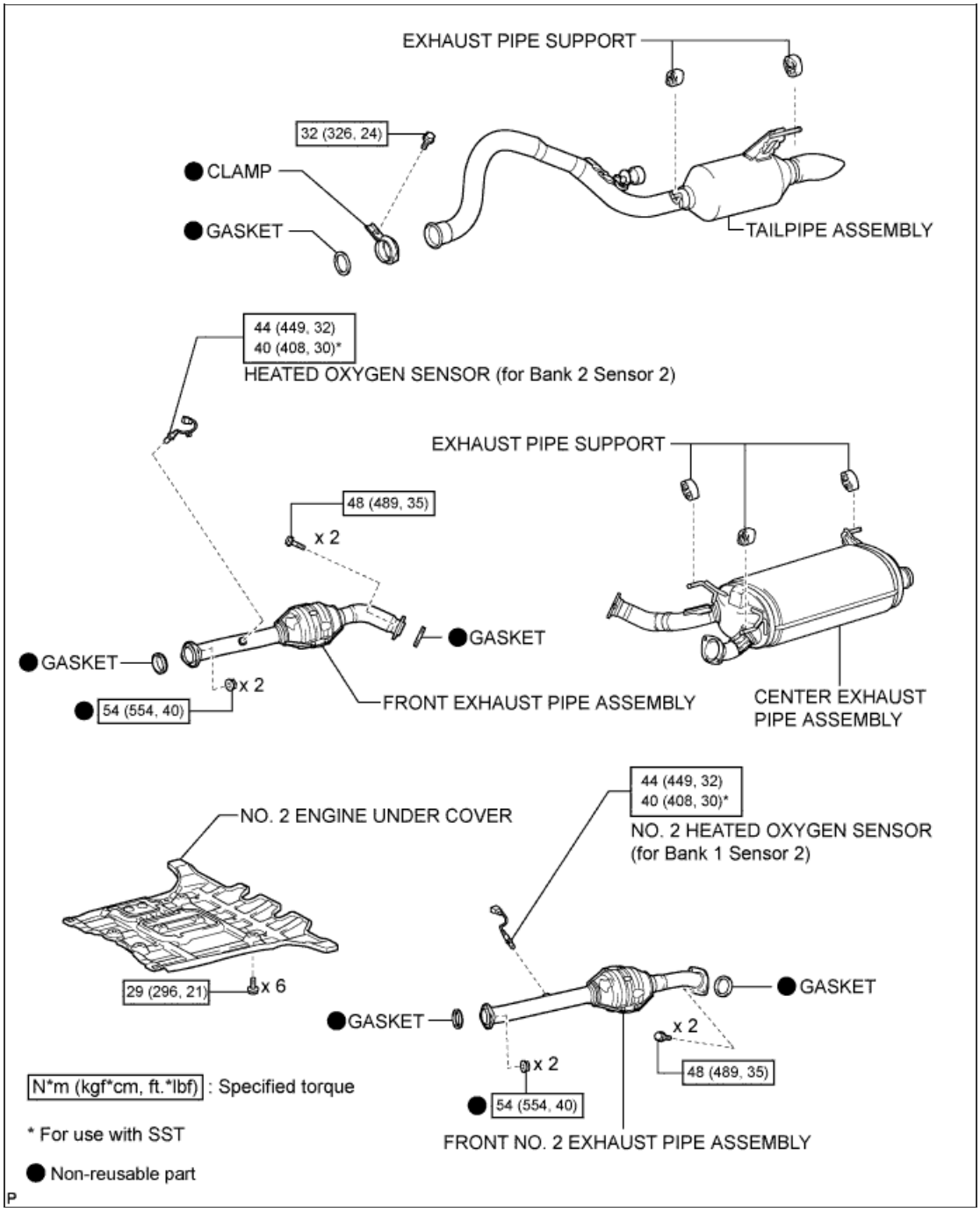
- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



3. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY

(Click here)

for Preparation Click here



for Preparation Click here

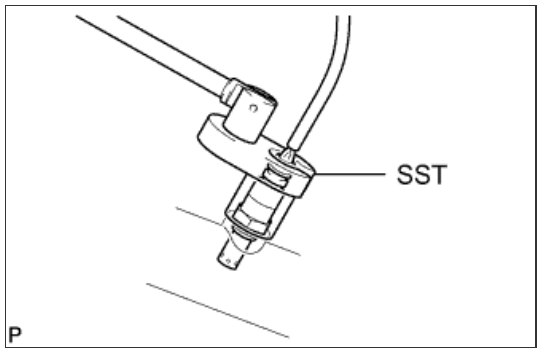
1. REMOVE FRONT EXHAUST PIPE ASSEMBLY

a. Remove the front exhaust pipe assembly (Click here).

2. REMOVE HEATED OXYGEN SENSOR (for Bank 2 Sensor 2)

a. Using SST, remove the sensor.

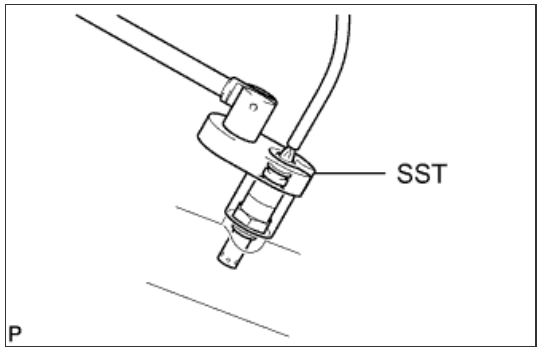
SST
09224-00010



3. REMOVE NO. 2 HEATED OXYGEN SENSOR (for Bank 1 Sensor 2)

a. Using SST, remove the sensor.

SST
09224-00010



for Preparation Click here

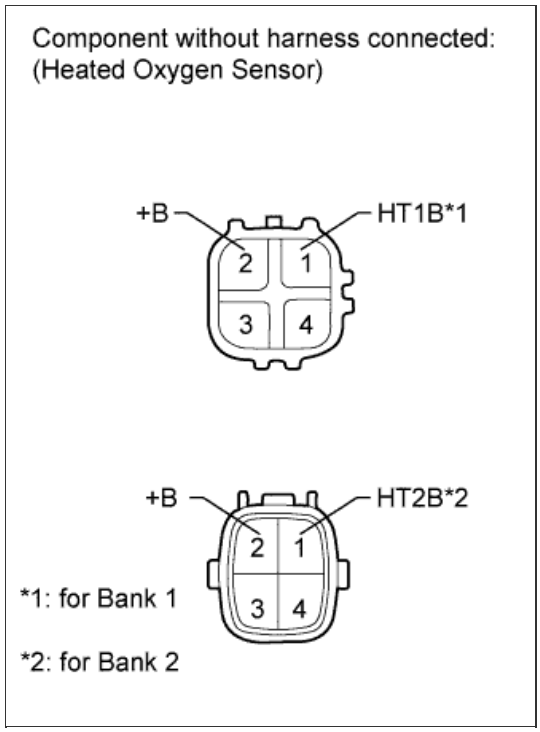
1. INSPECT HEATED OXYGEN SENSOR

a. Measure the heater resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 (HT1B) - 2 (+B) (for Bank 1)	20°C (68°F)	11 to 16 Ω
1 (HT2B) - 2 (+B) (for Bank 2)		

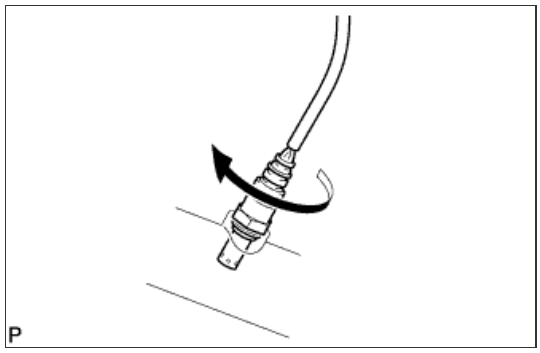
If the result is not as specified, replace the heated oxygen sensor.



for Preparation Click here

1. INSTALL NO. 2 HEATED OXYGEN SENSOR (for Bank 1 Sensor 2)

a. Temporarily install the sensor to the exhaust pipe by hand.



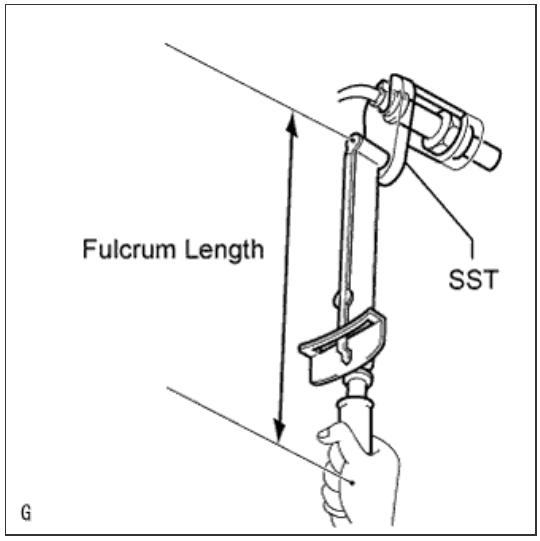
b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

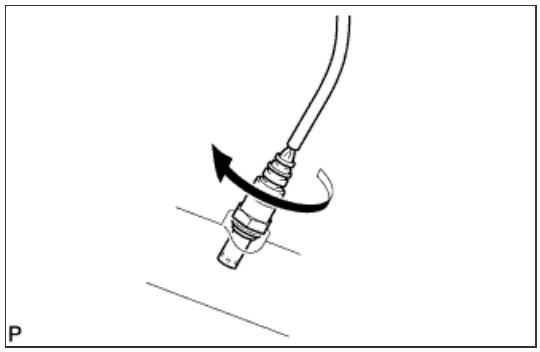
HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



2. INSTALL HEATED OXYGEN SENSOR (for Bank 2 Sensor 2)

a. Temporarily install the sensor to the exhaust pipe by hand.



b. Using SST, tighten the sensor.

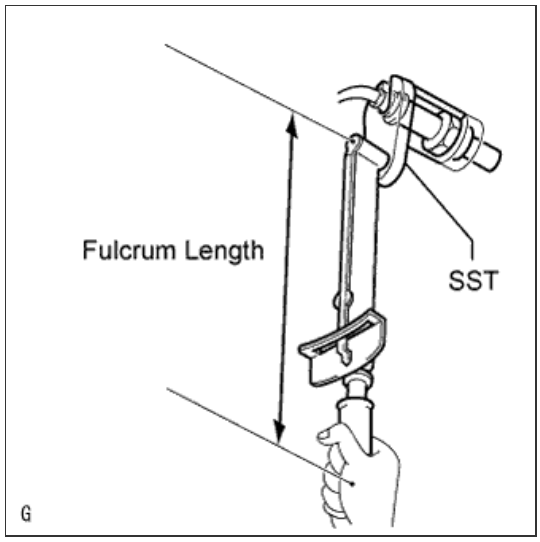
SST
09224-00010

Torque:
without SST:

44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

HINT:

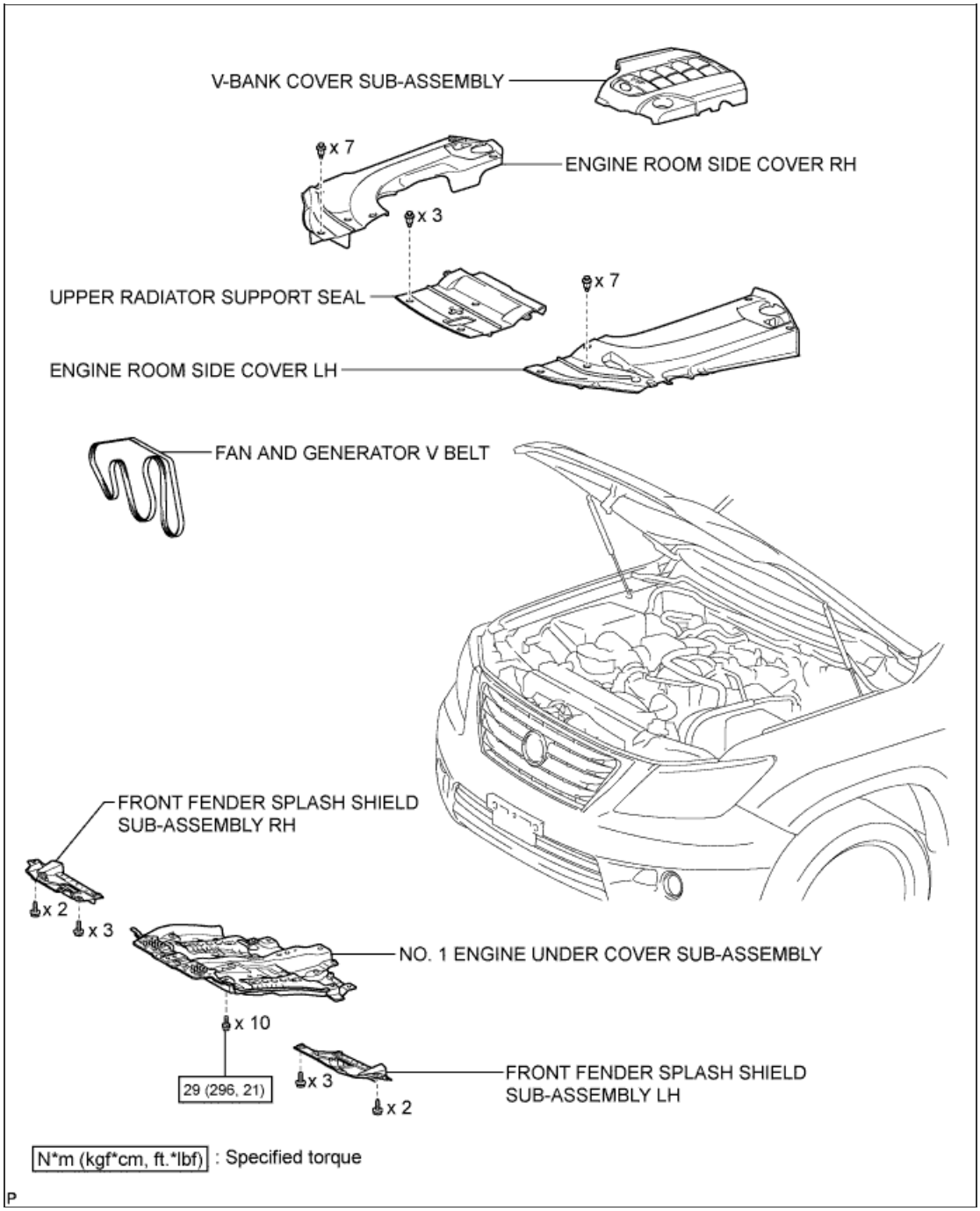
- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**

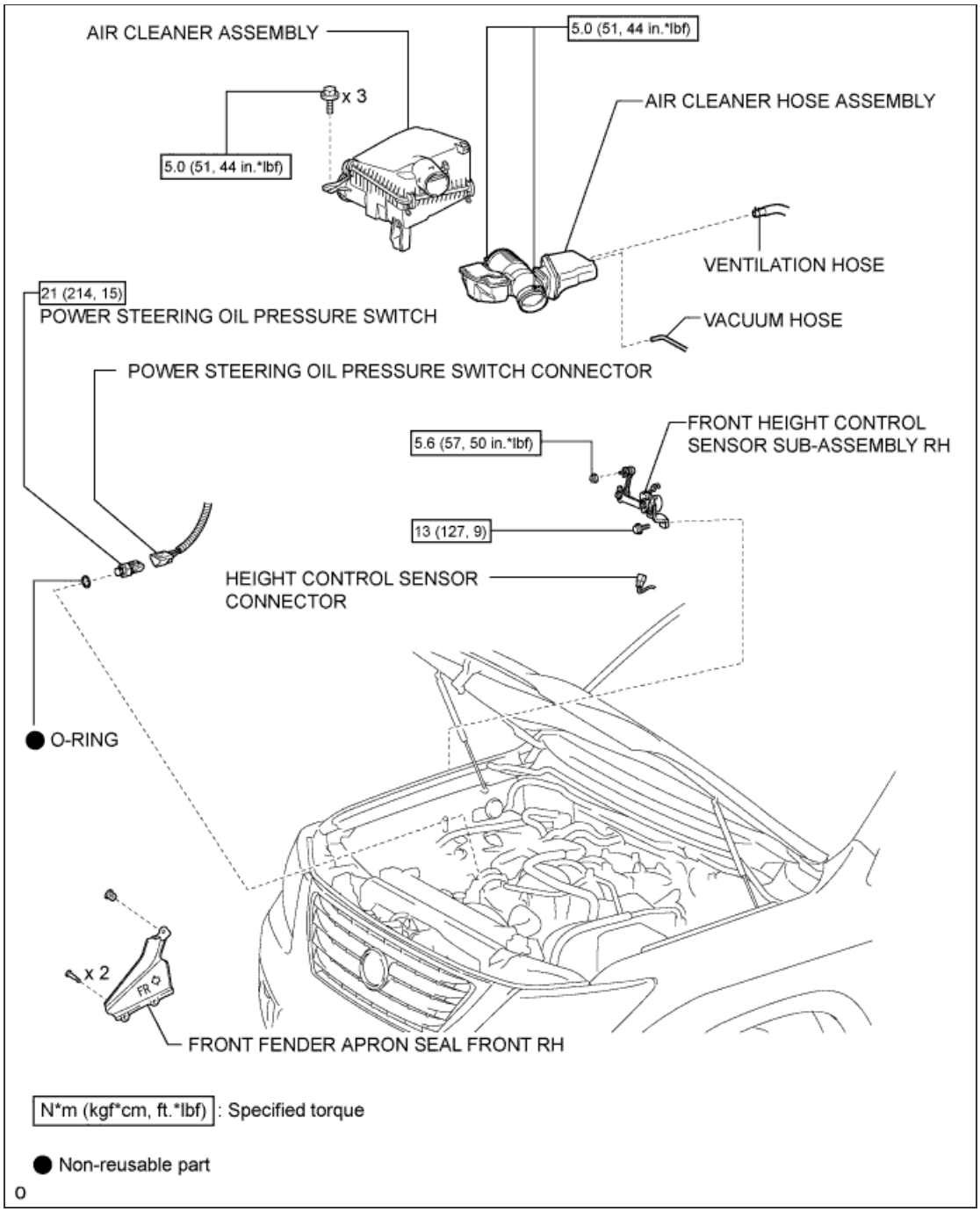


3. INSTALL FRONT EXHAUST PIPE ASSEMBLY

a. Install the front exhaust pipe assembly (Click here).

for Preparation Click here




AIR CLEANER ASSEMBLY
5.0 (51, 44 in.*lbf)
x 3
5.0 (51, 44 in.*lbf)
AIR CLEANER HOSE ASSEMBLY
VENTILATION HOSE
21 (214, 15)
POWER STEERING OIL PRESSURE SWITCH
VACUUM HOSE
POWER STEERING OIL PRESSURE SWITCH CONNECTOR
5.6 (57, 50 in.*lbf)
FRONT HEIGHT CONTROL SENSOR SUB-ASSEMBLY RH
13 (127, 9)
HEIGHT CONTROL SENSOR CONNECTOR
O-RING
x 2
FR
FRONT FENDER APRON SEAL FRONT RH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

o

for Preparation Click here

1. INSPECT POWER STEERING OIL PRESSURE SWITCH

a. Check the oil pressure switch.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch on.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Power Steering pressure.

v. Start the engine.

vi. Operate the steering wheel while idling, and read the value on the intelligent tester.

Standard:

Measurement Condition	Specified Condition
Power steering not operating	0 to 2 MPa (0 to 20 kgf/cm ^{2}, 0 to 290 psi)
Power steering operating	Values change from above value

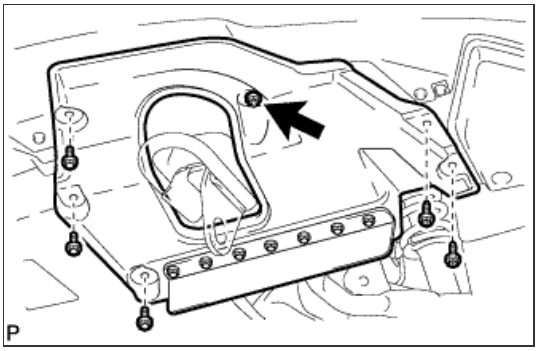
If not as specified, check for DTCs (Click here). If the power steering system inspection results are normal and a DTC is not output, replace the power steering oil pressure switch.
Inspect the power steering system (Click here). If the power steering system inspection results are normal and a DTC is not output, replace the power steering oil pressure switch.

for Preparation Click here

1. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



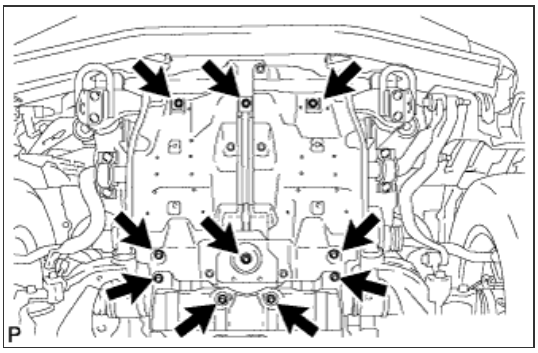
2. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

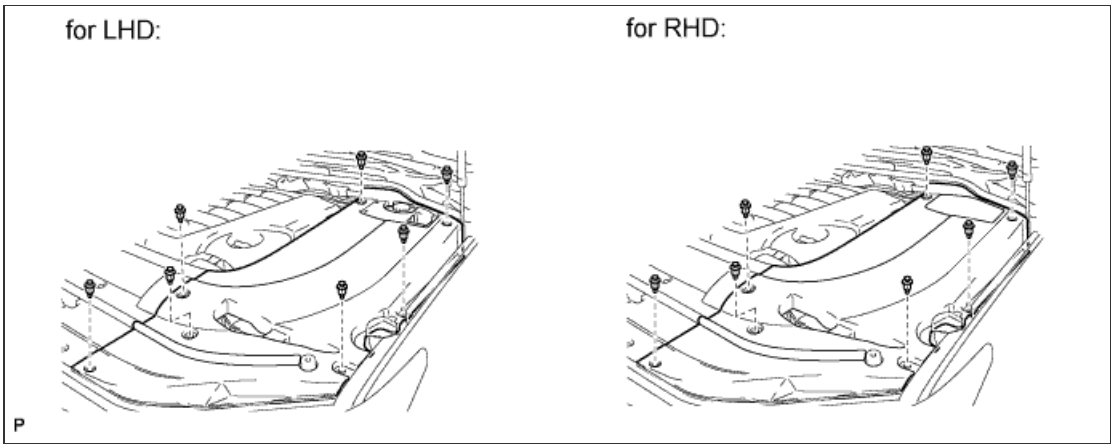
3. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



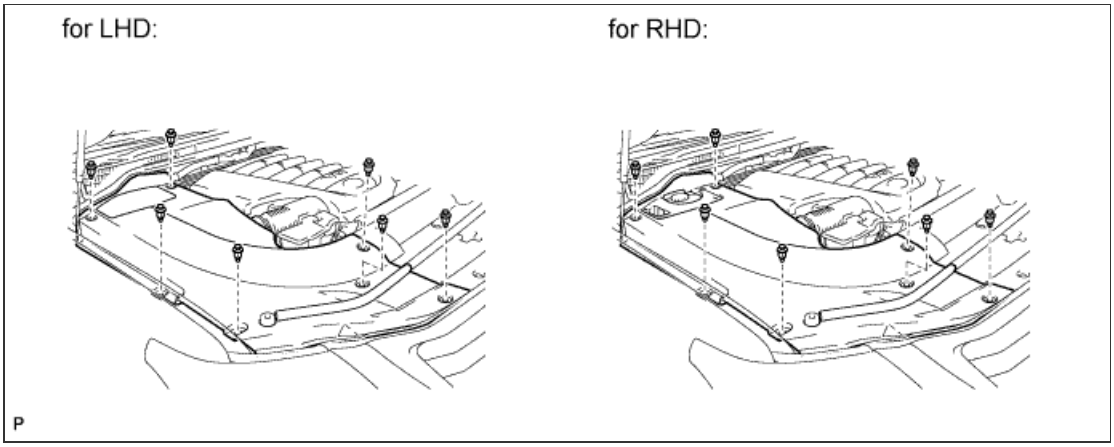
4. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



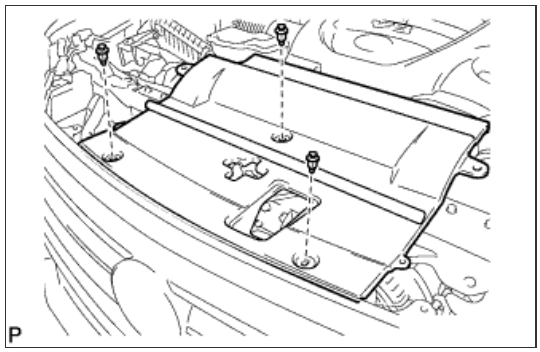
5. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



6. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



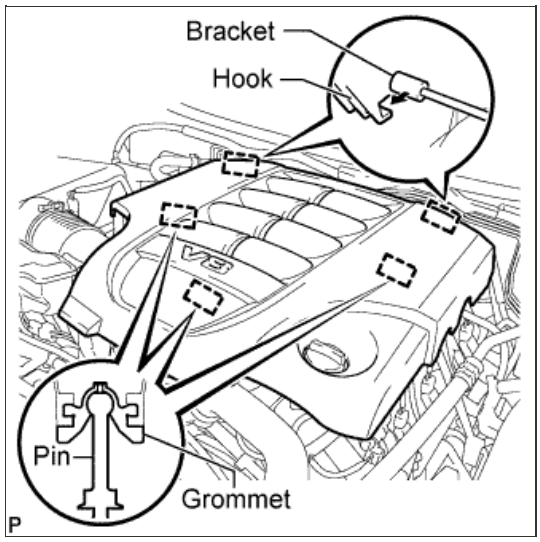
7. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

8. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

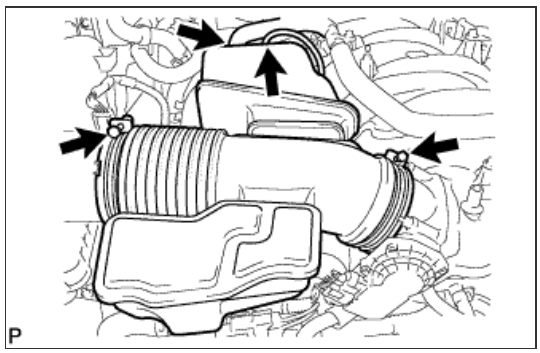


9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

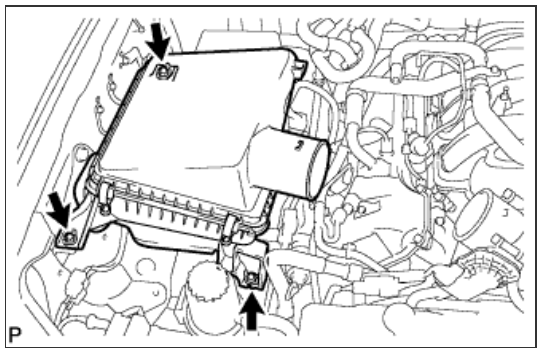
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



10. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



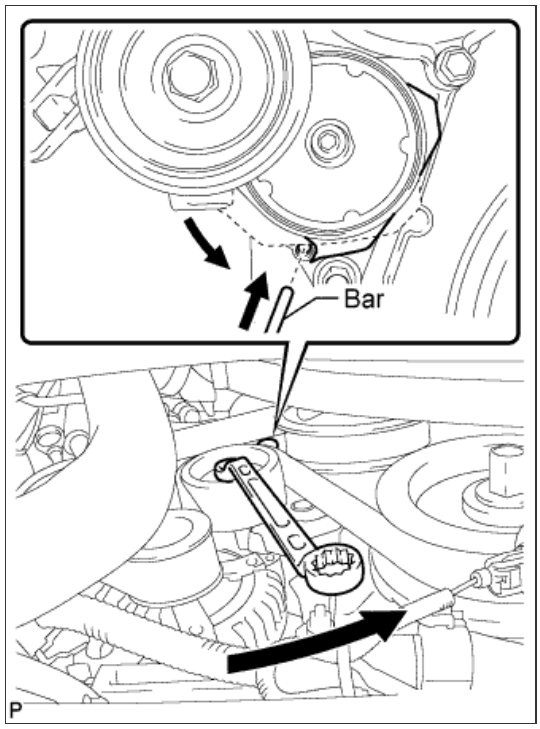
11. REMOVE FAN & GENERATOR V BELT

a. While turning the belt tensioner counterclockwise, align the service hole for the belt tensioner and the belt tensioner fixing position, and then insert a bar of φ5 mm (0.197 in.) into the service hole to fix the belt tensioner in place.

HINT:

The pulley bolt for the belt tensioner has a left-hand thread.

b. Remove the V belt.

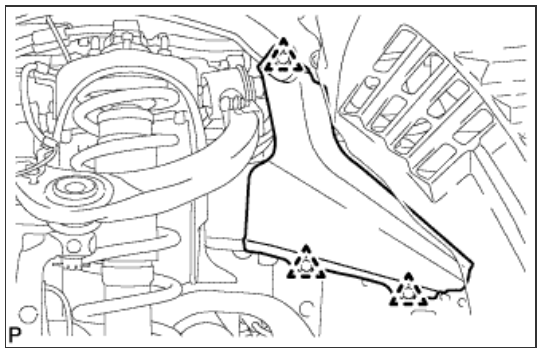


12. DRAIN POWER STEERING FLUID

13. REMOVE FRONT WHEEL

14. REMOVE FRONT FENDER APRON SEAL FRONT RH

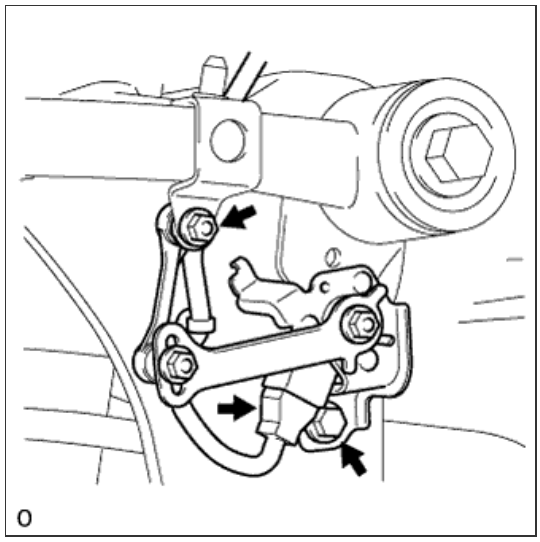
a. Using a clip remover, remove the 3 clips and fender apron seal.



15. REMOVE FRONT HEIGHT CONTROL SENSOR SUB-ASSEMBLY RH

a. Disconnect the connector.

b. Remove the nut, bolt and sensor.

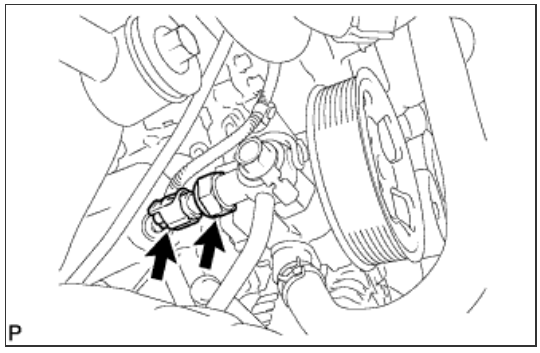


16. REMOVE POWER STEERING OIL PRESSURE SWITCH

a. Disconnect the switch connector.

b. Using a 24 mm deep socket wrench, remove the oil pressure switch.

c. Remove the O-ring.



for Preparation Click here

1. INSTALL POWER STEERING OIL PRESSURE SWITCH

a. Install a new O-ring to the oil pressure switch.

b. Apply a light coat of engine oil to the O-ring of the oil pressure switch.

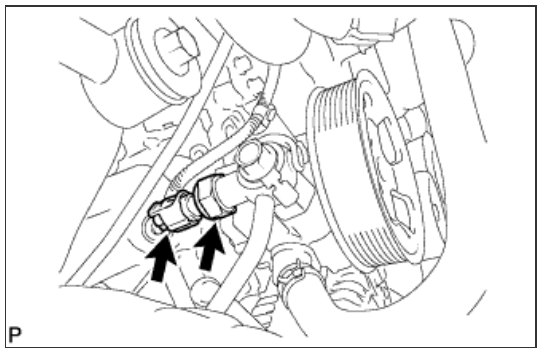
NOTICE:

- **When reusing the oil pressure switch, inspect the O-ring.**
- **If the O-ring has scratches or cuts, replace the oil pressure switch.**

c. Using a 24 mm deep socket wrench, install the oil pressure switch.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

d. Connect the oil pressure switch connector.

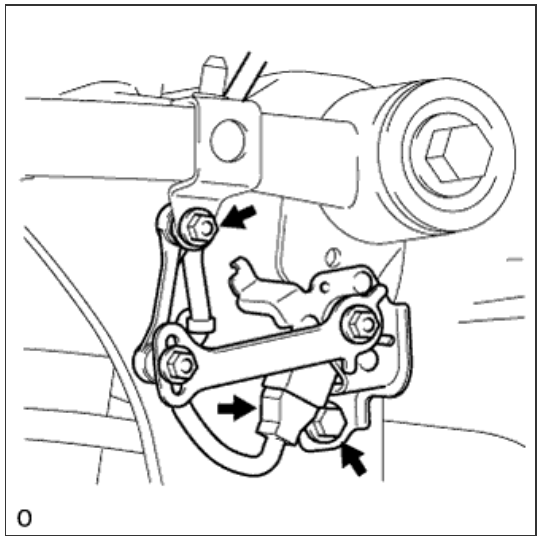


2. INSTALL FRONT HEIGHT CONTROL SENSOR SUB-ASSEMBLY RH

a. Install the sensor with the bolt and nut.

Torque:
for bolt:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }
for nut:
5.6 N*m{ 57 kgf*cm , 56 in.*lbf }

b. Connect the connector.



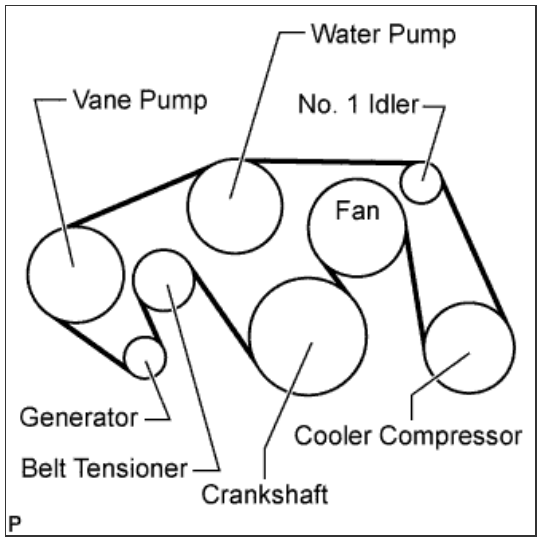
3. INSTALL FAN & GENERATOR V BELT

a. Set the V belt onto every part.

b. While turning the belt tensioner counterclockwise, remove the bar.

NOTICE:

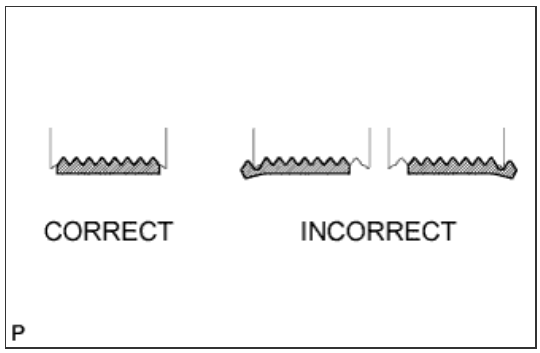
Make sure that the V belt is properly set to each pulley.



c. After installing the belt, check that it fits properly in the ribbed grooves.

HINT:

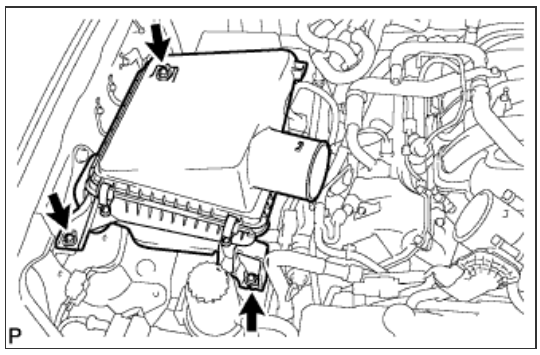
Make sure to check by hand that the belt has not slipped out of the grooves on the bottom of the pulley.



4. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



5. INSTALL AIR CLEANER HOSE ASSEMBLY

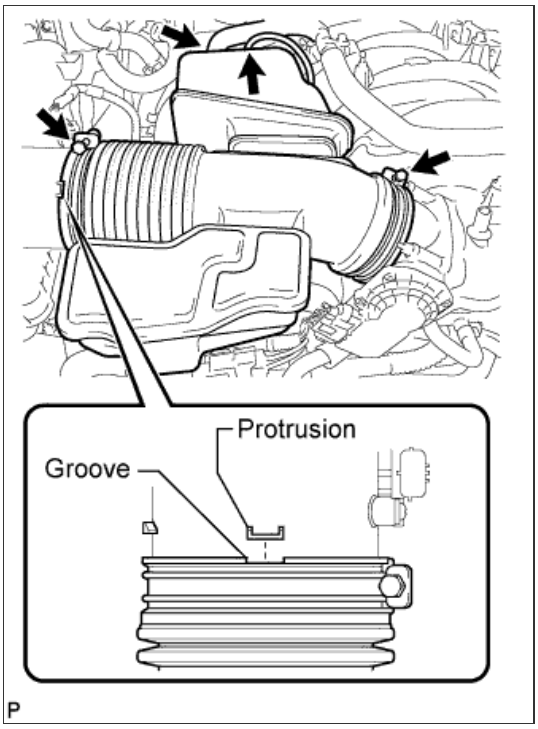
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



6. ADD POWER STEERING FLUID

7. BLEED POWER STEERING FLUID

a. Check the fluid level.

b. Jack up the front of the vehicle and support it with stands.

c. Turn the steering wheel.

i. With the engine stopped, turn the wheel slowly from lock to lock several times.

d. Lower the vehicle.

e. Start the engine.

f. Idle the engine for a few minutes.

g. Turn the steering wheel.

i. With the engine idling, turn the wheel left or right to the full lock position and keep it there for 2 to 3 seconds, then turn the wheel to the opposite full lock position and keep it there for 2 to 3 seconds.*1

ii. Repeat *1 several times.

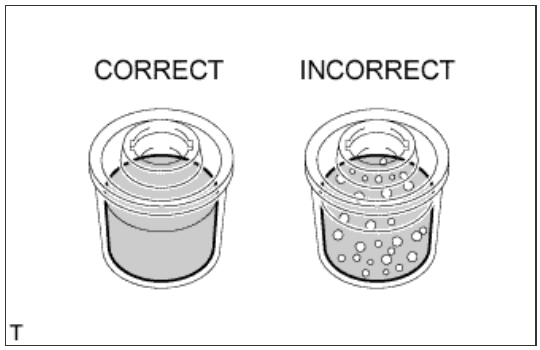
NOTICE:

For vehicles with VGRS, if the steering wheel is turned from lock to lock repeatedly, the system may stop operating and the amount of rotation before the steering wheel locks may increase due to operation of the overheating prevention function. When the system temperature drops, the system operation automatically returns to normal.

h. Stop the engine.

i. Check for foaming or emulsification.
If the system has to be bled twice because of foaming or emulsification, check for fluid leaks in the system.

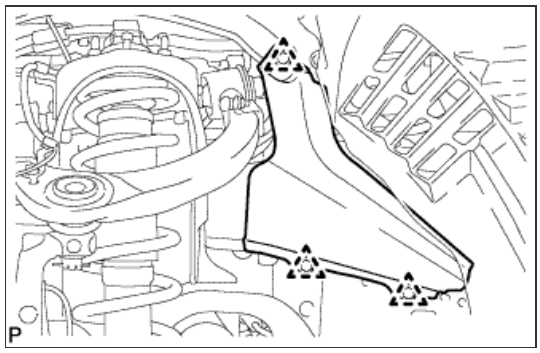
j. Check the fluid level.



8. INSPECT FOR POWER STEERING FLUID LEAK

9. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.

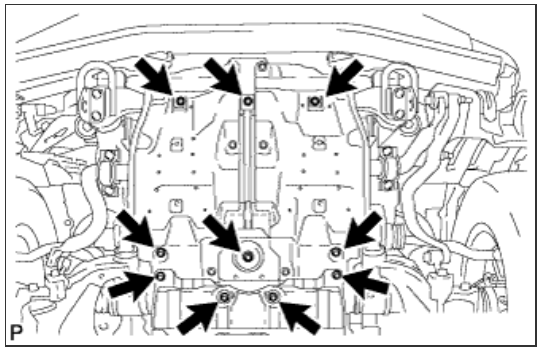


10. INSTALL FRONT WHEEL

11. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

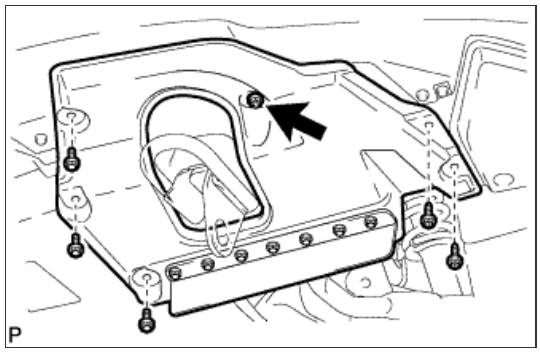
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



12. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



13. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

14. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

15. PERFORM VEHICLE HEIGHT OFFSET CALIBRATION

a. Perform the vehicle height offset calibration (Click here).

16. ADJUST FRONT HEIGHT CONTROL SENSOR LINK SUB-ASSEMBLY

NOTICE:

- **Make adjustments from the link that deviates the most from the specified vehicle height value.**
- **When the front and rear are at the same level, make adjustments from the front first.**
- **If adjustment cannot be completed through the vehicle height offset calibration, adjust the sensor link using the following procedure.**

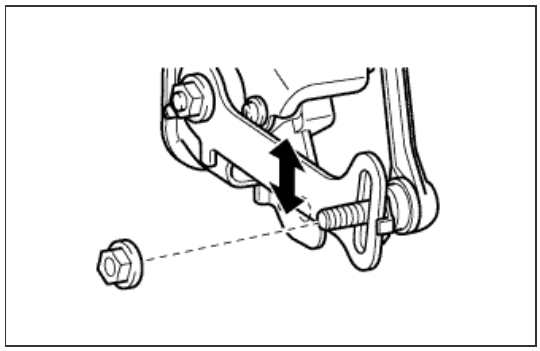
a. Loosen the nut and adjust the link installation position by moving the height control sensor link up or down in the long hole of the bracket.

HINT:

When the link is moved 1 mm (0.0394 in.), the vehicle height changes by approximately 2 mm (0.0787 in.).

b. Tighten the nut of the height control sensor link.

Torque:
5.6 N*m{ 57 kgf*cm , 50 in.*lbf }



17. PERFORM ZERO POINT CALIBRATION OF G SENSOR

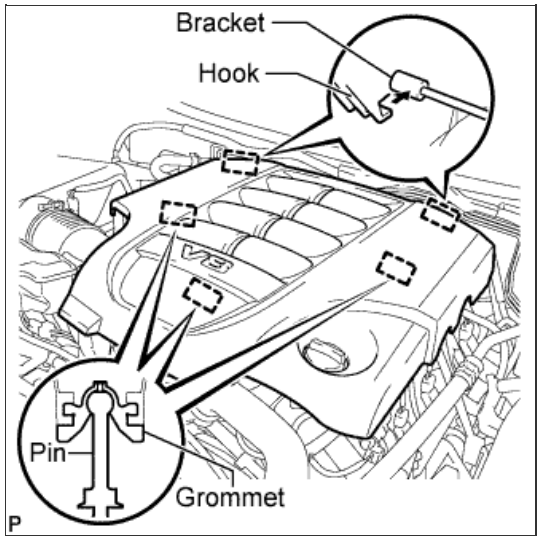
a. Perform the zero point calibration of the G sensor (Click here).

18. ADJUST HEADLIGHT ASSEMBLY

a. Adjust the headlight (Click here).

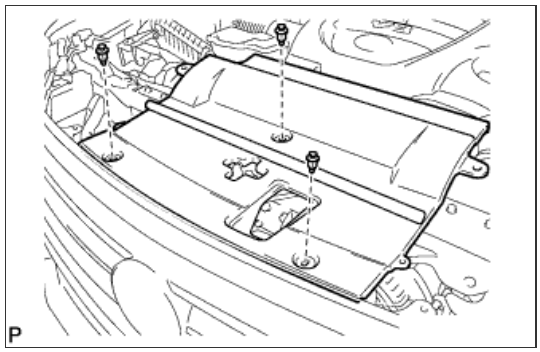
19. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



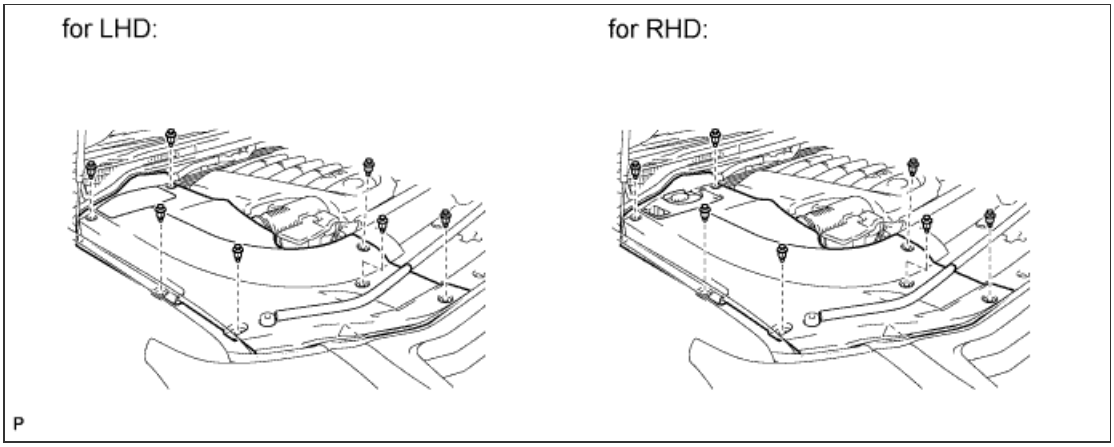
20. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



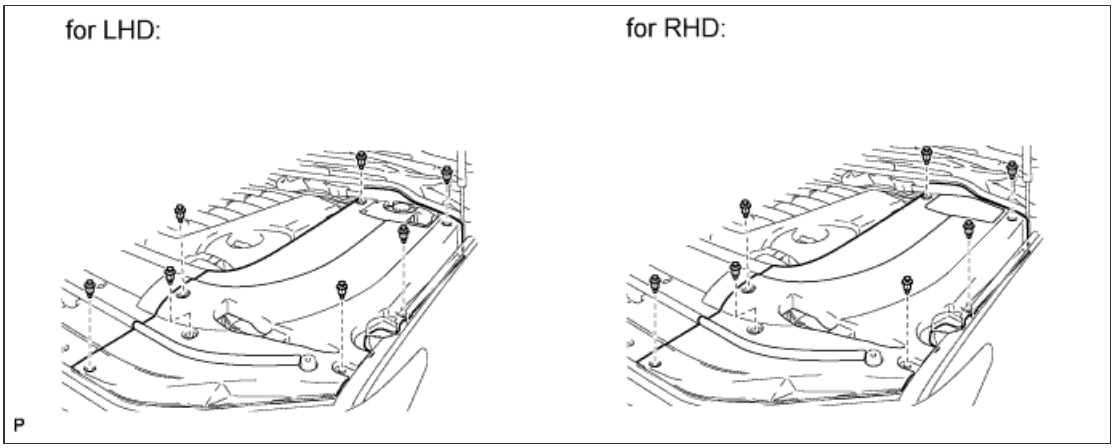
21. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



22. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



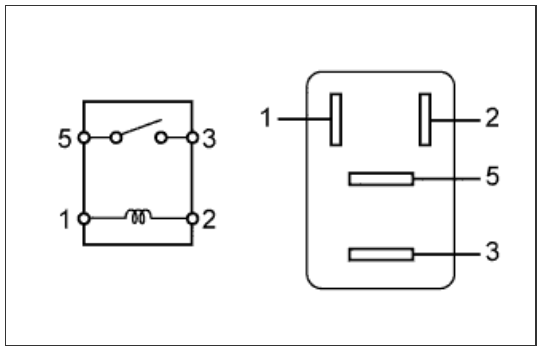
for Preparation Click here

1. INSPECT CIRCUIT OPENING RELAY (C/OPN)

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
3 - 5	Battery voltage is not applied to terminals 1 and 2	10 kΩ or higher
	Battery voltage is applied to terminals 1 and 2	Below 1 Ω



If the result is not as specified, replace the relay.

2. INSPECT INTEGRATION RELAY (IG2)

a. Measure the resistance of the IG2 MAIN fuse.

i. Remove the IG2 MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
IG2 MAIN fuse	Always	Below 1 Ω

If the result is not as specified, replace the IG2 MAIN fuse.

iii. Install the IG2 MAIN fuse to the integration relay.

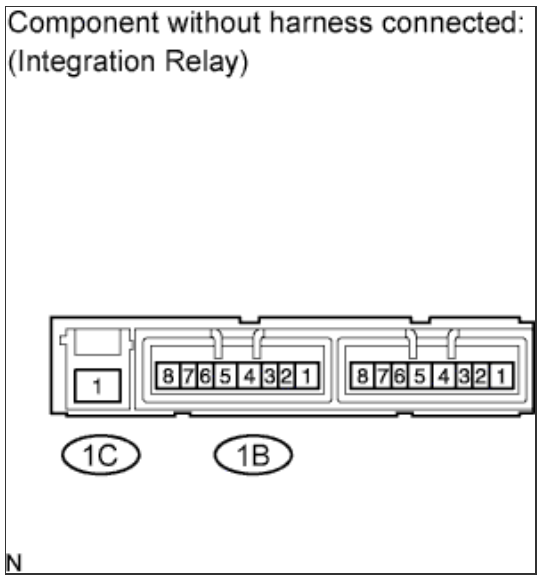
b. Measure the resistance of the ignition relay No. 2 (IG2) circuit.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-8	Battery voltage is not applied to terminals 1B-6 and 1B-7	10 kΩ or higher
	Battery voltage is applied to terminals 1B-6 and 1B-7	Below 1 Ω

If the result is not as specified, replace the integration relay.



3. INSPECT INTEGRATION RELAY (EFI)

a. Measure the resistance of the EFI MAIN fuse.

i. Remove the EFI MAIN fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

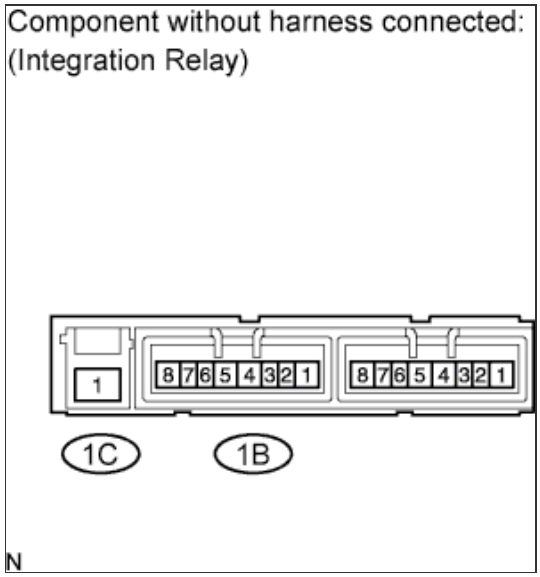
Standard Resistance:

Tester Connection	Condition	Specified Condition
EFI MAIN fuse	Always	Below 1 Ω

If the result is not as specified, replace the EFI MAIN fuse.

iii. Install the EFI MAIN fuse to the integration relay.

b. Measure the resistance of the EFI relay circuit.



i. Measure the resistance according to the value(s) in the table below.

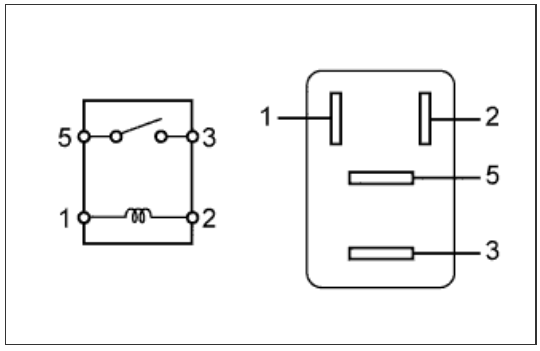
Standard Resistance:

Tester Connection	Condition	Specified Condition
1C-1 - 1B-4	Battery voltage is not applied to terminals 1B-2 and 1B-3	10 kΩ or higher
	Battery voltage is applied to terminals 1B-2 and 1B-3	Below 1 Ω

If the result is not as specified, replace the integration relay.

4. INSPECT EFI NO. 2 RELAY

a. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

Tester Connection	Condition	Specified Condition
3 - 5	Battery voltage is not applied to terminals 1 and 2	10 kΩ or higher
	Battery voltage is applied to terminals 1 and 2	Below 1 Ω

If the result is not as specified, replace the relay.

5. INSPECT INTEGRATION RELAY (A/F)

a. Measure the resistance of the A/F fuse.

i. Remove the A/F fuse from the integration relay.

ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A/F fuse	Always	Below 1 Ω

If the result is not as specified, replace the A/F fuse.

iii. Install the A/F fuse to the integration relay.

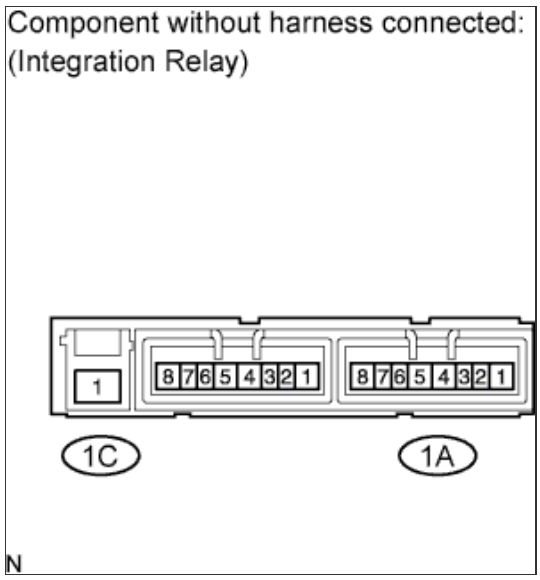
b. Measure the resistance of the A/F sensor heater relay circuit.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

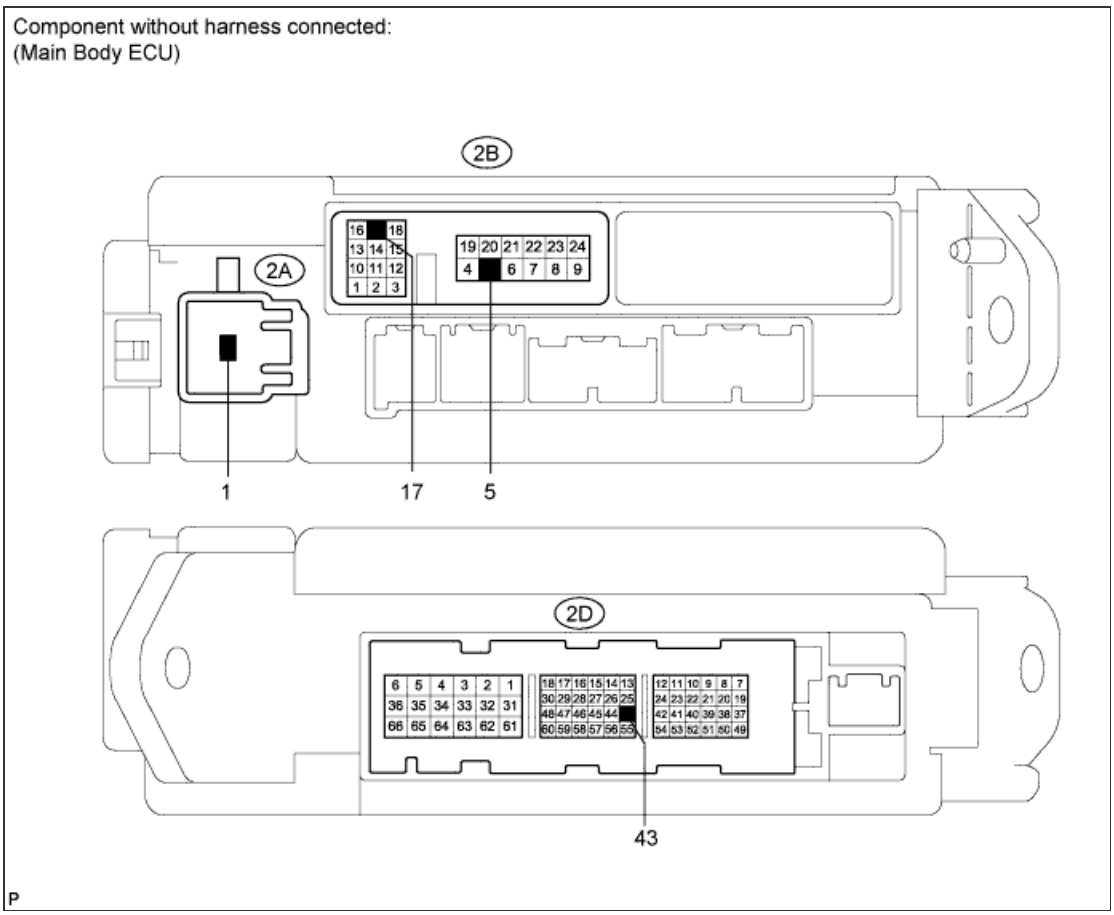
Tester Connection	Condition	Specified Condition
1C-1 - 1A-4	Battery voltage is not applied to terminals 1A-2 and 1A-3	10 kΩ or higher
	Battery voltage is applied to terminals 1 A-2 and 1A-3	Below 1 Ω

If the result is not as specified, replace the integration relay.



6. INSPECT MAIN BODY ECU (IG1 NO. 1)

a. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

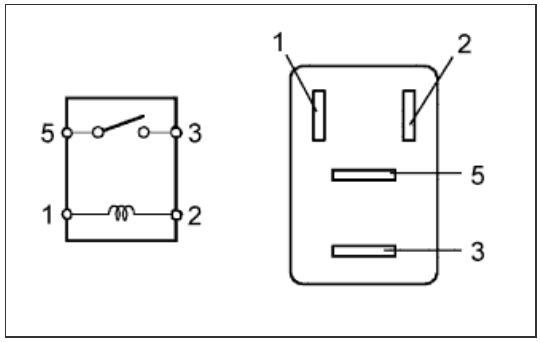
Tester Connection	Condition	Specified Condition

2A-1 - 2B-17	Battery voltage is not applied to terminals 2B-5 and 2D-43	10 kΩ or higher
	Battery voltage is applied to terminals 2B-5 and 2D-43	Below 1 Ω

If the result is not as specified, replace the main body ECU.

7. INSPECT STARTER RELAY (ST)

a. Measure the resistance according to the value(s) in the table below.



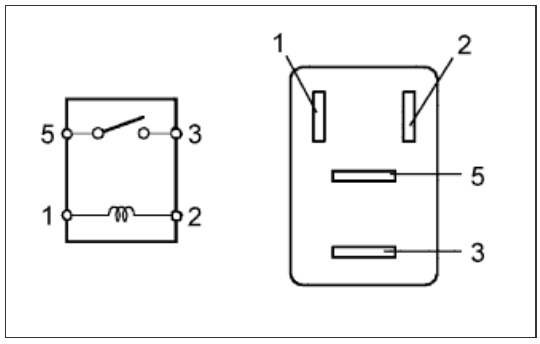
Standard Resistance:

Tester Connection	Condition	Specified Condition
3 - 5	Battery voltage not applied to terminals 1 and 2	10 kΩ or higher
	Battery voltage applied to terminals 1 and 2	Below 1 Ω

If the result is not as specified, replace the relay.

8. INSPECT STARTER CUT RELAY (ST CUT)

a. Measure the resistance according to the value(s) in the table below.



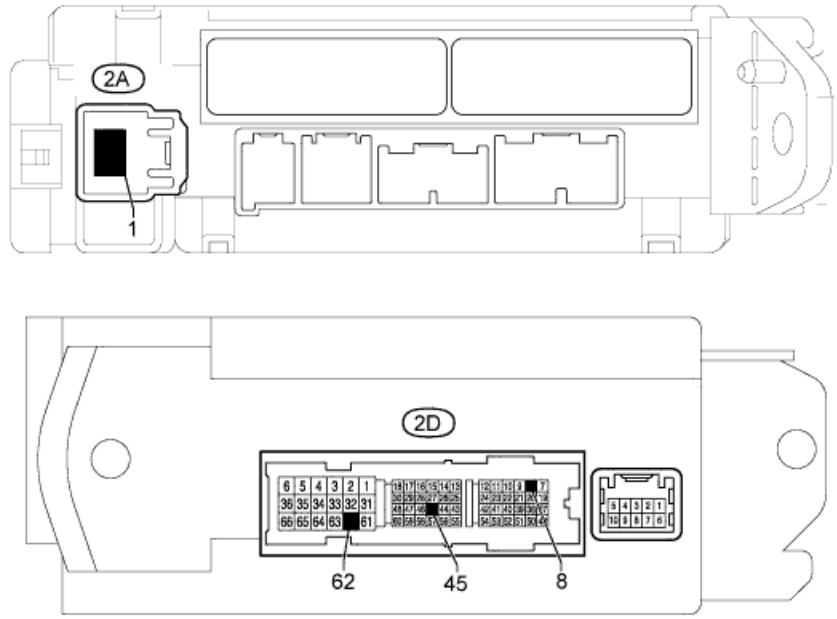
Standard Resistance:

Tester Connection	Condition	Specified Condition
3 - 5	Battery voltage not applied to terminals 1 and 2	10 kΩ or higher
	Battery voltage applied to terminals 1 and 2	Below 1 Ω

If the result is not as specified, replace the relay.

9. INSPECT MAIN BODY ECU (ACC RELAY)

Component without harness connected: (Main Body ECU)



P

a. Measure the resistance of the ACC relay circuit.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2A-1 - 2D-8	Battery voltage not applied between 2D-45 and 2D-62	10 kΩ or higher
	Battery voltage applied between 2D-45 and 2D-62	Below 1 Ω

If the result is not as specified, replace the main body ECU.

for Preparation Click here

1. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

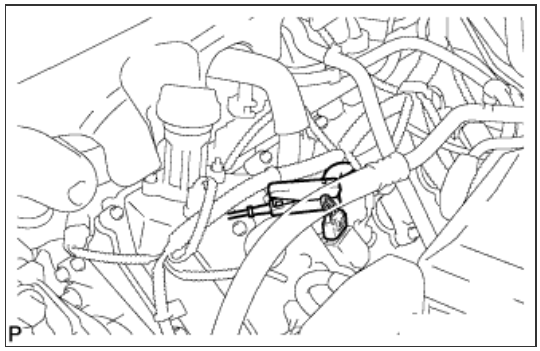
v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:

i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

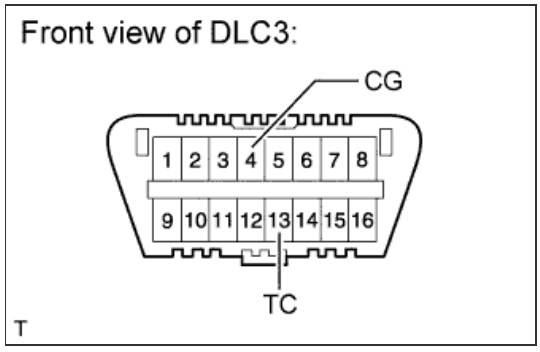


ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

SST
09843-18040

NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**



iii. Using the timing light, check the ignition timing.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch

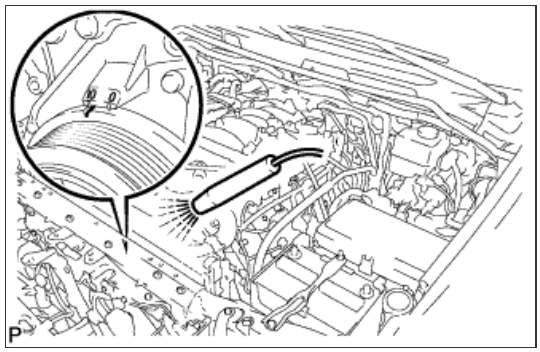
off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.



h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

2. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

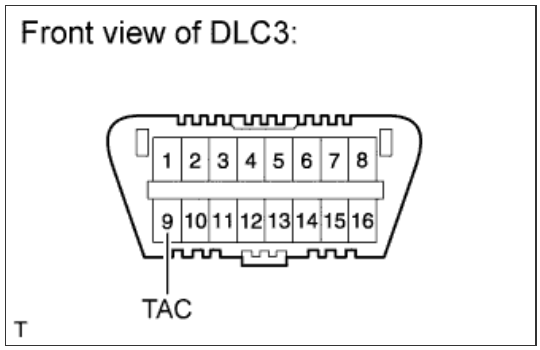
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Check the idle speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

3. INSPECT COMPRESSION

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the V-bank cover.

e. Remove the air cleaner hose assembly (Click here).

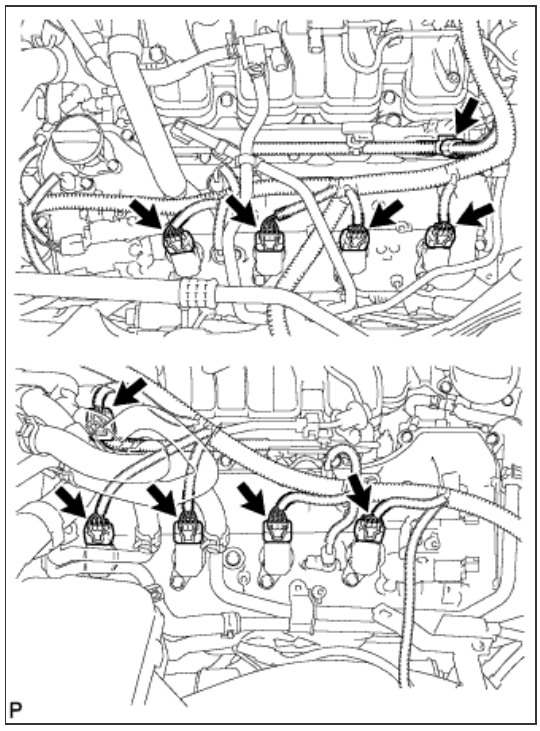
f. Remove the air cleaner assembly (Click here).

g. Disconnect the water by-pass pipe assembly (Click here).

h. Disconnect the 2 injector connectors and 8 ignition coil connectors.

i. Remove the 8 bolts and 8 ignition coils (Click here).

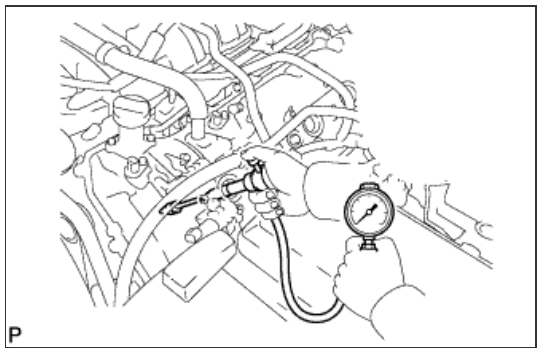
j. Remove the 8 spark plugs (Click here).



k. Check the cylinder compression pressure.

NOTICE:

Check the compression pressure of each cylinder in the same way.



i. Insert a compression gauge into the spark plug hole.

ii. Fully open the throttle.

iii. While cranking the engine, measure the compression pressure.

Standard compression pressure:
1300 kPa (13.3 kgf/cm^2, 189 psi) or more

Minimum pressure:
1000 kPa (10.2 kgf/cm^2, 145 psi)

Difference between each cylinder:
100 kPa (1.0 kgf/cm^2, 15 psi) or less

NOTICE:

- **Always use a fully charged battery to obtain an engine speed of 250 rpm or more.**
- **This measurement must be done as quickly as possible.**

iv. If the cylinder compression is low in one or more cylinders, pour a small amount of engine oil into the cylinder with low compression through its spark plug hole. Then inspect the cylinder compression pressure again.

HINT:

- **If adding oil helps boost the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.**
- **If pressure stays low, a valve may be stuck or seated improperly, or there may be leakage in the gasket.**

l. Install the 8 spark plugs (Click here).

m. Install the 8 ignition coils with the 8 bolts (Click here).

n. Connect the 2 injector connectors and 8 ignition coil connectors.

o. Connect the water by-pass pipe assembly (Click here).

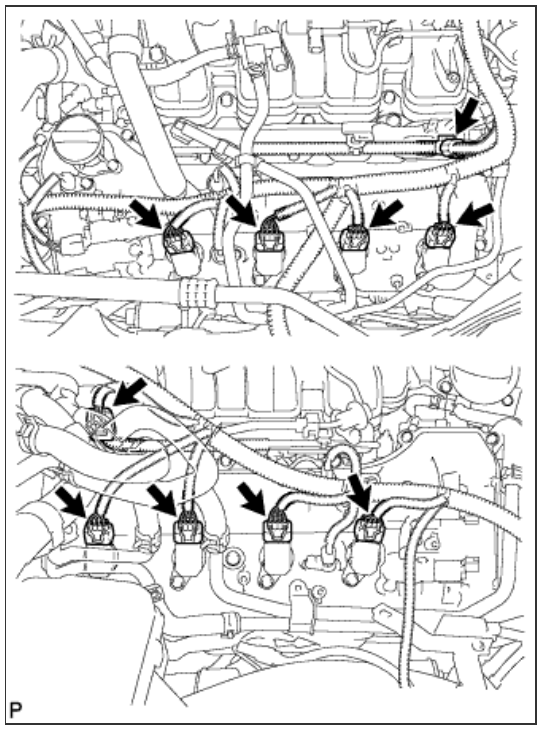
p. Install the air cleaner assembly (Click here).

q. Install the air cleaner hose assembly (Click here).

r. Install the V-bank cover.

s. Install the engine room side cover RH.

t. Install the engine room side cover LH.



4. INSPECT CO/HC

HINT:

This check is used only to determine whether or not the idle CO/HC complies with regulations.

a. Start the engine.

b. Keep the engine speed at 2500 rpm for approximately 180 seconds.

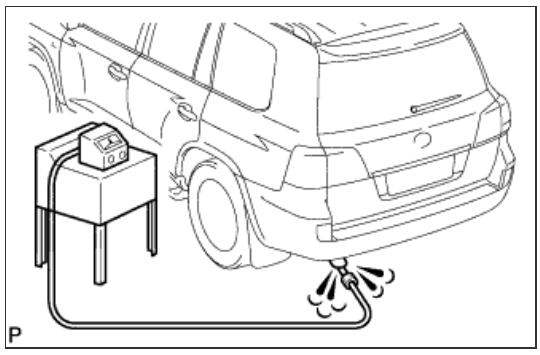
c. Insert the CO/HC meter testing probe at least 40 cm (1.31 ft.) into the tailpipe during idling.

d. Immediately check CO/HC concentration at idle and/or 2500 rpm.

HINT:

When performing the 2 mode (2500 rpm and idle) test, follow the measurement order prescribed by the applicable local regulations.

e. If the CO/HC concentration does not comply with the regulations, troubleshoot in the order given below.

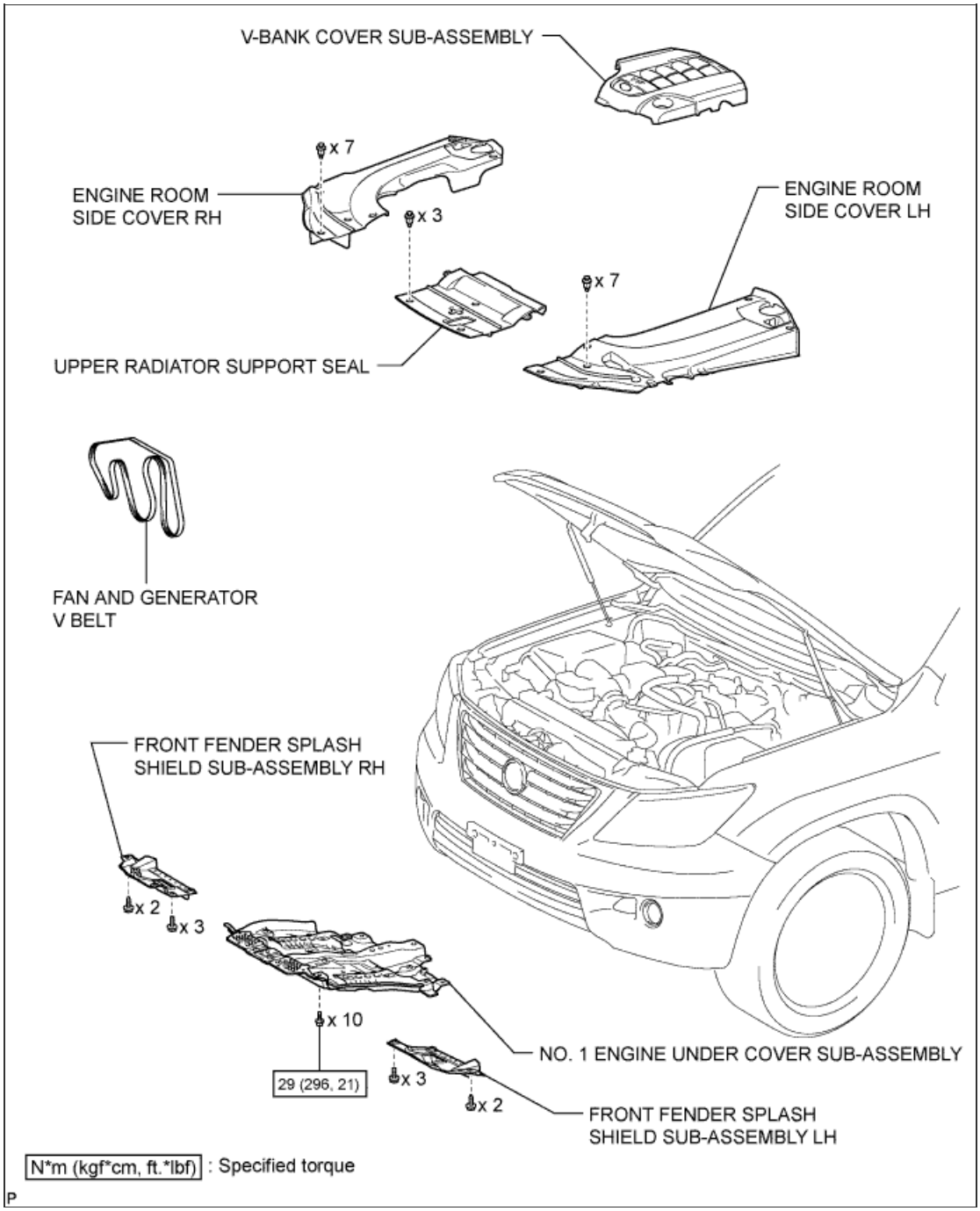


i. Check the A/F sensor operation (Click here) and heated oxygen sensor operation (Click here).

ii. See the table below for possible causes, and then inspect and correct the applicable causes if necessary.

CO	HC	Symptom	Cause
Normal	High	Rough idle	1. Faulty ignitions: • Incorrect timing • Plugs (contaminated, shorted or gaps are defective) 2. Incorrect valve clearance 3. Leaky intake and exhaust valves 4. Leaky cylinder
Low	High	Rough idle (Fluctuating HC reading)	1. Vacuum leaks: • PCV hose • Intake manifold • Throttle body 2. Lean mixture causing misfire
High	High	Rough idle (Black smoke from exhaust)	1. Restricted air filter 2. Faulty SFI system: • Faulty pressure regulator • Defective ECT sensor • Faulty ECM • Faulty injectors • Faulty throttle position sensor • Faulty MAF meter

for Preparation [Click here]



for Preparation Click here

1. INSPECT FAN & GENERATOR V BELT

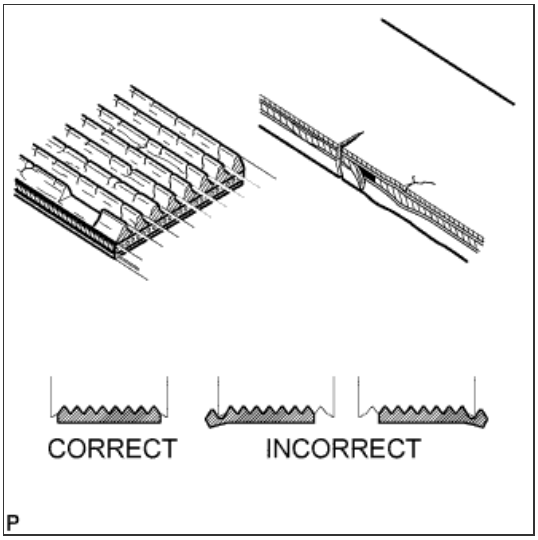
a. Check the belt for wear, cracks or other signs of damage.
If any of the following defects is found, replace the fan and generator V belt.

- The belt is cracked.
- The belt is worn out to the extent that the cords are exposed.
- The belt has chunks missing from the ribs.

b. Check that the belt fits properly in the ribbed grooves.

HINT:

Check with your hand to confirm that the belt has not slipped out of the grooves on the bottom of the pulley. If it has slipped out, replace the fan and generator V belt. Install a new fan and generator V belt correctly.



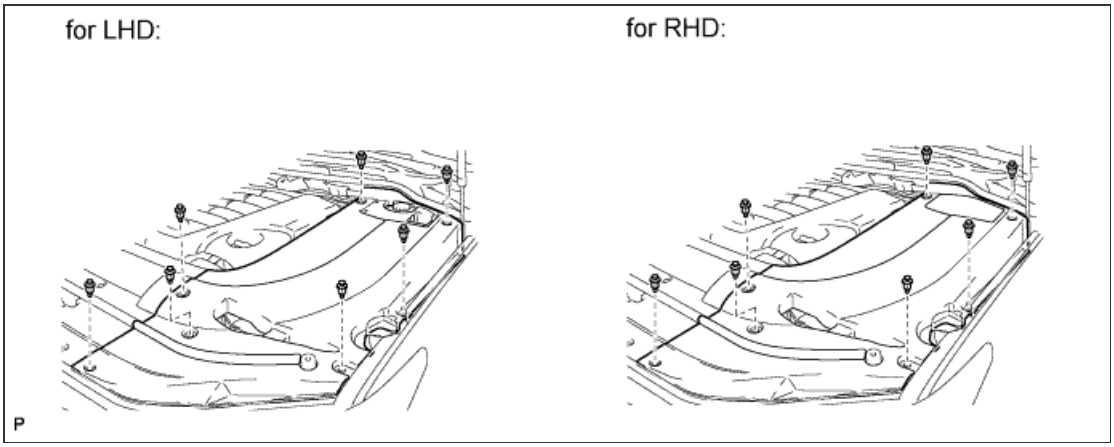
2. INSPECT V-RIBBED BELT TENSIONER ASSEMBLY

a. Check that nothing gets caught in the tensioner by turning it clockwise and counterclockwise. If a malfunction exists, replace the tensioner.

for Preparation Click here

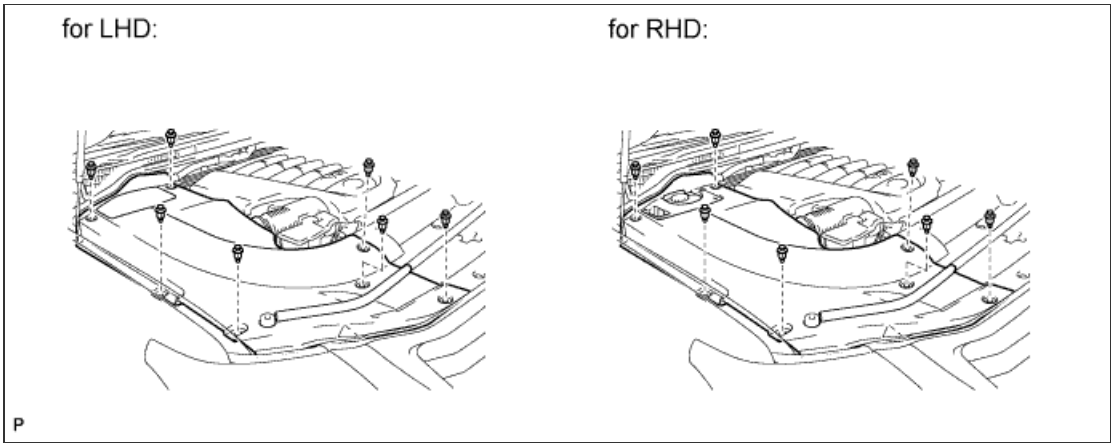
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



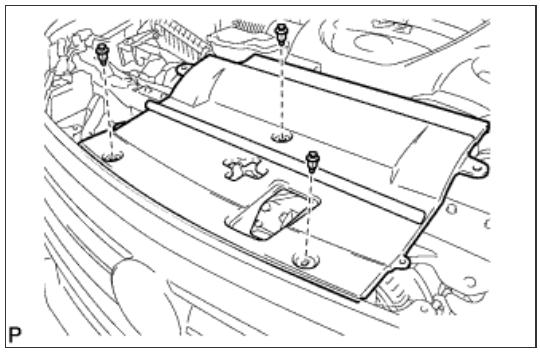
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



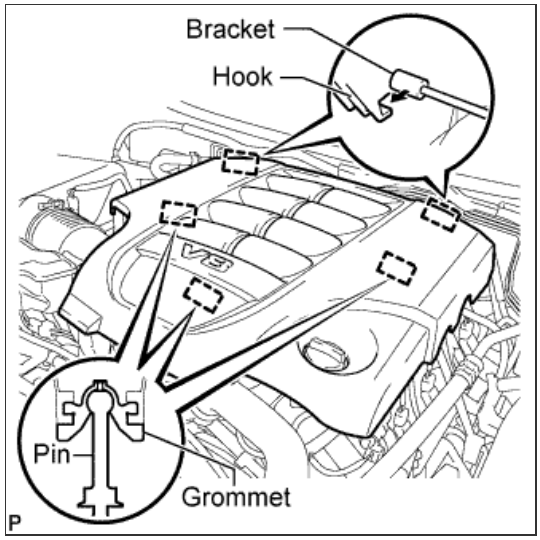
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

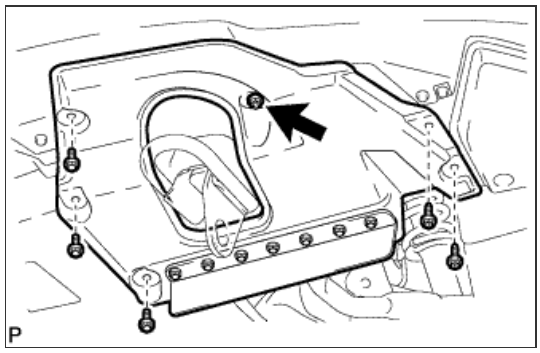
a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



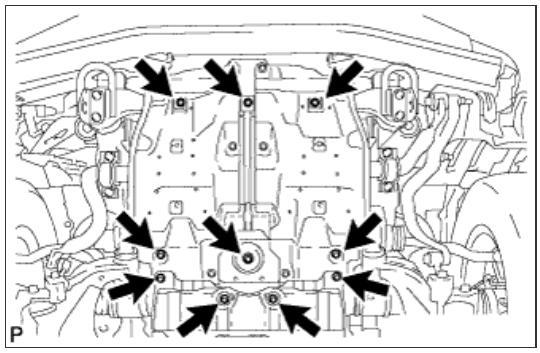
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



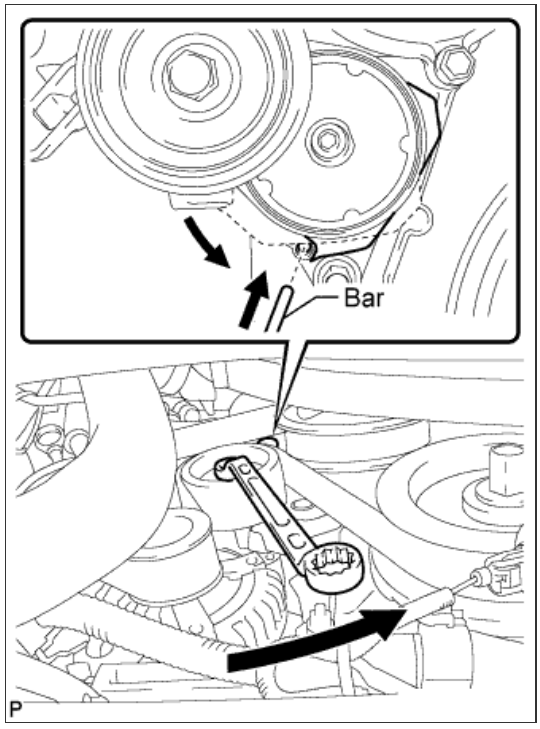
8. REMOVE FAN & GENERATOR V BELT

a. While turning the belt tensioner counterclockwise, align the service hole for the belt tensioner and the belt tensioner fixing position, and then insert a bar of φ5 mm (0.197 in.) into the service hole to fix the belt tensioner in place.

HINT:

The pulley bolt for the belt tensioner has a left-hand thread.

b. Remove the V belt.



for Preparation Click here

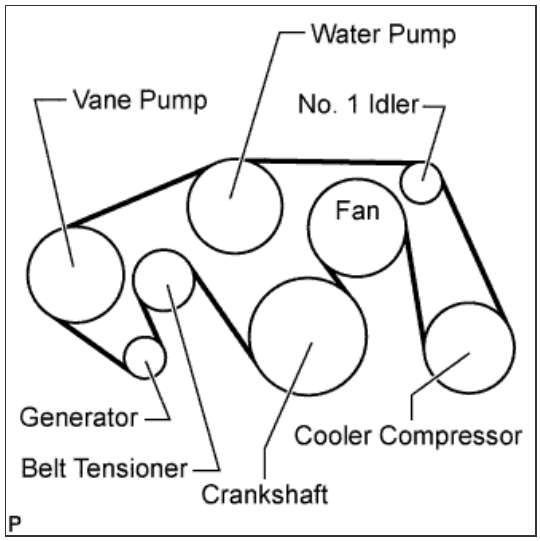
1. INSTALL FAN & GENERATOR V BELT

a. Set the V belt onto every part.

b. While turning the belt tensioner counterclockwise, remove the bar.

NOTICE:

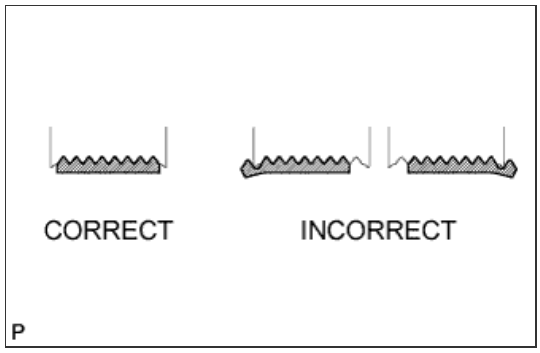
Make sure that the V belt is properly set to each pulley.



c. After installing the belt, check that it fits properly in the ribbed grooves.

HINT:

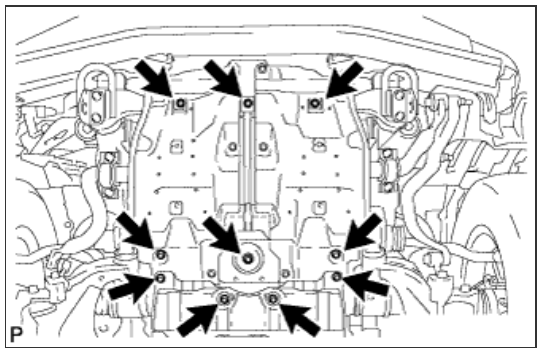
Make sure to check by hand that the belt has not slipped out of the grooves on the bottom of the pulley.



2. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

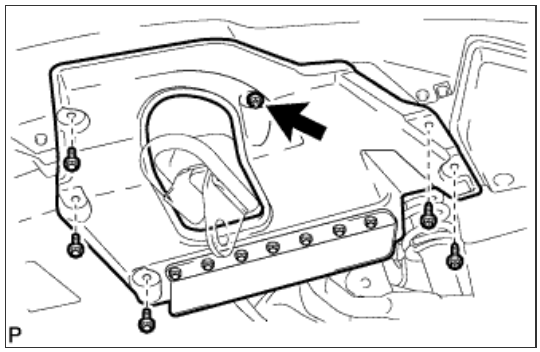
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



3. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



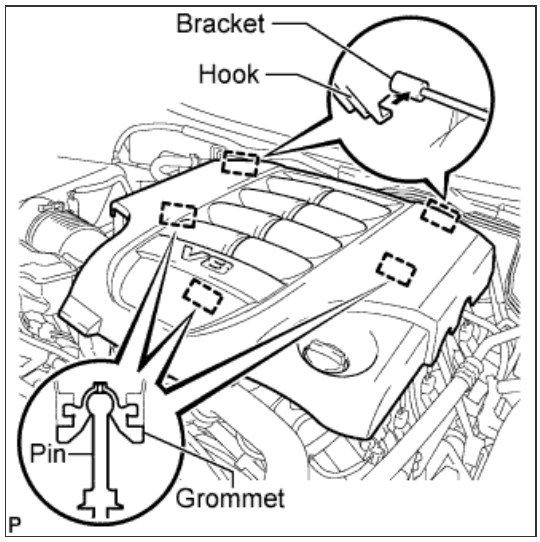
4. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

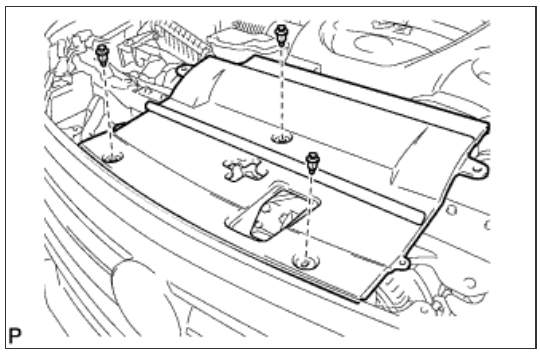
5. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



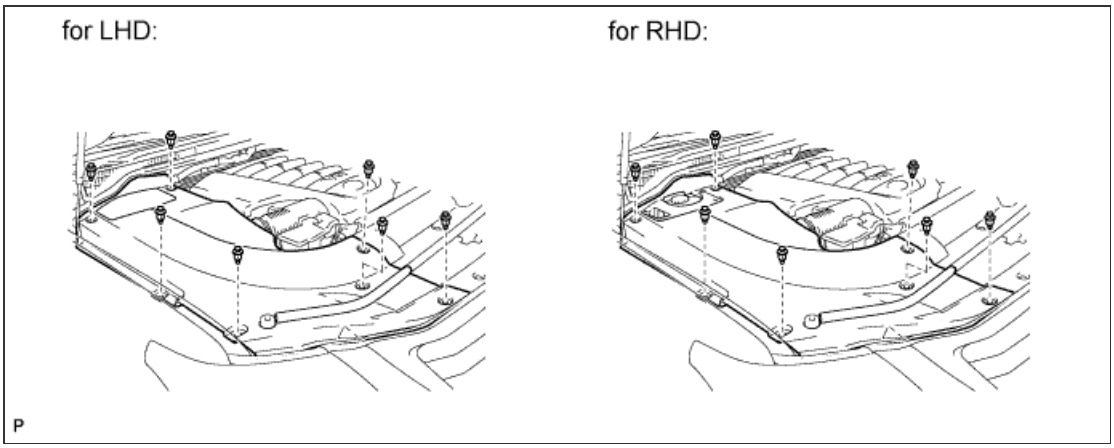
6. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



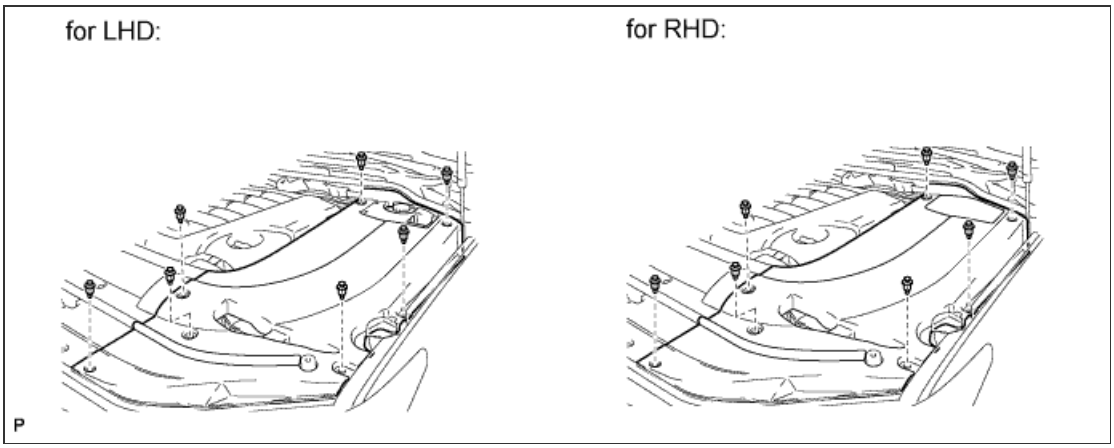
7. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

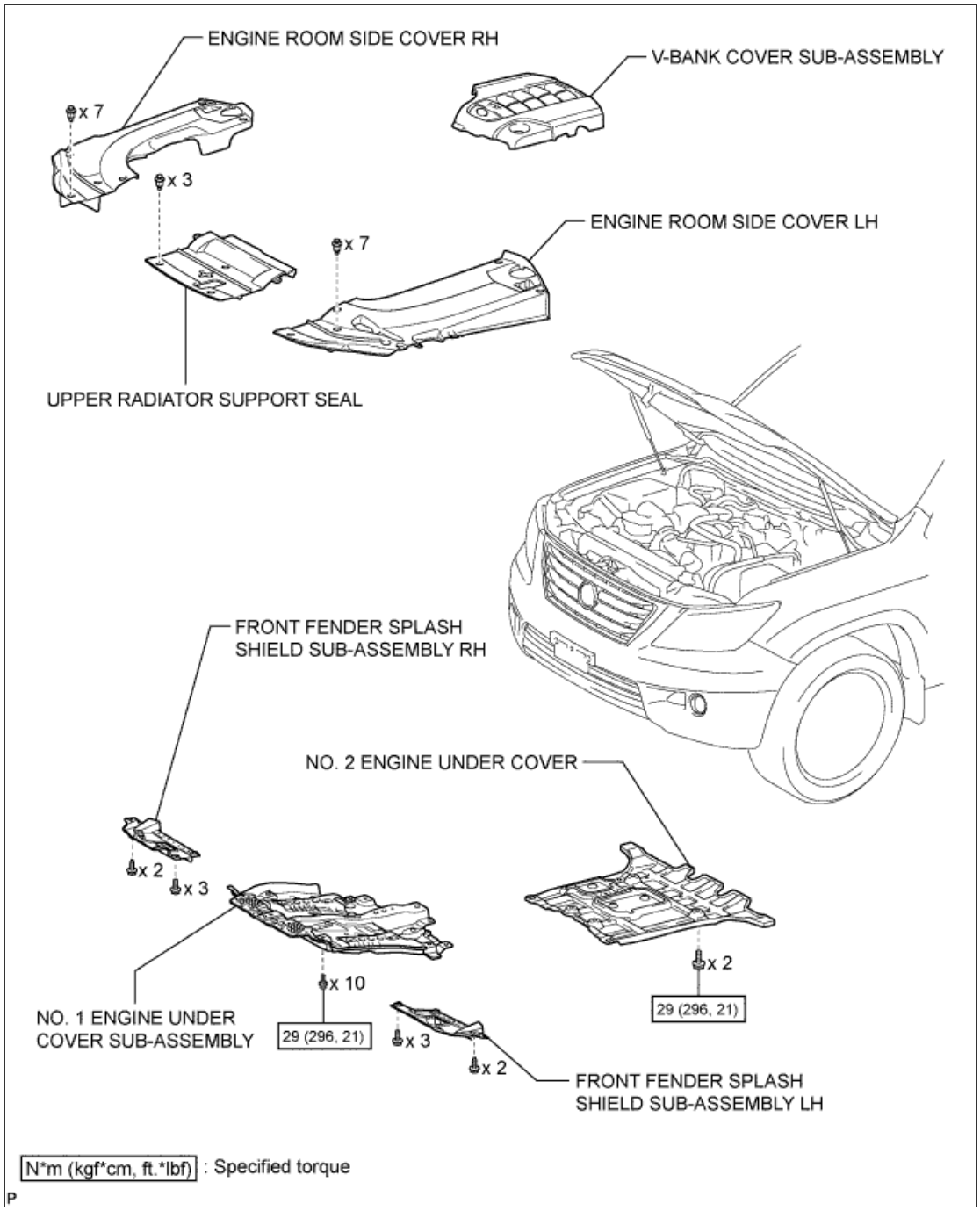


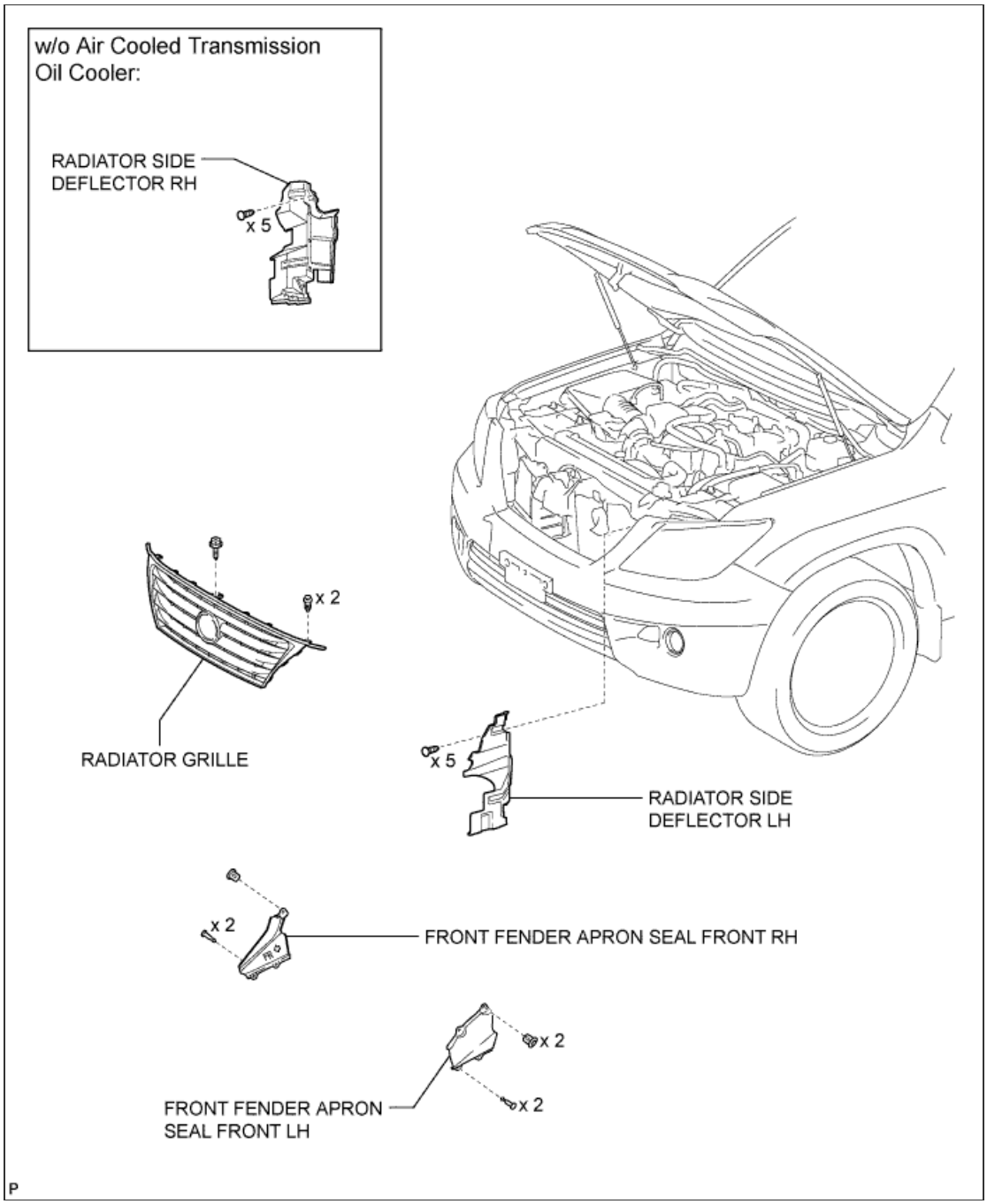
8. INSTALL ENGINE ROOM SIDE COVER LH

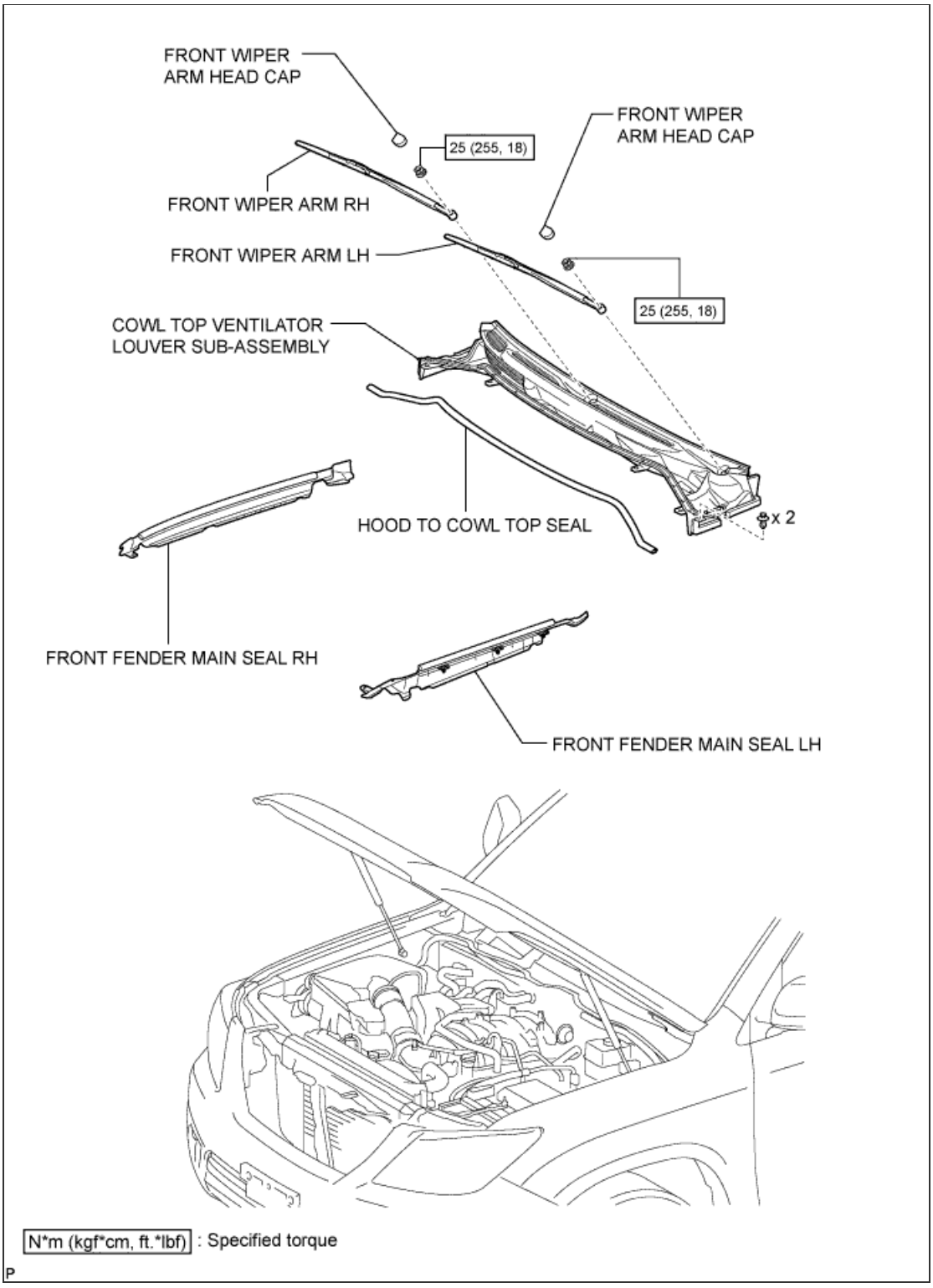
a. Install the engine room side cover with the 7 clips.



for Preparation Click here

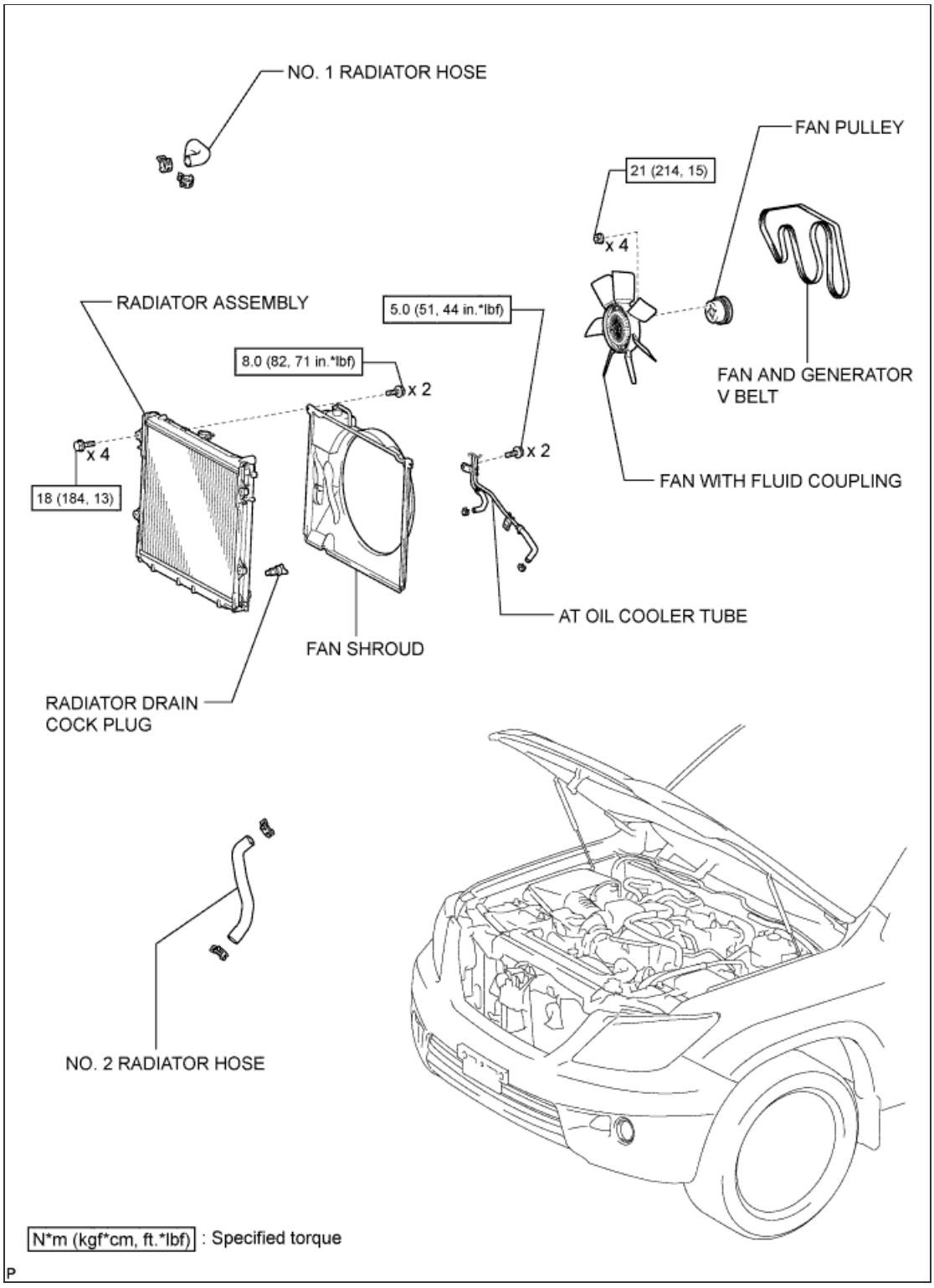


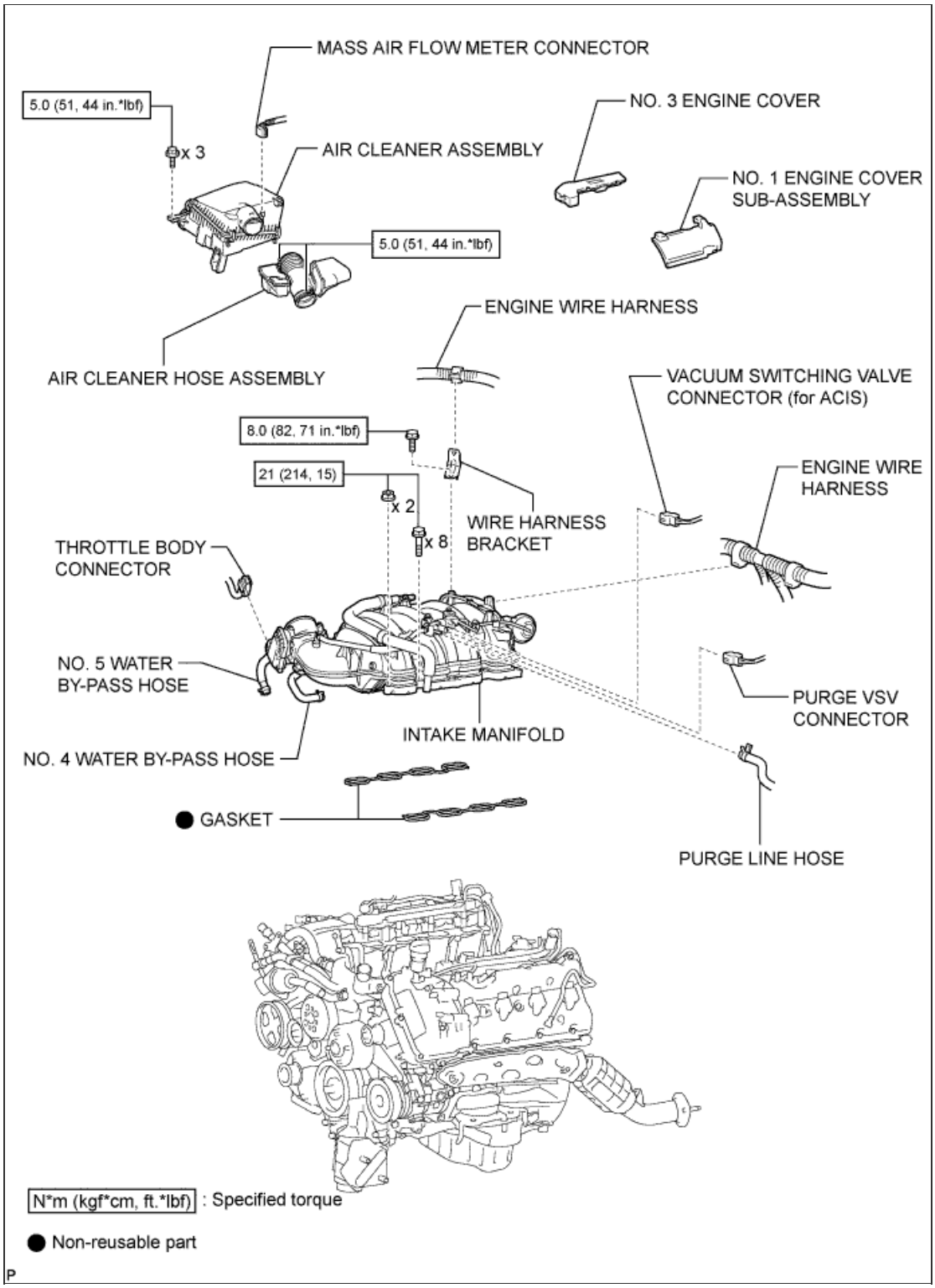

w/o Air Cooled Transmission Oil Cooler:
RADIATOR SIDE DEFLECTOR RH
x 5
x 2
RADIATOR GRILLE
x 5
RADIATOR SIDE DEFLECTOR LH
x 2
FRONT FENDER APRON SEAL FRONT RH
x 2
x 2
FRONT FENDER APRON SEAL FRONT LH
P

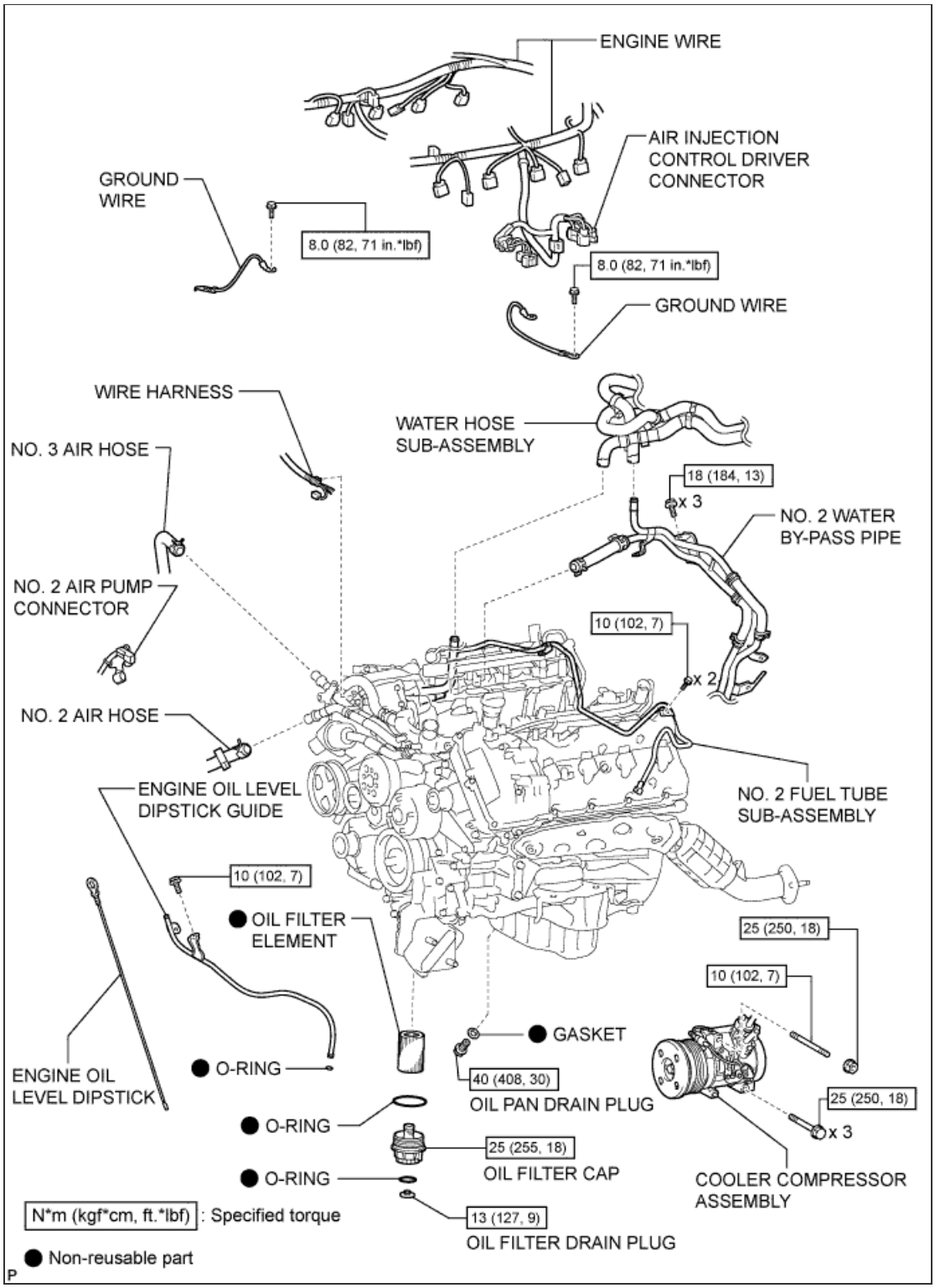


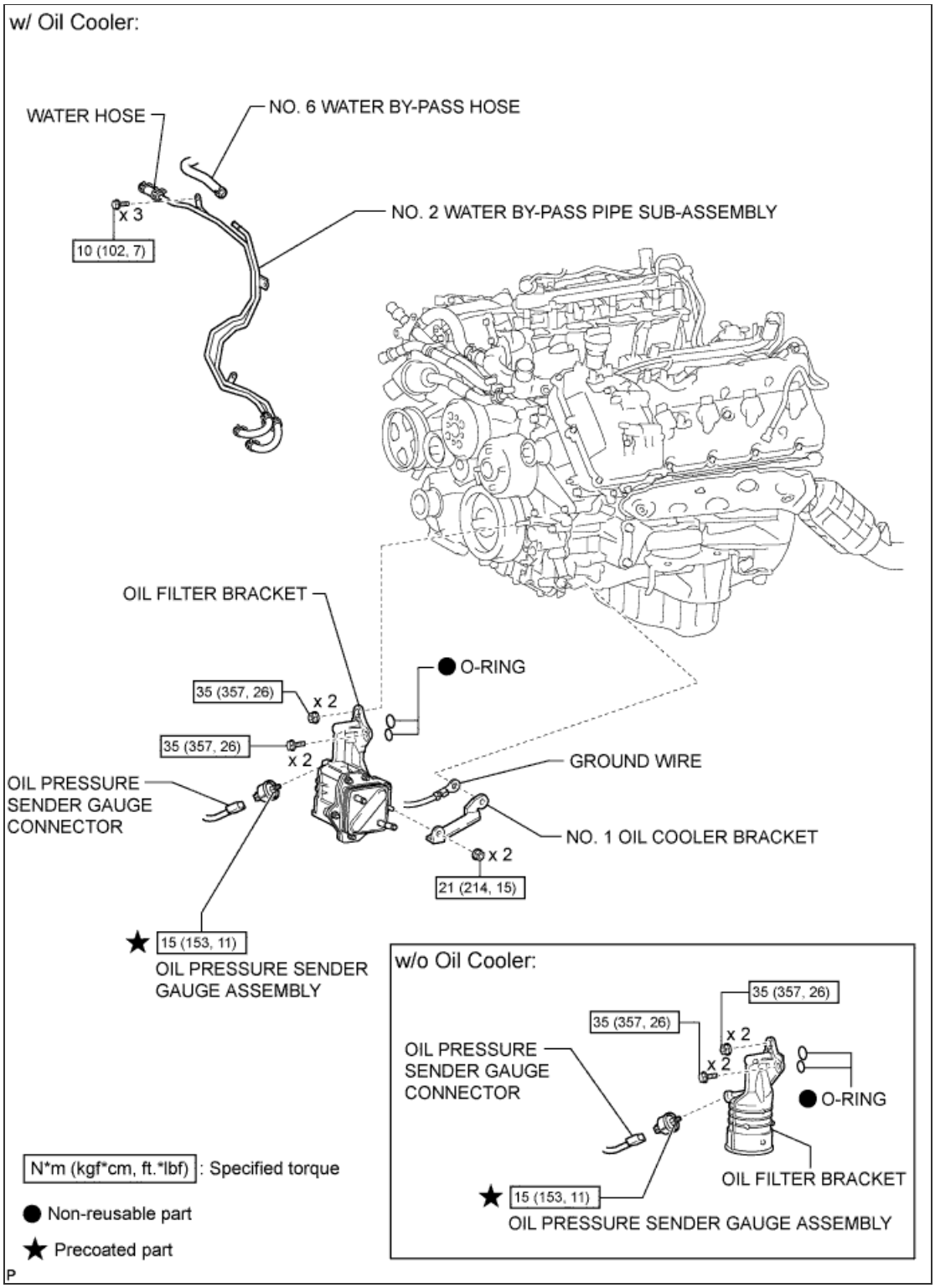
N*m (kgf*cm, ft.*lbf) : Specified torque

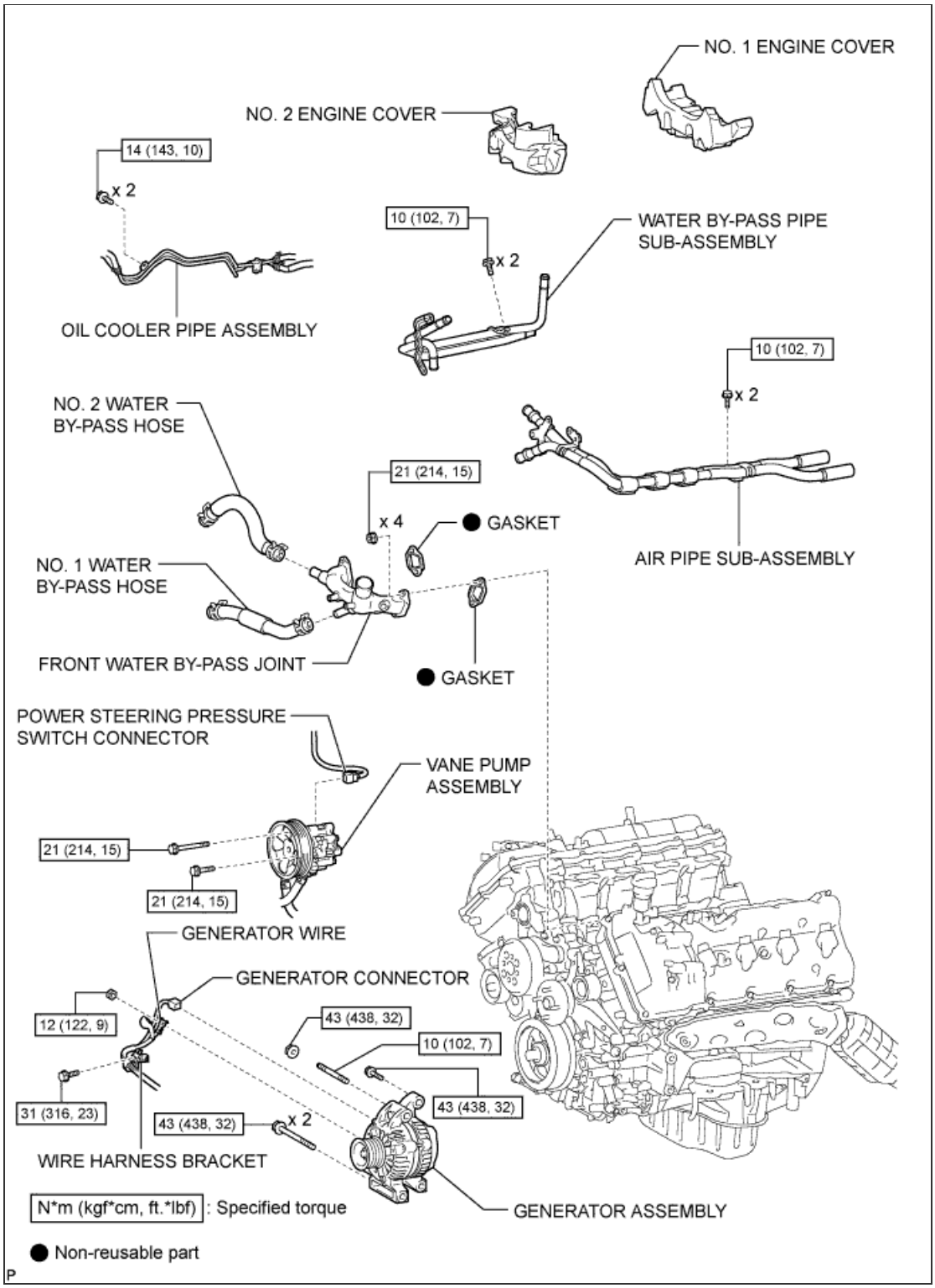
P

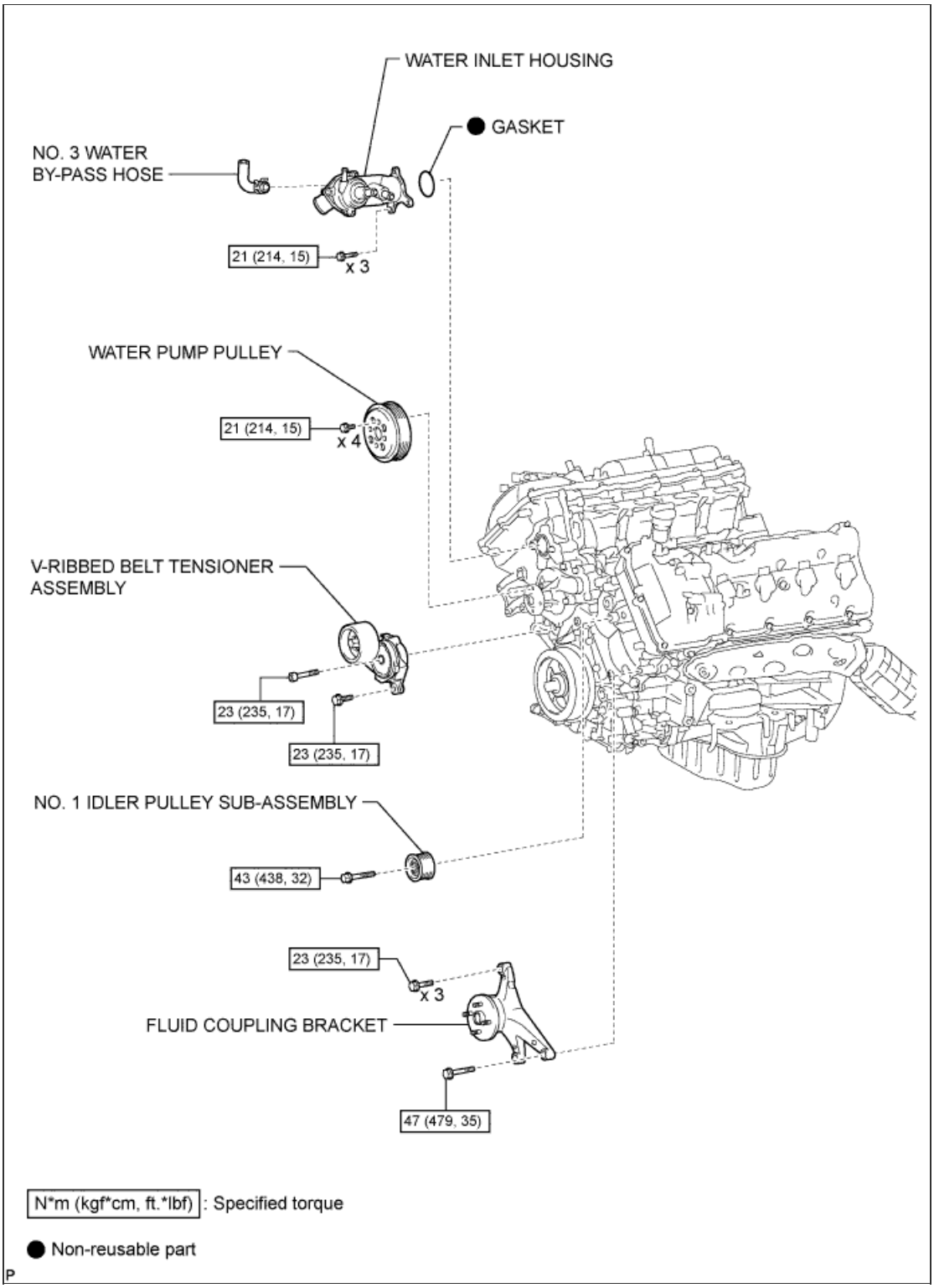

NO. 1 RADIATOR HOSE
FAN PULLEY
21 (214, 15)
x 4
RADIATOR ASSEMBLY
5.0 (51, 44 in.*lbf)
8.0 (82, 71 in.*lbf)
x 2
FAN AND GENERATOR V BELT
x 4
x 2
18 (184, 13)
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
FAN SHROUD
RADIATOR DRAIN COCK PLUG
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P

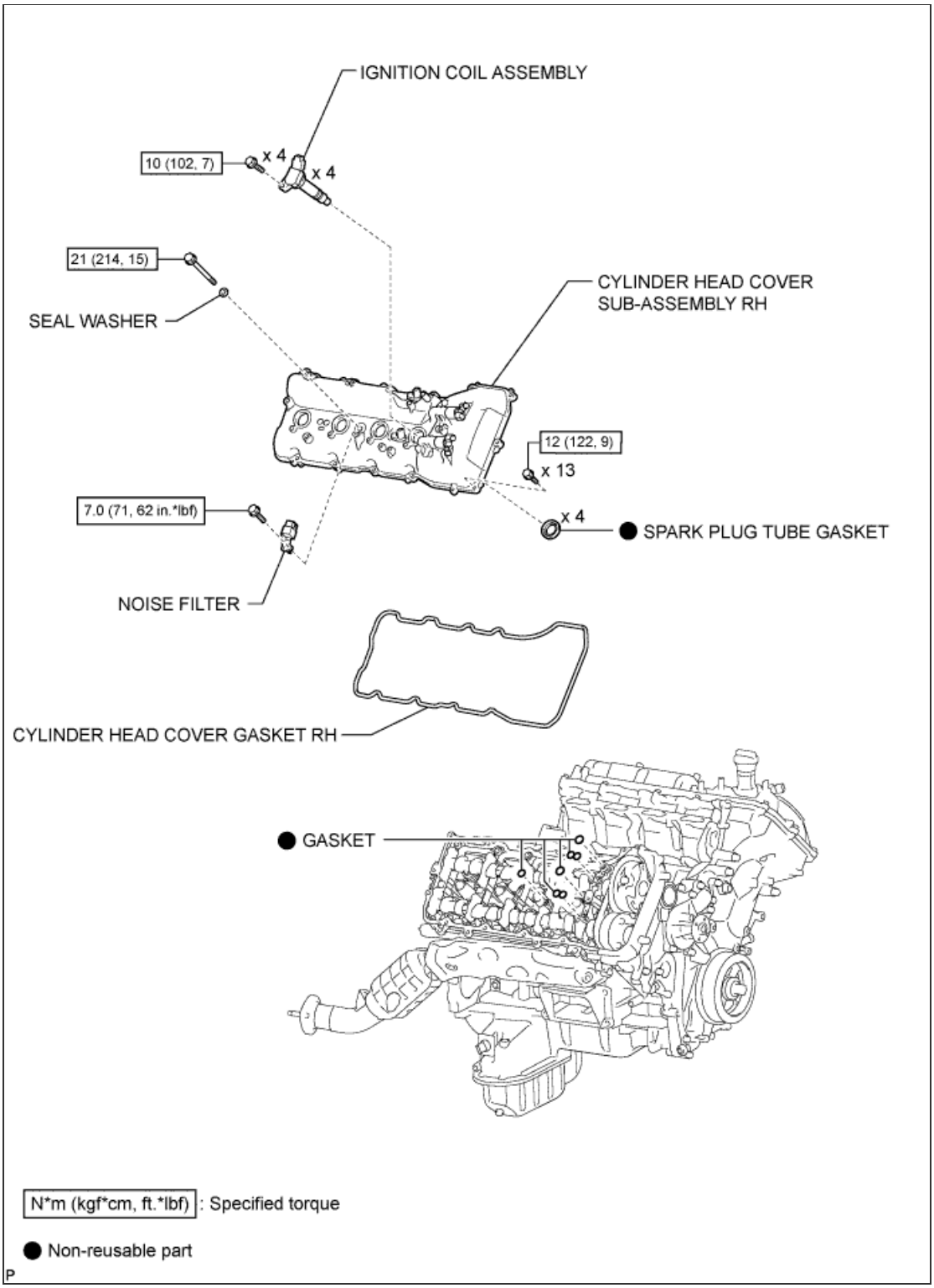

MASS AIR FLOW METER CONNECTOR
5.0 (51, 44 in.*lbf)
x 3
AIR CLEANER ASSEMBLY
NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
5.0 (51, 44 in.*lbf)
ENGINE WIRE HARNESS
AIR CLEANER HOSE ASSEMBLY
VACUUM SWITCHING VALVE CONNECTOR (for ACIS)
8.0 (82, 71 in.*lbf)
21 (214, 15)
x 2
x 8
WIRE HARNESS BRACKET
ENGINE WIRE HARNESS
THROTTLE BODY CONNECTOR
NO. 5 WATER BY-PASS HOSE
PURGE VSV CONNECTOR
INTAKE MANIFOLD
NO. 4 WATER BY-PASS HOSE
GASKET
PURGE LINE HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


ENGINE WIRE
AIR INJECTION CONTROL DRIVER CONNECTOR
GROUND WIRE
8.0 (82, 71 in.*lbf)
8.0 (82, 71 in.*lbf)
GROUND WIRE
WIRE HARNESS
WATER HOSE SUB-ASSEMBLY
NO. 3 AIR HOSE
18 (184, 13)
x 3
NO. 2 WATER BY-PASS PIPE
NO. 2 AIR PUMP CONNECTOR
10 (102, 7)
x 2
NO. 2 AIR HOSE
ENGINE OIL LEVEL DIPSTICK GUIDE
NO. 2 FUEL TUBE SUB-ASSEMBLY
10 (102, 7)
OIL FILTER ELEMENT
25 (250, 18)
10 (102, 7)
GASKET
ENGINE OIL LEVEL DIPSTICK
O-RING
40 (408, 30)
OIL PAN DRAIN PLUG
25 (250, 18)
x 3
O-RING
25 (255, 18)
OIL FILTER CAP
COOLER COMPRESSOR ASSEMBLY
O-RING
N*m (kgf*cm, ft.*lbf) : Specified torque
13 (127, 9)
OIL FILTER DRAIN PLUG
Non-reusable part
P

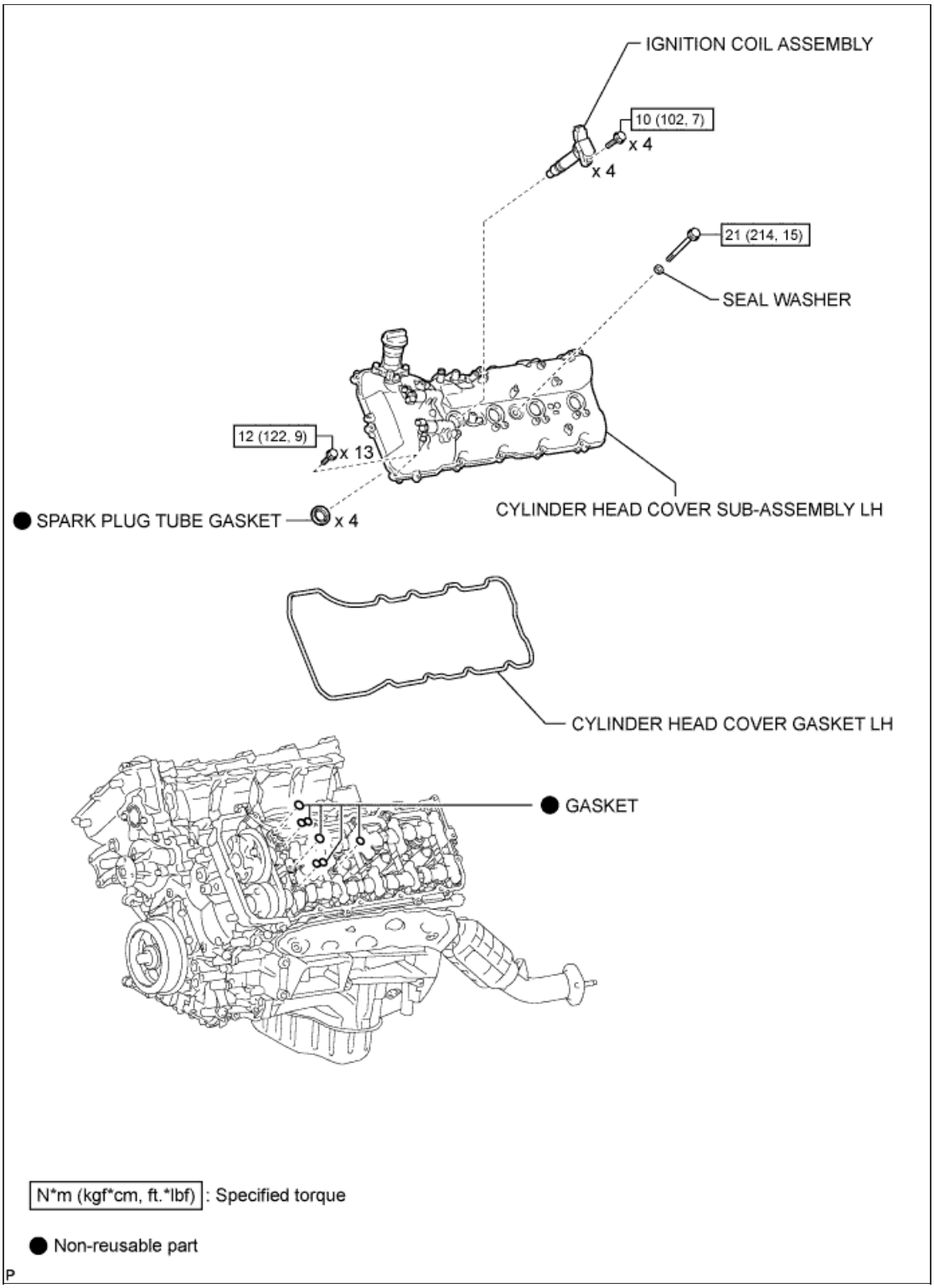

w/ Oil Cooler:
WATER HOSE
NO. 6 WATER BY-PASS HOSE
x 3
10 (102, 7)
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
OIL FILTER BRACKET
O-RING
35 (357, 26)
x 2
35 (357, 26)
x 2
GROUND WIRE
OIL PRESSURE SENDER GAUGE CONNECTOR
NO. 1 OIL COOLER BRACKET
x 2
21 (214, 15)
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
w/o Oil Cooler:
35 (357, 26)
35 (357, 26)
x 2
x 2
OIL PRESSURE SENDER GAUGE CONNECTOR
O-RING
OIL FILTER BRACKET
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
P


NO. 1 ENGINE COVER
NO. 2 ENGINE COVER
14 (143, 10)
x 2
OIL COOLER PIPE ASSEMBLY
10 (102, 7)
x 2
WATER BY-PASS PIPE SUB-ASSEMBLY
10 (102, 7)
x 2
AIR PIPE SUB-ASSEMBLY
NO. 2 WATER BY-PASS HOSE
21 (214, 15)
x 4
GASKET
NO. 1 WATER BY-PASS HOSE
FRONT WATER BY-PASS JOINT
GASKET
POWER STEERING PRESSURE SWITCH CONNECTOR
VANE PUMP ASSEMBLY
21 (214, 15)
21 (214, 15)
GENERATOR WIRE
GENERATOR CONNECTOR
12 (122, 9)
43 (438, 32)
10 (102, 7)
43 (438, 32)
31 (316, 23)
43 (438, 32)
x 2
WIRE HARNESS BRACKET
N*m (kgf*cm, ft.*lbf) : Specified torque
GENERATOR ASSEMBLY
Non-reusable part
P

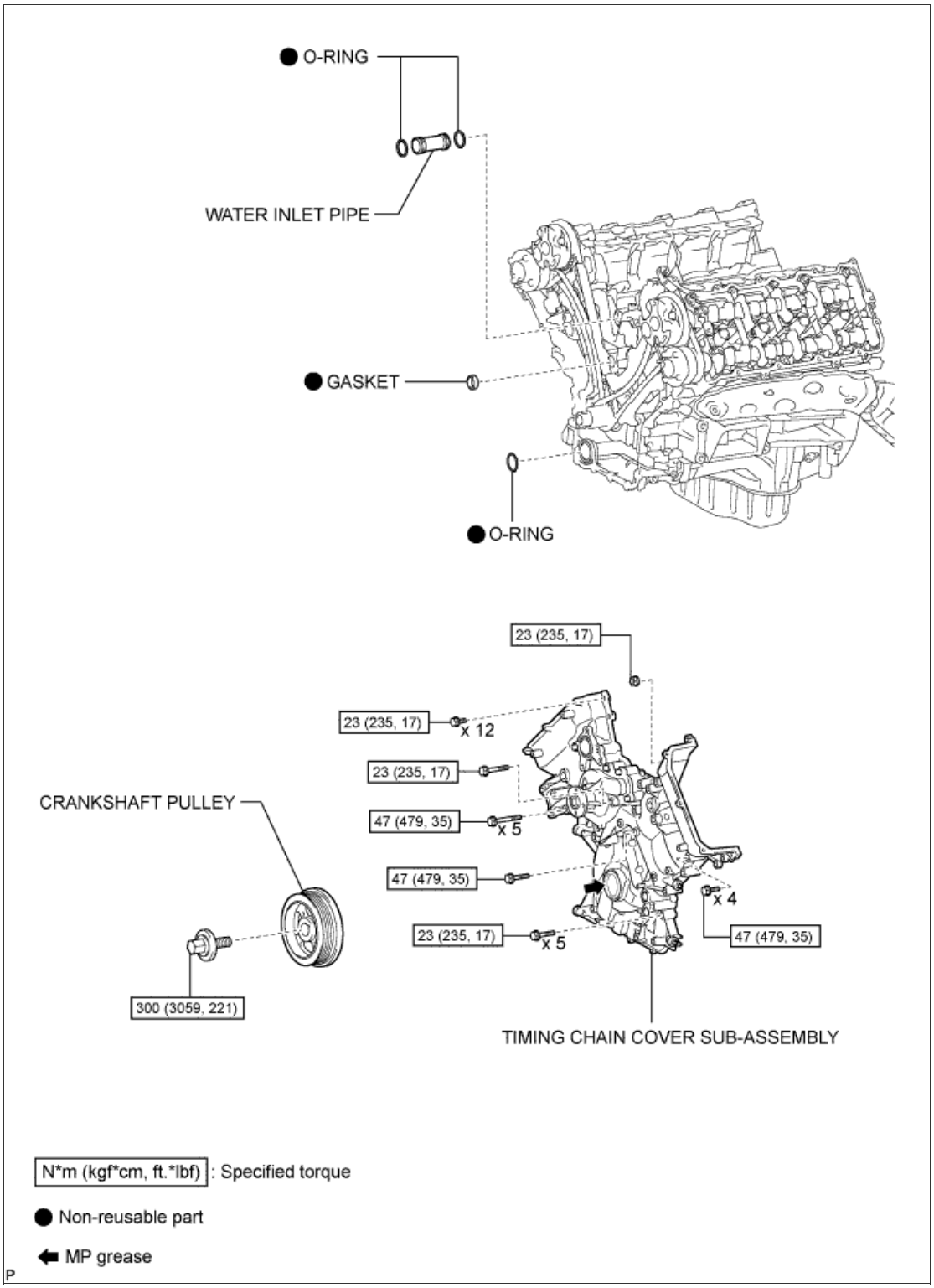

WATER INLET HOUSING
GASKET
NO. 3 WATER BY-PASS HOSE
21 (214, 15)
x 3
WATER PUMP PULLEY
21 (214, 15)
x 4
V-RIBBED BELT TENSIONER ASSEMBLY
23 (235, 17)
23 (235, 17)
NO. 1 IDLER PULLEY SUB-ASSEMBLY
43 (438, 32)
23 (235, 17)
x 3
FLUID COUPLING BRACKET
47 (479, 35)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

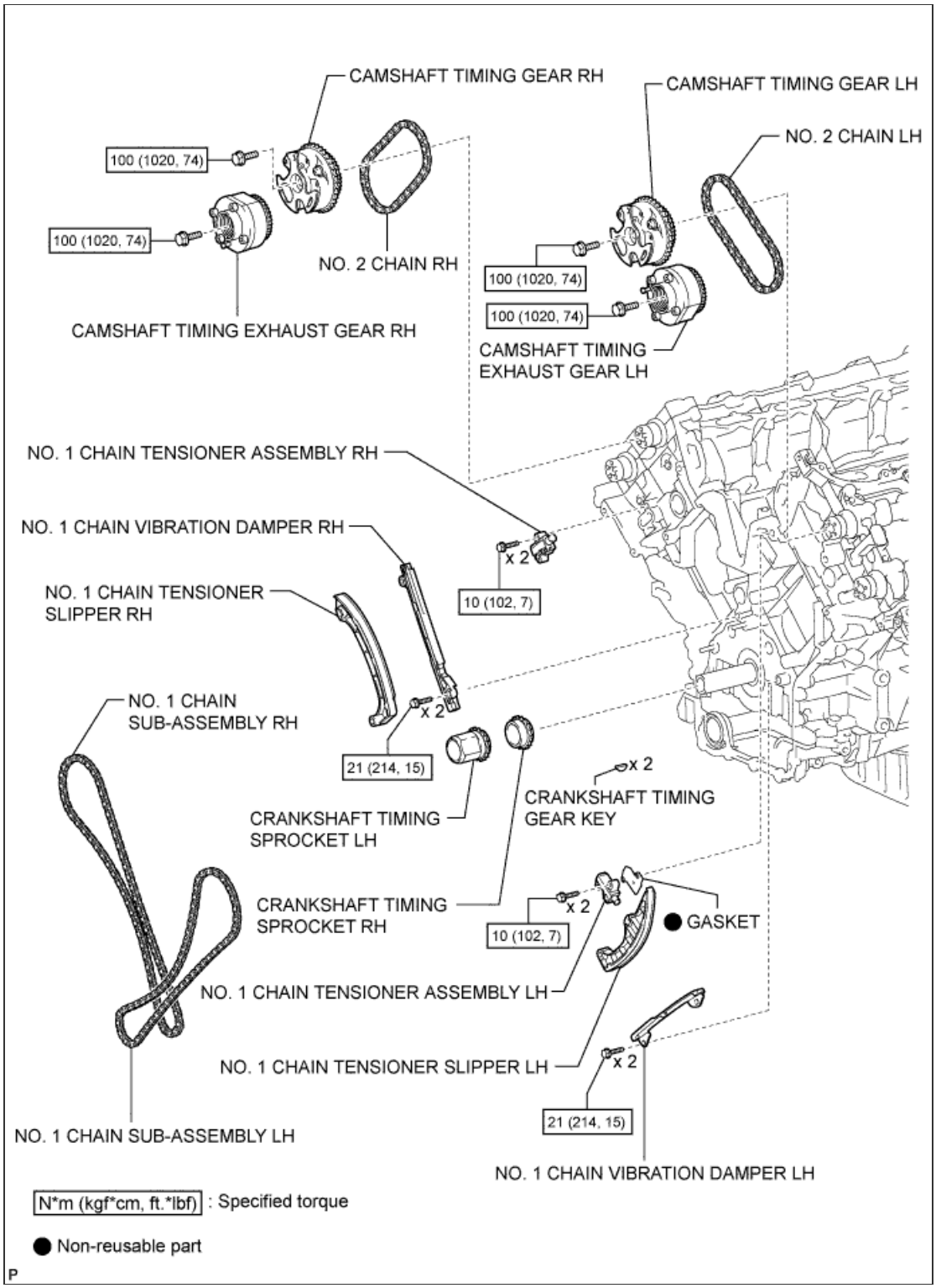

IGNITION COIL ASSEMBLY
10 (102, 7)
x 4
x 4
21 (214, 15)
SEAL WASHER
CYLINDER HEAD COVER
SUB-ASSEMBLY RH
12 (122, 9)
x 13
7.0 (71, 62 in.*lbf)
x 4
SPARK PLUG TUBE GASKET
NOISE FILTER
CYLINDER HEAD COVER GASKET RH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

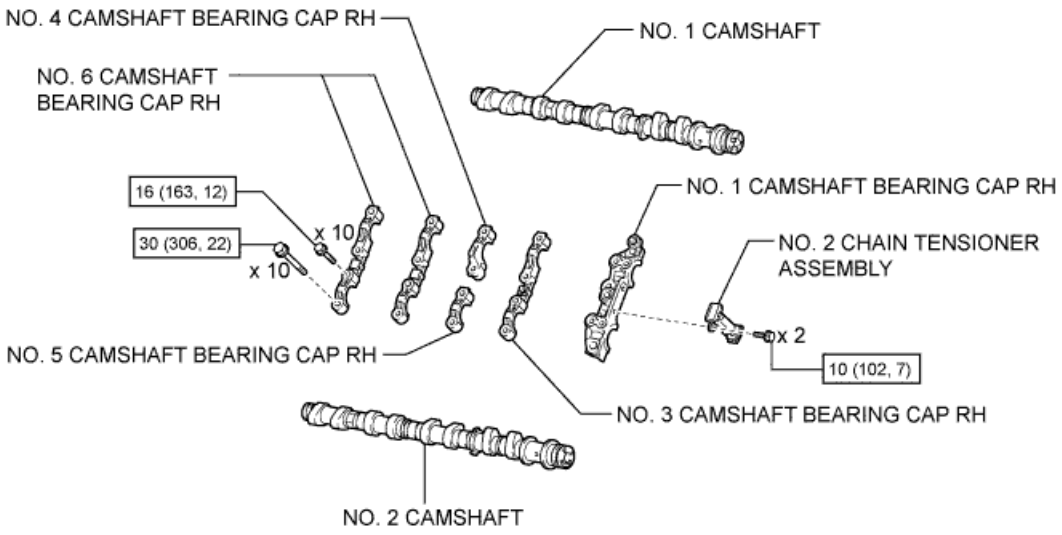
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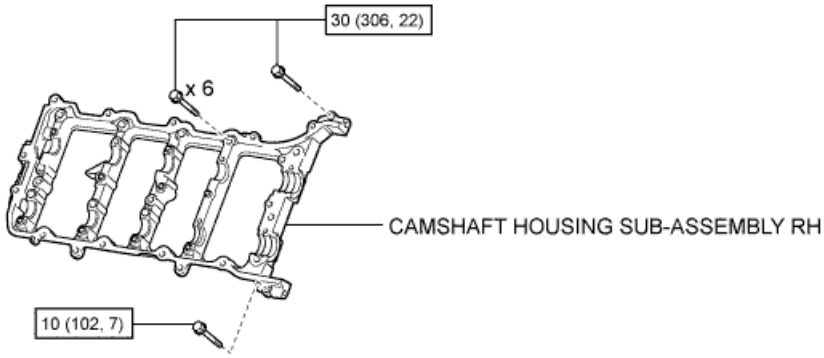

IGNITION COIL ASSEMBLY
10 (102, 7)
x 4
x 4
21 (214, 15)
SEAL WASHER
12 (122, 9)
x 13
SPARK PLUG TUBE GASKET
x 4
CYLINDER HEAD COVER SUB-ASSEMBLY LH
CYLINDER HEAD COVER GASKET LH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

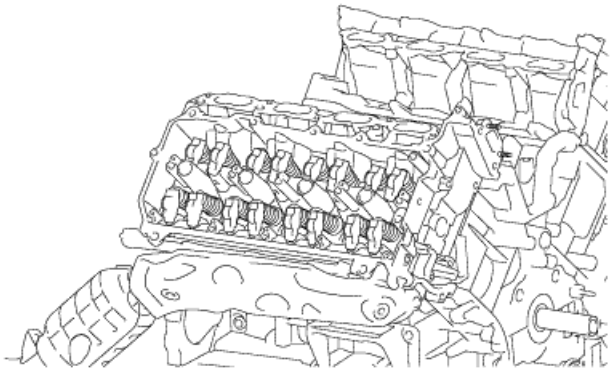
P


O-RING
WATER INLET PIPE
GASKET
O-RING
23 (235, 17)
23 (235, 17)
x 12
23 (235, 17)
47 (479, 35)
x 5
47 (479, 35)
23 (235, 17)
x 5
x 4
47 (479, 35)
CRANKSHAFT PULLEY
300 (3059, 221)
TIMING CHAIN COVER SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P


CAMSHAFT TIMING GEAR RH
CAMSHAFT TIMING GEAR LH
NO. 2 CHAIN LH
100 (1020, 74)
100 (1020, 74)
NO. 2 CHAIN RH
100 (1020, 74)
100 (1020, 74)
CAMSHAFT TIMING EXHAUST GEAR RH
CAMSHAFT TIMING EXHAUST GEAR LH
NO. 1 CHAIN TENSIONER ASSEMBLY RH
NO. 1 CHAIN VIBRATION DAMPER RH
x 2
10 (102, 7)
NO. 1 CHAIN TENSIONER SLIPPER RH
NO. 1 CHAIN SUB-ASSEMBLY RH
x 2
21 (214, 15)
x 2
CRANKSHAFT TIMING GEAR KEY
CRANKSHAFT TIMING SPROCKET LH
CRANKSHAFT TIMING SPROCKET RH
x 2
10 (102, 7)
GASKET
NO. 1 CHAIN TENSIONER ASSEMBLY LH
NO. 1 CHAIN TENSIONER SLIPPER LH
x 2
21 (214, 15)
NO. 1 CHAIN SUB-ASSEMBLY LH
NO. 1 CHAIN VIBRATION DAMPER LH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

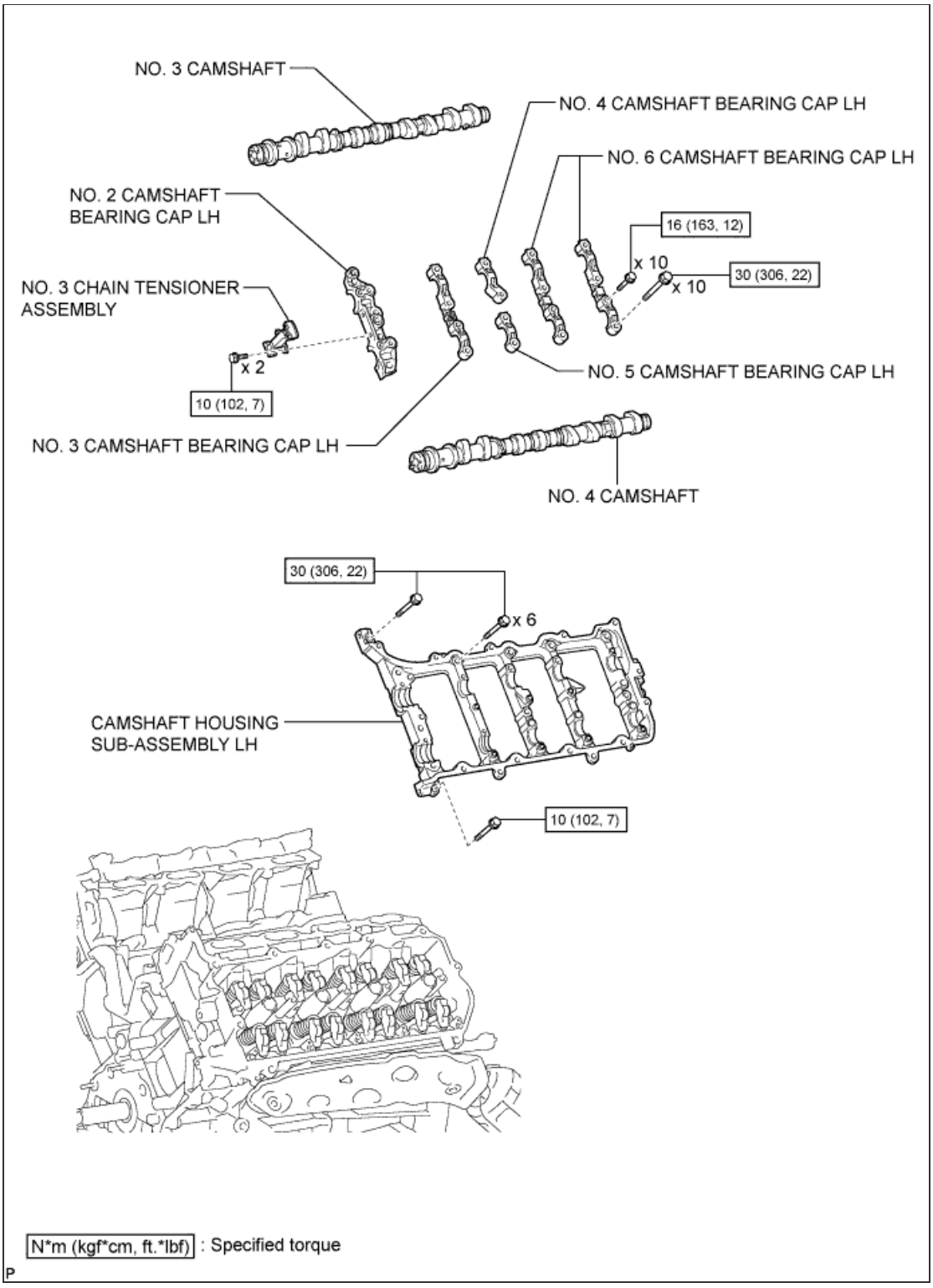






N*m (kgf*cm, ft.*lbf) : Specified torque

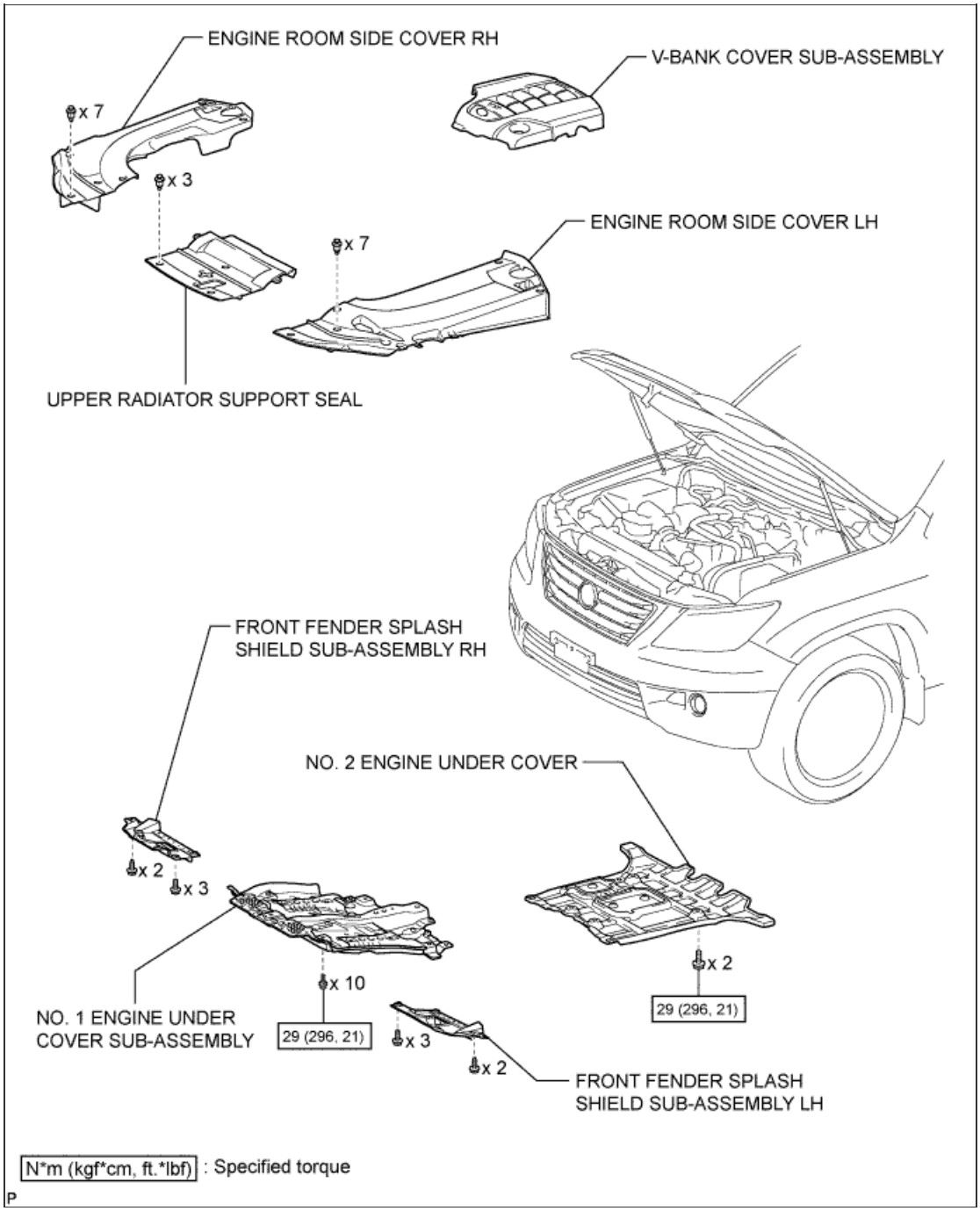
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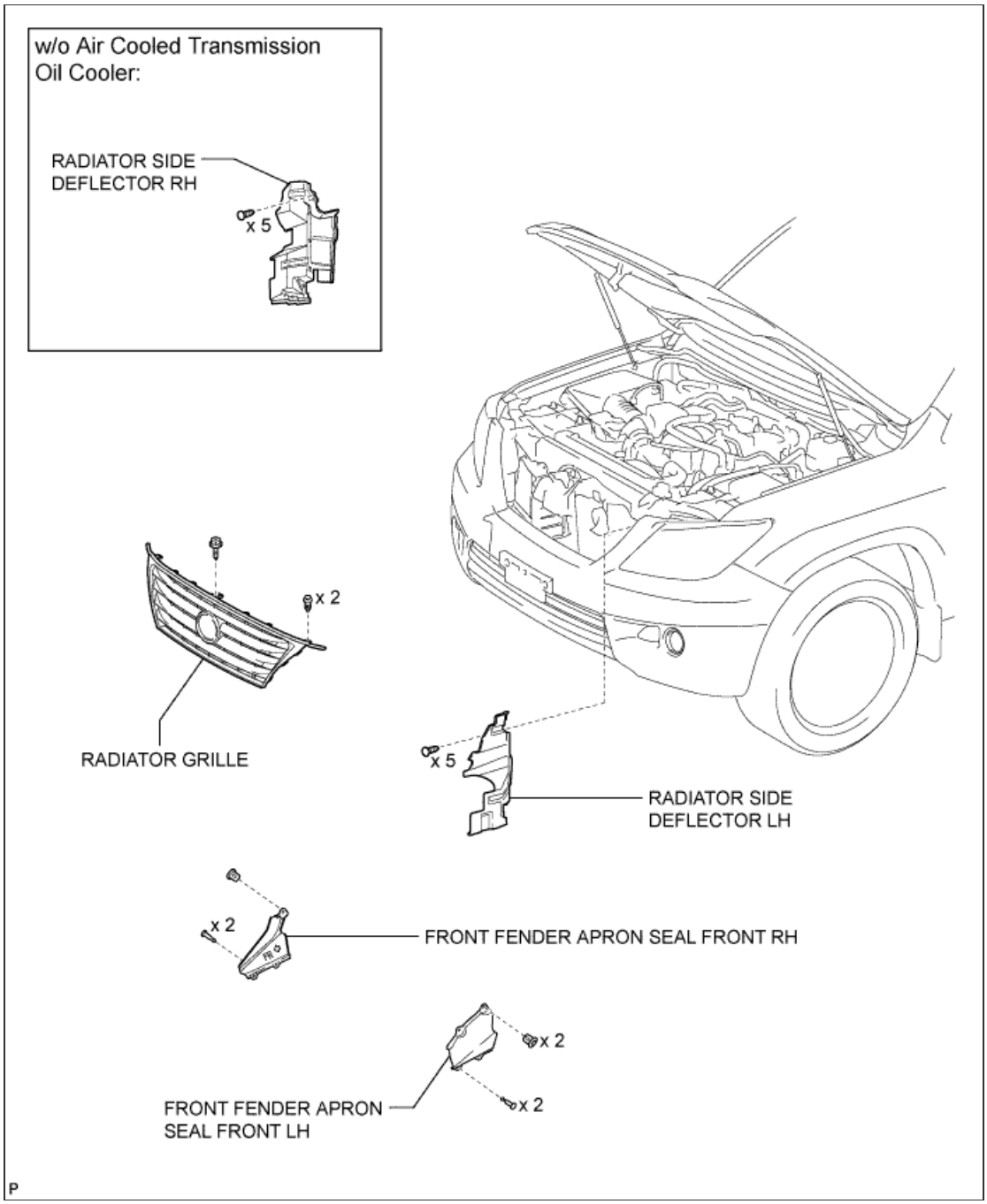


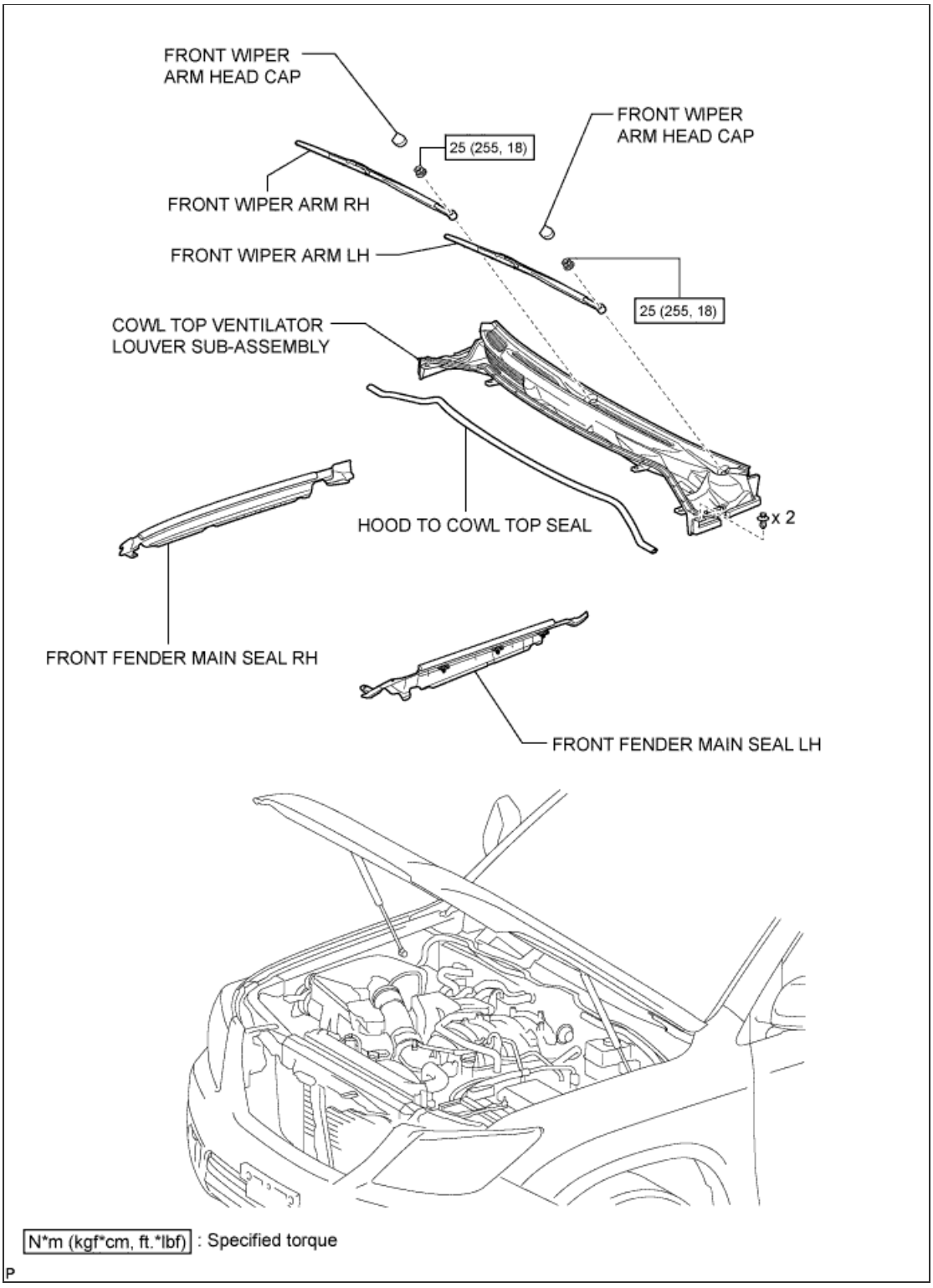
N*m (kgf*cm, ft.*lbf) : Specified torque

P

for Preparation Click here

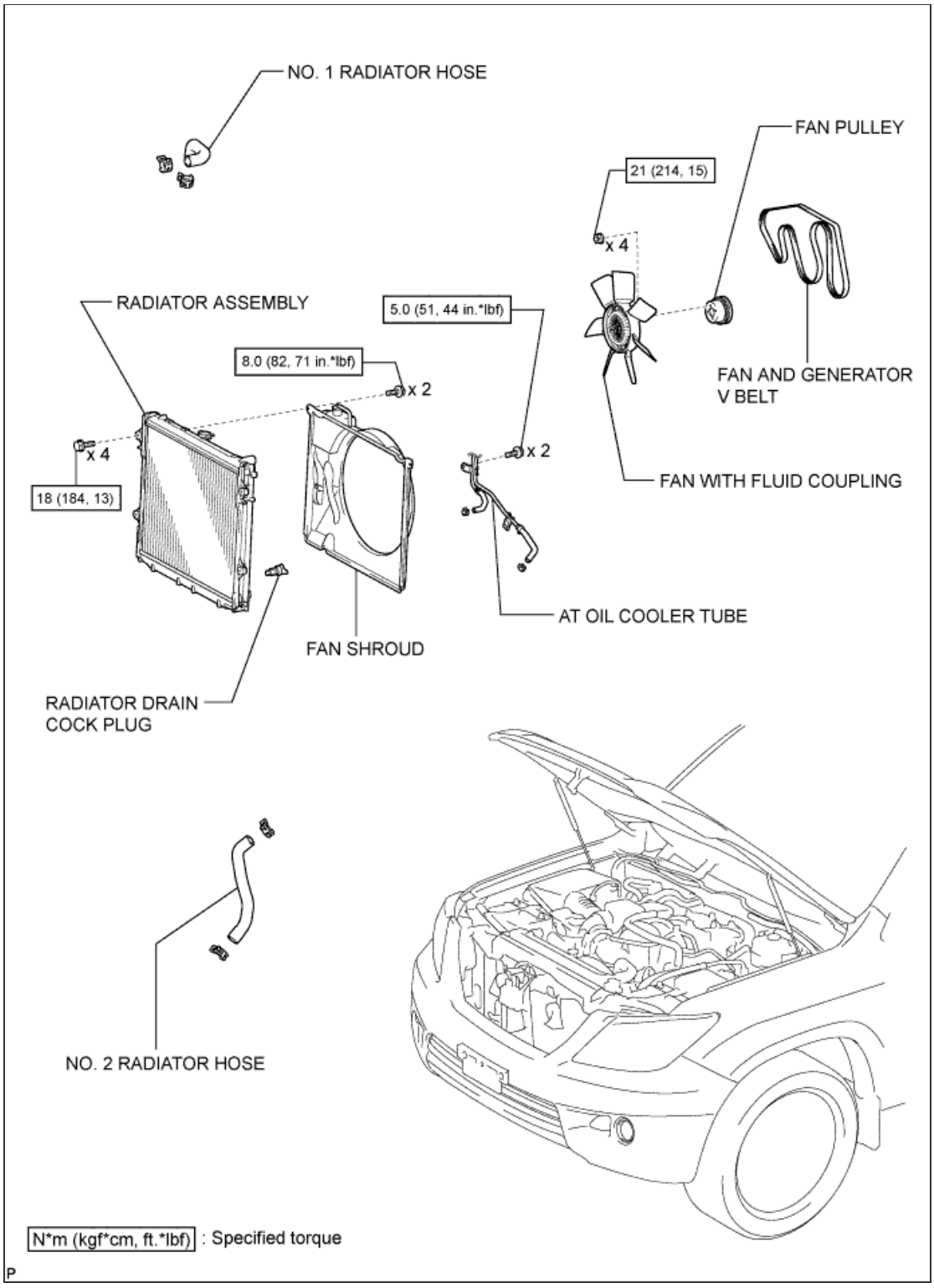


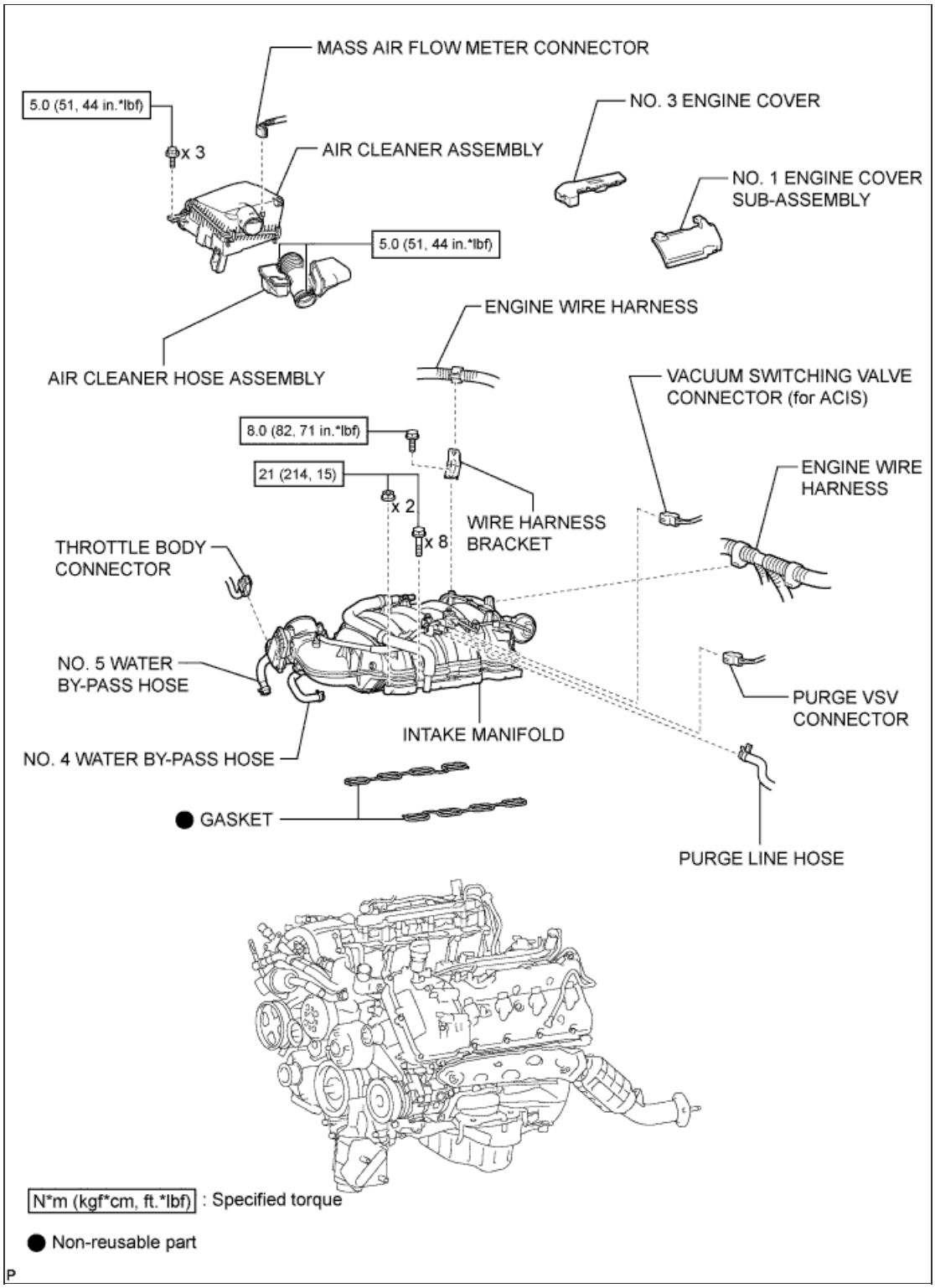

w/o Air Cooled Transmission Oil Cooler:
RADIATOR SIDE DEFLECTOR RH
x 5
x 2
RADIATOR GRILLE
x 5
RADIATOR SIDE DEFLECTOR LH
x 2
FRONT FENDER APRON SEAL FRONT RH
x 2
x 2
FRONT FENDER APRON SEAL FRONT LH
P

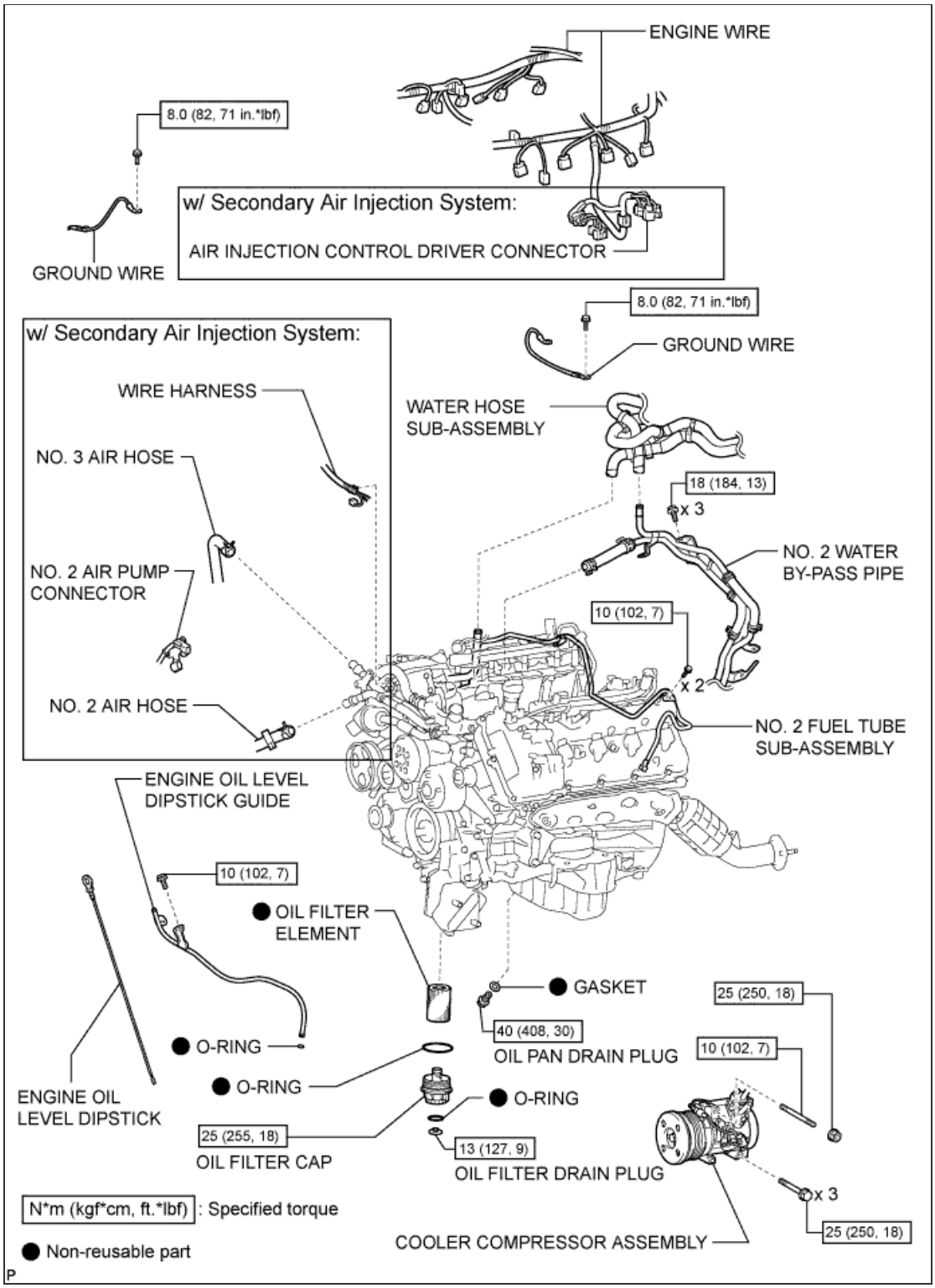


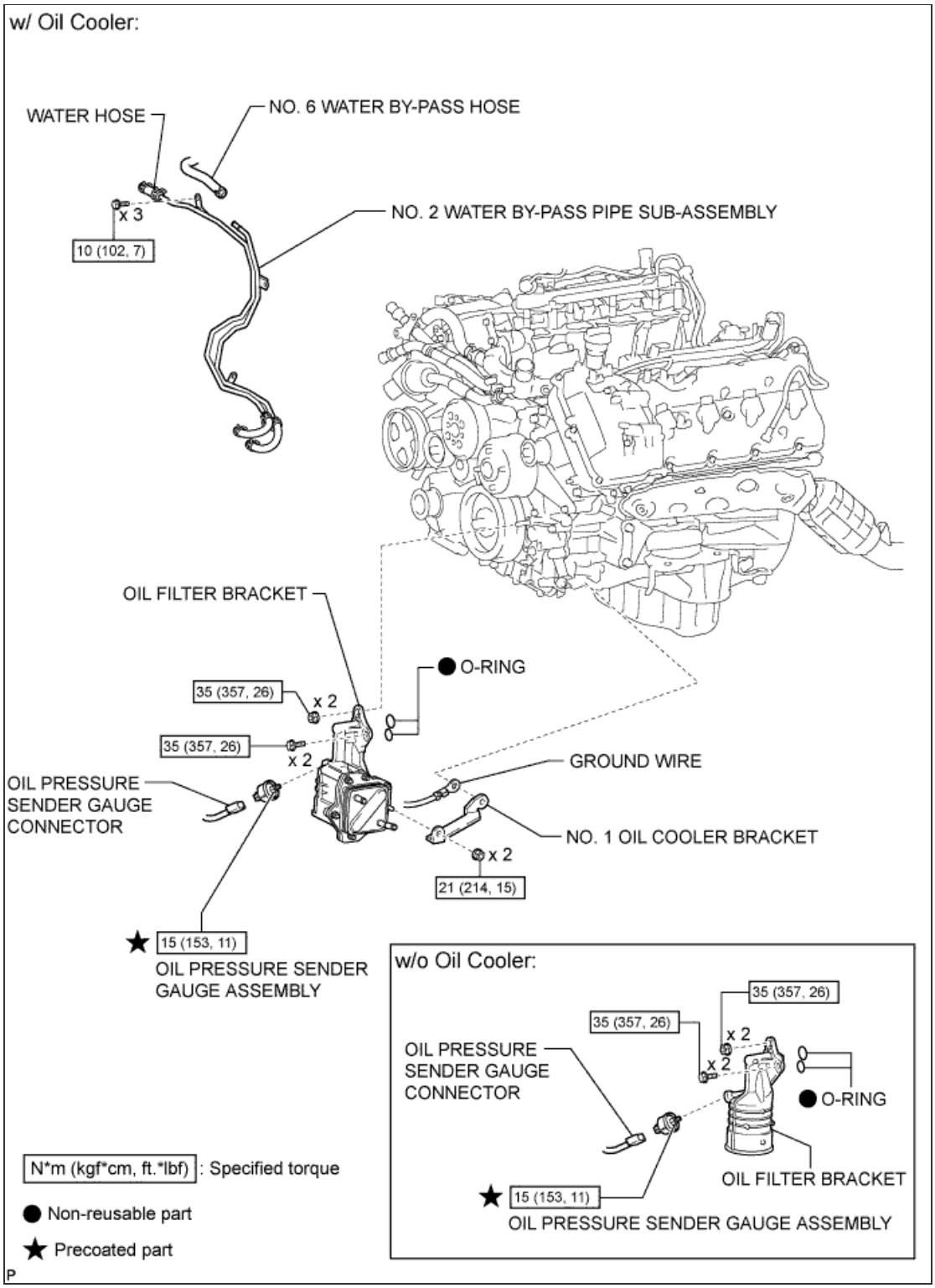
N*m (kgf*cm, ft.*lbf) : Specified torque

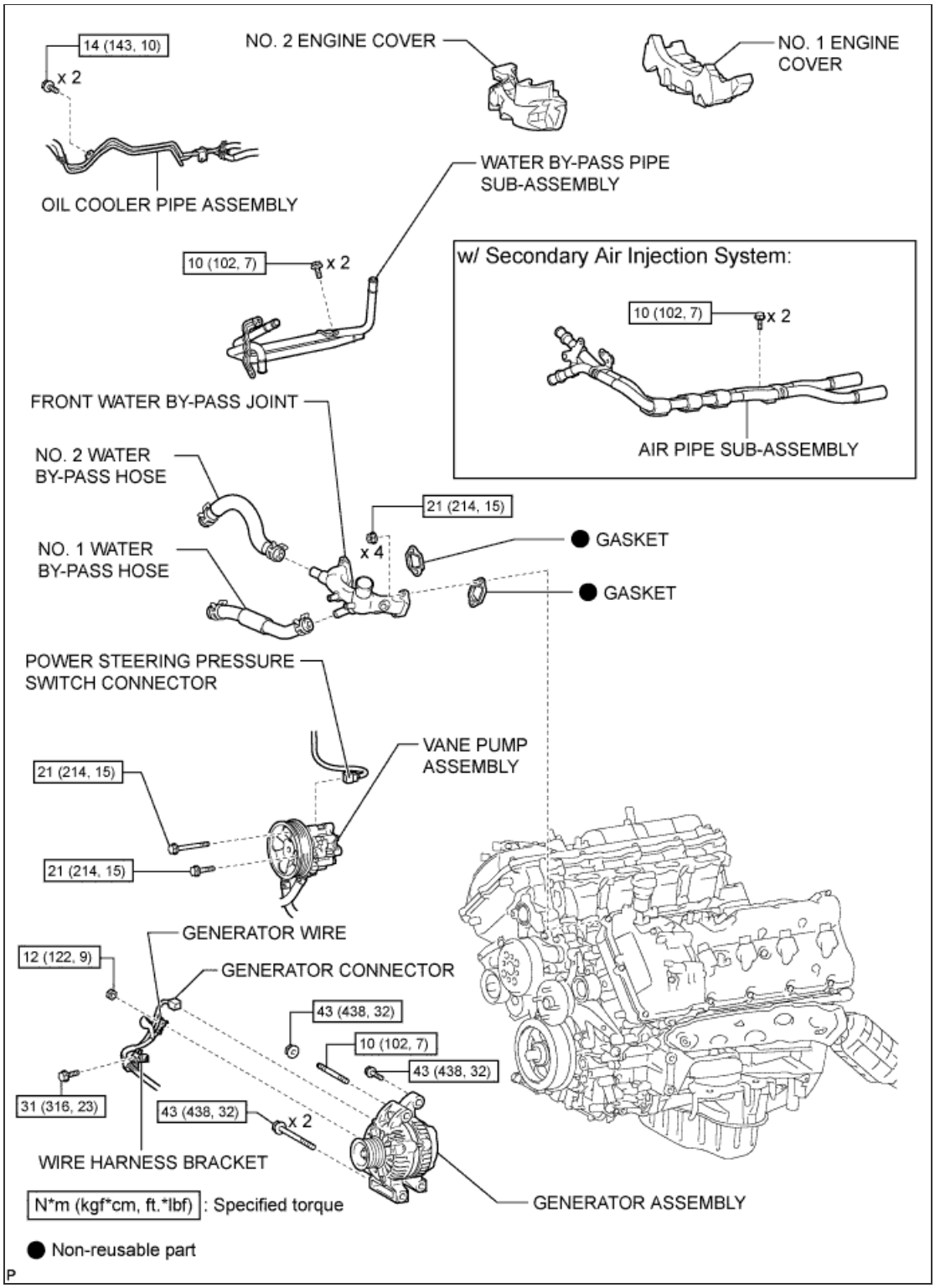
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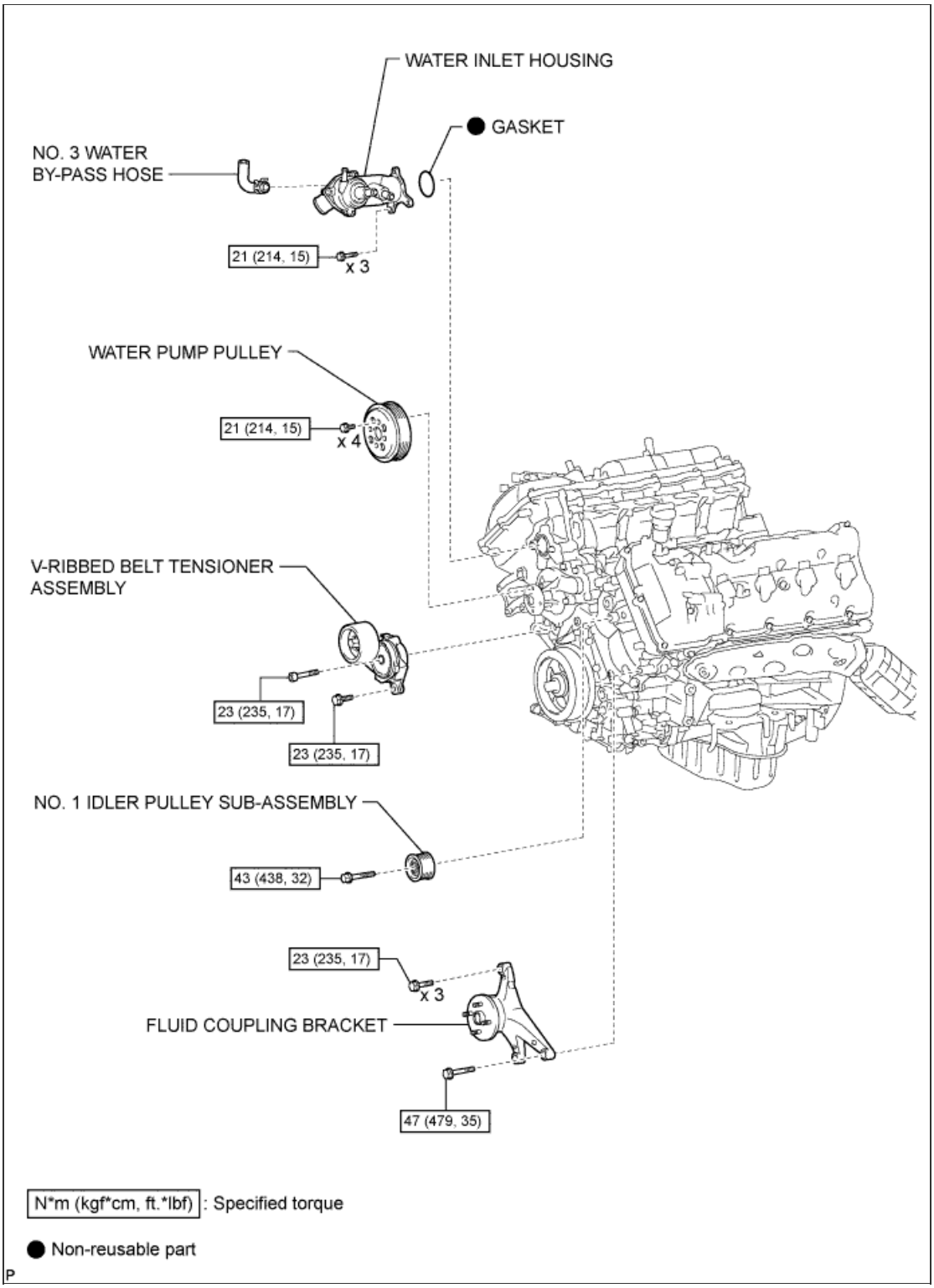

NO. 1 RADIATOR HOSE
FAN PULLEY
21 (214, 15)
x 4
RADIATOR ASSEMBLY
5.0 (51, 44 in.*lbf)
8.0 (82, 71 in.*lbf)
x 2
FAN AND GENERATOR V BELT
x 4
x 2
18 (184, 13)
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
FAN SHROUD
RADIATOR DRAIN COCK PLUG
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P

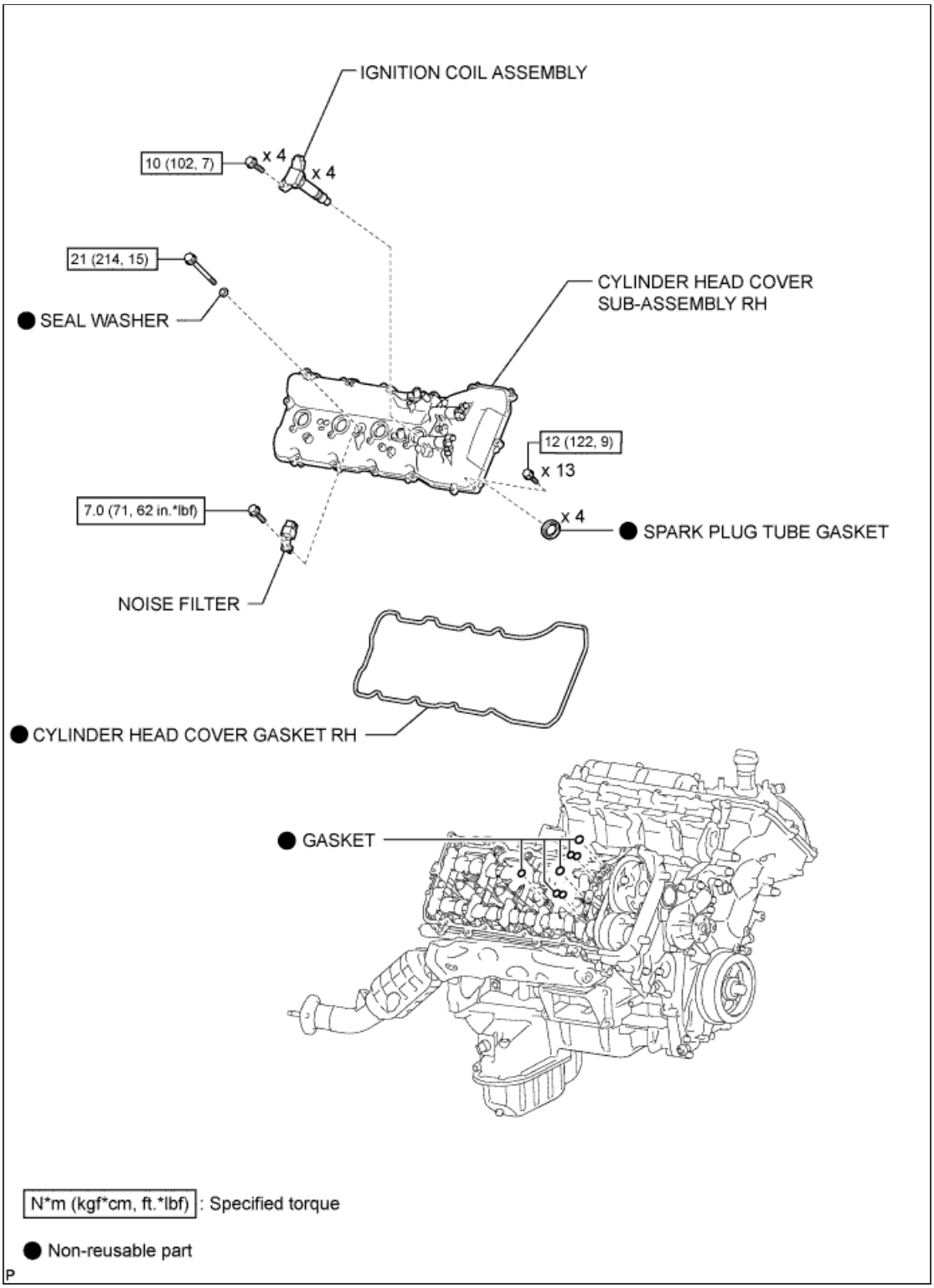

MASS AIR FLOW METER CONNECTOR
5.0 (51, 44 in.*lbf)
x 3
AIR CLEANER ASSEMBLY
NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
5.0 (51, 44 in.*lbf)
ENGINE WIRE HARNESS
AIR CLEANER HOSE ASSEMBLY
VACUUM SWITCHING VALVE CONNECTOR (for ACIS)
8.0 (82, 71 in.*lbf)
21 (214, 15)
x 2
x 8
WIRE HARNESS BRACKET
ENGINE WIRE HARNESS
THROTTLE BODY CONNECTOR
NO. 5 WATER BY-PASS HOSE
PURGE VSV CONNECTOR
INTAKE MANIFOLD
NO. 4 WATER BY-PASS HOSE
GASKET
PURGE LINE HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

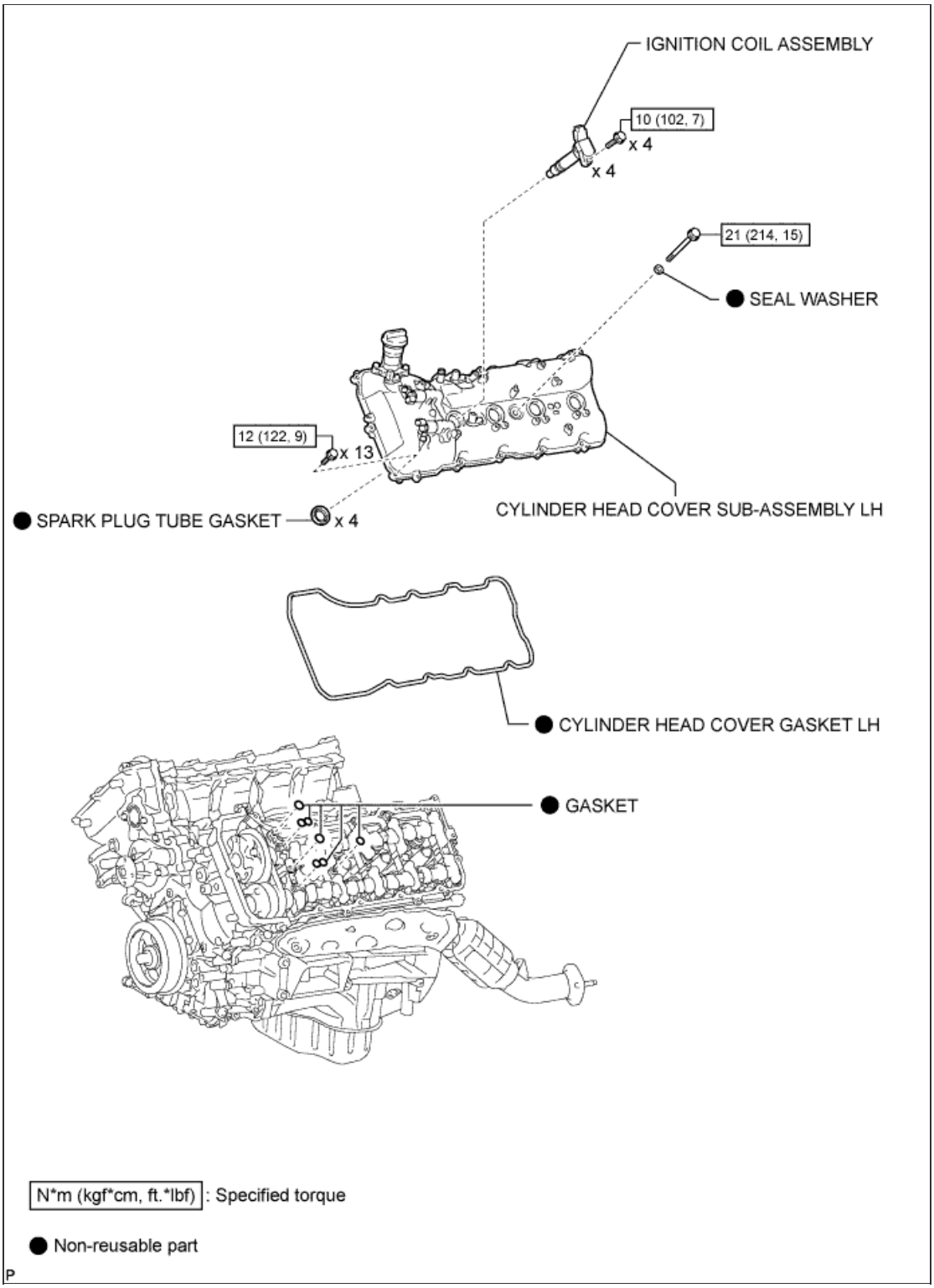

ENGINE WIRE
8.0 (82, 71 in.*lbf)
w/ Secondary Air Injection System:
AIR INJECTION CONTROL DRIVER CONNECTOR
GROUND WIRE
8.0 (82, 71 in.*lbf)
GROUND WIRE
w/ Secondary Air Injection System:
WIRE HARNESS
NO. 3 AIR HOSE
NO. 2 AIR PUMP CONNECTOR
NO. 2 AIR HOSE
WATER HOSE SUB-ASSEMBLY
18 (184, 13)
x 3
NO. 2 WATER BY-PASS PIPE
10 (102, 7)
x 2
NO. 2 FUEL TUBE SUB-ASSEMBLY
ENGINE OIL LEVEL DIPSTICK GUIDE
10 (102, 7)
OIL FILTER ELEMENT
GASKET
25 (250, 18)
40 (408, 30)
OIL PAN DRAIN PLUG
10 (102, 7)
O-RING
O-RING
O-RING
ENGINE OIL LEVEL DIPSTICK
25 (255, 18)
OIL FILTER CAP
13 (127, 9)
OIL FILTER DRAIN PLUG
x 3
25 (250, 18)
COOLER COMPRESSOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


w/ Oil Cooler:
WATER HOSE
NO. 6 WATER BY-PASS HOSE
x 3
10 (102, 7)
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
OIL FILTER BRACKET
O-RING
35 (357, 26)
x 2
35 (357, 26)
x 2
GROUND WIRE
OIL PRESSURE SENDER GAUGE CONNECTOR
NO. 1 OIL COOLER BRACKET
x 2
21 (214, 15)
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
w/o Oil Cooler:
35 (357, 26)
35 (357, 26)
x 2
x 2
OIL PRESSURE SENDER GAUGE CONNECTOR
O-RING
OIL FILTER BRACKET
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
P

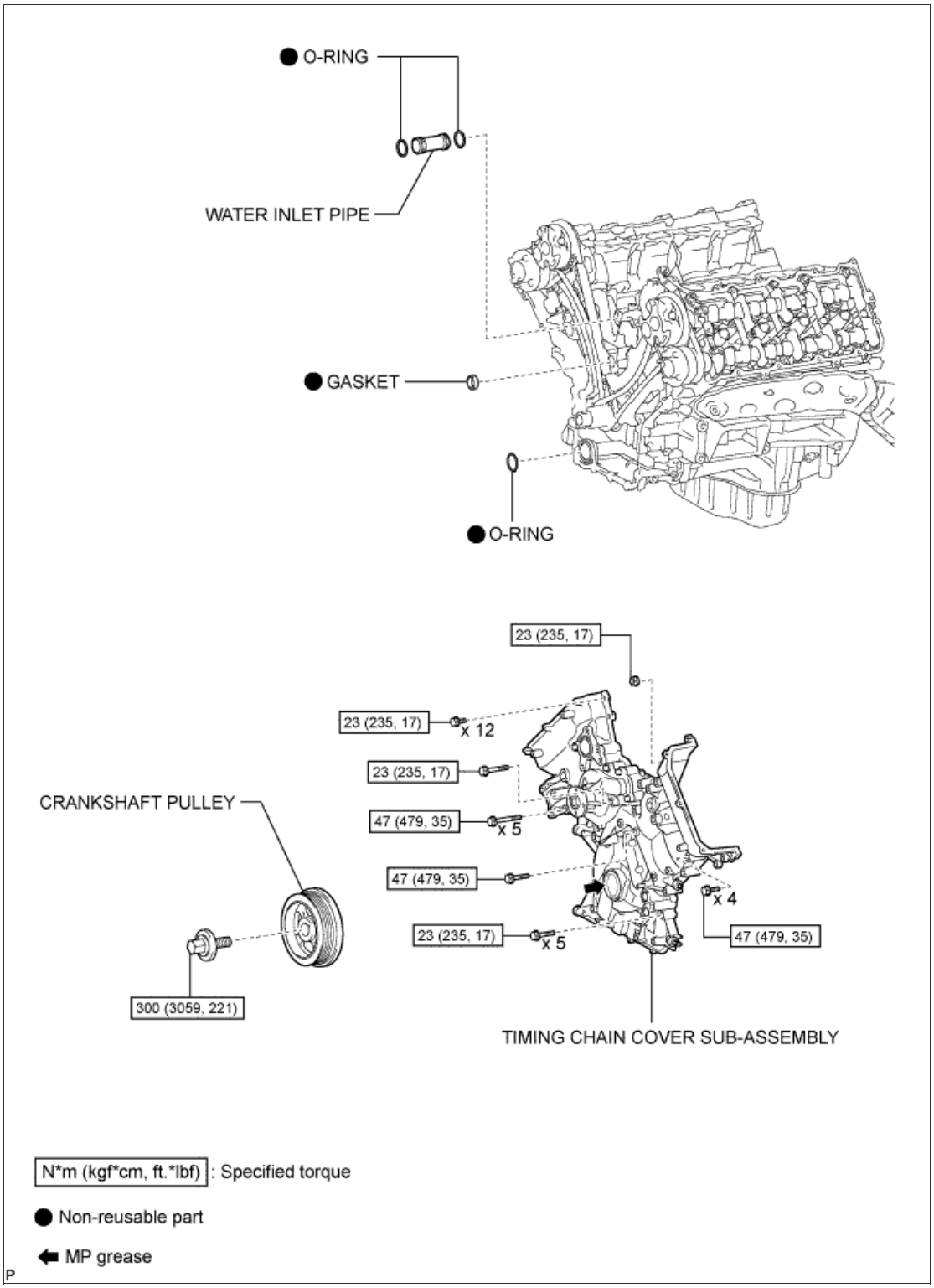

14 (143, 10)
x 2
NO. 2 ENGINE COVER
NO. 1 ENGINE COVER
OIL COOLER PIPE ASSEMBLY
WATER BY-PASS PIPE SUB-ASSEMBLY
10 (102, 7)
x 2
w/ Secondary Air Injection System:
10 (102, 7)
x 2
AIR PIPE SUB-ASSEMBLY
FRONT WATER BY-PASS JOINT
NO. 2 WATER BY-PASS HOSE
NO. 1 WATER BY-PASS HOSE
21 (214, 15)
x 4
GASKET
GASKET
POWER STEERING PRESSURE SWITCH CONNECTOR
VANE PUMP ASSEMBLY
21 (214, 15)
21 (214, 15)
GENERATOR WIRE
12 (122, 9)
GENERATOR CONNECTOR
43 (438, 32)
10 (102, 7)
43 (438, 32)
31 (316, 23)
43 (438, 32)
x 2
WIRE HARNESS BRACKET
GENERATOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

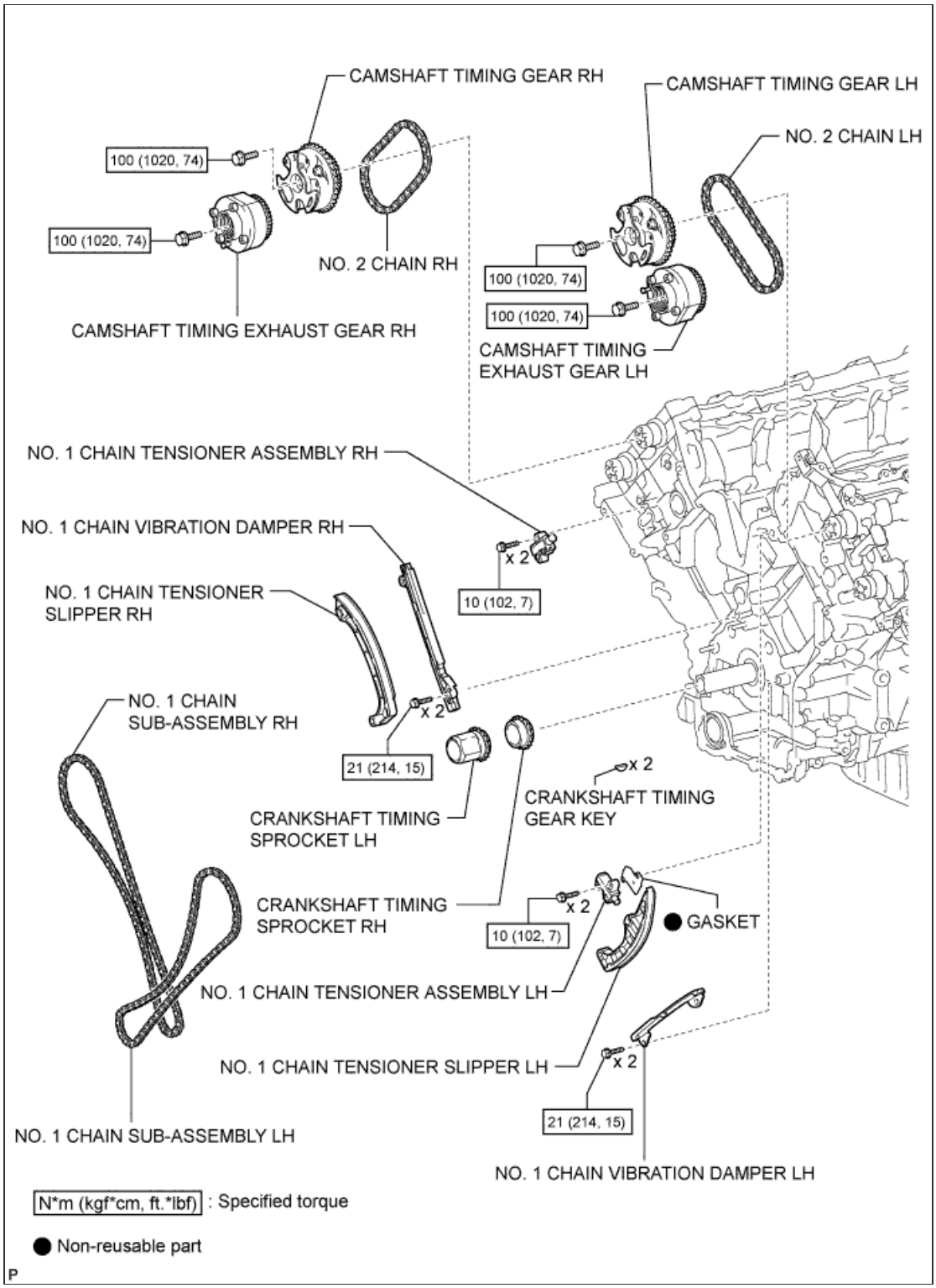

WATER INLET HOUSING
GASKET
NO. 3 WATER BY-PASS HOSE
21 (214, 15)
x 3
WATER PUMP PULLEY
21 (214, 15)
x 4
V-RIBBED BELT TENSIONER ASSEMBLY
23 (235, 17)
23 (235, 17)
NO. 1 IDLER PULLEY SUB-ASSEMBLY
43 (438, 32)
23 (235, 17)
x 3
FLUID COUPLING BRACKET
47 (479, 35)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

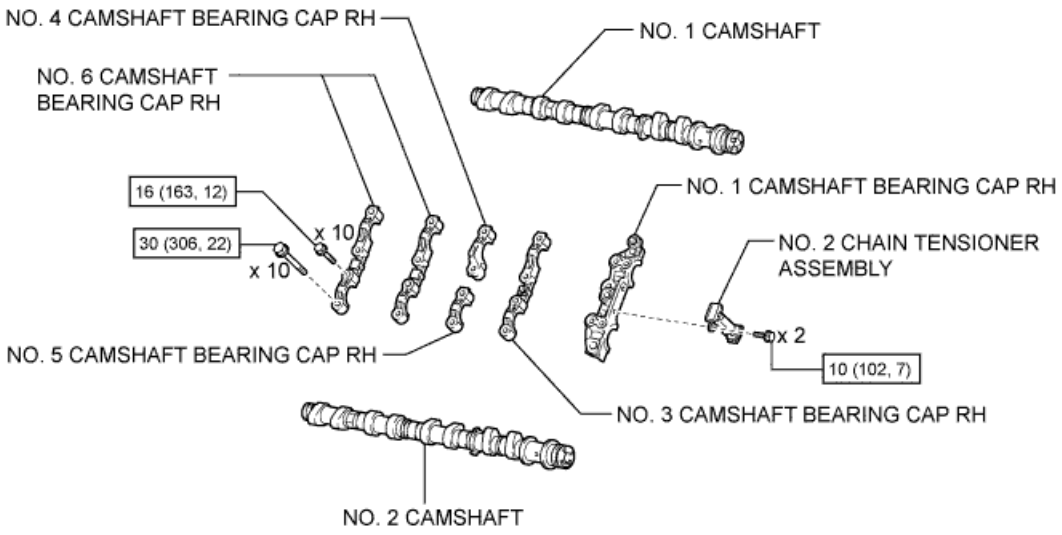

IGNITION COIL ASSEMBLY
10 (102, 7)
x 4
x 4
21 (214, 15)
SEAL WASHER
CYLINDER HEAD COVER SUB-ASSEMBLY RH
12 (122, 9)
x 13
7.0 (71, 62 in.*lbf)
x 4
SPARK PLUG TUBE GASKET
NOISE FILTER
CYLINDER HEAD COVER GASKET RH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

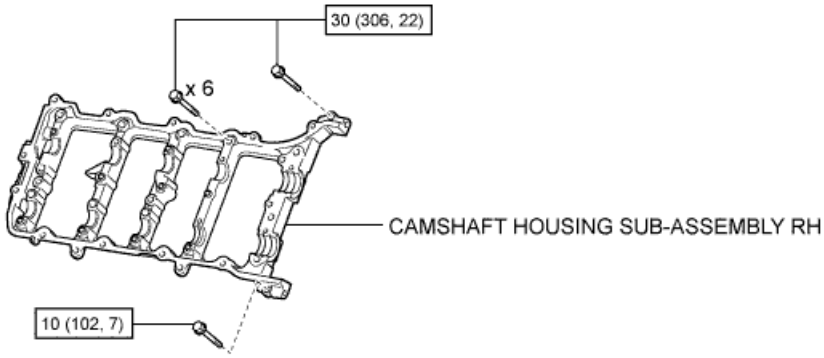

IGNITION COIL ASSEMBLY
10 (102, 7)
x 4
x 4
21 (214, 15)
SEAL WASHER
12 (122, 9)
x 13
SPARK PLUG TUBE GASKET
x 4
CYLINDER HEAD COVER SUB-ASSEMBLY LH
CYLINDER HEAD COVER GASKET LH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

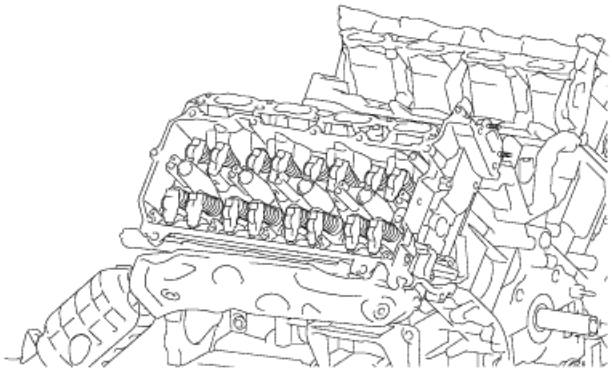
P


O-RING
WATER INLET PIPE
GASKET
O-RING
23 (235, 17)
23 (235, 17)
x 12
23 (235, 17)
47 (479, 35)
x 5
47 (479, 35)
23 (235, 17)
x 5
x 4
47 (479, 35)
CRANKSHAFT PULLEY
300 (3059, 221)
TIMING CHAIN COVER SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P


CAMSHAFT TIMING GEAR RH
CAMSHAFT TIMING GEAR LH
NO. 2 CHAIN LH
100 (1020, 74)
100 (1020, 74)
NO. 2 CHAIN RH
100 (1020, 74)
100 (1020, 74)
CAMSHAFT TIMING EXHAUST GEAR RH
CAMSHAFT TIMING EXHAUST GEAR LH
NO. 1 CHAIN TENSIONER ASSEMBLY RH
NO. 1 CHAIN VIBRATION DAMPER RH
x 2
10 (102, 7)
NO. 1 CHAIN TENSIONER SLIPPER RH
NO. 1 CHAIN SUB-ASSEMBLY RH
x 2
21 (214, 15)
x 2
CRANKSHAFT TIMING GEAR KEY
CRANKSHAFT TIMING SPROCKET LH
CRANKSHAFT TIMING SPROCKET RH
x 2
10 (102, 7)
GASKET
NO. 1 CHAIN TENSIONER ASSEMBLY LH
NO. 1 CHAIN TENSIONER SLIPPER LH
x 2
21 (214, 15)
NO. 1 CHAIN SUB-ASSEMBLY LH
NO. 1 CHAIN VIBRATION DAMPER LH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

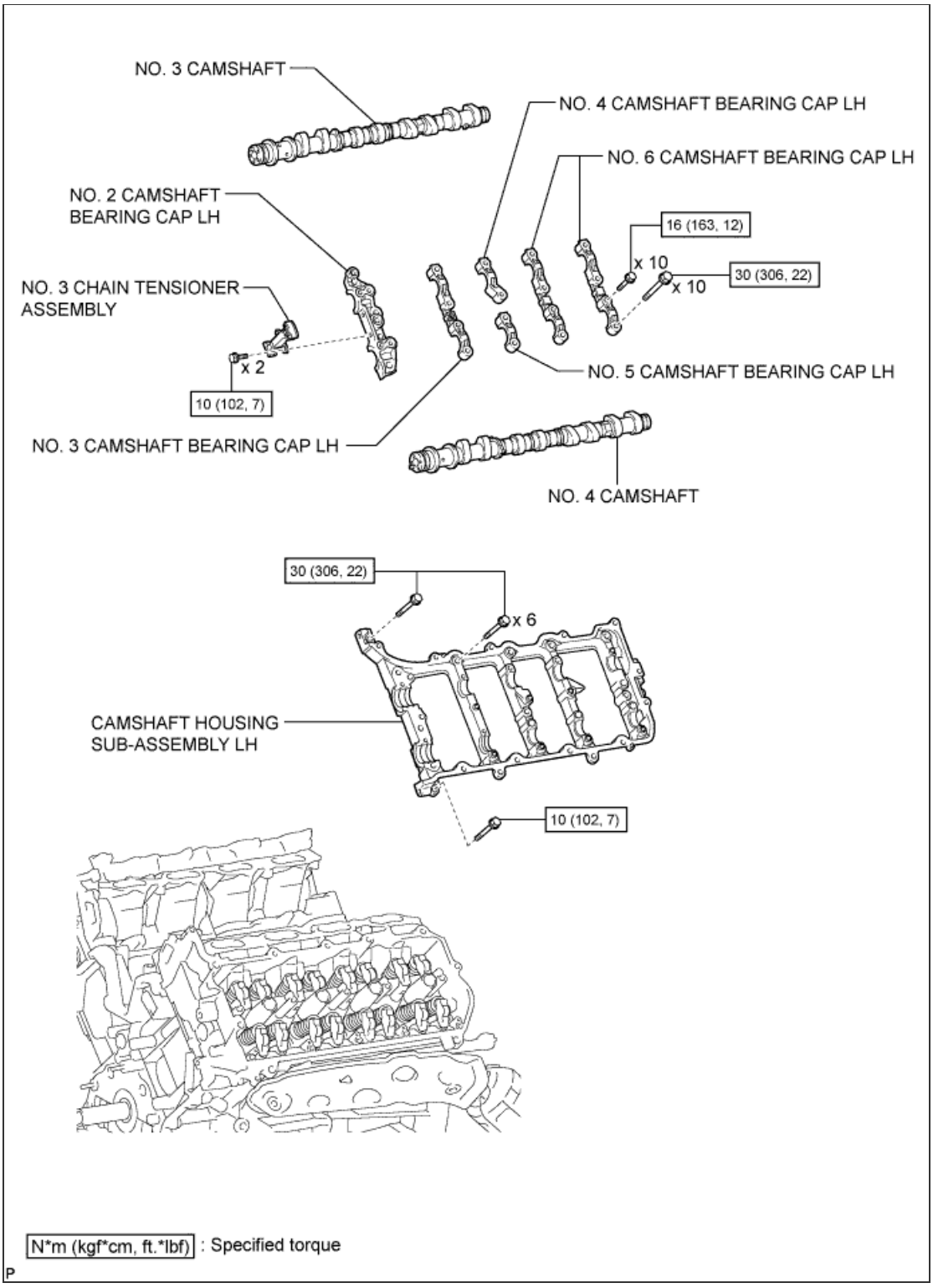






N*m (kgf*cm, ft.*lbf) : Specified torque

P



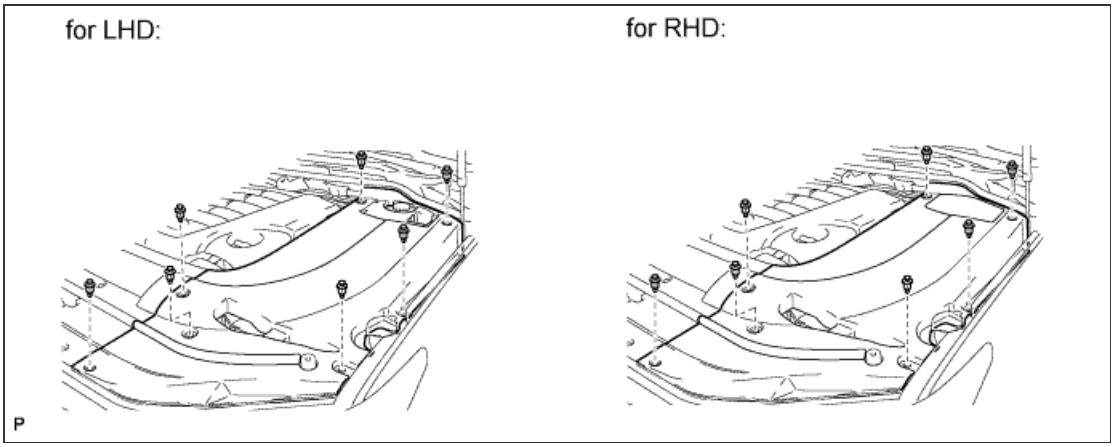
N*m (kgf*cm, ft.*lbf) : Specified torque

P

for Preparation Click here

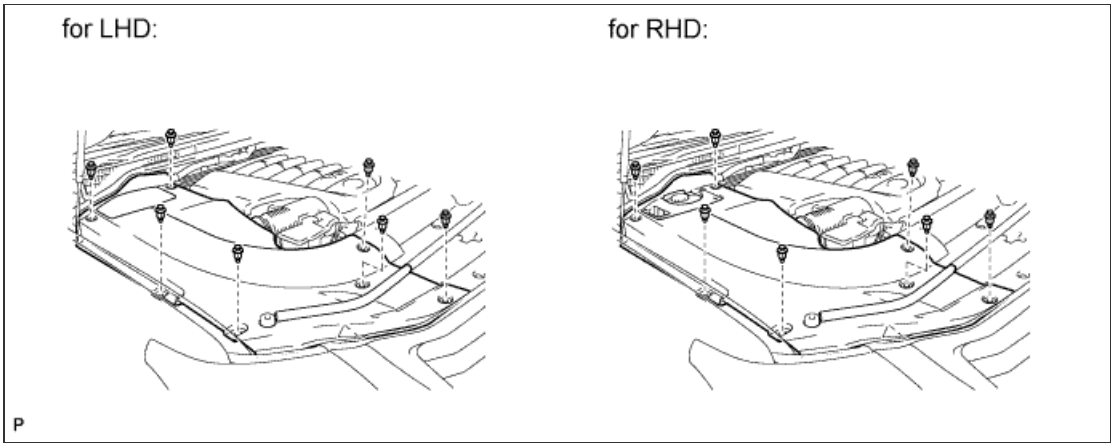
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



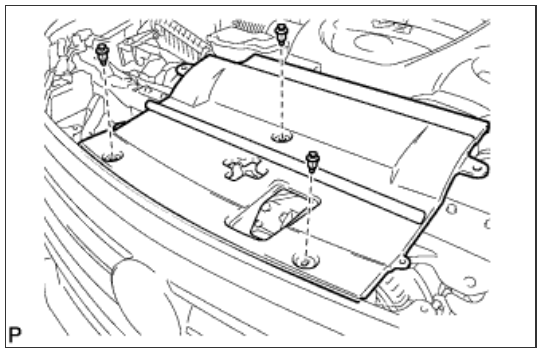
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



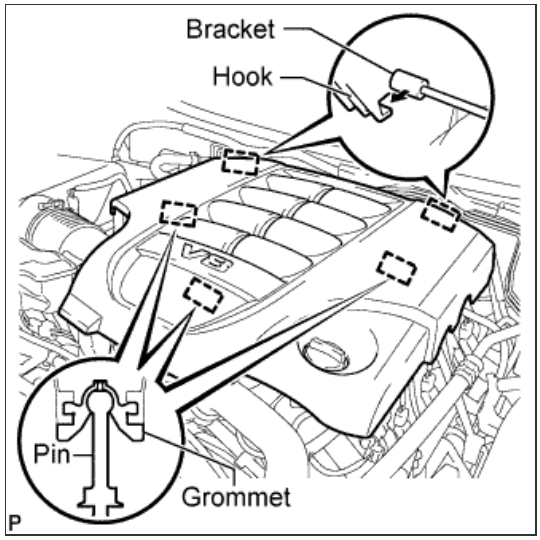
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

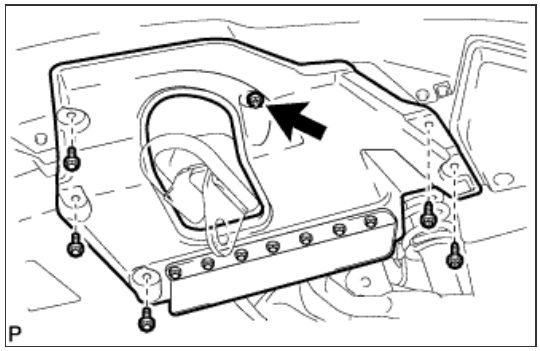
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

7. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



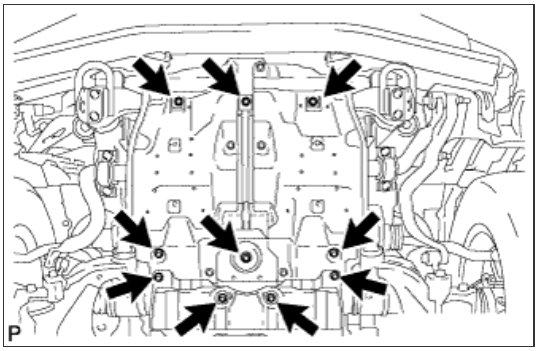
8. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

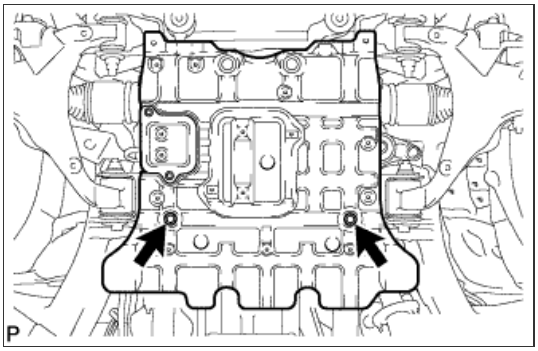
9. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



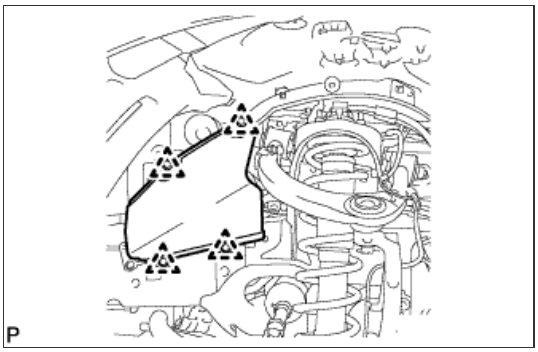
10. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



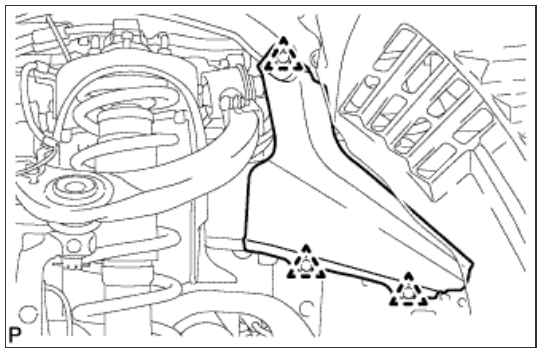
11. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



12. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.



13. REMOVE RADIATOR GRILLE

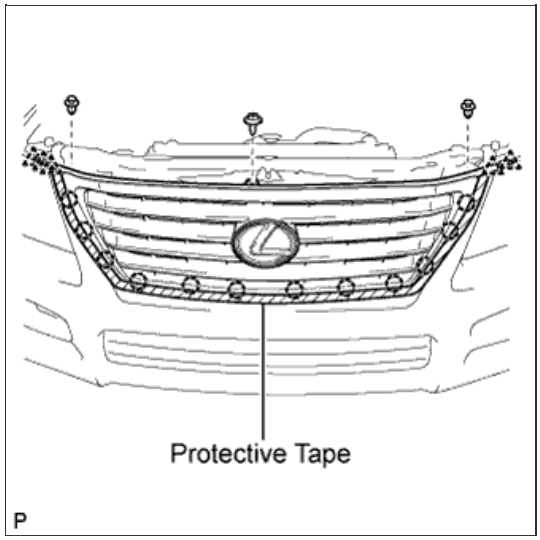
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

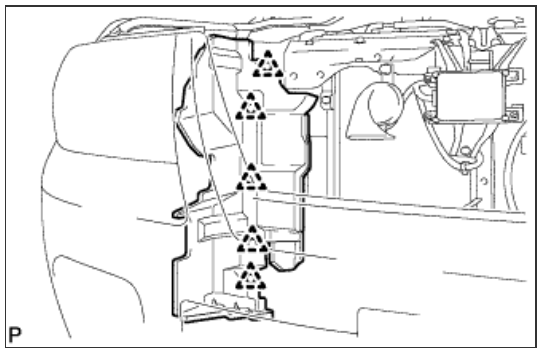
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



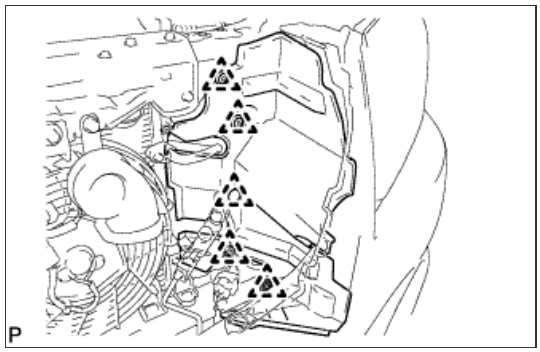
14. REMOVE RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



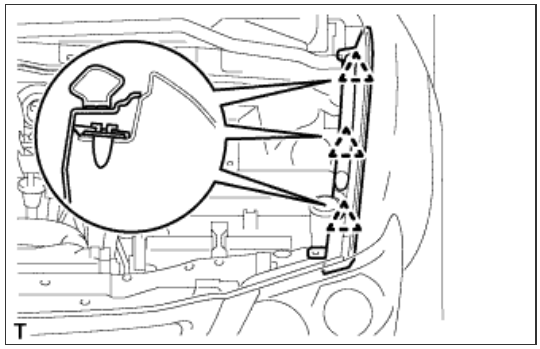
15. REMOVE RADIATOR SIDE DEFLECTOR LH

a. Using a clip remover, remove the 5 clips and side deflector.



16. REMOVE FRONT FENDER MAIN SEAL LH

a. Using a clip remover, detach the 3 clips and remove the fender main seal.



17. REMOVE FRONT FENDER MAIN SEAL RH

HINT:

Use the same procedures described for the LH side.

18. REMOVE FRONT WIPER ARM LH

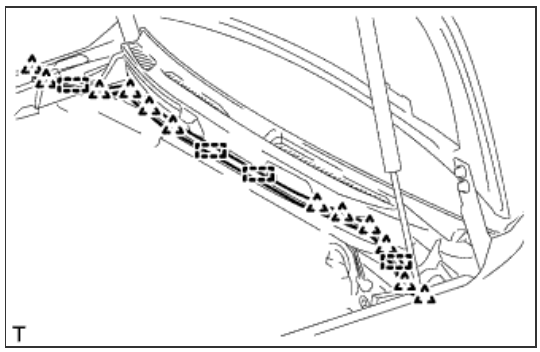
a. Remove the nut, wiper arm and blade.

19. REMOVE FRONT WIPER ARM RH

a. Remove the nut, wiper arm and blade.

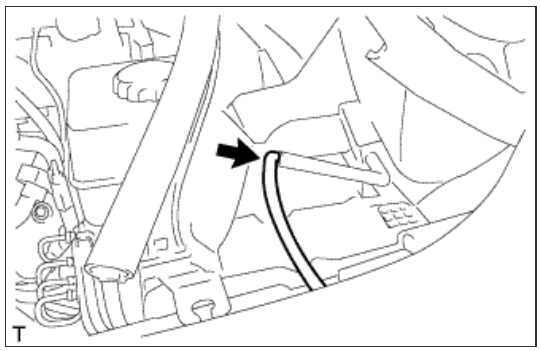
20. REMOVE HOOD TO COWL TOP SEAL

a. Using a clip remover, detach the 12 clips and 4 clamps, and remove the hood to cowl top seal.



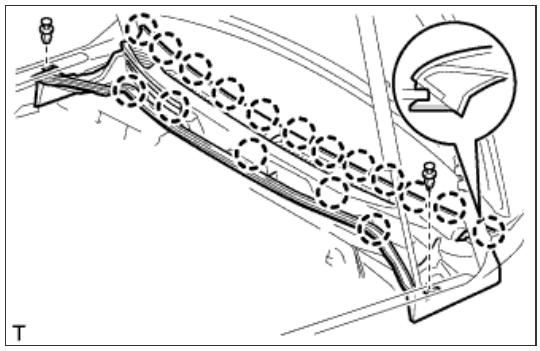
21. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Disconnect the washer hose.



b. Remove the 2 clips.

c. Detach the 17 claws and remove the cowl top ventilator louver sub-assembly.



22. DRAIN ENGINE OIL

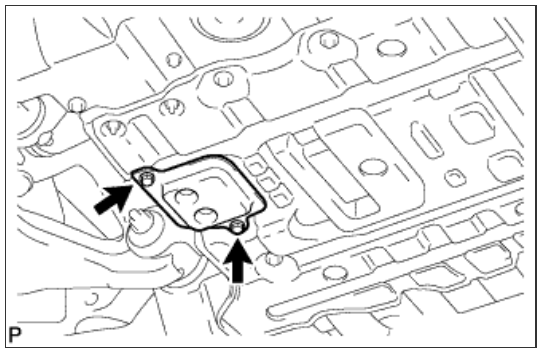
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

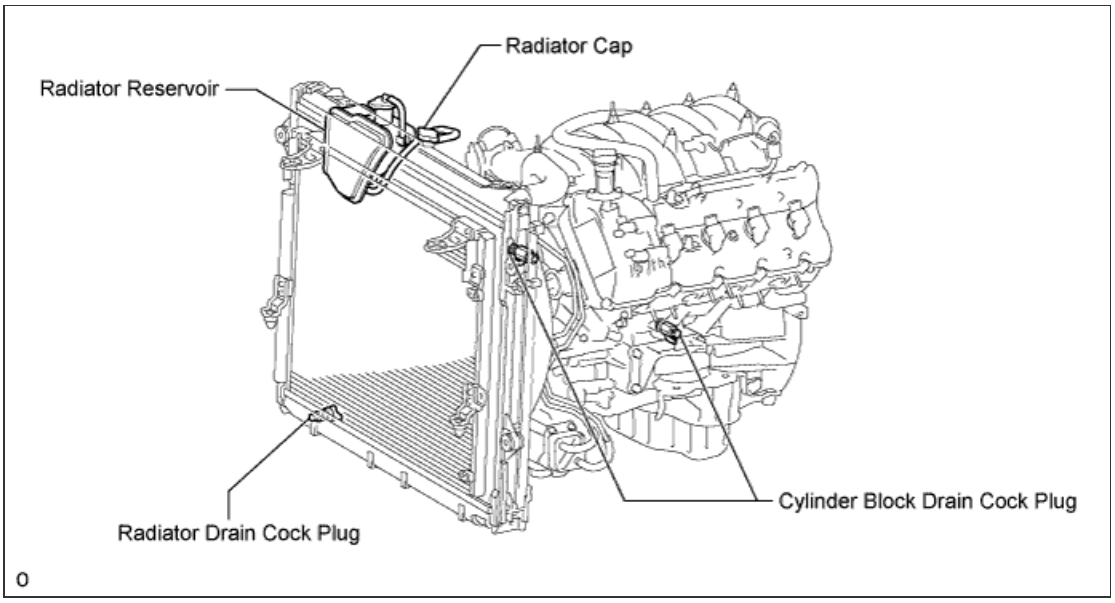
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



23. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

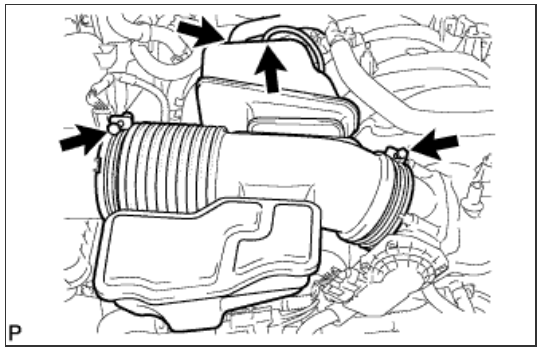
e. Tighten the radiator drain cock plug by hand.

24. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

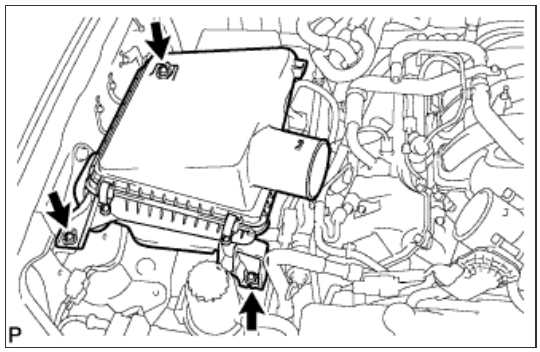
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



25. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



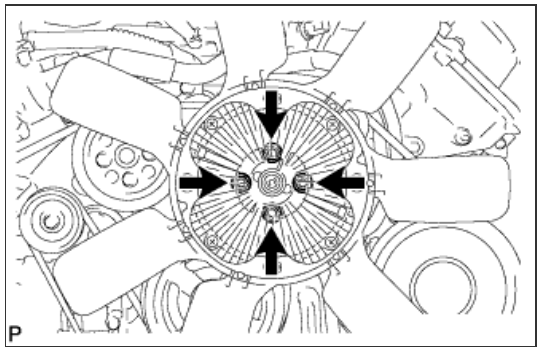
26. REMOVE NO. 1 RADIATOR HOSE

27. REMOVE NO. 2 RADIATOR HOSE

28. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

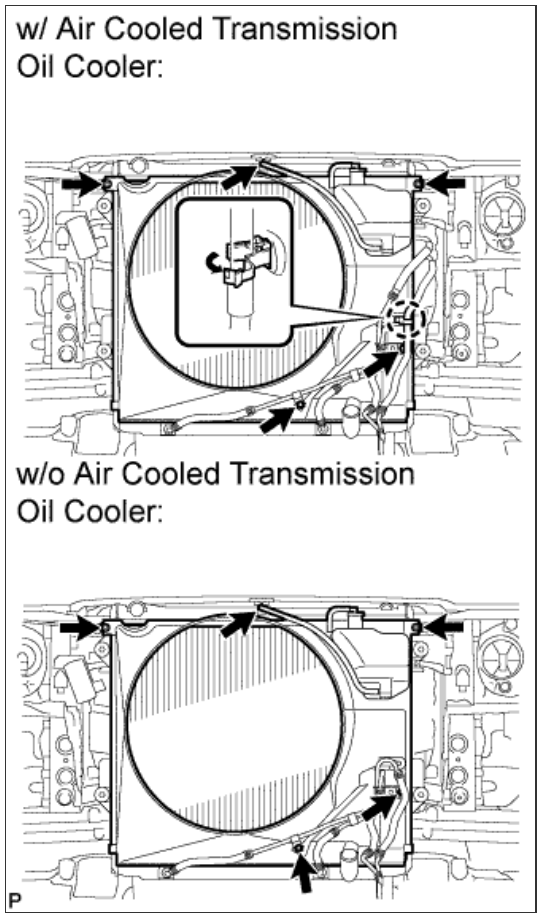
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

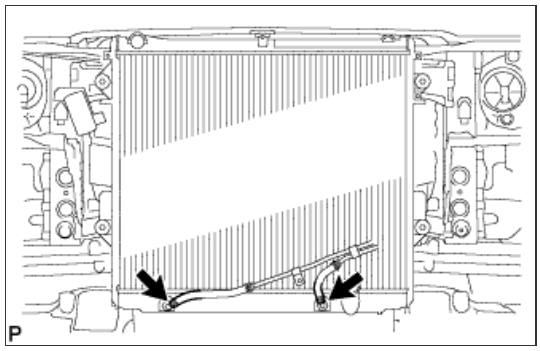
Be careful not to damage the radiator core.

h. Remove the fan pulley.

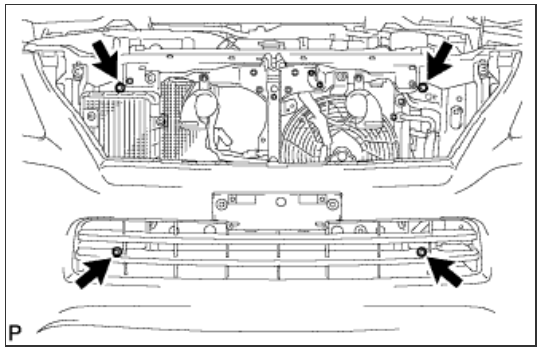


29. REMOVE RADIATOR ASSEMBLY

a. Disconnect the 2 oil cooler hoses.



b. Remove the 4 bolts and radiator.

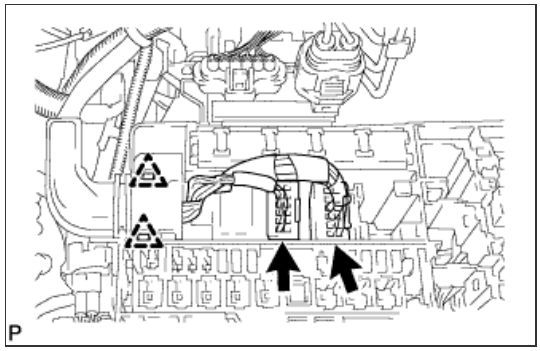


30. DISCONNECT ENGINE WIRE

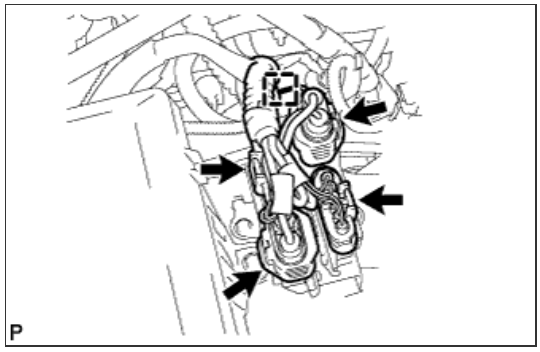
a. Engine Room LH Side:

i. Remove the engine room relay block cover.

ii. Disconnect the 2 connectors and 2 clips from the engine room junction block.



iii. Disconnect the 4 air injection control driver connectors and wire harness clamp.



iv. Disconnect the injector connector.

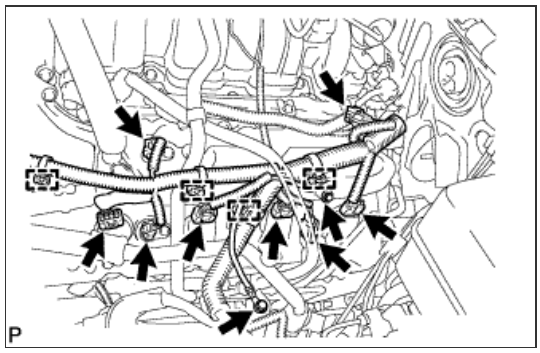
v. Disconnect the 4 ignition coil connectors.

vi. Disconnect the 2 VVT sensor connectors.

vii. Disconnect the 4 clamps.

viii. Remove the 2 bolts and ground wire.

ix. Disconnect the noise filter connector.



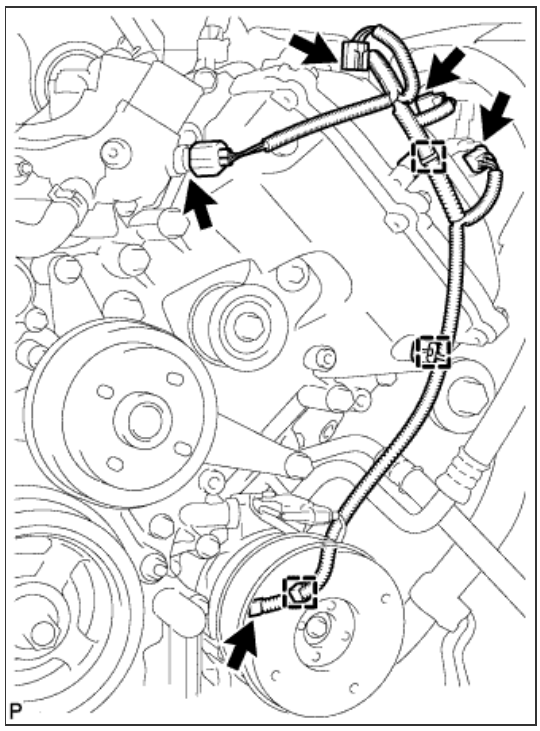
x. Disconnect the engine coolant temperature sensor connector.

xi. Disconnect the 2 camshaft timing oil control valve connectors.

xii. Disconnect the camshaft position sensor connector.

xiii. Disconnect the 3 clamps.

xiv. Disconnect the cooler compressor connector.



b. Engine Room RH Side:

i. Disconnect the 2 camshaft timing oil control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the injector connector.

iv. Disconnect the 2 VVT sensor connectors.

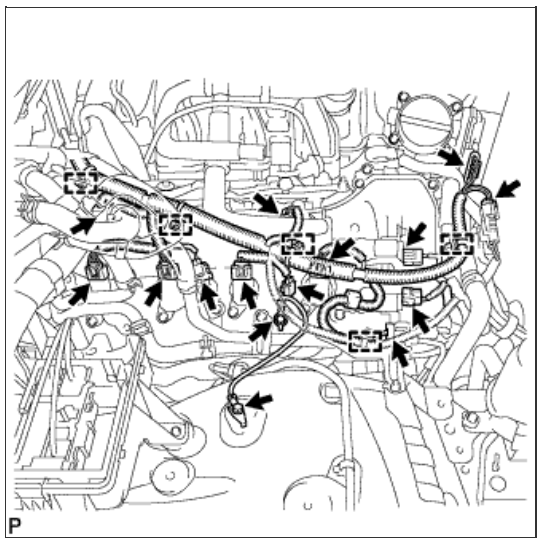
v. Disconnect the noise filter connector.

vi. Remove the 2 bolts and ground wire.

vii. Disconnect the 2 air pump connectors.

viii. Disconnect the throttle position sensor and throttle control motor connector.

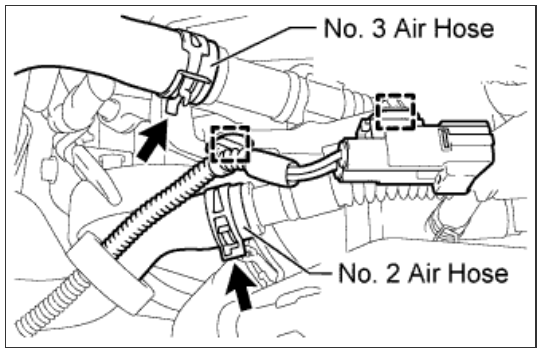
ix. Disconnect the 5 clamps.



31. DISCONNECT AIR PUMP HOSE AND WIRE HARNESS

a. Disconnect the No. 2 and No. 3 air hoses.

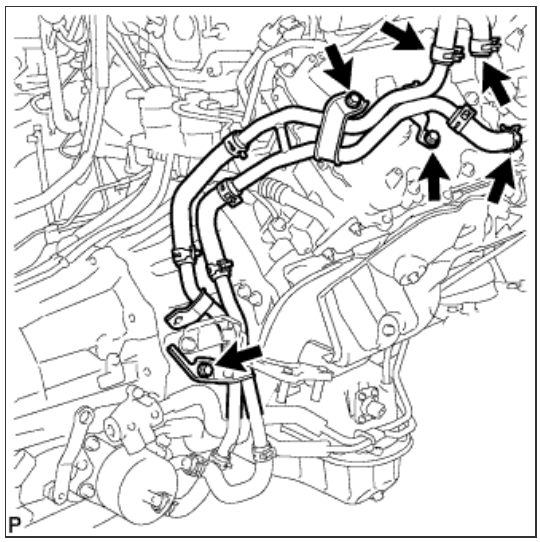
b. Disconnect the 2 clamps.



32. DISCONNECT NO. 2 WATER BY-PASS PIPE

a. Disconnect the 3 hoses.

b. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe from the cylinder head cover.

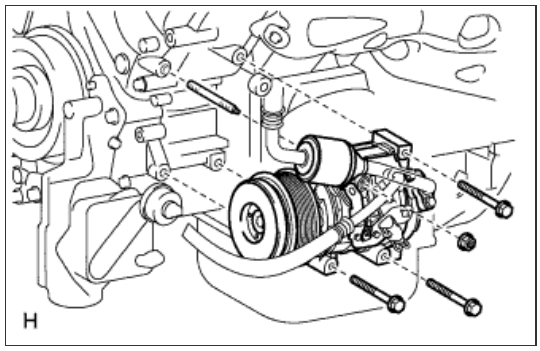


33. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

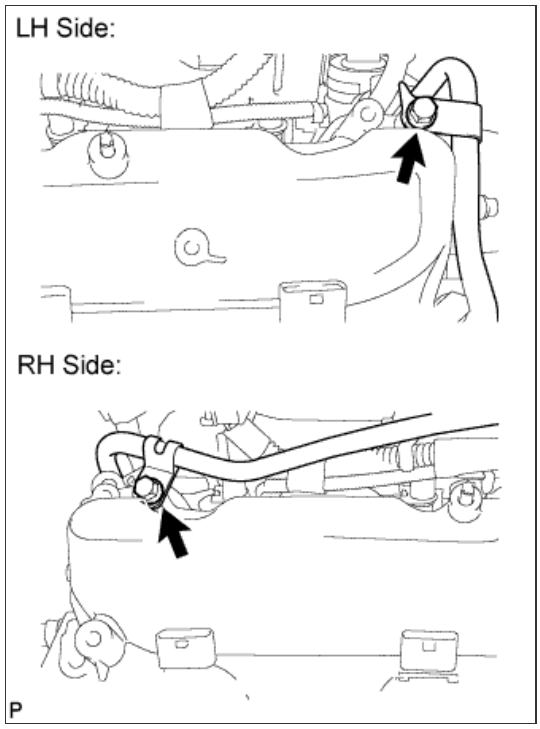
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.



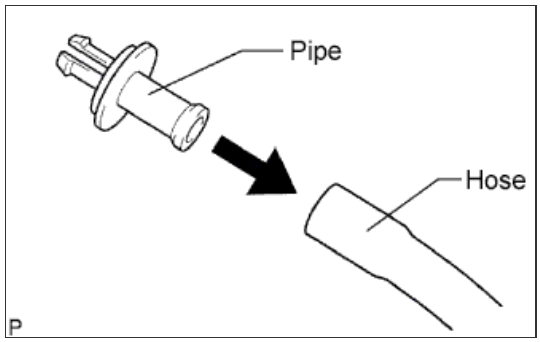
34. DISCONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Remove the 2 bolts and disconnect the fuel tube.

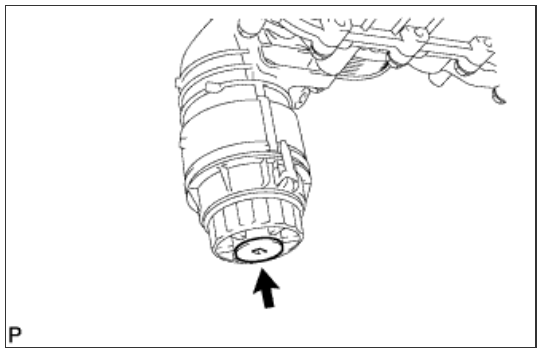


35. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



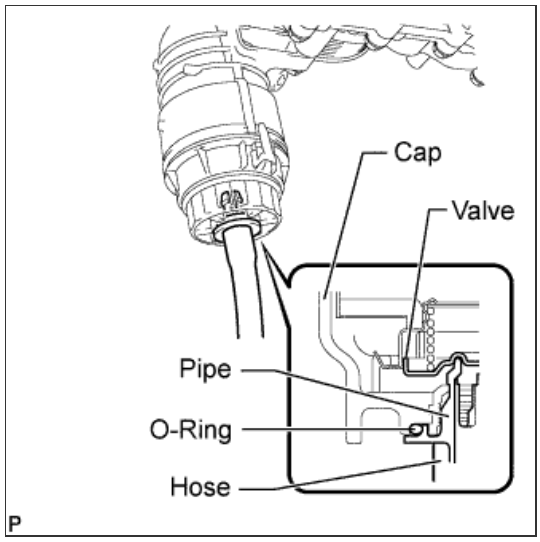
c. Install the pipe to the oil filter cap.

NOTICE:

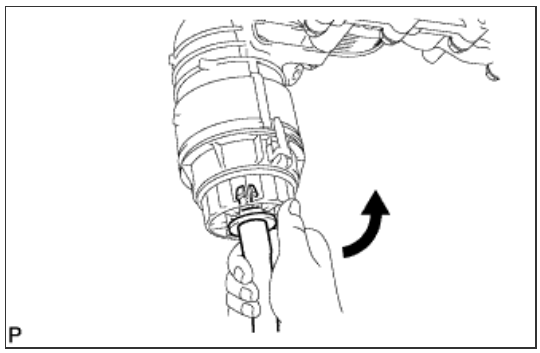
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

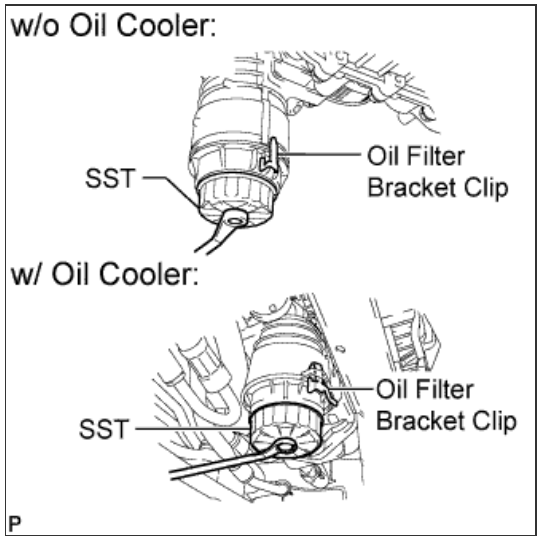


e. Using SST, remove the oil filter cap.

SST
09228-06501

NOTICE:

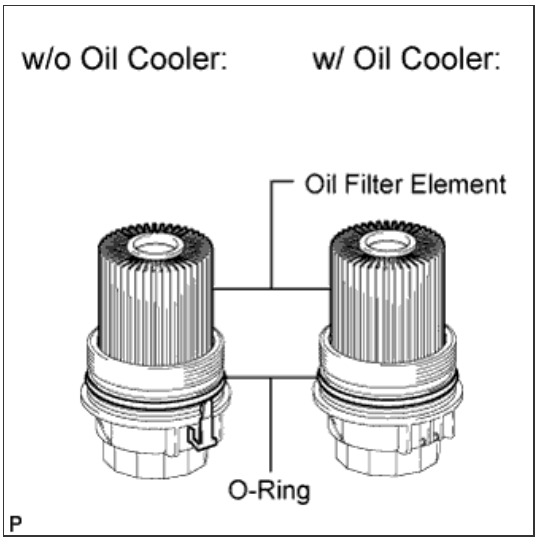
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

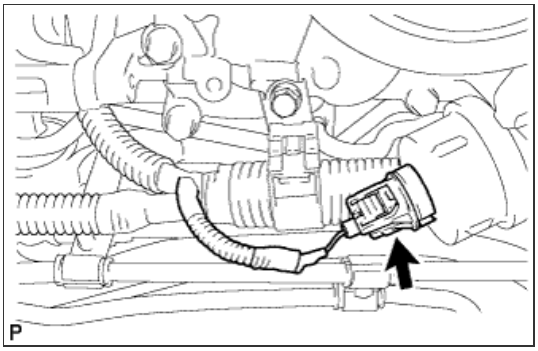
NOTICE:

Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.

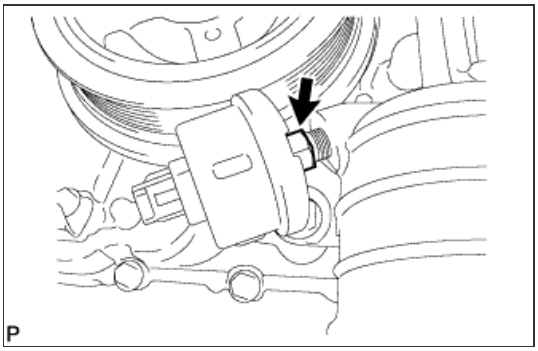


36. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.



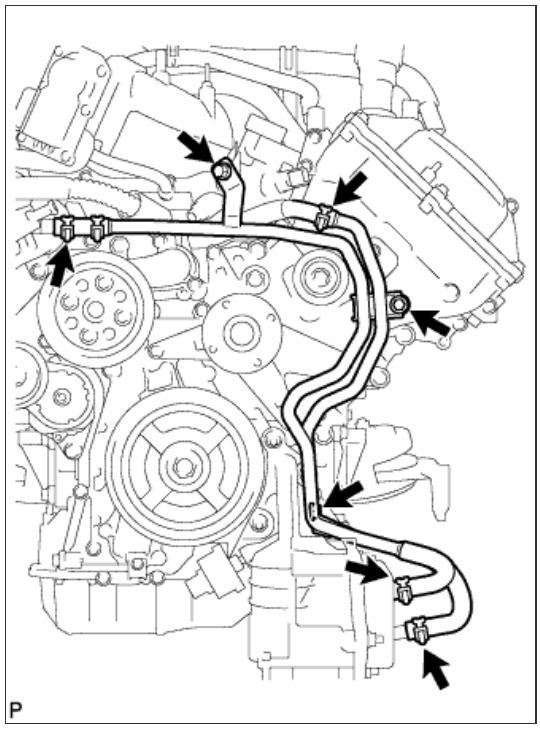
b. Remove the oil pressure sender gauge.



37. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Remove the 3 bolts.

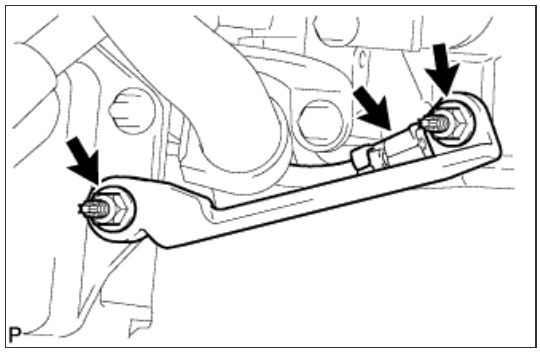
b. Disconnect the 4 hoses and remove the water by-pass pipe.



38. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

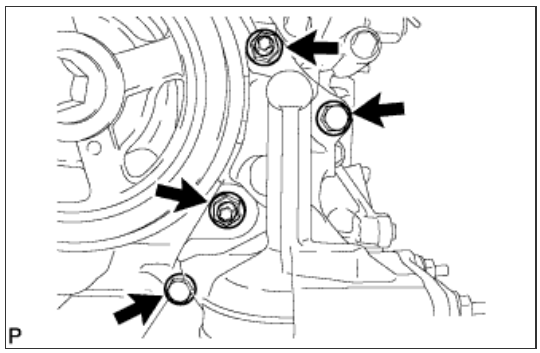
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

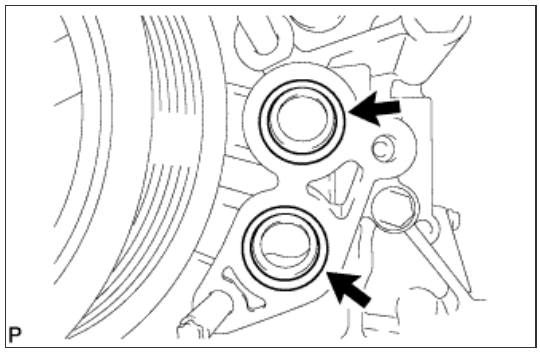


39. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.

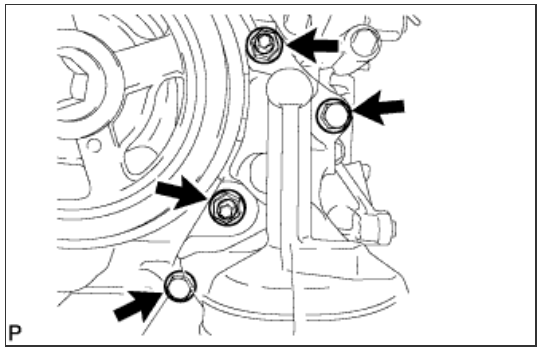


b. Remove the 2 O-rings.

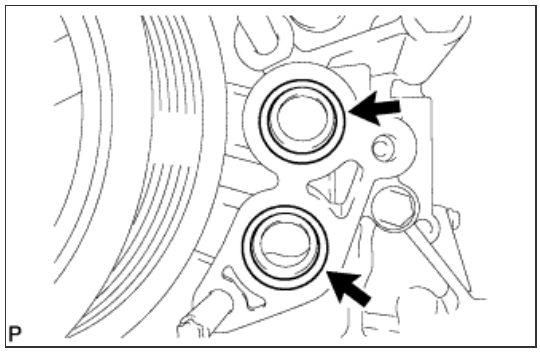


40. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.

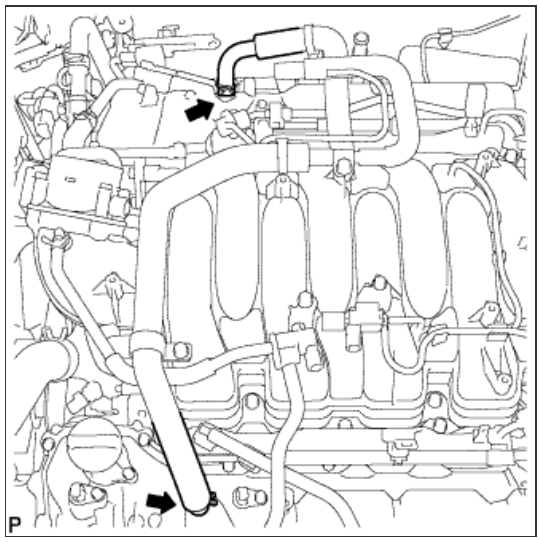


b. Remove the 2 O-rings.



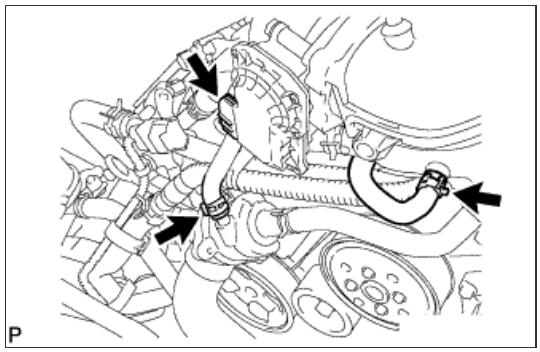
41. REMOVE INTAKE MANIFOLD

a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.

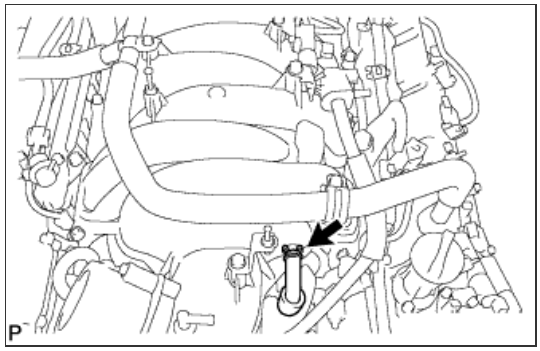


b. Disconnect the 2 water by-pass hoses.

c. Disconnect the throttle body connector.



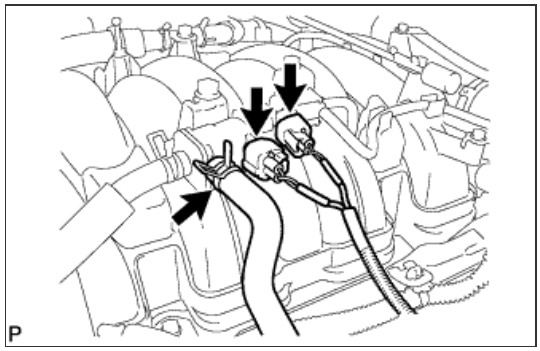
d. Disconnect the No. 1 ventilation hose.



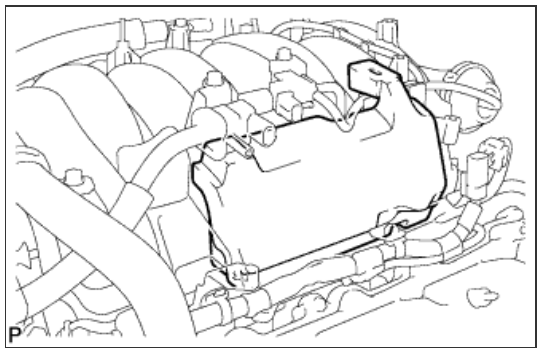
e. Disconnect the purge VSV connector.

f. Disconnect the purge line hose from the purge VSV.

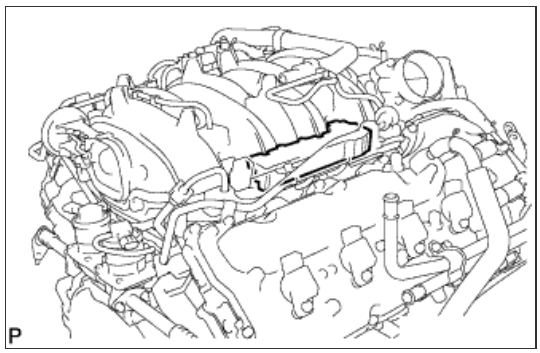
g. Disconnect the vacuum switching valve connector (for ACIS).



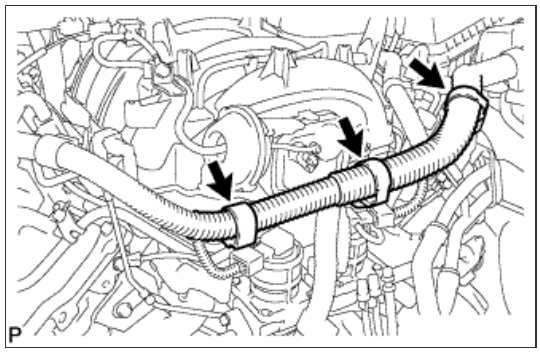
h. Remove the No. 1 engine cover sub-assembly.



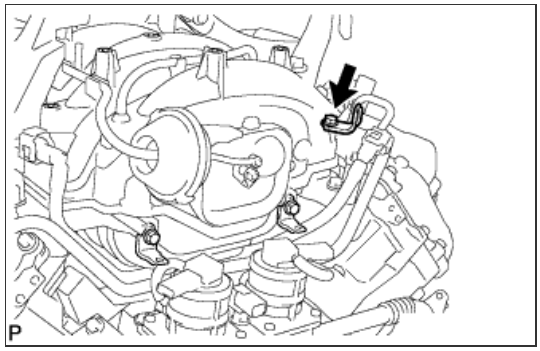
i. Remove the No. 3 engine cover.



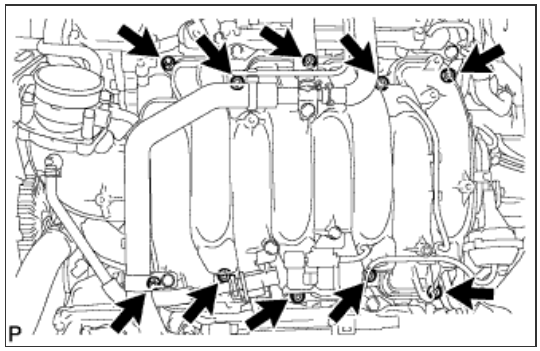
j. Disconnect the 3 wire clamps from the 3 wire brackets.



k. Remove the bolt and wire bracket from the intake manifold.

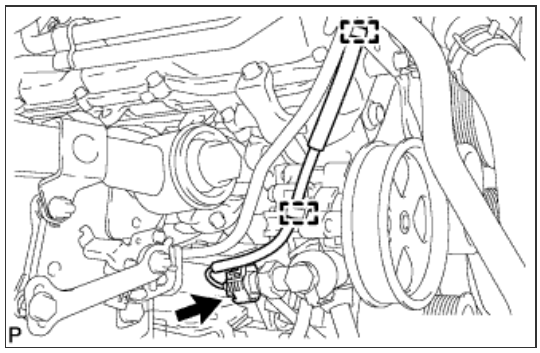


l. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.

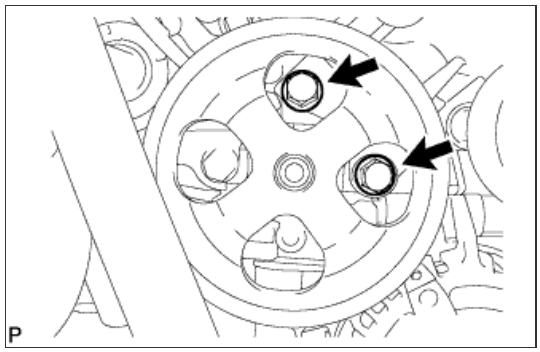


42. DISCONNECT VANE PUMP ASSEMBLY

a. Disconnect the 2 clamps and power steering oil pressure switch connector.



b. Remove the 2 bolts and disconnect the vane pump.

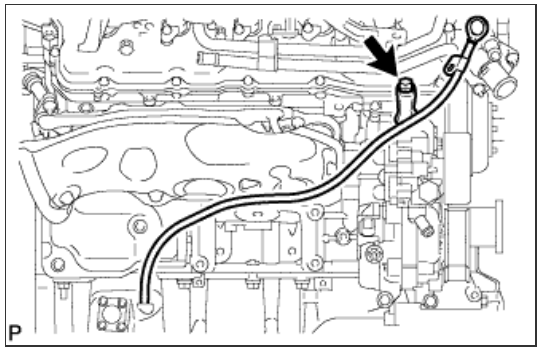


43. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

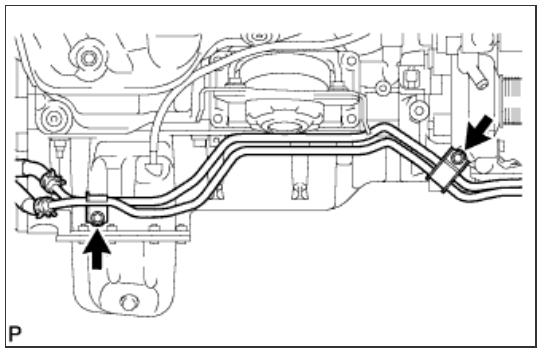
b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.



44. DISCONNECT OIL COOLER PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the oil cooler pipe.

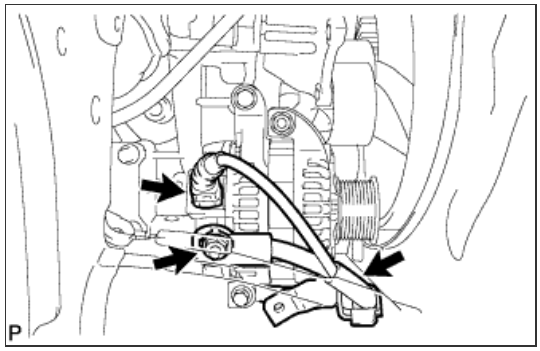


45. REMOVE GENERATOR ASSEMBLY

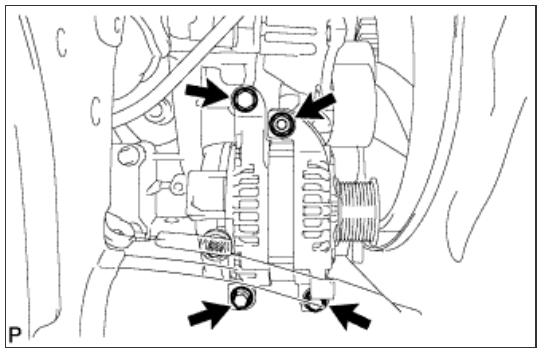
a. Disconnect the generator connector.

b. Remove the terminal cap and nut, and disconnect the generator wire.

c. Remove the bolt and wire harness bracket from the generator.

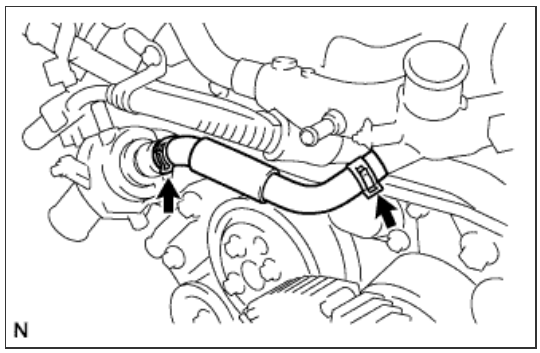


d. Remove the 3 bolts, nut and generator.



46. REMOVE NO. 1 WATER BY-PASS HOSE

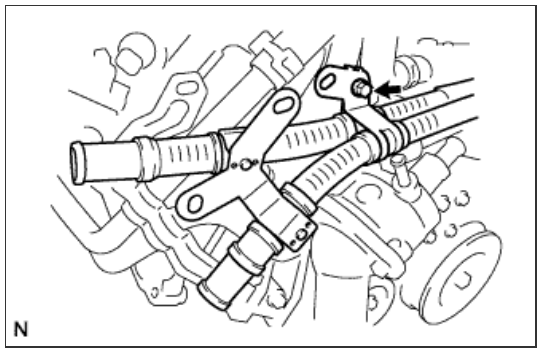
a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.



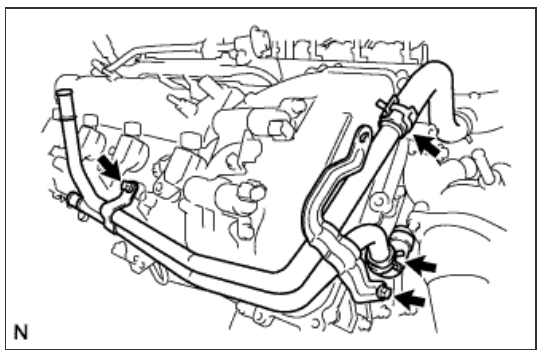
47. REMOVE WATER BY-PASS PIPE SUB-ASSEMBLY

a. Remove the bolt and disconnect the air tube.

b. Disconnect the 2 hoses.



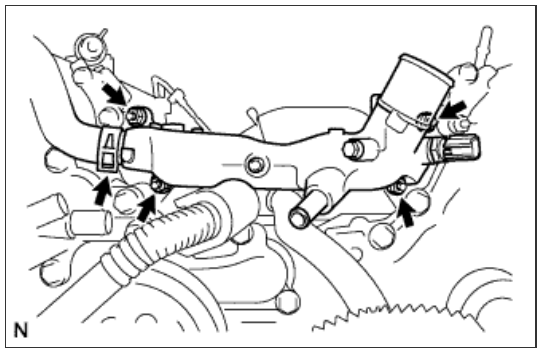
c. Remove the 2 bolts and water by-pass pipe.



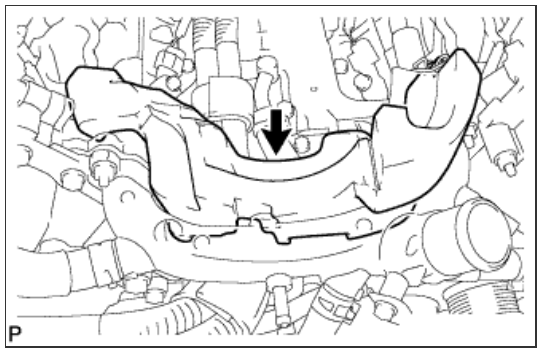
48. REMOVE FRONT WATER BY-PASS JOINT

a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

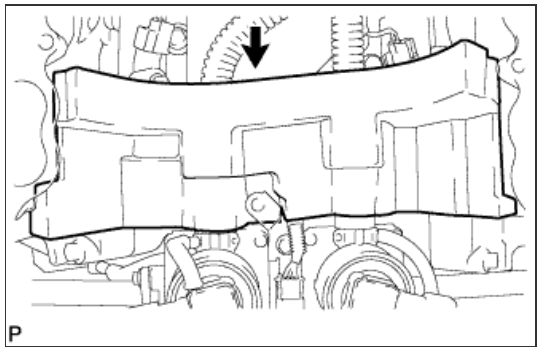
b. Remove the 4 nuts, water by-pass joint and 2 gaskets.



49. REMOVE NO. 2 ENGINE COVER

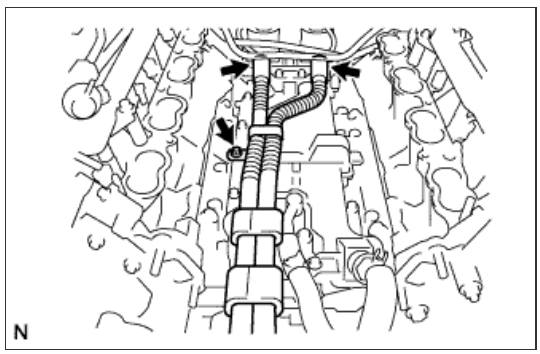


50. REMOVE NO. 1 ENGINE COVER



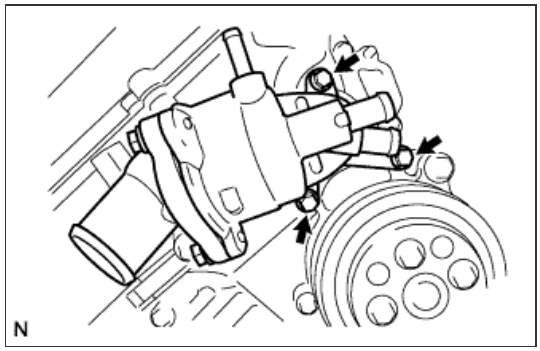
51. REMOVE AIR PIPE SUB-ASSEMBLY

a. Remove the bolt, disconnect the 2 hoses, and remove the air pipe.



52. REMOVE WATER INLET HOUSING

a. Remove the 3 bolts, water inlet housing and gasket.

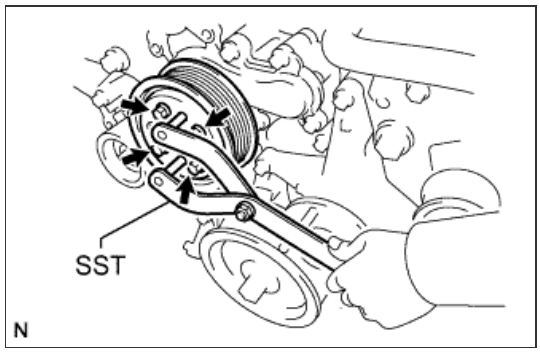


53. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

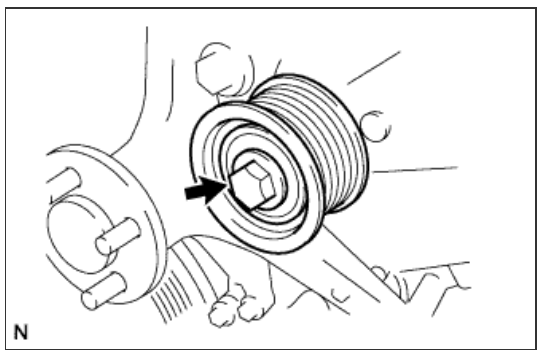
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



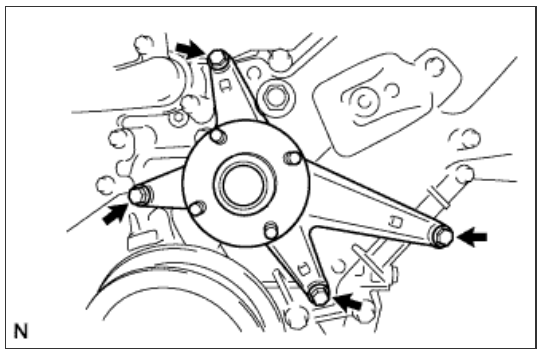
54. REMOVE NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Remove the bolt and idler pulley.



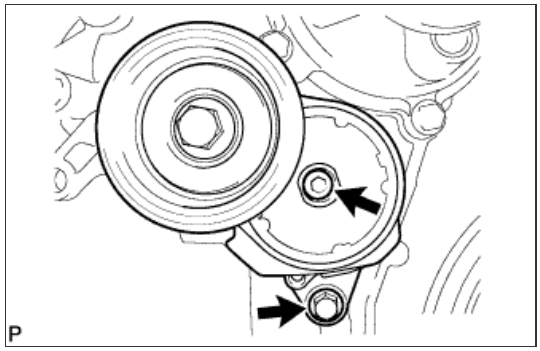
55. REMOVE FLUID COUPLING BRACKET

a. Remove the 4 bolts and fluid coupling bracket.



56. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY

a. Remove the standard bolt, 6 mm hexagon wrench bolt and belt tensioner.



57. REMOVE IGNITION COIL ASSEMBLY

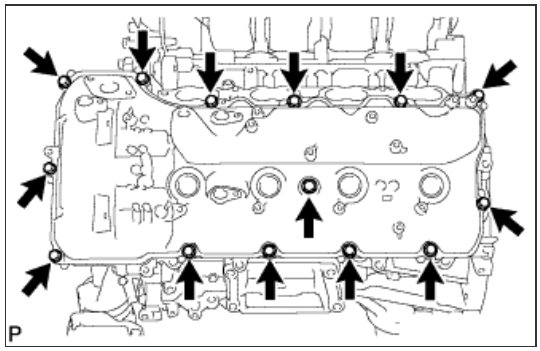
a. Remove the 8 bolts and 8 ignition coils.

58. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY LH

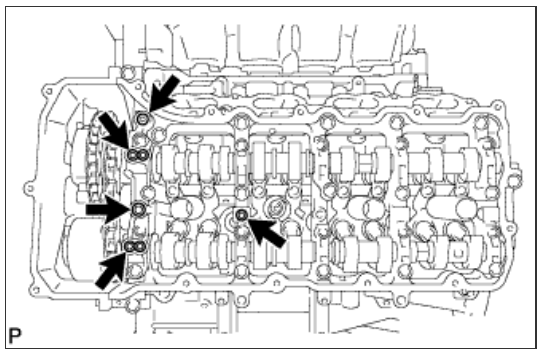
a. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

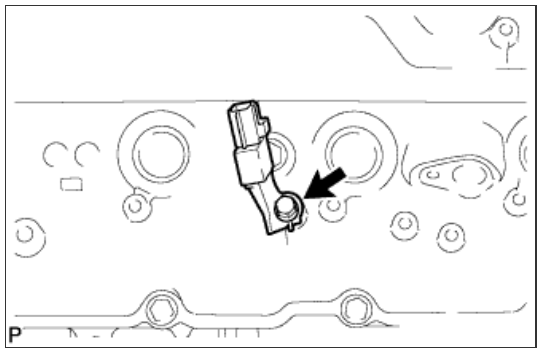


b. Remove the 5 gaskets from the camshaft bearing caps (No. 2, No. 3).



59. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY RH

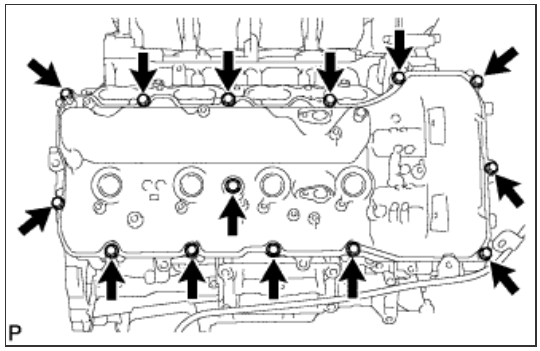
a. Remove the bolt and noise filter.



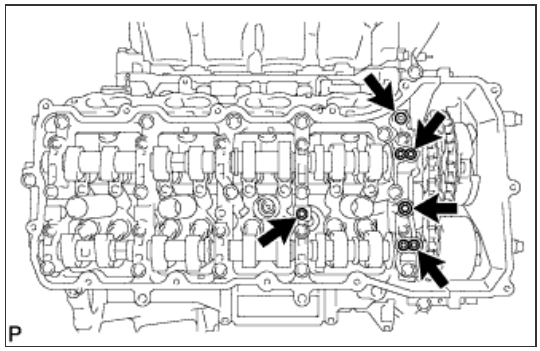
b. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.



c. Remove the 5 gaskets from the camshaft bearing caps (No. 1, No. 3).



60. REMOVE SPARK PLUG TUBE GASKET

a. Bend the 4 ventilation baffle plate claws on the cylinder head cover to an angle of 90° or more.

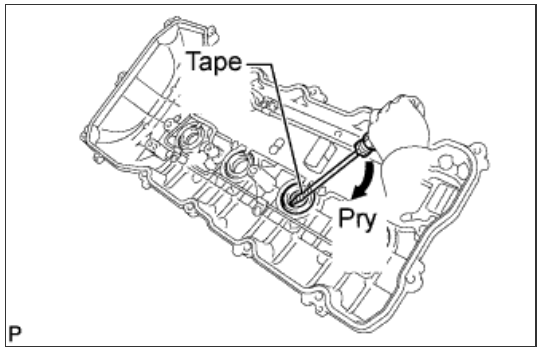
b. Using a screwdriver, pry out the gaskets.

HINT:

Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the cylinder head cover.**
- **Be careful not to damage the gasket when removing it, as the removed gasket needs to be used when installing a new one.**

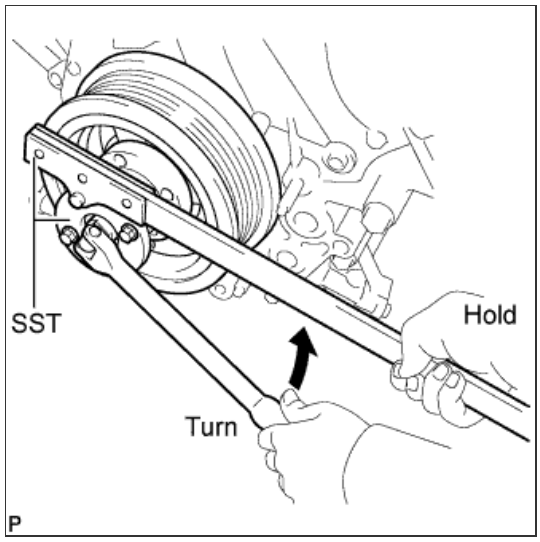


61. REMOVE CRANKSHAFT PULLEY

a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST

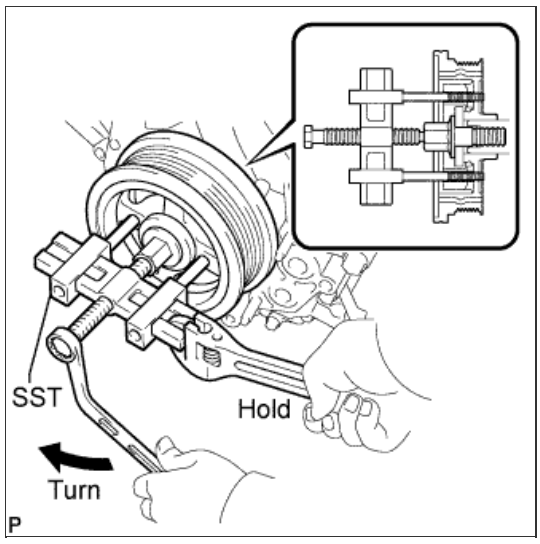
09213-70011 (09213-70020)
09330-00021



b. Using the pulley set bolt and SST, remove the crankshaft pulley.

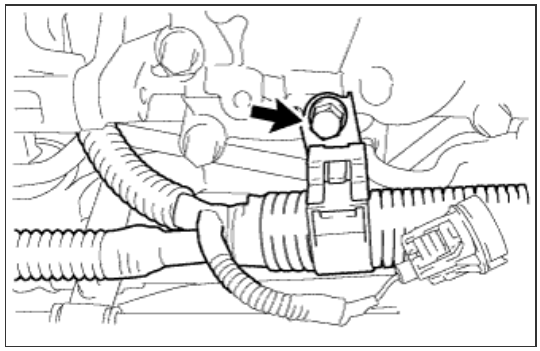
SST

09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



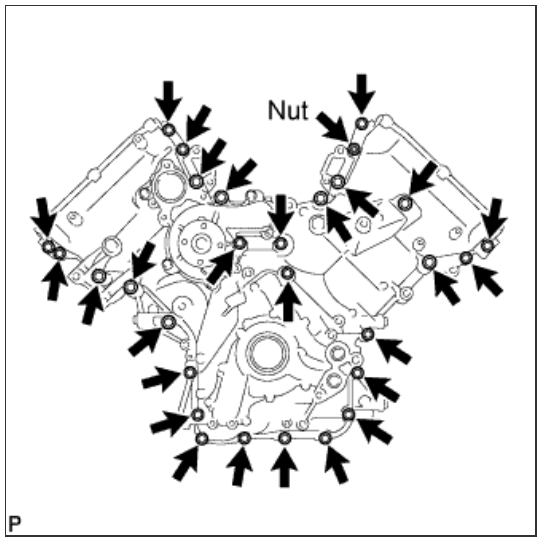
62. DISCONNECT WIRE HARNESS CLAMP BRACKET

a. Remove the bolt and disconnect the bracket.



63. REMOVE TIMING CHAIN COVER SUB-ASSEMBLY

a. Remove the 28 bolts and nut shown in the illustration.



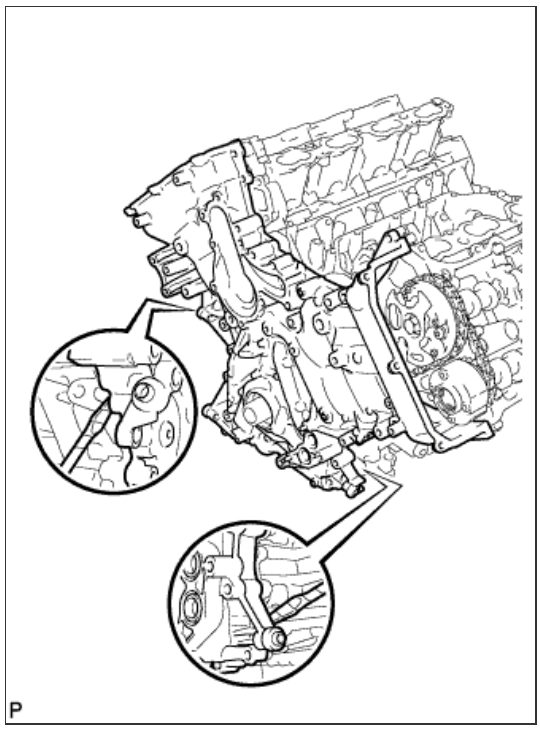
b. Remove the timing chain cover by prying between the timing chain cover and cylinder head or cylinder block with a screwdriver as shown in the illustration.

NOTICE:

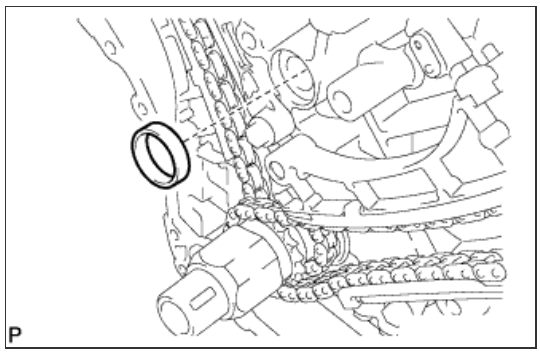
Be careful not to damage the contact surfaces of the cylinder head, cylinder block and chain cover.

HINT:

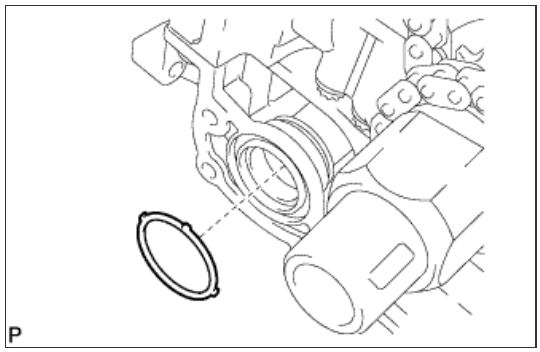
Tape the screwdriver tip before use.



c. Remove the oil pump gasket from the cylinder block.



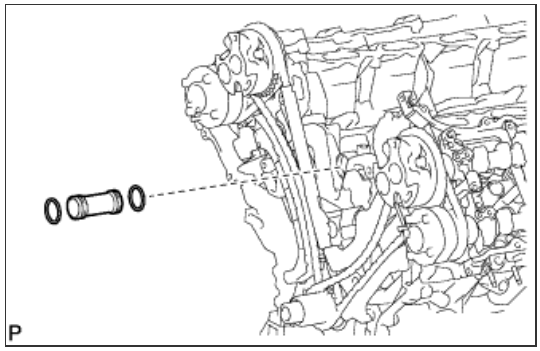
d. Remove the O-ring from the oil pan.



64. REMOVE WATER INLET PIPE

a. Remove the water inlet pipe.

b. Remove the 2 O-rings from the water inlet pipe.



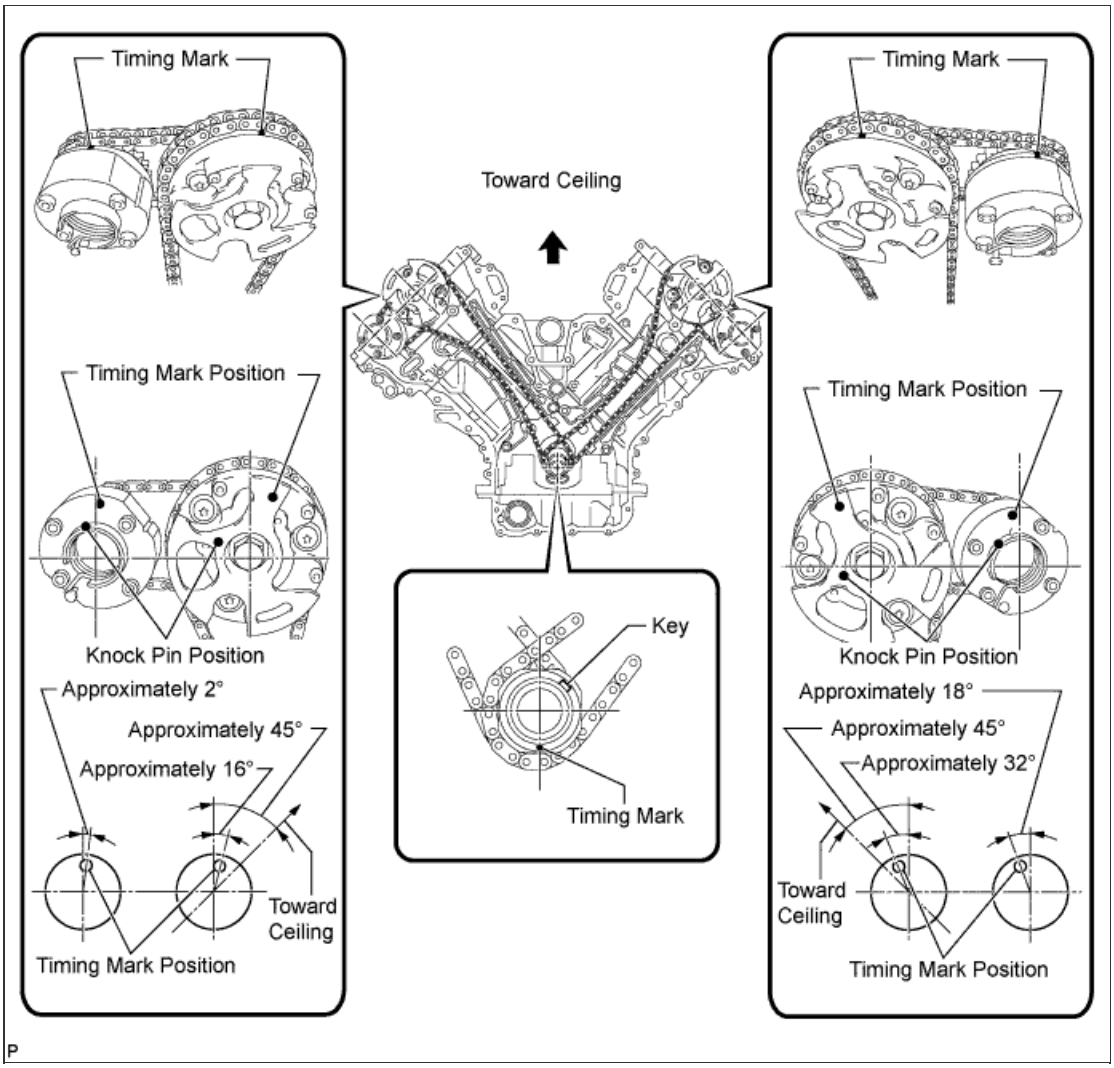
65. SET NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise so that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

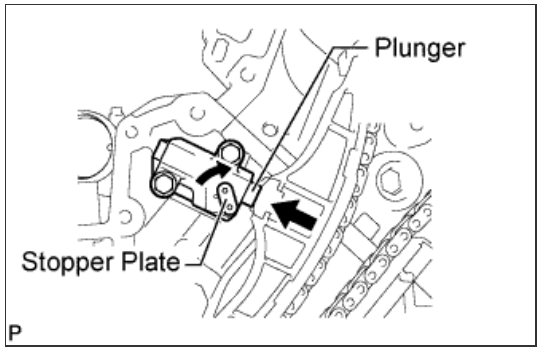
HINT:

If the timing marks do not align, rotate the crankshaft clockwise again and align the timing marks.

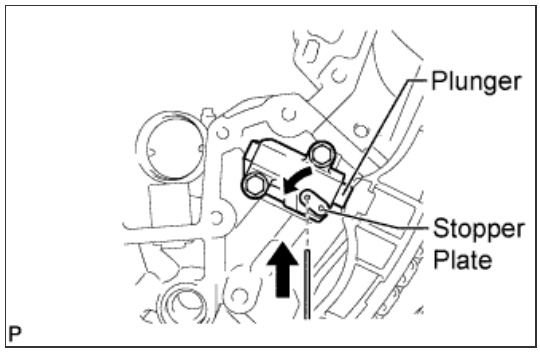


66. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY LH

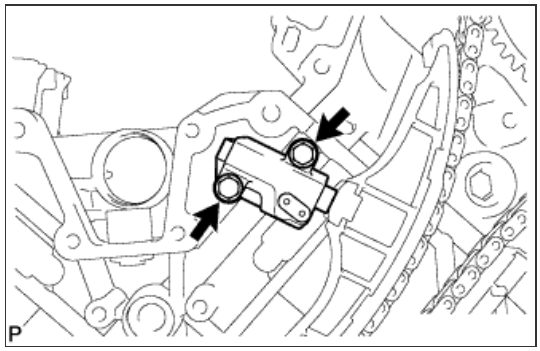
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



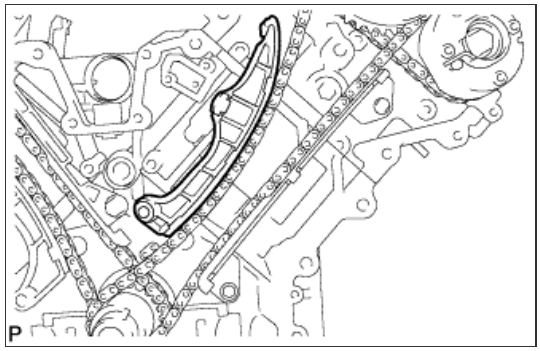
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts, chain tensioner and gasket.

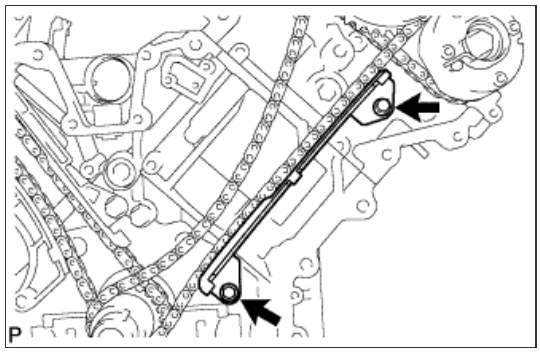


67. REMOVE NO. 1 CHAIN TENSIONER SLIPPER LH



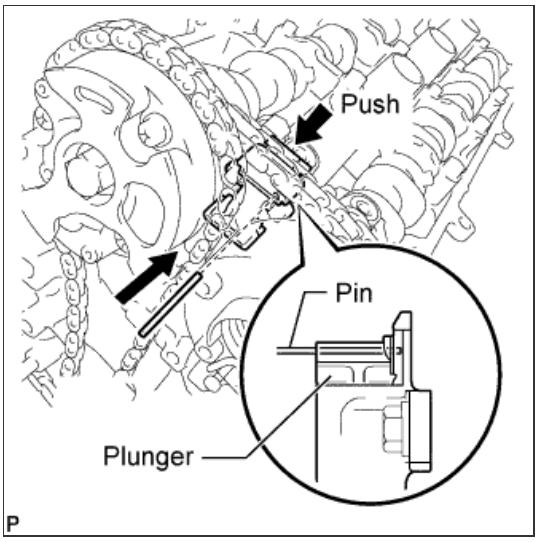
68. REMOVE NO. 1 CHAIN VIBRATION DAMPER LH

a. Remove the 2 bolts and chain vibration damper.



69. REMOVE NO. 1 CHAIN SUB-ASSEMBLY LH

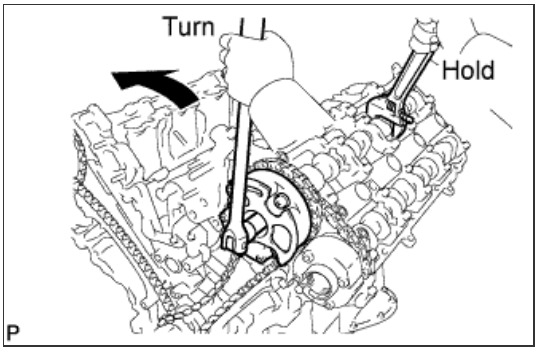
a. While pushing down the No. 3 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



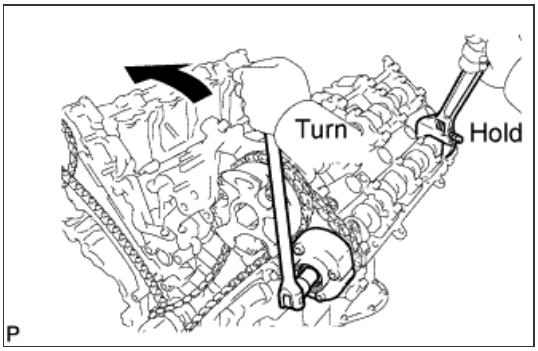
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

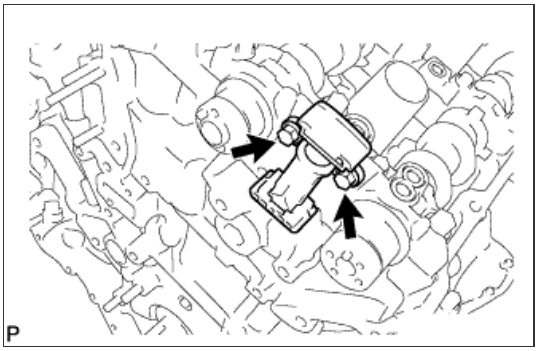
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket LH.

e. Remove the No. 1 and No. 2 chains from the gears.



70. REMOVE NO. 3 CHAIN TENSIONER ASSEMBLY

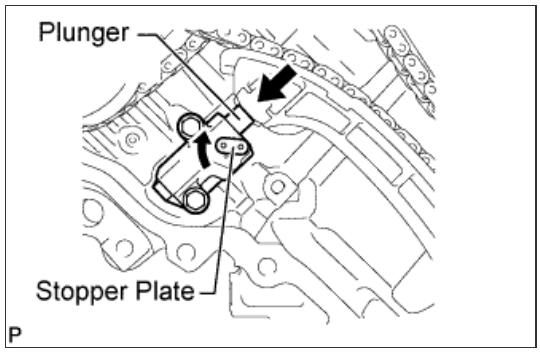
a. Remove the 2 bolts and chain tensioner.



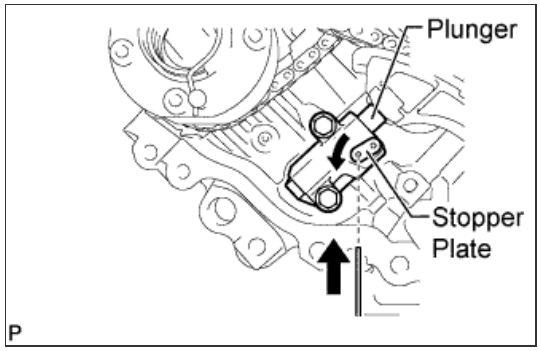
71. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY RH

a. Move the stopper plate clockwise to release the lock, and push the plunger deep

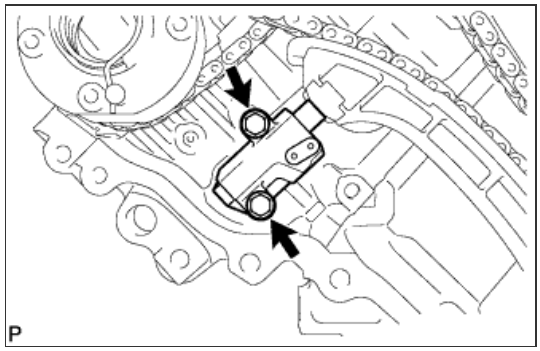
into the tensioner.



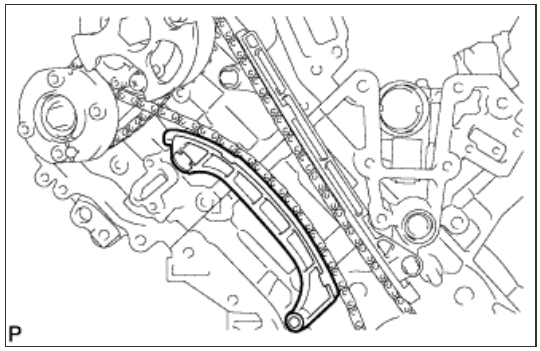
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts and chain tensioner.

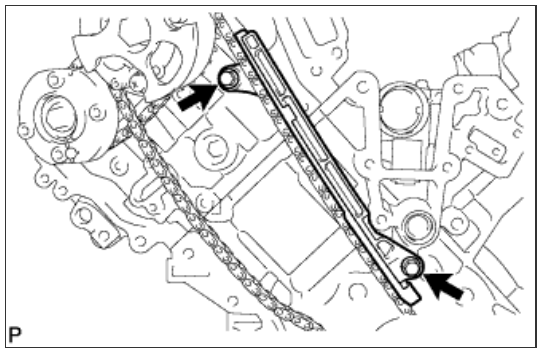


72. REMOVE NO. 1 CHAIN TENSIONER SLIPPER RH



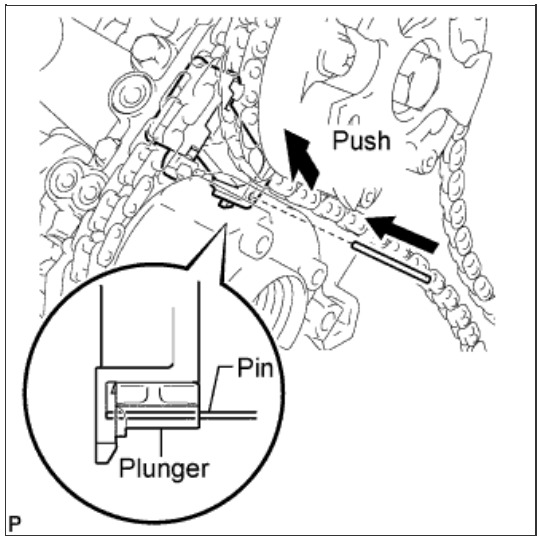
73. REMOVE NO. 1 CHAIN VIBRATION DAMPER RH

a. Remove the 2 bolts and vibration damper.



74. REMOVE NO. 1 CHAIN SUB-ASSEMBLY RH

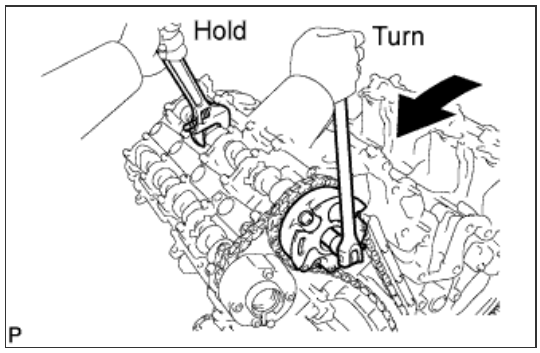
a. While raising up the No. 2 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



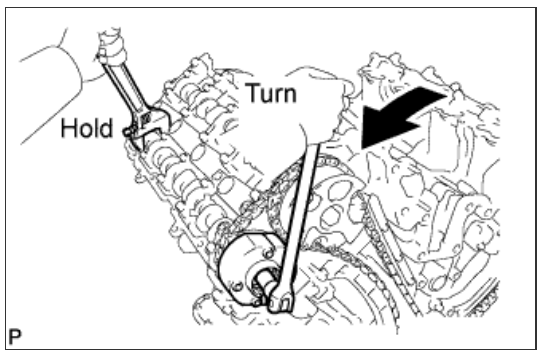
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

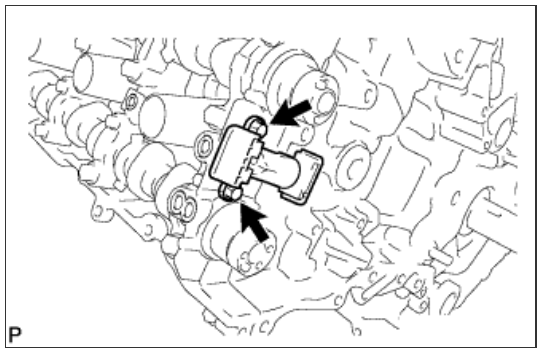
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket RH.

e. Remove the No. 1 and No. 2 chains from the gears.



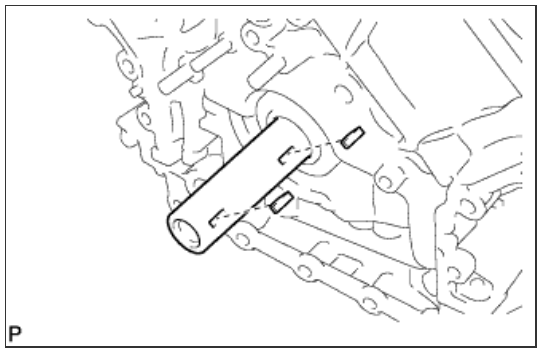
75. REMOVE NO. 2 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.



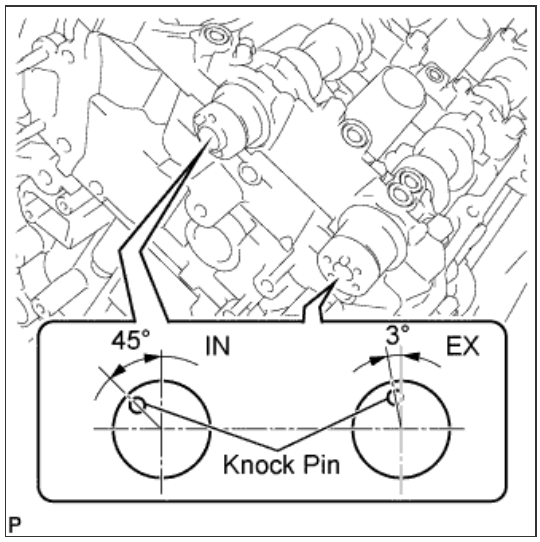
76. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Using a screwdriver, remove the 2 timing gear keys from the crankshaft.

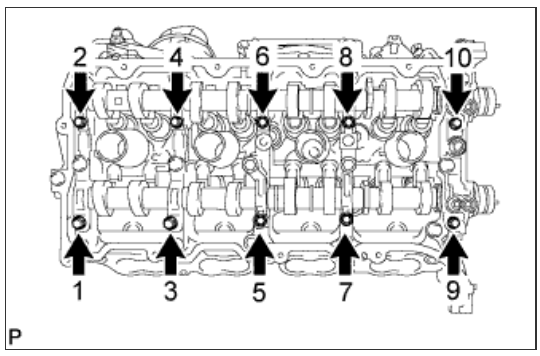


77. REMOVE CAMSHAFT BEARING CAP LH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in

the illustration.

NOTICE:

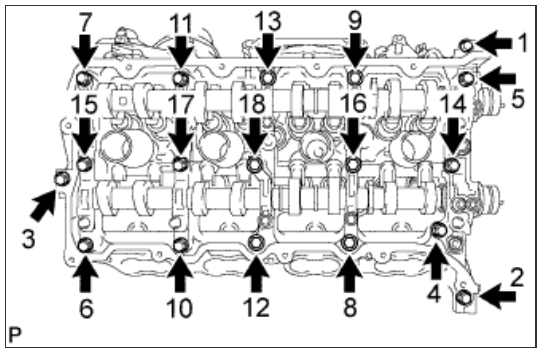
Uniformly loosen the bolts while keeping the camshaft level.

d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 3 and No. 4 camshafts.



78. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY LH

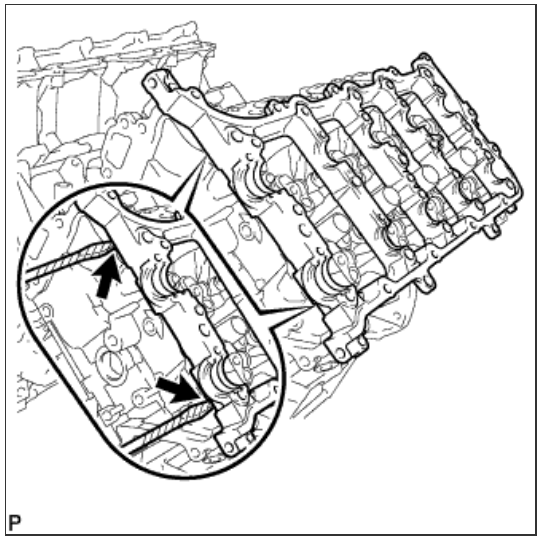
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

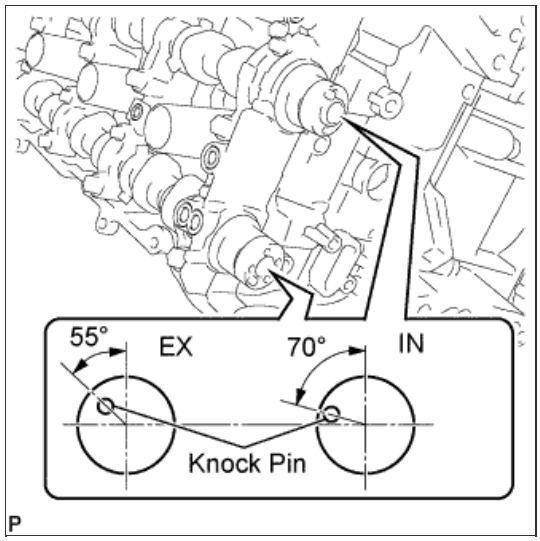
NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.

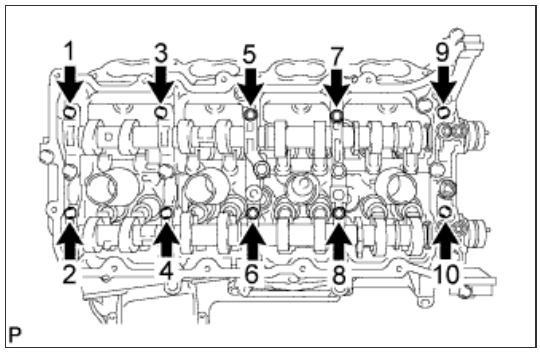


79. REMOVE CAMSHAFT BEARING CAP RH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

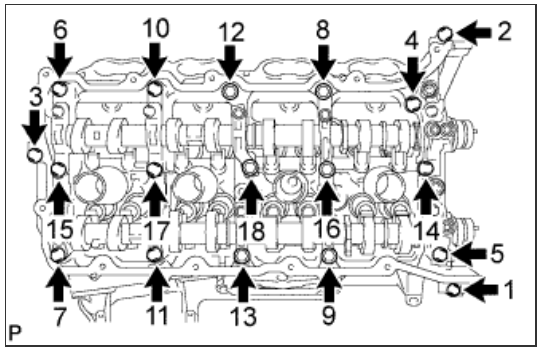
Uniformly loosen the bolts while keeping the camshaft level.

d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 1 and No. 2 camshafts.



80. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY RH

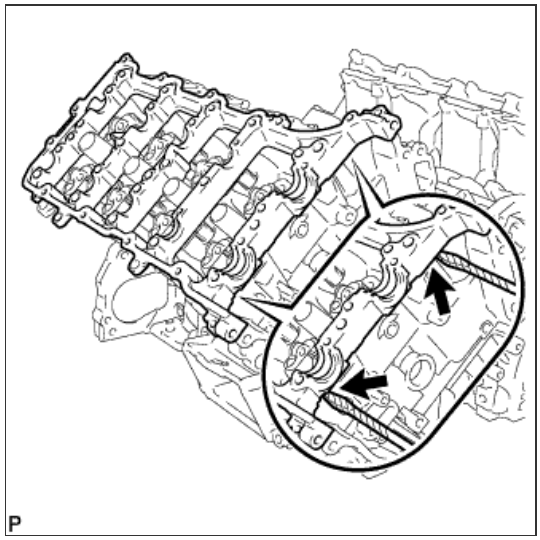
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

NOTICE:

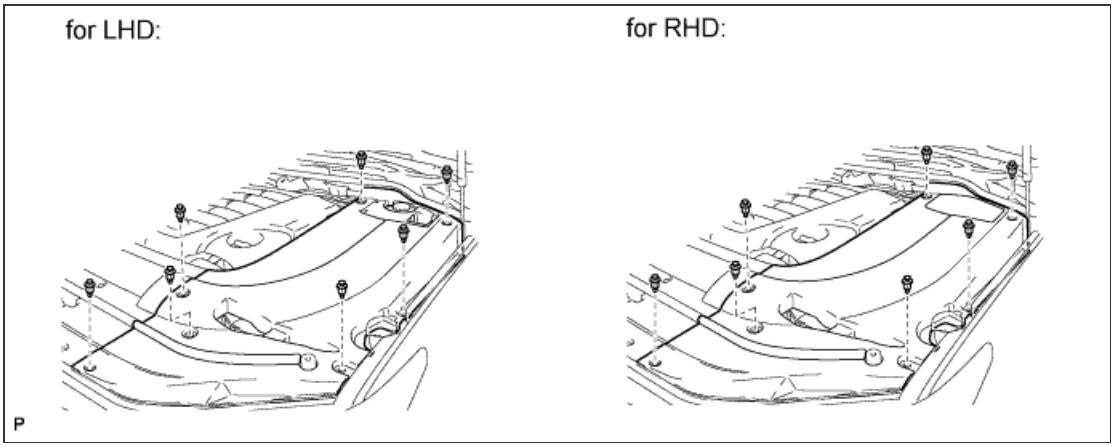
Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.



for Preparation Click here

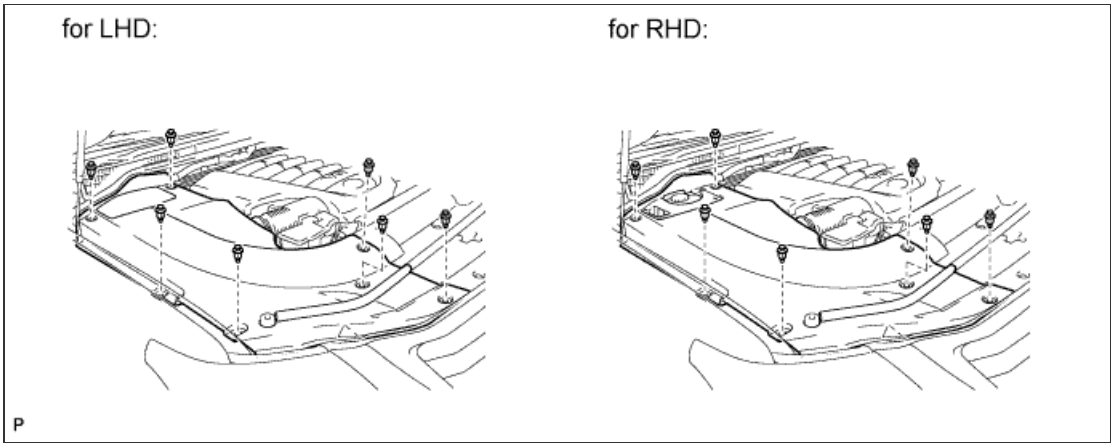
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



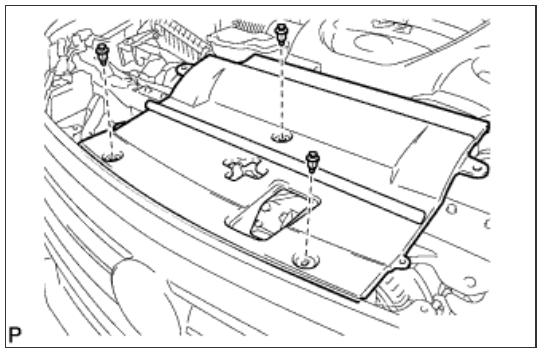
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



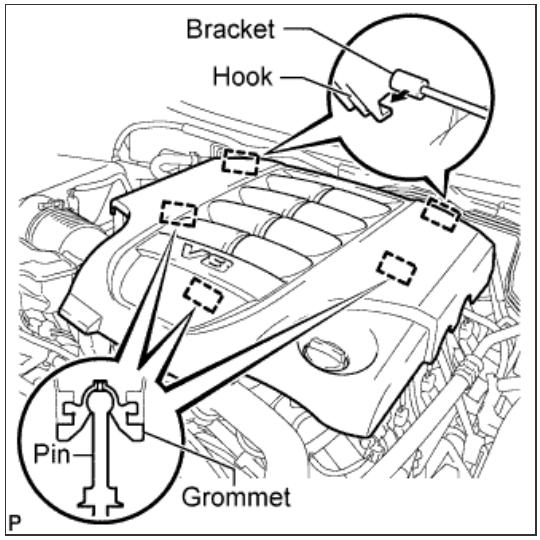
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

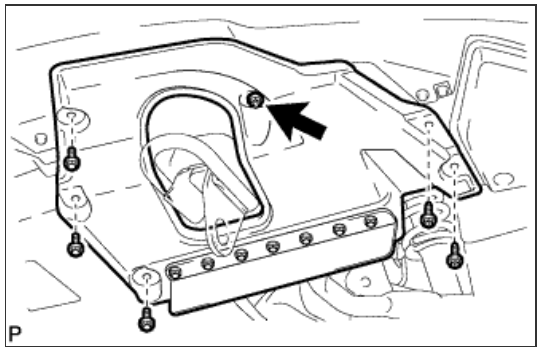
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

7. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



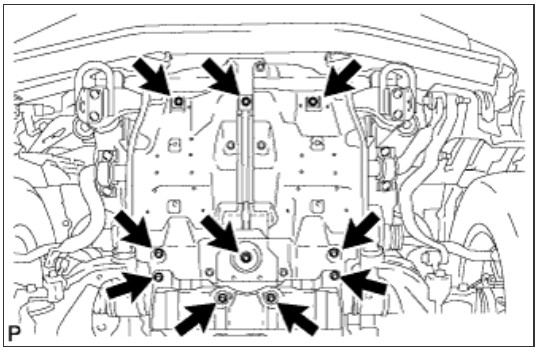
8. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

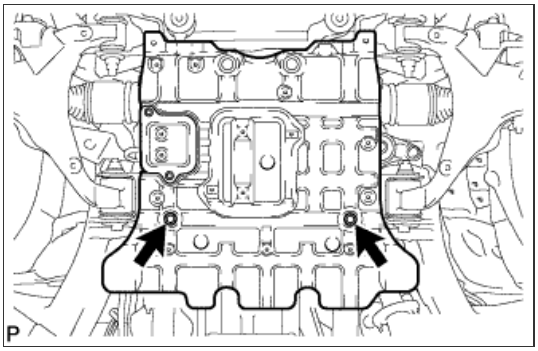
9. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



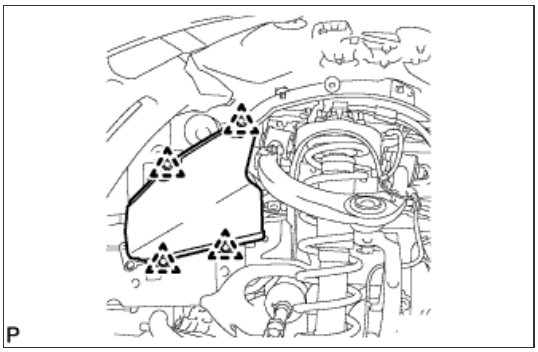
10. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



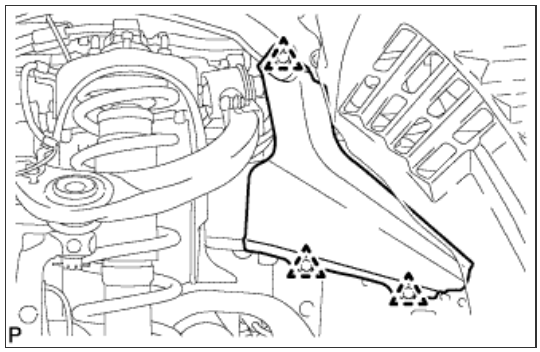
11. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



12. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.



13. REMOVE RADIATOR GRILLE

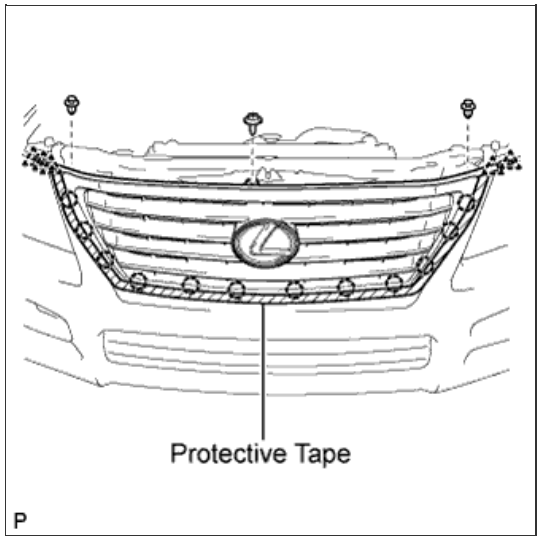
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

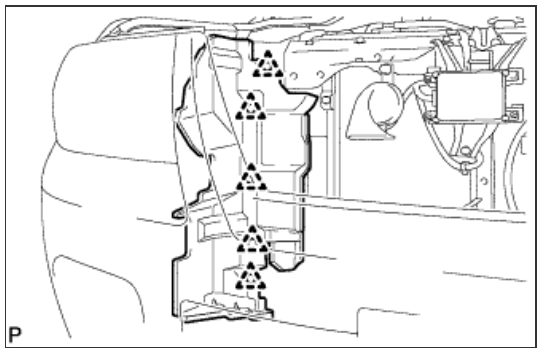
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



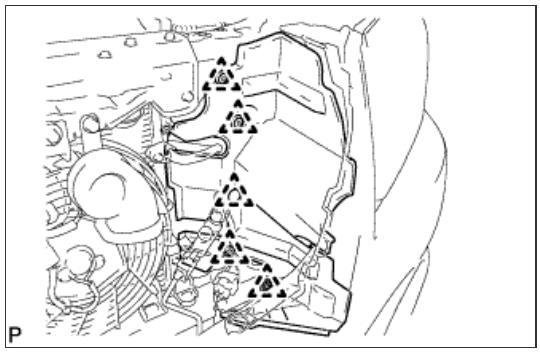
14. REMOVE RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



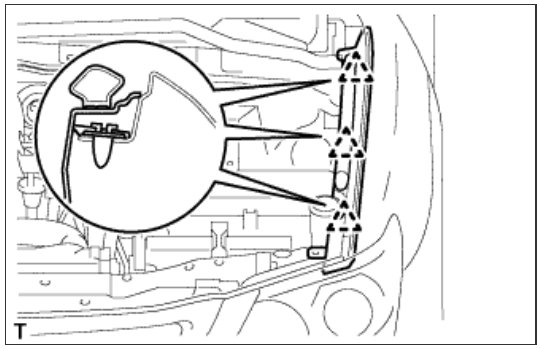
15. REMOVE RADIATOR SIDE DEFLECTOR LH

a. Using a clip remover, remove the 5 clips and side deflector.



16. REMOVE FRONT FENDER MAIN SEAL LH

a. Using a clip remover, detach the 3 clips and remove the fender main seal.



17. REMOVE FRONT FENDER MAIN SEAL RH

HINT:

Use the same procedures described for the LH side.

18. REMOVE FRONT WIPER ARM LH

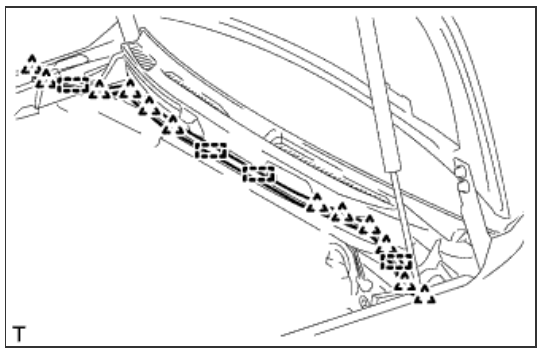
a. Remove the nut, wiper arm and blade.

19. REMOVE FRONT WIPER ARM RH

a. Remove the nut, wiper arm and blade.

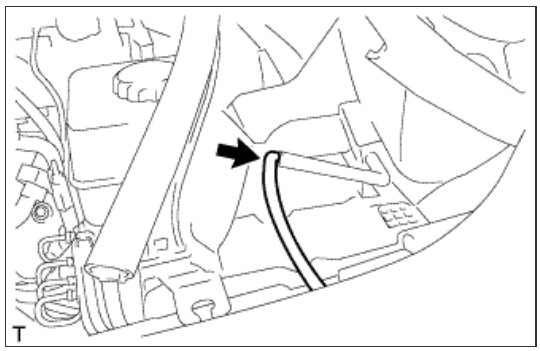
20. REMOVE HOOD TO COWL TOP SEAL

a. Using a clip remover, detach the 12 clips and 4 clamps, and remove the hood to cowl top seal.



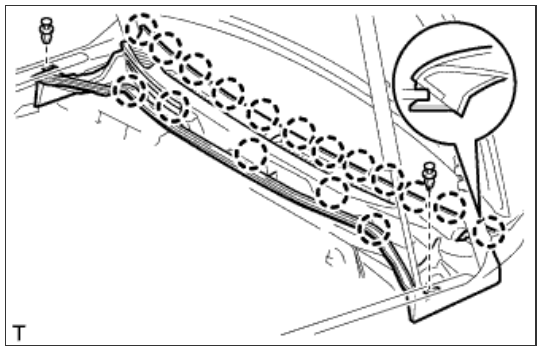
21. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Disconnect the washer hose.



b. Remove the 2 clips.

c. Detach the 17 claws and remove the cowl top ventilator louver sub-assembly.



22. DRAIN ENGINE OIL

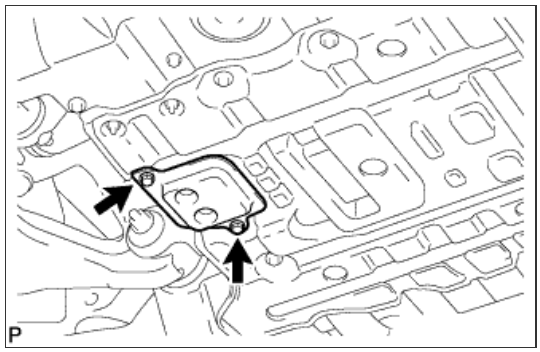
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

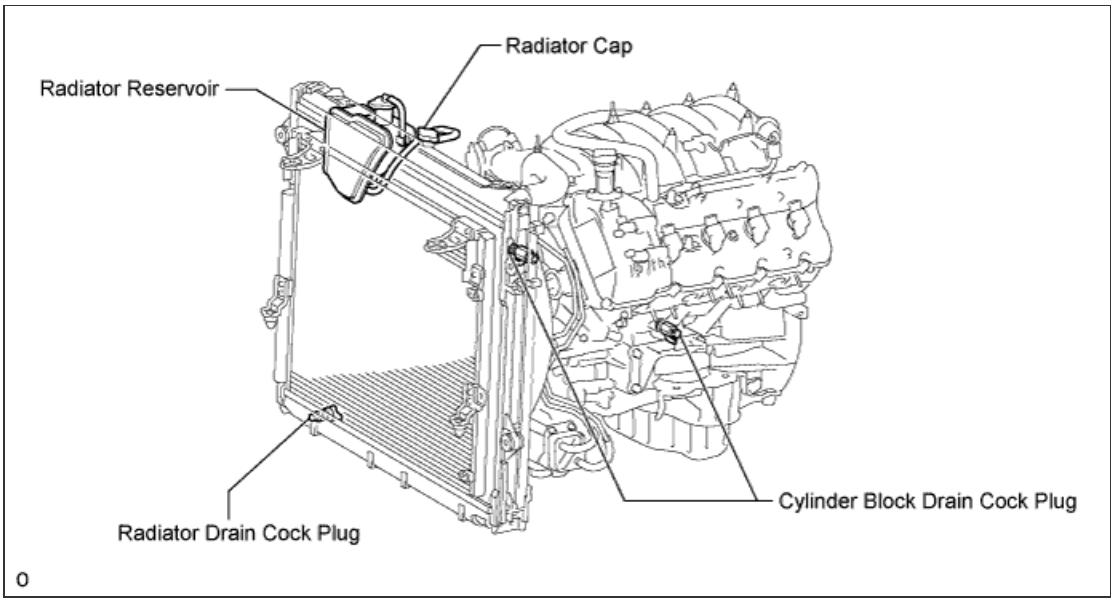
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



23. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

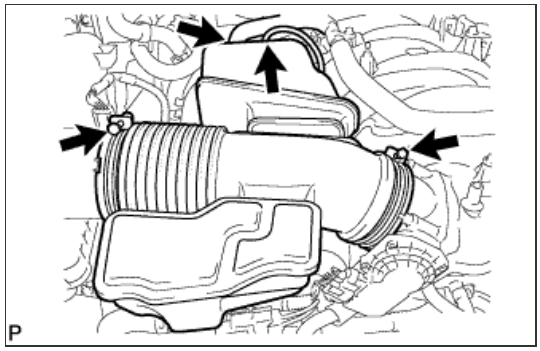
e. Tighten the radiator drain cock plug by hand.

24. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

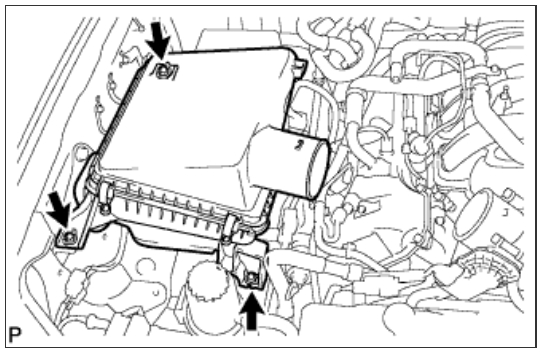
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



25. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



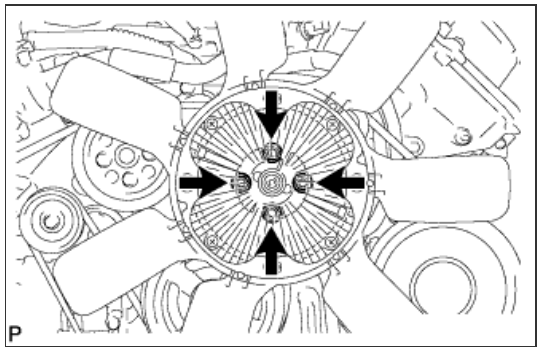
26. REMOVE NO. 1 RADIATOR HOSE

27. REMOVE NO. 2 RADIATOR HOSE

28. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

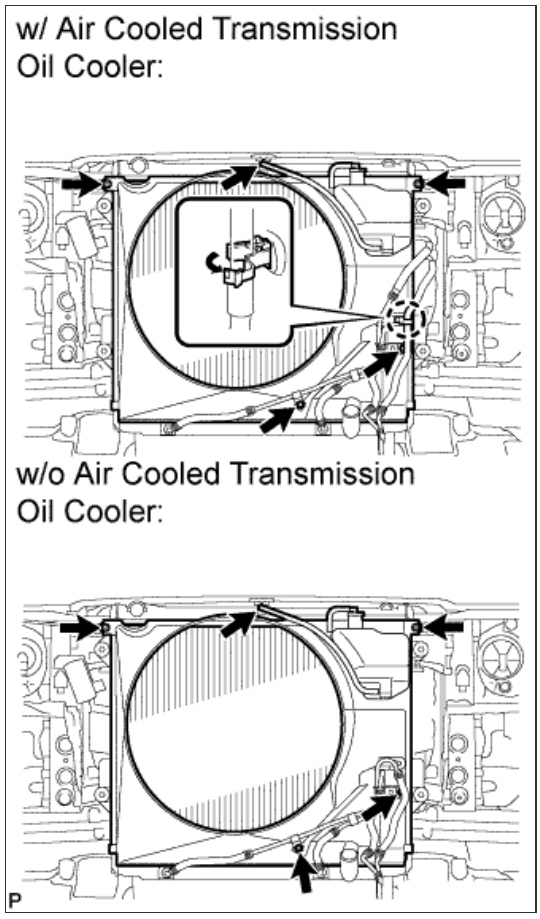
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

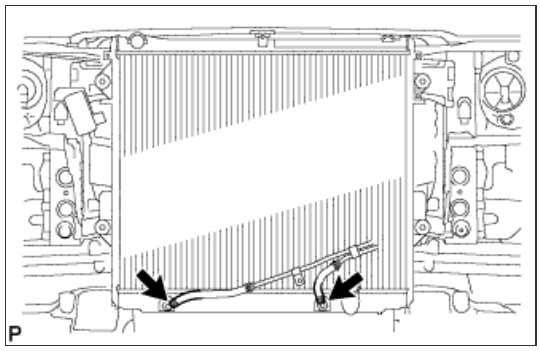
Be careful not to damage the radiator core.

h. Remove the fan pulley.

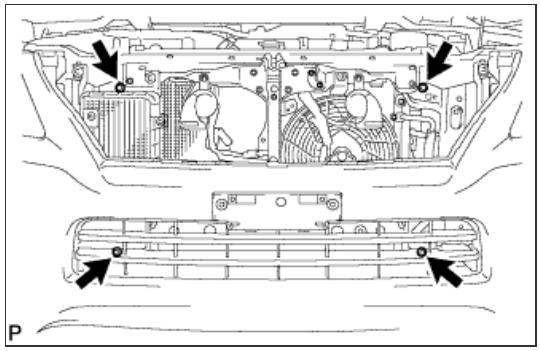


29. REMOVE RADIATOR ASSEMBLY

a. Disconnect the 2 oil cooler hoses.



b. Remove the 4 bolts and radiator.

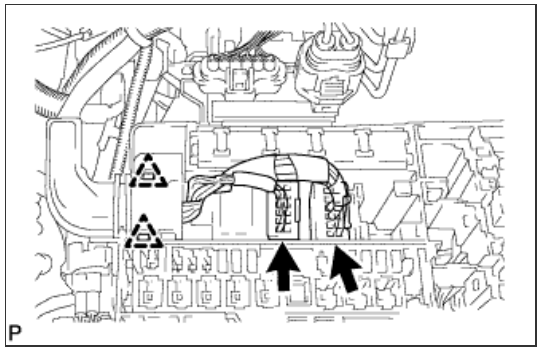


30. DISCONNECT ENGINE WIRE

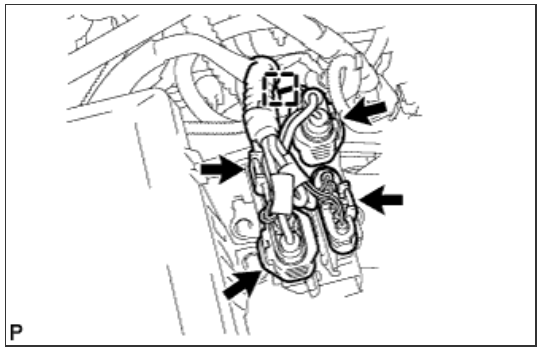
a. Engine Room LH Side:

i. Remove the engine room relay block cover.

ii. Disconnect the 2 connectors and 2 clips from the engine room junction block.



iii. w/ Secondary Air Injection System:
Disconnect the 4 air injection control driver connectors and wire harness clamp.



iv. Disconnect the injector connector.

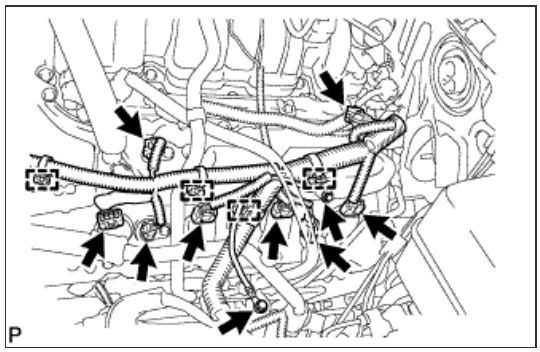
v. Disconnect the 4 ignition coil connectors.

vi. Disconnect the 2 VVT sensor connectors.

vii. Disconnect the 4 clamps.

viii. Remove the 2 bolts and ground wire.

ix. Disconnect the noise filter connector.



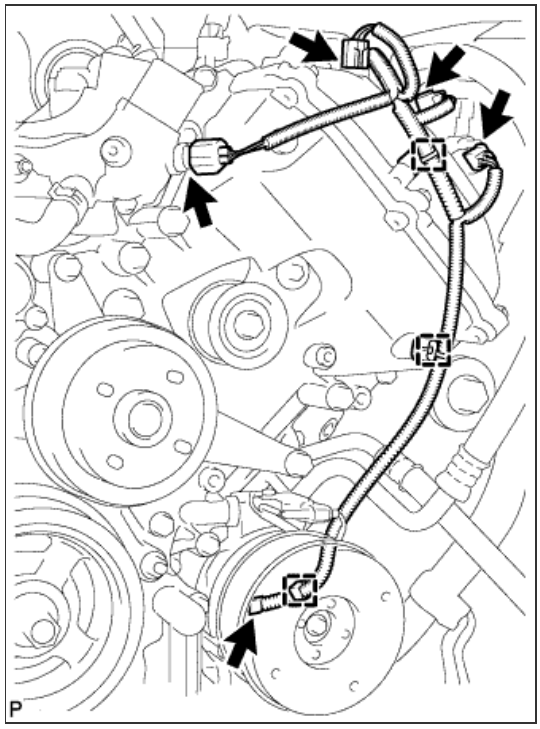
x. Disconnect the engine coolant temperature sensor connector.

xi. Disconnect the 2 camshaft timing oil control valve connectors.

xii. Disconnect the camshaft position sensor connector.

xiii. Disconnect the 3 clamps.

xiv. Disconnect the cooler compressor connector.



b. Engine Room RH Side:

i. Disconnect the 2 camshaft timing oil control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the injector connector.

iv. Disconnect the 2 VVT sensor connectors.

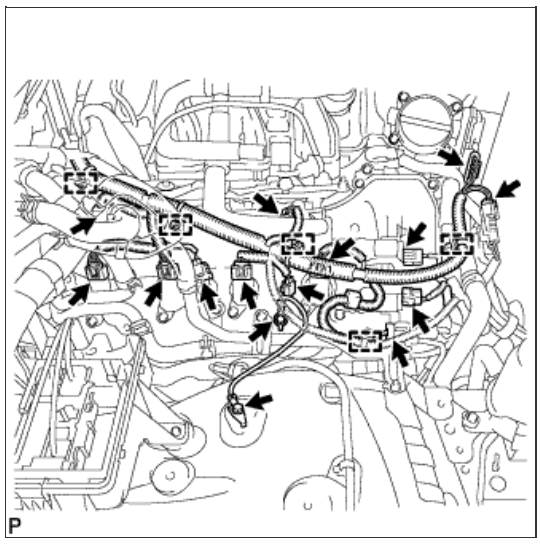
v. Disconnect the noise filter connector.

vi. Remove the 2 bolts and ground wire.

vii. w/ Secondary Air Injection System:
Disconnect the 2 air pump connectors.

viii. Disconnect the throttle position sensor and throttle control motor connector.

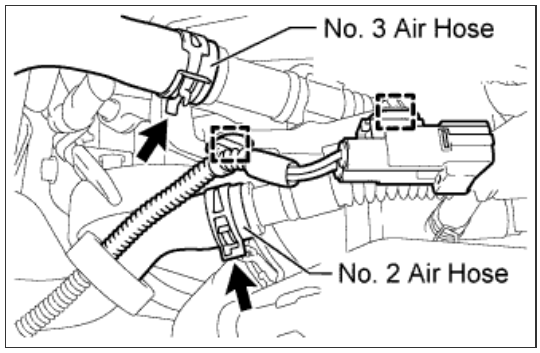
ix. Disconnect the 5 clamps.



31. DISCONNECT AIR PUMP HOSE AND WIRE HARNESS (w/ Secondary Air Injection System)

a. Disconnect the No. 2 and No. 3 air hoses.

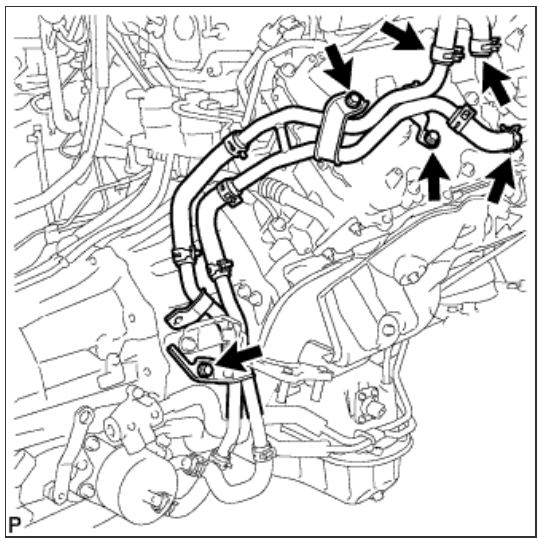
b. Disconnect the 2 clamps.



32. DISCONNECT NO. 2 WATER BY-PASS PIPE

a. Disconnect the 3 hoses.

b. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe from the cylinder head cover.

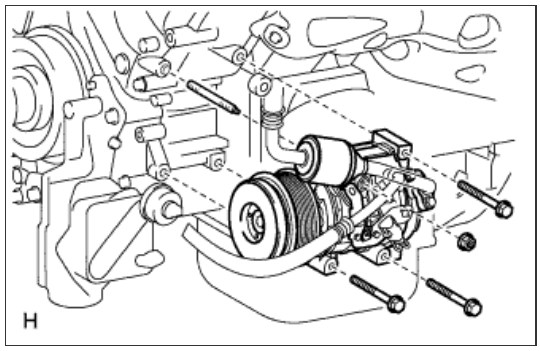


33. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

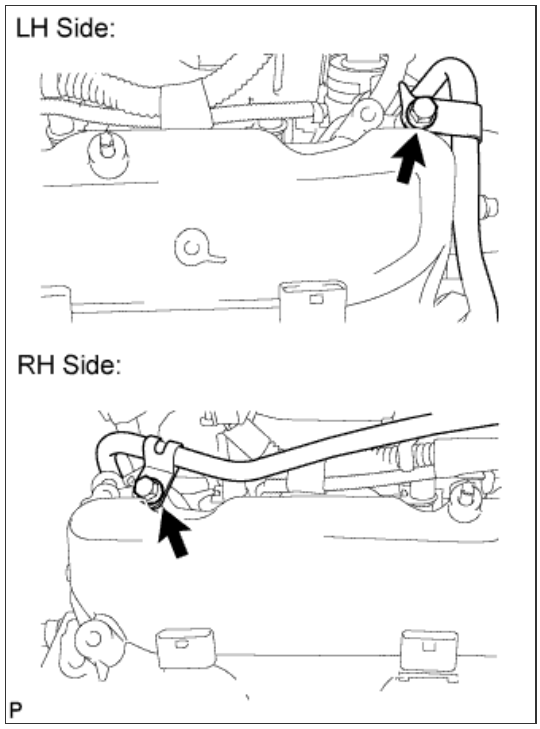
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.



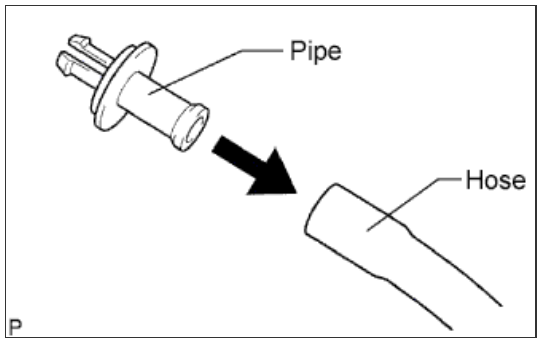
34. DISCONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Remove the 2 bolts and disconnect the fuel tube.

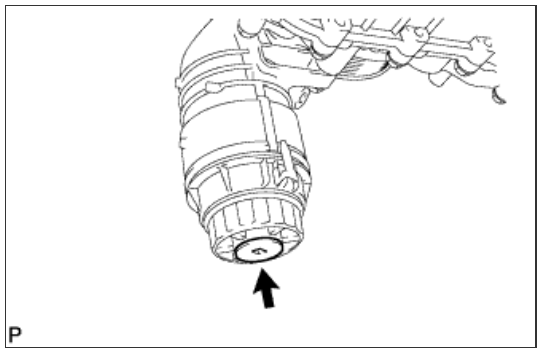


35. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



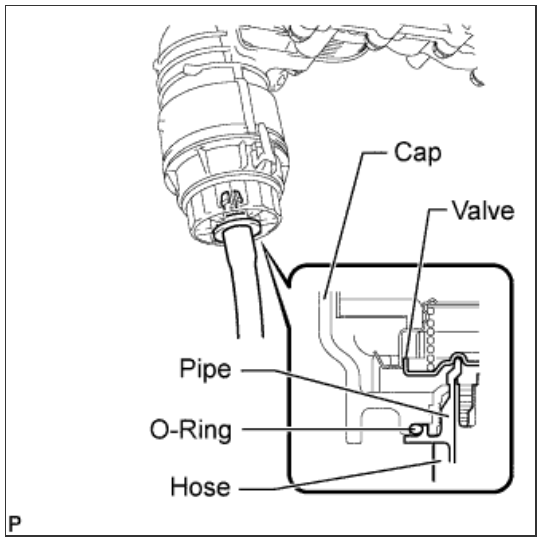
c. Install the pipe to the oil filter cap.

NOTICE:

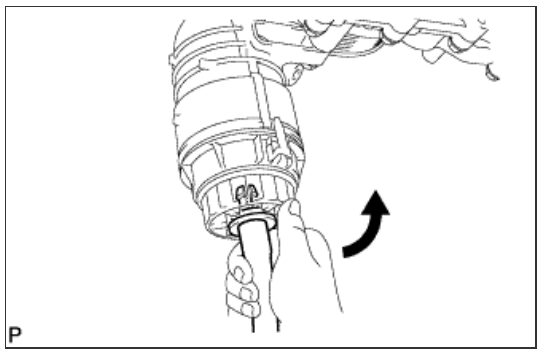
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

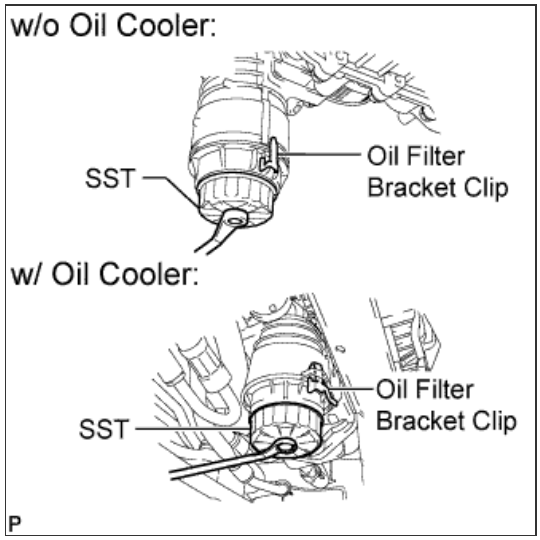


e. Using SST, remove the oil filter cap.

SST
09228-06501

NOTICE:

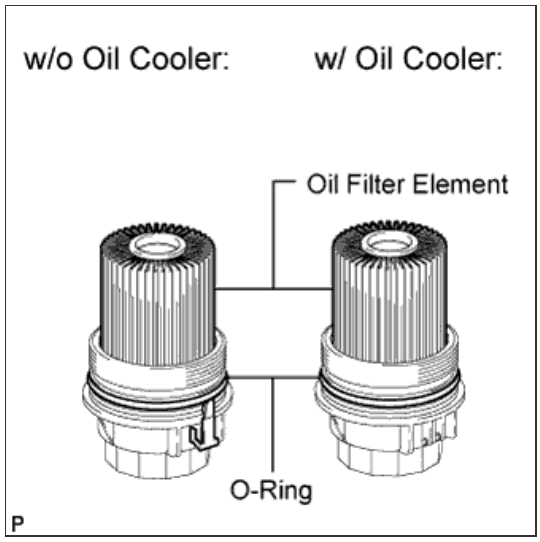
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

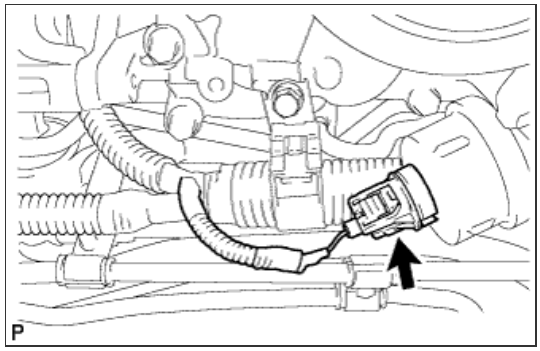
NOTICE:

Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.

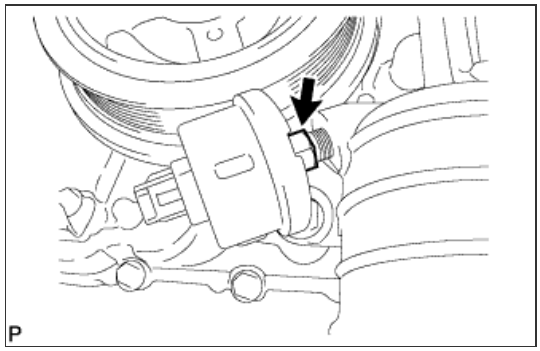


36. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.



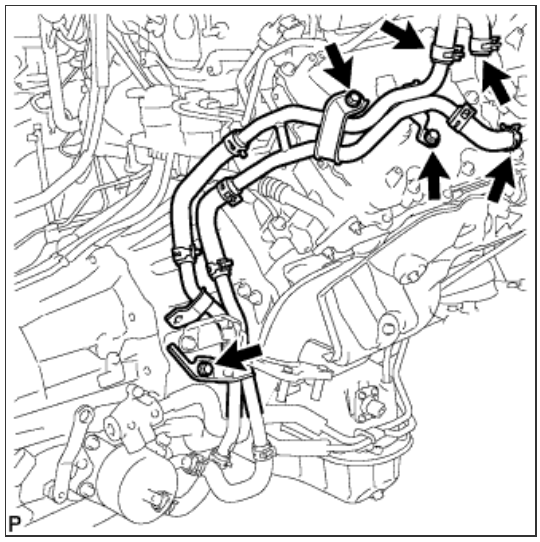
b. Remove the oil pressure sender gauge.



37. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Disconnect the 3 hoses.

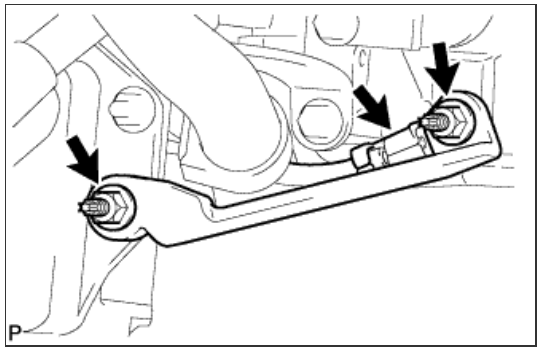
b. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe from the cylinder head cover.



38. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

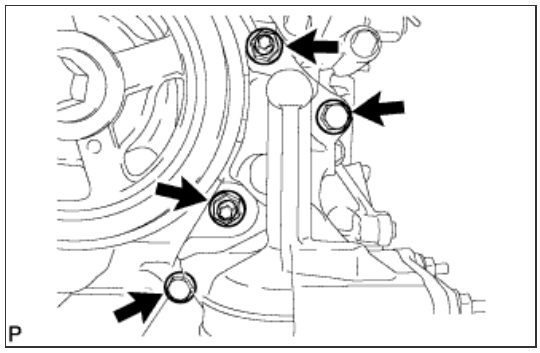
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

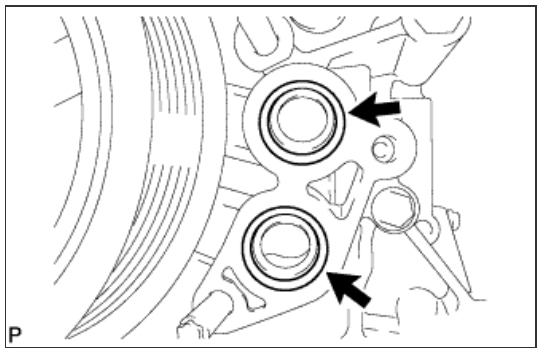


39. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.

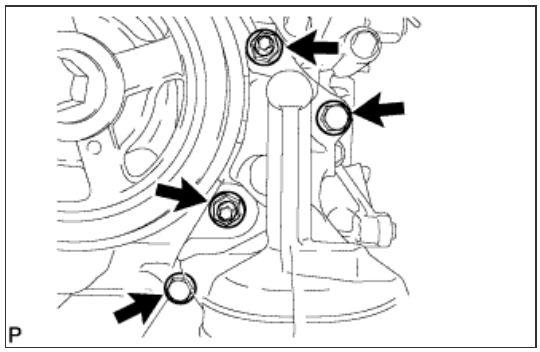


b. Remove the 2 O-rings.

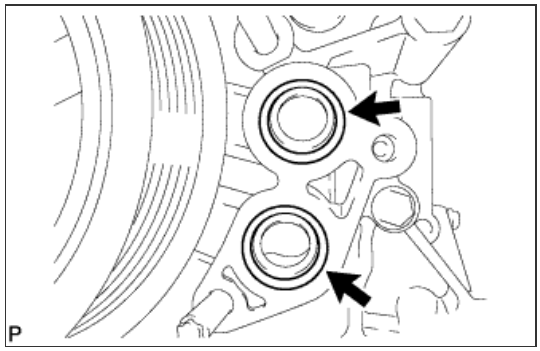


40. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.

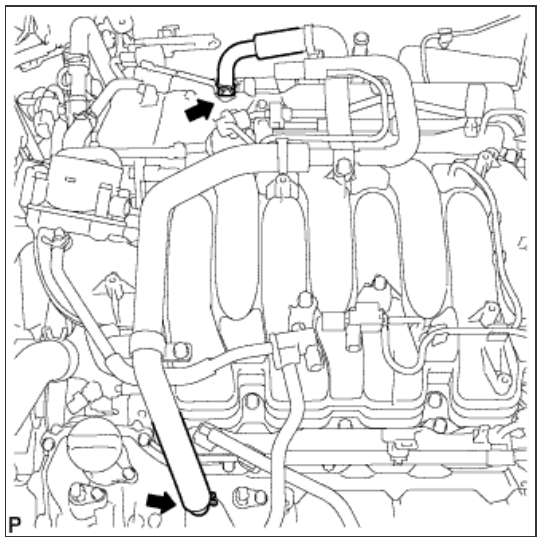


b. Remove the 2 O-rings.



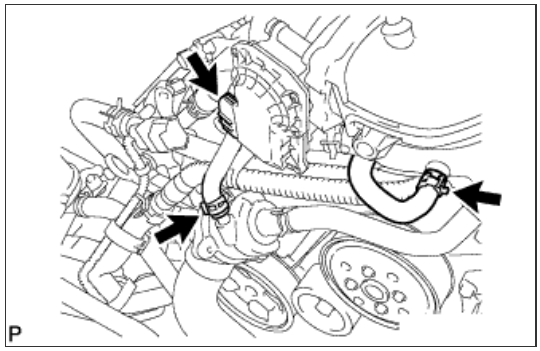
41. REMOVE INTAKE MANIFOLD

a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.

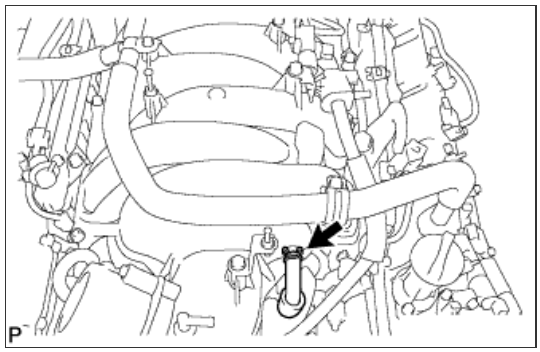


b. Disconnect the 2 water by-pass hoses.

c. Disconnect the throttle body connector.



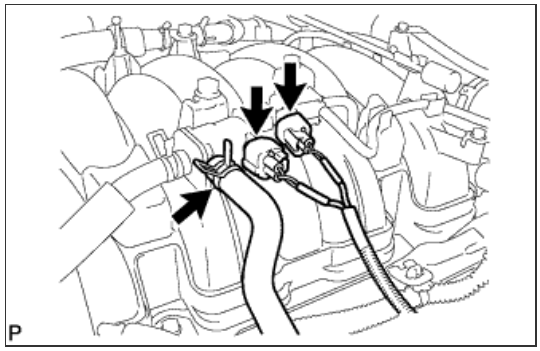
d. Disconnect the No. 1 ventilation hose.



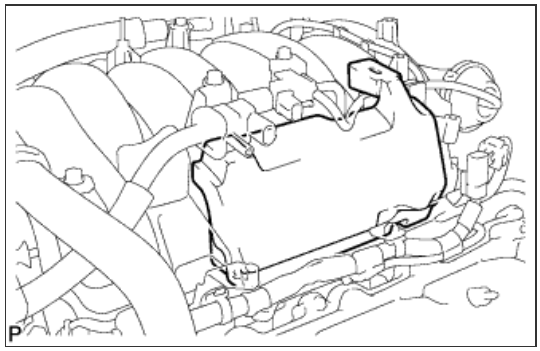
e. Disconnect the purge VSV connector.

f. Disconnect the purge line hose from the purge VSV.

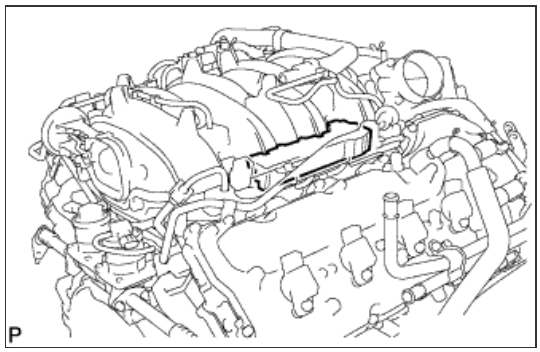
g. Disconnect the vacuum switching valve connector (for ACIS).



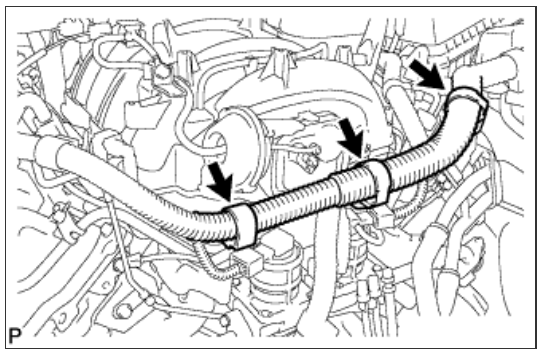
h. Remove the No. 1 engine cover sub-assembly.



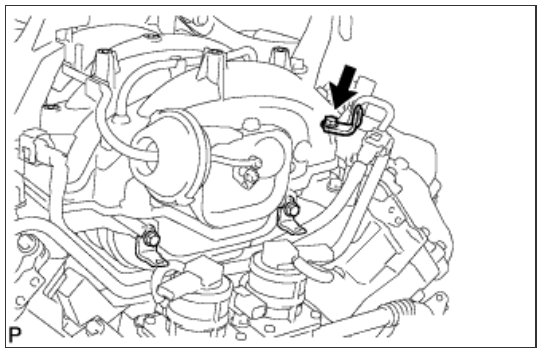
i. Remove the No. 3 engine cover.



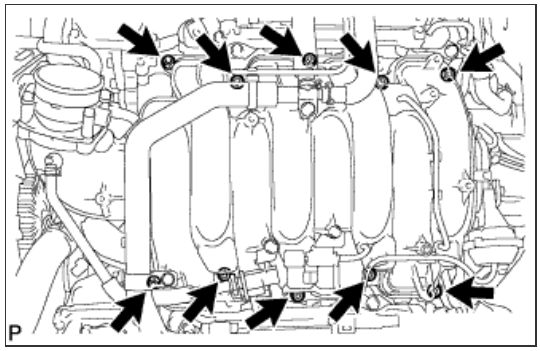
j. Disconnect the 3 wire clamps from the 3 wire brackets.



k. Remove the bolt and wire bracket from the intake manifold.

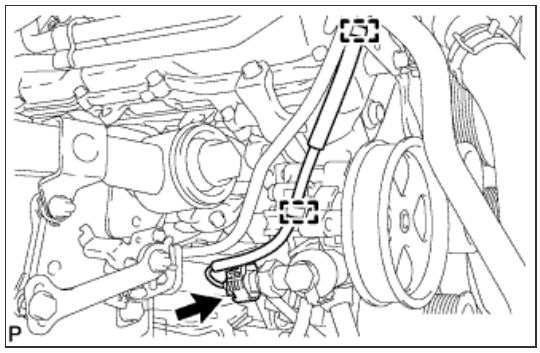


l. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.

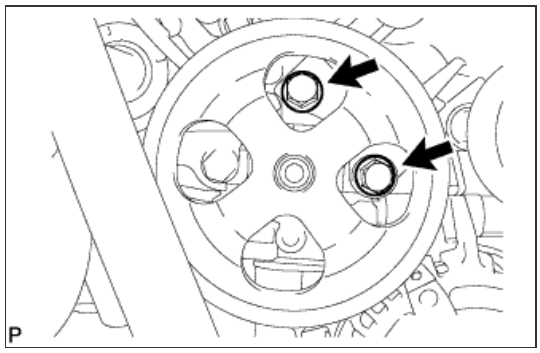


42. DISCONNECT VANE PUMP ASSEMBLY

a. Disconnect the 2 clamps and power steering oil pressure switch connector.



b. Remove the 2 bolts and disconnect the vane pump.

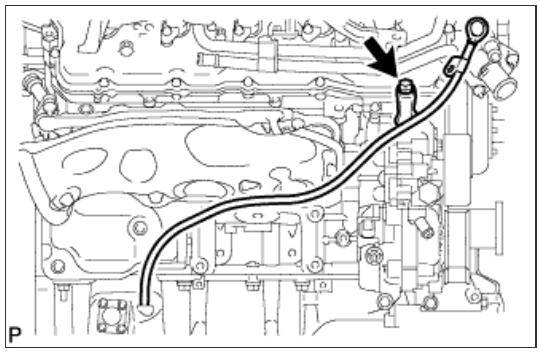


43. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

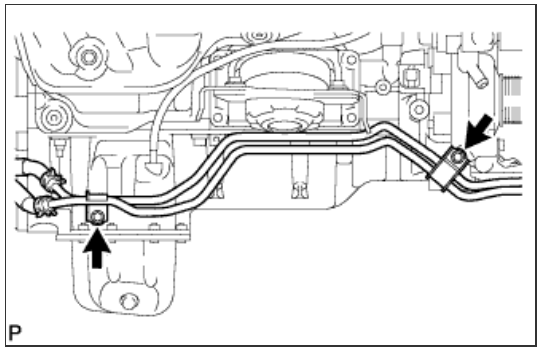
b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.



44. DISCONNECT OIL COOLER PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the oil cooler pipe.

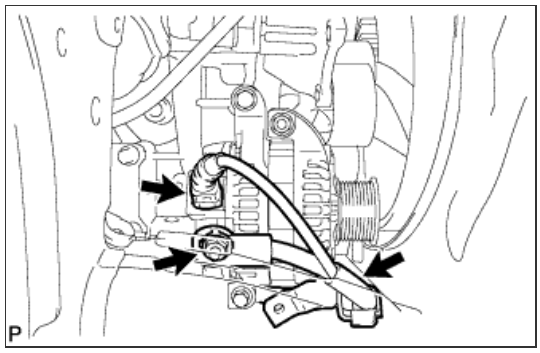


45. REMOVE GENERATOR ASSEMBLY

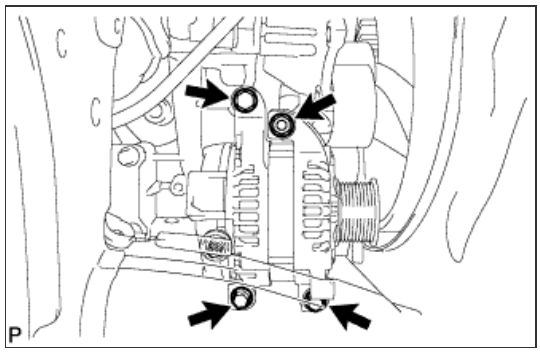
a. Disconnect the generator connector.

b. Remove the terminal cap and nut, and disconnect the generator wire.

c. Remove the bolt and wire harness bracket from the generator.

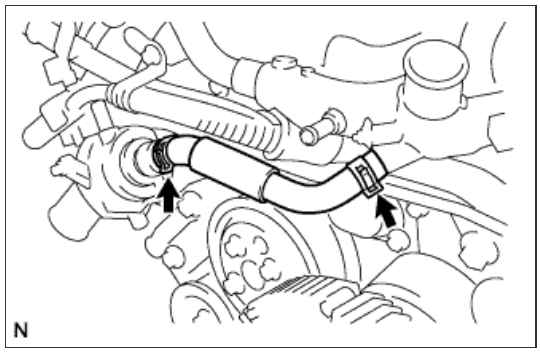


d. Remove the 3 bolts, nut and generator.



46. REMOVE NO. 1 WATER BY-PASS HOSE

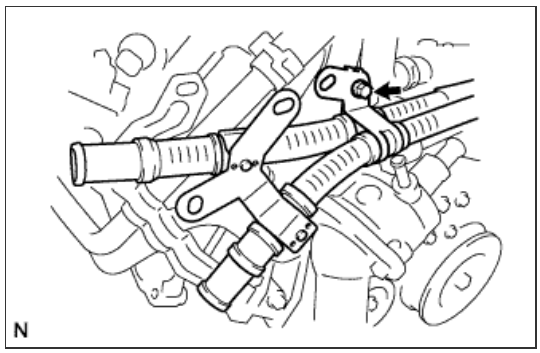
a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.



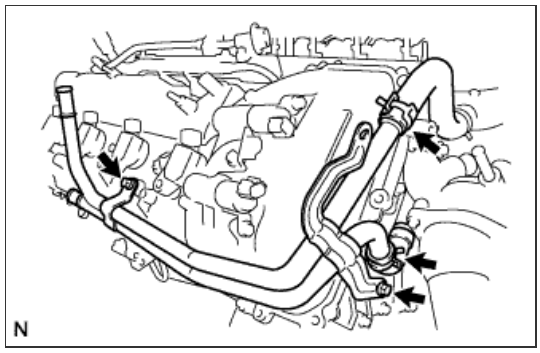
47. REMOVE WATER BY-PASS PIPE SUB-ASSEMBLY

a. w/ Secondary Air Injection System:
Remove the bolt and disconnect the air tube.

b. Disconnect the 2 hoses.



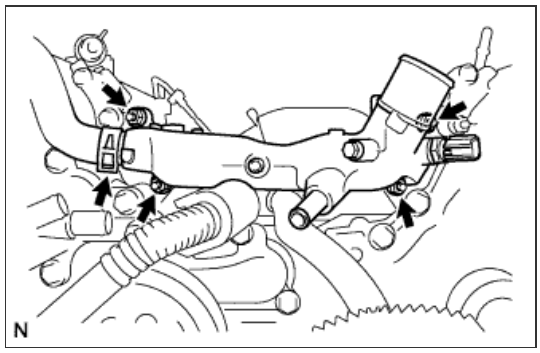
c. Remove the 2 bolts and water by-pass pipe.



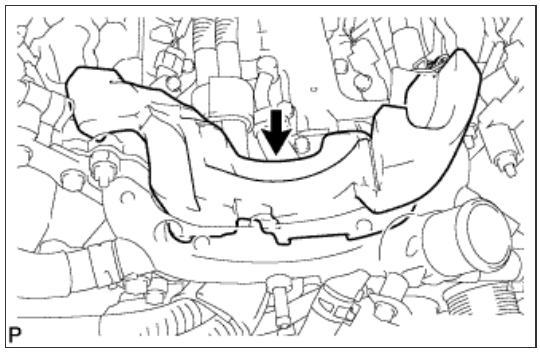
48. REMOVE FRONT WATER BY-PASS JOINT

a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

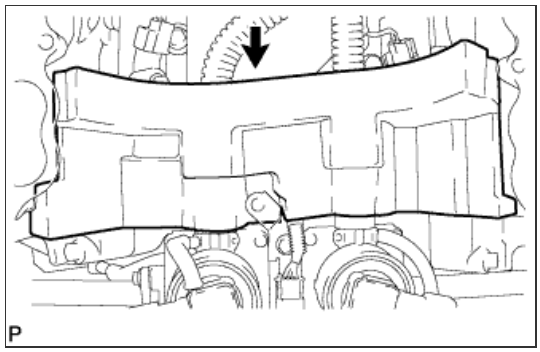
b. Remove the 4 nuts, water by-pass joint and 2 gaskets.



49. REMOVE NO. 2 ENGINE COVER

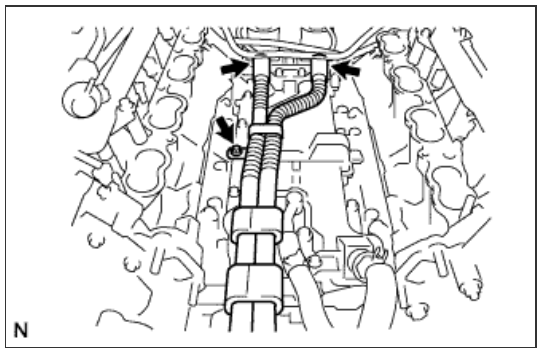


50. REMOVE NO. 1 ENGINE COVER



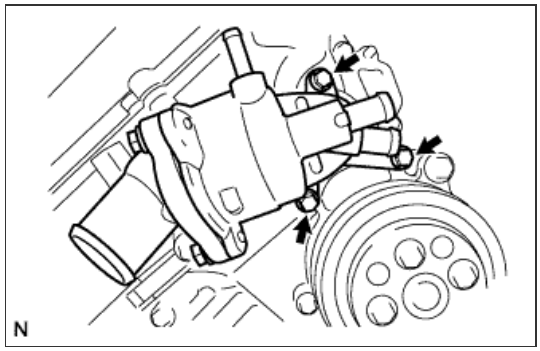
51. REMOVE AIR PIPE SUB-ASSEMBLY (w/ Secondary Air Injection System)

a. Remove the bolt, disconnect the 2 hoses, and remove the air pipe.



52. REMOVE WATER INLET HOUSING

a. Remove the 3 bolts, water inlet housing and gasket.

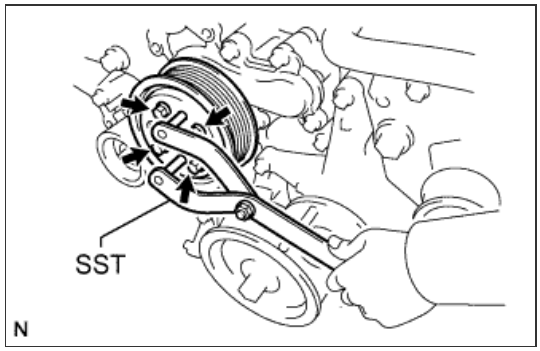


53. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

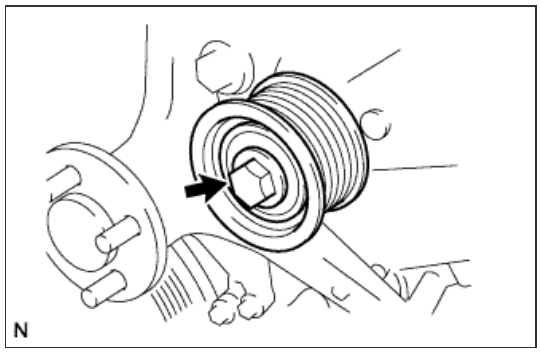
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



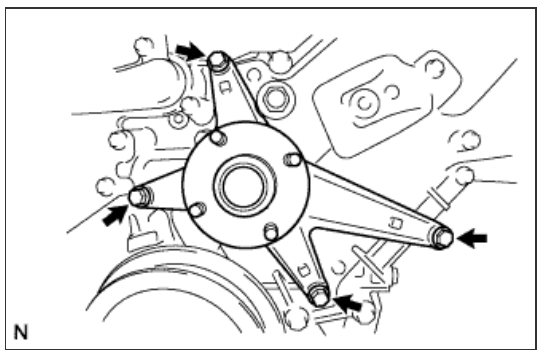
54. REMOVE NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Remove the bolt and idler pulley.



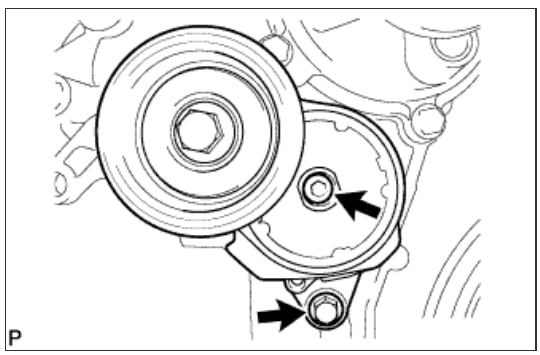
55. REMOVE FLUID COUPLING BRACKET

a. Remove the 4 bolts and fluid coupling bracket.



56. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY

a. Remove the standard bolt, 6 mm hexagon wrench bolt and belt tensioner.



57. REMOVE IGNITION COIL ASSEMBLY

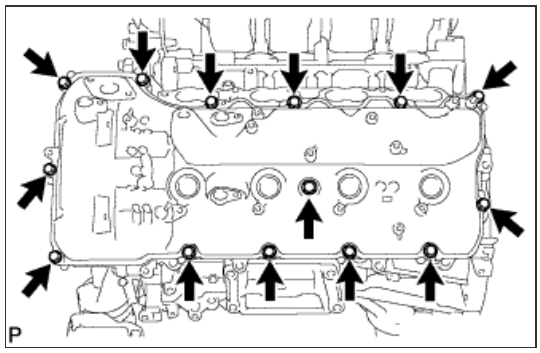
a. Remove the 8 bolts and 8 ignition coils.

58. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY LH

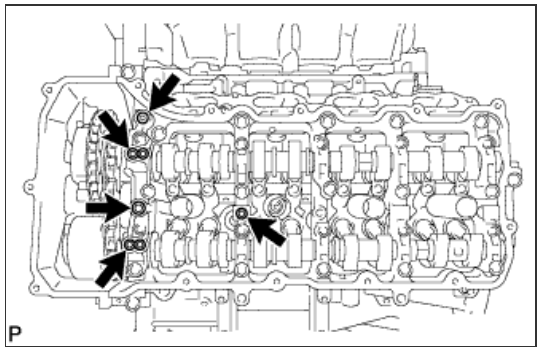
a. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

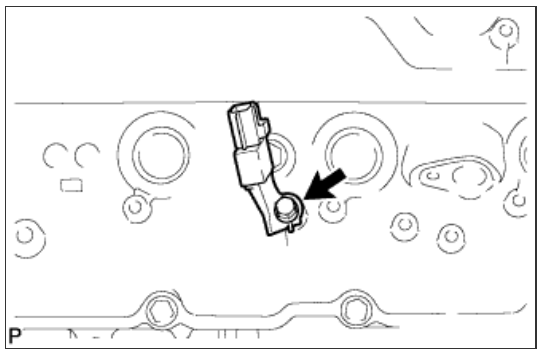


b. Remove the 5 gaskets from the camshaft bearing caps (No. 2, No. 3).



59. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY RH

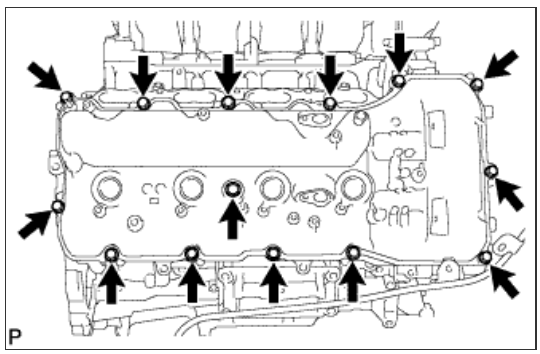
a. Remove the bolt and noise filter.



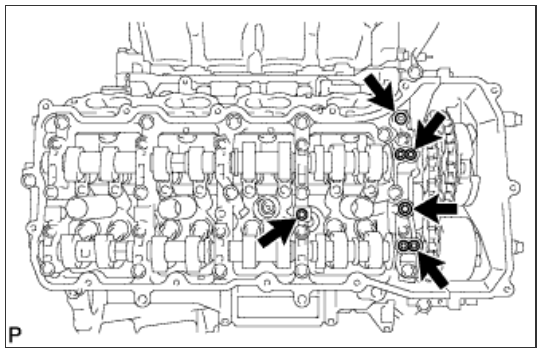
b. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.



c. Remove the 5 gaskets from the camshaft bearing caps (No. 1, No. 3).



60. REMOVE SPARK PLUG TUBE GASKET

a. Bend the 4 ventilation baffle plate claws on the cylinder head cover to an angle of 90° or more.

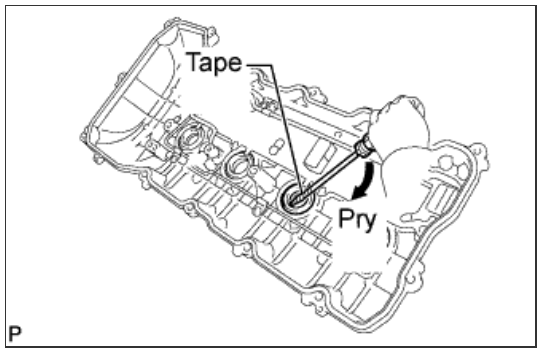
b. Using a screwdriver, pry out the gaskets.

HINT:

Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the cylinder head cover.**
- **Be careful not to damage the gasket when removing it, as the removed gasket needs to be used when installing a new one.**

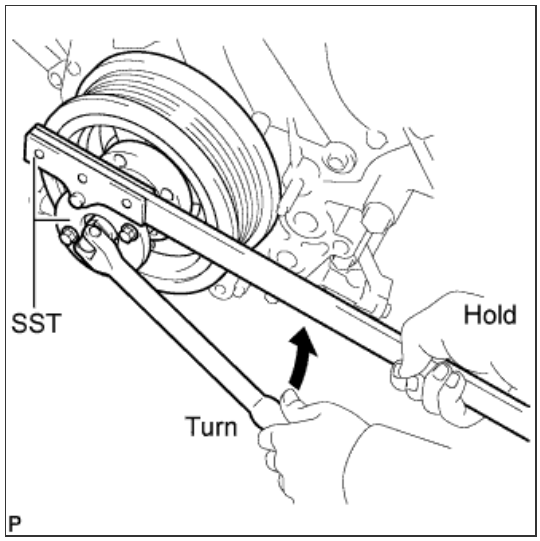


61. REMOVE CRANKSHAFT PULLEY

a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST

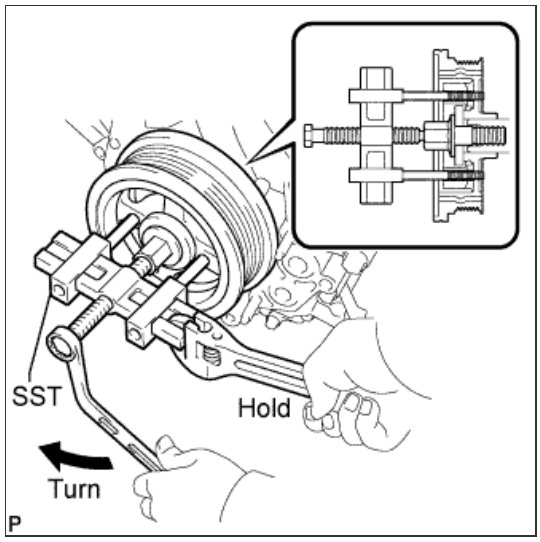
09213-70011 (09213-70020)
09330-00021



b. Using the pulley set bolt and SST, remove the crankshaft pulley.

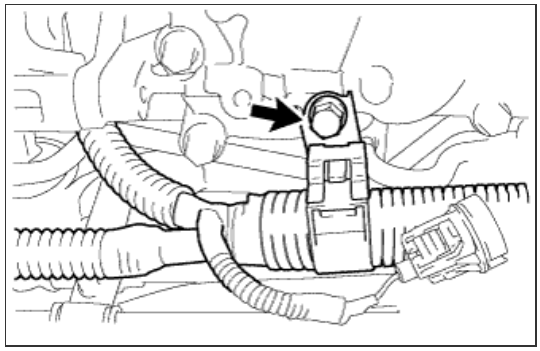
SST

09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



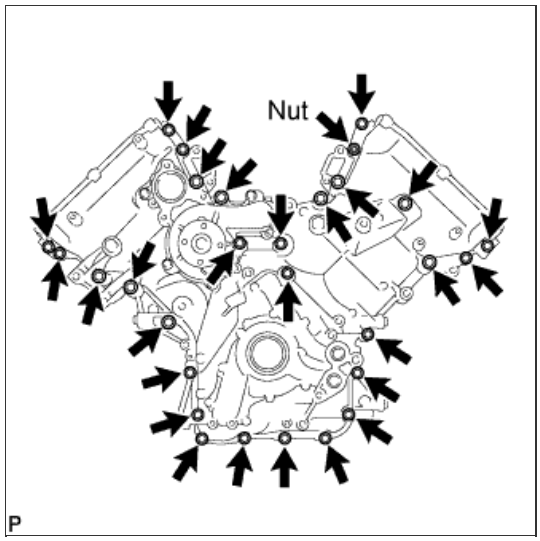
62. DISCONNECT WIRE HARNESS CLAMP BRACKET

a. Remove the bolt and disconnect the bracket.



63. REMOVE TIMING CHAIN COVER SUB-ASSEMBLY

a. Remove the 28 bolts and nut shown in the illustration.



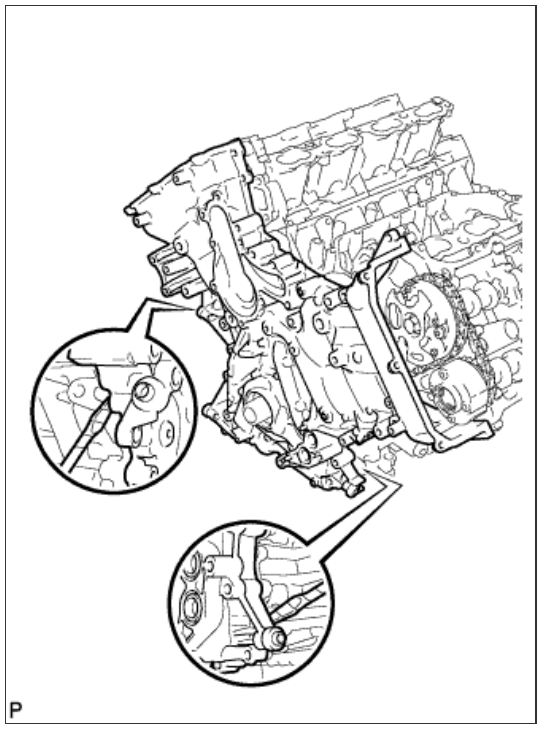
b. Remove the timing chain cover by prying between the timing chain cover and cylinder head or cylinder block with a screwdriver as shown in the illustration.

NOTICE:

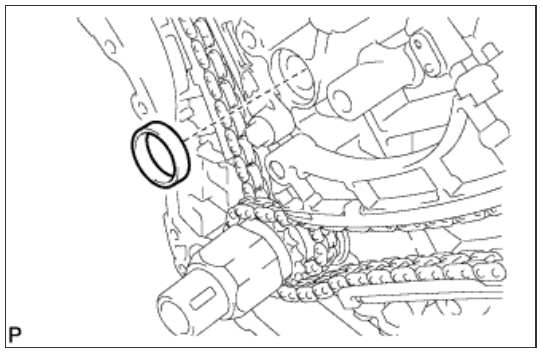
Be careful not to damage the contact surfaces of the cylinder head, cylinder block and chain cover.

HINT:

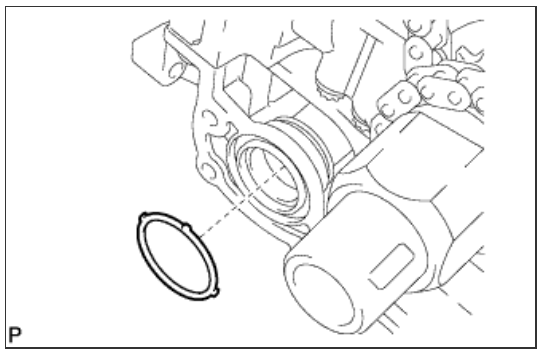
Tape the screwdriver tip before use.



c. Remove the oil pump gasket from the cylinder block.



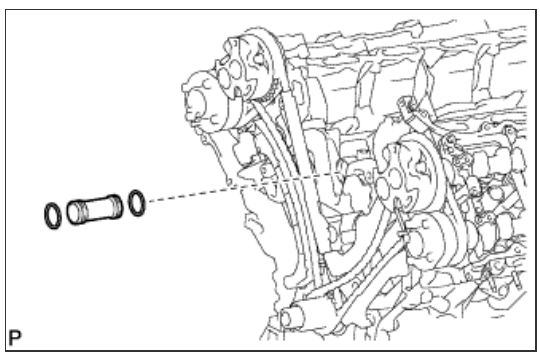
d. Remove the O-ring from the oil pan.



64. REMOVE WATER INLET PIPE

a. Remove the water inlet pipe.

b. Remove the 2 O-rings from the water inlet pipe.



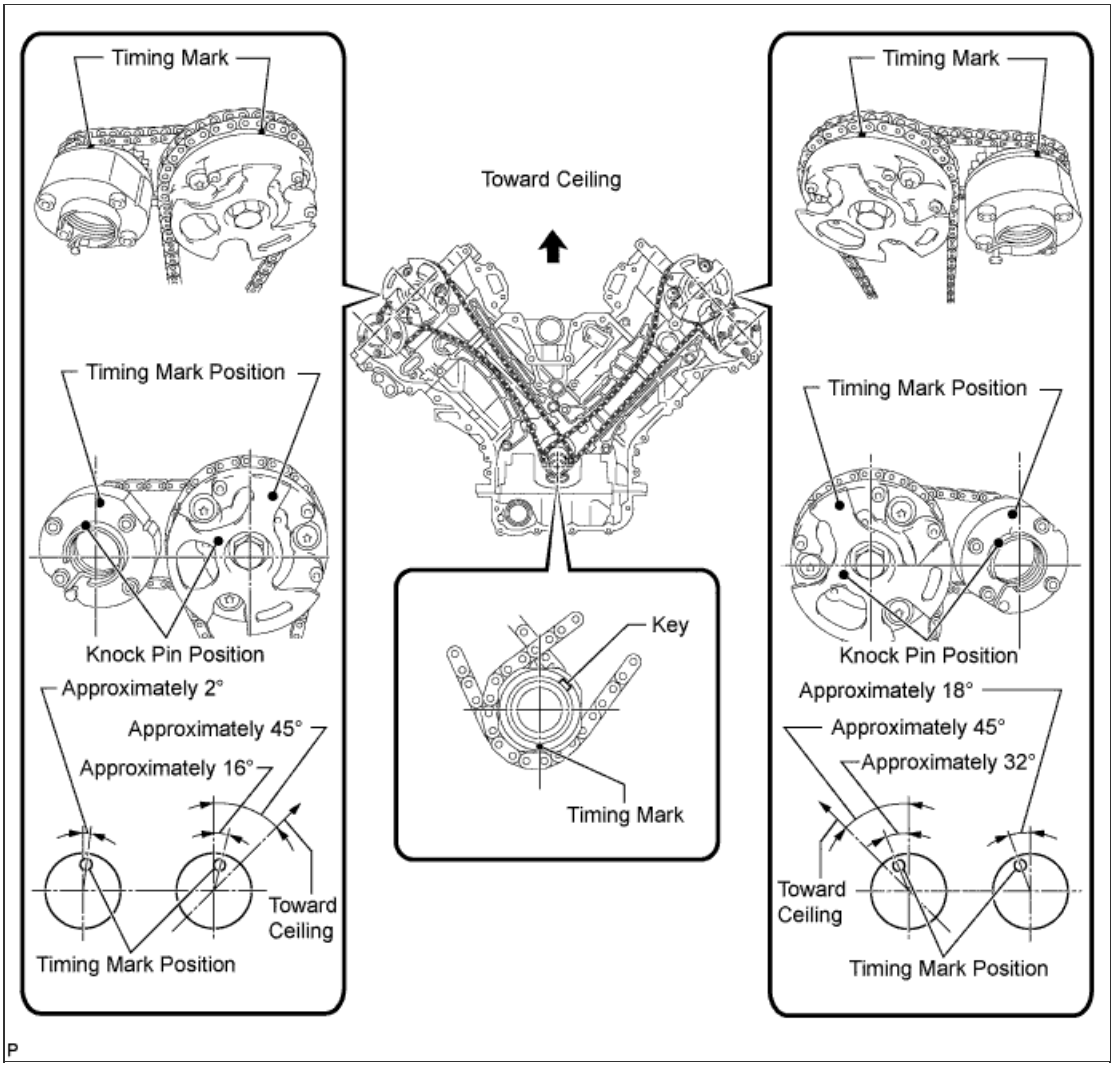
65. SET NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise so that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

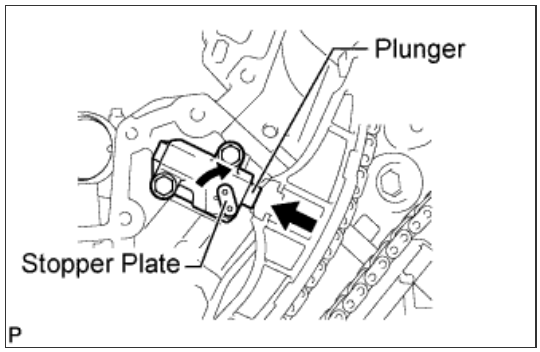
HINT:

If the timing marks do not align, rotate the crankshaft clockwise again and align the timing marks.

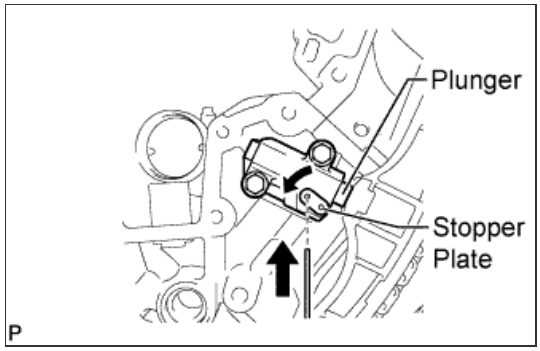


66. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY LH

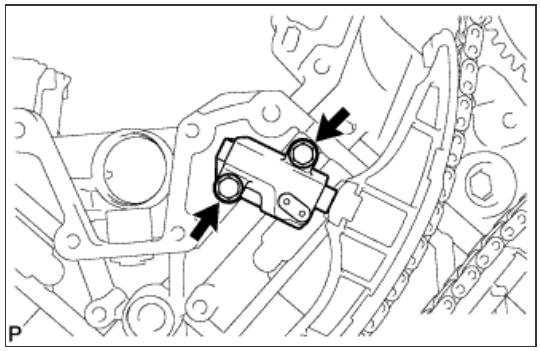
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



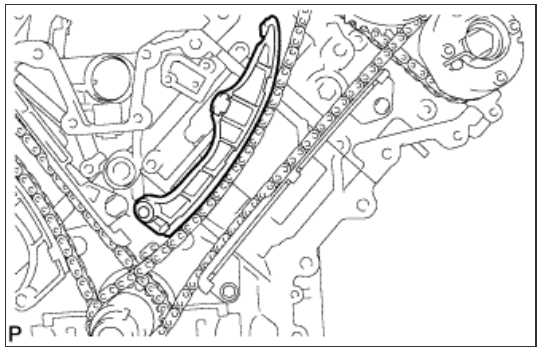
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts, chain tensioner and gasket.

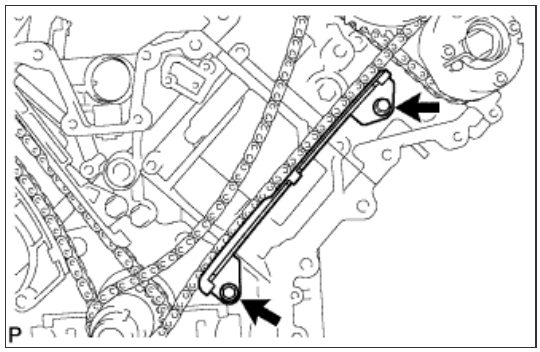


67. REMOVE NO. 1 CHAIN TENSIONER SLIPPER LH



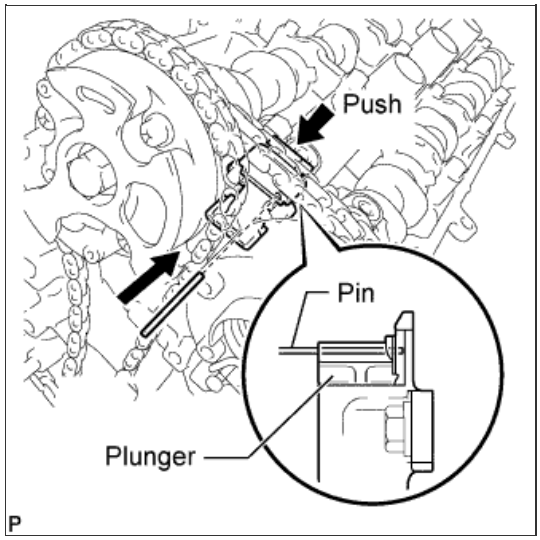
68. REMOVE NO. 1 CHAIN VIBRATION DAMPER LH

a. Remove the 2 bolts and chain vibration damper.



69. REMOVE NO. 1 CHAIN SUB-ASSEMBLY LH

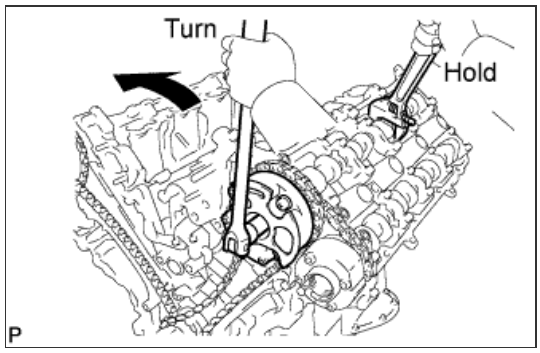
a. While pushing down the No. 3 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



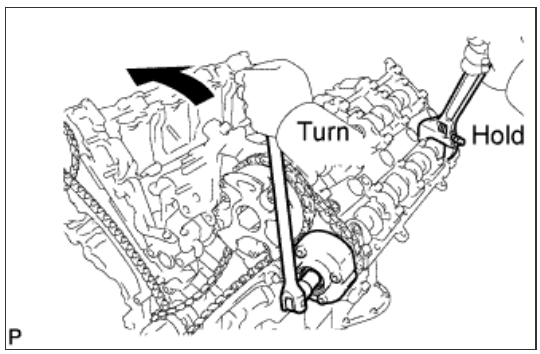
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

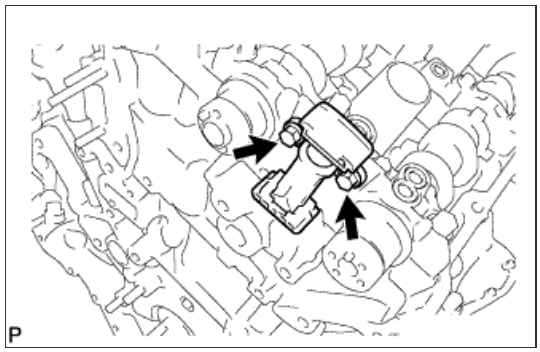
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket LH.

e. Remove the No. 1 and No. 2 chains from the gears.



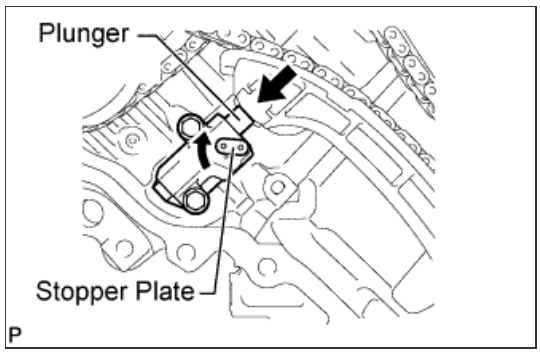
70. REMOVE NO. 3 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.

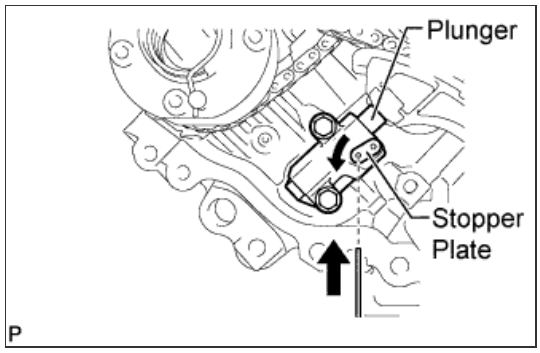


71. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY RH

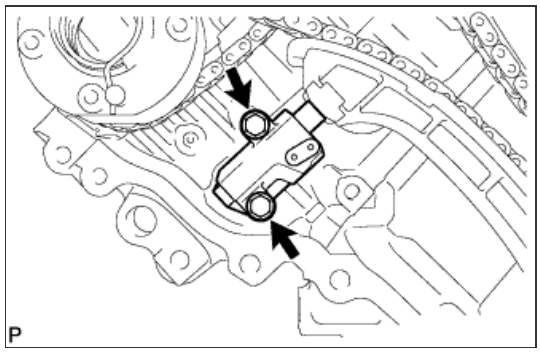
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



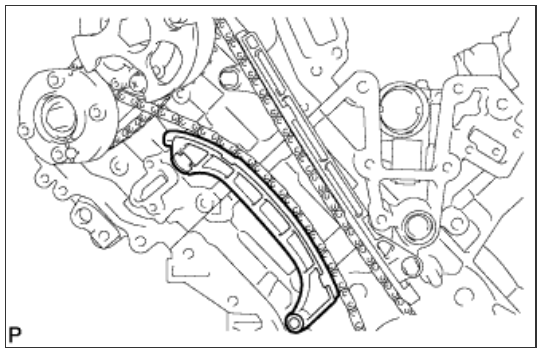
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts and chain tensioner.

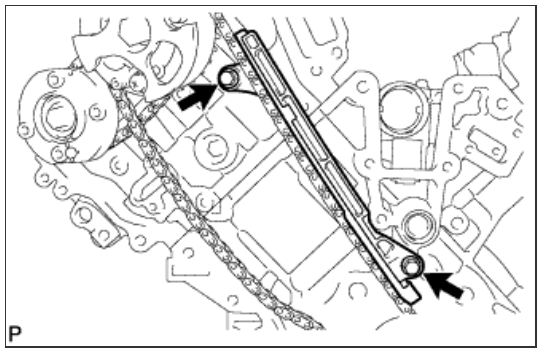


72. REMOVE NO. 1 CHAIN TENSIONER SLIPPER RH



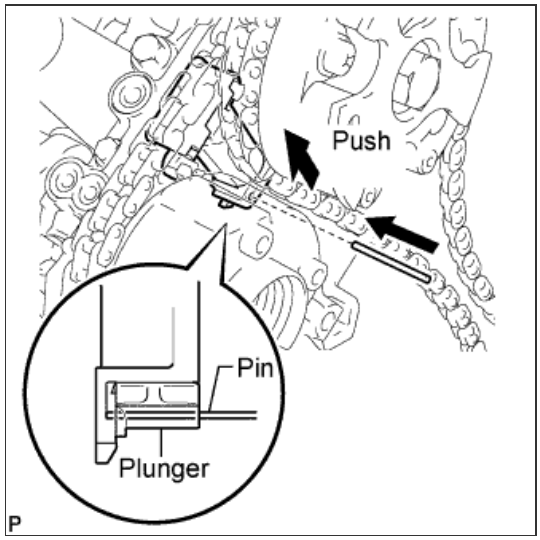
73. REMOVE NO. 1 CHAIN VIBRATION DAMPER RH

a. Remove the 2 bolts and vibration damper.



74. REMOVE NO. 1 CHAIN SUB-ASSEMBLY RH

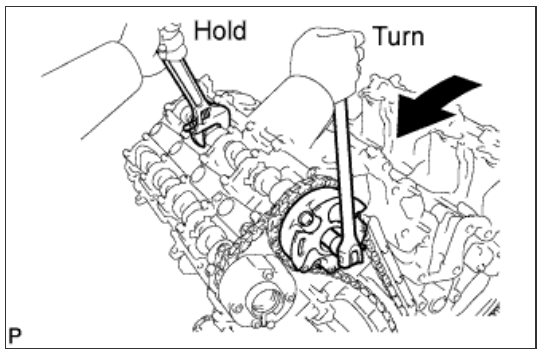
a. While raising up the No. 2 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



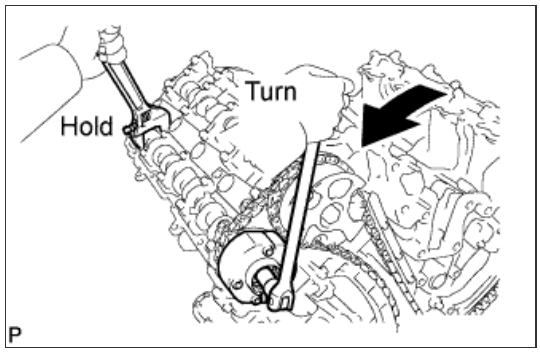
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

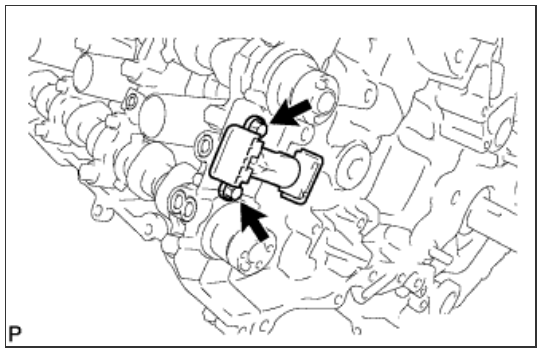
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket RH.

e. Remove the No. 1 and No. 2 chains from the gears.



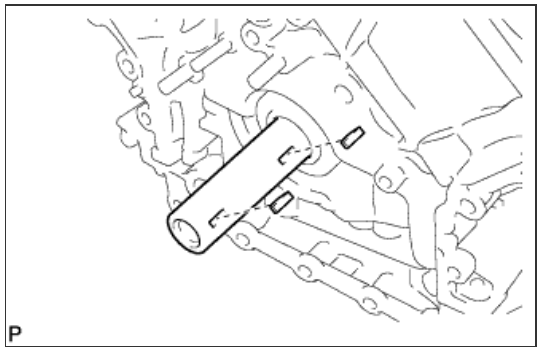
75. REMOVE NO. 2 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.



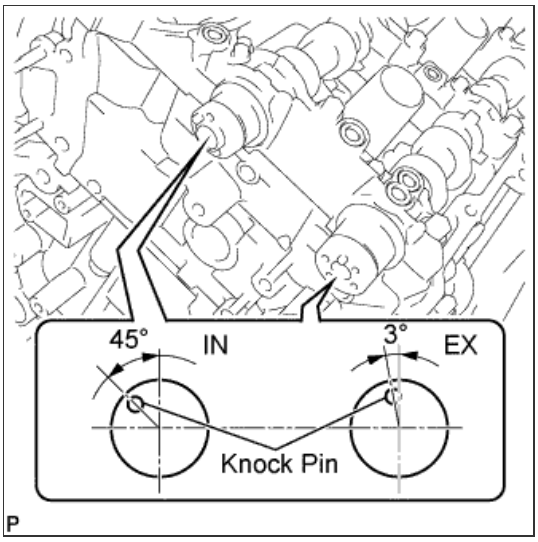
76. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Using a screwdriver, remove the 2 timing gear keys from the crankshaft.

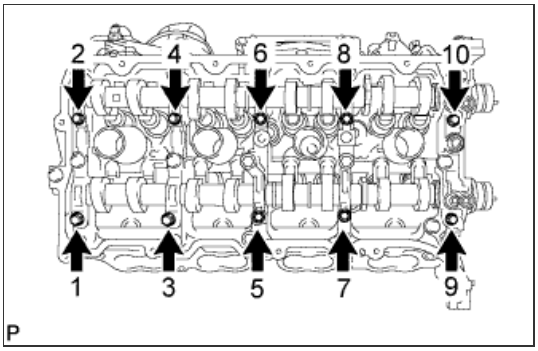


77. REMOVE CAMSHAFT BEARING CAP LH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

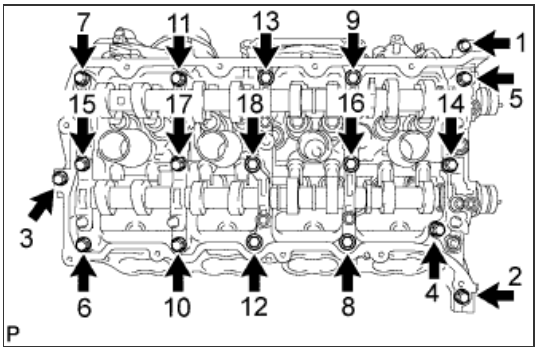
Uniformly loosen the bolts while keeping the camshaft level.

d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 3 and No. 4 camshafts.



78. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY LH

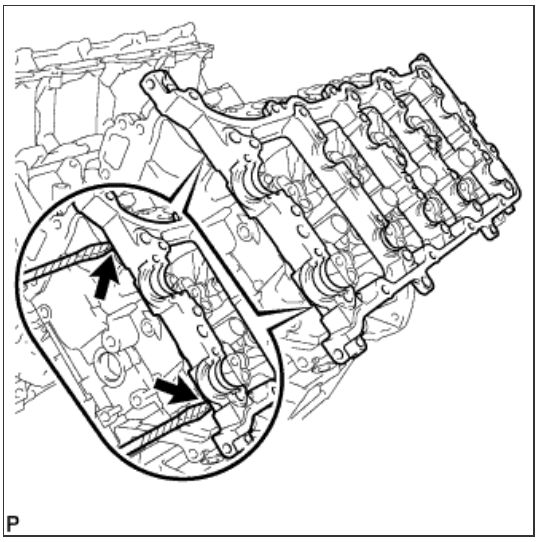
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

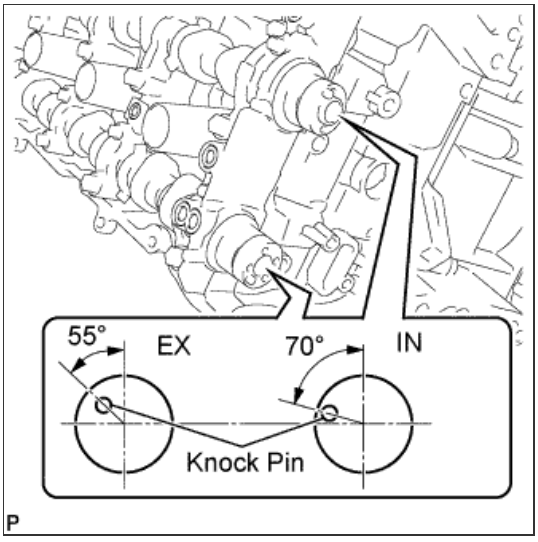
NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.

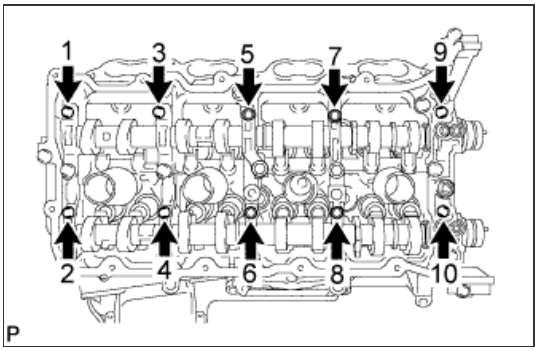


79. REMOVE CAMSHAFT BEARING CAP RH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

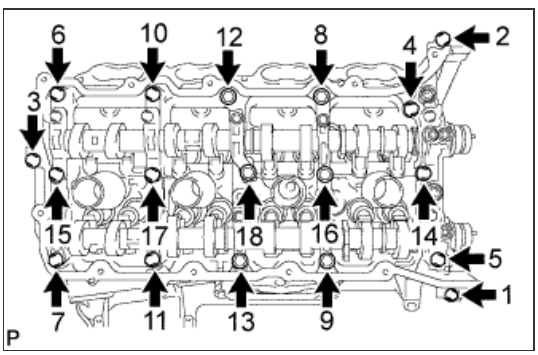
Uniformly loosen the bolts while keeping the camshaft level.

d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 1 and No. 2 camshafts.



80. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY RH

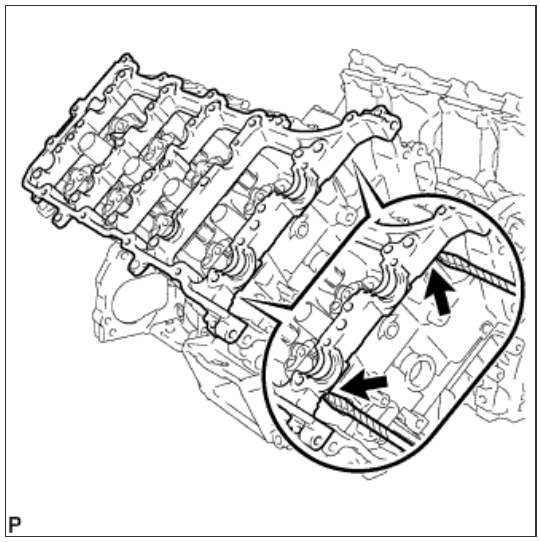
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.



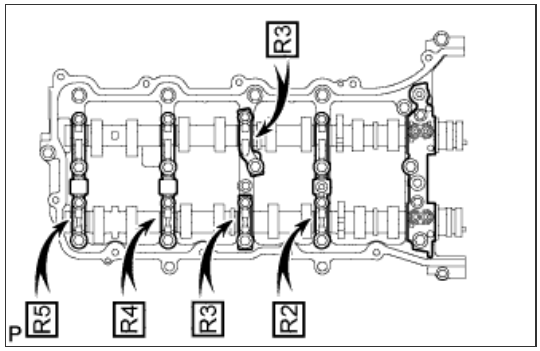
for Preparation Click here

1. INSTALL CAMSHAFT BEARING CAP RH

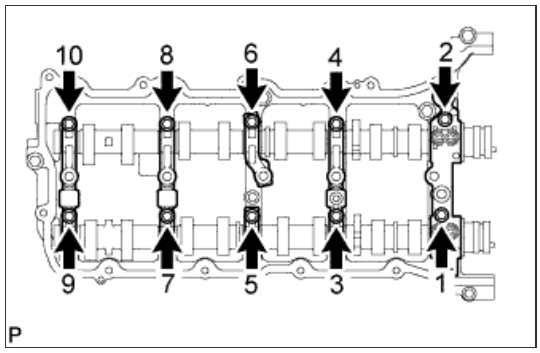
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 1 and No. 2 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

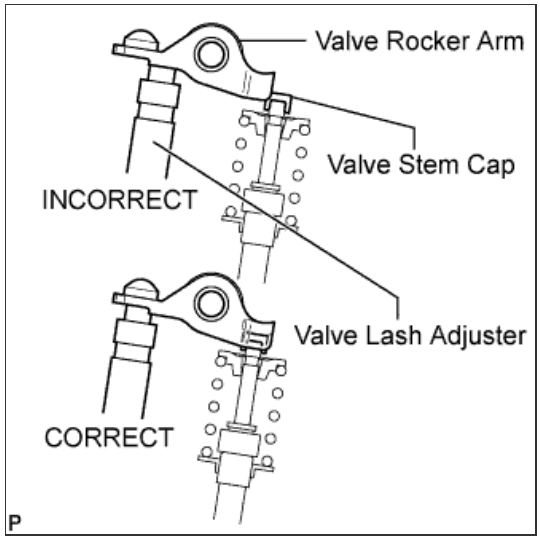


d. Temporarily install the 10 bolts in the order shown in the illustration.



2. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY RH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



b. Apply seal packing in a continuous line as shown in the illustration.

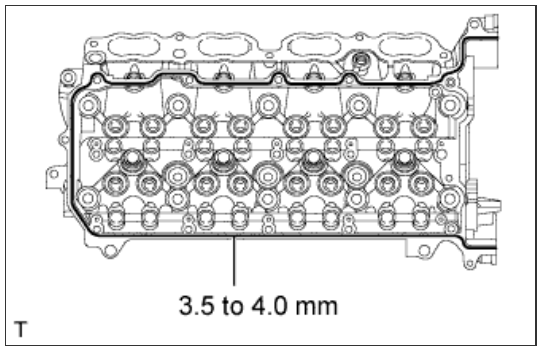
Seal packing:

Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

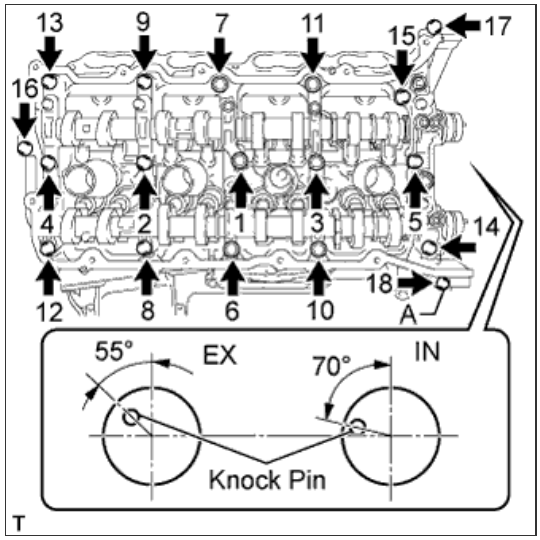


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

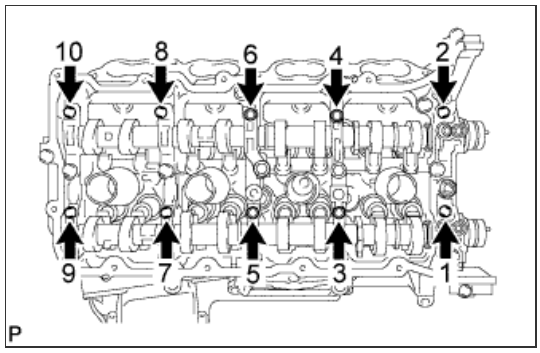


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

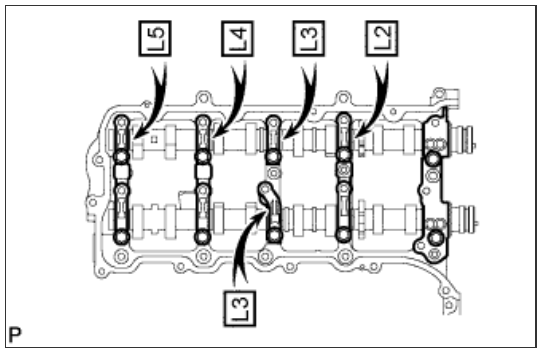


3. INSTALL CAMSHAFT BEARING CAP LH

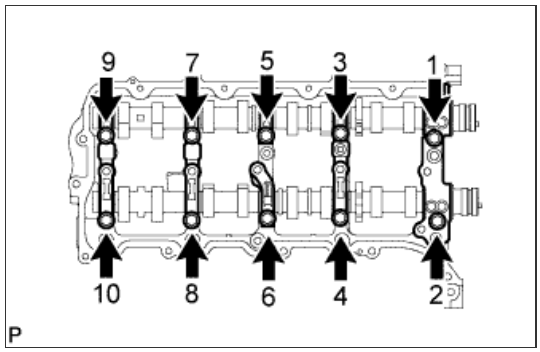
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 3 and No. 4 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

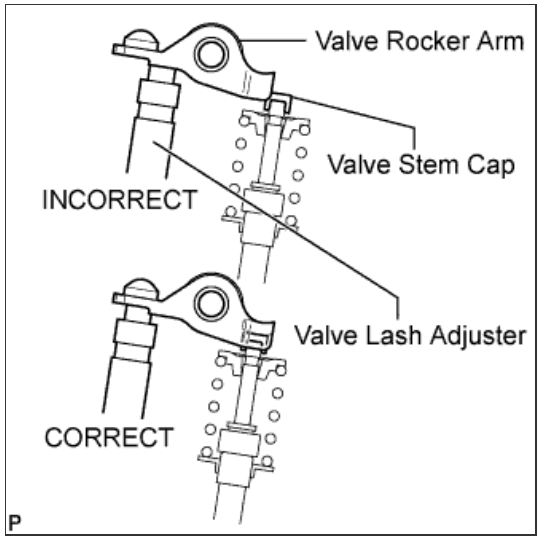


d. Temporarily install the 10 bolts in the order shown in the illustration.



4. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY LH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



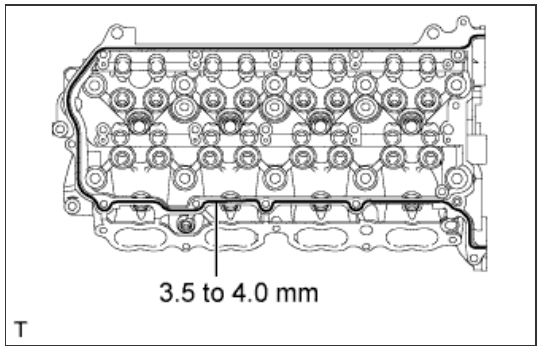
b. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

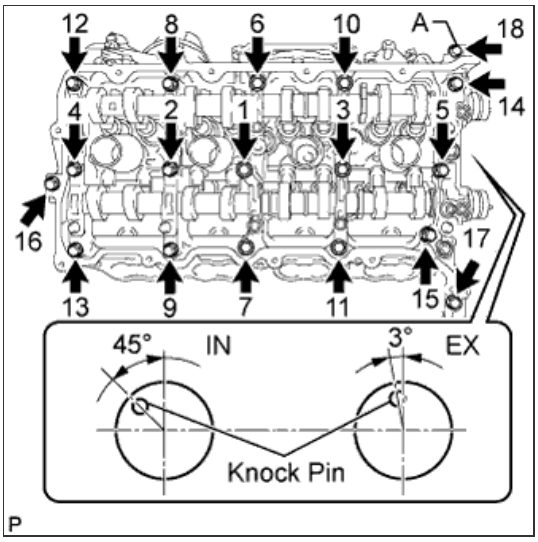


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

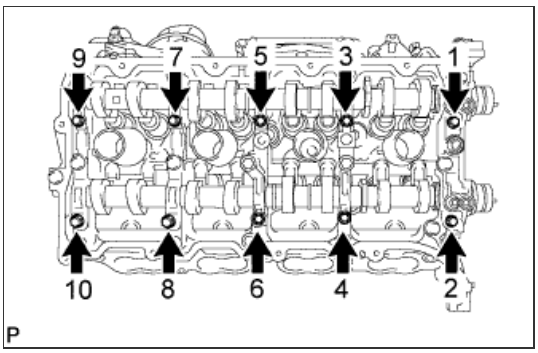


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

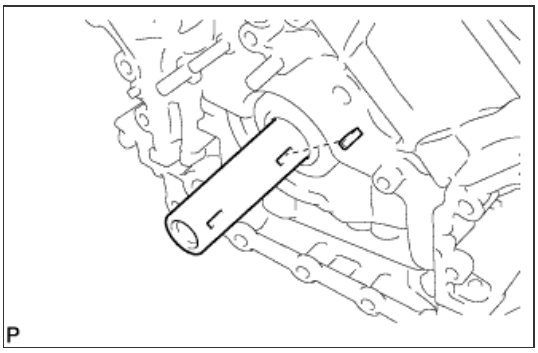


5. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the timing gear key.

HINT:

The other timing gear key will be installed at a later step.



6. SET NO. 1 CYLINDER TO TDC/COMPRESSION

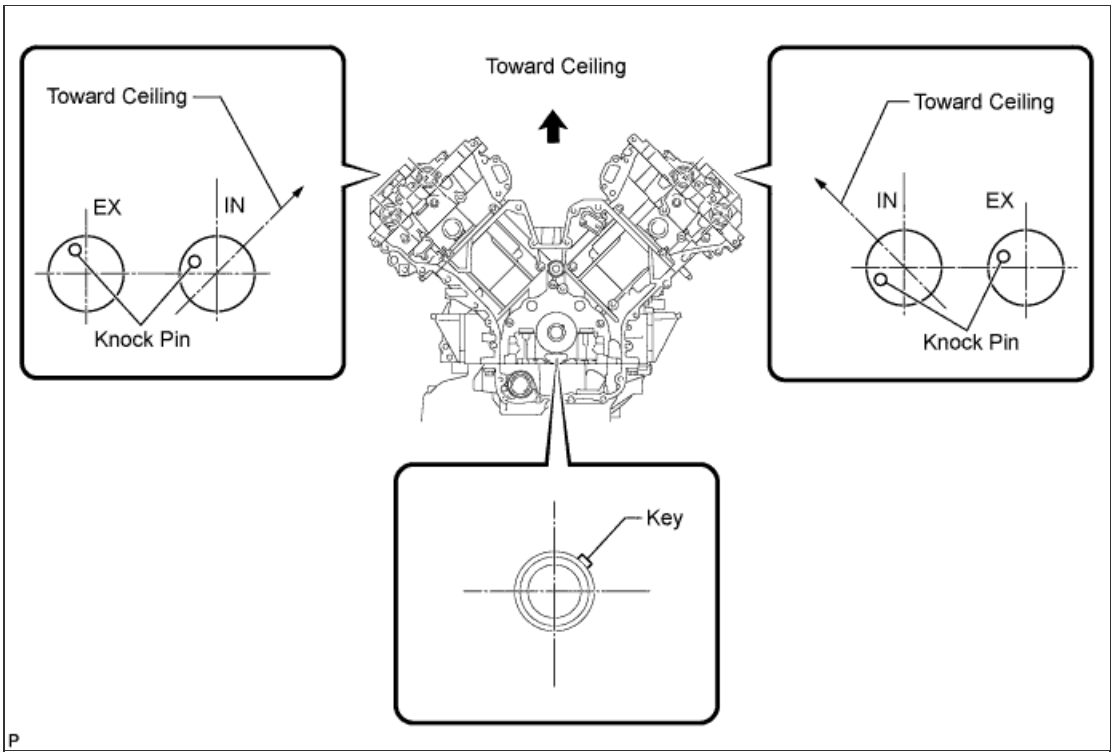
a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft so that the timing gear key is as shown in the illustration. Then using a wrench, rotate each camshaft so that the timing marks are as shown in the illustration.

NOTICE:

When the crankshaft or a camshaft is rotated excessively, the valves and pistons may interfere with each other.

c. Remove the crankshaft pulley bolt.

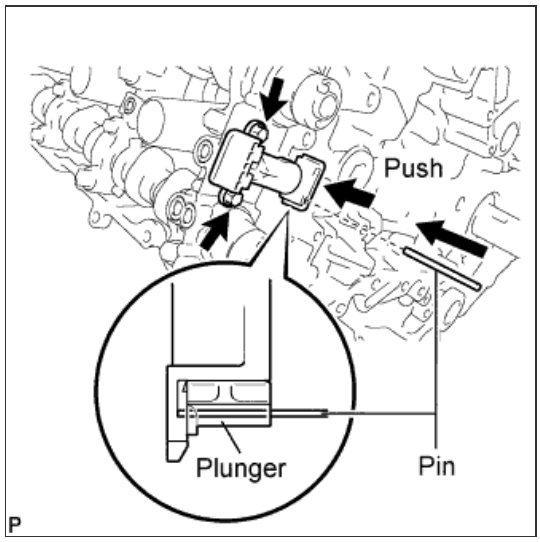


7. INSTALL NO. 2 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

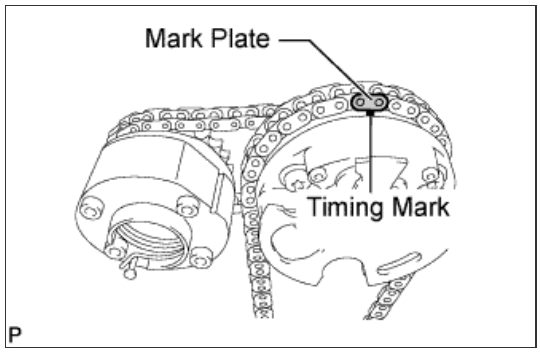
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While raising up the No. 2 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.

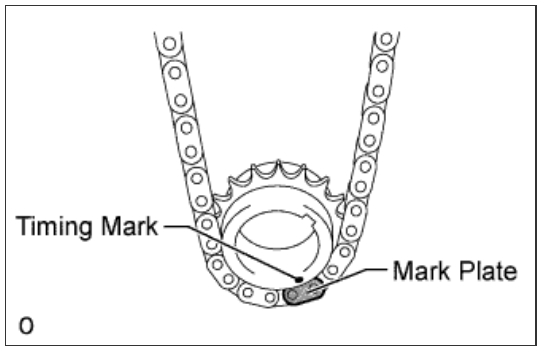


8. INSTALL NO. 1 CHAIN SUB-ASSEMBLY RH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



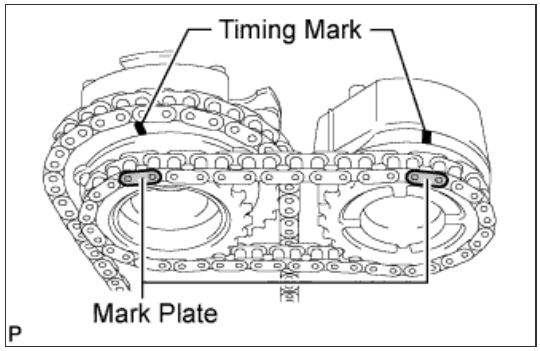
b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

HINT:

The crankshaft timing sprocket RH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.



d. Install the crankshaft timing sprocket RH to the crankshaft.

e. Align and attach the knock pin of the No. 1 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 2 camshaft, align and attach the knock pin of the No. 2 camshaft with the pin hole of the camshaft timing exhaust gear.

g. Remove the pin from the No. 2 chain tensioner.

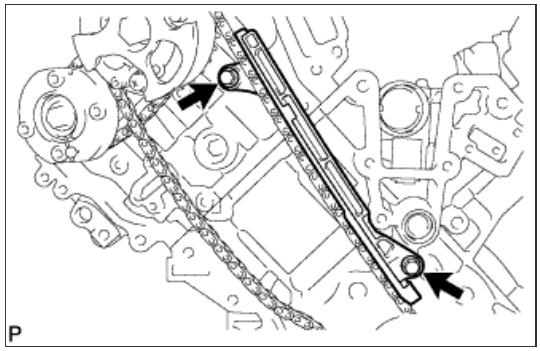
h. Using a wrench to hold the hexagonal portion of the No. 1 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, temporarily install the bolt.

9. INSTALL NO. 1 CHAIN VIBRATION DAMPER RH

a. Install the vibration damper with the 2 bolts.

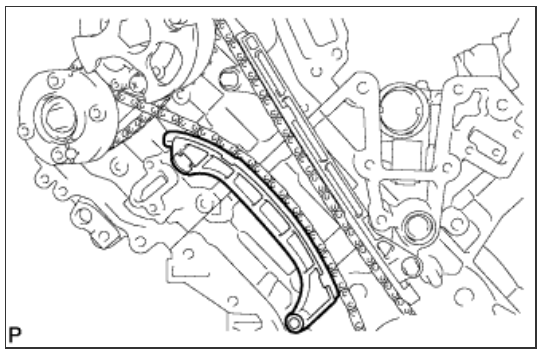
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



10. INSTALL NO. 1 CHAIN TENSIONER SLIPPER RH

HINT:

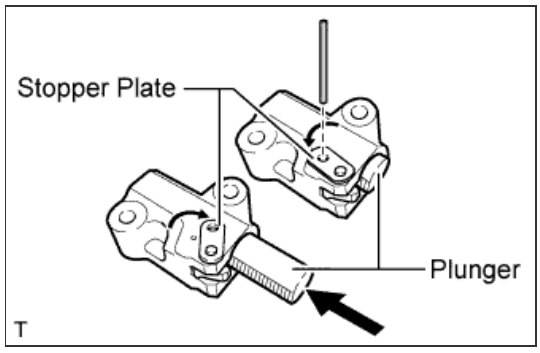
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and then install the chain tensioner slipper.



11. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY RH

a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

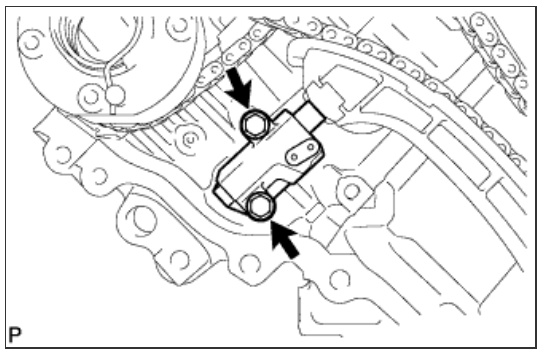
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Remove the hexagon wrench from the chain tensioner.

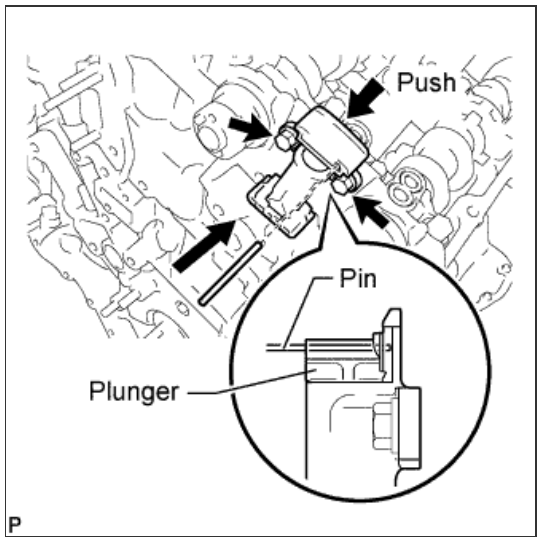


12. INSTALL NO. 3 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

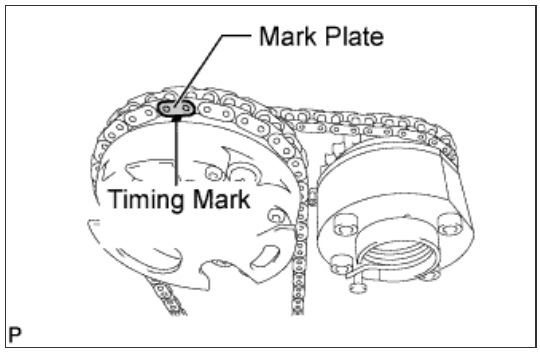
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While pushing down the No. 2 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.

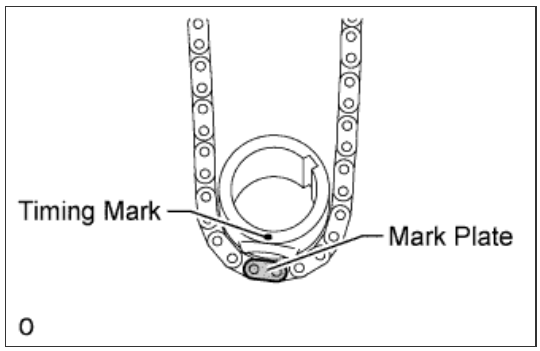


13. INSTALL NO. 1 CHAIN SUB-ASSEMBLY LH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



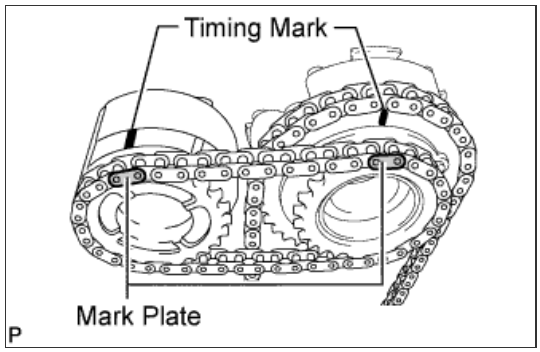
b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

HINT:

The crankshaft timing sprocket LH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.



d. Install the crankshaft timing sprocket LH to the crankshaft.

e. Align and attach the knock pin of the No. 3 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 4 camshaft, align and attach the knock pin of the No. 4 camshaft with the pin hole of the camshaft timing exhaust gear.

NOTICE:

Because the timing mark positions of the gears may shift due to looseness of the No. 1 chain, use the hexagonal portion of the camshaft to hold the No. 3 camshaft in place until the No. 1 chain tensioner is installed.

g. Remove the pin from the No. 3 chain tensioner.

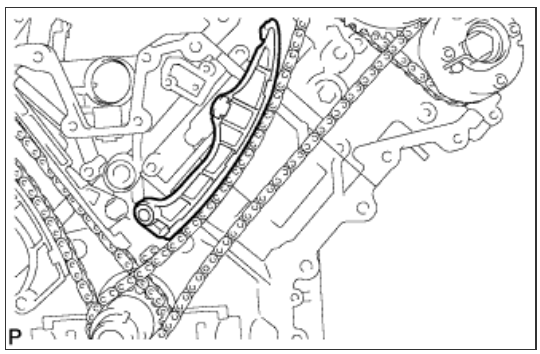
h. Using a wrench to hold the hexagonal portion of the No. 3 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, temporarily install the bolt.

14. INSTALL NO. 1 CHAIN TENSIONER SLIPPER LH

HINT:

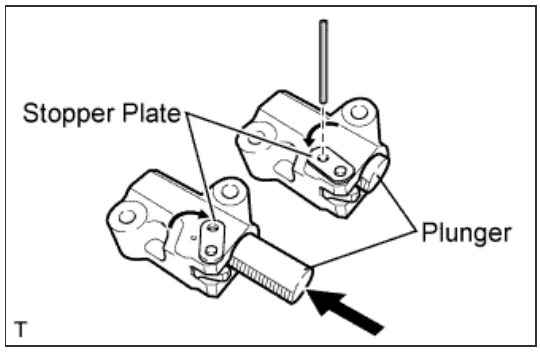
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and install the chain tensioner slipper.



15. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY LH

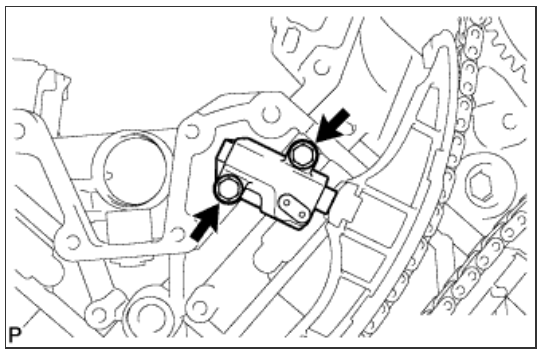
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install a new gasket and the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

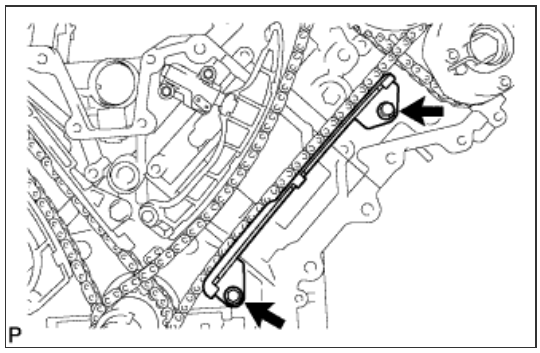


16. INSTALL NO. 1 CHAIN VIBRATION DAMPER LH

a. Install the vibration damper with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Remove the hexagon wrench from the No. 1 chain tensioner.



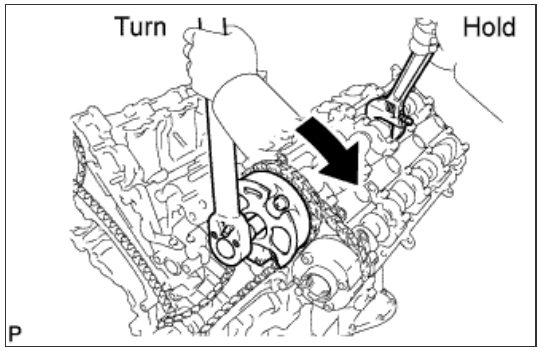
17. TIGHTEN CAMSHAFT TIMING GEAR ASSEMBLY

a. for Bank 1:

i. Using a wrench, hold the hexagonal portion of the No. 3 camshaft.

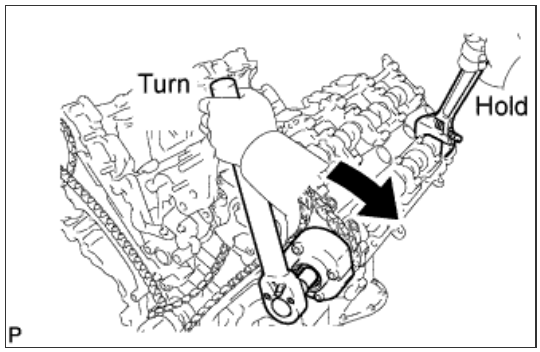
ii. Tighten the bolt of the camshaft timing gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

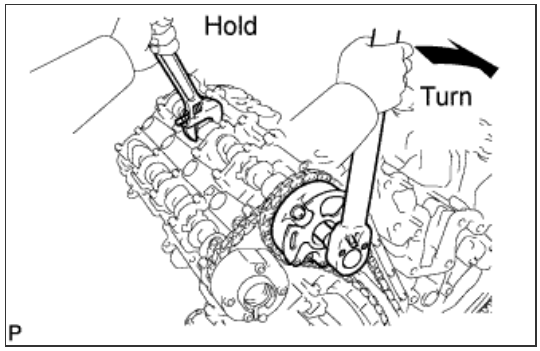


iii. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, tighten the bolt of the camshaft timing exhaust gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }



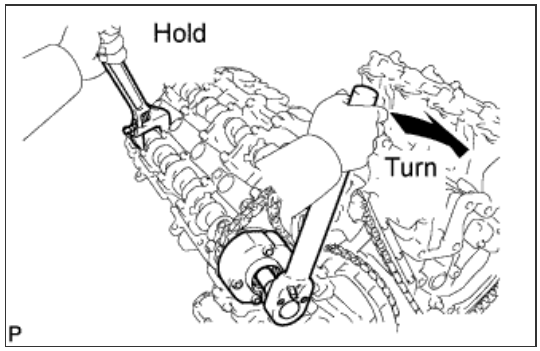
b. for Bank 2:



i. Using a wrench, hold the hexagonal portion of the No. 1 camshaft.

ii. Tighten the bolt of the camshaft timing gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }



iii. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, tighten the bolt of the camshaft timing exhaust gear.

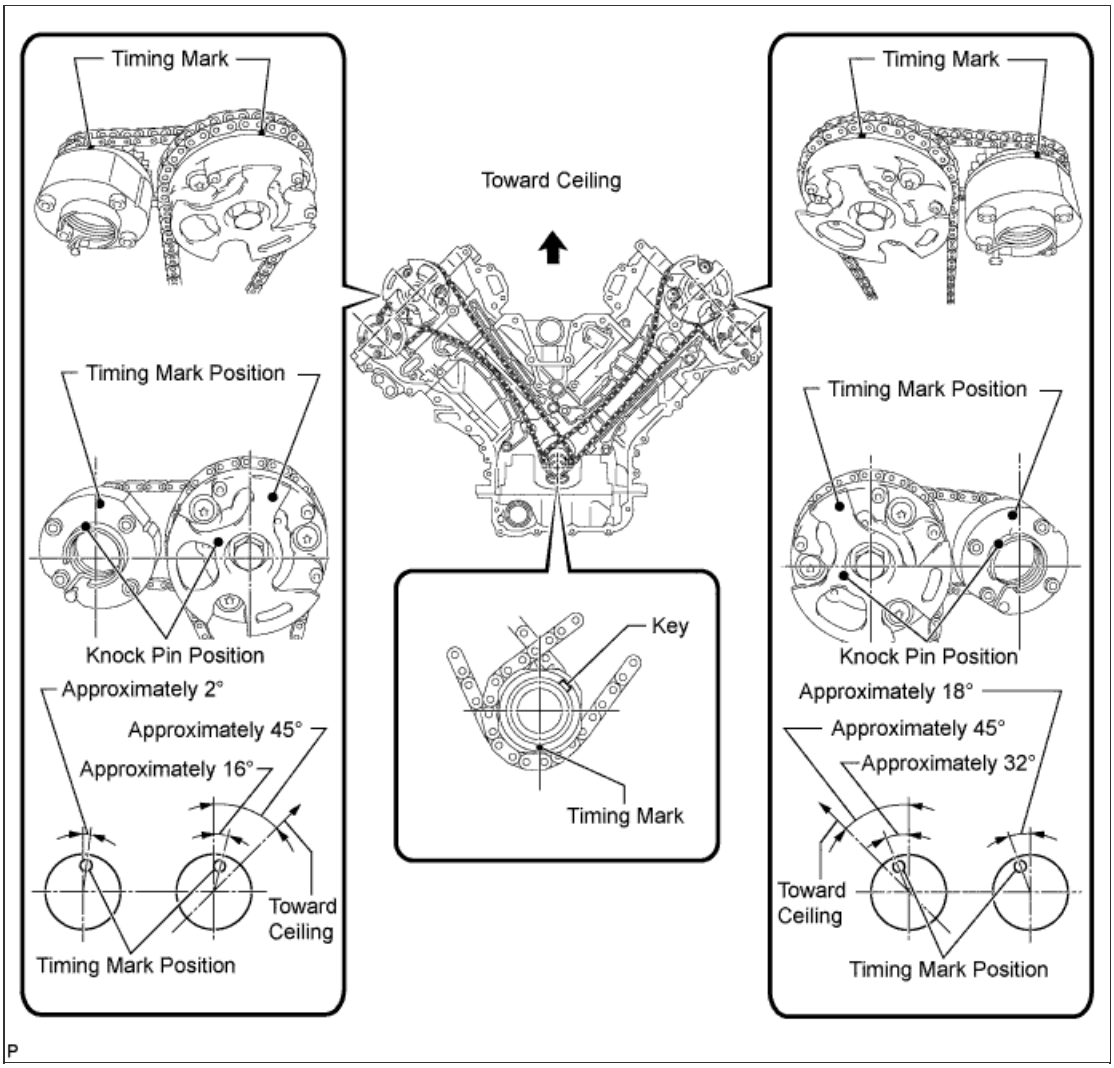
Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

18. CHECK NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise, and check that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

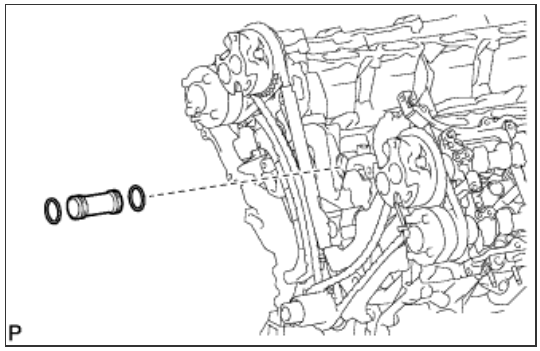
c. Remove the crankshaft pulley bolt.



19. INSTALL WATER INLET PIPE

a. Apply soapy water to 2 new O-rings and install them to the inlet pipe.

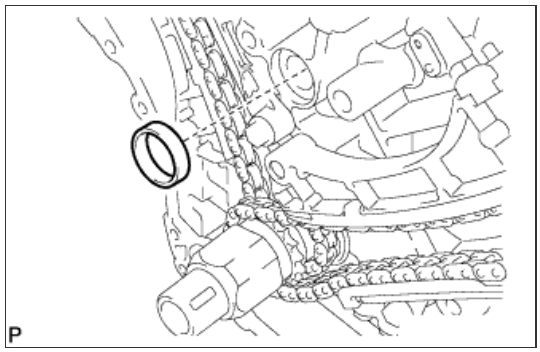
b. Install the inlet pipe to the No. 1 heat exchanger cover.



20. INSTALL TIMING CHAIN COVER SUB-ASSEMBLY

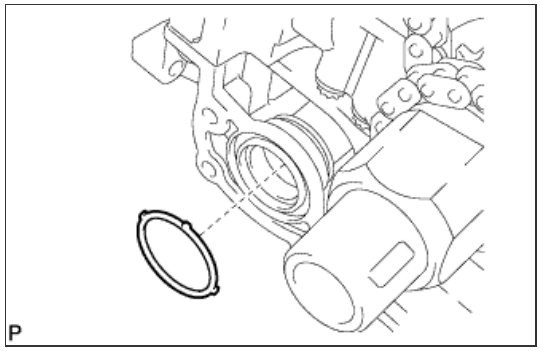
a. Apply a light coat of engine oil to a new oil pump gasket.

b. Install the oil pump gasket.

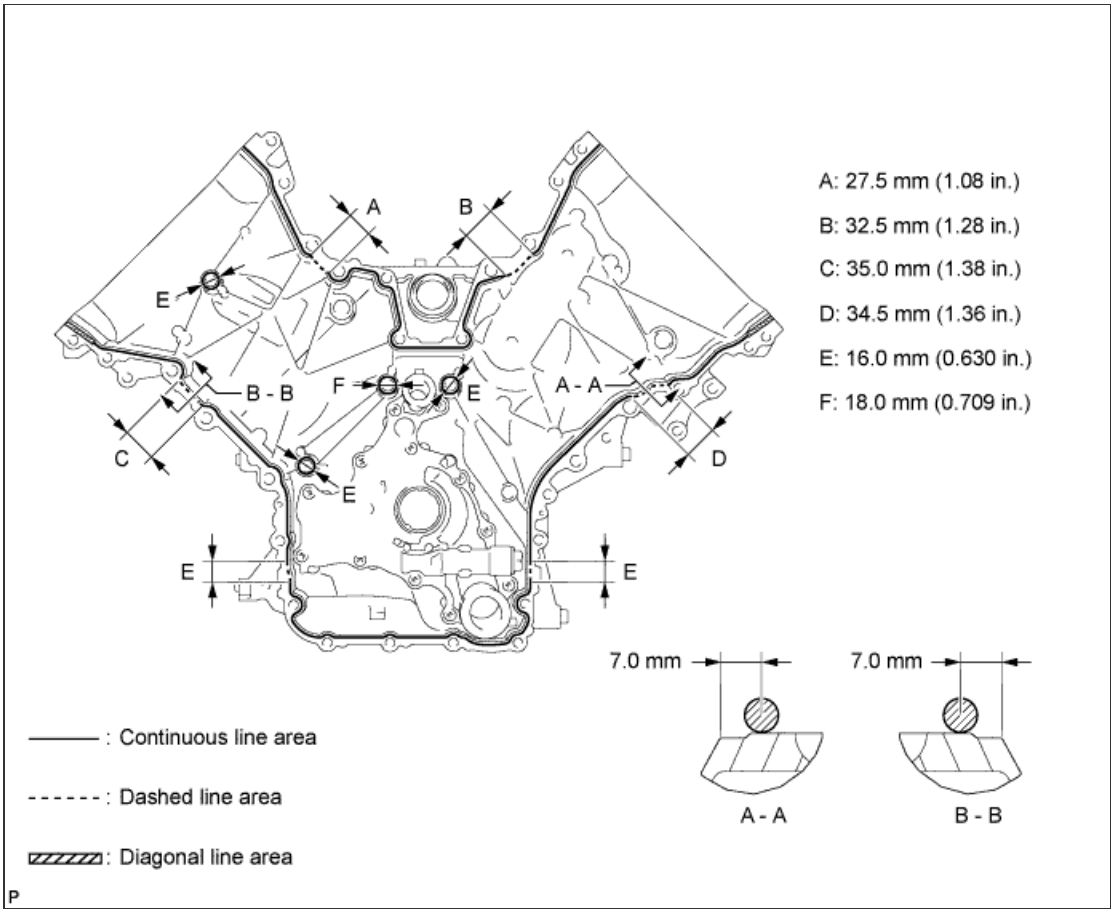


c. Apply a light coat of engine oil to a new O-ring.

d. Install the O-ring.



e. Apply seal packing in a continuous line to the timing chain cover as shown in the following illustration.

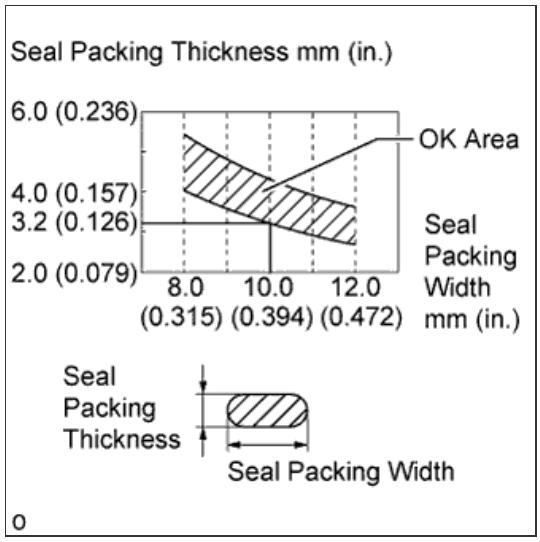


Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Apply seal packing as follows:

		Application Position from

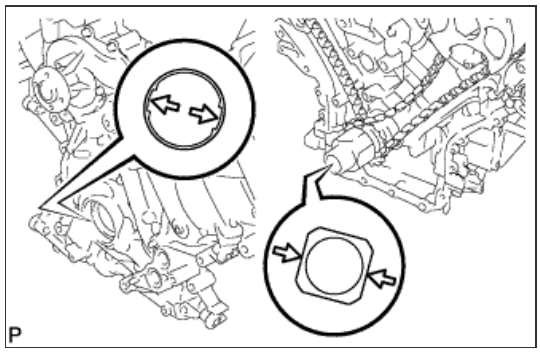
Area	Seal Packing Diameter	Inside Edge of Cover
Continuous Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	2.5 mm (0.0984 in.)
Dashed Line Area	6.4 mm (0.252 in.) or more, or within OK area shown in illustration	7.0 mm (0.276 in.)
Diagonal Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	5.5 mm (0.217 in.)



NOTICE:

- **When the contact surfaces are wet, wipe them with an oil-free cloth before applying seal packing.**
- **Install the chain cover within 3 minutes and tighten the bolts within 10 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after installing.**

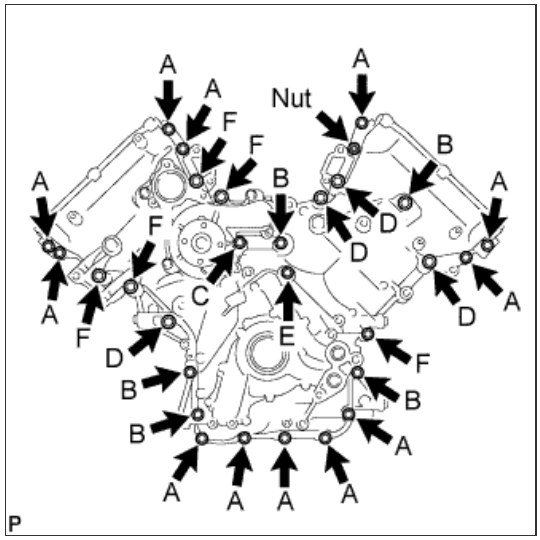
f. Align the oil pump drive rotor spline and crankshaft as shown in the illustration. Install the spline and chain cover to the crankshaft.



g. Temporarily install the timing chain cover with the 28 bolts and nut.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)



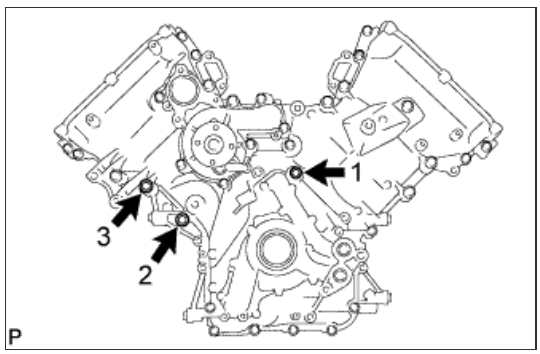
NOTICE:

Make sure that there is no oil on the bolt threads.

h. Tighten the 3 bolts in several steps in the sequence shown in the illustration.

Torque:

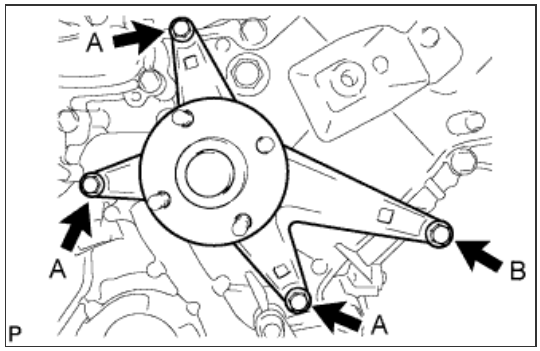
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



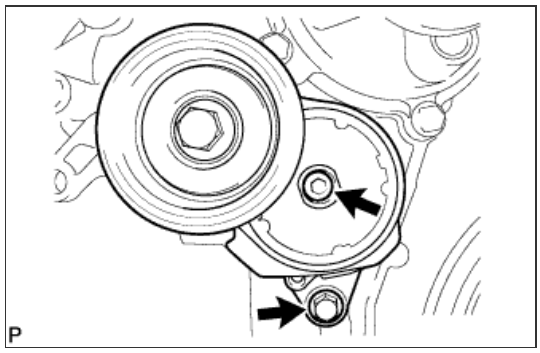
i. Temporarily install the fluid coupling bracket with the 4 bolts.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt B	80 mm (3.15 in.)	10 mm (0.394 in.)



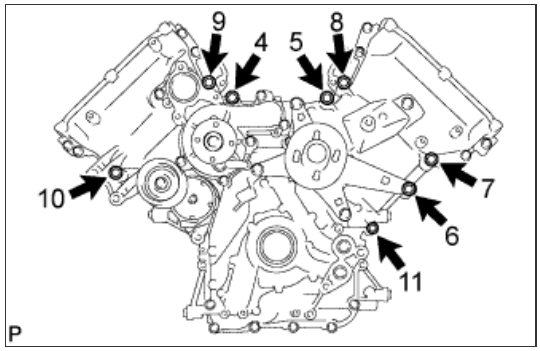
j. Temporarily install the belt tensioner with the standard bolt and 6 mm hexagon wrench bolt.



k. Tighten the 8 bolts labeled 4 to 11 in several steps in the sequence shown in the illustration.

Torque:

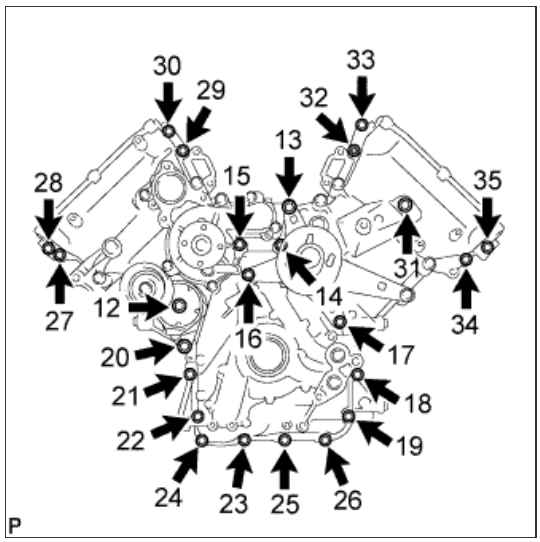
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



l. Tighten the 23 bolts and nut labeled 12 to 35 in several steps in the sequence shown in the illustration.

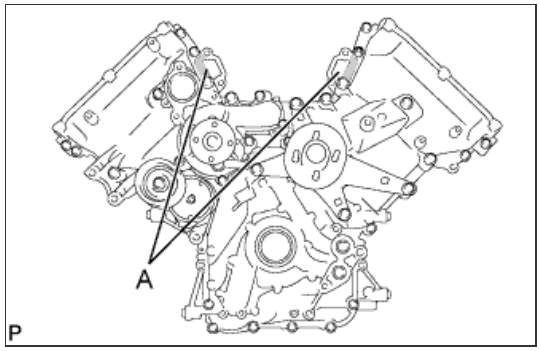
Torque:

23 N*m{ 235 kgf*cm , 17 ft.*lbf }



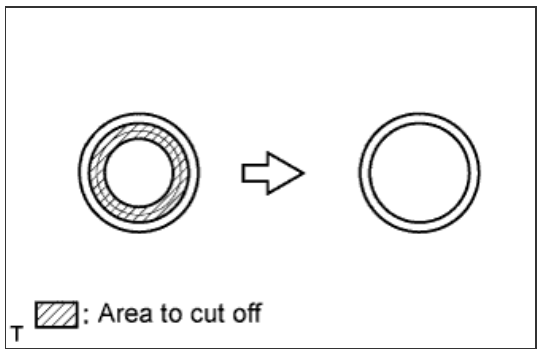
NOTICE:

After the installation, if the seal packing has seeped out at the areas labeled A shown in the illustration, wipe it off.



21. INSTALL SPARK PLUG TUBE GASKET

a. Using a cutter knife, cut off the seal part of the removed gasket.



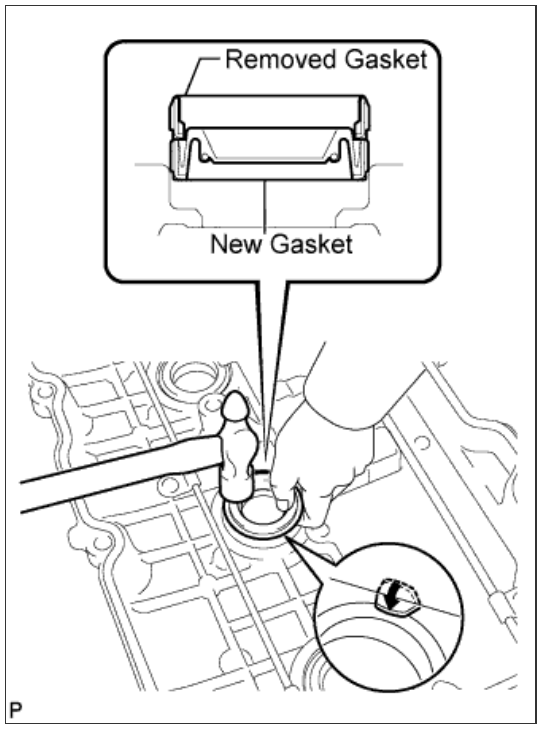
b. Using the removed gasket and a hammer, tap in a new gasket until it stops.

HINT:

If the removed gasket does not fit on the new one, correct the removed one with pliers.

c. Apply a light coat of MP grease to the lip of the gasket.

d. Return the 4 ventilation baffle plate claws to the original positions.



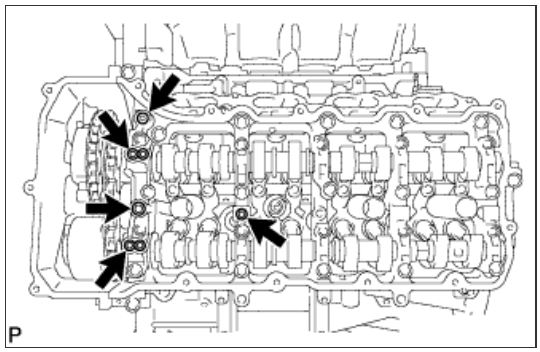
22. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY LH

a. Install 5 new gaskets to the camshaft bearing caps (No. 2, No. 3).

b. Install the gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

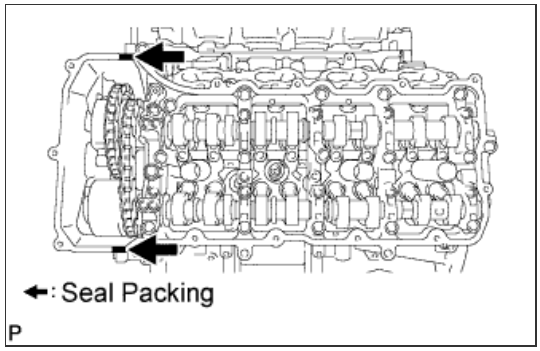


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

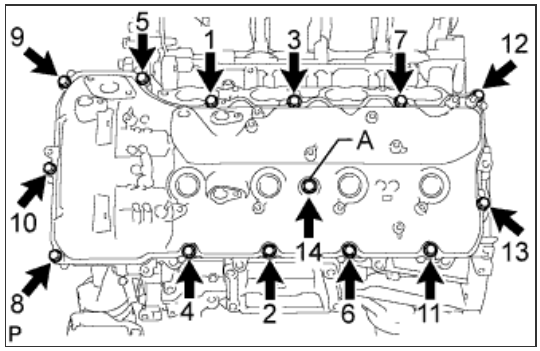
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



d. Install the cylinder head cover and the seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



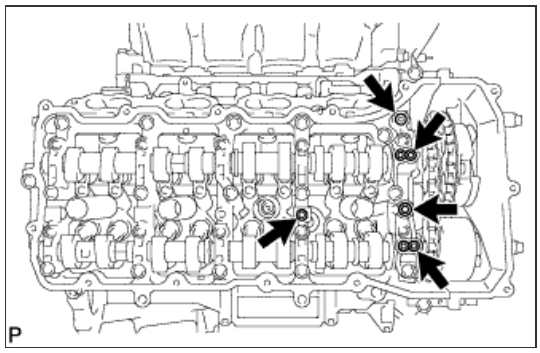
23. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY RH

a. Install 5 new gaskets to the camshaft bearing caps. (No. 1, No. 3).

b. Install the gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

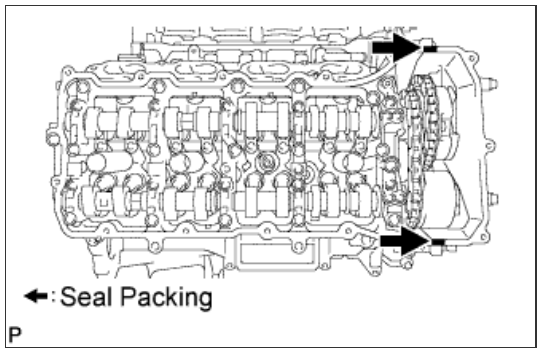


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

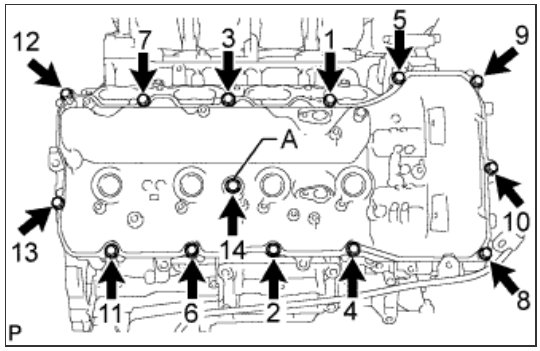
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



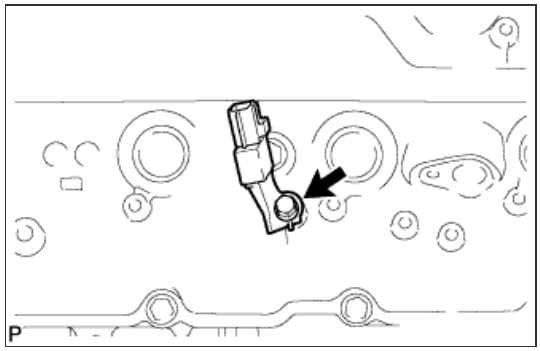
d. Install the cylinder head cover and the seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



e. Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }



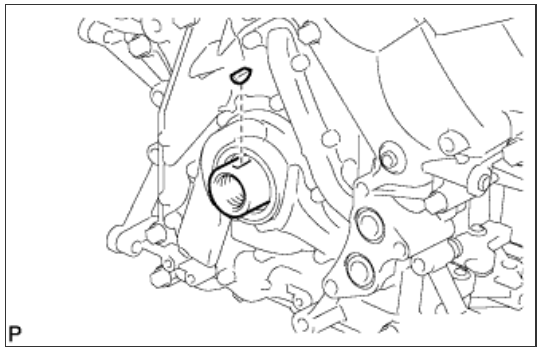
24. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

25. INSTALL CRANKSHAFT TIMING GEAR KEY

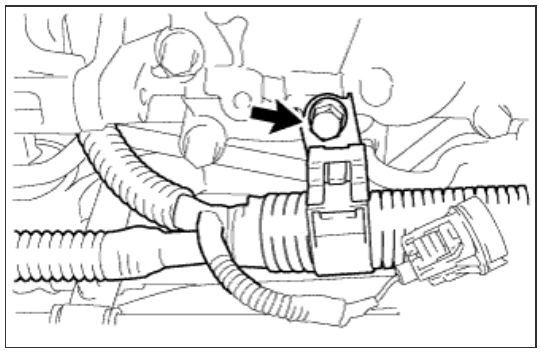
a. Install the crankshaft timing gear key to the crankshaft.



26. CONNECT WIRE HARNESS CLAMP BRACKET

a. Connect the bracket to the timing chain cover with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



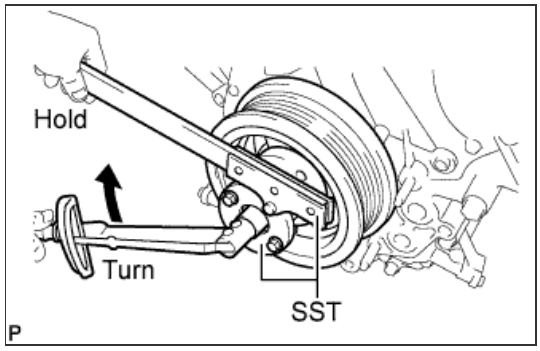
27. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

b. Using SST, install the pulley set bolt.

SST
09213-70011 (09213-70020)
09330-00021

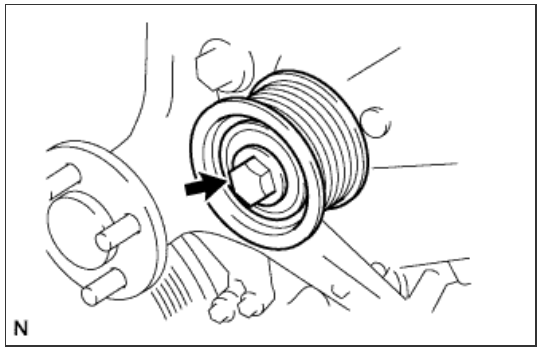
Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



28. INSTALL NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Install the idler pulley with the bolt.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



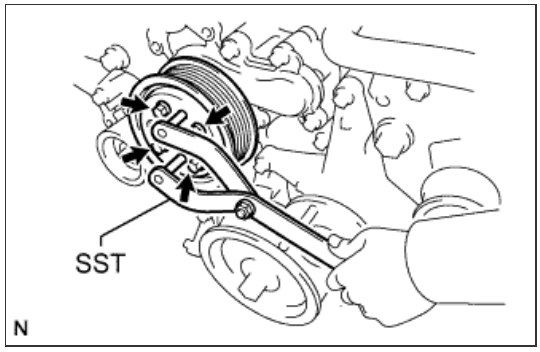
29. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.

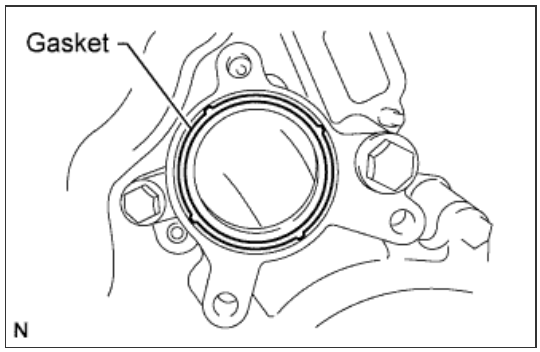
SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



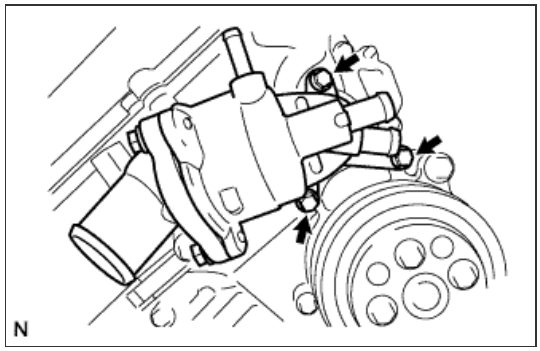
30. INSTALL WATER INLET HOUSING

a. Install a new gasket to the timing chain cover.



b. Install the water inlet with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

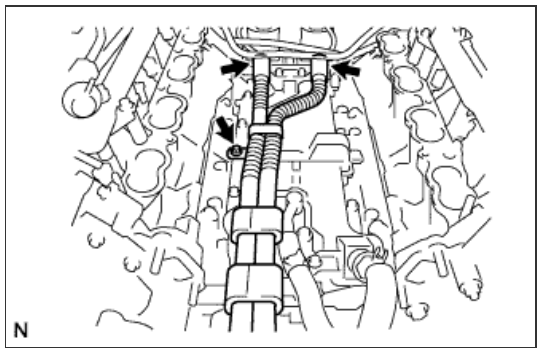


31. INSTALL AIR PIPE SUB-ASSEMBLY

a. Connect the 2 hoses.

b. Install the air pipe with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



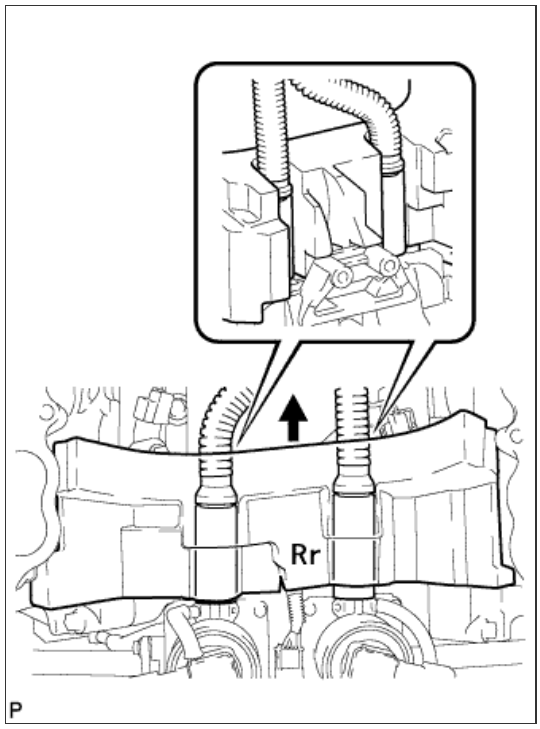
32. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



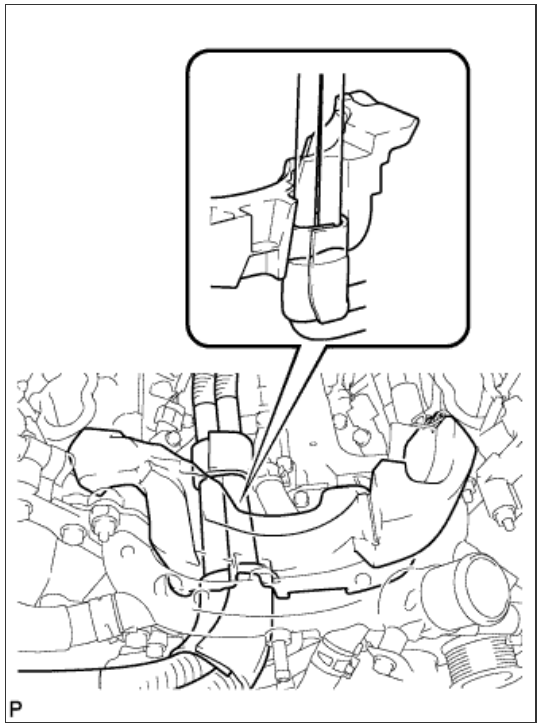
33. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.

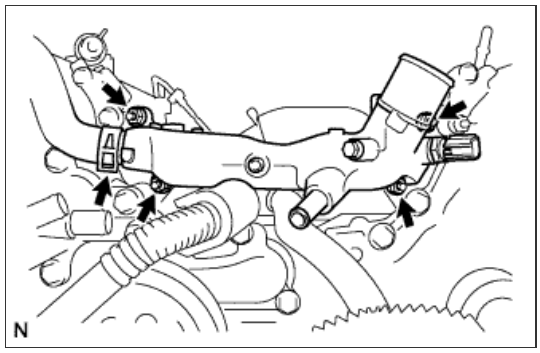


34. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the water by-pass joint with the 4 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the No. 2 water by-pass hose to the water by-pass joint.

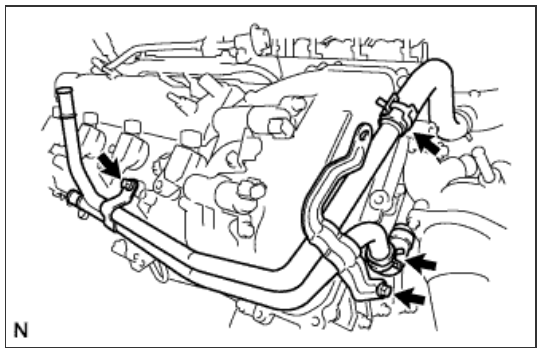


35. INSTALL WATER BY-PASS PIPE SUB-ASSEMBLY

a. Connect the 2 hoses.

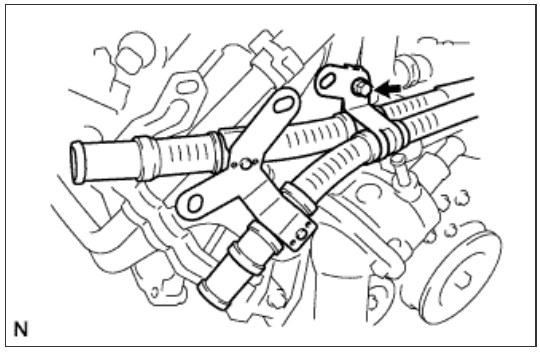
b. Install the water by-pass pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



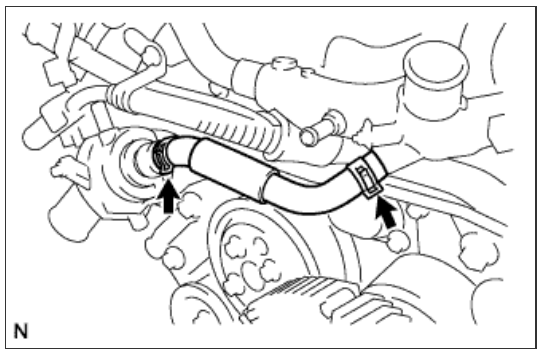
c. Connect the air tube with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



36. INSTALL NO. 1 WATER BY-PASS HOSE

a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.

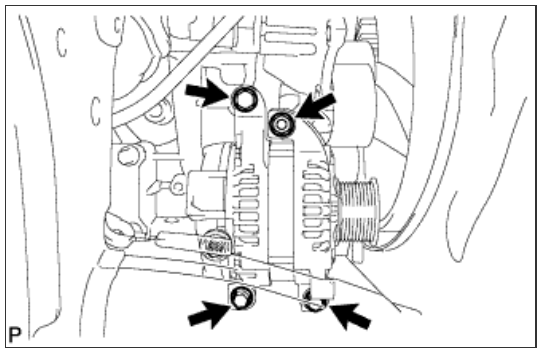


37. INSTALL GENERATOR ASSEMBLY

a. Install the generator with the 3 bolts and nut.

d. Install the generator with the 3 bolts and nut.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



b. Connect the generator connector.

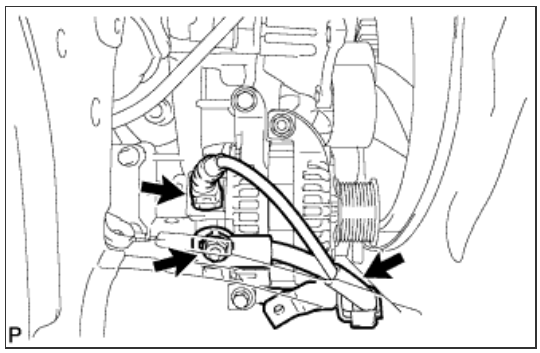
c. Connect the generator wire with the nut.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

d. Install the terminal cap.

e. Install the harness bracket to the generator with the bolt.

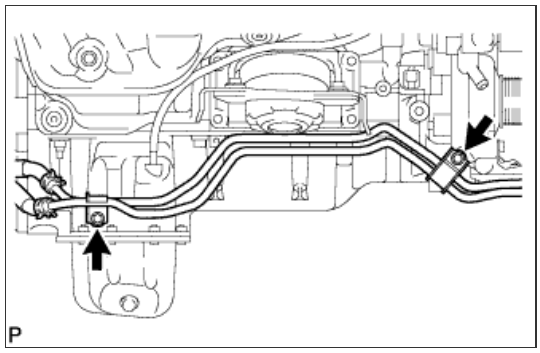
Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }



38. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }



39. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

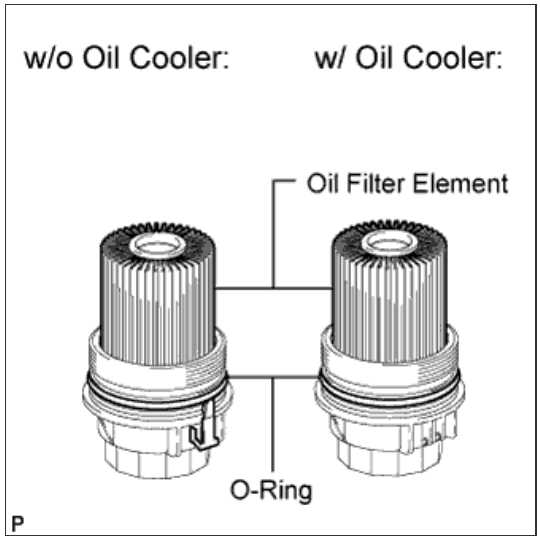
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



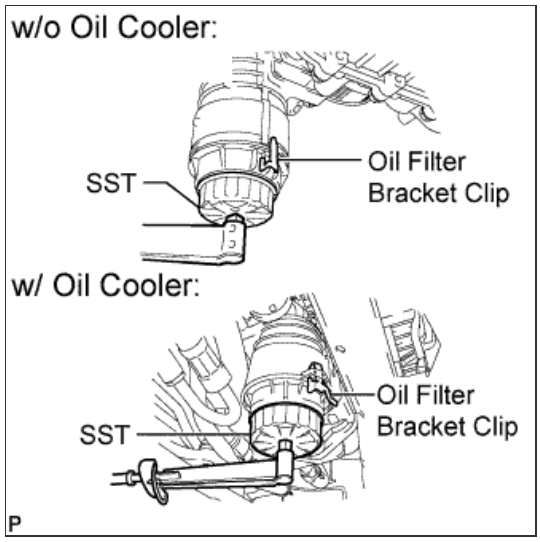
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

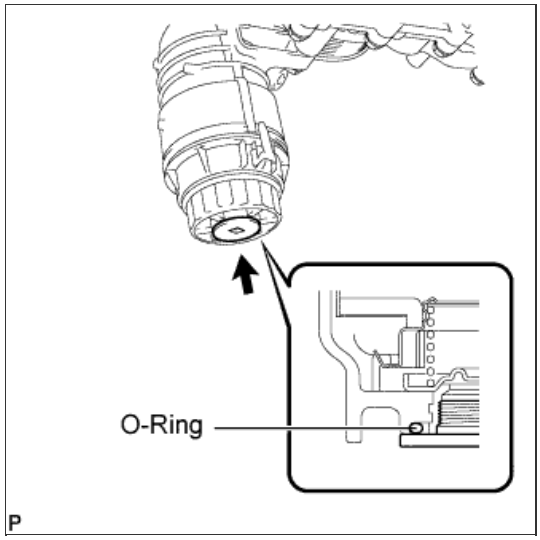
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

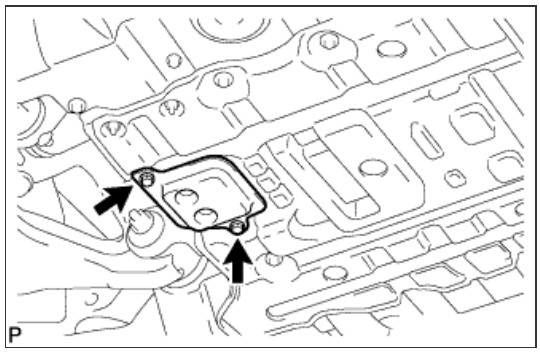
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

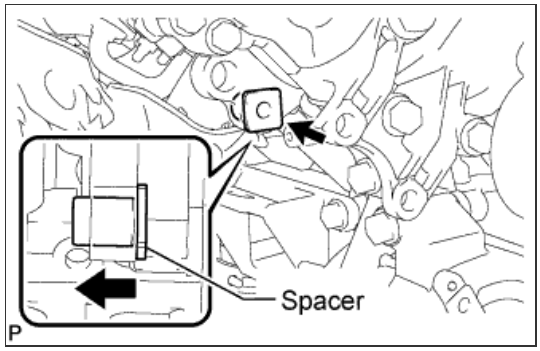
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



40. CONNECT VANE PUMP ASSEMBLY

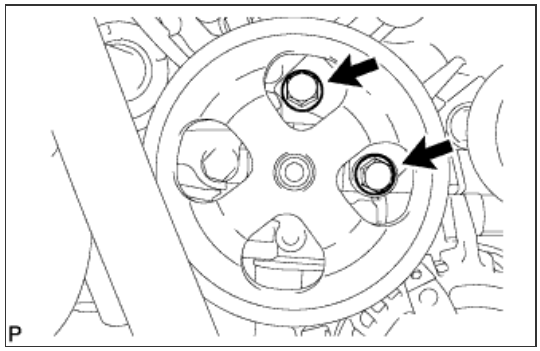
HINT:

Before performing the following procedures, move the spacer until the vane pump can be installed.

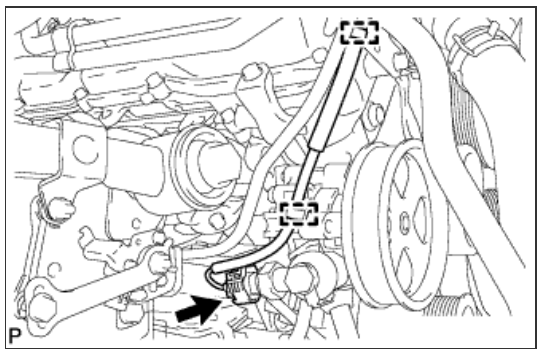


a. Connect the vane pump to the timing chain cover with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



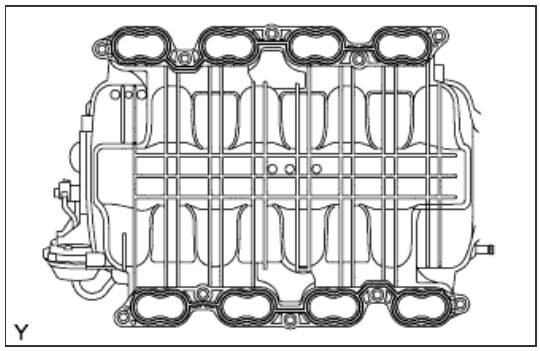
b. Connect the 2 clamps and power steering oil pressure switch connector.



41. INSTALL INTAKE MANIFOLD

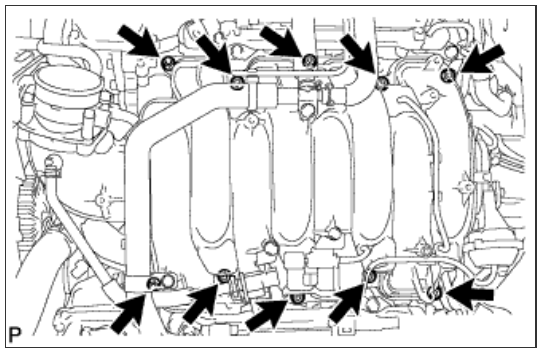
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



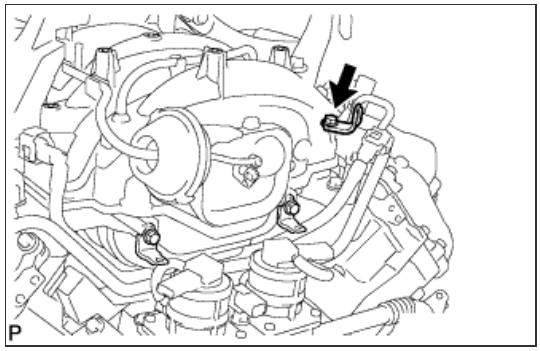
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

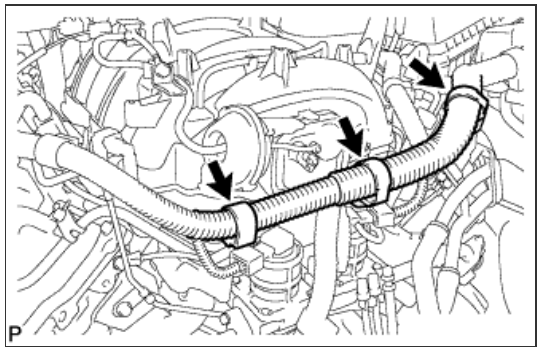


d. Install the wire bracket to the intake manifold with the bolt.

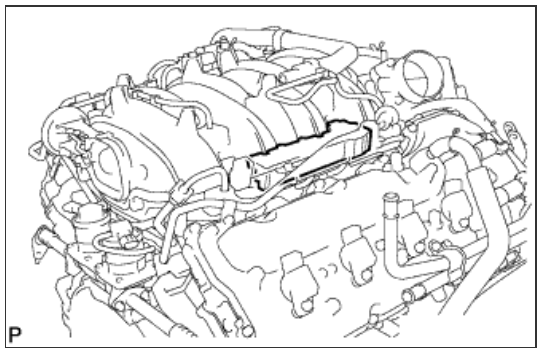
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



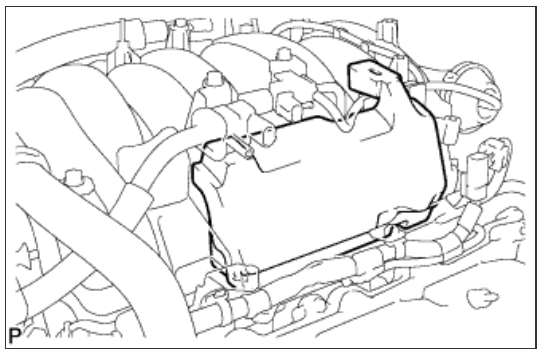
e. Connect the 3 wire clamps to the 3 wire brackets.



f. Install the No. 3 engine cover.



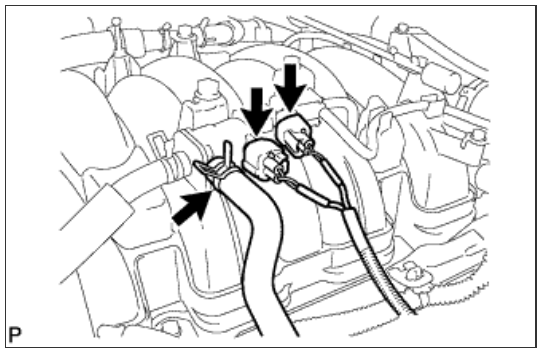
g. Install the No. 1 engine cover sub-assembly.



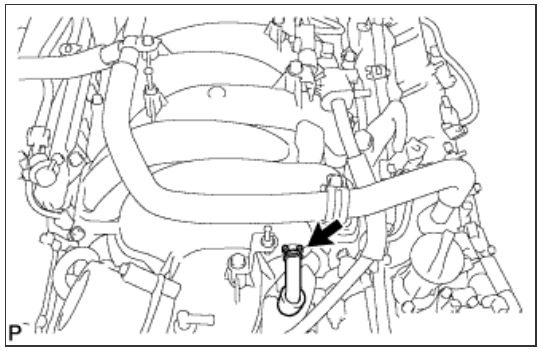
h. Connect the purge VSV connector.

i. Connect the purge line hose to the purge VSV.

j. Connect the vacuum switching valve connector (for ACIS).

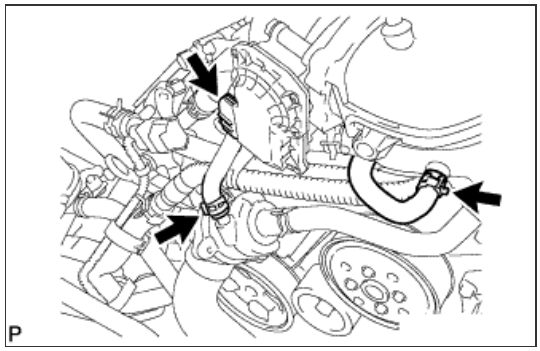


k. Connect the No. 1 ventilation hose.

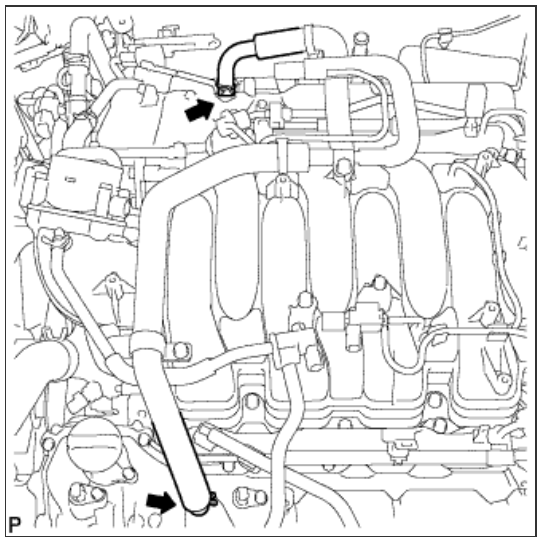


l. Connect the 2 water by-pass hoses.

m. Connect the throttle body connector.



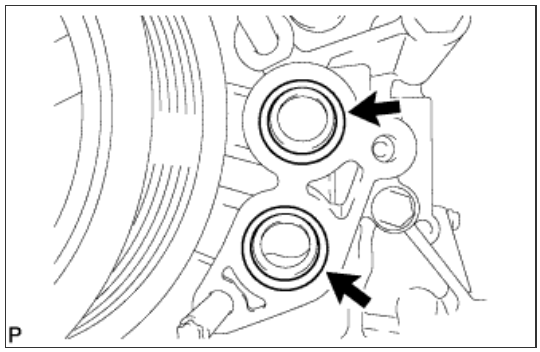
n. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.



42. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

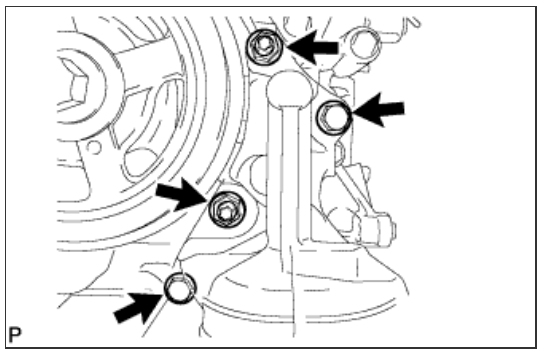
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

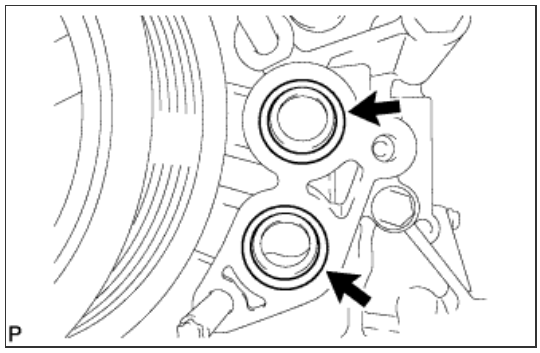
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



43. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

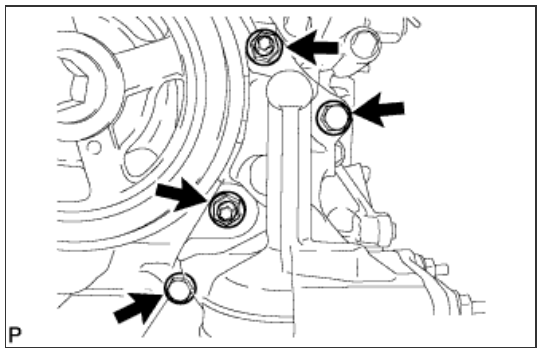
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

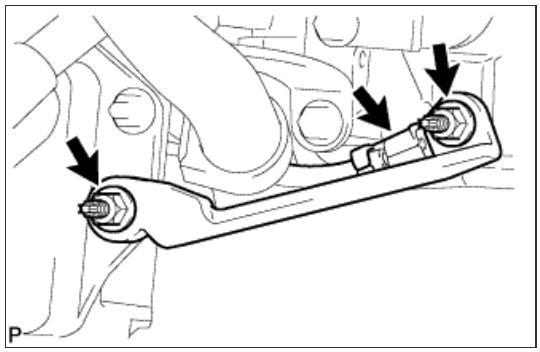


44. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

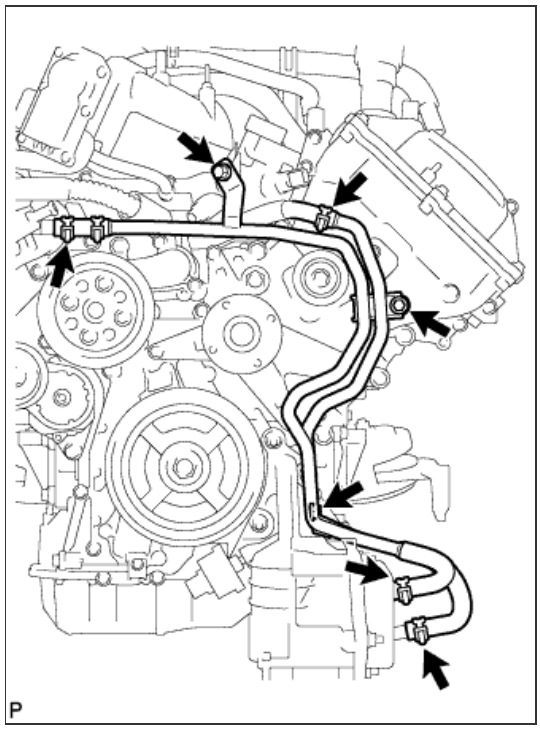


45. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

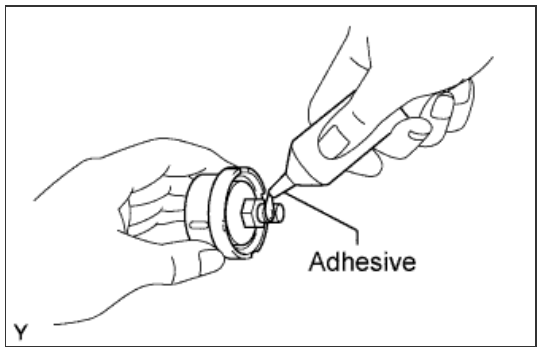
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



46. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

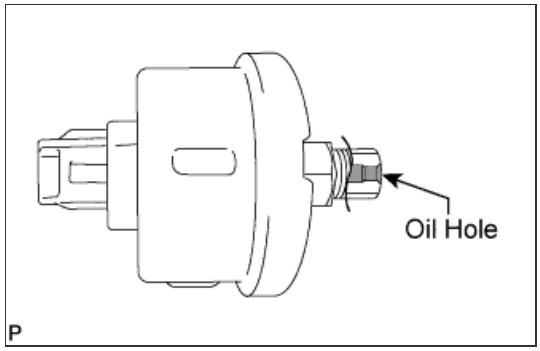
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

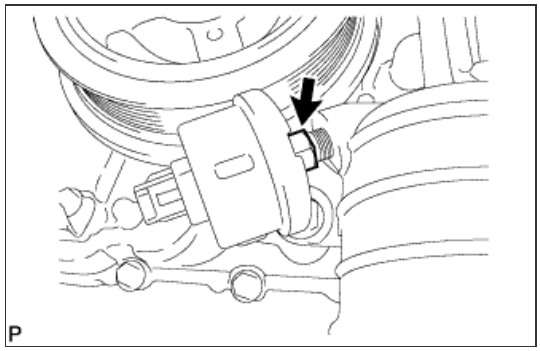


b. Install the oil pressure sender gauge.

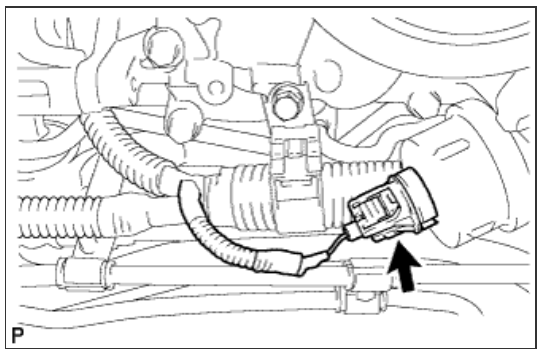
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



47. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

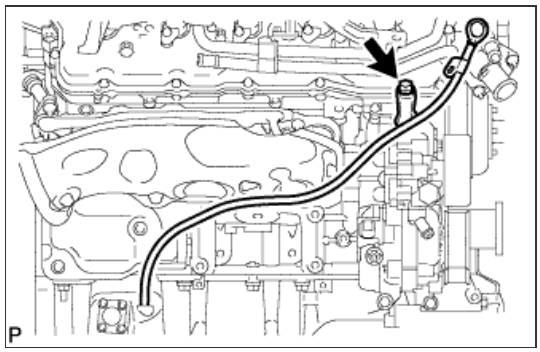
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

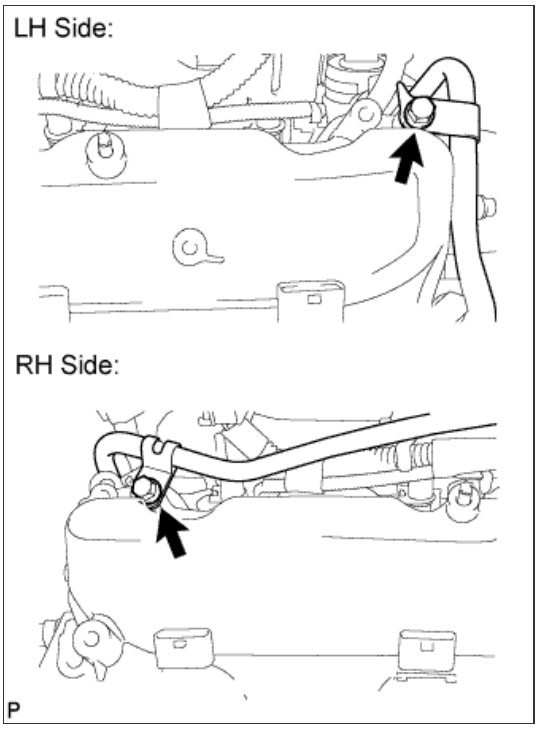
d. Install the dipstick.



48. CONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Connect the fuel tube with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



49. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

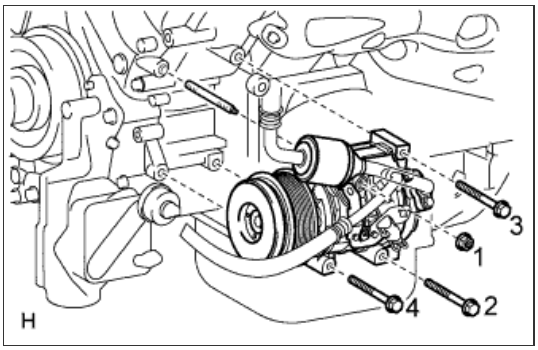
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

NOTICE:

Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.

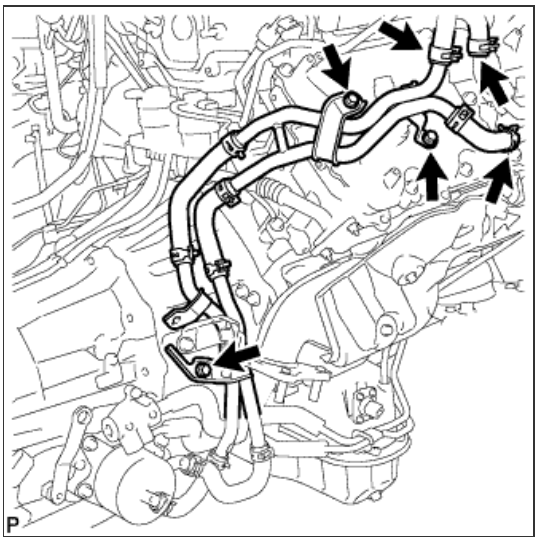


50. CONNECT NO. 2 WATER BY-PASS PIPE

a. Connect the No. 2 water by-pass pipe to the cylinder head cover with the 3 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }

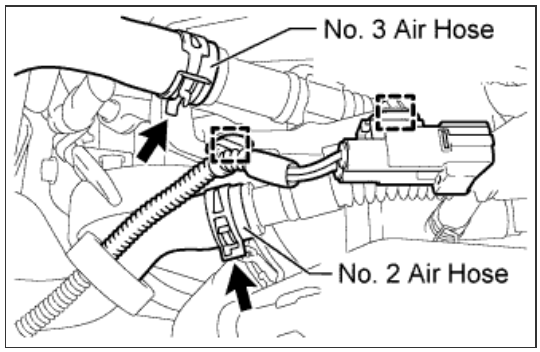
b. Connect the 3 hoses.



51. CONNECT AIR PUMP HOSE AND WIRE HARNESS

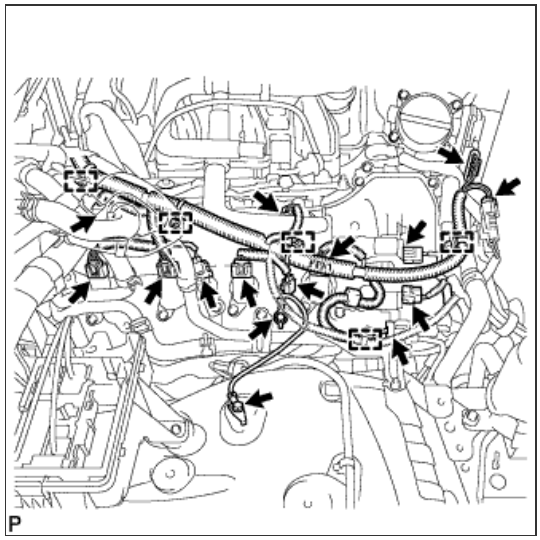
a. Connect the No. 2 and No. 3 air hoses.

b. Connect the 2 clamps and air pump wire harness.



52. CONNECT ENGINE WIRE

a. Engine Room RH Side:



i. Connect the 5 clamps.

ii. Connect the throttle position sensor and throttle control motor connector.

iii. Connect the 2 air pump connectors.

iv. Install the ground wire with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

v. Connect the noise filter connector.

vi. Connect the 2 VVT sensor connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

vii. Connect the injector connector.

viii. Connect the 4 ignition coil connectors.

ix. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

b. Engine Room LH Side:

i. Connect the cooler compressor connector.

ii. Connect the 3 clamps.

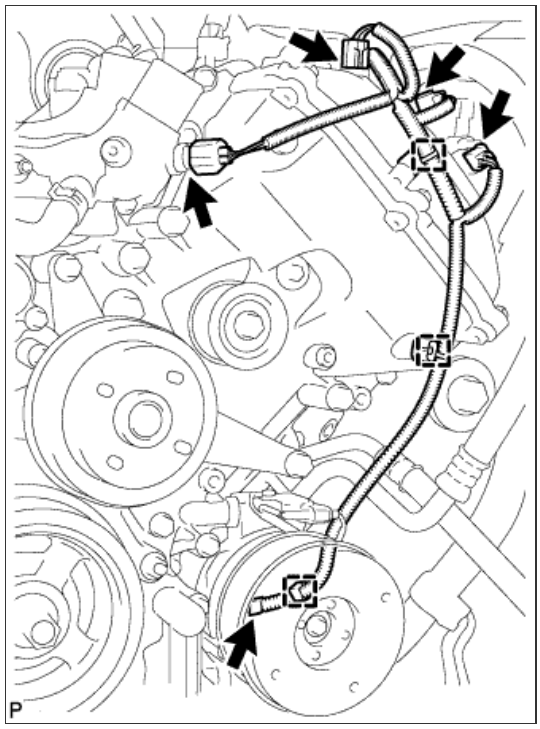
iii. Connect the camshaft position sensor connector.

iv. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

v. Connect the engine coolant temperature sensor connector.



vi. Connect the 4 clamps.

vii. Install the ground wire with the 2 bolts.

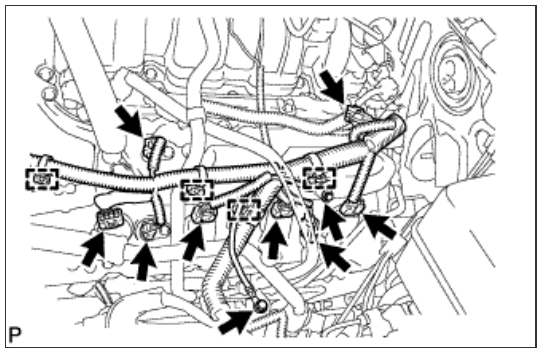
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

viii. Connect the noise filter connector.

ix. Connect the 2 VVT sensor connectors.

HINT:

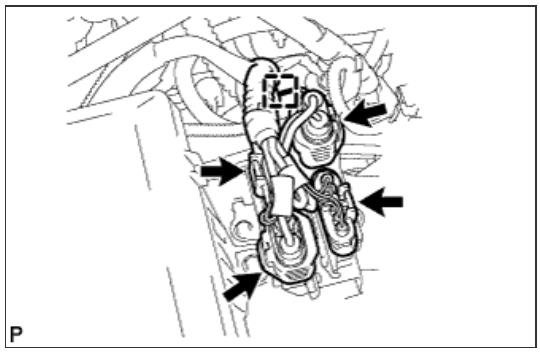
The wire harnesses on the exhaust side are wrapped with white tape.



x. Connect the 4 ignition coil connectors.

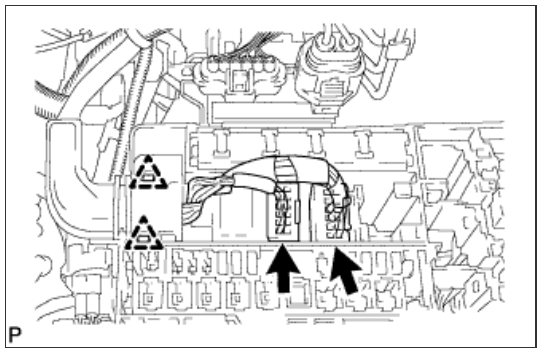
xi. Connect the injector connector.

xii. Connect the wire harness clamp and 4 air injection control driver connectors.



xiii. Connect the 2 connectors and 2 clips to the engine room junction block.

xiv. Install the engine room relay block cover.

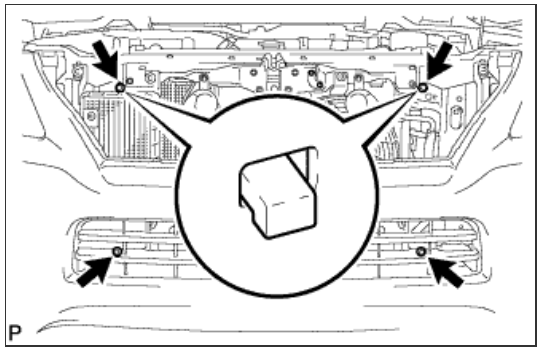


53. INSTALL RADIATOR ASSEMBLY

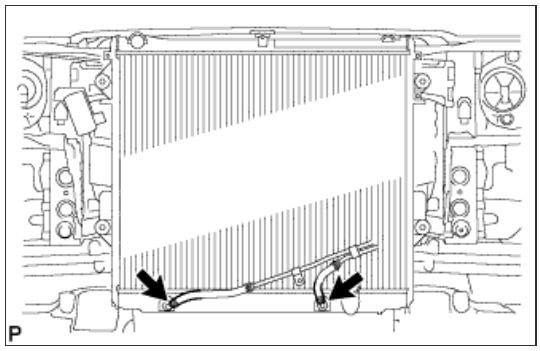
a. Set the radiator bracket hooks to the radiator support holes.

b. Install the radiator with the 4 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



c. Connect the 2 oil cooler hoses.



54. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

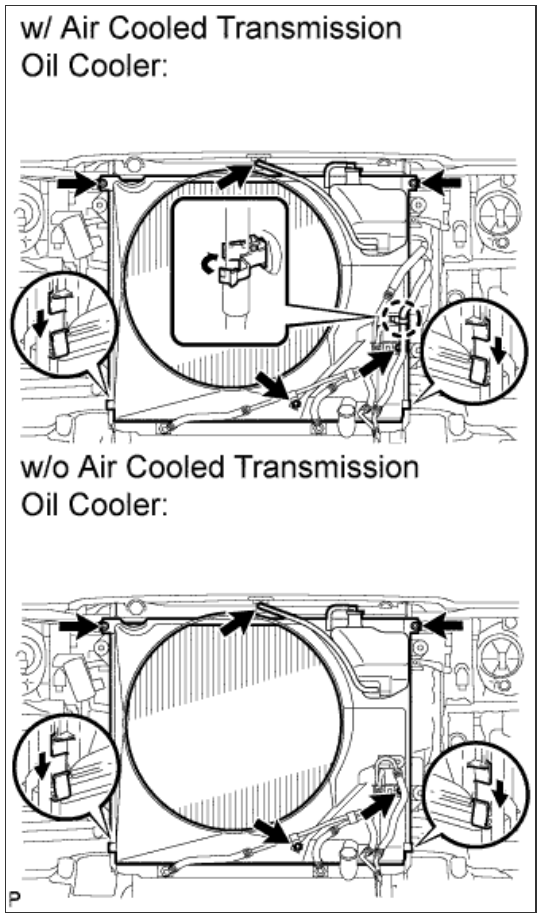
Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in

the illustration.

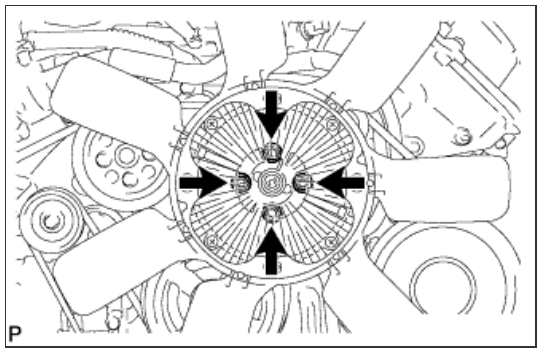
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



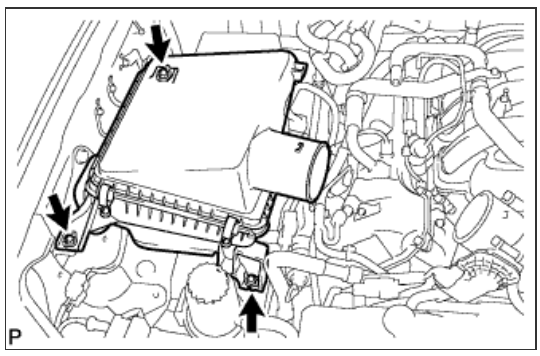
55. INSTALL NO. 2 RADIATOR HOSE

56. INSTALL NO. 1 RADIATOR HOSE

57. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



58. INSTALL AIR CLEANER HOSE ASSEMBLY

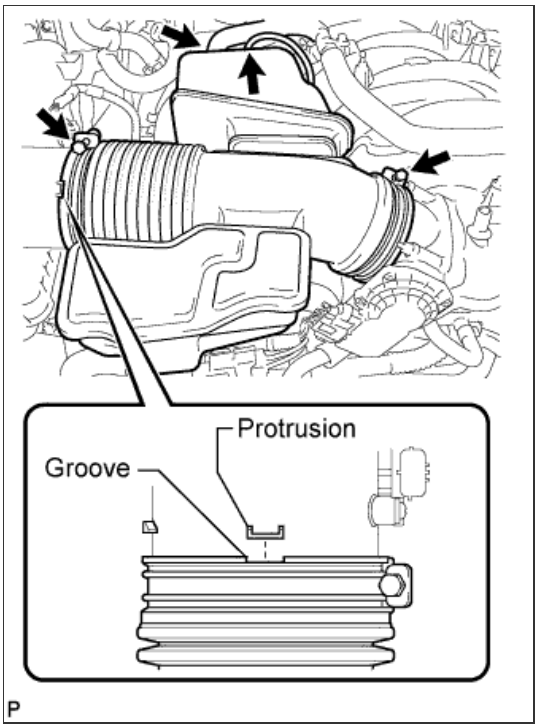
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

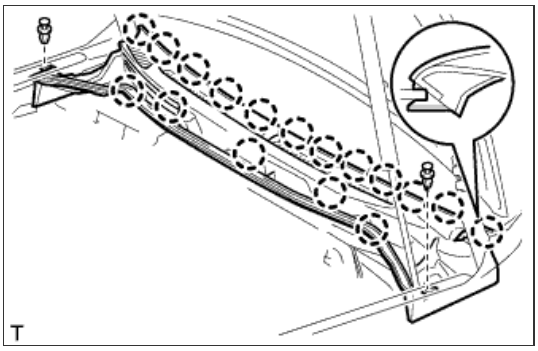
d. Connect the No. 2 ventilation hose.



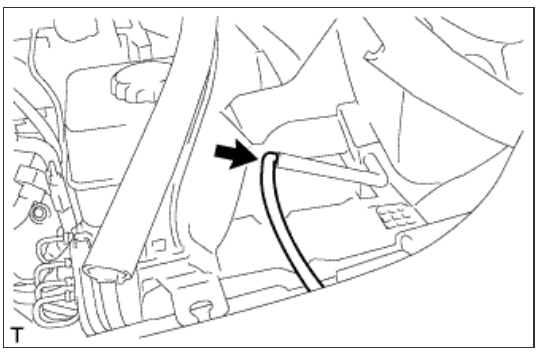
59. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Push in the ventilator louver to attach the 17 claws and install the ventilator louver.

b. Install the 2 clips.

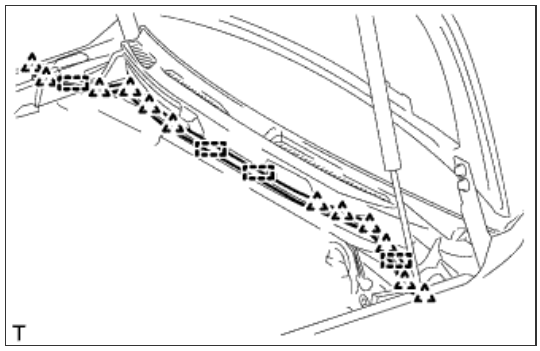


c. Connect the washer hose.



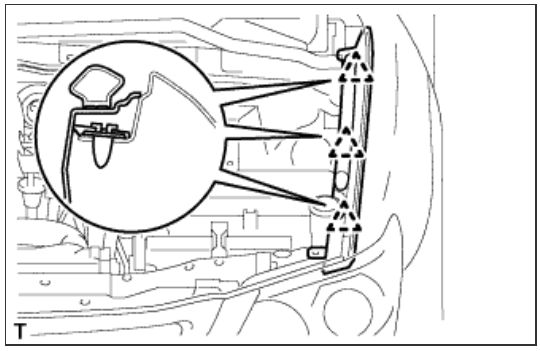
60. INSTALL HOOD TO COWL TOP SEAL

a. Attach the 12 clips and 4 clamps to install the hood to cowl top seal.



61. INSTALL FRONT FENDER MAIN SEAL LH

a. Attach the 3 clips to install the fender main seal.



62. INSTALL FRONT FENDER MAIN SEAL RH

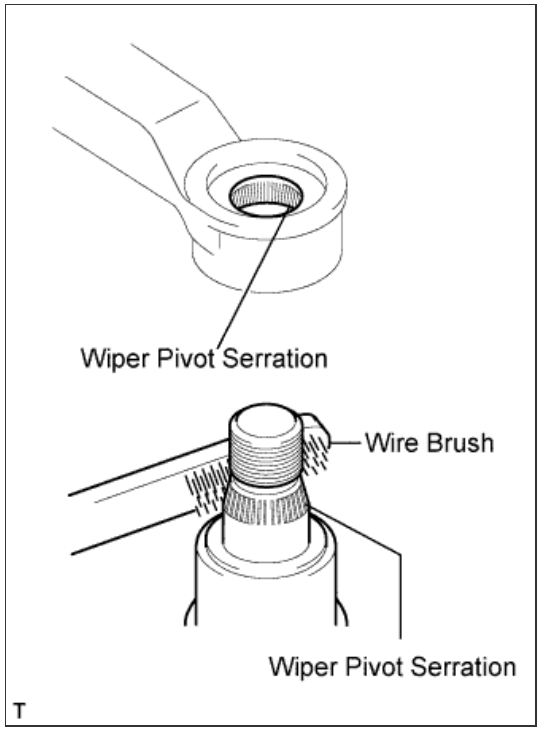
HINT:

Use the same procedures described for the LH side.

63. INSTALL FRONT WIPER ARM LH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

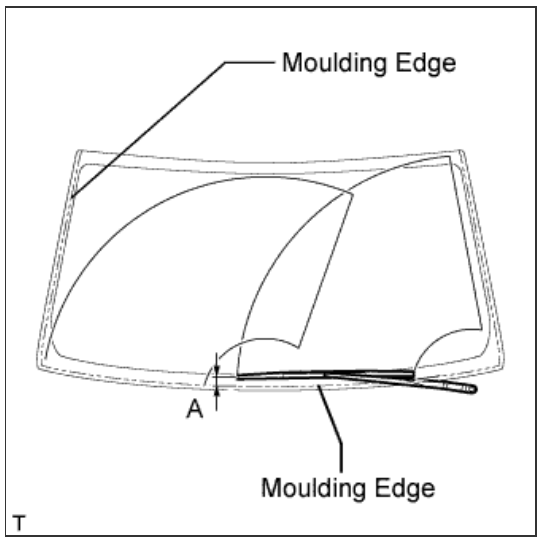
Standard:

Position	Specified Condition
A	16.8 to 36.8 mm (0.661 to 1.45 in.)

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

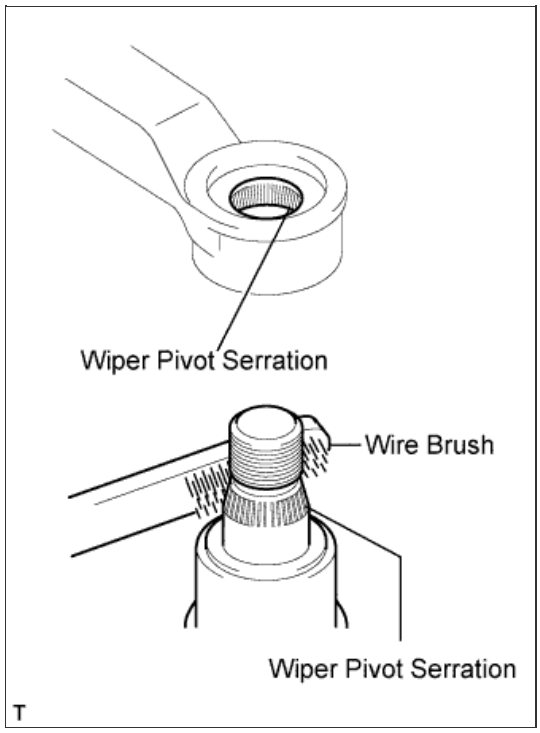
Hold down the wiper arm hinge with your hand while tightening the nut.



64. INSTALL FRONT WIPER ARM RH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

Standard:

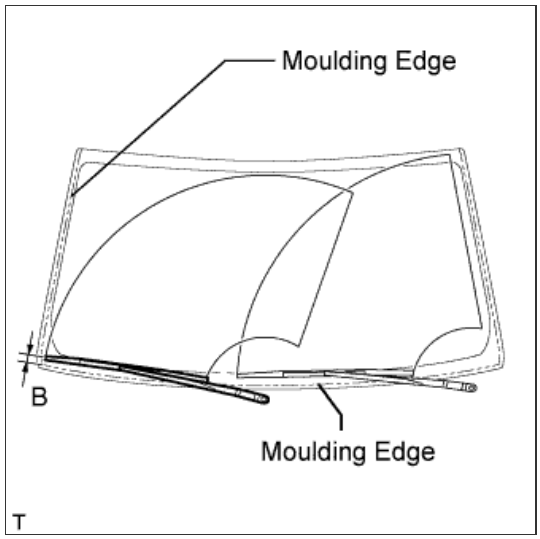
Position	Specified Condition
B	20.0 to 40.0 mm (0.787 to 1.57 in.)

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

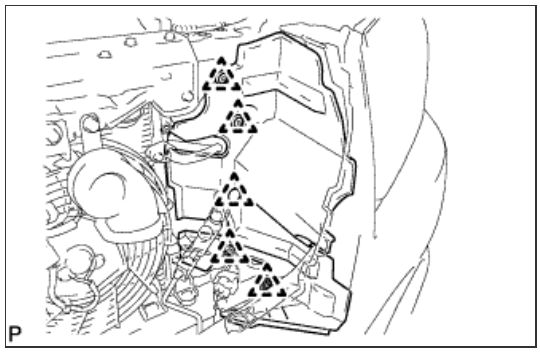
Hold down the wiper arm hinge with your hand while tightening the nut.

d. Operate the front wipers while spraying washer fluid on the windshield glass. Make sure that the front wipers function properly and there is no interference with the vehicle body.



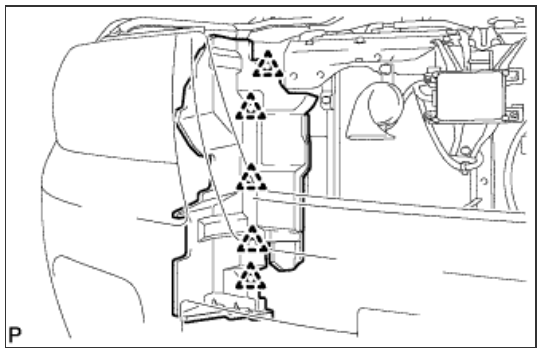
65. INSTALL RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



66. INSTALL RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



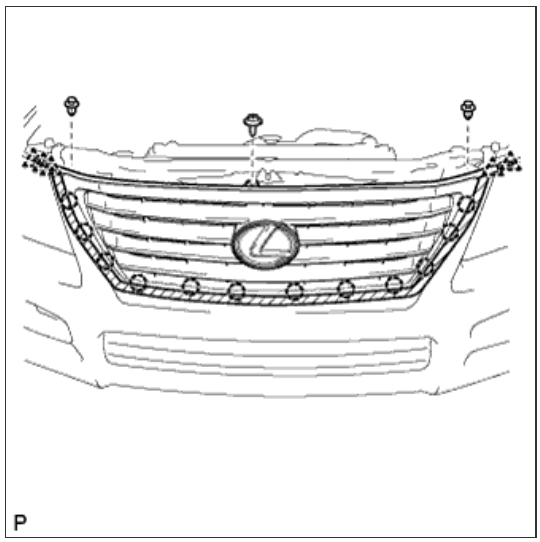
67. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



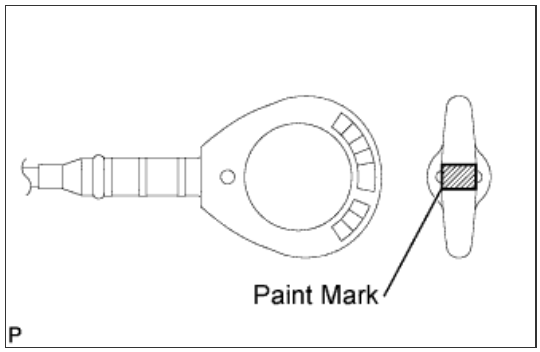
68. ADD ENGINE OIL

a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)

API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil	0W-20 5W-20 5W-30 10W-30
API grade SL or SM multigrade engine oil	15W-40 20W-50



Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

69. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

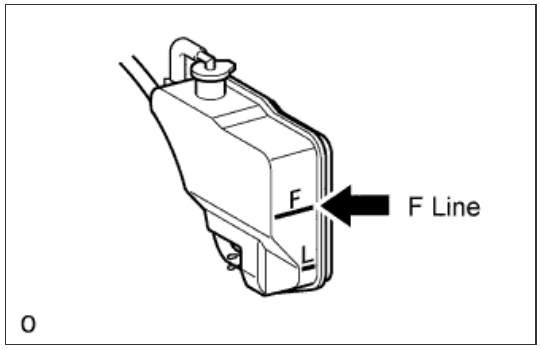
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally**

high temperature.

- If there is not enough coolant, the engine may burn out or overheat.
- Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.
- Run the engine at 2000 rpm until the coolant level has stabilized.

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

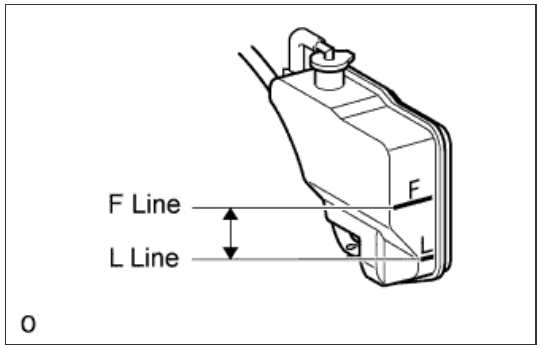
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



70. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

71. INSPECT FOR OIL LEAK

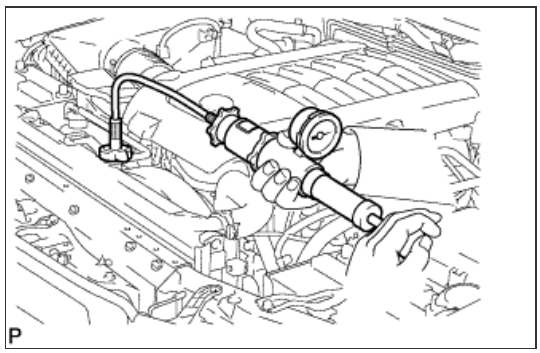
a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

72. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



73. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

NOTICE:

Do not fill engine oil above the full level mark.

74. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

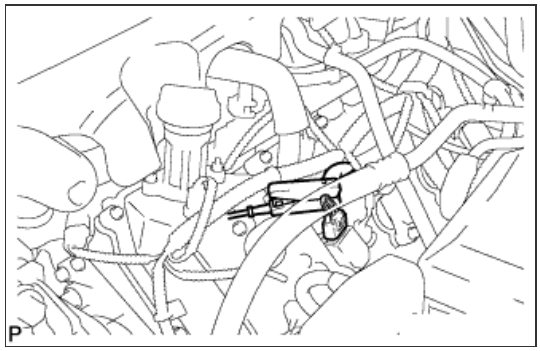
v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:

i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

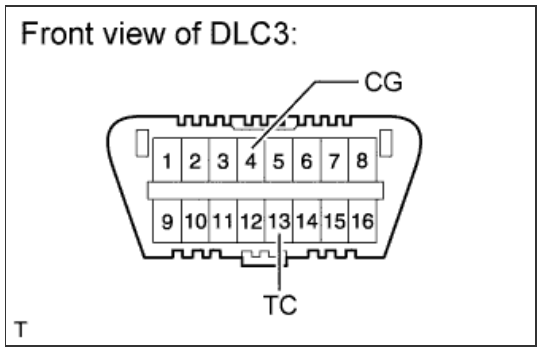


ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

SST
09843-18040

NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**



iii. Using the timing light, check the ignition timing.

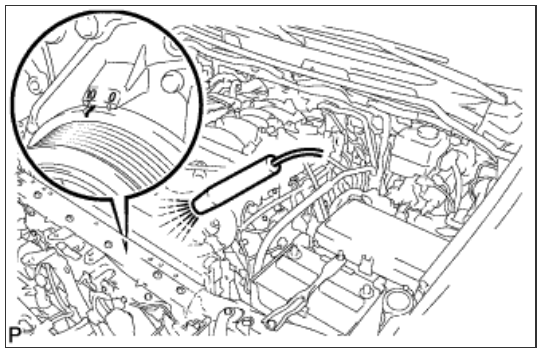
Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.



h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

75. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

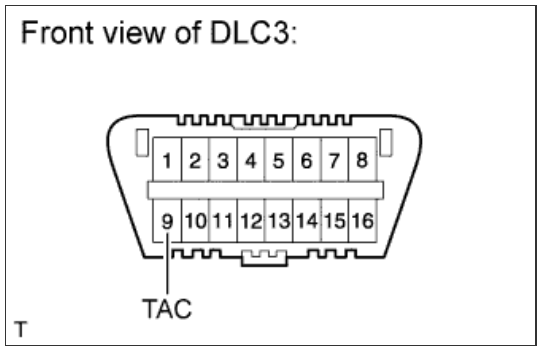
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Check the idle speed.

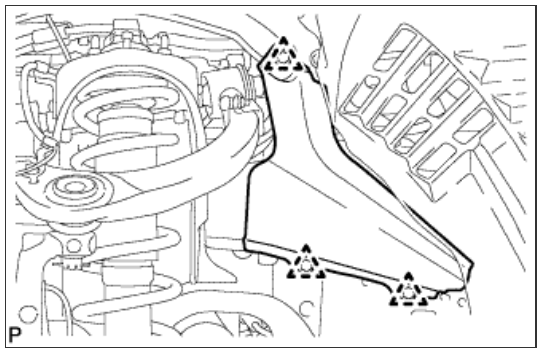
Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

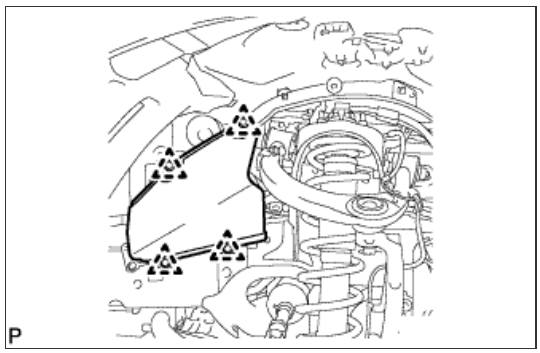
76. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



77. INSTALL FRONT FENDER APRON SEAL FRONT LH

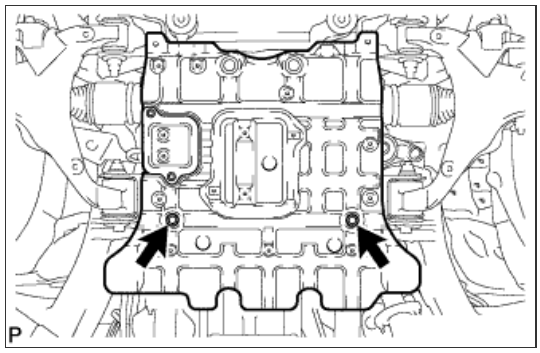
a. Install the fender apron seal with the 4 clips.



78. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

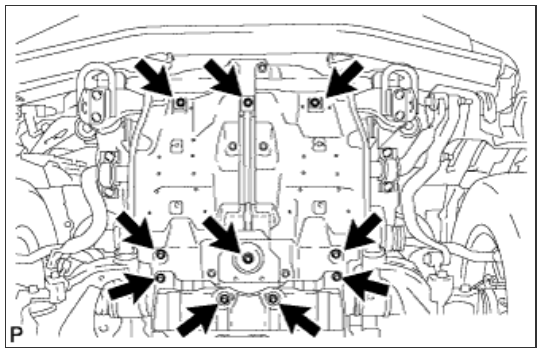
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



79. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

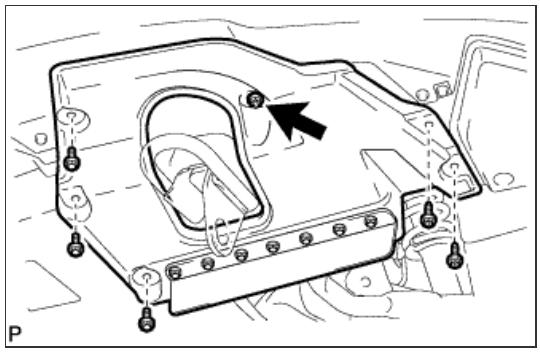
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



80. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



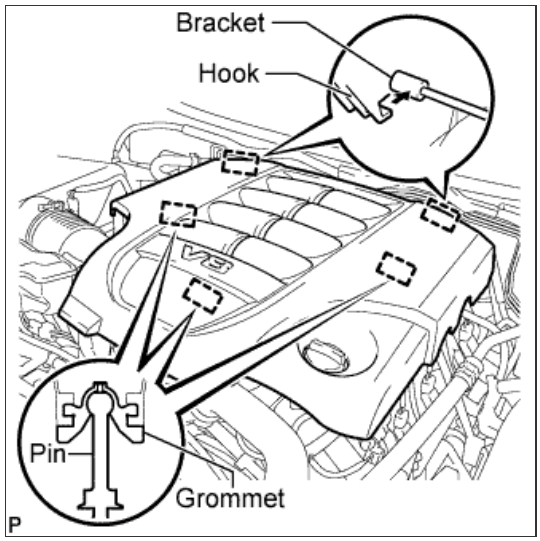
81. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

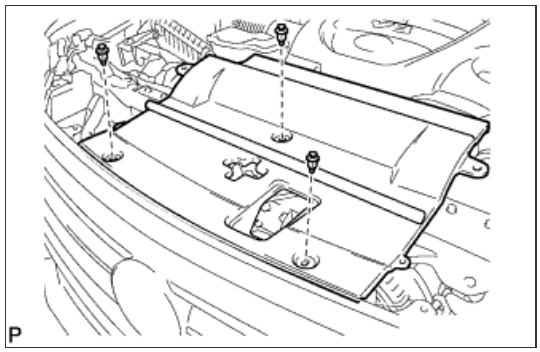
82. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



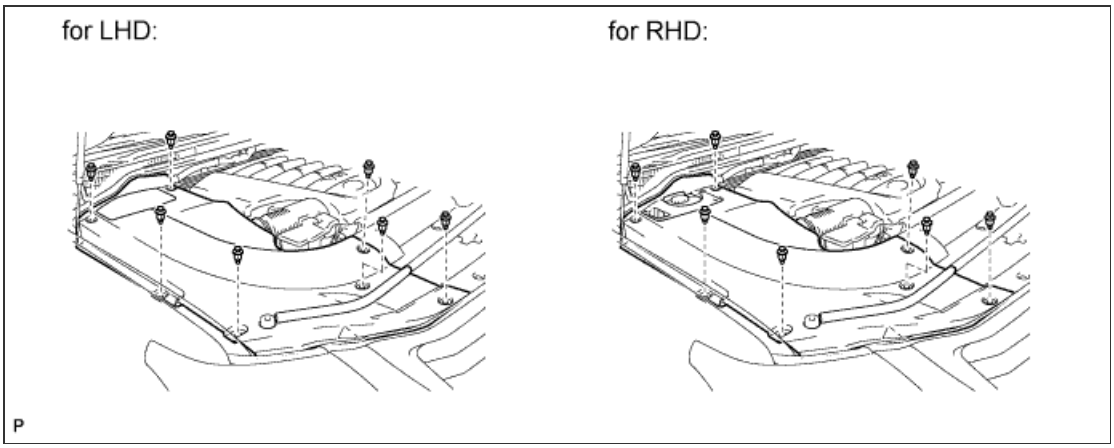
83. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



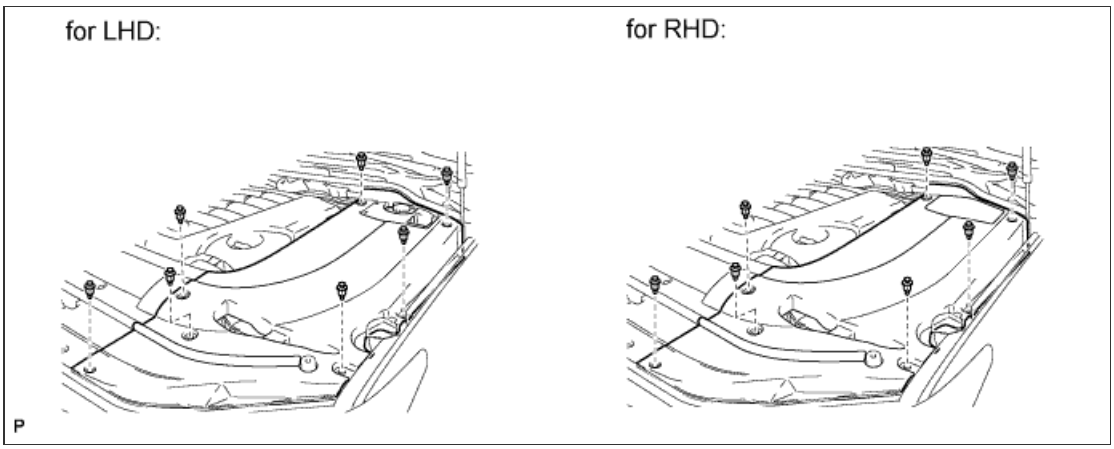
84. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



85. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



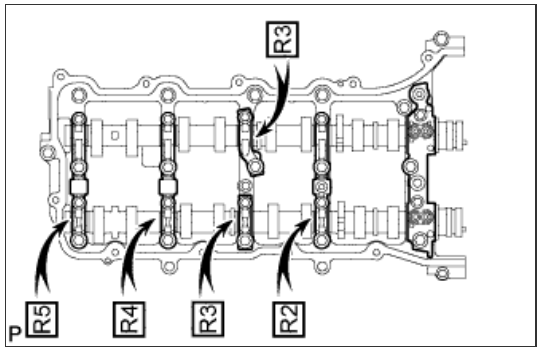
for Preparation Click here

1. INSTALL CAMSHAFT BEARING CAP RH

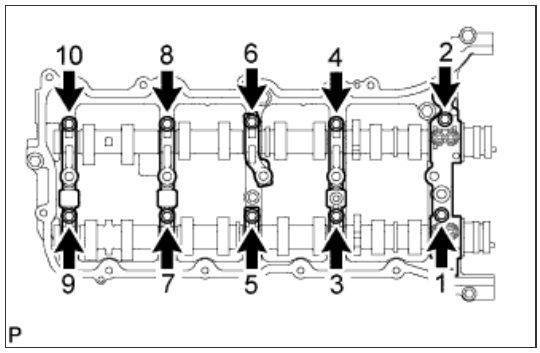
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 1 and No. 2 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

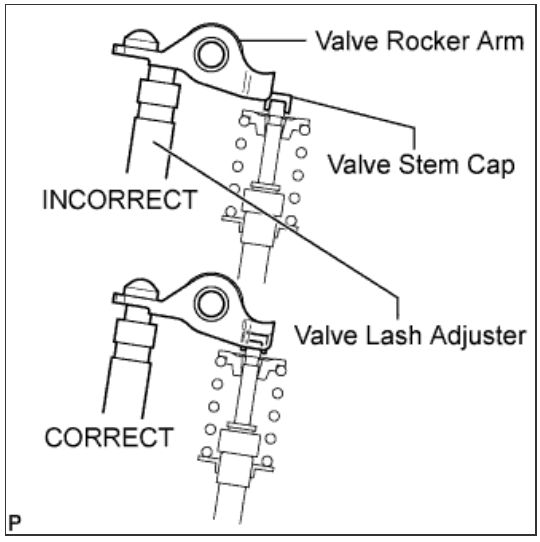


d. Temporarily install the 10 bolts in the order shown in the illustration.



2. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY RH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



b. Apply seal packing in a continuous line as shown in the illustration.

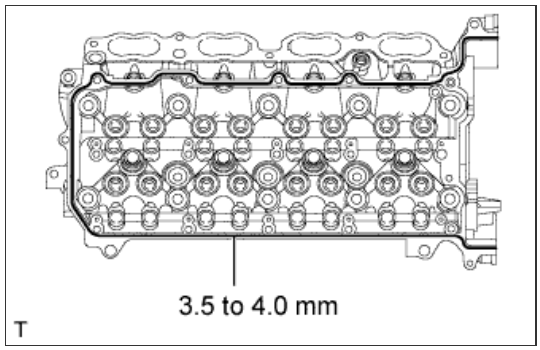
Seal packing:

Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

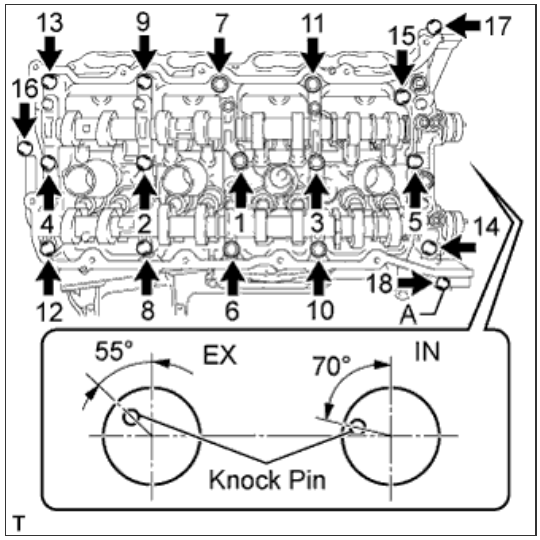


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

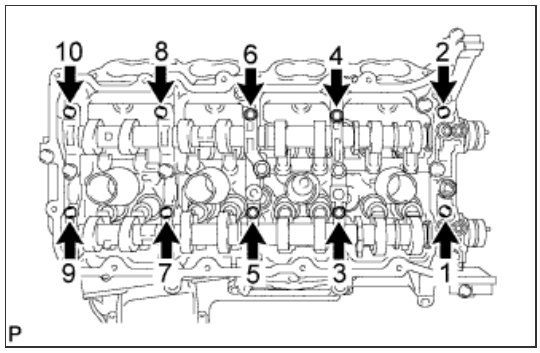


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

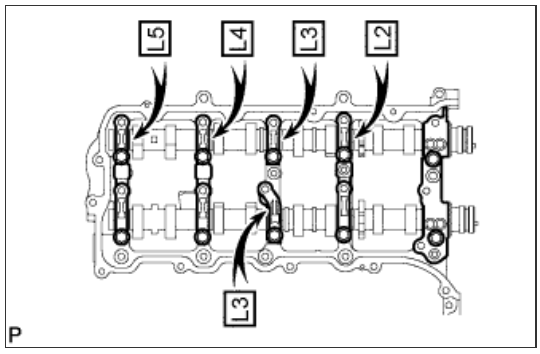


3. INSTALL CAMSHAFT BEARING CAP LH

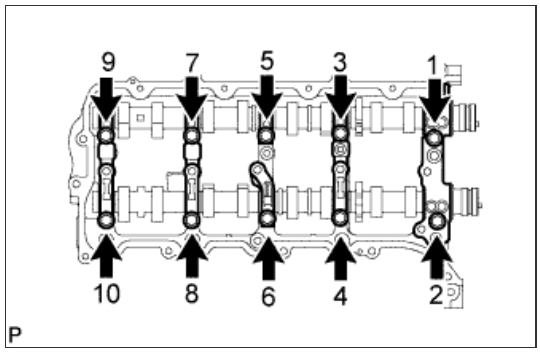
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 3 and No. 4 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

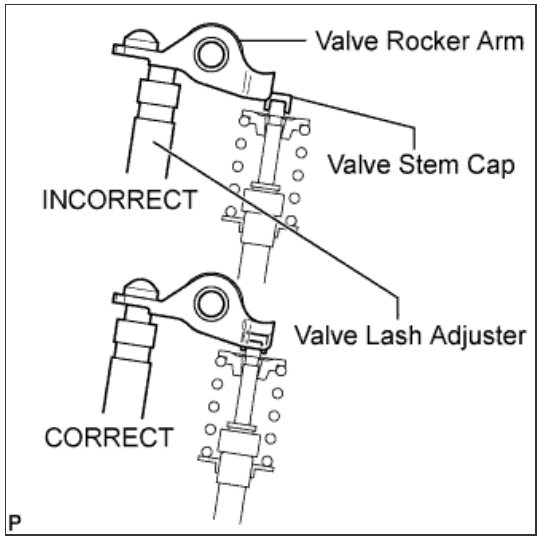


d. Temporarily install the 10 bolts in the order shown in the illustration.



4. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY LH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



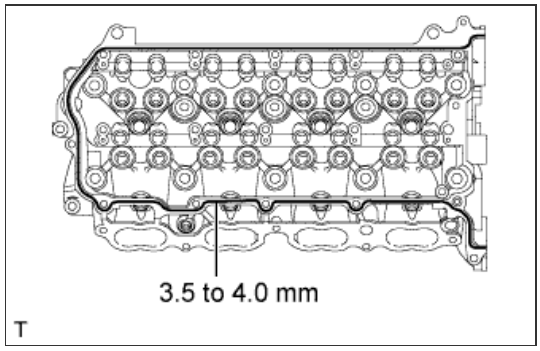
b. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

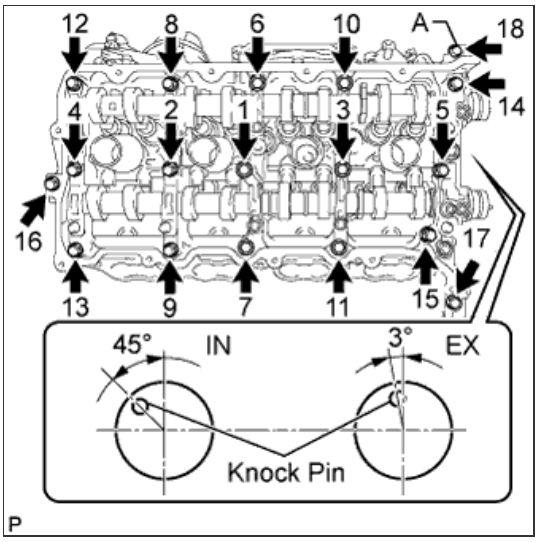


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

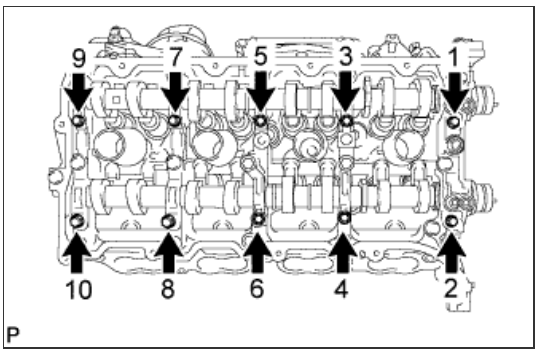


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

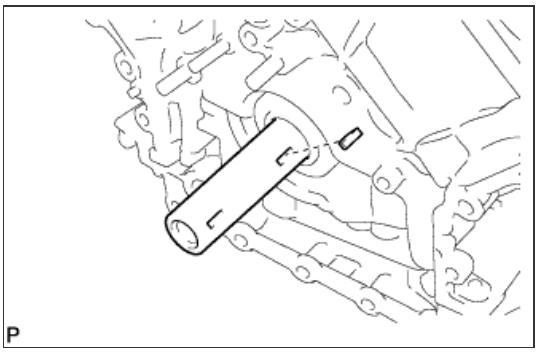


5. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the timing gear key.

HINT:

The other timing gear key will be installed at a later step.



6. SET NO. 1 CYLINDER TO TDC/COMPRESSION

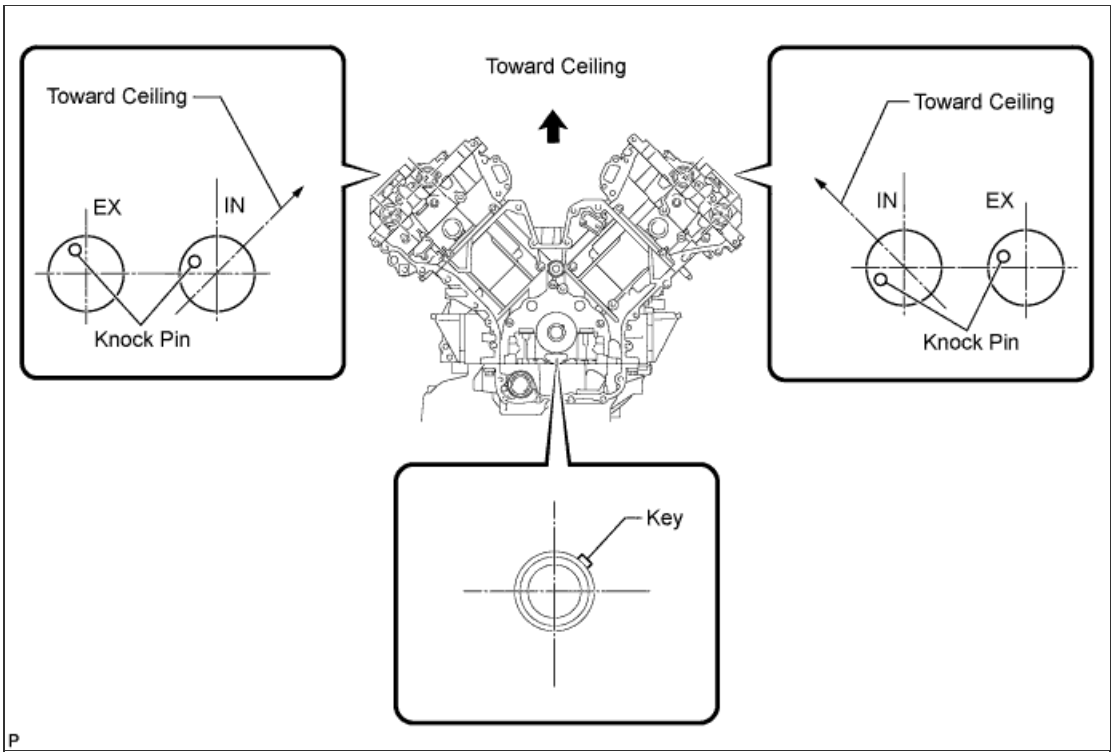
a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft so that the timing gear key is as shown in the illustration. Then using a wrench, rotate each camshaft so that the timing marks are as shown in the illustration.

NOTICE:

When the crankshaft or a camshaft is rotated excessively, the valves and pistons may interfere with each other.

c. Remove the crankshaft pulley bolt.

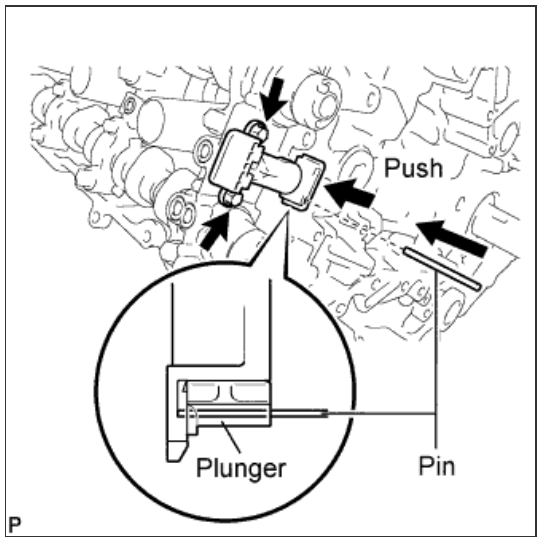


7. INSTALL NO. 2 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

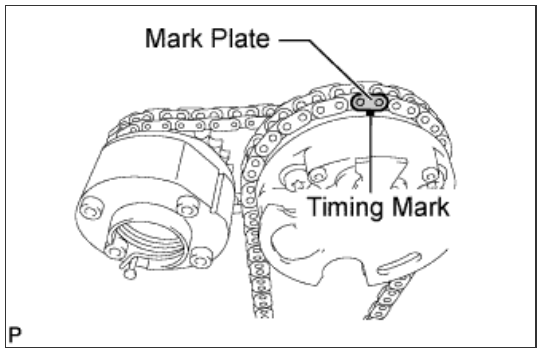
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While raising up the No. 2 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.

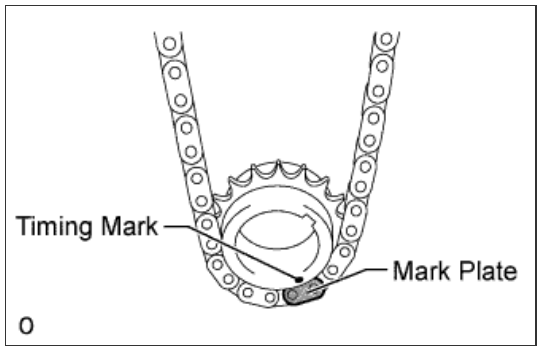


8. INSTALL NO. 1 CHAIN SUB-ASSEMBLY RH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



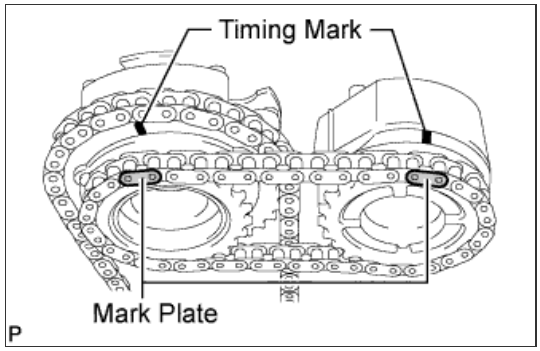
b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

HINT:

The crankshaft timing sprocket RH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.



d. Install the crankshaft timing sprocket RH to the crankshaft.

e. Align and attach the knock pin of the No. 1 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 2 camshaft, align and attach the knock pin of the No. 2 camshaft with the pin hole of the camshaft timing exhaust gear.

g. Remove the pin from the No. 2 chain tensioner.

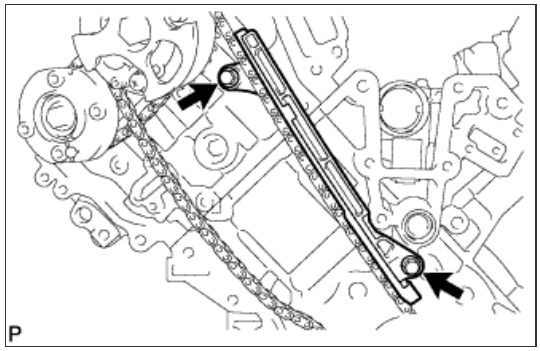
h. Using a wrench to hold the hexagonal portion of the No. 1 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, temporarily install the bolt.

9. INSTALL NO. 1 CHAIN VIBRATION DAMPER RH

a. Install the vibration damper with the 2 bolts.

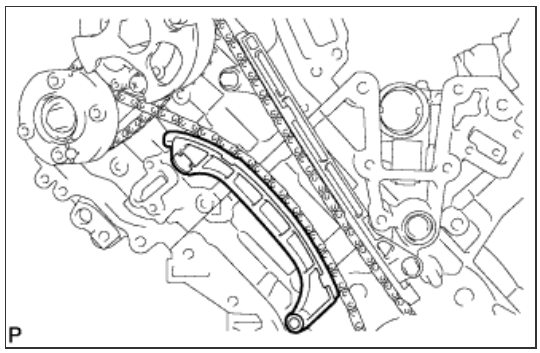
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



10. INSTALL NO. 1 CHAIN TENSIONER SLIPPER RH

HINT:

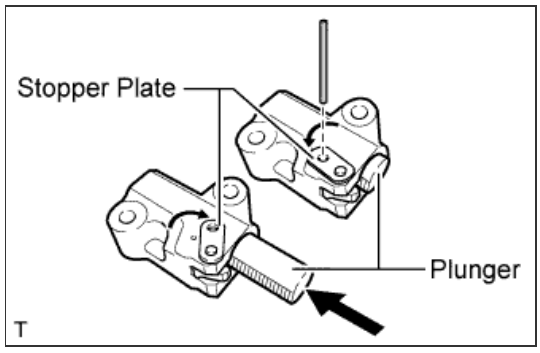
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and then install the chain tensioner slipper.



11. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY RH

a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

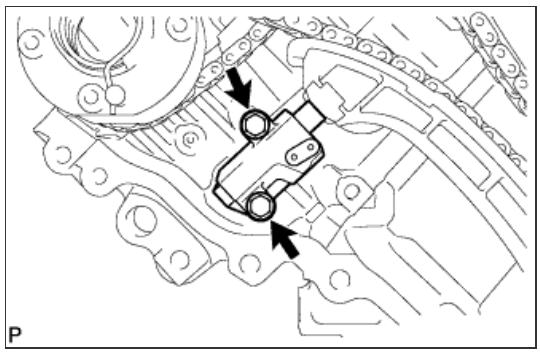
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Remove the hexagon wrench from the chain tensioner.

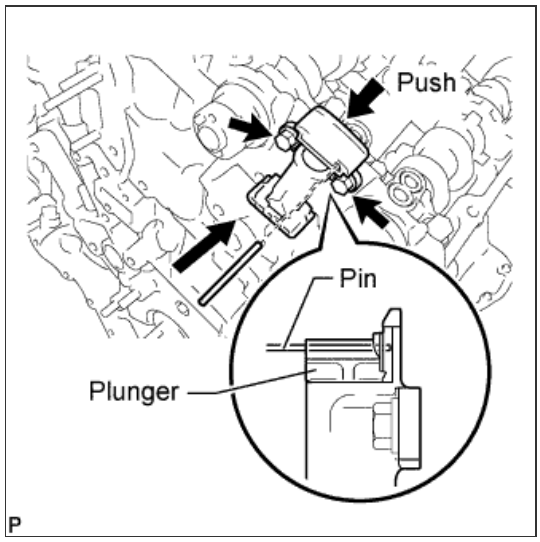


12. INSTALL NO. 3 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

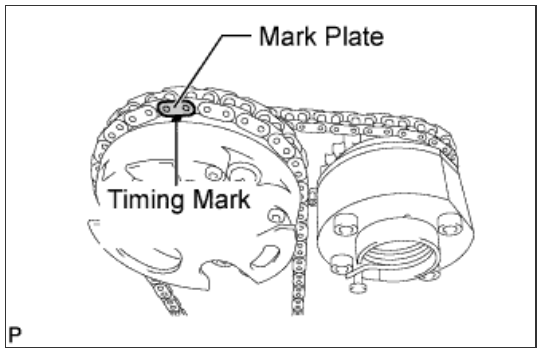
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While pushing down the No. 2 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.

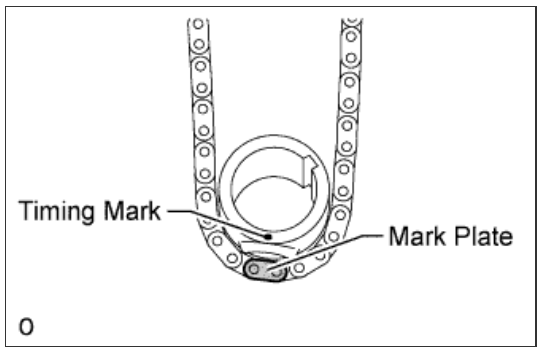


13. INSTALL NO. 1 CHAIN SUB-ASSEMBLY LH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



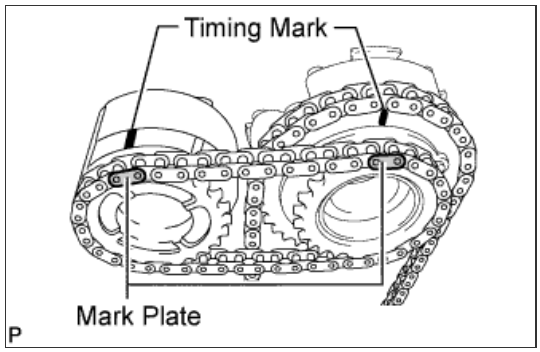
b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

HINT:

The crankshaft timing sprocket LH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.



d. Install the crankshaft timing sprocket LH to the crankshaft.

e. Align and attach the knock pin of the No. 3 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 4 camshaft, align and attach the knock pin of the No. 4 camshaft with the pin hole of the camshaft timing exhaust gear.

NOTICE:

Because the timing mark positions of the gears may shift due to looseness of the No. 1 chain, use the hexagonal portion of the camshaft to hold the No. 3 camshaft in place until the No. 1 chain tensioner is installed.

g. Remove the pin from the No. 3 chain tensioner.

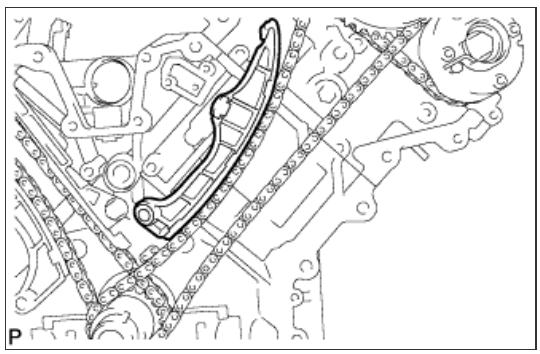
h. Using a wrench to hold the hexagonal portion of the No. 3 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, temporarily install the bolt.

14. INSTALL NO. 1 CHAIN TENSIONER SLIPPER LH

HINT:

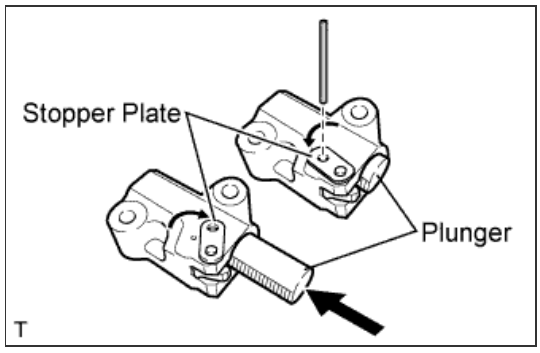
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and install the chain tensioner slipper.



15. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY LH

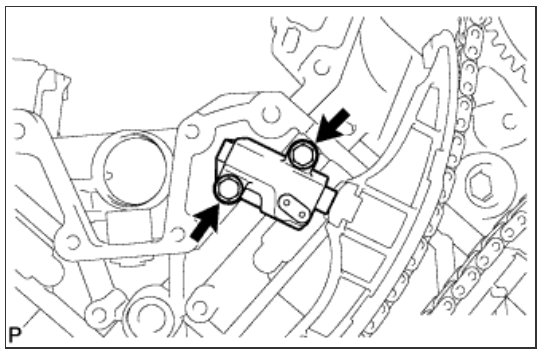
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install a new gasket and the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

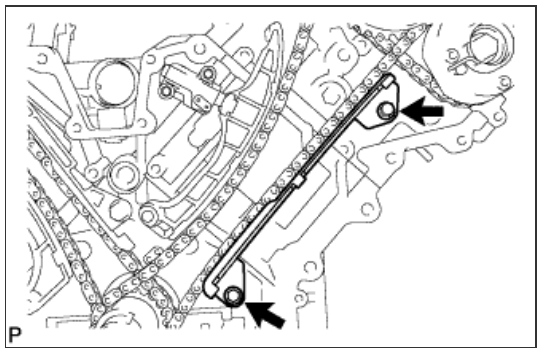


16. INSTALL NO. 1 CHAIN VIBRATION DAMPER LH

a. Install the vibration damper with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Remove the hexagon wrench from the No. 1 chain tensioner.



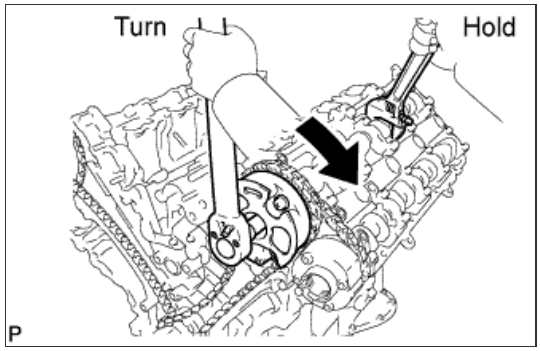
17. TIGHTEN CAMSHAFT TIMING GEAR ASSEMBLY

a. for Bank 1:

i. Using a wrench, hold the hexagonal portion of the No. 3 camshaft.

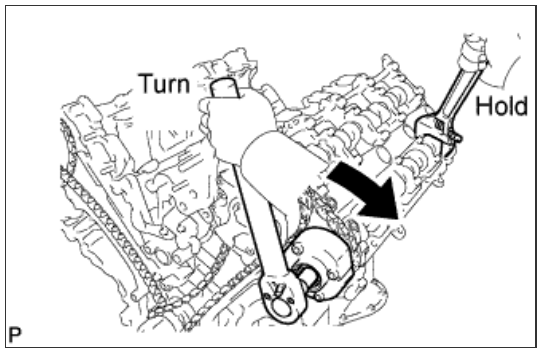
ii. Tighten the bolt of the camshaft timing gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

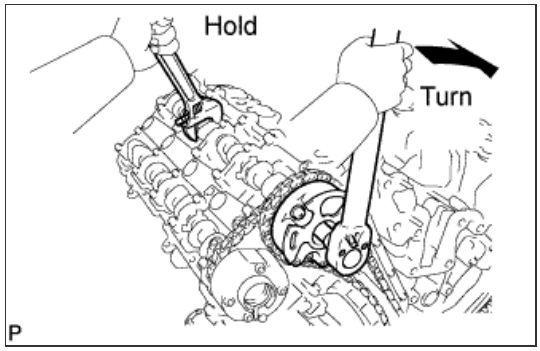


iii. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, tighten the bolt of the camshaft timing exhaust gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }



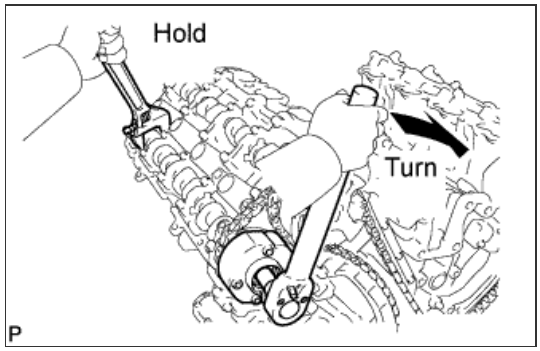
b. for Bank 2:



i. Using a wrench, hold the hexagonal portion of the No. 1 camshaft.

ii. Tighten the bolt of the camshaft timing gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }



iii. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, tighten the bolt of the camshaft timing exhaust gear.

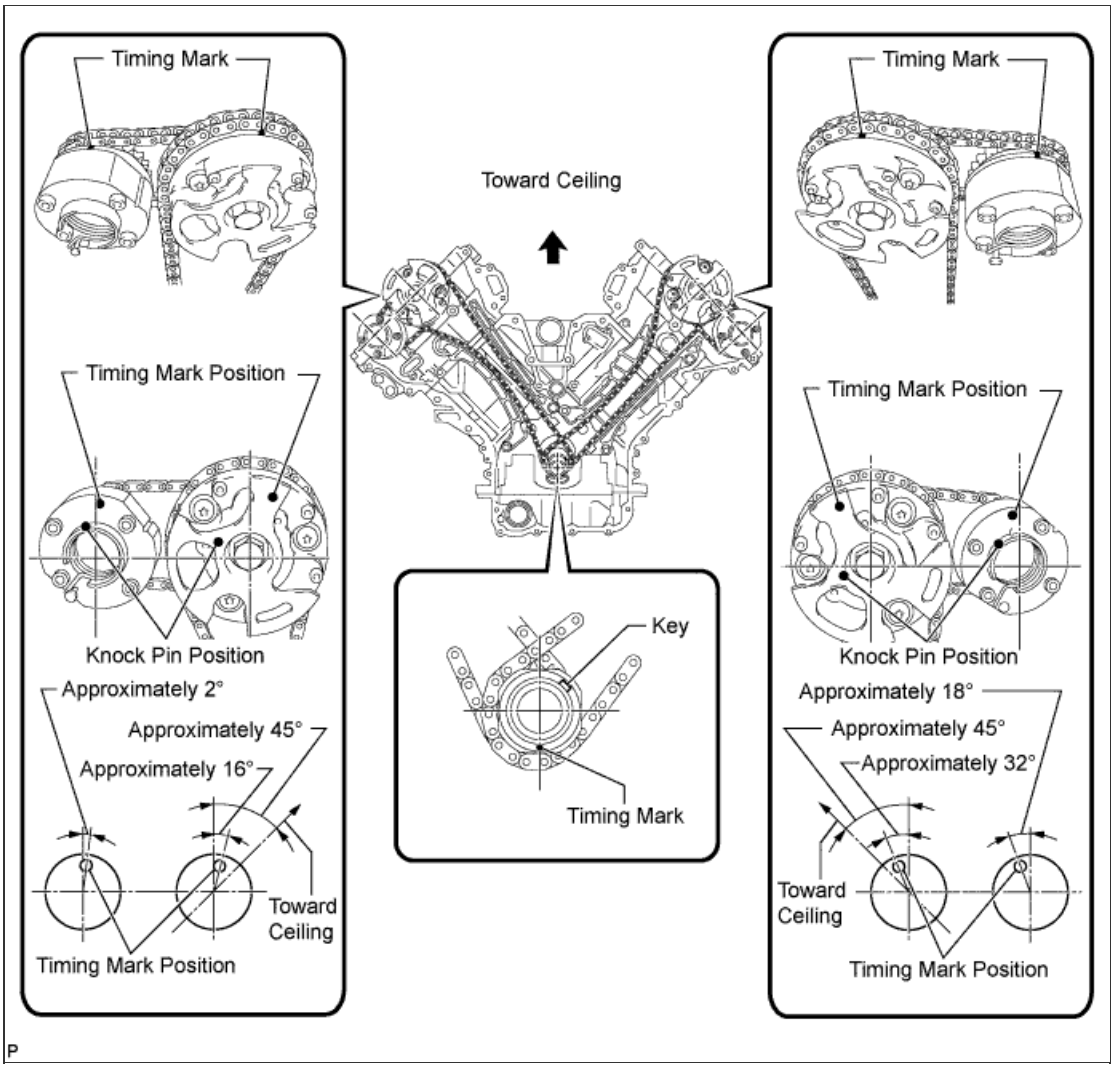
Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

18. CHECK NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise, and check that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

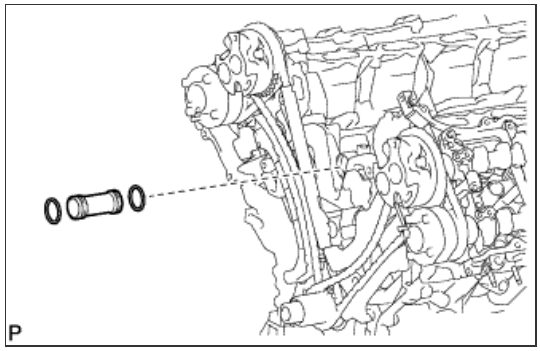
c. Remove the crankshaft pulley bolt.



19. INSTALL WATER INLET PIPE

a. Apply soapy water to 2 new O-rings and install them to the inlet pipe.

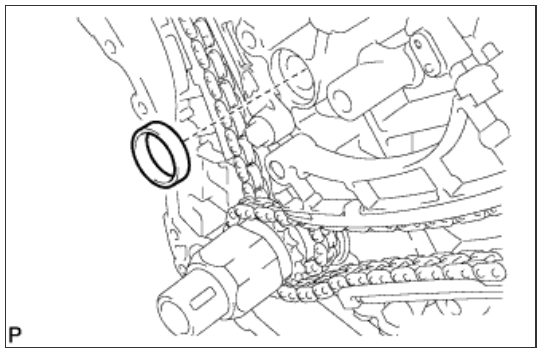
b. Install the inlet pipe to the No. 1 heat exchanger cover.



20. INSTALL TIMING CHAIN COVER SUB-ASSEMBLY

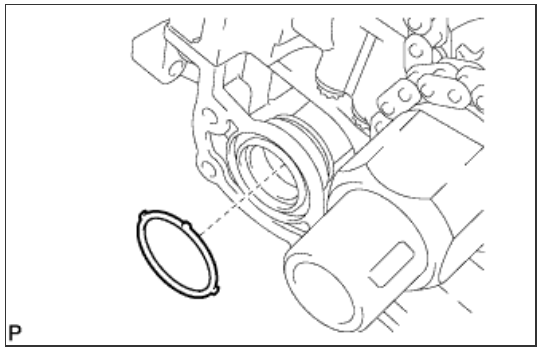
a. Apply a light coat of engine oil to a new oil pump gasket.

b. Install the oil pump gasket.

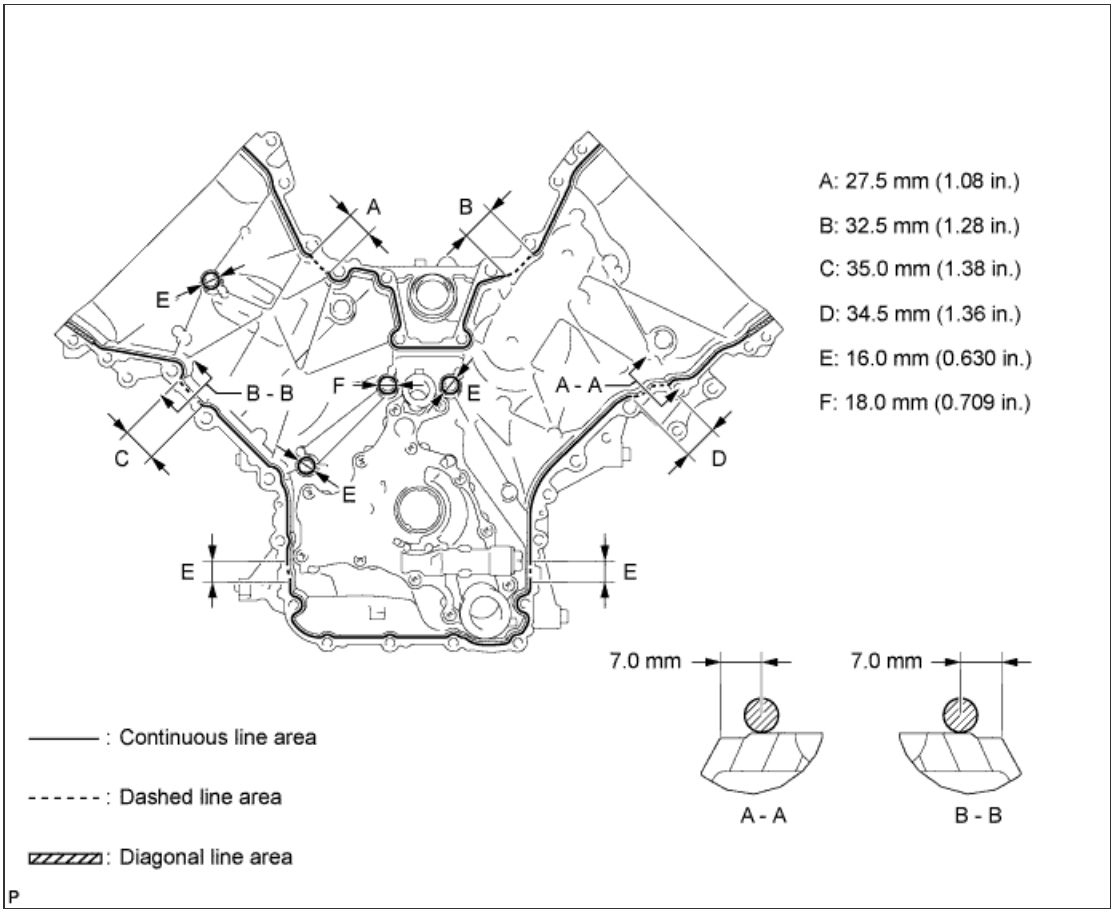


c. Apply a light coat of engine oil to a new O-ring.

d. Install the O-ring.



e. Apply seal packing in a continuous line to the timing chain cover as shown in the following illustration.

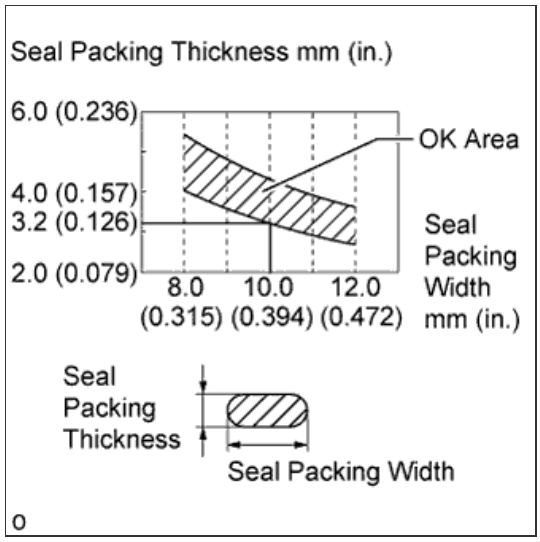


Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Apply Seal Packing as Follows:

		Application Position from

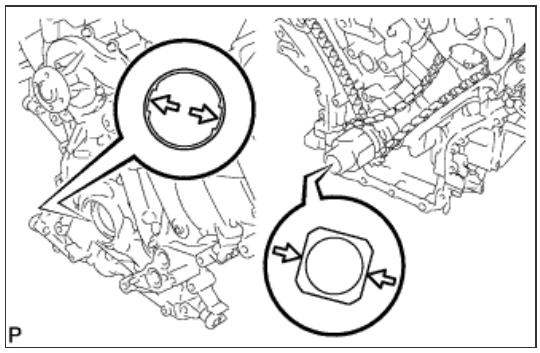
Area	Seal Packing Diameter	Inside Edge of Cover
Continuous Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	2.5 mm (0.0984 in.)
Dashed Line Area	6.4 mm (0.252 in.) or more, or within OK area shown in illustration	7.0 mm (0.276 in.)
Diagonal Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	5.5 mm (0.217 in.)



NOTICE:

- **When the contact surfaces are wet, wipe them with an oil-free cloth before applying seal packing.**
- **Install the chain cover within 3 minutes and tighten the bolts within 10 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after installing.**

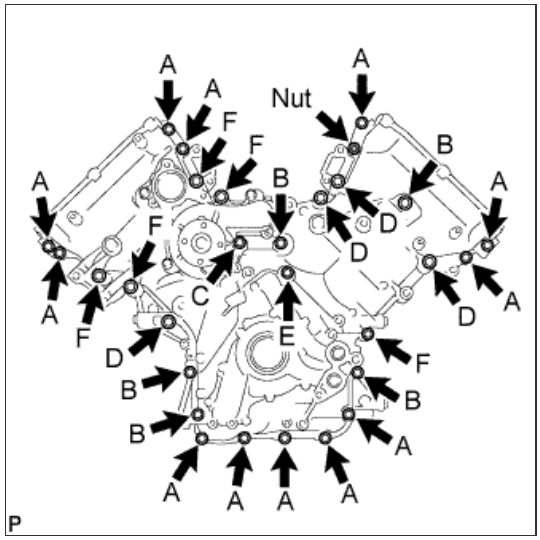
f. Align the oil pump drive rotor spline and crankshaft as shown in the illustration. Install the spline and chain cover to the crankshaft.



g. Temporarily install the timing chain cover with the 28 bolts and nut.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)



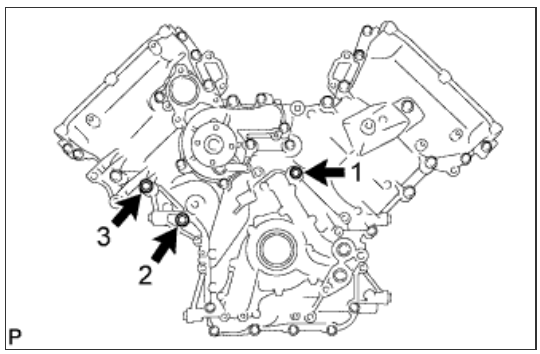
NOTICE:

Make sure that there is no oil on the bolt threads.

h. Tighten the 3 bolts in several steps in the sequence shown in the illustration.

Torque:

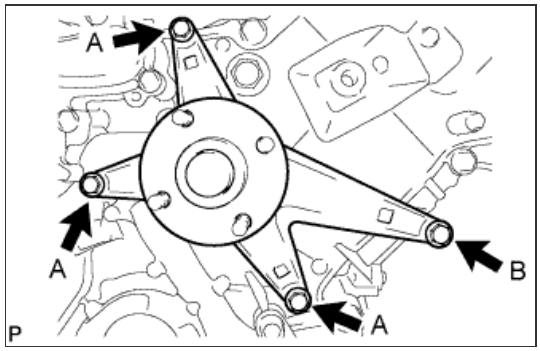
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



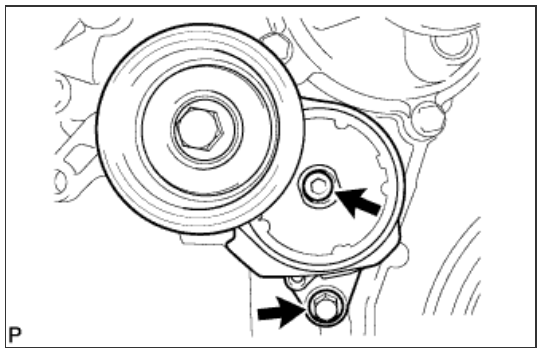
i. Temporarily install the fluid coupling bracket with the 4 bolts.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt B	80 mm (3.15 in.)	10 mm (0.394 in.)



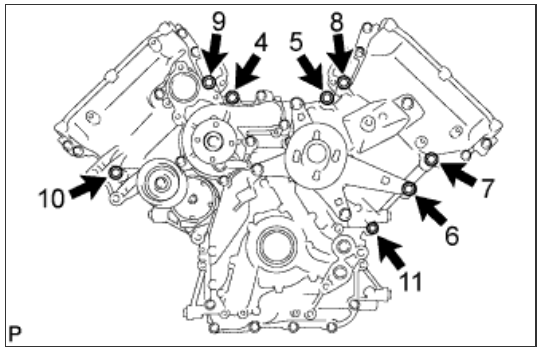
j. Temporarily install the belt tensioner with the standard bolt and 6 mm hexagon wrench bolt.



k. Tighten the 8 bolts labeled 4 to 11 in several steps in the sequence shown in the illustration.

Torque:

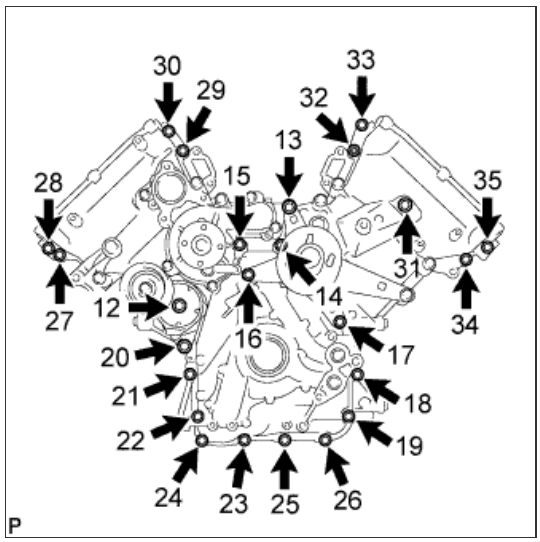
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



l. Tighten the 23 bolts and nut labeled 12 to 35 in several steps in the sequence shown in the illustration.

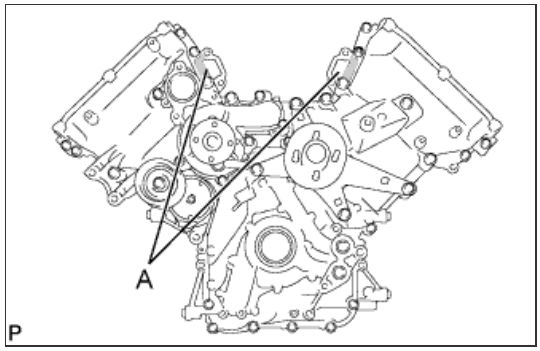
Torque:

23 N*m{ 235 kgf*cm , 17 ft.*lbf }



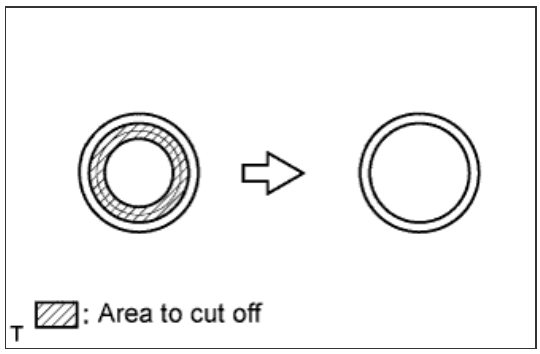
NOTICE:

After the installation, if the seal packing has seeped out at the areas labeled A shown in the illustration, wipe it off.



21. INSTALL SPARK PLUG TUBE GASKET

a. Using a cutter knife, cut off the seal part of the removed gasket.



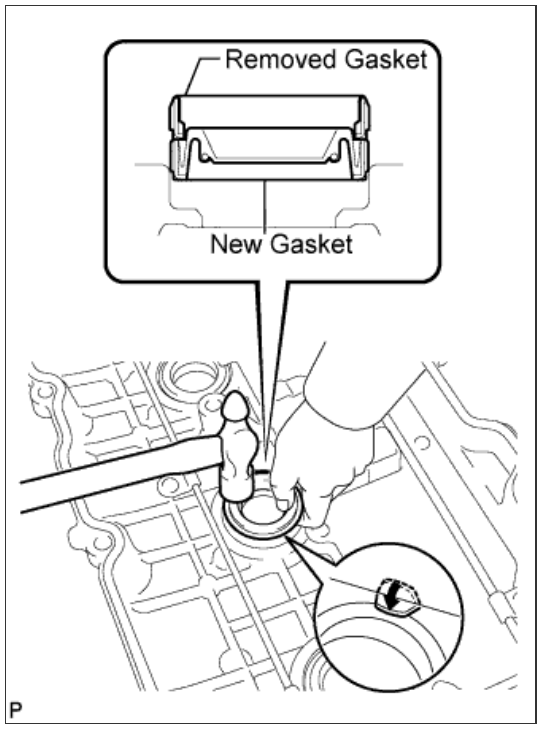
b. Using the removed gasket and a hammer, tap in a new gasket until it stops.

HINT:

If the removed gasket does not fit on the new one, correct the removed one with pliers.

c. Apply a light coat of MP grease to the lip of the gasket.

d. Return the 4 ventilation baffle plate claws to the original positions.



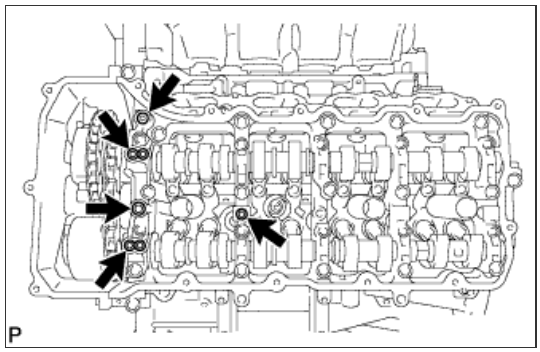
22. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY LH

a. Install 5 new gaskets to the camshaft bearing caps (No. 2, No. 3).

b. Install a new gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

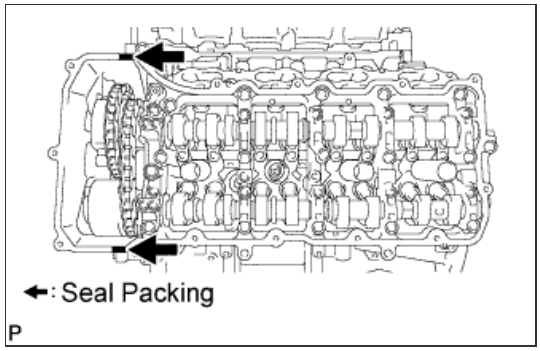


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

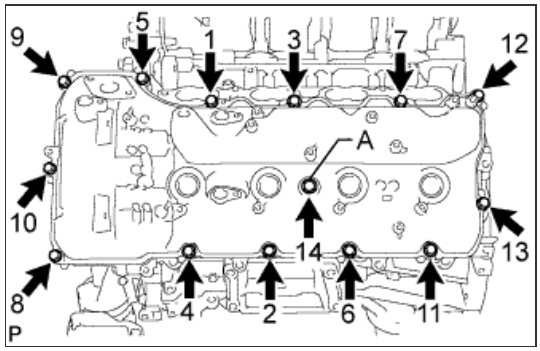
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



d. Install the cylinder head cover and a new seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



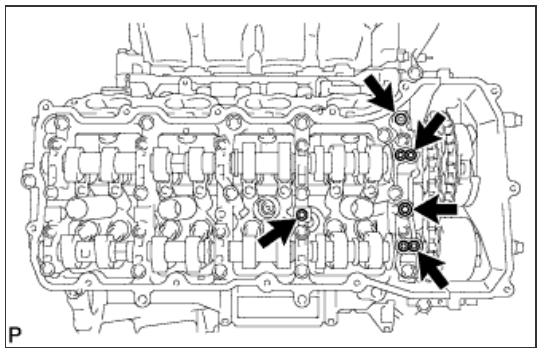
23. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY RH

a. Install 5 new gaskets to the camshaft bearing caps. (No. 1, No. 3).

b. Install a new gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

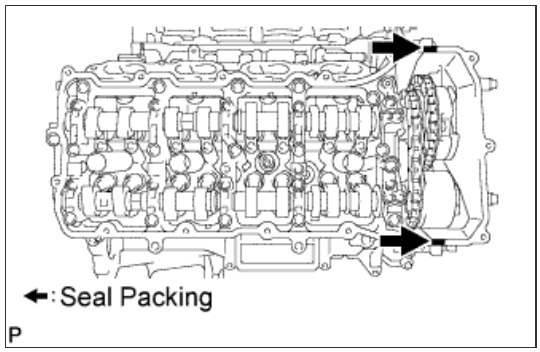


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

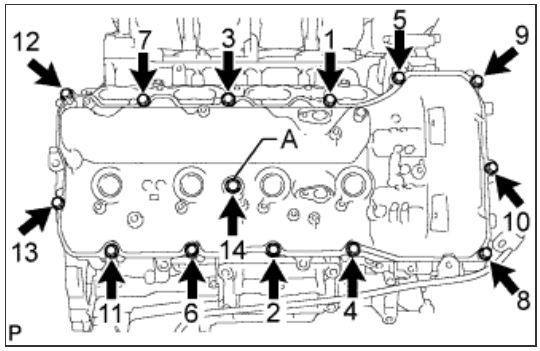
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



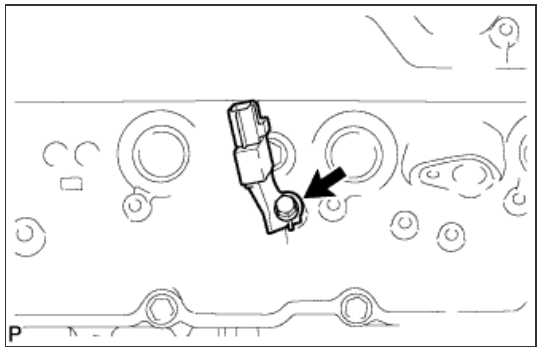
d. Install the cylinder head cover and a new seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



e. Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }



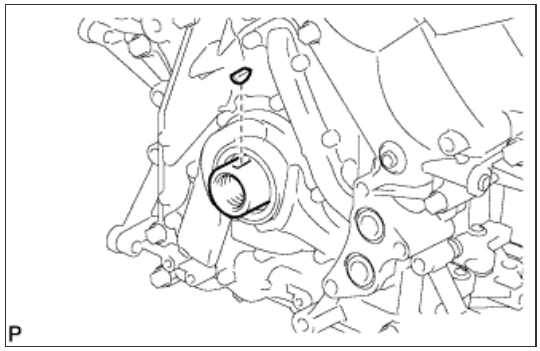
24. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

25. INSTALL CRANKSHAFT TIMING GEAR KEY

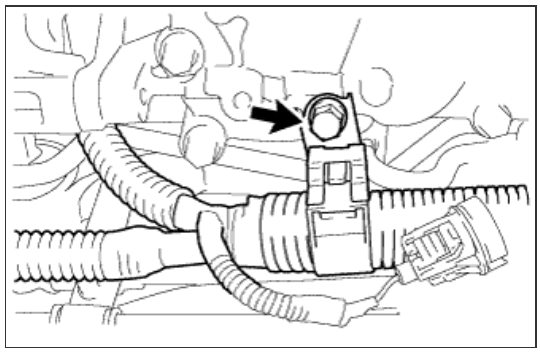
a. Install the crankshaft timing gear key to the crankshaft.



26. CONNECT WIRE HARNESS CLAMP BRACKET

a. Connect the bracket to the timing chain cover with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



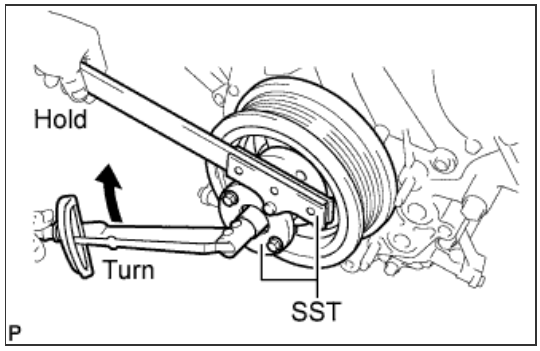
27. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

b. Using SST, install the pulley set bolt.

SST
09213-70011 (09213-70020)
09330-00021

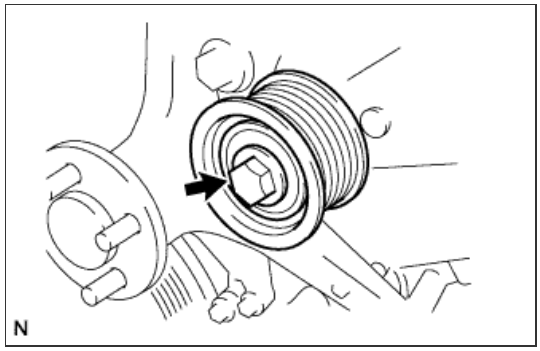
Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



28. INSTALL NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Install the idler pulley with the bolt.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



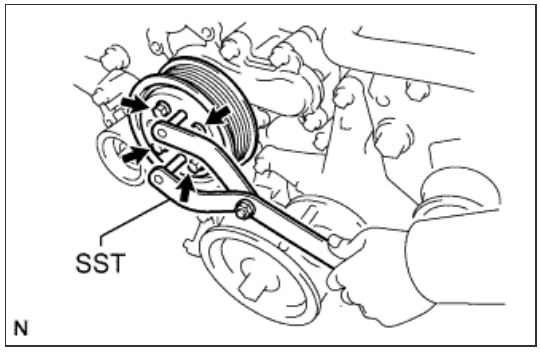
29. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.

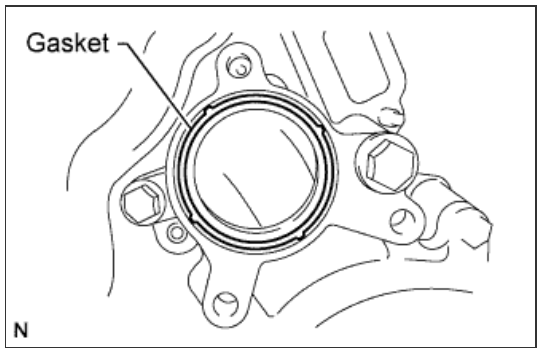
SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



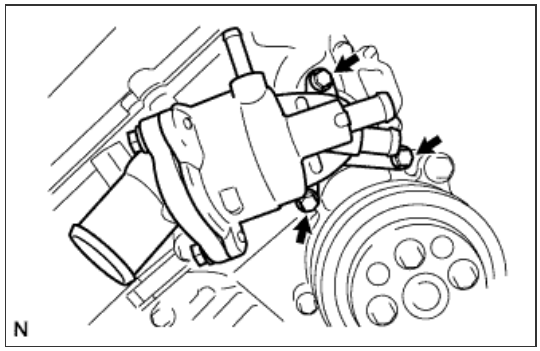
30. INSTALL WATER INLET HOUSING

a. Install a new gasket to the timing chain cover.



b. Install the water inlet with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

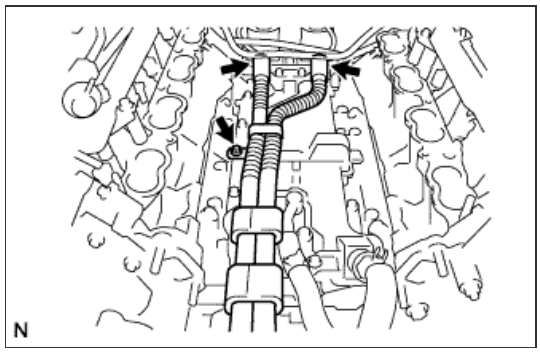


31. INSTALL AIR PIPE SUB-ASSEMBLY (w/ Secondary Air Injection System)

a. Connect the 2 hoses.

b. Install the air pipe with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



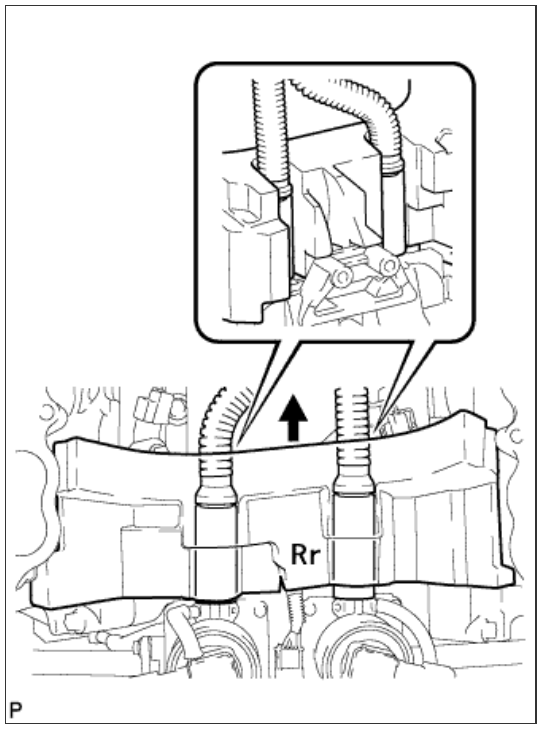
32. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



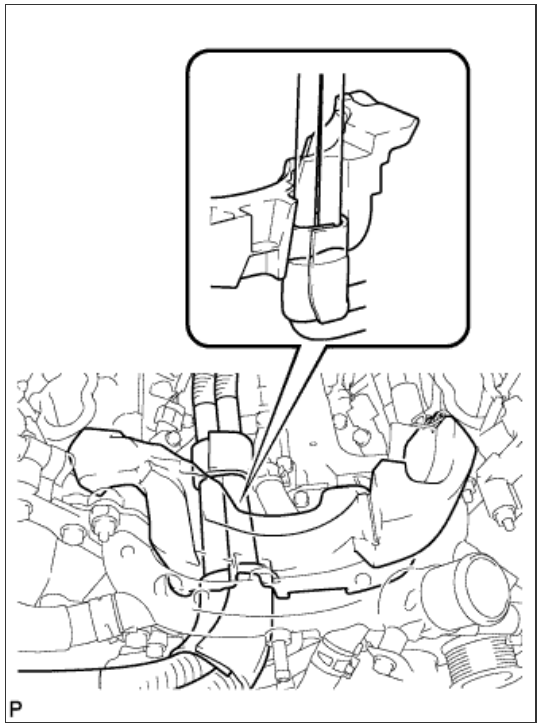
33. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.

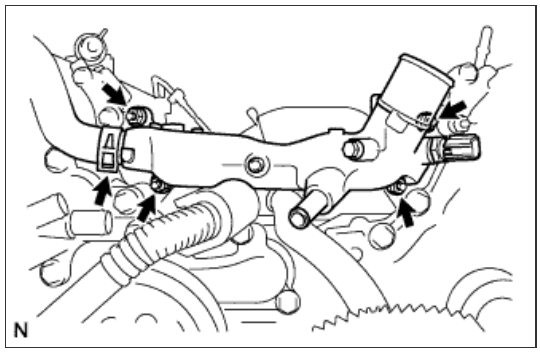


34. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the water by-pass joint with the 4 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the No. 2 water by-pass hose to the water by-pass joint.

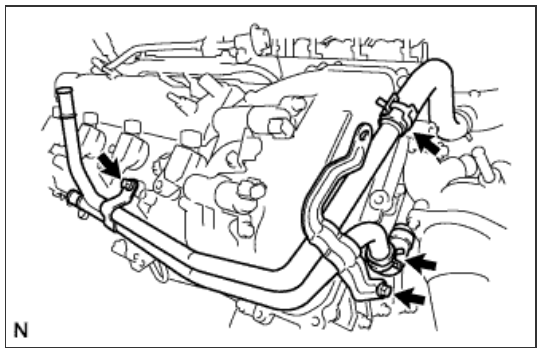


35. INSTALL WATER BY-PASS PIPE SUB-ASSEMBLY

a. Connect the 2 hoses.

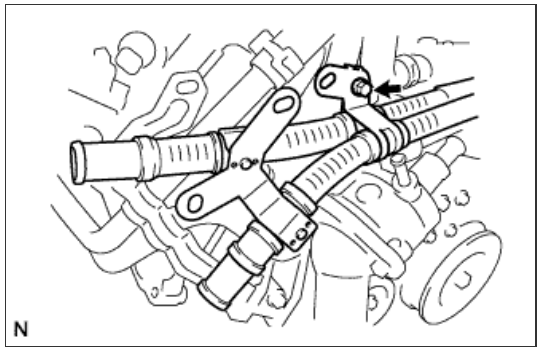
b. Install the water by-pass pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



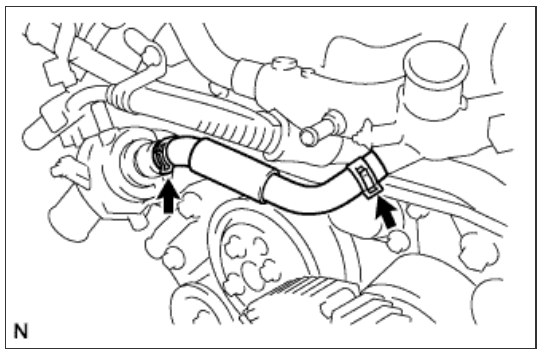
c. w/ Secondary Air Injection System:
Connect the air tube with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



36. INSTALL NO. 1 WATER BY-PASS HOSE

a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.

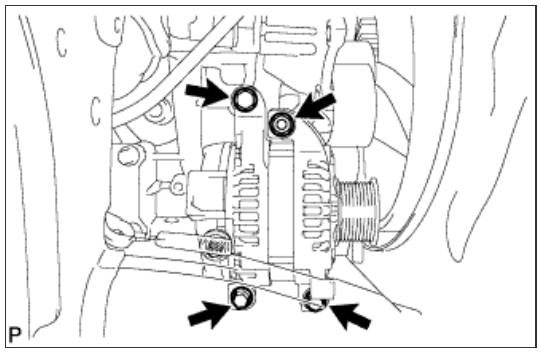


37. INSTALL GENERATOR ASSEMBLY

a. Install the generator with the 3 bolts and nut.

d. Install the generator with the 3 bolts and nut.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



b. Connect the generator connector.

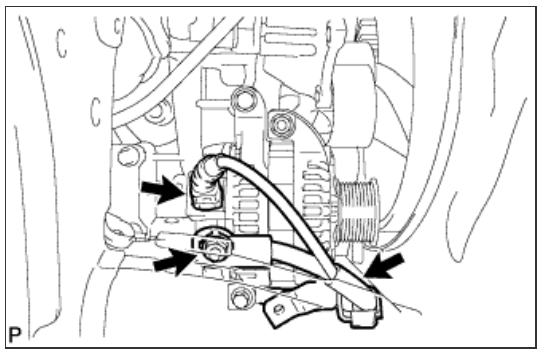
c. Connect the generator wire with the nut.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

d. Install the terminal cap.

e. Install the harness bracket to the generator with the bolt.

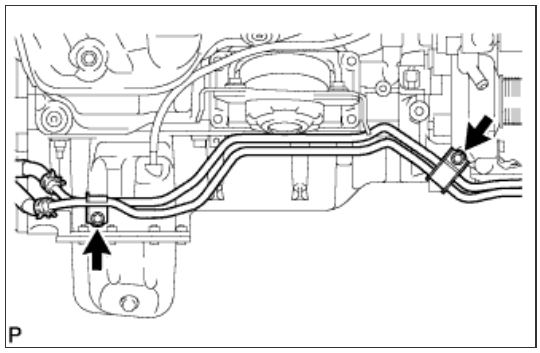
Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }



38. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }



39. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

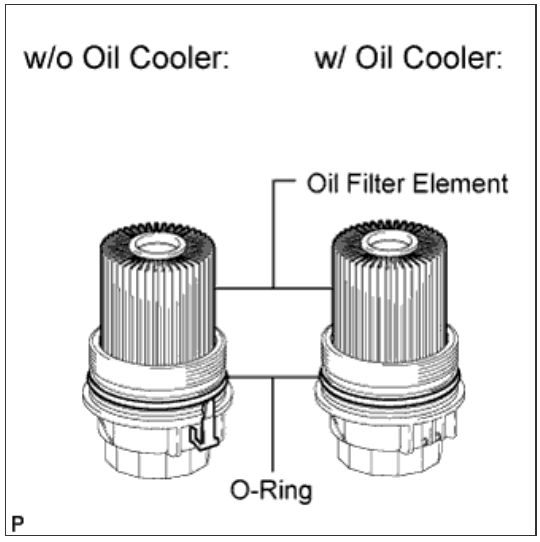
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



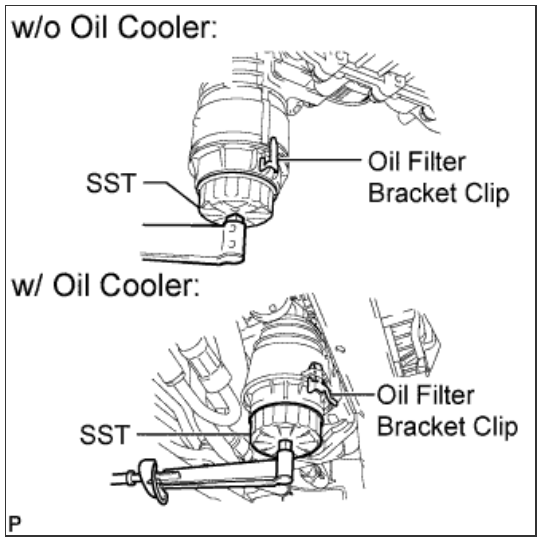
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

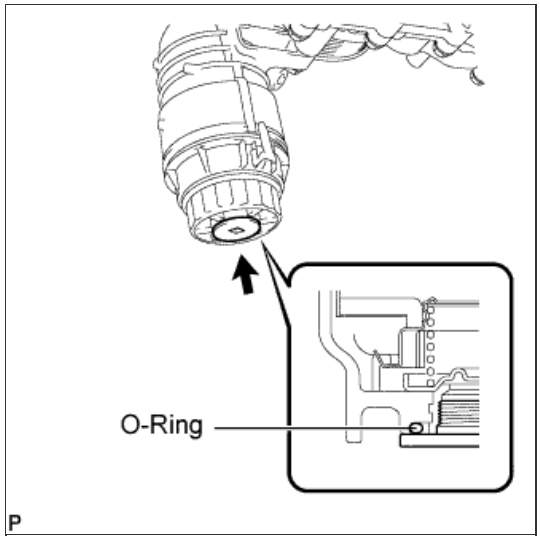
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

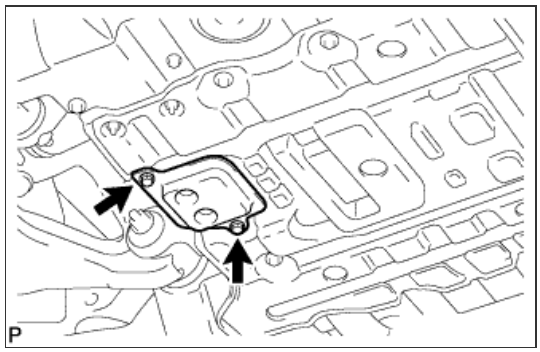
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

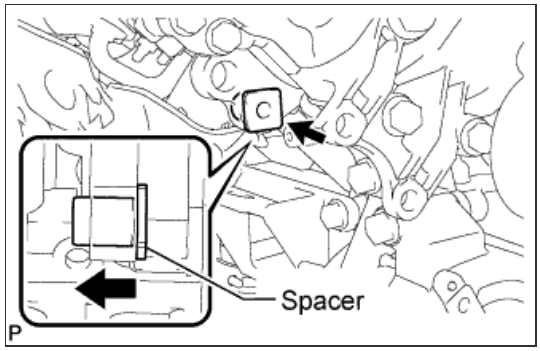
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



40. CONNECT VANE PUMP ASSEMBLY

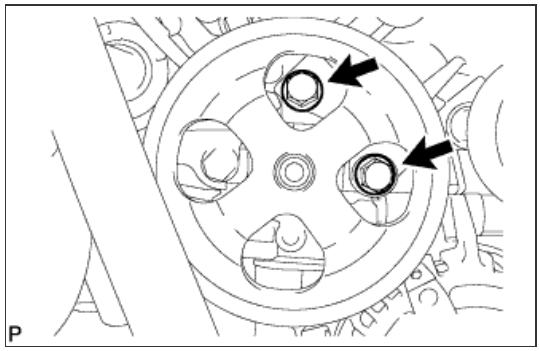
HINT:

Before performing the following procedures, move the spacer until the vane pump can be installed.

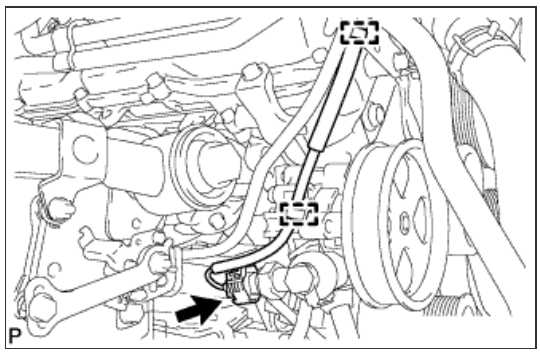


a. Connect the vane pump to the timing chain cover with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



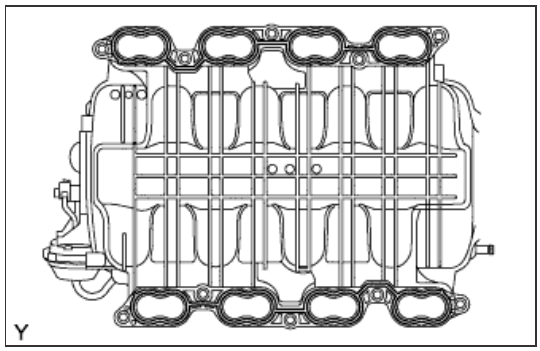
b. Connect the 2 clamps and power steering oil pressure switch connector.



41. INSTALL INTAKE MANIFOLD

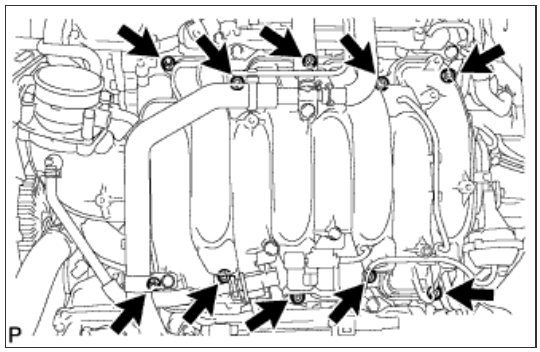
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



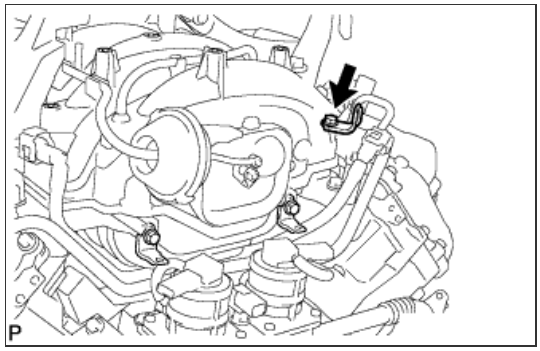
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

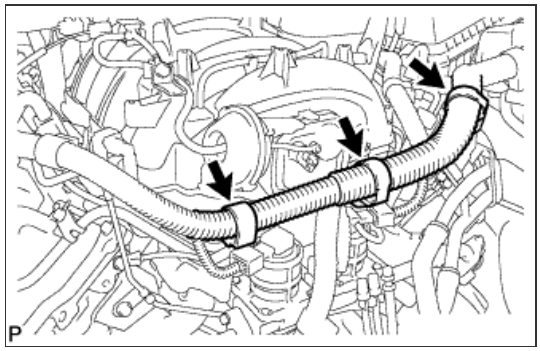


d. Install the wire bracket to the intake manifold with the bolt.

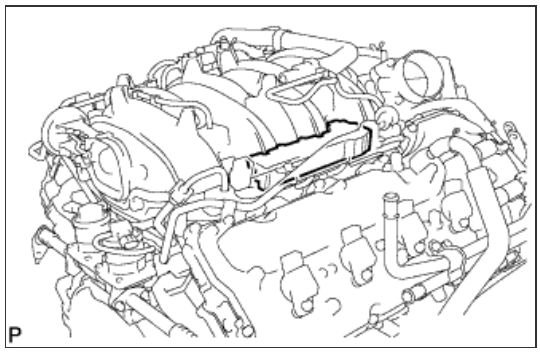
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



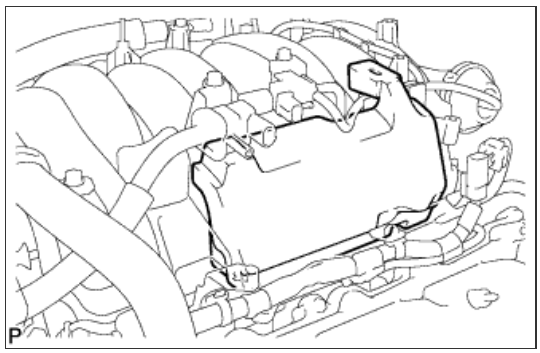
e. Connect the 3 wire clamps to the 3 wire brackets.



f. Install the No. 3 engine cover.



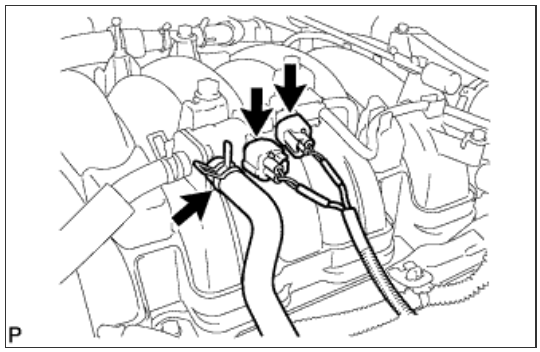
g. Install the No. 1 engine cover sub-assembly.



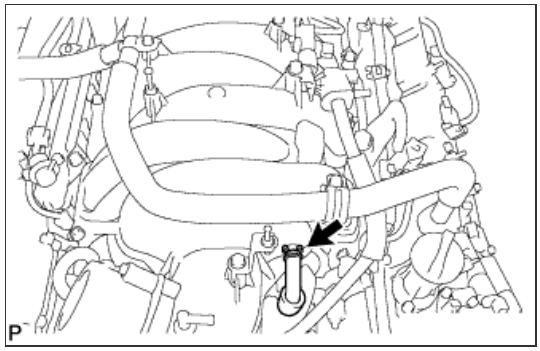
h. Connect the purge VSV connector.

i. Connect the purge line hose to the purge VSV.

j. Connect the vacuum switching valve connector (for ACIS).

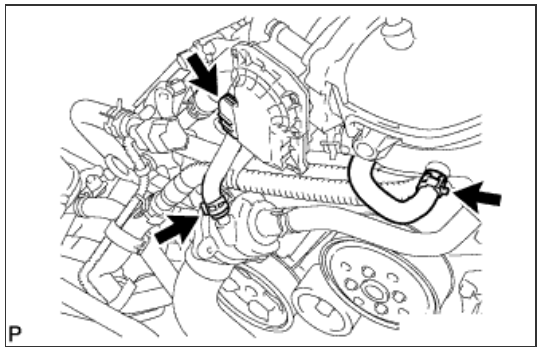


k. Connect the No. 1 ventilation hose.

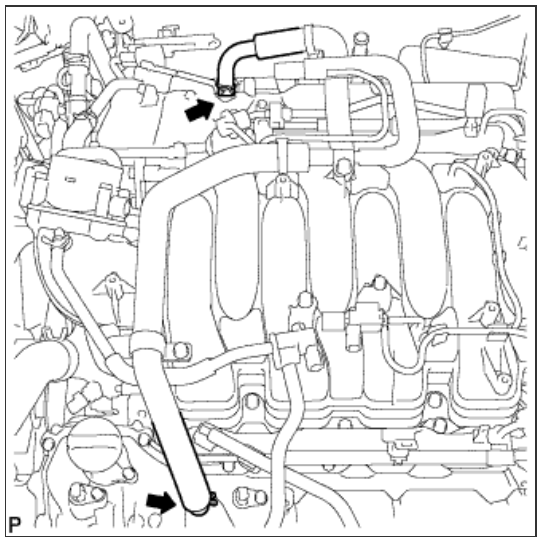


l. Connect the 2 water by-pass hoses.

m. Connect the throttle body connector.



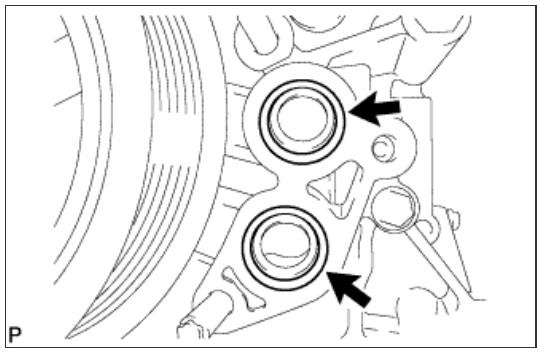
n. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.



42. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

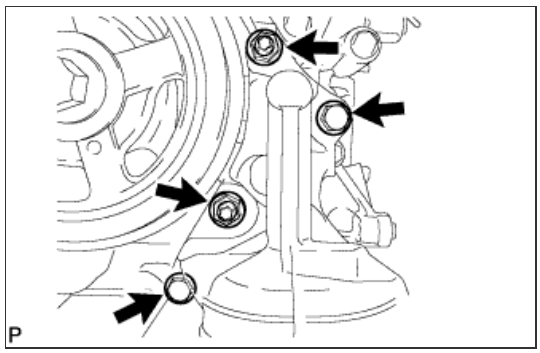
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

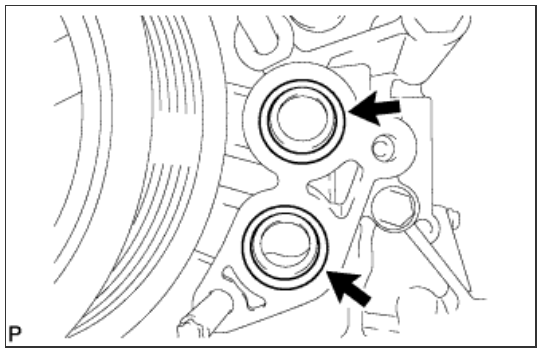
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



43. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

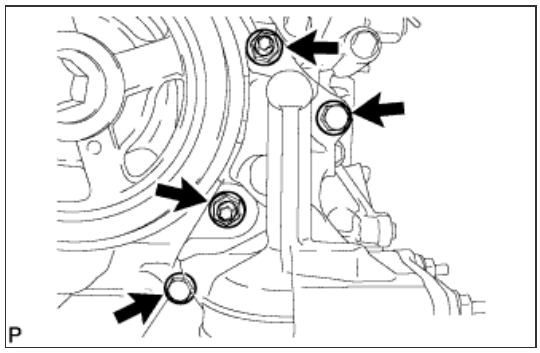
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

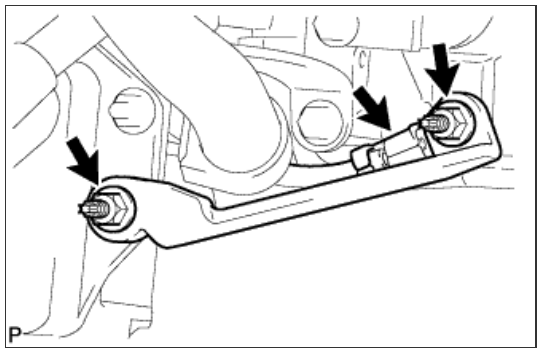


44. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

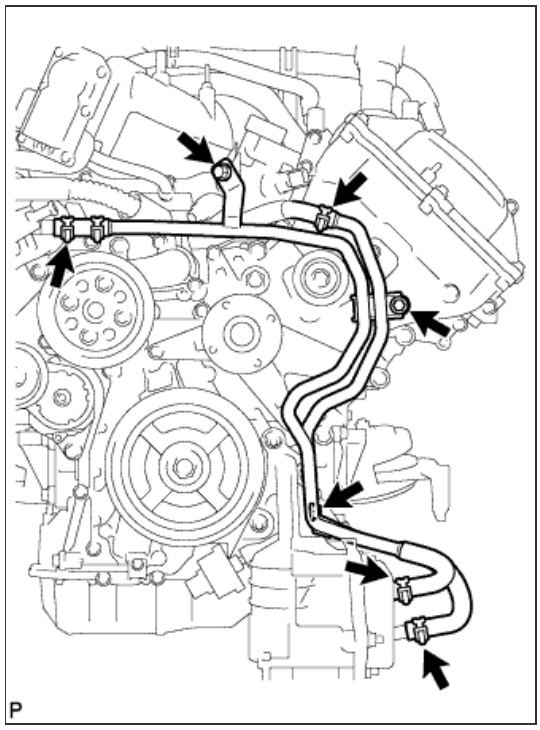


45. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

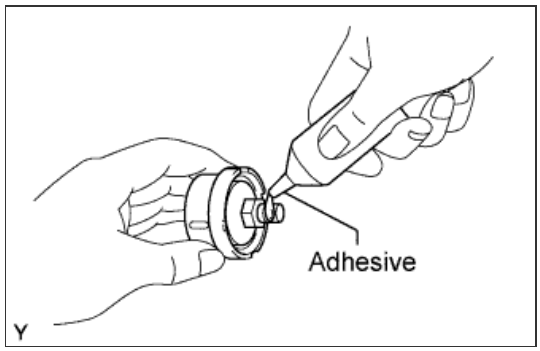
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



46. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

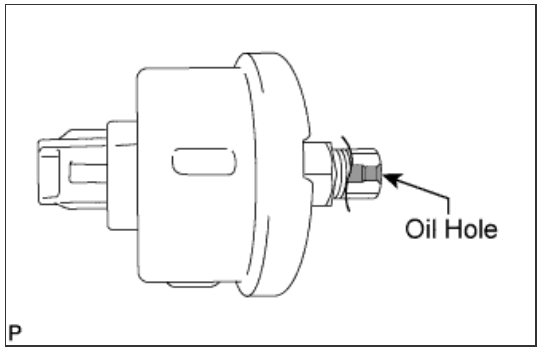
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

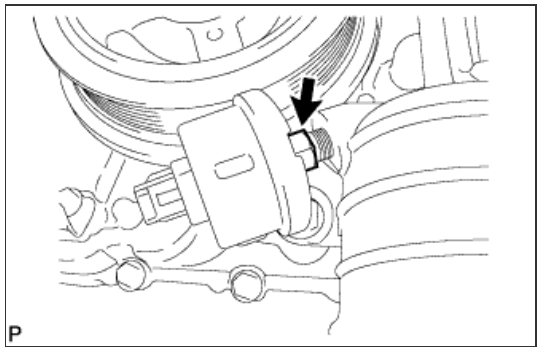


b. Install the oil pressure sender gauge.

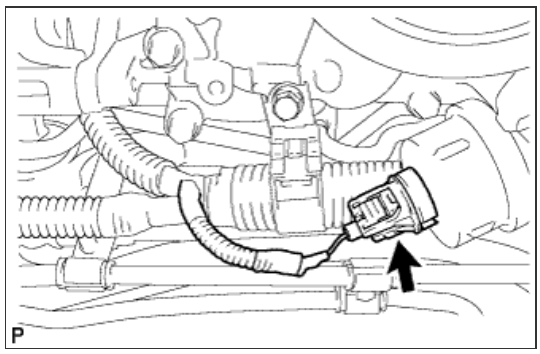
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



47. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

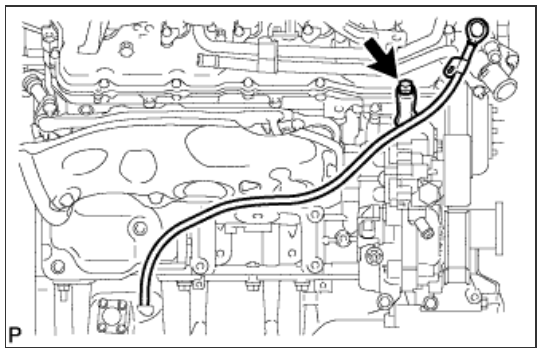
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

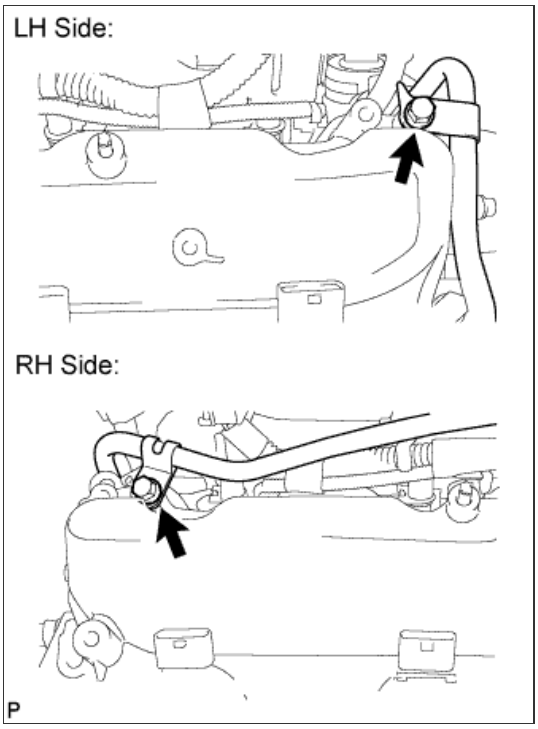
d. Install the dipstick.



48. CONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Connect the fuel tube with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



49. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

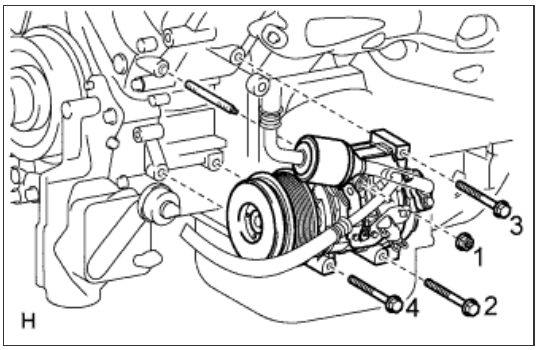
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

NOTICE:

Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.

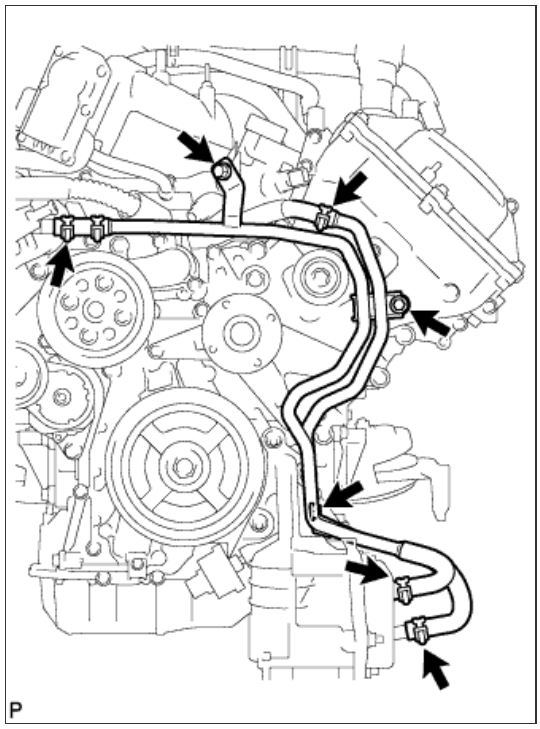


50. CONNECT NO. 2 WATER BY-PASS PIPE

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

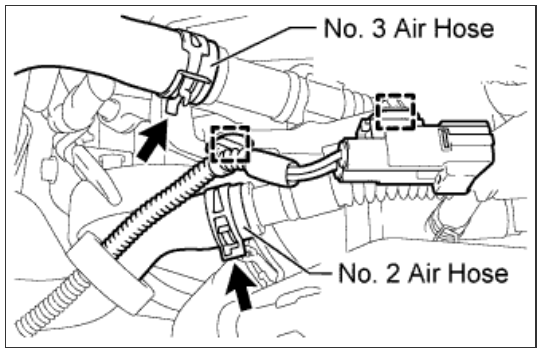
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



51. CONNECT AIR PUMP HOSE AND WIRE HARNESS (w/ Secondary Air Injection System)

a. Connect the No. 2 and No. 3 air hoses.

b. Connect the 2 clamps and air pump wire harness.



52. CONNECT ENGINE WIRE

a. Engine Room RH Side:

i. Connect the 5 clamps.

ii. Connect the throttle position sensor and throttle control motor connector.

iii. w/ Secondary Air Injection System:
Connect the 2 air pump connectors.

iv. Install the ground wire with the 2 bolts.

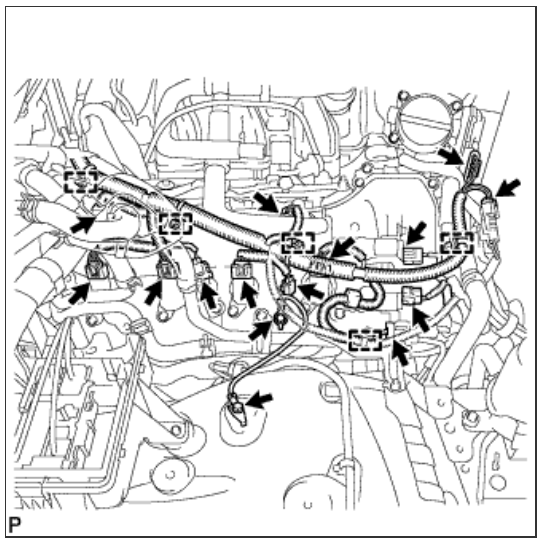
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

v. Connect the noise filter connector.

vi. Connect the 2 VVT sensor connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



vii. Connect the injector connector.

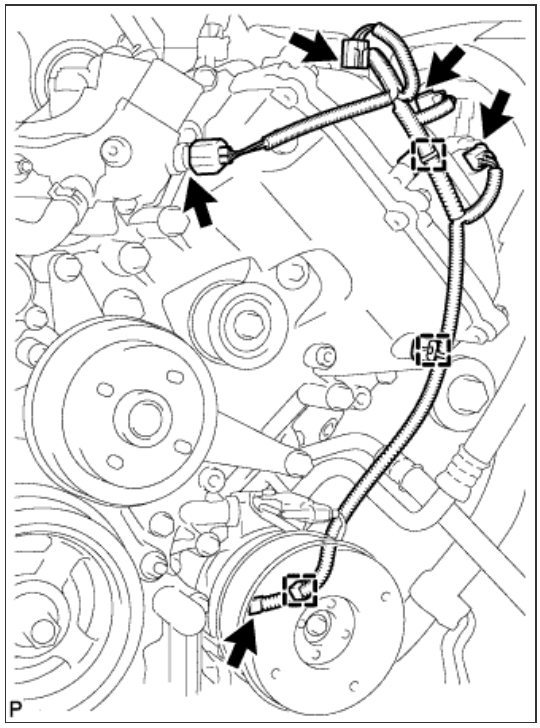
viii. Connect the 4 ignition coil connectors.

ix. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

b. Engine Room LH Side:



i. Connect the cooler compressor connector.

ii. Connect the 3 clamps.

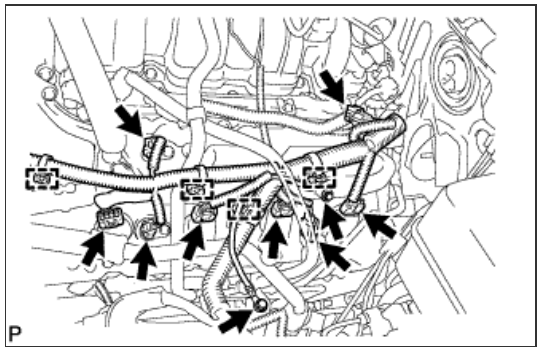
iii. Connect the camshaft position sensor connector.

iv. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

v. Connect the engine coolant temperature sensor connector.



vi. Connect the 4 clamps.

vii. Install the ground wire with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

viii. Connect the noise filter connector.

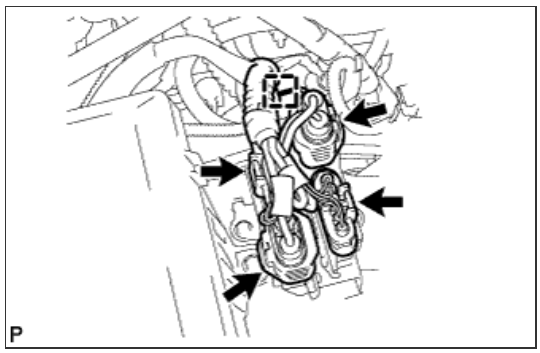
ix. Connect the 2 VVT sensor connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

x. Connect the 4 ignition coil connectors.

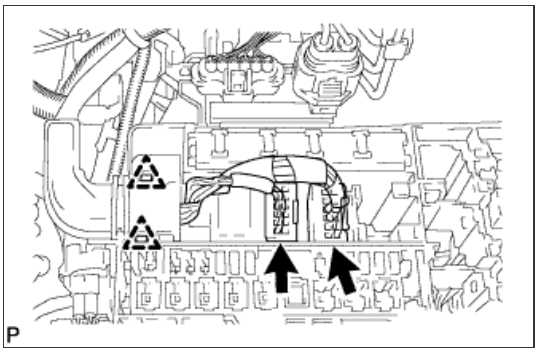
xi. Connect the injector connector.



xii. w/ Secondary Air Injection System:
Connect the wire harness clamp and 4 air injection control driver connectors.

xiii. Connect the 2 connectors and 2 clips to the engine room junction block.

xiv. Install the engine room relay block cover.

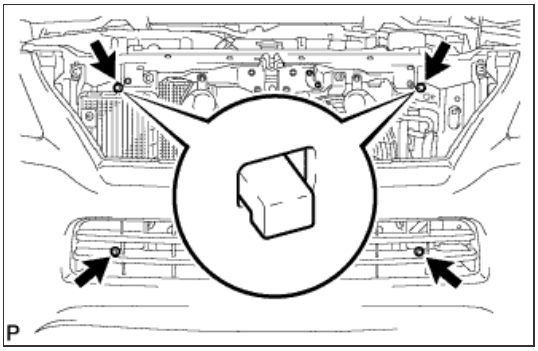


53. INSTALL RADIATOR ASSEMBLY

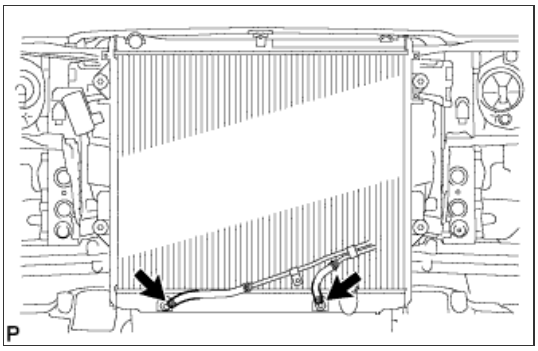
a. Set the radiator bracket hooks to the radiator support holes.

b. Install the radiator with the 4 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



c. Connect the 2 oil cooler hoses.



54. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

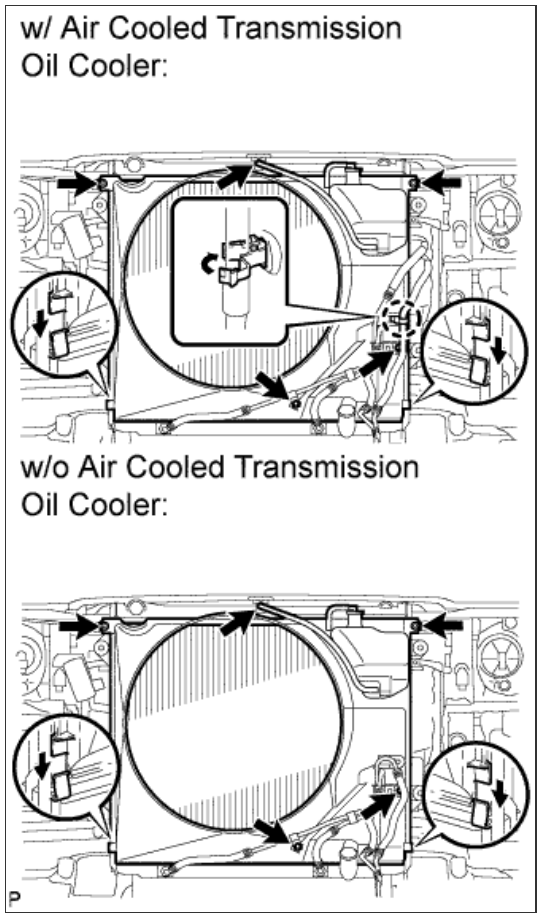
Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in

the illustration.

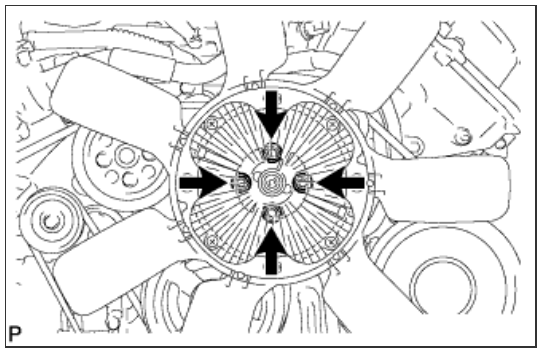
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



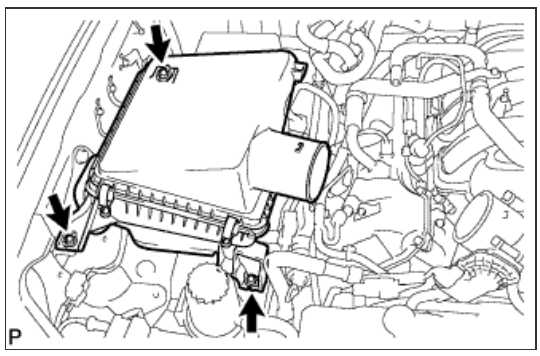
55. INSTALL NO. 2 RADIATOR HOSE

56. INSTALL NO. 1 RADIATOR HOSE

57. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



58. INSTALL AIR CLEANER HOSE ASSEMBLY

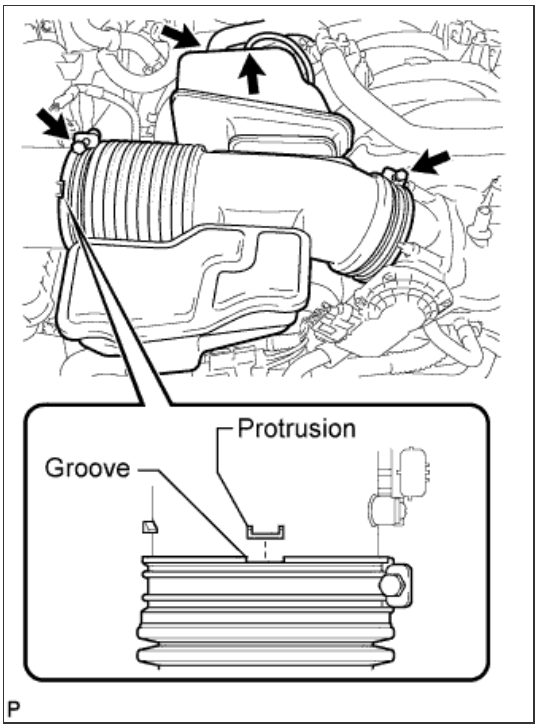
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

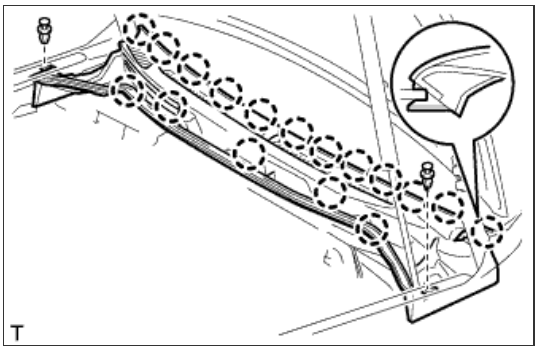
d. Connect the No. 2 ventilation hose.



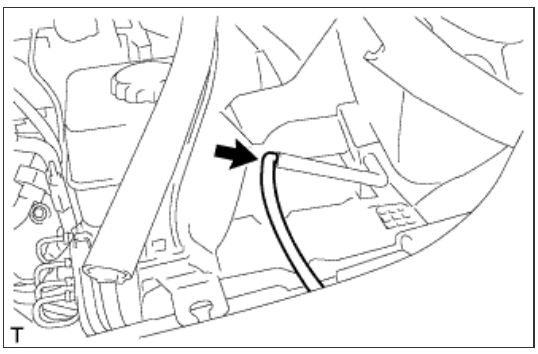
59. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Push in the ventilator louver to attach the 17 claws and install the ventilator louver.

b. Install the 2 clips.

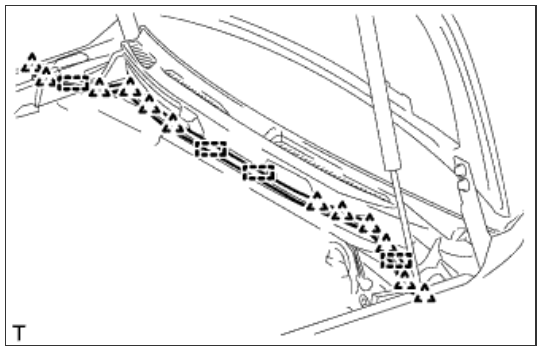


c. Connect the washer hose.



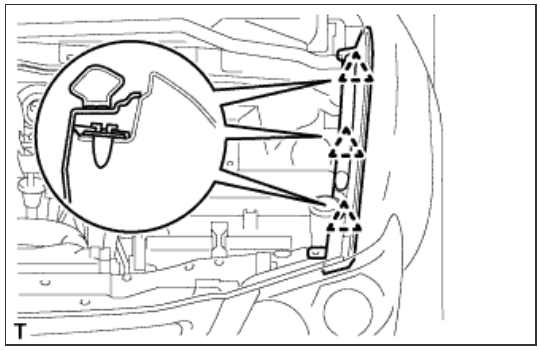
60. INSTALL HOOD TO COWL TOP SEAL

a. Attach the 12 clips and 4 clamps to install the hood to cowl top seal.



61. INSTALL FRONT FENDER MAIN SEAL LH

a. Attach the 3 clips to install the fender main seal.



62. INSTALL FRONT FENDER MAIN SEAL RH

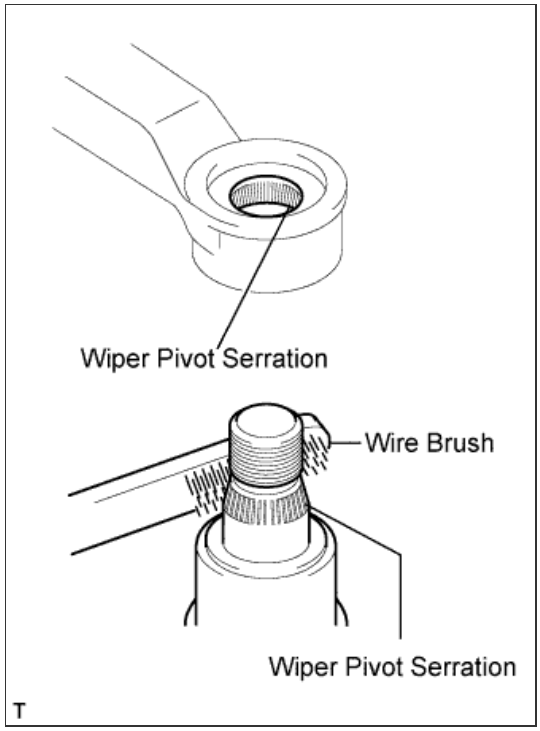
HINT:

Use the same procedures described for the LH side.

63. INSTALL FRONT WIPER ARM LH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

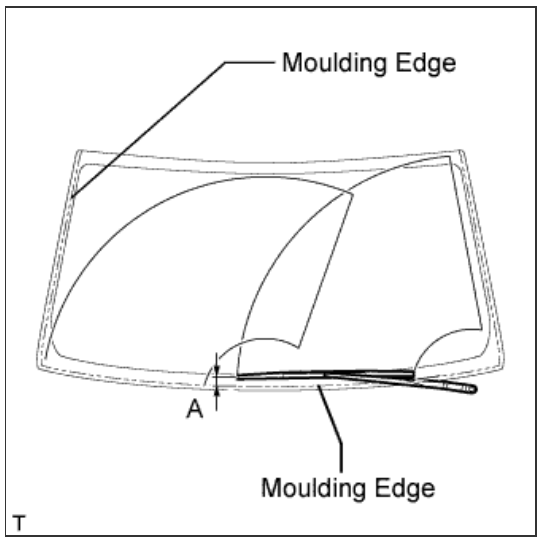
Standard:

Position	Specified Condition
A	16.8 to 36.8 mm (0.661 to 1.45 in.)

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

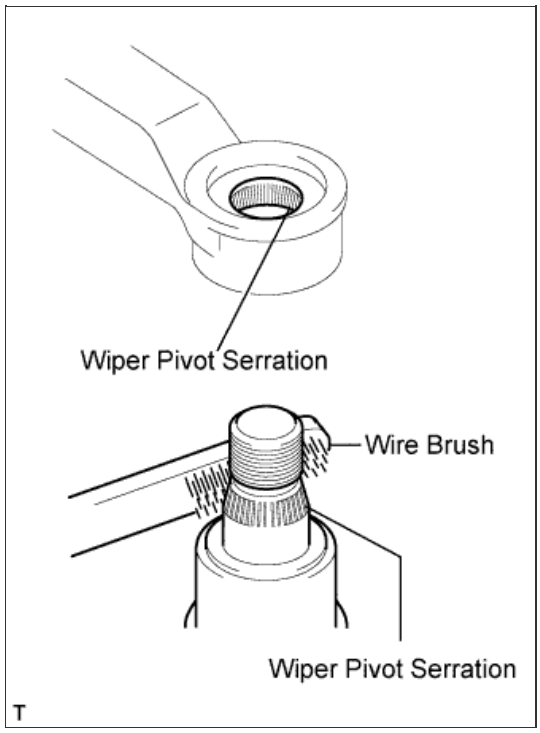
Hold down the wiper arm hinge with your hand while tightening the nut.



64. INSTALL FRONT WIPER ARM RH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

Standard:

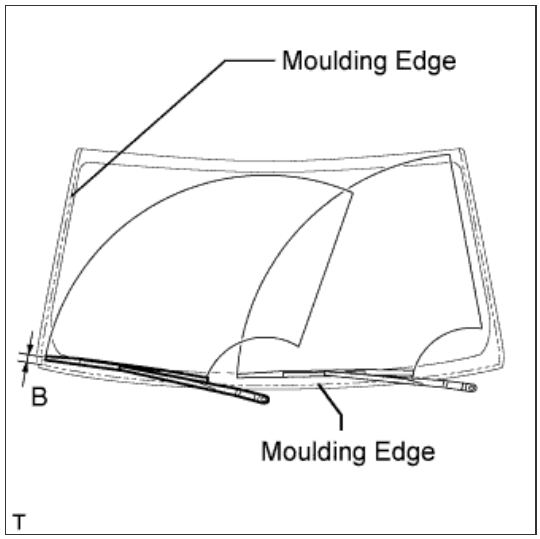
Position	Specified Condition
B	20.0 to 40.0 mm (0.787 to 1.57 in.)

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

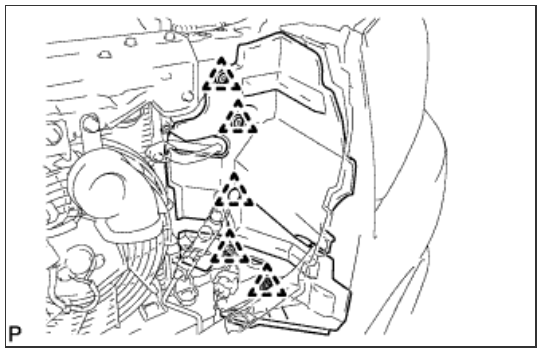
Hold down the wiper arm hinge with your hand while tightening the nut.

d. Operate the front wipers while spraying washer fluid on the windshield glass. Make sure that the front wipers function properly and there is no interference with the vehicle body.



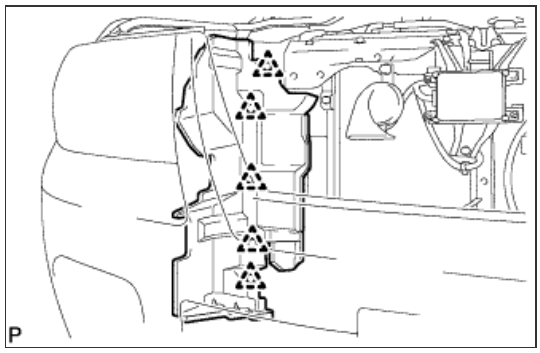
65. INSTALL RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



66. INSTALL RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



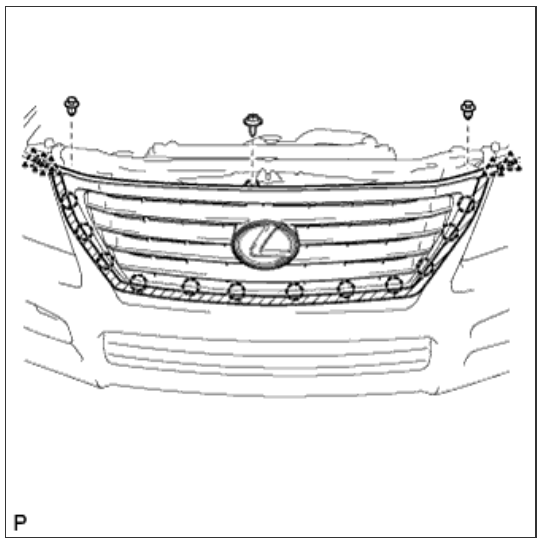
67. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



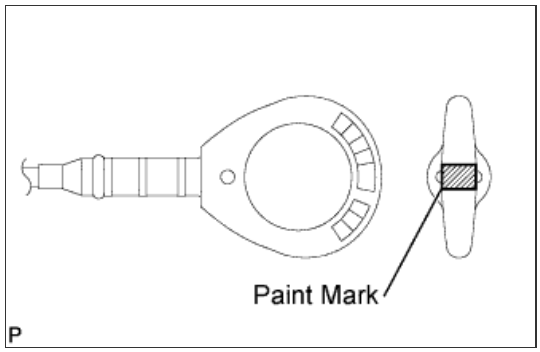
68. ADD ENGINE OIL

a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)

API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil	0W-20 5W-20 5W-30 10W-30
API grade SL or SM multigrade engine oil	15W-40 20W-50



Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

69. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

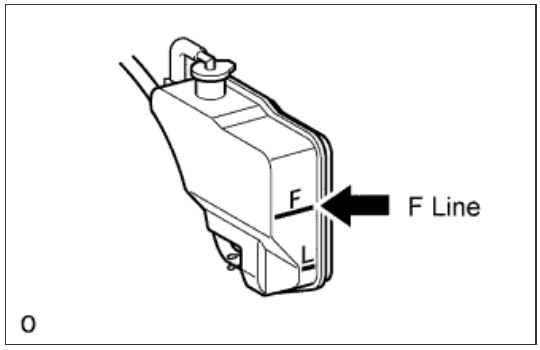
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally**

high temperature.

- If there is not enough coolant, the engine may burn out or overheat.
- Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.
- Run the engine at 2000 rpm until the coolant level has stabilized.

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

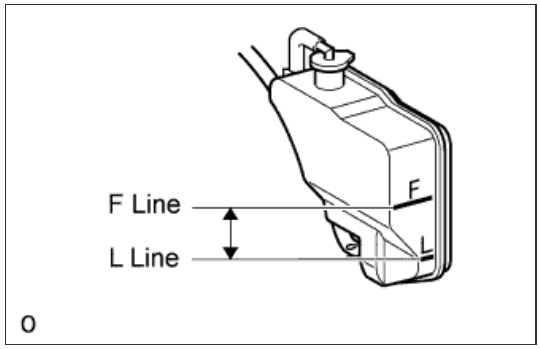
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



70. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

71. INSPECT FOR OIL LEAK

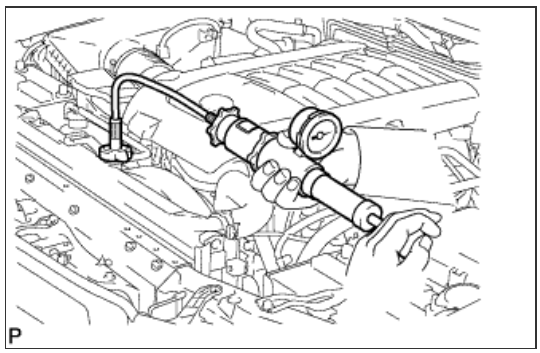
a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

72. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



73. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

NOTICE:

Do not fill engine oil above the full level mark.

74. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

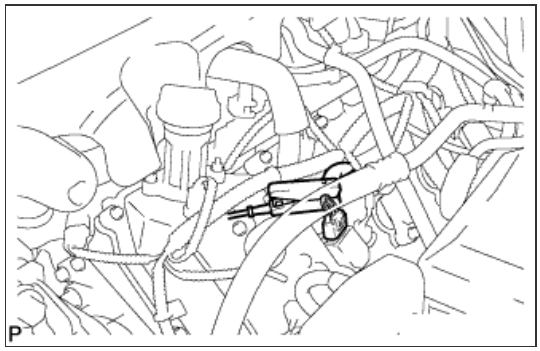
v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:

i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

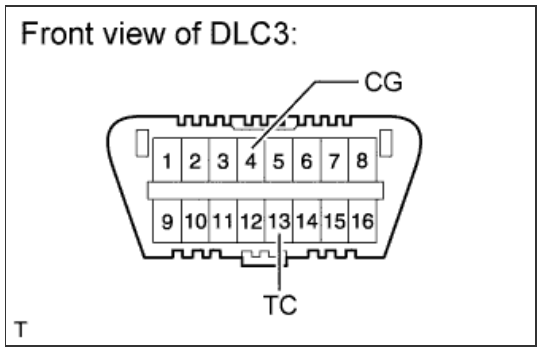


ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

SST
09843-18040

NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**



iii. Using the timing light, check the ignition timing.

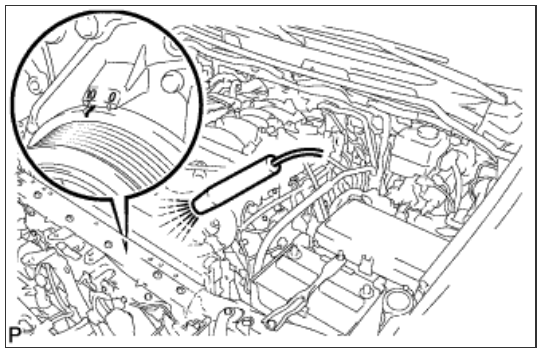
Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.



h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

75. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

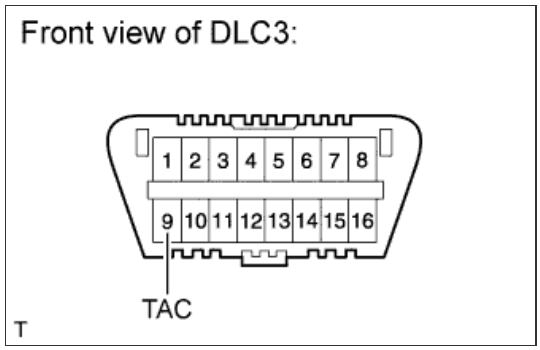
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Check the idle speed.

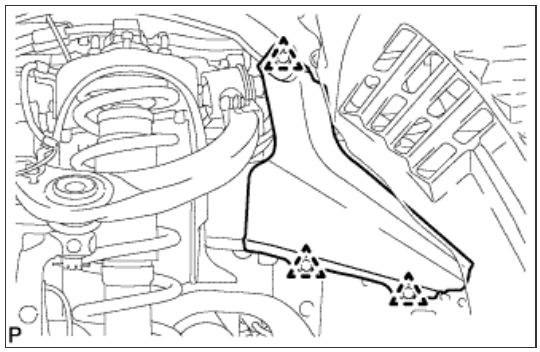
Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

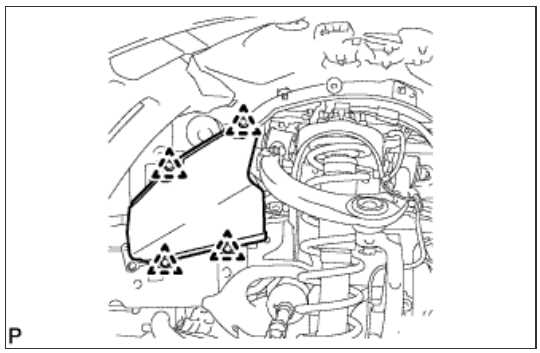
76. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



77. INSTALL FRONT FENDER APRON SEAL FRONT LH

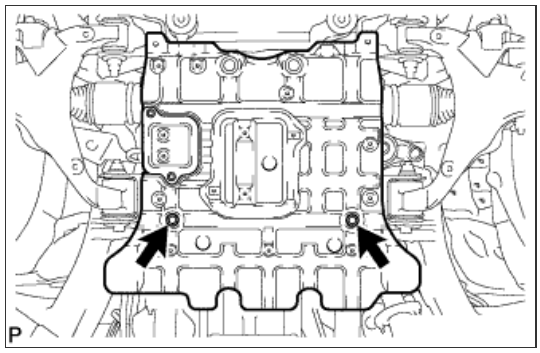
a. Install the fender apron seal with the 4 clips.



78. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

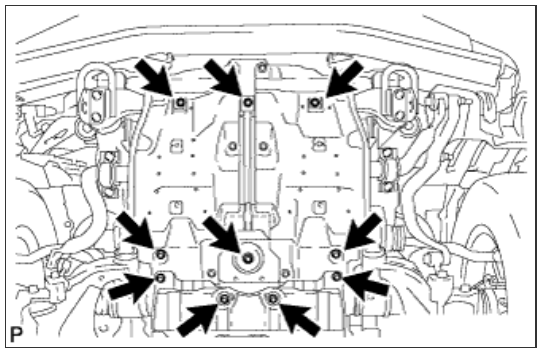
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



79. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

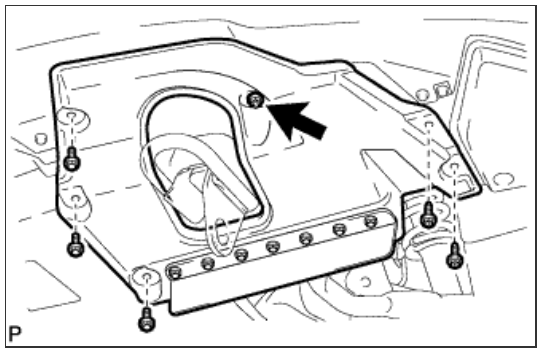
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



80. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



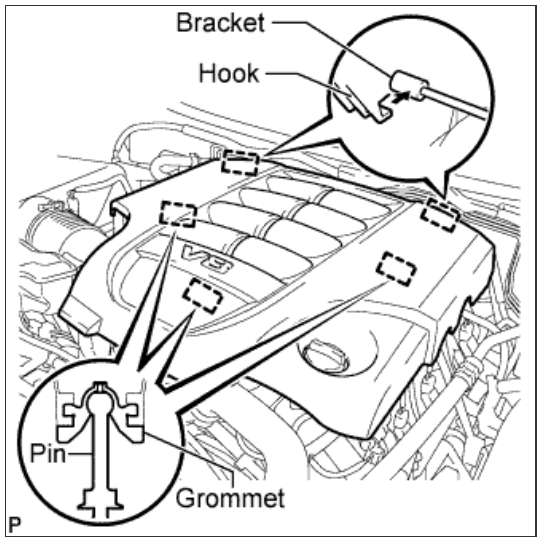
81. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

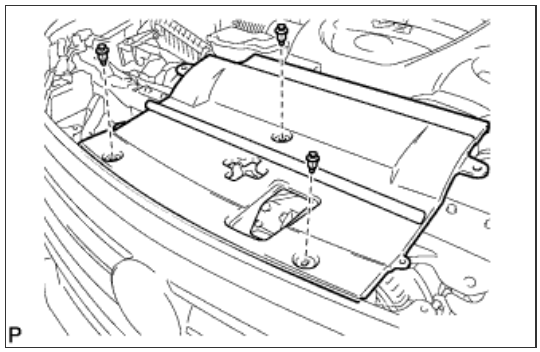
82. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



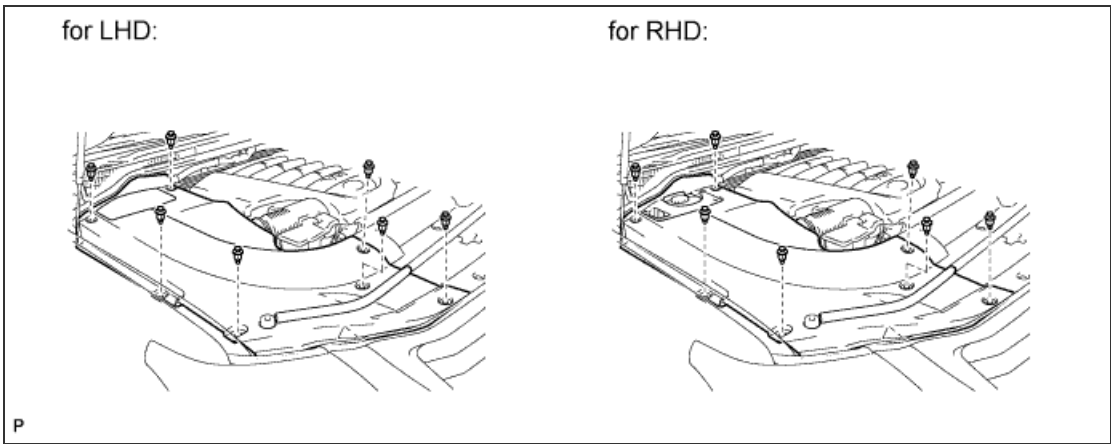
83. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



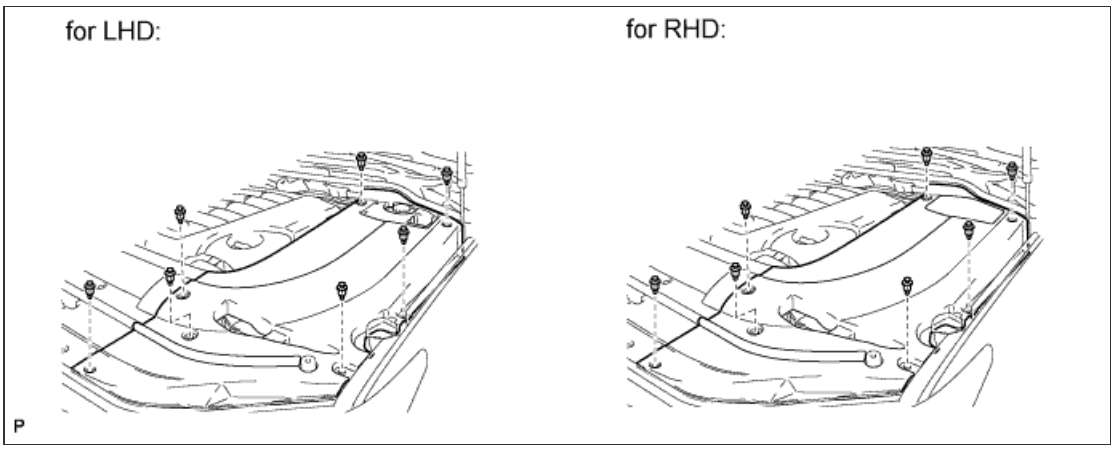
84. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

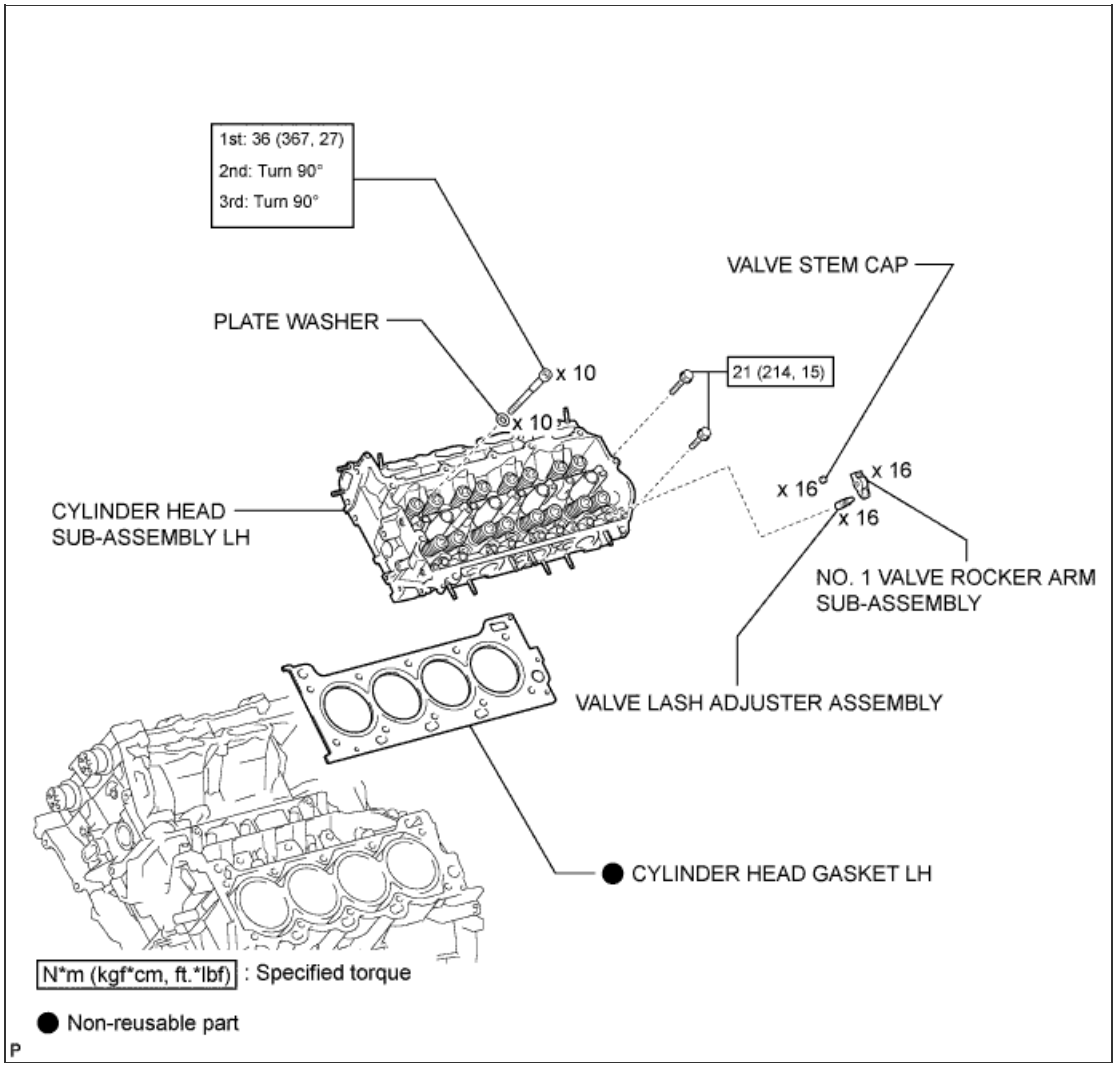


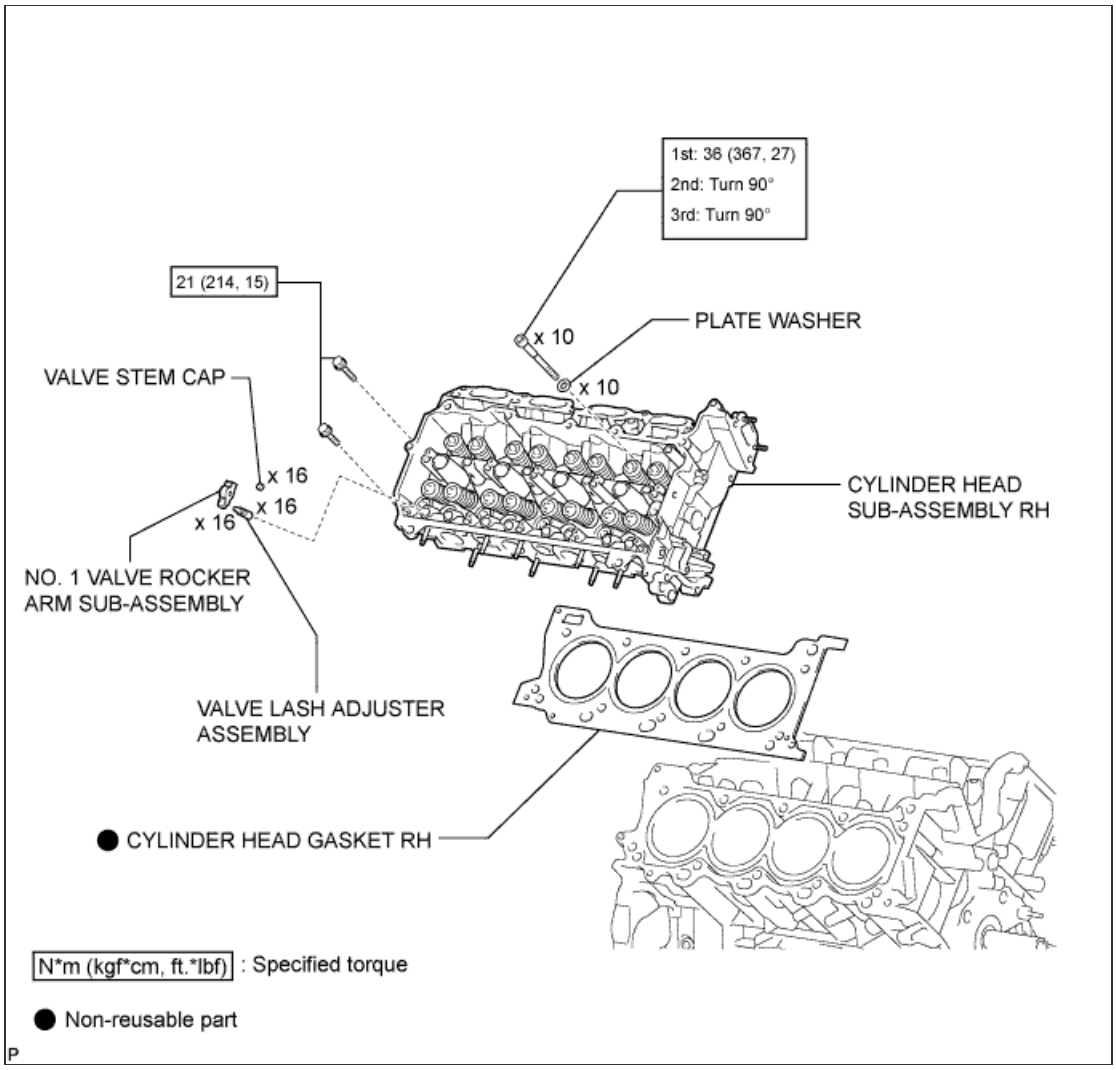
85. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



for Preparation Click here




1st: 36 (367, 27)
2nd: Turn 90°
3rd: Turn 90°
21 (214, 15)
x 10
PLATE WASHER
x 10
VALVE STEM CAP
x 16
x 16
x 16
CYLINDER HEAD SUB-ASSEMBLY RH
NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY
VALVE LASH ADJUSTER ASSEMBLY
CYLINDER HEAD GASKET RH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

1. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

3. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY

a. Remove the exhaust manifold (Click here).

4. REMOVE CAMSHAFT

a. Remove the camshaft (Click here).

5. REMOVE NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Remove the 32 valve rocker arms from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

6. REMOVE VALVE LASH ADJUSTER ASSEMBLY

a. Remove the 32 valve lash adjusters from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

7. REMOVE VALVE STEM CAP

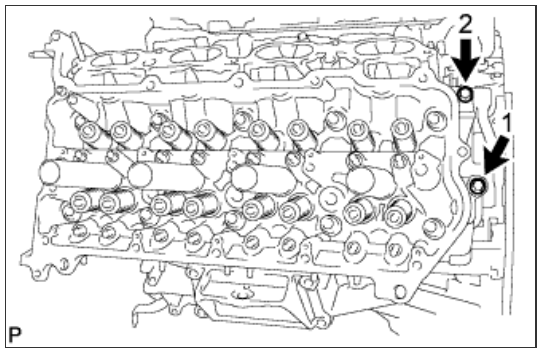
a. Remove the 32 valve stem caps from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

8. REMOVE CYLINDER HEAD SUB-ASSEMBLY LH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



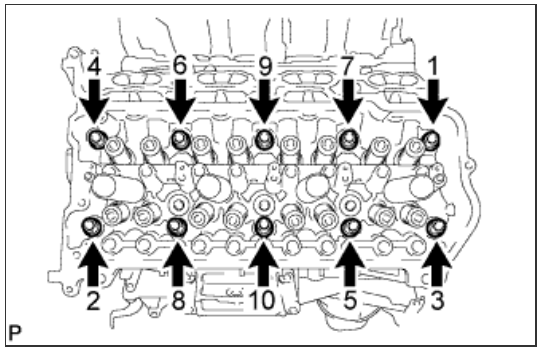
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

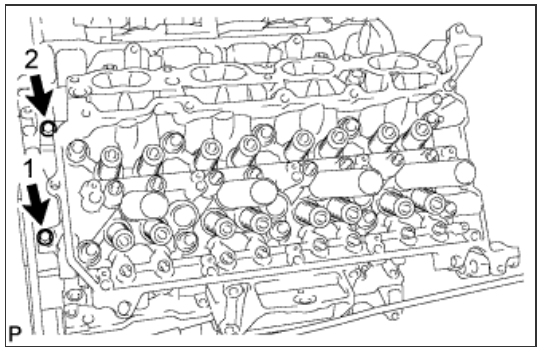
- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



c. Remove the cylinder head and gasket.

9. REMOVE CYLINDER HEAD SUB-ASSEMBLY RH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



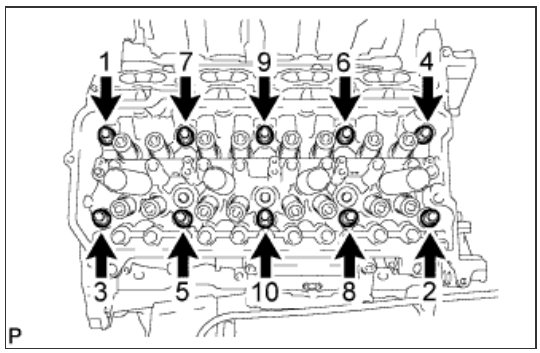
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



c. Remove the cylinder head and gasket.

for Preparation Click here

1. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

3. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY

a. Remove the exhaust manifold (Click here).

4. REMOVE CAMSHAFT

a. Remove the camshaft (Click here).

5. REMOVE NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Remove the 32 valve rocker arms from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

6. REMOVE VALVE LASH ADJUSTER ASSEMBLY

a. Remove the 32 valve lash adjusters from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

7. REMOVE VALVE STEM CAP

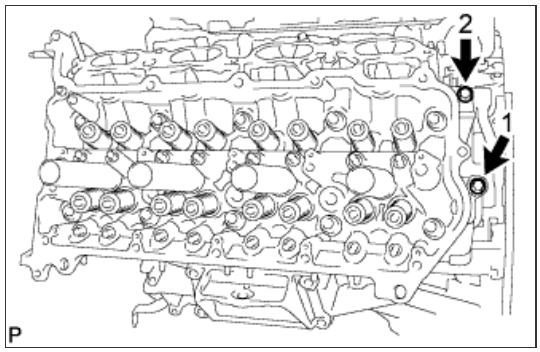
a. Remove the 32 valve stem caps from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

8. REMOVE CYLINDER HEAD SUB-ASSEMBLY LH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



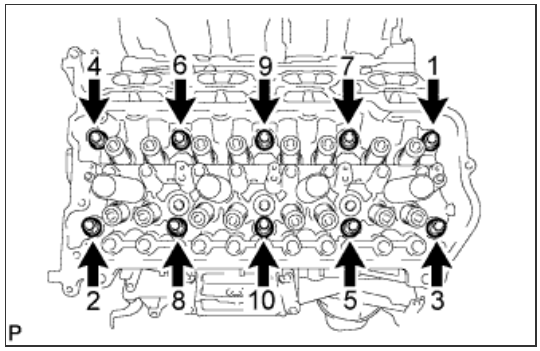
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

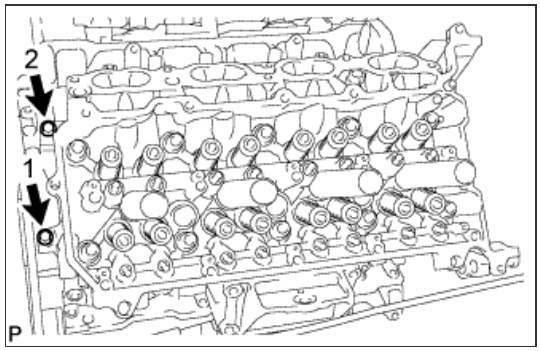
- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



c. Remove the cylinder head and gasket.

9. REMOVE CYLINDER HEAD SUB-ASSEMBLY RH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



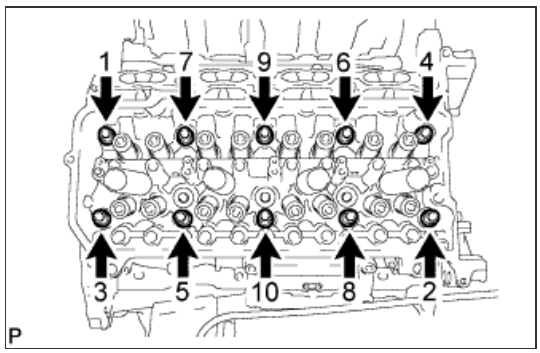
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**

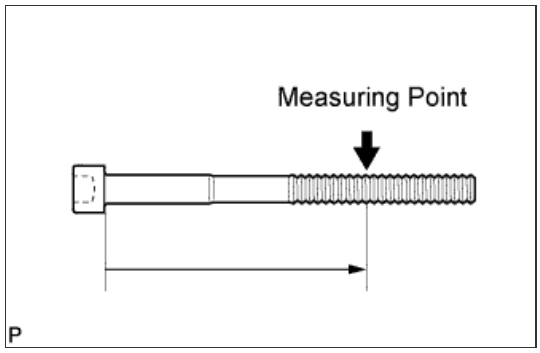


c. Remove the cylinder head and gasket.

for Preparation Click here

1. INSPECT CYLINDER HEAD SET BOLT

a. Using a vernier caliper, measure the diameter of the elongated thread at the measuring point.



Measuring point:
94 mm (3.70 in.) for intake side bolt
89 mm (3.50 in.) for exhaust side bolt

Standard diameter:
10.85 to 11.00 mm (0.427 to 0.433 in.)

Minimum diameter:
10.6 mm (0.417 in.)

If the diameter is less than the minimum, replace the cylinder head bolt.

HINT:

If a visual check reveals no excessively thin areas, check the center of the bolt (see illustration) and find the area that has the smallest diameter.

2. INSPECT CYLINDER HEAD SUB-ASSEMBLY

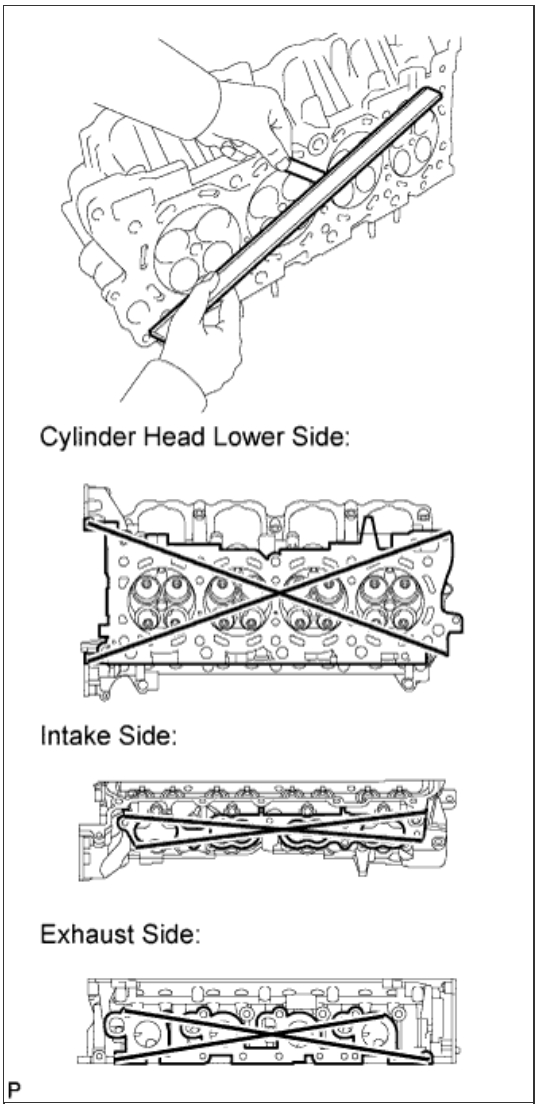
a. Using a precision straightedge and feeler gauge, measure the warpage of the surfaces where the cylinder head contacts the cylinder block and manifold.

Standard Warpage:

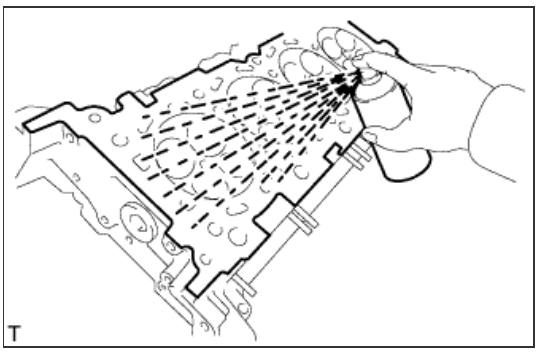
Item	Specified Condition
Cylinder head lower side	0.05 mm (0.00197 in.)
Intake side	0.08 mm (0.00315 in.)
Exhaust side	0.05 mm (0.00197 in.)

Maximum warpage:
0.10 mm (0.00394 in.)

If the warpage is more than the maximum, replace the cylinder head.



b. Using a dye penetrant, check the intake ports, exhaust ports and cylinder surface for cracks.
If cracked, replace the cylinder head.



3. INSTALL CYLINDER HEAD SUB-ASSEMBLY RH

a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.

NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**

d. Place the cylinder head on the cylinder block.

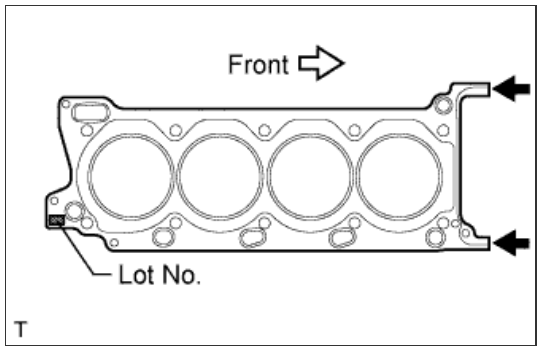
HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

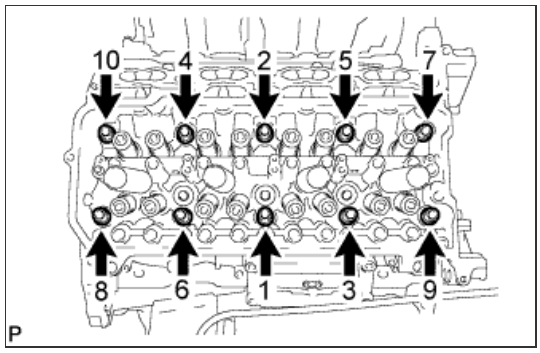
e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.



f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

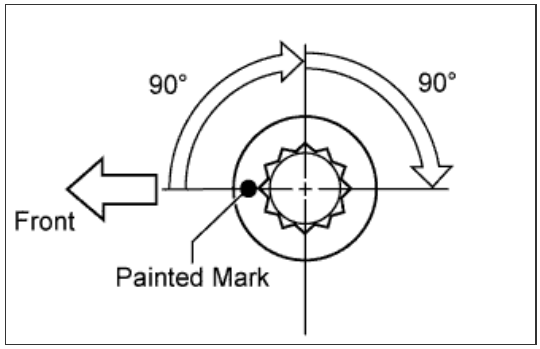
i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.

h. Step 3:

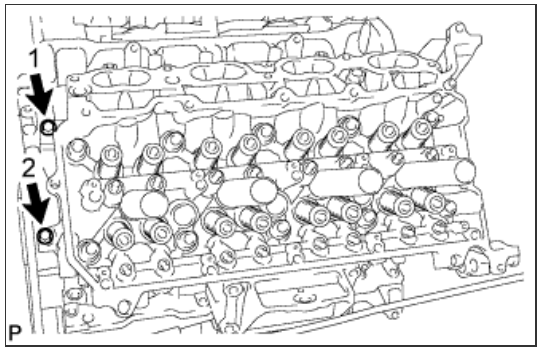
i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painting marks are now facing rearward.



i. Uniformly install the 2 bolts in the sequence shown in the illustration.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



4. INSTALL CYLINDER HEAD SUB-ASSEMBLY LH

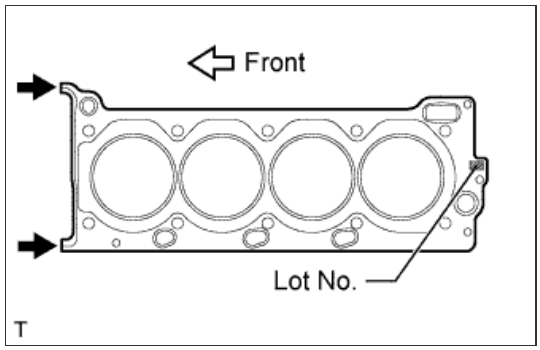
a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.

NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**



d. Place the cylinder head on the cylinder block.

HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

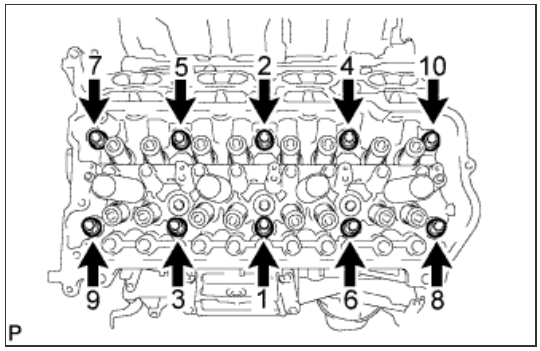
- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.

f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

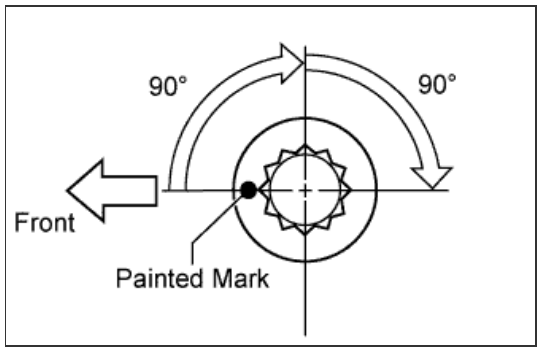
i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.

h. Step 3:

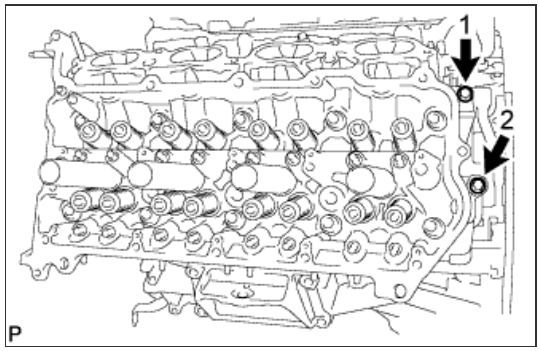
i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painted marks are now facing rearward.



i. Uniformly install the 2 bolts in the sequence shown in the illustration.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



5. INSTALL VALVE STEM CAP

a. Apply a light coat of engine oil to the valve stem caps.

b. Install the 32 valve stem caps to the cylinder heads.

6. INSTALL VALVE LASH ADJUSTER ASSEMBLY

a. Inspect the valve lash adjuster before installing it (Click here).

b. Install the 32 valve lash adjusters to the cylinder heads.

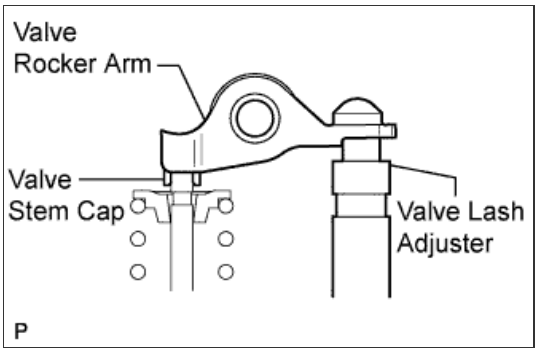
NOTICE:

Install the lash adjuster to the same place it was removed from.

7. INSTALL NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Apply engine oil to the lash adjuster tips and valve stem cap ends.

b. Install the 32 valve rocker arms as shown in the illustration.



8. INSTALL CAMSHAFT

a. Install the camshaft (Click here).

9. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY

a. Install the exhaust manifold (Click here).

10. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

11. INSPECT FOR EXHAUST GAS LEAK

12. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

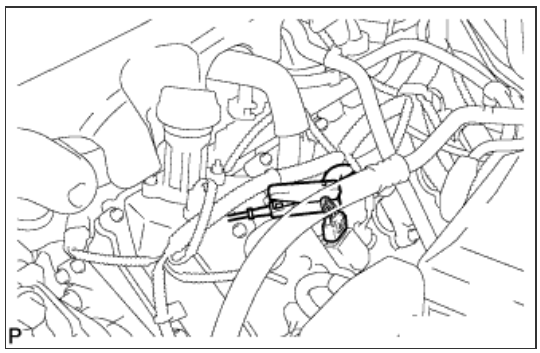
HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:



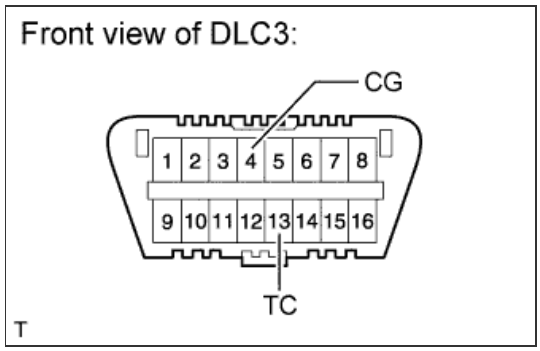
i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

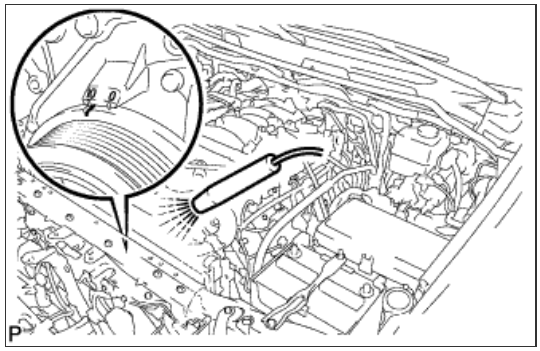
SST
09843-18040



NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**

iii. Using the timing light, check the ignition timing.



Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.

h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

13. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

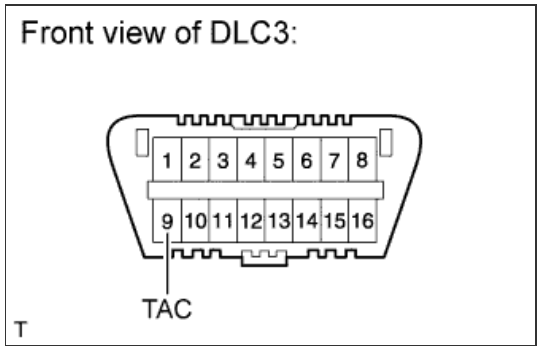
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Check the idle speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

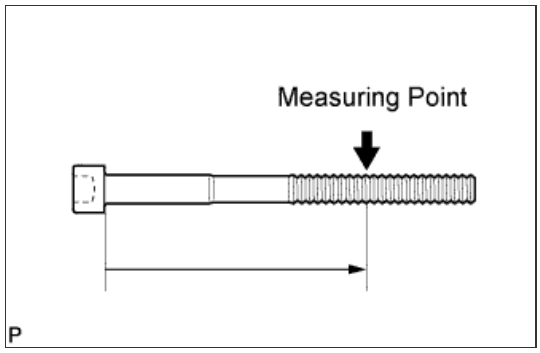
If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

for Preparation Click here

1. INSPECT CYLINDER HEAD SET BOLT

a. Using a vernier caliper, measure the diameter of the elongated thread at the measuring point.



Measuring point:
94 mm (3.70 in.) for intake side bolt
89 mm (3.50 in.) for exhaust side bolt

Standard diameter:
10.85 to 11.00 mm (0.427 to 0.433 in.)

Minimum diameter:
10.6 mm (0.417 in.)

If the diameter is less than the minimum, replace the cylinder head bolt.

HINT:

If a visual check reveals no excessively thin areas, check the center of the bolt (see illustration) and find the area that has the smallest diameter.

2. INSPECT CYLINDER HEAD SUB-ASSEMBLY

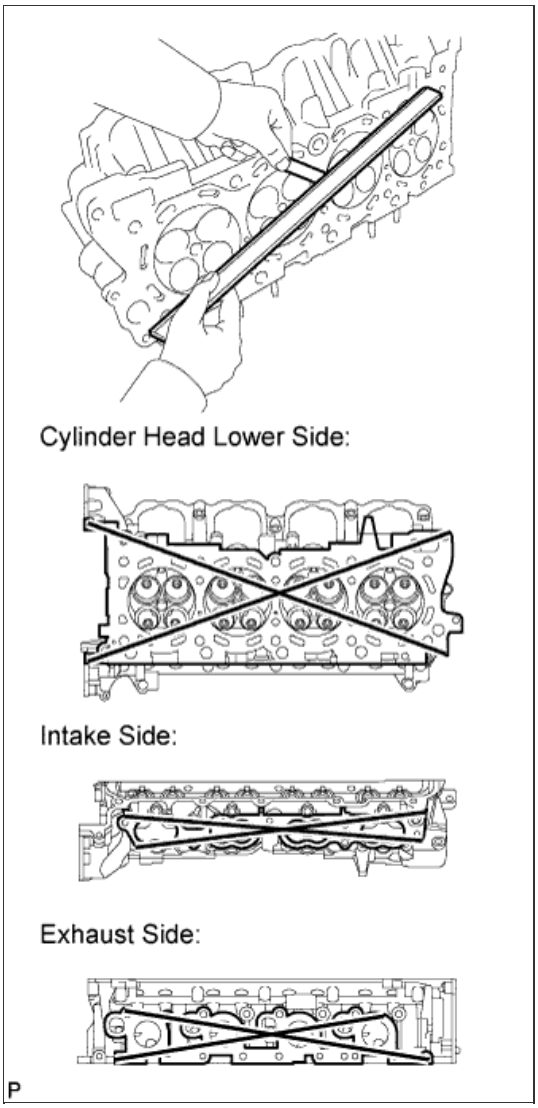
a. Using a precision straightedge and feeler gauge, measure the warpage of the surfaces where the cylinder head contacts the cylinder block and manifold.

Standard Warpage:

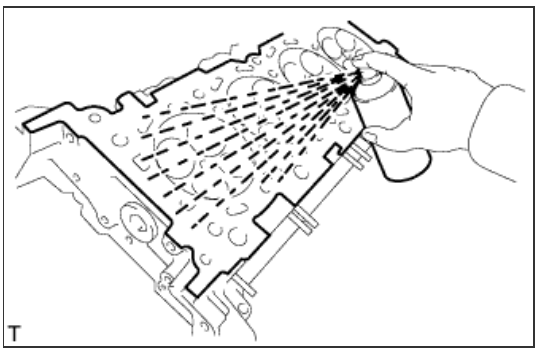
Item	Specified Condition
Cylinder head lower side	0.05 mm (0.00197 in.)
Intake side	0.08 mm (0.00315 in.)
Exhaust side	0.05 mm (0.00197 in.)

Maximum warpage:
0.10 mm (0.00394 in.)

If the warpage is more than the maximum, replace the cylinder head.



b. Using a dye penetrant, check the intake ports, exhaust ports and cylinder surface for cracks.
If cracked, replace the cylinder head.



3. INSTALL CYLINDER HEAD SUB-ASSEMBLY RH

a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.

NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**

d. Place the cylinder head on the cylinder block.

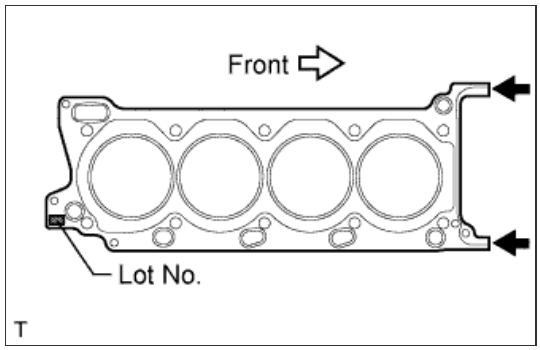
HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

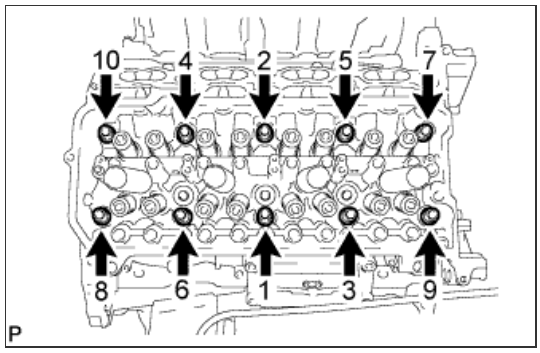
e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.



f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

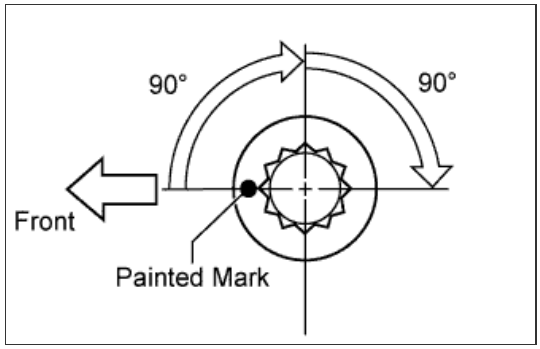
i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.

h. Step 3:

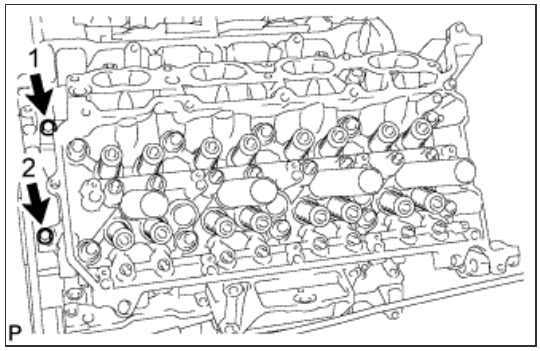
i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painting marks are now facing rearward.



i. Uniformly install the 2 bolts in the sequence shown in the illustration.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



4. INSTALL CYLINDER HEAD SUB-ASSEMBLY LH

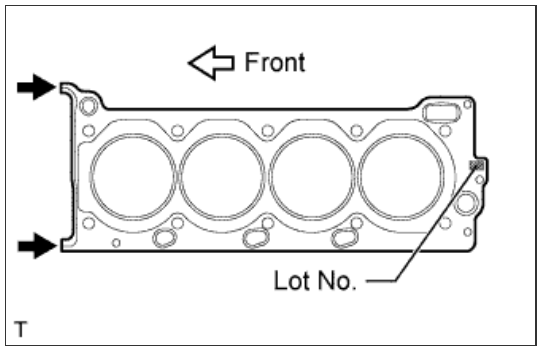
a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.

NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**



d. Place the cylinder head on the cylinder block.

HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

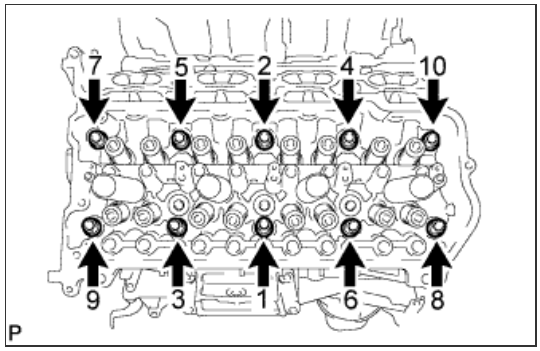
- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.

f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

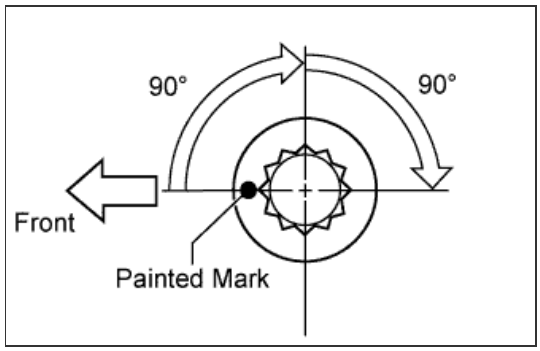
i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.

h. Step 3:

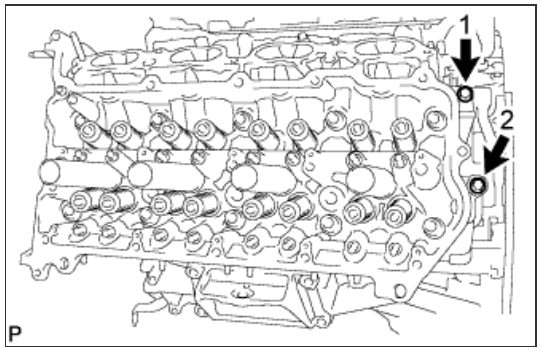
i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painted marks are now facing rearward.



i. Uniformly install the 2 bolts in the sequence shown in the illustration.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



5. INSTALL VALVE STEM CAP

a. Apply a light coat of engine oil to the valve stem caps.

b. Install the 32 valve stem caps to the cylinder heads.

6. INSTALL VALVE LASH ADJUSTER ASSEMBLY

a. Inspect the valve lash adjuster before installing it (Click here).

b. Install the 32 valve lash adjusters to the cylinder heads.

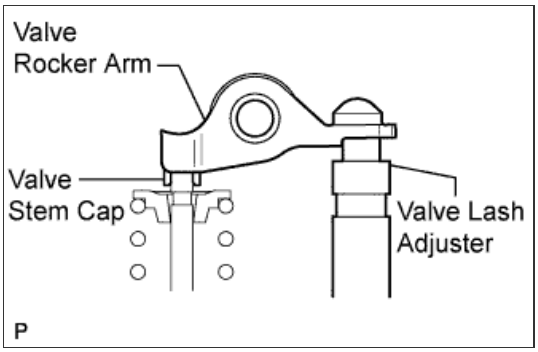
NOTICE:

Install the lash adjuster to the same place it was removed from.

7. INSTALL NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Apply engine oil to the lash adjuster tips and valve stem cap ends.

b. Install the 32 valve rocker arms as shown in the illustration.



8. INSTALL CAMSHAFT

a. Install the camshaft (Click here).

9. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY

a. Install the exhaust manifold (Click here).

10. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

11. INSPECT FOR EXHAUST GAS LEAK

12. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

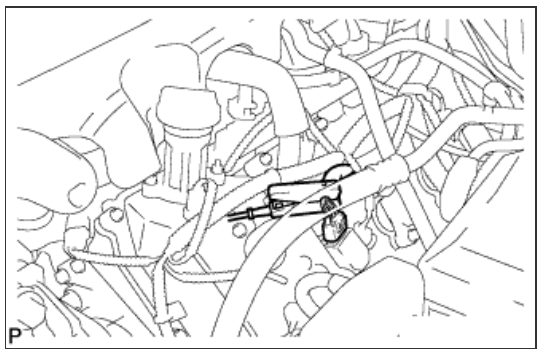
HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:



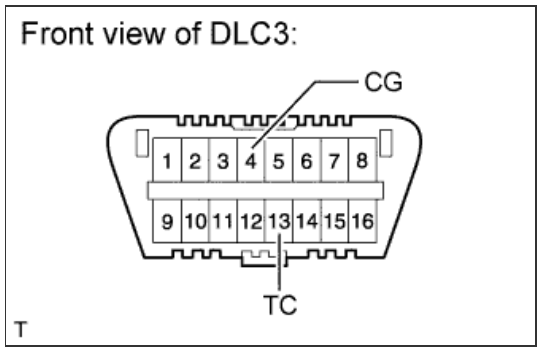
i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

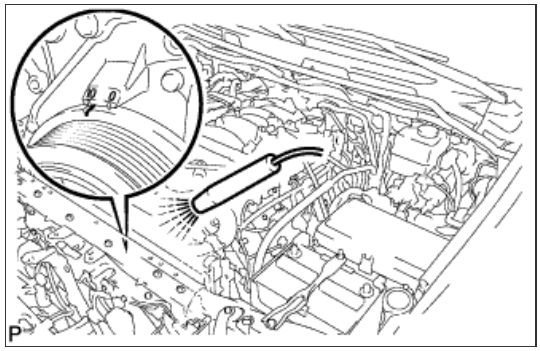
SST
09843-18040



NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**

iii. Using the timing light, check the ignition timing.



Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.

h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

13. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

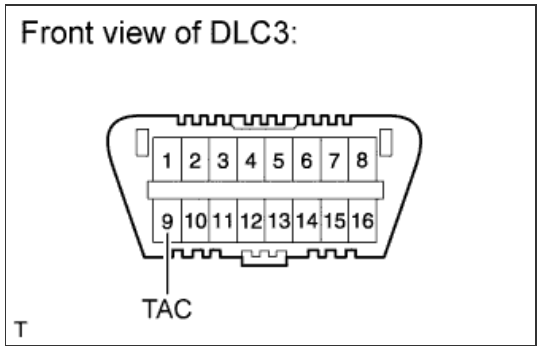
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

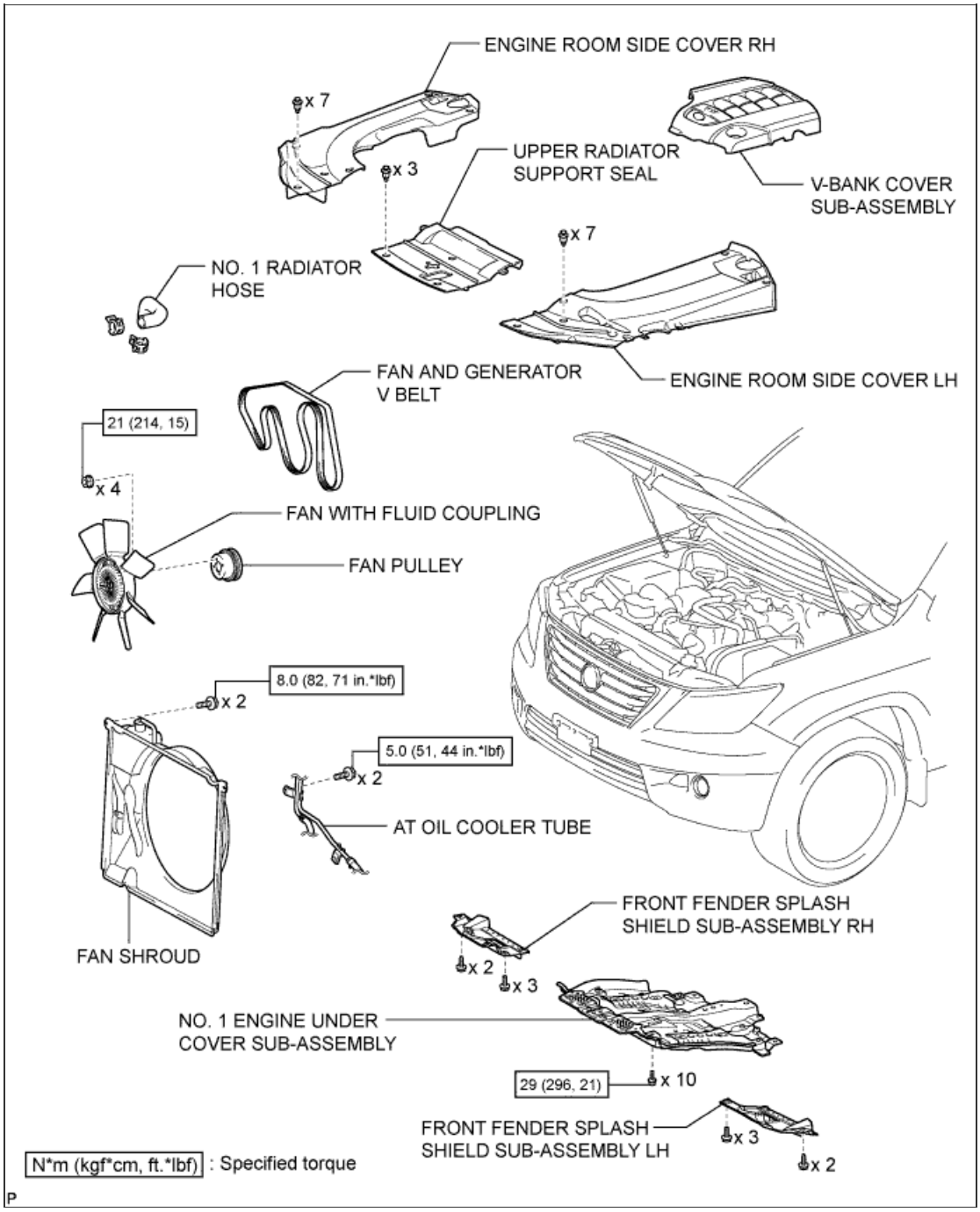
iii. Check the idle speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

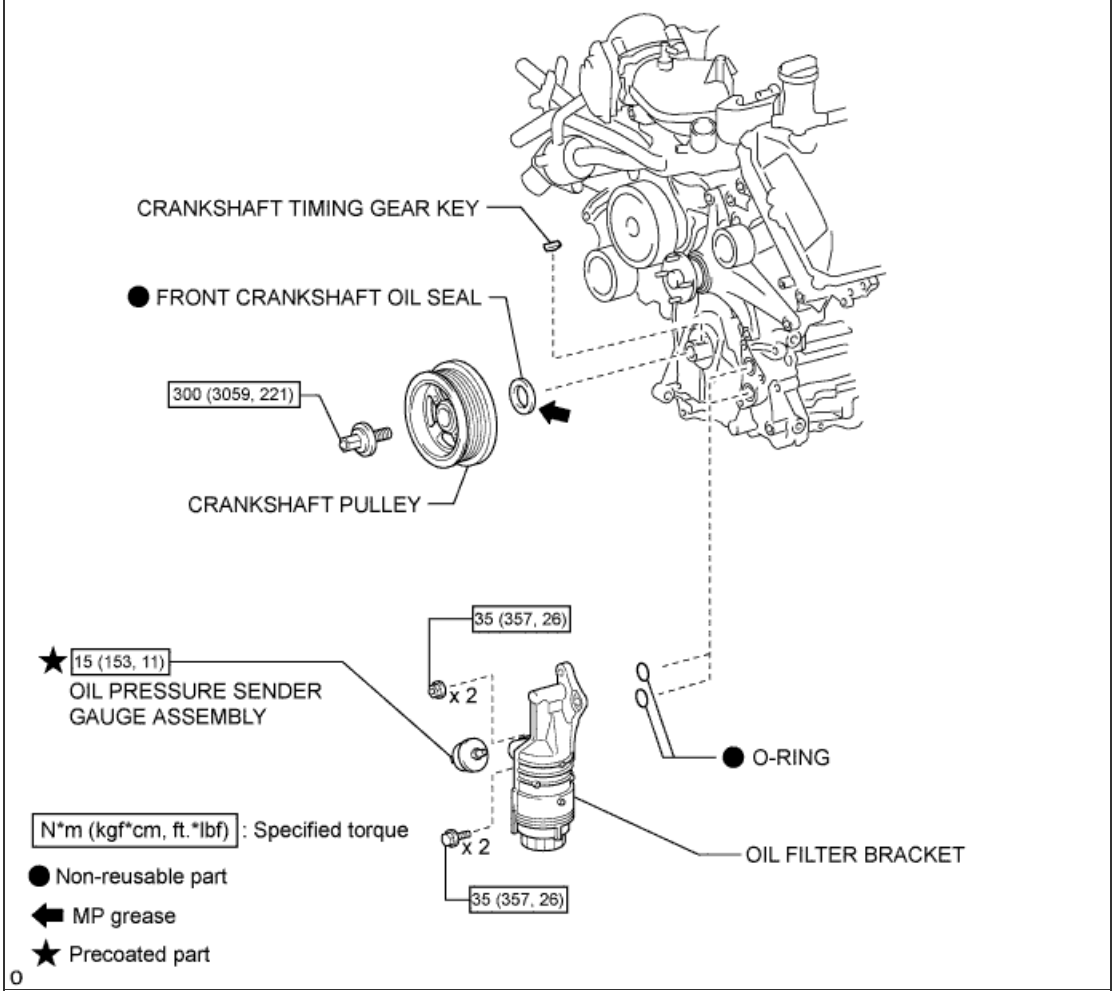
If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

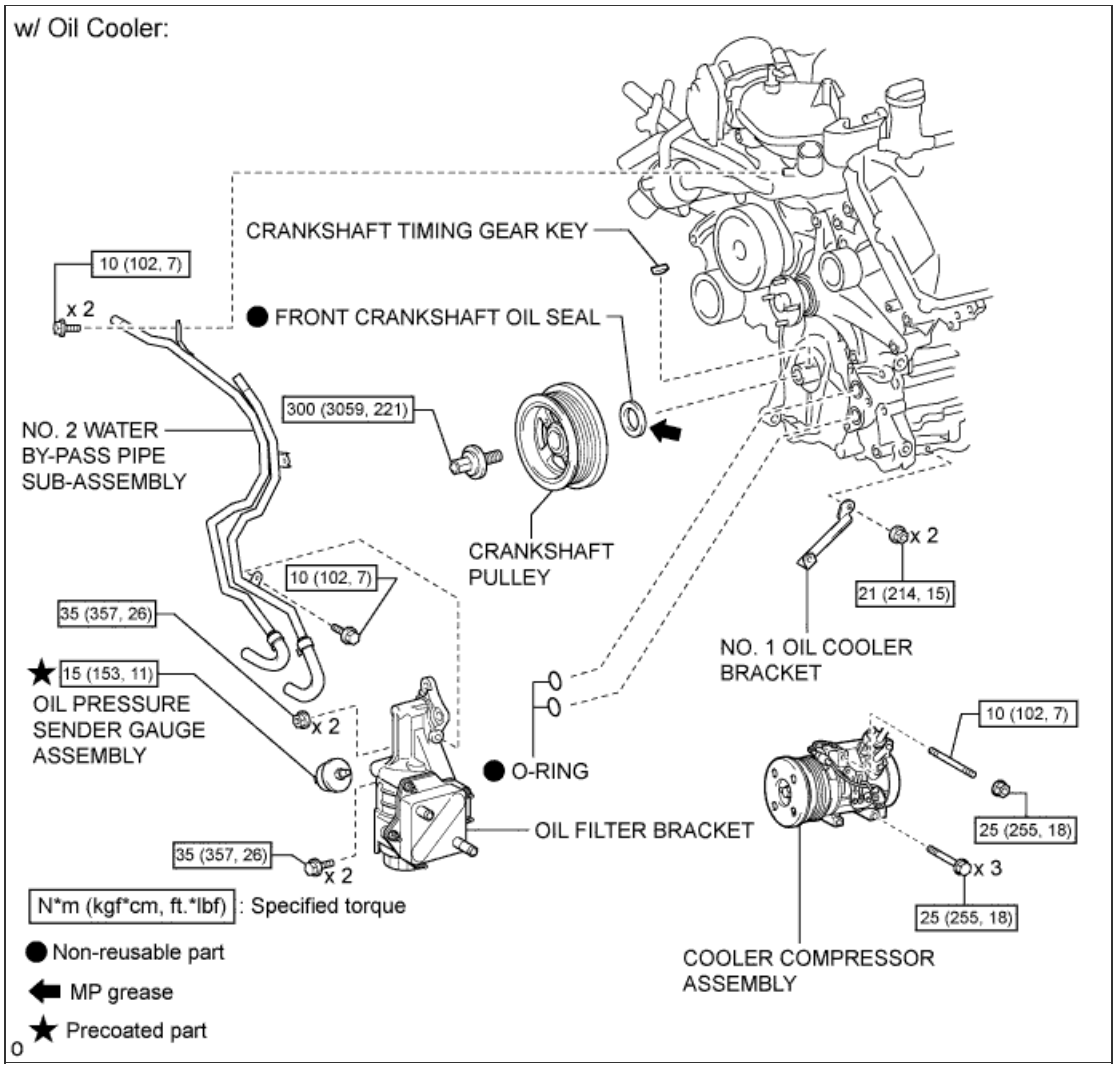
for Preparation Click here



w/o Oil Cooler:



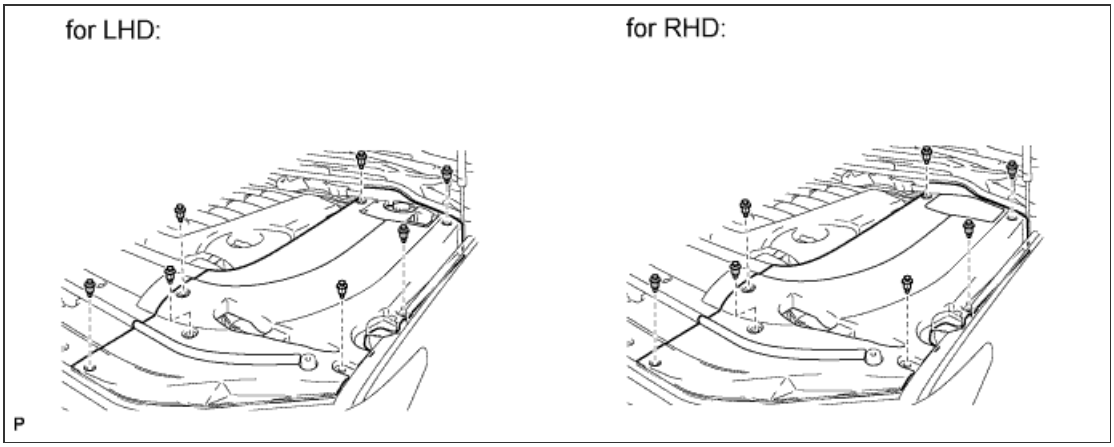
o


w/ Oil Cooler:
CRANKSHAFT TIMING GEAR KEY
10 (102, 7)
x 2
FRONT CRANKSHAFT OIL SEAL
300 (3059, 221)
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
CRANKSHAFT PULLEY
10 (102, 7)
35 (357, 26)
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
x 2
O-RING
OIL FILTER BRACKET
35 (357, 26)
x 2
x 2
21 (214, 15)
NO. 1 OIL COOLER BRACKET
10 (102, 7)
25 (255, 18)
x 3
25 (255, 18)
COOLER COMPRESSOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
Precoated part

for Preparation Click here

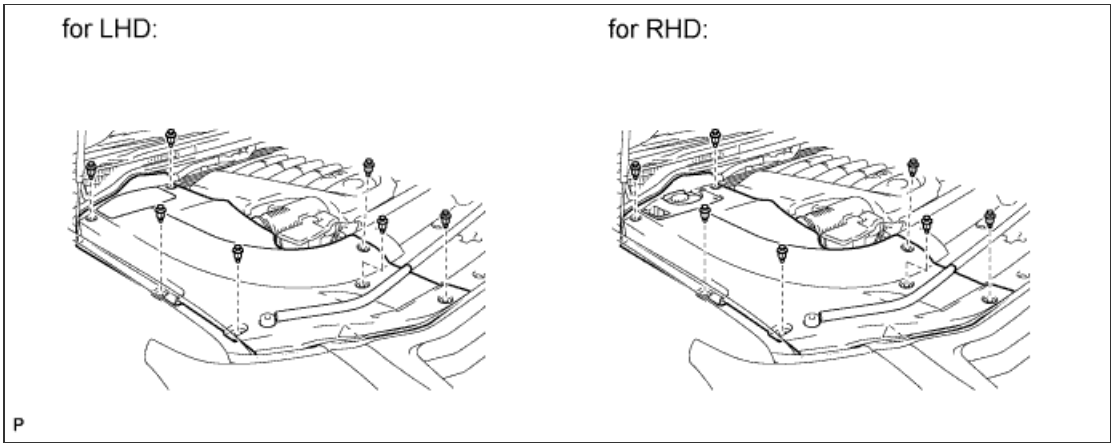
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



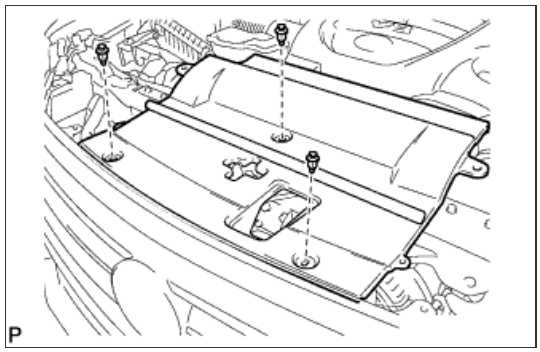
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



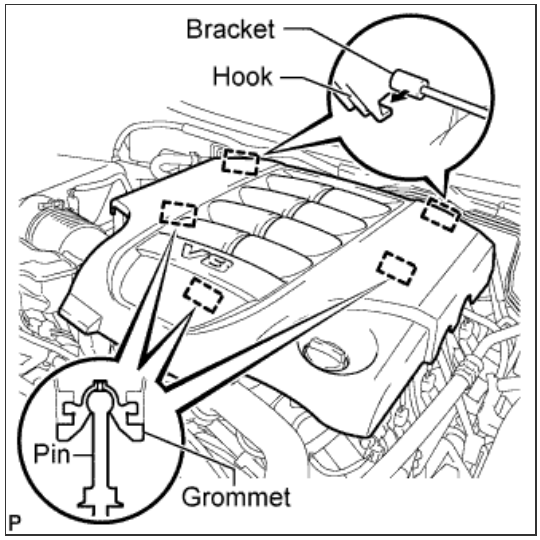
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

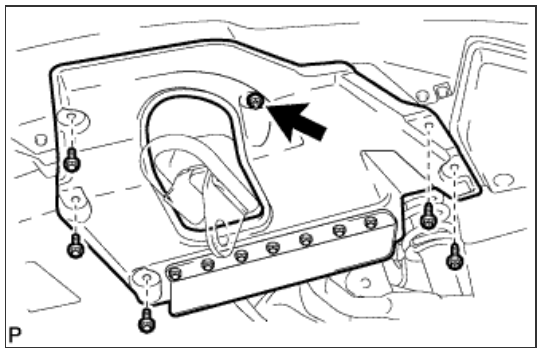
a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



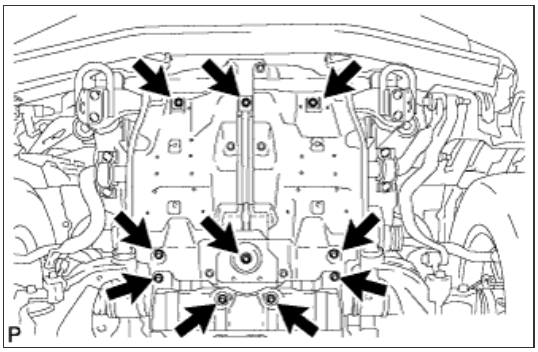
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

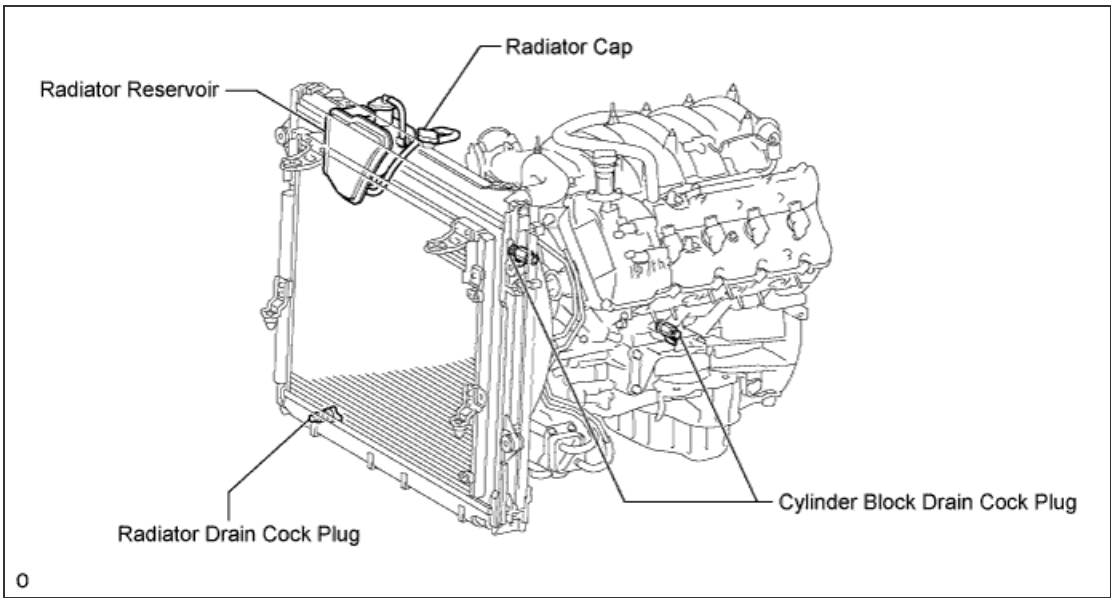
a. Remove the 10 bolts and No. 1 engine under cover.



8. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

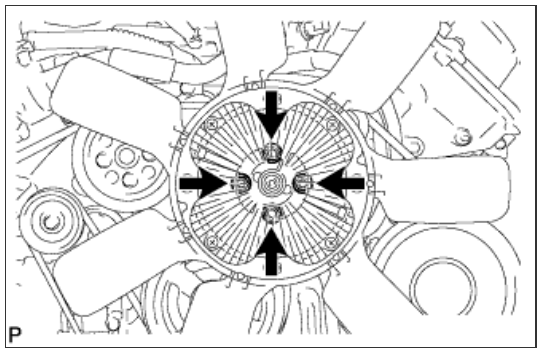
e. Tighten the radiator drain cock plug by hand.

9. REMOVE NO. 1 RADIATOR HOSE

10. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

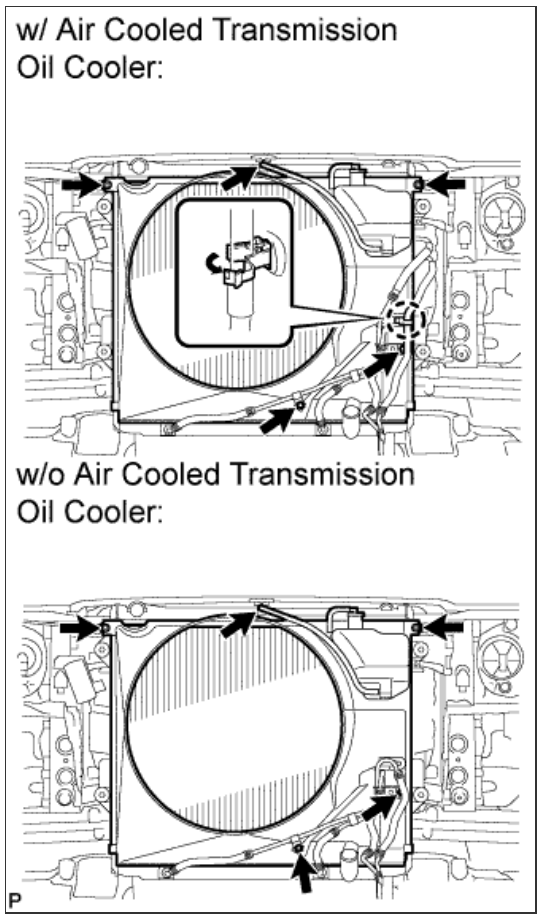
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

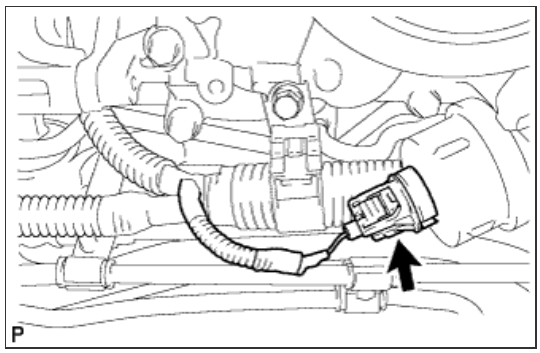
Be careful not to damage the radiator core.

h. Remove the fan pulley.

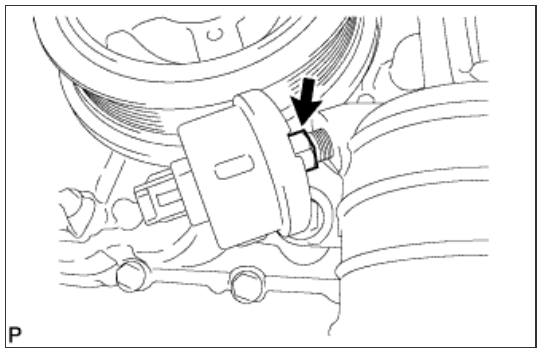


11. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.

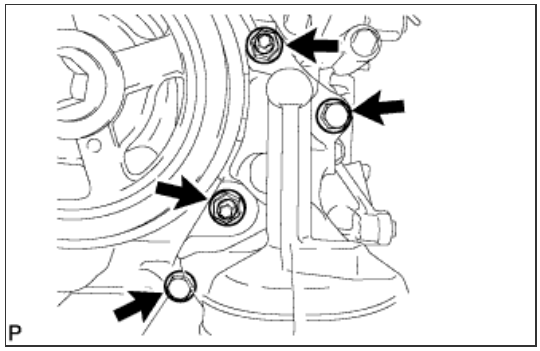


b. Remove the oil pressure sender gauge.

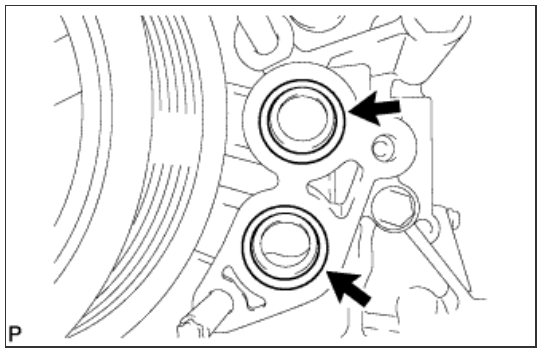


12. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.



b. Remove the 2 O-rings.

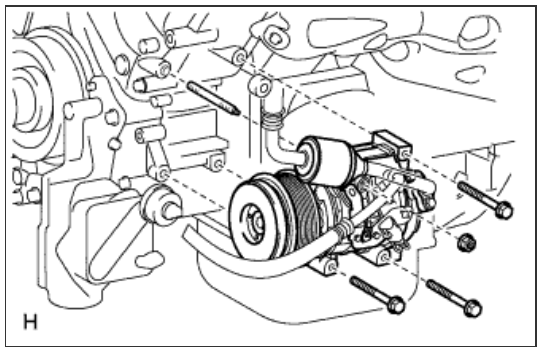


13. DISCONNECT COOLER COMPRESSOR ASSEMBLY (w/ Oil Cooler)

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

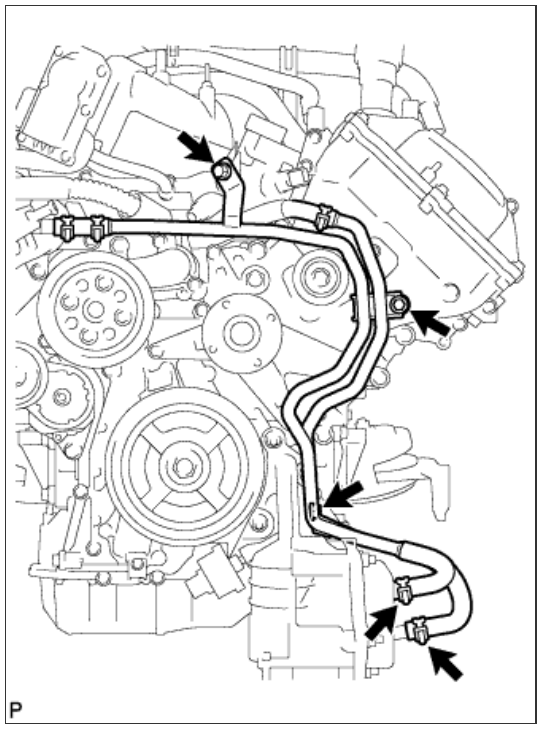
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.



14. DISCONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

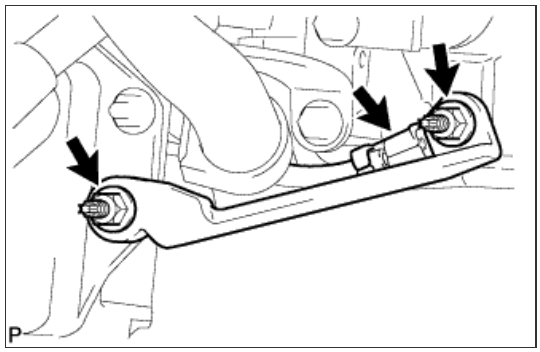
a. Remove the 3 bolts and disconnect the 2 water by-pass hoses from the oil cooler.



15. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

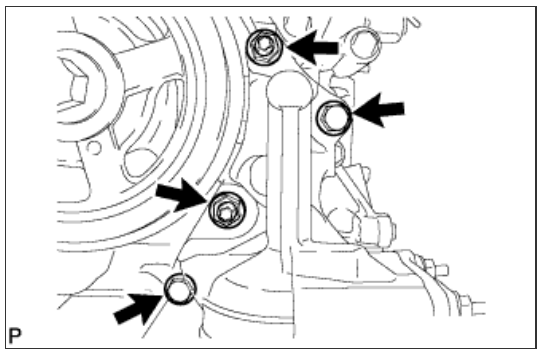
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

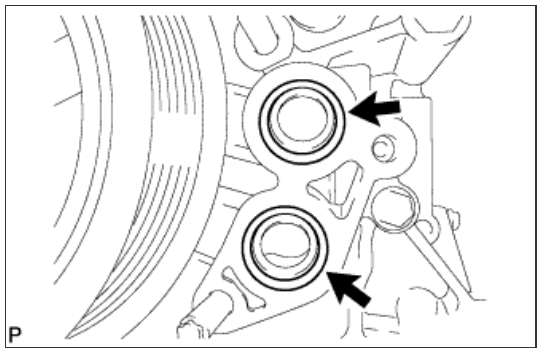


16. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.



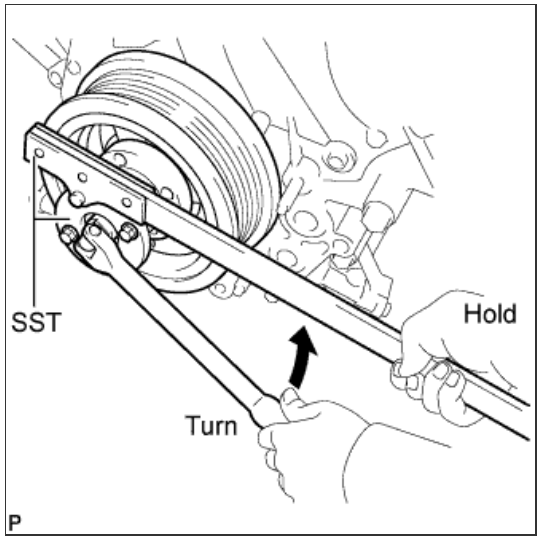
b. Remove the 2 O-rings.



17. REMOVE CRANKSHAFT PULLEY

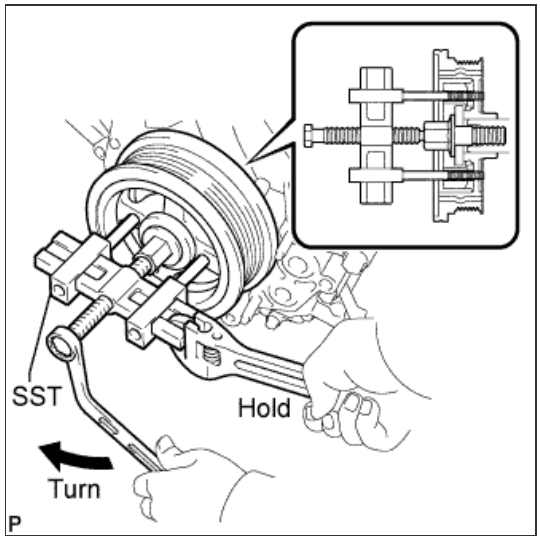
a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST
09213-70011 (09213-70020)
09330-00021



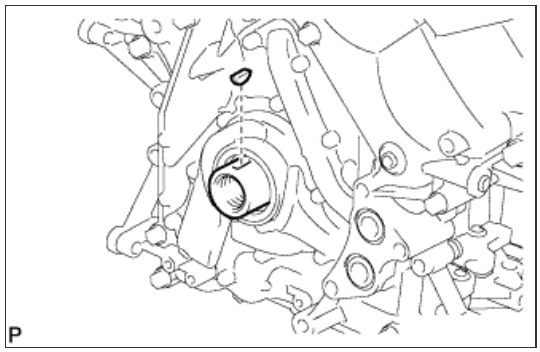
b. Using the pulley set bolt and SST, remove the crankshaft pulley.

SST
09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



18. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Remove the crankshaft timing gear key from the crankshaft.



19. REMOVE FRONT CRANKSHAFT OIL SEAL

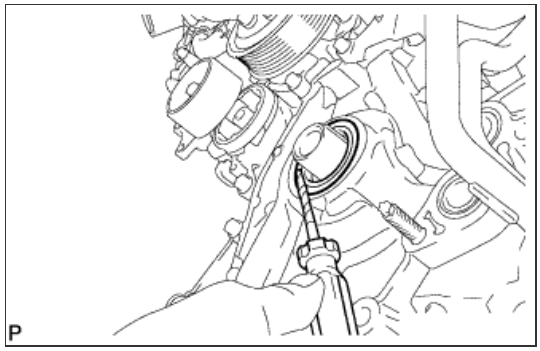
a. Using a screwdriver, pry out the oil seal.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Do not damage the surface of the oil seal press fit hole and crankshaft.



for Preparation Click here

1. INSTALL FRONT CRANKSHAFT OIL SEAL

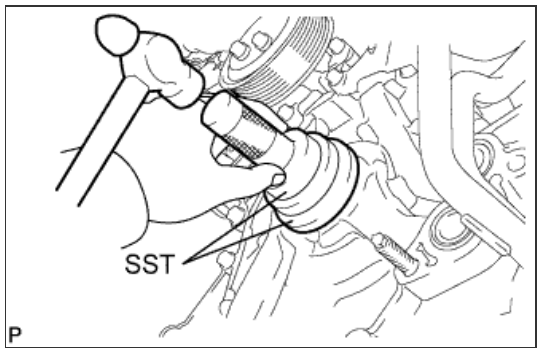
a. Apply MP grease to the lip of a new oil seal.

b. Using SST and a hammer, tap in the oil seal to a depth between 0 and 1.0 mm (0 and 0.0394 in.) from the timing chain cover edge.

SST
09223-22010
09506-35010

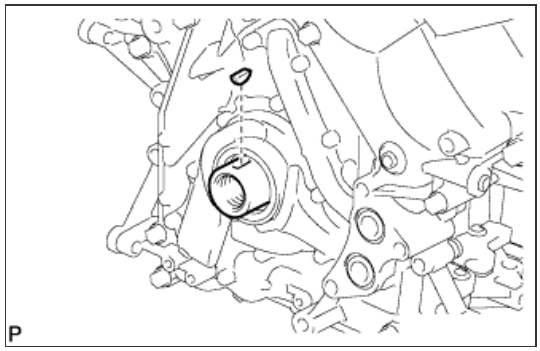
NOTICE:

- **Keep the lip free from foreign matter.**
- **Do not tap the oil seal at an angle.**



2. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the crankshaft timing gear key.



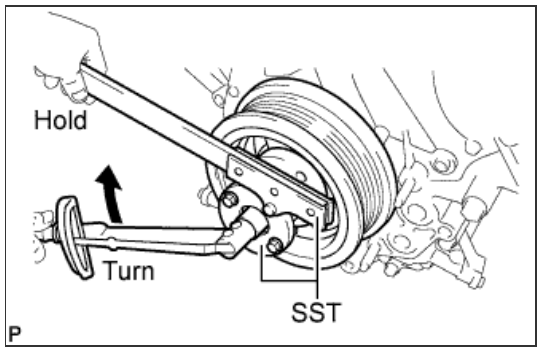
3. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

b. Using SST, install the pulley set bolt.

SST
09213-70011 (09213-70020)
09330-00021

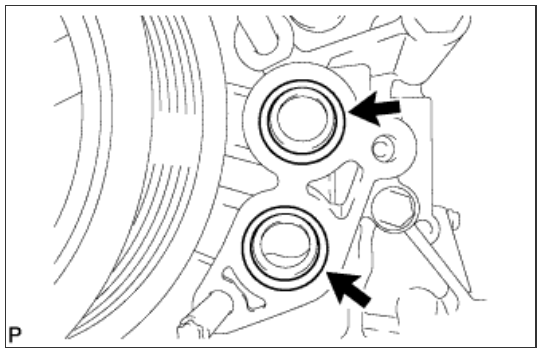
Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



4. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

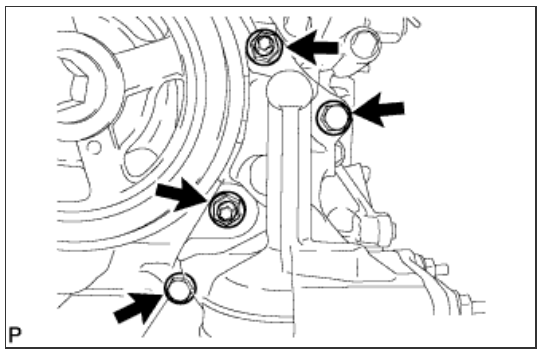
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

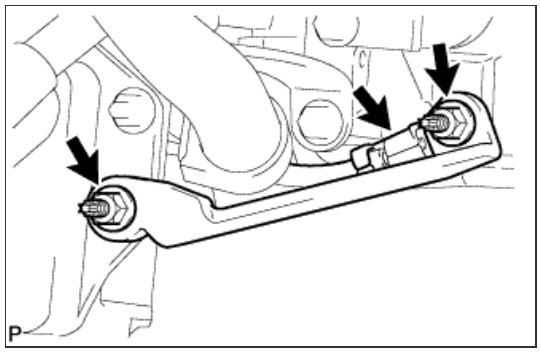


5. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

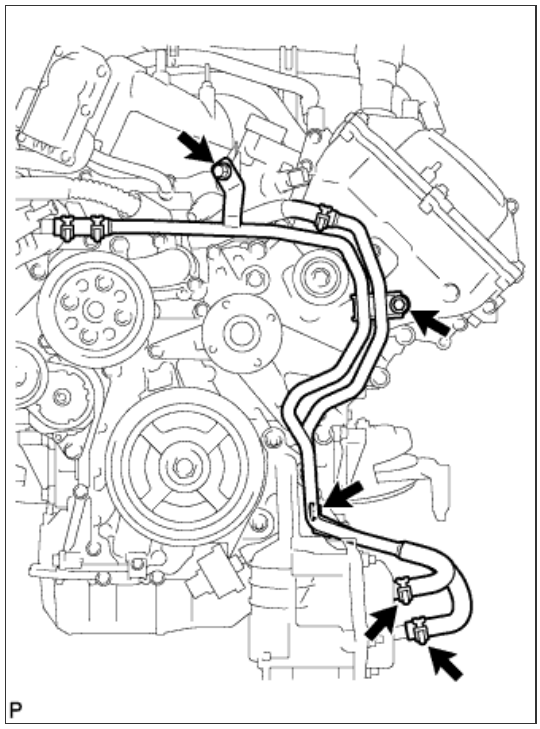


6. CONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 2 water by-pass hoses to the oil cooler.

b. Install the 3 by-pass pipe bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



7. CONNECT COOLER COMPRESSOR ASSEMBLY (w/ Oil Cooler)

a. Install the cooler compressor with the stud bolt.

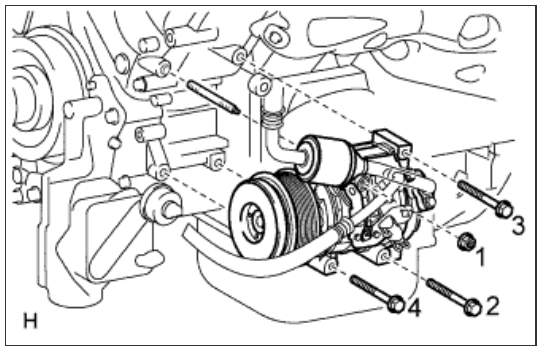
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

NOTICE:

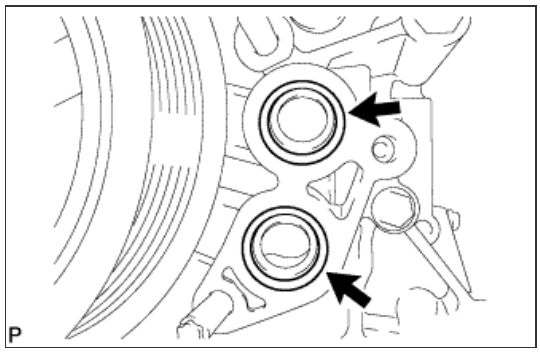
Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.



8. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

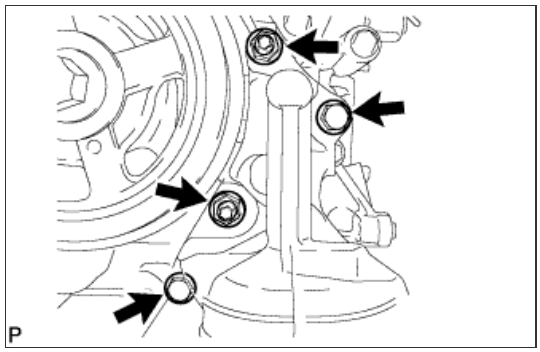
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

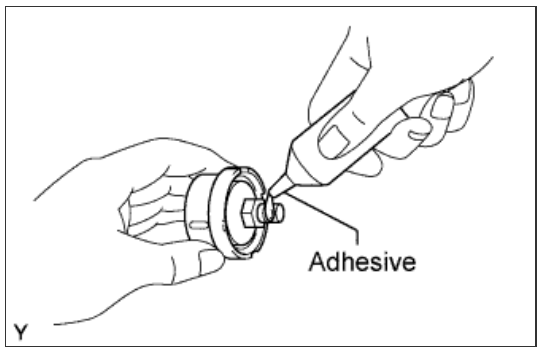
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



9. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

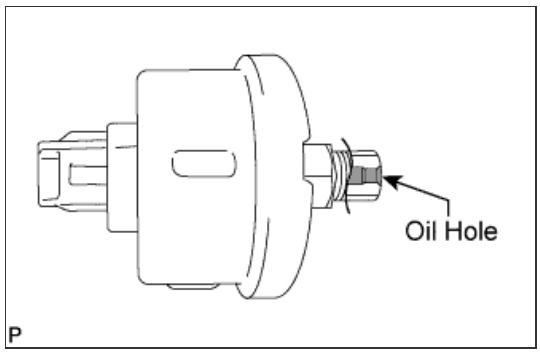
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

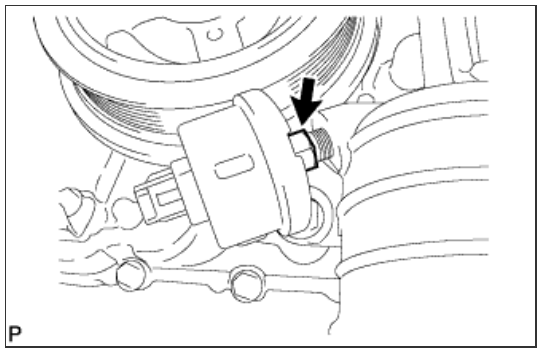


b. Install the oil pressure sender gauge.

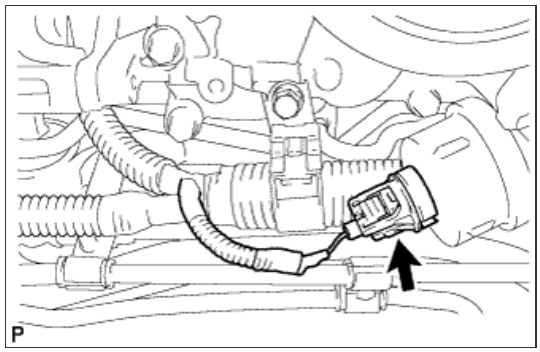
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



10. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

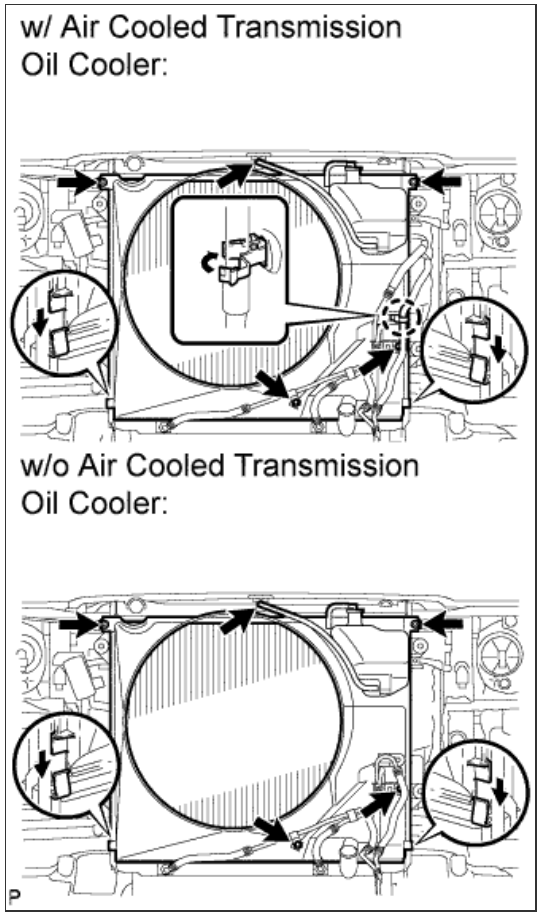
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

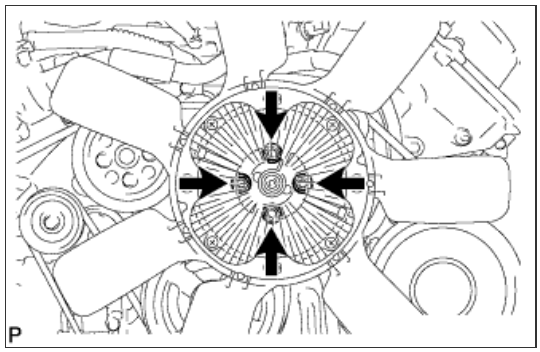
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



11. INSTALL NO. 1 RADIATOR HOSE

12. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

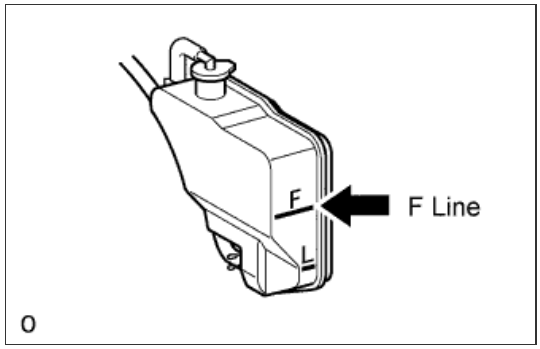
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

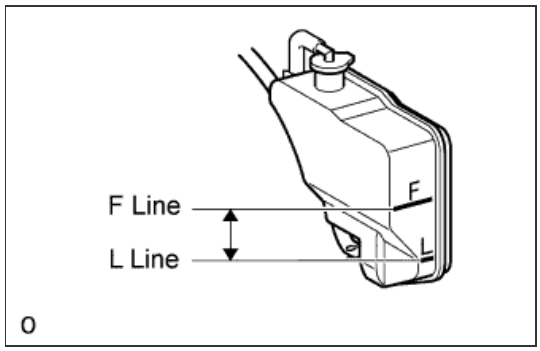
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

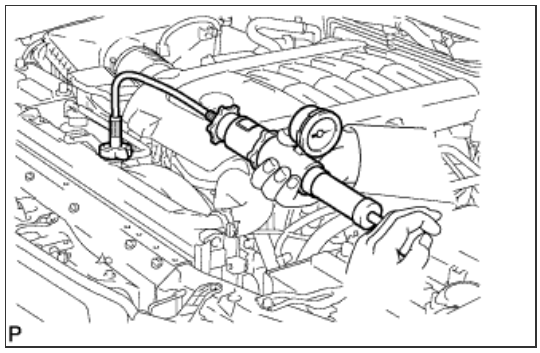


13. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



14. INSPECT FOR OIL LEAK

a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

15. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

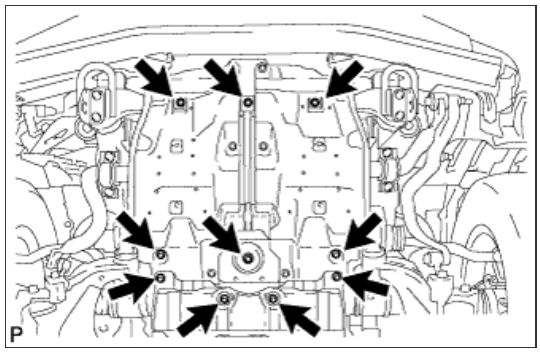
NOTICE:

Do not fill engine oil above the full level mark.

16. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

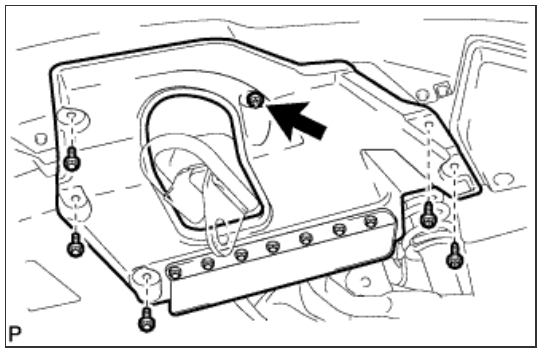
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



17. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



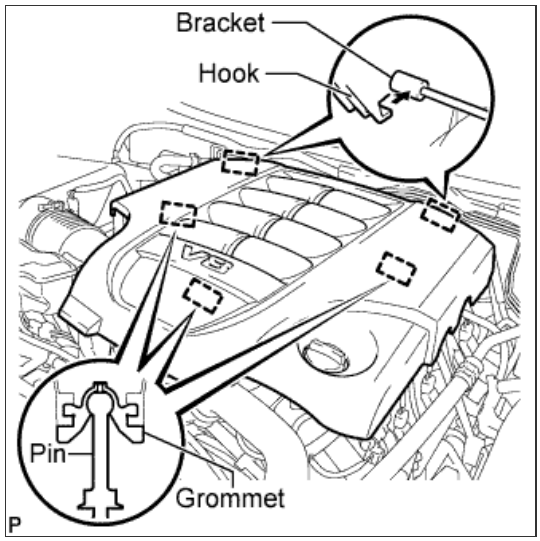
18. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

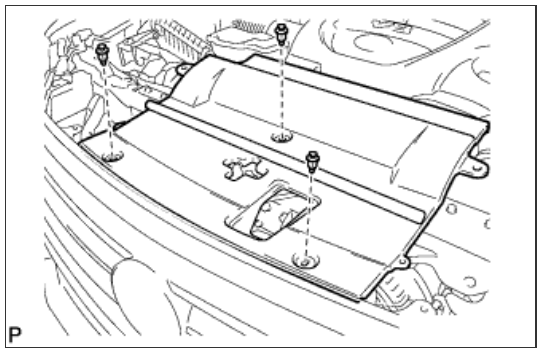
19. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



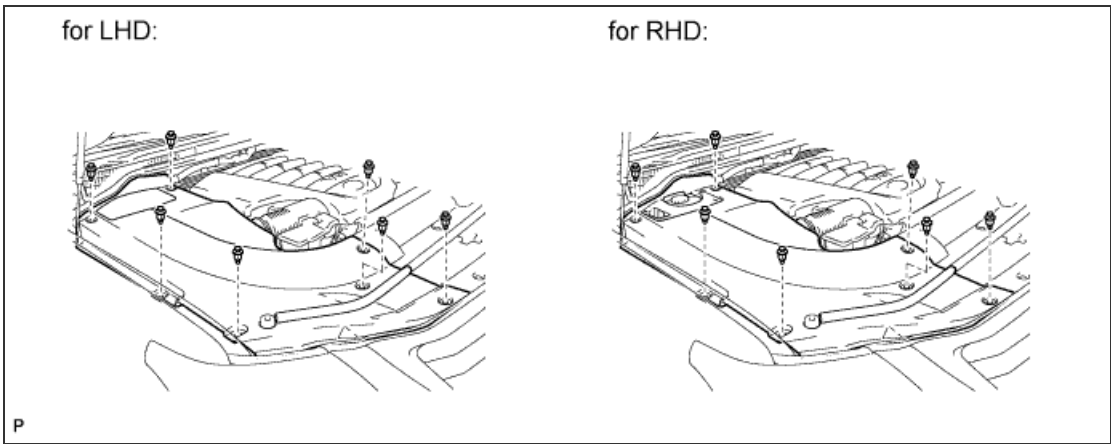
20. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



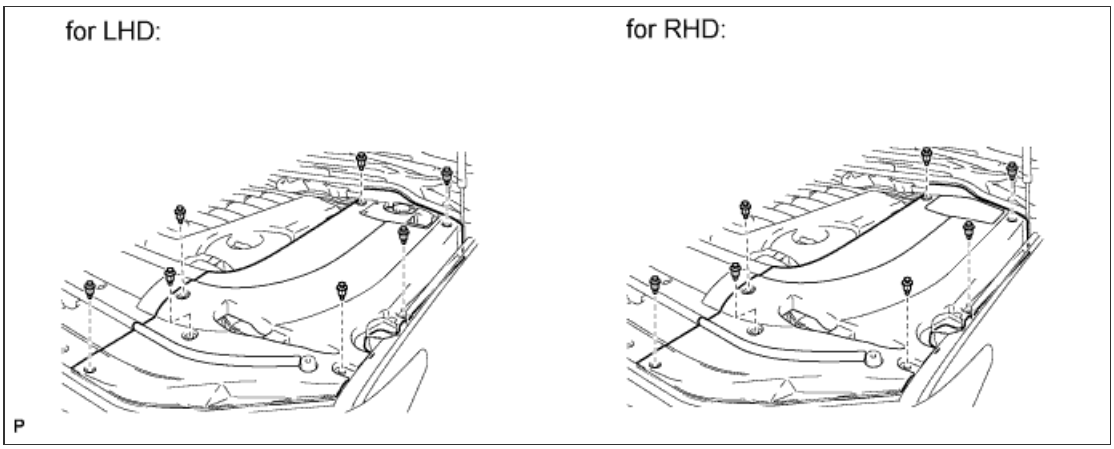
21. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

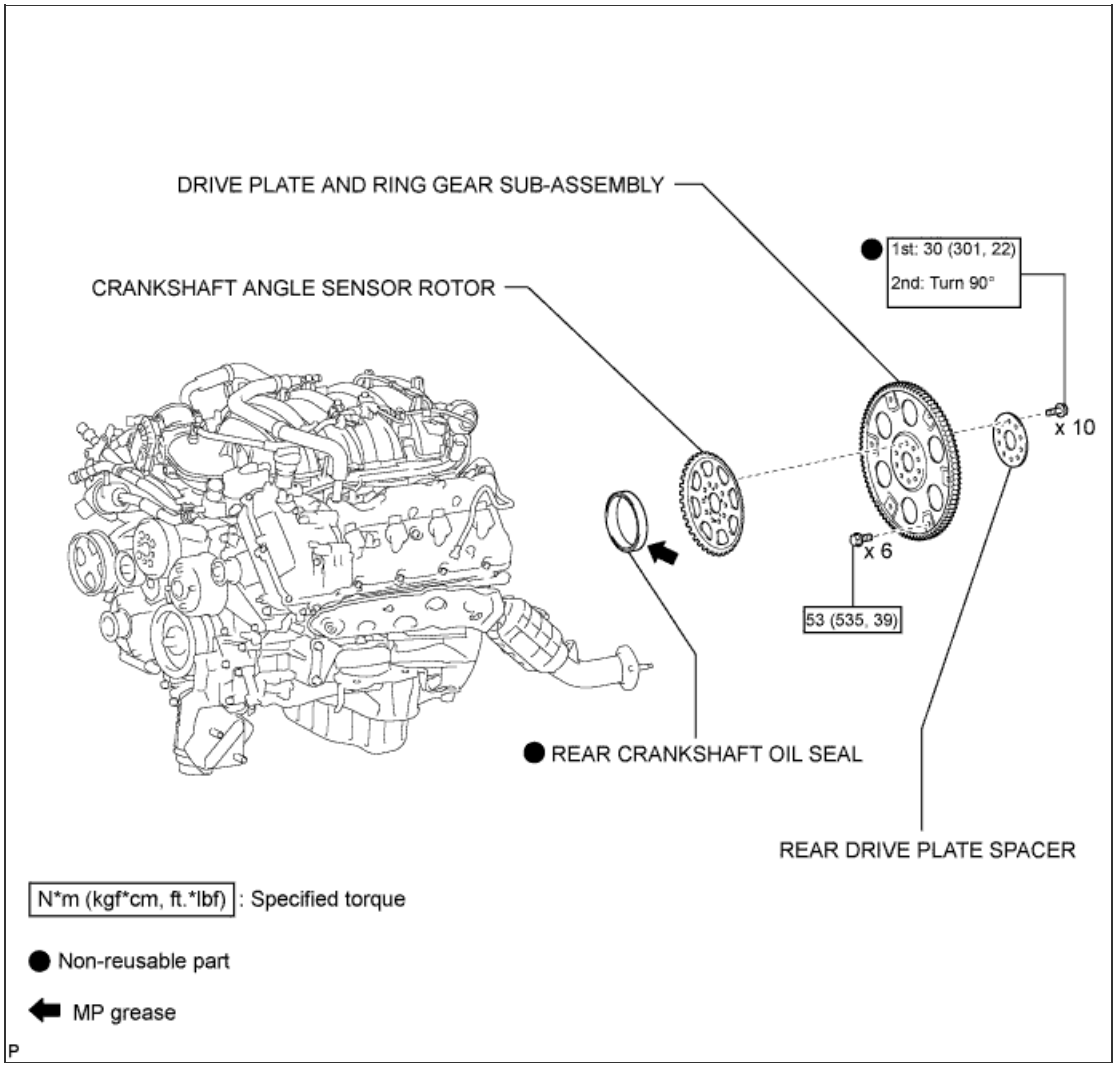


22. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



for Preparation [Click here]



for Preparation Click here

1. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

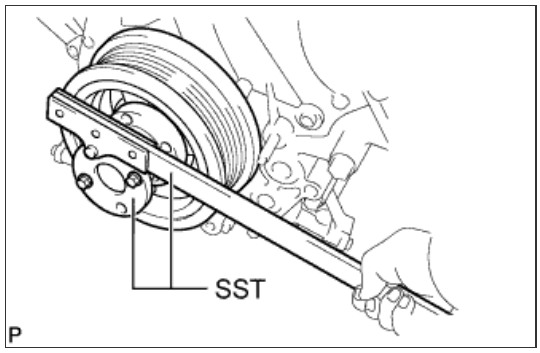
2. REMOVE AUTOMATIC TRANSMISSION ASSEMBLY

a. Remove the automatic transmission (Click here).

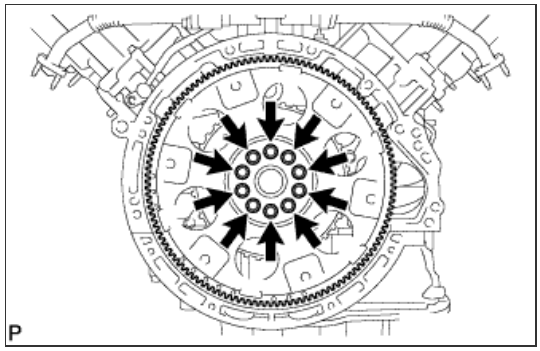
3. REMOVE DRIVE PLATE AND RING GEAR SUB-ASSEMBLY

a. Using SST, hold the crankshaft.

SST
09213-70011 (09213-70020)
09330-00021



b. Remove the 10 bolts, rear drive plate spacer, drive plate and crankshaft angle sensor rotor.



4. REMOVE REAR CRANKSHAFT OIL SEAL

a. Using a knife, cut off the lip of the oil seal.

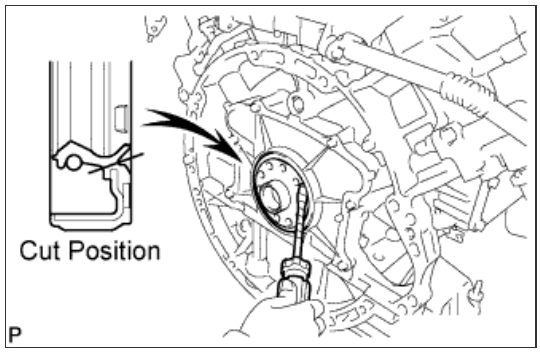
b. Using a screwdriver, pry out the oil seal.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Do not damage the surface of the oil seal press fit hole and crankshaft.


Cut Position
P

for Preparation Click here

1. INSTALL REAR CRANKSHAFT OIL SEAL

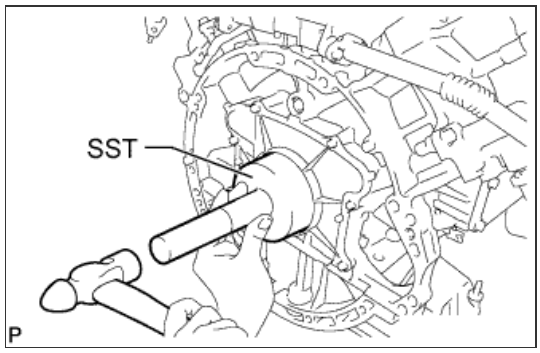
a. Apply MP grease to the lip of a new oil seal.

b. Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

SST
09223-56010

NOTICE:

- **Keep the lip free from foreign matter.**
- **Do not tap on the oil seal at an angle.**

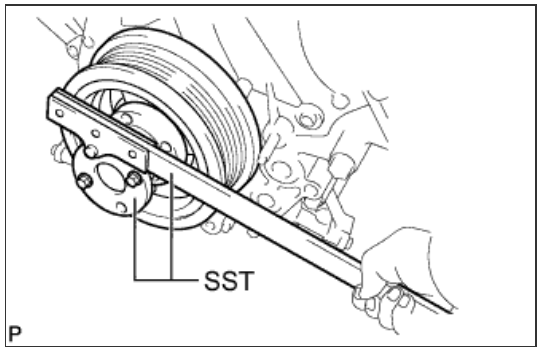


2. INSTALL DRIVE PLATE AND RING GEAR SUB-ASSEMBLY

a. Using SST, hold the crankshaft.

SST
09213-70011 (09213-70020)
09330-00021

b. Install the crankshaft angle sensor rotor, drive plate and rear drive plate spacer to the crankshaft.

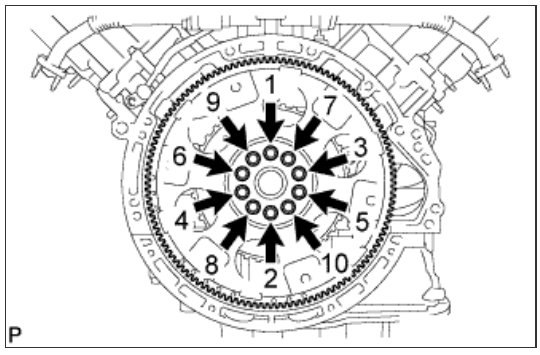


c. Install and uniformly tighten 10 new bolts in the sequence shown in the illustration.

Torque:
30 N*m{ 301 kgf*cm , 22 ft.*lbf }

NOTICE:

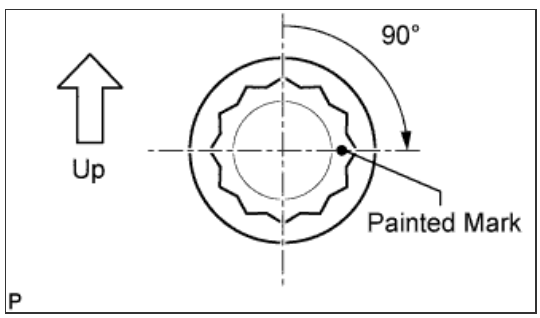
- **Do not reuse the flywheel installation bolts.**
- **Do not strike or damage the flywheel installation bolts. Be sure to handle them carefully.**



d. Mark the upside of each flywheel installation bolt with paint.

e. Tighten the flywheel installation bolts 90° as shown in the illustration.

f. Check that the painted marks are now at a 90° angle to the upside.



3. INSTALL AUTOMATIC TRANSMISSION ASSEMBLY

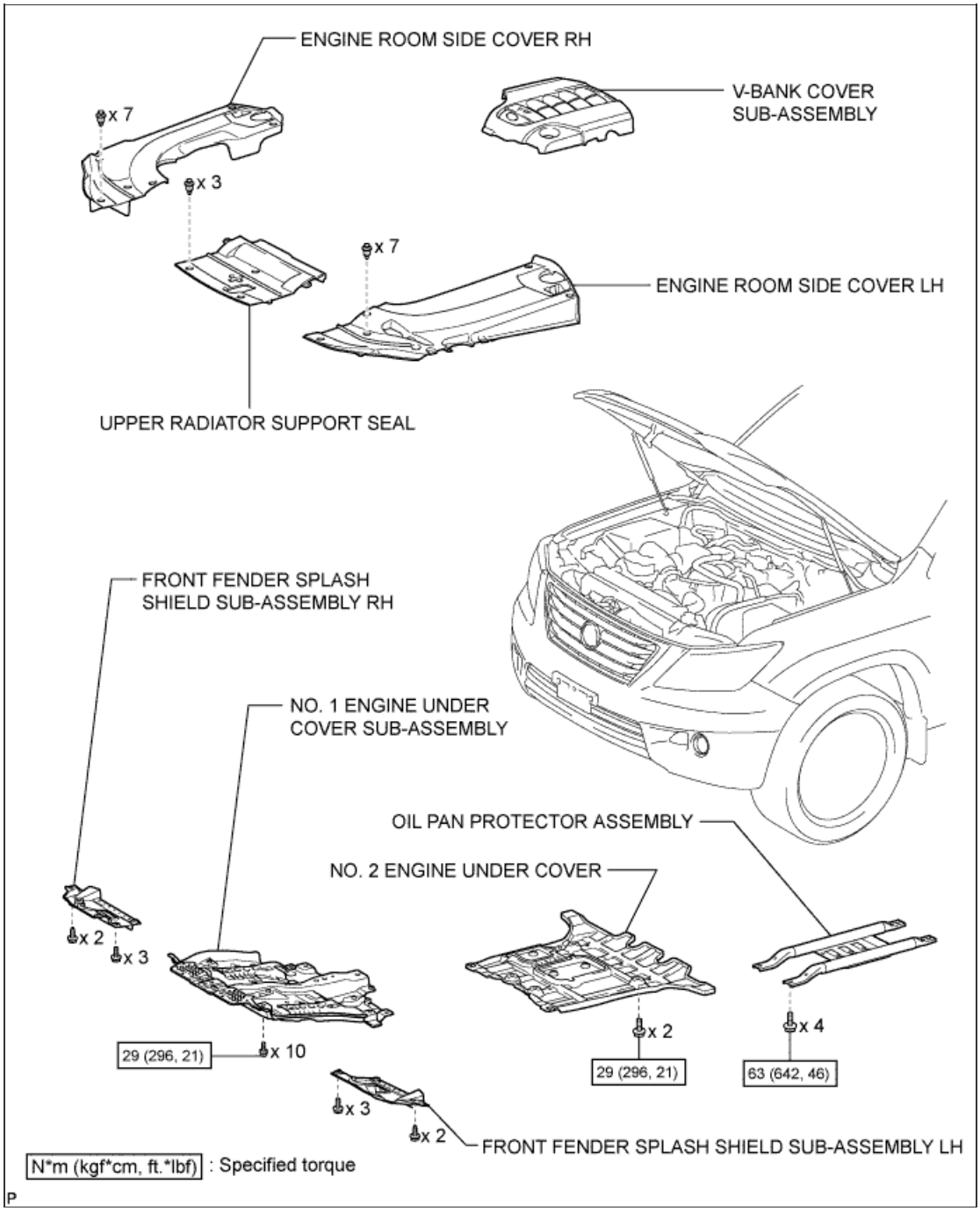
a. Install the automatic transmission (Click here).

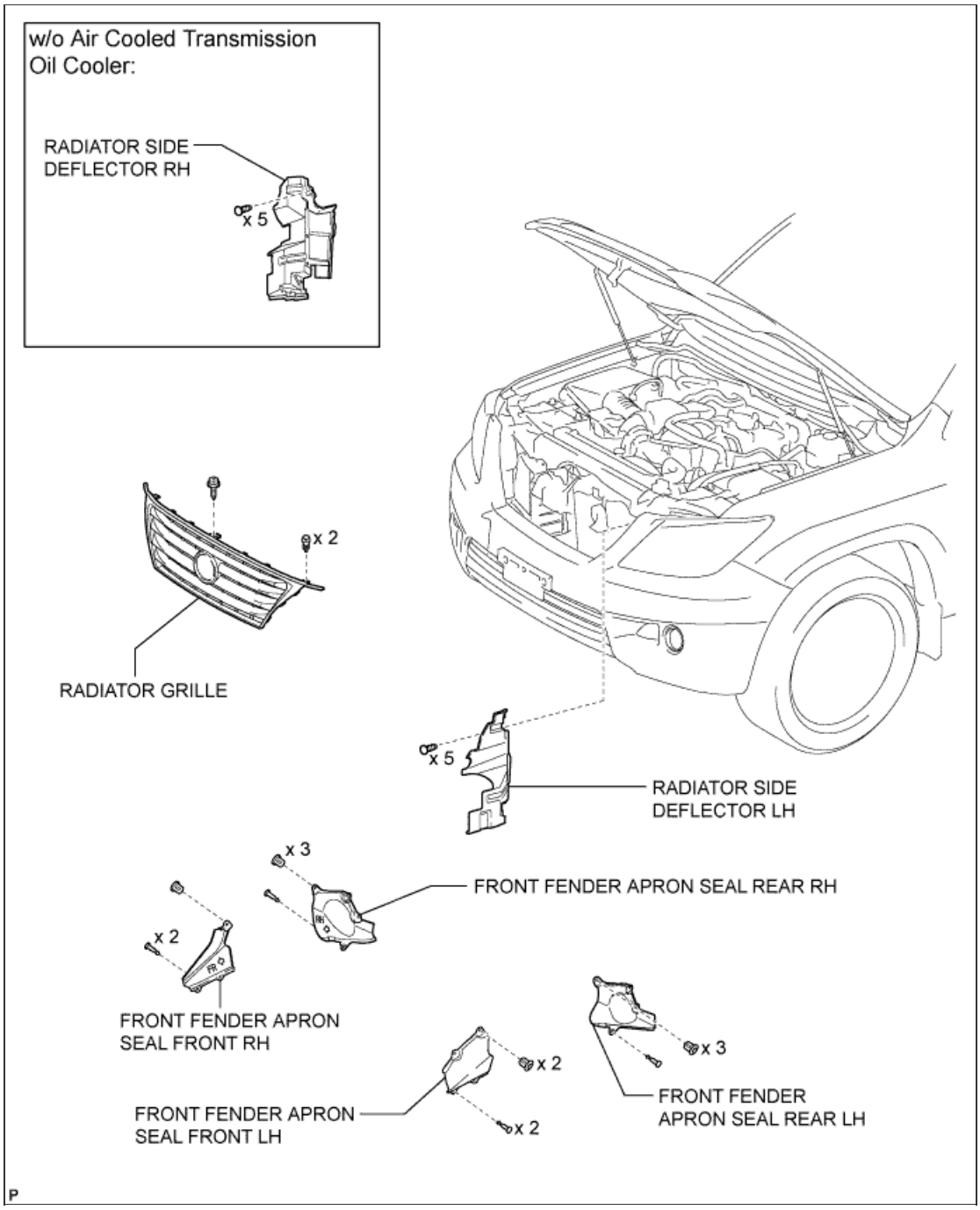
4. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

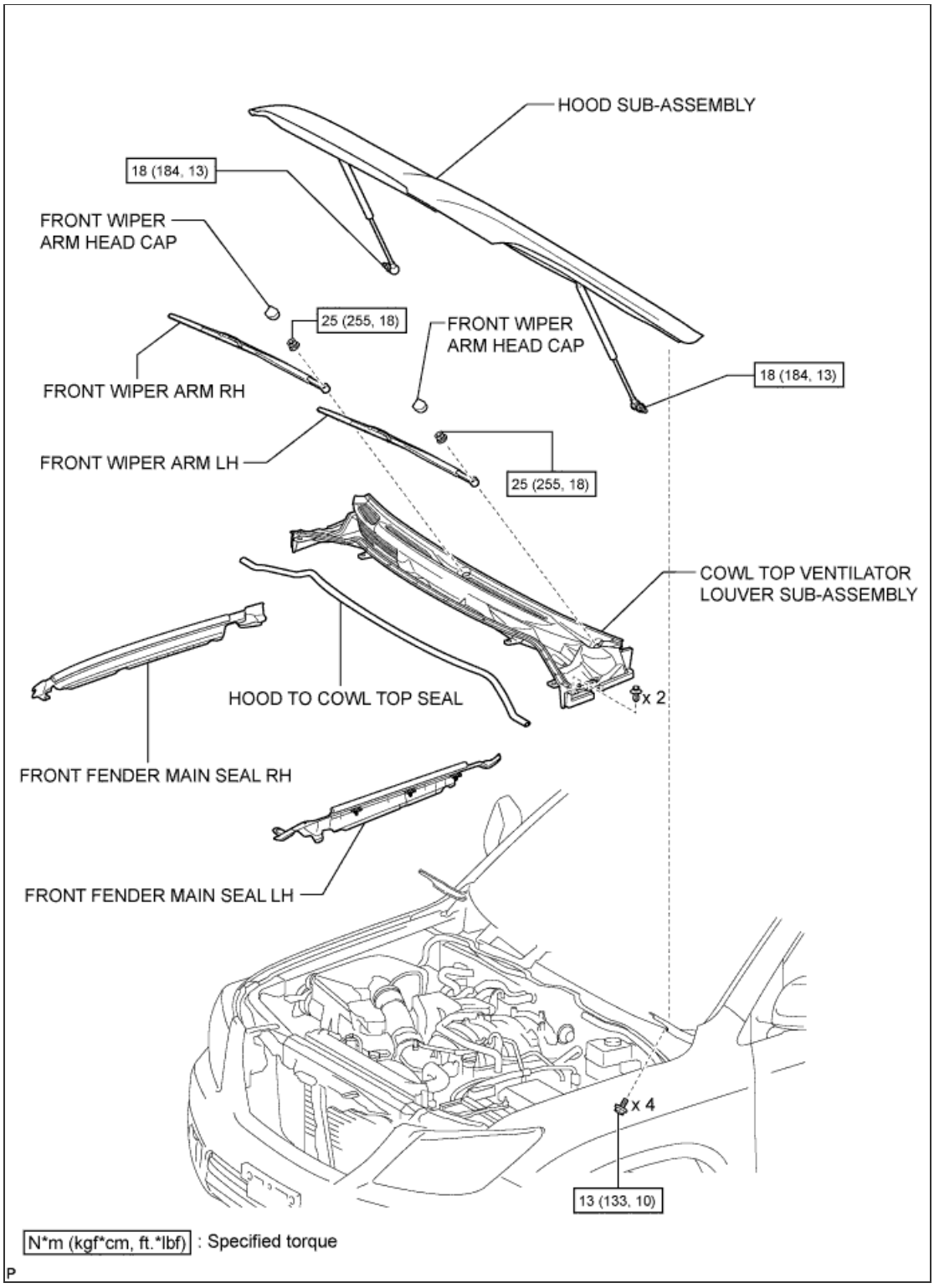
NOTICE:

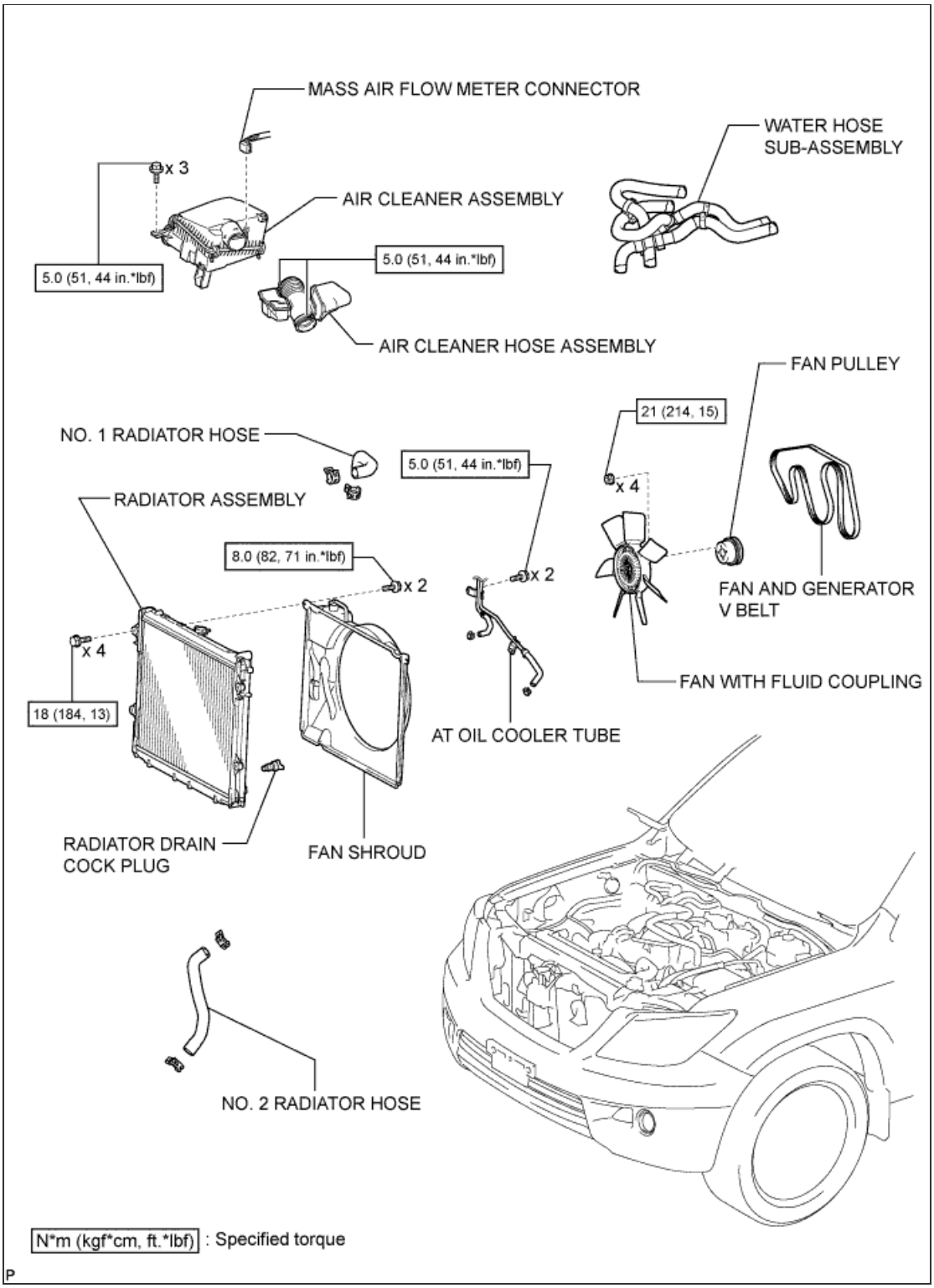
When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

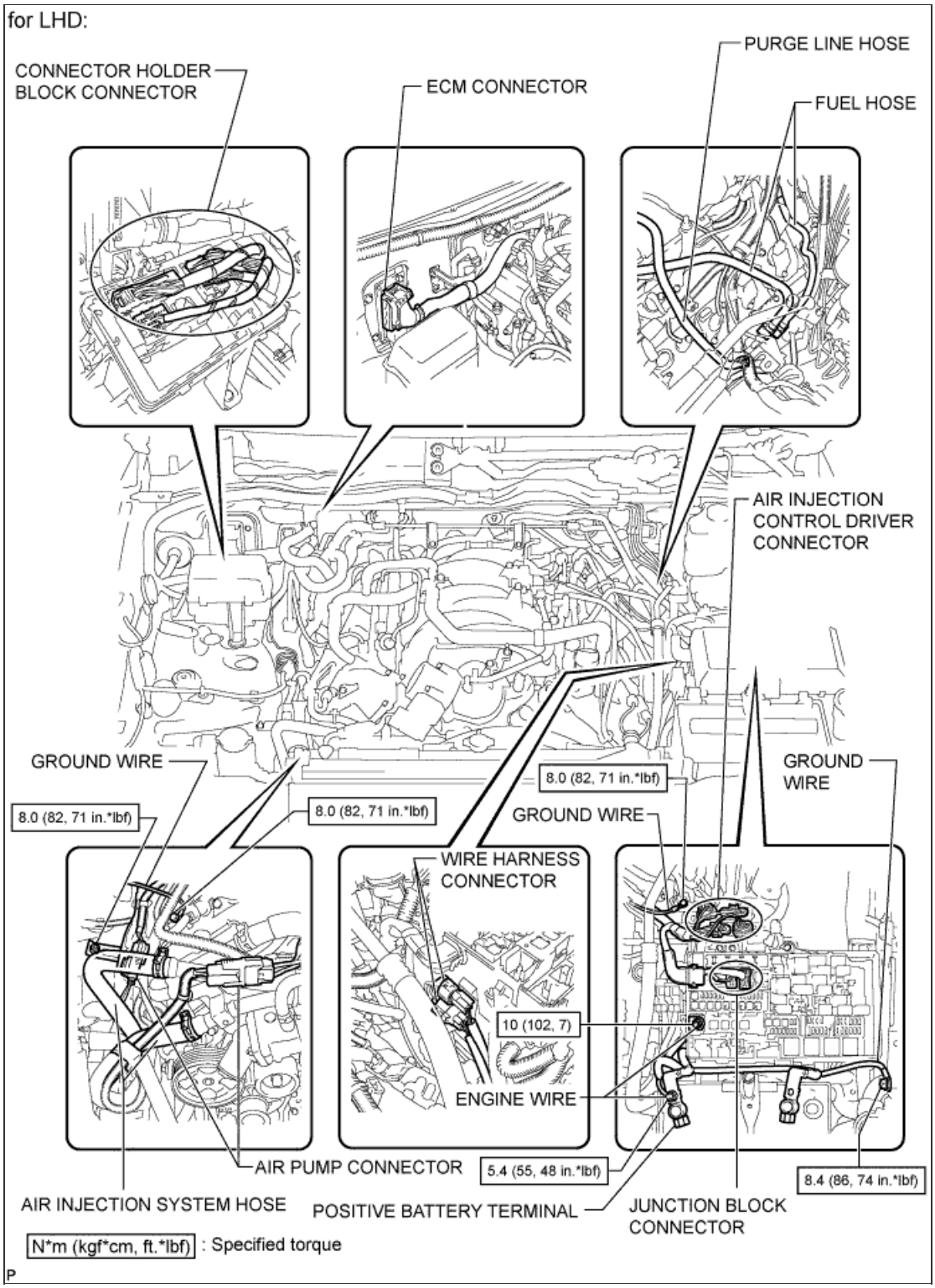
for Preparation Click here

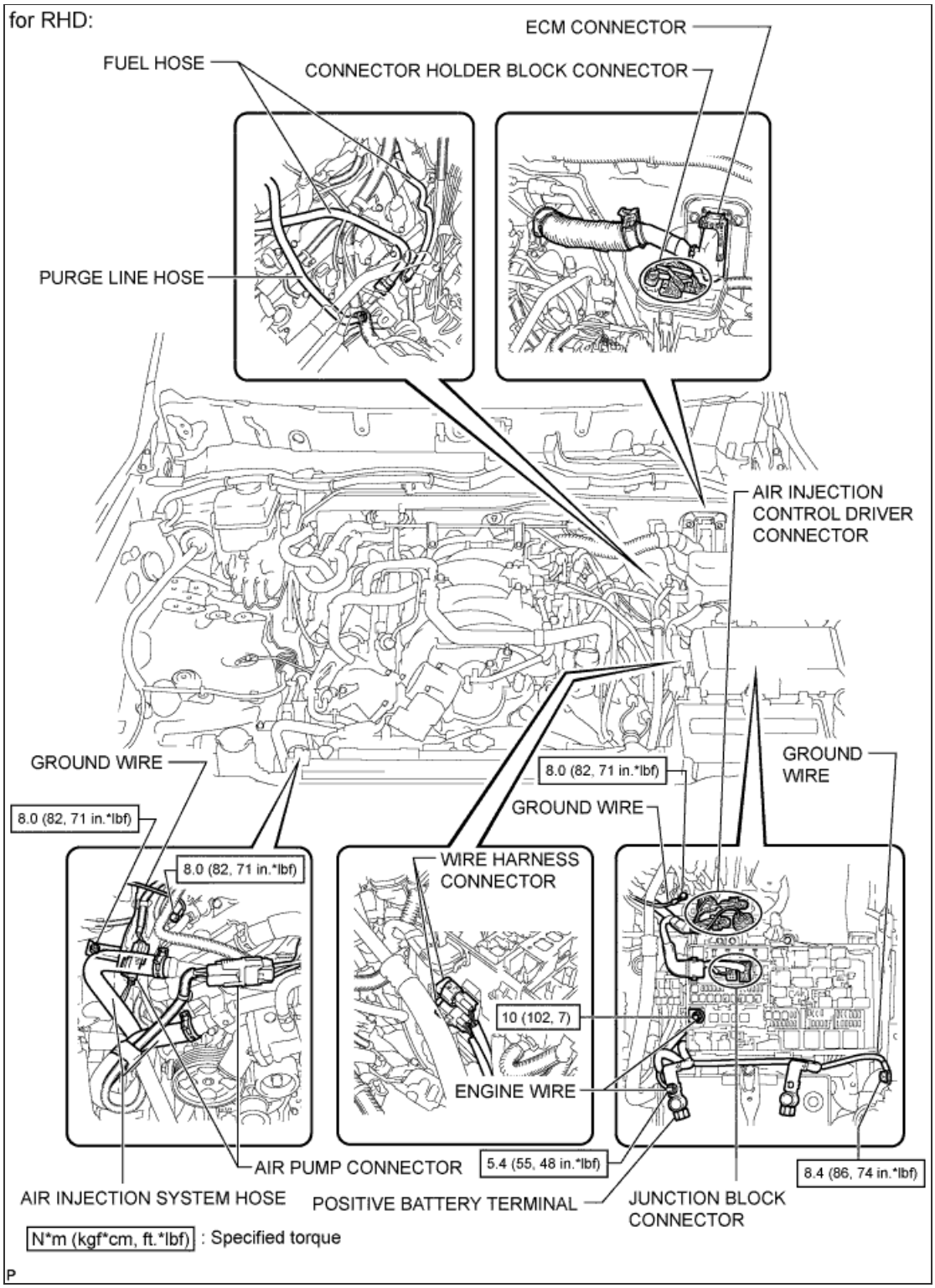


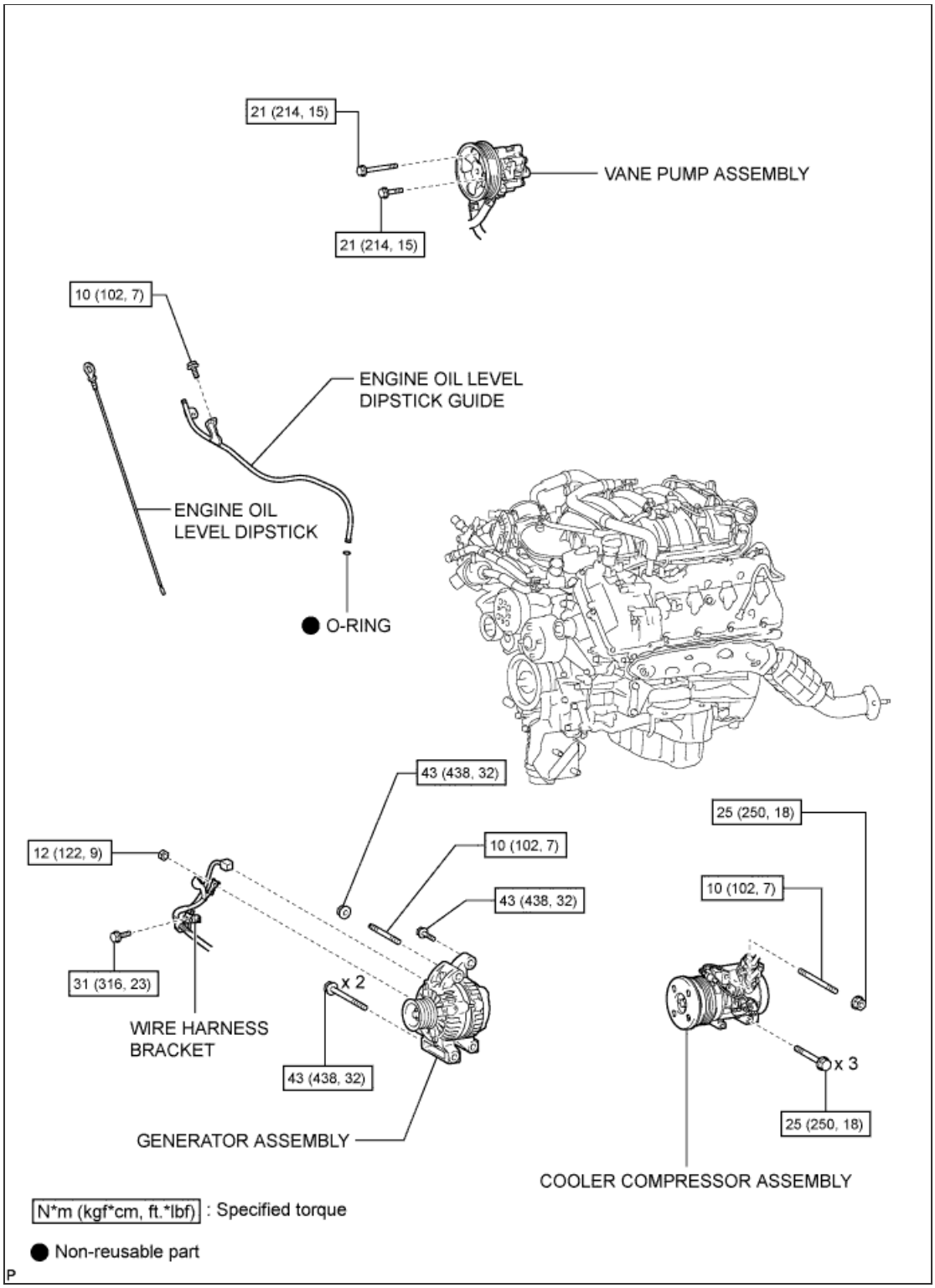

w/o Air Cooled Transmission Oil Cooler:
RADIATOR SIDE DEFLECTOR RH
x 5
x 2
RADIATOR GRILLE
x 5
RADIATOR SIDE DEFLECTOR LH
x 3
FRONT FENDER APRON SEAL REAR RH
x 2
FRONT FENDER APRON SEAL FRONT RH
x 2
x 2
FRONT FENDER APRON SEAL FRONT LH
x 3
FRONT FENDER APRON SEAL REAR LH
P

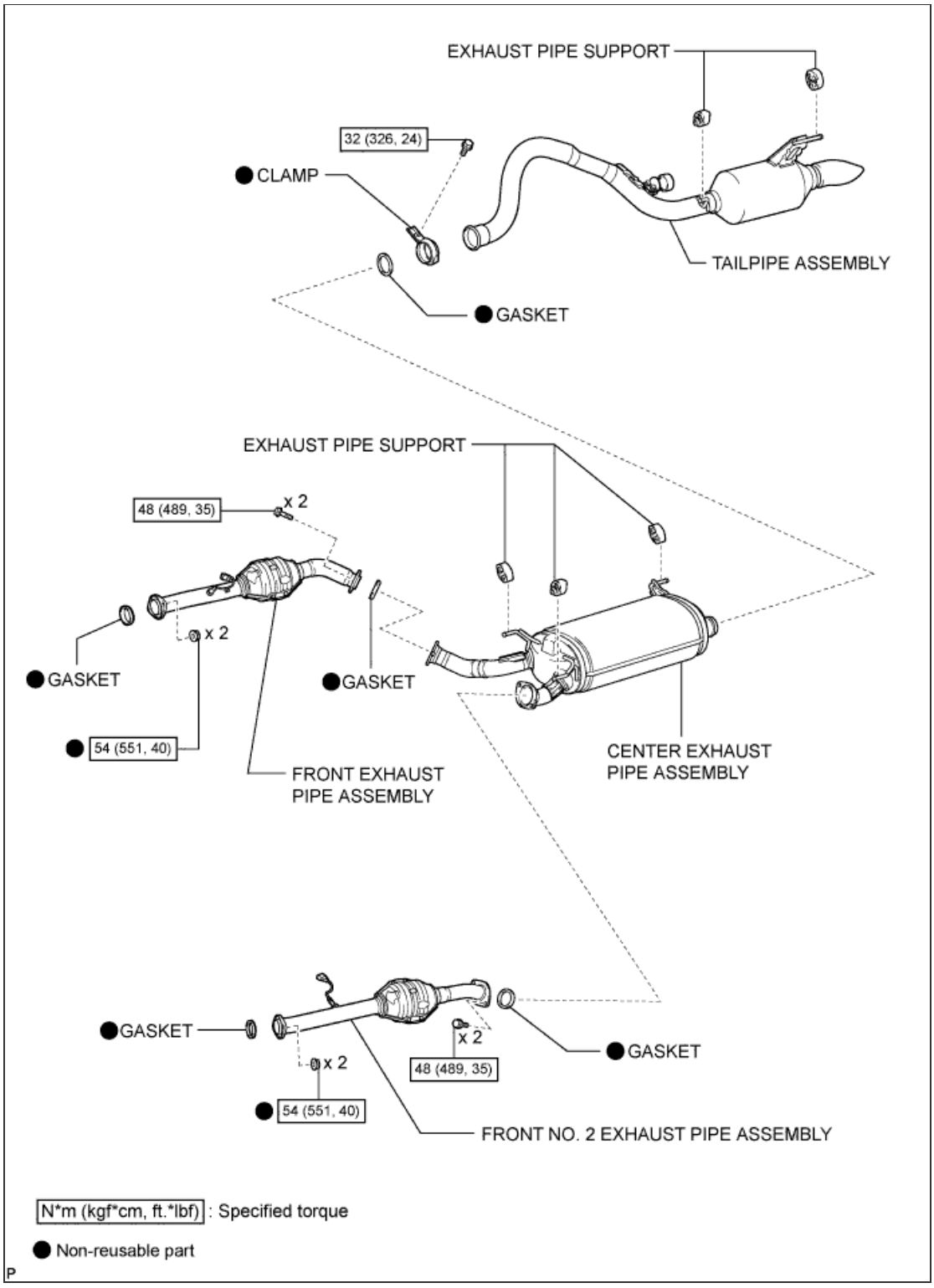

HOOD SUB-ASSEMBLY
18 (184, 13)
FRONT WIPER ARM HEAD CAP
25 (255, 18)
FRONT WIPER ARM HEAD CAP
18 (184, 13)
FRONT WIPER ARM RH
FRONT WIPER ARM LH
25 (255, 18)
COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY
x 2
HOOD TO COWL TOP SEAL
FRONT FENDER MAIN SEAL RH
FRONT FENDER MAIN SEAL LH
x 4
13 (133, 10)
N*m (kgf*cm, ft.*lbf) : Specified torque
P

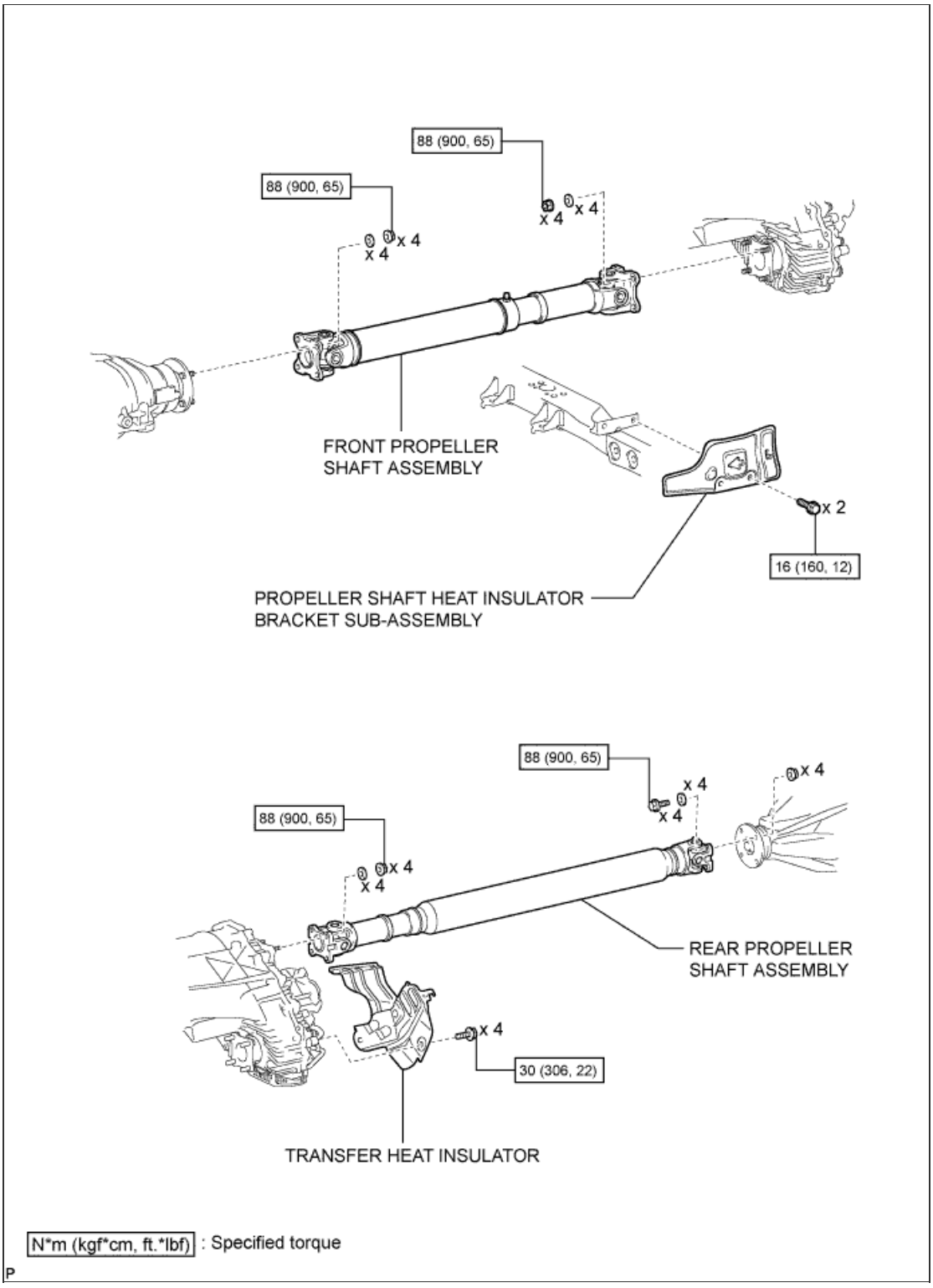

MASS AIR FLOW METER CONNECTOR
WATER HOSE SUB-ASSEMBLY
x 3
AIR CLEANER ASSEMBLY
5.0 (51, 44 in.*lbf)
5.0 (51, 44 in.*lbf)
AIR CLEANER HOSE ASSEMBLY
FAN PULLEY
21 (214, 15)
NO. 1 RADIATOR HOSE
5.0 (51, 44 in.*lbf)
x 4
RADIATOR ASSEMBLY
8.0 (82, 71 in.*lbf)
x 2
x 2
FAN AND GENERATOR V BELT
x 4
18 (184, 13)
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
RADIATOR DRAIN COCK PLUG
FAN SHROUD
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P

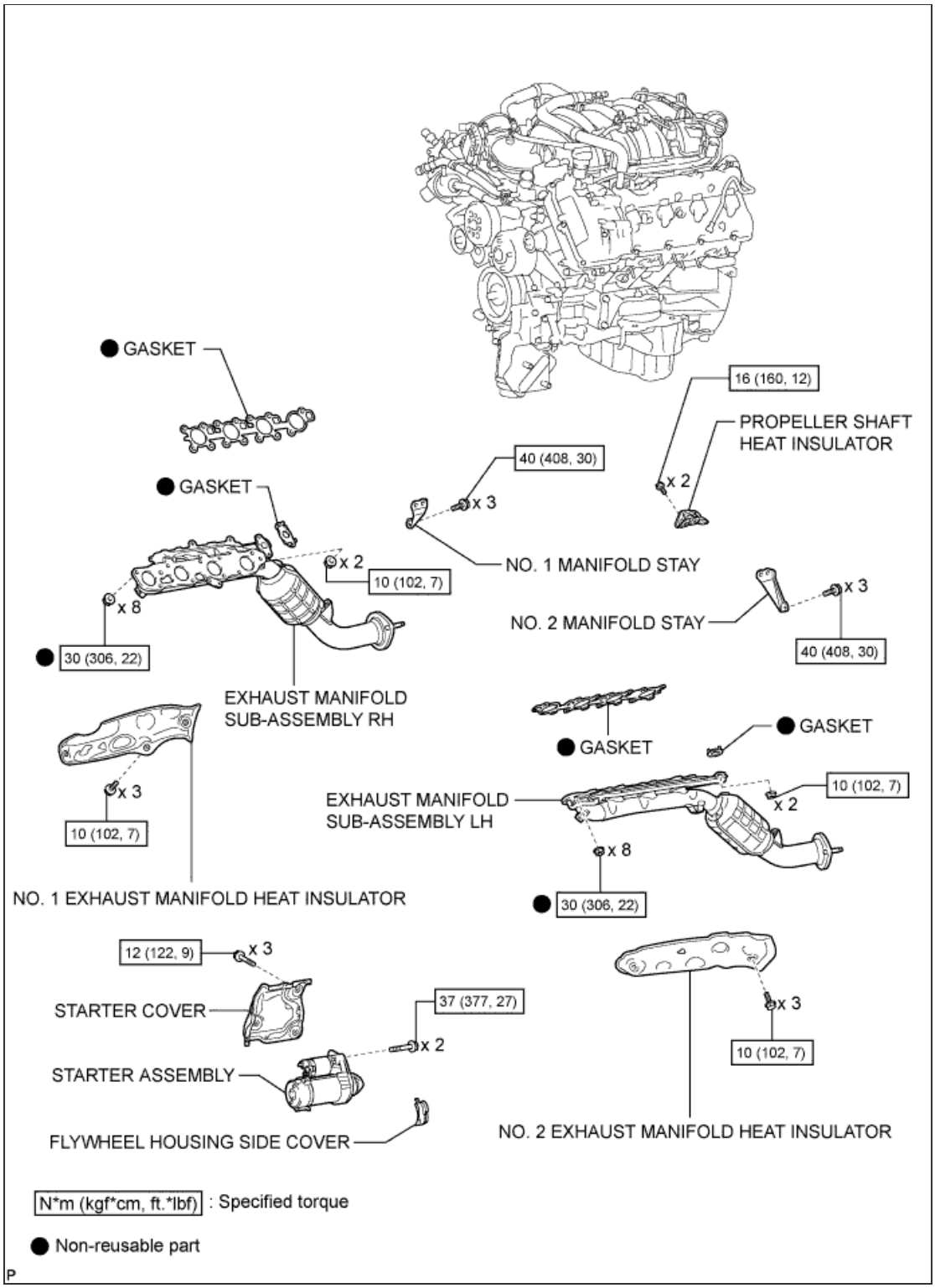

for LHD:
CONNECTOR HOLDER BLOCK CONNECTOR
ECM CONNECTOR
PURGE LINE HOSE
FUEL HOSE
AIR INJECTION CONTROL DRIVER CONNECTOR
GROUND WIRE
8.0 (82, 71 in.*lbf)
8.0 (82, 71 in.*lbf)
8.0 (82, 71 in.*lbf)
GROUND WIRE
GROUND WIRE
WIRE HARNESS CONNECTOR
10 (102, 7)
ENGINE WIRE
AIR PUMP CONNECTOR
5.4 (55, 48 in.*lbf)
8.4 (86, 74 in.*lbf)
AIR INJECTION SYSTEM HOSE
POSITIVE BATTERY TERMINAL
JUNCTION BLOCK CONNECTOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P

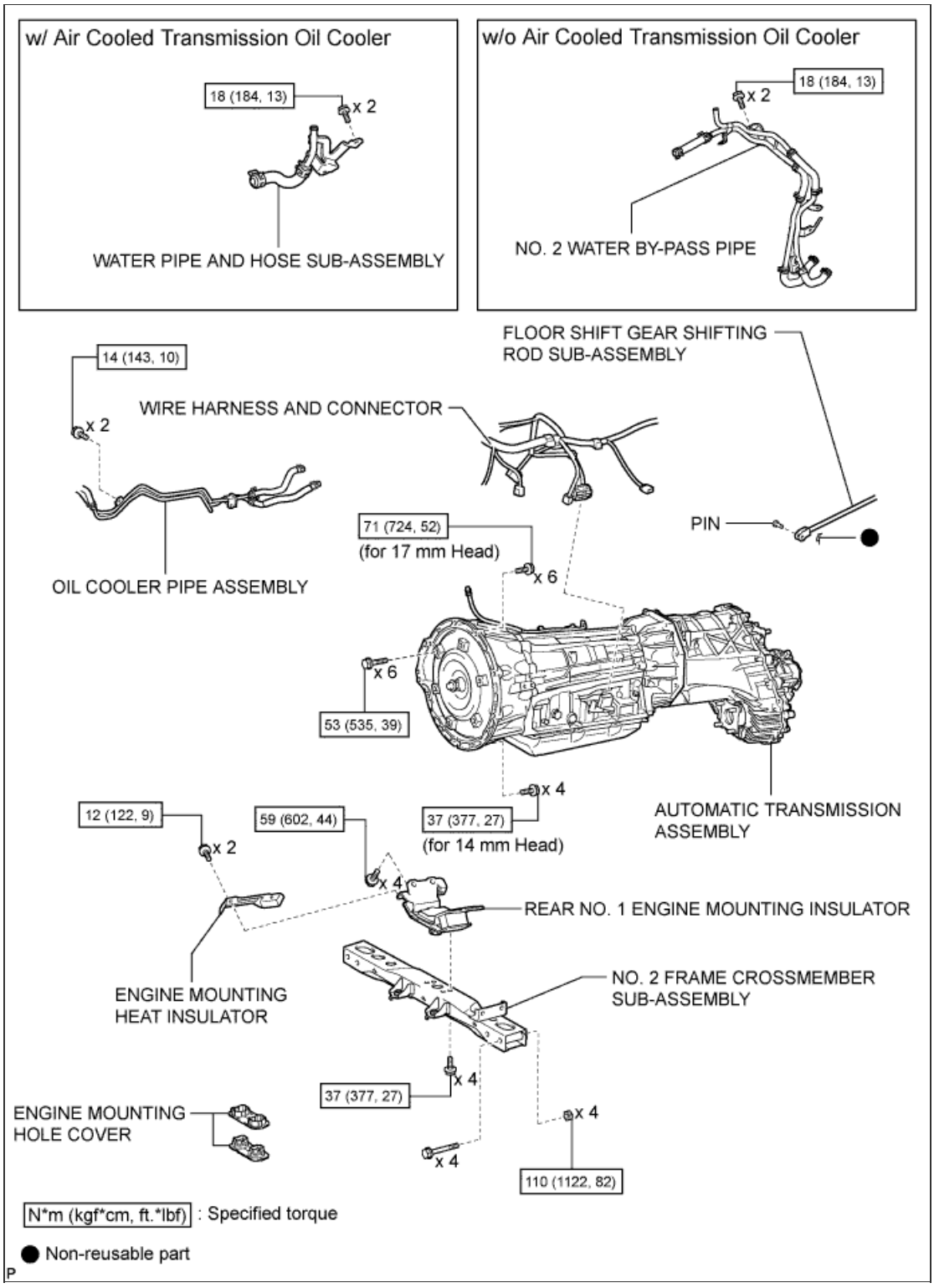

for RHD:
ECM CONNECTOR
FUEL HOSE
CONNECTOR HOLDER BLOCK CONNECTOR
PURGE LINE HOSE
AIR INJECTION CONTROL DRIVER CONNECTOR
GROUND WIRE
8.0 (82, 71 in.*lbf)
GROUND WIRE
8.0 (82, 71 in.*lbf)
GROUND WIRE
8.0 (82, 71 in.*lbf)
WIRE HARNESS CONNECTOR
10 (102, 7)
ENGINE WIRE
AIR PUMP CONNECTOR
5.4 (55, 48 in.*lbf)
8.4 (86, 74 in.*lbf)
AIR INJECTION SYSTEM HOSE
POSITIVE BATTERY TERMINAL
JUNCTION BLOCK CONNECTOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P

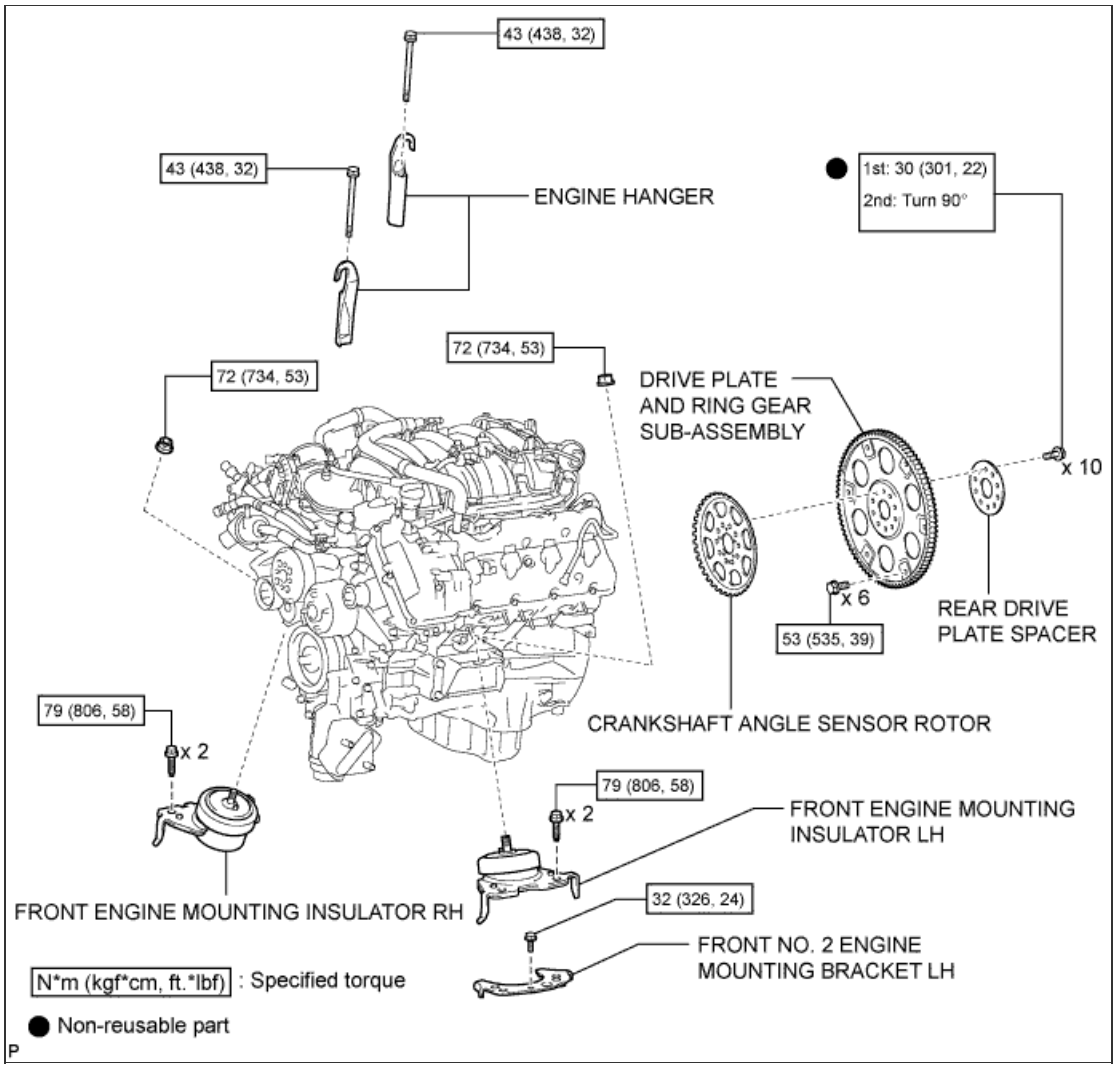

21 (214, 15)
VANE PUMP ASSEMBLY
21 (214, 15)
10 (102, 7)
ENGINE OIL LEVEL
DIPSTICK GUIDE
ENGINE OIL
LEVEL DIPSTICK
O-RING
43 (438, 32)
25 (250, 18)
12 (122, 9)
10 (102, 7)
43 (438, 32)
10 (102, 7)
31 (316, 23)
x 2
WIRE HARNESS
BRACKET
43 (438, 32)
x 3
25 (250, 18)
GENERATOR ASSEMBLY
COOLER COMPRESSOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


EXHAUST PIPE SUPPORT
32 (326, 24)
CLAMP
TAILPIPE ASSEMBLY
GASKET
EXHAUST PIPE SUPPORT
48 (489, 35)
x 2
x 2
GASKET
GASKET
54 (551, 40)
FRONT EXHAUST PIPE ASSEMBLY
CENTER EXHAUST PIPE ASSEMBLY
GASKET
x 2
48 (489, 35)
GASKET
x 2
54 (551, 40)
FRONT NO. 2 EXHAUST PIPE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

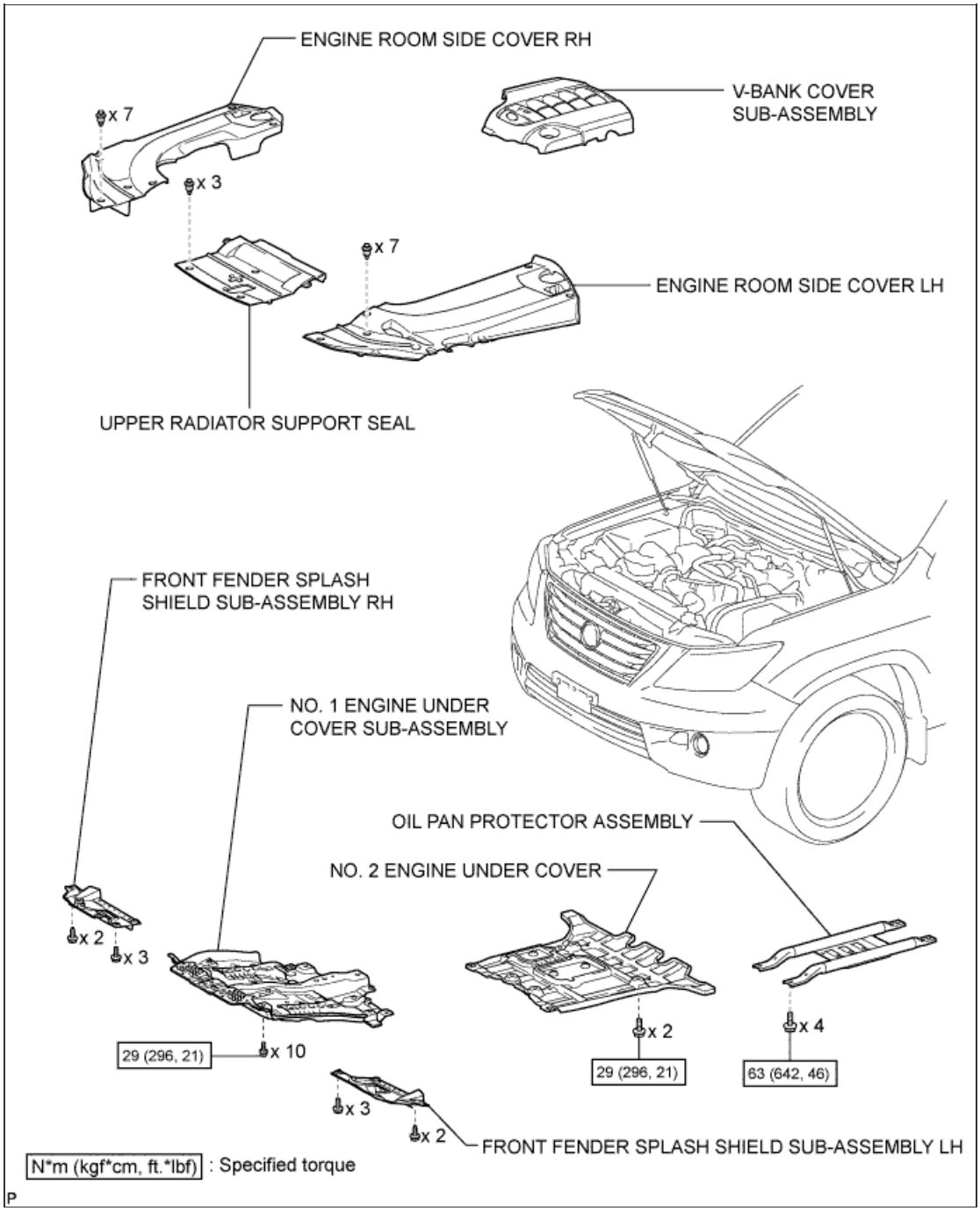

88 (900, 65)
88 (900, 65)
x 4
x 4
x 4
x 4
FRONT PROPELLER
SHAFT ASSEMBLY
x 2
16 (160, 12)
PROPELLER SHAFT HEAT INSULATOR
BRACKET SUB-ASSEMBLY
88 (900, 65)
88 (900, 65)
x 4
x 4
x 4
x 4
REAR PROPELLER
SHAFT ASSEMBLY
x 4
30 (306, 22)
TRANSFER HEAT INSULATOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P

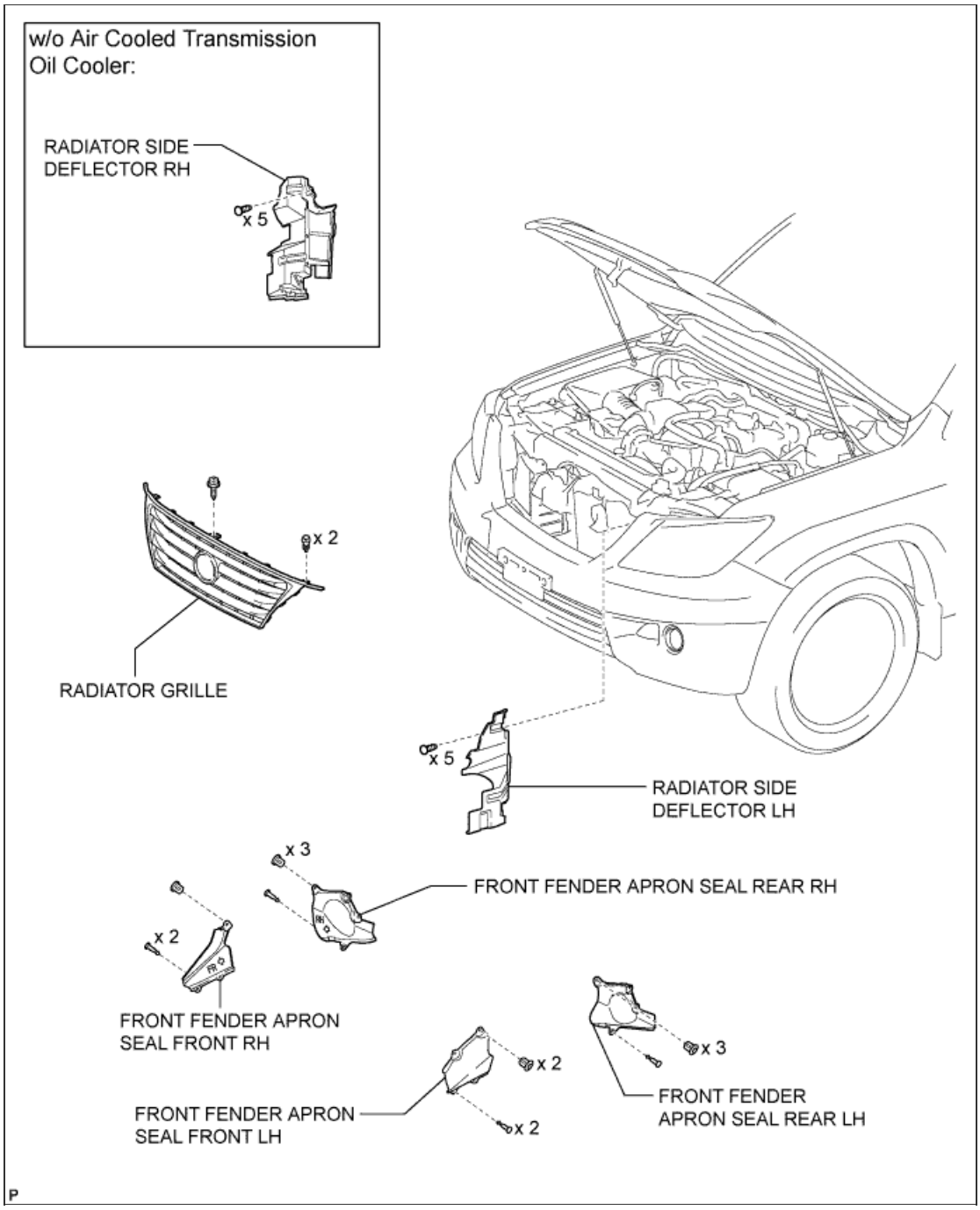

GASKET
16 (160, 12)
PROPELLER SHAFT HEAT INSULATOR
40 (408, 30)
x 3
x 2
GASKET
NO. 1 MANIFOLD STAY
x 2
10 (102, 7)
x 8
NO. 2 MANIFOLD STAY
x 3
40 (408, 30)
30 (306, 22)
EXHAUST MANIFOLD SUB-ASSEMBLY RH
GASKET
GASKET
x 3
10 (102, 7)
EXHAUST MANIFOLD SUB-ASSEMBLY LH
10 (102, 7)
x 2
x 8
NO. 1 EXHAUST MANIFOLD HEAT INSULATOR
30 (306, 22)
12 (122, 9)
x 3
STARTER COVER
37 (377, 27)
x 2
STARTER ASSEMBLY
FLYWHEEL HOUSING SIDE COVER
x 3
10 (102, 7)
NO. 2 EXHAUST MANIFOLD HEAT INSULATOR
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

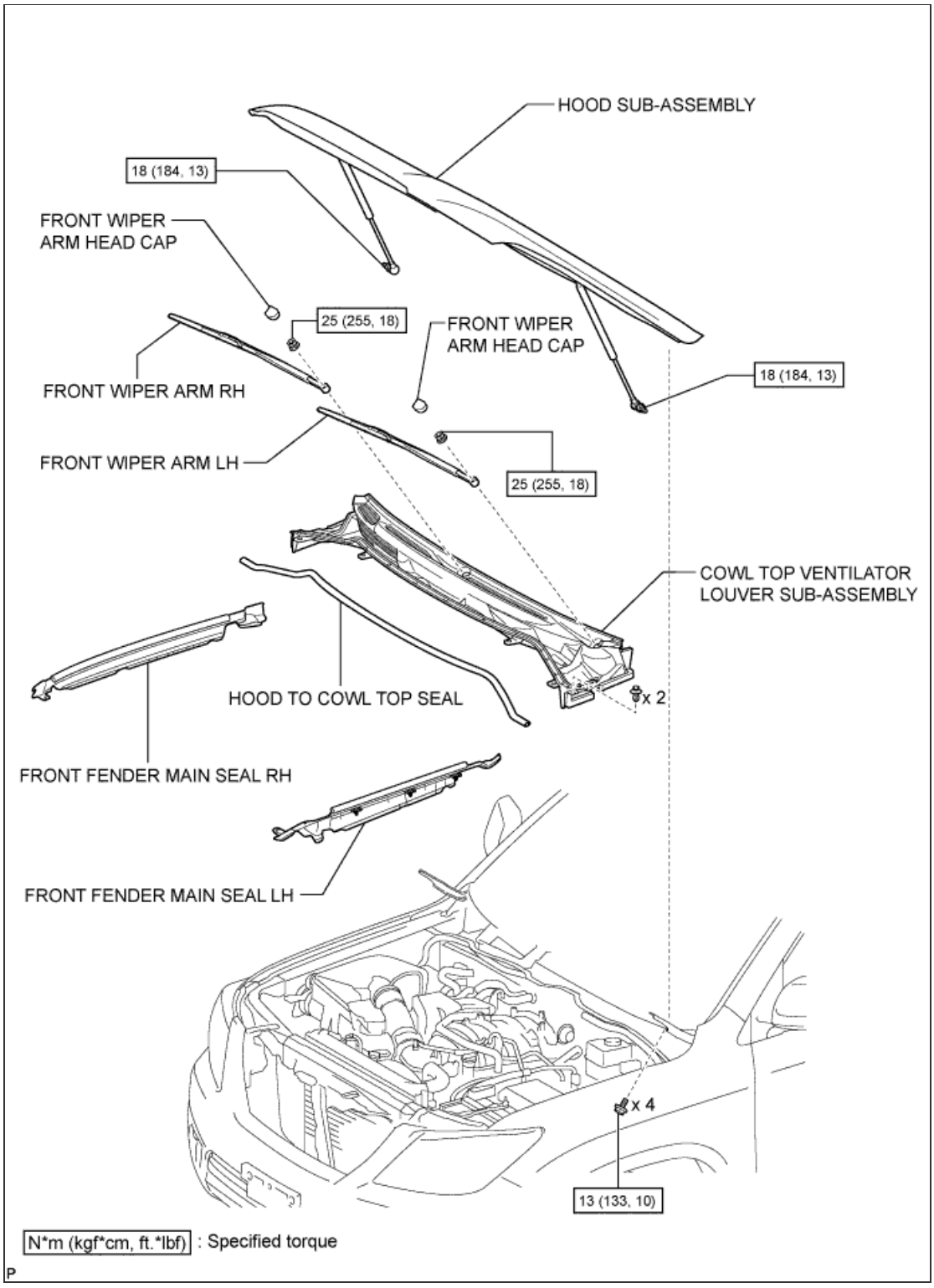

w/ Air Cooled Transmission Oil Cooler
18 (184, 13)
x 2
WATER PIPE AND HOSE SUB-ASSEMBLY
w/o Air Cooled Transmission Oil Cooler
18 (184, 13)
x 2
NO. 2 WATER BY-PASS PIPE
FLOOR SHIFT GEAR SHIFTING ROD SUB-ASSEMBLY
14 (143, 10)
x 2
WIRE HARNESS AND CONNECTOR
PIN
OIL COOLER PIPE ASSEMBLY
71 (724, 52)
(for 17 mm Head)
x 6
x 6
53 (535, 39)
x 4
AUTOMATIC TRANSMISSION ASSEMBLY
12 (122, 9)
x 2
59 (602, 44)
x 4
37 (377, 27)
(for 14 mm Head)
REAR NO. 1 ENGINE MOUNTING INSULATOR
ENGINE MOUNTING HEAT INSULATOR
NO. 2 FRAME CROSSMEMBER SUB-ASSEMBLY
37 (377, 27)
x 4
x 4
x 4
ENGINE MOUNTING HOLE COVER
110 (1122, 82)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

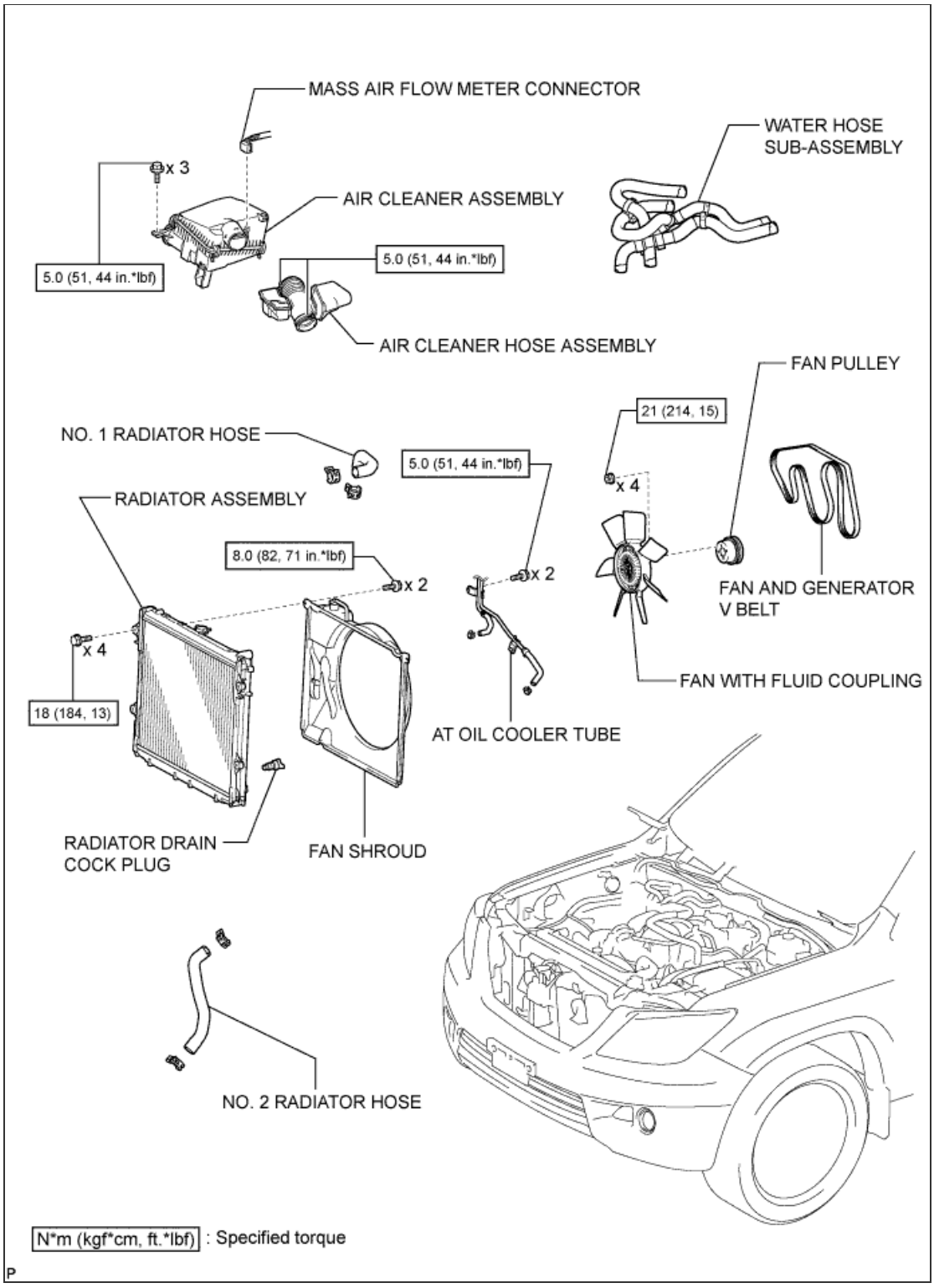

43 (438, 32)
43 (438, 32)
ENGINE HANGER
1st: 30 (301, 22)
2nd: Turn 90°
72 (734, 53)
72 (734, 53)
DRIVE PLATE
AND RING GEAR
SUB-ASSEMBLY
x 10
x 6
53 (535, 39)
REAR DRIVE
PLATE SPACER
CRANKSHAFT ANGLE SENSOR ROTOR
79 (806, 58)
x 2
79 (806, 58)
x 2
FRONT ENGINE MOUNTING
INSULATOR LH
32 (326, 24)
FRONT NO. 2 ENGINE
MOUNTING BRACKET LH
FRONT ENGINE MOUNTING INSULATOR RH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

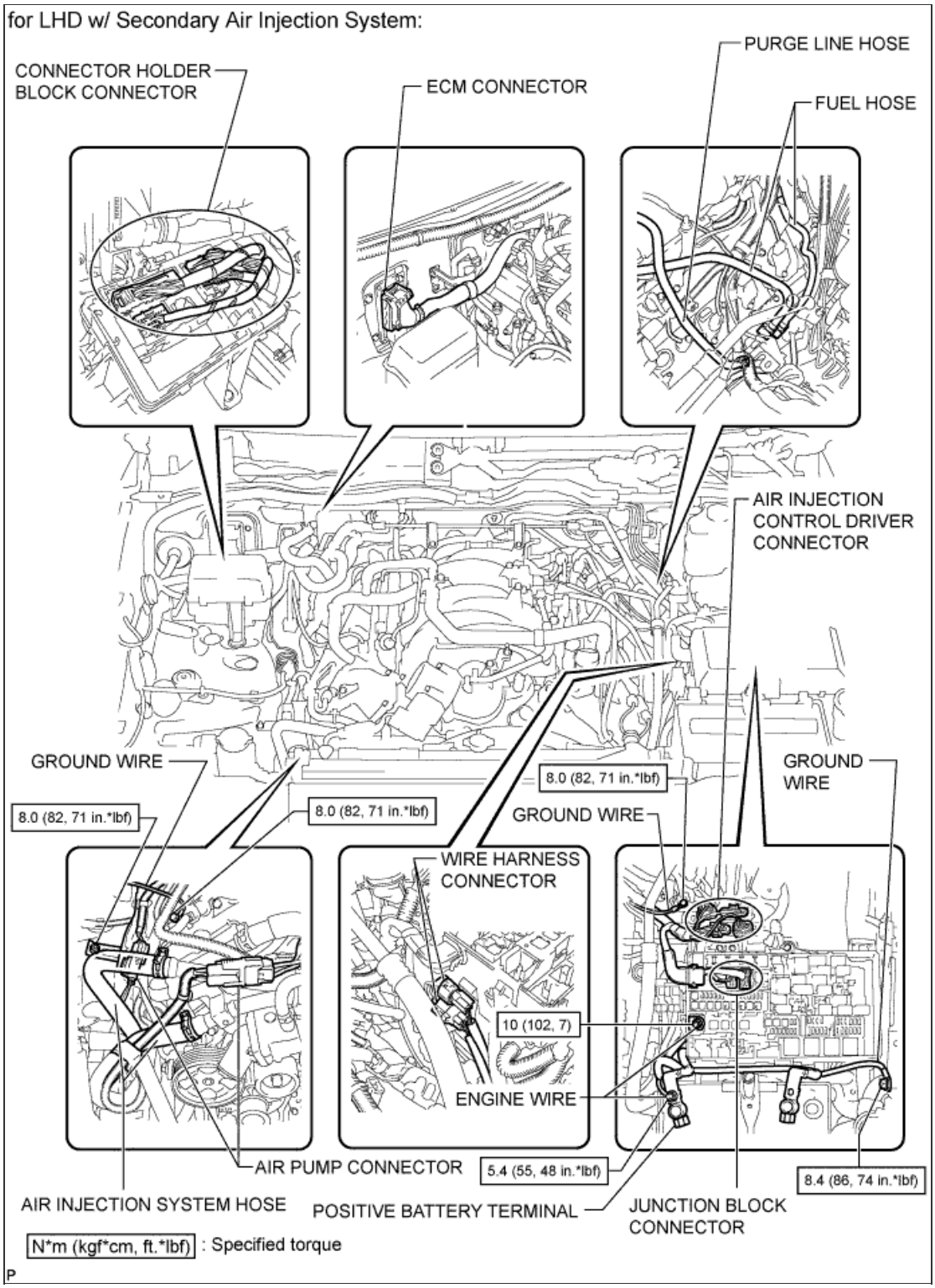
for Preparation Click here



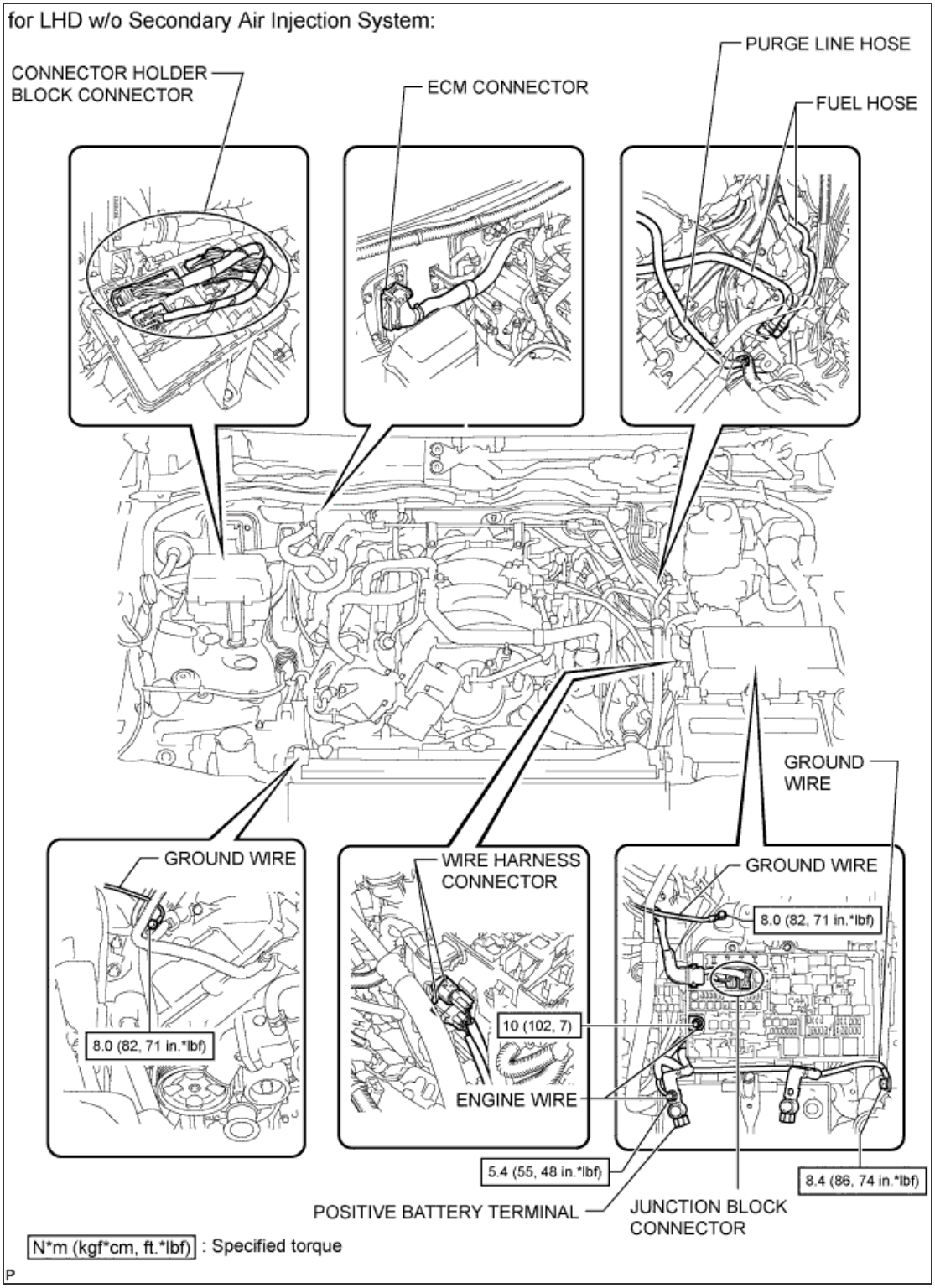

w/o Air Cooled Transmission Oil Cooler:
RADIATOR SIDE DEFLECTOR RH
x 5
x 2
RADIATOR GRILLE
x 5
RADIATOR SIDE DEFLECTOR LH
x 3
FRONT FENDER APRON SEAL REAR RH
x 2
FRONT FENDER APRON SEAL FRONT RH
x 2
x 2
FRONT FENDER APRON SEAL FRONT LH
x 3
FRONT FENDER APRON SEAL REAR LH
P


HOOD SUB-ASSEMBLY
18 (184, 13)
FRONT WIPER ARM HEAD CAP
25 (255, 18)
FRONT WIPER ARM HEAD CAP
18 (184, 13)
FRONT WIPER ARM RH
FRONT WIPER ARM LH
25 (255, 18)
COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY
HOOD TO COWL TOP SEAL
x 2
FRONT FENDER MAIN SEAL RH
FRONT FENDER MAIN SEAL LH
x 4
13 (133, 10)
N*m (kgf*cm, ft.*lbf) : Specified torque
P

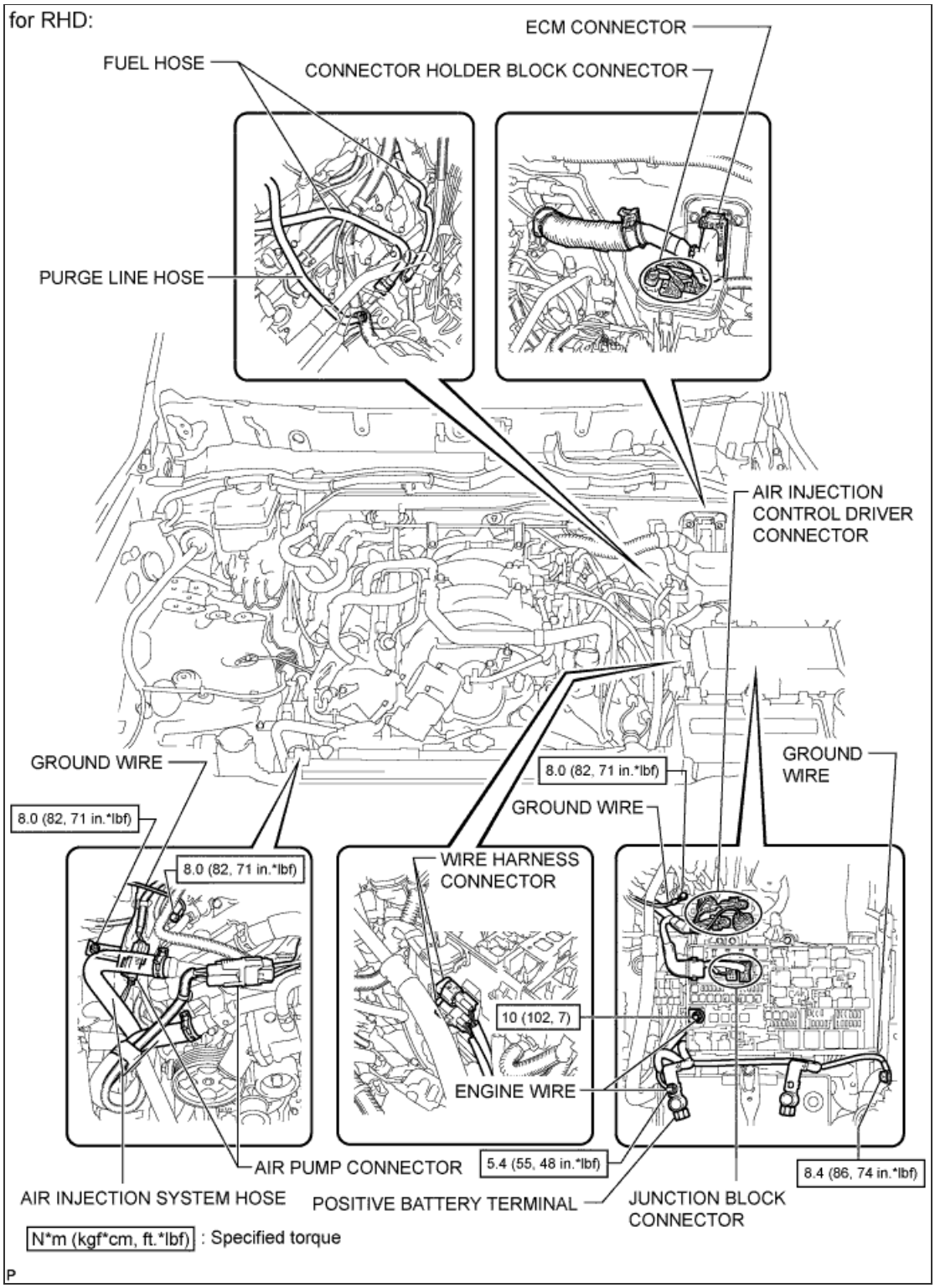

MASS AIR FLOW METER CONNECTOR
WATER HOSE SUB-ASSEMBLY
x 3
AIR CLEANER ASSEMBLY
5.0 (51, 44 in.*lbf)
5.0 (51, 44 in.*lbf)
AIR CLEANER HOSE ASSEMBLY
FAN PULLEY
21 (214, 15)
NO. 1 RADIATOR HOSE
5.0 (51, 44 in.*lbf)
x 4
RADIATOR ASSEMBLY
8.0 (82, 71 in.*lbf)
x 2
x 2
FAN AND GENERATOR V BELT
x 4
18 (184, 13)
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
RADIATOR DRAIN COCK PLUG
FAN SHROUD
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P

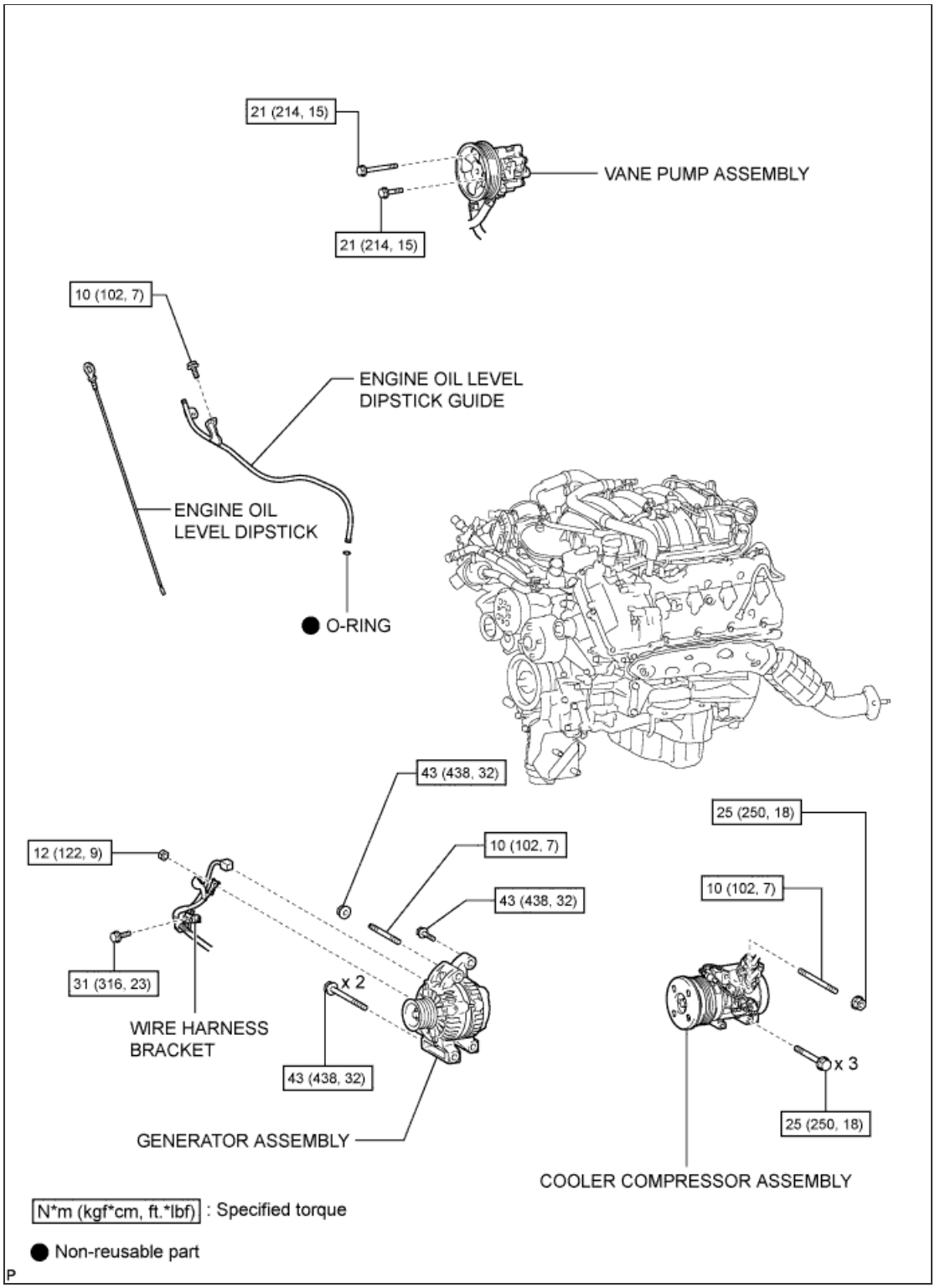

for LHD w/ Secondary Air Injection System:
CONNECTOR HOLDER BLOCK CONNECTOR
ECM CONNECTOR
PURGE LINE HOSE
FUEL HOSE
AIR INJECTION CONTROL DRIVER CONNECTOR
GROUND WIRE
8.0 (82, 71 in.*lbf)
8.0 (82, 71 in.*lbf)
8.0 (82, 71 in.*lbf)
GROUND WIRE
GROUND WIRE
WIRE HARNESS CONNECTOR
10 (102, 7)
ENGINE WIRE
AIR PUMP CONNECTOR
5.4 (55, 48 in.*lbf)
8.4 (86, 74 in.*lbf)
AIR INJECTION SYSTEM HOSE
POSITIVE BATTERY TERMINAL
JUNCTION BLOCK CONNECTOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P

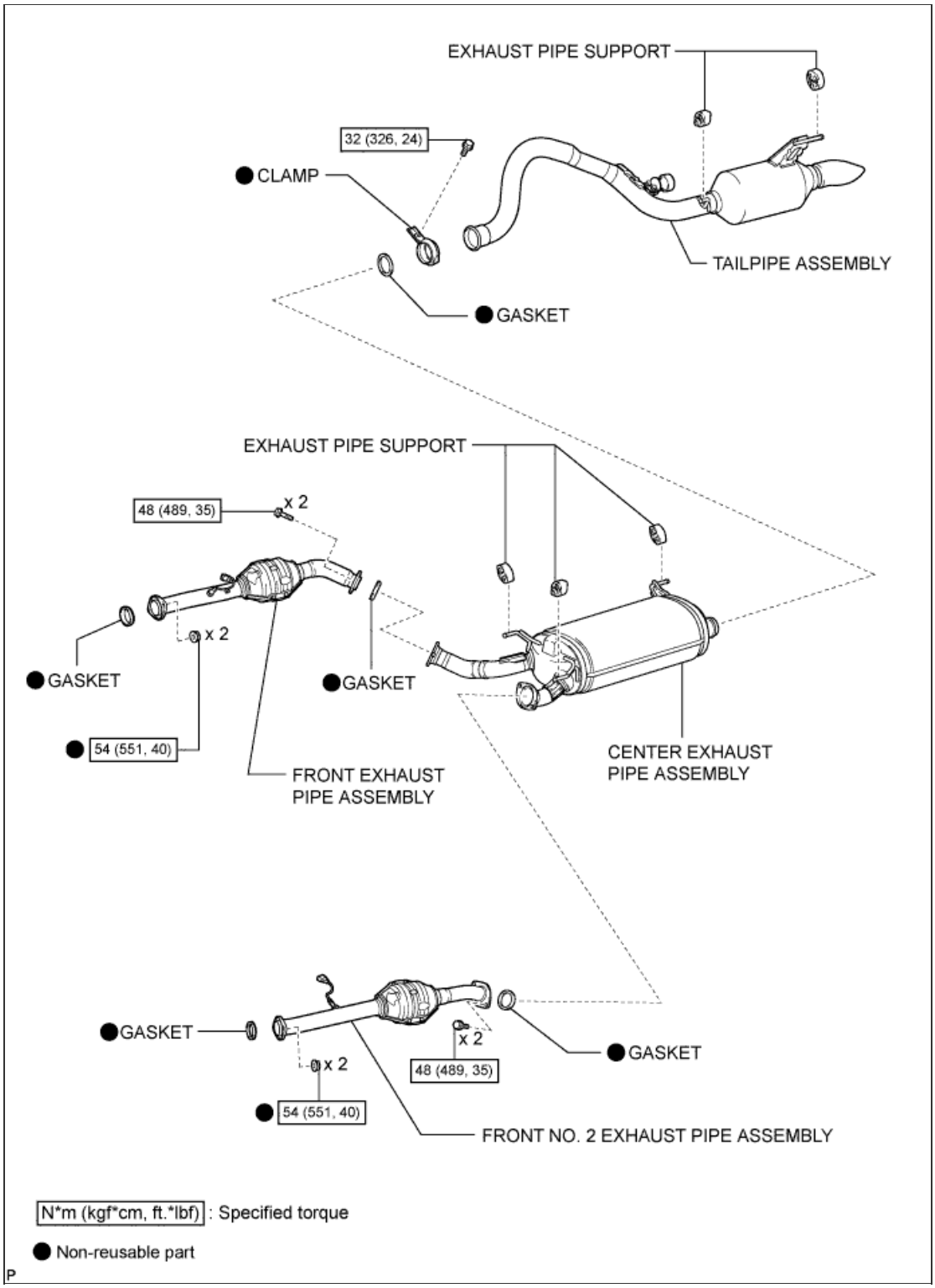
for LHD w/o Secondary Air Injection System:



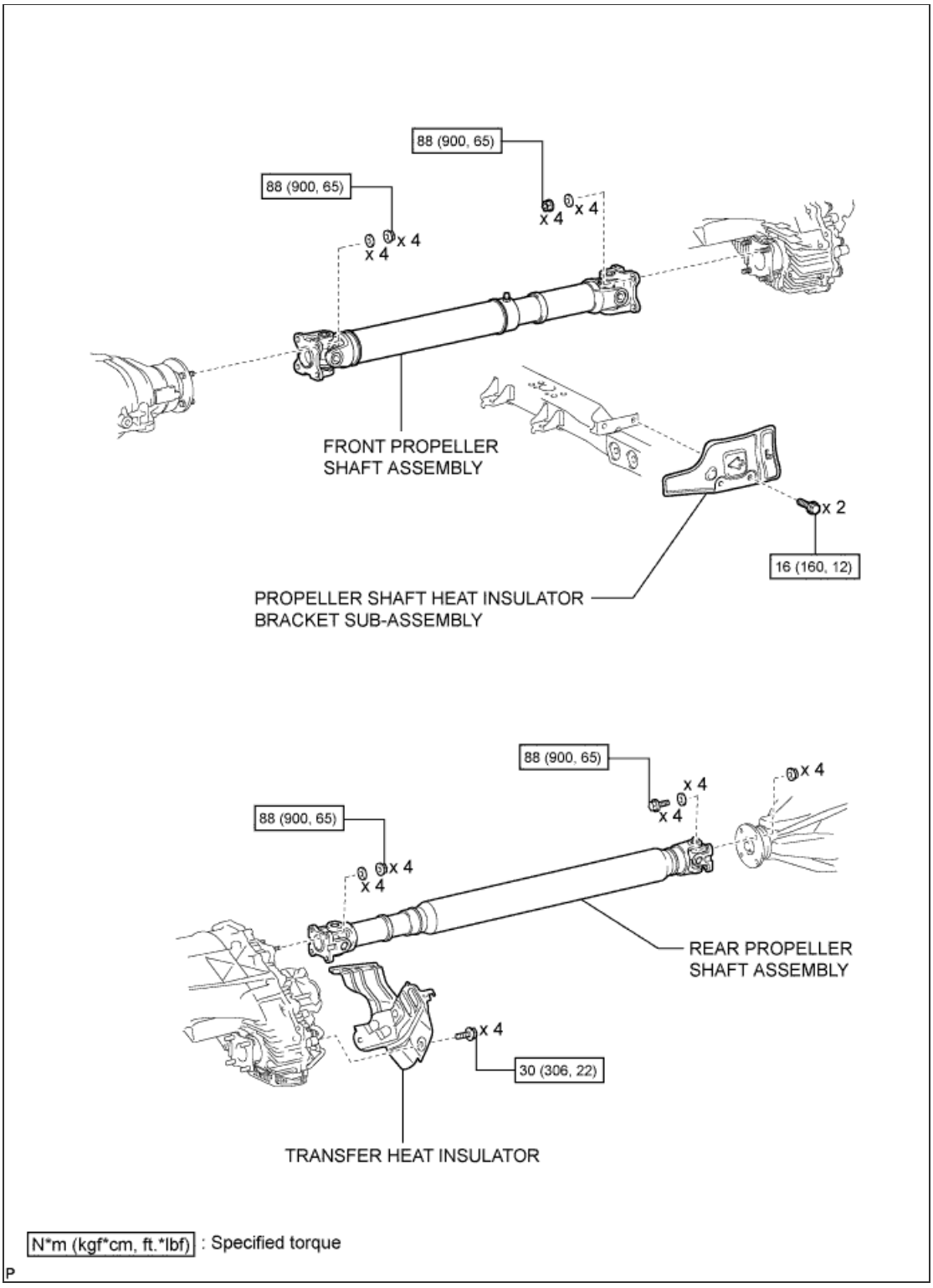
P

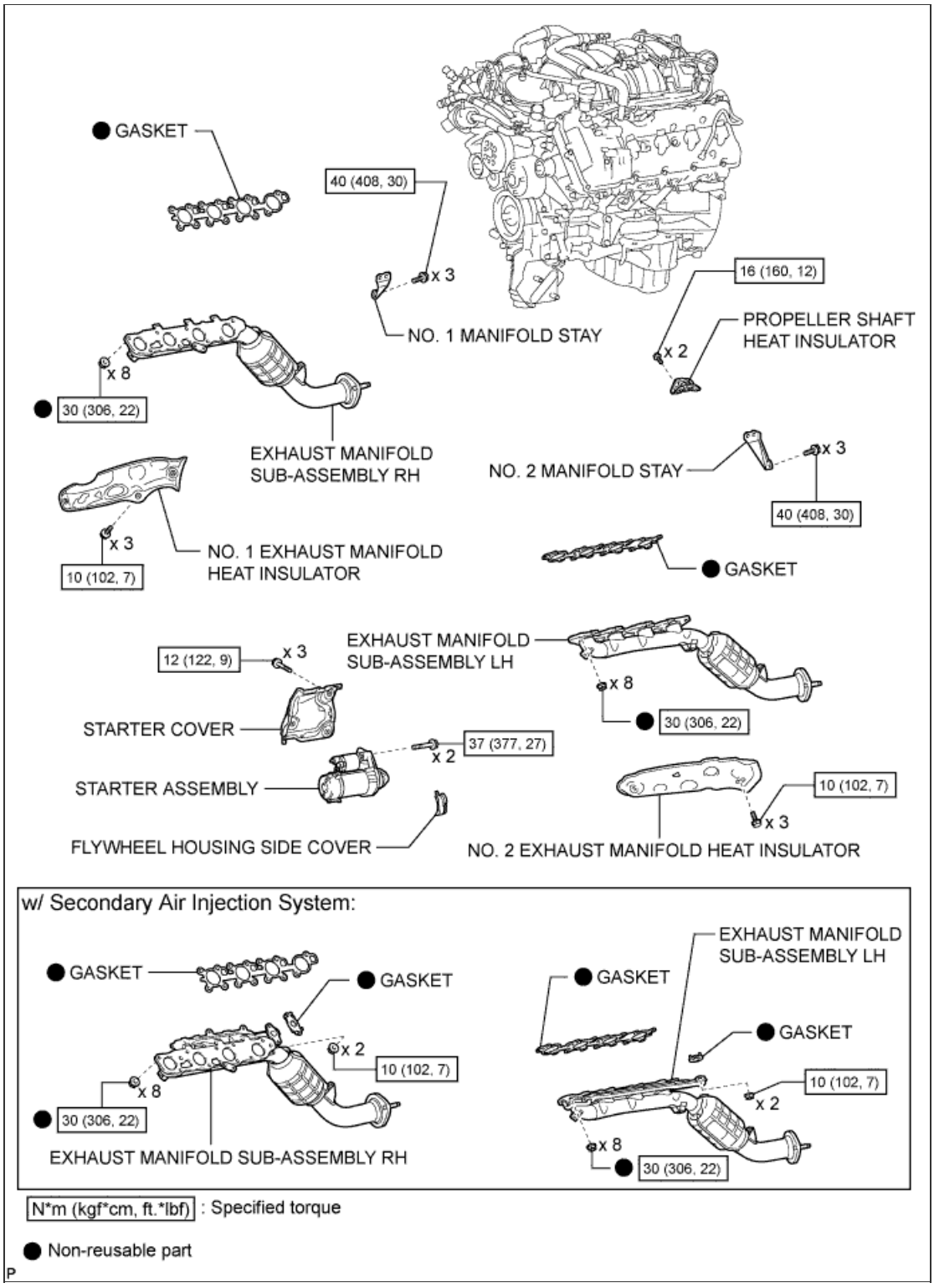

for RHD:
ECM CONNECTOR
FUEL HOSE
CONNECTOR HOLDER BLOCK CONNECTOR
PURGE LINE HOSE
AIR INJECTION CONTROL DRIVER CONNECTOR
GROUND WIRE
8.0 (82, 71 in.*lbf)
GROUND WIRE
8.0 (82, 71 in.*lbf)
8.0 (82, 71 in.*lbf)
WIRE HARNESS CONNECTOR
10 (102, 7)
ENGINE WIRE
AIR PUMP CONNECTOR
5.4 (55, 48 in.*lbf)
8.4 (86, 74 in.*lbf)
AIR INJECTION SYSTEM HOSE
POSITIVE BATTERY TERMINAL
JUNCTION BLOCK CONNECTOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P


21 (214, 15)
VANE PUMP ASSEMBLY
21 (214, 15)
10 (102, 7)
ENGINE OIL LEVEL
DIPSTICK GUIDE
ENGINE OIL
LEVEL DIPSTICK
O-RING
43 (438, 32)
25 (250, 18)
12 (122, 9)
10 (102, 7)
43 (438, 32)
10 (102, 7)
31 (316, 23)
x 2
WIRE HARNESS
BRACKET
43 (438, 32)
x 3
25 (250, 18)
GENERATOR ASSEMBLY
COOLER COMPRESSOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

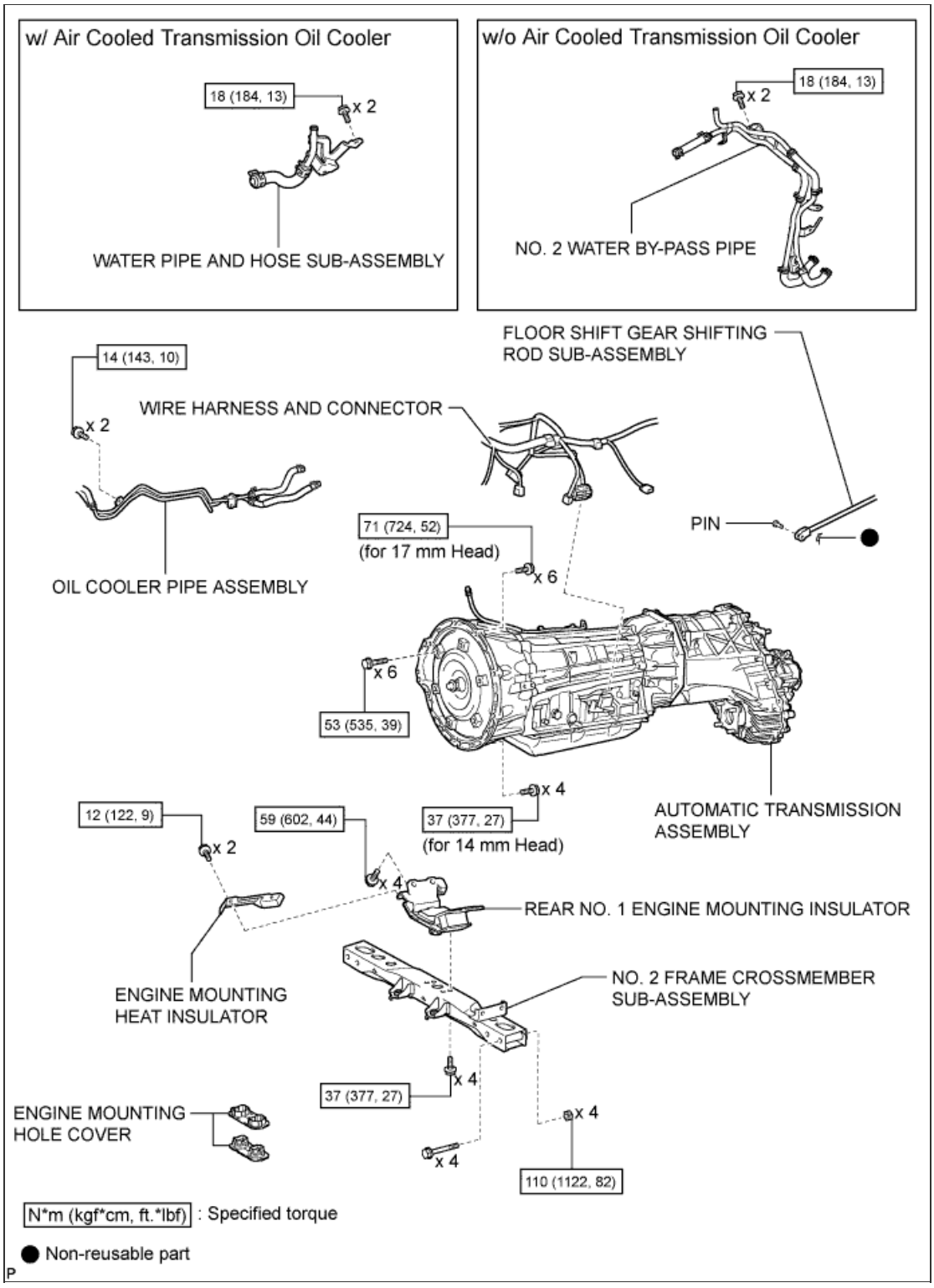

EXHAUST PIPE SUPPORT
32 (326, 24)
CLAMP
TAILPIPE ASSEMBLY
GASKET
EXHAUST PIPE SUPPORT
48 (489, 35)
x 2
x 2
GASKET
GASKET
54 (551, 40)
FRONT EXHAUST PIPE ASSEMBLY
CENTER EXHAUST PIPE ASSEMBLY
GASKET
x 2
48 (489, 35)
GASKET
x 2
54 (551, 40)
FRONT NO. 2 EXHAUST PIPE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

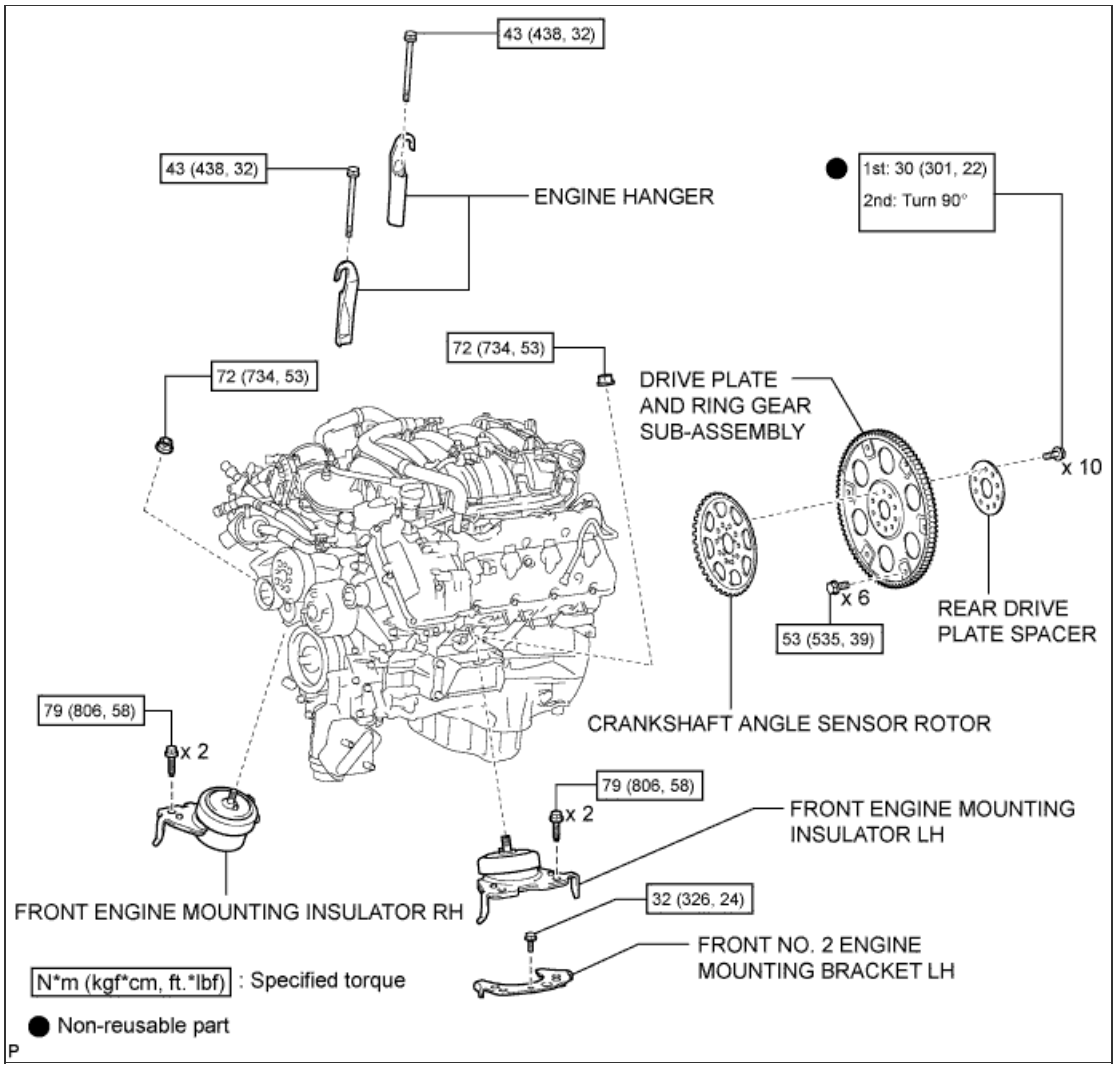
P


88 (900, 65)
88 (900, 65)
x 4
x 4
x 4
x 4
FRONT PROPELLER
SHAFT ASSEMBLY
x 2
16 (160, 12)
PROPELLER SHAFT HEAT INSULATOR
BRACKET SUB-ASSEMBLY
88 (900, 65)
88 (900, 65)
x 4
x 4
x 4
x 4
x 4
REAR PROPELLER
SHAFT ASSEMBLY
x 4
30 (306, 22)
TRANSFER HEAT INSULATOR
N*m (kgf*cm, ft.*lbf) : Specified torque
P


GASKET
40 (408, 30)
x 3
NO. 1 MANIFOLD STAY
16 (160, 12)
x 2
PROPELLER SHAFT HEAT INSULATOR
x 8
30 (306, 22)
EXHAUST MANIFOLD SUB-ASSEMBLY RH
NO. 2 MANIFOLD STAY
x 3
40 (408, 30)
x 3
10 (102, 7)
NO. 1 EXHAUST MANIFOLD HEAT INSULATOR
GASKET
12 (122, 9)
x 3
EXHAUST MANIFOLD SUB-ASSEMBLY LH
x 8
30 (306, 22)
STARTER COVER
37 (377, 27)
x 2
STARTER ASSEMBLY
10 (102, 7)
x 3
FLYWHEEL HOUSING SIDE COVER
NO. 2 EXHAUST MANIFOLD HEAT INSULATOR
w/ Secondary Air Injection System:
GASKET
GASKET
x 2
10 (102, 7)
x 8
30 (306, 22)
EXHAUST MANIFOLD SUB-ASSEMBLY RH
GASKET
EXHAUST MANIFOLD SUB-ASSEMBLY LH
GASKET
10 (102, 7)
x 2
x 8
30 (306, 22)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

P

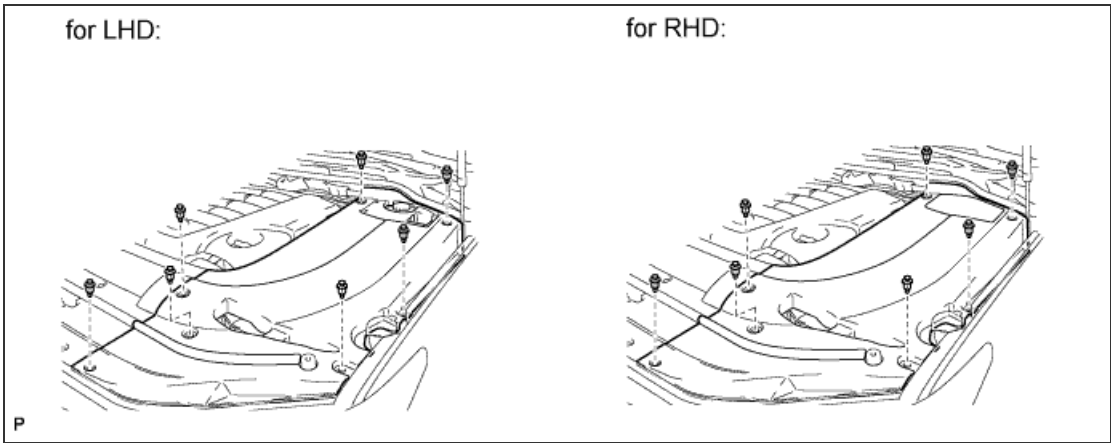

w/ Air Cooled Transmission Oil Cooler
18 (184, 13)
x 2
WATER PIPE AND HOSE SUB-ASSEMBLY
w/o Air Cooled Transmission Oil Cooler
18 (184, 13)
x 2
NO. 2 WATER BY-PASS PIPE
FLOOR SHIFT GEAR SHIFTING ROD SUB-ASSEMBLY
14 (143, 10)
x 2
WIRE HARNESS AND CONNECTOR
PIN
OIL COOLER PIPE ASSEMBLY
71 (724, 52)
(for 17 mm Head)
x 6
x 6
53 (535, 39)
x 4
12 (122, 9)
x 2
59 (602, 44)
x 4
37 (377, 27)
(for 14 mm Head)
AUTOMATIC TRANSMISSION ASSEMBLY
REAR NO. 1 ENGINE MOUNTING INSULATOR
ENGINE MOUNTING HEAT INSULATOR
NO. 2 FRAME CROSSMEMBER SUB-ASSEMBLY
37 (377, 27)
x 4
x 4
x 4
ENGINE MOUNTING HOLE COVER
110 (1122, 82)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


43 (438, 32)
43 (438, 32)
ENGINE HANGER
1st: 30 (301, 22)
2nd: Turn 90°
72 (734, 53)
72 (734, 53)
DRIVE PLATE
AND RING GEAR
SUB-ASSEMBLY
x 10
x 6
53 (535, 39)
REAR DRIVE
PLATE SPACER
CRANKSHAFT ANGLE SENSOR ROTOR
79 (806, 58)
x 2
79 (806, 58)
x 2
FRONT ENGINE MOUNTING
INSULATOR LH
32 (326, 24)
FRONT NO. 2 ENGINE
MOUNTING BRACKET LH
FRONT ENGINE MOUNTING INSULATOR RH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

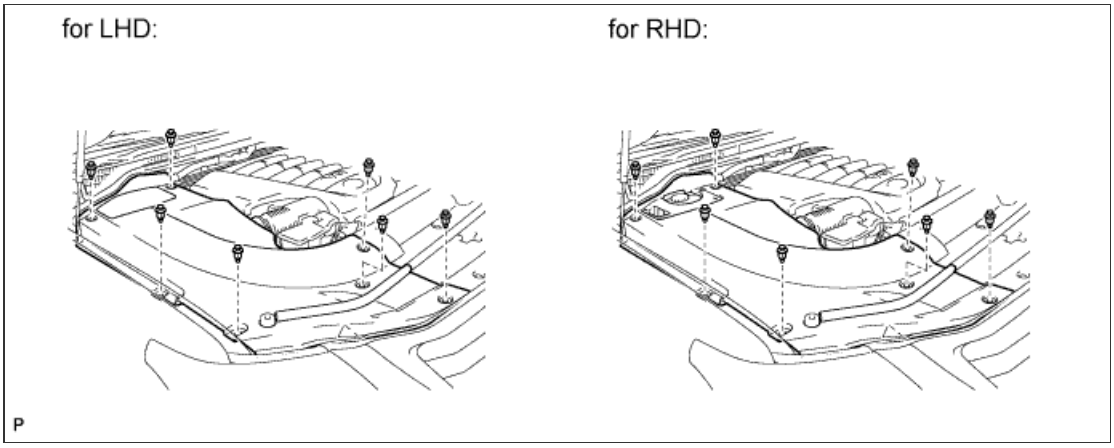
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



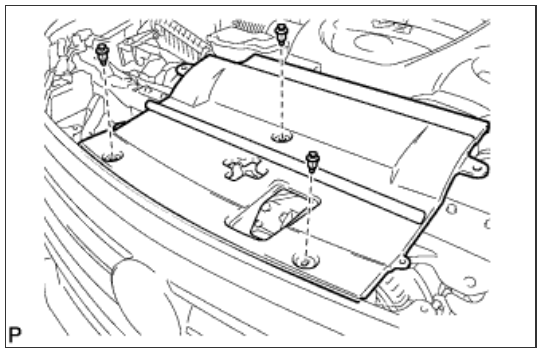
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



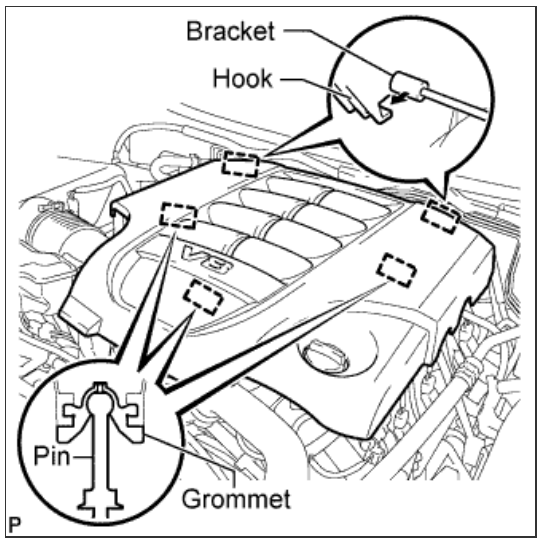
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

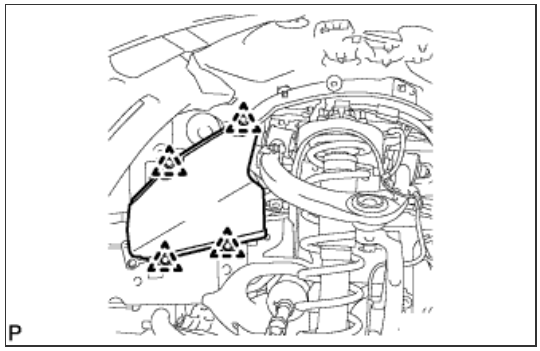
6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

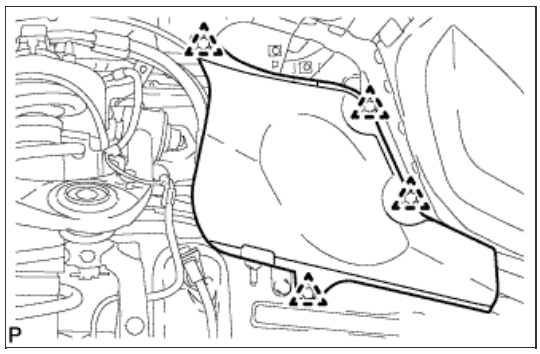
7. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



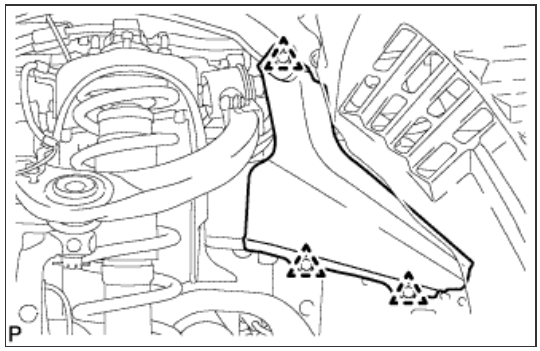
8. REMOVE FRONT FENDER APRON SEAL REAR LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



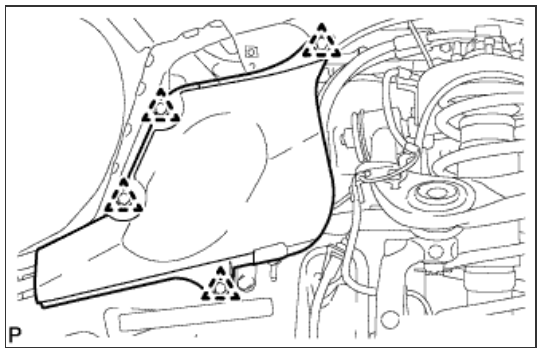
9. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.



10. REMOVE FRONT FENDER APRON SEAL REAR RH

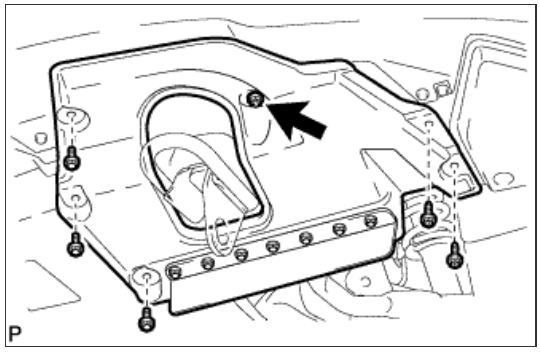
a. Using a clip remover, remove the 4 clips and fender apron seal.



11. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



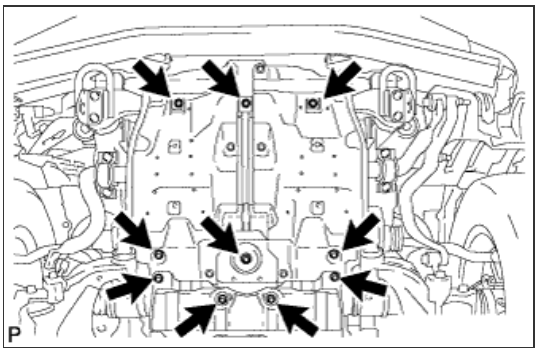
12. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

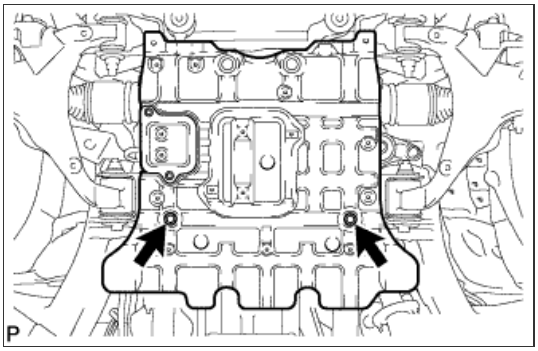
13. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



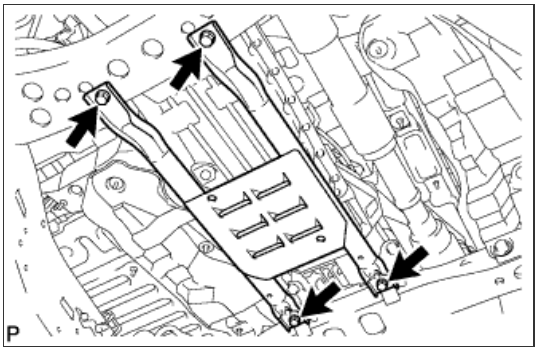
14. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



15. REMOVE OIL PAN PROTECTOR ASSEMBLY

a. Remove the 4 bolts and oil pan protector.



16. REMOVE RADIATOR GRILLE

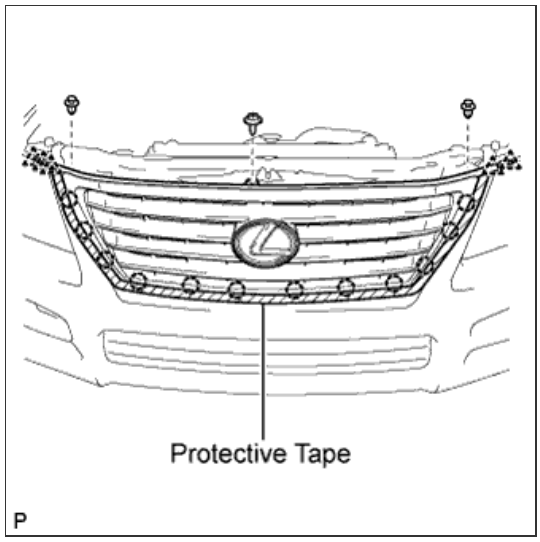
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

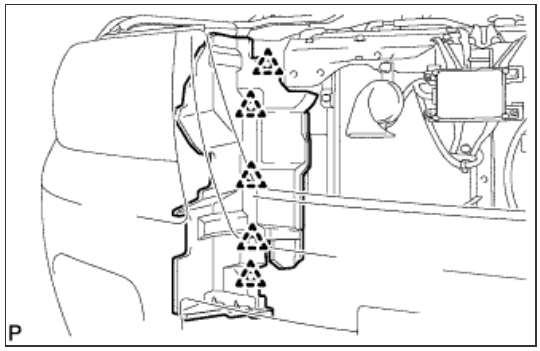
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



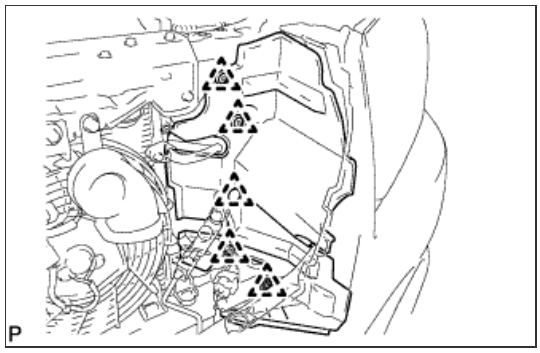
17. REMOVE RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



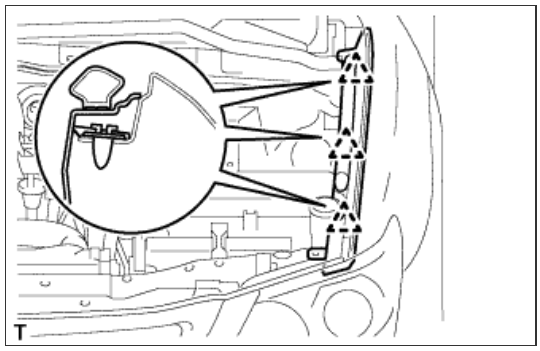
18. REMOVE RADIATOR SIDE DEFLECTOR LH

a. Using a clip remover, remove the 5 clips and side deflector.



19. REMOVE FRONT FENDER MAIN SEAL LH

a. Using a clip remover, detach the 3 clips and remove the fender main seal.



20. REMOVE FRONT FENDER MAIN SEAL RH

HINT:

Use the same procedures described for the LH side.

21. REMOVE FRONT WIPER ARM LH

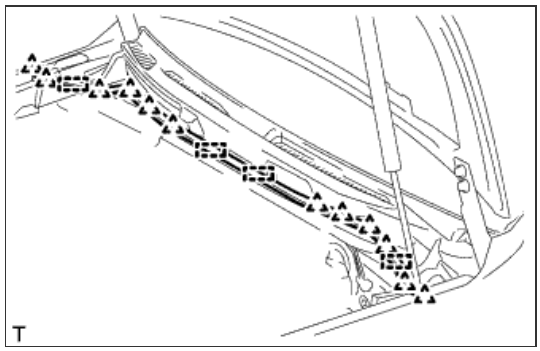
a. Remove the nut, wiper arm and blade.

22. REMOVE FRONT WIPER ARM RH

a. Remove the nut, wiper arm and blade.

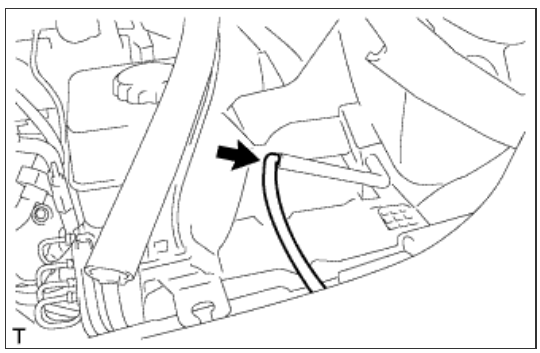
23. REMOVE HOOD TO COWL TOP SEAL

a. Using a clip remover, detach the 12 clips and 4 clamps, and remove the hood to cowl top seal.



24. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

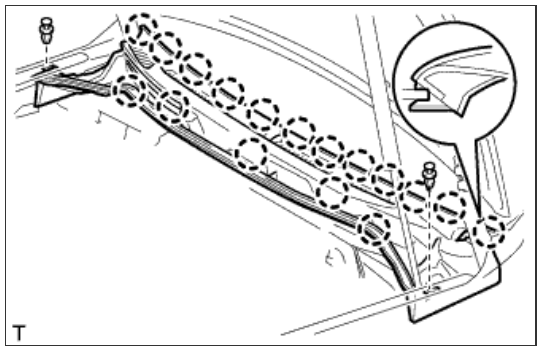
a. Disconnect the washer hose.



b. Remove the 2 clips.

b. Remove the 2 clips.

c. Detach the 17 claws and remove the cowl top ventilator louver sub-assembly.



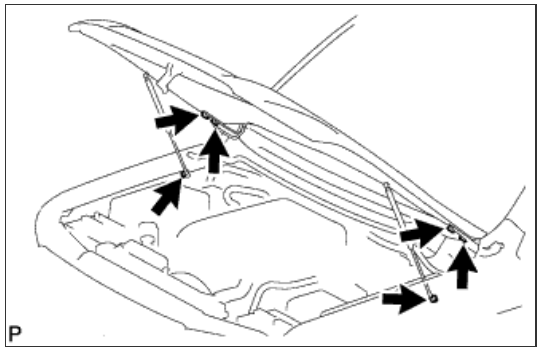
25. REMOVE HOOD SUB-ASSEMBLY

a. Remove the 2 hood support bolts and disconnect the hood supports.

CAUTION:

Remove the hood support assembly while supporting the hood by hand.

b. Remove the 4 bolts and hood.



26. DRAIN ENGINE OIL

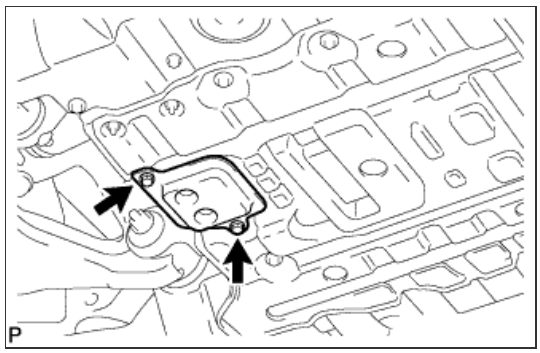
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

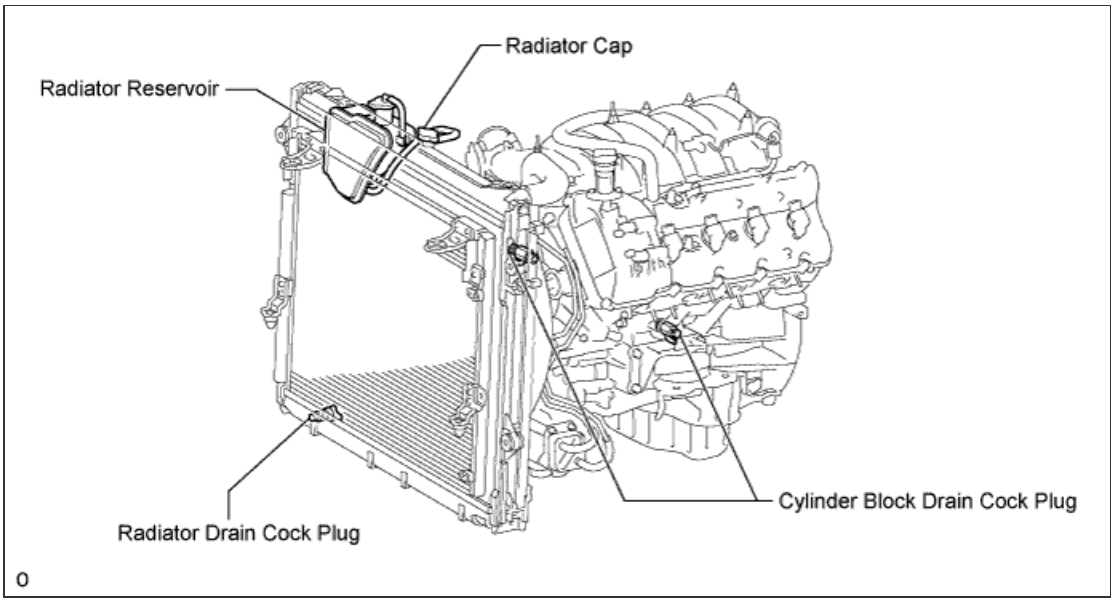
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



27. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

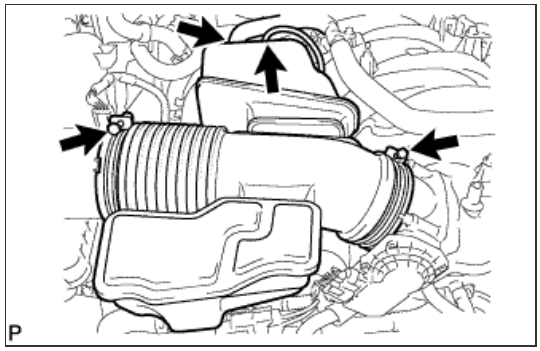
e. Tighten the radiator drain cock plug by hand.

28. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

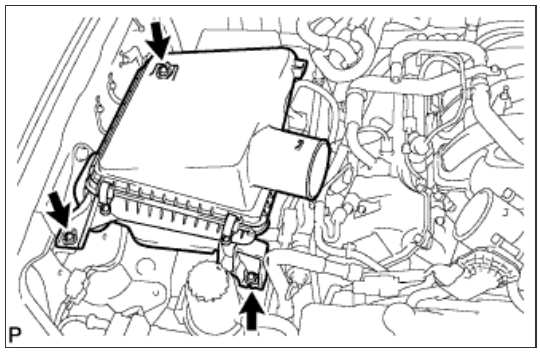
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



29. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



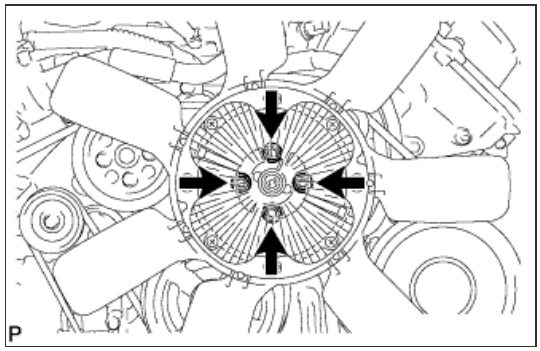
30. REMOVE NO. 1 RADIATOR HOSE

31. REMOVE NO. 2 RADIATOR HOSE

32. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

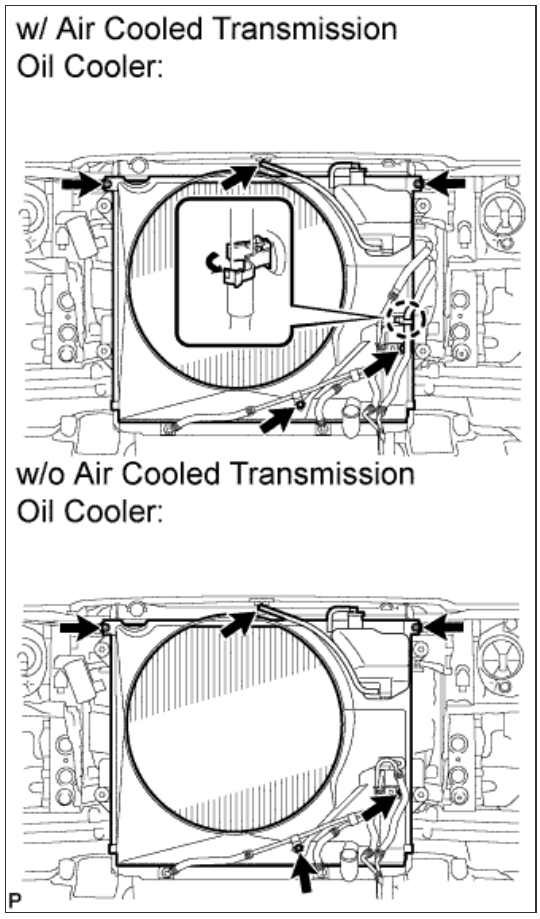
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

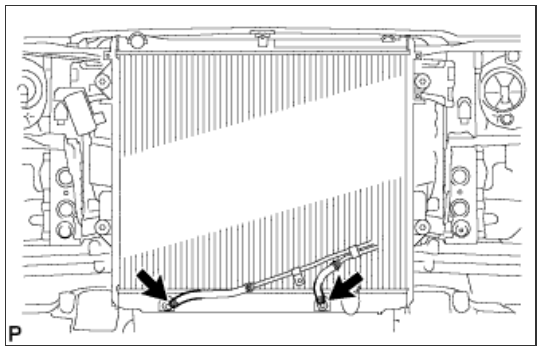
Be careful not to damage the radiator core.

h. Remove the fan pulley.

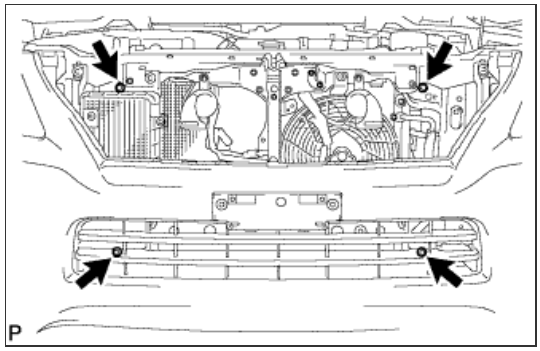


33. REMOVE RADIATOR ASSEMBLY

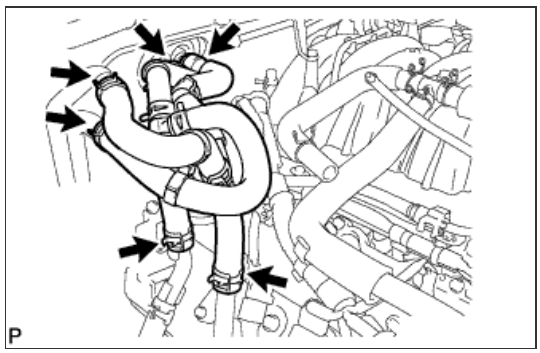
a. Disconnect the 2 oil cooler hoses.



b. Remove the 4 bolts and radiator.



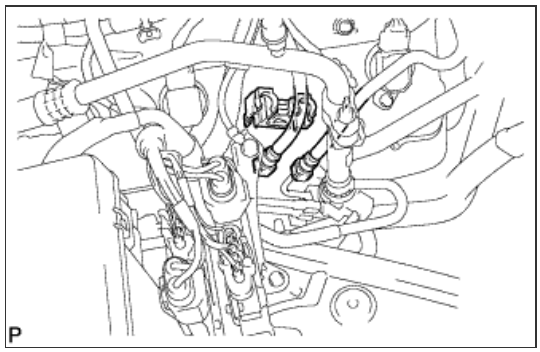
34. REMOVE WATER HOSE SUB-ASSEMBLY



35. DISCONNECT FUEL MAIN AND RETURN HOSE

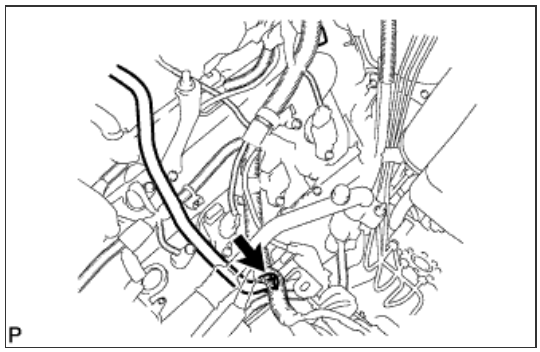
a. Remove the fuel pipe clamp.

b. Disconnect the fuel main and return hoses (Click here).



36. DISCONNECT WIRE HARNESS AND HOSE

a. Disconnect the purge line hose.

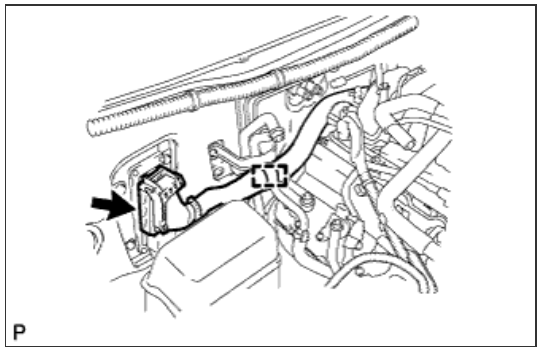


b. Disconnect the ECM connector.

i. for LHD:
Disconnect the clamp and ECM connector.

HINT:

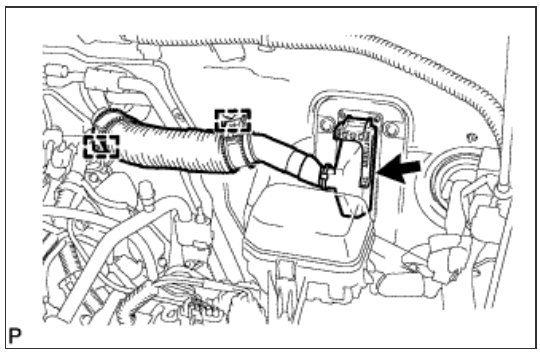
Refer to the following procedures to disconnect the ECM connector (Click here).



ii. for RHD:
Disconnect the 2 clamps and ECM connector.

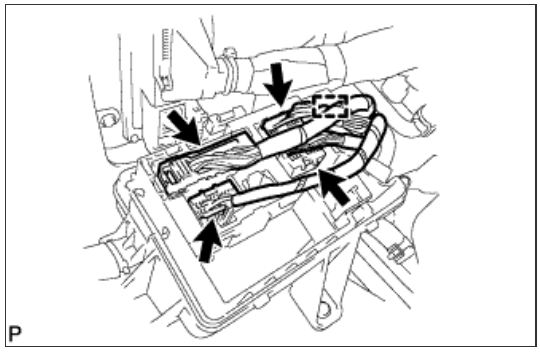
HINT:

Refer to the following procedures to disconnect the ECM connector (Click here).



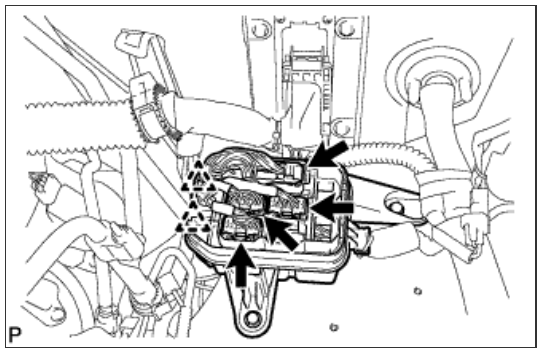
c. Disconnect the 4 connectors.

i. for LHD:
Disconnect the 4 connectors and clamp from the connector holder block.



ii. for RHD:

Disconnect the 4 connectors and 2 clips from the connector holder block.

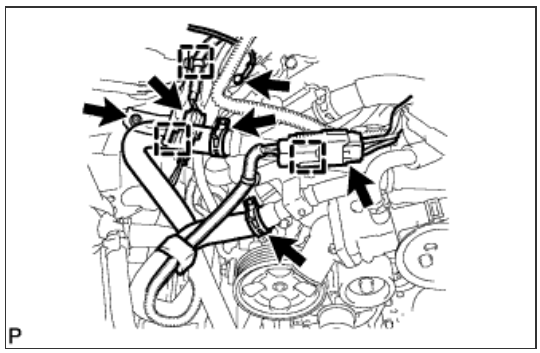


d. Disconnect the 2 air pump connectors and 3 clamps.

e. Remove the nut and connector bracket.

f. Remove the bolt and disconnect the ground wire.

g. Disconnect the 2 air injection system hoses.



h. Remove the nut and disconnect the wire from the positive (+) battery cable.

i. Disconnect the cable from the positive (+) battery terminal.

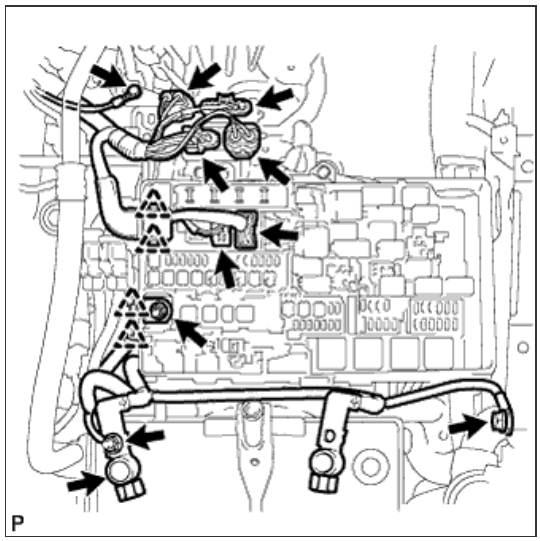
j. Remove the bolt and disconnect the ground wire from the body.

k. Remove the bolt and disconnect the ground wire from the air injection control bracket.

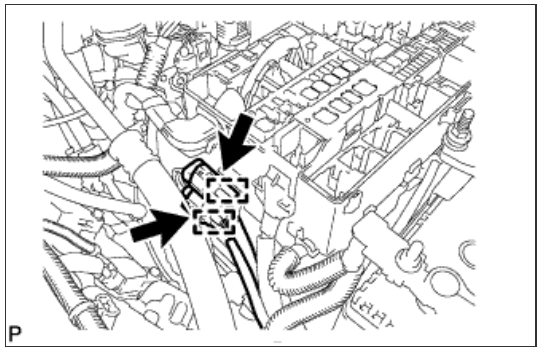
l. Disconnect the 4 air injection control driver connectors.

m. Remove the nut and disconnect the wire and 2 clips from the engine room junction block.

n. Disconnect the 2 connectors and 2 clips from the engine room junction block.



o. Disconnect the 2 connectors and clamps.

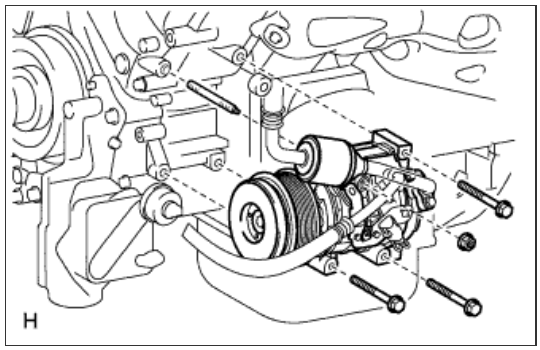


37. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

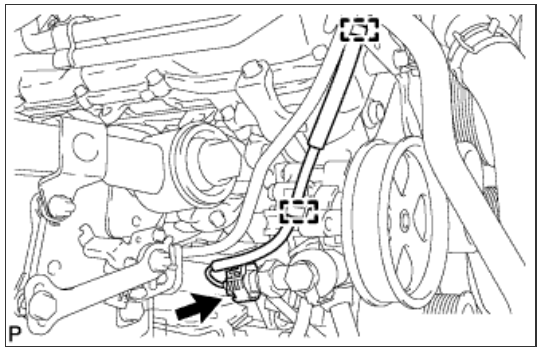
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.

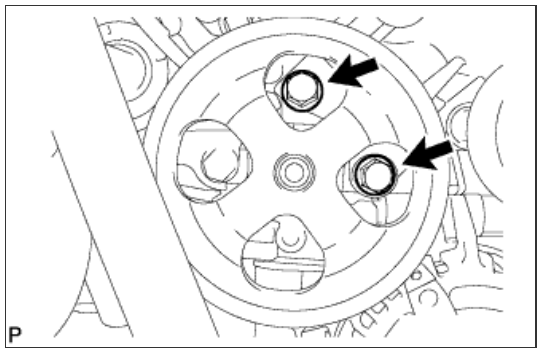


38. DISCONNECT VANE PUMP ASSEMBLY

a. Disconnect the 2 clamps and power steering oil pressure switch connector.



b. Remove the 2 bolts and disconnect the vane pump.

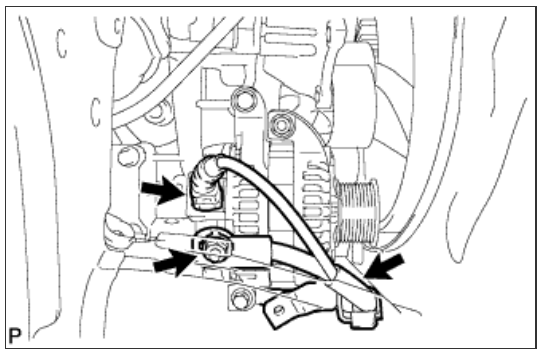


39. REMOVE GENERATOR ASSEMBLY

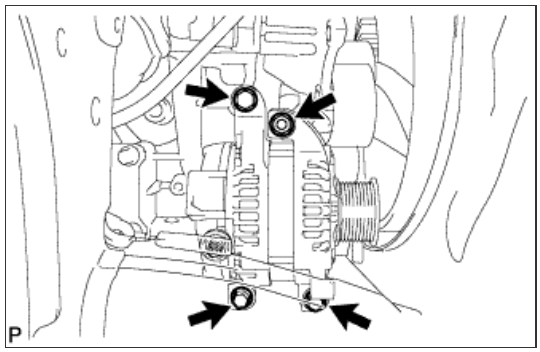
a. Disconnect the generator connector.

b. Remove the terminal cap and nut, and disconnect the generator wire.

c. Remove the bolt and wire harness bracket from the generator.



d. Remove the 3 bolts, nut and generator.

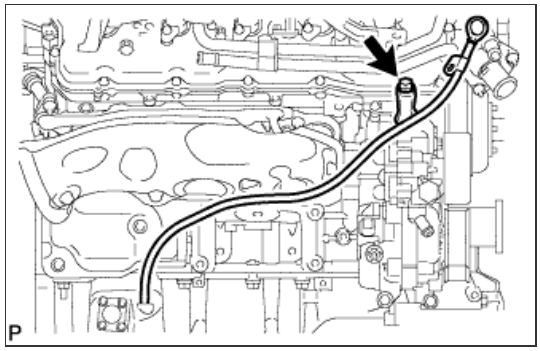


40. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.



41. REMOVE TAILPIPE ASSEMBLY

a. Remove the bolt, clamp and gasket.

b. Remove the tailpipe from the 2 exhaust pipe supports.

c. Remove the bolt and clamp, and then disconnect the tailpipe from the center exhaust pipe.

42. REMOVE CENTER EXHAUST PIPE ASSEMBLY

a. Remove the 4 bolts.

b. Remove the center exhaust pipe from the 3 exhaust pipe supports.

c. Remove the 2 gaskets from the front exhaust pipe and front No. 2 exhaust pipe.

43. REMOVE FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front No. 2 exhaust pipe and gasket from the exhaust manifold LH.

44. REMOVE FRONT EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front exhaust pipe and gasket from the exhaust manifold RH.

45. REMOVE FRONT PROPELLER SHAFT ASSEMBLY

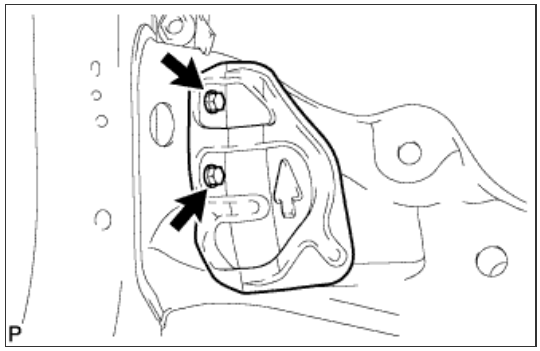
a. Remove the front propeller shaft (Click here).

46. REMOVE REAR PROPELLER SHAFT ASSEMBLY

a. Remove the rear propeller shaft (Click here).

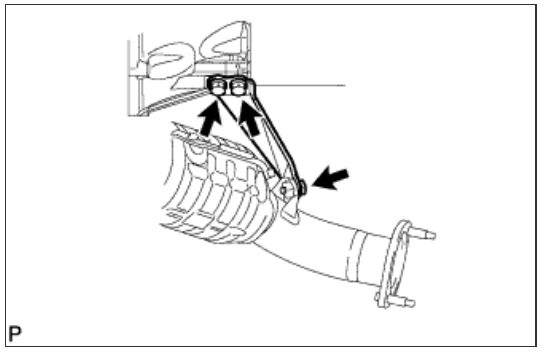
47. REMOVE PROPELLER SHAFT HEAT INSULATOR

a. Remove the 2 bolts and heat insulator.



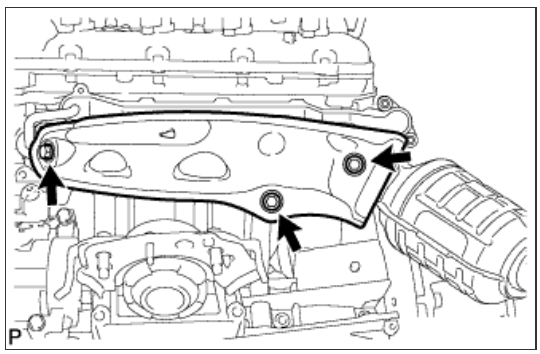
48. REMOVE NO. 2 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



49. REMOVE NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

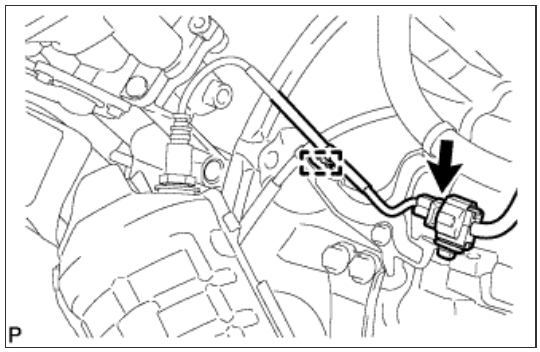
a. Remove the 3 bolts and heat insulator.



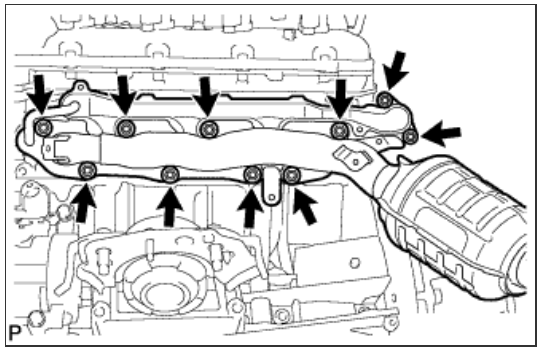
50. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Disconnect the connector.

b. Using a clip remover, detach the wire harness clamp.

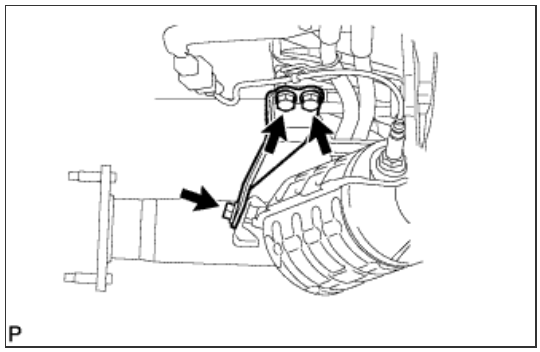


c. Remove the 10 nuts, exhaust manifold and 2 gaskets.



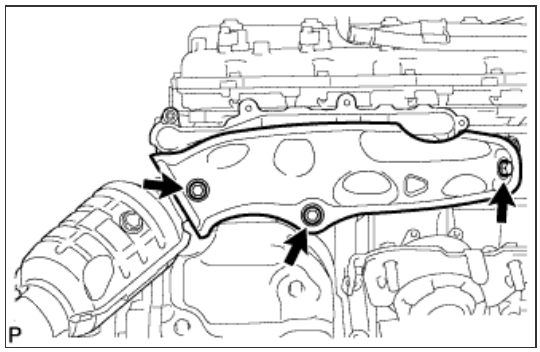
51. REMOVE NO. 1 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



52. REMOVE NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

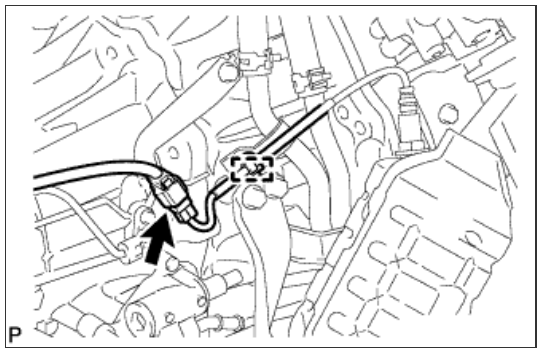
a. Remove the 3 bolts and heat insulator.



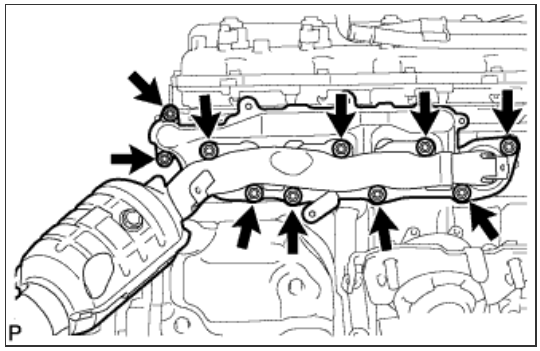
53. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Disconnect the connector.

b. Using a clip remover, detach the wire harness clamp.

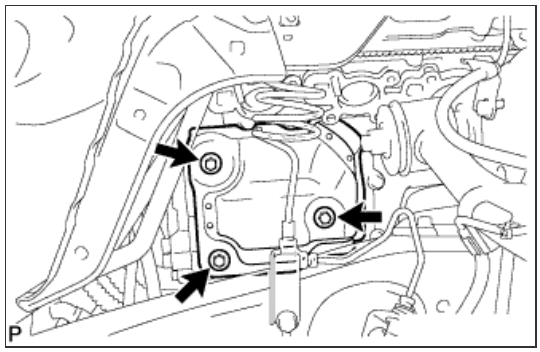


c. Remove the 10 nuts, exhaust manifold and 2 gaskets.



54. REMOVE STARTER COVER

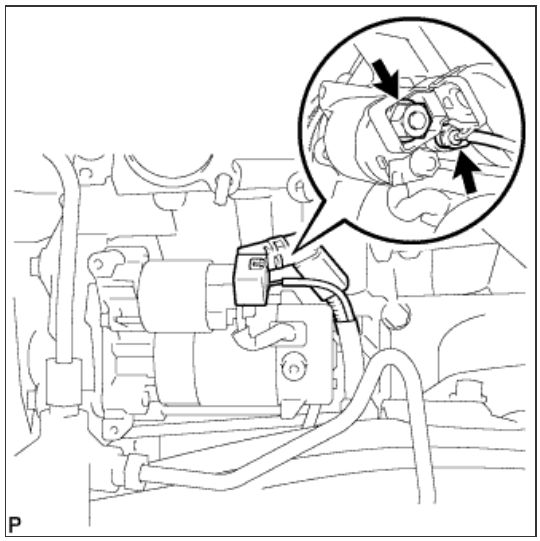
a. Remove the 3 bolts and starter cover.



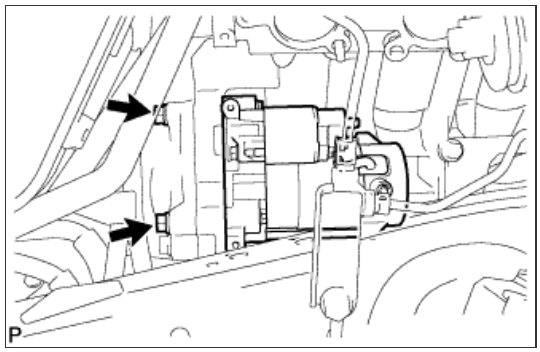
55. REMOVE STARTER ASSEMBLY

a. Disconnect the starter connector.

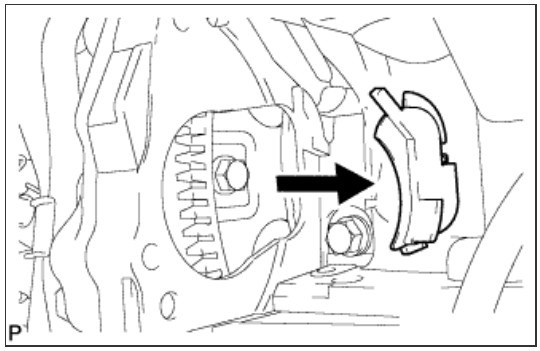
b. Remove the nut and disconnect the starter wire.



c. Remove the 2 bolts and starter.



d. Remove the flywheel housing side cover.



56. REMOVE AUTOMATIC TRANSMISSION ASSEMBLY

a. Remove the automatic transmission (Click here).

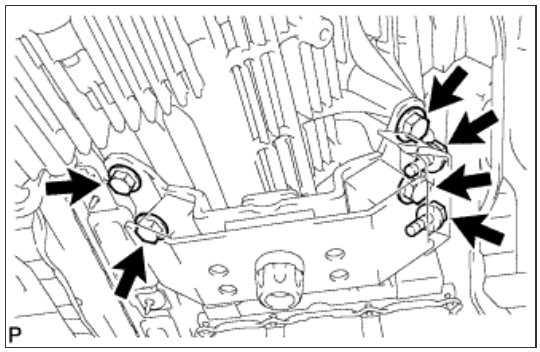
57. REMOVE REAR NO. 1 ENGINE MOUNTING INSULATOR

HINT:

Only perform this procedure when replacement of the engine mounting insulator is necessary.

a. Remove the 2 bolts and front engine mounting insulator RH.

b. Remove the 4 bolts and rear engine mounting insulator from the transmission.

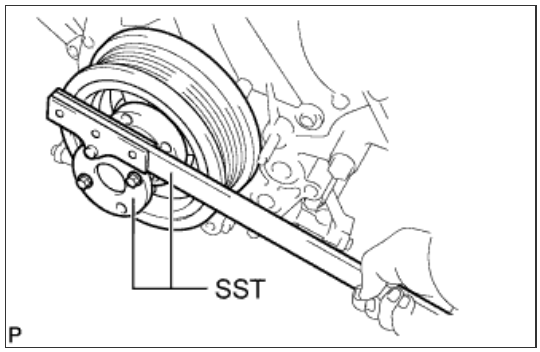


58. REMOVE DRIVE PLATE AND RING GEAR SUB-ASSEMBLY

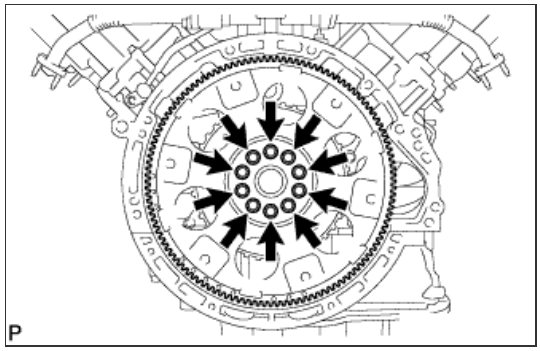
a. Using SST, hold the crankshaft.

SST

09213-70011 (09213-70020)
09330-00021

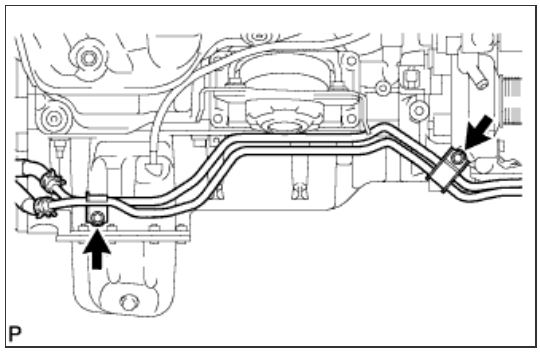


b. Remove the 10 bolts, rear drive plate spacer, drive plate and crankshaft angle sensor rotor.



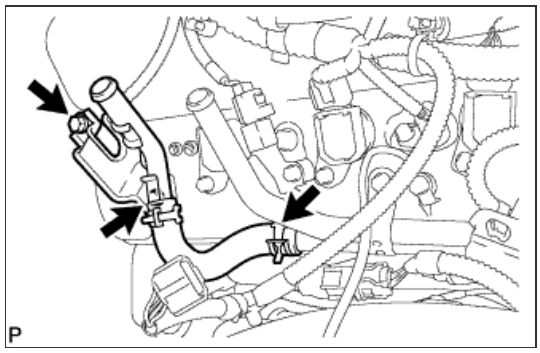
59. DISCONNECT OIL COOLER PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the oil cooler pipe.



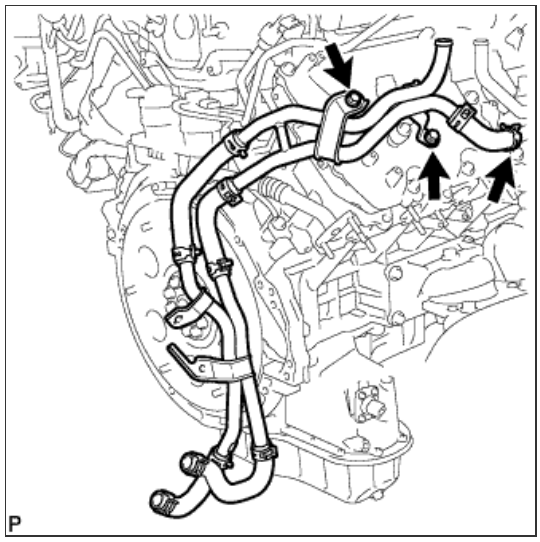
60. REMOVE WATER PIPE AND HOSE SUB-ASSEMBLY (w/ Air Cooled Transmission Oil Cooler)

a. Remove the 2 bolts and disconnect the hose. Then remove the water pipe and hose.



61. REMOVE NO. 2 WATER BY-PASS PIPE (w/o Air Cooled Transmission Oil Cooler)

a. Remove the 2 bolts and disconnect the hose. Then remove the water by-pass pipe.



62. REMOVE ENGINE ASSEMBLY

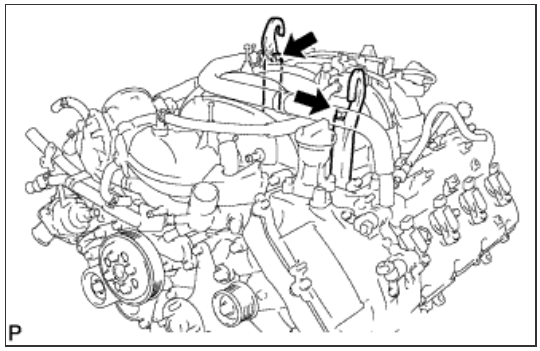
a. Install 2 engine hangers with 2 bolts as shown in the illustration.

Part No.:

Item	Part No.
Engine hanger	12281-38030
Bolt	90119-14120

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }

b. Attach an engine sling device and hang the engine with a chain block.

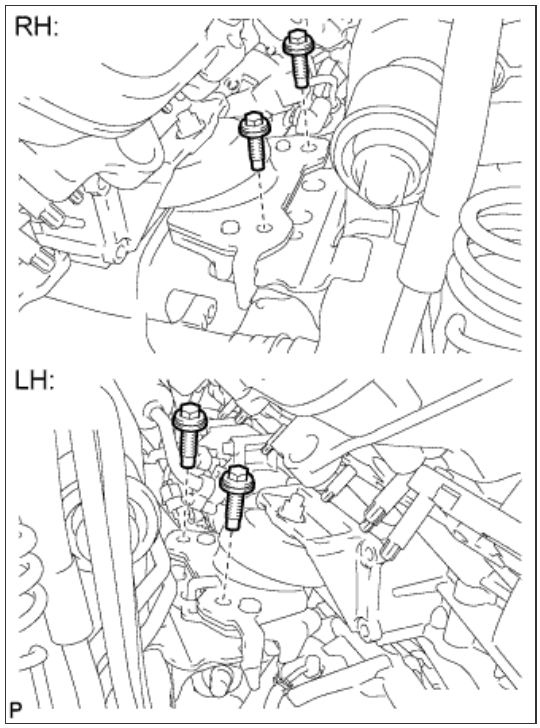


c. Remove the 4 engine mounting insulator bolts.

d. Lift the engine out from the vehicle slowly and carefully.

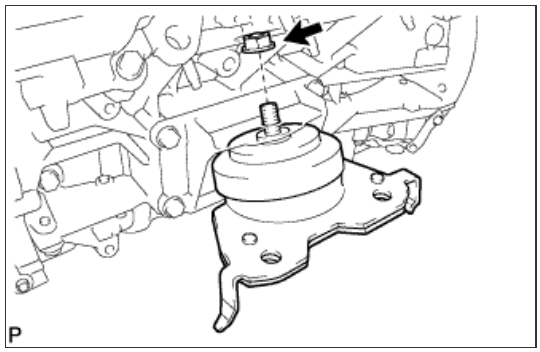
NOTICE:

Make sure the engine is clear of all wiring, hoses and cables.



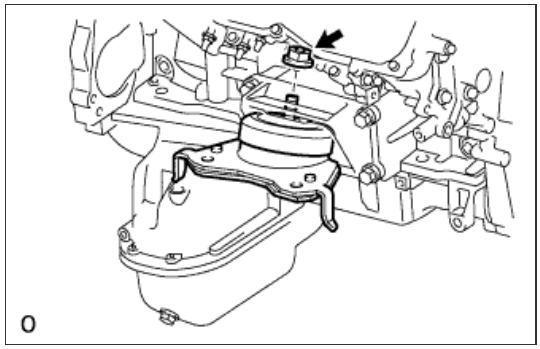
63. REMOVE FRONT ENGINE MOUNTING INSULATOR LH

a. Remove the nut and mounting insulator.



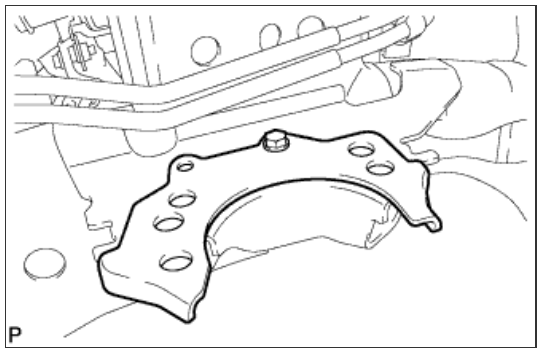
64. REMOVE FRONT ENGINE MOUNTING INSULATOR RH

a. Remove the nut and mounting insulator.



65. REMOVE FRONT NO. 2 ENGINE MOUNTING BRACKET LH

a. Remove the bolt and engine mounting bracket LH.



66. INSTALL ENGINE ON ENGINE STAND

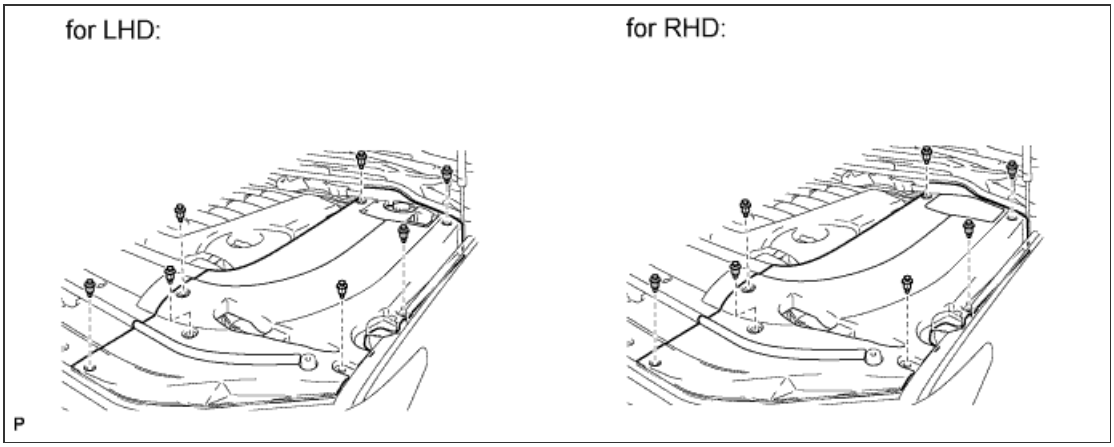
a. Install the engine onto an engine stand with bolts.

b. Remove the 2 bolts and 2 engine hangers.

for Preparation Click here

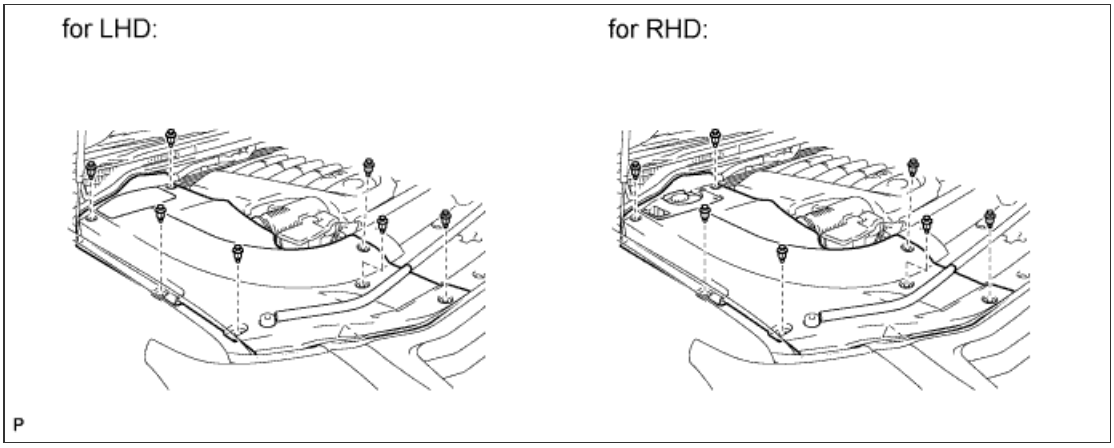
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



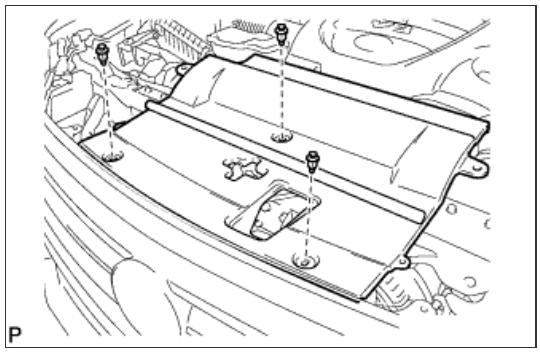
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



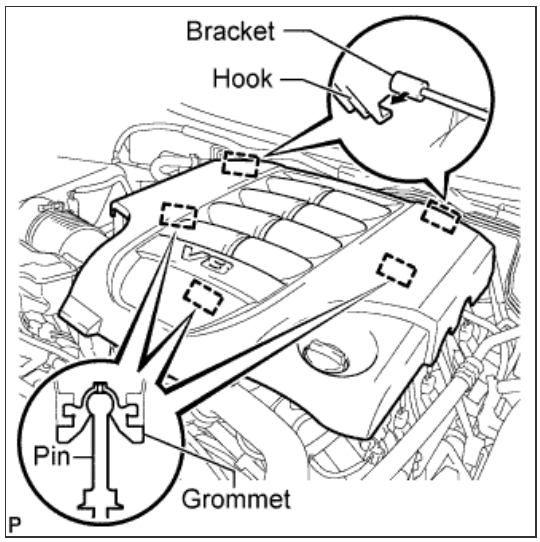
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

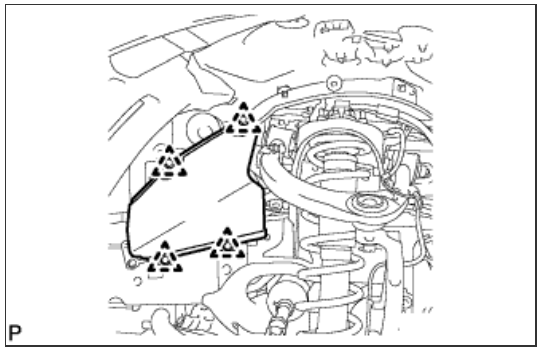
6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

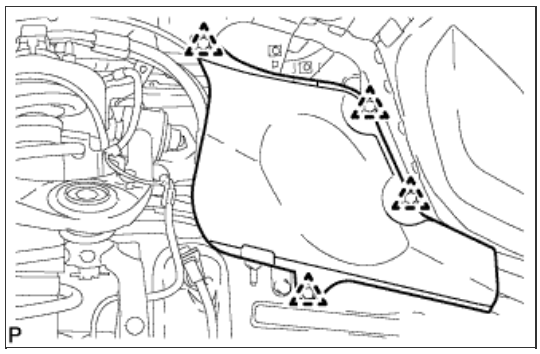
7. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



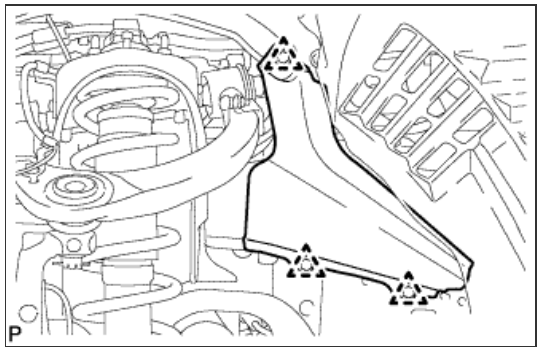
8. REMOVE FRONT FENDER APRON SEAL REAR LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



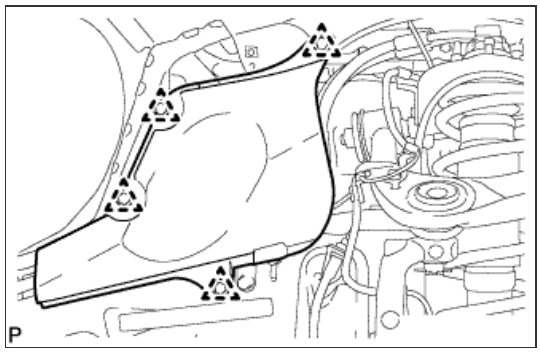
9. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.



10. REMOVE FRONT FENDER APRON SEAL REAR RH

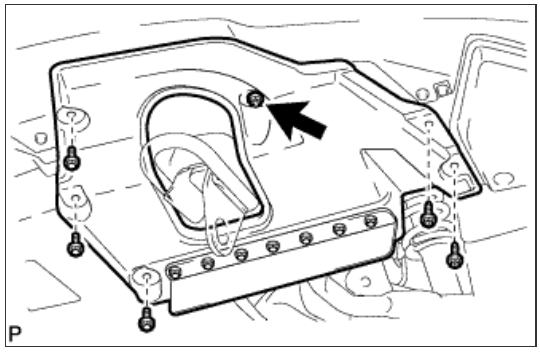
a. Using a clip remover, remove the 4 clips and fender apron seal.



11. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



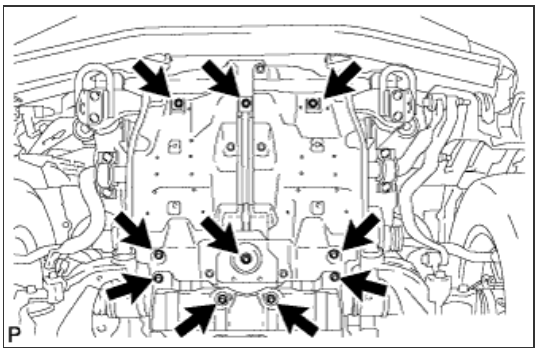
12. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

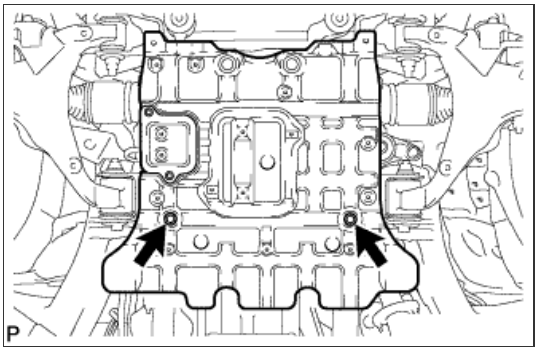
13. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



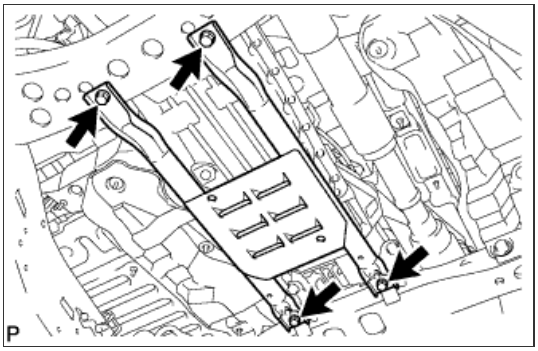
14. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



15. REMOVE OIL PAN PROTECTOR ASSEMBLY

a. Remove the 4 bolts and oil pan protector.



16. REMOVE RADIATOR GRILLE

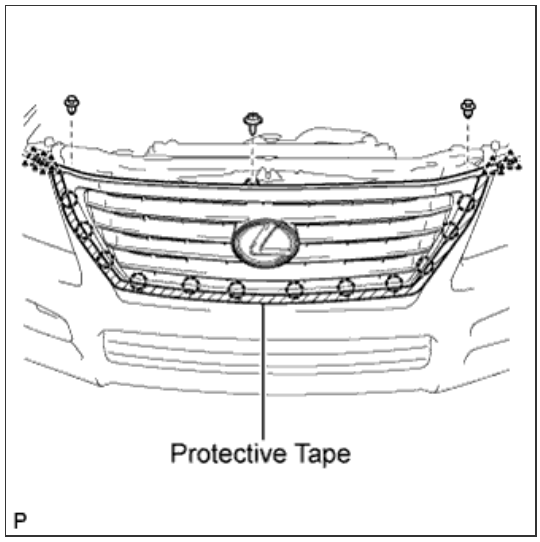
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

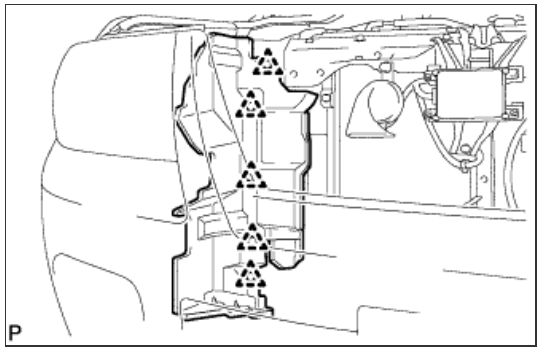
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



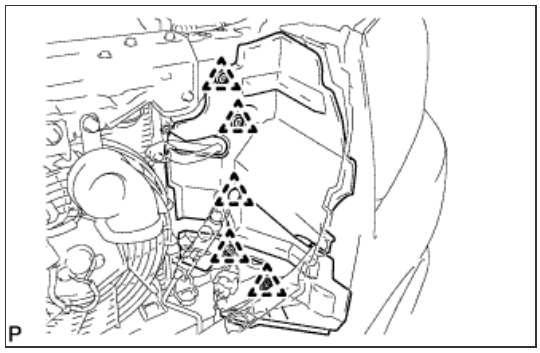
17. REMOVE RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



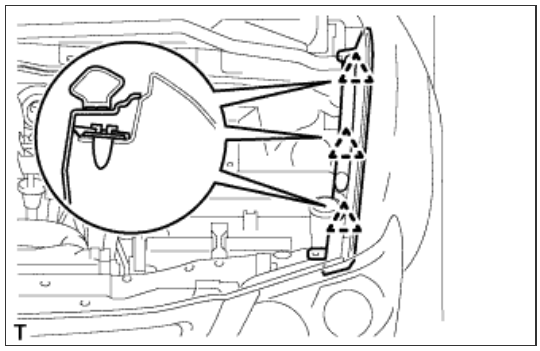
18. REMOVE RADIATOR SIDE DEFLECTOR LH

a. Using a clip remover, remove the 5 clips and side deflector.



19. REMOVE FRONT FENDER MAIN SEAL LH

a. Using a clip remover, detach the 3 clips and remove the fender main seal.



20. REMOVE FRONT FENDER MAIN SEAL RH

HINT:

Use the same procedures described for the LH side.

21. REMOVE FRONT WIPER ARM LH

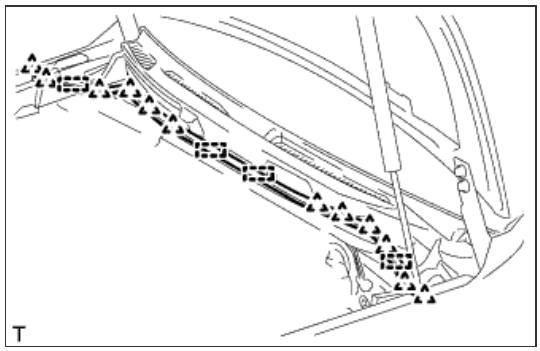
a. Remove the nut, wiper arm and blade.

22. REMOVE FRONT WIPER ARM RH

a. Remove the nut, wiper arm and blade.

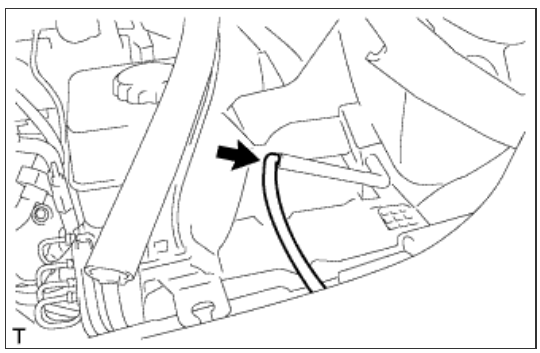
23. REMOVE HOOD TO COWL TOP SEAL

a. Using a clip remover, detach the 12 clips and 4 clamps, and remove the hood to cowl top seal.



24. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

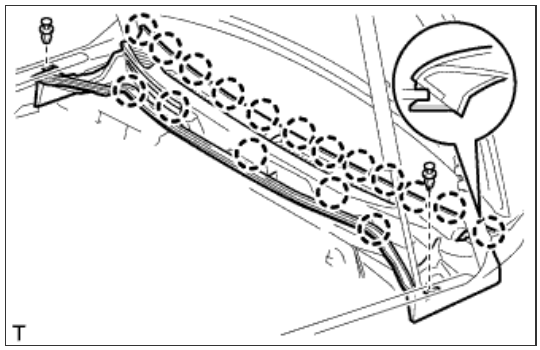
a. Disconnect the washer hose.



b. Remove the 2 clips.

b. Remove the 2 clips.

c. Detach the 17 claws and remove the cowl top ventilator louver sub-assembly.



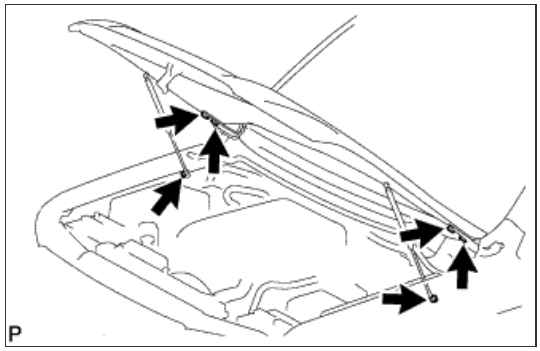
25. REMOVE HOOD SUB-ASSEMBLY

a. Remove the 2 hood support bolts and disconnect the hood supports.

CAUTION:

Remove the hood support assembly while supporting the hood by hand.

b. Remove the 4 bolts and hood.



26. DRAIN ENGINE OIL

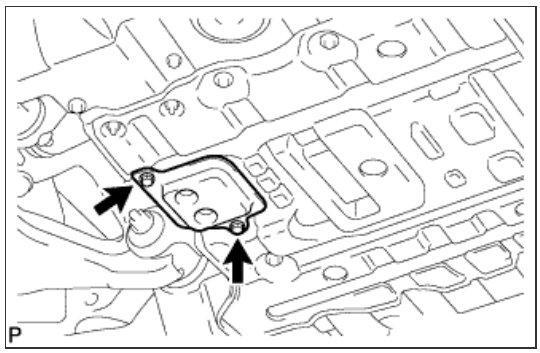
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

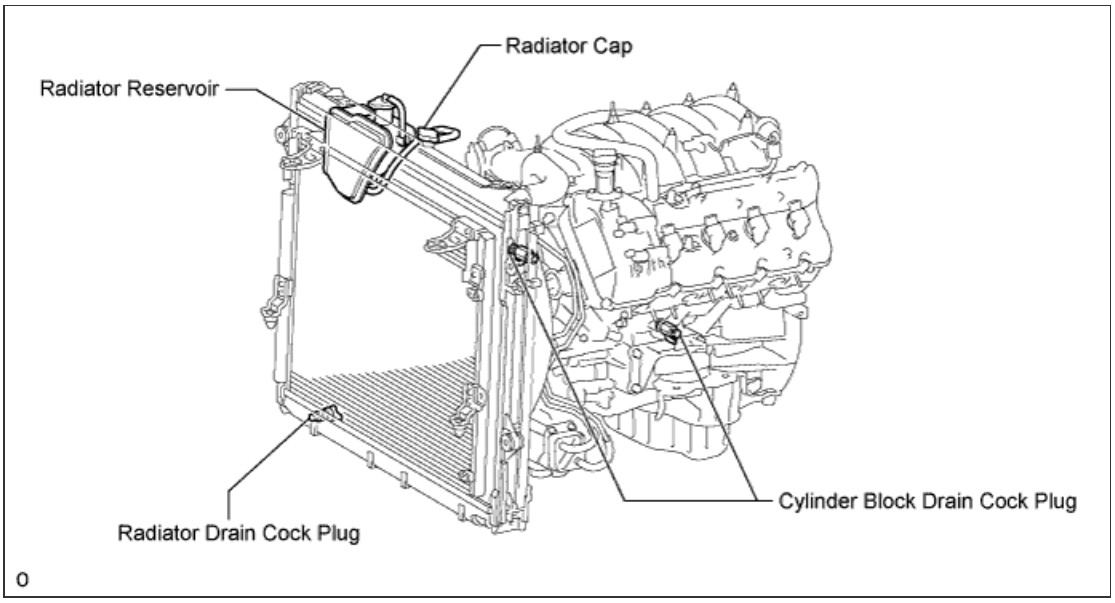
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



27. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

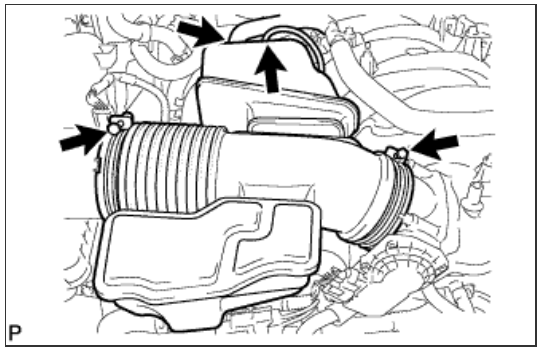
e. Tighten the radiator drain cock plug by hand.

28. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

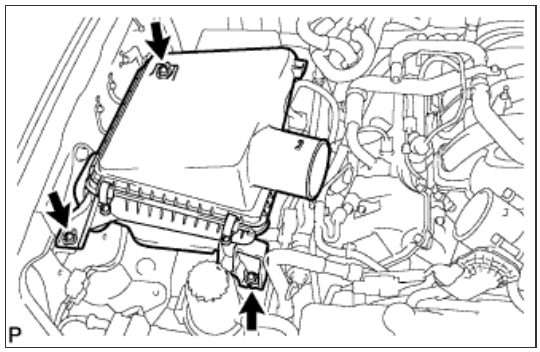
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



29. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



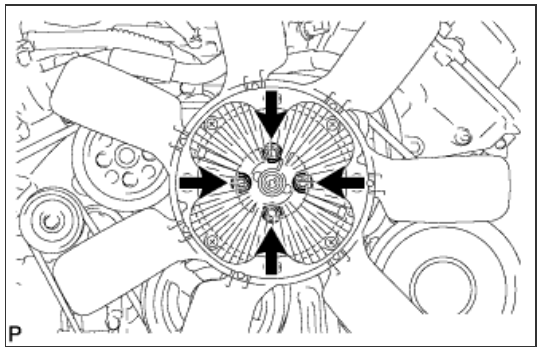
30. REMOVE NO. 1 RADIATOR HOSE

31. REMOVE NO. 2 RADIATOR HOSE

32. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

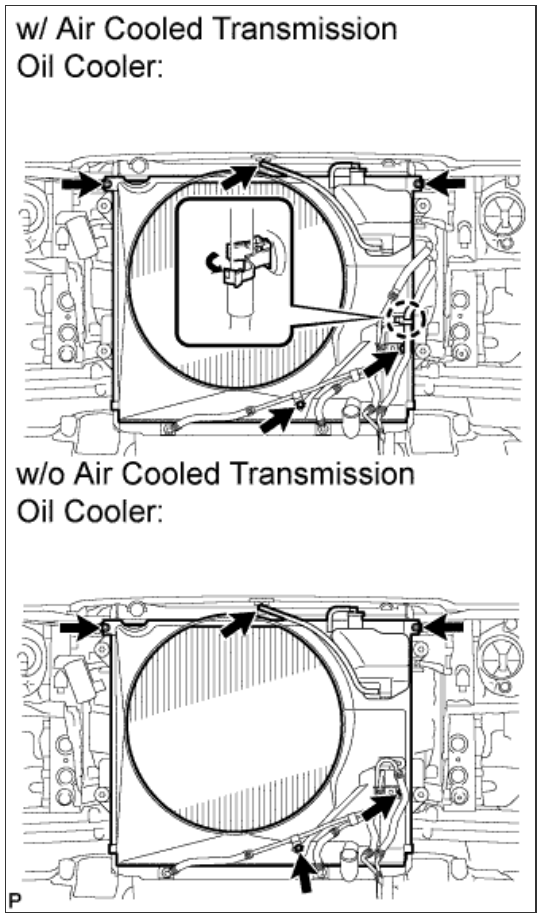
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

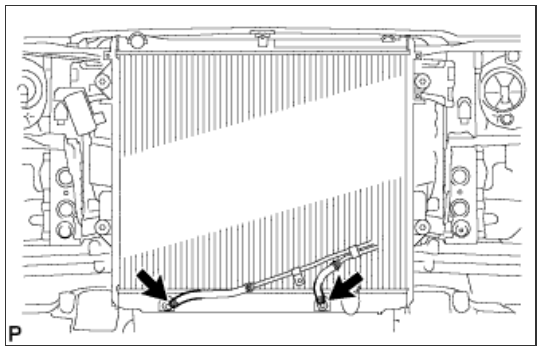
Be careful not to damage the radiator core.

h. Remove the fan pulley.

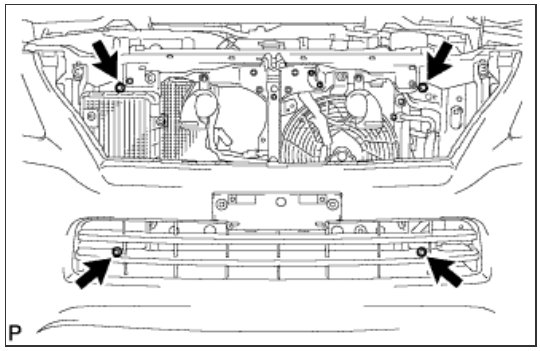


33. REMOVE RADIATOR ASSEMBLY

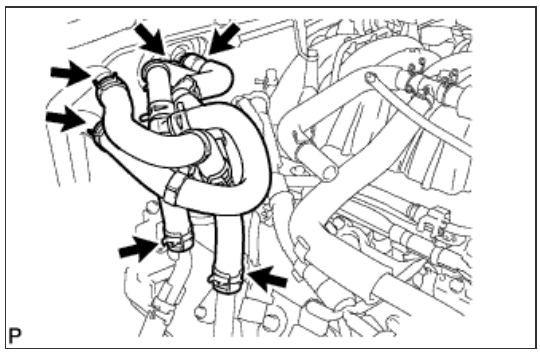
a. Disconnect the 2 oil cooler hoses.



b. Remove the 4 bolts and radiator.



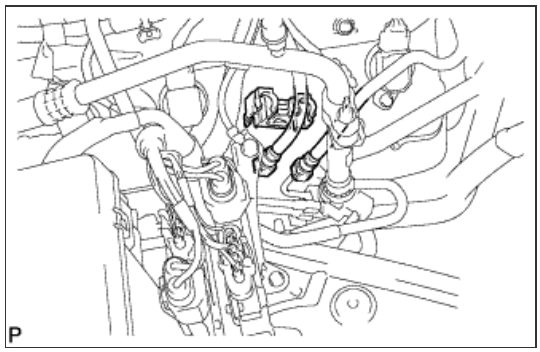
34. REMOVE WATER HOSE SUB-ASSEMBLY



35. DISCONNECT FUEL MAIN AND RETURN HOSE

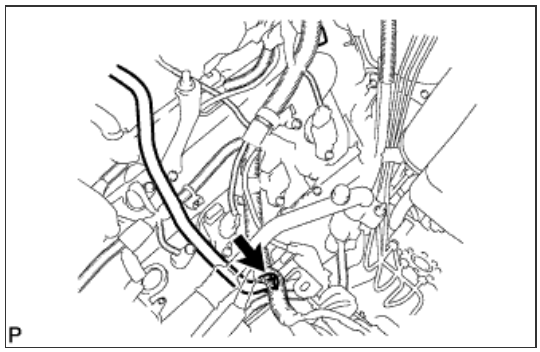
a. Remove the fuel pipe clamp.

b. Disconnect the fuel main and return hoses (Click here).



36. DISCONNECT WIRE HARNESS AND HOSE

a. Disconnect the purge line hose.

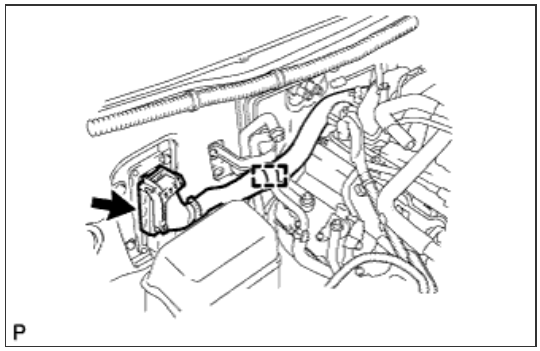


b. Disconnect the ECM connector.

i. for LHD:
Disconnect the clamp and ECM connector.

HINT:

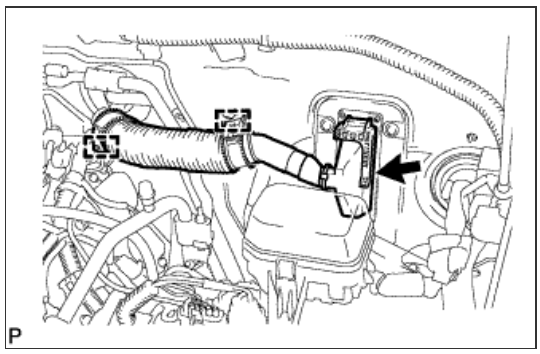
Refer to the following procedures to disconnect the ECM connector (Click here).



ii. for RHD:
Disconnect the 2 clamps and ECM connector.

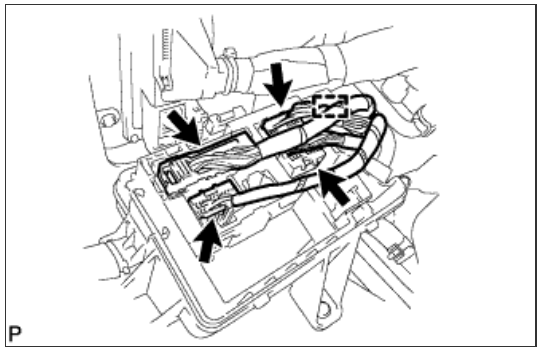
HINT:

Refer to the following procedures to disconnect the ECM connector (Click here).



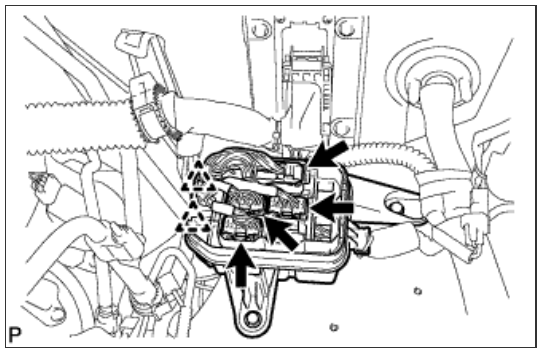
c. Disconnect the 4 connectors.

i. for LHD:
Disconnect the 4 connectors and clamp from the connector holder block.



ii. for RHD:

Disconnect the 4 connectors and 2 clips from the connector holder block.

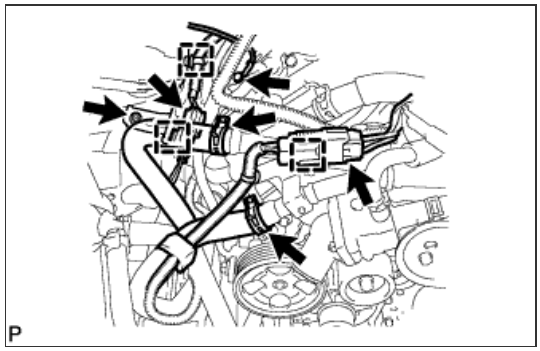


d. w/ Secondary Air Injection System:
Disconnect the 2 air pump connectors and 3 clamps.

e. w/ Secondary Air Injection System:
Remove the nut and connector bracket.

f. Remove the bolt and disconnect the ground wire.

g. w/ Secondary Air Injection System:
Disconnect the 2 air injection system hoses.



h. Remove the nut and disconnect the wire from the positive (+) battery cable.

i. Disconnect the cable from the positive (+) battery terminal.

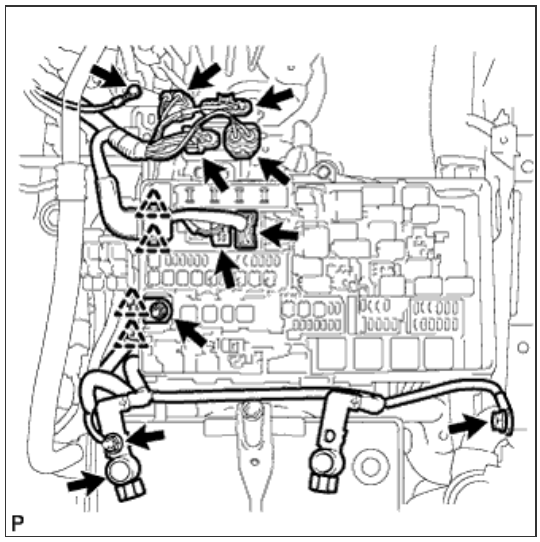
j. Remove the bolt and disconnect the ground wire from the body.

k. Remove the bolt and disconnect the ground wire from the bracket.

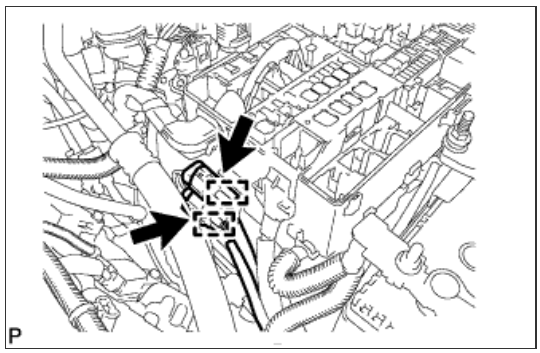
l. w/ Secondary Air Injection System:
Disconnect the 4 air injection control driver connectors.

m. Remove the nut and disconnect the wire and 2 clips from the engine room junction block.

n. Disconnect the 2 connectors and 2 clips from the engine room junction block.



o. Disconnect the 2 connectors and clamps.

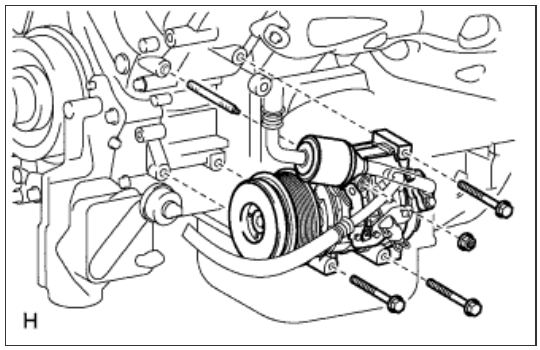


37. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

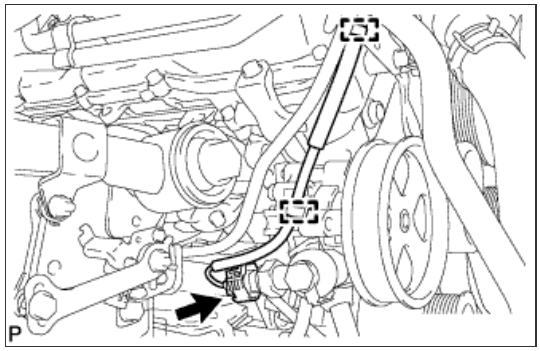
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.

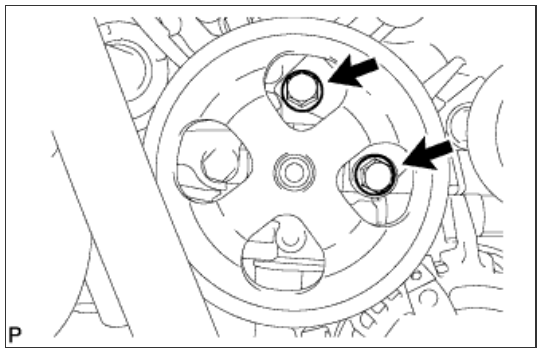


38. DISCONNECT VANE PUMP ASSEMBLY

a. Disconnect the 2 clamps and power steering oil pressure switch connector.



b. Remove the 2 bolts and disconnect the vane pump.

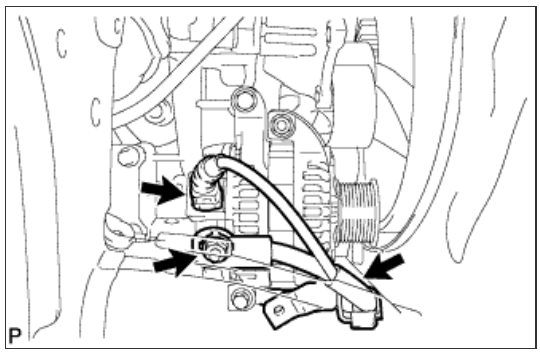


39. REMOVE GENERATOR ASSEMBLY

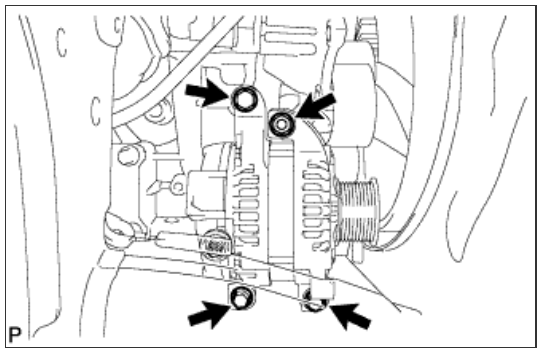
a. Disconnect the generator connector.

b. Remove the terminal cap and nut, and disconnect the generator wire.

c. Remove the bolt and wire harness bracket from the generator.



d. Remove the 3 bolts, nut and generator.

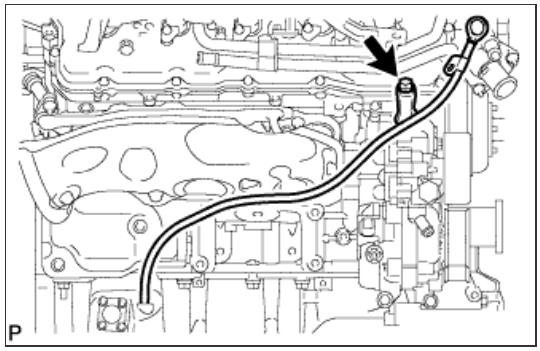


40. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.



41. REMOVE TAILPIPE ASSEMBLY

a. Remove the bolt, clamp and gasket.

b. Remove the tailpipe from the 2 exhaust pipe supports.

c. Remove the bolt and clamp, and then disconnect the tailpipe from the center exhaust pipe.

42. REMOVE CENTER EXHAUST PIPE ASSEMBLY

a. Remove the 4 bolts.

b. Remove the center exhaust pipe from the 3 exhaust pipe supports.

c. Remove the 2 gaskets from the front exhaust pipe and front No. 2 exhaust pipe.

43. REMOVE FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front No. 2 exhaust pipe and gasket from the exhaust manifold LH.

44. REMOVE FRONT EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front exhaust pipe and gasket from the exhaust manifold RH.

45. REMOVE FRONT PROPELLER SHAFT ASSEMBLY

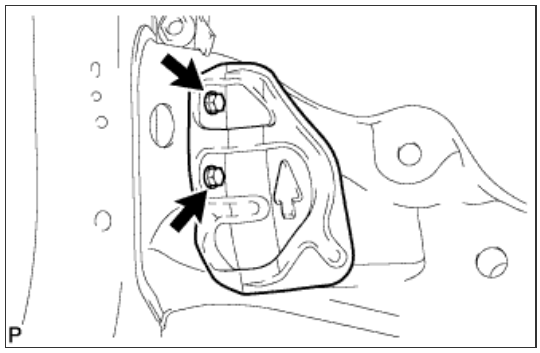
(Click here)

46. REMOVE REAR PROPELLER SHAFT ASSEMBLY

(Click here)

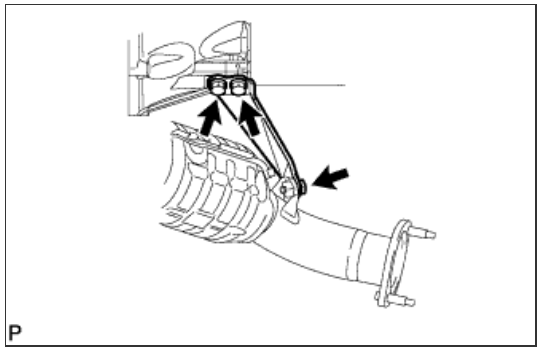
47. REMOVE PROPELLER SHAFT HEAT INSULATOR

a. Remove the 2 bolts and heat insulator.



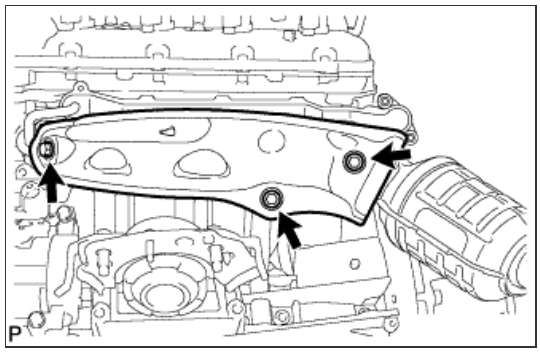
48. REMOVE NO. 2 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



49. REMOVE NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

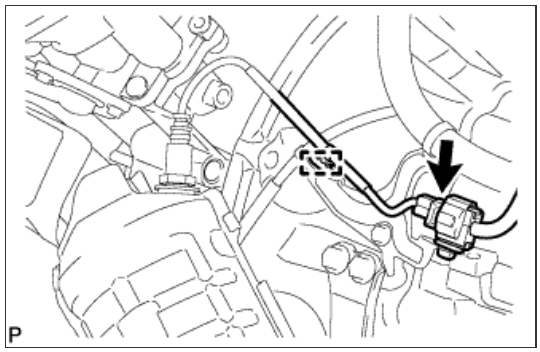
a. Remove the 3 bolts and heat insulator.



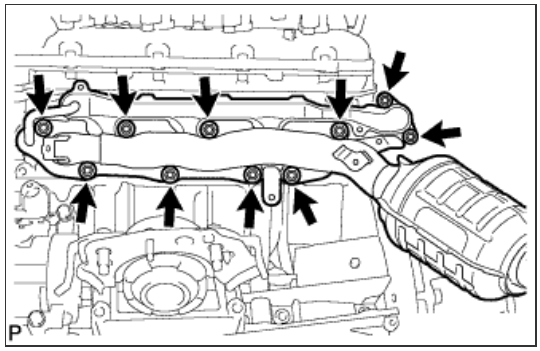
50. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Disconnect the connector.

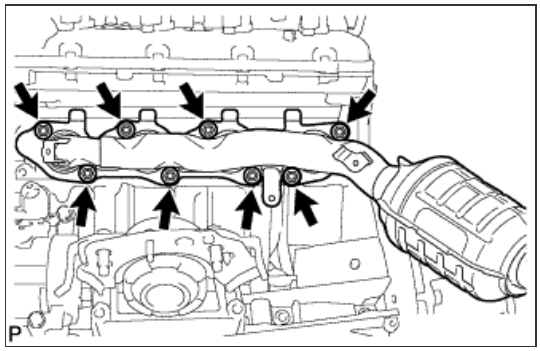
b. Using a clip remover, detach the wire harness clamp.



c. w/ Secondary Air Injection System:
Remove the 10 nuts, exhaust manifold and 2 gaskets.

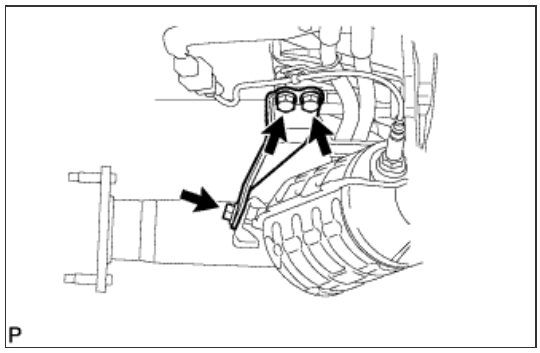


d. w/o Secondary Air Injection System:
Remove the 8 nuts, exhaust manifold and gasket.



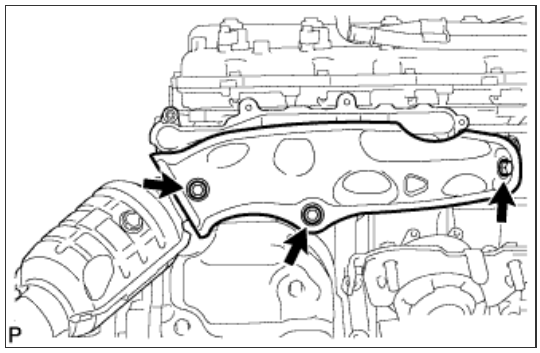
51. REMOVE NO. 1 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



52. REMOVE NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

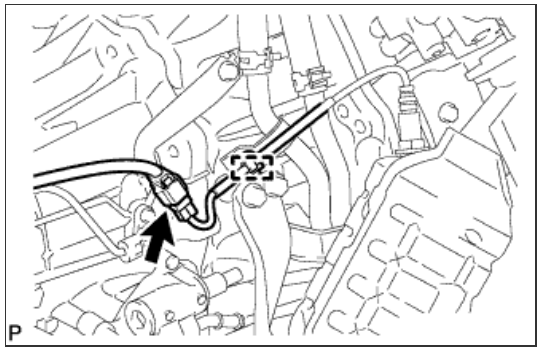
a. Remove the 3 bolts and heat insulator.



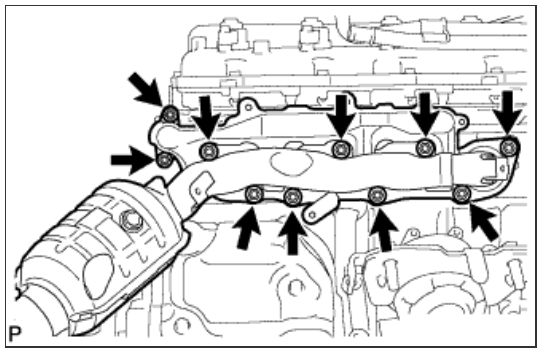
53. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Disconnect the connector.

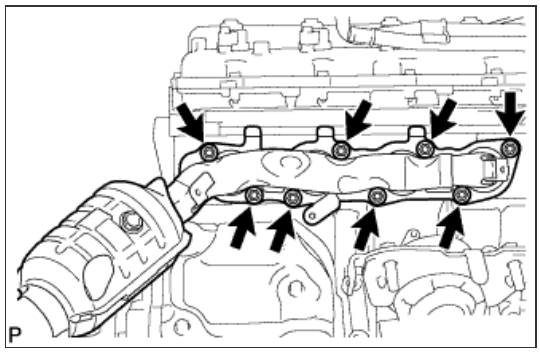
b. Using a clip remover, detach the wire harness clamp.



c. w/ Secondary Air Injection System:
Remove the 10 nuts, exhaust manifold and 2 gaskets.

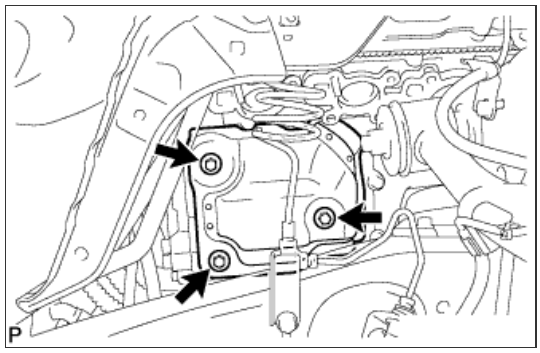


d. w/o Secondary Air Injection System:
Remove the 8 nuts, exhaust manifold and gasket.



54. REMOVE STARTER COVER

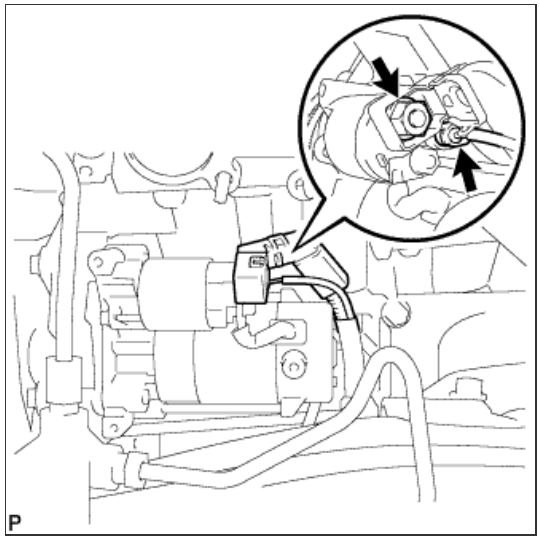
a. Remove the 3 bolts and starter cover.



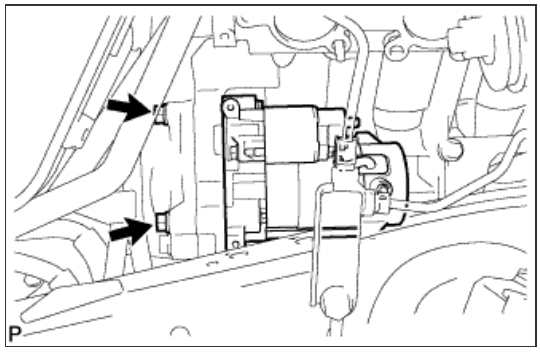
55. REMOVE STARTER ASSEMBLY

a. Disconnect the starter connector.

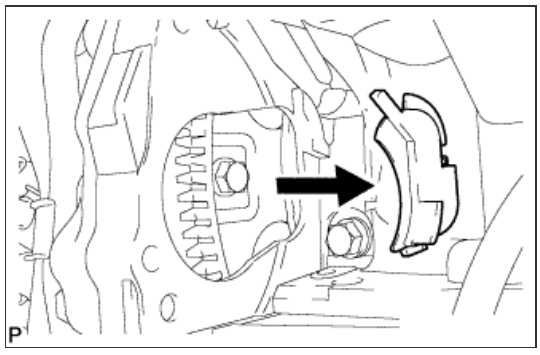
b. Remove the nut and disconnect the starter wire.



c. Remove the 2 bolts and starter.



d. Remove the flywheel housing side cover.



56. REMOVE AUTOMATIC TRANSMISSION ASSEMBLY

(Click here)

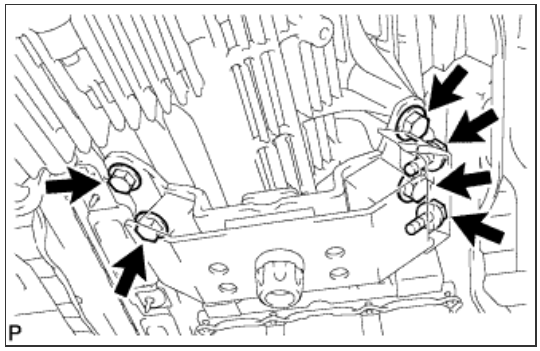
57. REMOVE REAR NO. 1 ENGINE MOUNTING INSULATOR

HINT:

Only perform this procedure when replacement of the engine mounting insulator is necessary.

a. Remove the 2 bolts and front engine mounting insulator RH.

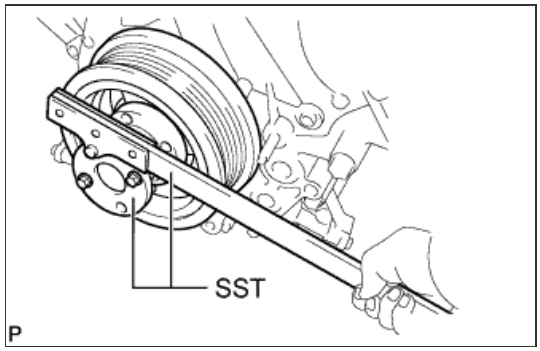
b. Remove the 4 bolts and rear engine mounting insulator from the transmission.



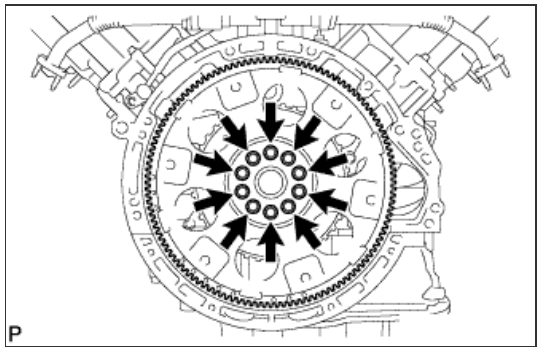
58. REMOVE DRIVE PLATE AND RING GEAR SUB-ASSEMBLY

a. Using SST, hold the crankshaft.

SST
09213-70011 (09213-70020)
09330-00021

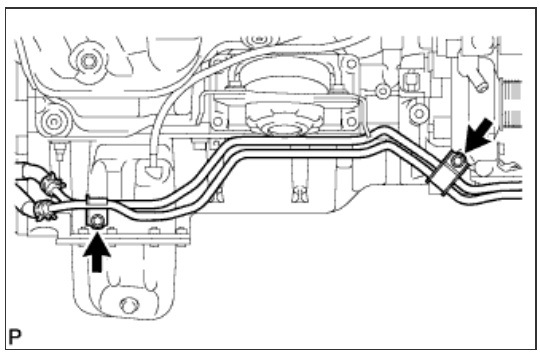


b. Remove the 10 bolts, rear drive plate spacer, drive plate and crankshaft angle sensor rotor.



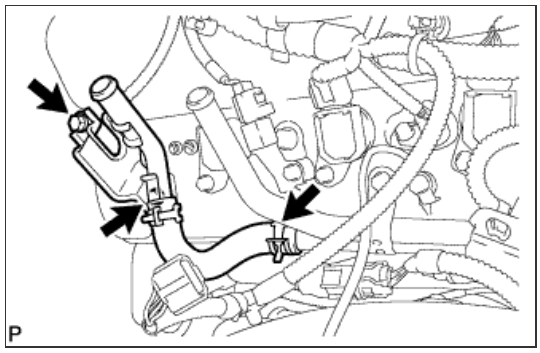
59. DISCONNECT OIL COOLER PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the oil cooler pipe.



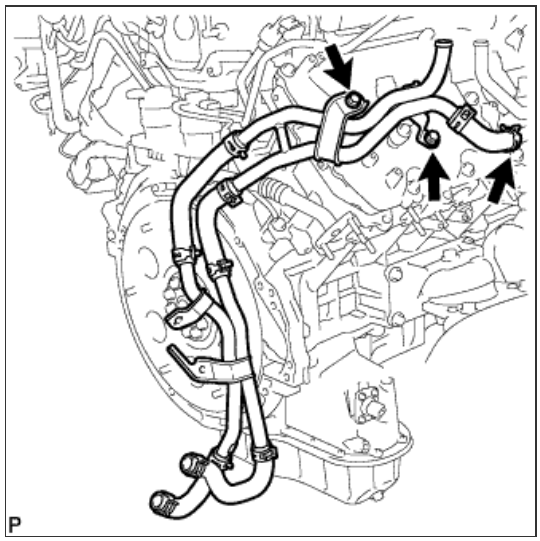
60. REMOVE WATER PIPE AND HOSE SUB-ASSEMBLY (w/ Air Cooled Transmission Oil Cooler)

a. Remove the 2 bolts and disconnect the hose. Then remove the water pipe and hose.



61. REMOVE NO. 2 WATER BY-PASS PIPE (w/o Air Cooled Transmission Oil Cooler)

a. Remove the 2 bolts and disconnect the hose. Then remove the water by-pass pipe.



62. REMOVE ENGINE ASSEMBLY

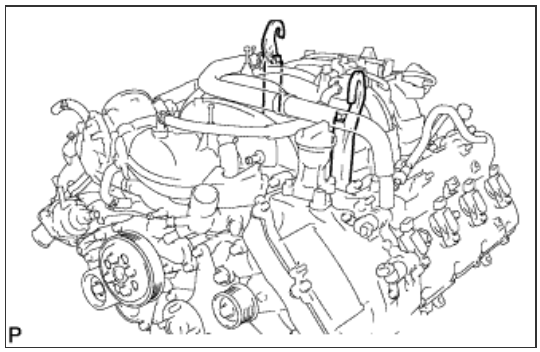
a. Install 2 engine hangers with 2 bolts as shown in the illustration.

Torque:

43 N*m{ 438 kgf*cm , 32 ft.*lbf }

HINT:

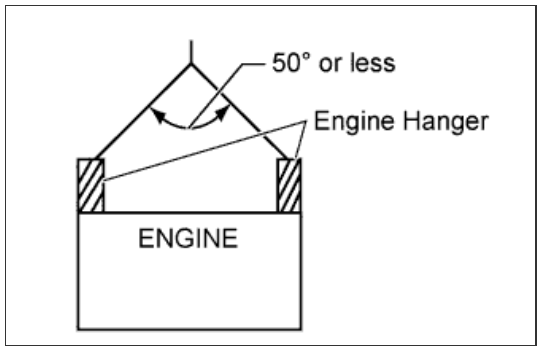
Item	Part No.
Engine hanger	12281-38150
Bolt	90119-14120



b. Attach an engine sling device and hang the engine with a chain block.

NOTICE:

When hanging the engine, make sure to hang the engine with the sling device's hanging angle at 50° or less. If not, the engine or engine hangers may be damaged.

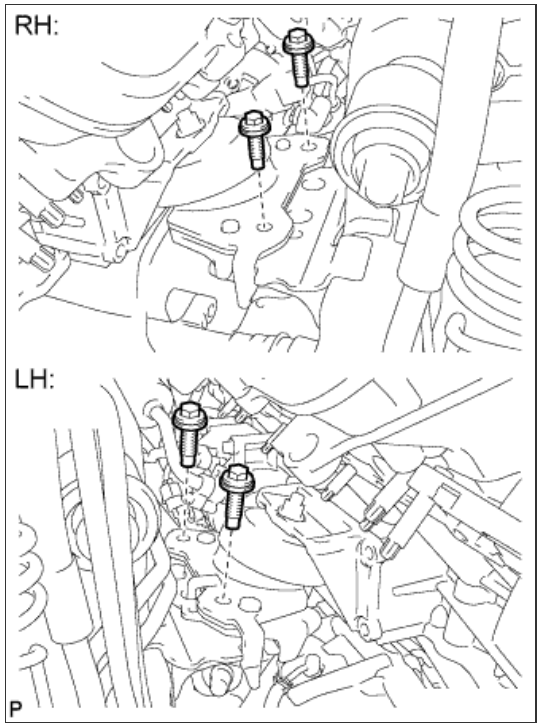


c. Remove the 4 engine mounting insulator bolts.

d. Lift the engine out from the vehicle slowly and carefully.

NOTICE:

- **Make sure the engine is clear of all wiring, hoses and cables.**
- **With the exception of installing the engine assembly to an engine stand or removing the engine assembly from an engine stand, do not perform any work on the engine while it is suspended, as doing so is dangerous.**
- **Pay attention to the angle of the sling device as the engine assembly or engine hangers may be damaged or deformed if the angle is incorrect.**



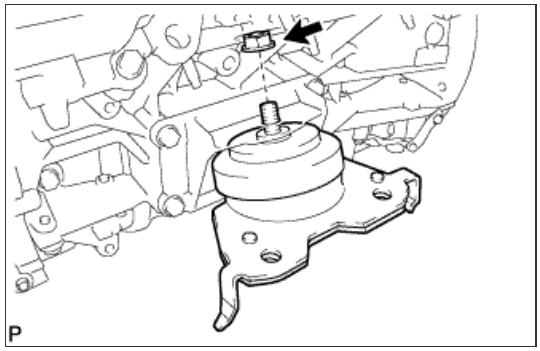
63. INSTALL ENGINE ON ENGINE STAND

a. Install the engine onto an engine stand with bolts.

b. Remove the 2 bolts and 2 engine hangers.

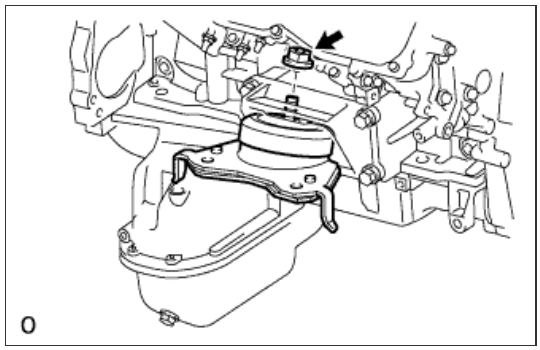
64. REMOVE FRONT ENGINE MOUNTING INSULATOR LH

a. Remove the nut and mounting insulator.



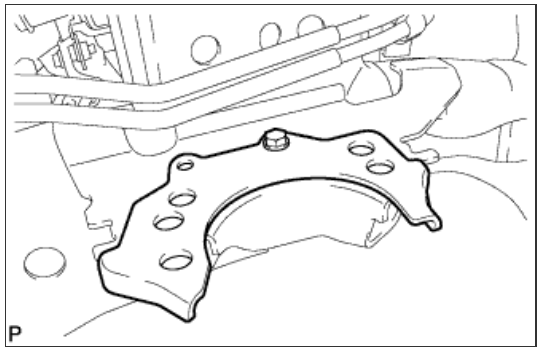
65. REMOVE FRONT ENGINE MOUNTING INSULATOR RH

a. Remove the nut and mounting insulator.



66. REMOVE FRONT NO. 2 ENGINE MOUNTING BRACKET LH

a. Remove the bolt and engine mounting bracket LH.



for Preparation Click here

1. REMOVE ENGINE STAND

a. Install 2 engine hangers with 2 bolts as shown in the illustration.

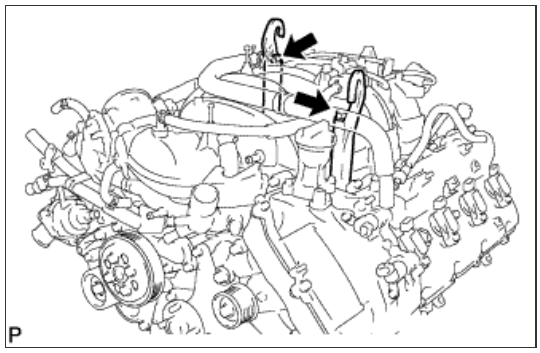
Part No.:

Item	Part No.
Engine hanger	12281-38030
Bolt	90119-14120

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }

b. Attach an engine sling device and hang the engine with a chain block.

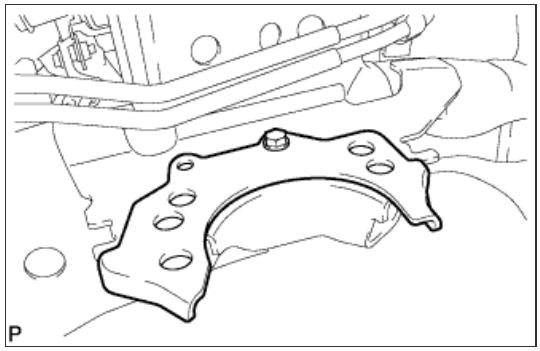
c. Remove the bolts and engine assembly from the engine stand.



2. INSTALL FRONT NO. 2 ENGINE MOUNTING BRACKET LH

a. Install the engine mounting bracket LH with the bolt.

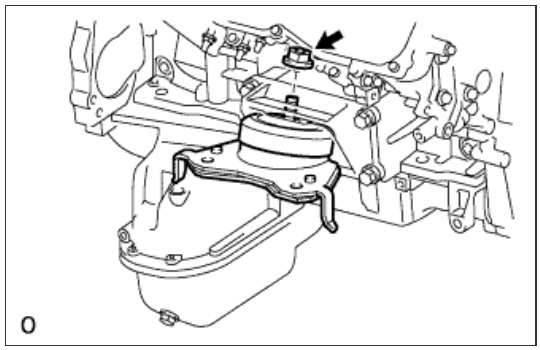
Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }



3. INSTALL FRONT ENGINE MOUNTING INSULATOR RH

a. Install the mounting insulator with the nut.

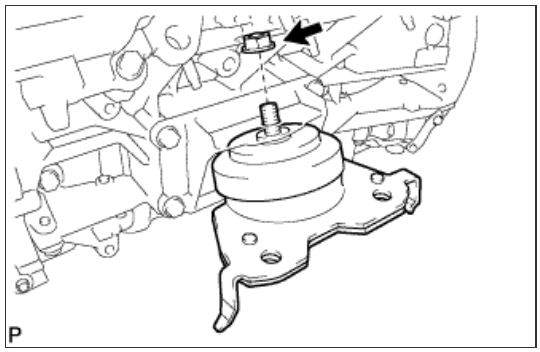
Torque:
72 N*m{ 734 kgf*cm , 53 ft.*lbf }



4. INSTALL FRONT ENGINE MOUNTING INSULATOR LH

a. Install the mounting insulator with the nut.

Torque:
72 N*m{ 734 kgf*cm , 53 ft.*lbf }



5. INSTALL ENGINE ASSEMBLY

a. Slowly lower the engine assembly into the engine compartment.

NOTICE:

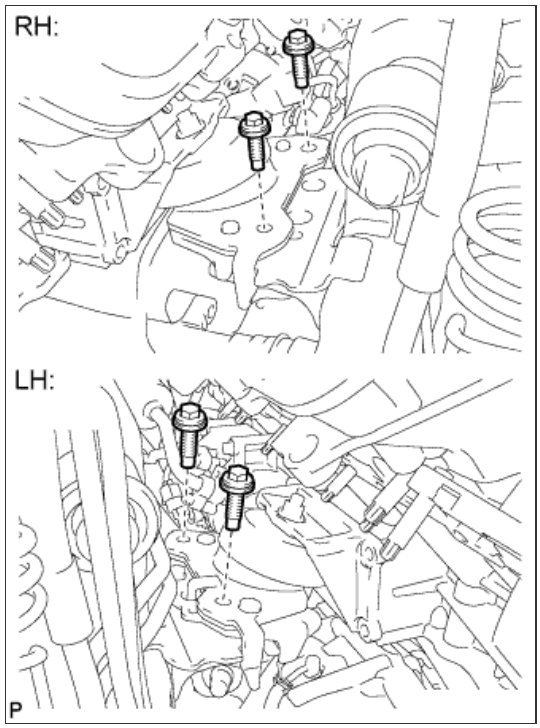
Make sure that the engine is clear of all wiring and hoses.

b. Attach the engine mounting insulators to the vehicle.

c. Install the 4 engine mounting insulator bolts.

Torque:
79 N*m{ 806 kgf*cm , 58 ft.*lbf }

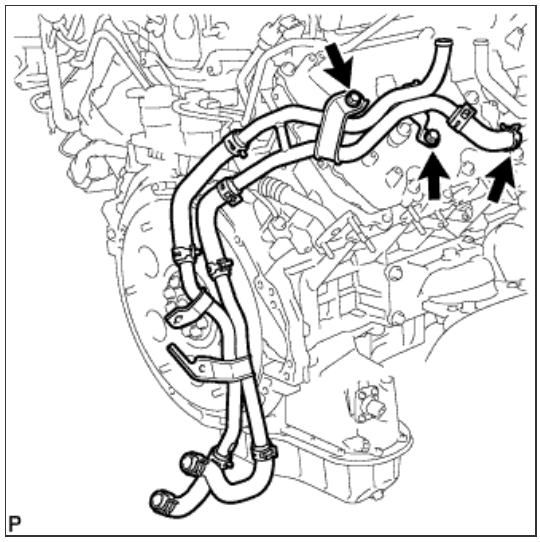
d. Remove the 2 bolts and 2 engine hangers.



6. INSTALL NO. 2 WATER BY-PASS PIPE (w/o Air Cooled Transmission Oil Cooler)

a. Connect the hose and install the water by-pass pipe with the 2 bolts.

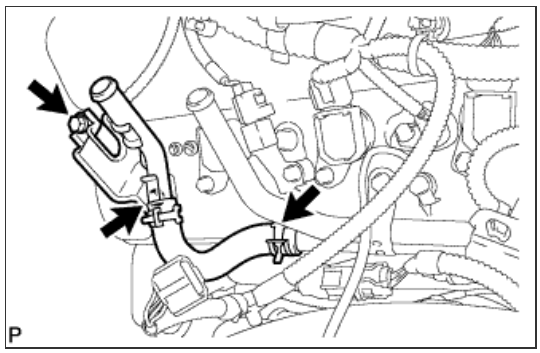
Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



7. INSTALL WATER PIPE AND HOSE SUB-ASSEMBLY (w/ Air Cooled Transmission Oil Cooler)

a. Connect the hose and install the water pipe and hose with the 2 bolts.

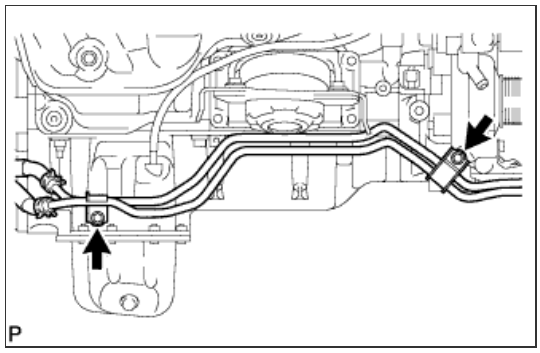
Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



8. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }

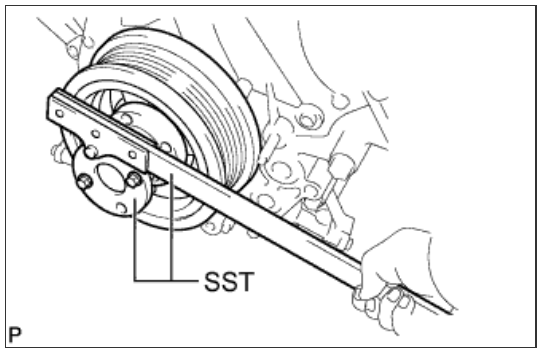


9. INSTALL DRIVE PLATE AND RING GEAR SUB-ASSEMBLY

a. Using SST, hold the crankshaft.

SST
09213-70011 (09213-70020)
09330-00021

b. Install the crankshaft angle sensor rotor, drive plate and rear drive plate spacer to the crankshaft.

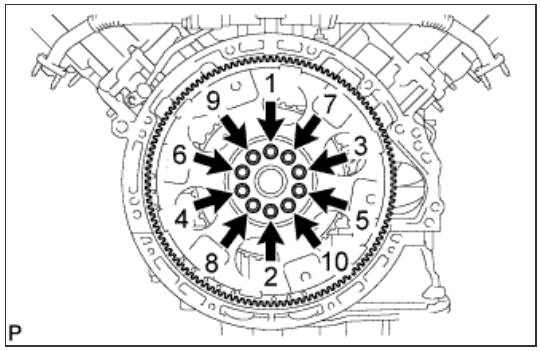


c. Install and uniformly tighten 10 new bolts in the sequence shown in the illustration.

Torque:
30 N*m{ 301 kgf*cm , 22 ft.*lbf }

NOTICE:

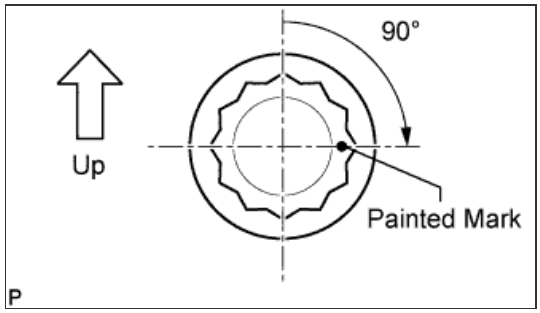
- **Do not reuse the flywheel installation bolts.**
- **Do not strike or damage the flywheel installation bolts. Be sure to handle them carefully.**



d. Mark the upside of each flywheel installation bolt with paint.

e. Tighten the flywheel installation bolts 90° as shown in the illustration.

f. Check that the painted marks are now at a 90° angle to the upside.



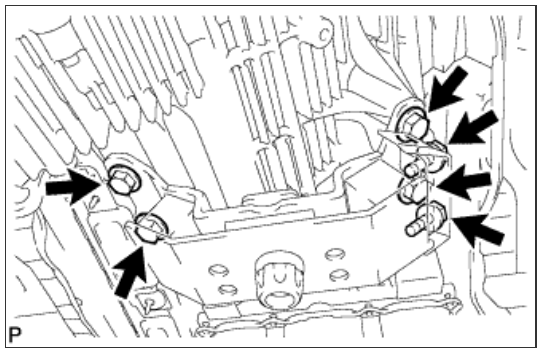
10. INSTALL REAR NO. 1 ENGINE MOUNTING INSULATOR

a. Install the rear engine mounting insulator to the transmission with the 4 bolts.

Torque:
59 N*m{ 602 kgf*cm , 44 ft.*lbf }

b. Install the front engine mounting insulator RH with the 2 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

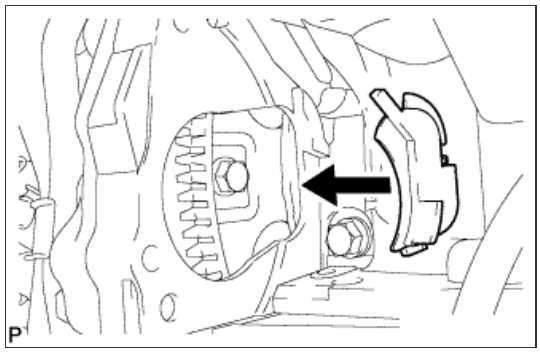


11. INSTALL AUTOMATIC TRANSMISSION ASSEMBLY

a. Install the automatic transmission (Click here).

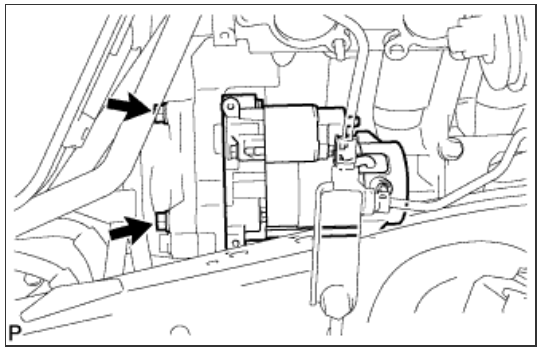
12. INSTALL STARTER ASSEMBLY

a. Install the flywheel housing side cover.



b. Install the starter with the 2 bolts.

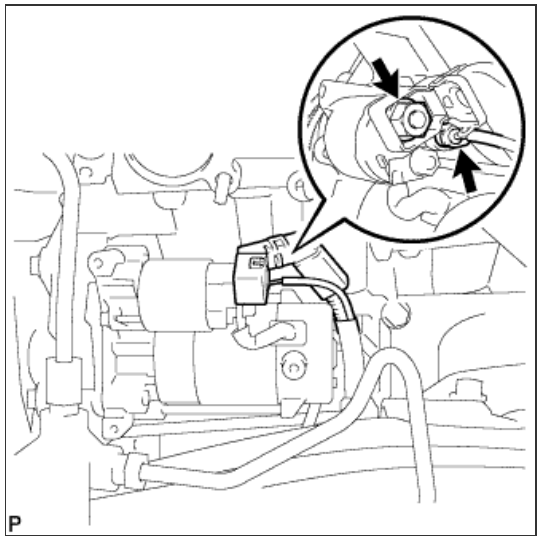
Torque:
37 N*m{ 377 kgf*cm , 27 ft.*lbf }



c. Install the starter wire with the nut.

Torque:
9.8 N*m{ 100 kgf*cm , 87 in.*lbf }

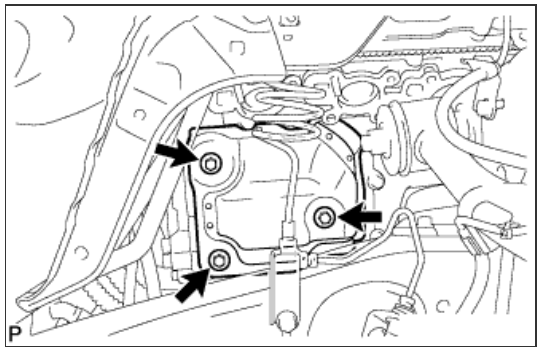
d. Connect the starter connector.



13. INSTALL STARTER COVER

a. Install the starter cover with the 3 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

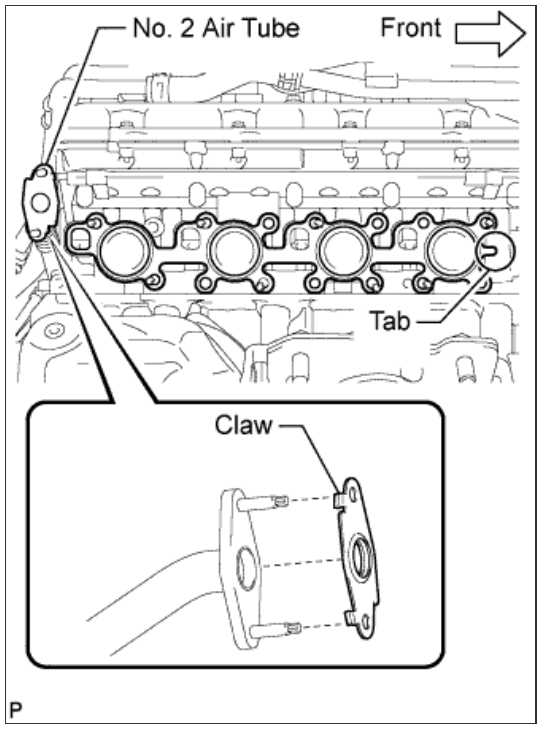


14. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Install a new gasket to the cylinder head and a new gasket to the No. 2 air tube.

HINT:

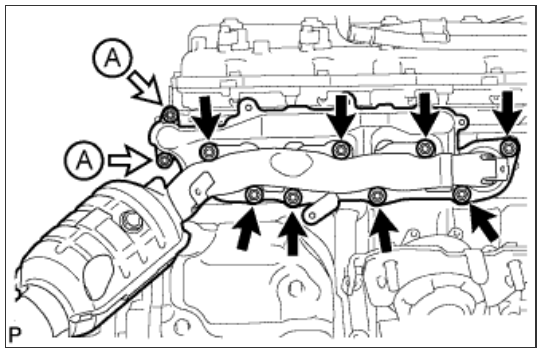
- **Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



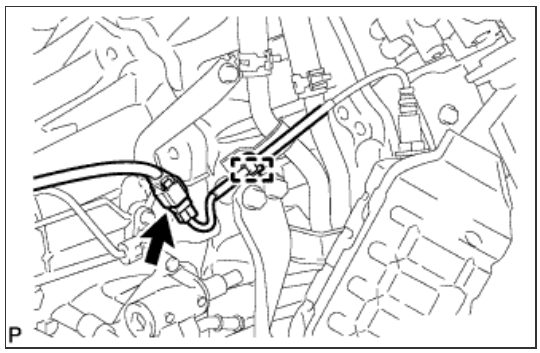
b. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

c. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



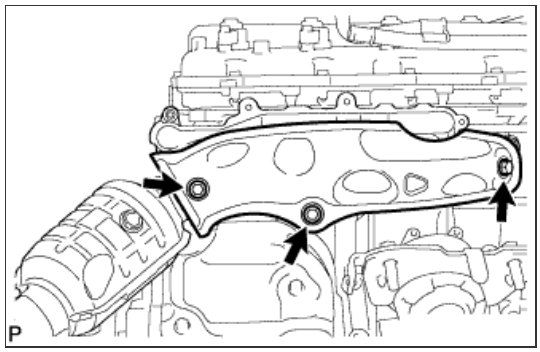
d. Attach the wire harness clamp to the bracket and connect the connector.



15. INSTALL NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

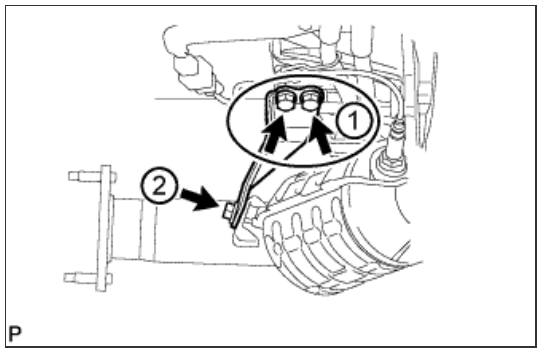


16. INSTALL NO. 1 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

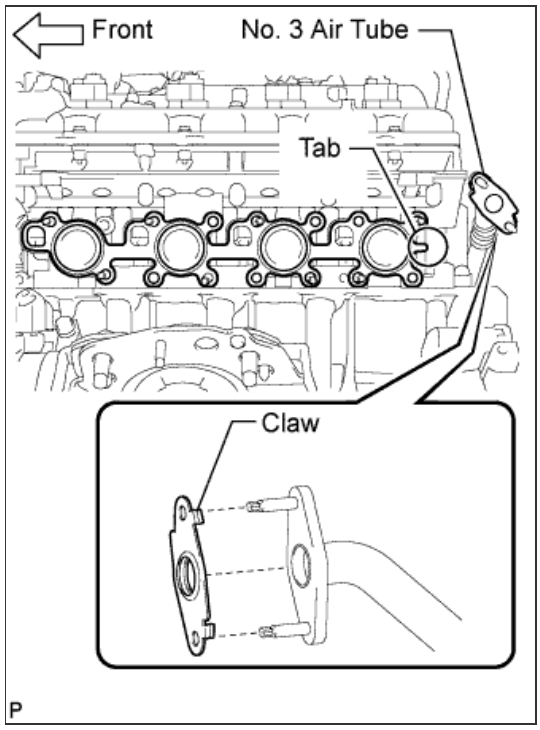


17. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Install a new gasket to the cylinder head and a new gasket to the No. 3 air tube.

HINT:

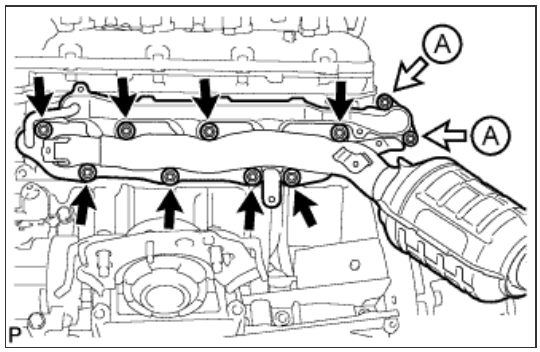
- **Install the exhaust manifold gasket with the gasket tab facing toward the rear of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



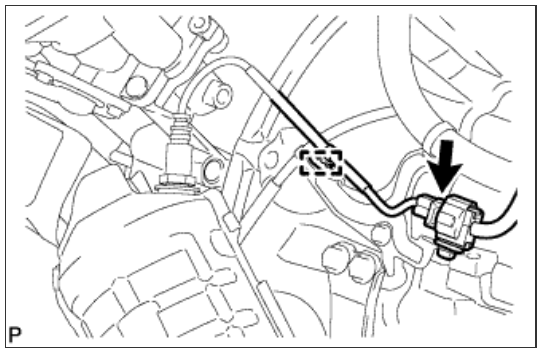
b. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

c. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



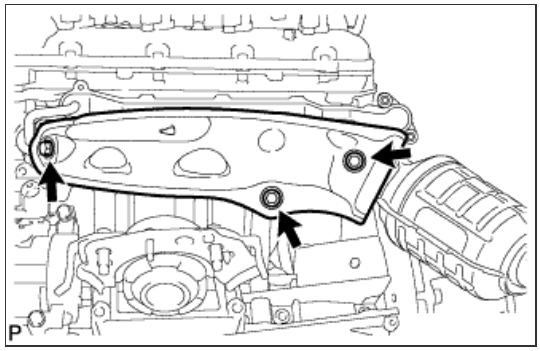
d. Attach the wire harness clamp to the bracket and connect the connector.



18. INSTALL NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

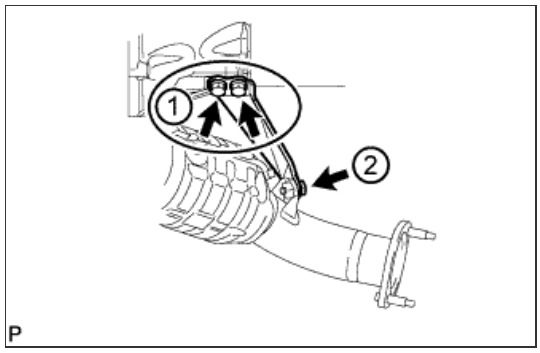


19. INSTALL NO. 2 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

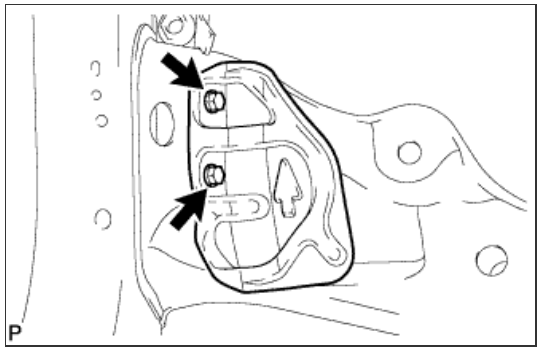
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



20. INSTALL PROPELLER SHAFT HEAT INSULATOR

a. Install the heat insulator with the 2 bolts.

Torque:
16 N*m{ 160 kgf*cm , 12 ft.*lbf }



21. INSTALL REAR PROPELLER SHAFT ASSEMBLY

a. Install the rear propeller shaft (Click here).

22. INSTALL FRONT PROPELLER SHAFT ASSEMBLY

a. Install the front propeller shaft (Click here).

23. INSTALL FRONT EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front exhaust pipe to the exhaust manifold RH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

24. INSTALL FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front No. 2 exhaust pipe to the exhaust manifold LH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

25. INSTALL CENTER EXHAUST PIPE ASSEMBLY

a. Install 2 new gaskets to the front exhaust pipe and front No. 2 exhaust pipe.

b. Install the center exhaust pipe to the 3 exhaust pipe supports, and then install the 4 bolts.

Torque:
48 N*m{ 489 kgf*cm , 35 ft.*lbf }

26. INSTALL TAILPIPE ASSEMBLY

a. Install the tailpipe to the 2 exhaust pipe supports.

b. Install a new gasket to the center exhaust pipe.

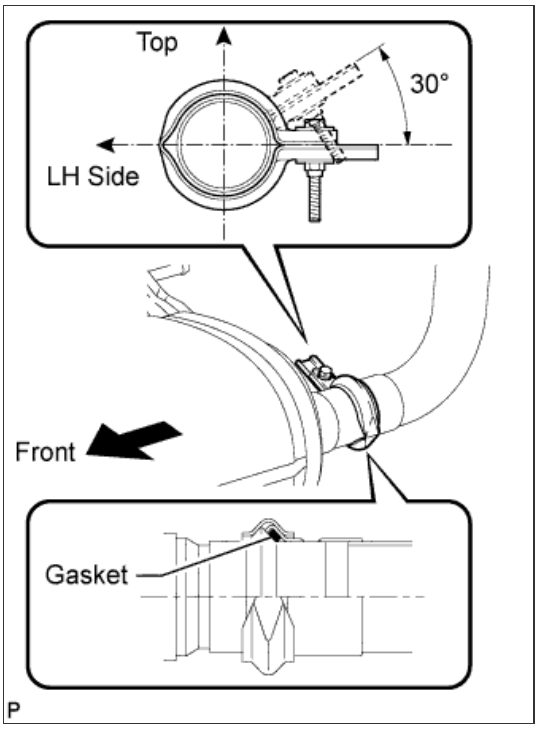
c. Connect the tailpipe to the center exhaust pipe.

d. Attach a new clamp to the tailpipe and center exhaust pipe. Then install the bolt to the clamp.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }

HINT:

Install the clamp within the angle range shown in the illustration.



27. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

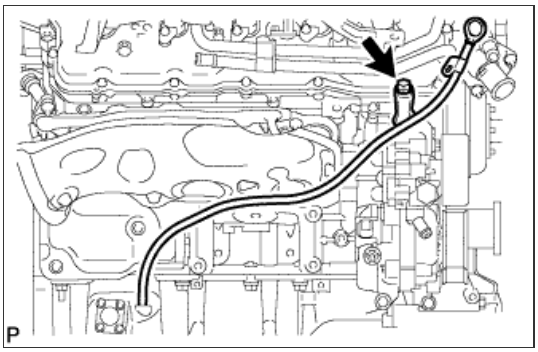
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

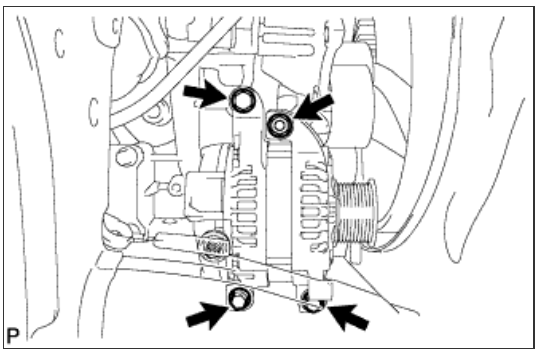
d. Install the dipstick.



28. INSTALL GENERATOR ASSEMBLY

a. Install the generator with the 3 bolts and nut.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



b. Connect the generator connector.

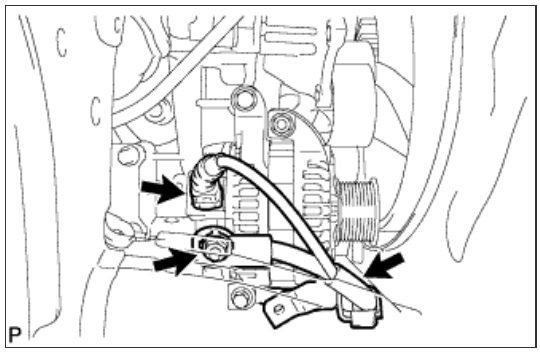
c. Connect the generator wire with the nut.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

d. Install the terminal cap.

e. Install the harness bracket to the generator with the bolt.

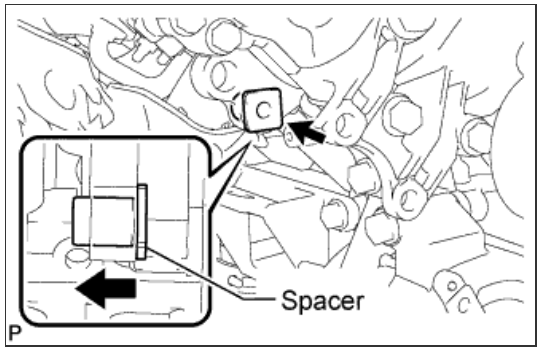
Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }



29. CONNECT VANE PUMP ASSEMBLY

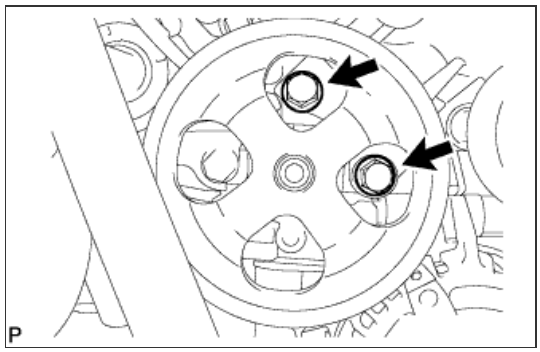
HINT:

Before performing the following procedures, move the spacer until the vane pump can be installed.

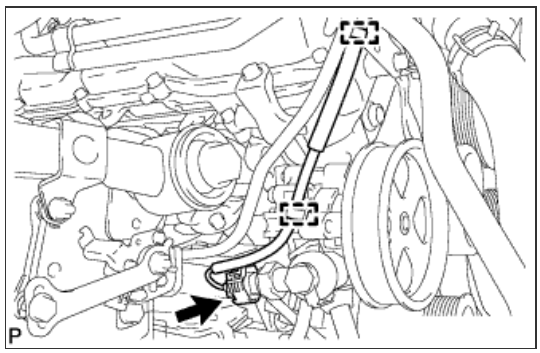


a. Connect the vane pump to the timing chain cover with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



b. Connect the 2 clamps and power steering oil pressure switch connector.



30. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

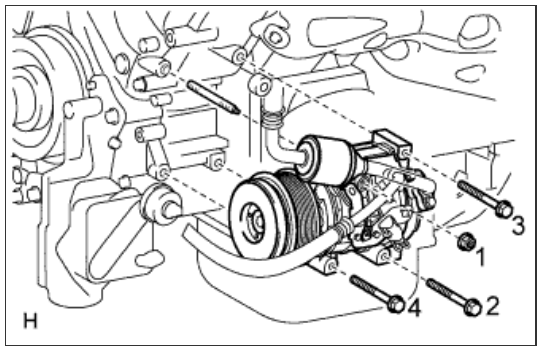
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

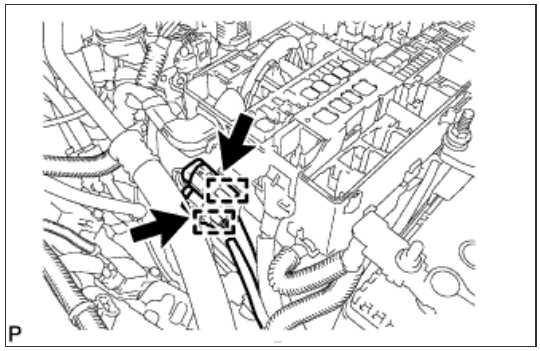
NOTICE:

Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.



31. CONNECT WIRE HARNESS AND HOSE

a. Connect the clamp and 2 connectors.



b. Connect the 2 connectors and 2 clips to the engine room junction block.

c. Install the engine wire with the nut. Then connect the 2 clips.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Connect the 4 air injection control driver connectors.

e. Install the ground wire to the air injection control bracket with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

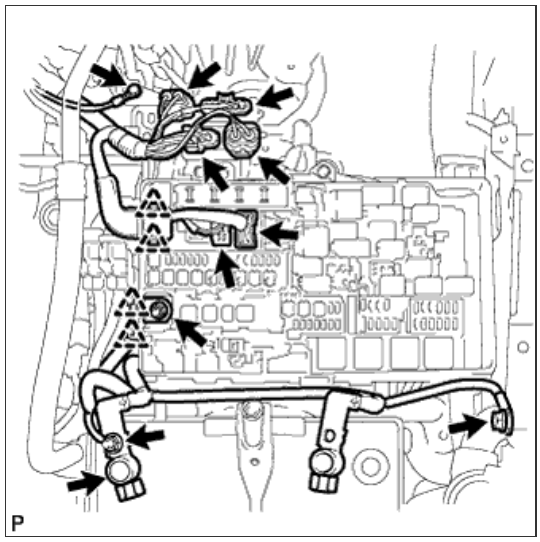
f. Install the ground wire to the body with the bolt.

Torque:
8.4 N*m{ 86 kgf*cm , 74 in.*lbf }

g. Connect the cable to the positive (+) battery terminal.

h. Install the wire to the positive (+) battery cable with the nut.

Torque:
5.4 N*m{ 55 kgf*cm , 48 in.*lbf }



i. Connect the 2 air injection system hoses.

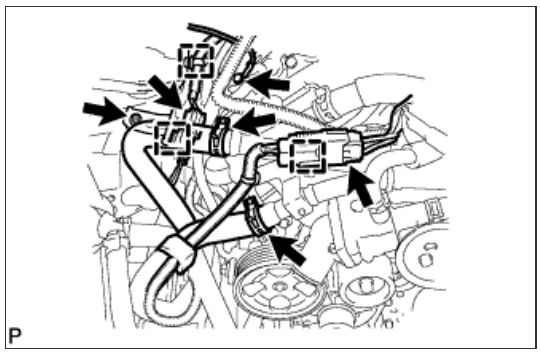
j. Install the ground wire with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

k. Connect the 3 clamps and 2 air pump connectors.

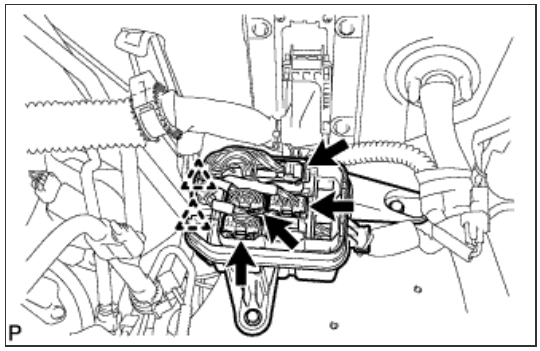
l. Install the connector bracket with the nut.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

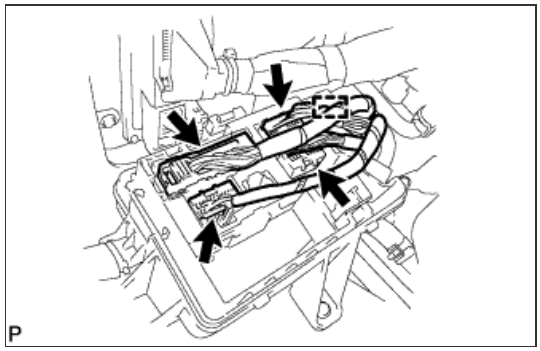


m. Connect the 4 connectors.

i. for RHD:
Connect the 4 connectors and 2 clips to the connector holder block.



ii. for LHD:
Connect the 4 connectors and clamp to the connector holder block.

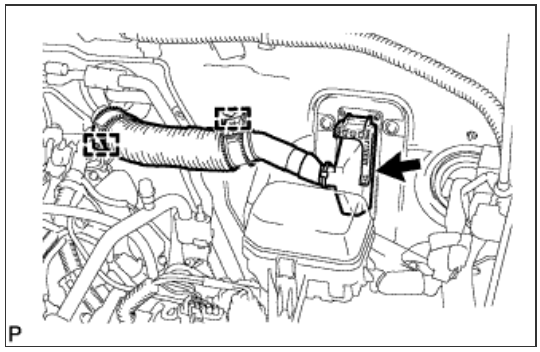


n. Connect the ECM connector.

i. for RHD:
Connect the 2 clamps and ECM connector.

HINT:

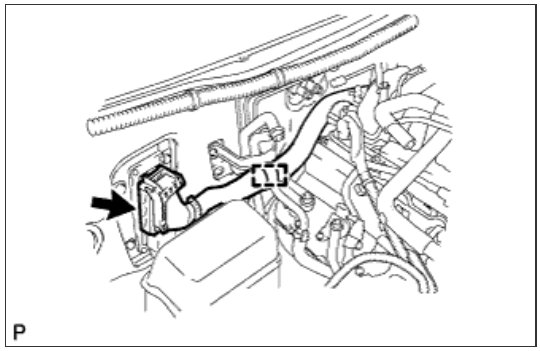
Refer to the following procedures to connect the ECM connector (Click here).



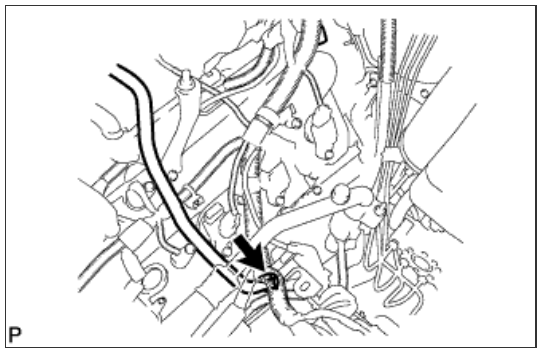
ii. for LHD:
Connect the clamp and ECM connector.

HINT:

Refer to the following procedures to connect the ECM connector (Click here).



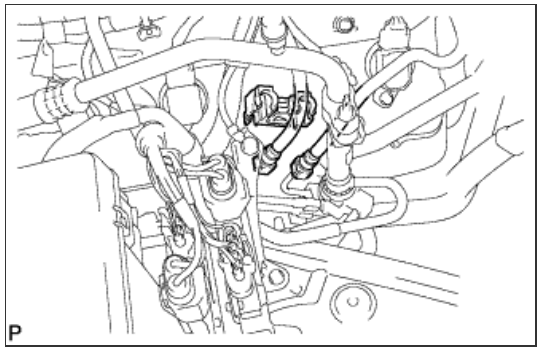
o. Connect the purge line hose.



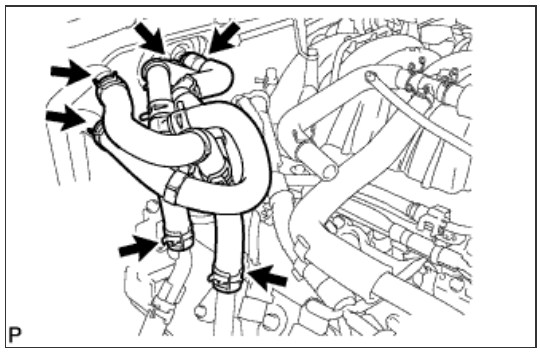
32. CONNECT FUEL MAIN AND RETURN HOSE

a. Connect the fuel main and return hoses (Click here).

b. Install the fuel pipe clamp.



33. INSTALL WATER HOSE SUB-ASSEMBLY

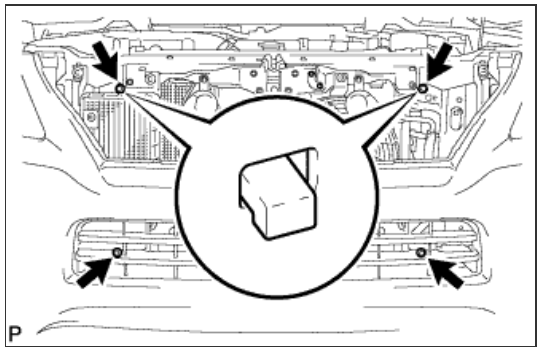


34. INSTALL RADIATOR ASSEMBLY

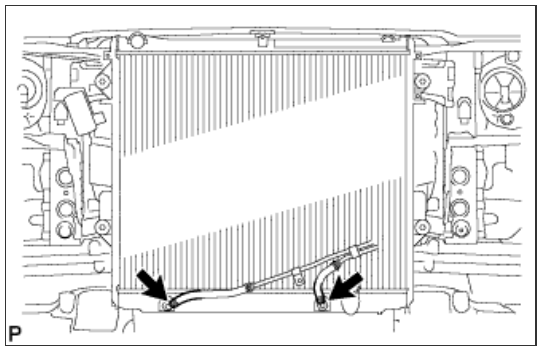
a. Set the radiator bracket hooks to the radiator support holes.

b. Install the radiator with the 4 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



c. Connect the 2 oil cooler hoses.



35. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

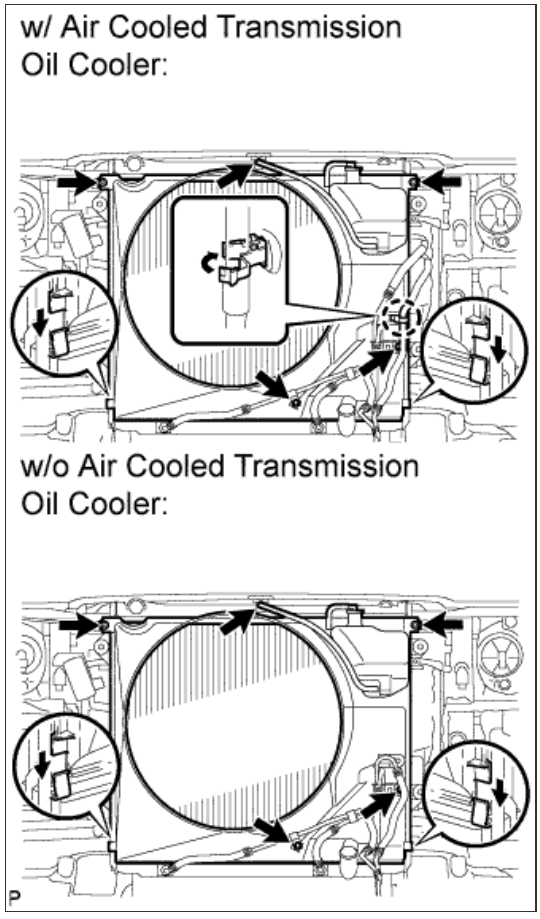
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

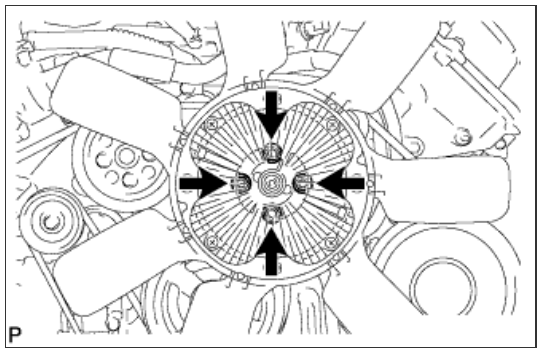
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



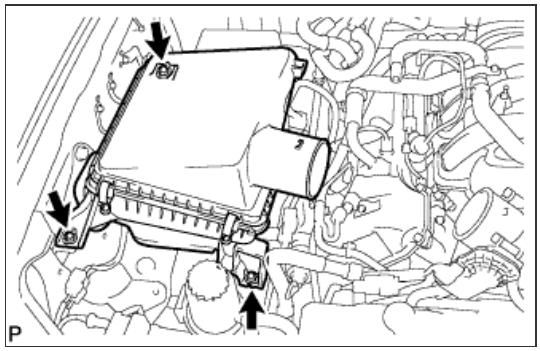
36. INSTALL NO. 2 RADIATOR HOSE

37. INSTALL NO. 1 RADIATOR HOSE

38. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



39. INSTALL AIR CLEANER HOSE ASSEMBLY

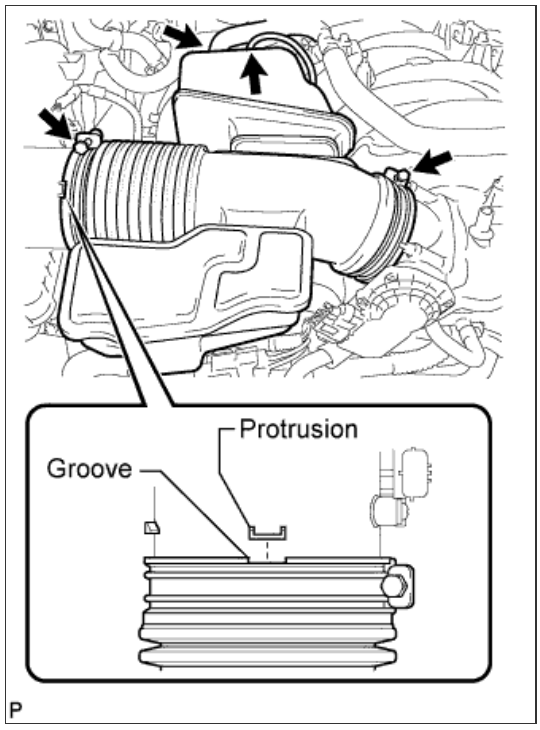
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



40. INSTALL HOOD SUB-ASSEMBLY

a. Install the hood with the 4 bolts.

Torque:
13 N*m{ 133 kgf*cm , 10 ft.*lbf }

b. Connect the 2 hood supports with the 2 hood support bolts.

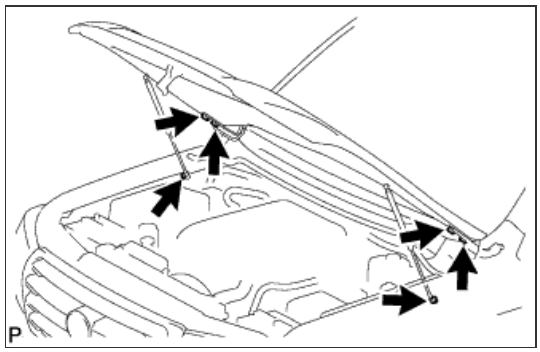
Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }

CAUTION:

Install the hood support while supporting the hood by hand.

NOTICE:

Check that the hood support is engaged in the ball joint and that it cannot be pulled out.



41. ADJUST HOOD SUB-ASSEMBLY

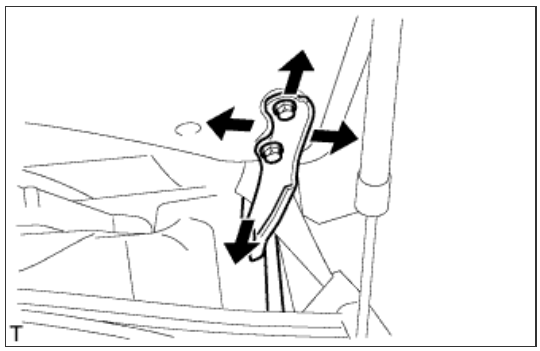
a. Adjust the hood position.

i. Loosen the 4 hinge bolts of the hood.

ii. Move the hood and adjust the clearance between the hood and front fender.

iii. Tighten the 4 hinge bolts of the hood after the adjustment.

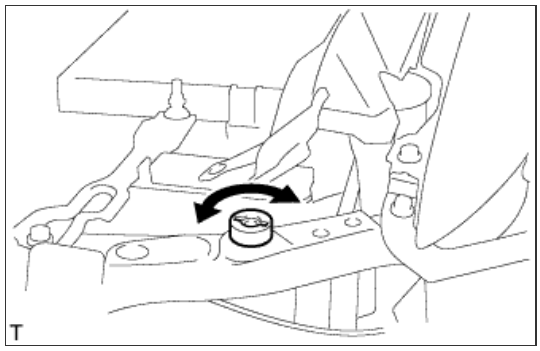
Torque:
13 N*m{ 133 kgf*cm , 10 ft.*lbf }



iv. Adjust the cushion rubber so that the height of the hood and fender are aligned.

HINT:

Raise or lower the front end of the hood by turning the cushion rubber.



b. Adjust the hood lock.

i. Using a screwdriver, remove the hood lock nut cap as shown in the illustration.

HINT:

Tape the screwdriver tip before use.

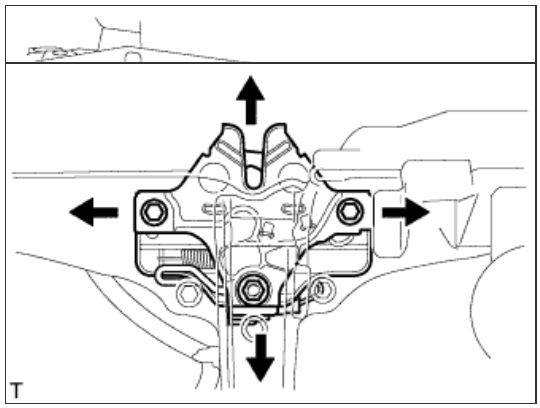
ii. Loosen the 2 bolts and hood lock nut.

iii. Adjust the hood lock position so that the striker can enter it smoothly.

iv. Tighten the bolts and nut after the adjustment.

Torque:
5.5 N*m{ 56 kgf*cm , 49 in.*lbf }

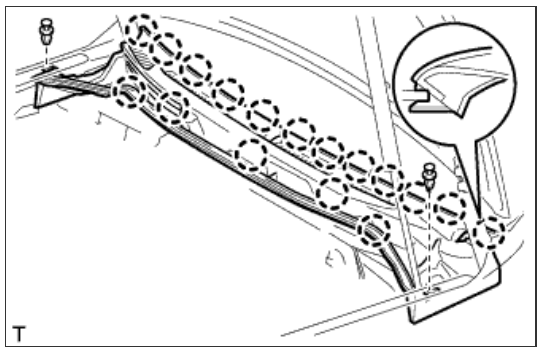
v. Install a new cap.



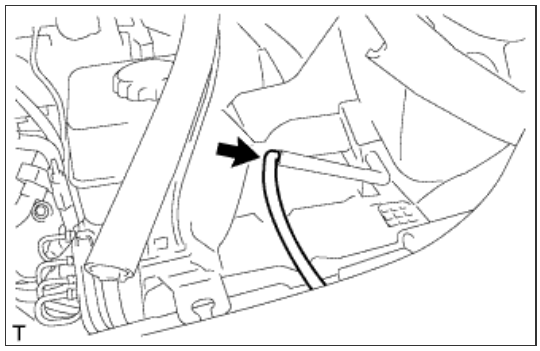
42. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Push in the ventilator louver to attach the 17 claws and install the ventilator louver.

b. Install the 2 clips.

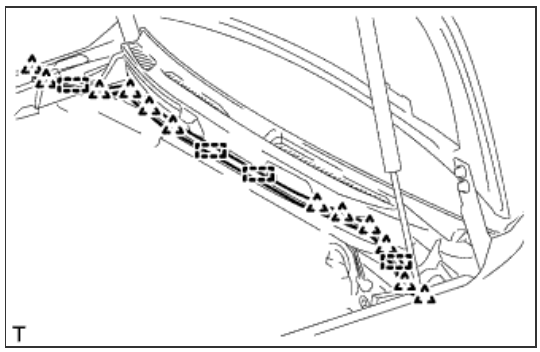


c. Connect the washer hose.



43. INSTALL HOOD TO COWL TOP SEAL

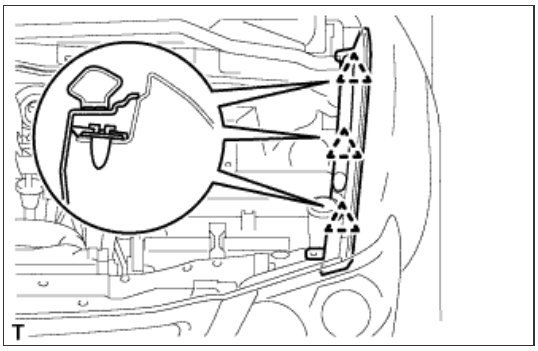
a. Attach the 12 clips and 4 clamps to install the hood to cowl top seal.



44. INSTALL FRONT FENDER MAIN SEAL LH

a. Attach the 3 clips to install the fender main seal

a. Attach the 3 clips to install the fender main seal.



45. INSTALL FRONT FENDER MAIN SEAL RH

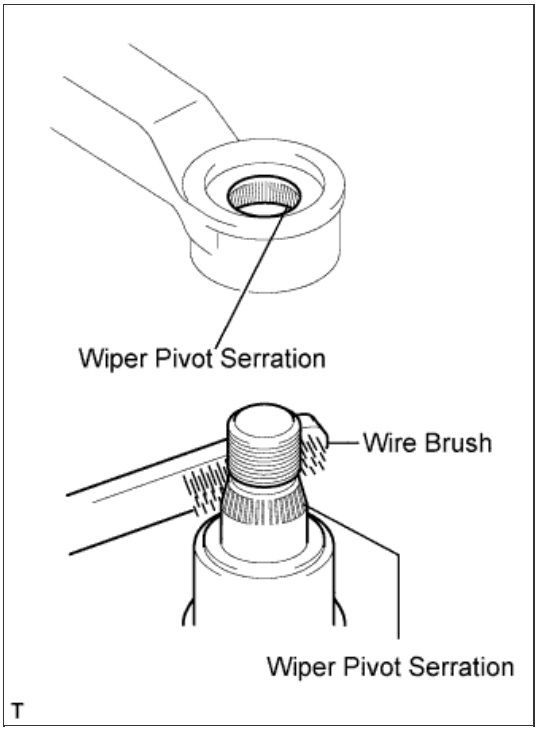
HINT:

Use the same procedures described for the LH side.

46. INSTALL FRONT WIPER ARM LH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

Standard:

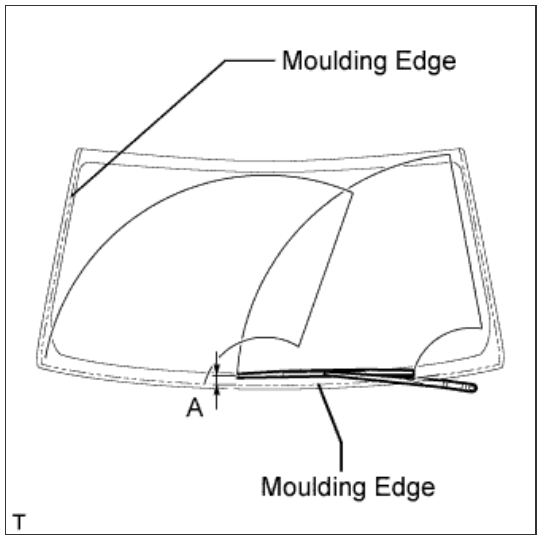
Position	Specified Condition
A	16.8 to 36.8 mm (0.661 to 1.45 in.)

Torque:

25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

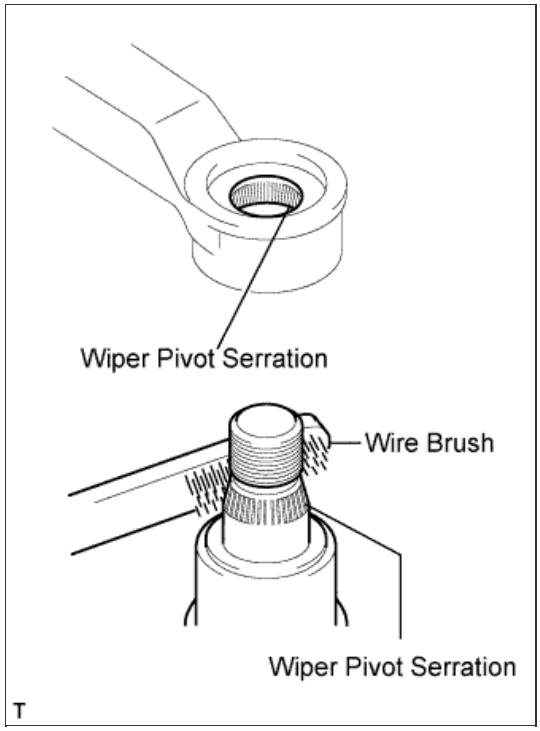
Hold down the wiper arm hinge with your hand while tightening the nut.



47. INSTALL FRONT WIPER ARM RH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

Standard:

Position	Specified Condition
B	20.0 to 40.0 mm (0.787 to 1.57 in.)

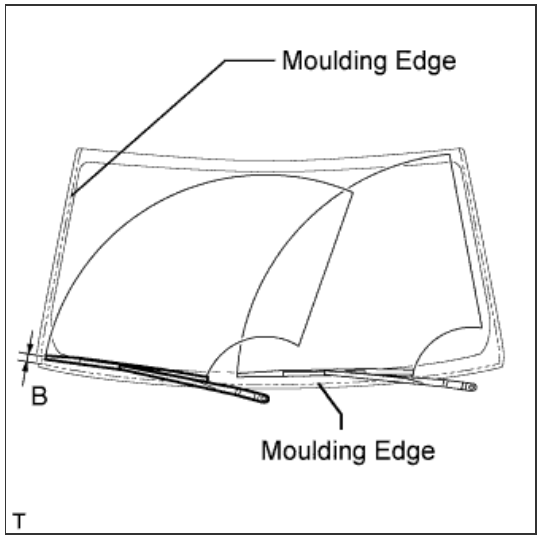
Torque:

25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

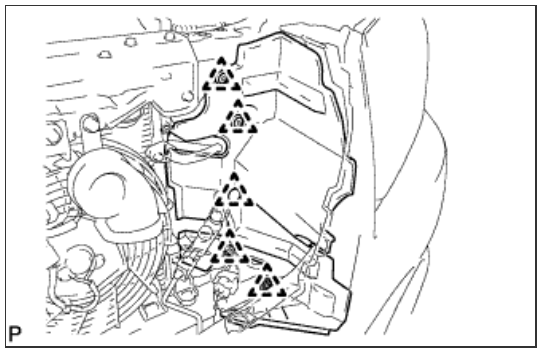
Hold down the wiper arm hinge with your hand while tightening the nut.

d. Operate the front wipers while spraying washer fluid on the windshield glass. Make sure that the front wipers function properly and there is no interference with the vehicle body.



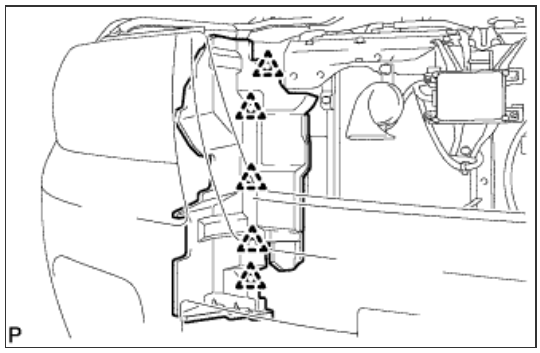
48. INSTALL RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



49. INSTALL RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



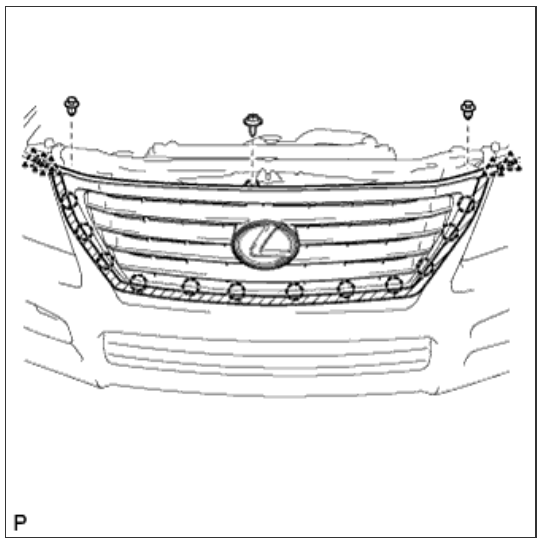
50. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

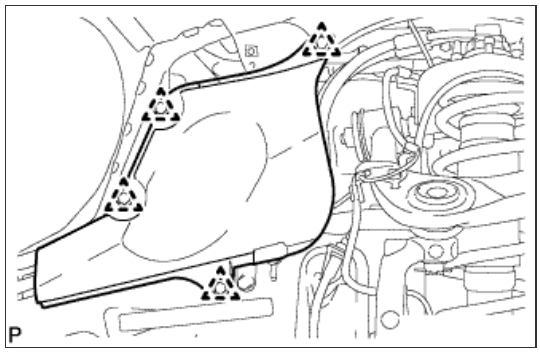
c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



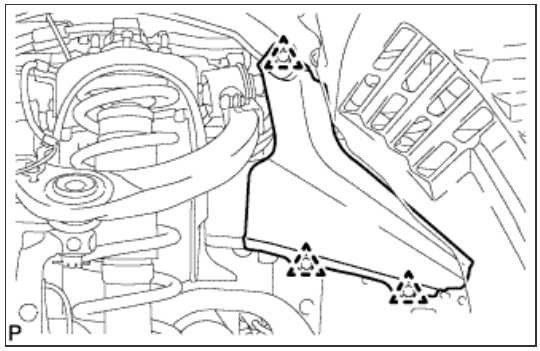
51. INSTALL FRONT FENDER APRON SEAL REAR RH

a. Install the fender apron seal with the 4 clips.



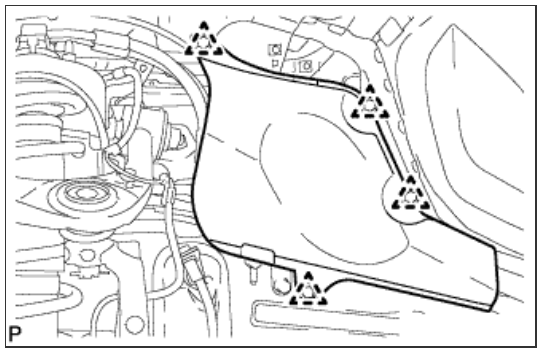
52. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



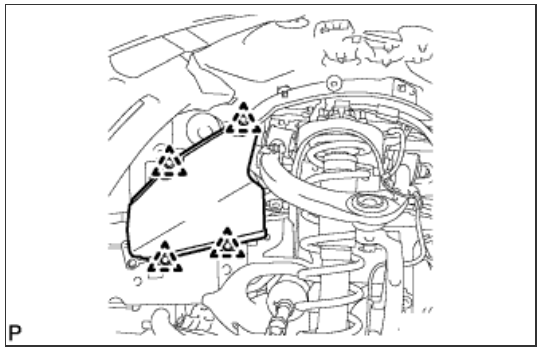
53. INSTALL FRONT FENDER APRON SEAL REAR LH

a. Install the fender apron seal with the 4 clips.



54. INSTALL FRONT FENDER APRON SEAL FRONT LH

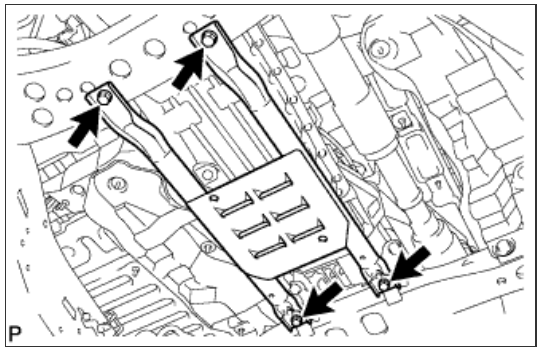
a. Install the fender apron seal with the 4 clips.



55. INSTALL OIL PAN PROTECTOR ASSEMBLY

a. Install the oil pan protector with the 4 bolts.

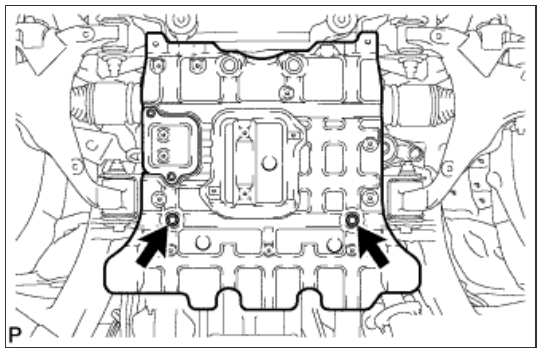
Torque:
63 N*m{ 642 kgf*cm , 46 ft.*lbf }



56. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

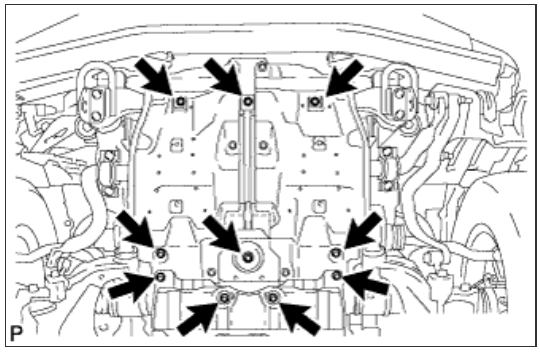
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



57. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

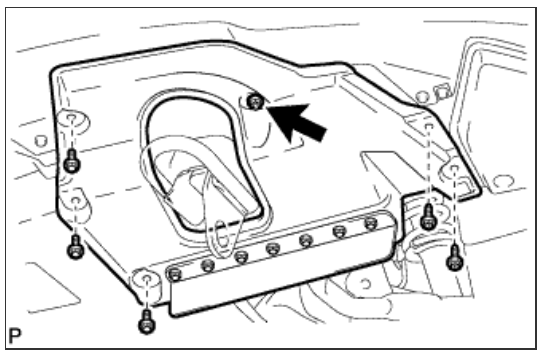
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



58. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



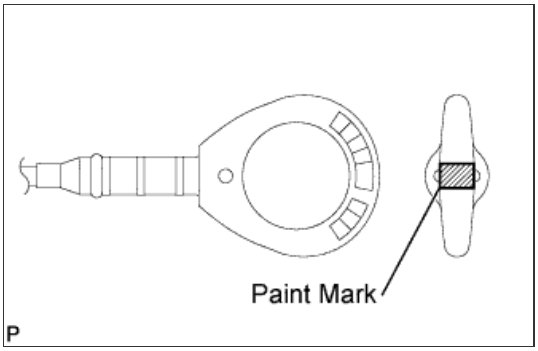
59. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

60. ADD ENGINE OIL

a. Add fresh oil and install the oil filler cap.



Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

61. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

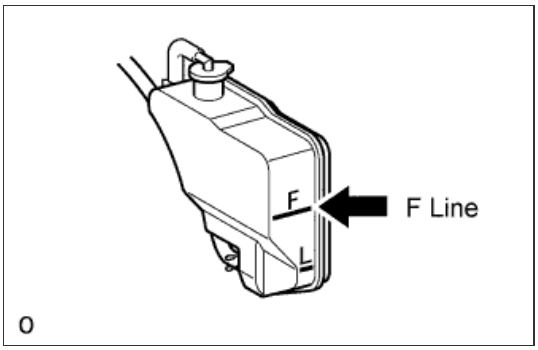
HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.



e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

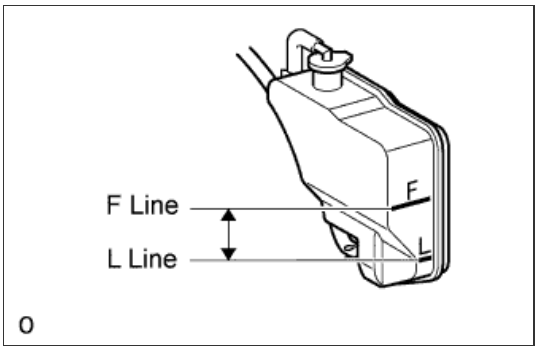
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



62. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

63. INSPECT FOR OIL LEAK

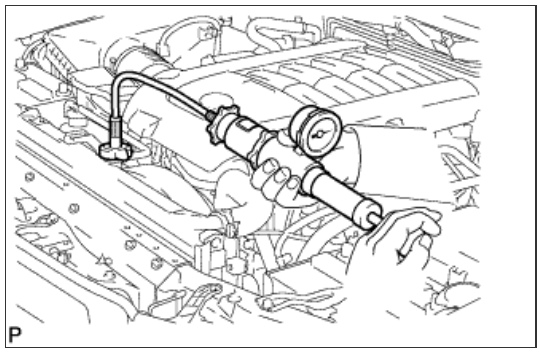
a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

64. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



65. INSPECT FOR EXHAUST GAS LEAK

66. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

67. INSPECT SHIFT LEVER POSITION

a. When moving the shift lever from P to R with the engine switch on (IG) and the brake pedal depressed, make sure that it moves smoothly and correctly into position.

b. Check that the shift lever does not stop when moving the shift lever from R to P, and check that the shift lever does not stick when moving the shift lever from D to S.

c. Start the engine and make sure that the vehicle moves forward after moving the shift lever from N to D and moves rearward after moving the shift lever to R.
If the operation cannot be performed as specified, inspect the park/neutral position switch assembly and check the shift lever assembly installation condition.

68. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

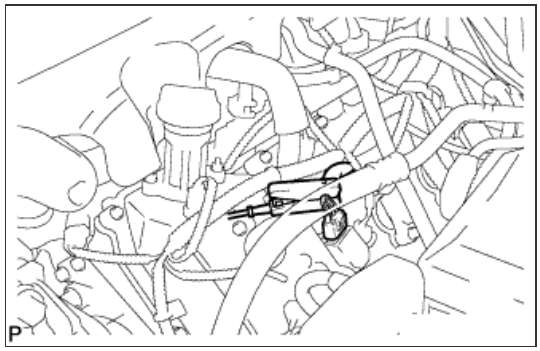
HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:

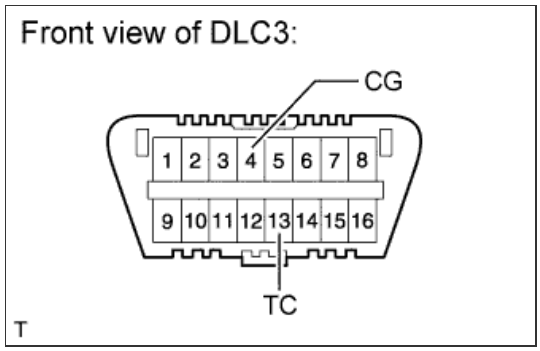


i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

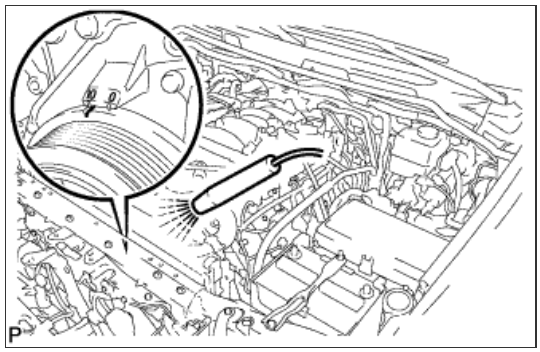


SST
09843-18040

NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**

iii. Using the timing light, check the ignition timing.



Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.

h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

69. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

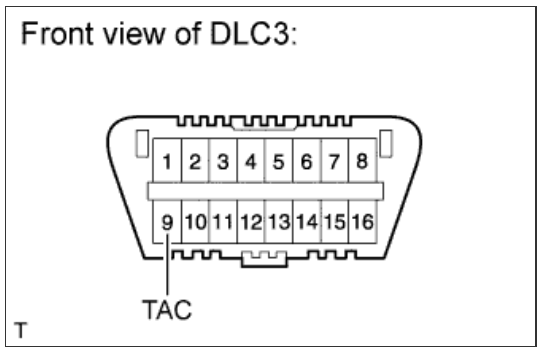
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Check the idle speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

70. INSPECT CO/HC

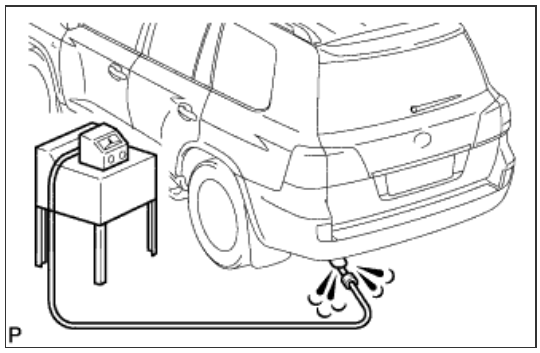
HINT:

This check is used only to determine whether or not the idle CO/HC complies with regulations.

a. Start the engine.

b. Keep the engine speed at 2500 rpm for approximately 180 seconds.

c. Insert the CO/HC meter testing probe at least 40 cm (1.31 ft.) into the tailpipe during idling.



d. Immediately check CO/HC concentration at idle and/or 2500 rpm.

HINT:

When performing the 2 mode (2500 rpm and idle) test, follow the measurement order prescribed by the applicable local regulations.

e. If the CO/HC concentration does not comply with the regulations, troubleshoot in the order given below.

i. Check the A/F sensor operation (Click here) and heated oxygen sensor operation (Click here).

ii. See the table below for possible causes, and then inspect and correct the applicable causes if necessary.

CO	HC	Symptom	Cause
Normal	High	Rough idle	1. Faulty ignitions: • Incorrect timing • Plugs (contaminated, shorted or gaps are defective) 2. Incorrect valve clearance 3. Leaky intake and exhaust valves 4. Leaky cylinder
Low	High	Rough idle (Fluctuating HC reading)	1. Vacuum leaks: • PCV hose • Intake manifold • Throttle body 2. Lean mixture causing misfire
High	High	Rough idle (Black smoke from exhaust)	1. Restricted air filter 2. Faulty SFI system: • Faulty pressure regulator • Defective ECT sensor • Faulty ECM • Faulty injectors • Faulty throttle position sensor • Faulty MAF meter

71. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark. If low, check for leakage and add oil up to the full level mark.

NOTICE:

Do not fill engine oil above the full level mark.

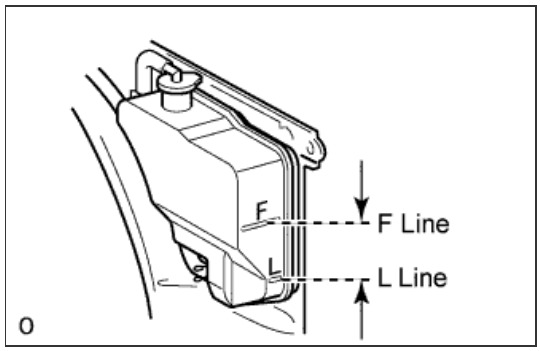
72. INSPECT ENGINE COOLANT LEVEL

a. Check that the engine coolant level is between the L and F lines when the engine is cold.
If the engine coolant is below the L line, check for leaks and add "TOYOTA Super Long Life Coolant" or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology to the F line.

NOTICE:

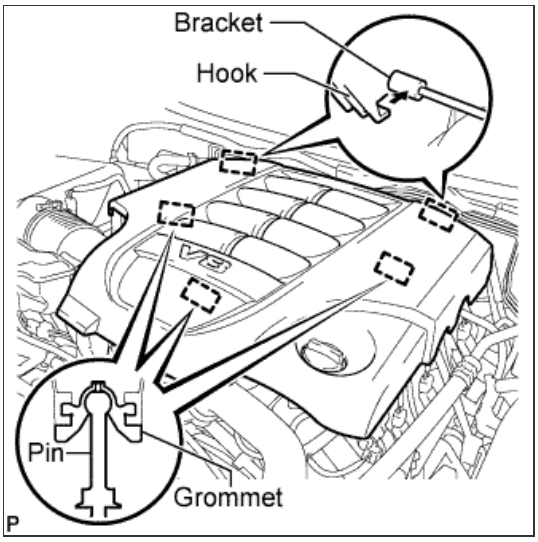
Do not substitute plain water for engine coolant.

b. Remove the radiator cap, and check that the coolant level is up to the radiator filler hole.



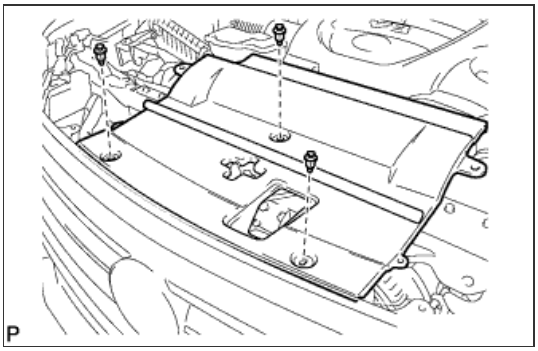
73. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



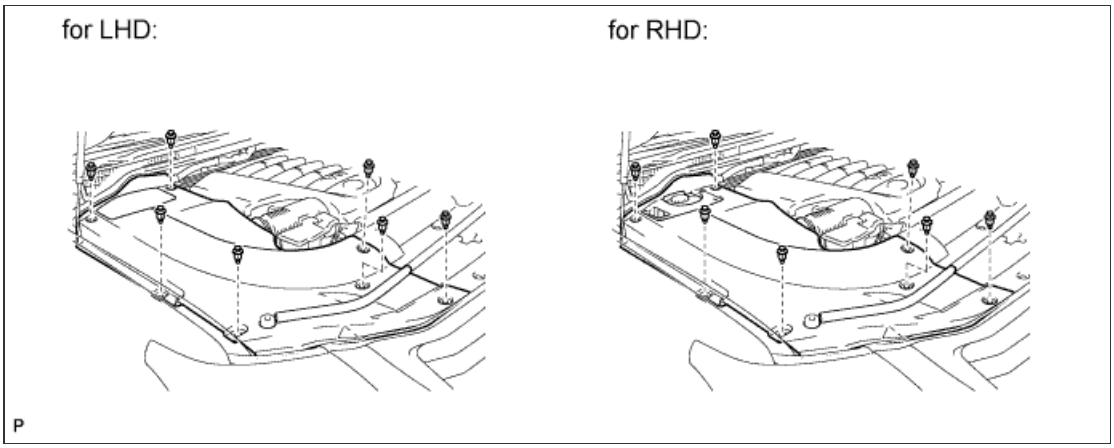
74. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



75. INSTALL ENGINE ROOM SIDE COVER RH

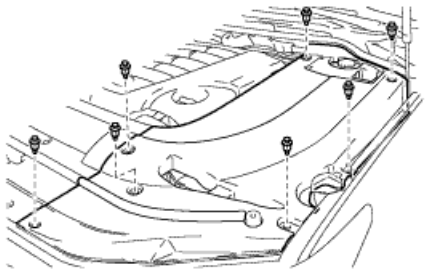
a. Install the engine room side cover with the 7 clips.



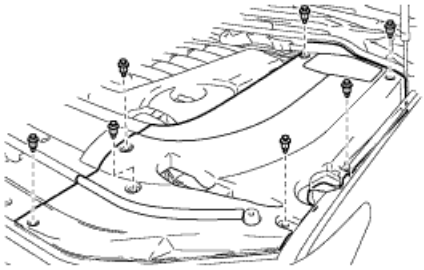
76. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

for LHD:



for RHD:



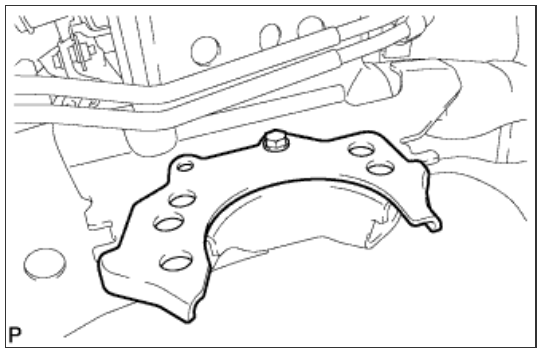
P

for Preparation Click here

1. INSTALL FRONT NO. 2 ENGINE MOUNTING BRACKET LH

a. Install the engine mounting bracket LH with the bolt.

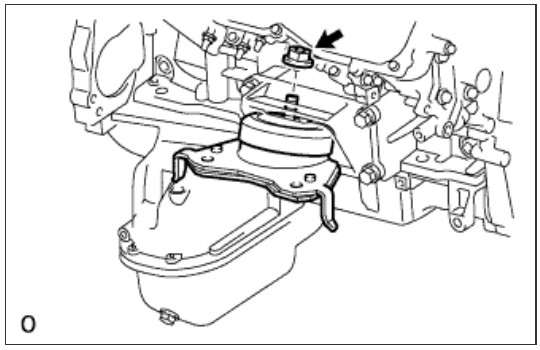
Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }



2. INSTALL FRONT ENGINE MOUNTING INSULATOR RH

a. Install the mounting insulator with the nut.

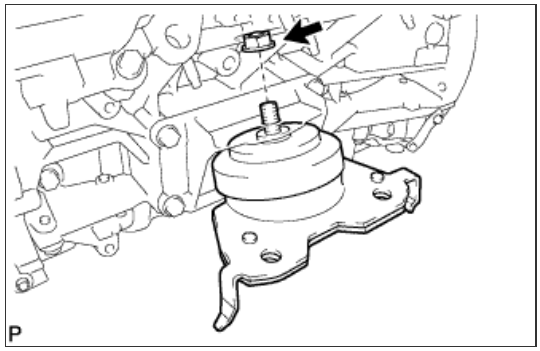
Torque:
72 N*m{ 734 kgf*cm , 53 ft.*lbf }



3. INSTALL FRONT ENGINE MOUNTING INSULATOR LH

a. Install the mounting insulator with the nut.

Torque:
72 N*m{ 734 kgf*cm , 53 ft.*lbf }



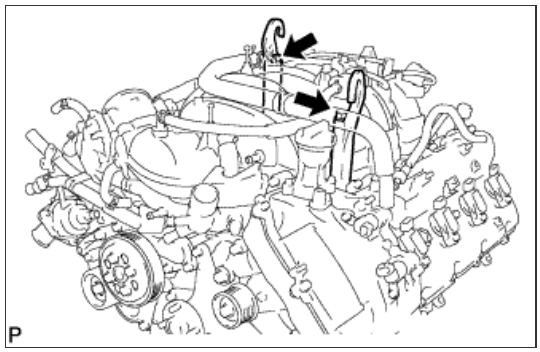
4. REMOVE ENGINE STAND

a. Install 2 engine hangers with 2 bolts as shown in the illustration.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }

HINT:

Item	Part No.
Engine hanger	12281-38150
Bolt	90119-14120



b. Attach an engine sling device and hang the engine with a chain block.

c. Remove the bolts and engine assembly from the engine stand.

NOTICE:

- **With the exception of installing the engine assembly to an engine stand or removing the engine assembly from an engine stand, do not perform any work on the engine while it is suspended, as doing so is dangerous.**
- **Pay attention to the angle of the sling device as the engine assembly or engine hangers may be damaged or deformed if the angle is incorrect.**

5. INSTALL ENGINE ASSEMBLY

a. Slowly lower the engine assembly into the engine compartment.

NOTICE:

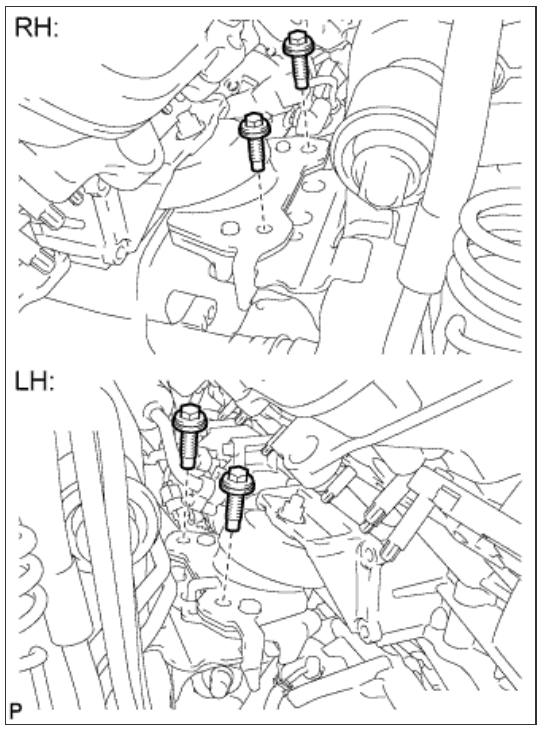
Make sure that the engine is clear of all wiring and hoses.

b. Attach the engine mounting insulators to the vehicle.

c. Install the 4 engine mounting insulator bolts.

Torque:
79 N*m{ 806 kgf*cm , 58 ft.*lbf }

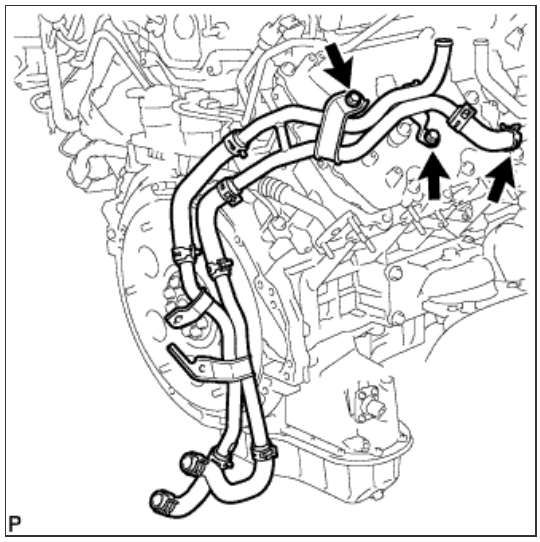
d. Remove the 2 bolts and 2 engine hangers.



6. INSTALL NO. 2 WATER BY-PASS PIPE (w/o Air Cooled Transmission Oil Cooler)

a. Connect the hose and install the water by-pass pipe with the 2 bolts.

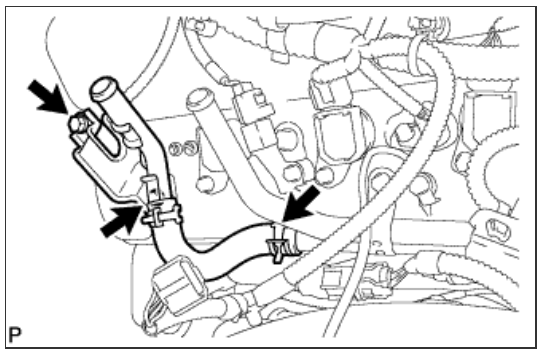
Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



7. INSTALL WATER PIPE AND HOSE SUB-ASSEMBLY (w/ Air Cooled Transmission Oil Cooler)

a. Connect the hose and install the water pipe and hose with the 2 bolts.

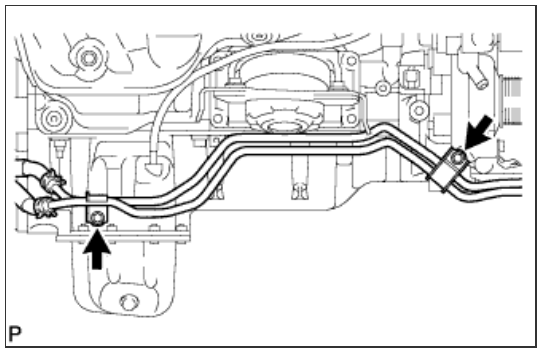
Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



8. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

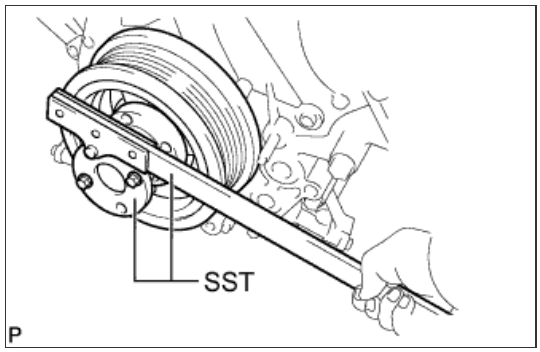
Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }



9. INSTALL DRIVE PLATE AND RING GEAR SUB-ASSEMBLY

a. Using SST, hold the crankshaft.

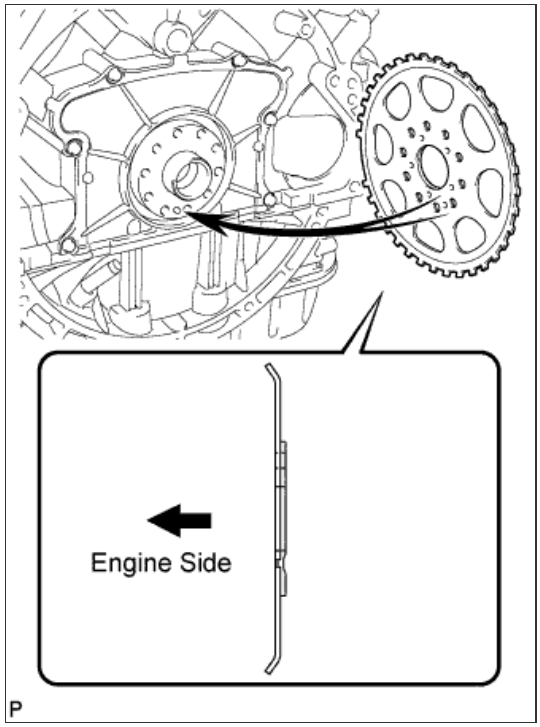
SST
09213-70011
09330-00021



b. Install the crankshaft angle sensor rotor.

HINT:

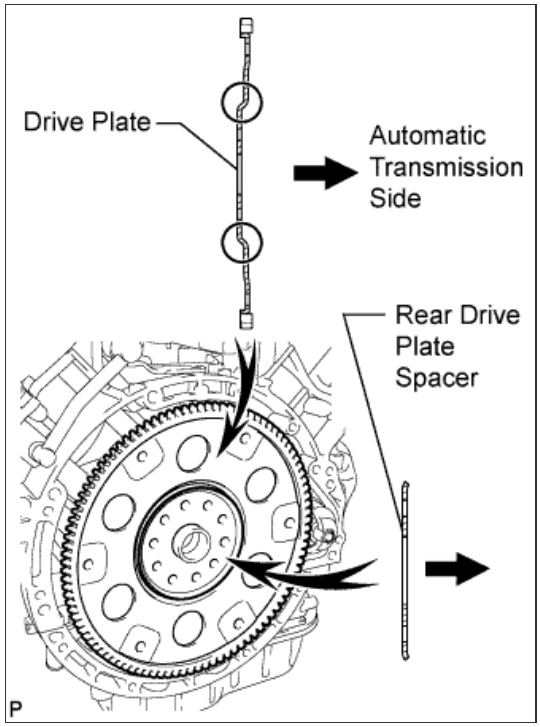
- **Align the pin hole of the crankshaft angle sensor rotor with the pin of the crankshaft.**
- **As the crankshaft angle sensor rotor is not reversible, be sure to install it so that it is facing in the direction shown in the illustration.**



c. Install the drive plate and rear drive plate spacer onto the crankshaft.

HINT:

As the rear drive plate spacer and the drive plate are not reversible, be sure to install them so that they are facing in the direction shown in the illustration.



d. Install the drive plate and ring gear and bolts.

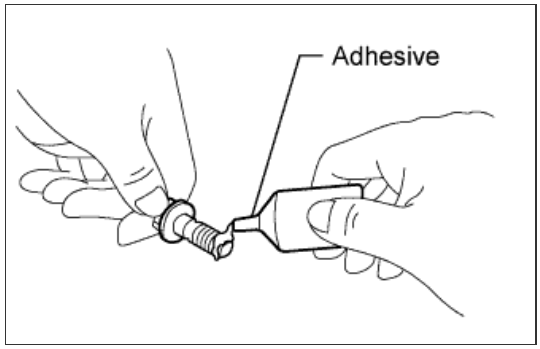
HINT:

The bolts are tightened in 2 progressive steps.

i. Clean the bolts and bolt holes.

ii. Apply adhesive to 2 or 3 threads at the end of each of the 10 bolts.

Adhesive:
Toyota Genuine Adhesive 1324, Three Bond 1324 or equivalent

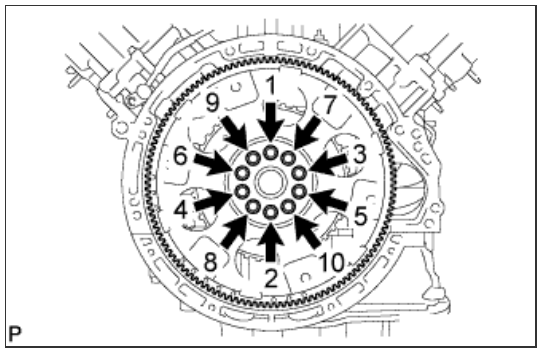


iii. Step 1:
Install and uniformly tighten 10 new bolts in the sequence shown in the illustration.

Torque:
30 N*m{ 301 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not reuse the flywheel installation bolts.**
- **Do not strike or damage the flywheel installation bolts. Be sure to handle them carefully.**



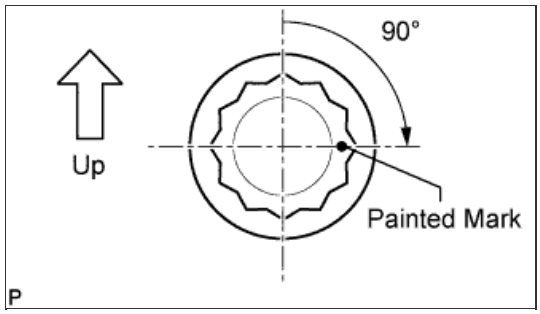
iv. Mark the upside of each flywheel installation bolt with paint.

v. Step 2:
Tighten the flywheel installation bolts 90° as shown in the illustration.

vi. Check that the painted marks are now at a 90° angle to the upside.

NOTICE:

Do not start the engine for at least an hour after installing the drive plate.



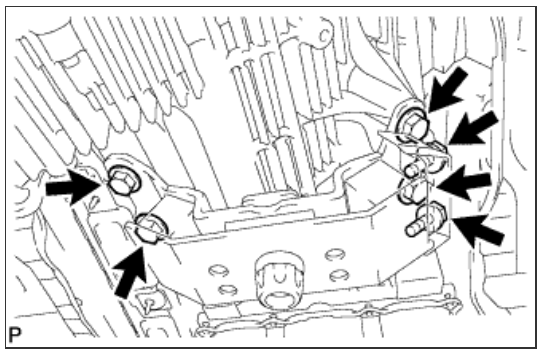
10. INSTALL REAR NO. 1 ENGINE MOUNTING INSULATOR

a. Install the rear engine mounting insulator to the transmission with the 4 bolts.

Torque:
59 N*m{ 602 kgf*cm , 44 ft.*lbf }

b. Install the front engine mounting insulator RH with the 2 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

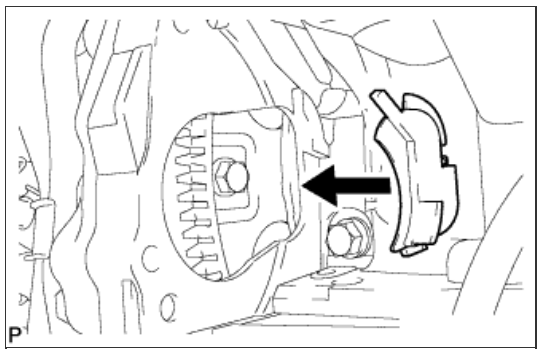


11. INSTALL AUTOMATIC TRANSMISSION ASSEMBLY

(Click here)

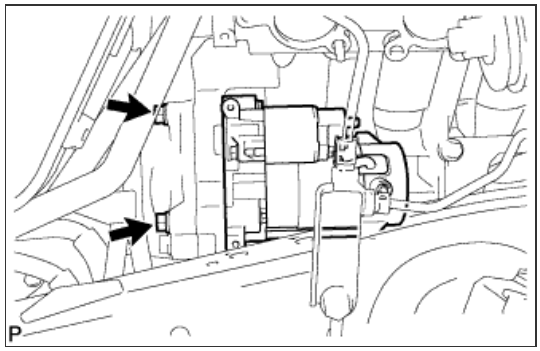
12. INSTALL STARTER ASSEMBLY

a. Install the flywheel housing side cover.



b. Install the starter with the 2 bolts.

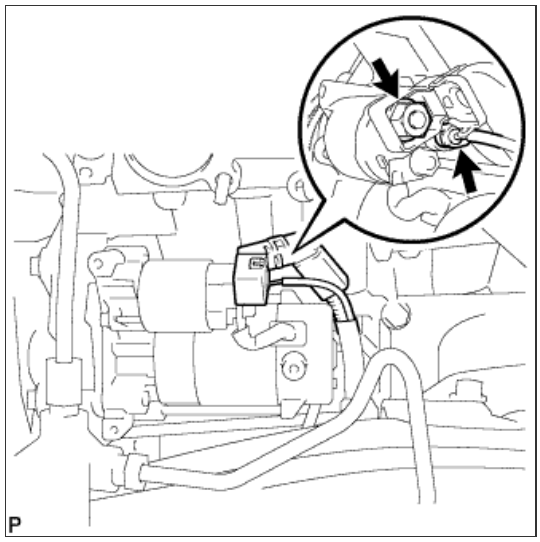
Torque:
37 N*m{ 377 kgf*cm , 27 ft.*lbf }



c. Install the starter wire with the nut.

Torque:
9.8 N*m{ 100 kgf*cm , 87 in.*lbf }

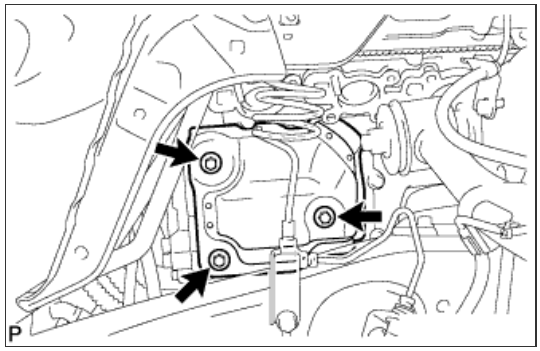
d. Connect the starter connector.



13. INSTALL STARTER COVER

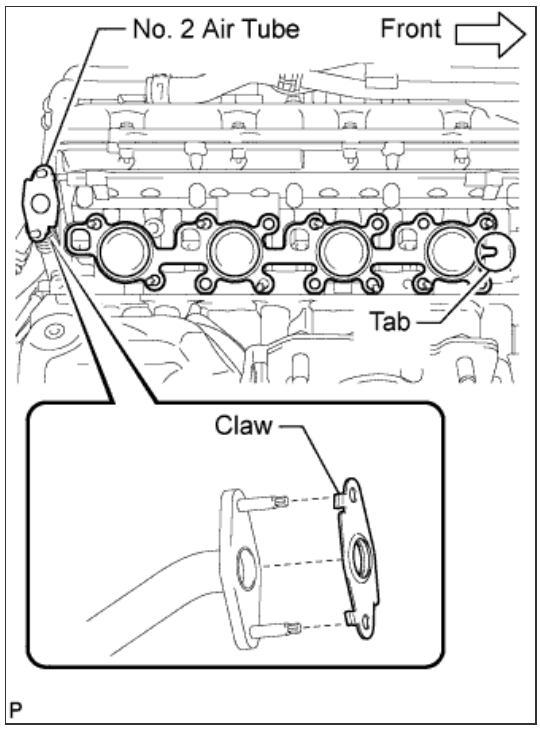
a. Install the starter cover with the 3 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



14. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY RH

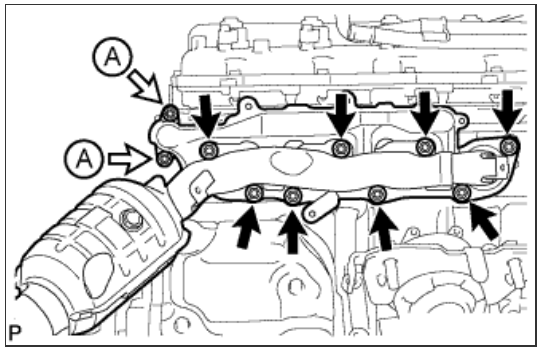
a. w/ Secondary Air Injection System:



i. Install a new gasket to the cylinder head and a new gasket to the No. 2 air tube.

HINT:

- **Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**

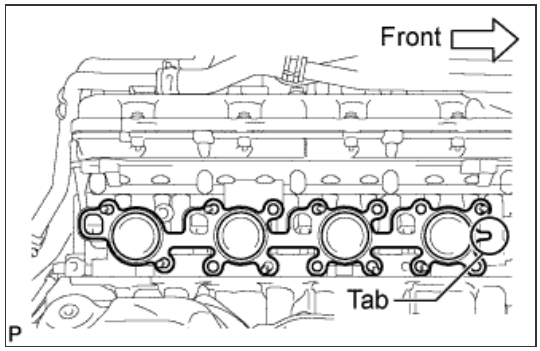


ii. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

iii. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

b. w/o Secondary Air Injection System:



i. Install a new gasket to the cylinder head.

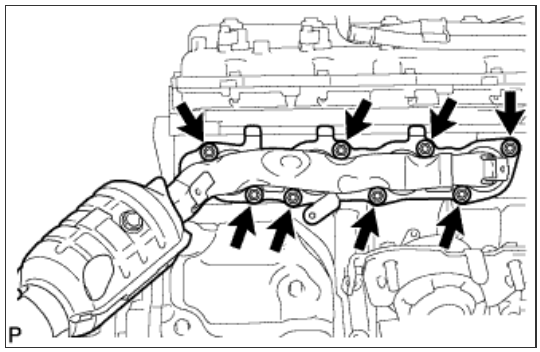
HINT:

Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.

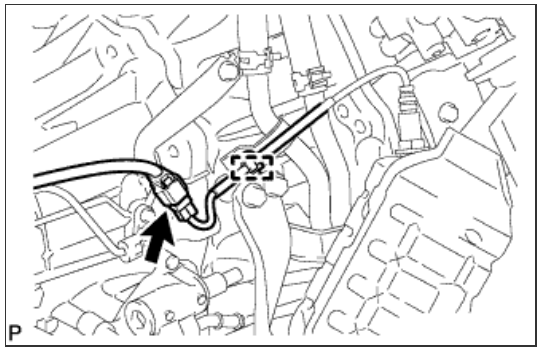
ii. Temporarily install the exhaust manifold with the 8 new nuts.

iii. Uniformly tighten the 8 nuts.

Torque:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



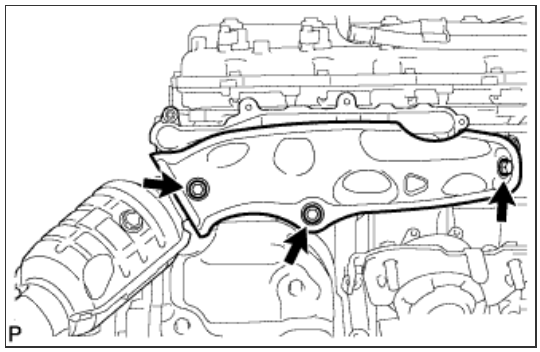
c. Attach the wire harness clamp to the bracket and connect the connector.



15. INSTALL NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

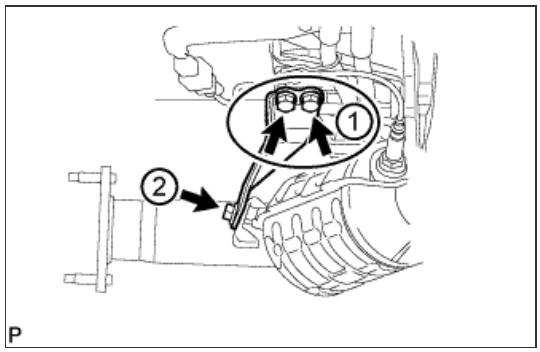


16. INSTALL NO. 1 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



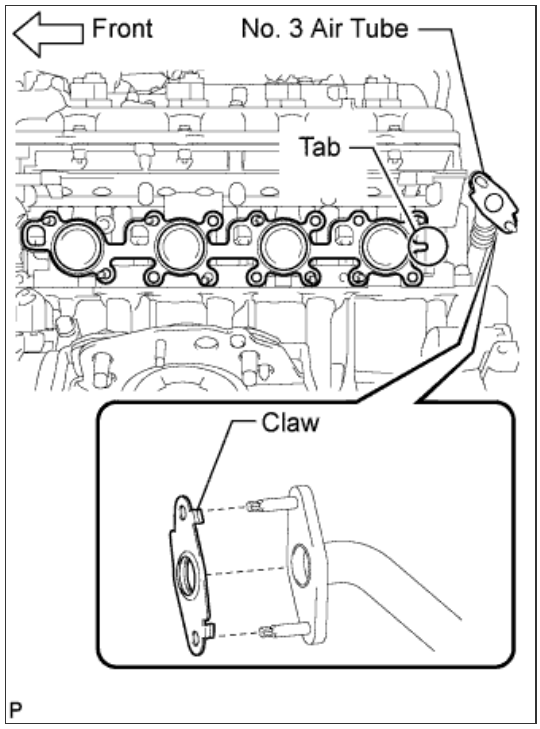
17. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. w/ Secondary Air Injection System:

i. Install a new gasket to the cylinder head and a new gasket to the No. 3 air tube.

HINT:

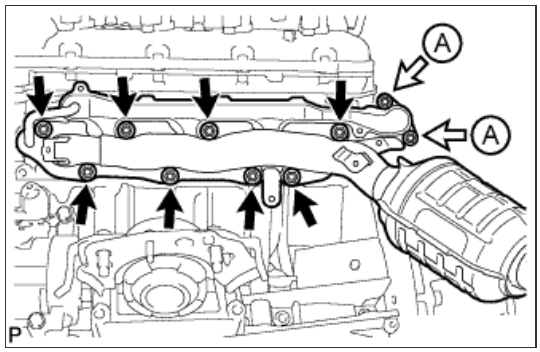
- **Install the exhaust manifold gasket with the gasket tab facing toward the rear of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



ii. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

iii. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

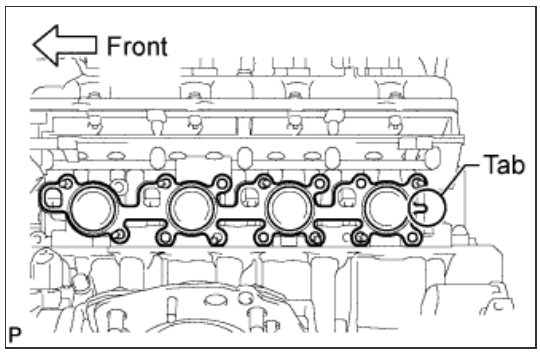


b. w/o Secondary Air Injection System:

i. Install a new gasket to the cylinder head.

HINT:

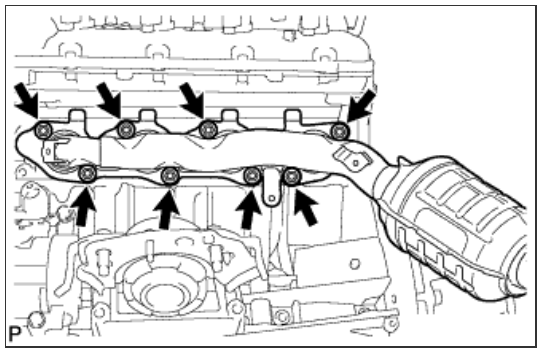
Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.



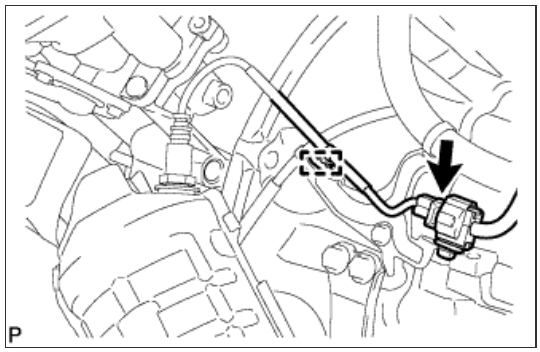
ii. Temporarily install the exhaust manifold with the 8 new nuts.

iii. Uniformly tighten the 8 nuts.

Torque:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



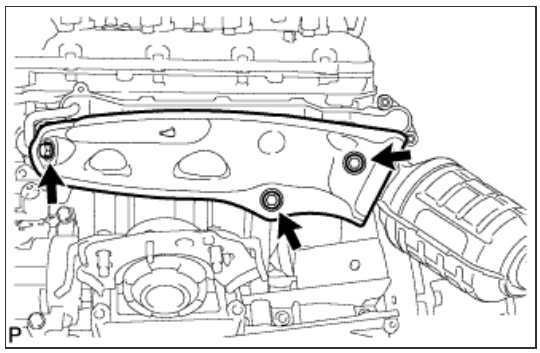
c. Attach the wire harness clamp to the bracket and connect the connector.



18. INSTALL NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

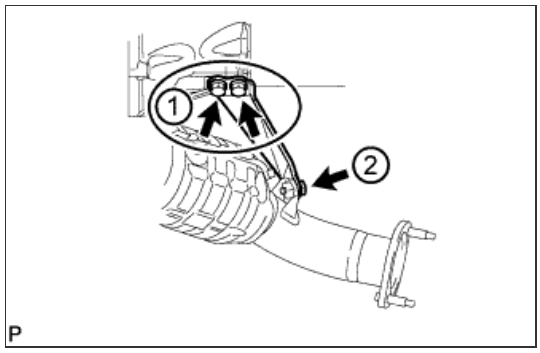


19. INSTALL NO. 2 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

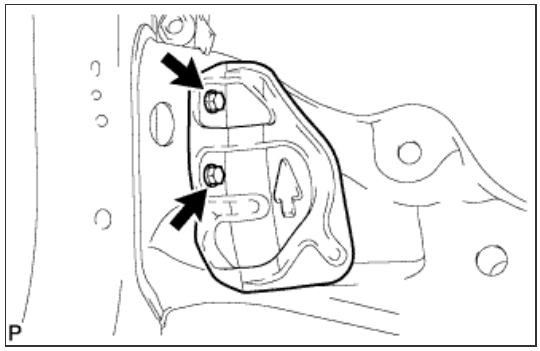
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



20. INSTALL PROPELLER SHAFT HEAT INSULATOR

a. Install the heat insulator with the 2 bolts.

Torque:
16 N*m{ 160 kgf*cm , 12 ft.*lbf }



21. INSTALL REAR PROPELLER SHAFT ASSEMBLY

(Click here)

22. INSTALL FRONT PROPELLER SHAFT ASSEMBLY

(Click here)

23. INSTALL FRONT EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front exhaust pipe to the exhaust manifold RH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

24. INSTALL FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front No. 2 exhaust pipe to the exhaust manifold LH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

25. INSTALL CENTER EXHAUST PIPE ASSEMBLY

a. Install 2 new gaskets to the front exhaust pipe and front No. 2 exhaust pipe.

b. Install the center exhaust pipe to the 3 exhaust pipe supports, and then install the 4 bolts.

Torque:
48 N*m{ 489 kgf*cm , 35 ft.*lbf }

26. INSTALL TAILPIPE ASSEMBLY

a. Install the tailpipe to the 2 exhaust pipe supports.

b. Install a new gasket to the center exhaust pipe.

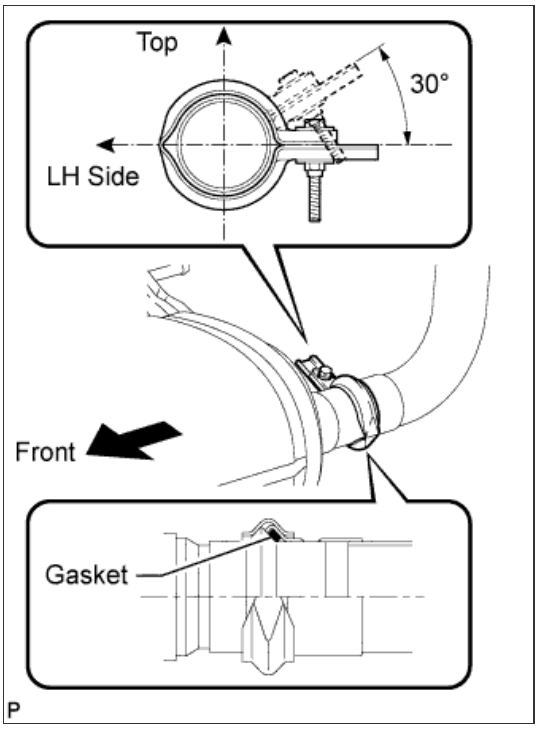
c. Connect the tailpipe to the center exhaust pipe.

d. Attach a new clamp to the tailpipe and center exhaust pipe. Then install the bolt to the clamp.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }

HINT:

Install the clamp within the angle range shown in the illustration.



27. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

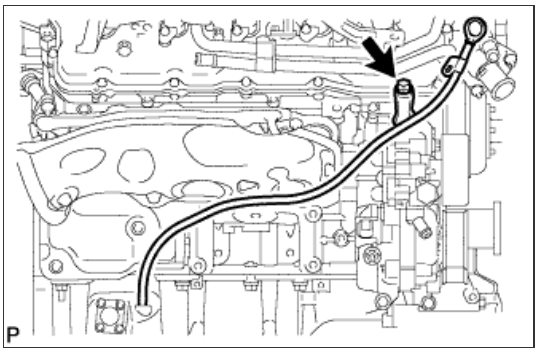
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

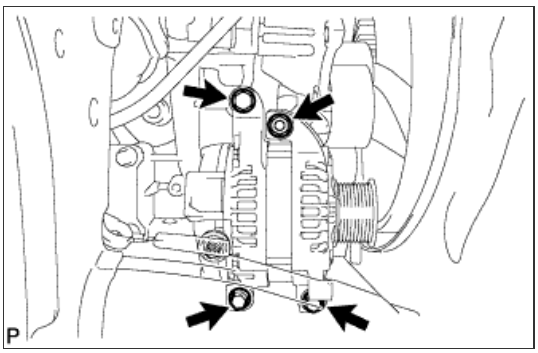
d. Install the dipstick.



28. INSTALL GENERATOR ASSEMBLY

a. Install the generator with the 3 bolts and nut.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



b. Connect the generator connector.

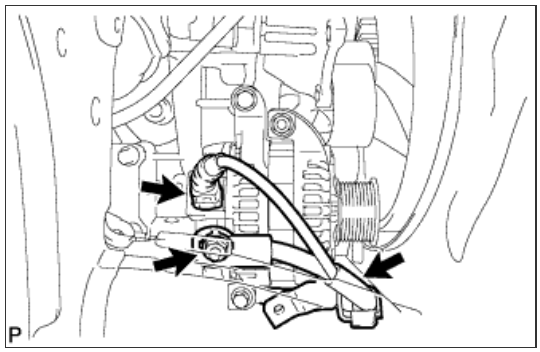
c. Connect the generator wire with the nut.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

d. Install the terminal cap.

e. Install the harness bracket to the generator with the bolt.

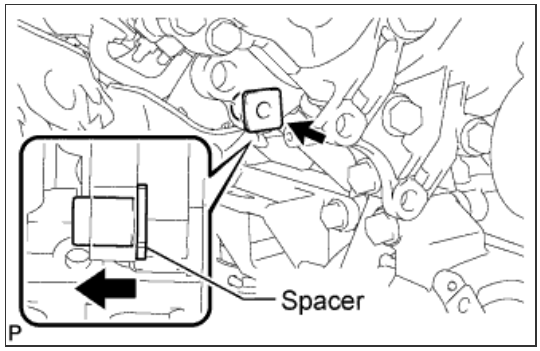
Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }



29. CONNECT VANE PUMP ASSEMBLY

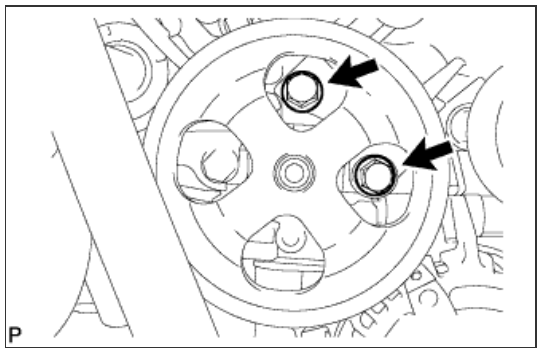
HINT:

Before performing the following procedures, move the spacer until the vane pump can be installed.

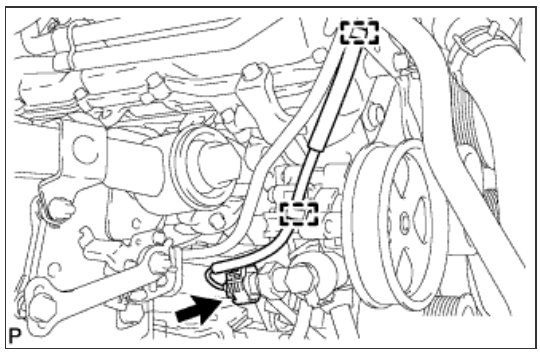


a. Connect the vane pump to the timing chain cover with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



b. Connect the 2 clamps and power steering oil pressure switch connector.



30. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

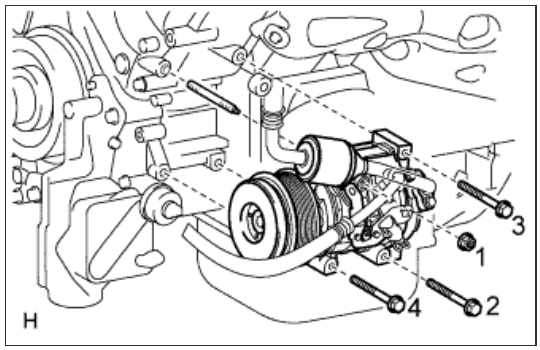
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

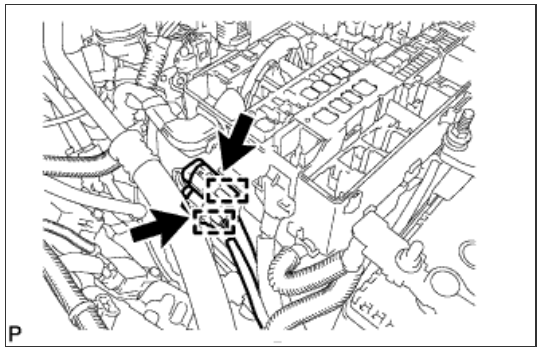
NOTICE:

Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.



31. CONNECT WIRE HARNESS AND HOSE

a. Connect the clamp and 2 connectors.



b. Connect the 2 connectors and 2 clips to the engine room junction block.

c. Install the engine wire with the nut. Then connect the 2 clips.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. w/ Secondary Air Injection System:
Connect the 4 air injection control driver connectors.

e. Install the ground wire to the bracket with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

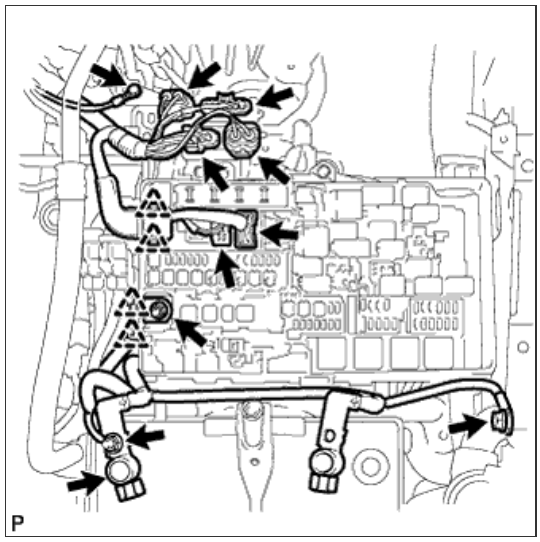
f. Install the ground wire to the body with the bolt.

Torque:
8.4 N*m{ 86 kgf*cm , 74 in.*lbf }

g. Connect the cable to the positive (+) battery terminal.

h. Install the wire to the positive (+) battery cable with the nut.

Torque:
5.4 N*m{ 55 kgf*cm , 48 in.*lbf }



i. w/ Secondary Air Injection System:
Connect the 2 air injection system hoses.

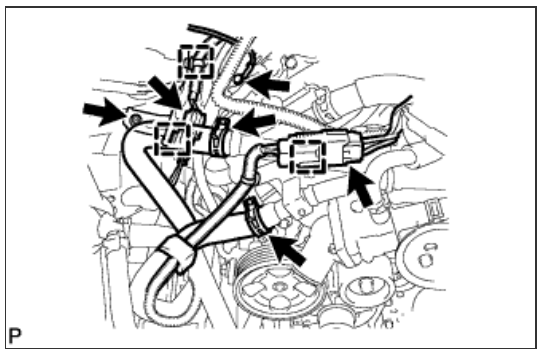
j. Install the ground wire with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

k. w/ Secondary Air Injection System:
Connect the 3 clamps and 2 air pump connectors.

l. w/ Secondary Air Injection System:
Install the connector bracket with the nut.

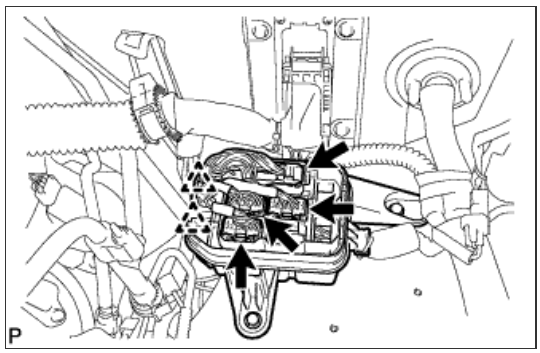
Torque:



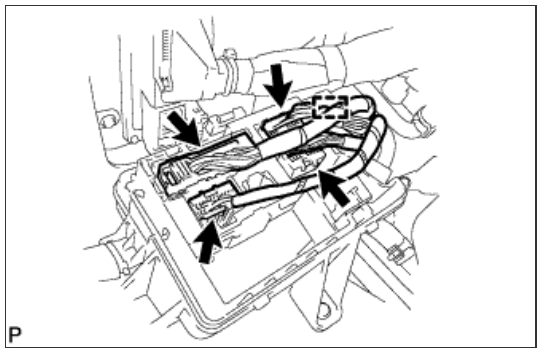
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

m. Connect the 4 connectors.

i. for RHD:
Connect the 4 connectors and 2 clips to the connector holder block.



ii. for LHD:
Connect the 4 connectors and clamp to the connector holder block.

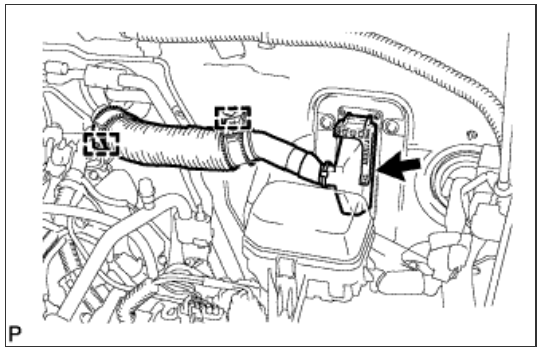


n. Connect the ECM connector.

i. for RHD:
Connect the 2 clamps and ECM connector.

HINT:

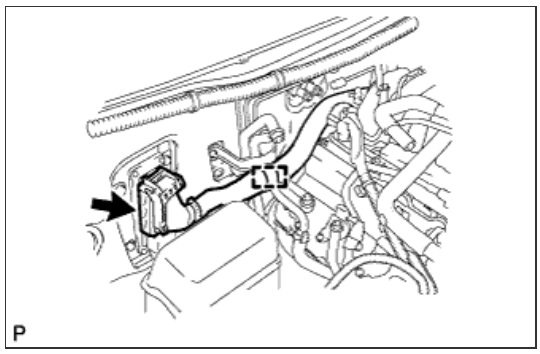
Refer to the following procedures to connect the ECM connector (Click here).



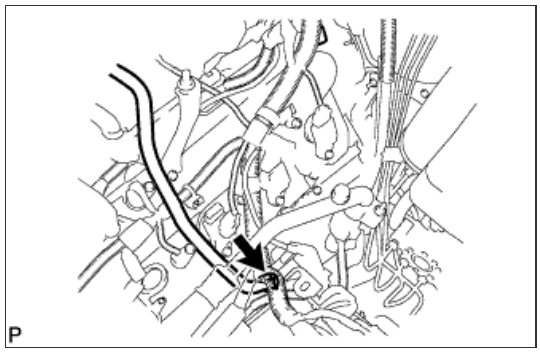
ii. for LHD:
Connect the clamp and ECM connector.

HINT:

Refer to the following procedures to connect the ECM connector (Click here).



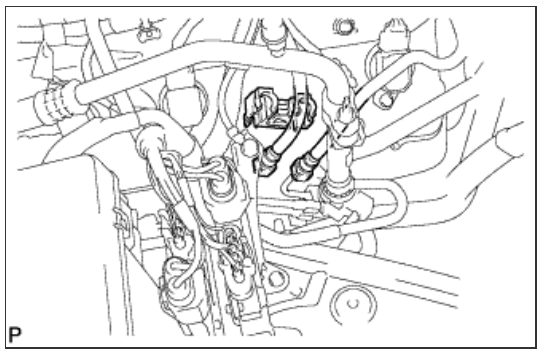
o. Connect the purge line hose.



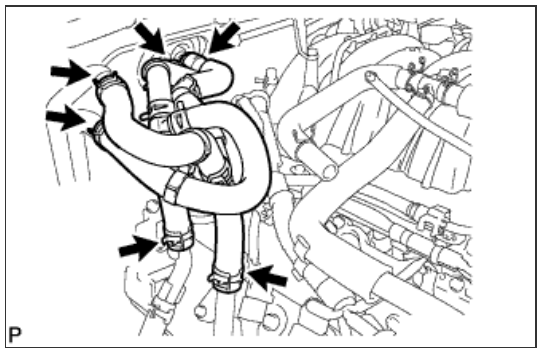
32. CONNECT FUEL MAIN AND RETURN HOSE

a. Connect the fuel main and return hoses (Click here).

b. Install the fuel pipe clamp.



33. INSTALL WATER HOSE SUB-ASSEMBLY

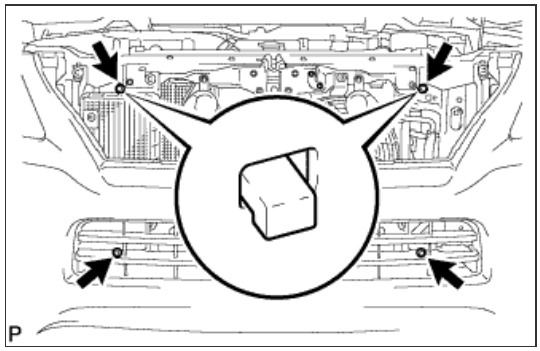


34. INSTALL RADIATOR ASSEMBLY

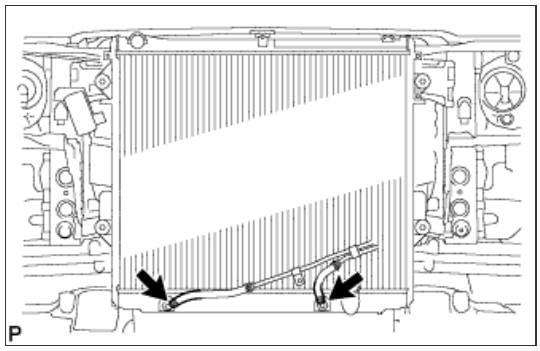
a. Set the radiator bracket hooks to the radiator support holes.

b. Install the radiator with the 4 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



c. Connect the 2 oil cooler hoses.



35. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

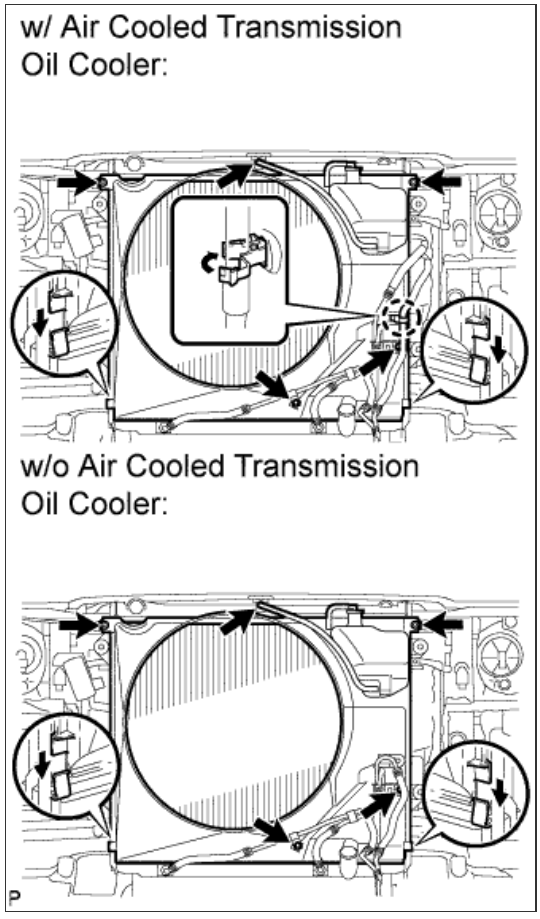
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

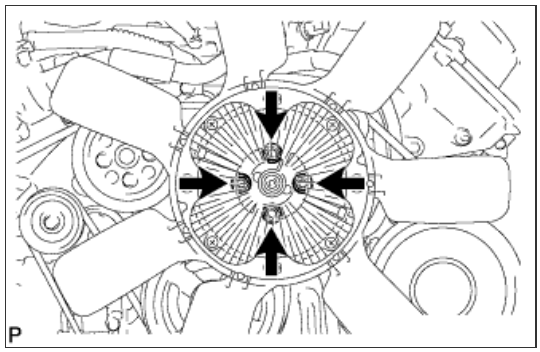
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



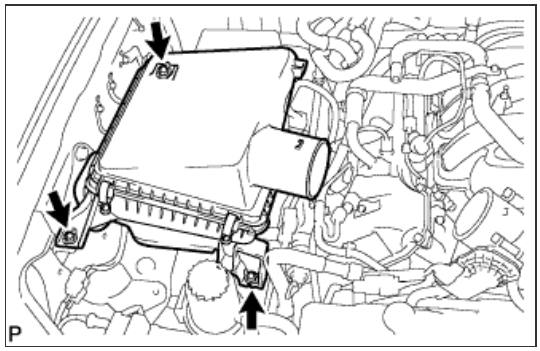
36. INSTALL NO. 2 RADIATOR HOSE

37. INSTALL NO. 1 RADIATOR HOSE

38. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



39. INSTALL AIR CLEANER HOSE ASSEMBLY

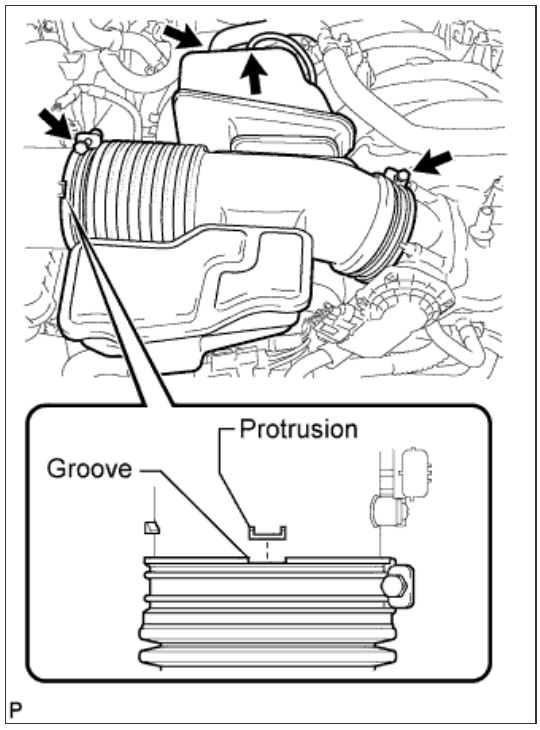
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



40. INSTALL HOOD SUB-ASSEMBLY

a. Install the hood with the 4 bolts.

Torque:
13 N*m{ 133 kgf*cm , 10 ft.*lbf }

b. Connect the 2 hood supports with the 2 hood support bolts.

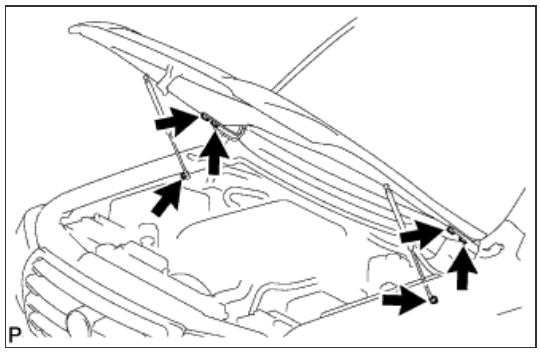
Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }

CAUTION:

Install the hood support while supporting the hood by hand.

NOTICE:

Check that the hood support is engaged in the ball joint and that it cannot be pulled out.



41. ADJUST HOOD SUB-ASSEMBLY

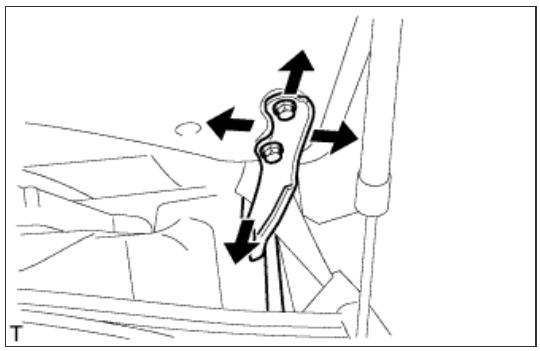
a. Adjust the hood position.

i. Loosen the 4 hinge bolts of the hood.

ii. Move the hood and adjust the clearance between the hood and front fender.

iii. Tighten the 4 hinge bolts of the hood after the adjustment.

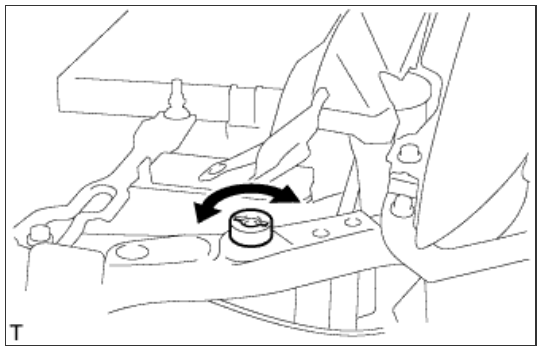
Torque:
13 N*m{ 133 kgf*cm , 10 ft.*lbf }



iv. Adjust the cushion rubber so that the height of the hood and fender are aligned.

HINT:

Raise or lower the front end of the hood by turning the cushion rubber.



b. Adjust the hood lock.

i. Using a screwdriver, remove the hood lock nut cap as shown in the illustration.

HINT:

Tape the screwdriver tip before use.

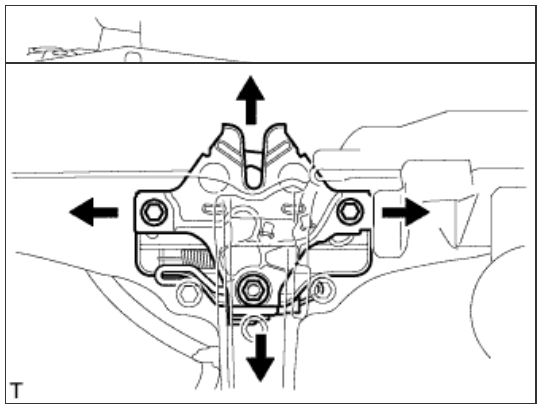
ii. Loosen the 2 bolts and hood lock nut.

iii. Adjust the hood lock position so that the striker can enter it smoothly.

iv. Tighten the bolts and nut after the adjustment.

Torque:
5.5 N*m{ 56 kgf*cm , 49 in.*lbf }

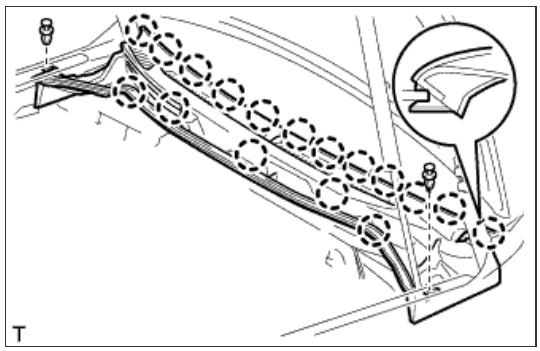
v. Install a new cap.



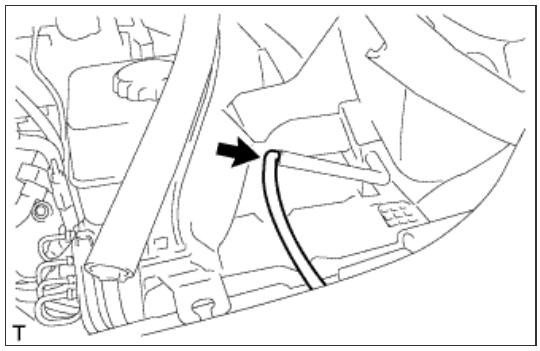
42. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Push in the ventilator louver to attach the 17 claws and install the ventilator louver.

b. Install the 2 clips.

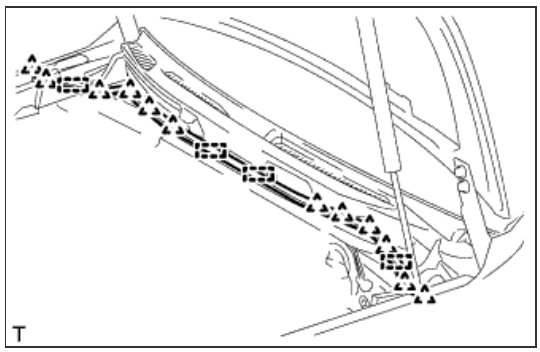


c. Connect the washer hose.



43. INSTALL HOOD TO COWL TOP SEAL

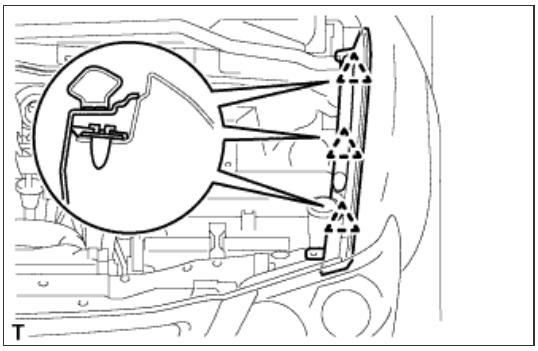
a. Attach the 12 clips and 4 clamps to install the hood to cowl top seal.



44. INSTALL FRONT FENDER MAIN SEAL LH

a. Attach the 3 clips to install the fender main seal

a. Attach the 3 clips to install the fender main seal.



45. INSTALL FRONT FENDER MAIN SEAL RH

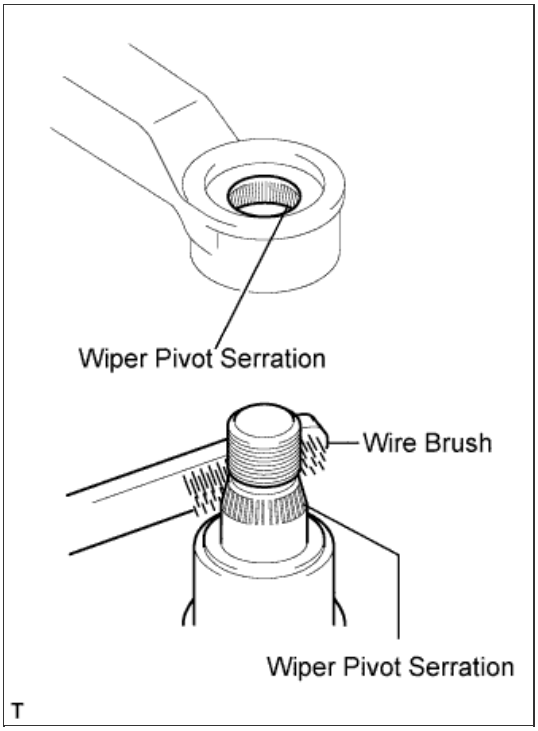
HINT:

Use the same procedures described for the LH side.

46. INSTALL FRONT WIPER ARM LH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

Standard:

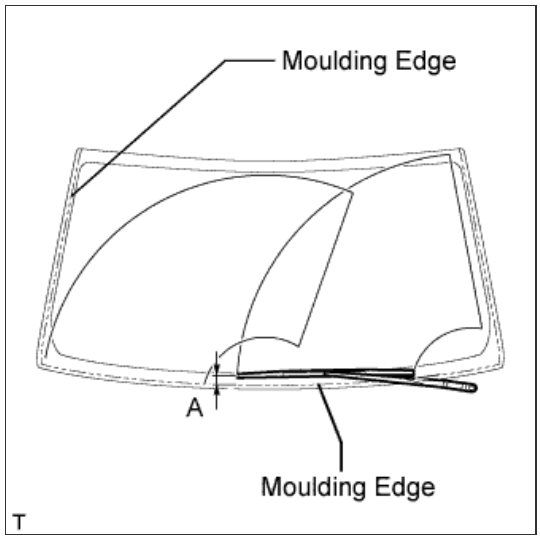
Position	Specified Condition
A	16.8 to 36.8 mm (0.661 to 1.45 in.)

Torque:

25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

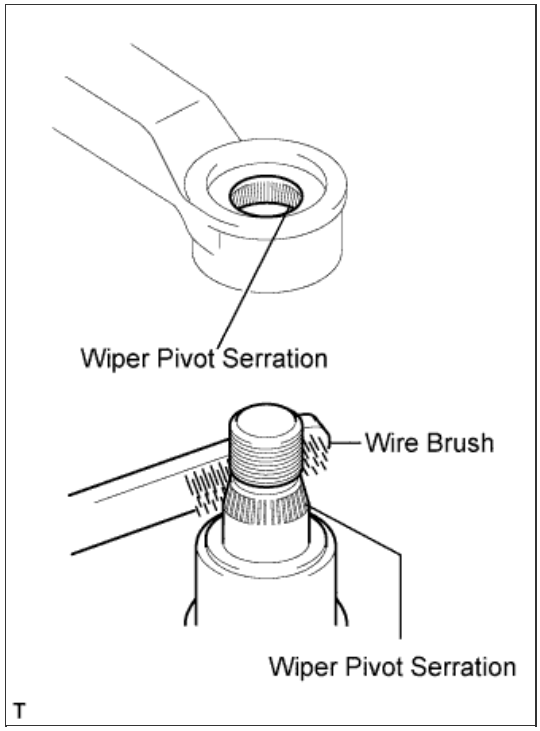
Hold down the wiper arm hinge with your hand while tightening the nut.



47. INSTALL FRONT WIPER ARM RH

a. Stop the wiper motor at the automatic stop position.

b. Clean the wiper pivot serrations with a wire brush.



c. Install the wiper arm and blade with the nut. Make sure that the wiper arm and blade come to the position shown in the illustration.

Standard:

Position	Specified Condition
B	20.0 to 40.0 mm (0.787 to 1.57 in.)

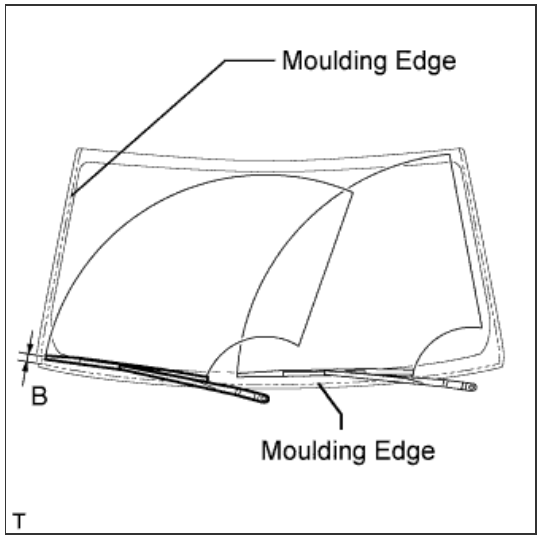
Torque:

25 N*m{ 255 kgf*cm , 18 ft.*lbf }

HINT:

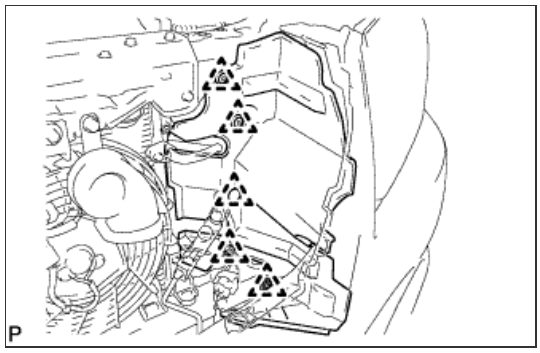
Hold down the wiper arm hinge with your hand while tightening the nut.

d. Operate the front wipers while spraying washer fluid on the windshield glass. Make sure that the front wipers function properly and there is no interference with the vehicle body.



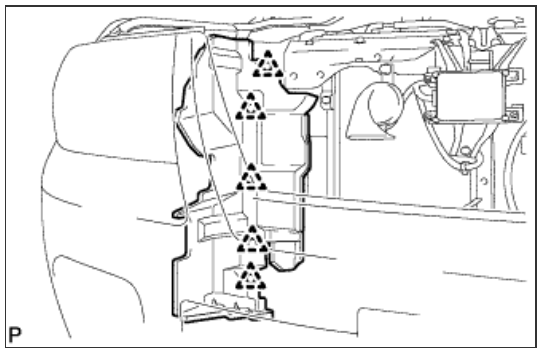
48. INSTALL RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



49. INSTALL RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



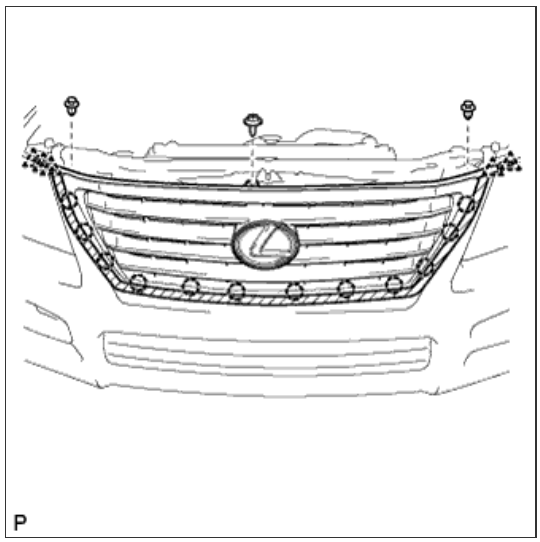
50. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

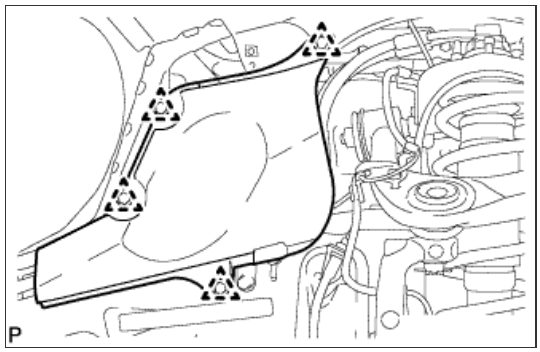
c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



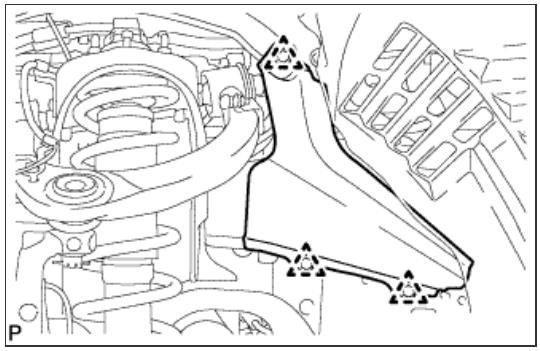
51. INSTALL FRONT FENDER APRON SEAL REAR RH

a. Install the fender apron seal with the 4 clips.



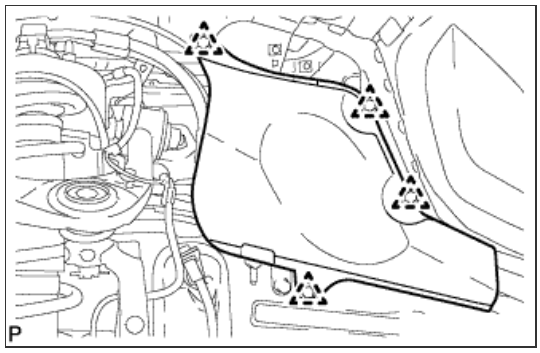
52. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



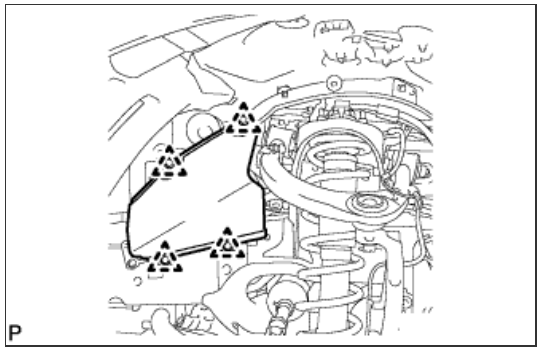
53. INSTALL FRONT FENDER APRON SEAL REAR LH

a. Install the fender apron seal with the 4 clips.



54. INSTALL FRONT FENDER APRON SEAL FRONT LH

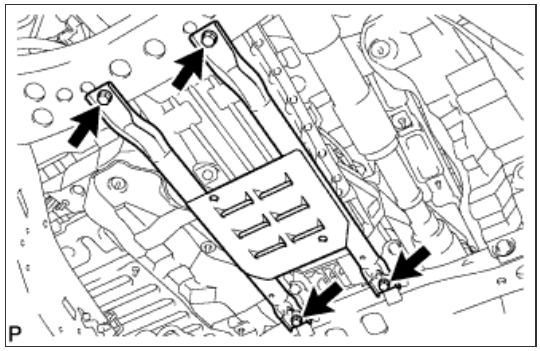
a. Install the fender apron seal with the 4 clips.



55. INSTALL OIL PAN PROTECTOR ASSEMBLY

a. Install the oil pan protector with the 4 bolts.

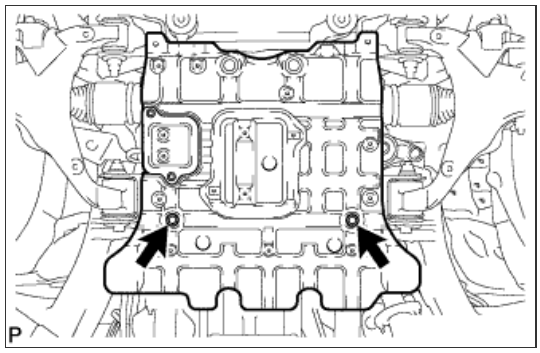
Torque:
63 N*m{ 642 kgf*cm , 46 ft.*lbf }



56. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

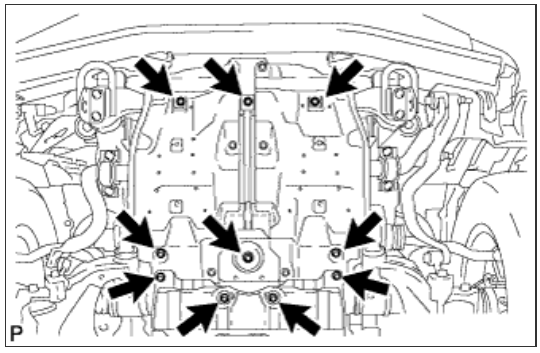
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



57. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

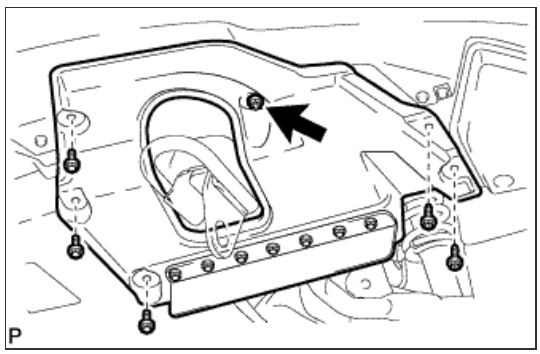
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



58. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



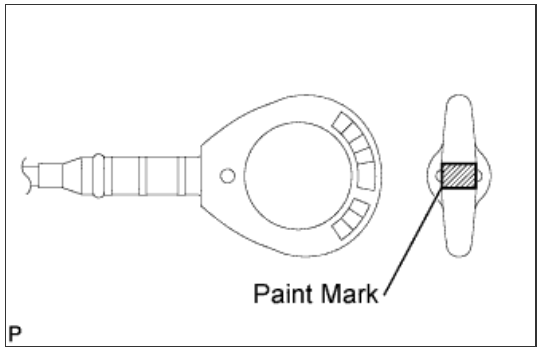
59. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

60. ADD ENGINE OIL

a. Add fresh oil and install the oil filler cap.



Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

61. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

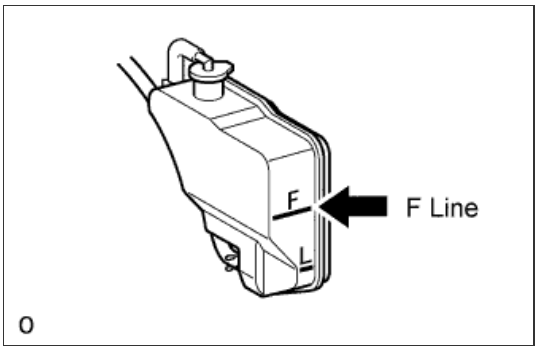
HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.



e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

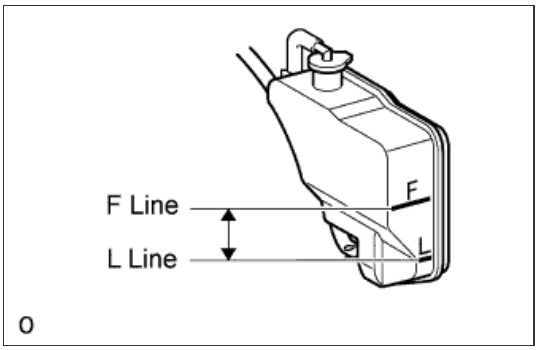
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



62. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

63. INSPECT FOR OIL LEAK

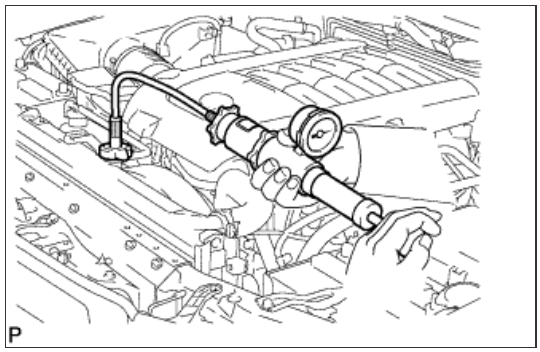
a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

64. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



65. INSPECT FOR EXHAUST GAS LEAK

66. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

67. INSPECT SHIFT LEVER POSITION

a. When moving the shift lever from P to R with the engine switch on (IG) and the brake pedal depressed, make sure that it moves smoothly and correctly into position.

b. Check that the shift lever does not stop when moving the shift lever from R to P, and check that the shift lever does not stick when moving the shift lever from D to S.

c. Start the engine and make sure that the vehicle moves forward after moving the shift lever from N to D and moves rearward after moving the shift lever to R.
If the operation cannot be performed as specified, inspect the park/neutral position switch assembly and check the shift lever assembly installation condition.

68. INSPECT IGNITION TIMING

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. Remove the engine room side cover LH.

c. Remove the engine room side cover RH.

d. Remove the upper radiator support seal.

e. Remove the V-bank cover.

f. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

ii. Start the engine and idle it.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / IGN Advance.

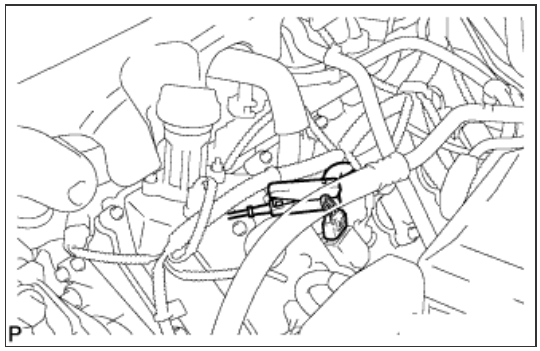
HINT:

Refer to the intelligent tester operator's manual for further details.

Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

v. Disconnect the intelligent tester from the DLC3.

g. When not using the intelligent tester:

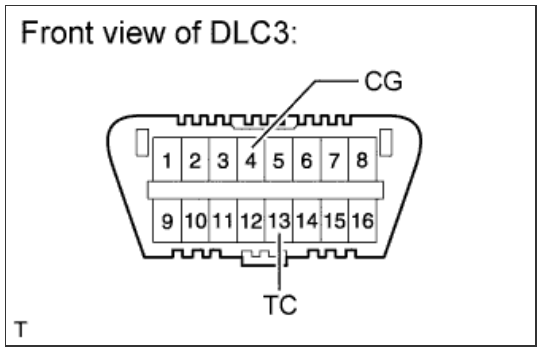


i. Connect the tester probe of a timing light to the wire of the ignition coil connector for the No. 1 cylinder.

NOTICE:

Use a timing light that detects primary signals.

ii. Using SST, connect terminals 13 (TC) and 4 (CG) of the DLC3.

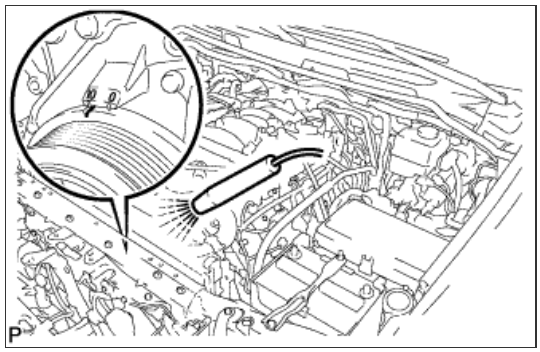


SST
09843-18040

NOTICE:

- **Confirm the terminal numbers before connecting them. Connecting the wrong terminals can damage the engine.**
- **Switch off all accessories and the A/C before connecting the terminals.**

iii. Using the timing light, check the ignition timing.



Standard ignition timing:
8 to 12° BTDC @ idle (transmission in neutral and A/C switch off)

iv. Remove SST from the DLC3.

v. Check the ignition timing.

Standard ignition timing:
7 to 24° BTDC @ idle (transmission in neutral and A/C switch off)

vi. Disconnect the timing light from the engine.

h. Install the V-bank cover.

i. Install the upper radiator support seal.

j. Install the engine room side cover RH.

k. Install the engine room side cover LH.

69. INSPECT ENGINE IDLE SPEED

a. Warm up and stop the engine.

i. Allow the engine to warm up to a normal operating temperature.

b. When using the intelligent tester:

i. Connect the intelligent tester to the DLC3.

NOTICE:

Switch off all accessories and the A/C before connecting the intelligent tester.

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Turn the intelligent tester ON.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / Primary / Engine Speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

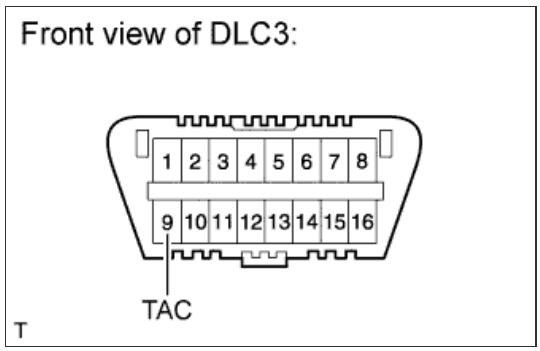
HINT:

Refer to the intelligent tester operator's manual for further details.

If the idle speed is not as specified, check the air intake system.

v. Disconnect the intelligent tester from the DLC3.

c. When not using the intelligent tester:



i. Using SST, connect the tachometer probe to terminal 9 (TAC) of the DLC3.

SST
09843-18030

NOTICE:

- **Confirm the terminal number before connecting the probe. Connecting the probe to the wrong terminal can damage the engine.**
- **Switch off all accessories and the A/C before connecting the probe.**

ii. Race the engine at 2500 rpm for approximately 90 seconds.

iii. Check the idle speed.

Standard idle speed:
650 to 750 rpm (transmission in neutral and A/C switch off)

If the idle speed is not as specified, check the air intake system.

iv. Disconnect the tachometer probe from the DLC3.

70. INSPECT CO/HC

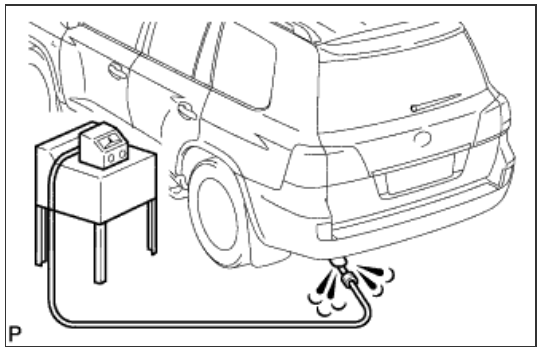
HINT:

This check is used only to determine whether or not the idle CO/HC complies with regulations.

a. Start the engine.

b. Keep the engine speed at 2500 rpm for approximately 180 seconds.

c. Insert the CO/HC meter testing probe at least 40 cm (1.31 ft.) into the tailpipe during idling.



d. Immediately check CO/HC concentration at idle and/or 2500 rpm.

HINT:

When performing the 2 mode (2500 rpm and idle) test, follow the measurement order prescribed by the applicable local regulations.

e. If the CO/HC concentration does not comply with the regulations, troubleshoot in the order given below.

i. Check the A/F sensor operation (Click here) and heated oxygen sensor operation (Click here).

ii. See the table below for possible causes, and then inspect and correct the applicable causes if necessary.

CO	HC	Symptom	Cause
Normal	High	Rough idle	1. Faulty ignitions: • Incorrect timing • Plugs (contaminated, shorted or gaps are defective) 2. Incorrect valve clearance 3. Leaky intake and exhaust valves 4. Leaky cylinder
Low	High	Rough idle (Fluctuating HC reading)	1. Vacuum leaks: • PCV hose • Intake manifold • Throttle body 2. Lean mixture causing misfire
High	High	Rough idle (Black smoke from exhaust)	1. Restricted air filter 2. Faulty SFI system: • Faulty pressure regulator • Defective ECT sensor • Faulty ECM • Faulty injectors • Faulty throttle position sensor • Faulty MAF meter

71. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark. If low, check for leakage and add oil up to the full level mark.

NOTICE:

Do not fill engine oil above the full level mark.

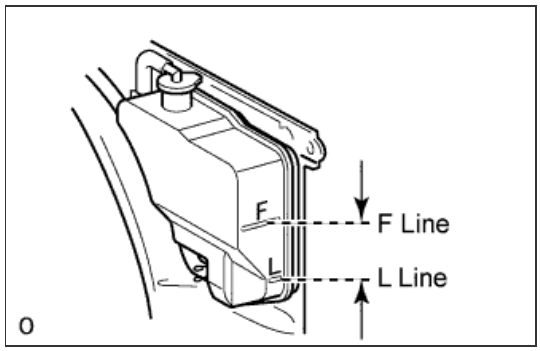
72. INSPECT ENGINE COOLANT LEVEL

a. Check that the engine coolant level is between the L and F lines when the engine is cold.
If the engine coolant is below the L line, check for leaks and add "TOYOTA Super Long Life Coolant" or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology to the F line.

NOTICE:

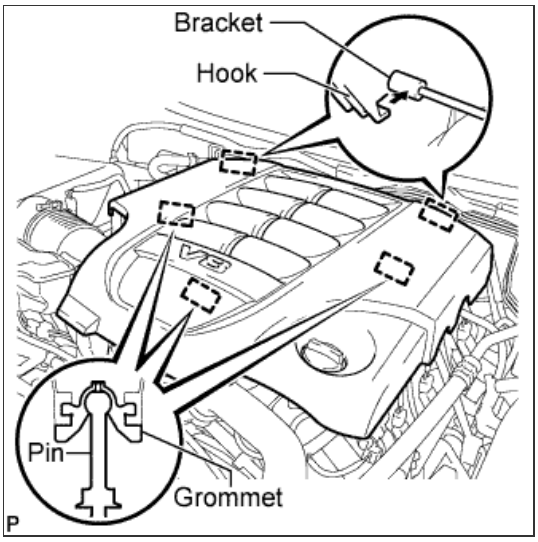
Do not substitute plain water for engine coolant.

b. Remove the radiator cap, and check that the coolant level is up to the radiator filler hole.



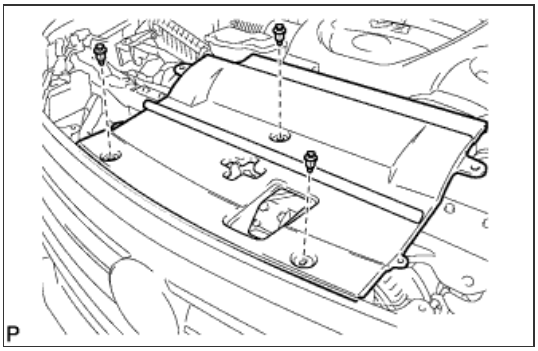
73. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



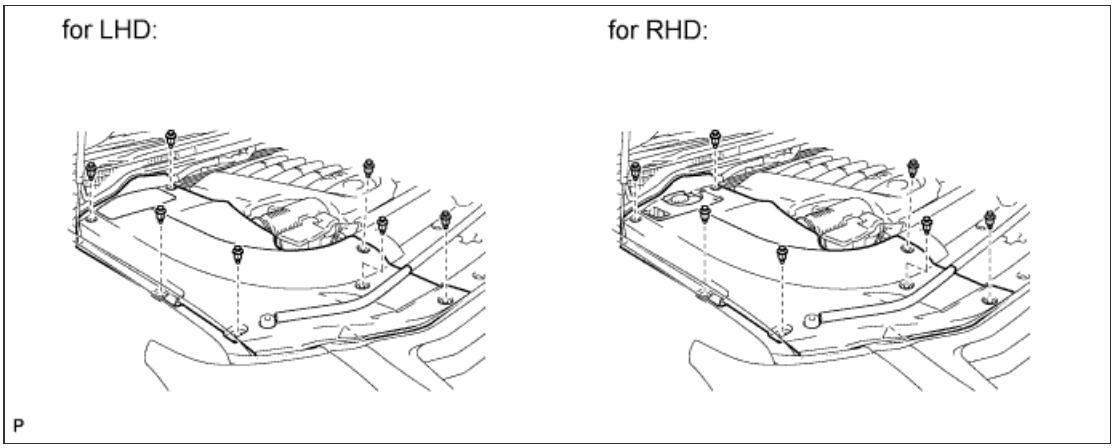
74. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



75. INSTALL ENGINE ROOM SIDE COVER RH

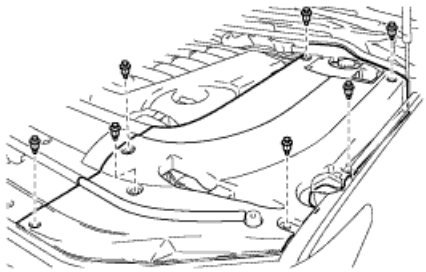
a. Install the engine room side cover with the 7 clips.



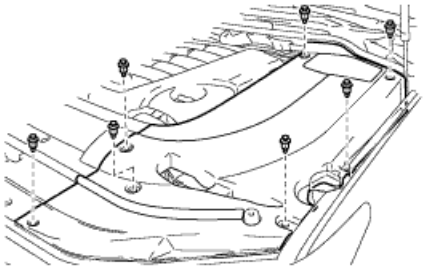
76. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

for LHD:

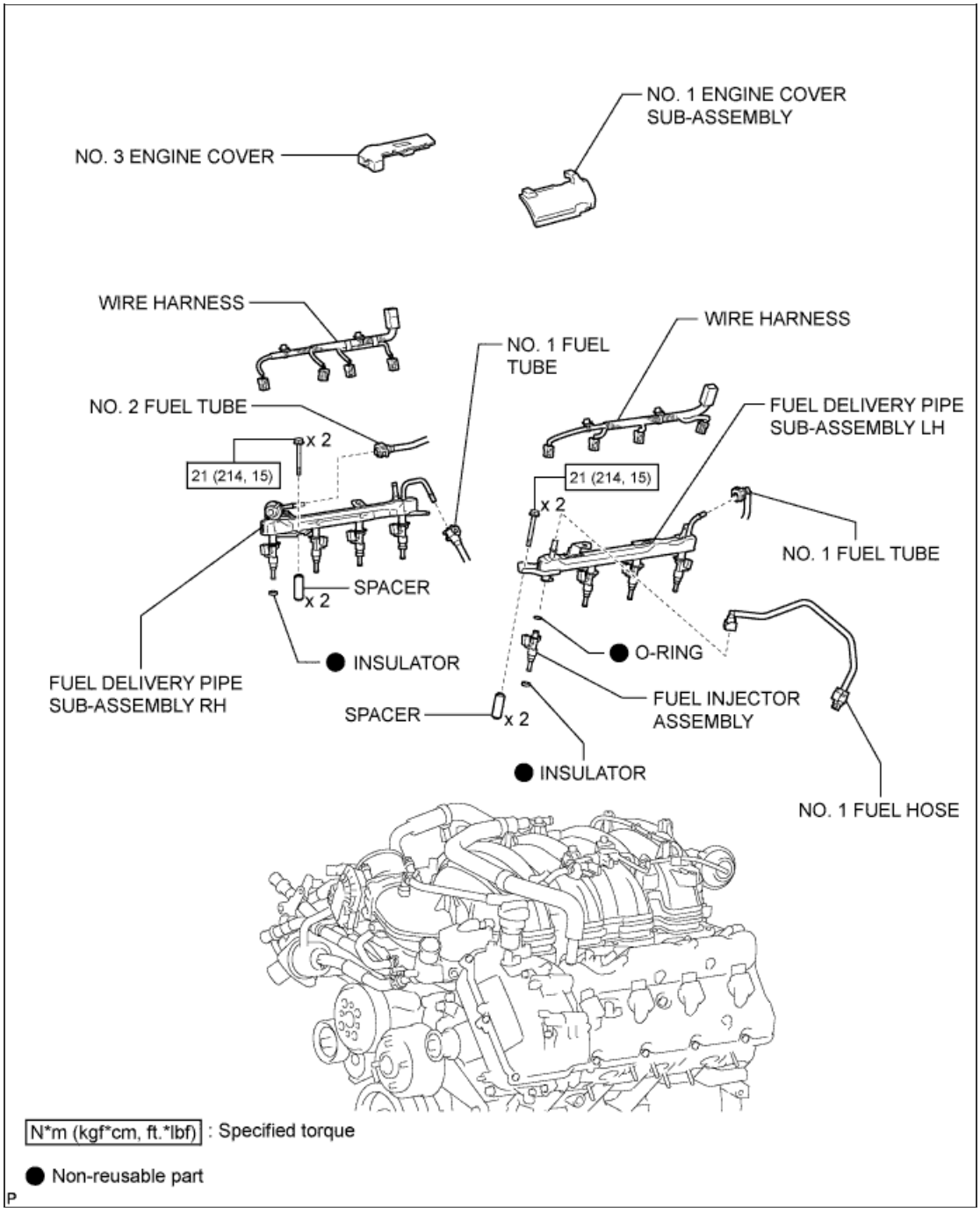


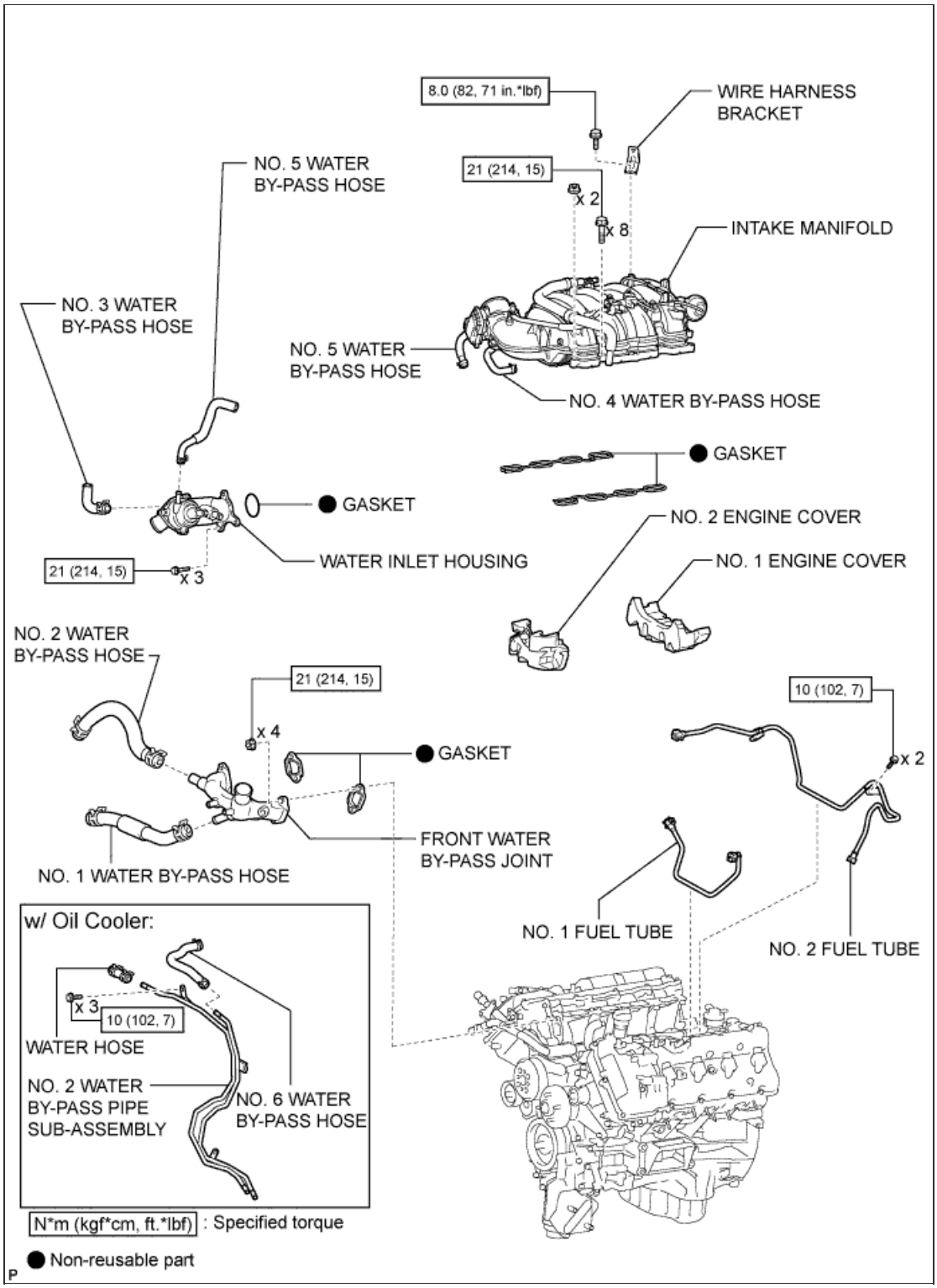
for RHD:

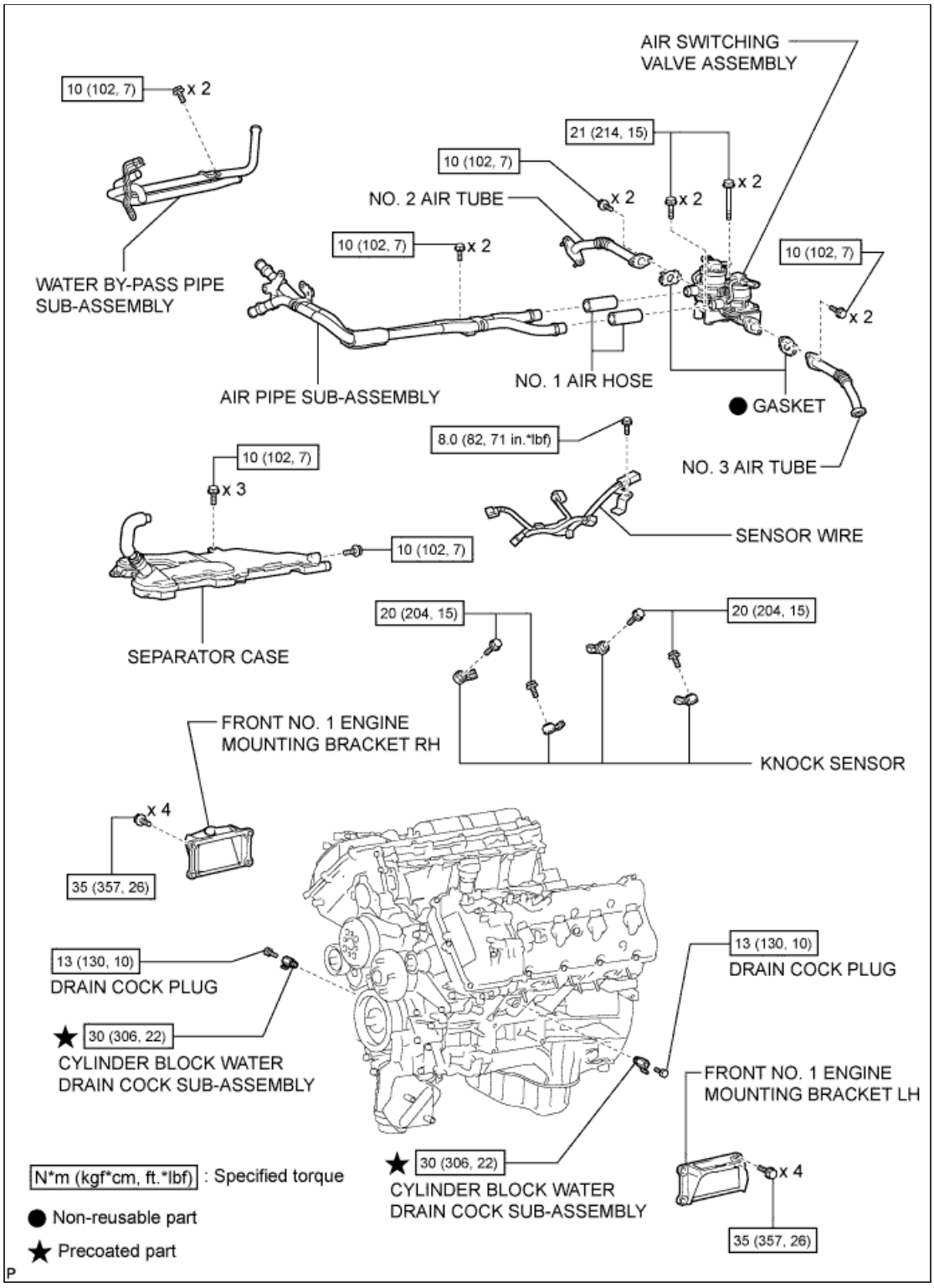


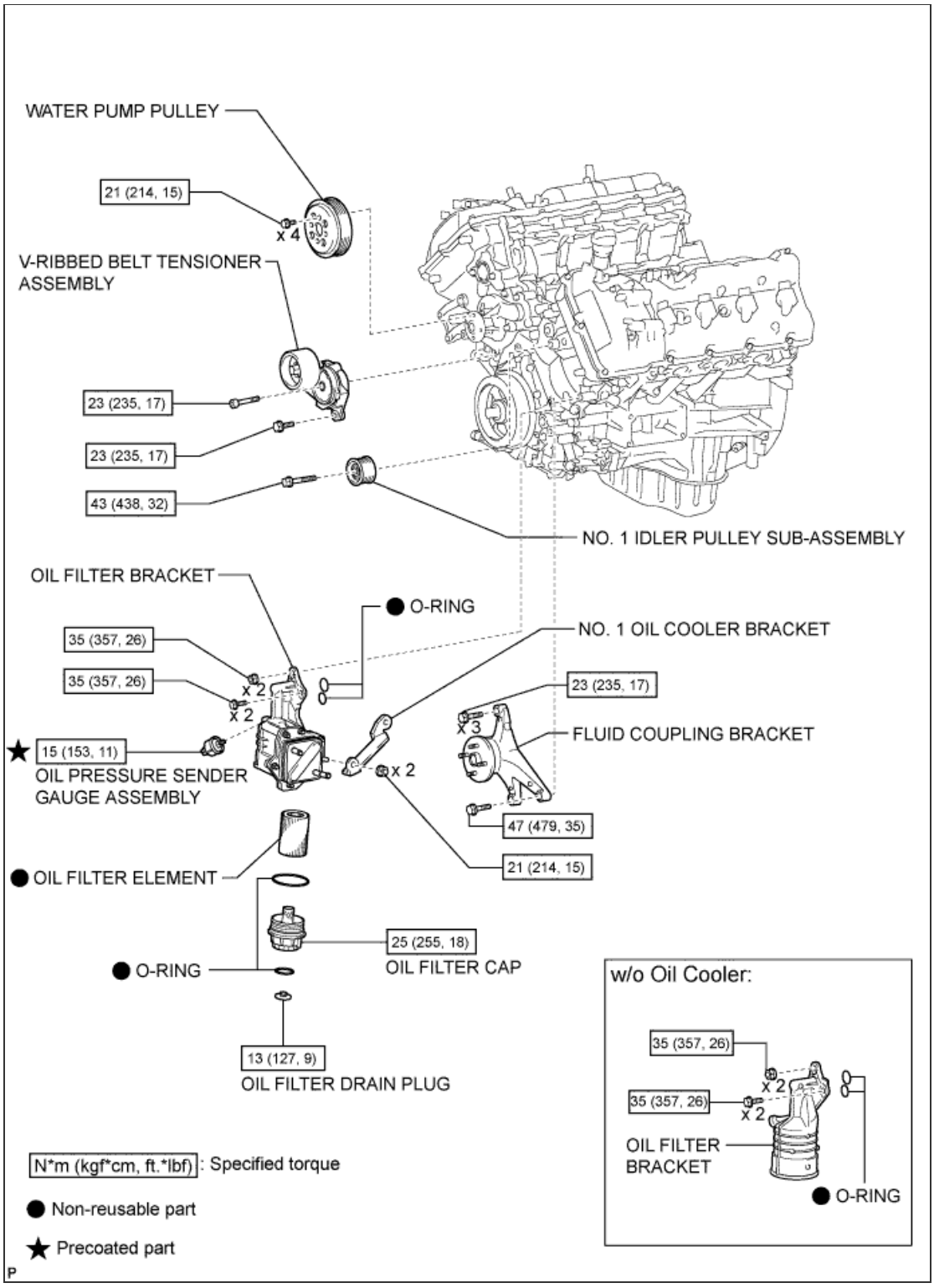
P

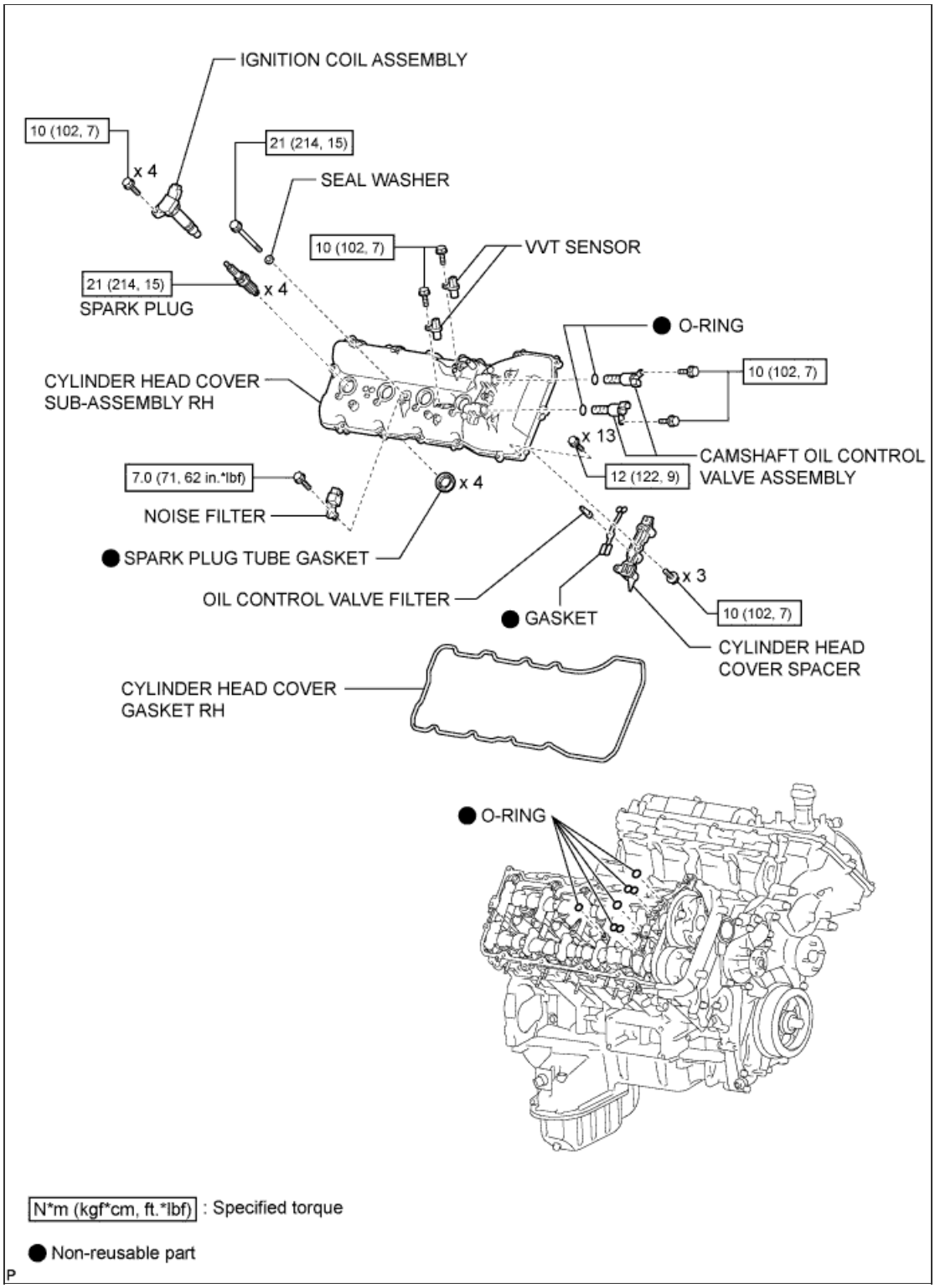
for Preparation Click here



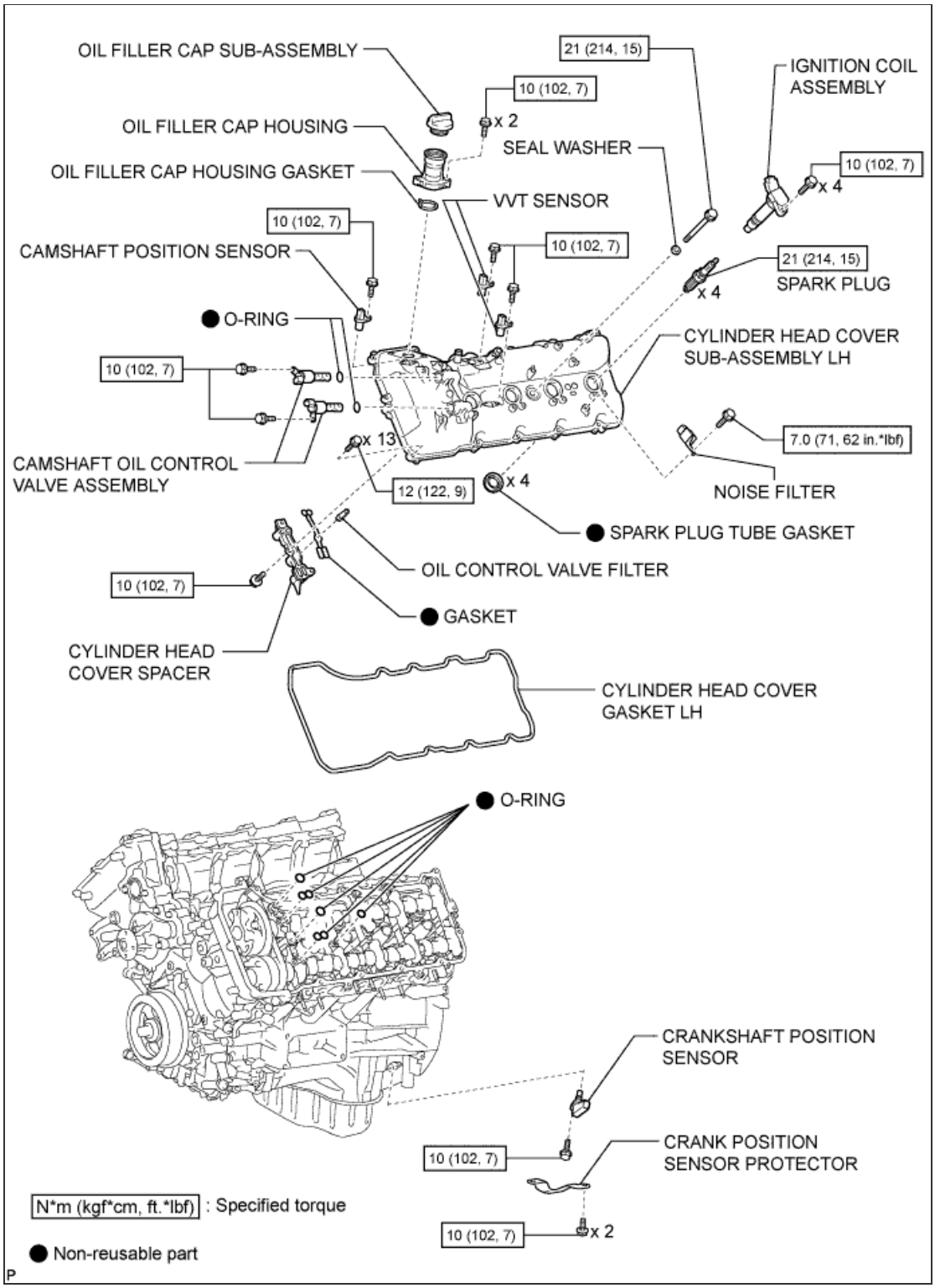

8.0 (82, 71 in.*lbf)
WIRE HARNESS BRACKET
NO. 5 WATER BY-PASS HOSE
21 (214, 15)
x 2
x 8
INTAKE MANIFOLD
NO. 3 WATER BY-PASS HOSE
NO. 5 WATER BY-PASS HOSE
NO. 4 WATER BY-PASS HOSE
GASKET
GASKET
NO. 2 ENGINE COVER
NO. 1 ENGINE COVER
WATER INLET HOUSING
21 (214, 15)
x 3
NO. 2 WATER BY-PASS HOSE
21 (214, 15)
x 4
GASKET
10 (102, 7)
x 2
FRONT WATER BY-PASS JOINT
NO. 1 WATER BY-PASS HOSE
NO. 1 FUEL TUBE
NO. 2 FUEL TUBE
w/ Oil Cooler:
x 3
10 (102, 7)
WATER HOSE
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
NO. 6 WATER BY-PASS HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

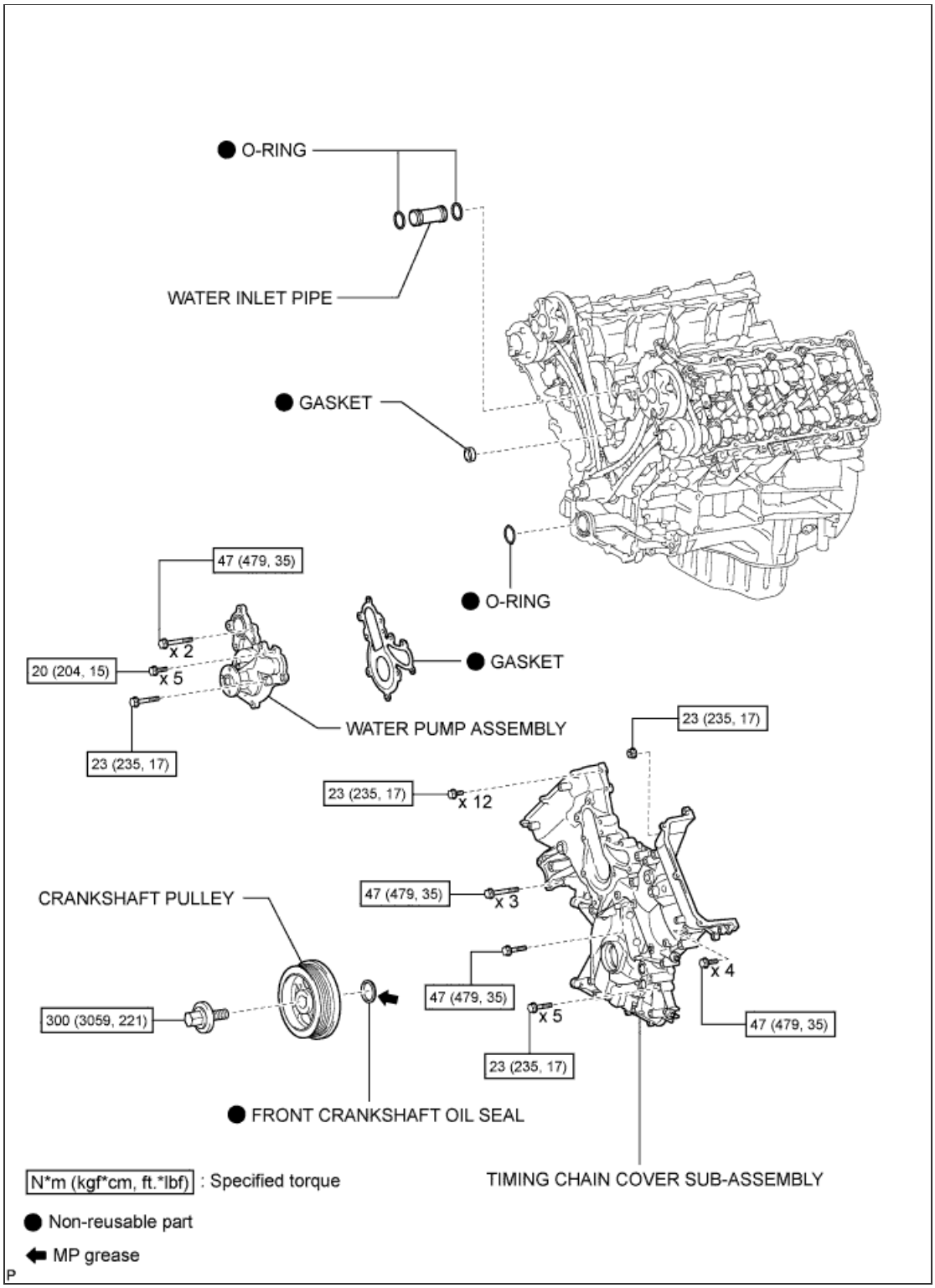

AIR SWITCHING VALVE ASSEMBLY
10 (102, 7)
x 2
21 (214, 15)
10 (102, 7)
x 2
x 2
NO. 2 AIR TUBE
x 2
10 (102, 7)
x 2
10 (102, 7)
x 2
WATER BY-PASS PIPE SUB-ASSEMBLY
AIR PIPE SUB-ASSEMBLY
NO. 1 AIR HOSE
GASKET
8.0 (82, 71 in.*lbf)
10 (102, 7)
x 3
NO. 3 AIR TUBE
SENSOR WIRE
10 (102, 7)
SEPARATOR CASE
20 (204, 15)
20 (204, 15)
FRONT NO. 1 ENGINE MOUNTING BRACKET RH
KNOCK SENSOR
x 4
35 (357, 26)
13 (130, 10)
DRAIN COCK PLUG
13 (130, 10)
DRAIN COCK PLUG
30 (306, 22)
CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY
FRONT NO. 1 ENGINE MOUNTING BRACKET LH
30 (306, 22)
CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY
x 4
35 (357, 26)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
P

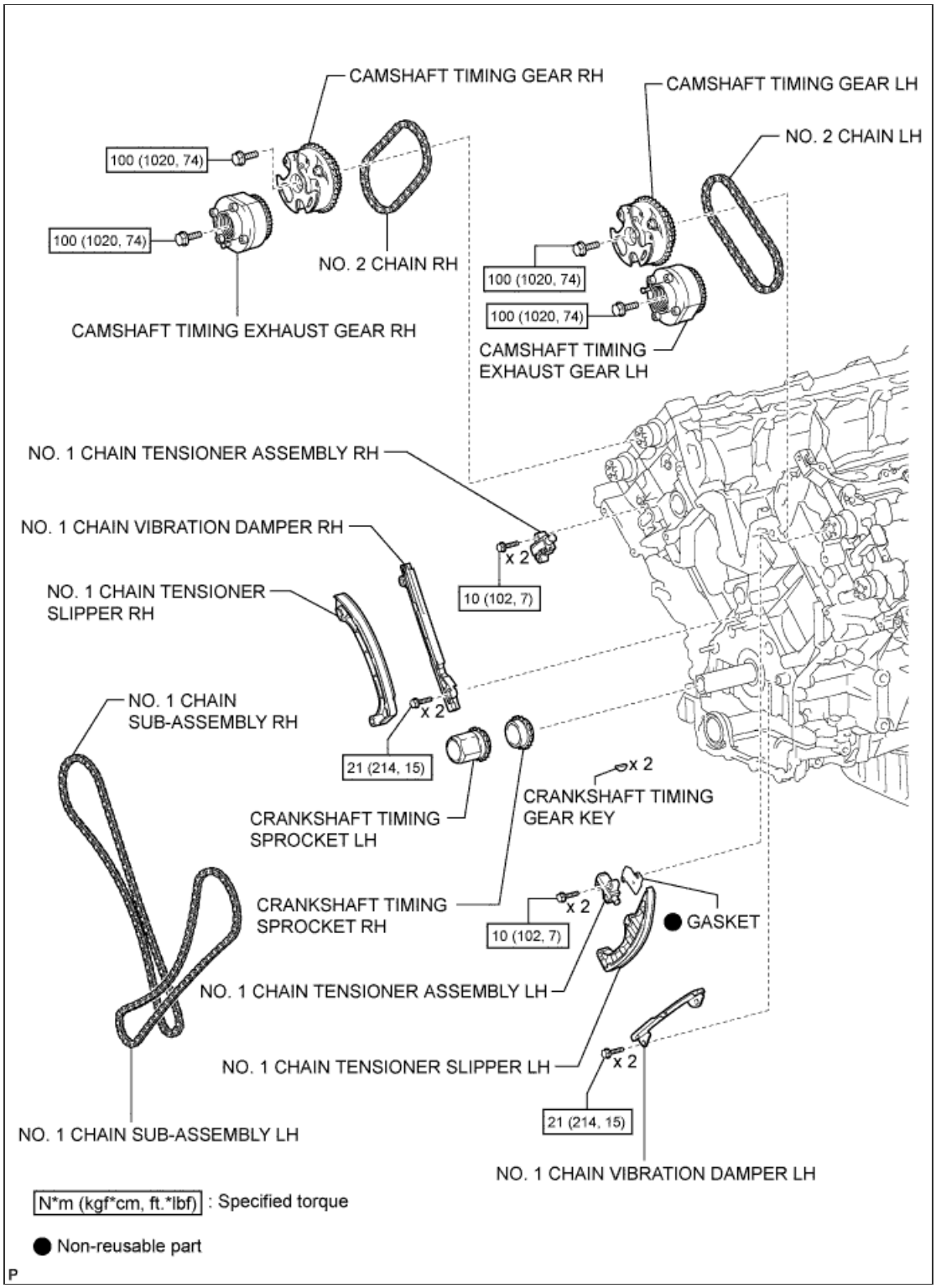

WATER PUMP PULLEY
21 (214, 15)
x 4
V-RIBBED BELT TENSIONER ASSEMBLY
23 (235, 17)
23 (235, 17)
43 (438, 32)
NO. 1 IDLER PULLEY SUB-ASSEMBLY
OIL FILTER BRACKET
O-RING
35 (357, 26)
35 (357, 26)
x 2
x 2
NO. 1 OIL COOLER BRACKET
23 (235, 17)
x 3
FLUID COUPLING BRACKET
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
x 2
47 (479, 35)
21 (214, 15)
OIL FILTER ELEMENT
25 (255, 18)
OIL FILTER CAP
O-RING
13 (127, 9)
OIL FILTER DRAIN PLUG
w/o Oil Cooler:
35 (357, 26)
35 (357, 26)
x 2
x 2
OIL FILTER BRACKET
O-RING
N*m (kgf*cm, ft.*lbf): Specified torque
Non-reusable part
Precoated part
P

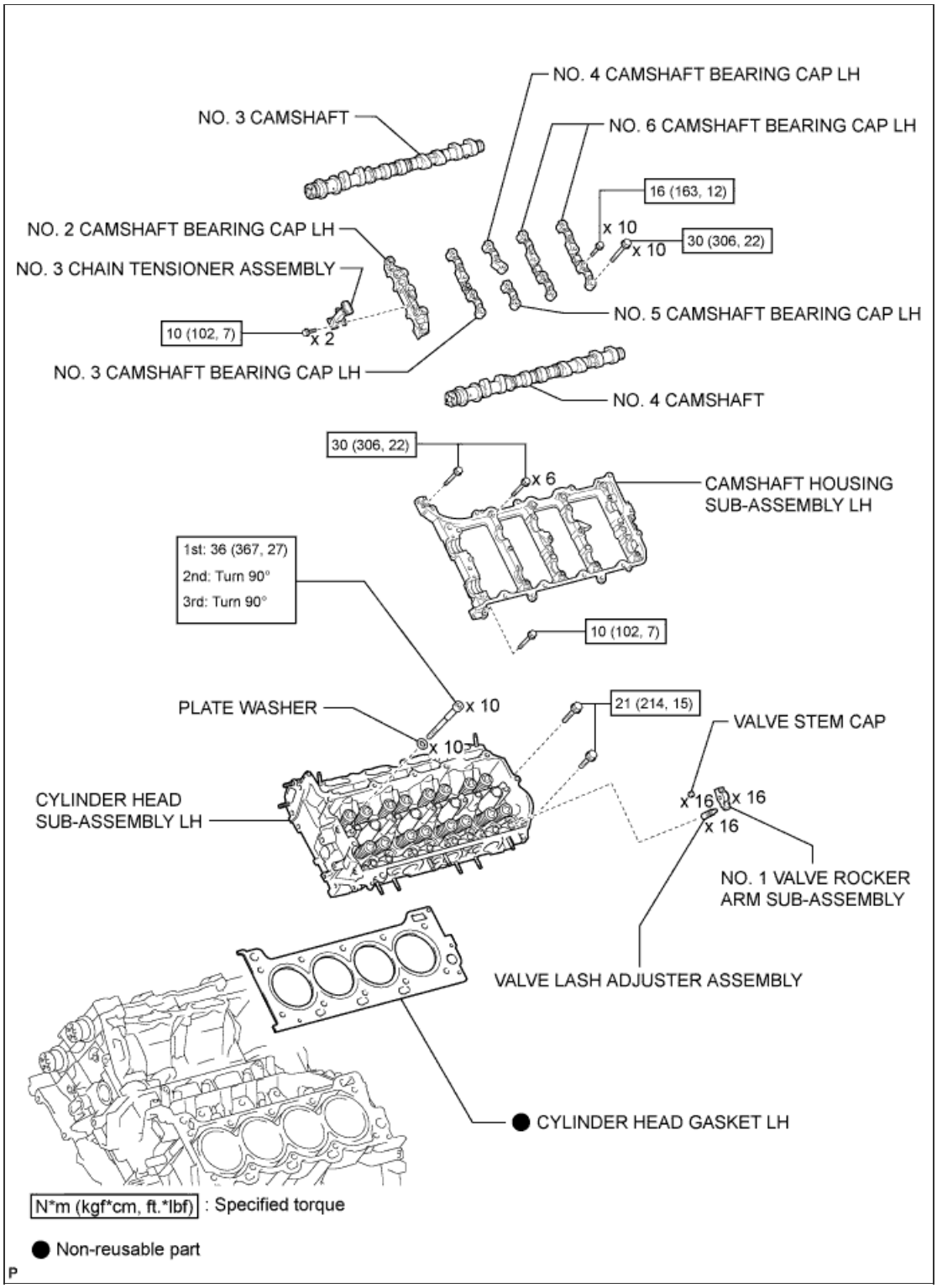

IGNITION COIL ASSEMBLY
10 (102, 7)
x 4
21 (214, 15)
SEAL WASHER
10 (102, 7)
VVT SENSOR
21 (214, 15)
x 4
SPARK PLUG
O-RING
CYLINDER HEAD COVER
SUB-ASSEMBLY RH
10 (102, 7)
x 13
CAMSHAFT OIL CONTROL
VALVE ASSEMBLY
12 (122, 9)
7.0 (71, 62 in.*lbf)
x 4
NOISE FILTER
SPARK PLUG TUBE GASKET
OIL CONTROL VALVE FILTER
GASKET
x 3
10 (102, 7)
CYLINDER HEAD
COVER SPACER
CYLINDER HEAD COVER
GASKET RH
O-RING
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

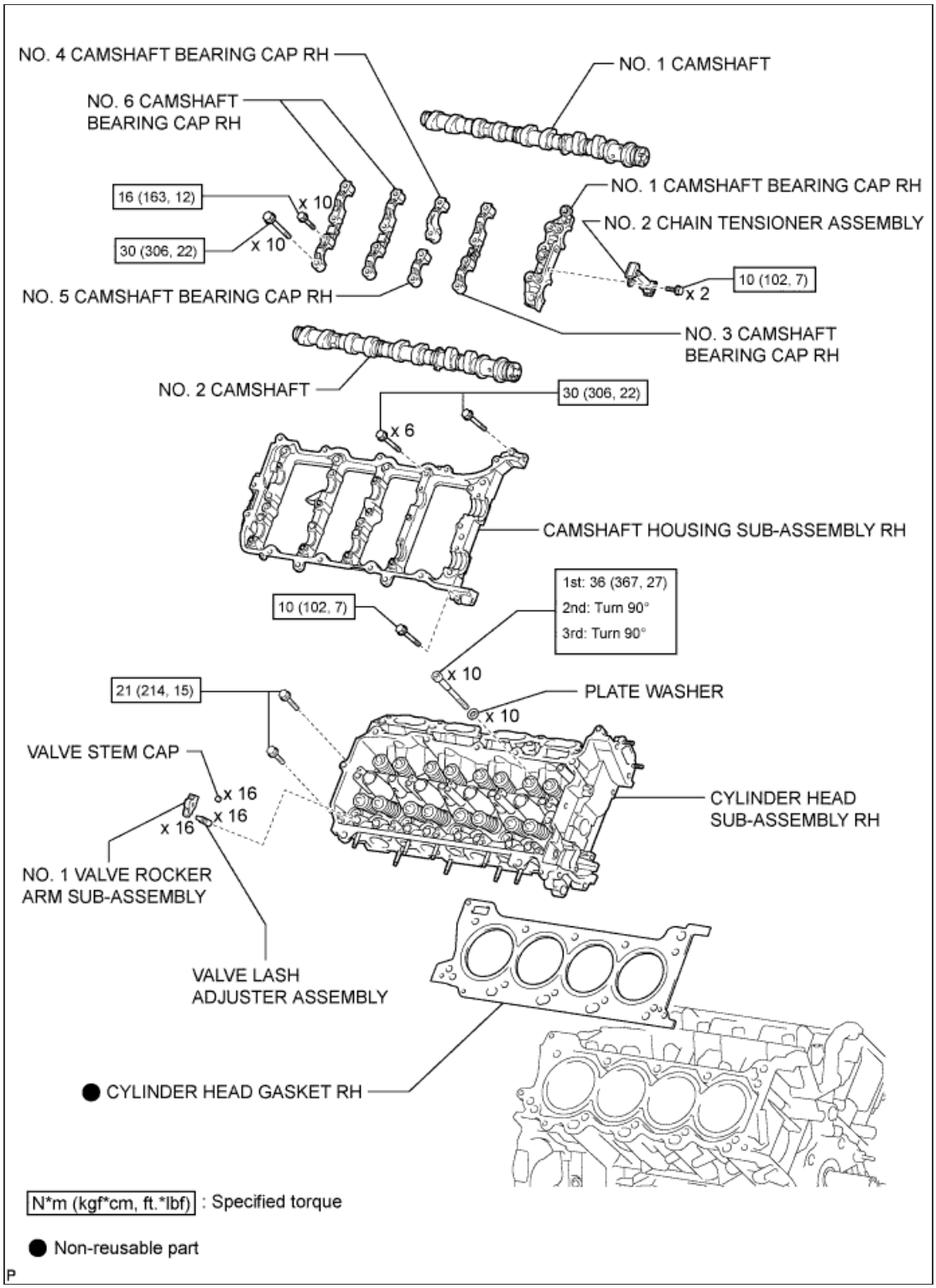
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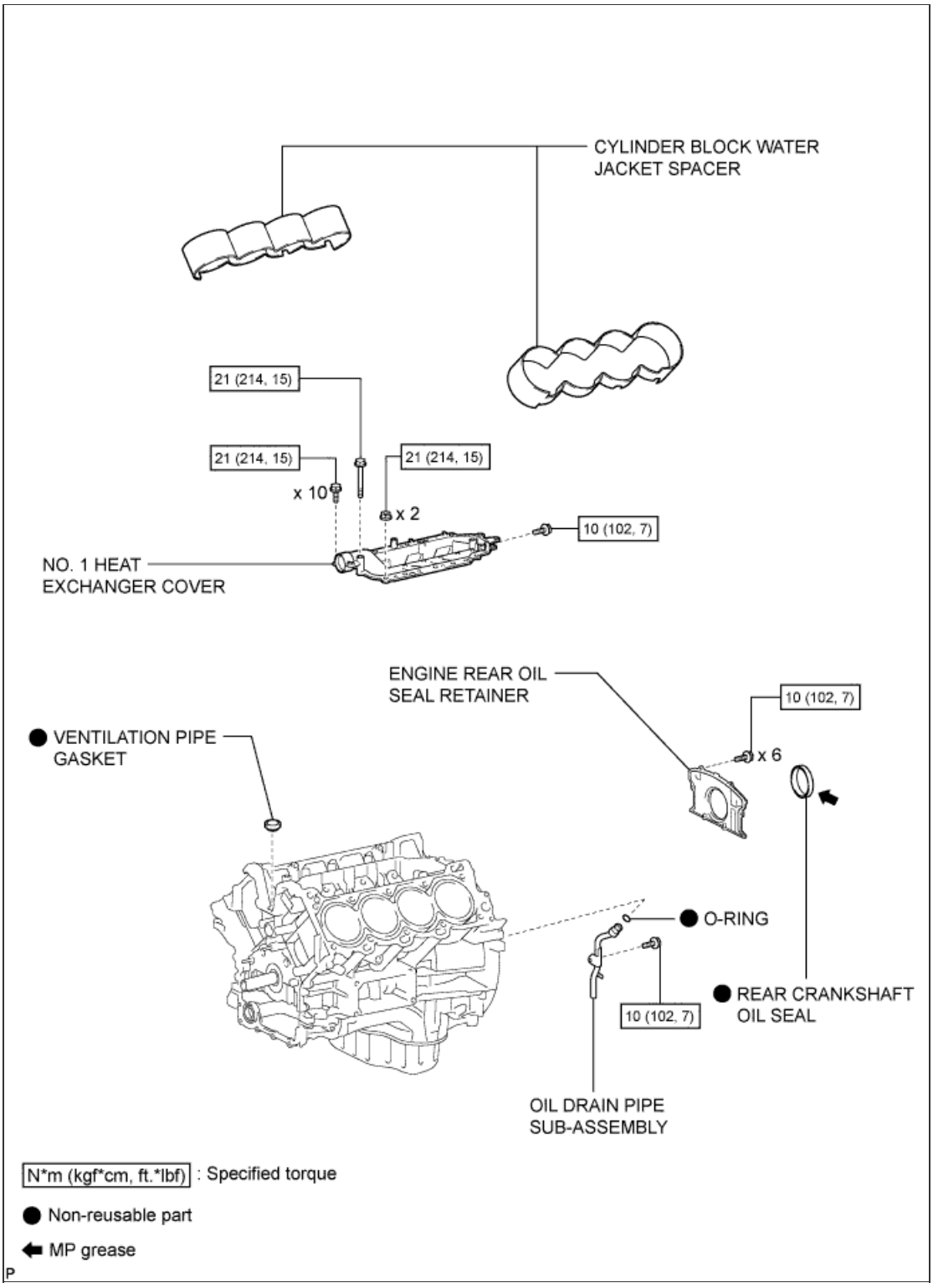

OIL FILLER CAP SUB-ASSEMBLY
21 (214, 15)
IGNITION COIL ASSEMBLY
10 (102, 7)
x 2
OIL FILLER CAP HOUSING
SEAL WASHER
OIL FILLER CAP HOUSING GASKET
10 (102, 7)
x 4
VVT SENSOR
10 (102, 7)
CAMSHAFT POSITION SENSOR
10 (102, 7)
21 (214, 15)
SPARK PLUG
x 4
O-RING
CYLINDER HEAD COVER SUB-ASSEMBLY LH
10 (102, 7)
x 13
7.0 (71, 62 in.*lbf)
CAMSHAFT OIL CONTROL VALVE ASSEMBLY
12 (122, 9)
x 4
NOISE FILTER
SPARK PLUG TUBE GASKET
OIL CONTROL VALVE FILTER
10 (102, 7)
GASKET
CYLINDER HEAD COVER SPACER
CYLINDER HEAD COVER GASKET LH
O-RING
CRANKSHAFT POSITION SENSOR
10 (102, 7)
CRANK POSITION SENSOR PROTECTOR
10 (102, 7)
x 2
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

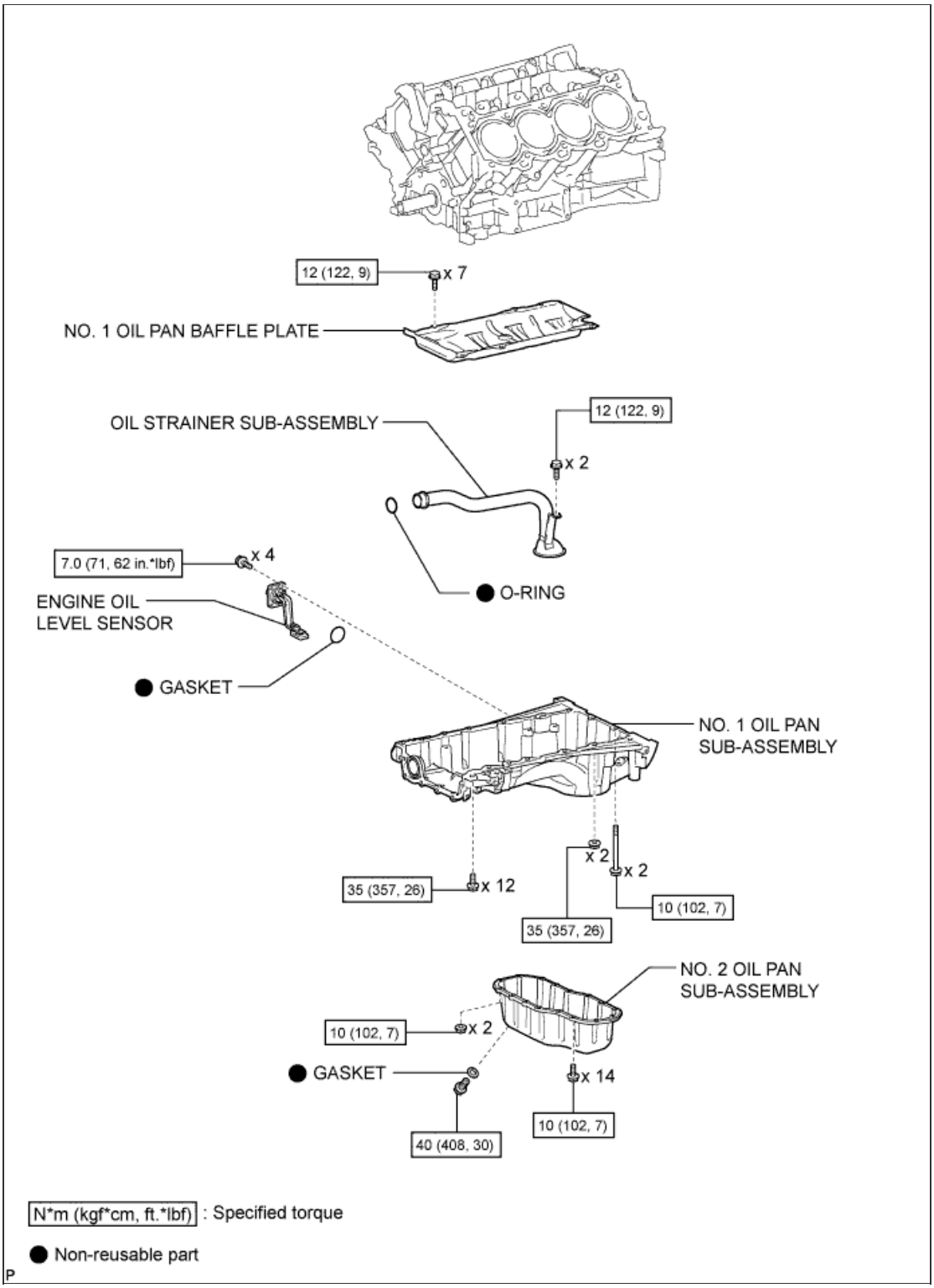

O-RING
WATER INLET PIPE
GASKET
O-RING
47 (479, 35)
x 2
20 (204, 15)
x 5
23 (235, 17)
GASKET
WATER PUMP ASSEMBLY
23 (235, 17)
23 (235, 17)
x 12
CRANKSHAFT PULLEY
47 (479, 35)
x 3
47 (479, 35)
x 4
300 (3059, 221)
47 (479, 35)
x 5
23 (235, 17)
FRONT CRANKSHAFT OIL SEAL
TIMING CHAIN COVER SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P


CAMSHAFT TIMING GEAR RH
CAMSHAFT TIMING GEAR LH
NO. 2 CHAIN LH
100 (1020, 74)
100 (1020, 74)
NO. 2 CHAIN RH
100 (1020, 74)
100 (1020, 74)
CAMSHAFT TIMING EXHAUST GEAR RH
CAMSHAFT TIMING EXHAUST GEAR LH
NO. 1 CHAIN TENSIONER ASSEMBLY RH
NO. 1 CHAIN VIBRATION DAMPER RH
x 2
10 (102, 7)
NO. 1 CHAIN TENSIONER SLIPPER RH
NO. 1 CHAIN SUB-ASSEMBLY RH
x 2
21 (214, 15)
x 2
CRANKSHAFT TIMING GEAR KEY
CRANKSHAFT TIMING SPROCKET LH
CRANKSHAFT TIMING SPROCKET RH
x 2
10 (102, 7)
GASKET
NO. 1 CHAIN TENSIONER ASSEMBLY LH
NO. 1 CHAIN TENSIONER SLIPPER LH
x 2
21 (214, 15)
NO. 1 CHAIN SUB-ASSEMBLY LH
NO. 1 CHAIN VIBRATION DAMPER LH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


NO. 4 CAMSHAFT BEARING CAP LH
NO. 3 CAMSHAFT
NO. 6 CAMSHAFT BEARING CAP LH
16 (163, 12)
x 10
x 10
30 (306, 22)
NO. 2 CAMSHAFT BEARING CAP LH
NO. 3 CHAIN TENSIONER ASSEMBLY
NO. 5 CAMSHAFT BEARING CAP LH
10 (102, 7)
x 2
NO. 3 CAMSHAFT BEARING CAP LH
NO. 4 CAMSHAFT
30 (306, 22)
x 6
CAMSHAFT HOUSING SUB-ASSEMBLY LH
1st: 36 (367, 27)
2nd: Turn 90°
3rd: Turn 90°
10 (102, 7)
PLATE WASHER
x 10
x 10
21 (214, 15)
VALVE STEM CAP
CYLINDER HEAD SUB-ASSEMBLY LH
x 16
x 16
x 16
NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY
VALVE LASH ADJUSTER ASSEMBLY
● CYLINDER HEAD GASKET LH
N*m (kgf*cm, ft.*lbf) : Specified torque
● Non-reusable part
P

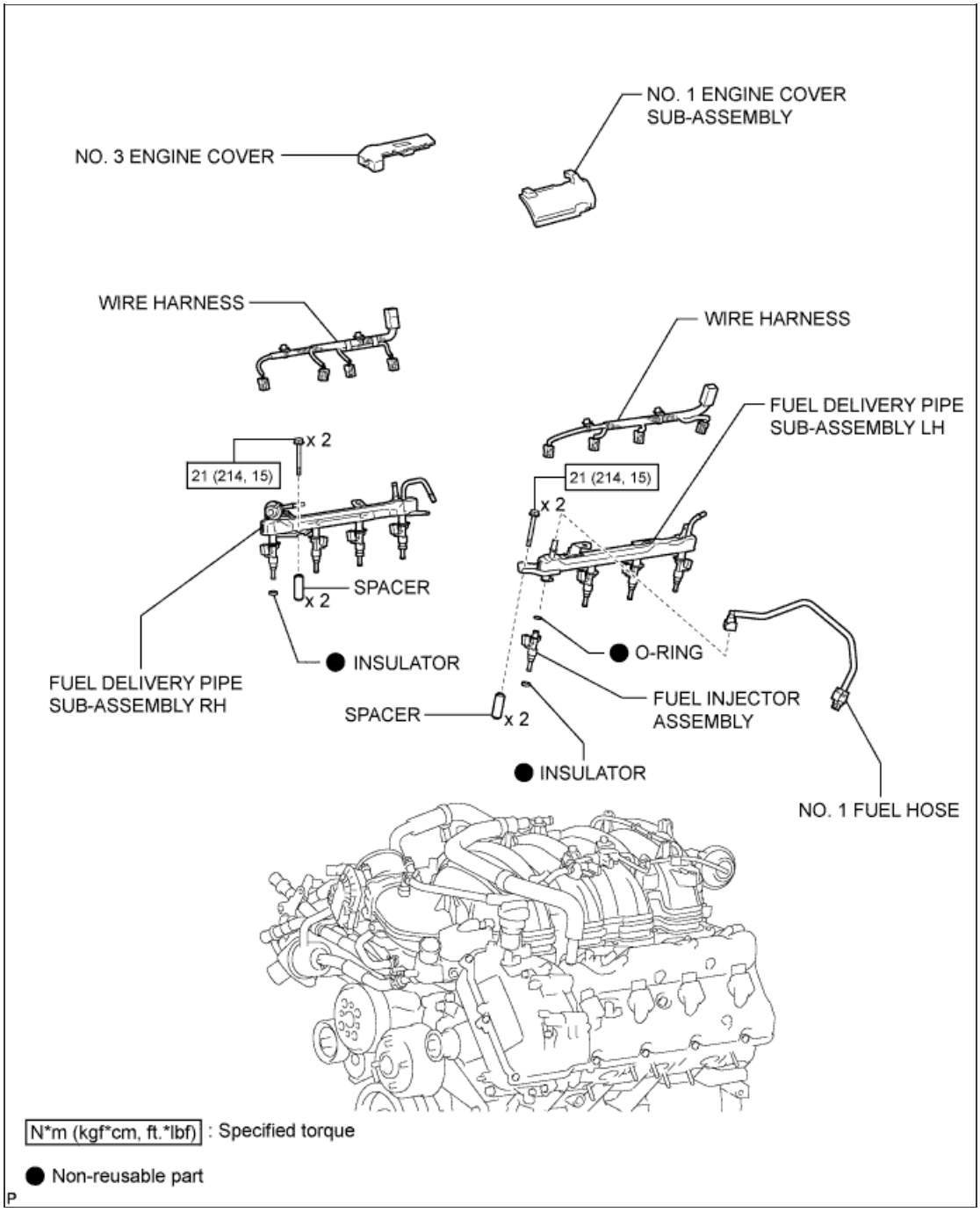

NO. 4 CAMSHAFT BEARING CAP RH
NO. 1 CAMSHAFT
NO. 6 CAMSHAFT BEARING CAP RH
16 (163, 12)
x 10
30 (306, 22)
x 10
NO. 1 CAMSHAFT BEARING CAP RH
NO. 2 CHAIN TENSIONER ASSEMBLY
10 (102, 7)
x 2
NO. 5 CAMSHAFT BEARING CAP RH
NO. 3 CAMSHAFT BEARING CAP RH
NO. 2 CAMSHAFT
30 (306, 22)
x 6
CAMSHAFT HOUSING SUB-ASSEMBLY RH
10 (102, 7)
1st: 36 (367, 27)
2nd: Turn 90°
3rd: Turn 90°
x 10
21 (214, 15)
PLATE WASHER
x 10
VALVE STEM CAP
x 16
x 16
x 16
CYLINDER HEAD SUB-ASSEMBLY RH
NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY
VALVE LASH ADJUSTER ASSEMBLY
● CYLINDER HEAD GASKET RH
N*m (kgf*cm, ft.*lbf) : Specified torque
● Non-reusable part
P

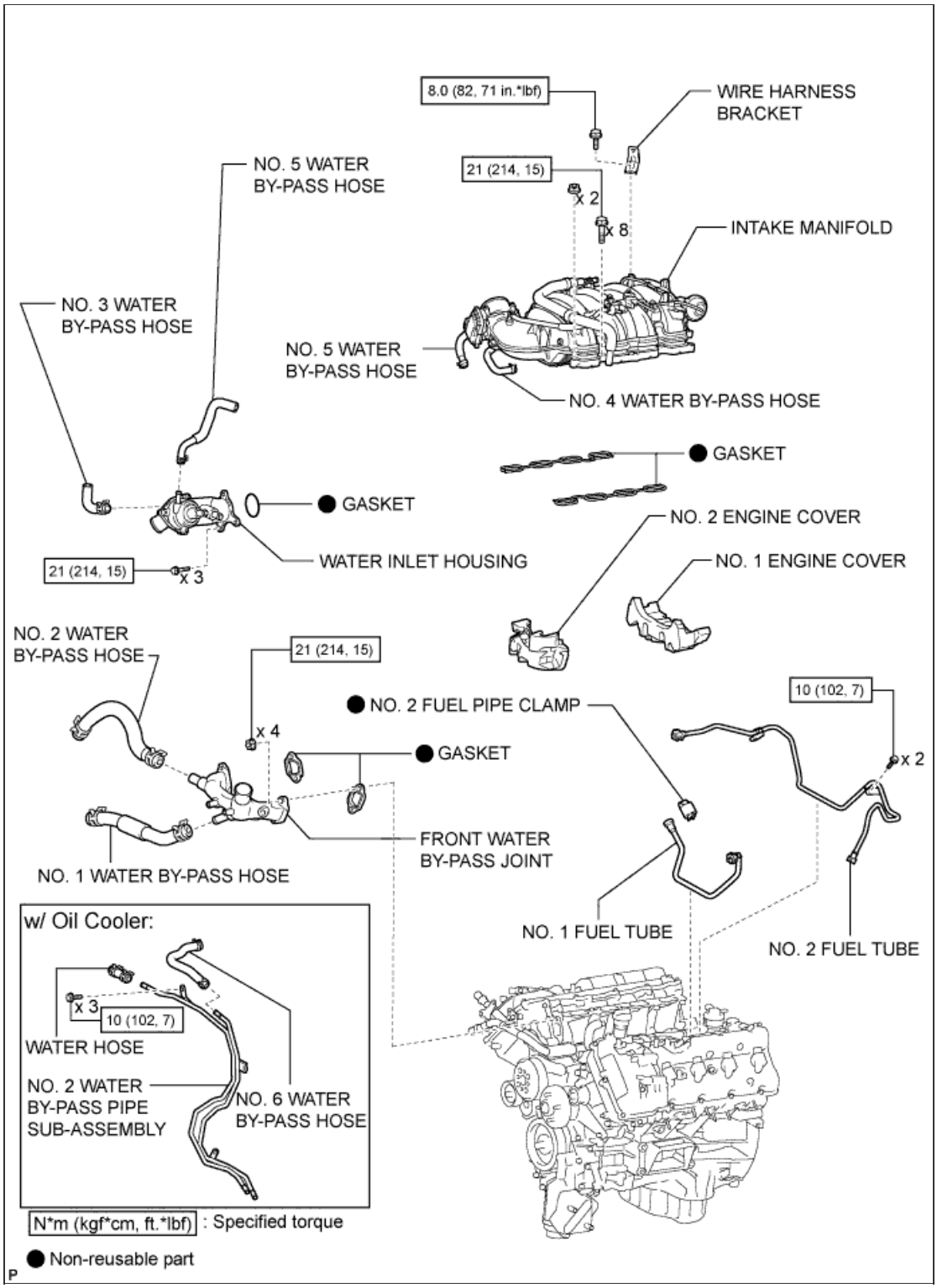

CYLINDER BLOCK WATER JACKET SPACER
21 (214, 15)
21 (214, 15)
21 (214, 15)
x 10
x 2
10 (102, 7)
NO. 1 HEAT EXCHANGER COVER
ENGINE REAR OIL SEAL RETAINER
10 (102, 7)
x 6
VENTILATION PIPE GASKET
O-RING
REAR CRANKSHAFT OIL SEAL
10 (102, 7)
OIL DRAIN PIPE SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P

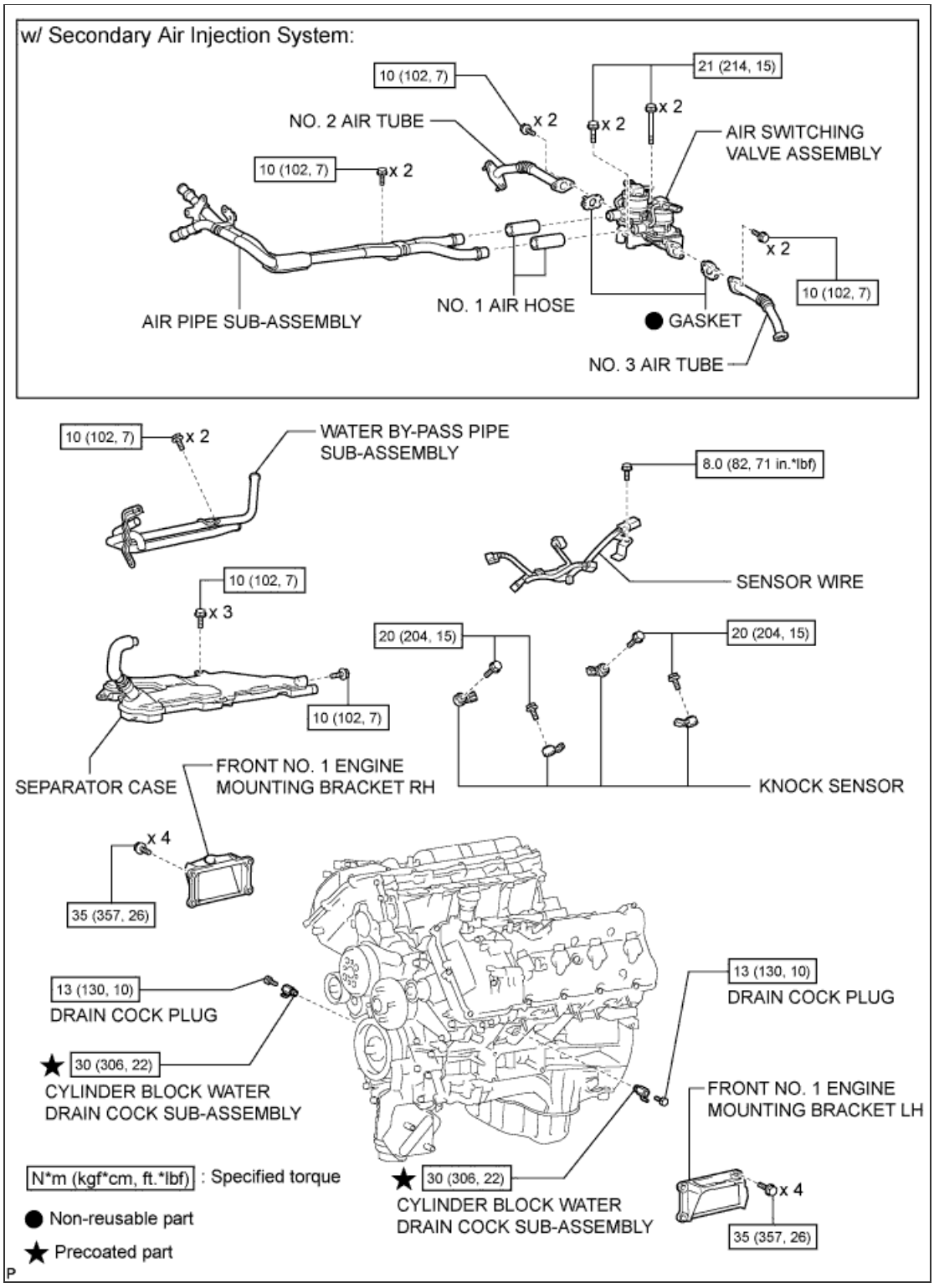

12 (122, 9)
x 7
NO. 1 OIL PAN BAFFLE PLATE
OIL STRAINER SUB-ASSEMBLY
12 (122, 9)
x 2
7.0 (71, 62 in.*lbf)
x 4
ENGINE OIL
LEVEL SENSOR
O-RING
GASKET
NO. 1 OIL PAN
SUB-ASSEMBLY
x 2
x 2
35 (357, 26)
x 12
10 (102, 7)
35 (357, 26)
NO. 2 OIL PAN
SUB-ASSEMBLY
10 (102, 7)
x 2
GASKET
x 14
10 (102, 7)
40 (408, 30)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

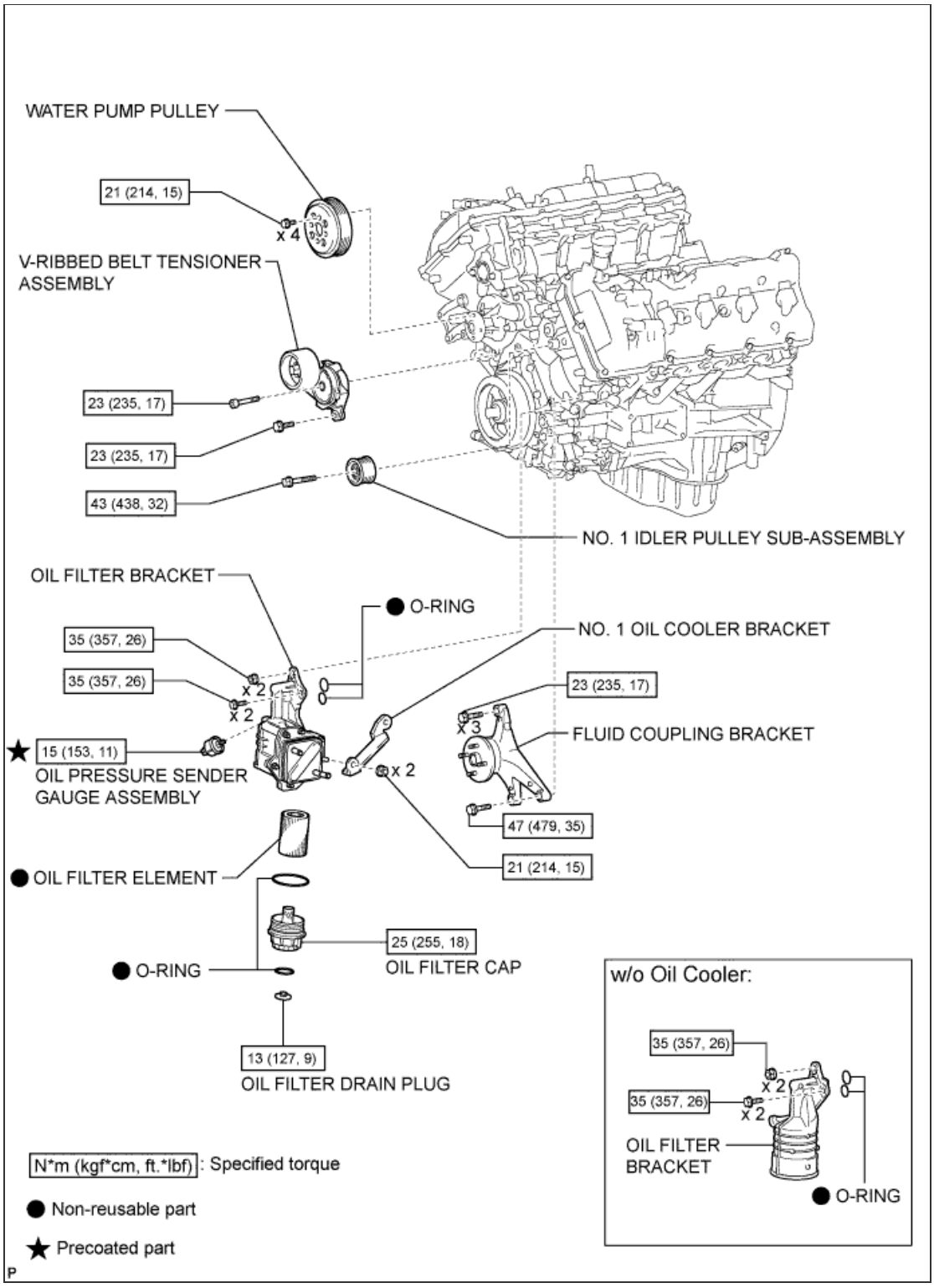
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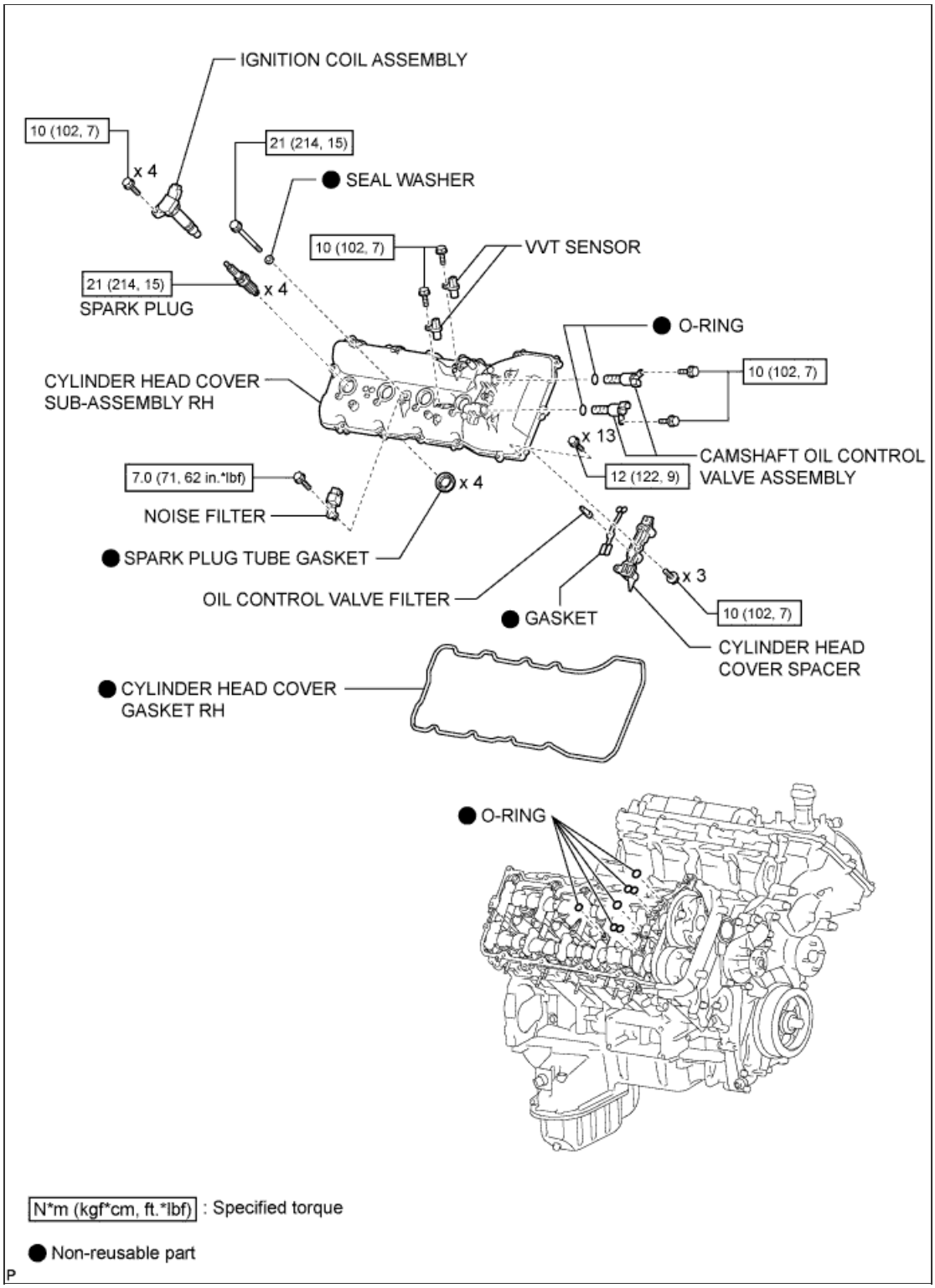
for Preparation [Click here]



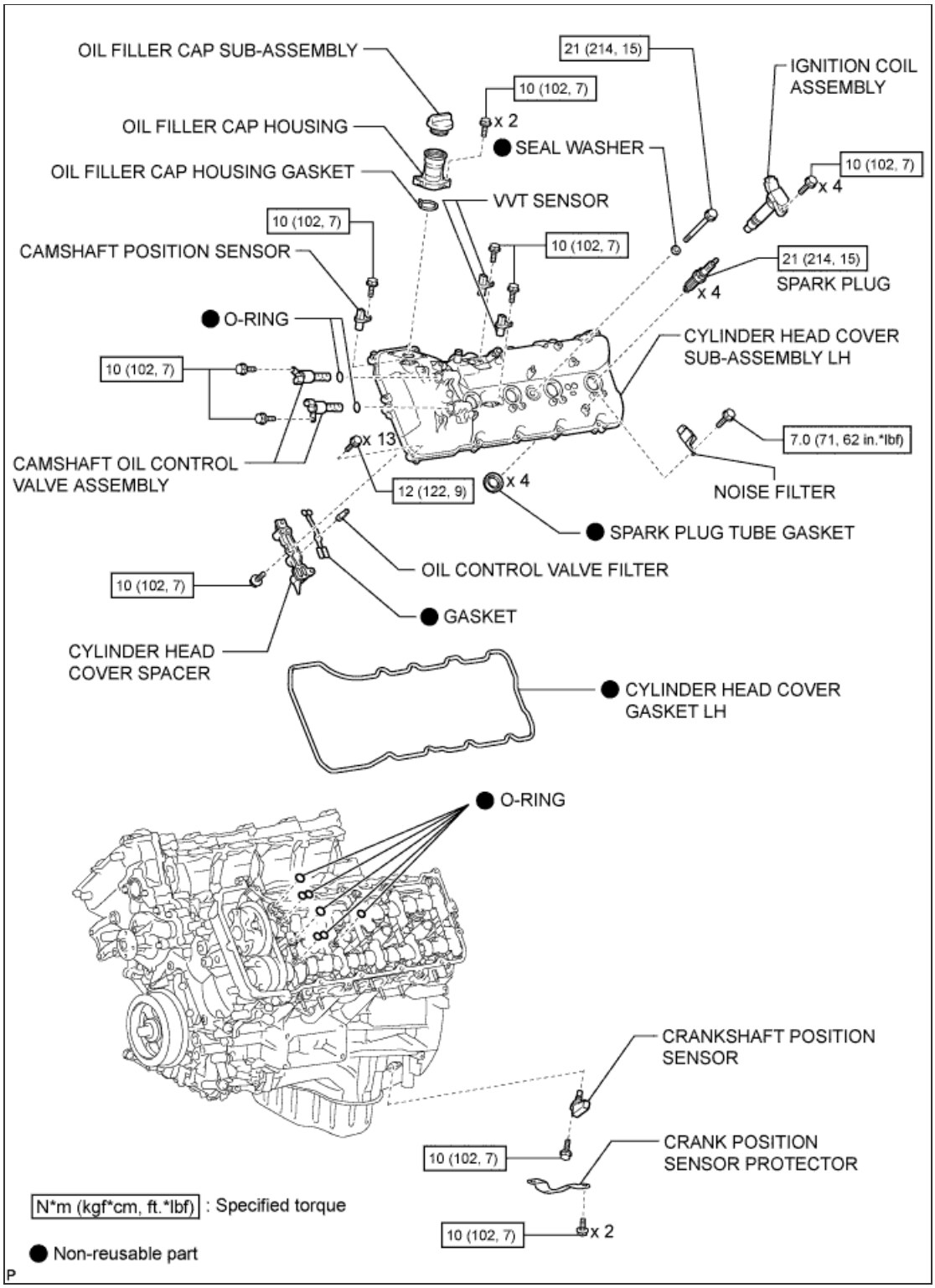

8.0 (82, 71 in.*lbf)
WIRE HARNESS BRACKET
NO. 5 WATER BY-PASS HOSE
21 (214, 15)
x 2
x 8
INTAKE MANIFOLD
NO. 3 WATER BY-PASS HOSE
NO. 5 WATER BY-PASS HOSE
NO. 4 WATER BY-PASS HOSE
GASKET
GASKET
NO. 2 ENGINE COVER
NO. 1 ENGINE COVER
WATER INLET HOUSING
21 (214, 15)
x 3
NO. 2 WATER BY-PASS HOSE
21 (214, 15)
NO. 2 FUEL PIPE CLAMP
10 (102, 7)
x 4
GASKET
x 2
FRONT WATER BY-PASS JOINT
NO. 1 WATER BY-PASS HOSE
NO. 1 FUEL TUBE
NO. 2 FUEL TUBE
w/ Oil Cooler:
x 3
10 (102, 7)
WATER HOSE
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
NO. 6 WATER BY-PASS HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

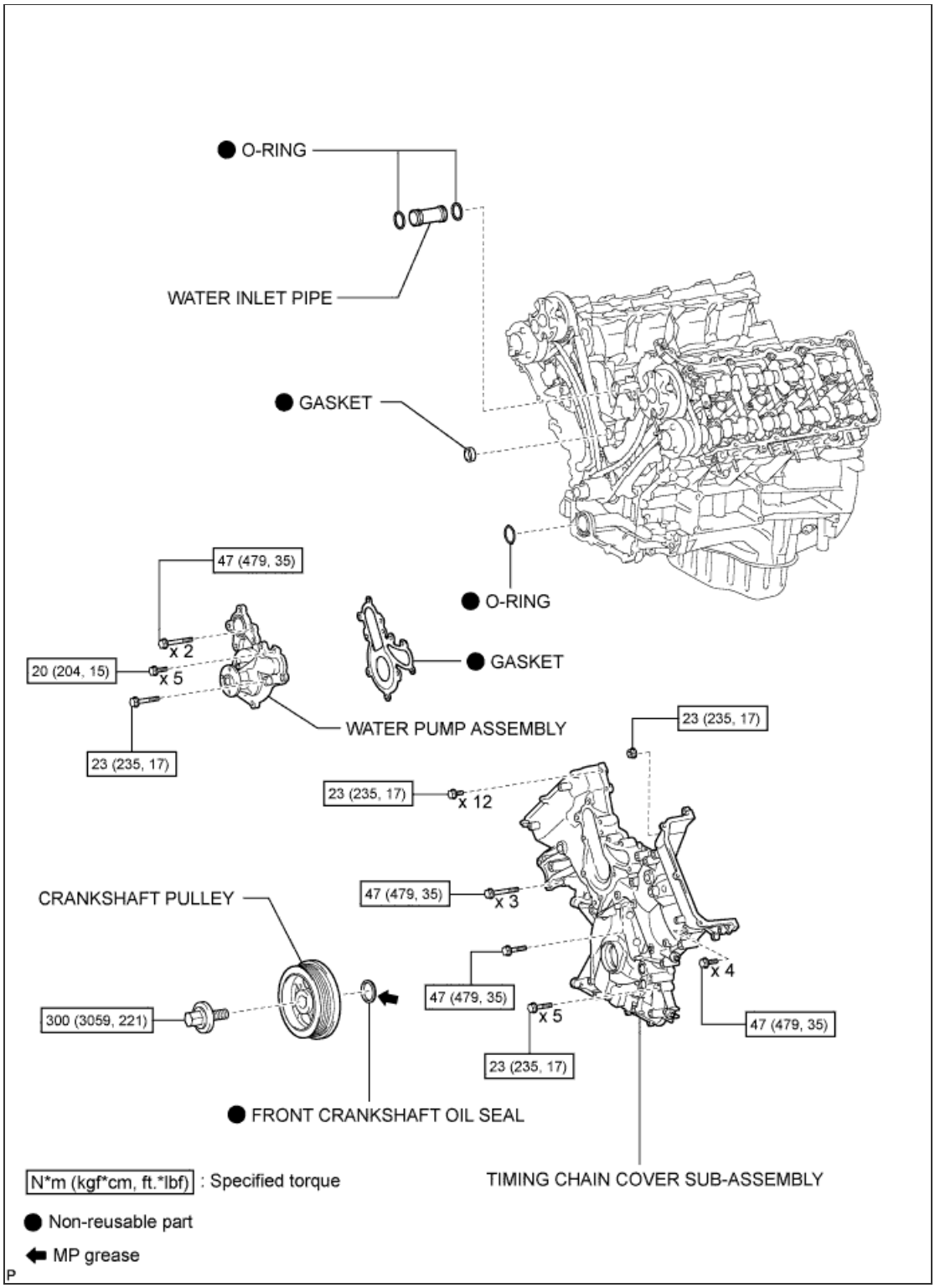

w/ Secondary Air Injection System:
10 (102, 7)
x 2
NO. 2 AIR TUBE
21 (214, 15)
x 2
x 2
AIR SWITCHING VALVE ASSEMBLY
10 (102, 7)
x 2
x 2
10 (102, 7)
AIR PIPE SUB-ASSEMBLY
NO. 1 AIR HOSE
GASKET
NO. 3 AIR TUBE
10 (102, 7)
x 2
WATER BY-PASS PIPE SUB-ASSEMBLY
8.0 (82, 71 in.*lbf)
SENSOR WIRE
10 (102, 7)
x 3
10 (102, 7)
20 (204, 15)
20 (204, 15)
SEPARATOR CASE
FRONT NO. 1 ENGINE MOUNTING BRACKET RH
KNOCK SENSOR
x 4
35 (357, 26)
13 (130, 10)
DRAIN COCK PLUG
30 (306, 22)
CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY
13 (130, 10)
DRAIN COCK PLUG
FRONT NO. 1 ENGINE MOUNTING BRACKET LH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
30 (306, 22)
CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY
x 4
35 (357, 26)
P

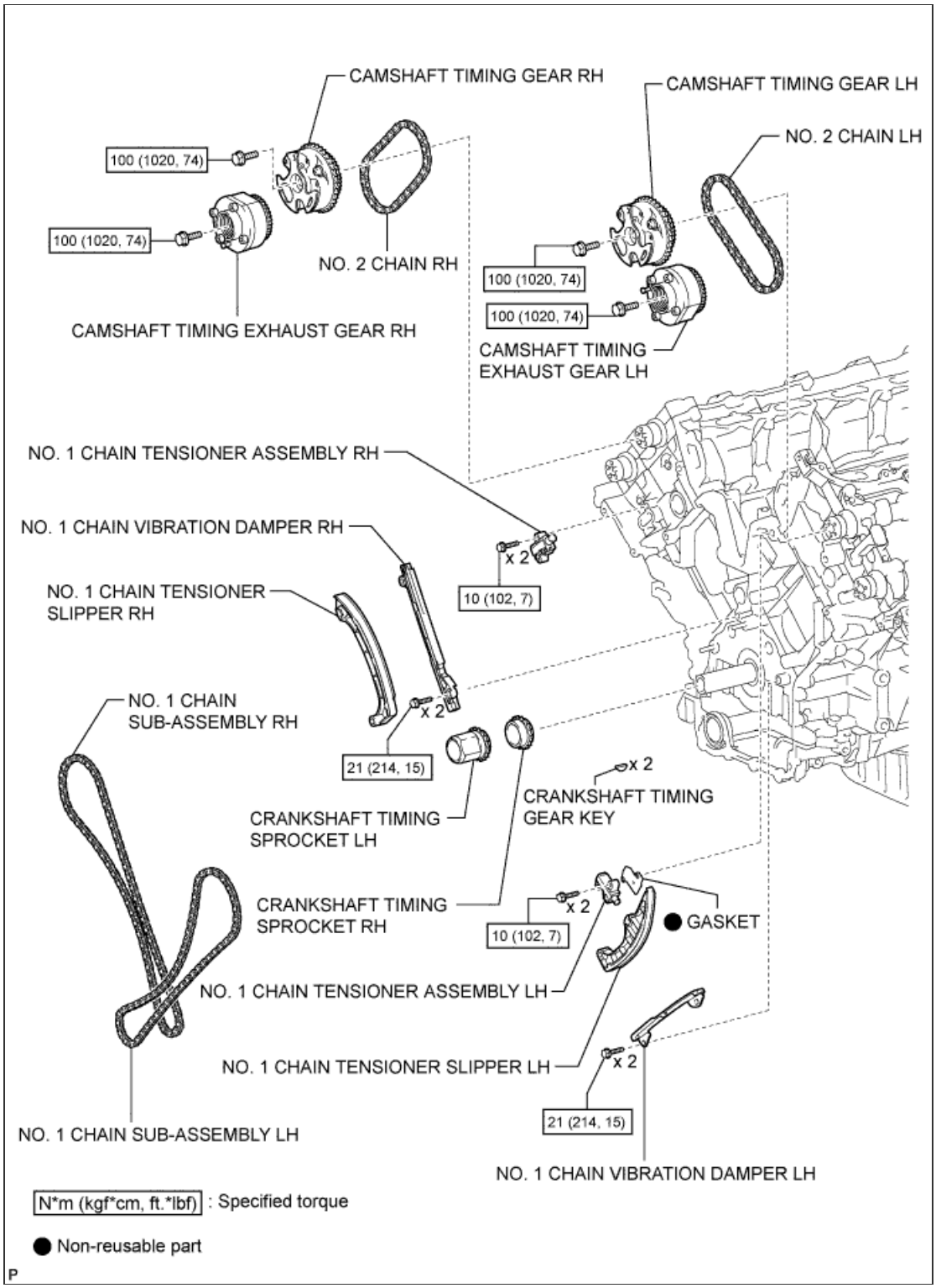

WATER PUMP PULLEY
21 (214, 15)
x 4
V-RIBBED BELT TENSIONER ASSEMBLY
23 (235, 17)
23 (235, 17)
43 (438, 32)
NO. 1 IDLER PULLEY SUB-ASSEMBLY
OIL FILTER BRACKET
O-RING
35 (357, 26)
35 (357, 26)
x 2
x 2
NO. 1 OIL COOLER BRACKET
23 (235, 17)
x 3
FLUID COUPLING BRACKET
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
x 2
47 (479, 35)
21 (214, 15)
OIL FILTER ELEMENT
25 (255, 18)
OIL FILTER CAP
O-RING
13 (127, 9)
OIL FILTER DRAIN PLUG
w/o Oil Cooler:
35 (357, 26)
35 (357, 26)
x 2
x 2
OIL FILTER BRACKET
O-RING
N*m (kgf*cm, ft.*lbf): Specified torque
Non-reusable part
Precoated part
P

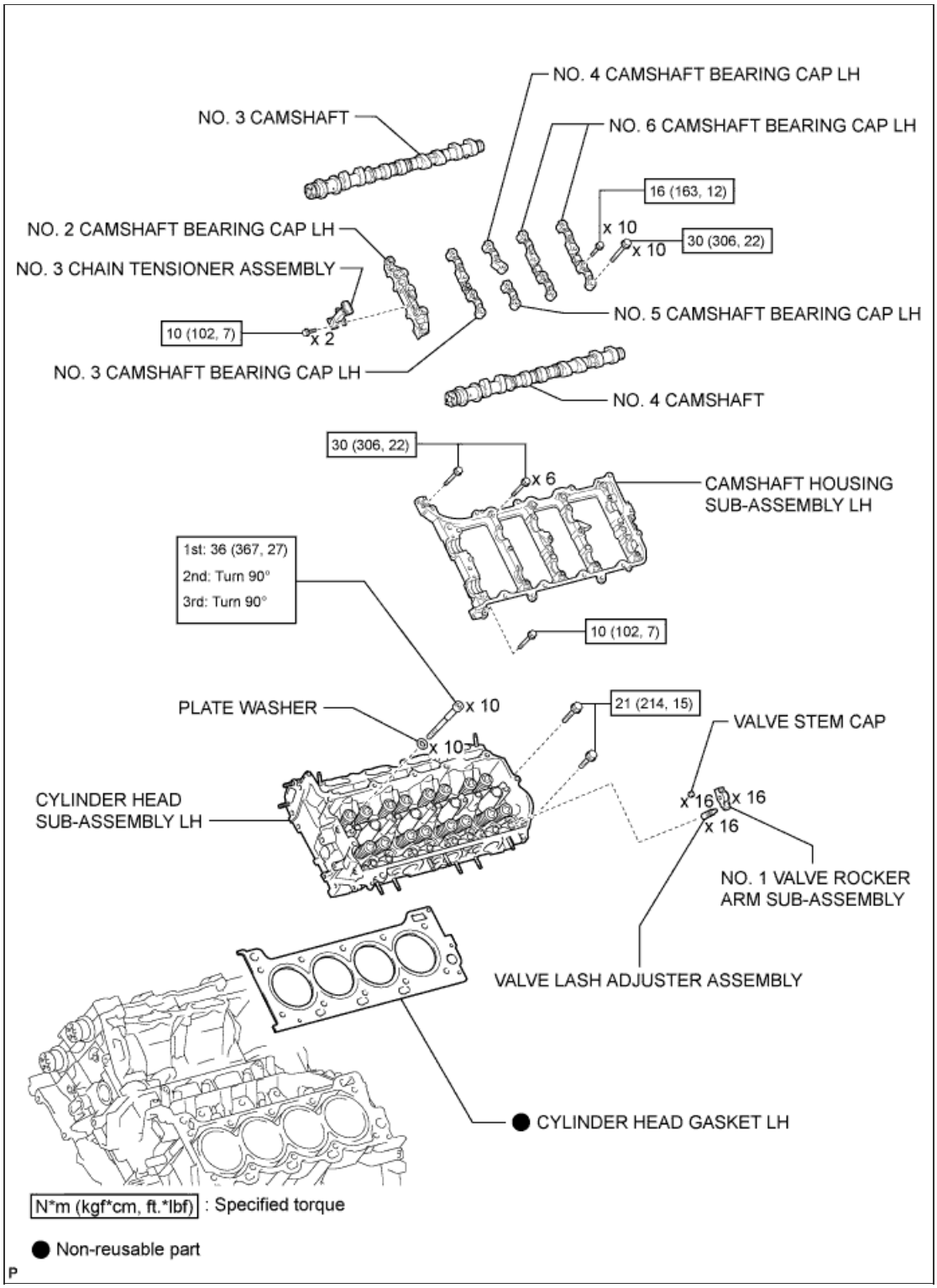

IGNITION COIL ASSEMBLY
10 (102, 7)
x 4
21 (214, 15)
SEAL WASHER
10 (102, 7)
VVT SENSOR
21 (214, 15)
x 4
SPARK PLUG
O-RING
CYLINDER HEAD COVER SUB-ASSEMBLY RH
10 (102, 7)
x 13
CAMSHAFT OIL CONTROL VALVE ASSEMBLY
12 (122, 9)
7.0 (71, 62 in.*lbf)
x 4
NOISE FILTER
SPARK PLUG TUBE GASKET
OIL CONTROL VALVE FILTER
GASKET
x 3
10 (102, 7)
CYLINDER HEAD COVER SPACER
CYLINDER HEAD COVER GASKET RH
O-RING
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

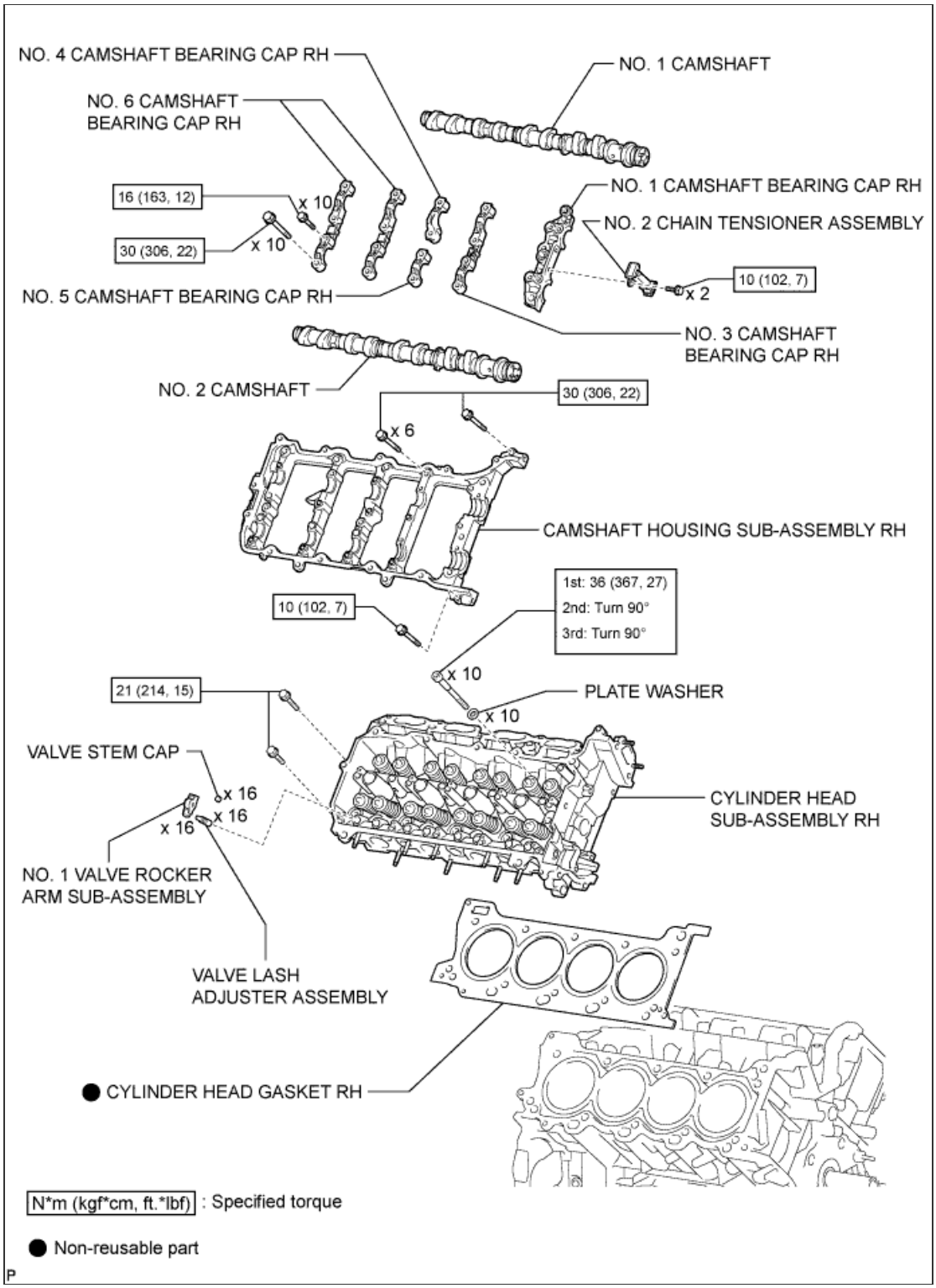
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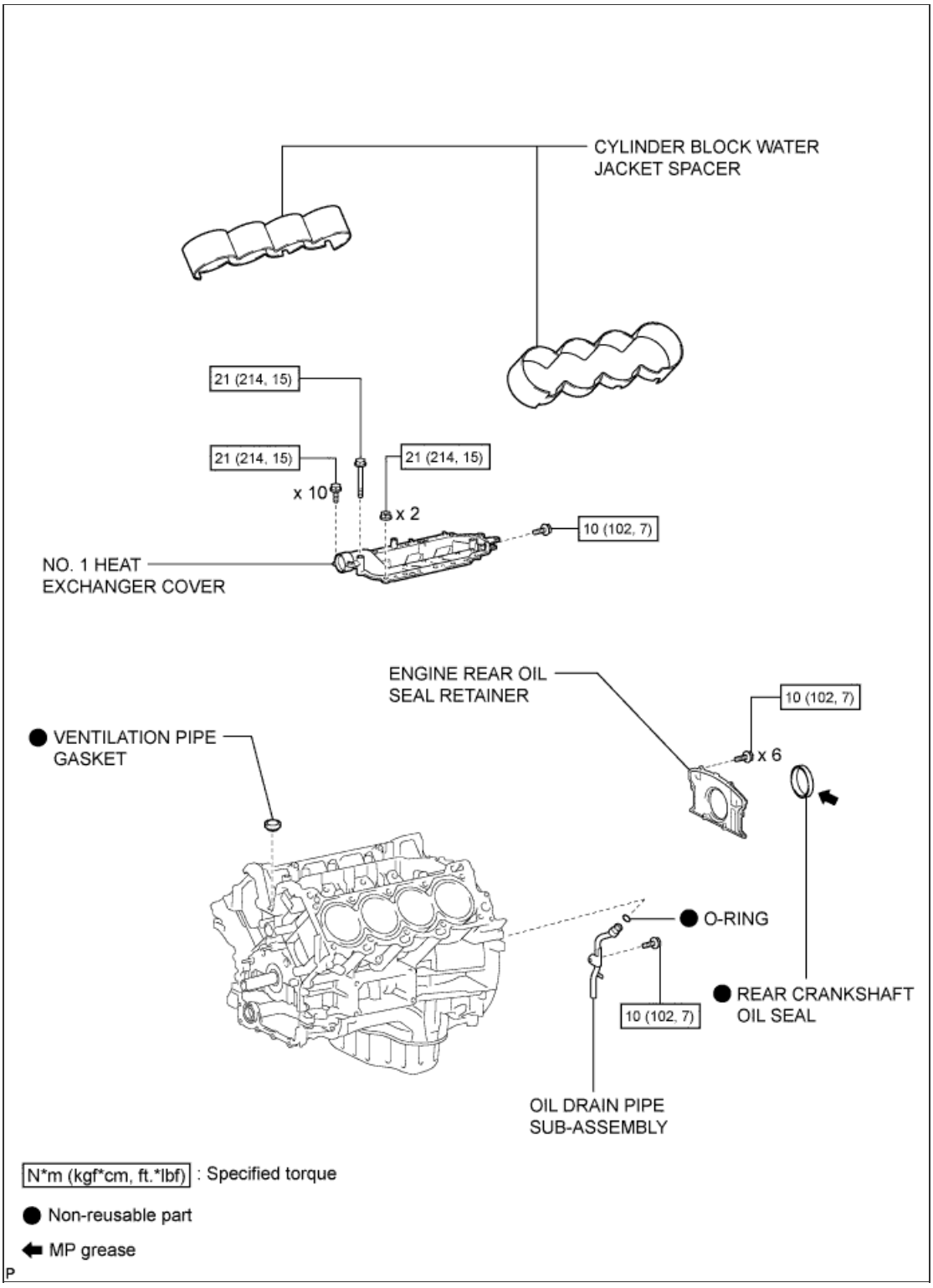

OIL FILLER CAP SUB-ASSEMBLY
21 (214, 15)
IGNITION COIL ASSEMBLY
10 (102, 7)
x 2
OIL FILLER CAP HOUSING
SEAL WASHER
OIL FILLER CAP HOUSING GASKET
10 (102, 7)
x 4
VVT SENSOR
10 (102, 7)
CAMSHAFT POSITION SENSOR
10 (102, 7)
21 (214, 15)
SPARK PLUG
x 4
O-RING
CYLINDER HEAD COVER SUB-ASSEMBLY LH
10 (102, 7)
x 13
7.0 (71, 62 in.*lbf)
CAMSHAFT OIL CONTROL VALVE ASSEMBLY
12 (122, 9)
x 4
NOISE FILTER
SPARK PLUG TUBE GASKET
OIL CONTROL VALVE FILTER
10 (102, 7)
GASKET
CYLINDER HEAD COVER SPACER
CYLINDER HEAD COVER GASKET LH
O-RING
CRANKSHAFT POSITION SENSOR
10 (102, 7)
CRANK POSITION SENSOR PROTECTOR
10 (102, 7)
x 2
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

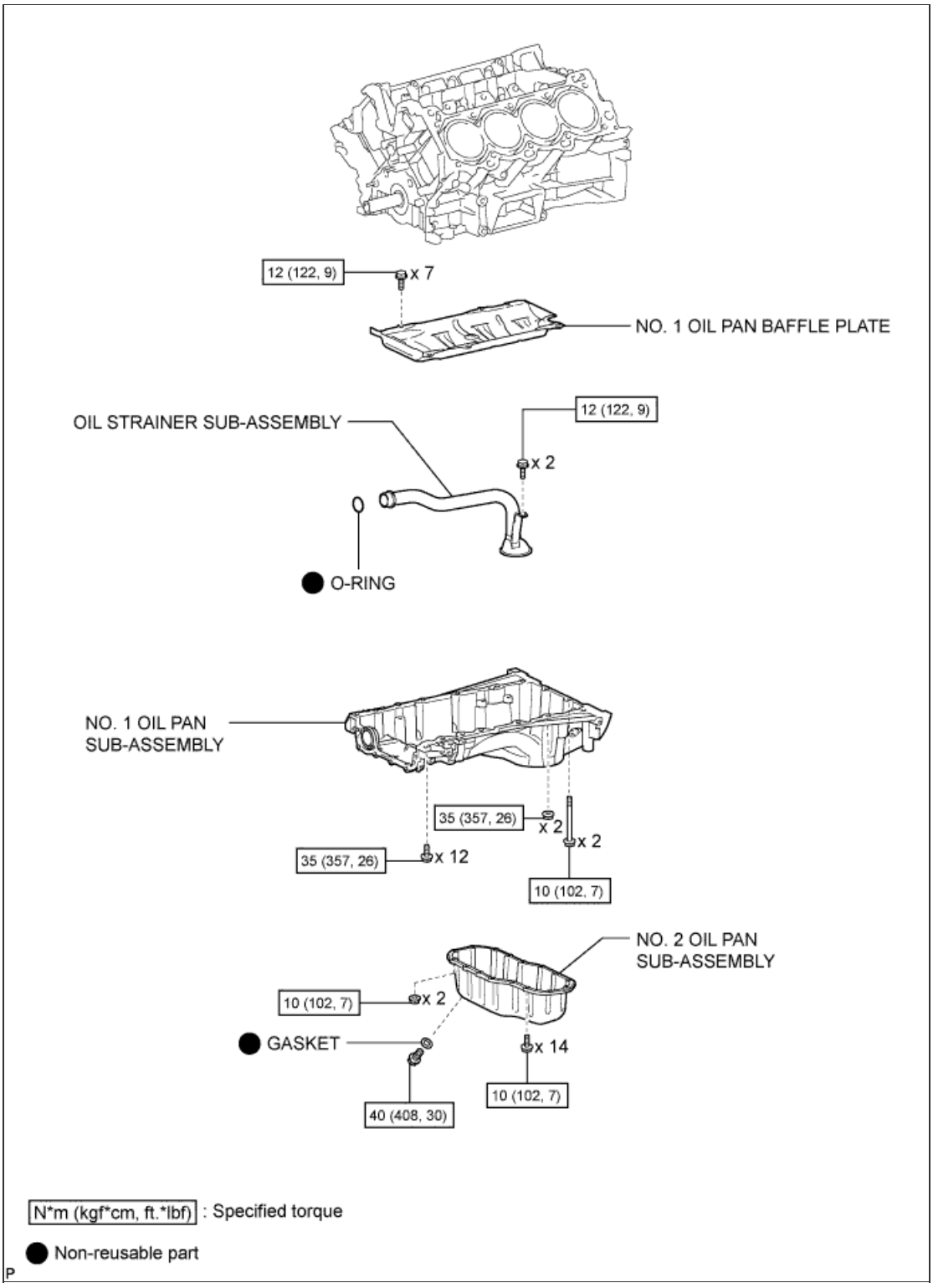

O-RING
WATER INLET PIPE
GASKET
O-RING
47 (479, 35)
x 2
20 (204, 15)
x 5
23 (235, 17)
GASKET
WATER PUMP ASSEMBLY
23 (235, 17)
23 (235, 17)
x 12
CRANKSHAFT PULLEY
47 (479, 35)
x 3
47 (479, 35)
x 4
300 (3059, 221)
47 (479, 35)
x 5
23 (235, 17)
FRONT CRANKSHAFT OIL SEAL
TIMING CHAIN COVER SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P


CAMSHAFT TIMING GEAR RH
CAMSHAFT TIMING GEAR LH
NO. 2 CHAIN LH
100 (1020, 74)
100 (1020, 74)
NO. 2 CHAIN RH
100 (1020, 74)
100 (1020, 74)
CAMSHAFT TIMING EXHAUST GEAR RH
CAMSHAFT TIMING EXHAUST GEAR LH
NO. 1 CHAIN TENSIONER ASSEMBLY RH
NO. 1 CHAIN VIBRATION DAMPER RH
x 2
10 (102, 7)
NO. 1 CHAIN TENSIONER SLIPPER RH
NO. 1 CHAIN SUB-ASSEMBLY RH
x 2
21 (214, 15)
x 2
CRANKSHAFT TIMING GEAR KEY
CRANKSHAFT TIMING SPROCKET LH
CRANKSHAFT TIMING SPROCKET RH
x 2
10 (102, 7)
GASKET
NO. 1 CHAIN TENSIONER ASSEMBLY LH
NO. 1 CHAIN TENSIONER SLIPPER LH
x 2
21 (214, 15)
NO. 1 CHAIN SUB-ASSEMBLY LH
NO. 1 CHAIN VIBRATION DAMPER LH
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


NO. 4 CAMSHAFT BEARING CAP LH
NO. 3 CAMSHAFT
NO. 6 CAMSHAFT BEARING CAP LH
16 (163, 12)
x 10
x 10
30 (306, 22)
NO. 2 CAMSHAFT BEARING CAP LH
NO. 3 CHAIN TENSIONER ASSEMBLY
NO. 5 CAMSHAFT BEARING CAP LH
10 (102, 7)
x 2
NO. 3 CAMSHAFT BEARING CAP LH
NO. 4 CAMSHAFT
30 (306, 22)
x 6
CAMSHAFT HOUSING SUB-ASSEMBLY LH
1st: 36 (367, 27)
2nd: Turn 90°
3rd: Turn 90°
10 (102, 7)
PLATE WASHER
x 10
x 10
21 (214, 15)
VALVE STEM CAP
CYLINDER HEAD SUB-ASSEMBLY LH
x 16
x 16
x 16
NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY
VALVE LASH ADJUSTER ASSEMBLY
● CYLINDER HEAD GASKET LH
N*m (kgf*cm, ft.*lbf) : Specified torque
● Non-reusable part
P


NO. 4 CAMSHAFT BEARING CAP RH
NO. 1 CAMSHAFT
NO. 6 CAMSHAFT BEARING CAP RH
16 (163, 12)
x 10
30 (306, 22)
x 10
NO. 1 CAMSHAFT BEARING CAP RH
NO. 2 CHAIN TENSIONER ASSEMBLY
10 (102, 7)
x 2
NO. 5 CAMSHAFT BEARING CAP RH
NO. 3 CAMSHAFT BEARING CAP RH
NO. 2 CAMSHAFT
30 (306, 22)
x 6
CAMSHAFT HOUSING SUB-ASSEMBLY RH
10 (102, 7)
1st: 36 (367, 27)
2nd: Turn 90°
3rd: Turn 90°
x 10
21 (214, 15)
PLATE WASHER
x 10
VALVE STEM CAP
x 16
x 16
x 16
CYLINDER HEAD SUB-ASSEMBLY RH
NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY
VALVE LASH ADJUSTER ASSEMBLY
● CYLINDER HEAD GASKET RH
N*m (kgf*cm, ft.*lbf) : Specified torque
● Non-reusable part
P


CYLINDER BLOCK WATER JACKET SPACER
21 (214, 15)
21 (214, 15)
21 (214, 15)
x 10
x 2
10 (102, 7)
NO. 1 HEAT EXCHANGER COVER
ENGINE REAR OIL SEAL RETAINER
10 (102, 7)
x 6
VENTILATION PIPE GASKET
O-RING
REAR CRANKSHAFT OIL SEAL
10 (102, 7)
OIL DRAIN PIPE SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P

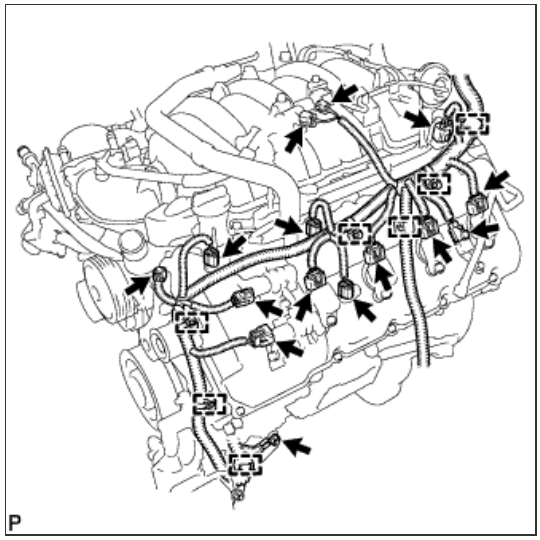

12 (122, 9)
x 7
NO. 1 OIL PAN BAFFLE PLATE
OIL STRAINER SUB-ASSEMBLY
12 (122, 9)
x 2
O-RING
NO. 1 OIL PAN
SUB-ASSEMBLY
35 (357, 26)
x 2
x 2
35 (357, 26)
x 12
10 (102, 7)
NO. 2 OIL PAN
SUB-ASSEMBLY
10 (102, 7)
x 2
GASKET
x 14
10 (102, 7)
40 (408, 30)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

P

for Preparation Click here

1. REMOVE ENGINE WIRE

a. Engine LH Side:



i. Disconnect the 2 camshaft timing control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the 2 VVT sensor connectors.

iv. Disconnect the camshaft position sensor connector.

v. Disconnect the vacuum switching valve connector (for ACIS).

vi. Disconnect the purge VSV connector.

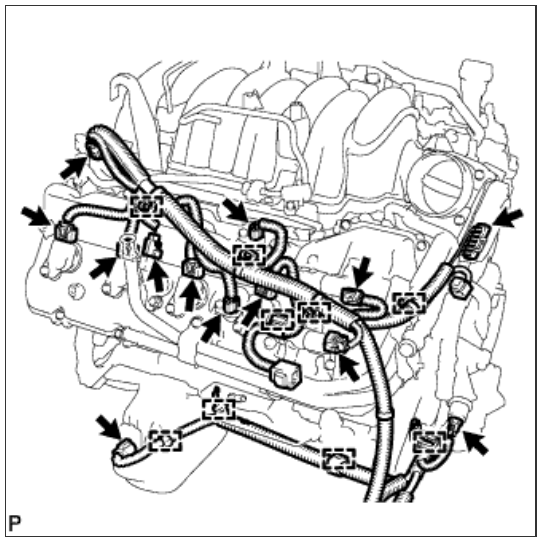
vii. Disconnect the engine coolant temperature sensor connector.

viii. Disconnect the fuel injector connector.

ix. Disconnect the noise filter connector.

x. Remove the bolt and disconnect the 7 clamps.

b. Engine RH Side:



i. Disconnect the 2 camshaft timing control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the 2 VVT sensor connectors.

iv. Disconnect the fuel injector connector.

v. Disconnect the noise filter connector.

vi. Disconnect the throttle sensor connector.

vii. Disconnect the oil pressure sender gauge connector.

viii. Disconnect the oil level sensor connector.

ix. Disconnect the 9 clamps.

c. Engine Rear Side:

i. Disconnect the 2 air switching valve connectors.

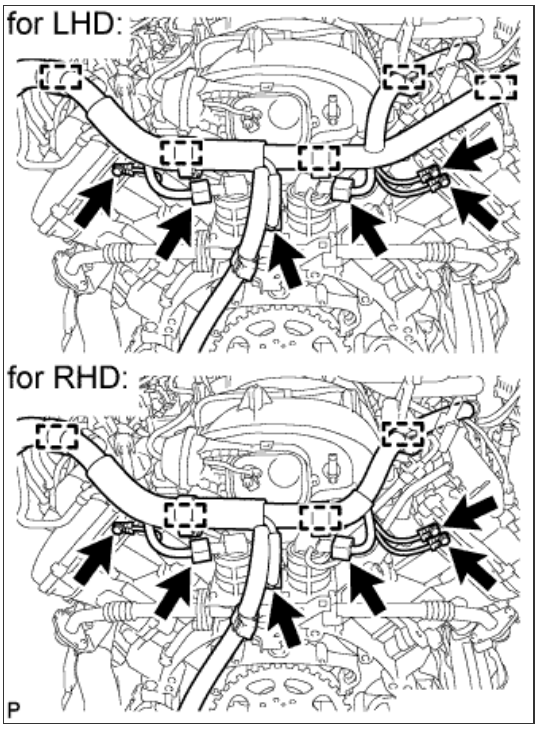
ii. Disconnect the sensor wire connector.

iii. for LHD:
Disconnect the 5 clamps.

iv. for RHD:
Disconnect the 4 clamps.

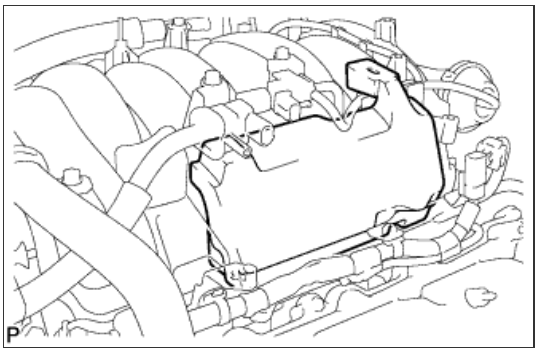
v. Remove the 3 bolts.

d. Remove the engine wire.



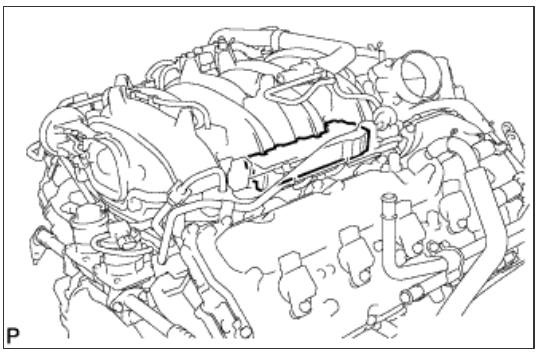
2. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Remove the No. 1 engine cover sub-assembly.



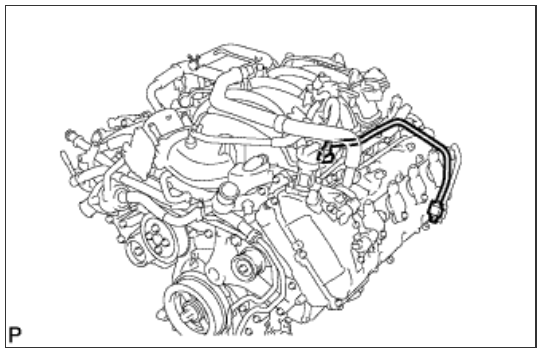
3. REMOVE NO. 3 ENGINE COVER

a. Remove the No. 3 engine cover.



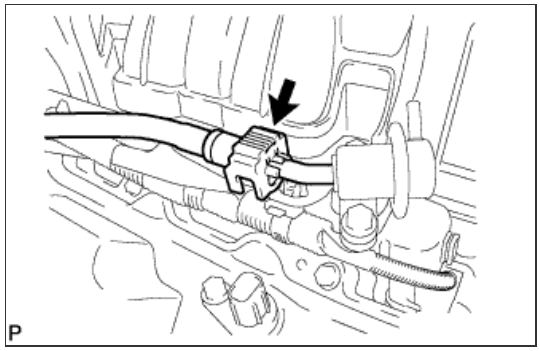
4. REMOVE NO. 1 FUEL HOSE

a. Remove the fuel hose (Click here).



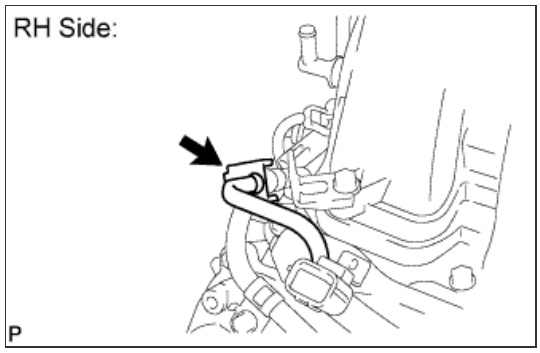
5. DISCONNECT NO. 2 FUEL TUBE

a. Disconnect the No. 2 fuel tube from the fuel pressure regulator (Click here).

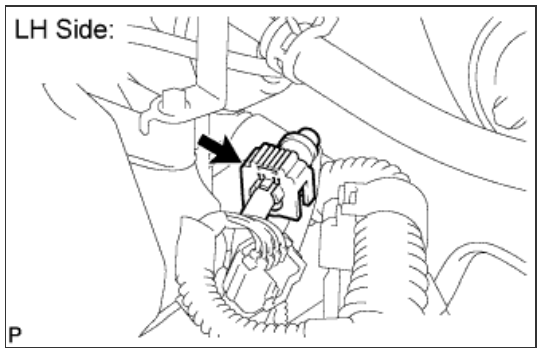


6. DISCONNECT NO. 1 FUEL TUBE

a. RH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe RH (Click here).



b. LH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe LH (Click here).



7. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Disconnect the No. 7 wire harness connector.

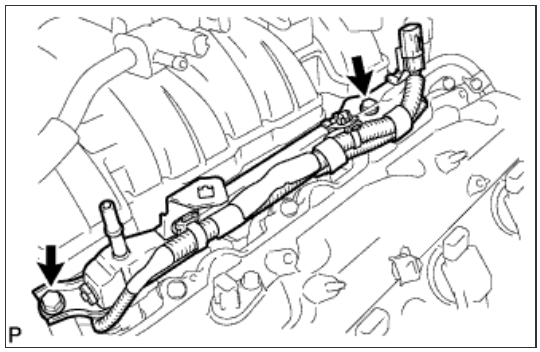
b. Remove the 2 bolts and fuel delivery pipe LH

b. Remove the 2 bolts and fuel delivery pipe LH.

NOTICE:

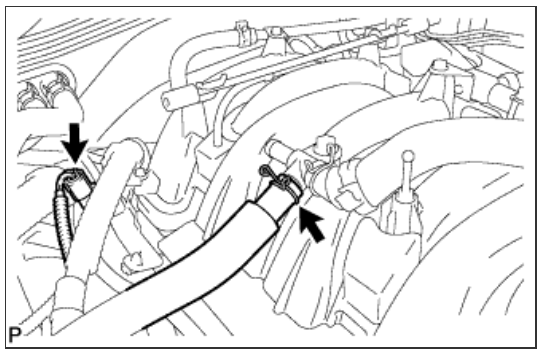
When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.

c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head LH.



8. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Disconnect the ventilation hose and No. 6 wire harness connector.

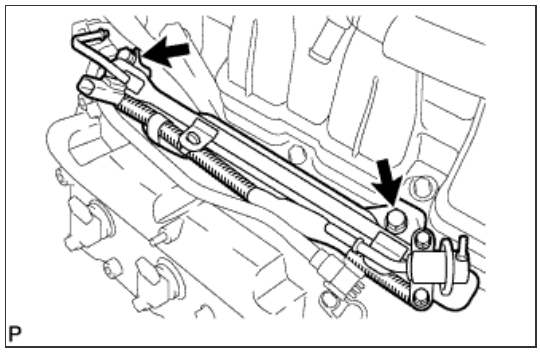


b. Remove the 2 bolts and fuel delivery pipe RH.

NOTICE:

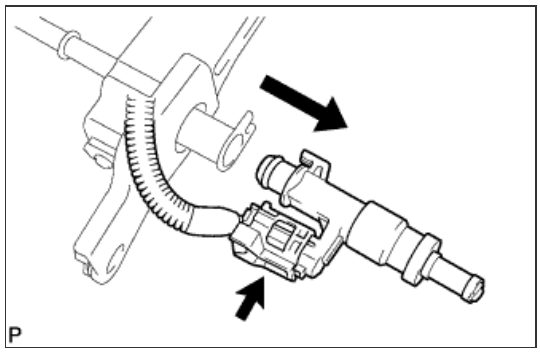
When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.

c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head RH.



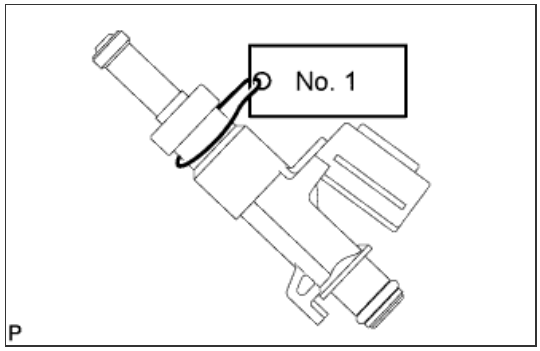
9. REMOVE FUEL INJECTOR ASSEMBLY

a. Remove the fuel injector from the fuel delivery pipe, and then disconnect the injector connector.

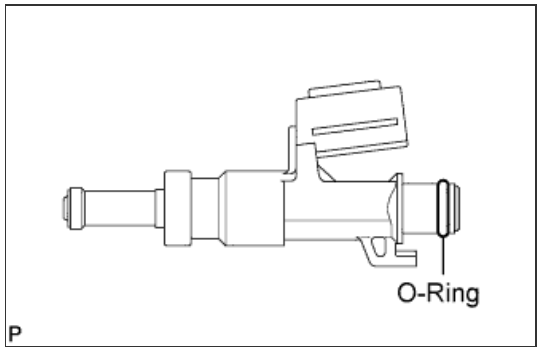


NOTICE:

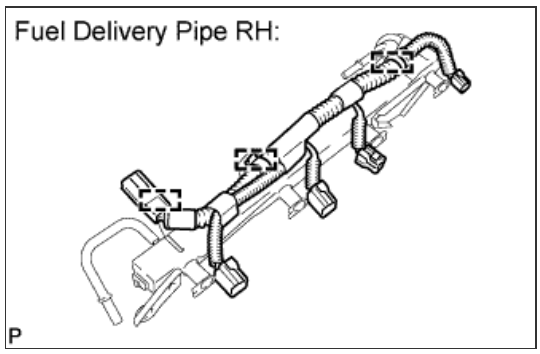
For reinstallation, attach a tag or label to the injector shaft.



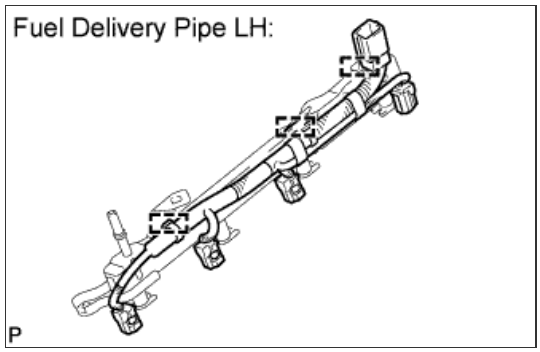
b. Remove the O-ring from the fuel injector.



c. Detach the 3 clamps and then remove the No. 6 wire harness from the delivery pipe RH.

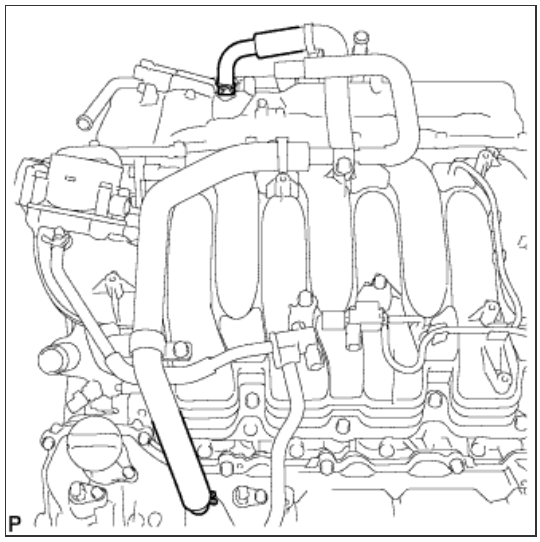


d. Detach the 3 clamps and then remove the No. 7 wire harness from the delivery pipe LH.

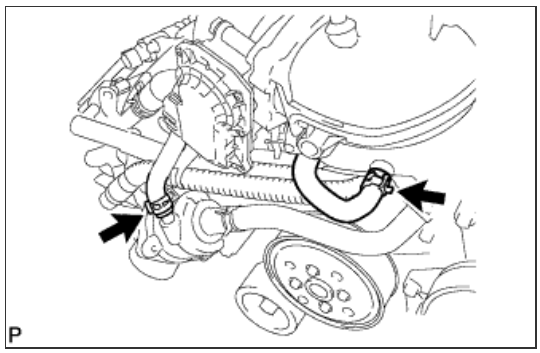


10. REMOVE INTAKE MANIFOLD

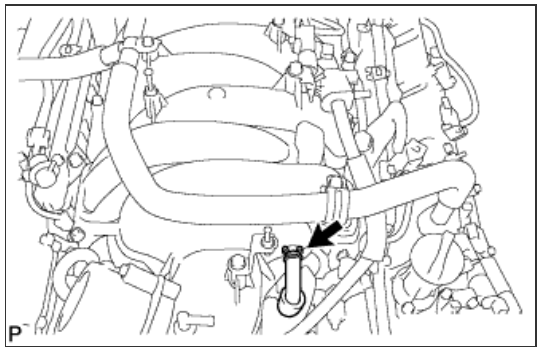
a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.



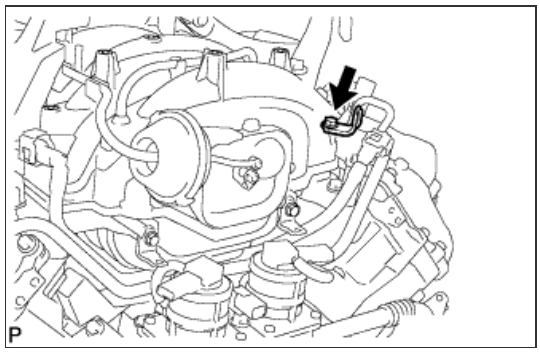
b. Disconnect the 2 water by-pass hoses.



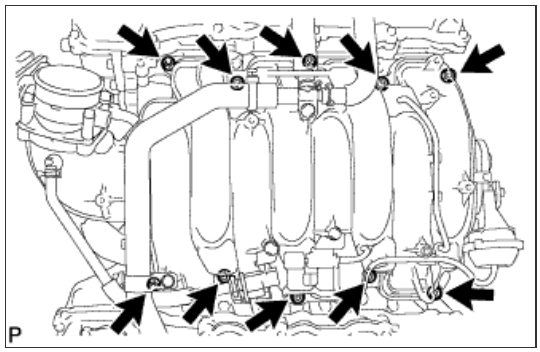
c. Disconnect the No. 1 ventilation hose.



d. Remove the bolt and wire bracket from the intake manifold.

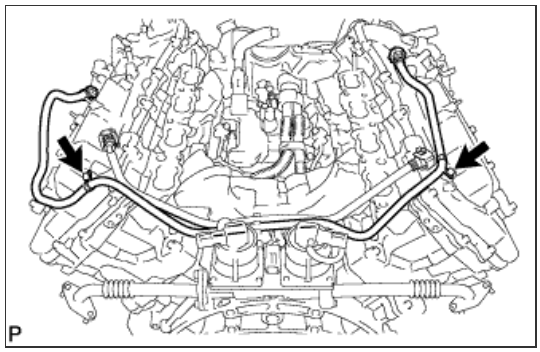


e. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.

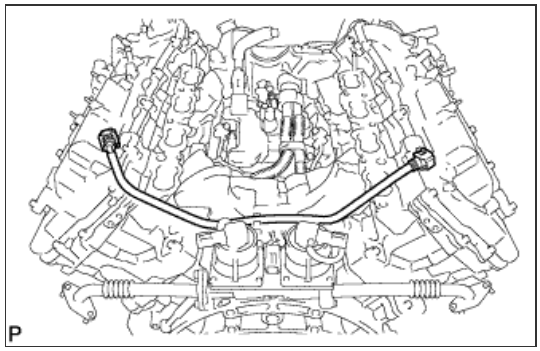


11. REMOVE NO. 2 FUEL TUBE

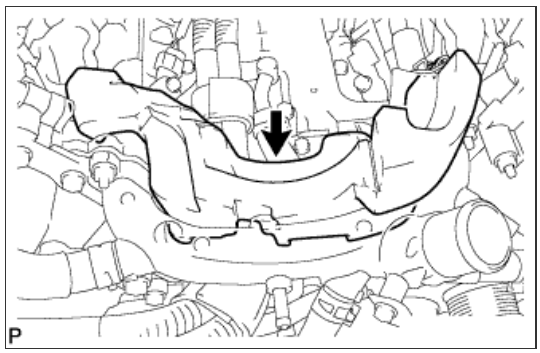
a. Remove the 2 bolts and No. 2 fuel tube.



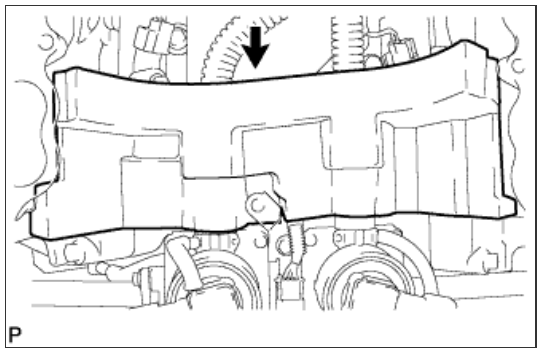
12. REMOVE NO. 1 FUEL TUBE



13. REMOVE NO. 2 ENGINE COVER



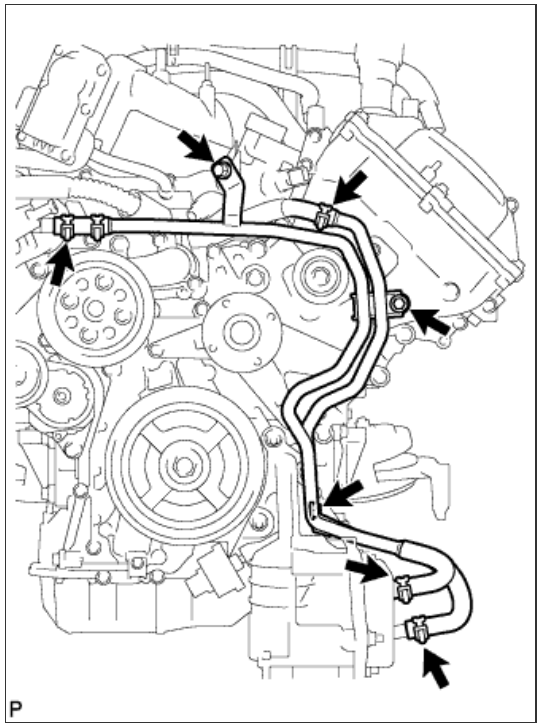
14. REMOVE NO. 1 ENGINE COVER



15. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

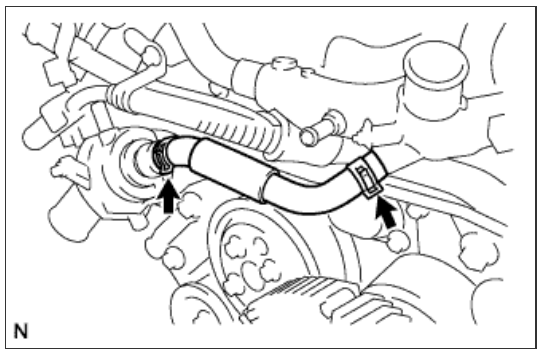
a. Remove the 3 bolts.

b. Disconnect the 4 hoses and remove the water by-pass pipe.



16. REMOVE NO. 1 WATER BY-PASS HOSE

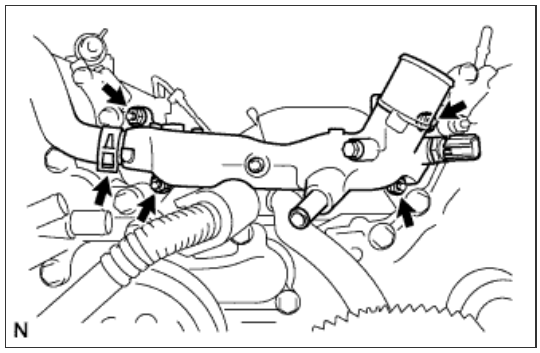
a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.



17. REMOVE FRONT WATER BY-PASS JOINT

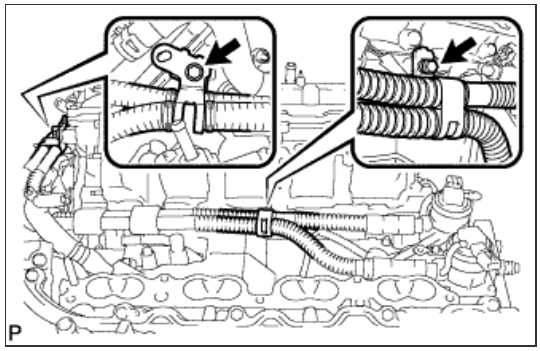
a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

b. Remove the 4 nuts, water by-pass joint and 2 gaskets.



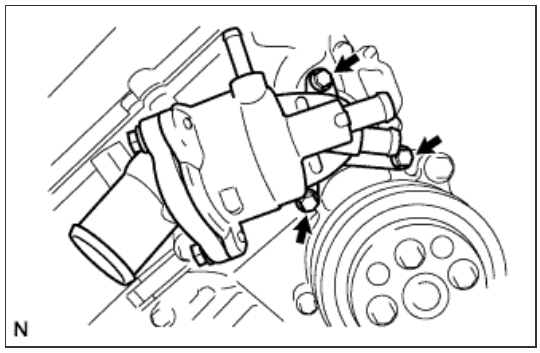
18. REMOVE AIR PIPE SUB-ASSEMBLY

a. Remove the 2 bolts, air pipe and 2 No. 1 air hoses.



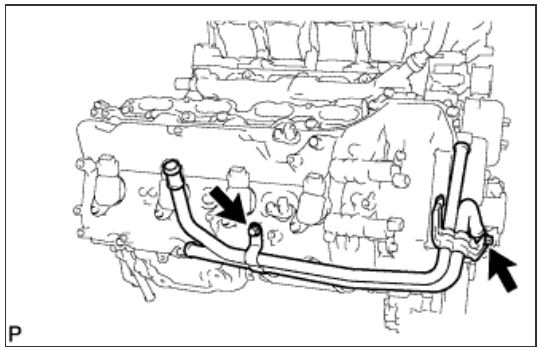
19. REMOVE WATER INLET HOUSING

a. Remove the 3 bolts, water inlet housing and gasket.



20. REMOVE WATER BY-PASS PIPE SUB-ASSEMBLY

a. Remove the 2 bolts and water by-pass pipe.

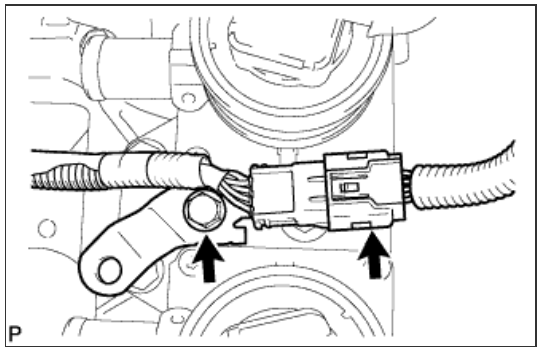


21. REMOVE AIR SWITCHING VALVE ASSEMBLY

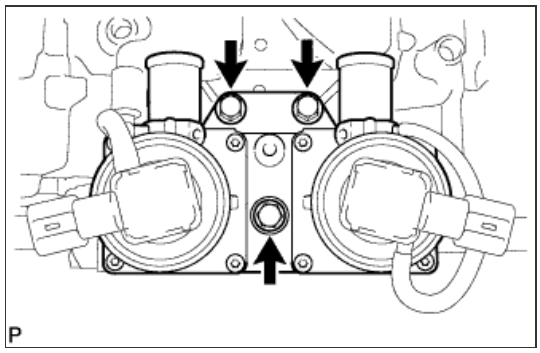
a. Disconnect the knock sensor connector.

b. Remove the bolt and bracket.

c. Disconnect the 2 air switching valve connectors.



d. Remove the 3 bolts and air switching valve.

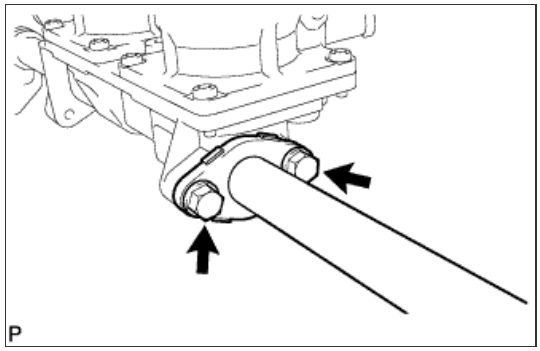


22. REMOVE NO. 2 AIR TUBE

a. Remove the 2 bolts, No. 2 air tube and gasket.

NOTICE:

Be careful not to damage the installation surface of the gaskets.

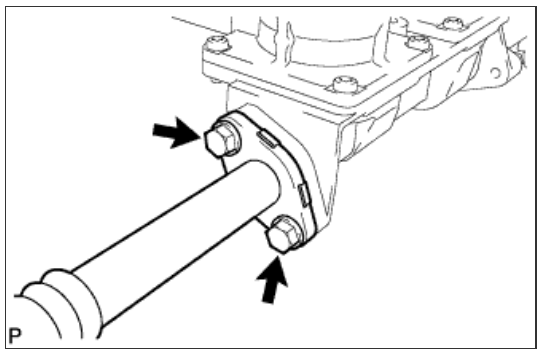


23. REMOVE NO. 3 AIR TUBE

a. Remove the 2 bolts, No. 3 air tube and gasket.

NOTICE:

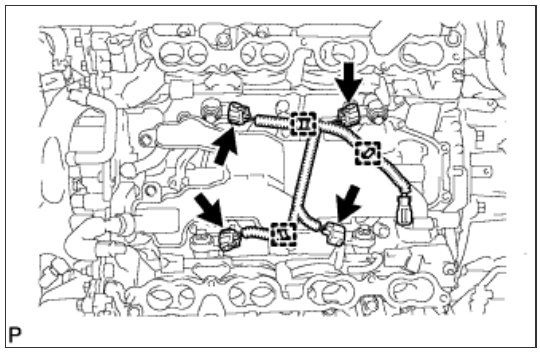
Be careful not to damage the installation surface of the gaskets.



24. REMOVE SENSOR WIRE

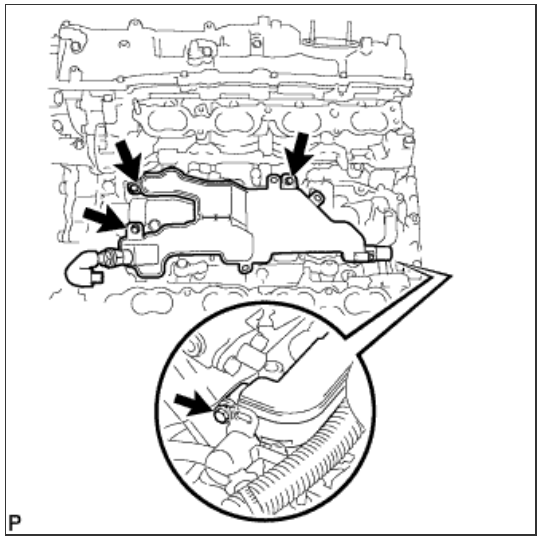
a. Disconnect the 4 knock sensor connectors.

b. Disconnect the 3 clamps. Then remove the sensor wire.



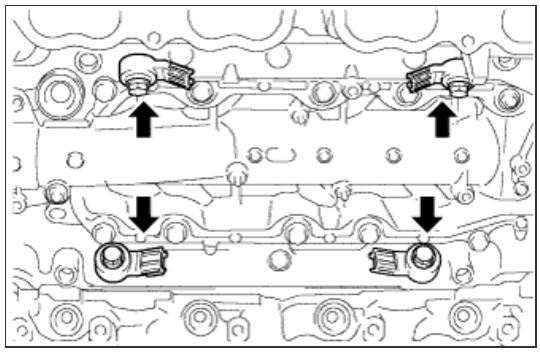
25. REMOVE SEPARATOR CASE

a. Remove the 4 bolts and separator case.



26. REMOVE KNOCK SENSOR

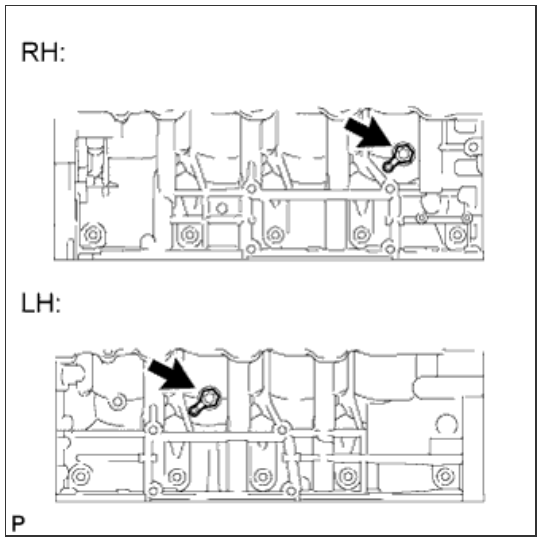
a. Remove the 4 bolts and 4 knock sensors.



27. REMOVE CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY

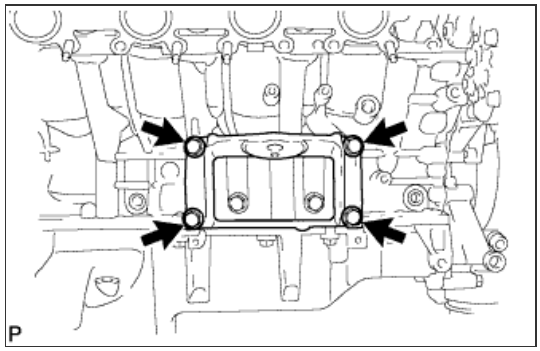
a. Remove the 2 water drain cock plugs from the water drain cocks.

b. Remove the 2 water drain cocks from the cylinder block.



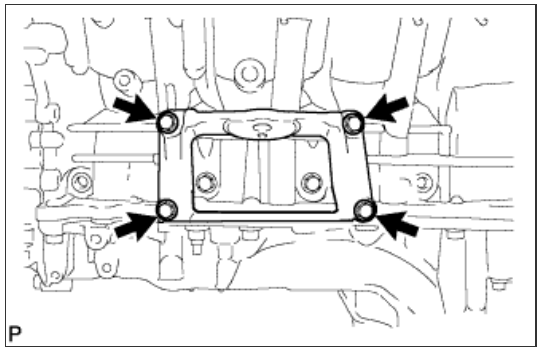
28. REMOVE FRONT NO. 1 ENGINE MOUNTING BRACKET RH

a. Remove the 4 bolts and mounting bracket.



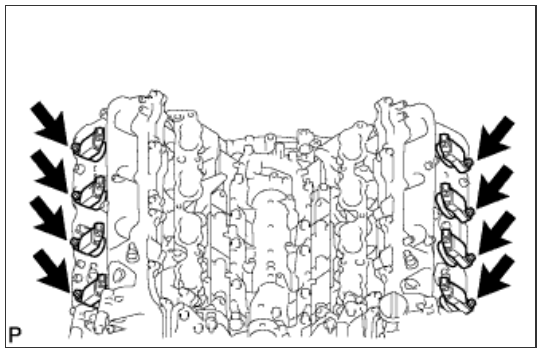
29. REMOVE FRONT NO. 1 ENGINE MOUNTING BRACKET LH

a. Remove the 4 bolts and mounting bracket.



30. REMOVE IGNITION COIL ASSEMBLY

a. Remove the 8 bolts and 8 ignition coils.



31. REMOVE NOISE FILTER

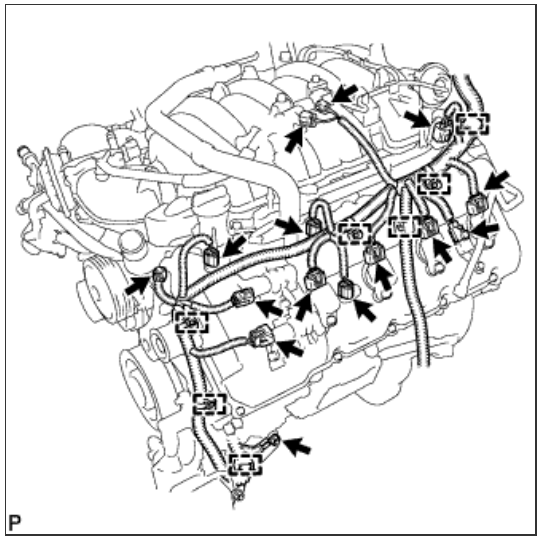
a. LH:
Remove the bolt and noise filter from the cylinder head cover.

b. RH:
Remove the bolt and noise filter from the cylinder head cover.

for Preparation Click here

1. REMOVE ENGINE WIRE

a. Engine LH Side:



i. Disconnect the 2 camshaft timing control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the 2 VVT sensor connectors.

iv. Disconnect the camshaft position sensor connector.

v. Disconnect the vacuum switching valve connector (for ACIS).

vi. Disconnect the purge VSV connector.

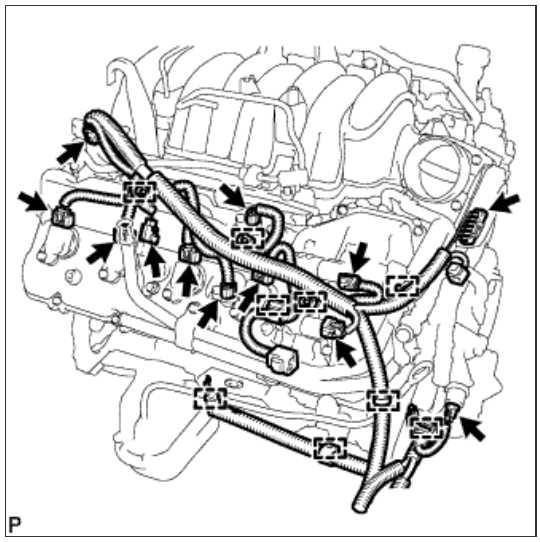
vii. Disconnect the engine coolant temperature sensor connector.

viii. Disconnect the fuel injector connector.

ix. Disconnect the noise filter connector.

x. Remove the bolt and disconnect the 7 clamps.

b. Engine RH Side:



i. Disconnect the 2 camshaft timing control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the 2 VVT sensor connectors.

iv. Disconnect the fuel injector connector.

v. Disconnect the noise filter connector.

vi. Disconnect the throttle sensor connector.

vii. Disconnect the oil pressure sender gauge connector.

viii. Disconnect the 9 clamps.

c. Engine Rear Side:

i. w/ Secondary Air Injection System:
Disconnect the 2 air switching valve connectors.

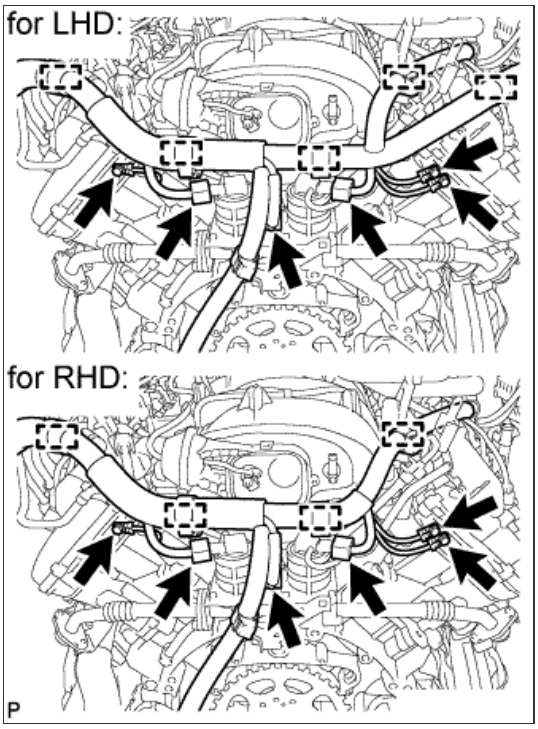
ii. Disconnect the sensor wire connector.

iii. for LHD:
Disconnect the 5 clamps.

iv. for RHD:
Disconnect the 4 clamps.

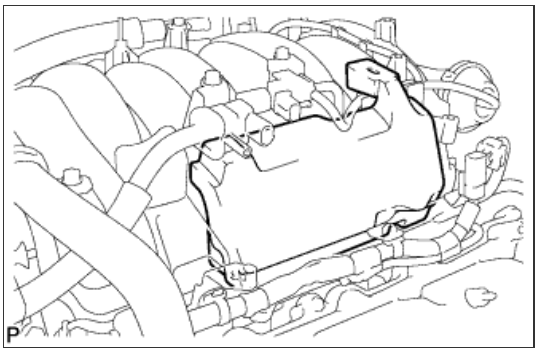
v. Remove the 3 bolts.

d. Remove the engine wire.



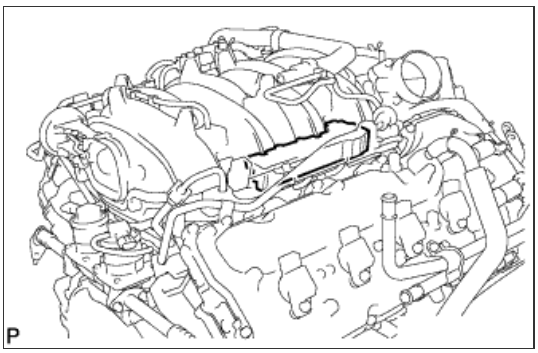
2. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Remove the No. 1 engine cover sub-assembly.



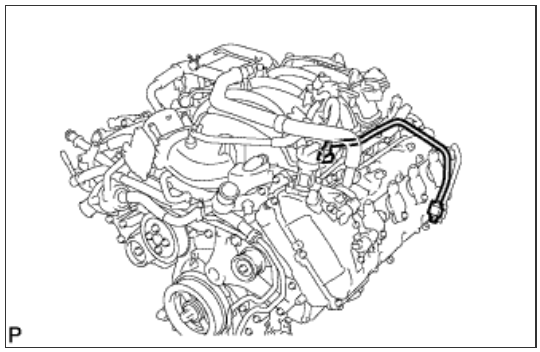
3. REMOVE NO. 3 ENGINE COVER

a. Remove the No. 3 engine cover.



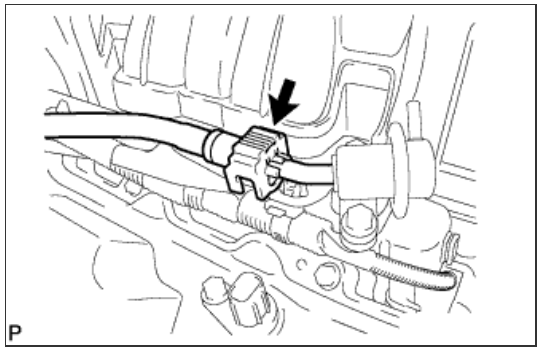
4. REMOVE NO. 1 FUEL HOSE

a. Remove the fuel hose (Click here).



5. DISCONNECT NO. 2 FUEL TUBE

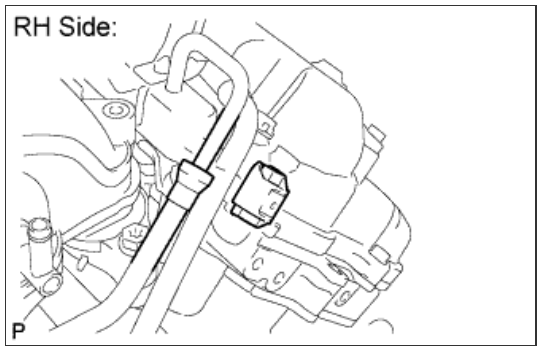
a. Disconnect the No. 2 fuel tube from the fuel pressure regulator (Click here).



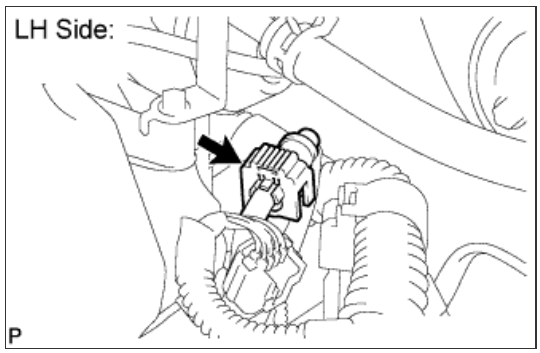
6. DISCONNECT NO. 1 FUEL TUBE

a. RH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe RH (for metallic type) (Click here).

SST
09268-21011



b. LH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe LH (Click here).



7. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Disconnect the No. 7 wire harness connector.

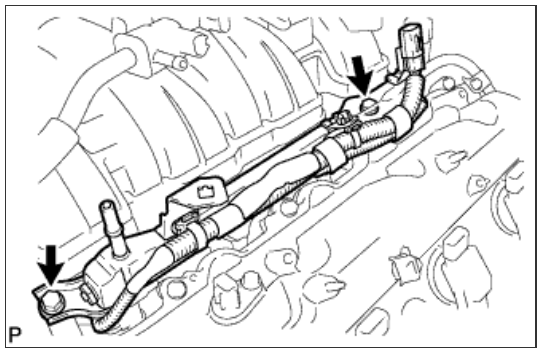
b. Remove the 2 bolts and fuel delivery pipe LH.

b. Remove the 2 bolts and fuel delivery pipe LH.

NOTICE:

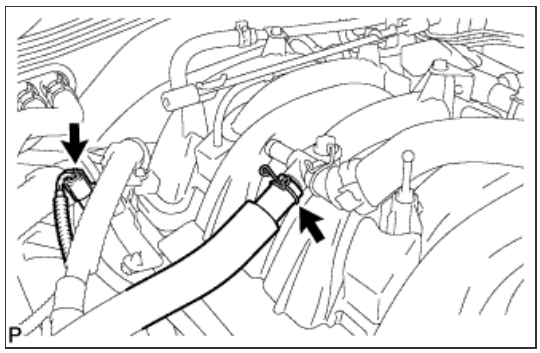
When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.

c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head LH.



8. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Disconnect the ventilation hose and No. 6 wire harness connector.

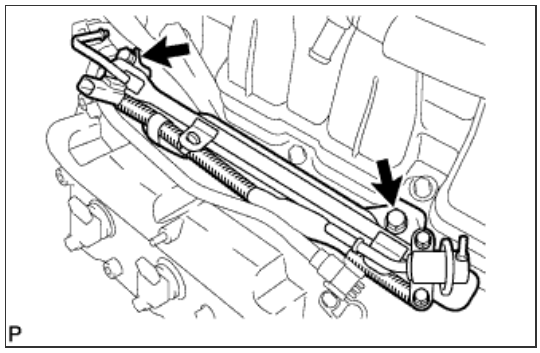


b. Remove the 2 bolts and fuel delivery pipe RH.

NOTICE:

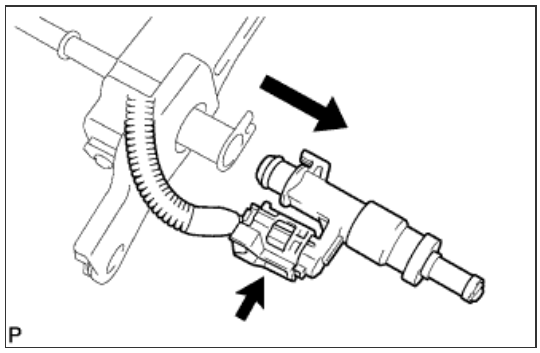
When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.

c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head RH.



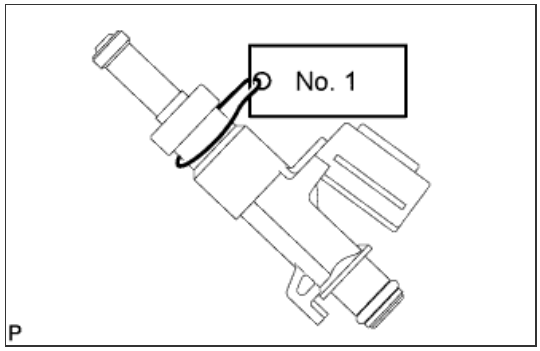
9. REMOVE FUEL INJECTOR ASSEMBLY

a. Remove the fuel injector from the fuel delivery pipe, and then disconnect the injector connector.

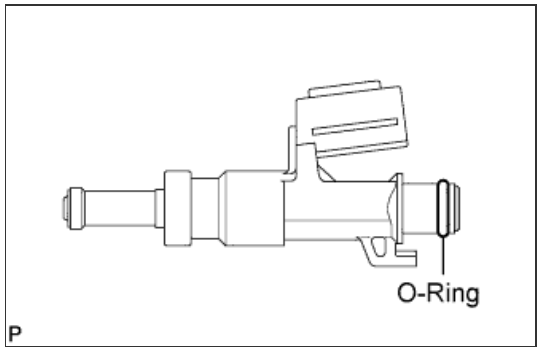


NOTICE:

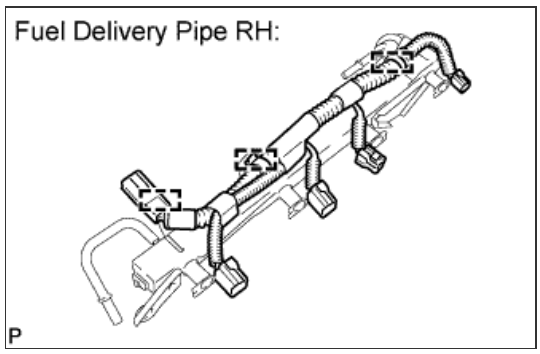
For reinstallation, attach a tag or label to the injector shaft.



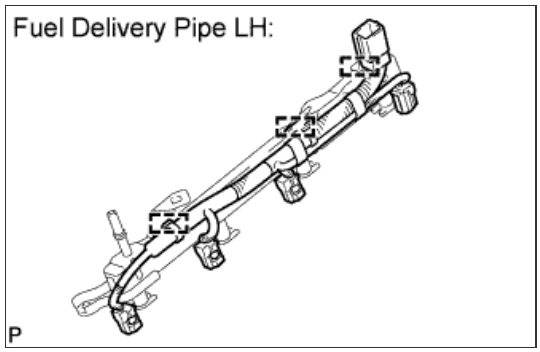
b. Remove the O-ring from the fuel injector.



c. Detach the 3 clamps and then remove the No. 6 wire harness from the delivery pipe RH.

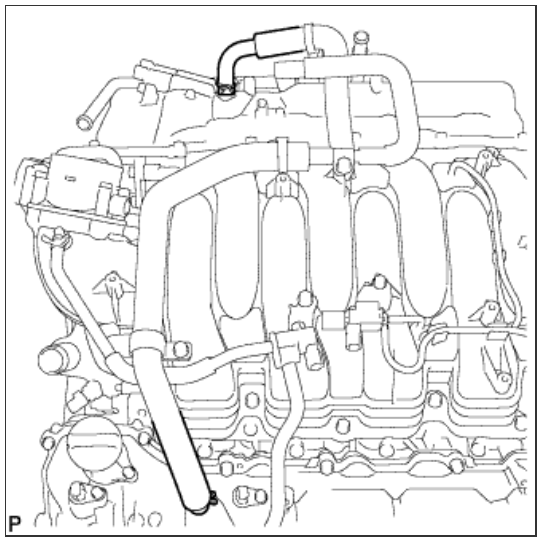


d. Detach the 3 clamps and then remove the No. 7 wire harness from the delivery pipe LH.

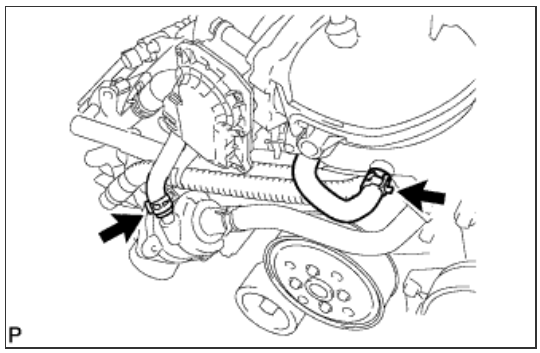


10. REMOVE INTAKE MANIFOLD

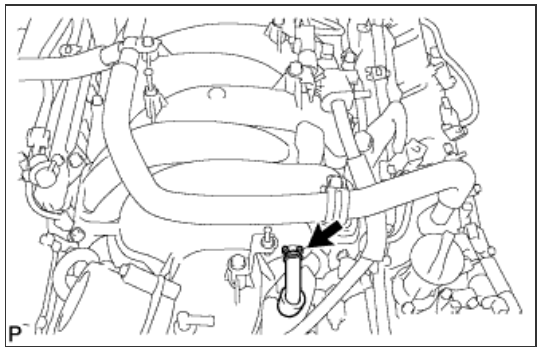
a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.



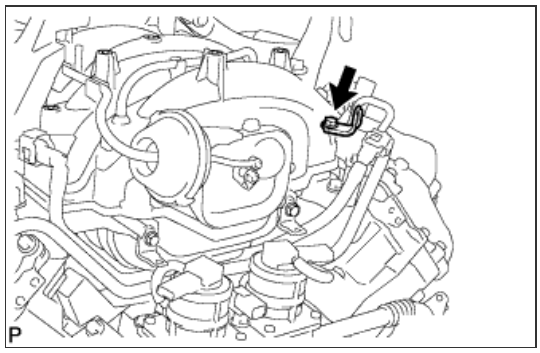
b. Disconnect the 2 water by-pass hoses.



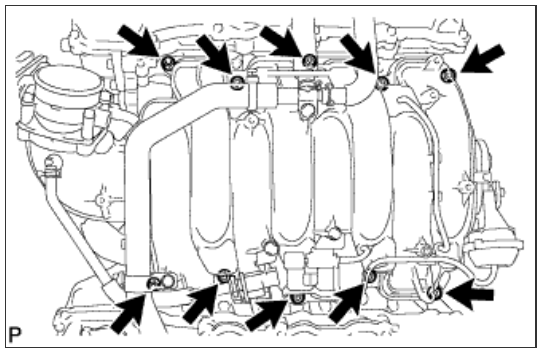
c. Disconnect the No. 1 ventilation hose.



d. Remove the bolt and wire bracket from the intake manifold.

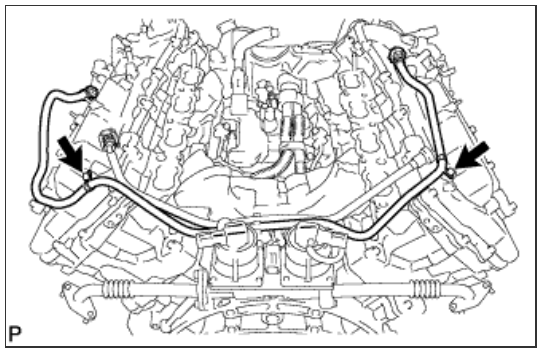


e. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.

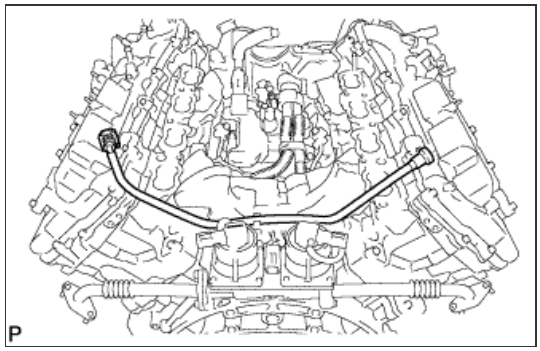


11. REMOVE NO. 2 FUEL TUBE

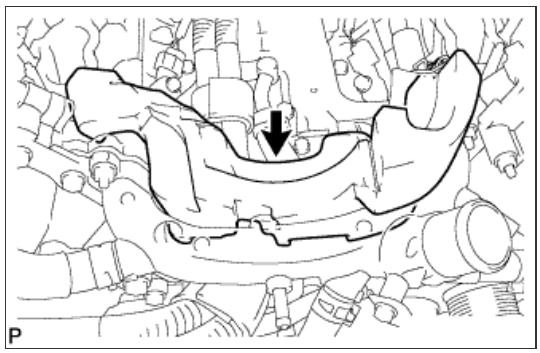
a. Remove the 2 bolts and No. 2 fuel tube.



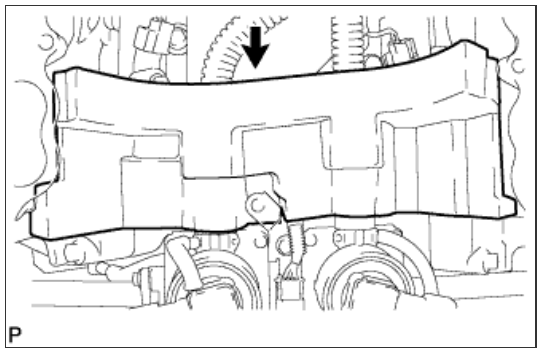
12. REMOVE NO. 1 FUEL TUBE



13. REMOVE NO. 2 ENGINE COVER



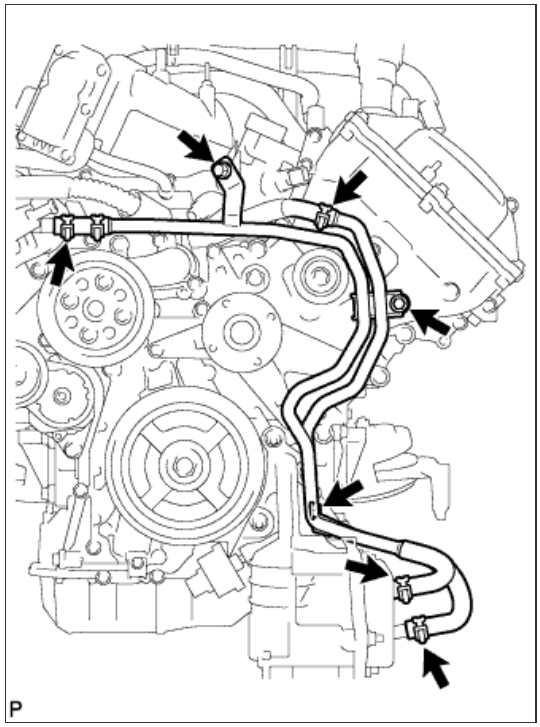
14. REMOVE NO. 1 ENGINE COVER



15. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

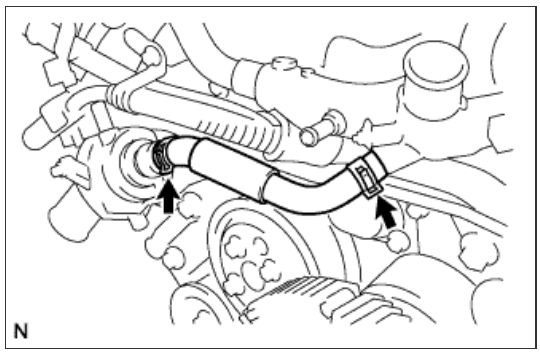
a. Remove the 3 bolts.

b. Disconnect the 4 hoses and remove the water by-pass pipe.



16. REMOVE NO. 1 WATER BY-PASS HOSE

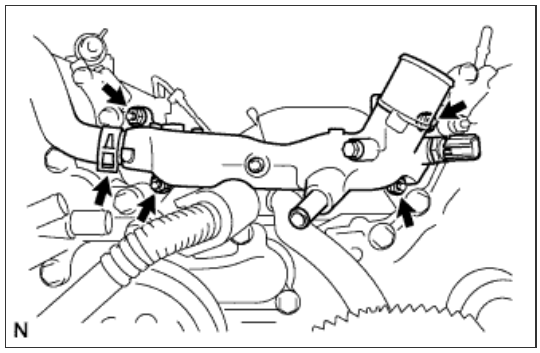
a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.



17. REMOVE FRONT WATER BY-PASS JOINT

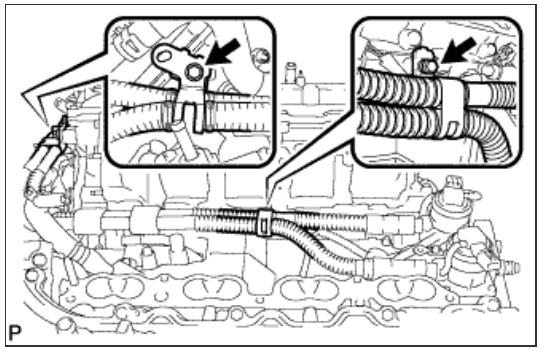
a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

b. Remove the 4 nuts, water by-pass joint and 2 gaskets.



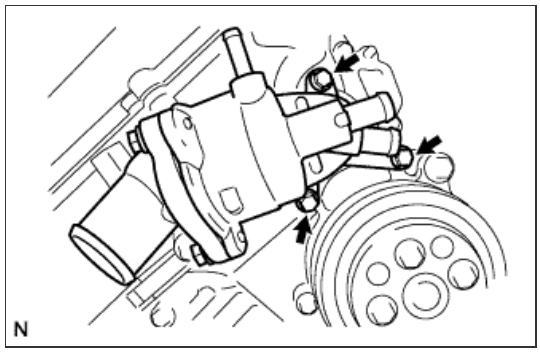
18. REMOVE AIR PIPE SUB-ASSEMBLY (w/ Secondary Air Injection System)

a. Remove the 2 bolts, air pipe and 2 No. 1 air hoses.



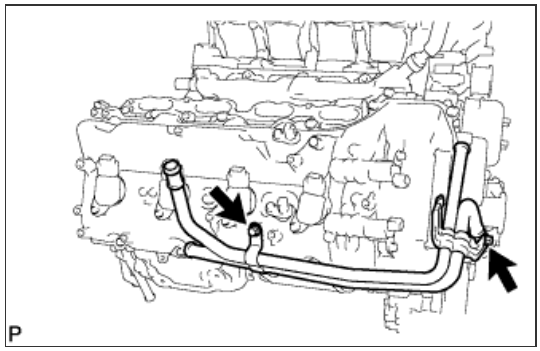
19. REMOVE WATER INLET HOUSING

a. Remove the 3 bolts, water inlet housing and gasket.



20. REMOVE WATER BY-PASS PIPE SUB-ASSEMBLY

a. Remove the 2 bolts and water by-pass pipe.

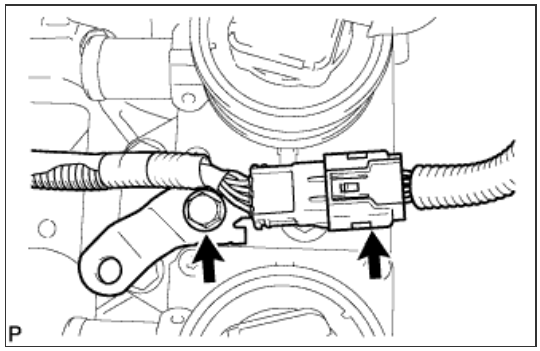


21. REMOVE AIR SWITCHING VALVE ASSEMBLY (w/ Secondary Air Injection System)

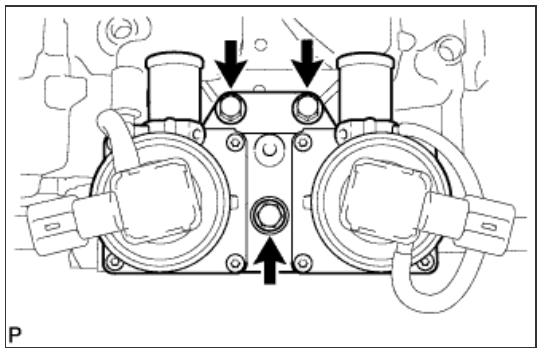
a. Disconnect the knock sensor connector.

b. Remove the bolt and bracket.

c. Disconnect the 2 air switching valve connectors.



d. Remove the 3 bolts and air switching valve.

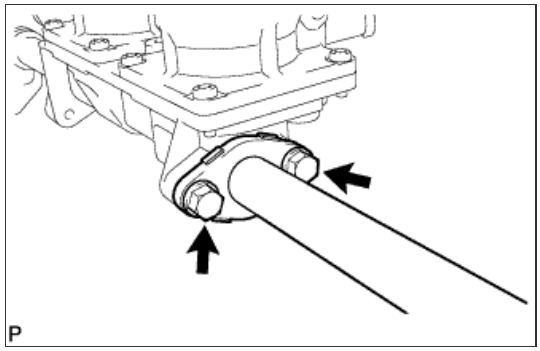


22. REMOVE NO. 2 AIR TUBE (w/ Secondary Air Injection System)

a. Remove the 2 bolts, No. 2 air tube and gasket.

NOTICE:

Be careful not to damage the installation surface of the gaskets.

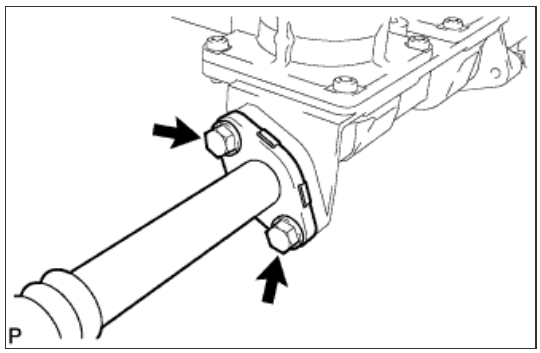


23. REMOVE NO. 3 AIR TUBE (w/ Secondary Air Injection System)

a. Remove the 2 bolts, No. 3 air tube and gasket.

NOTICE:

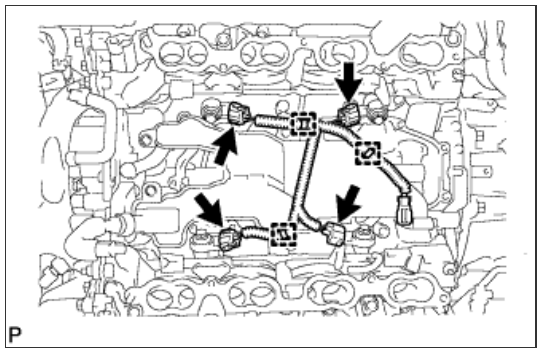
Be careful not to damage the installation surface of the gaskets.



24. REMOVE SENSOR WIRE

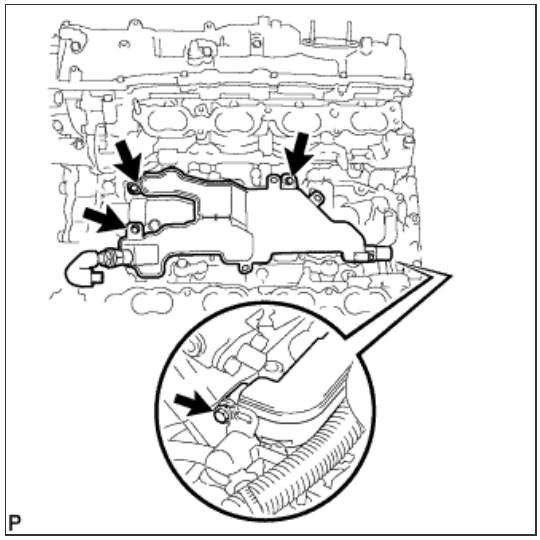
a. Disconnect the 4 knock sensor connectors.

b. Disconnect the 3 clamps. Then remove the sensor wire.



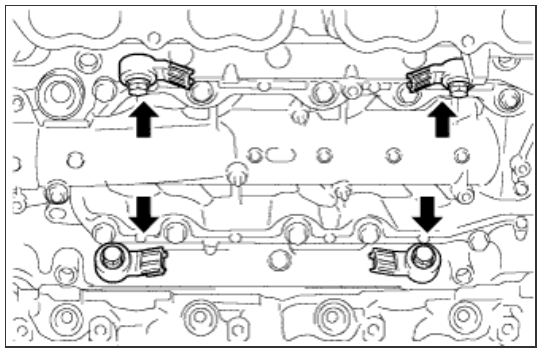
25. REMOVE SEPARATOR CASE

a. Remove the 4 bolts and separator case.



26. REMOVE KNOCK SENSOR

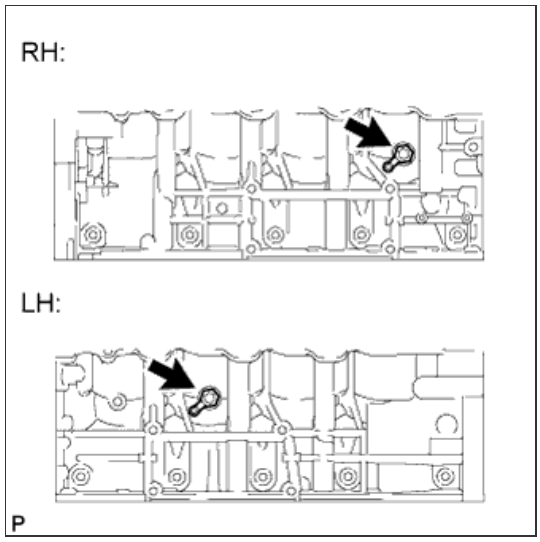
a. Remove the 4 bolts and 4 knock sensors.



27. REMOVE CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY

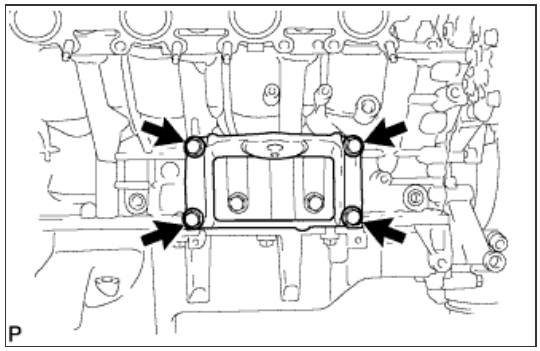
a. Remove the 2 water drain cock plugs from the water drain cocks.

b. Remove the 2 water drain cocks from the cylinder block.



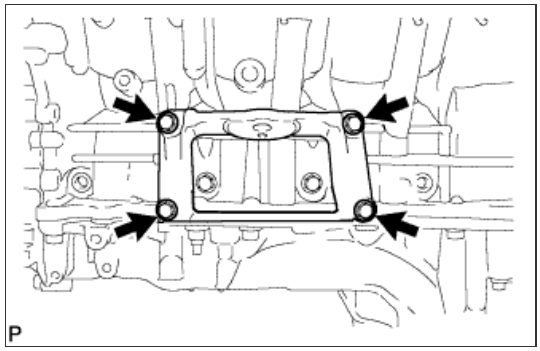
28. REMOVE FRONT NO. 1 ENGINE MOUNTING BRACKET RH

a. Remove the 4 bolts and mounting bracket.



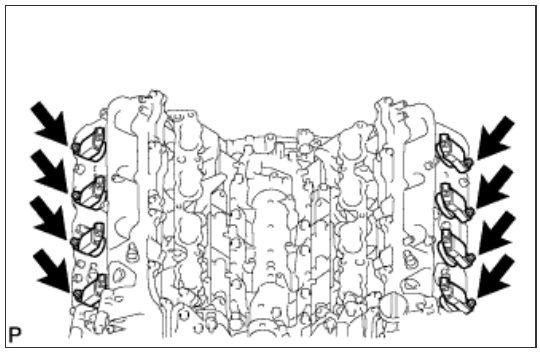
29. REMOVE FRONT NO. 1 ENGINE MOUNTING BRACKET LH

a. Remove the 4 bolts and mounting bracket.



30. REMOVE IGNITION COIL ASSEMBLY

a. Remove the 8 bolts and 8 ignition coils.



31. REMOVE NOISE FILTER

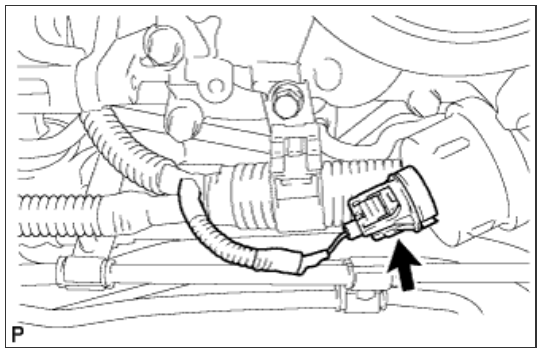
a. LH:
Remove the bolt and noise filter from the cylinder head cover.

b. RH:
Remove the bolt and noise filter from the cylinder head cover.

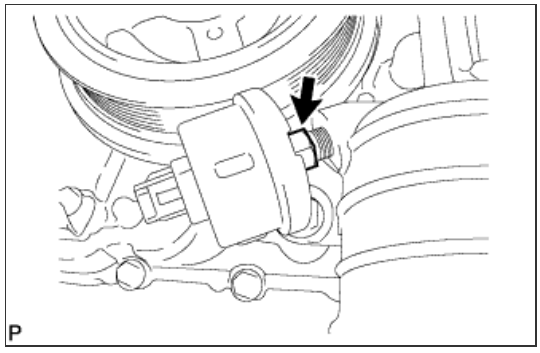
for Preparation Click here

1. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.

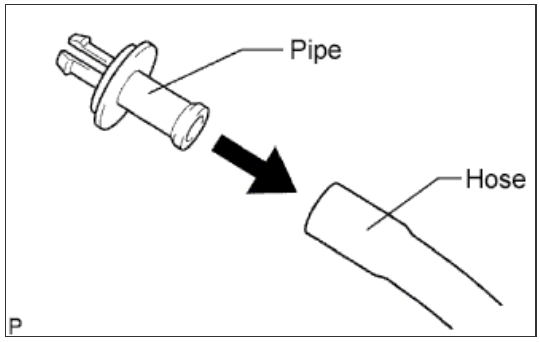


b. Remove the oil pressure sender gauge.

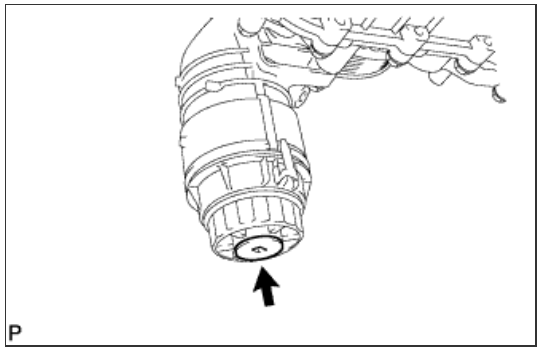


2. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



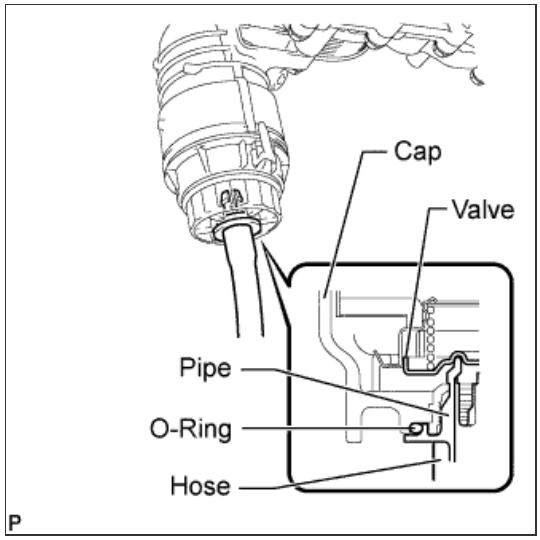
c. Install the pipe to the oil filter cap.

NOTICE:

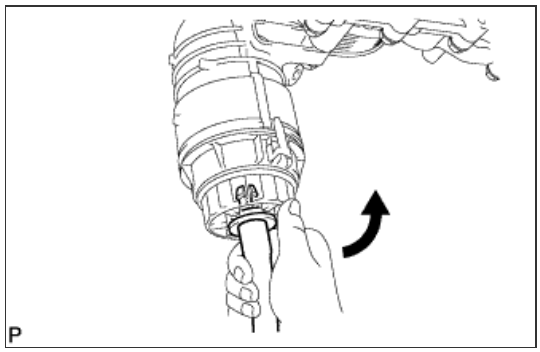
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

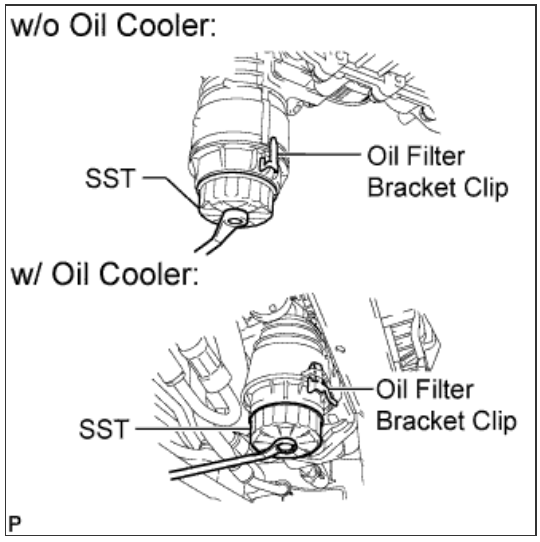


e. Using SST, remove the oil filter cap.

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NOTICE:

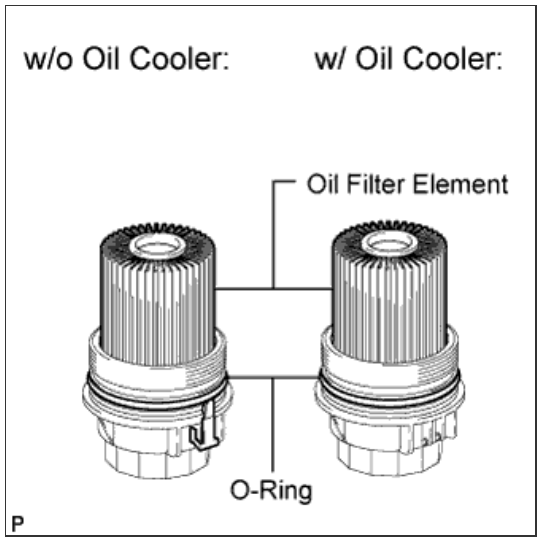
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

NOTICE:

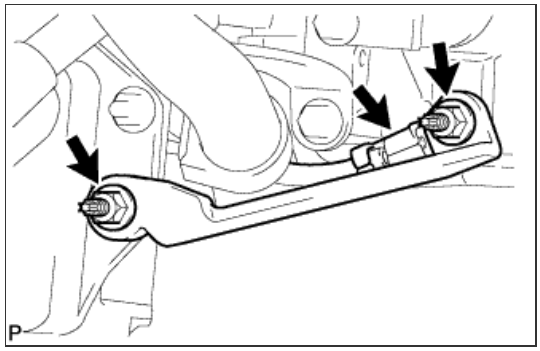
Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.



3. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

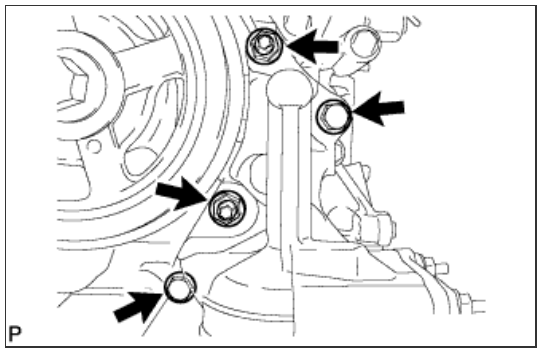
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

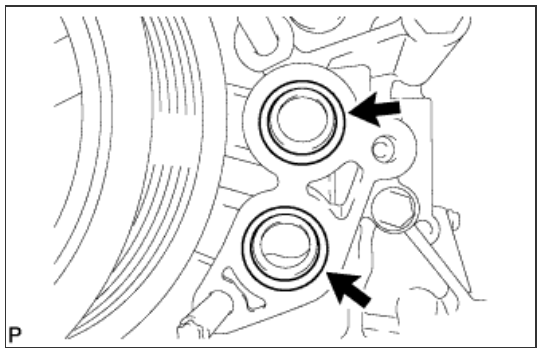


4. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.

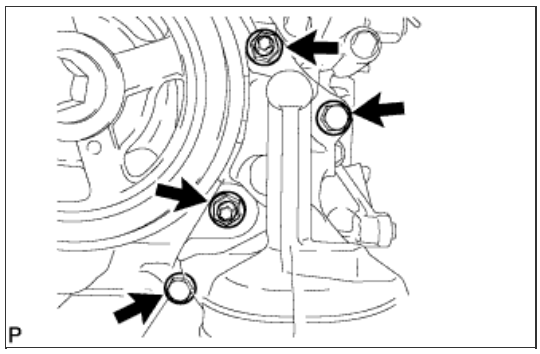


b. Remove the 2 O-rings.

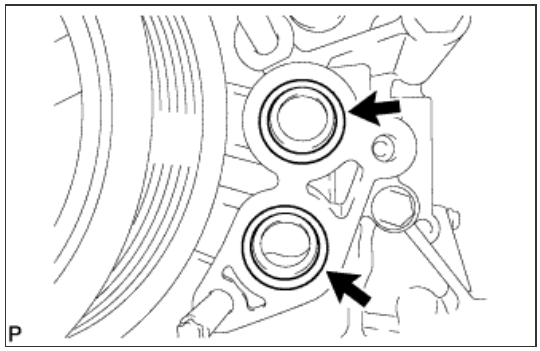


5. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.



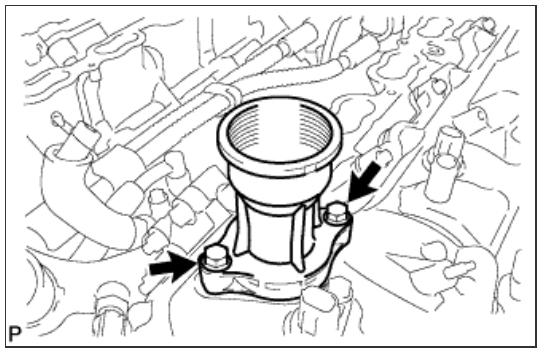
b. Remove the 2 O-rings.



6. REMOVE OIL FILLER CAP SUB-ASSEMBLY

7. REMOVE OIL FILLER CAP HOUSING

a. Remove the 2 bolts, filler cap housing and gasket.

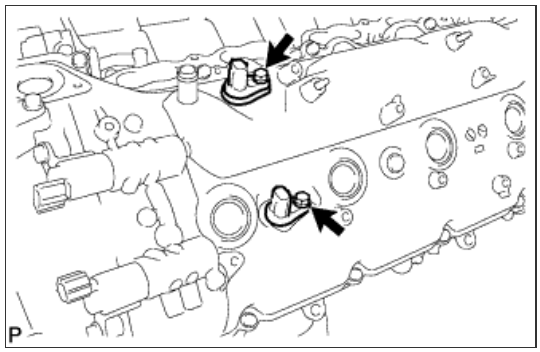


8. REMOVE SPARK PLUG

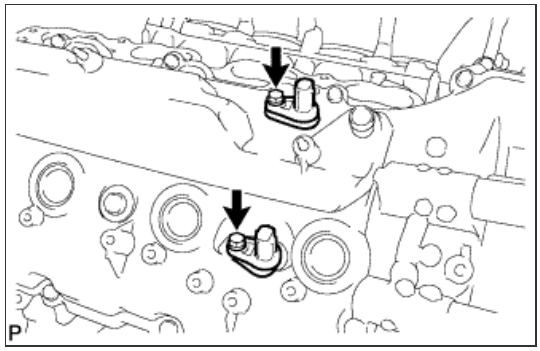
a. Using a 16 mm plug wrench, remove the 8 spark plugs.

9. REMOVE VVT SENSOR

a. LH:
Remove the 2 bolts and 2 VVT sensors.

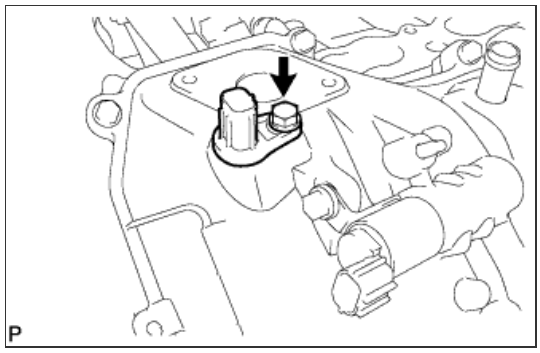


b. RH:
Remove the 2 bolts and 2 VVT sensors.



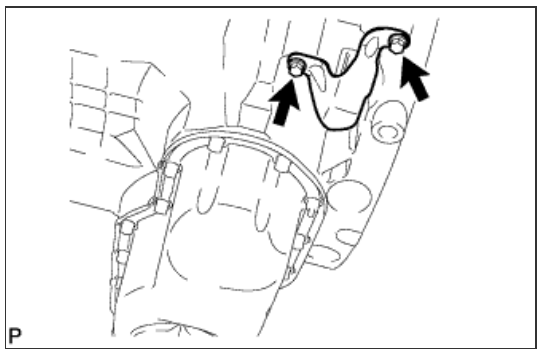
10. REMOVE CAMSHAFT POSITION SENSOR

a. Remove the bolt and camshaft position sensor.



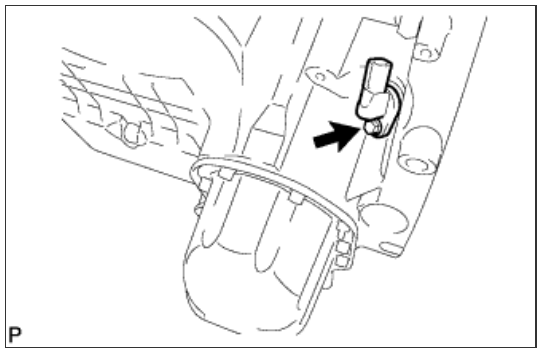
11. REMOVE CRANK POSITION SENSOR PROTECTOR

a. Remove the 2 bolts and sensor protector.



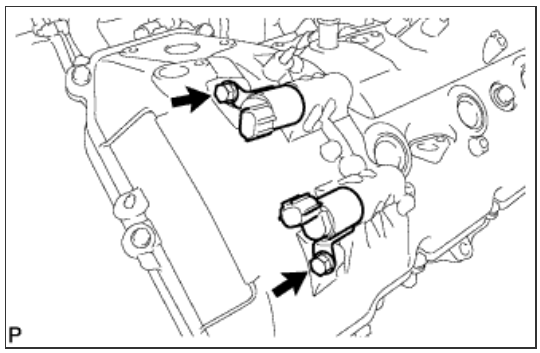
12. REMOVE CRANKSHAFT POSITION SENSOR

a. Remove the bolt and crankshaft position sensor.

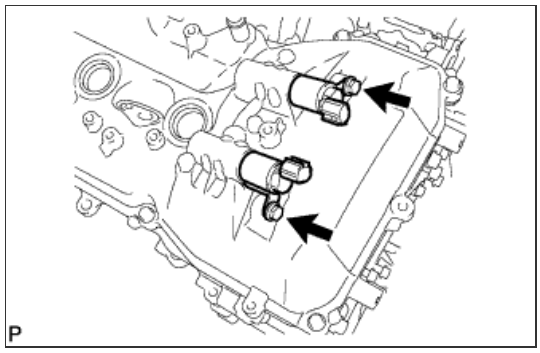


13. REMOVE CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. LH:
Remove the 2 bolts and 2 oil control valves.



b. RH:
Remove the 2 bolts and 2 oil control valves.

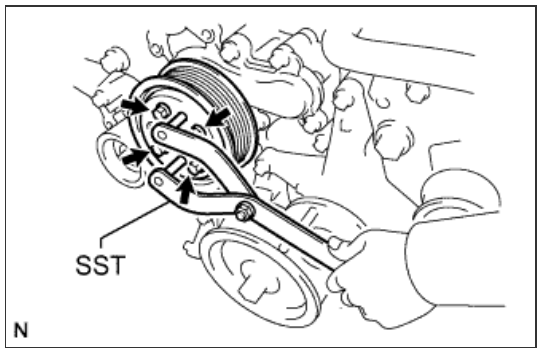


14. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

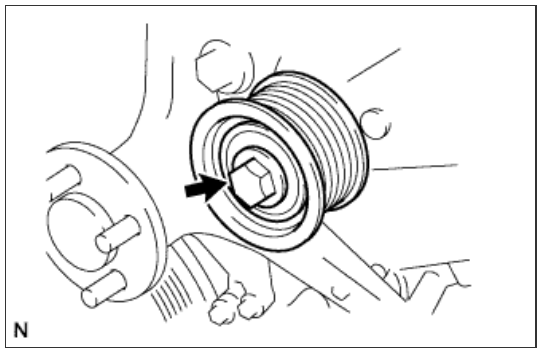
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



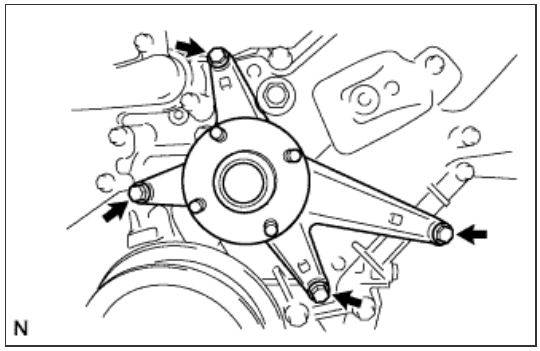
15. REMOVE NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Remove the bolt and idler pulley.



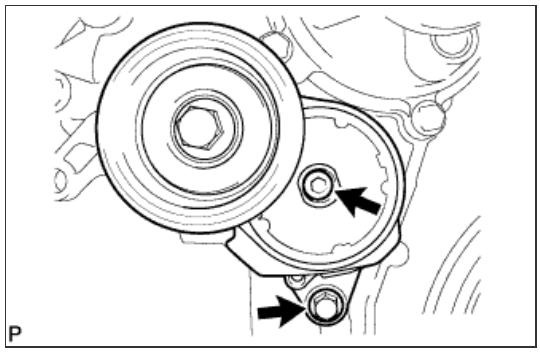
16. REMOVE FLUID COUPLING BRACKET

a. Remove the 4 bolts and fluid coupling bracket.



17. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY

a. Remove the standard bolt, 6 mm hexagon wrench bolt and belt tensioner.

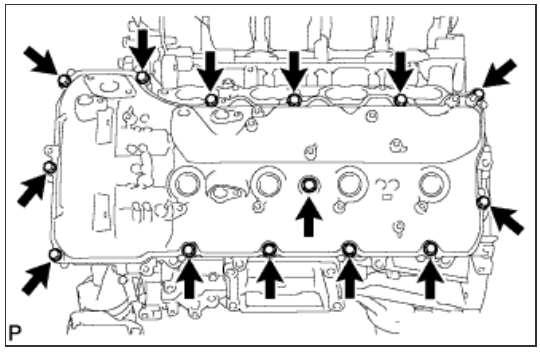


18. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY LH

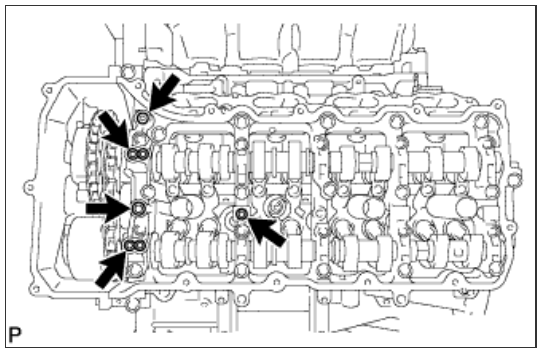
a. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

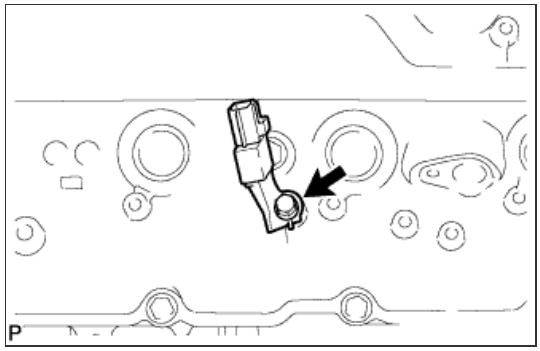


b. Remove the 5 gaskets from the camshaft bearing caps (No. 2, No. 3).



19. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY RH

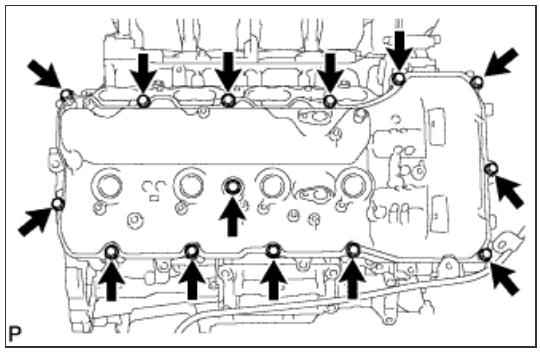
a. Remove the bolt and noise filter.



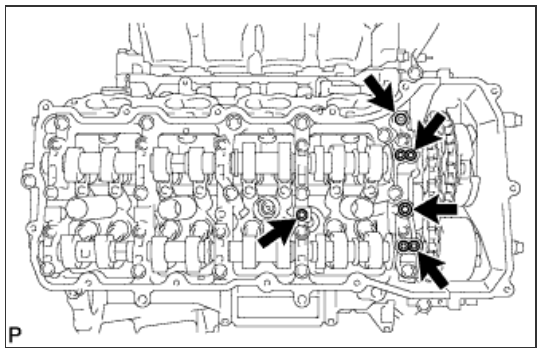
b. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

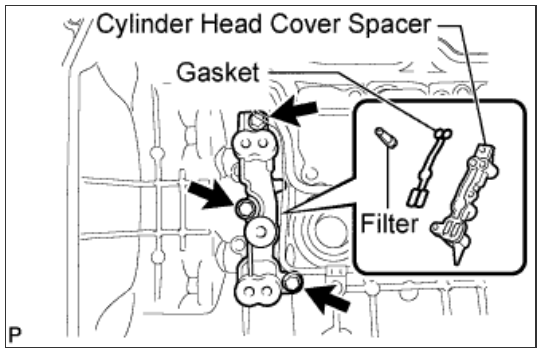


c. Remove the 5 gaskets from the camshaft bearing caps (No. 1, No. 3).

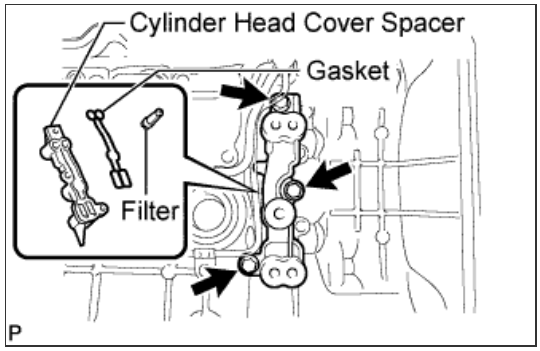


20. REMOVE OIL CONTROL VALVE FILTER

a. LH:
Remove the 3 bolts, cylinder head cover spacer, gasket and filter.



b. RH:
Remove the 3 bolts, cylinder head cover spacer, gasket and filter.



21. REMOVE SPARK PLUG TUBE GASKET

a. Bend the 4 ventilation baffle plate claws on the cylinder head cover to an angle of 90° or more.

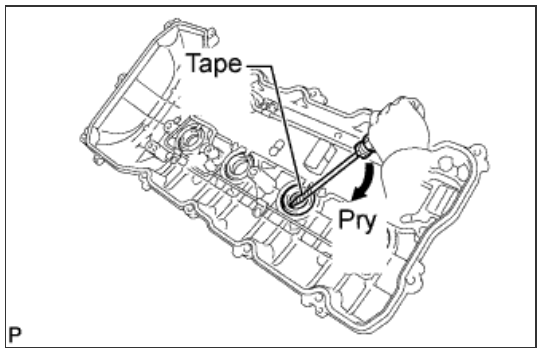
b. Using a screwdriver, pry out the gaskets.

HINT:

Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the cylinder head cover.**
- **Be careful not to damage the gasket when removing it, as the removed gasket needs to be used when installing a new one.**

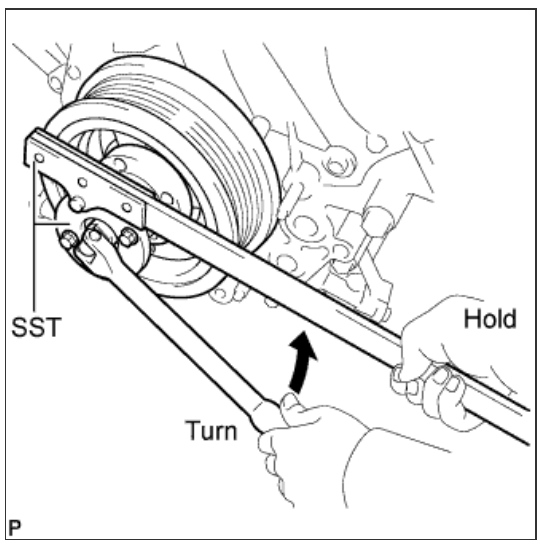


22. REMOVE CRANKSHAFT PULLEY

a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST

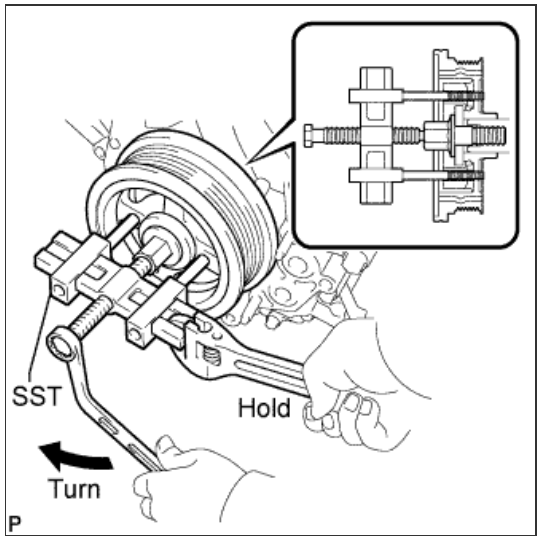
09213-70011 (09213-70020)
09330-00021



b. Using the pulley set bolt and SST, remove the crankshaft pulley.

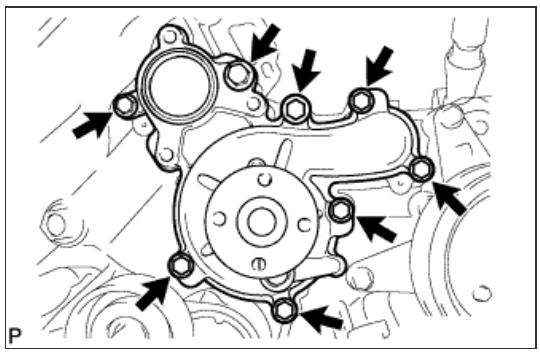
SST

09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



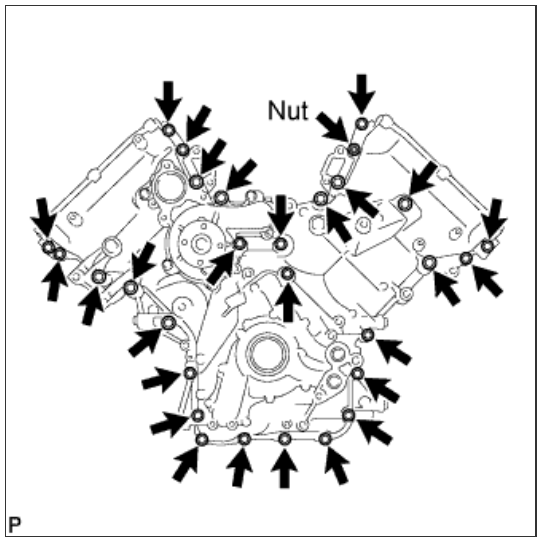
23. REMOVE WATER PUMP ASSEMBLY

a. Remove the 8 bolts, water pump and gasket.



24. REMOVE TIMING CHAIN COVER SUB-ASSEMBLY

a. Remove the 28 bolts and nut shown in the illustration.



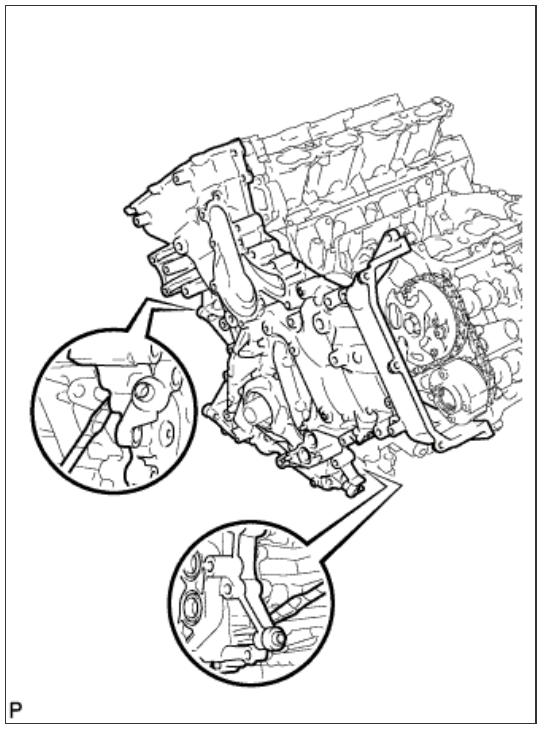
b. Remove the timing chain cover by prying between the timing chain cover and cylinder head or cylinder block with a screwdriver as shown in the illustration.

NOTICE:

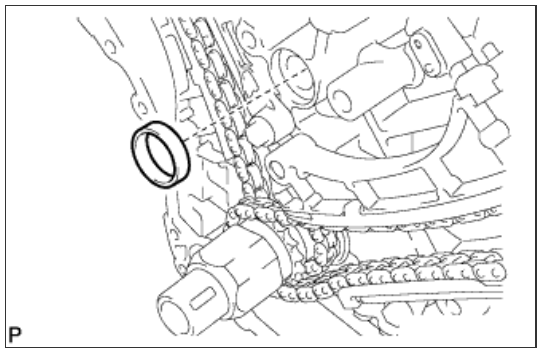
Be careful not to damage the contact surfaces of the cylinder head, cylinder block and chain cover.

HINT:

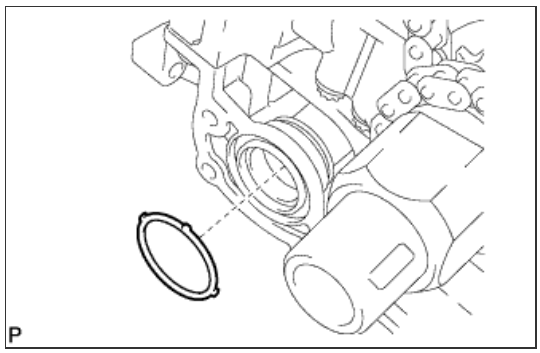
Tape the screwdriver tip before use.



c. Remove the oil pump gasket from the cylinder block.



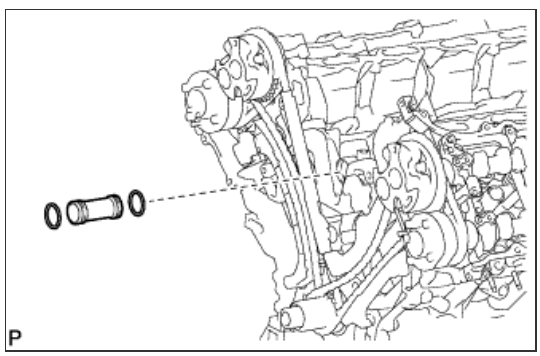
d. Remove the O-ring from the oil pan.



25. REMOVE WATER INLET PIPE

a. Remove the water inlet pipe.

b. Remove the 2 O-rings from the water inlet pipe.



26. REMOVE FRONT CRANKSHAFT OIL SEAL

a. Place the timing chain cover on wooden blocks.

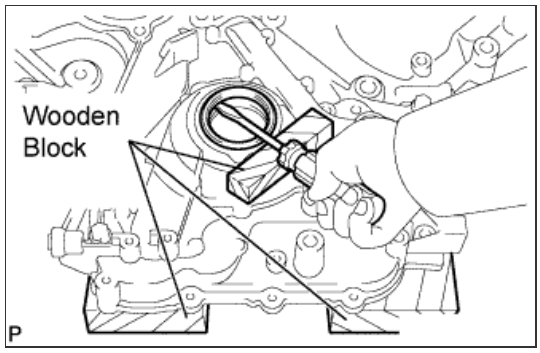
b. Using a screwdriver and wooden block, pry out the oil seal.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Do not damage the surface of the oil seal press fit hole.



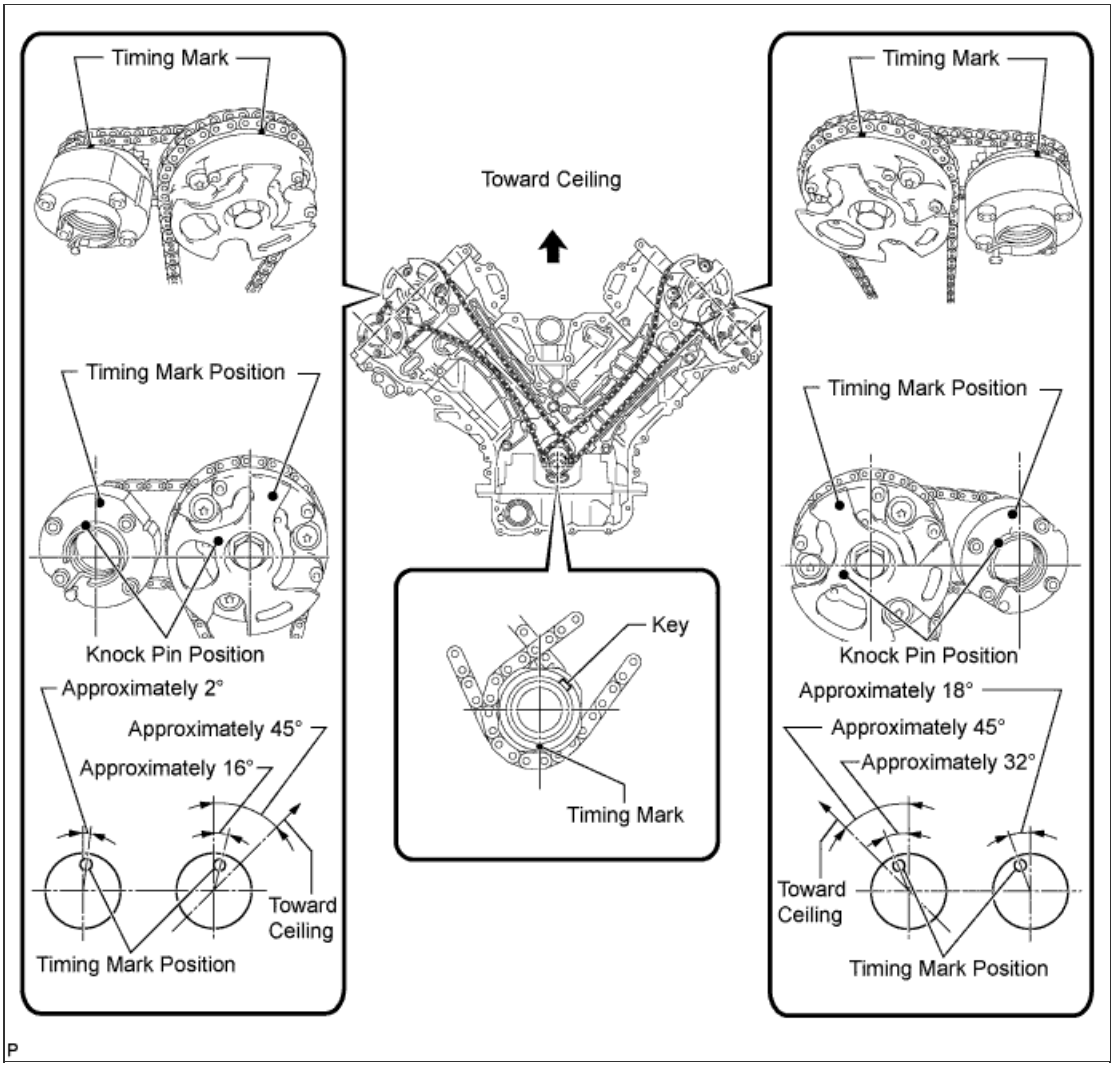
27. SET NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise so that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

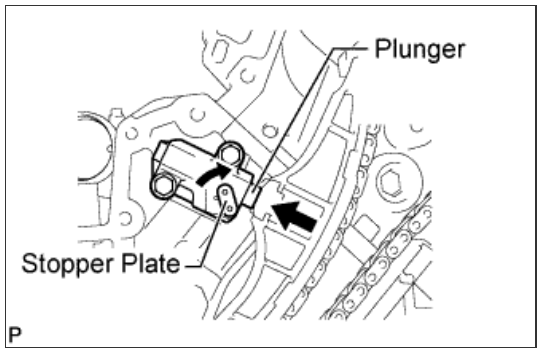
HINT:

If the timing marks do not align, rotate the crankshaft clockwise again and align the timing marks.

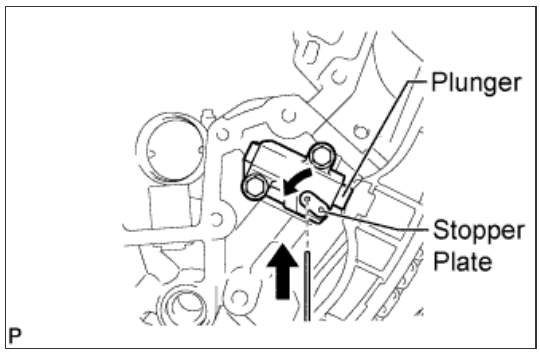


28. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY LH

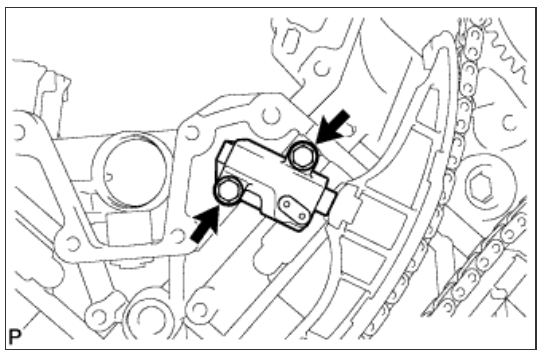
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



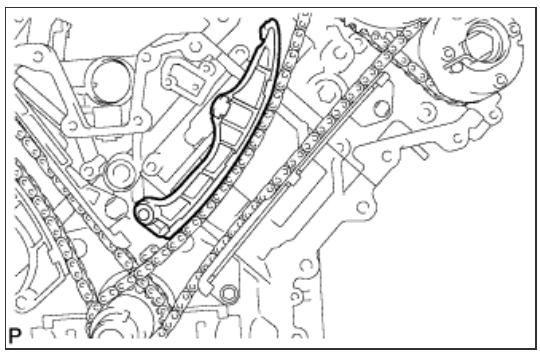
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts, chain tensioner and gasket.

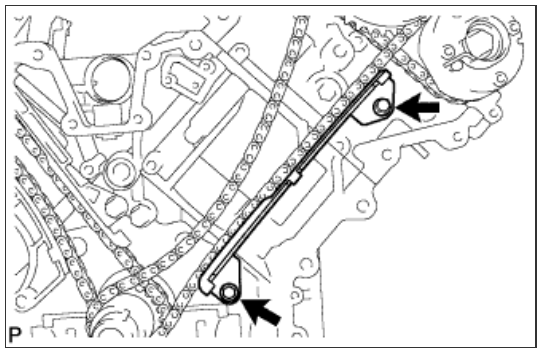


29. REMOVE NO. 1 CHAIN TENSIONER SLIPPER LH



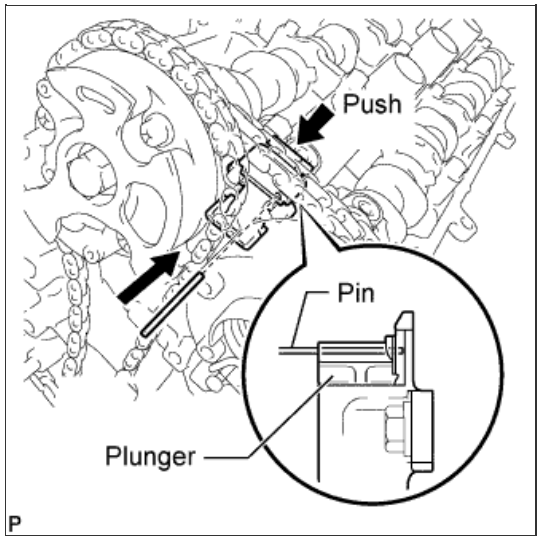
30. REMOVE NO. 1 CHAIN VIBRATION DAMPER LH

a. Remove the 2 bolts and chain vibration damper.



31. REMOVE NO. 1 CHAIN SUB-ASSEMBLY LH

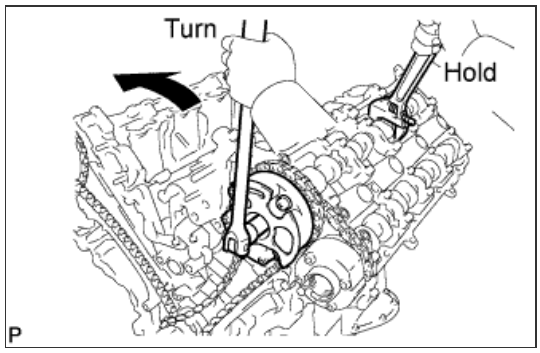
a. While pushing down the No. 3 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



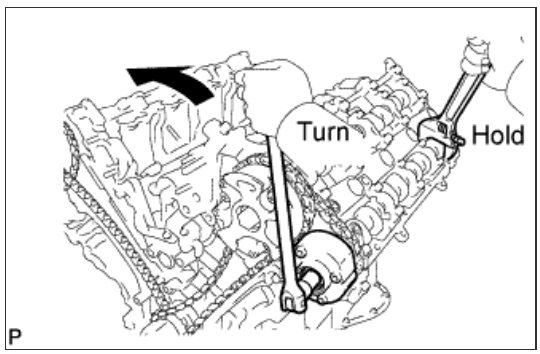
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

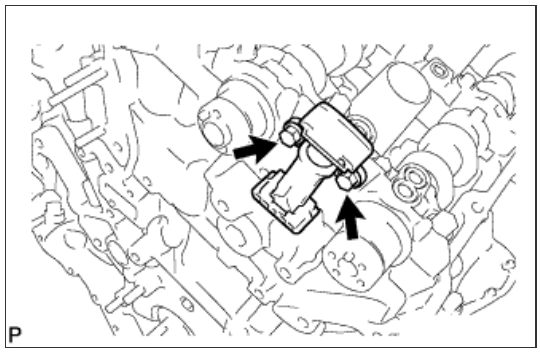
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket LH.

e. Remove the No. 1 and No. 2 chains from the gears.



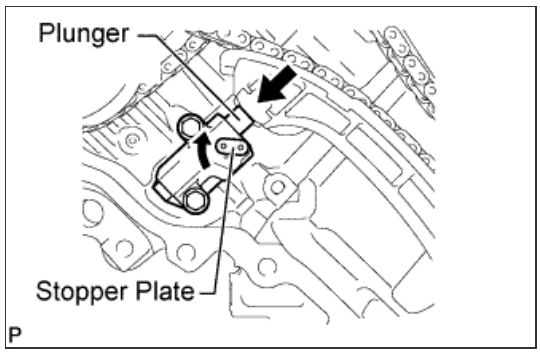
32. REMOVE NO. 3 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.

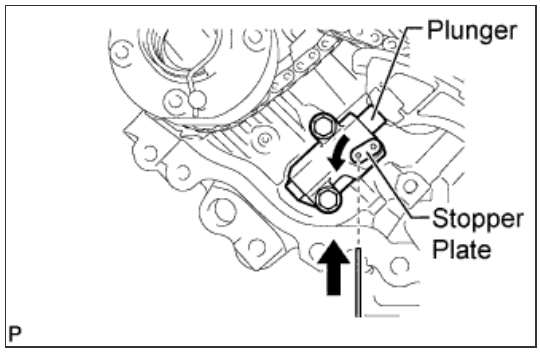


33. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY RH

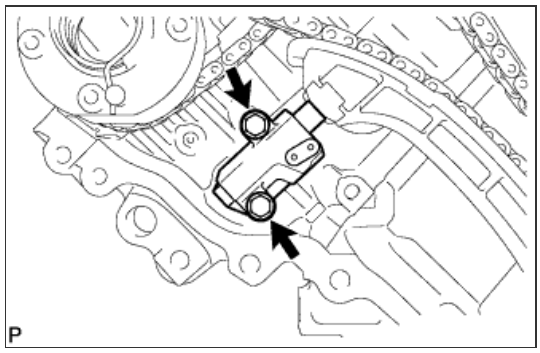
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



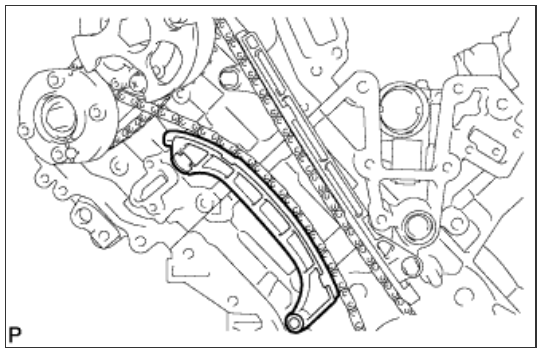
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts and chain tensioner.

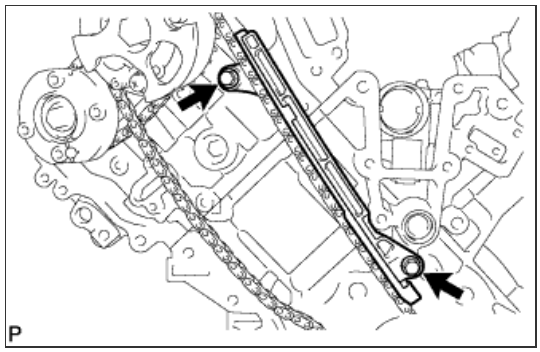


34. REMOVE NO. 1 CHAIN TENSIONER SLIPPER RH



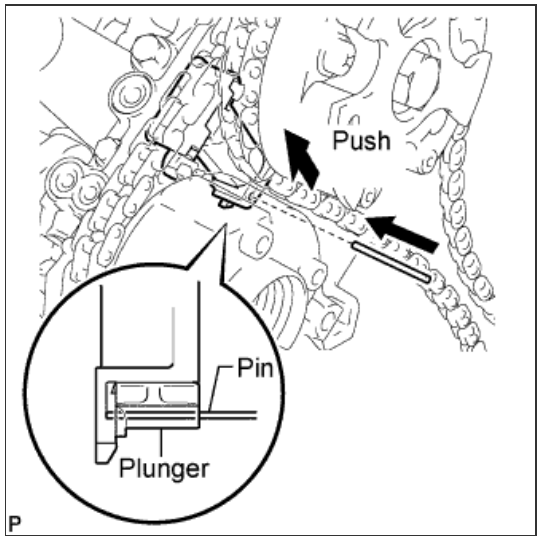
35. REMOVE NO. 1 CHAIN VIBRATION DAMPER RH

a. Remove the 2 bolts and vibration damper.



36. REMOVE NO. 1 CHAIN SUB-ASSEMBLY RH

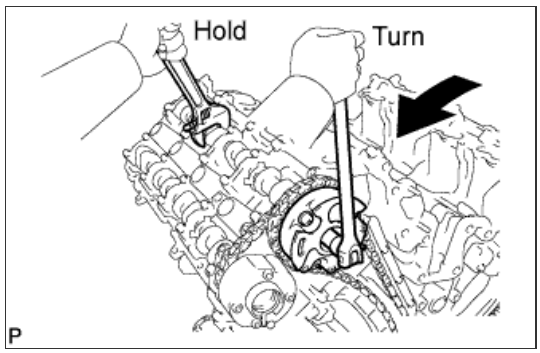
a. While raising up the No. 2 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



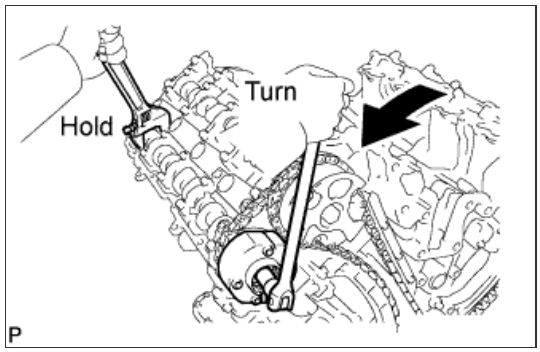
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

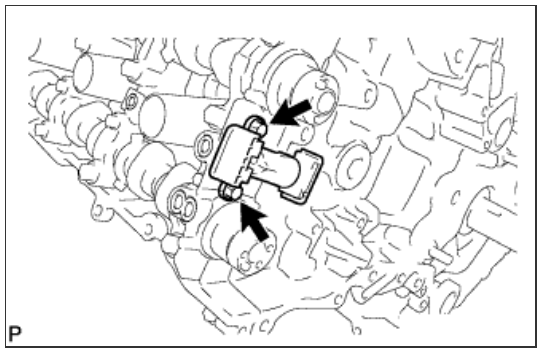
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket RH.

e. Remove the No. 1 and No. 2 chains from the gears.



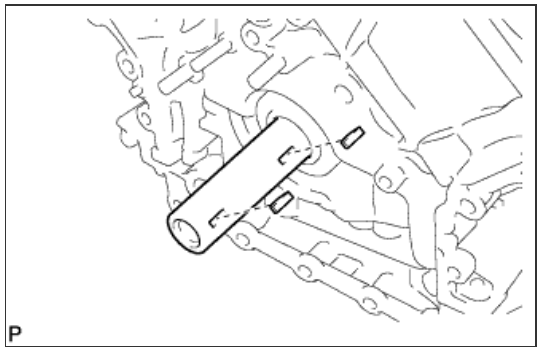
37. REMOVE NO. 2 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.



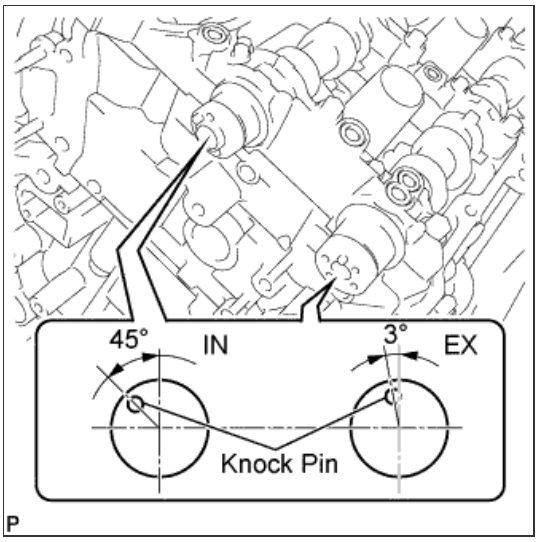
38. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Using a screwdriver, remove the 2 timing gear keys from the crankshaft.

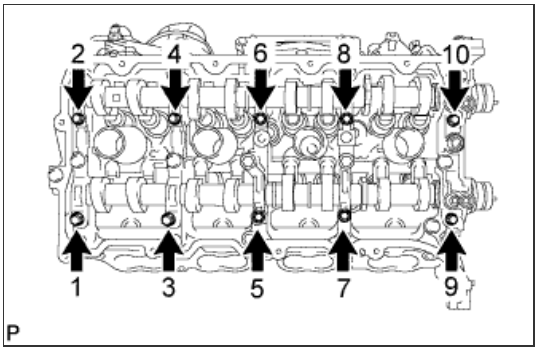


39. REMOVE CAMSHAFT BEARING CAP LH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



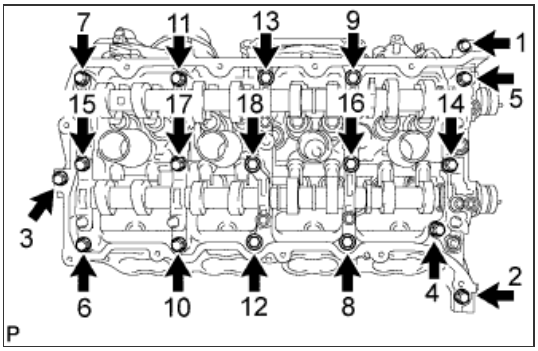
b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

Uniformly loosen the bolts while keeping the camshaft level.



d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 3 and No. 4 camshafts.

40. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY LH

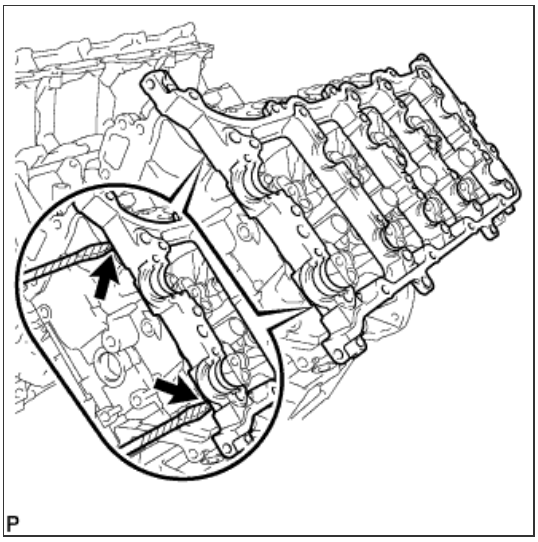
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

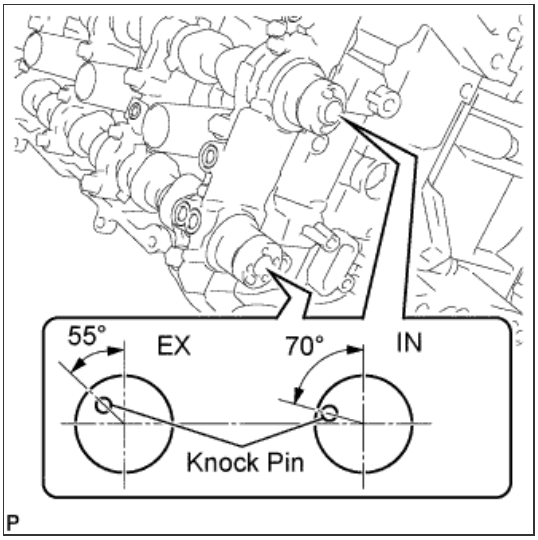
NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.

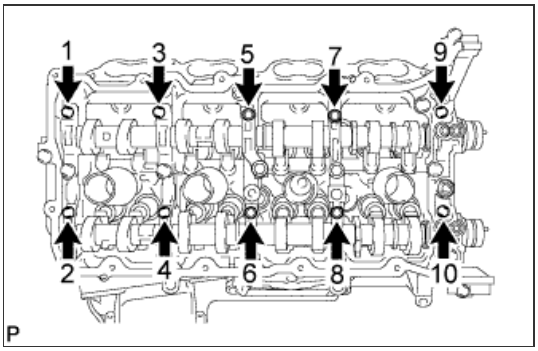


41. REMOVE CAMSHAFT BEARING CAP RH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

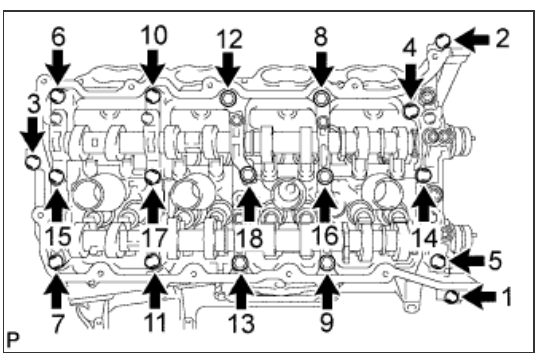
Uniformly loosen the bolts while keeping the camshaft level.

d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 1 and No. 2 camshafts.



42. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY RH

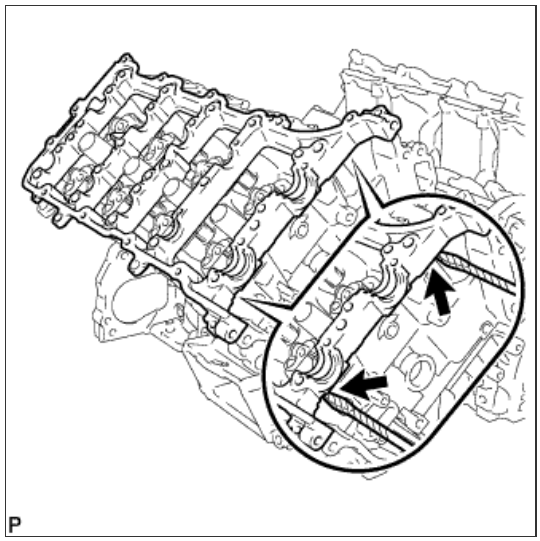
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.



43. REMOVE NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Remove the 32 valve rocker arms from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

44. REMOVE VALVE LASH ADJUSTER ASSEMBLY

a. Remove the 32 valve lash adjusters from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

45. REMOVE VALVE STEM CAP

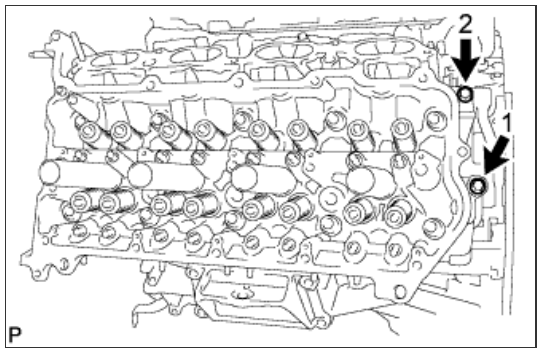
a. Remove the 32 valve stem caps from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

46. REMOVE CYLINDER HEAD SUB-ASSEMBLY LH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



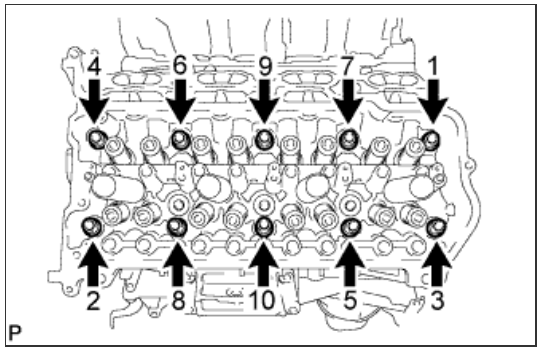
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

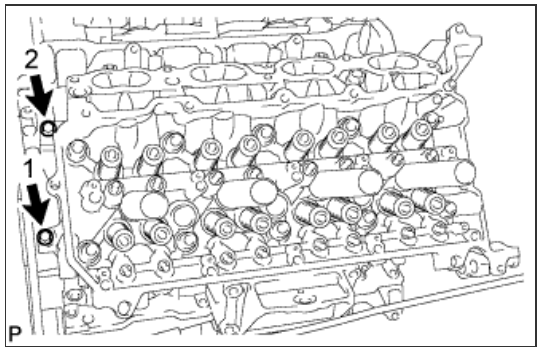
- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



c. Remove the cylinder head and gasket.

47. REMOVE CYLINDER HEAD SUB-ASSEMBLY RH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



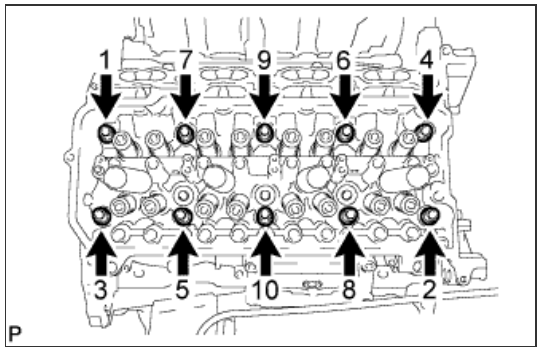
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



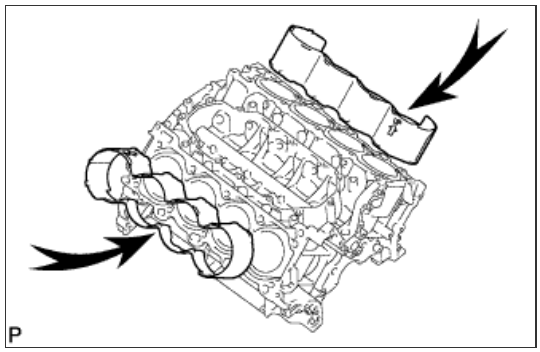
c. Remove the cylinder head and gasket.

48. REMOVE CYLINDER BLOCK WATER JACKET SPACER

a. Remove the 2 water jacket spacers from the cylinder block.

NOTICE:

Be sure to remove the water jacket spacers. If not, they may fall and become damaged when the cylinder block is inverted.

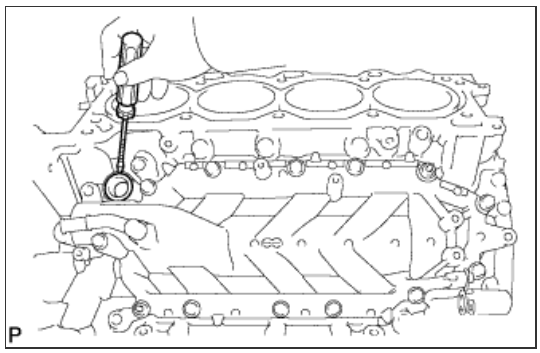


49. REMOVE VENTILATION PIPE GASKET

a. Using a screwdriver, pry out the ventilation pipe gasket.

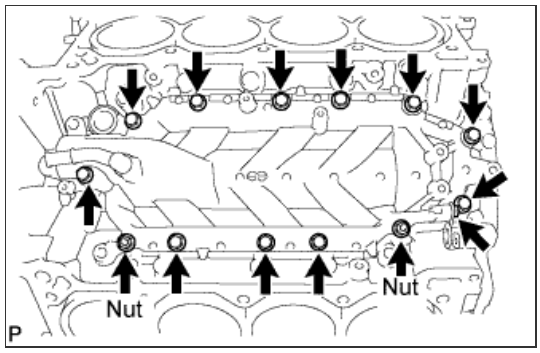
HINT:

Tape the screwdriver tip before use.



50. REMOVE NO. 1 HEAT EXCHANGER COVER

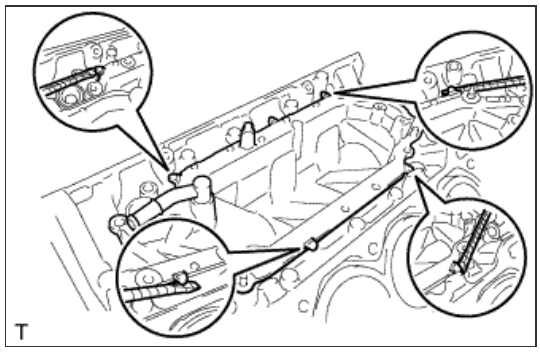
a. Remove the 12 bolts and 2 nuts.



b. Remove the heat exchanger by prying between the heat exchanger and cylinder block with a screwdriver.

HINT:

Tape the screwdriver tip before use.

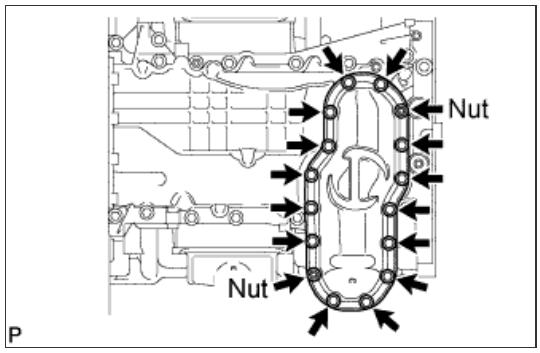


51. REMOVE NO. 2 OIL PAN SUB-ASSEMBLY

a. Remove the engine oil level sensor (Click here).

b. Remove the 14 bolts and 2 nuts.

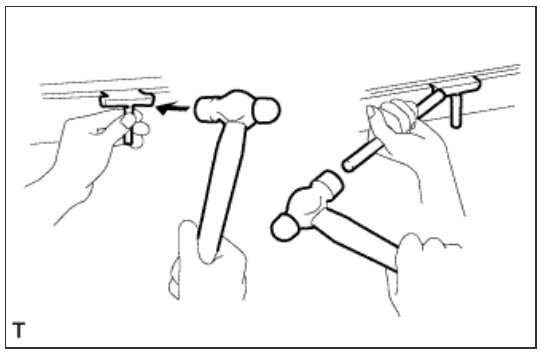
b. Remove the 14 bolts and 2 nuts.



c. Insert the blade of an oil pan seal cutter between the oil pans. Cut through the applied sealer and remove the No. 2 oil pan.

NOTICE:

Be careful not to damage the contact surfaces of the oil pans.

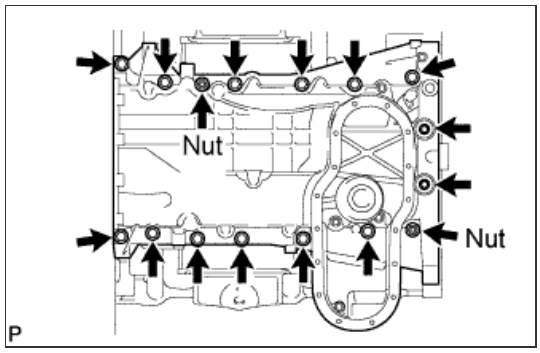


52. REMOVE NO. 1 OIL PAN SUB-ASSEMBLY

a. Remove the 14 bolts and 2 nuts.

HINT:

Be sure to clean the bolts and stud bolts, and check the threads for cracks or other damage.



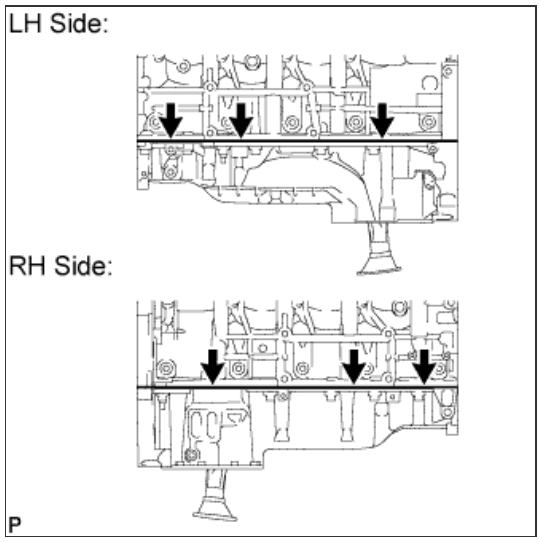
b. Remove the oil pan by prying between the oil pan and cylinder block with a screwdriver.

HINT:

Tape the screwdriver tip before use.

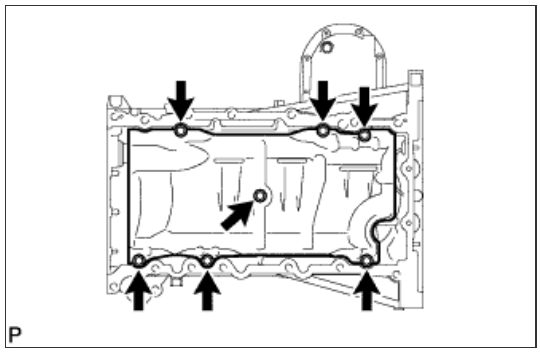
NOTICE:

Be careful not to damage the contact surfaces of the cylinder block and oil pan.



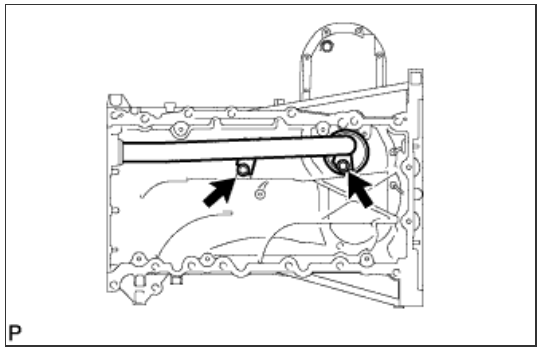
53. REMOVE NO. 1 OIL PAN BAFFLE PLATE

a. Remove the 7 bolts and baffle plate.



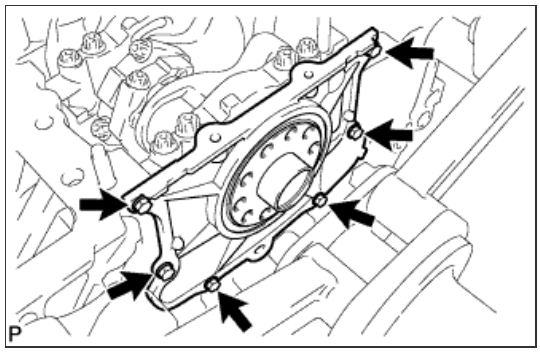
54. REMOVE OIL STRAINER SUB-ASSEMBLY

a. Remove the 2 bolts, oil strainer and O-ring.



55. REMOVE ENGINE REAR OIL SEAL RETAINER

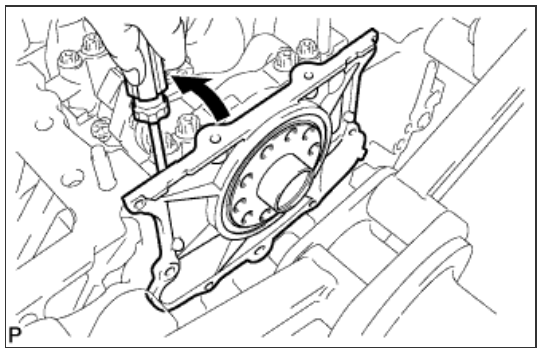
a. Remove the 6 bolts and oil seal retainer.



b. Using a screwdriver, pry out the oil seal retainer.

HINT:

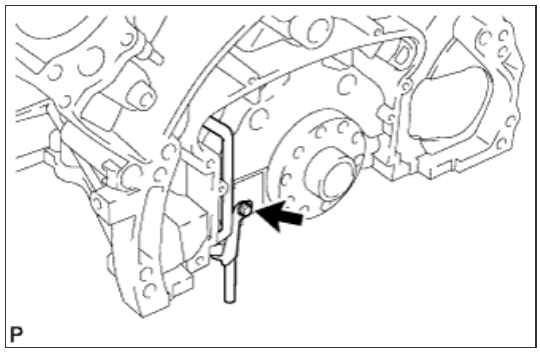
Tape the screwdriver tip before use.



56. REMOVE OIL DRAIN PIPE SUB-ASSEMBLY

a. Remove the bolt and oil drain pipe.

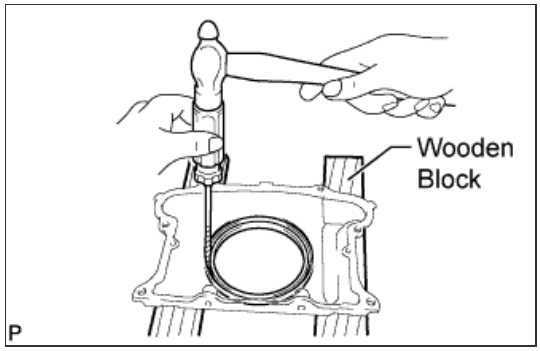
b. Remove the O-ring.



57. REMOVE REAR CRANKSHAFT OIL SEAL

a. Place the oil seal retainer on wooden blocks.

b. Using a screwdriver and hammer, tap out the oil seal.



58. REMOVE RING PIN

NOTICE:

It is not necessary to remove the ring pin unless it is being replaced.

59. REMOVE STUD BOLT

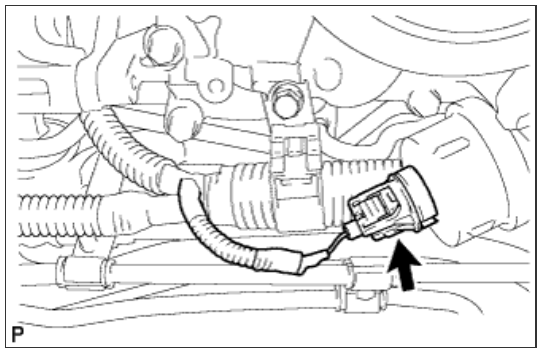
NOTICE:

If the stud bolt is deformed or its threads are damaged, replace it.

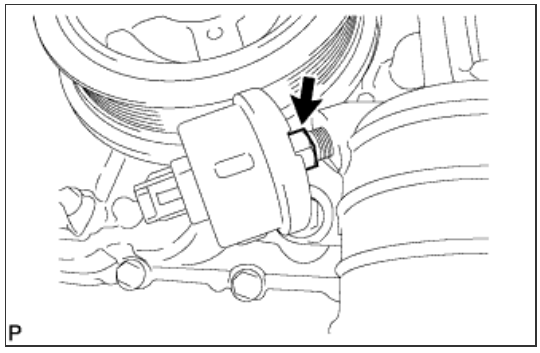
for Preparation Click here

1. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.

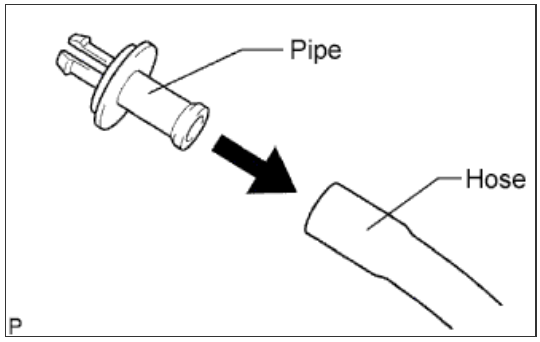


b. Remove the oil pressure sender gauge.

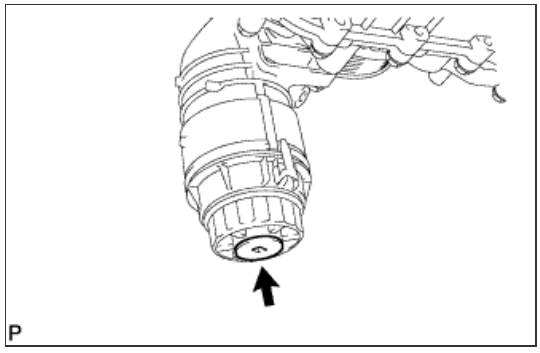


2. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



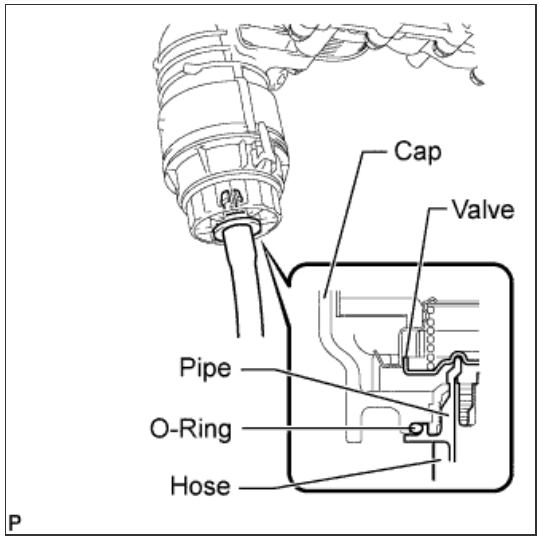
c. Install the pipe to the oil filter cap.

NOTICE:

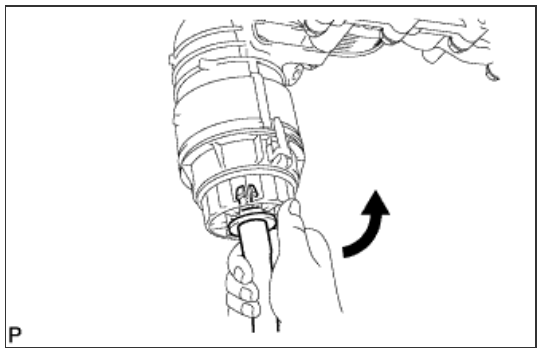
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

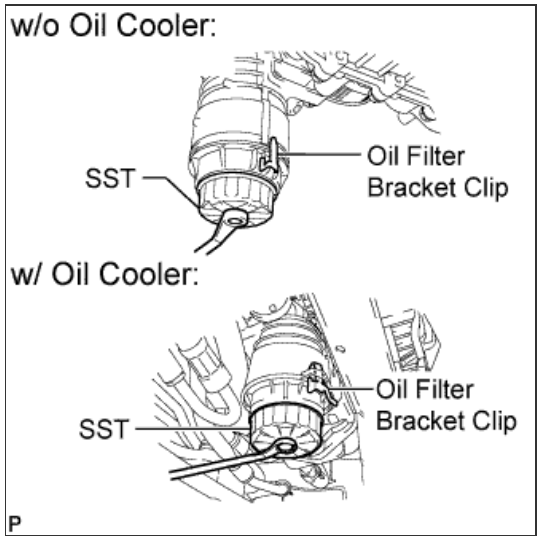


e. Using SST, remove the oil filter cap.

SST
09228-06501

NOTICE:

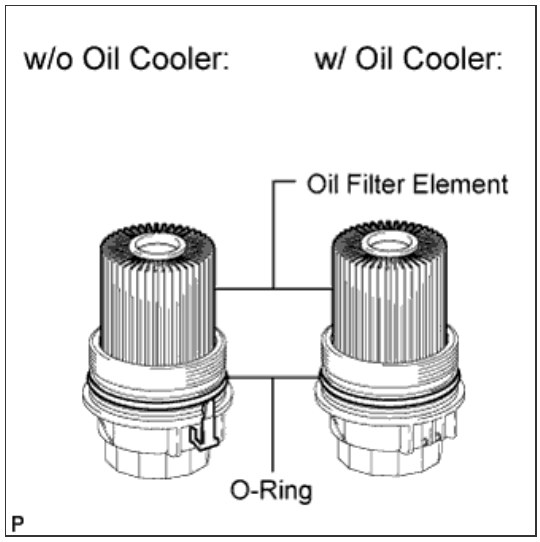
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

NOTICE:

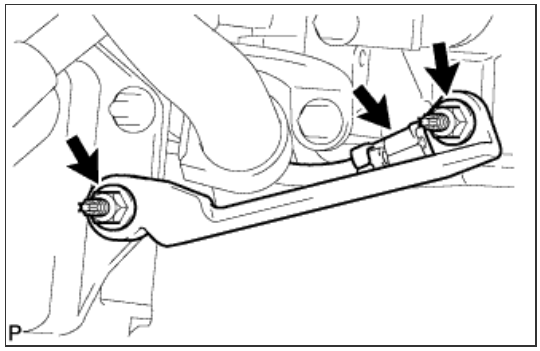
Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.



3. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

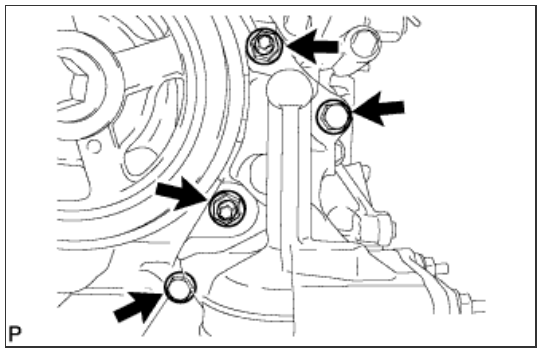
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

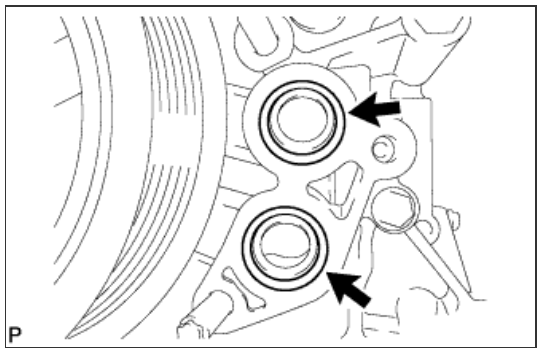


4. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.

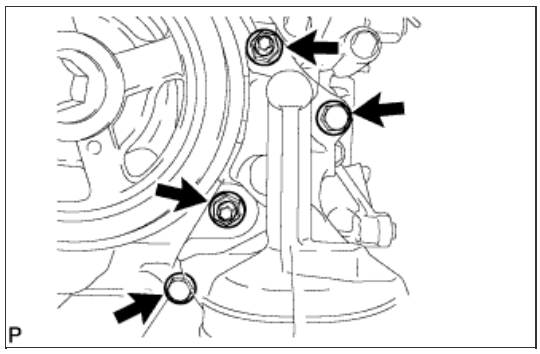


b. Remove the 2 O-rings.

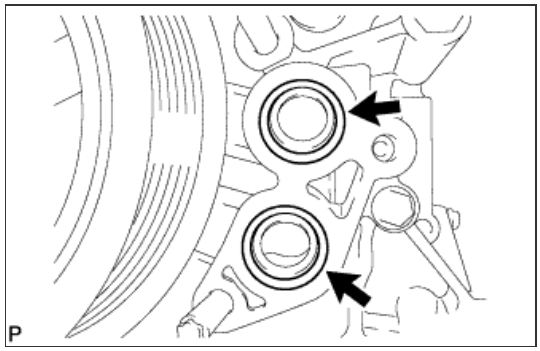


5. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.



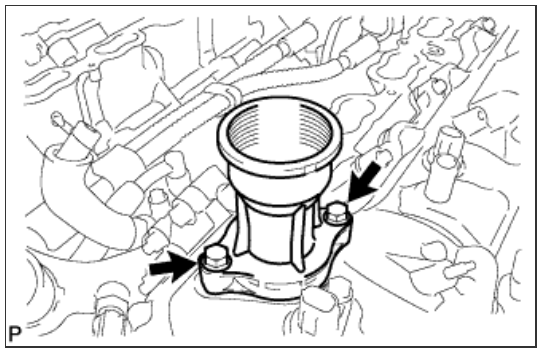
b. Remove the 2 O-rings.



6. REMOVE OIL FILLER CAP SUB-ASSEMBLY

7. REMOVE OIL FILLER CAP HOUSING

a. Remove the 2 bolts, filler cap housing and gasket.

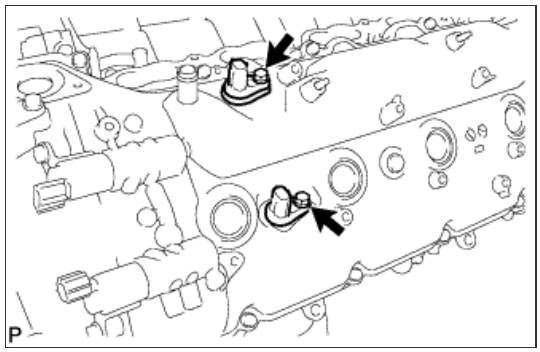


8. REMOVE SPARK PLUG

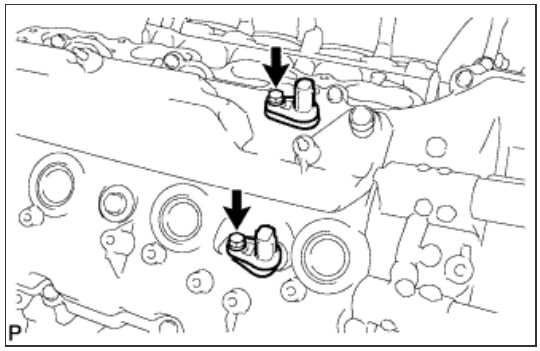
a. Using a 16 mm plug wrench, remove the 8 spark plugs.

9. REMOVE VVT SENSOR

a. LH:
Remove the 2 bolts and 2 VVT sensors.

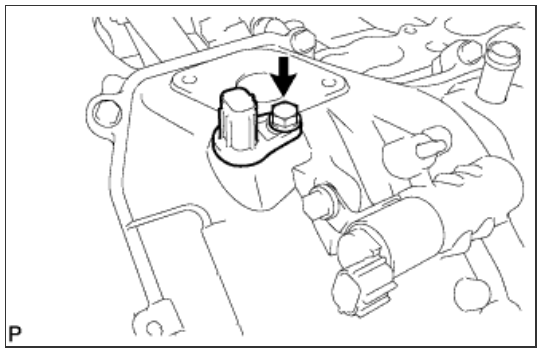


b. RH:
Remove the 2 bolts and 2 VVT sensors.



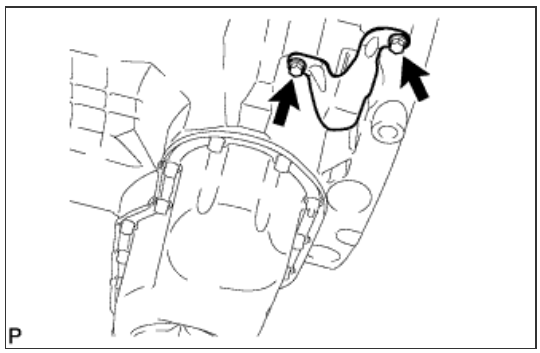
10. REMOVE CAMSHAFT POSITION SENSOR

a. Remove the bolt and camshaft position sensor.



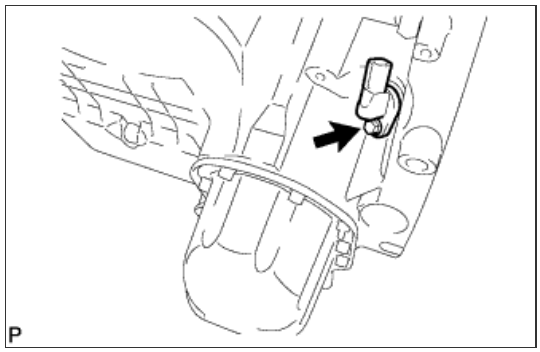
11. REMOVE CRANK POSITION SENSOR PROTECTOR

a. Remove the 2 bolts and sensor protector.



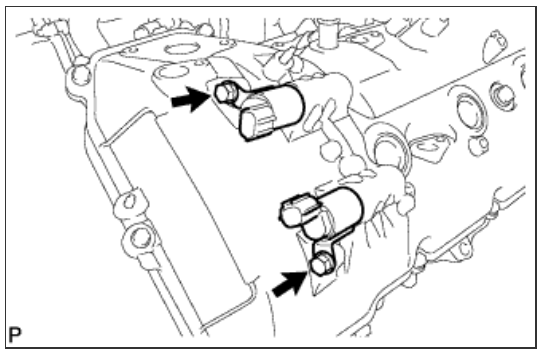
12. REMOVE CRANKSHAFT POSITION SENSOR

a. Remove the bolt and crankshaft position sensor.

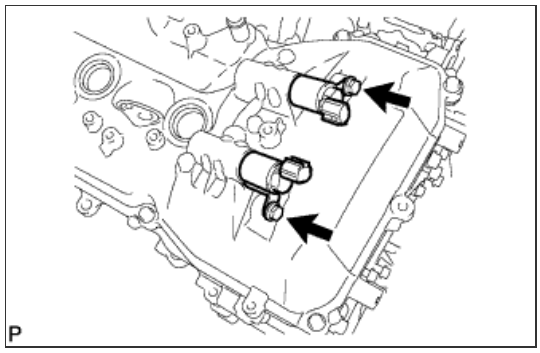


13. REMOVE CAMSHAFT OIL CONTROL VALVE ASSEMBLY

a. LH:
Remove the 2 bolts and 2 oil control valves.



b. RH:
Remove the 2 bolts and 2 oil control valves.

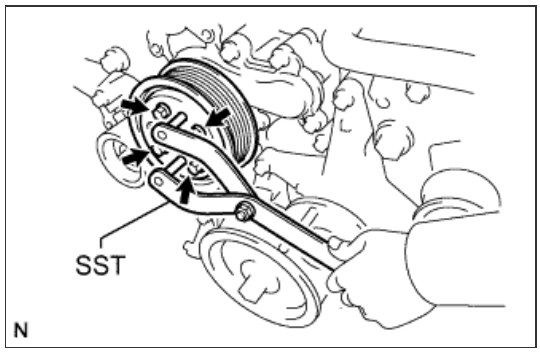


14. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

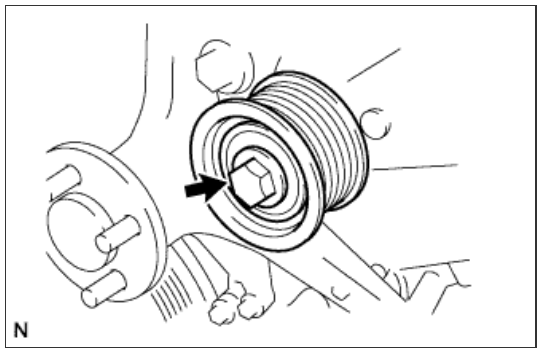
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



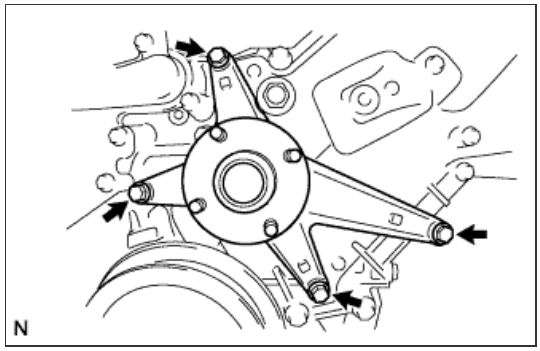
15. REMOVE NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Remove the bolt and idler pulley.



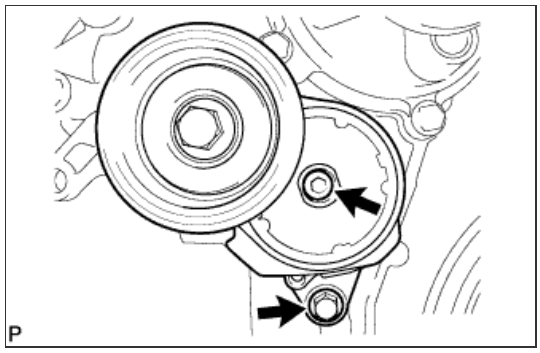
16. REMOVE FLUID COUPLING BRACKET

a. Remove the 4 bolts and fluid coupling bracket.



17. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY

a. Remove the standard bolt, 6 mm hexagon wrench bolt and belt tensioner.

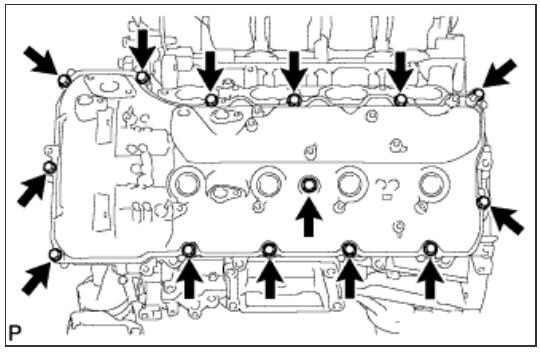


18. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY LH

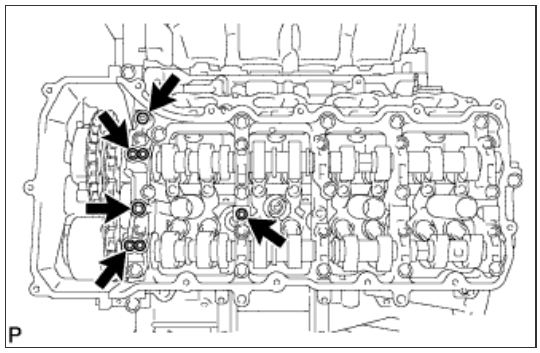
a. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

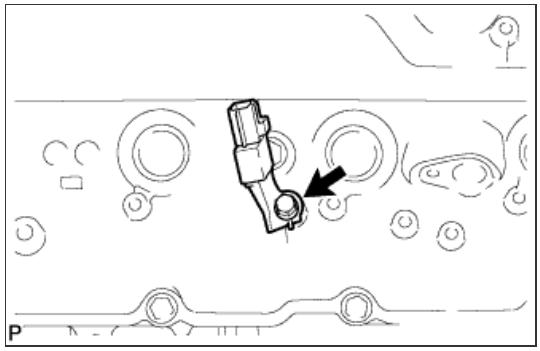


b. Remove the 5 gaskets from the camshaft bearing caps (No. 2, No. 3).



19. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY RH

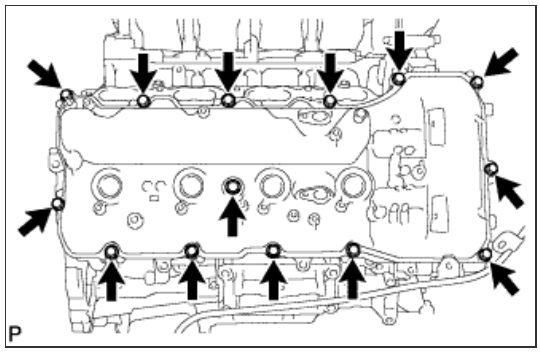
a. Remove the bolt and noise filter.



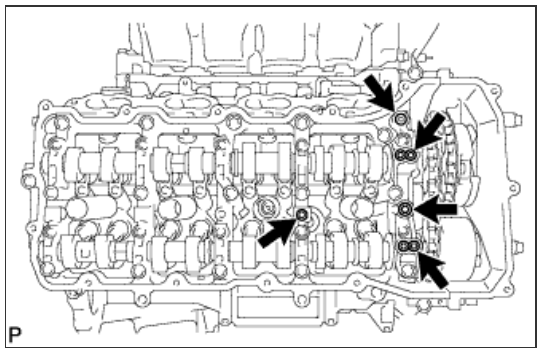
b. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

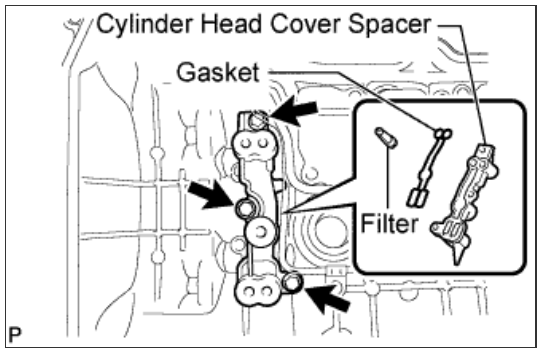


c. Remove the 5 gaskets from the camshaft bearing caps (No. 1, No. 3).

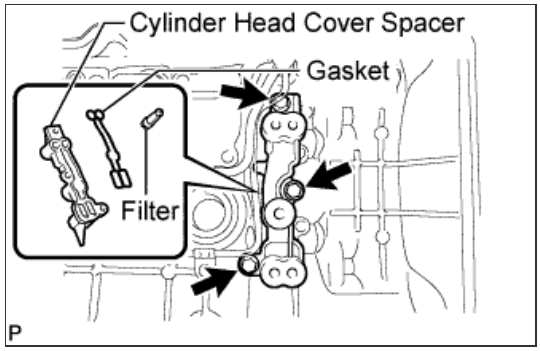


20. REMOVE OIL CONTROL VALVE FILTER

a. LH:
Remove the 3 bolts, cylinder head cover spacer, gasket and filter.



b. RH:
Remove the 3 bolts, cylinder head cover spacer, gasket and filter.



21. REMOVE SPARK PLUG TUBE GASKET

a. Bend the 4 ventilation baffle plate claws on the cylinder head cover to an angle of 90° or more.

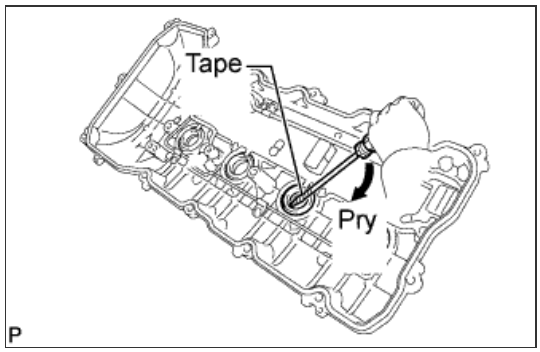
b. Using a screwdriver, pry out the gaskets.

HINT:

Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the cylinder head cover.**
- **Be careful not to damage the gasket when removing it, as the removed gasket needs to be used when installing a new one.**

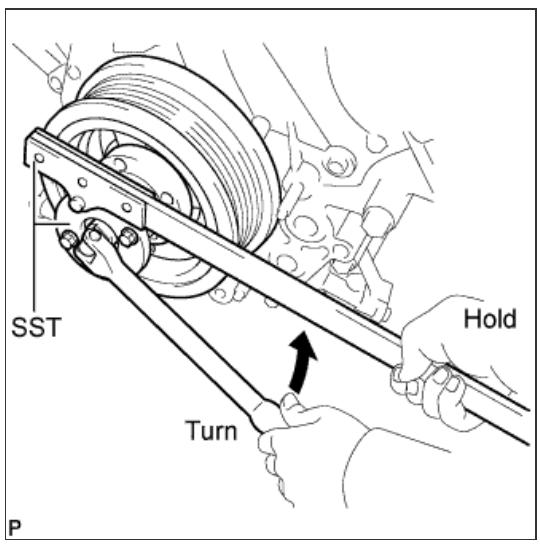


22. REMOVE CRANKSHAFT PULLEY

a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST

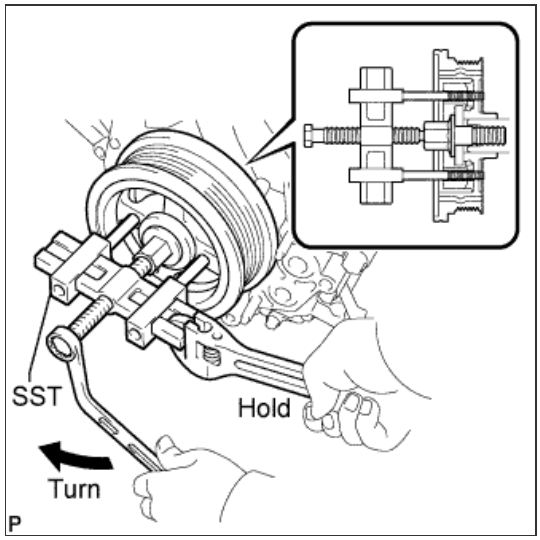
09213-70011 (09213-70020)
09330-00021



b. Using the pulley set bolt and SST, remove the crankshaft pulley.

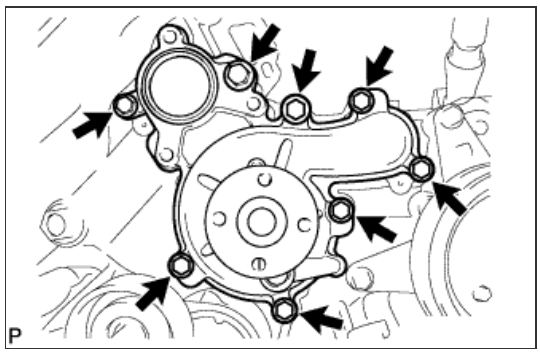
SST

09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



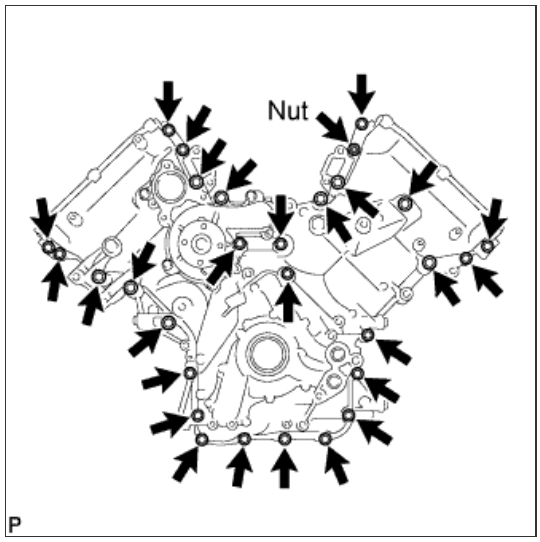
23. REMOVE WATER PUMP ASSEMBLY

a. Remove the 8 bolts, water pump and gasket.



24. REMOVE TIMING CHAIN COVER SUB-ASSEMBLY

a. Remove the 28 bolts and nut shown in the illustration.



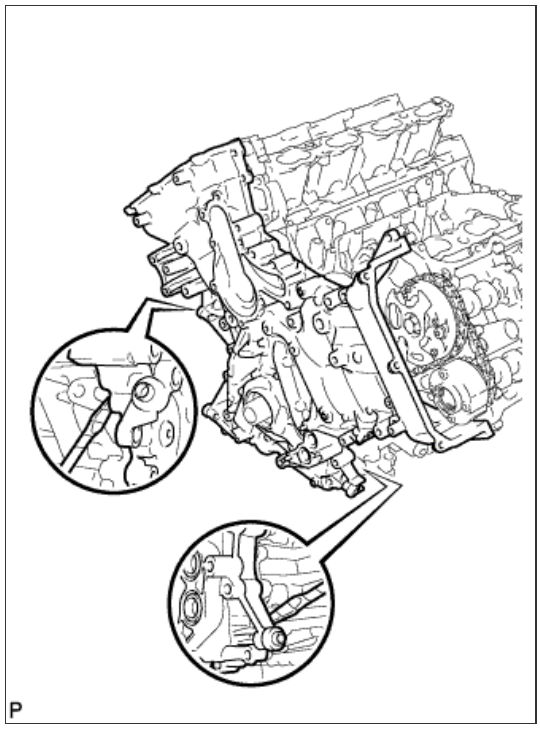
b. Remove the timing chain cover by prying between the timing chain cover and cylinder head or cylinder block with a screwdriver as shown in the illustration.

NOTICE:

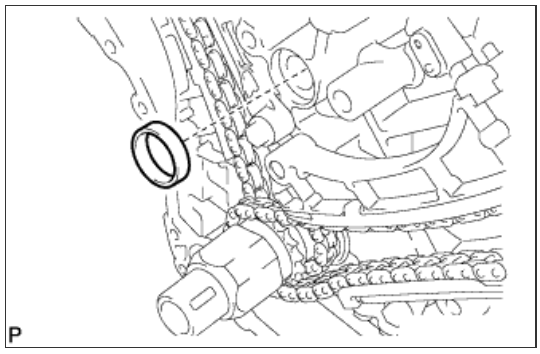
Be careful not to damage the contact surfaces of the cylinder head, cylinder block and chain cover.

HINT:

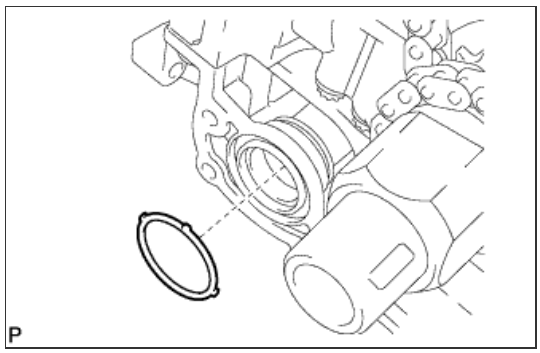
Tape the screwdriver tip before use.



c. Remove the oil pump gasket from the cylinder block.



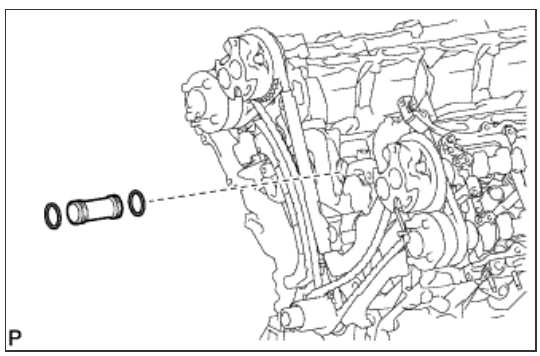
d. Remove the O-ring from the oil pan.



25. REMOVE WATER INLET PIPE

a. Remove the water inlet pipe.

b. Remove the 2 O-rings from the water inlet pipe.



26. REMOVE FRONT CRANKSHAFT OIL SEAL

a. Place the timing chain cover on wooden blocks.

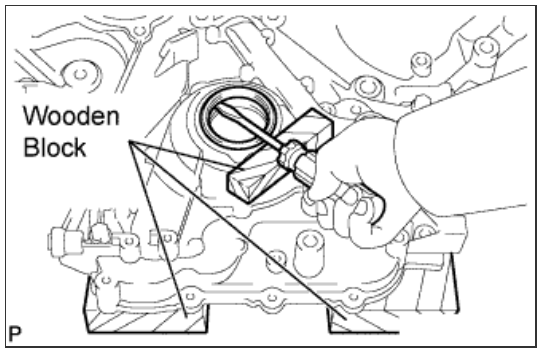
b. Using a screwdriver and wooden block, pry out the oil seal.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Do not damage the surface of the oil seal press fit hole.



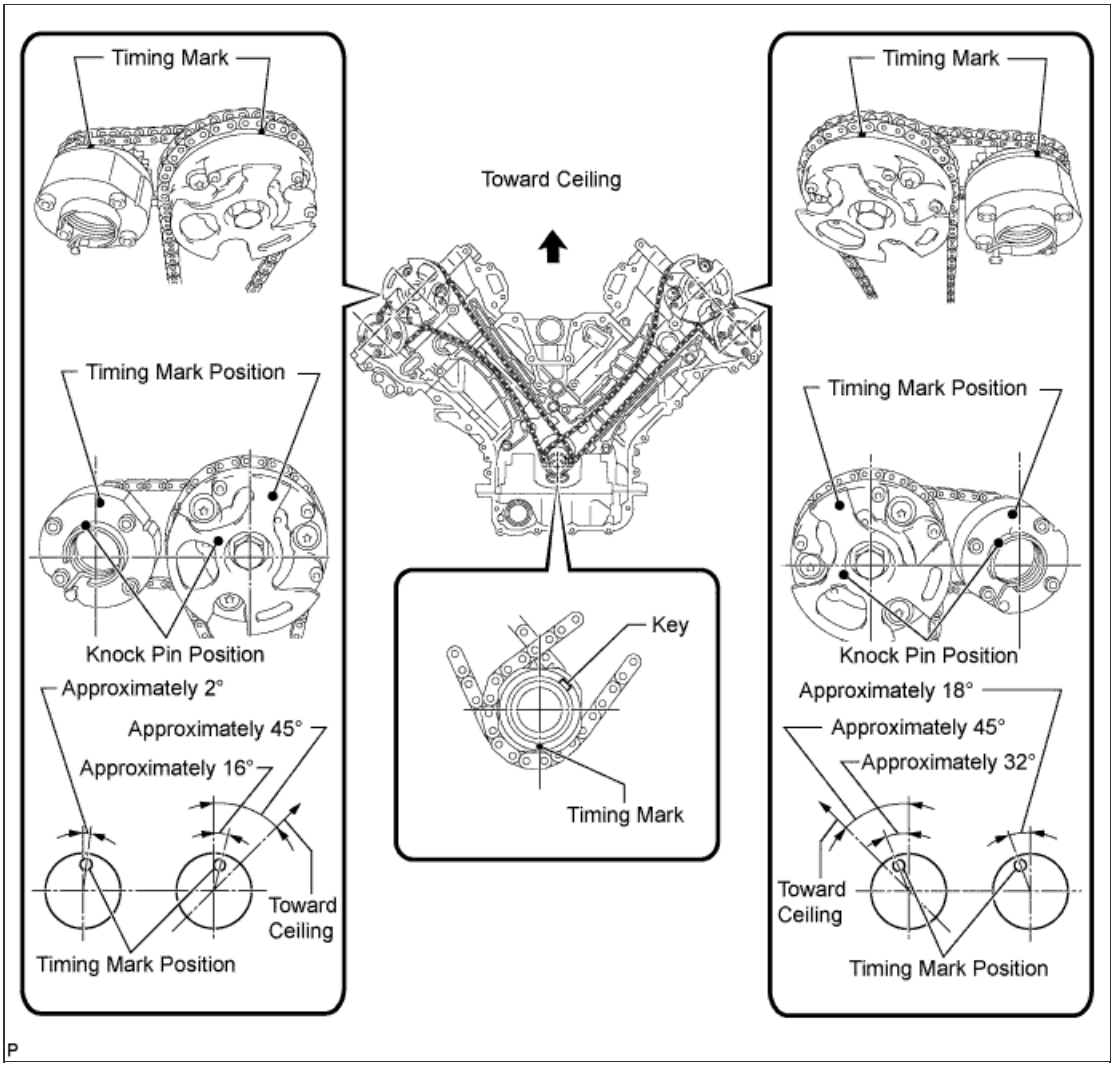
27. SET NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise so that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

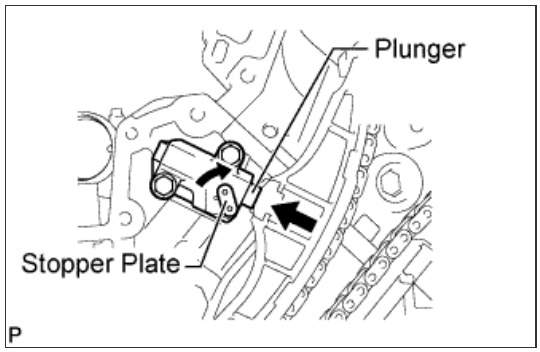
HINT:

If the timing marks do not align, rotate the crankshaft clockwise again and align the timing marks.

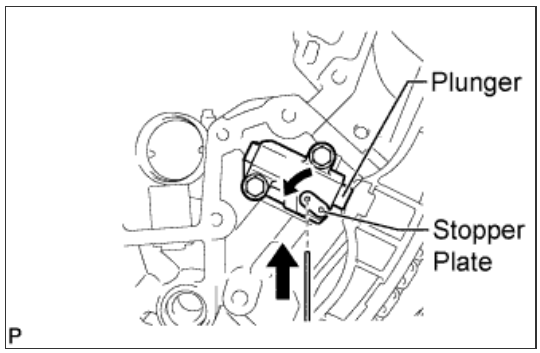


28. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY LH

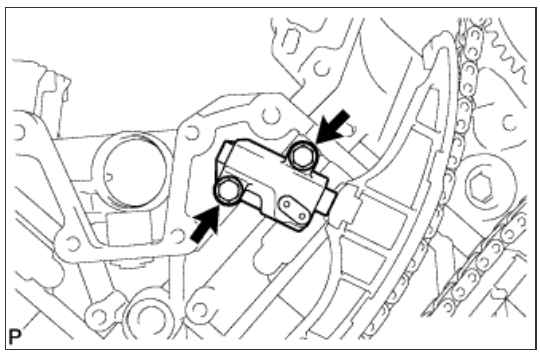
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



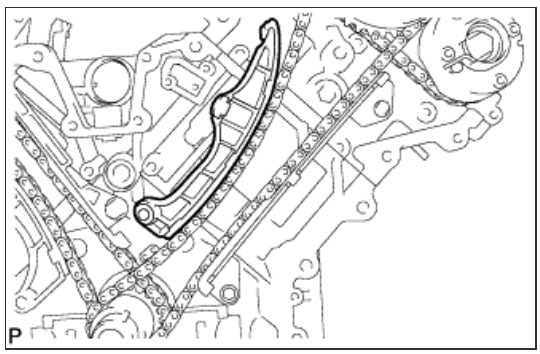
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts, chain tensioner and gasket.

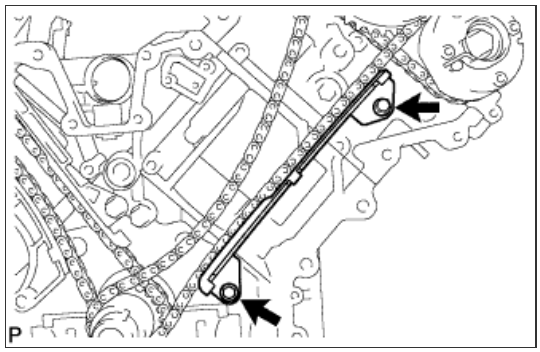


29. REMOVE NO. 1 CHAIN TENSIONER SLIPPER LH



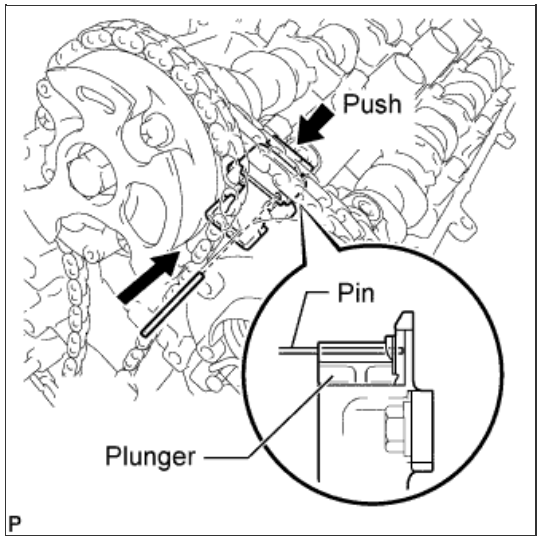
30. REMOVE NO. 1 CHAIN VIBRATION DAMPER LH

a. Remove the 2 bolts and chain vibration damper.



31. REMOVE NO. 1 CHAIN SUB-ASSEMBLY LH

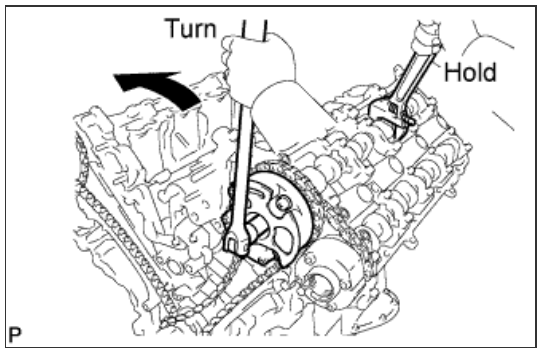
a. While pushing down the No. 3 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



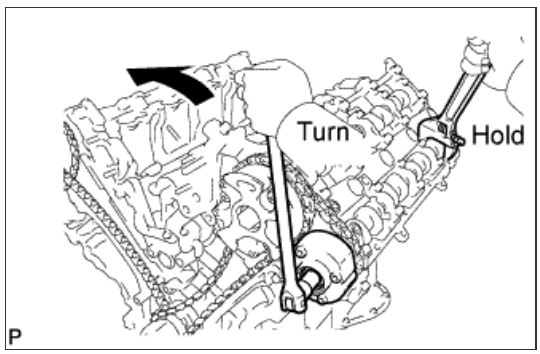
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

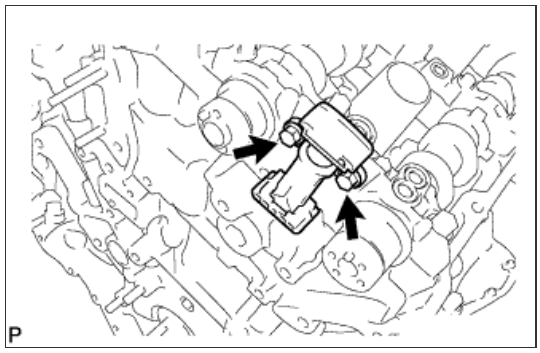
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket LH.

e. Remove the No. 1 and No. 2 chains from the gears.



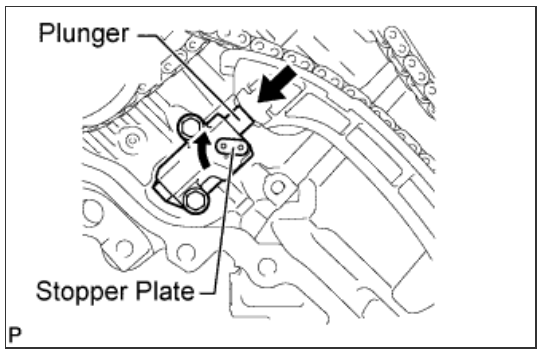
32. REMOVE NO. 3 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.

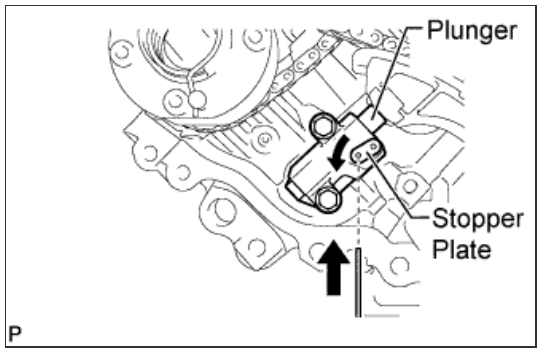


33. REMOVE NO. 1 CHAIN TENSIONER ASSEMBLY RH

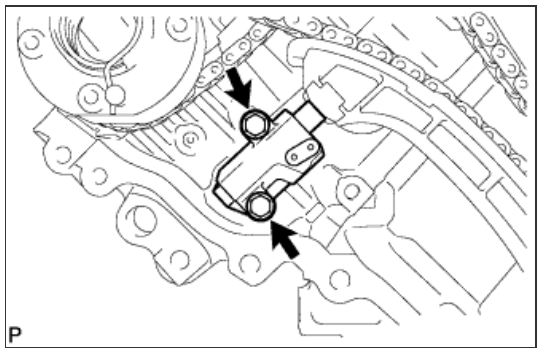
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.



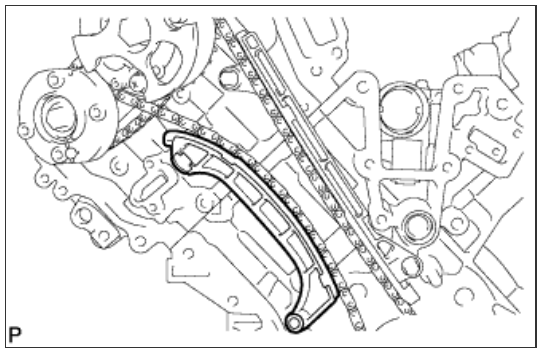
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the stopper plate hole.



c. Remove the 2 bolts and chain tensioner.

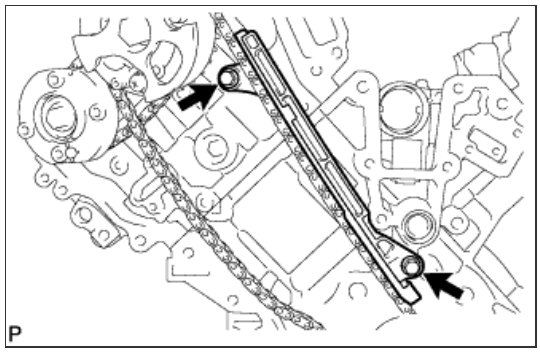


34. REMOVE NO. 1 CHAIN TENSIONER SLIPPER RH



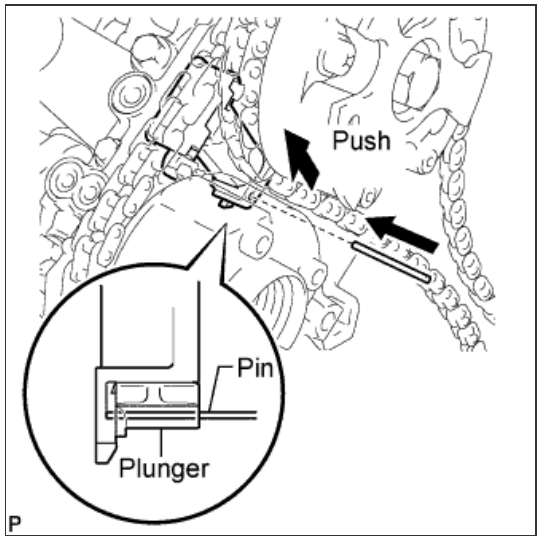
35. REMOVE NO. 1 CHAIN VIBRATION DAMPER RH

a. Remove the 2 bolts and vibration damper.



36. REMOVE NO. 1 CHAIN SUB-ASSEMBLY RH

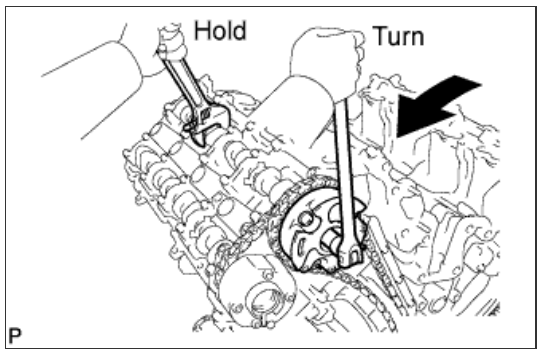
a. While raising up the No. 2 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.



b. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

- **Be careful not to damage the cylinder head with the wrench.**
- **Do not disassemble the camshaft timing gear.**



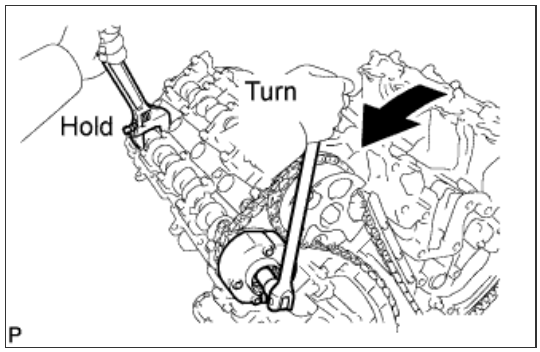
c. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

NOTICE:

Be careful not to damage the cylinder head with the wrench.

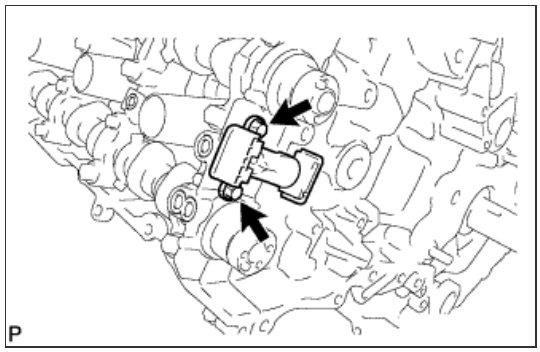
d. Remove the 2 bolts. Then with the No. 1 and No. 2 chains still connected to the gears, remove the camshaft timing gear, camshaft timing exhaust gear and crankshaft timing sprocket RH.

e. Remove the No. 1 and No. 2 chains from the gears.



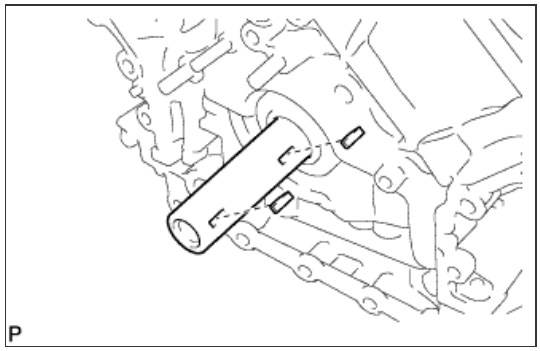
37. REMOVE NO. 2 CHAIN TENSIONER ASSEMBLY

a. Remove the 2 bolts and chain tensioner.



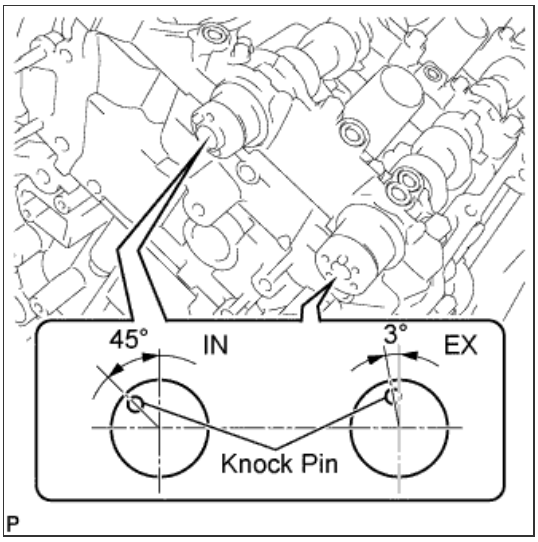
38. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Using a screwdriver, remove the 2 timing gear keys from the crankshaft.

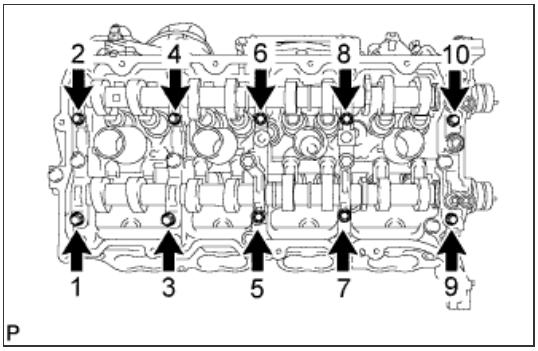


39. REMOVE CAMSHAFT BEARING CAP LH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



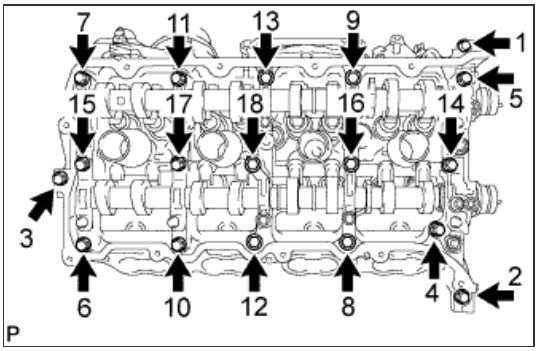
b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

Uniformly loosen the bolts while keeping the camshaft level.



d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 3 and No. 4 camshafts.

40. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY LH

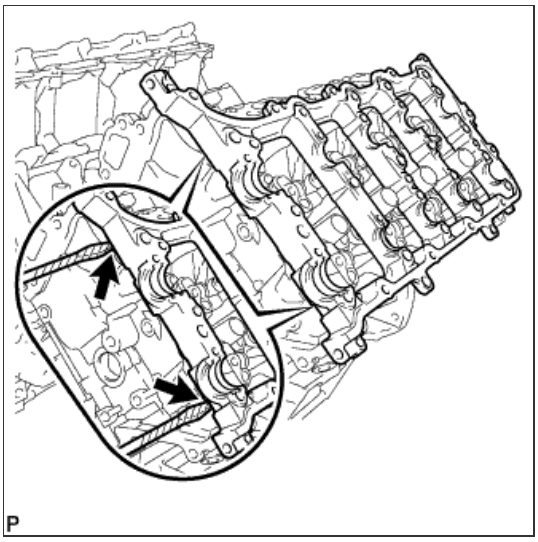
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

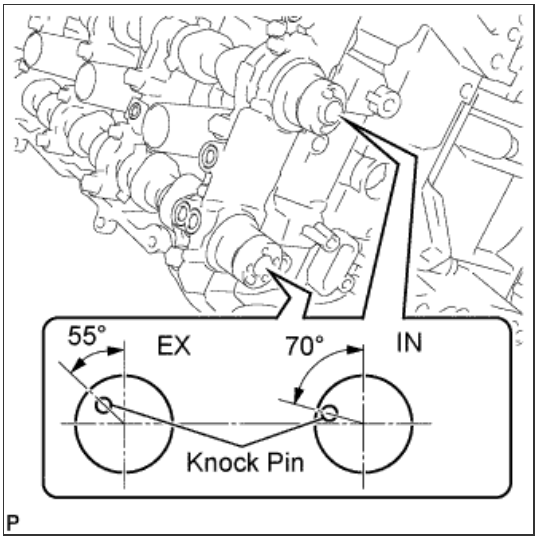
NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.

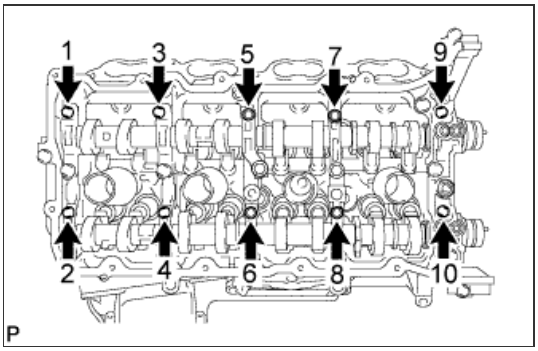


41. REMOVE CAMSHAFT BEARING CAP RH

a. Make sure that the knock pin of the camshaft is positioned as shown in the illustration.



b. Uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.



c. Uniformly loosen and remove the 18 bearing cap bolts in the sequence shown in the illustration.

NOTICE:

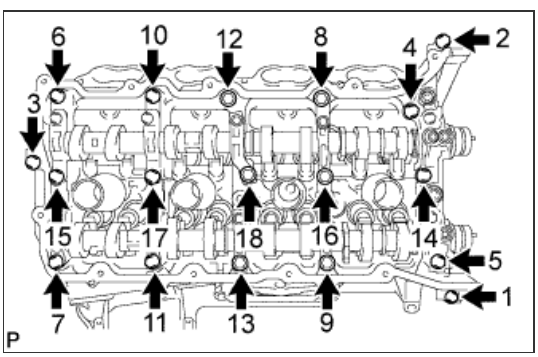
Uniformly loosen the bolts while keeping the camshaft level.

d. Remove the 6 bearing caps.

HINT:

Arrange the removed parts in the correct order.

e. Remove the No. 1 and No. 2 camshafts.



42. REMOVE CAMSHAFT HOUSING SUB-ASSEMBLY RH

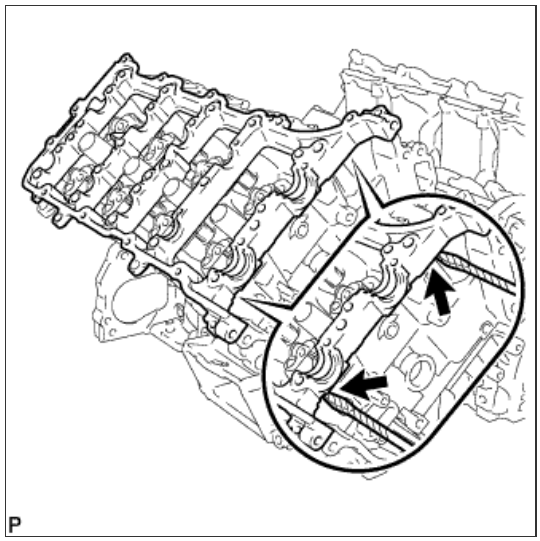
a. Remove the camshaft housing by prying between the cylinder head and camshaft housing with a screwdriver.

HINT:

Tape the screwdriver tip before use.

NOTICE:

Be careful not to damage the contact surfaces of the cylinder head and camshaft housing.



43. REMOVE NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Remove the 32 valve rocker arms from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

44. REMOVE VALVE LASH ADJUSTER ASSEMBLY

a. Remove the 32 valve lash adjusters from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

45. REMOVE VALVE STEM CAP

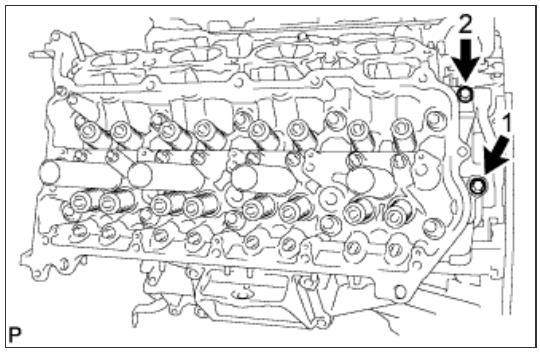
a. Remove the 32 valve stem caps from the cylinder heads.

HINT:

Arrange the removed parts in the correct order.

46. REMOVE CYLINDER HEAD SUB-ASSEMBLY LH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



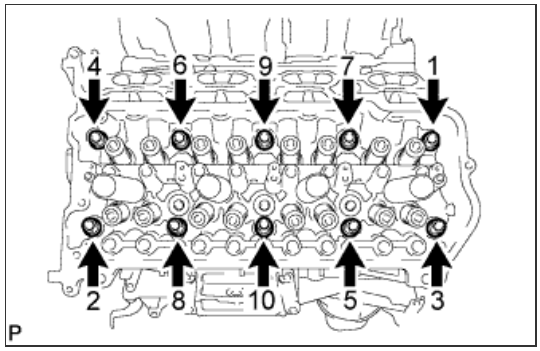
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

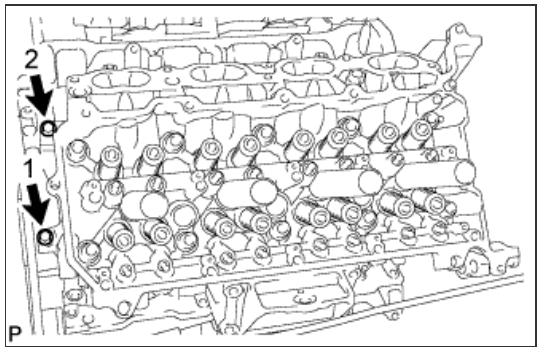
- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



c. Remove the cylinder head and gasket.

47. REMOVE CYLINDER HEAD SUB-ASSEMBLY RH

a. Uniformly loosen and remove the 2 bolts in the sequence shown in the illustration.



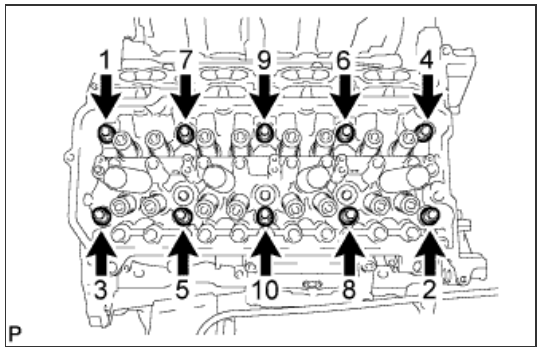
b. Using a 10 mm bi-hexagon wrench, uniformly loosen the 10 cylinder head bolts in the sequence shown in the illustration. Remove the 10 cylinder head bolts and plate washers.

HINT:

Be sure to arrange the removed parts for each installation position separately.

NOTICE:

- **Be careful not to drop washers into the cylinder head.**
- **Head warpage or cracking could result from removing bolts in an incorrect order.**



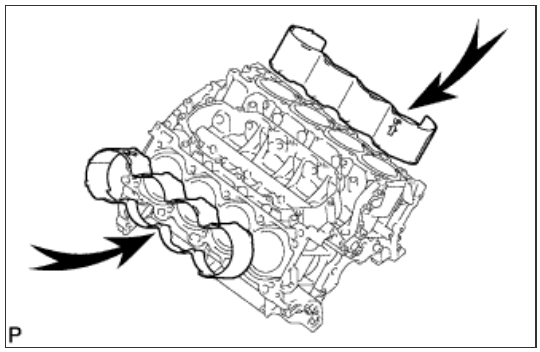
c. Remove the cylinder head and gasket.

48. REMOVE CYLINDER BLOCK WATER JACKET SPACER

a. Remove the 2 water jacket spacers from the cylinder block.

NOTICE:

Be sure to remove the water jacket spacers. If not, they may fall and become damaged when the cylinder block is inverted.

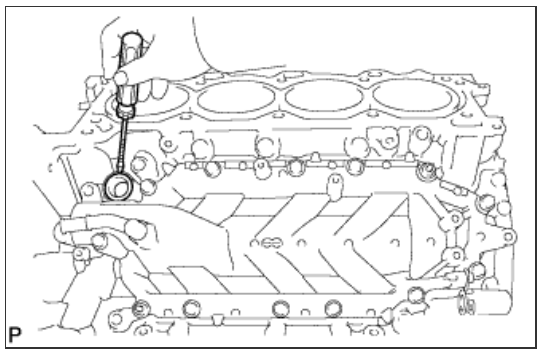


49. REMOVE VENTILATION PIPE GASKET

a. Using a screwdriver, pry out the ventilation pipe gasket.

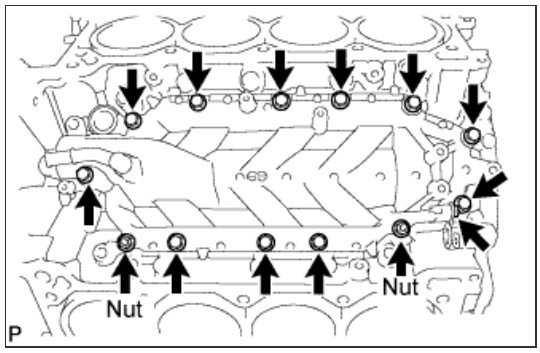
HINT:

Tape the screwdriver tip before use.



50. REMOVE NO. 1 HEAT EXCHANGER COVER

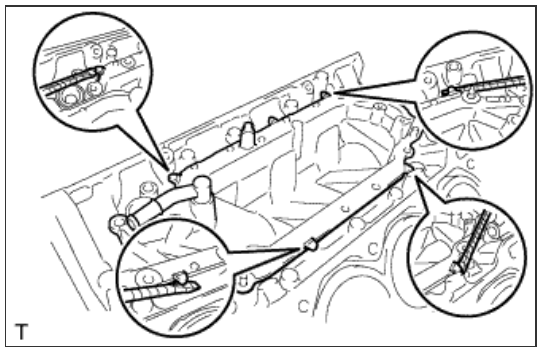
a. Remove the 12 bolts and 2 nuts.



b. Remove the heat exchanger by prying between the heat exchanger and cylinder block with a screwdriver.

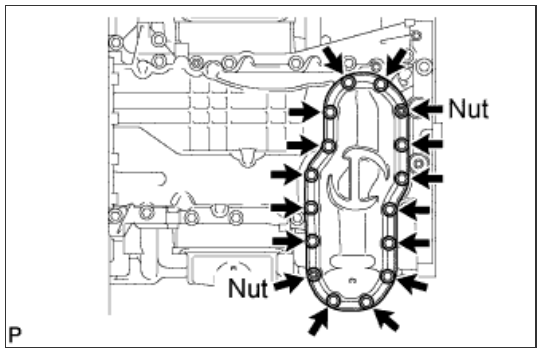
HINT:

Tape the screwdriver tip before use.



51. REMOVE NO. 2 OIL PAN SUB-ASSEMBLY

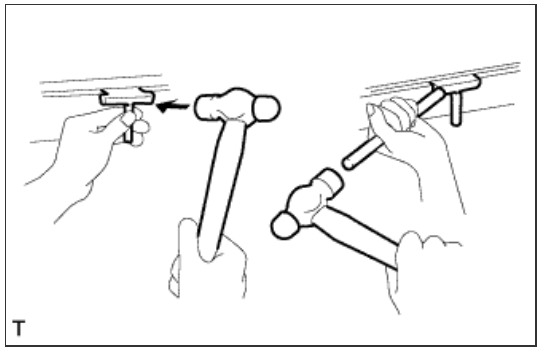
a. Remove the 14 bolts and 2 nuts.



b. Insert the blade of an oil pan seal cutter between the oil pans. Cut through the applied sealer and remove the No. 2 oil pan.

NOTICE:

Be careful not to damage the contact surfaces of the oil pans.

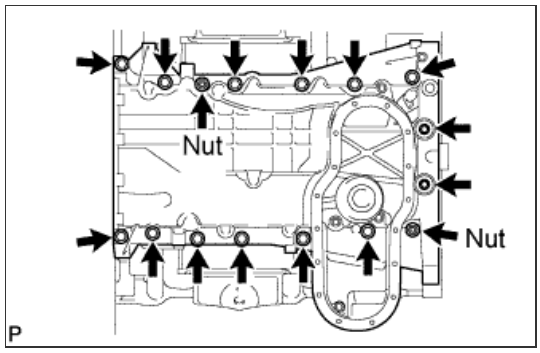


52. REMOVE NO. 1 OIL PAN SUB-ASSEMBLY

a. Remove the 14 bolts and 2 nuts.

HINT:

Be sure to clean the bolts and stud bolts, and check the threads for cracks or other damage.



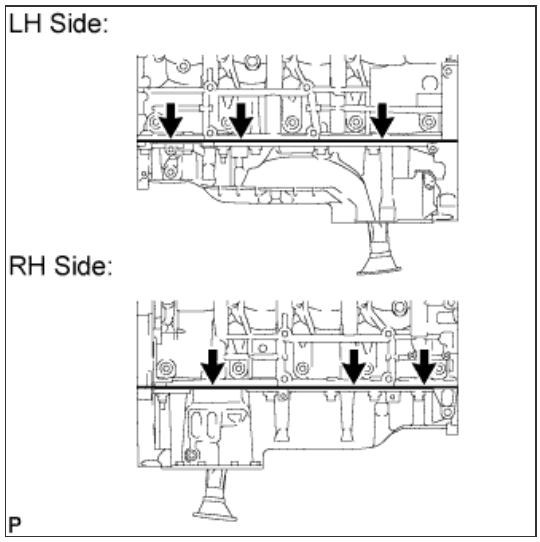
b. Remove the oil pan by prying between the oil pan and cylinder block with a screwdriver.

HINT:

Tape the screwdriver tip before use.

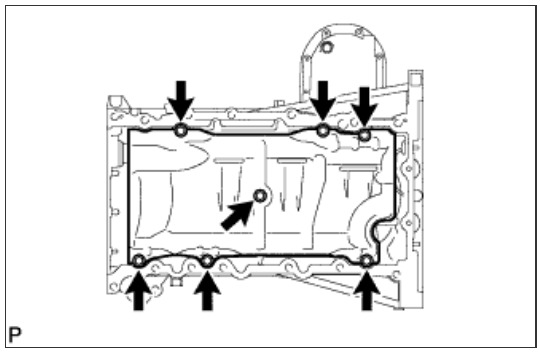
NOTICE:

Be careful not to damage the contact surfaces of the cylinder block and oil pan.



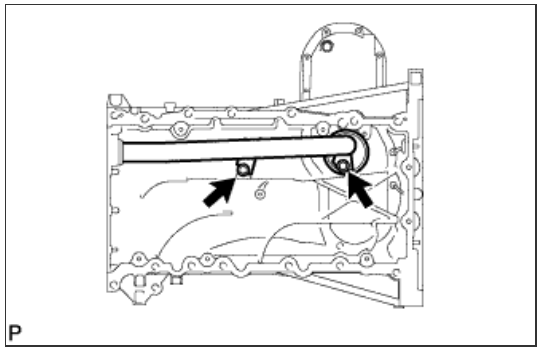
53. REMOVE NO. 1 OIL PAN BAFFLE PLATE

a. Remove the 7 bolts and baffle plate.



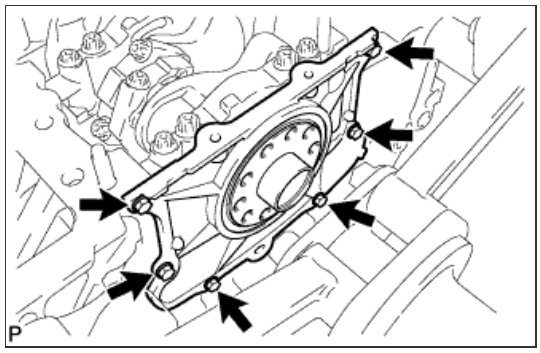
54. REMOVE OIL STRAINER SUB-ASSEMBLY

a. Remove the 2 bolts, oil strainer and O-ring.



55. REMOVE ENGINE REAR OIL SEAL RETAINER

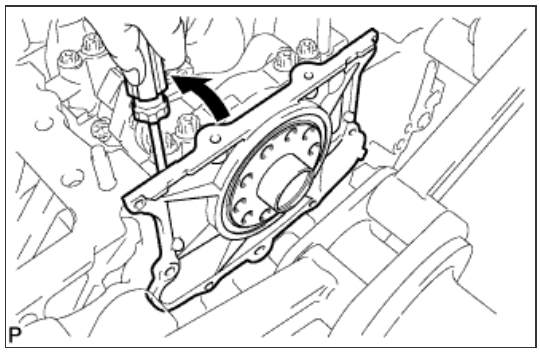
a. Remove the 6 bolts and oil seal retainer.



b. Using a screwdriver, pry out the oil seal retainer.

HINT:

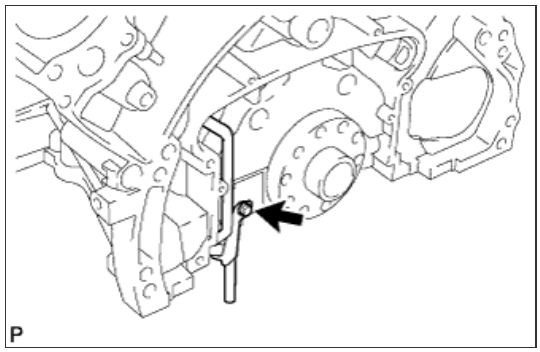
Tape the screwdriver tip before use.



56. REMOVE OIL DRAIN PIPE SUB-ASSEMBLY

a. Remove the bolt and oil drain pipe.

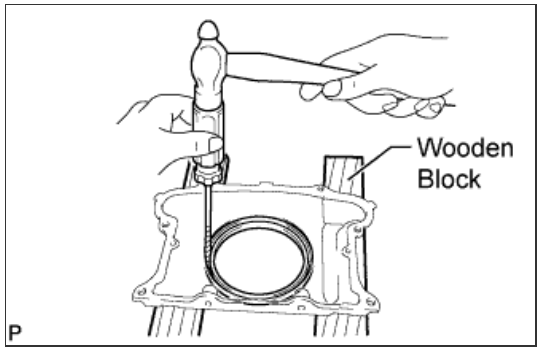
b. Remove the O-ring.



57. REMOVE REAR CRANKSHAFT OIL SEAL

a. Place the oil seal retainer on wooden blocks.

b. Using a screwdriver and hammer, tap out the oil seal.



58. REMOVE RING PIN

NOTICE:

It is not necessary to remove the ring pin unless it is being replaced.

59. REMOVE STUD BOLT

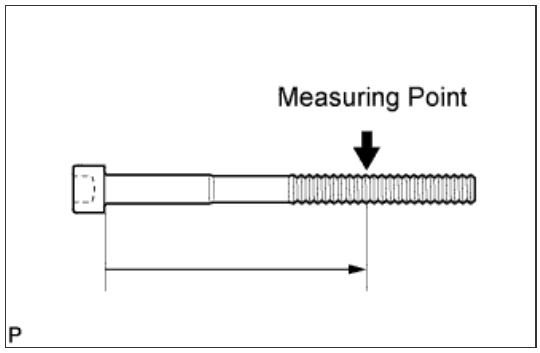
NOTICE:

If the stud bolt is deformed or its threads are damaged, replace it.

for Preparation Click here

1. INSPECT CYLINDER HEAD SET BOLT

a. Using a vernier caliper, measure the diameter of the elongated thread at the measuring point.



Measuring point:
94 mm (3.70 in.) for intake side bolt
89 mm (3.50 in.) for exhaust side bolt

Standard diameter:
10.85 to 11.00 mm (0.427 to 0.433 in.)

Minimum diameter:
10.6 mm (0.417 in.)

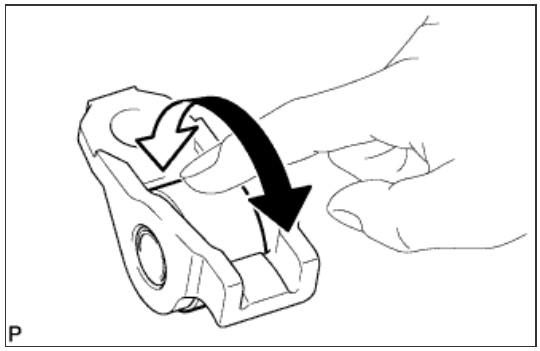
If the diameter is less than the minimum, replace the cylinder head bolt.

HINT:

If a visual check reveals no excessively thin areas, check the center of the bolt (see illustration) and find the area that has the smallest diameter.

2. INSPECT NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Turn the roller by hand to check that it turns smoothly.
If the roller does not turn smoothly, replace the valve rocker arm.



3. INSPECT VALVE LASH ADJUSTER ASSEMBLY

NOTICE:

- **Keep the adjuster free from dirt and foreign objects.**
- **Use only clean engine oil.**

a. Place the lash adjuster into a container full of new engine oil.

b. Insert the tip of SST into the lash adjuster plunger and use the tip to press down on the check ball inside the plunger.

SST
09276-75010

c. Squeeze SST and the lash adjuster together to move the plunger up and down 5 to 6 times.

d. Check the movement of the plunger and bleed air.

OK:

Plunger moves up and down.

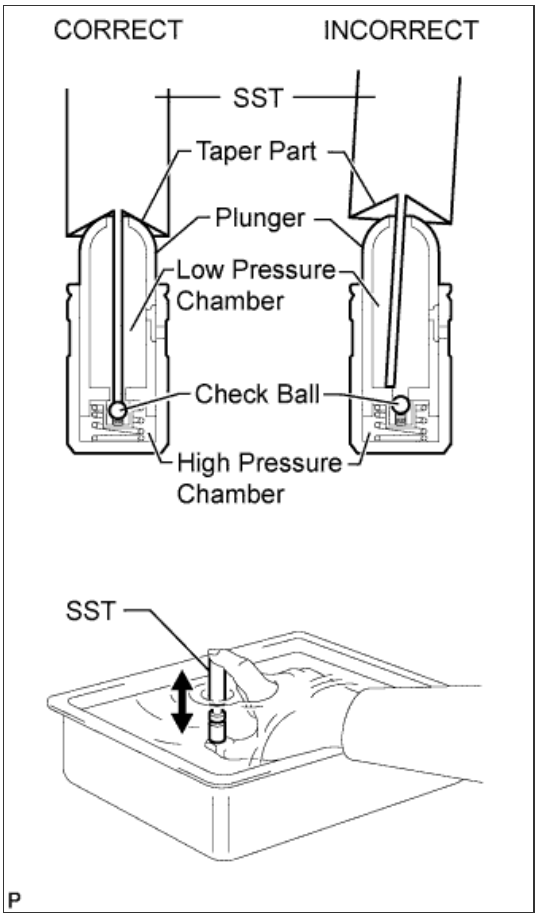
NOTICE:

When bleeding high-pressure air from the compression chamber, make sure that the tip of SST is actually pressing the check ball as shown in the illustration. If the check ball is not pressed, air will not bleed.

e. After bleeding the air, remove SST. Then try to quickly and firmly press the plunger with your fingers.

OK:
Plunger can be pressed 3 times.

If the plunger can still be compressed after pressing it 3 times, replace the valve lash adjuster with a new one.



4. INSPECT CAMSHAFT SUB-ASSEMBLY

a. Inspect the camshaft for runout.

i. Place the camshaft on V-blocks.

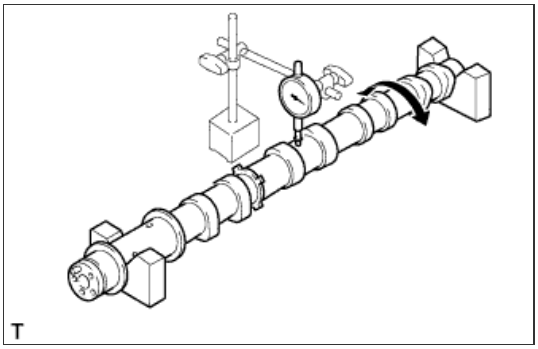
ii. Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:
0.04 mm (0.00157 in.)

If the circle runout is more than the maximum, replace the camshaft sub-assembly.

HINT:

Check the oil clearance after replacing the camshaft.



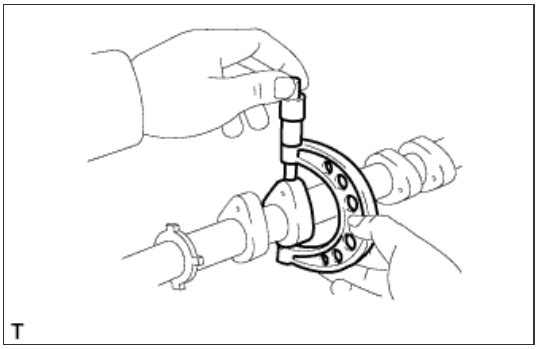
b. Using a micrometer, measure the cam lobe height.

Standard Cam Lobe Height:

Item	Specified Condition
Intake	44.291 to 44.441 mm (1.744 to 1.750 in.)
Exhaust	44.196 to 44.346 mm (1.740 to 1.746 in.)

Minimum Cam Lobe Height:

Item	Specified Condition
Intake	44.241 mm (1.742 in.)
Exhaust	44.146 mm (1.738 in.)



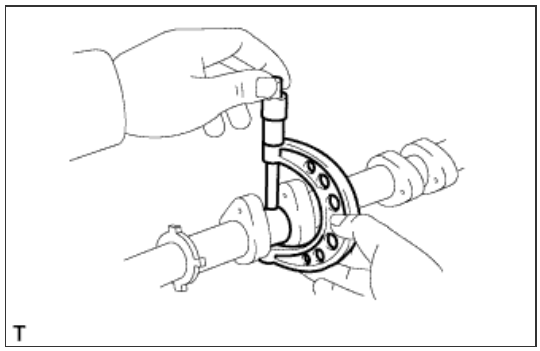
If the cam lobe height is less than the minimum, replace the camshaft sub-assembly.

c. Using a micrometer, measure the journal diameter.

Standard Journal Diameter:

Item	Specified Condition
No. 1 journal	29.956 to 29.970 mm (1.179 to 1.180 in.)
Other journals	25.959 to 25.975 mm (1.022 to 1.023 in.)

If the journal diameter is not as specified, check the oil clearance.



5. INSPECT CAMSHAFT OIL CLEARANCE

a. Clean the bearing caps, camshaft housing and camshaft journals.

b. Place the camshafts on the camshaft housing.

c. Lay a strip of Plastigage across each of the camshaft journals.

d. Install the camshaft bearing caps (Click here).

NOTICE:

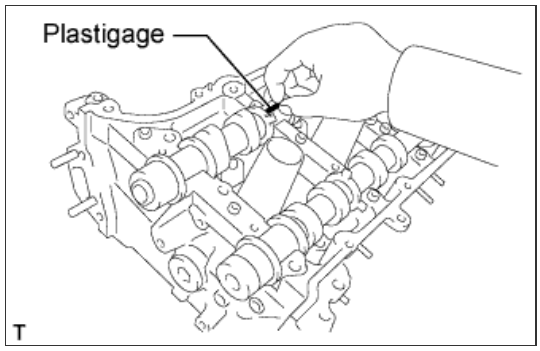
Do not turn the camshaft.

e. Install the camshaft housing (Click here).

NOTICE:

Do not turn the camshaft.

f. Remove the camshaft bearing caps (Click here).



g. Measure the Plastigage at its widest point.

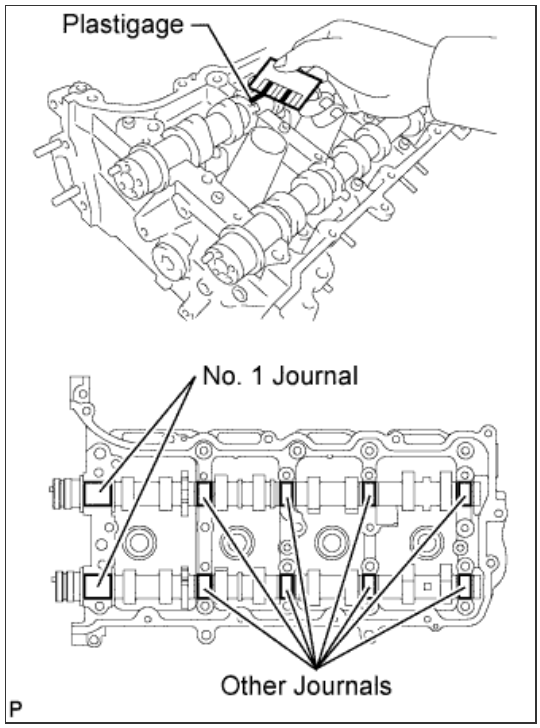
Standard Oil Clearance:

Item	Specified Condition
No. 1 journal	0.030 to 0.065 mm (0.00118 to 0.00256 in.)
Other journals	0.025 to 0.062 mm (0.000984 to 0.00244 in.)

Maximum Oil Clearance:

Item	Specified Condition
No. 1 journal	0.10 mm (0.00394 in.)
Other journals	0.09 mm (0.00354 in.)

If the oil clearance is more than the maximum, replace the camshaft. If necessary, replace the camshaft housing.



6. INSPECT CAMSHAFT TIMING GEAR

a. Install the camshaft bearing caps (Click here).

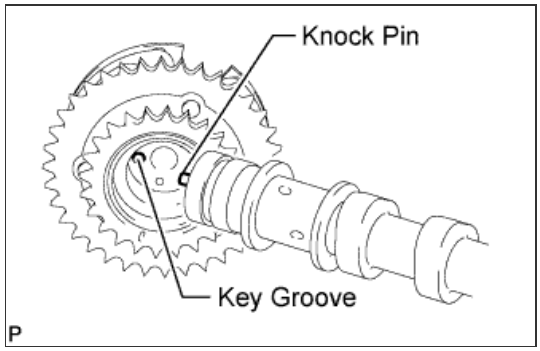
HINT:

Only install the intake camshaft.

b. Install the camshaft housing (Click here).

c. Apply a light coat of engine oil to the camshaft and camshaft timing gear.

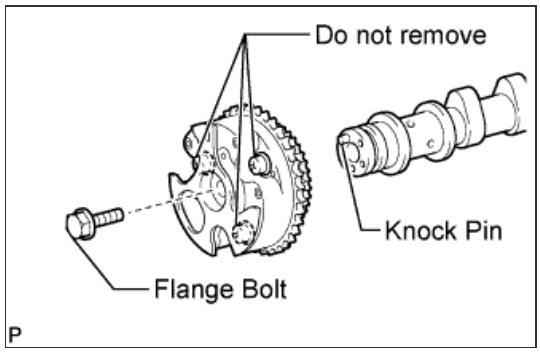
d. Using the hexagonal portion of the camshaft, align and attach the knock pin of the camshaft with the pin hole of the camshaft timing gear.



NOTICE:

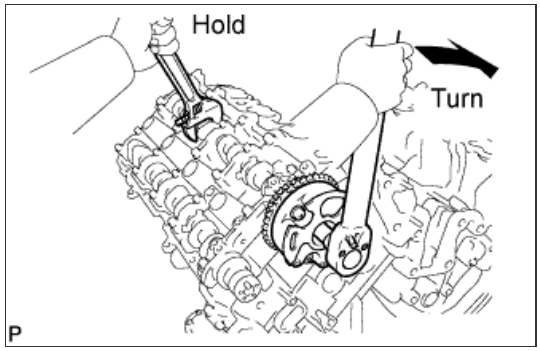
- **Do not forcefully push on the camshaft timing gear. This may cause the camshaft knock pin tip to damage the installation surface of the camshaft timing gear.**

- **Do not loosen or remove the 3 bolts shown in the illustration. If any of them are loosened or removed, the backlash of the gear in the timing tube will go out of adjustment. In this case, replace the camshaft timing gear assembly with a new one.**



e. Apply a light coat of engine oil to the threads and under the head of the bolt.

f. Using a wrench to hold the hexagonal portion of the camshaft, install the camshaft timing gear with the bolt.



Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

g. Remove the camshaft bearing caps (Click here).

h. Check the lock of the camshaft timing gear.

i. Make sure that the camshaft timing gear is locked.

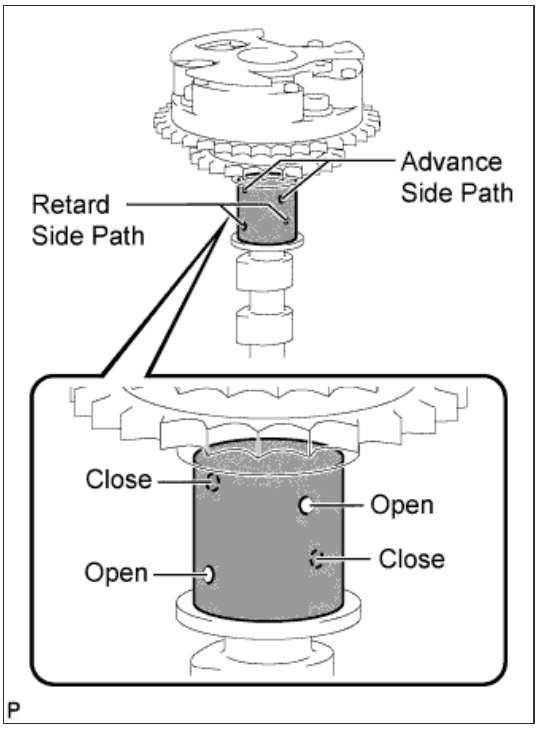
NOTICE:

Be careful not to damage the camshaft.

i. Release the lock pin.

i. Cover the 4 oil paths of the cam journal with vinyl tape as shown in the illustration.

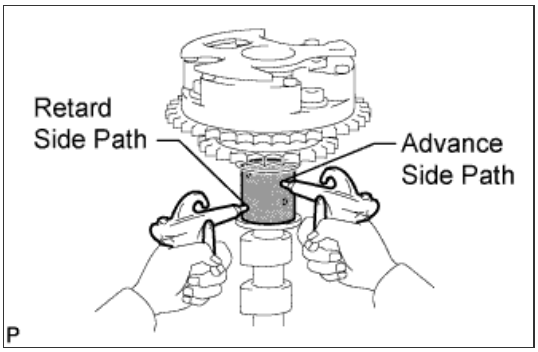
ii. Break through the tape of the advance side path and retard side path as shown in the illustration.



iii. Apply approximately 200 kPa (2.0 kgf/cm^2, 29 psi) of air pressure to the two broken paths.

NOTICE:

Cover the paths with a piece of cloth when applying pressure to keep oil from splashing.



iv. Check that the camshaft timing gear revolves in the advance direction when reducing the air pressure applied to the retard side path.

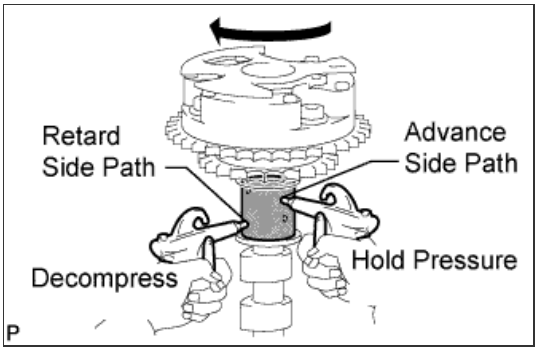
HINT:

This operation releases the lock pin for the most retarded position.

v. When the camshaft timing gear reaches the most advanced position, release the air pressure from the retard side path and advance side path, in that order.

NOTICE:

Do not release the air pressure from the advance side path first. The gear may abruptly shift in the retard direction and break the lock pin.



j. Check for smooth rotation.

i. Turn the camshaft timing gear within its movable range (21°) 2 or 3 times, but do not turn it to the most retarded position. Make sure that the gear turns smoothly.

NOTICE:

Do not use air pressure to perform the smooth rotation check.

k. Check the lock in the most retarded position.

i. Confirm that the camshaft timing gear is locked at the most retarded position.

l. Install the camshaft bearing caps (Click here).

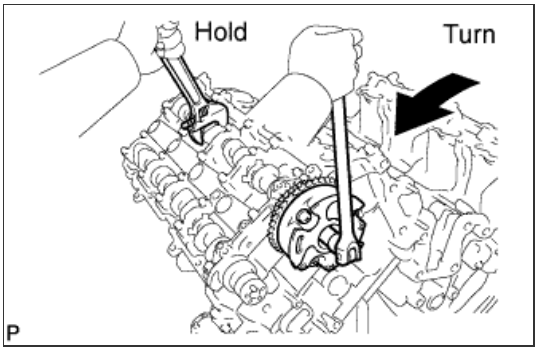
HINT:

Only install the intake camshaft.

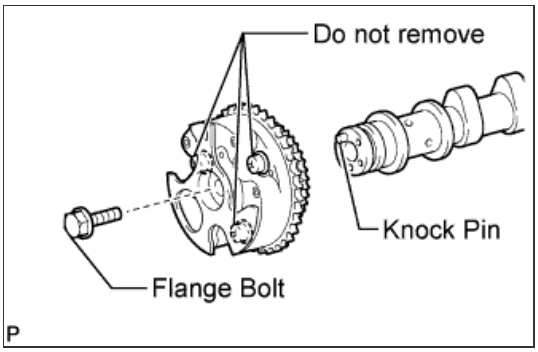
m. Install the camshaft housing (Click here).

n. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

o. Remove the camshaft bearing caps (Click here).



p. Remove the flange bolt and camshaft timing gear.



7. INSPECT CAMSHAFT TIMING EXHAUST GEAR

a. Install the camshaft bearing caps (Click here).

HINT:

Only install the exhaust camshaft.

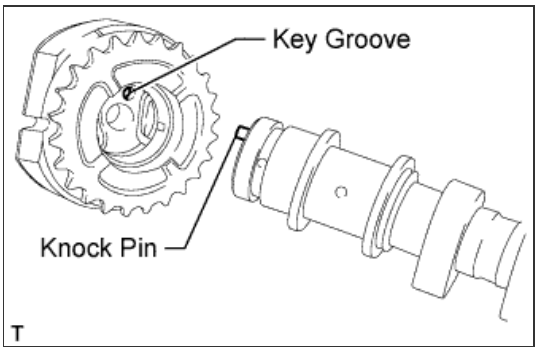
b. Install the camshaft housing (Click here).

c. Apply a light coat of engine oil to the camshaft and camshaft timing exhaust gear.

d. Using the hexagonal portion of the camshaft, align and attach the knock pin of the camshaft with the pin hole of the camshaft timing exhaust gear.

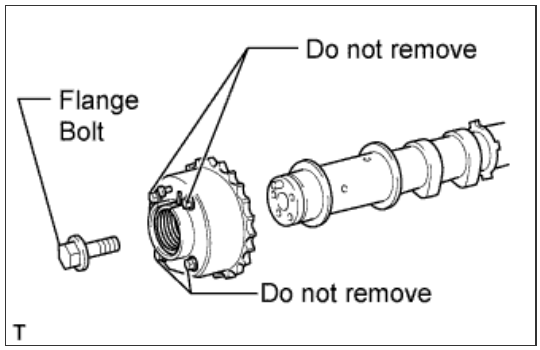
NOTICE:

- **Do not forcefully push on the camshaft timing exhaust gear. This may cause the camshaft knock pin tip to damage the installation surface of the camshaft timing exhaust gear.**



- **Do not loosen or remove the 4 bolts shown in the illustration. If any of them are loosened or removed, the backlash of the gear in the timing tube will go out of adjustment. In this case, replace the camshaft timing exhaust gear assembly with a new one.**

e. Apply a light coat of engine oil to the threads and under the head of the bolt.

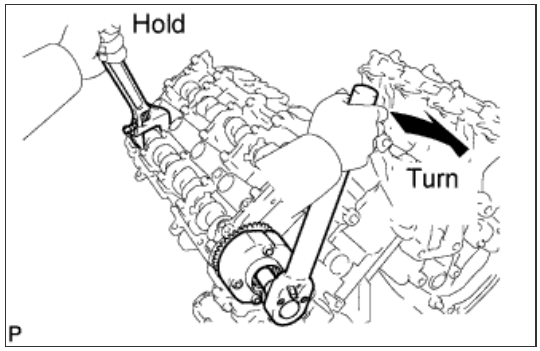


f. Using a wrench to hold the hexagonal portion of the camshaft, install the camshaft timing exhaust gear with the bolt.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

g. Remove the camshaft bearing caps (Click here).

h. Check the camshaft timing exhaust gear lock.

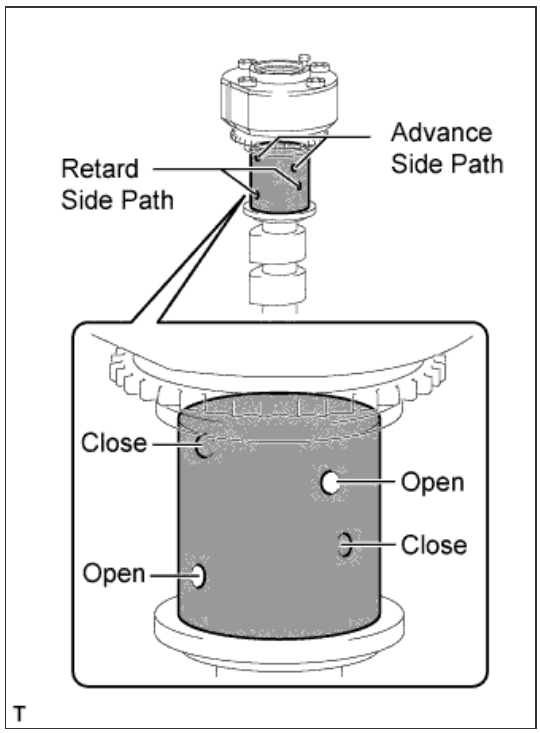


i. Make sure that the camshaft timing exhaust gear is locked.

i. Release the lock pin.

i. Cover the 4 oil paths of the cam journal with vinyl tape as shown in the illustration.

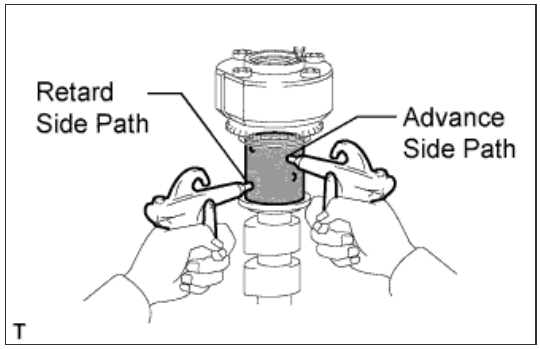
ii. Break through the tape of the advance side path and retard side path as shown in the illustration.



iii. Apply approximately 200 kPa (2.0 kgf/cm^2, 29 psi) of air pressure to the two broken paths (the advance side path and the retard side path).

NOTICE:

Cover the paths with a piece of cloth when applying pressure to keep oil from splashing.

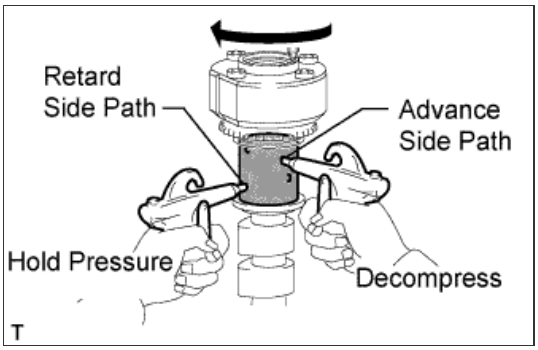


iv. Check that the camshaft timing exhaust gear turns in the retard direction when reducing the air pressure applied to the advance side

path.

HINT:

The lock pin is released and the camshaft timing exhaust gear turns in the retard direction.



v. When the camshaft timing exhaust gear moves to the most retarded position, release the air pressure from the advance side path, and then release the air pressure from the retard side path.

NOTICE:

Be sure to release the air pressure from the advance side path first. If the air pressure of the retard side path is released first, the camshaft timing exhaust gear may abruptly shift in the advance direction and break the lock pin or other parts.

j. Check for smooth rotation.

i. Turn the camshaft timing exhaust gear within its movable range (18.5°) 2 or 3 times, but do not turn it to the most advanced position. Make sure that the gear turns smoothly.

NOTICE:

When the air pressure is released from the advance side path and then from the retard side path, the gear automatically returns to the most advanced position due to the advance assist spring operation, and locks. Gradually release the air pressure from the retard side path before performing the smooth rotation check.

k. Check the lock at the most advanced position.

i. Make sure that the camshaft timing exhaust gear is locked at the most advanced position.

l. Install the camshaft bearing caps (Click here).

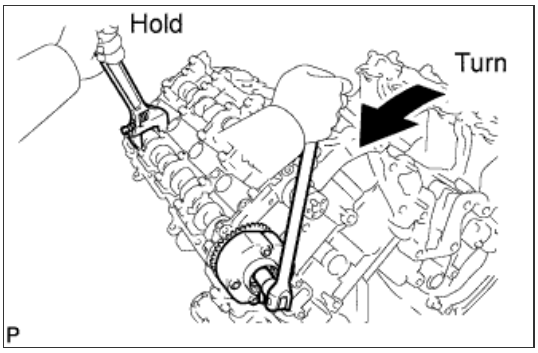
HINT:

Only install the exhaust camshaft.

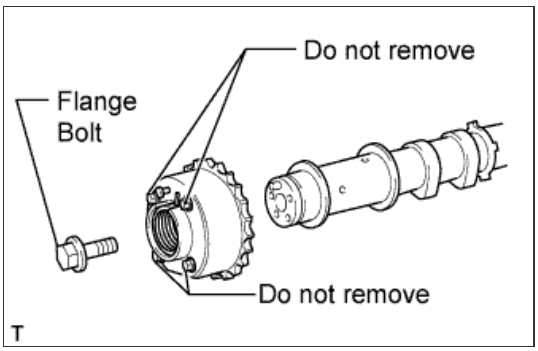
m. Install the camshaft housing (Click here).

n. Hold the hexagonal portion of the camshaft with a wrench and loosen the bolt.

o. Remove the camshaft bearing caps (Click here).



p. Remove the flange bolt and camshaft timing exhaust gear.



8. INSPECT NO. 1 CHAIN SUB-ASSEMBLY

a. Using a spring scale, pull the chain with a force of 147 N (15 kgf, 33.0 lbf) as

shown in the illustration.

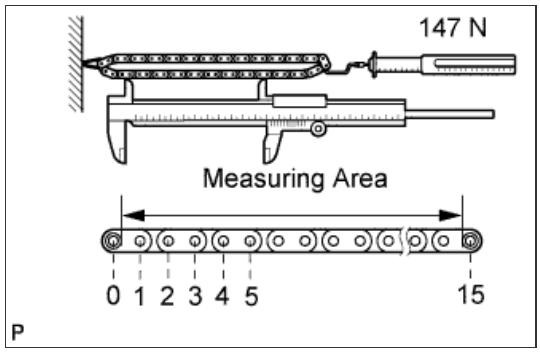
b. Using a vernier caliper, measure the length of 15 pins.

Maximum chain elongation:
136.9 mm (5.39 in.)

HINT:

Perform the measurement at 3 random places.

If the elongation is more than the maximum, replace the No. 1 chain.



9. INSPECT NO. 2 CHAIN SUB-ASSEMBLY

a. Using a spring scale, pull the chain with a force of 147 N (15 kgf, 33.0 lbf) as shown in the illustration.

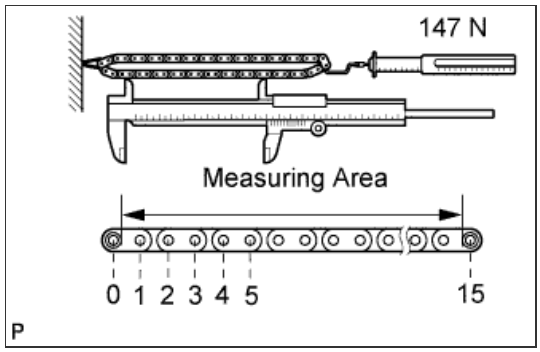
b. Using a vernier caliper, measure the length of 15 pins.

Maximum chain elongation:
137.6 mm (5.42 in.)

HINT:

Perform the measurement at 3 random places.

If the elongation is more than the maximum, replace the No. 2 chain.



10. INSPECT CRANKSHAFT TIMING SPROCKET RH

a. Wrap the chain around the sprocket.

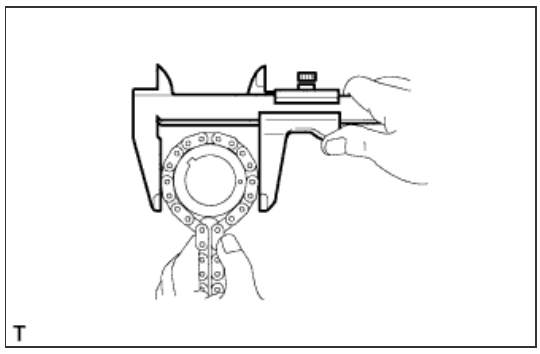
b. Using a vernier caliper, measure the sprocket diameter with the chain.

Minimum sprocket diameter (with chain):
61.4 mm (2.42 in.)

If the diameter is less than the minimum, replace the chain and crankshaft timing sprocket RH.

HINT:

The vernier caliper must contact the chain rollers for the measurement.



11. INSPECT CRANKSHAFT TIMING SPROCKET LH

a. Wrap the chain around the sprocket.

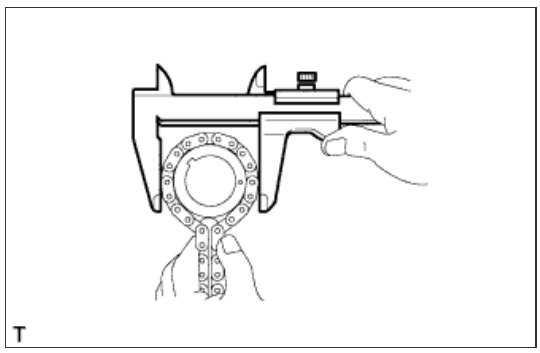
b. Using a vernier caliper, measure the sprocket diameter with the chain.

Minimum sprocket diameter (with chain):
61.4 mm (2.42 in.)

If the diameter is less than the minimum, replace the chain and crankshaft timing sprocket LH.

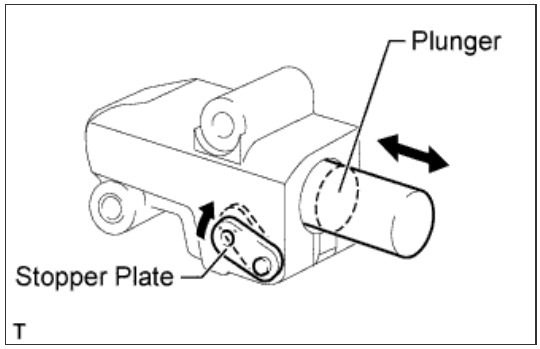
HINT:

The vernier caliper must contact the chain rollers for the measurement.



12. INSPECT NO. 1 CHAIN TENSIONER ASSEMBLY

a. Move the stopper plate clockwise to release the lock. Push the plunger and check that it moves smoothly.
If necessary, replace the No. 1 chain tensioner.



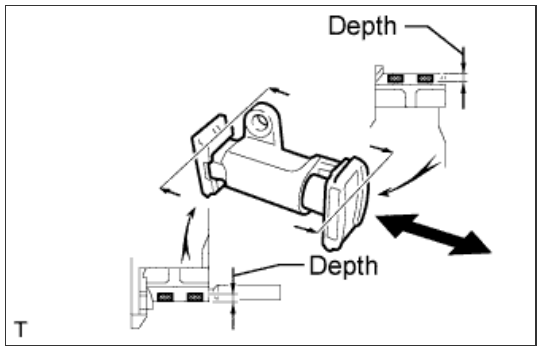
13. INSPECT NO. 2 CHAIN TENSIONER ASSEMBLY

a. Check that the plunger moves smoothly.

b. Measure the worn depth of the chain tensioner.

Maximum depth:
0.9 mm (0.0354 in.)

If the depth is more than the maximum, replace the No. 2 chain tensioner.



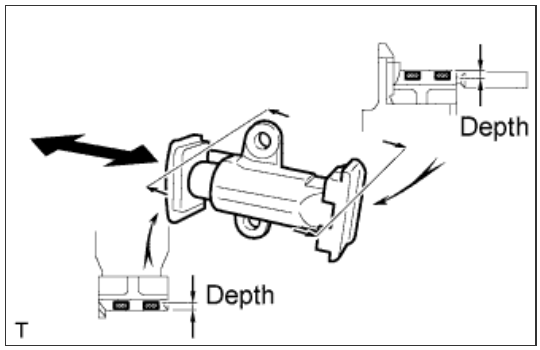
14. INSPECT NO. 3 CHAIN TENSIONER ASSEMBLY

a. Check that the plunger moves smoothly.

b. Measure the worn depth of the chain tensioner.

Maximum depth:
0.9 mm (0.0354 in.)

If the depth is more than the maximum, replace the No. 3 chain tensioner.



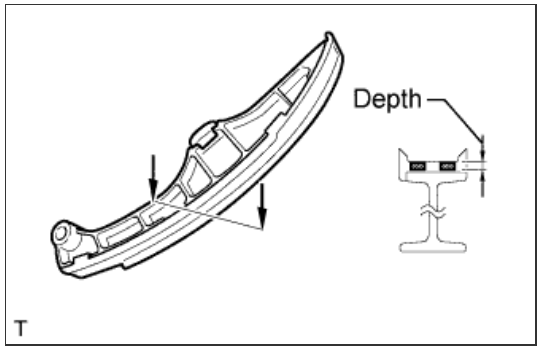
15. INSPECT NO. 1 CHAIN TENSIONER SLIPPER

a. for LH:

i. Measure the worn depth of the chain tensioner slipper.

Maximum depth:
1.0 mm (0.0394 in.)

If the depth is more than the maximum, replace the No. 1 chain tensioner slipper.

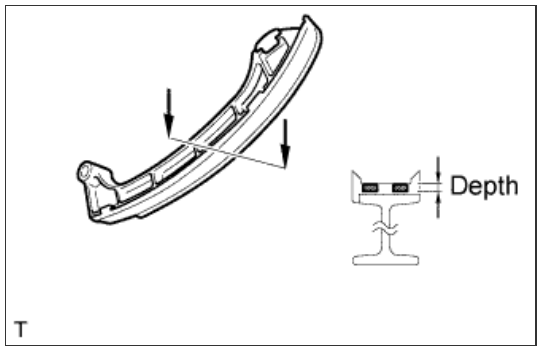


b. for RH:

i. Measure the worn depth of the chain tensioner slipper.

Maximum depth:
1.0 mm (0.0394 in.)

If the depth is more than the maximum, replace the No. 1 chain tensioner slipper.



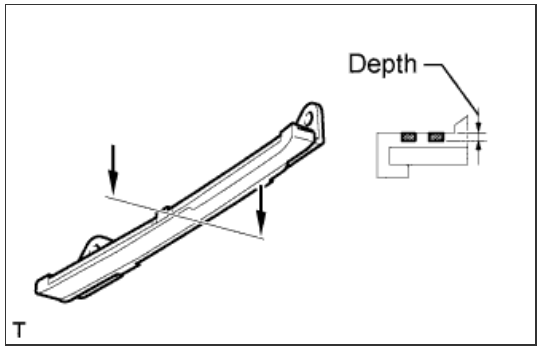
16. INSPECT NO. 1 CHAIN VIBRATION DAMPER

a. for LH:

i. Measure the worn depth of the chain vibration damper.

Maximum depth:
1.0 mm (0.0394 in.)

If the depth is more than the maximum, replace the No. 1 chain vibration damper.

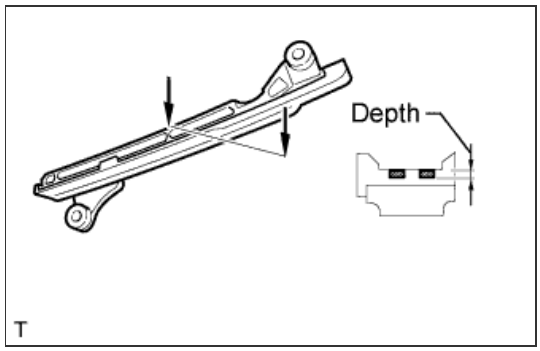


b. for RH:

i. Measure the worn depth of the chain vibration damper.

Maximum depth:
1.0 mm (0.0394 in.)

If the depth is more than the maximum, replace the No. 1 chain vibration damper.

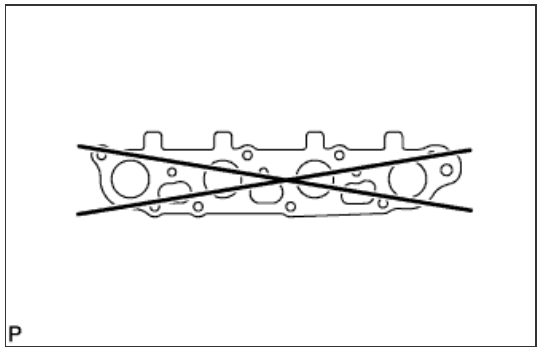


17. INSPECT EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Using a precision straightedge and feeler gauge, measure the warpage of the surface where the exhaust manifold LH contacts the cylinder head.

Maximum warpage:
0.7 mm (0.0276 in.)

If the warpage is more than the maximum, replace the exhaust manifold LH.



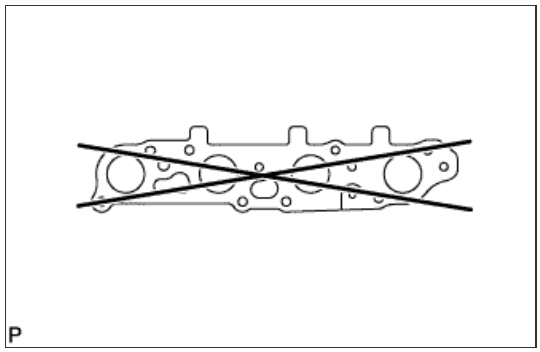
18. INSPECT EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Using a precision straightedge and feeler gauge, measure the warpage of the surface where the exhaust manifold RH contacts the cylinder head.

Maximum warpage:

0.7 mm (0.0276 in.)

If the warpage is more than the maximum, replace the exhaust manifold RH.



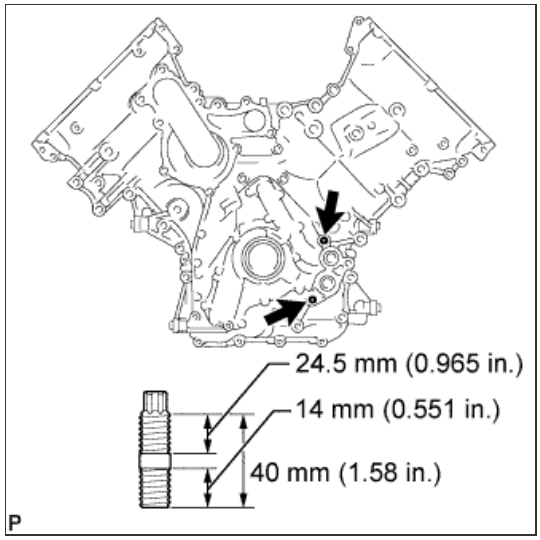
for Preparation Click here

1. INSTALL STUD BOLT

a. Install the timing chain cover stud bolt.

i. Using an E10 "TORX" socket wrench, install the 2 stud bolts as shown in the illustration.

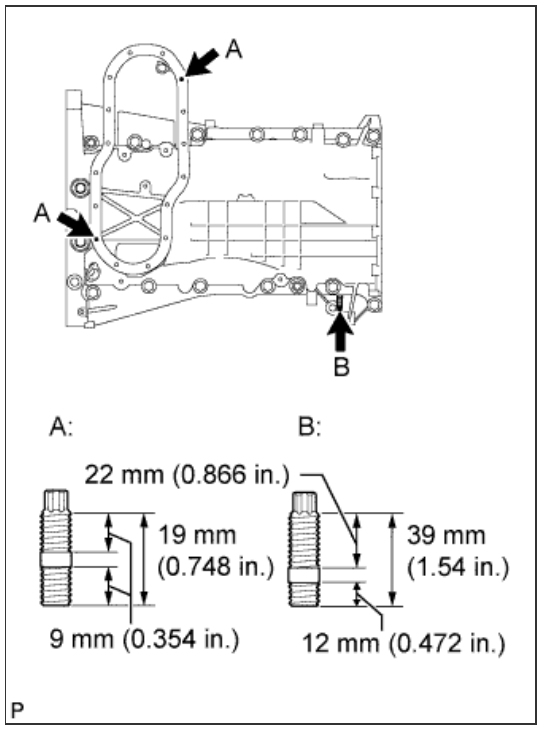
Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }



b. Install the oil pan stud bolt.

i. Using an E6 and E7 "TORX" socket wrench, install the 3 stud bolts as shown in the illustration.

Torque:
for stud bolt A:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }
for stud bolt B:
9.0 N*m{ 92 kgf*cm , 80 in.*lbf }

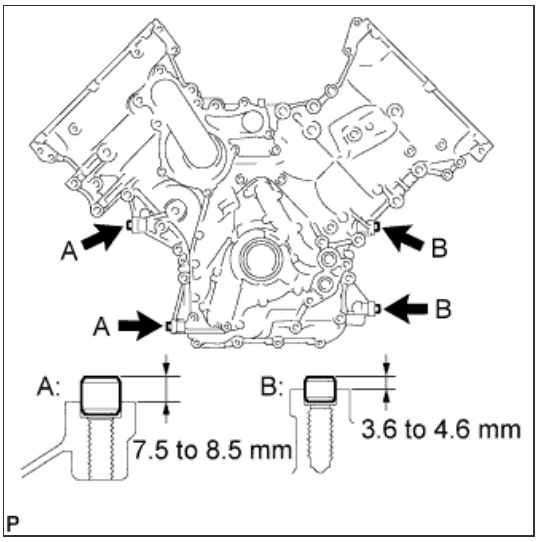


2. INSTALL RING PIN

a. Using a plastic-faced hammer, tap in new ring pins to the timing chain cover.

Standard Protrusion:

Item	Ring Pin Diameter	Specified Condition
Ring pin A	13 mm (0.512 in.)	7.5 to 8.5 mm (0.295 to 0.335 in.)
Ring pin B	11 mm (0.433 in.)	3.6 to 4.6 mm (0.142 to 0.181 in.)



3. INSTALL REAR CRANKSHAFT OIL SEAL

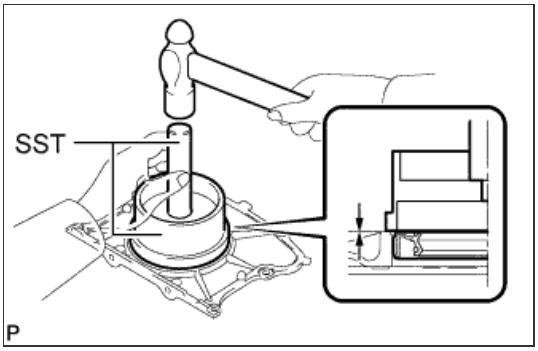
a. Using SST, tap in a new oil seal until its surface is flush with the oil seal retainer edge.

SST
09223-15030
09950-70010 (09951-07100)

Standard depth:
0 to 1.0 mm (0 to 0.0394 in.)

NOTICE:

- **Keep the lip free from foreign matter.**
- **Do not tap on the oil seal at an angle.**



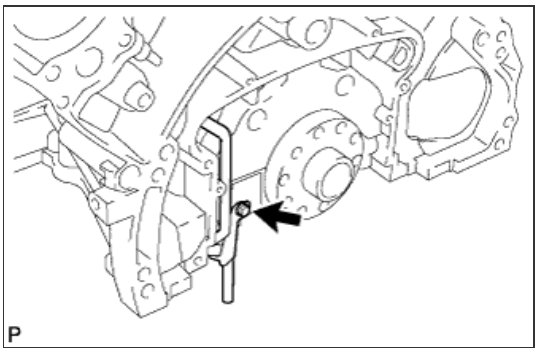
4. INSTALL OIL DRAIN PIPE SUB-ASSEMBLY

a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the drain pipe.

c. Install the oil drain pipe with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



5. INSTALL ENGINE REAR OIL SEAL RETAINER

a. Apply seal packing in a continuous line as shown in the illustration.

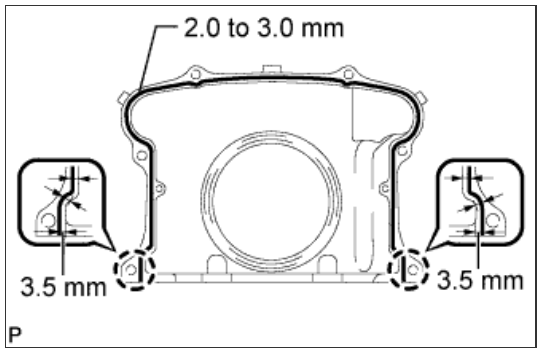
Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
2.0 to 3.0 mm (0.0787 to 0.118 in.)

Application position from inside edge of retainer:
3.5 mm (0.138 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the oil seal retainer within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

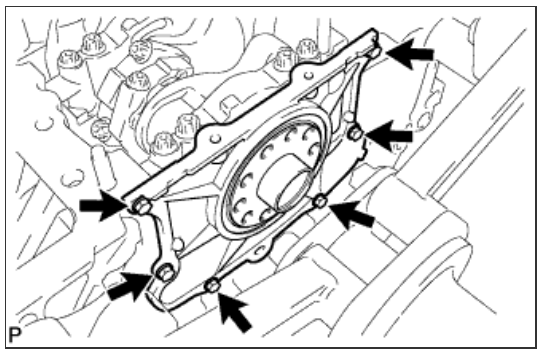


b. Install the oil seal retainer with the 6 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after installing.**
- **When installing the oil seal retainer, make sure the lip of the oil seal is not damaged.**
- **When installing the oil seal retainer, make sure the lip of the oil seal is not folded incorrectly.**



6. INSTALL OIL STRAINER SUB-ASSEMBLY

a. Apply a light coat of engine oil to a new O-ring.

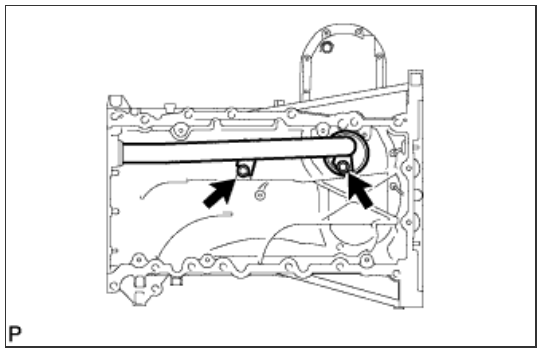
b. Install the O-ring to the oil strainer.

c. Install the oil strainer with the 2 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

NOTICE:

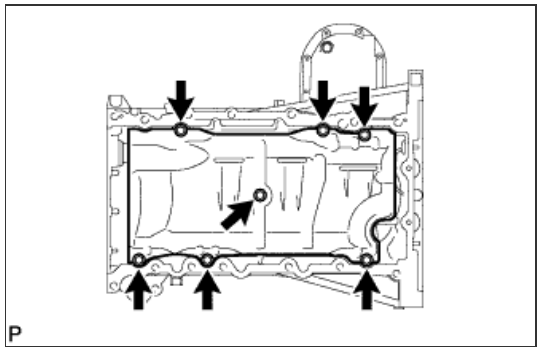
Make sure the O-ring is not twisted or damaged.



7. INSTALL NO. 1 OIL PAN BAFFLE PLATE

a. Install the baffle plate with the 7 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



8. INSTALL NO. 1 OIL PAN SUB-ASSEMBLY

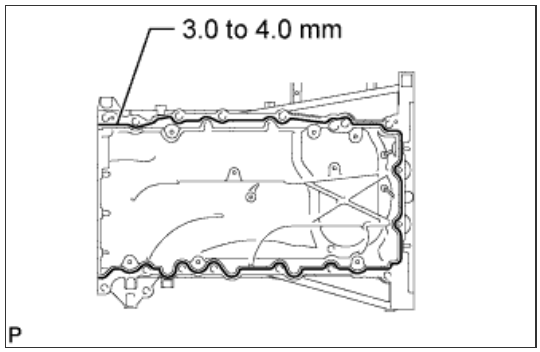
a. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.0 to 4.0 mm (0.118 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the oil pan within 3 minutes and tighten the bolts and nuts within 15 minutes after applying seal packing.**



b. Install the oil pan with the 14 bolts and 2 nuts.

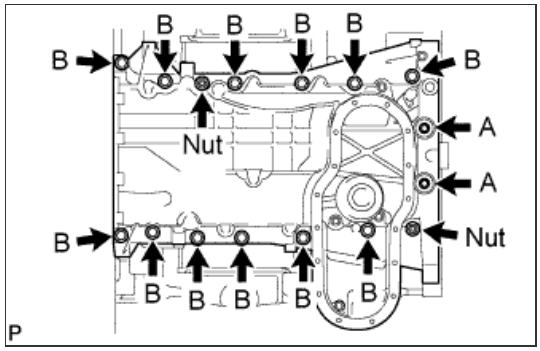
Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
for bolt B:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }
for nut:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

NOTICE:

Do not start the engine for at least 2 hours after installing.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	92 mm (3.62 in.)	6 mm (0.236 in.)
Bolt B	30 mm (1.18 in.)	10 mm (0.394 in.)



9. INSTALL NO. 2 OIL PAN SUB-ASSEMBLY

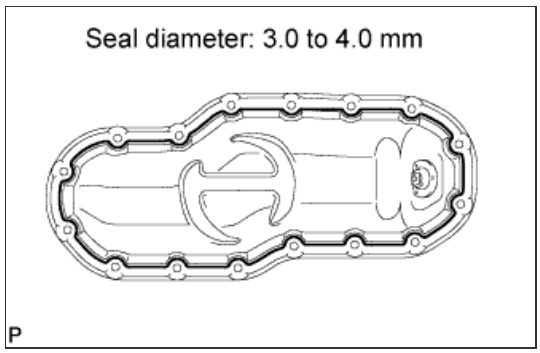
a. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.0 to 4.0 mm (0.118 to 0.156 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the oil pan within 3 minutes and tighten the bolts and nuts within 15 minutes after applying seal packing.**



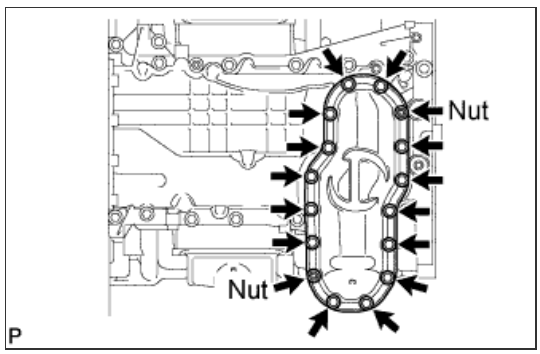
b. Install the oil pan with the 14 bolts and 2 nuts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

Do not start the engine for at least 2 hours after installing.

c. Install the engine oil level sensor (Click here).



10. INSTALL NO. 1 HEAT EXCHANGER COVER

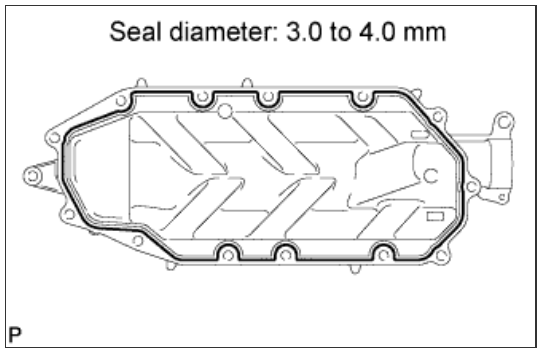
a. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing 1282B, Three Bond 1282B or equivalent

Standard seal diameter:
3.0 to 4.0 mm (0.118 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the heat exchanger cover within 3 minutes and tighten the bolts and nuts within 15 minutes after applying seal packing.**



b. Install the heat exchanger cover with the 12 bolts and 2 nuts.

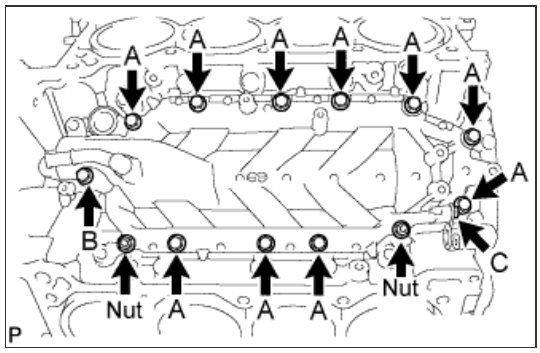
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

NOTICE:

Do not start the engine for at least 2 hours after installing.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	20 mm (0.787 in.)	8 mm (0.315 in.)
Bolt B	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt C	16 mm (0.630 in.)	6 mm (0.236 in.)



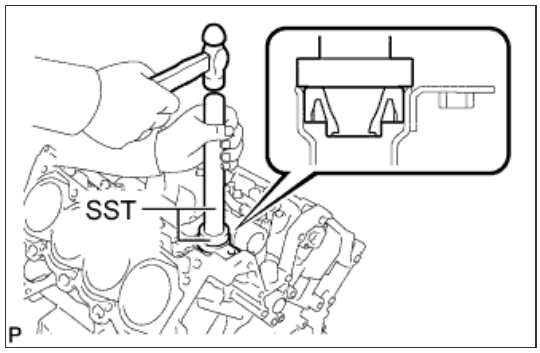
11. INSTALL VENTILATION PIPE GASKET

a. Using SST, evenly tap in a new ventilation pipe gasket until its surface is flush with the lip of the ventilation pipe.

SST
09950-60010 (09951-00360)
09950-70010 (09951-07100)

NOTICE:

- **Do not tap the gasket at an angle.**
- **Do not tap the gasket excessively.**

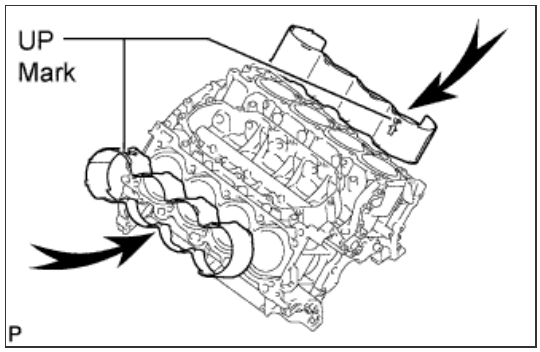


12. INSTALL CYLINDER BLOCK WATER JACKET SPACER

a. Install the 2 water jacket spacers as shown in the illustration.

HINT:

- **Face the cutouts indicated by the arrows in illustration away from the engine.**
- **Face the "UP" mark as shown in the illustration.**

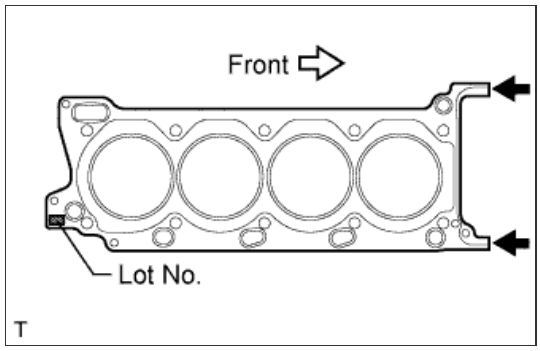


13. INSTALL CYLINDER HEAD SUB-ASSEMBLY RH

a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.



NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**

d. Place the cylinder head on the cylinder block.

HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

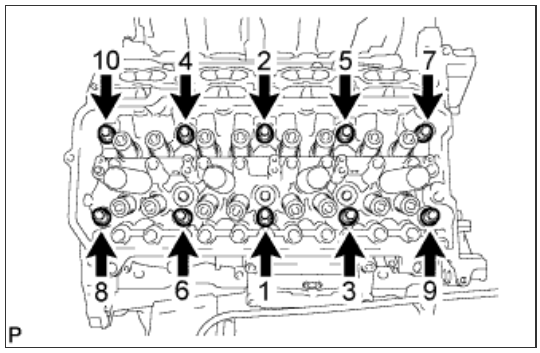
- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.

f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

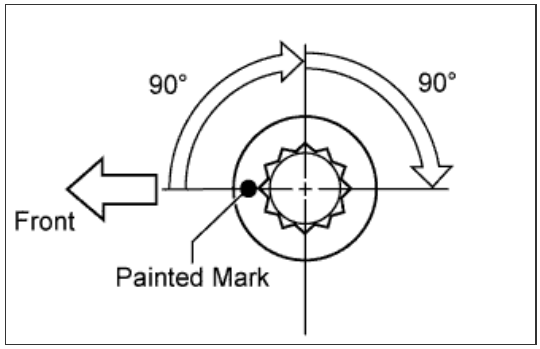
i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.

h. Step 3:

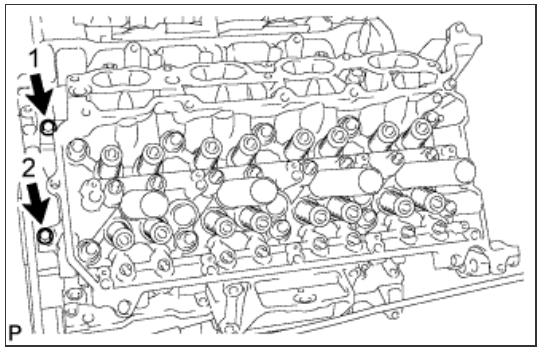
i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painting marks are now facing rearward.



i. Uniformly install the 2 bolts in the sequence shown in the illustration.

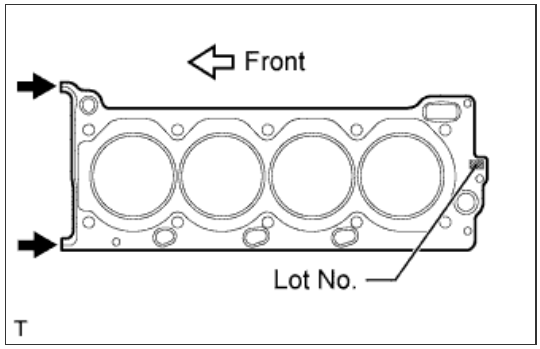
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.



NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**

d. Place the cylinder head on the cylinder block.

HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

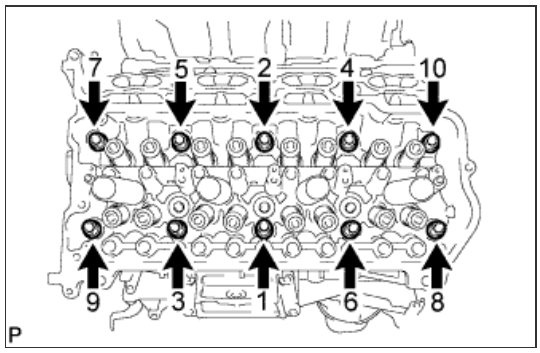
- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.

f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

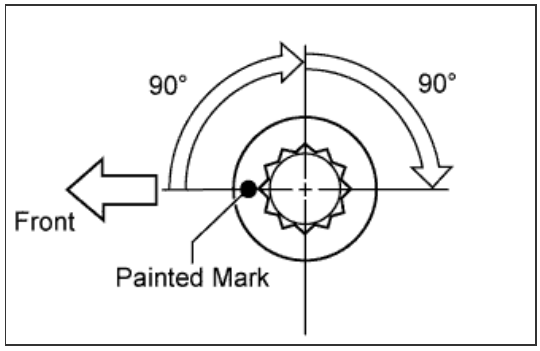
Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.



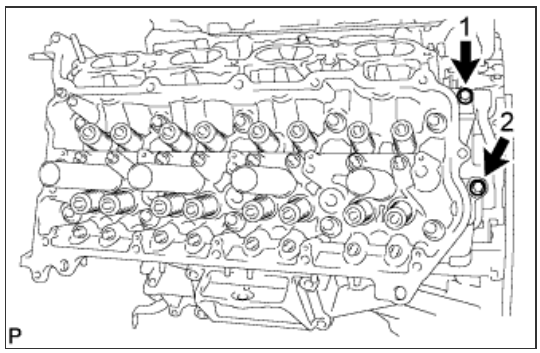
h. Step 3:

i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painted marks are now facing rearward.

i. Uniformly install the 2 bolts in the sequence shown in the illustration.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



15. INSTALL VALVE STEM CAP

a. Apply a light coat of engine oil to the valve stem caps.

b. Install the 32 valve stem caps to the cylinder heads.

16. INSTALL VALVE LASH ADJUSTER ASSEMBLY

a. Inspect the valve lash adjuster before installing it (Click here).

b. Install the 32 valve lash adjusters to the cylinder heads.

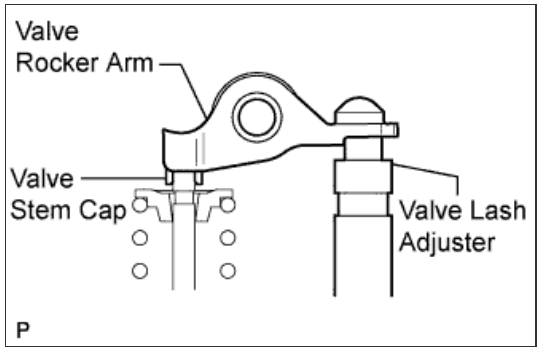
NOTICE:

Install the lash adjuster to the same place it was removed from.

17. INSTALL NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Apply engine oil to the lash adjuster tips and valve stem cap ends.

b. Install the 32 valve rocker arms as shown in the illustration.

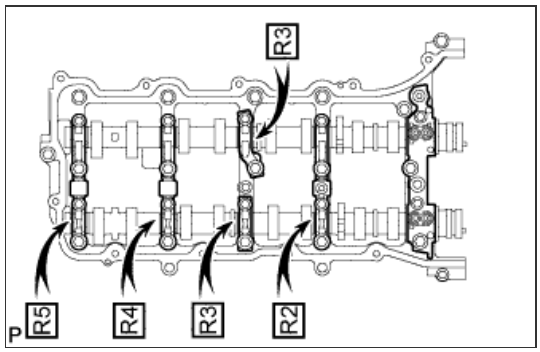


18. INSTALL CAMSHAFT BEARING CAP RH

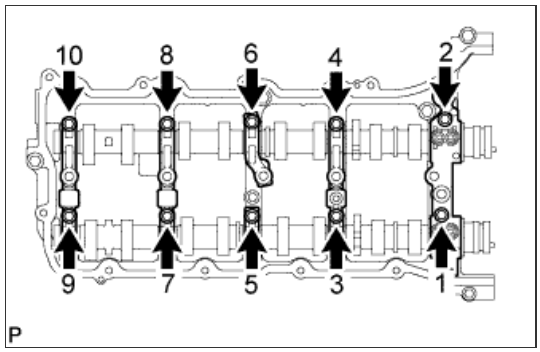
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 1 and No. 2 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

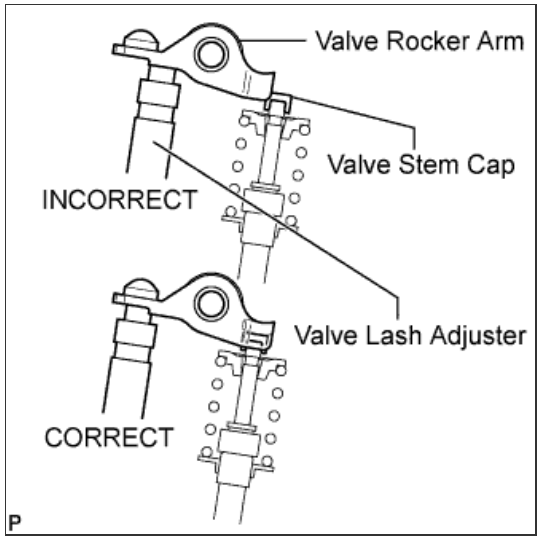


d. Temporarily install the 10 bolts in the order shown in the illustration.



19. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY RH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



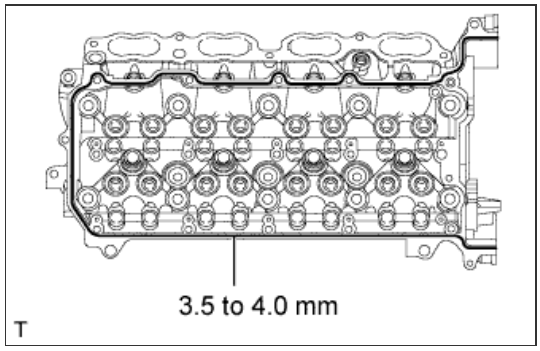
b. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

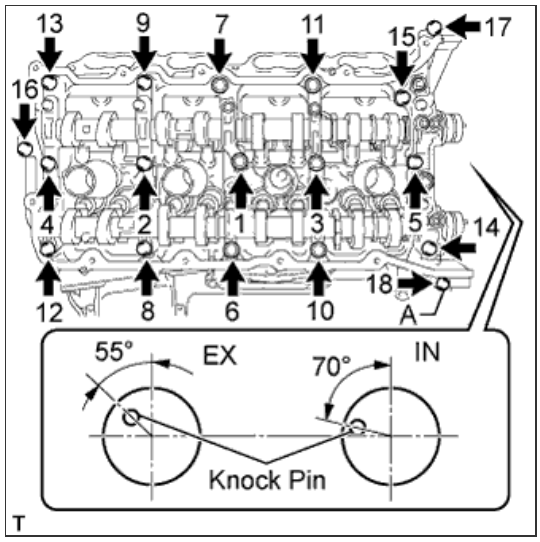


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

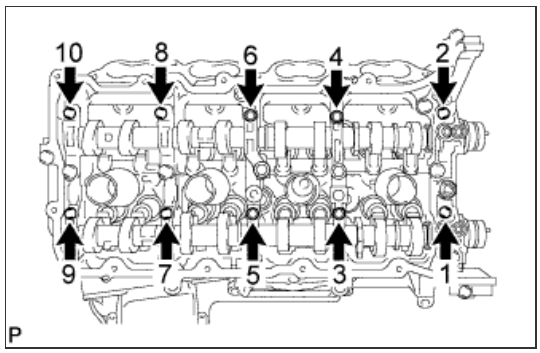


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

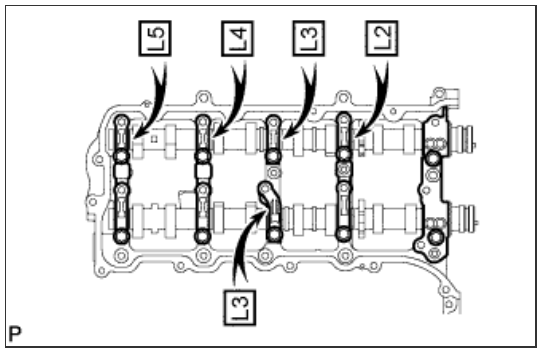


20. INSTALL CAMSHAFT BEARING CAP LH

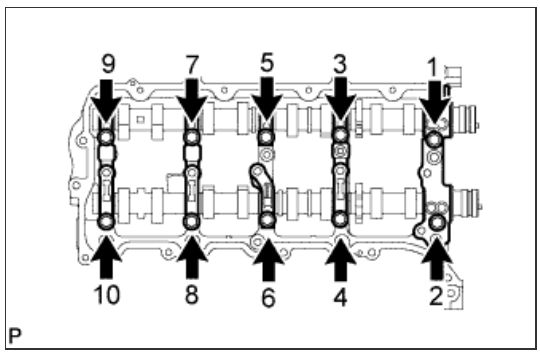
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 3 and No. 4 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

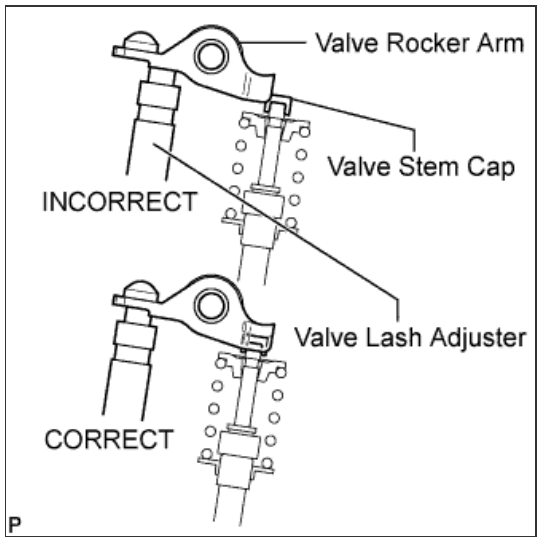


d. Temporarily install the 10 bolts in the order shown in the illustration.



21. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY LH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



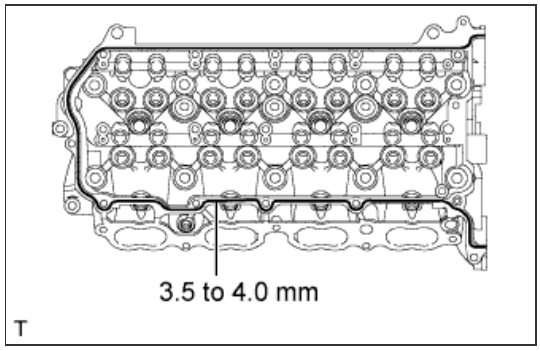
b. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

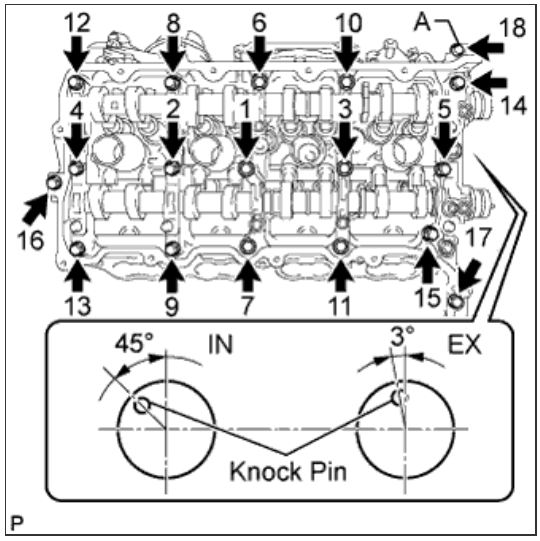


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

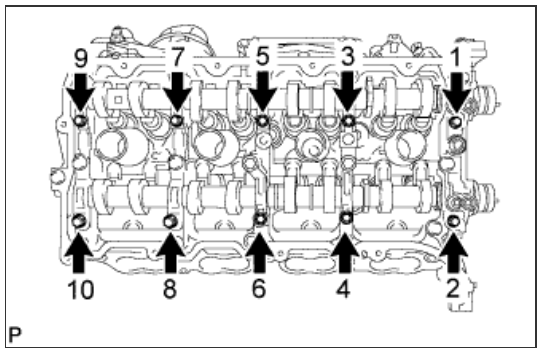


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

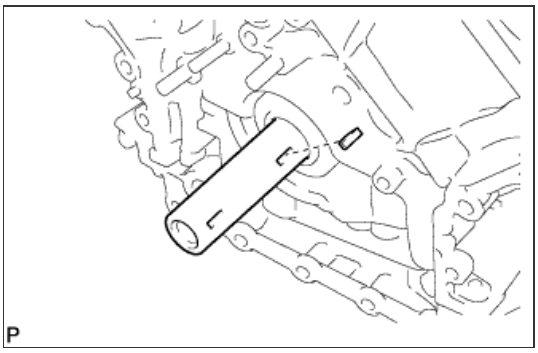


22. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the timing gear key.

HINT:

The other timing gear key will be installed at a later step.



23. SET NO. 1 CYLINDER TO TDC/COMPRESSION

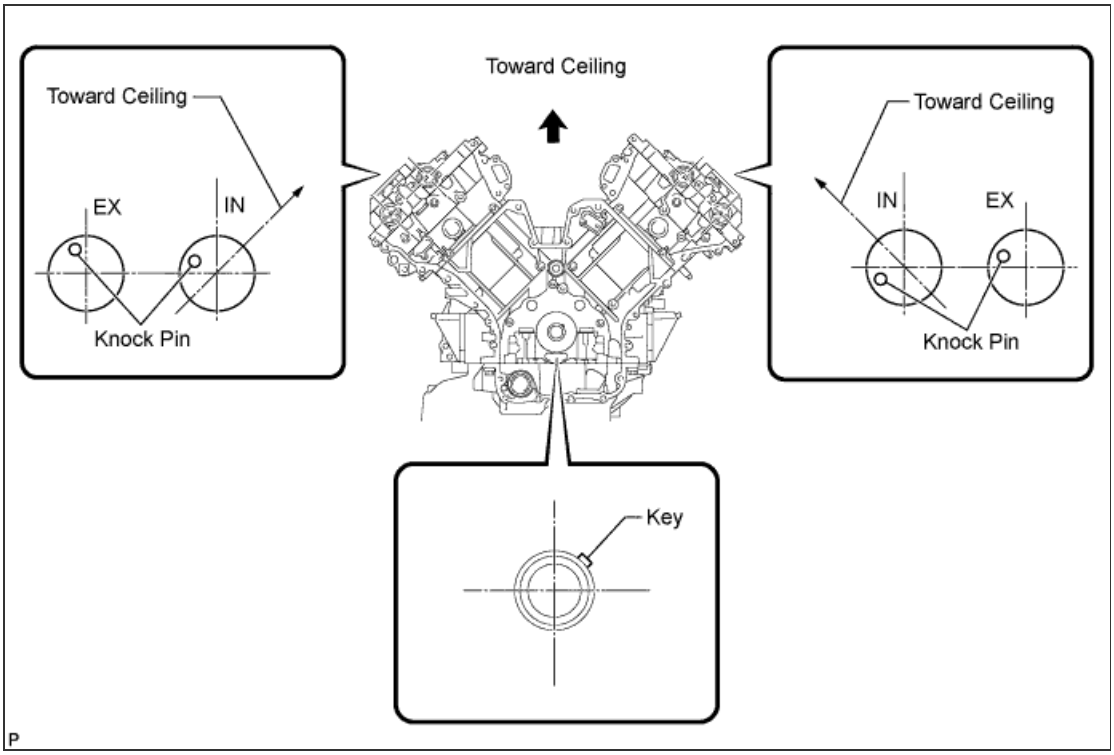
a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft so that the timing gear key is as shown in the illustration. Then using a wrench, rotate each camshaft so that the timing marks are as shown in the illustration.

NOTICE:

When the crankshaft or a camshaft is rotated excessively, the valves and pistons may interfere with each other.

c. Remove the crankshaft pulley bolt.



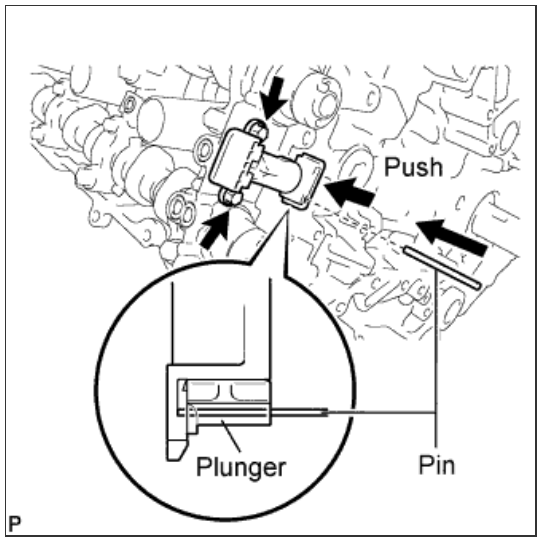
24. INSTALL NO. 2 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

Torque:

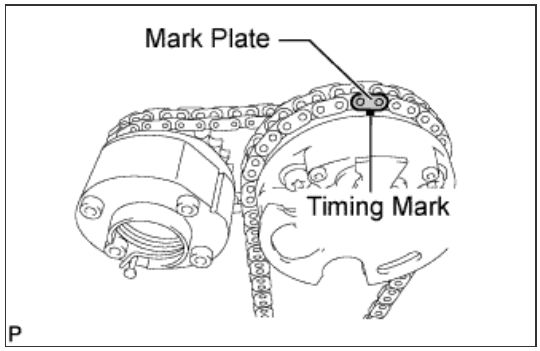
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While raising up the No. 2 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.

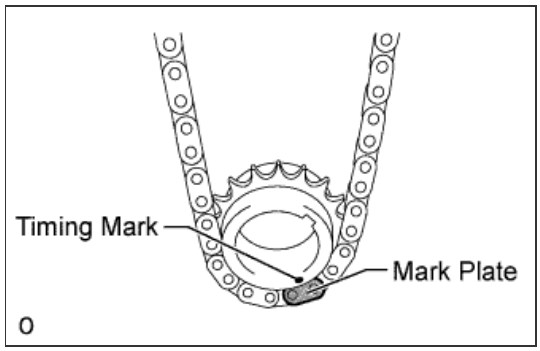


25. INSTALL NO. 1 CHAIN SUB-ASSEMBLY RH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



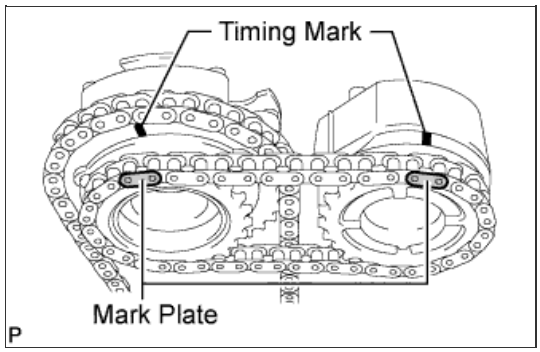
b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

HINT:

The crankshaft timing sprocket RH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.



d. Install the crankshaft timing sprocket RH to the crankshaft.

e. Align and attach the knock pin of the No. 1 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 2 camshaft, align and attach the knock pin of the No. 2 camshaft with the pin hole of the camshaft timing exhaust gear.

g. Remove the pin from the No. 2 chain tensioner.

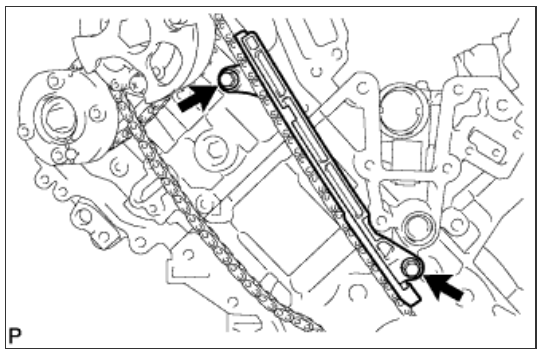
h. Using a wrench to hold the hexagonal portion of the No. 1 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, temporarily install the bolt.

26. INSTALL NO. 1 CHAIN VIBRATION DAMPER RH

a. Install the vibration damper with the 2 bolts.

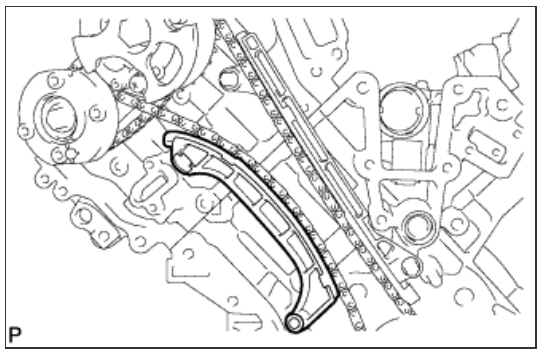
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



27. INSTALL NO. 1 CHAIN TENSIONER SLIPPER RH

HINT:

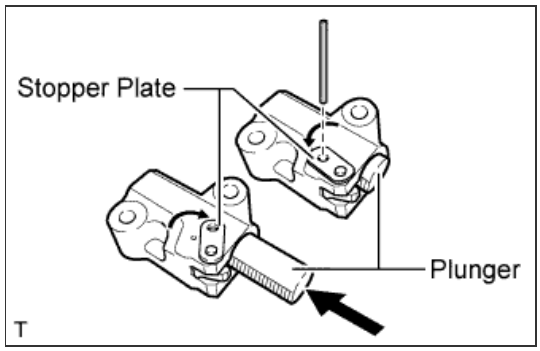
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and then install the chain tensioner slipper.



28. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY RH

a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

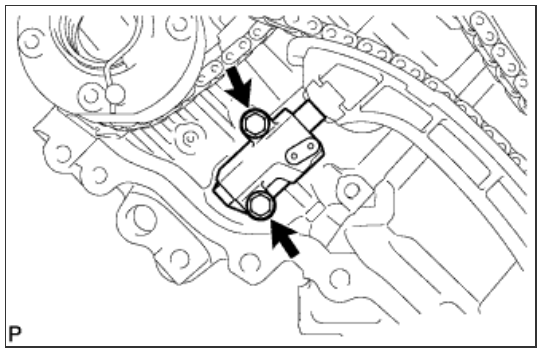
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Remove the hexagon wrench from the chain tensioner.

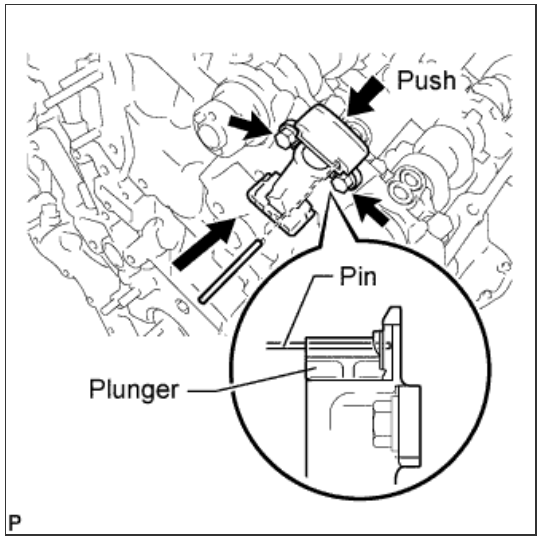


29. INSTALL NO. 3 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

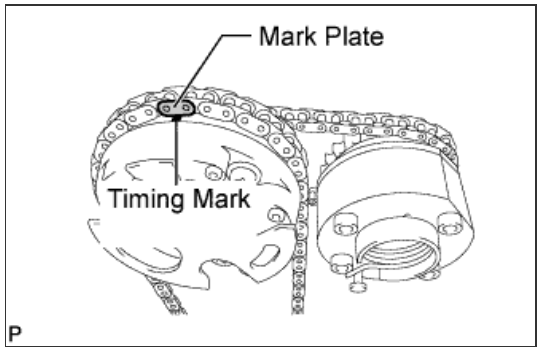
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While pushing down the No. 2 chain tensioner, insert a pin of φ1.0 mm (0.0394 in.) into the hole to fix it in place.

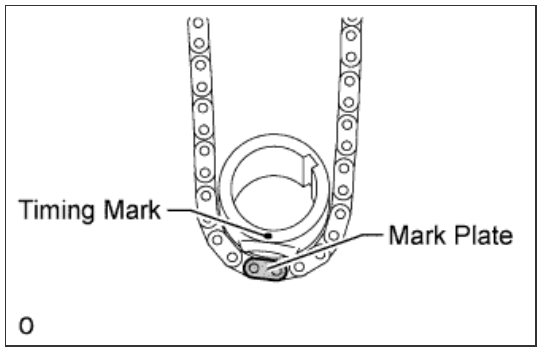


30. INSTALL NO. 1 CHAIN SUB-ASSEMBLY LH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

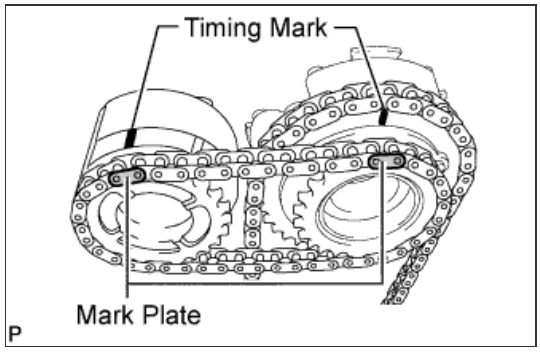
HINT:

The crankshaft timing sprocket LH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.

d. Install the crankshaft timing sprocket LH to the crankshaft.

e. Align and attach the knock pin of the No. 3 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 4 camshaft, align and attach the knock pin of the No. 4 camshaft with the pin hole of the camshaft timing exhaust gear.



NOTICE:

Because the timing mark positions of the gears may shift due to looseness of the No. 1 chain, use the hexagonal portion of the camshaft to hold the No. 3 camshaft in place until the No. 1 chain tensioner is installed.

g. Remove the pin from the No. 3 chain tensioner.

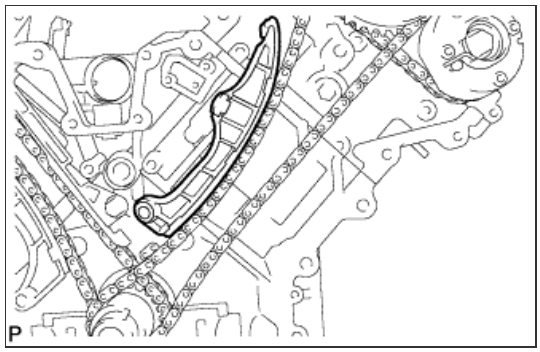
h. Using a wrench to hold the hexagonal portion of the No. 3 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, temporarily install the bolt.

31. INSTALL NO. 1 CHAIN TENSIONER SLIPPER LH

HINT:

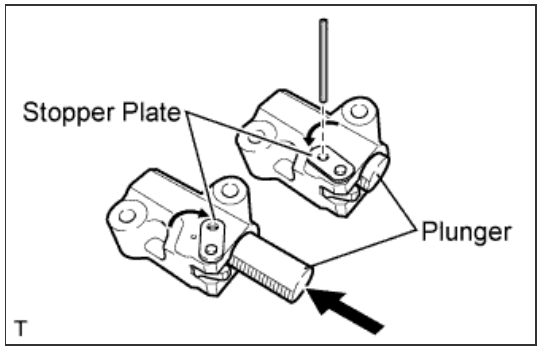
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and install the chain tensioner slipper.



32. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY LH

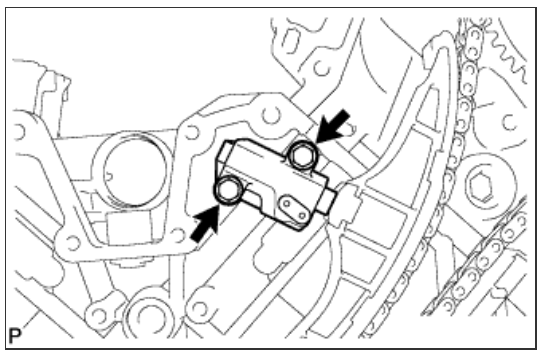
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install a new gasket and the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

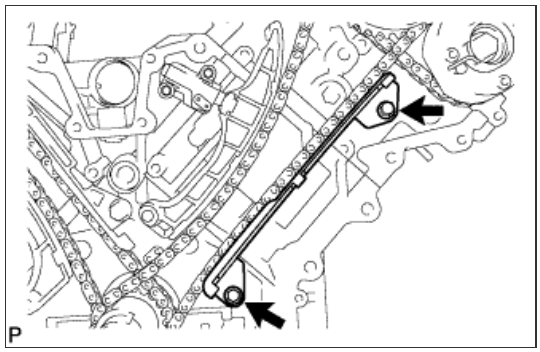


33. INSTALL NO. 1 CHAIN VIBRATION DAMPER LH

a. Install the vibration damper with the 2 bolts.

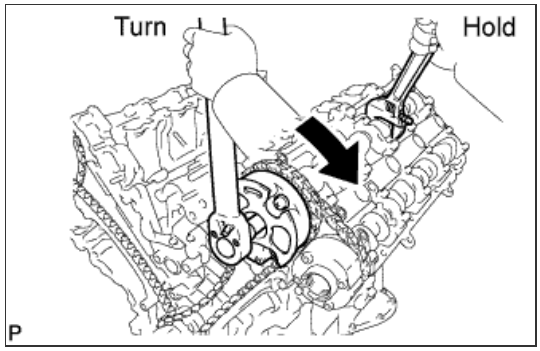
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Remove the hexagon wrench from the No. 1 chain tensioner.



34. TIGHTEN CAMSHAFT TIMING GEAR

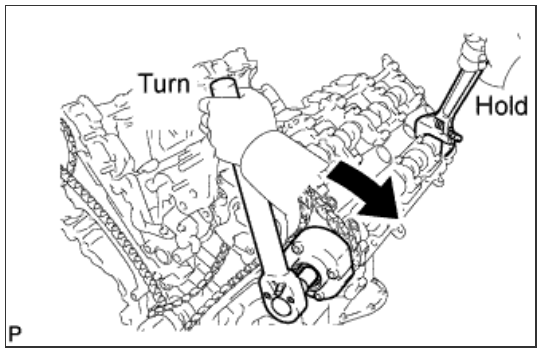
a. for Bank 1:



i. Using a wrench, hold the hexagonal portion of the No. 3 camshaft.

ii. Tighten the bolt of the camshaft timing gear.

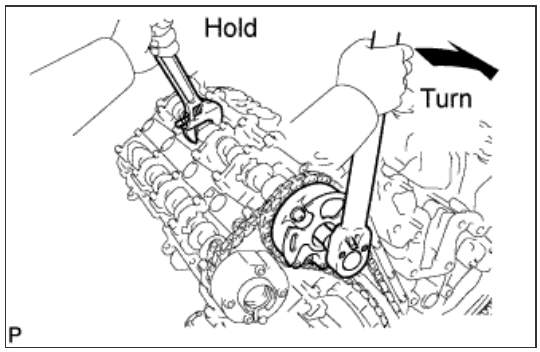
Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }



iii. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, tighten the bolt of the camshaft timing exhaust gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

b. for Bank 2:



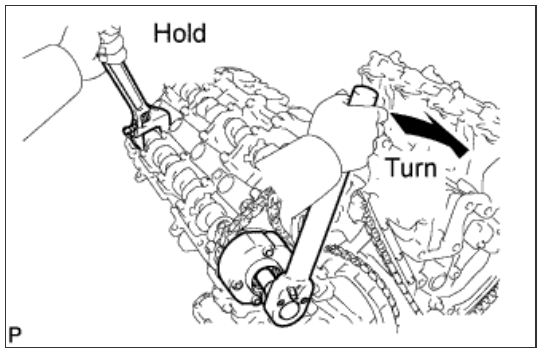
i. Using a wrench, hold the hexagonal portion of the No. 1 camshaft.

ii. Tighten the bolt of the camshaft timing gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

iii. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, tighten the bolt of the camshaft timing exhaust gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

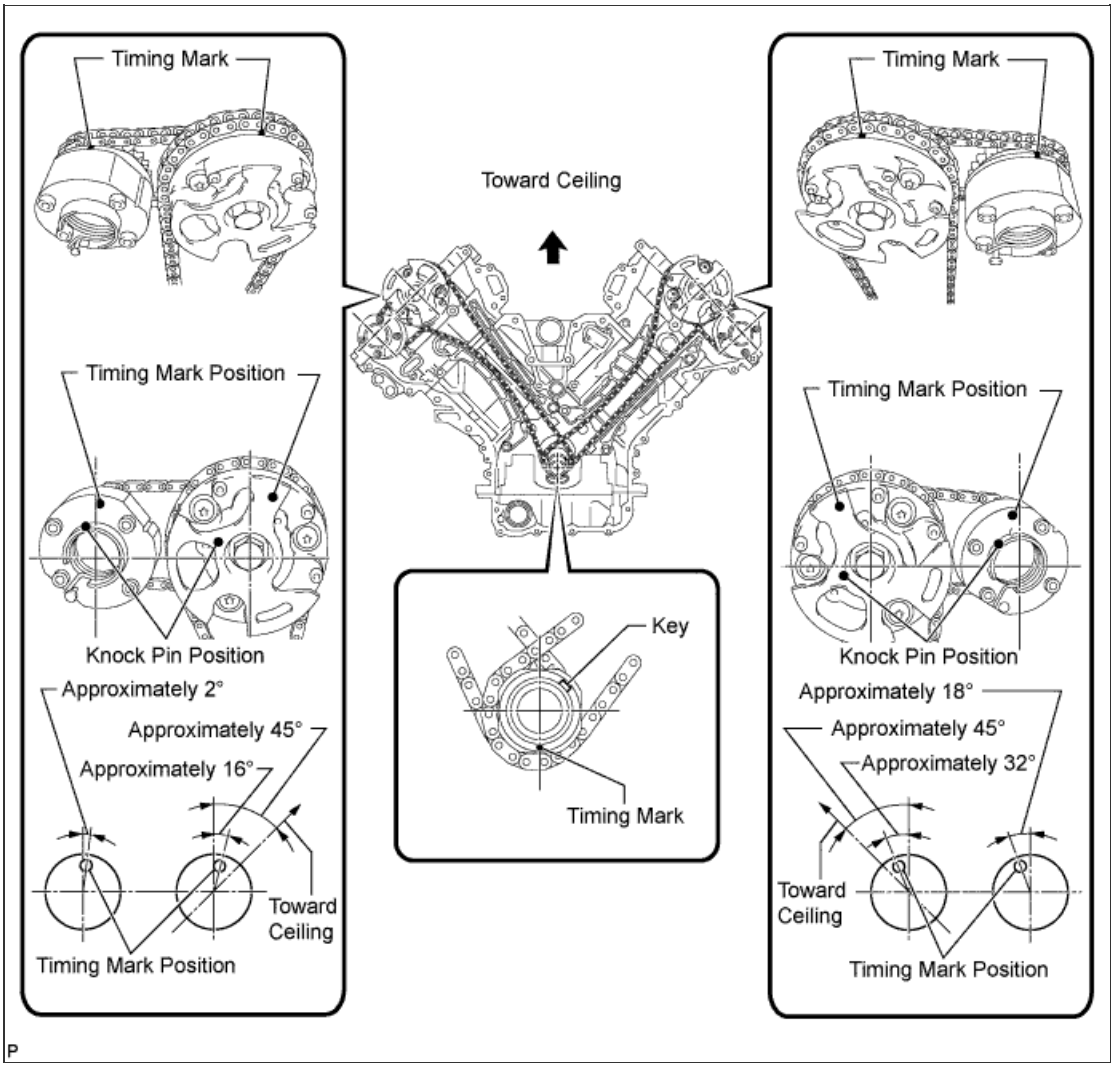


35. CHECK NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise, and check that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

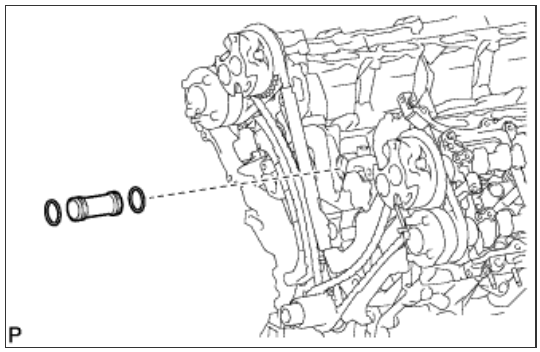
c. Remove the crankshaft pulley bolt.



36. INSTALL WATER INLET PIPE

a. Apply soapy water to 2 new O-rings and install them to the inlet pipe.

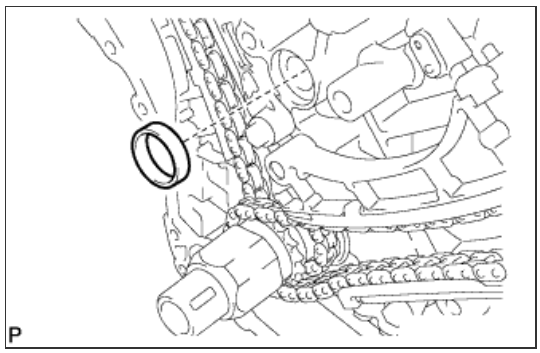
b. Install the inlet pipe to the No. 1 heat exchanger cover.



37. INSTALL TIMING CHAIN COVER SUB-ASSEMBLY

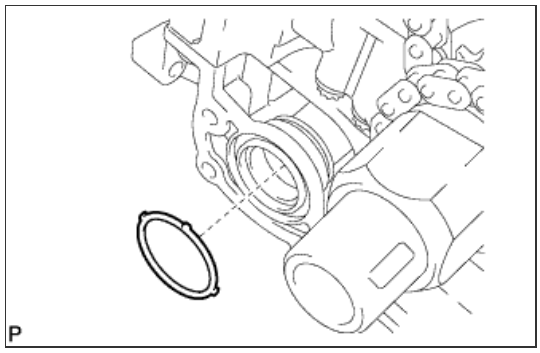
a. Apply a light coat of engine oil to a new oil pump gasket.

b. Install the oil pump gasket.

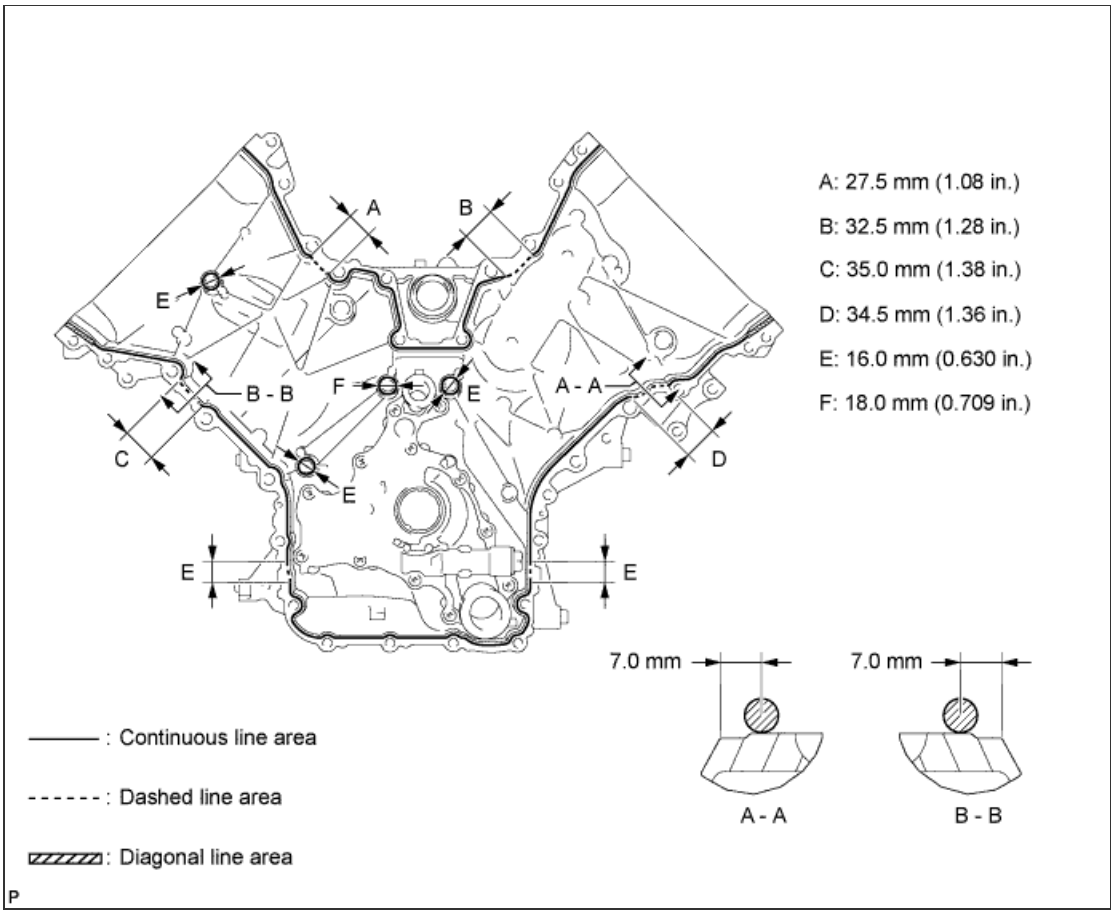


c. Apply a light coat of engine oil to a new O-ring.

d. Install the O-ring.



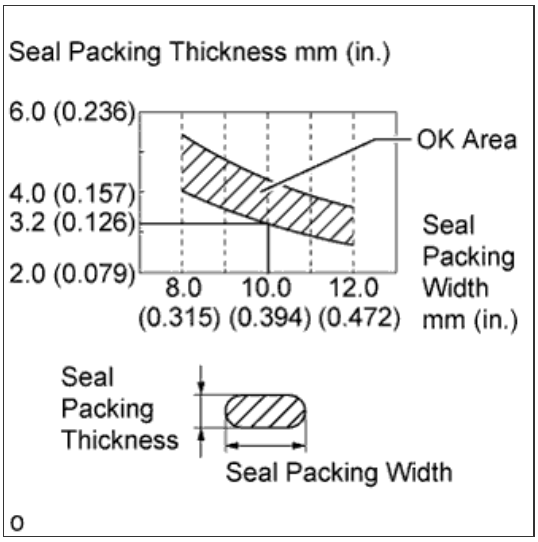
e. Apply seal packing in a continuous line to the timing chain cover as shown in the following illustration.



Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Apply seal packing as follows:

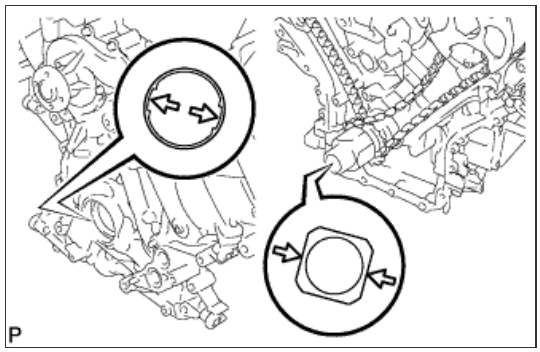
Area	Seal Packing Diameter	Application Position from Inside Edge of Cover
Continuous Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	2.5 mm (0.0984 in.)
Dashed Line Area	6.4 mm (0.252 in.) or more, or within OK area shown in illustration	7.0 mm (0.276 in.)
Diagonal Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	5.5 mm (0.217 in.)



NOTICE:

- **When the contact surfaces are wet, wipe them with an oil-free cloth before applying seal packing.**
- **Install the chain cover within 3 minutes and tighten the bolts within 10 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after installing.**

f. Align the oil pump drive rotor spline and crankshaft as shown in the illustration.
Install the spline and chain cover to the crankshaft.



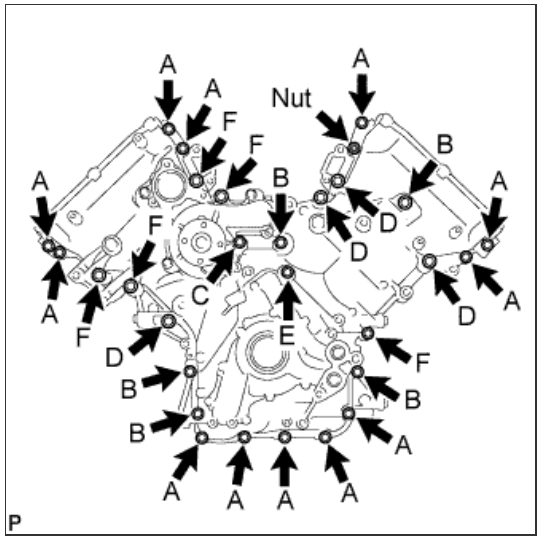
g. Temporarily install the timing chain cover with the 28 bolts and nut.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)

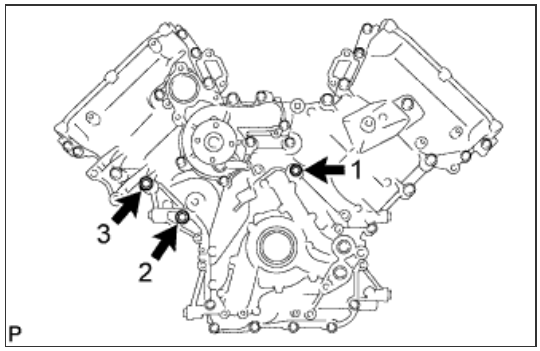
NOTICE:

Make sure that there is no oil on the bolt threads.



h. Tighten the 3 bolts in several steps in the sequence shown in the illustration.

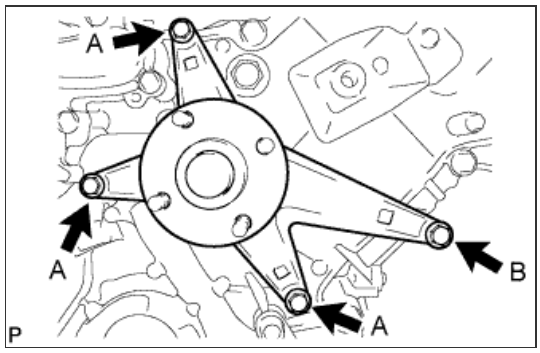
Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



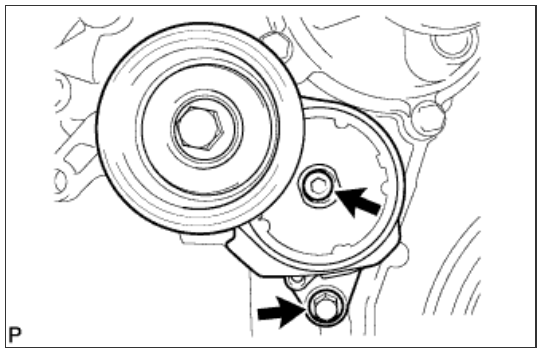
i. Temporarily install the fluid coupling bracket with the 4 bolts.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt B	80 mm (3.15 in.)	10 mm (0.394 in.)

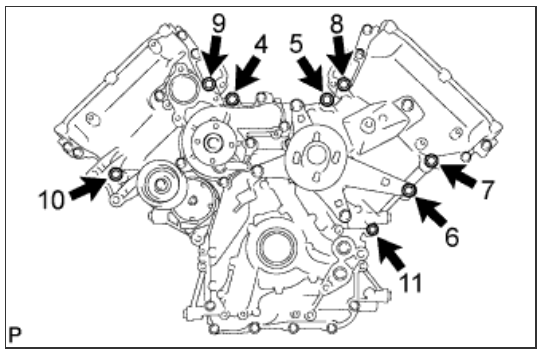


j. Temporarily install the belt tensioner with the standard bolt and 6 mm hexagon wrench bolt.



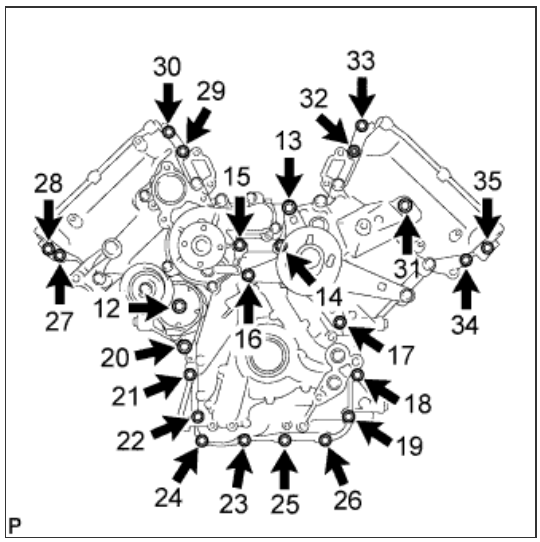
k. Tighten the 8 bolts labeled 4 to 11 in several steps in the sequence shown in the illustration.

Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



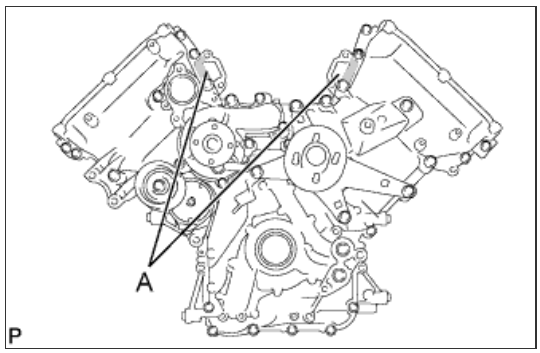
l. Tighten the 23 bolts and nut labeled 12 to 35 in several steps in the sequence shown in the illustration.

Torque:
23 N*m{ 235 kgf*cm , 17 ft.*lbf }



NOTICE:

After the installation, if the seal packing has seeped out at the areas labeled A shown in the illustration, wipe it off.



38. INSTALL WATER PUMP ASSEMBLY

a. Install a new gasket and the water pump with the 8 bolts shown in the illustration.

Torque:

for bolt A:

47 N*m{ 479 kgf*cm , 35 ft.*lbf }

for bolt B:

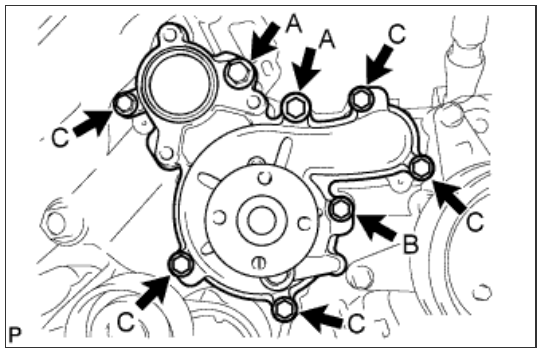
23 N*m{ 235 kgf*cm , 17 ft.*lbf }

for bolt C:

20 N*m{ 204 kgf*cm , 15 ft.*lbf }

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	80 mm (3.15 in.)	10 mm (0.394 in.)
Bolt B	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt C	25 mm (0.984 in.)	8 mm (0.315 in.)



39. INSTALL FRONT CRANKSHAFT OIL SEAL

a. Apply MP grease to the lip of a new oil seal.

b. Using SST and a hammer, tap in the oil seal to a depth between 0 and 1.0 mm (0 and 0.0394 in.) from the timing chain cover edge.

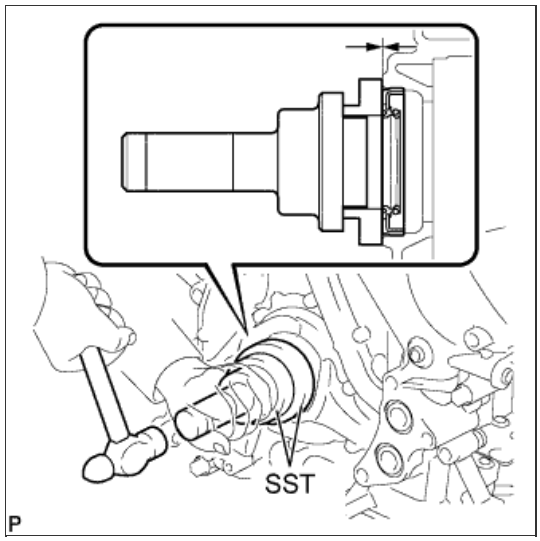
SST

09223-22010

09506-35010

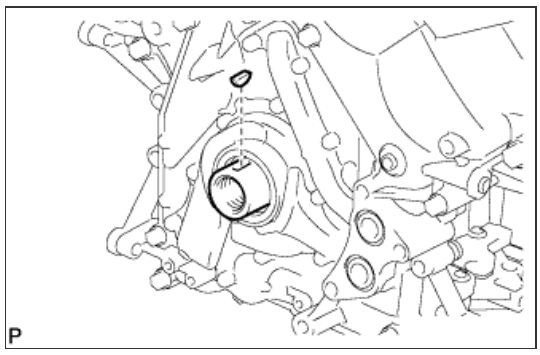
NOTICE:

- **Keep the lip free from foreign matter.**
- **Do not tap the oil seal at an angle.**



40. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the crankshaft timing gear key to the crankshaft.



41. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

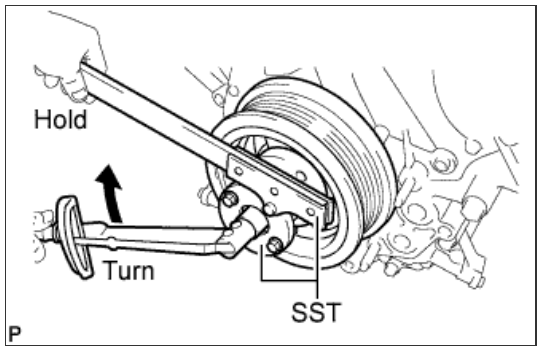
b. Using SST, install the pulley set bolt.

SST

09213-70011 (09213-70020)

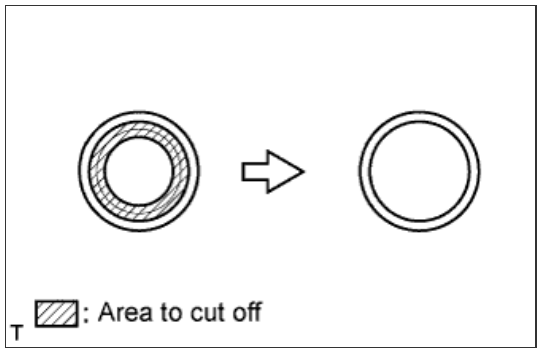
09330-00021

Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



42. INSTALL SPARK PLUG TUBE GASKET

a. Using a cutter knife, cut off the seal part of the removed gasket.



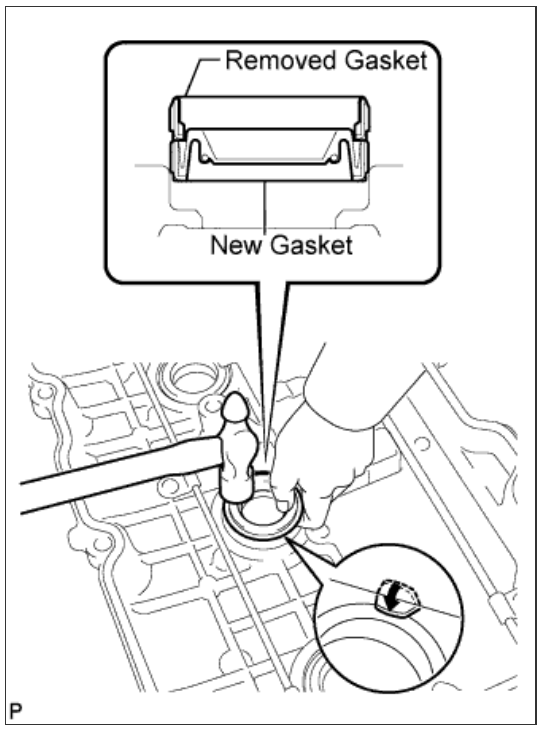
b. Using the removed gasket and a hammer, tap in a new gasket until it stops.

HINT:

If the removed gasket does not fit on the new one, correct the removed one with pliers.

c. Apply a light coat of MP grease to the lip of the gasket.

d. Return the 4 ventilation baffle plate claws to the original positions.



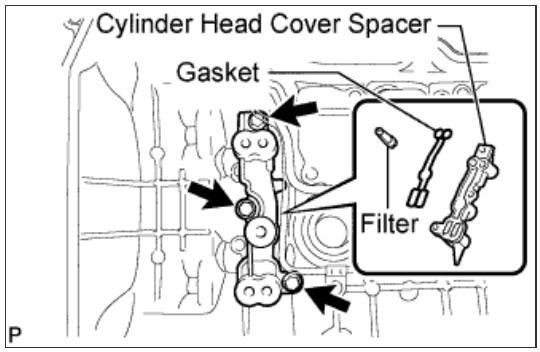
43. INSTALL OIL CONTROL VALVE FILTER

a. LH:

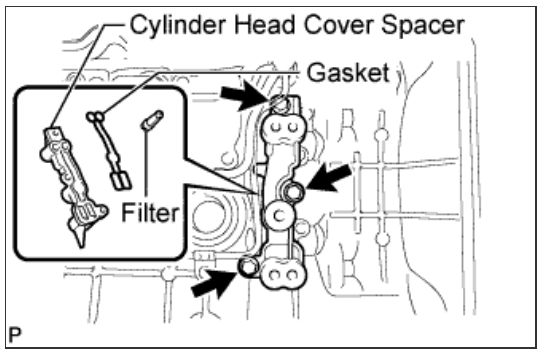
i. Install the filter in the cylinder head.

ii. Install a new gasket and the cylinder head cover spacer with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



b. RH:



i. Install the filter in the cylinder head.

ii. Install a new gasket and the cylinder head cover spacer with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

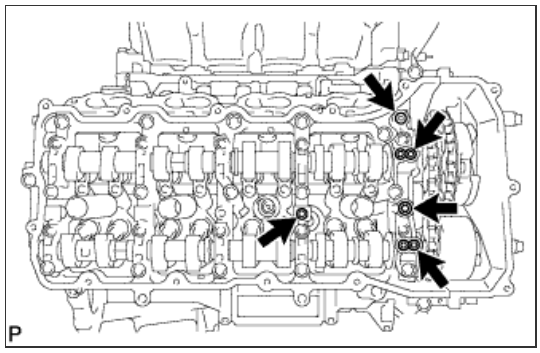
44. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY RH

a. Install 5 new gaskets to the camshaft bearing caps. (No. 1, No. 3).

b. Install the gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

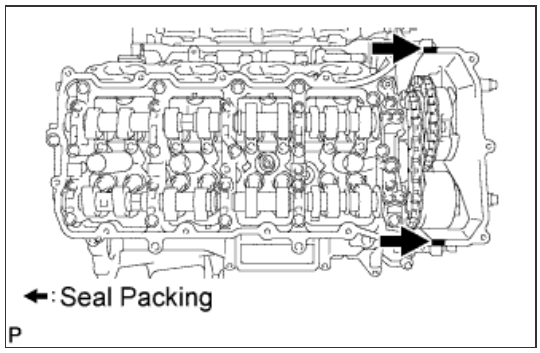


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

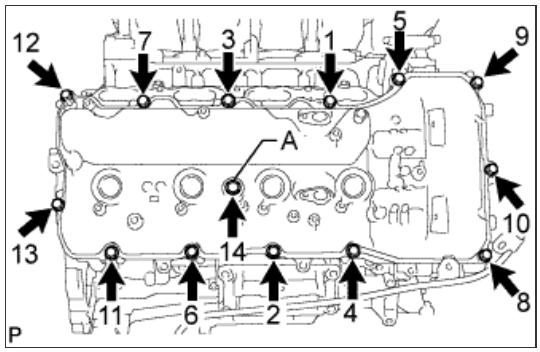
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



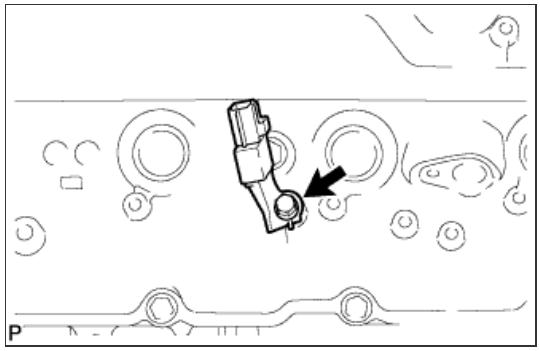
d. Install the cylinder head cover and the seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



e. Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }



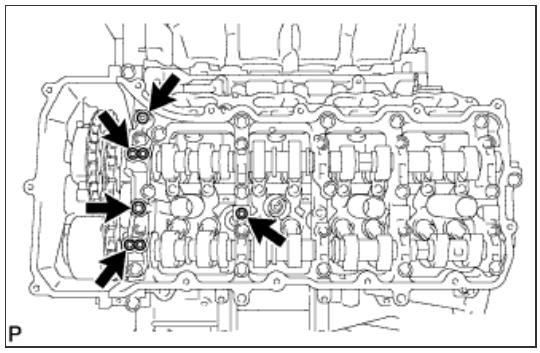
45. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY LH

a. Install 5 new gaskets to the camshaft bearing caps (No. 2, No. 3).

b. Install the gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

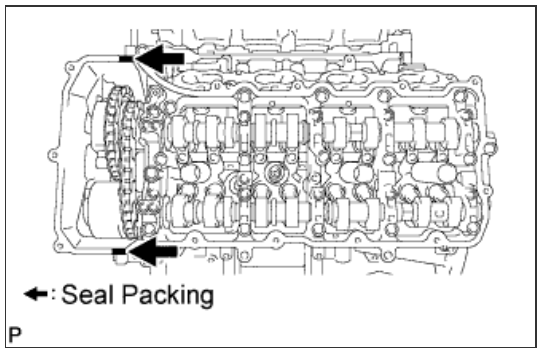


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

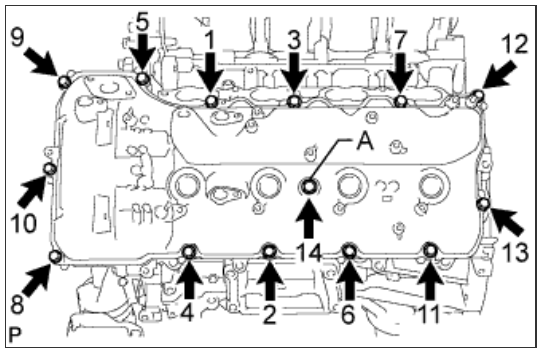
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



d. Install the cylinder head cover and the seal washer with the 14 bolts in the order shown in the illustration.

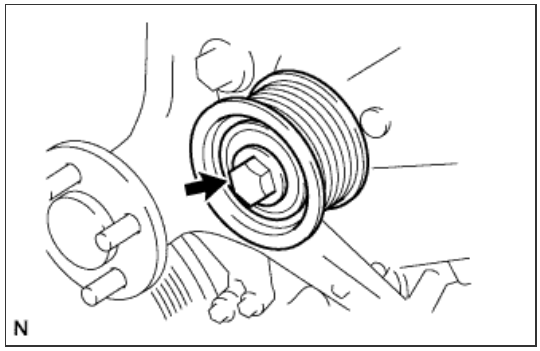
Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



46. INSTALL NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Install the idler pulley with the bolt.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



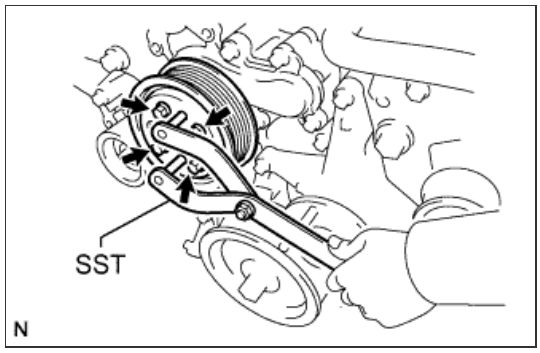
47. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.

SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



48. INSTALL CAMSHAFT OIL CONTROL VALVE ASSEMBLY

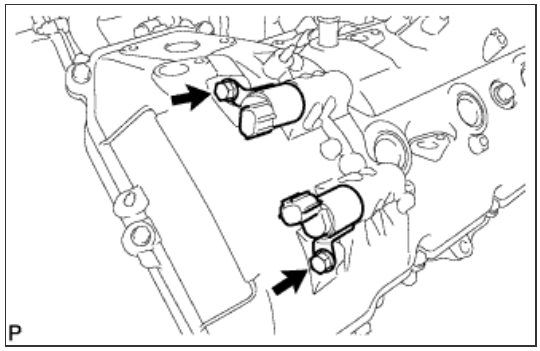
a. for Bank 1:

i. Apply a light coat of engine oil to 2 new O-rings.

ii. Install the 2 O-rings to the 2 oil control valves.

iii. Install the 2 oil control valves with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



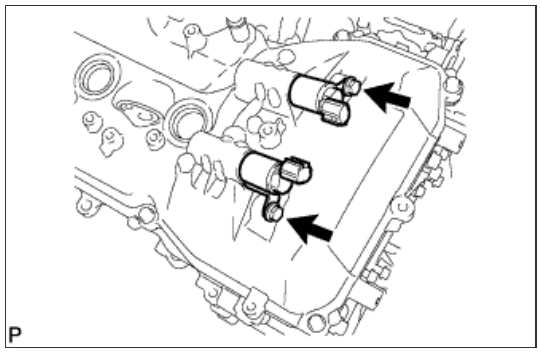
b. for Bank 2:

i. Apply a light coat of engine oil to 2 new O-rings.

ii. Install the 2 O-rings to the 2 oil control valves.

iii. Install the 2 oil control valves with the 2 bolts.

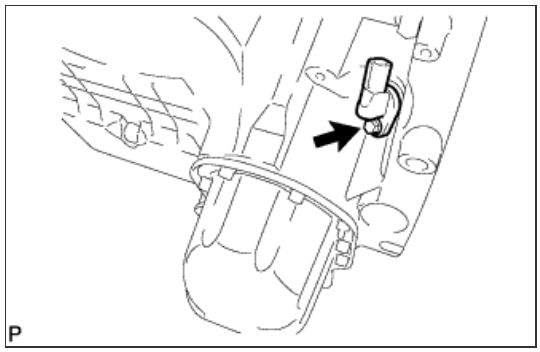
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



49. INSTALL CRANKSHAFT POSITION SENSOR

a. Install the crankshaft position sensor with the bolt.

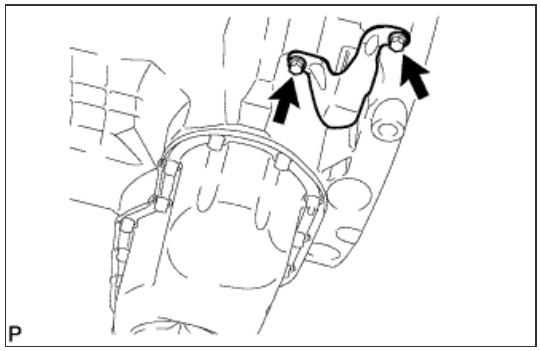
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



50. INSTALL CRANK POSITION SENSOR PROTECTOR

a. Install the sensor protector with the 2 bolts.

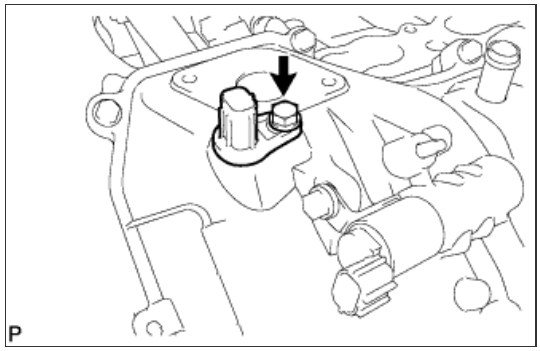
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



51. INSTALL CAMSHAFT POSITION SENSOR

a. Install the camshaft position sensor with the bolt.

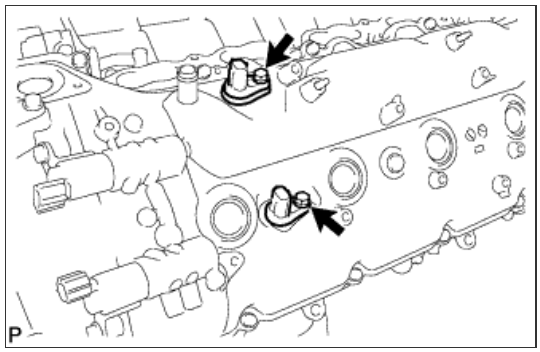
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



52. INSTALL VVT SENSOR

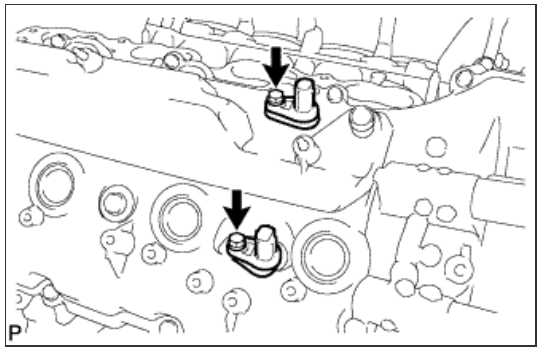
a. for Bank 1:
Install the 2 VVT sensors with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



b. for Bank 2:
Install the 2 VVT sensors with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



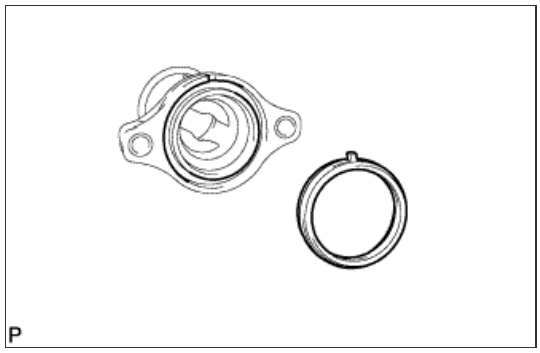
53. INSTALL SPARK PLUG

a. Using a 16 mm plug wrench, install the 8 spark plugs.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

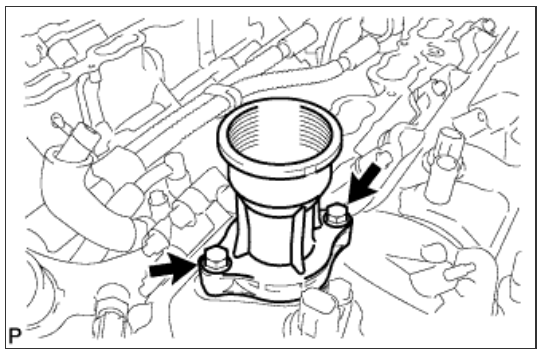
54. INSTALL OIL FILLER CAP HOUSING

a. Align the protrusion of a new gasket with the cutout of the oil filler cap housing, and install the gasket to the housing.



b. Install the cap housing with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

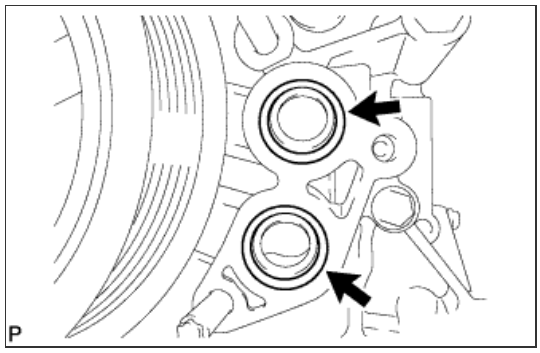


55. INSTALL OIL FILLER CAP SUB-ASSEMBLY

56. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

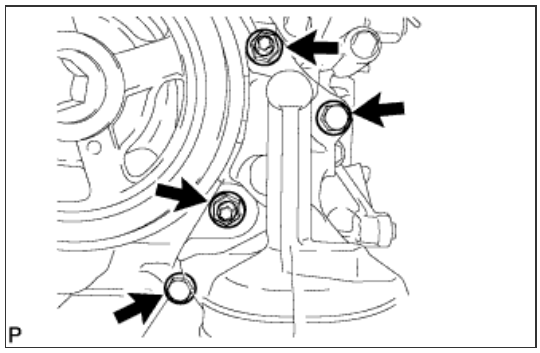
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

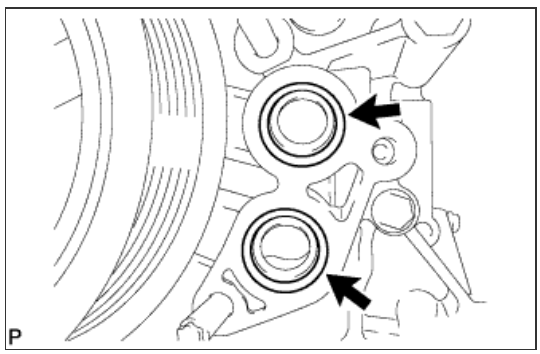
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



57. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

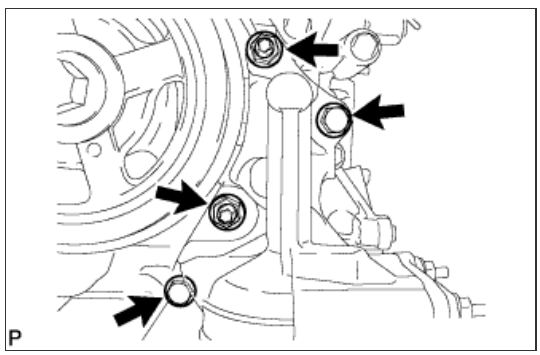
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



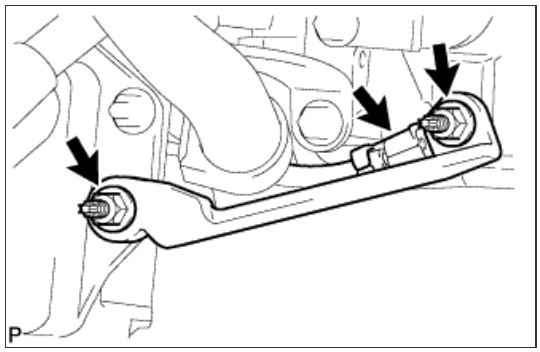
58. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block

d. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



59. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

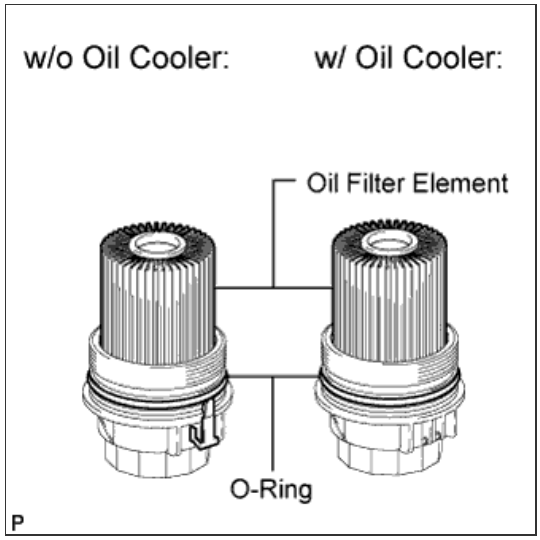
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



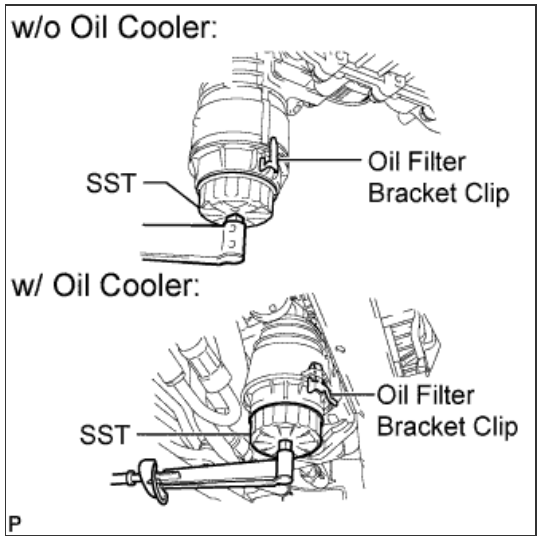
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

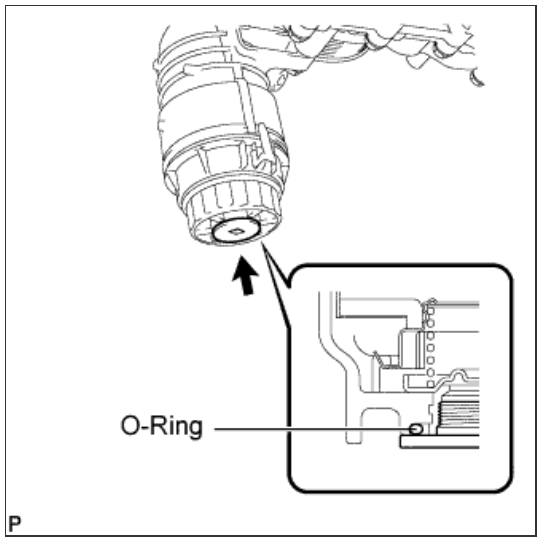
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

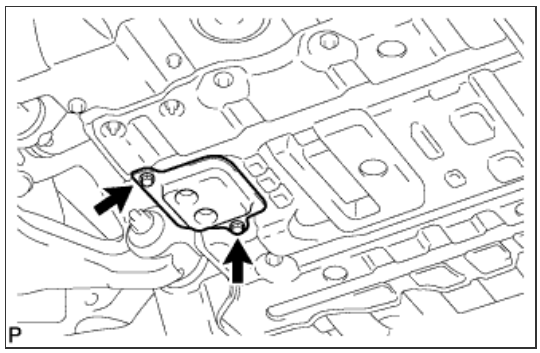
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

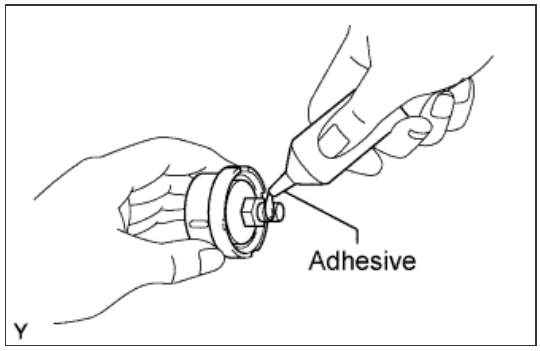
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



60. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

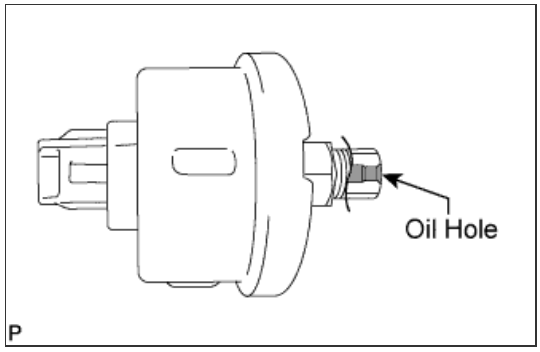
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.



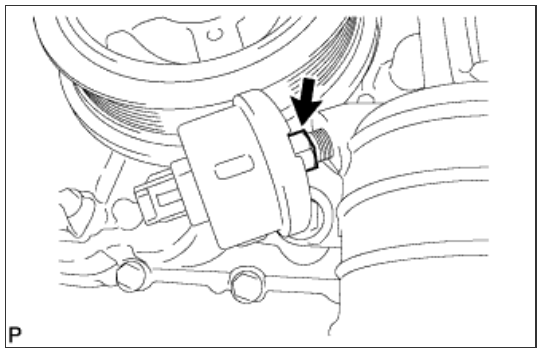
b. Install the oil pressure sender gauge.

Torque:

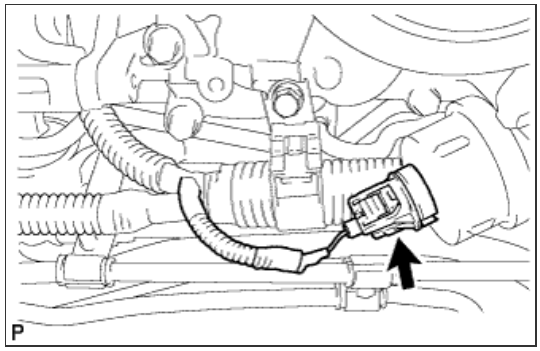
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



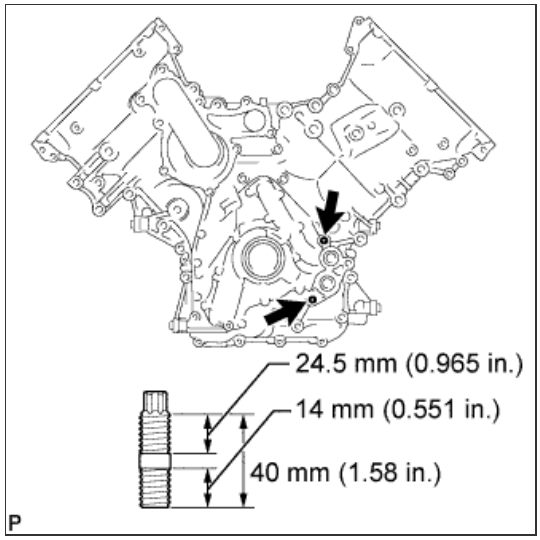
for Preparation Click here

1. INSTALL STUD BOLT

a. Install the timing chain cover stud bolt.

i. Using an E10 "TORX" socket wrench, install the 2 stud bolts as shown in the illustration.

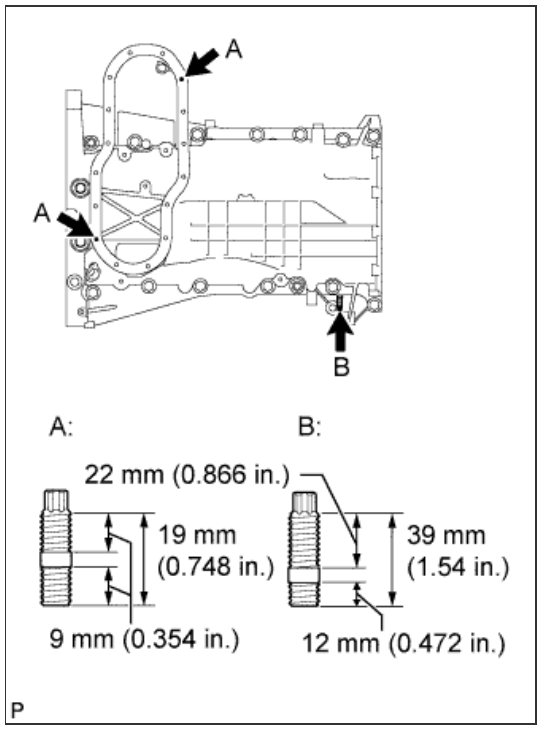
Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }



b. Install the oil pan stud bolt.

i. Using an E6 and E7 "TORX" socket wrench, install the 3 stud bolts as shown in the illustration.

Torque:
for stud bolt A:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }
for stud bolt B:
9.0 N*m{ 92 kgf*cm , 80 in.*lbf }

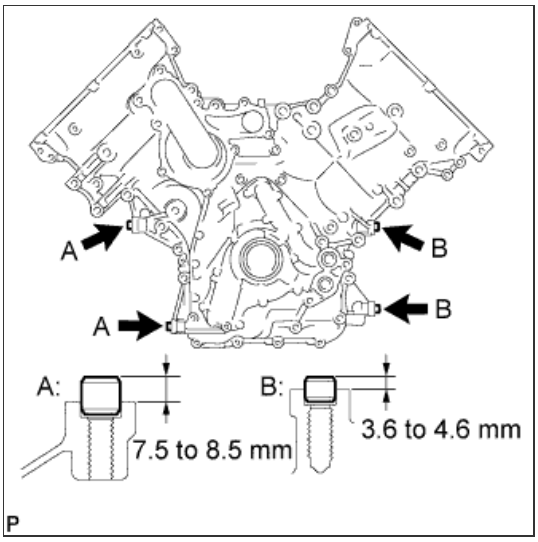


2. INSTALL RING PIN

a. Using a plastic-faced hammer, tap in new ring pins to the timing chain cover.

Standard Protrusion:

Item	Ring Pin Diameter	Specified Condition
Ring pin A	13 mm (0.512 in.)	7.5 to 8.5 mm (0.295 to 0.335 in.)
Ring pin B	11 mm (0.433 in.)	3.6 to 4.6 mm (0.142 to 0.181 in.)



3. INSTALL REAR CRANKSHAFT OIL SEAL

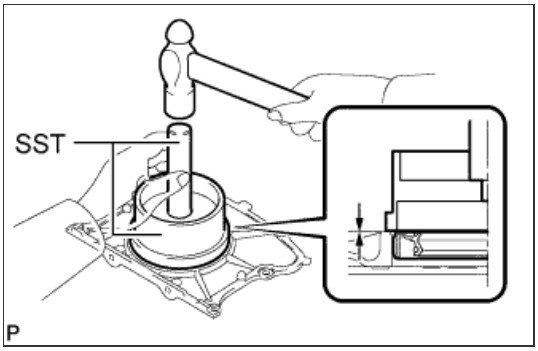
a. Using SST, tap in a new oil seal until its surface is flush with the oil seal retainer edge.

SST
09223-15030
09950-70010 (09951-07100)

Standard depth:
0 to 1.0 mm (0 to 0.0394 in.)

NOTICE:

- **Keep the lip free from foreign matter.**
- **Do not tap on the oil seal at an angle.**



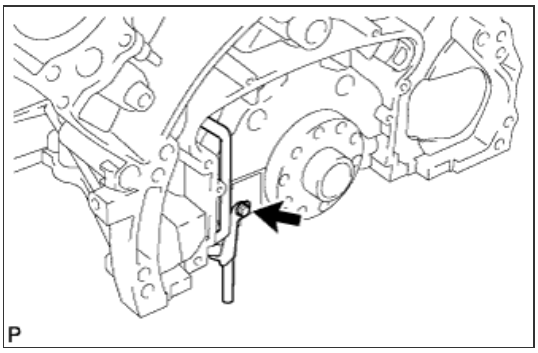
4. INSTALL OIL DRAIN PIPE SUB-ASSEMBLY

a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the drain pipe.

c. Install the oil drain pipe with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



5. INSTALL ENGINE REAR OIL SEAL RETAINER

a. Apply seal packing in a continuous line as shown in the illustration.

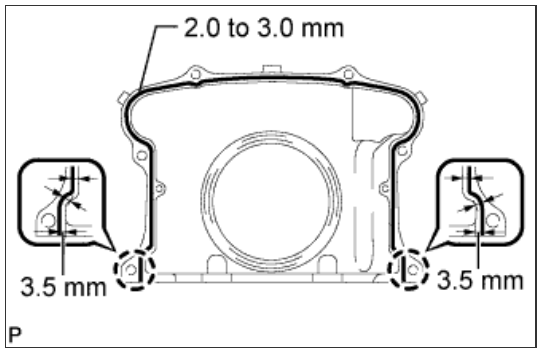
Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
2.0 to 3.0 mm (0.0787 to 0.118 in.)

Application position from inside edge of retainer:
3.5 mm (0.138 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the oil seal retainer within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

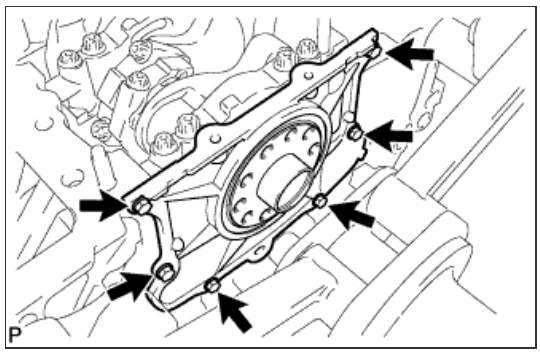


b. Install the oil seal retainer with the 6 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after installing.**
- **When installing the oil seal retainer, make sure the lip of the oil seal is not damaged.**
- **When installing the oil seal retainer, make sure the lip of the oil seal is not folded incorrectly.**



6. INSTALL OIL STRAINER SUB-ASSEMBLY

a. Apply a light coat of engine oil to a new O-ring.

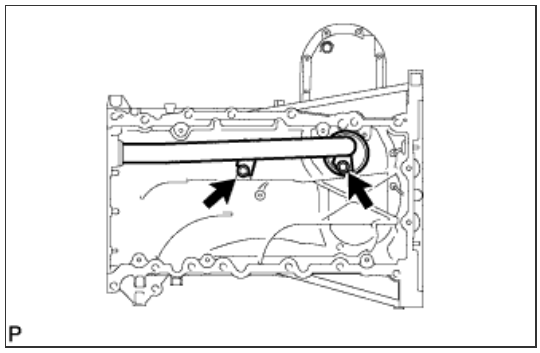
b. Install the O-ring to the oil strainer.

c. Install the oil strainer with the 2 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

NOTICE:

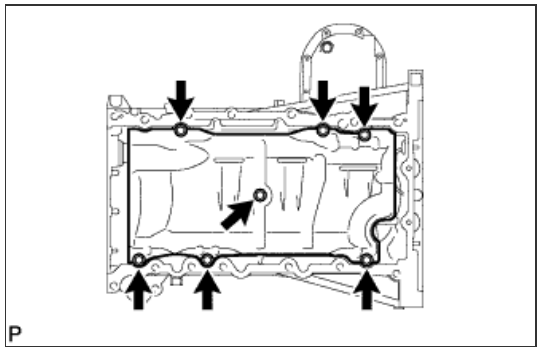
Make sure the O-ring is not twisted or damaged.



7. INSTALL NO. 1 OIL PAN BAFFLE PLATE

a. Install the baffle plate with the 7 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



8. INSTALL NO. 1 OIL PAN SUB-ASSEMBLY

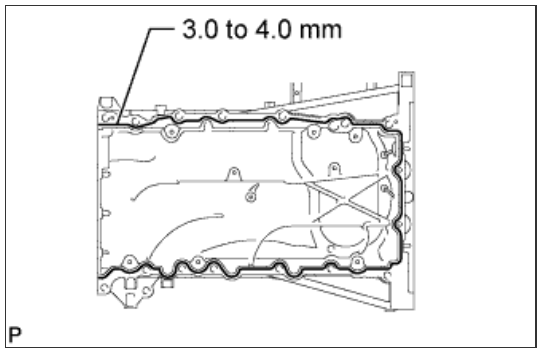
a. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.0 to 4.0 mm (0.118 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the oil pan within 3 minutes and tighten the bolts and nuts within 15 minutes after applying seal packing.**

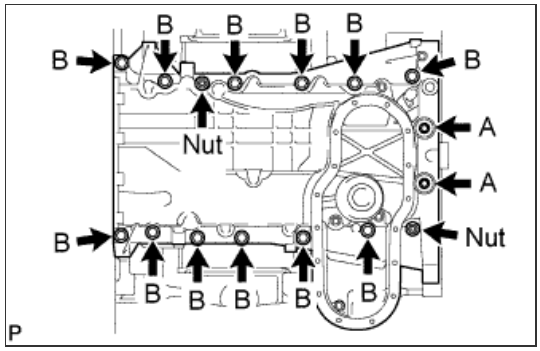


b. Install the oil pan with the 14 bolts and 2 nuts.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
for bolt B:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }
for nut:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

NOTICE:

Do not start the engine for at least 2 hours after installing.



Standard Bolt:

Item	Length	Thread Diameter
Bolt A	92 mm (3.62 in.)	6 mm (0.236 in.)
Bolt B	30 mm (1.18 in.)	10 mm (0.394 in.)

9. INSTALL NO. 2 OIL PAN SUB-ASSEMBLY

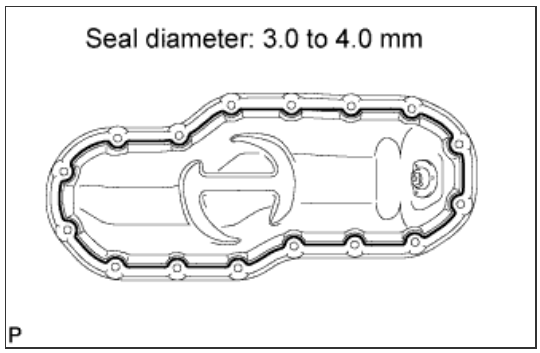
a. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.0 to 4.0 mm (0.118 to 0.156 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the oil pan within 3 minutes and tighten the bolts and nuts within 15 minutes after applying seal packing.**

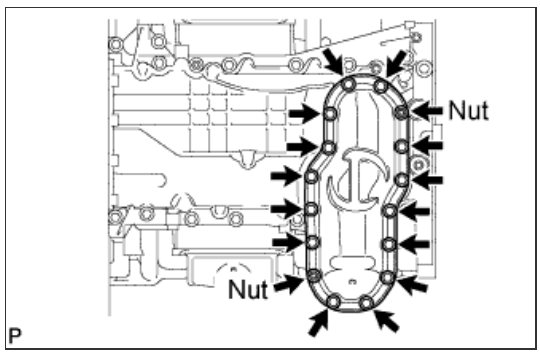


b. Install the oil pan with the 14 bolts and 2 nuts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

NOTICE:

Do not start the engine for at least 2 hours after installing.



10. INSTALL NO. 1 HEAT EXCHANGER COVER

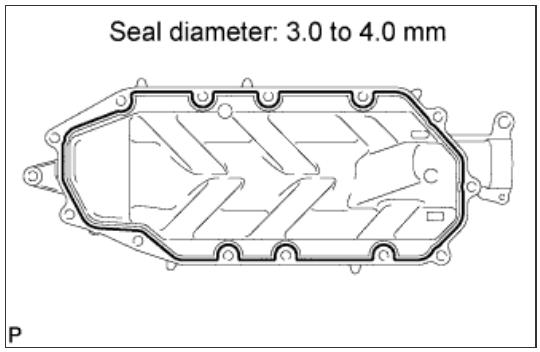
a. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing 1282B, Three Bond 1282B or equivalent

Standard seal diameter:
3.0 to 4.0 mm (0.118 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the heat exchanger cover within 3 minutes and tighten the bolts and nuts within 15 minutes after applying seal packing.**



b. Install the heat exchanger cover with the 12 bolts and 2 nuts.

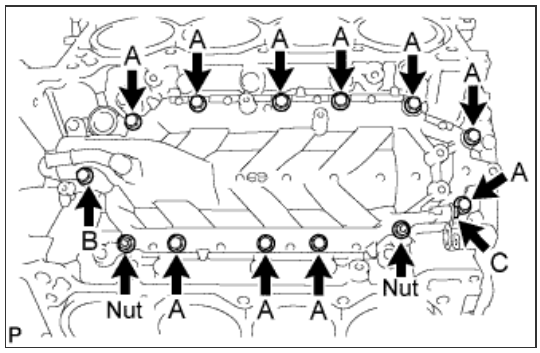
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

NOTICE:

Do not start the engine for at least 2 hours after installing.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	20 mm (0.787 in.)	8 mm (0.315 in.)
Bolt B	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt C	16 mm (0.630 in.)	6 mm (0.236 in.)



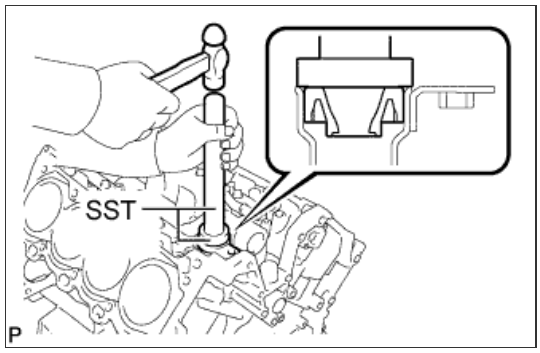
11. INSTALL VENTILATION PIPE GASKET

a. Using SST, evenly tap in a new ventilation pipe gasket until its surface is flush with the lip of the ventilation pipe.

SST
09950-60010 (09951-00360)
09950-70010 (09951-07100)

NOTICE:

- **Do not tap the gasket at an angle.**
- **Do not tap the gasket excessively.**

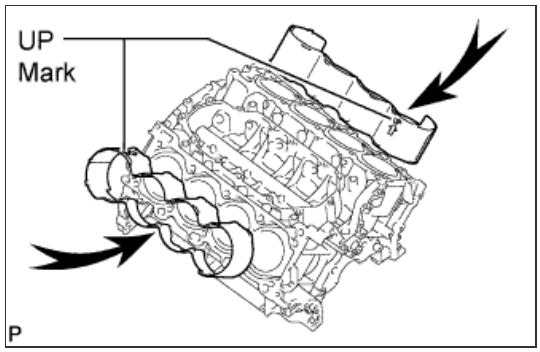


12. INSTALL CYLINDER BLOCK WATER JACKET SPACER

a. Install the 2 water jacket spacers as shown in the illustration.

HINT:

- **Face the cutouts indicated by the arrows in illustration away from the engine.**
- **Face the "UP" mark as shown in the illustration.**

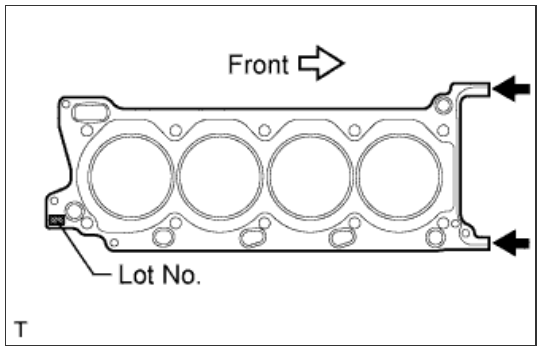


13. INSTALL CYLINDER HEAD SUB-ASSEMBLY RH

a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.



NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**

d. Place the cylinder head on the cylinder block.

HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

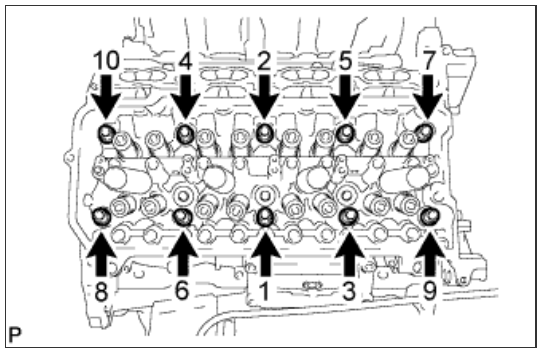
- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.

f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

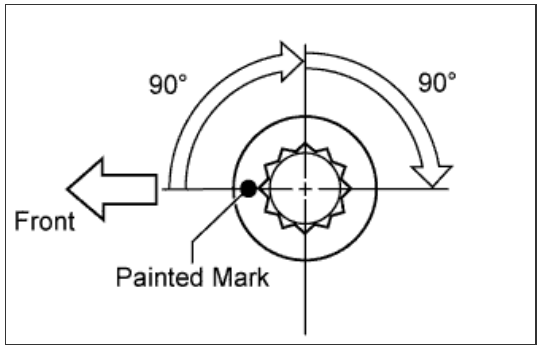
i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.

h. Step 3:

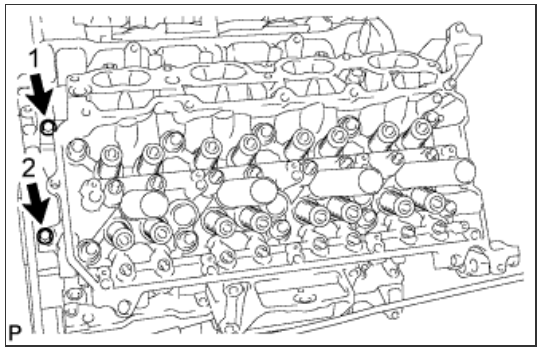
i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painting marks are now facing rearward.



i. Uniformly install the 2 bolts in the sequence shown in the illustration.

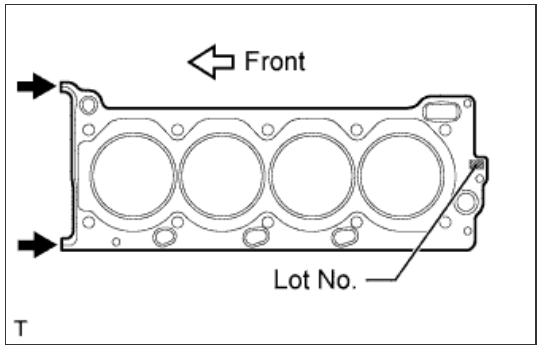
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



a. Clean the cylinder block with solvent.

b. Set the piston of the No. 1 cylinder to slightly ATDC.

c. Place the cylinder head gasket on the cylinder block surface with the front face of the Lot No. stamp upward.



NOTICE:

- **Be careful of the installation direction.**
- **Make sure that no oil is on the front end (indicated by the arrows) of the cylinder head gasket.**

d. Place the cylinder head on the cylinder block.

HINT:

The cylinder head bolts are tightened in 3 progressive steps.

NOTICE:

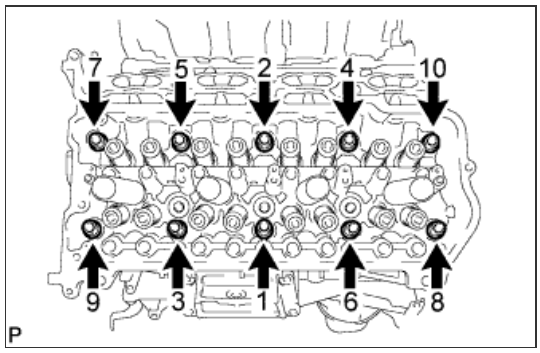
- **Ensure that no oil is on the mounting surface of the cylinder head.**
- **Gently place the cylinder head in order not to damage the gasket with the bottom part of the head.**

e. Apply a light coat of engine oil to the threads and under the heads of the cylinder head bolts.

f. Step 1:

i. Using a 10 mm bi-hexagon wrench, install and uniformly tighten the 10 cylinder head bolts with the plate washers in several steps in the sequence shown in the illustration.

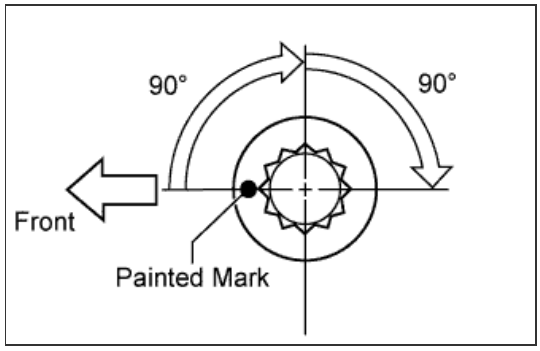
Torque:
36 N*m{ 367 kgf*cm , 27 ft.*lbf }



g. Step 2:

i. Mark each cylinder head bolt head with paint as shown in the illustration.

ii. Tighten the cylinder head bolts 90° in the sequence shown in step 1.



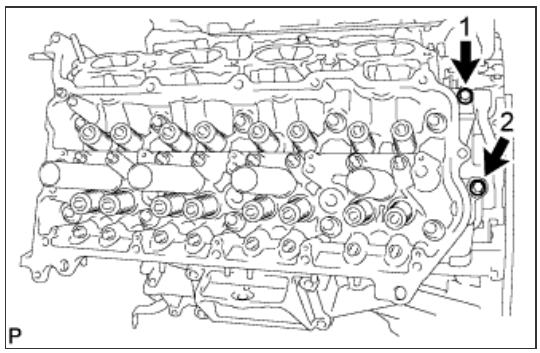
h. Step 3:

i. Tighten the cylinder head bolts another 90° in the sequence shown in step 1.

ii. Check that the painted marks are now facing rearward.

i. Uniformly install the 2 bolts in the sequence shown in the illustration.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



15. INSTALL VALVE STEM CAP

a. Apply a light coat of engine oil to the valve stem caps.

b. Install the 32 valve stem caps to the cylinder heads.

16. INSTALL VALVE LASH ADJUSTER ASSEMBLY

a. Inspect the valve lash adjuster before installing it (Click here).

b. Install the 32 valve lash adjusters to the cylinder heads.

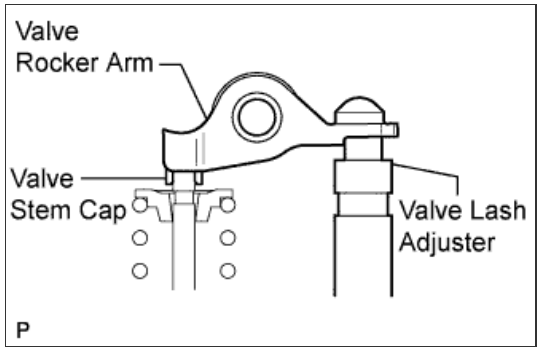
NOTICE:

Install the lash adjuster to the same place it was removed from.

17. INSTALL NO. 1 VALVE ROCKER ARM SUB-ASSEMBLY

a. Apply engine oil to the lash adjuster tips and valve stem cap ends.

b. Install the 32 valve rocker arms as shown in the illustration.

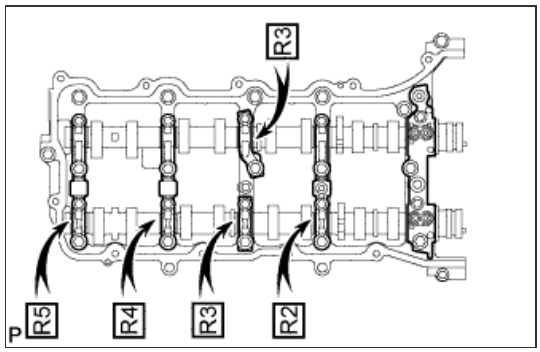


18. INSTALL CAMSHAFT BEARING CAP RH

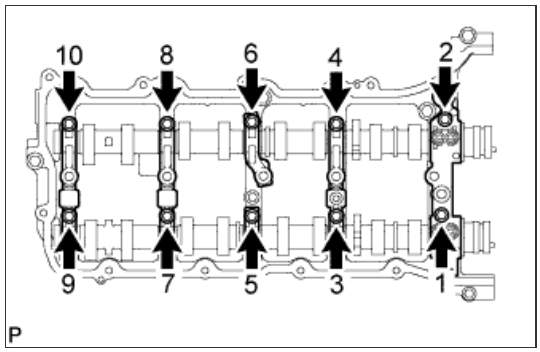
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 1 and No. 2 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

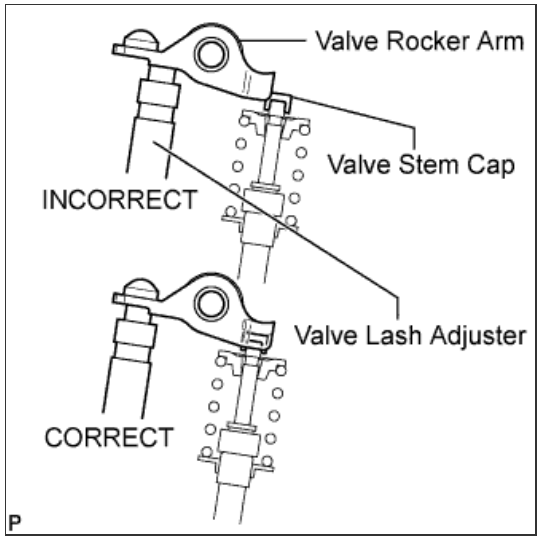


d. Temporarily install the 10 bolts in the order shown in the illustration.



19. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY RH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



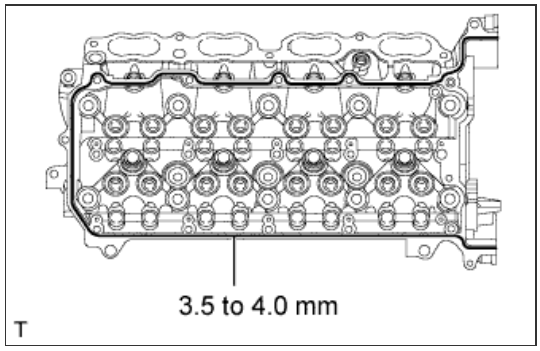
b. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

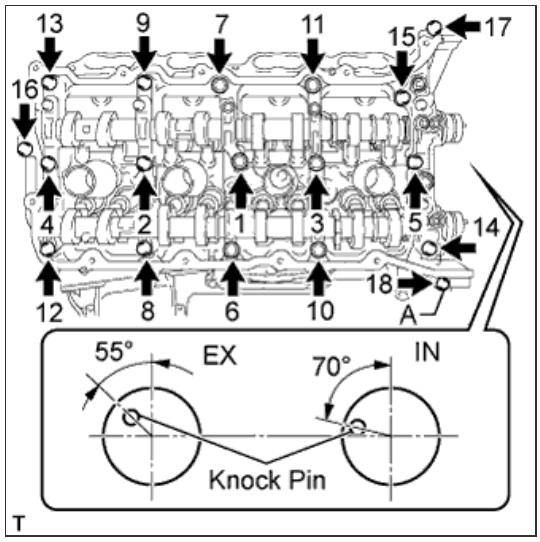


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

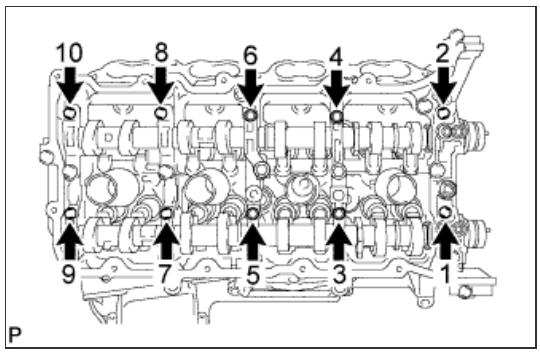


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

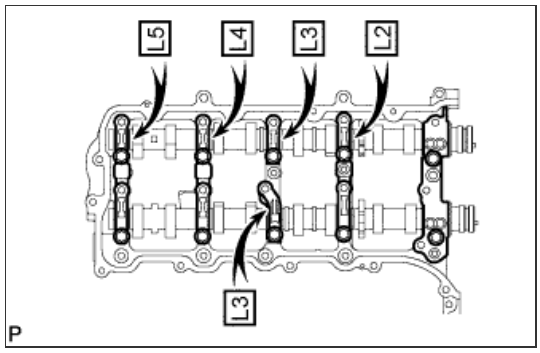


20. INSTALL CAMSHAFT BEARING CAP LH

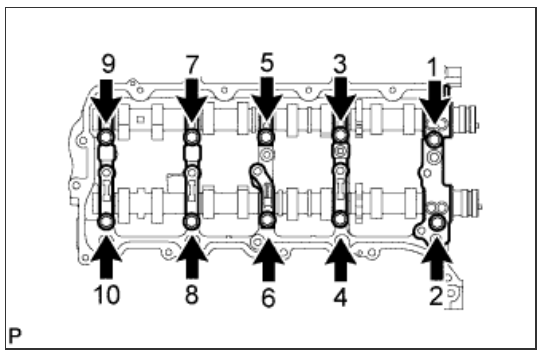
a. Apply a light coat of engine oil to the camshaft journals, camshaft housings and bearing caps.

b. Install the No. 3 and No. 4 camshafts to the camshaft housing.

c. Confirm the marks and numbers on the camshaft bearing caps and place them in their proper positions and directions.

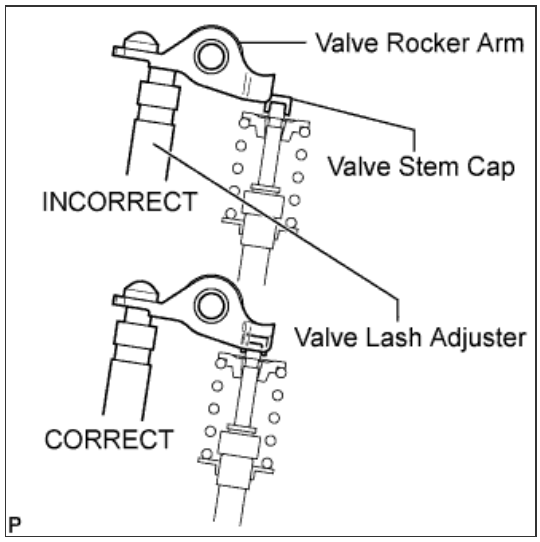


d. Temporarily install the 10 bolts in the order shown in the illustration.



21. INSTALL CAMSHAFT HOUSING SUB-ASSEMBLY LH

a. Make sure that the valve rocker arms are installed as shown in the illustration.



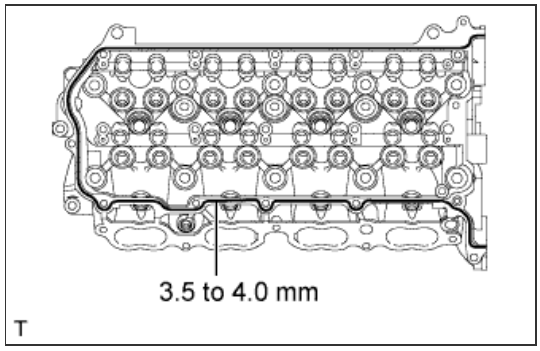
b. Apply seal packing in a continuous line as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Standard seal diameter:
3.5 to 4.0 mm (0.138 to 0.157 in.)

NOTICE:

- **Remove any oil from the contact surface.**
- **Install the camshaft housing within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**

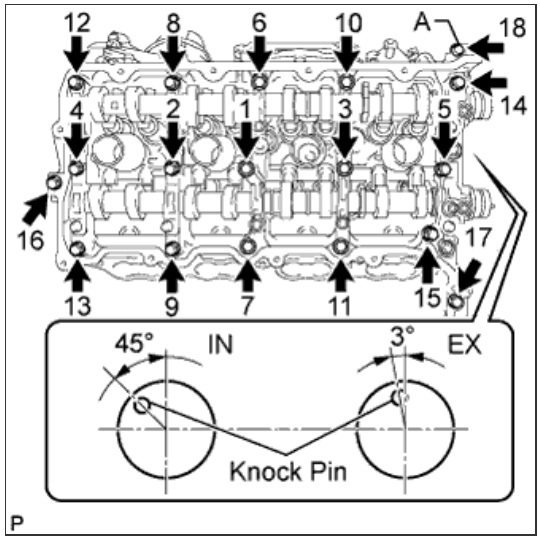


c. Install the camshaft housing, and install the 18 bolts in the order shown in the illustration.

Torque:
for bolt A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except bolt A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not start the engine for at least 2 hours after the installation.**
- **Make sure that the knock pin of the camshaft is positioned as shown in the illustration before installing the camshaft housing.**

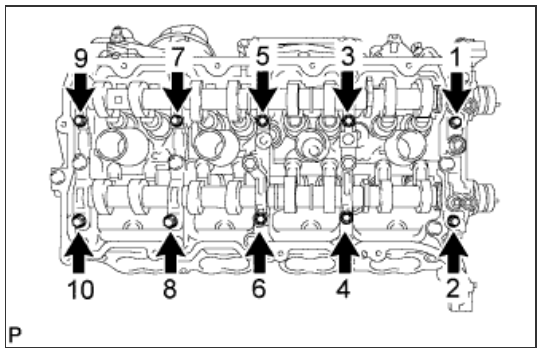


d. Tighten the 10 bolts in the order shown in the illustration.

Torque:
16 N*m{ 163 kgf*cm , 12 ft.*lbf }

NOTICE:

Thoroughly wipe clean any seal packing.

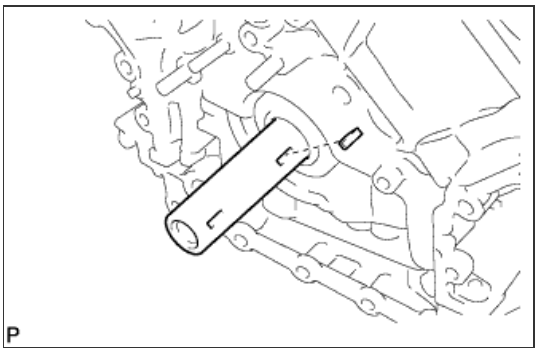


22. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the timing gear key.

HINT:

The other timing gear key will be installed at a later step.



23. SET NO. 1 CYLINDER TO TDC/COMPRESSION

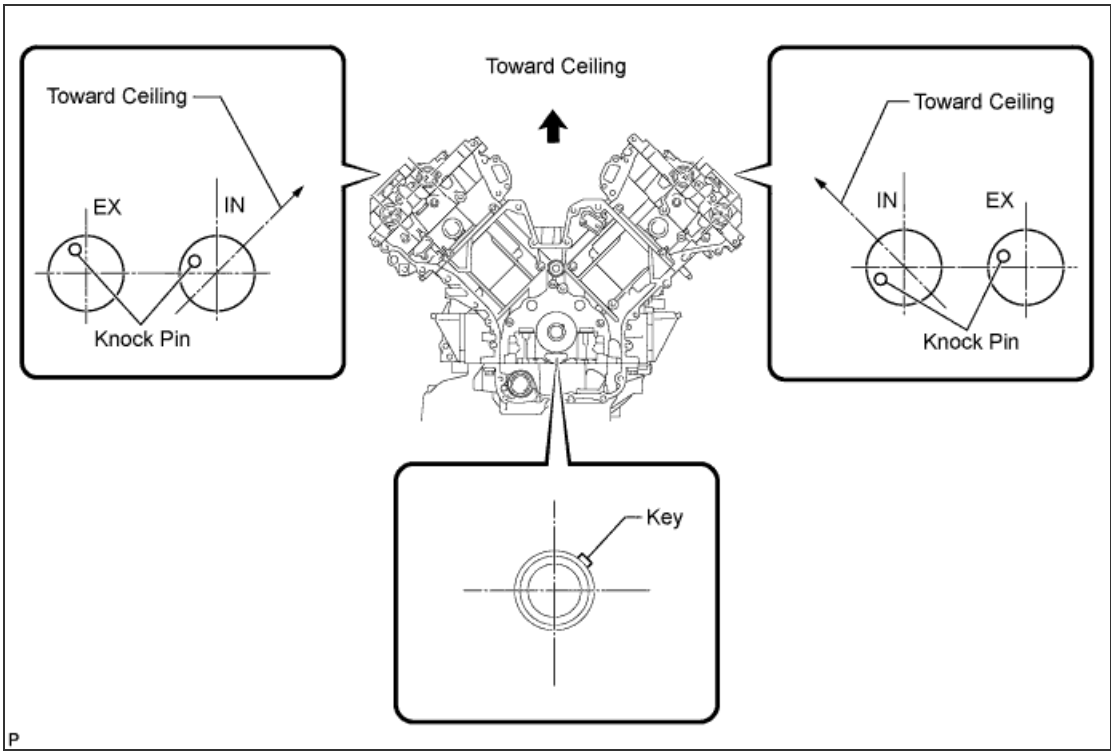
a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft so that the timing gear key is as shown in the illustration. Then using a wrench, rotate each camshaft so that the timing marks are as shown in the illustration.

NOTICE:

When the crankshaft or a camshaft is rotated excessively, the valves and pistons may interfere with each other.

c. Remove the crankshaft pulley bolt.



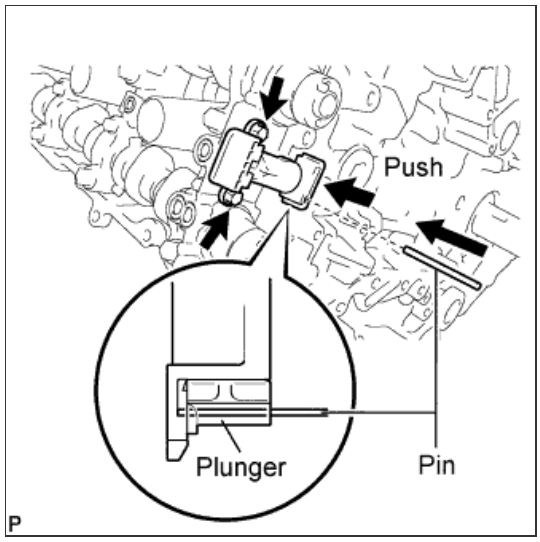
24. INSTALL NO. 2 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

Torque:

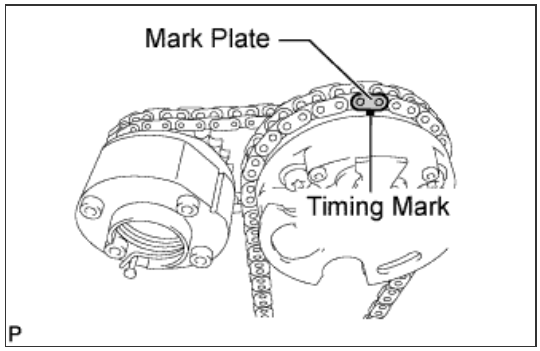
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While raising up the No. 2 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.

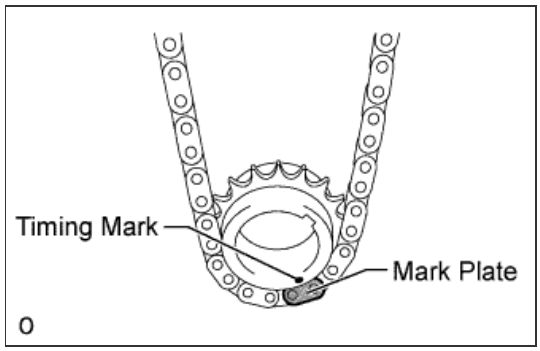


25. INSTALL NO. 1 CHAIN SUB-ASSEMBLY RH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



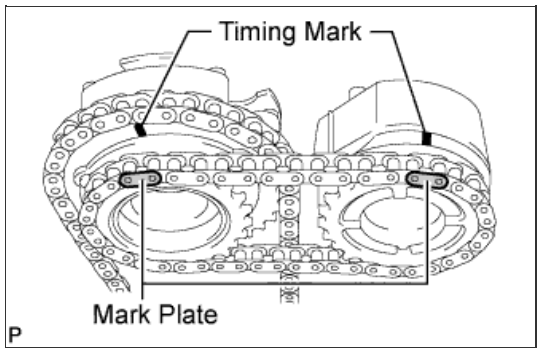
b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

HINT:

The crankshaft timing sprocket RH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.



d. Install the crankshaft timing sprocket RH to the crankshaft.

e. Align and attach the knock pin of the No. 1 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 2 camshaft, align and attach the knock pin of the No. 2 camshaft with the pin hole of the camshaft timing exhaust gear.

g. Remove the pin from the No. 2 chain tensioner.

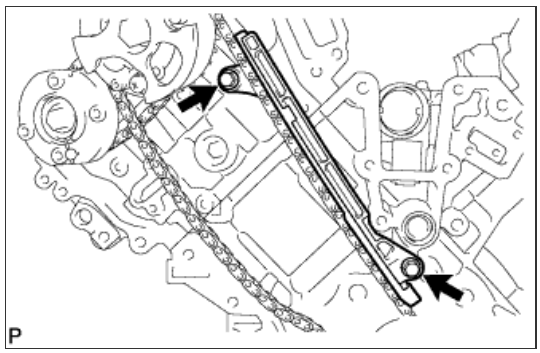
h. Using a wrench to hold the hexagonal portion of the No. 1 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, temporarily install the bolt.

26. INSTALL NO. 1 CHAIN VIBRATION DAMPER RH

a. Install the vibration damper with the 2 bolts.

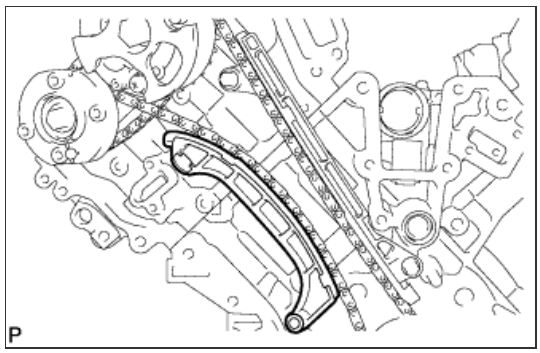
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



27. INSTALL NO. 1 CHAIN TENSIONER SLIPPER RH

HINT:

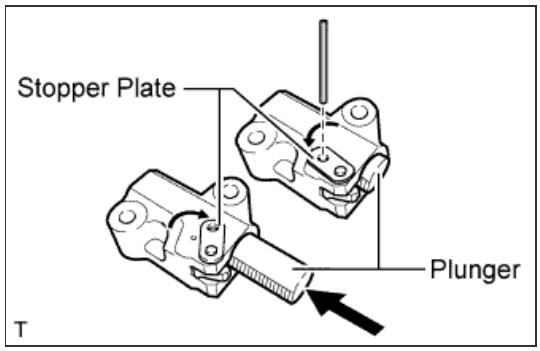
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and then install the chain tensioner slipper.



28. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY RH

a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

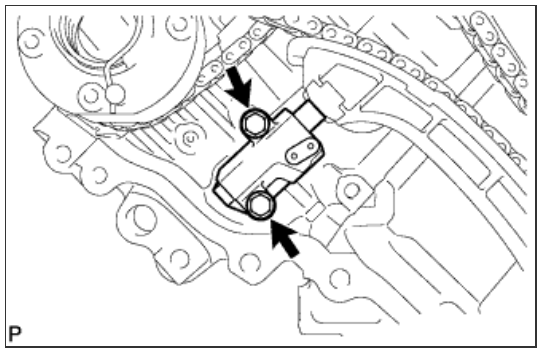
b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Remove the hexagon wrench from the chain tensioner.

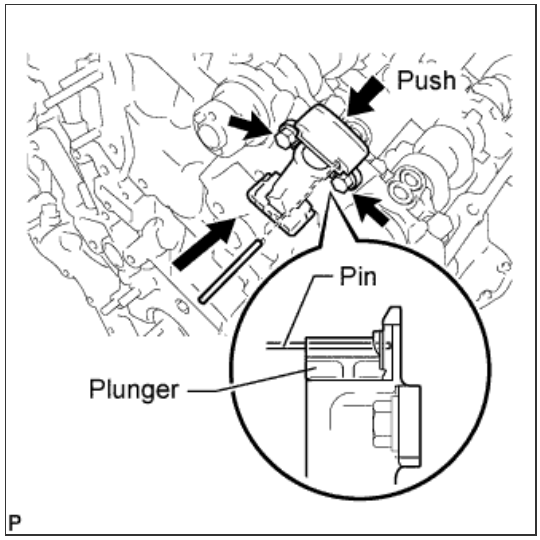


29. INSTALL NO. 3 CHAIN TENSIONER ASSEMBLY

a. Install the chain tensioner with the 2 bolts.

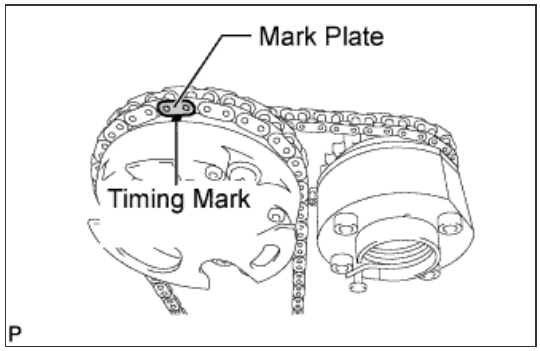
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. While pushing down the No. 2 chain tensioner, insert a pin of 1.0 mm (0.0394 in.) into the hole to fix it in place.

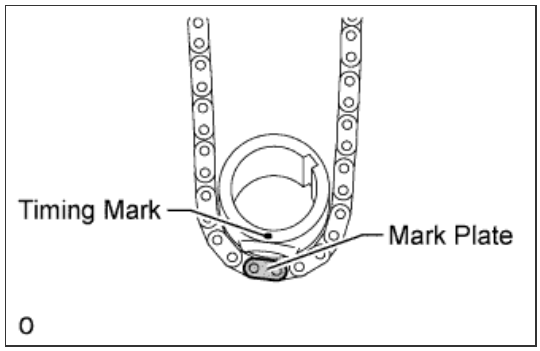


30. INSTALL NO. 1 CHAIN SUB-ASSEMBLY LH

a. Align the No. 1 chain orange mark plate with the camshaft timing gear timing mark, and attach the chain to the gear as shown in the illustration.



b. Align the No. 1 chain orange mark plate with the crankshaft timing sprocket timing mark, and attach the chain to the gear as shown in the illustration.



c. Align the No. 2 chain yellow mark plates with the timing marks of the camshaft timing gear assembly and camshaft timing exhaust gear assembly, and attach the No. 2 chain to the gears as shown in the illustration.

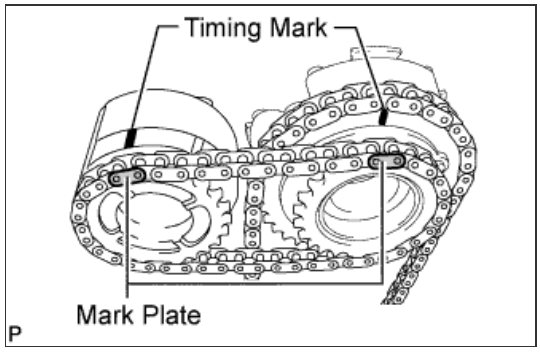
HINT:

The crankshaft timing sprocket LH and camshaft timing exhaust gear will be installed with the No. 1 and No. 2 chains connected to the gears.

d. Install the crankshaft timing sprocket LH to the crankshaft.

e. Align and attach the knock pin of the No. 3 camshaft with the pin hole of the camshaft timing gear.

f. Using the hexagonal portion of the No. 4 camshaft, align and attach the knock pin of the No. 4 camshaft with the pin hole of the camshaft timing exhaust gear.



NOTICE:

Because the timing mark positions of the gears may shift due to looseness of the No. 1 chain, use the hexagonal portion of the camshaft to hold the No. 3 camshaft in place until the No. 1 chain tensioner is installed.

g. Remove the pin from the No. 3 chain tensioner.

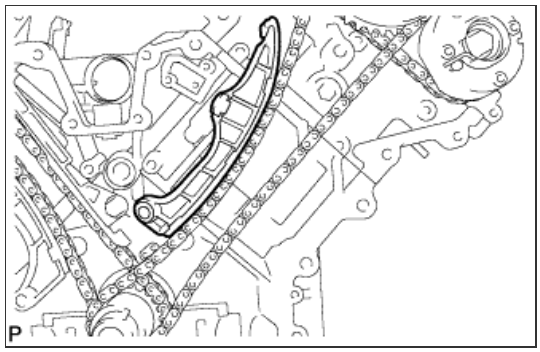
h. Using a wrench to hold the hexagonal portion of the No. 3 camshaft, temporarily install the bolt.

i. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, temporarily install the bolt.

31. INSTALL NO. 1 CHAIN TENSIONER SLIPPER LH

HINT:

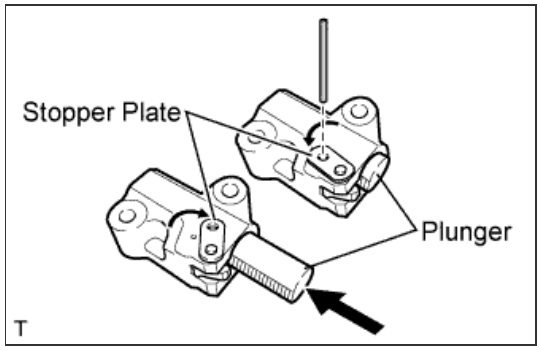
If you cannot install the chain tensioner slipper due to the tension of the chain, use the hexagonal portion of the camshaft to loosen the chain, and install the chain tensioner slipper.



32. INSTALL NO. 1 CHAIN TENSIONER ASSEMBLY LH

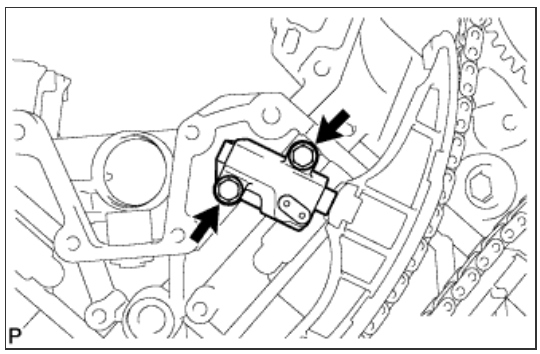
a. Move the stopper plate clockwise to release the lock, and push the plunger deep into the tensioner.

b. Move the stopper plate counterclockwise to set the lock, and insert a hexagon wrench into the hole of the stopper plate.



c. Install a new gasket and the chain tensioner with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

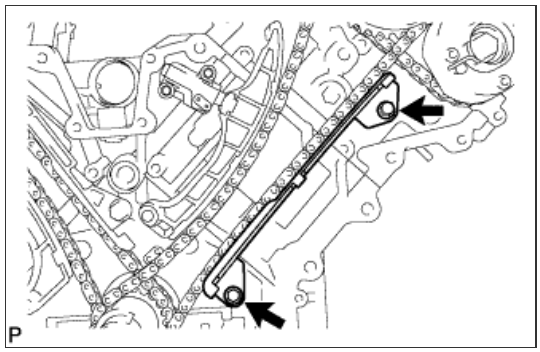


33. INSTALL NO. 1 CHAIN VIBRATION DAMPER LH

a. Install the vibration damper with the 2 bolts.

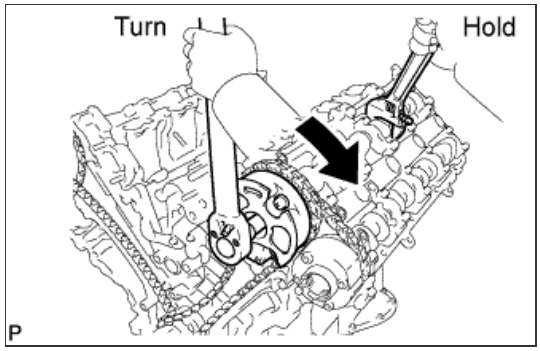
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Remove the hexagon wrench from the No. 1 chain tensioner.



34. TIGHTEN CAMSHAFT TIMING GEAR

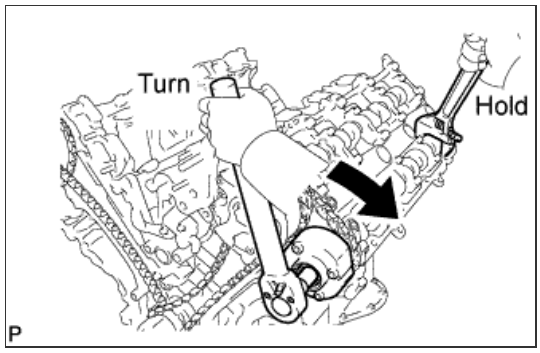
a. for Bank 1:



i. Using a wrench, hold the hexagonal portion of the No. 3 camshaft.

ii. Tighten the bolt of the camshaft timing gear.

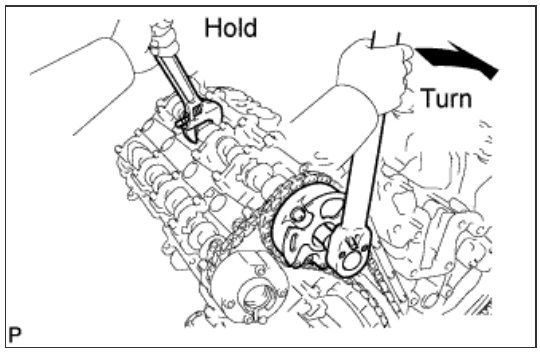
Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }



iii. Using a wrench to hold the hexagonal portion of the No. 4 camshaft, tighten the bolt of the camshaft timing exhaust gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

b. for Bank 2:



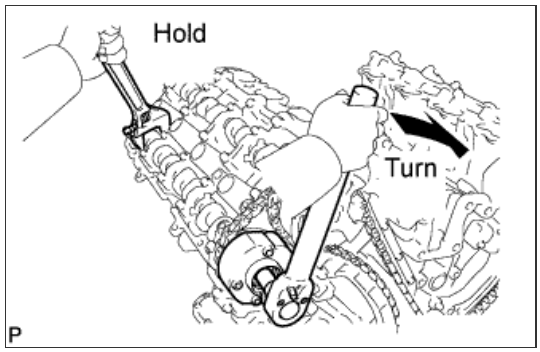
i. Using a wrench, hold the hexagonal portion of the No. 1 camshaft.

ii. Tighten the bolt of the camshaft timing gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

iii. Using a wrench to hold the hexagonal portion of the No. 2 camshaft, tighten the bolt of the camshaft timing exhaust gear.

Torque:
100 N*m{ 1020 kgf*cm , 74 ft.*lbf }

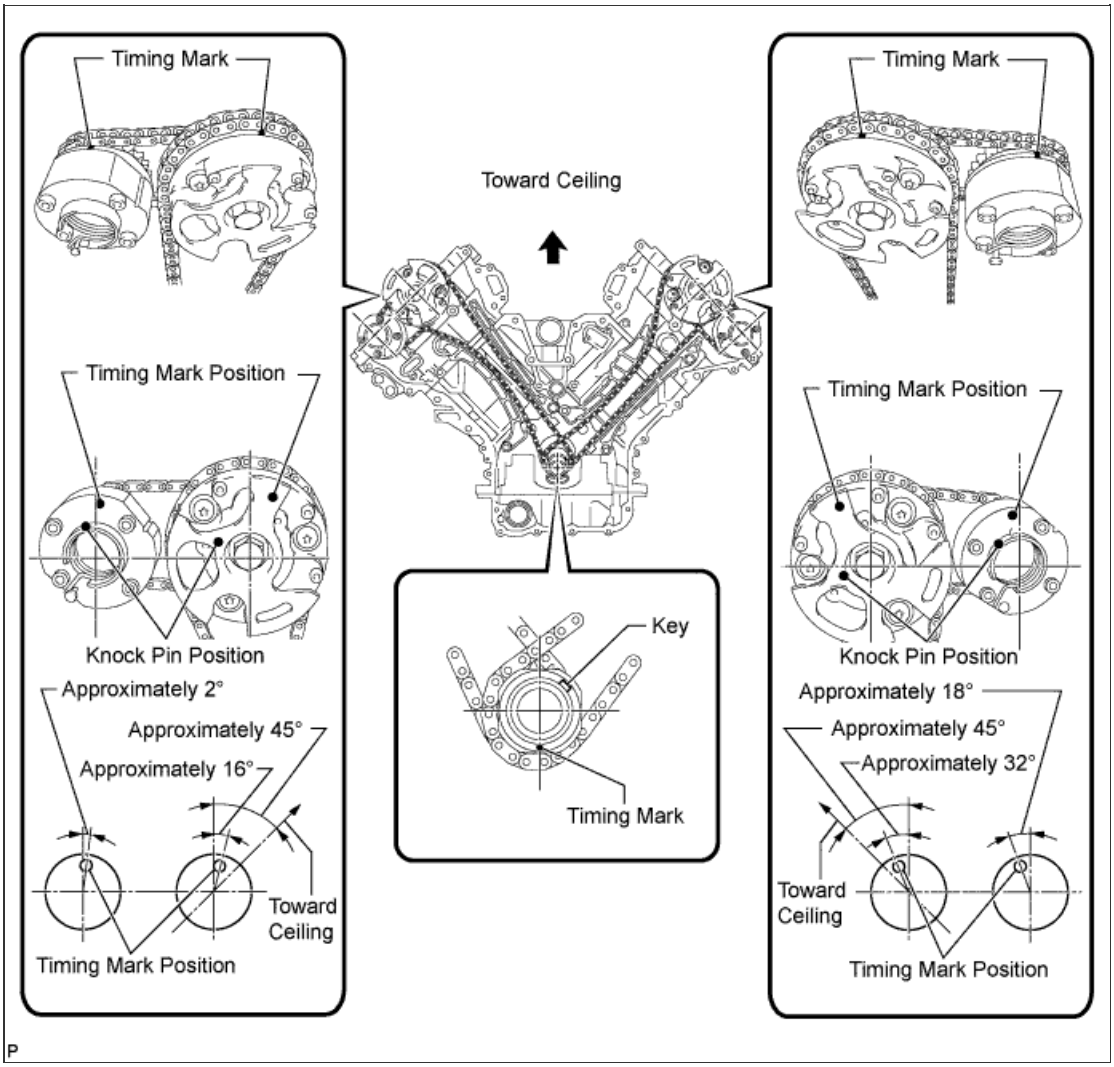


35. CHECK NO. 1 CYLINDER TO TDC/COMPRESSION

a. Temporarily install the crankshaft pulley bolt.

b. Rotate the crankshaft clockwise, and check that the timing marks on the crankshaft timing sprocket and camshaft timing gears are as shown in the illustration.

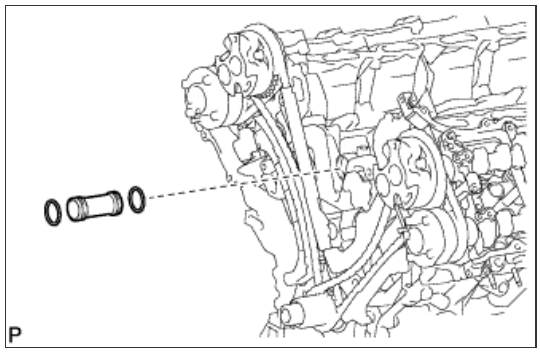
c. Remove the crankshaft pulley bolt.



36. INSTALL WATER INLET PIPE

a. Apply soapy water to 2 new O-rings and install them to the inlet pipe.

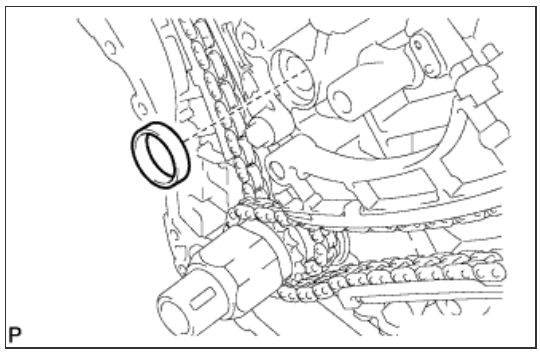
b. Install the inlet pipe to the No. 1 heat exchanger cover.



37. INSTALL TIMING CHAIN COVER SUB-ASSEMBLY

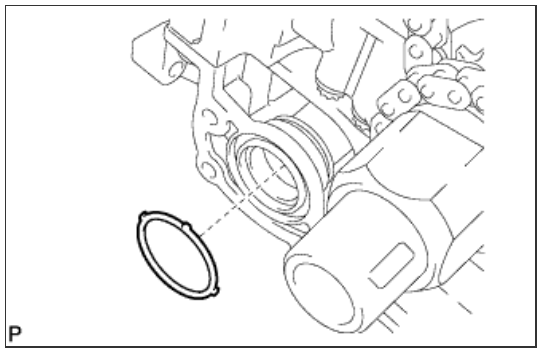
a. Apply a light coat of engine oil to a new oil pump gasket.

b. Install the oil pump gasket.

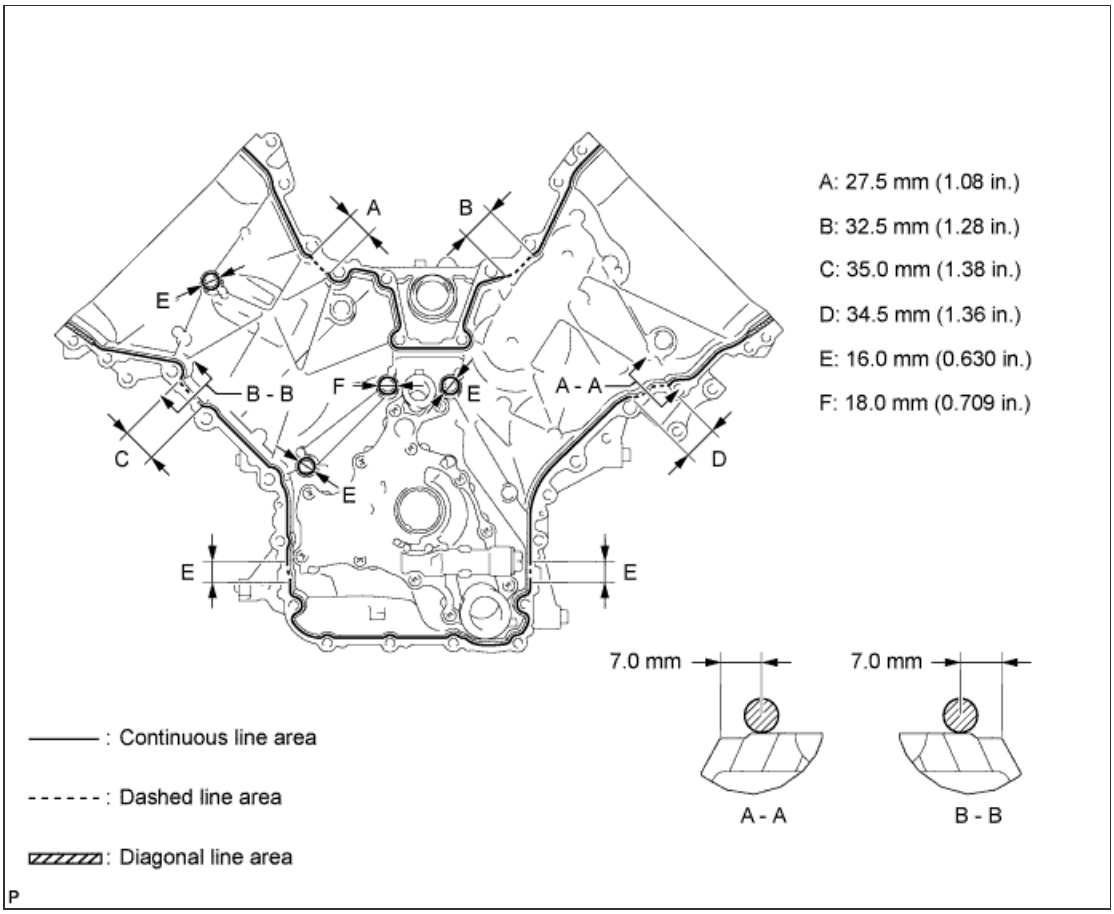


c. Apply a light coat of engine oil to a new O-ring.

d. Install the O-ring.



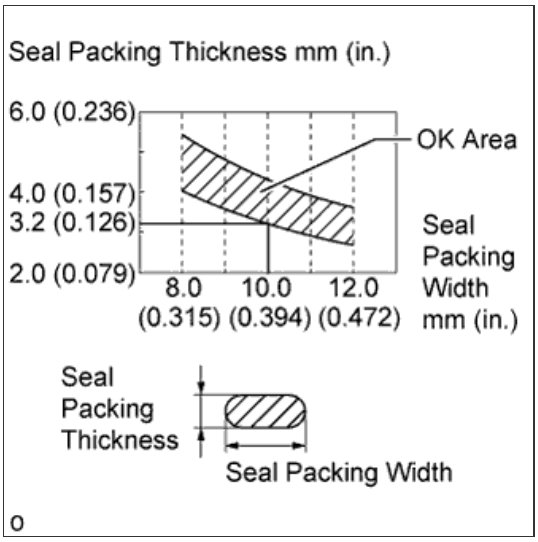
e. Apply seal packing in a continuous line to the timing chain cover as shown in the following illustration.



Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Apply Seal Packing as Follows:

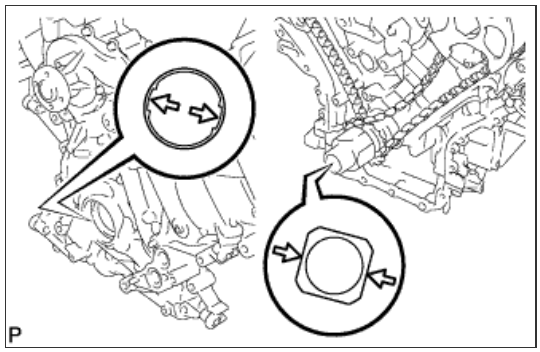
Area	Seal Packing Diameter	Application Position from Inside Edge of Cover
Continuous Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	2.5 mm (0.0984 in.)
Dashed Line Area	6.4 mm (0.252 in.) or more, or within OK area shown in illustration	7.0 mm (0.276 in.)
Diagonal Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	5.5 mm (0.217 in.)



NOTICE:

- **When the contact surfaces are wet, wipe them with an oil-free cloth before applying seal packing.**
- **Install the chain cover within 3 minutes and tighten the bolts within 10 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after installing.**

f. Align the oil pump drive rotor spline and crankshaft as shown in the illustration.
Install the spline and chain cover to the crankshaft.



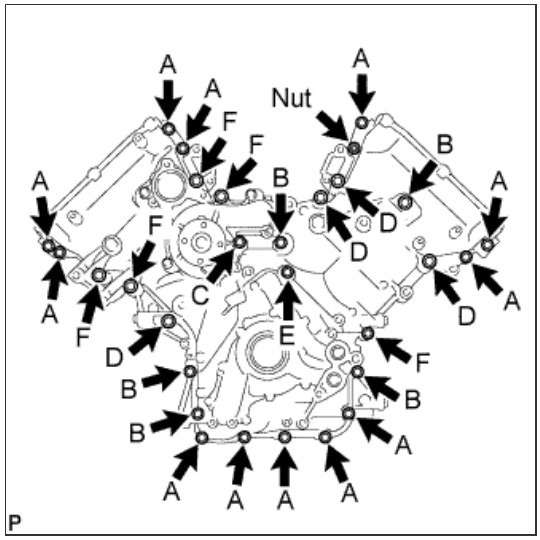
g. Temporarily install the timing chain cover with the 28 bolts and nut.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)

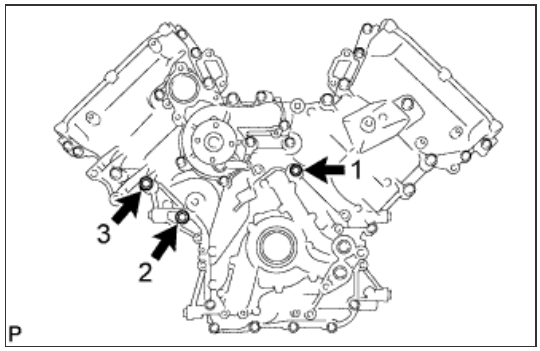
NOTICE:

Make sure that there is no oil on the bolt threads.



h. Tighten the 3 bolts in several steps in the sequence shown in the illustration.

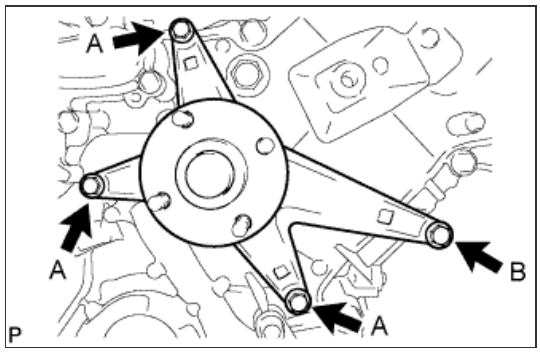
Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



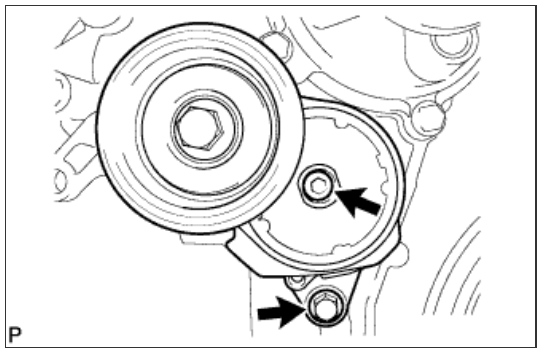
i. Temporarily install the fluid coupling bracket with the 4 bolts.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt B	80 mm (3.15 in.)	10 mm (0.394 in.)

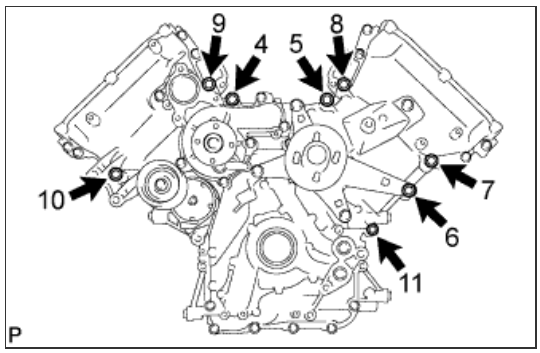


j. Temporarily install the belt tensioner with the standard bolt and 6 mm hexagon wrench bolt.



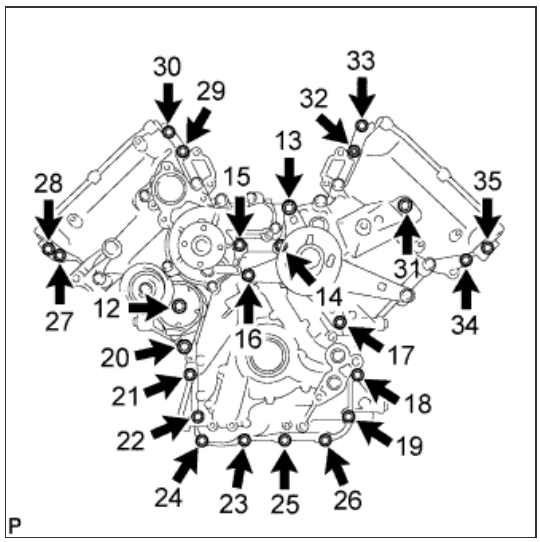
k. Tighten the 8 bolts labeled 4 to 11 in several steps in the sequence shown in the illustration.

Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



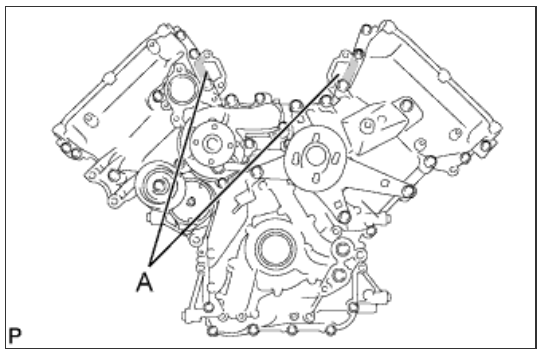
l. Tighten the 23 bolts and nut labeled 12 to 35 in several steps in the sequence shown in the illustration.

Torque:
23 N*m{ 235 kgf*cm , 17 ft.*lbf }



NOTICE:

After the installation, if the seal packing has seeped out at the areas labeled A shown in the illustration, wipe it off.



38. INSTALL WATER PUMP ASSEMBLY

a. Install a new gasket and the water pump with the 8 bolts shown in the illustration.

Torque:

for bolt A:

47 N*m{ 479 kgf*cm , 35 ft.*lbf }

for bolt B:

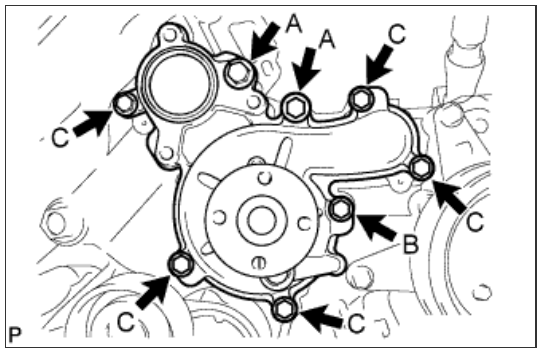
23 N*m{ 235 kgf*cm , 17 ft.*lbf }

for bolt C:

20 N*m{ 204 kgf*cm , 15 ft.*lbf }

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	80 mm (3.15 in.)	10 mm (0.394 in.)
Bolt B	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt C	25 mm (0.984 in.)	8 mm (0.315 in.)



39. INSTALL FRONT CRANKSHAFT OIL SEAL

a. Apply MP grease to the lip of a new oil seal.

b. Using SST and a hammer, tap in the oil seal to a depth between 0 and 1.0 mm (0 and 0.0394 in.) from the timing chain cover edge.

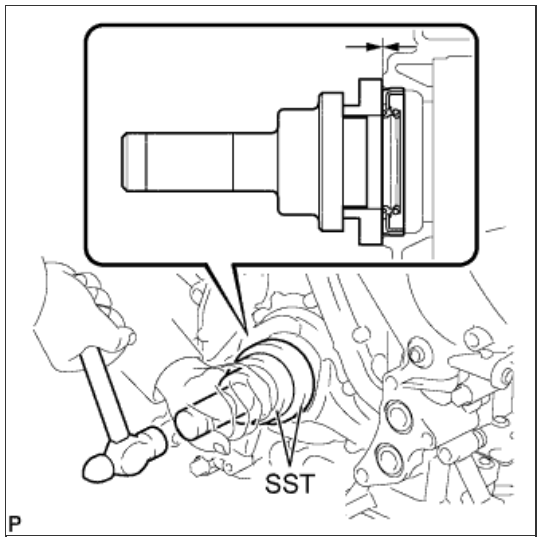
SST

09223-22010

09506-35010

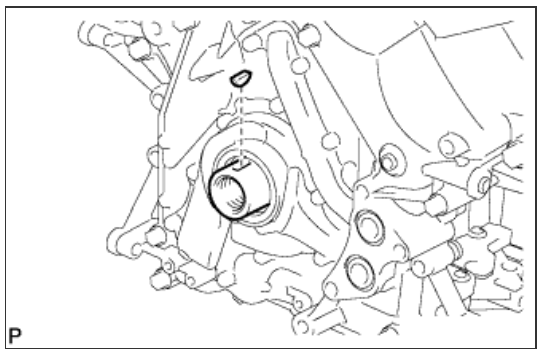
NOTICE:

- **Keep the lip free from foreign matter.**
- **Do not tap the oil seal at an angle.**



40. INSTALL CRANKSHAFT TIMING GEAR KEY

a. Install the crankshaft timing gear key to the crankshaft.



41. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

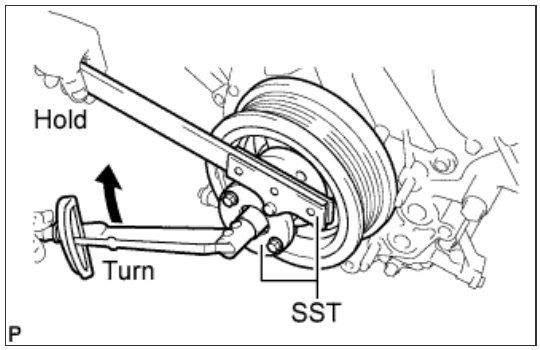
b. Using SST, install the pulley set bolt.

SST

09213-70011 (09213-70020)

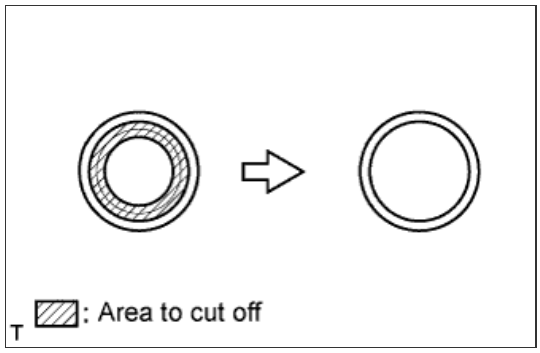
09330-00021

Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



42. INSTALL SPARK PLUG TUBE GASKET

a. Using a cutter knife, cut off the seal part of the removed gasket.



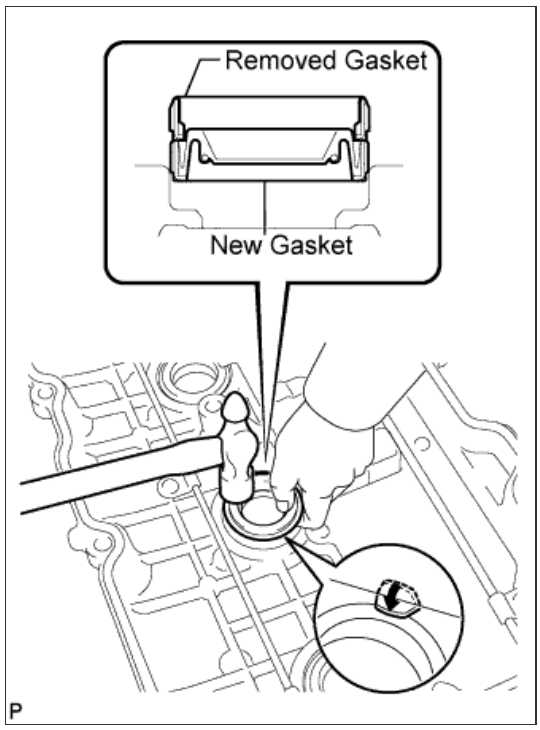
b. Using the removed gasket and a hammer, tap in a new gasket until it stops.

HINT:

If the removed gasket does not fit on the new one, correct the removed one with pliers.

c. Apply a light coat of MP grease to the lip of the gasket.

d. Return the 4 ventilation baffle plate claws to the original positions.



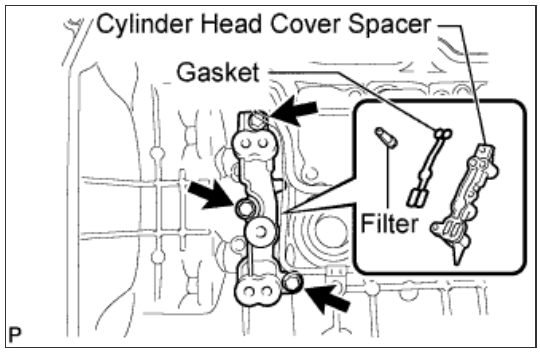
43. INSTALL OIL CONTROL VALVE FILTER

a. LH:

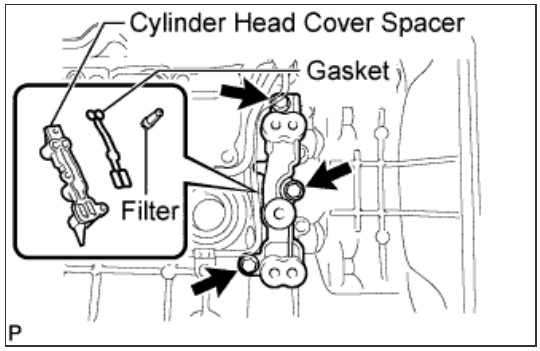
i. Install the filter in the cylinder head.

ii. Install a new gasket and the cylinder head cover spacer with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



b. RH:



i. Install the filter in the cylinder head.

ii. Install a new gasket and the cylinder head cover spacer with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

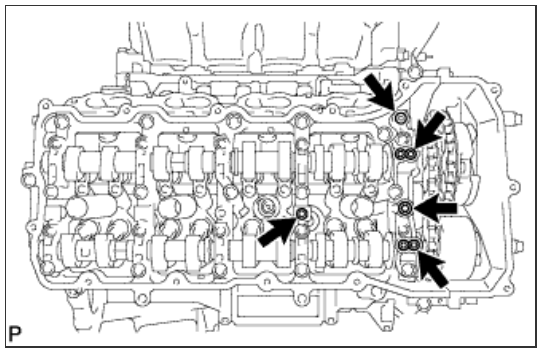
44. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY RH

a. Install 5 new gaskets to the camshaft bearing caps. (No. 1, No. 3).

b. Install a new gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

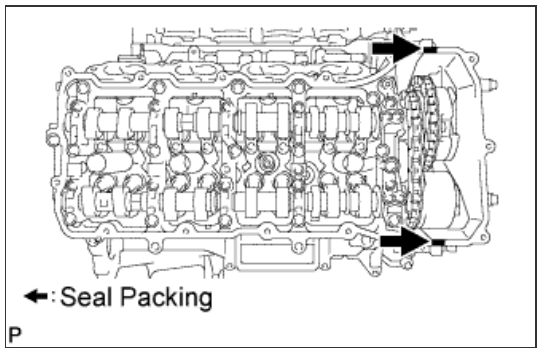


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

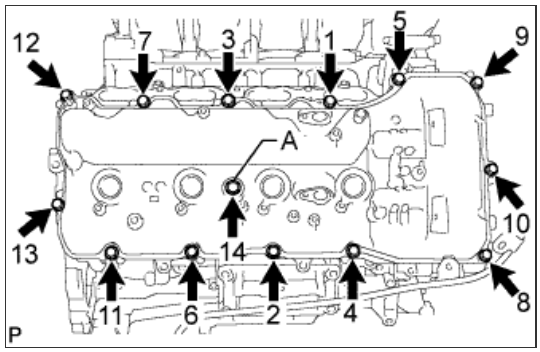
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



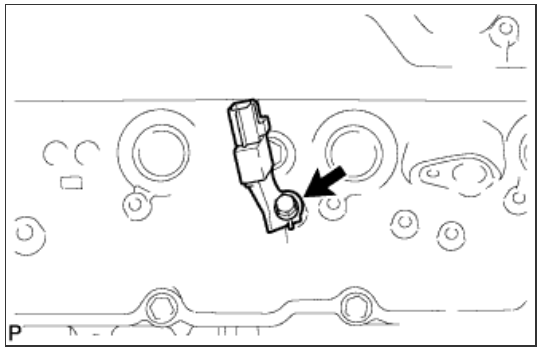
d. Install the cylinder head cover and a new seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



e. Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }



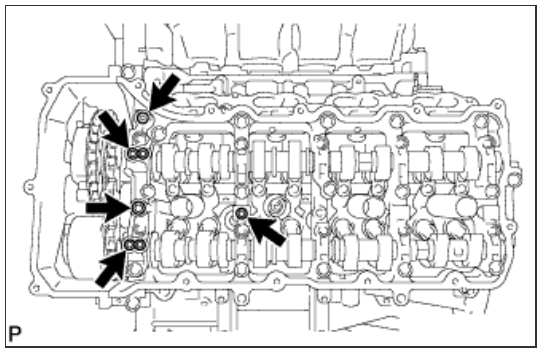
45. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY LH

a. Install 5 new gaskets to the camshaft bearing caps (No. 2, No. 3).

b. Install a new gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

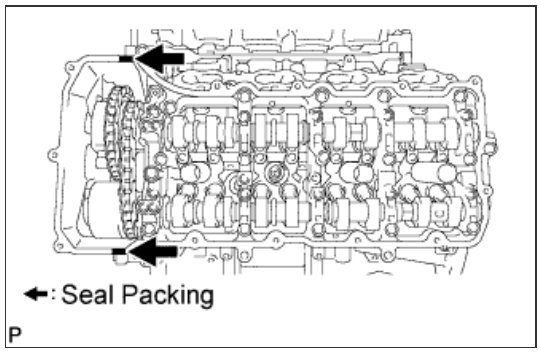


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

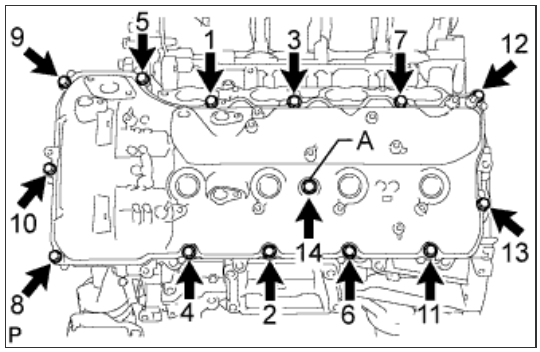
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



d. Install the cylinder head cover and a new seal washer with the 14 bolts in the order shown in the illustration.

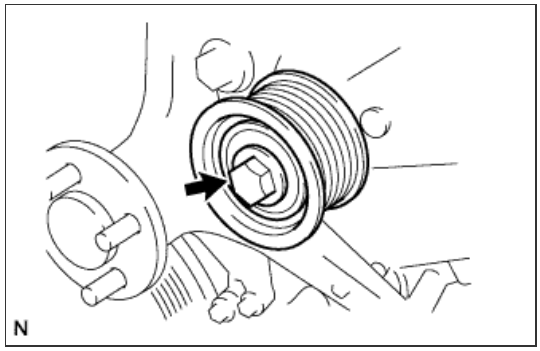
Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



46. INSTALL NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Install the idler pulley with the bolt.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



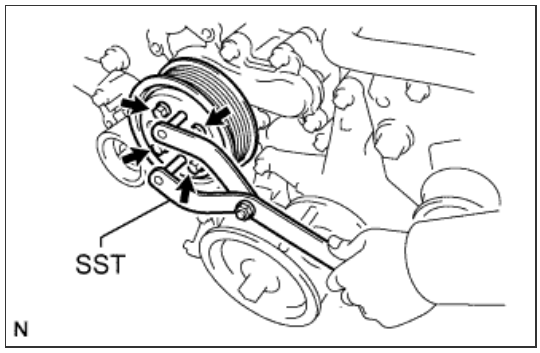
47. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.

SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



48. INSTALL CAMSHAFT OIL CONTROL VALVE ASSEMBLY

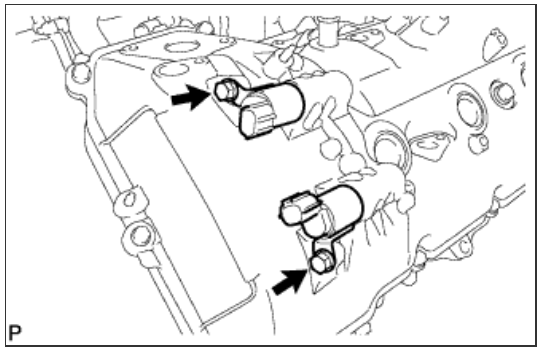
a. for Bank 1:

i. Apply a light coat of engine oil to 2 new O-rings.

ii. Install the 2 O-rings to the 2 oil control valves.

iii. Install the 2 oil control valves with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



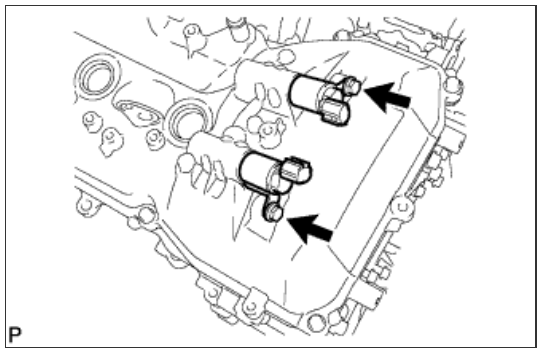
b. for Bank 2:

i. Apply a light coat of engine oil to 2 new O-rings.

ii. Install the 2 O-rings to the 2 oil control valves.

iii. Install the 2 oil control valves with the 2 bolts.

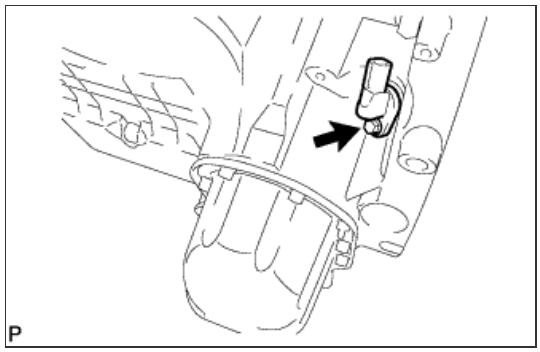
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



49. INSTALL CRANKSHAFT POSITION SENSOR

a. Install the crankshaft position sensor with the bolt.

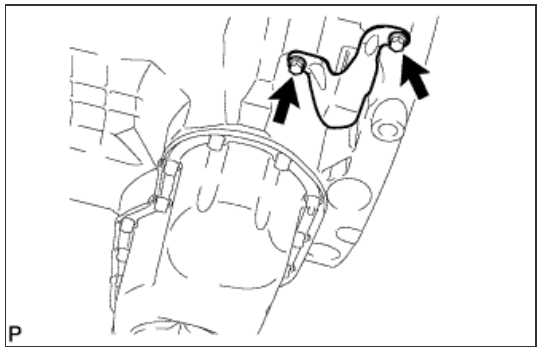
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



50. INSTALL CRANK POSITION SENSOR PROTECTOR

a. Install the sensor protector with the 2 bolts.

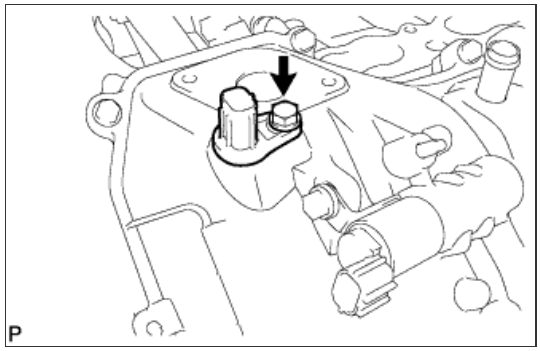
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



51. INSTALL CAMSHAFT POSITION SENSOR

a. Install the camshaft position sensor with the bolt.

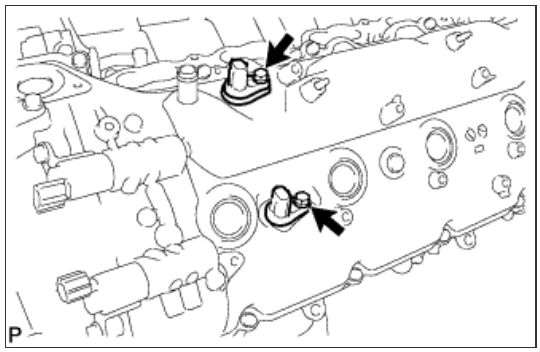
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



52. INSTALL VVT SENSOR

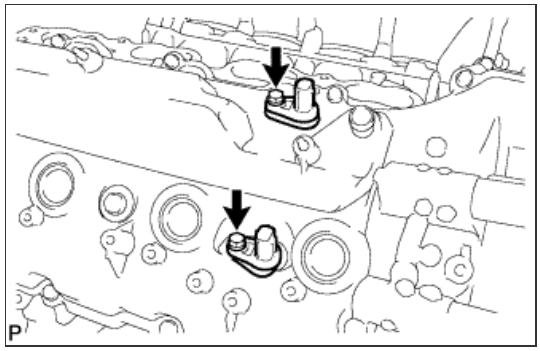
a. for Bank 1:
Install the 2 VVT sensors with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



b. for Bank 2:
Install the 2 VVT sensors with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



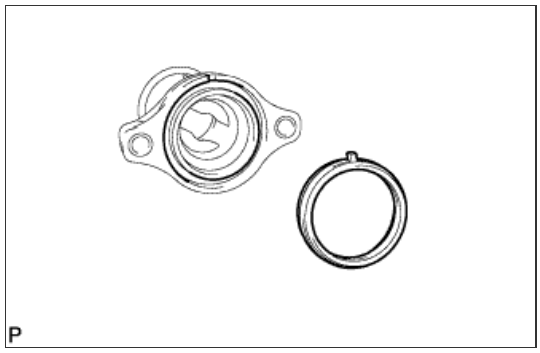
53. INSTALL SPARK PLUG

a. Using a 16 mm plug wrench, install the 8 spark plugs.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

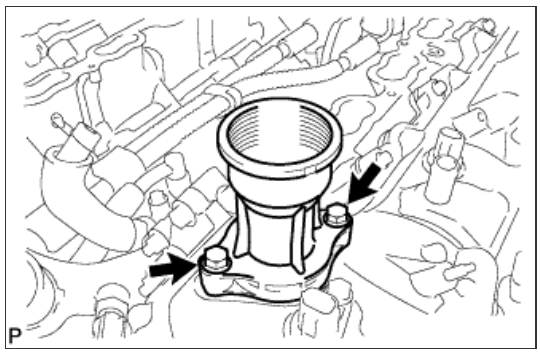
54. INSTALL OIL FILLER CAP HOUSING

a. Align the protrusion of a new gasket with the cutout of the oil filler cap housing, and install the gasket to the housing.



b. Install the cap housing with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

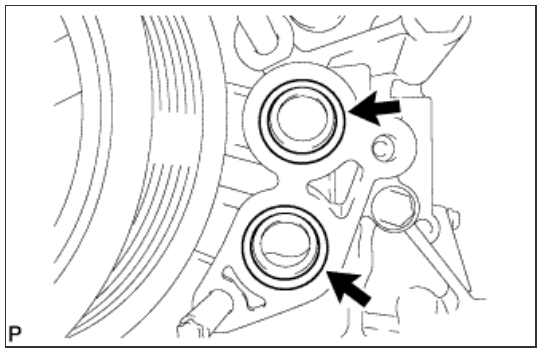


55. INSTALL OIL FILLER CAP SUB-ASSEMBLY

56. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

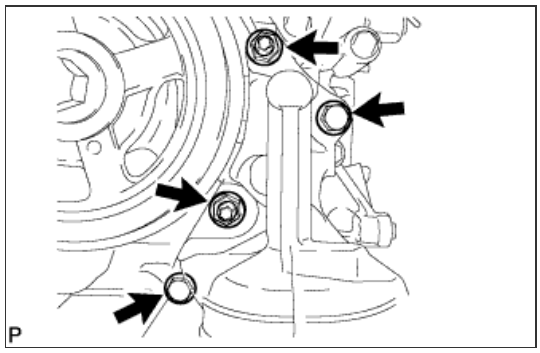
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

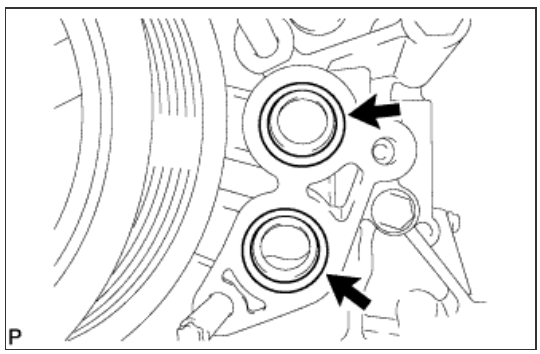
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



57. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

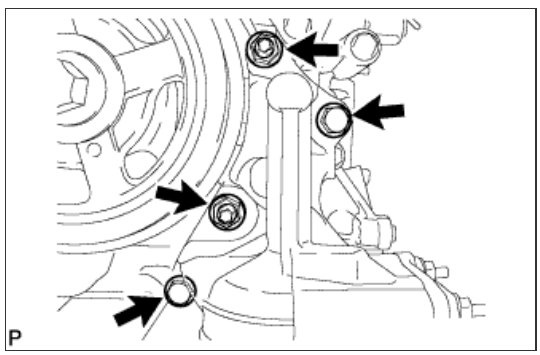
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



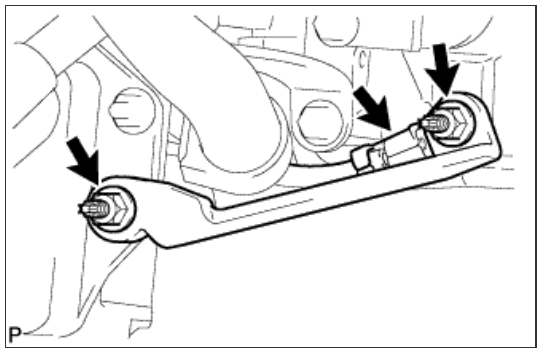
58. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block

d. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



59. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

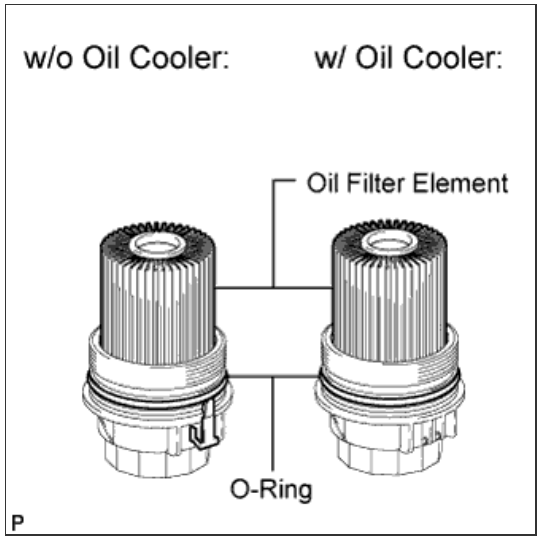
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



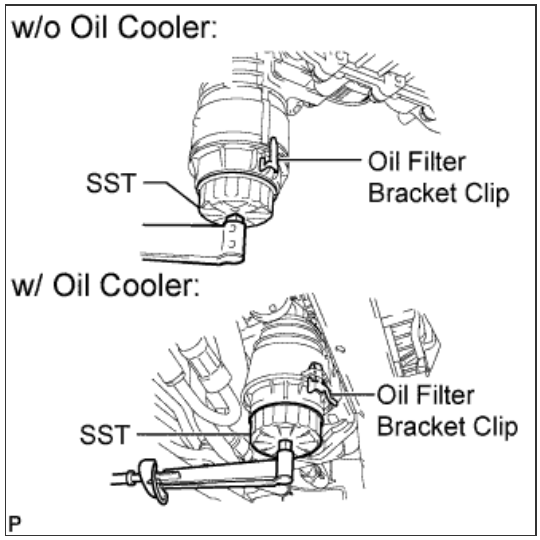
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

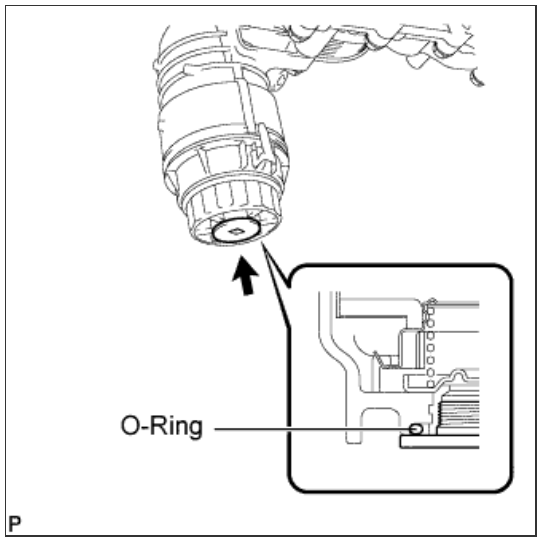
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

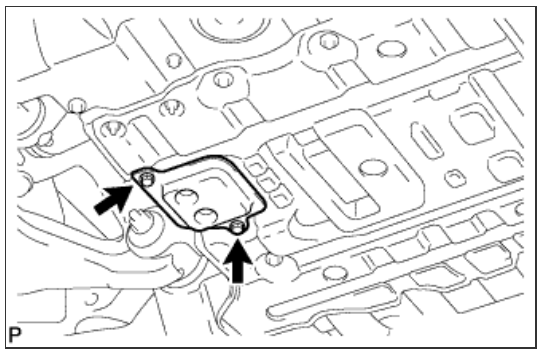
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

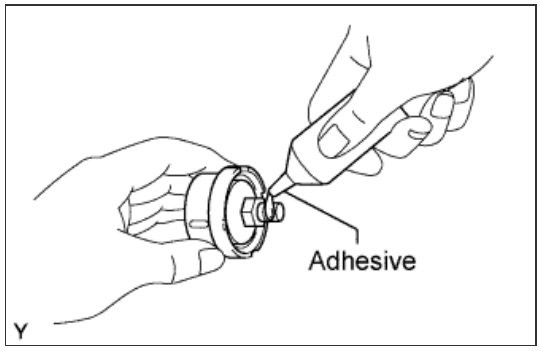
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



60. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

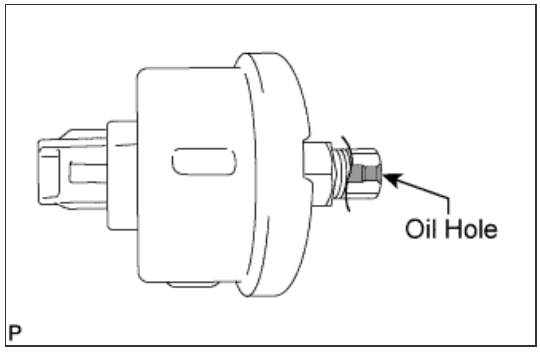
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.



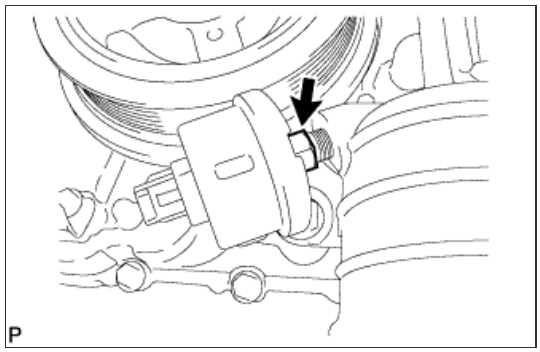
b. Install the oil pressure sender gauge.

Torque:

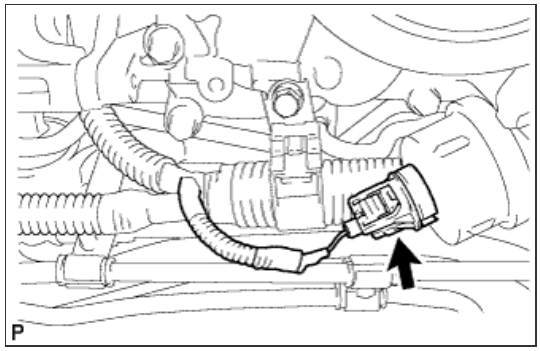
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



for Preparation Click here

1. INSTALL NOISE FILTER

a. RH:
Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }

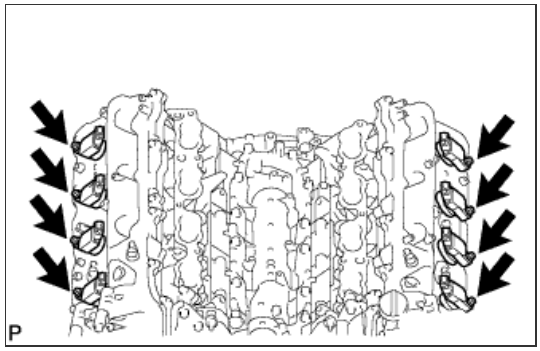
b. LH:
Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }

2. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

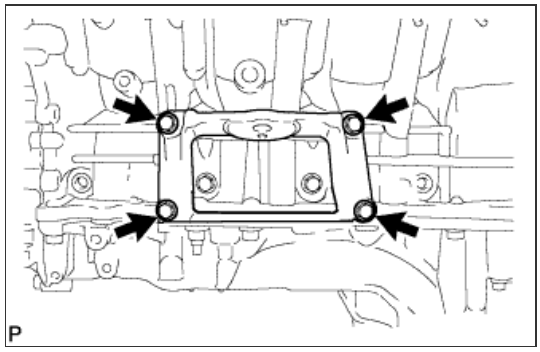
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



3. INSTALL FRONT NO. 1 ENGINE MOUNTING BRACKET LH

a. Install the mounting bracket with the 4 bolts.

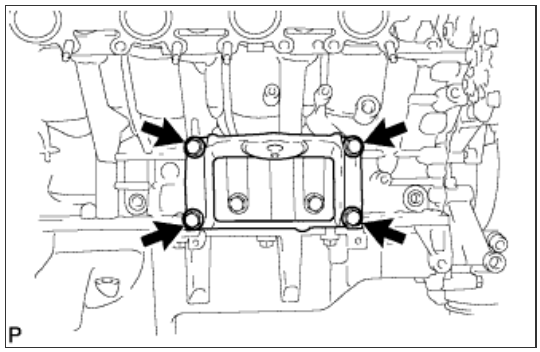
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



4. INSTALL FRONT NO. 1 ENGINE MOUNTING BRACKET RH

a. Install the mounting bracket with the 4 bolts.

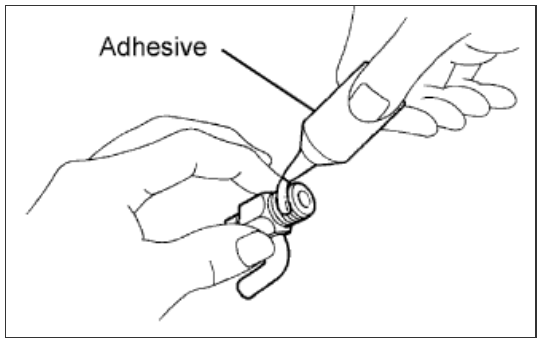
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



5. INSTALL CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY

a. Apply adhesive to 2 or 3 threads of the drain cocks.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



b. Install the water drain cocks as shown in the illustration.

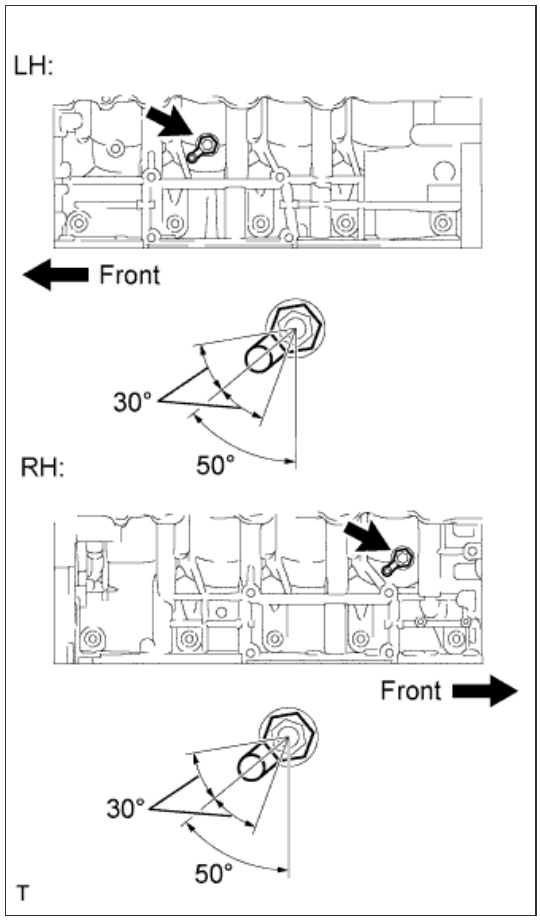
Torque:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not rotate the drain cocks more than 1 revolution (360°) after tightening the drain cocks to the specified torque.**
- **Do not loosen the drain cocks to adjust them. If an adjustment is necessary, remove the drain cocks and reinstall them.**

c. Install the water drain cock plugs to the water drain cocks.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }



6. INSTALL KNOCK SENSOR

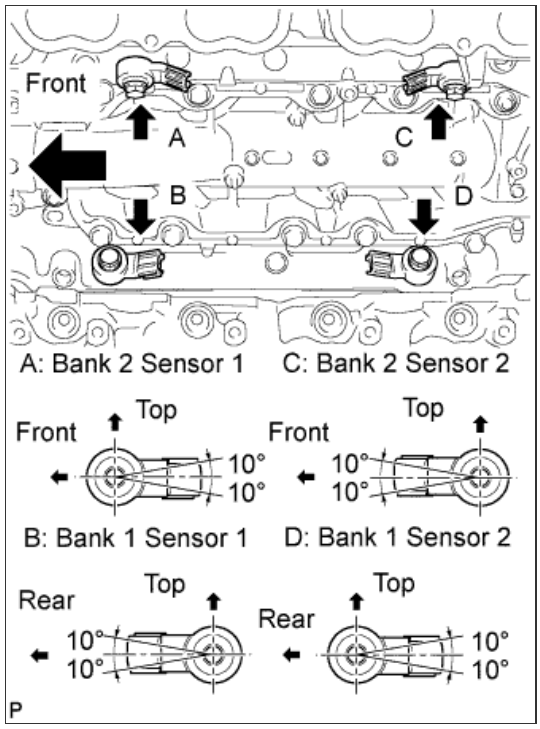
a. Install the 4 sensors with the 4 bolts so that the sensors are angled as shown in the illustration.

Torque:

20 N*m{ 204 kgf*cm , 15 ft.*lbf }

NOTICE:

The acceptable installation angle of the sensor is between 10° upward and downward from the horizontal position.



7. INSTALL SEPARATOR CASE

a. After inserting the pipe on the rear of the separator case into the oil return pipe and the pipe on the front into the ventilation pipe, temporarily install bolt A.

b. Temporarily install bolt B and tighten bolt A.

Torque:

10 N*m{ 102 kgf*cm , 7 ft.*lbf }

c. Install the bolts labeled C.

Torque:

10 N*m{ 102 kgf*cm , 7 ft.*lbf }

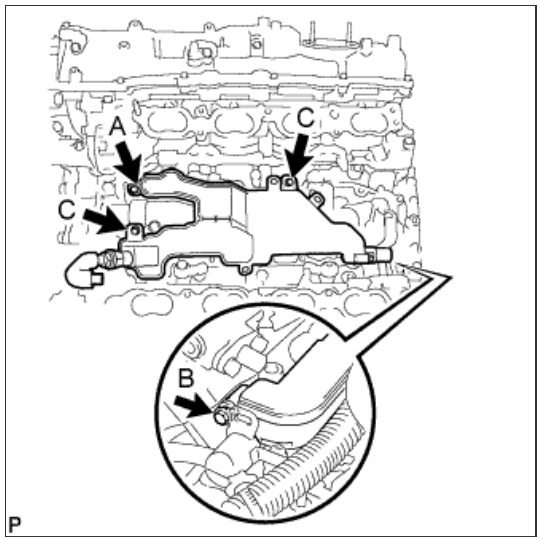
d. Tighten bolt B.

Torque:

10 N*m{ 102 kgf*cm , 7 ft.*lbf }

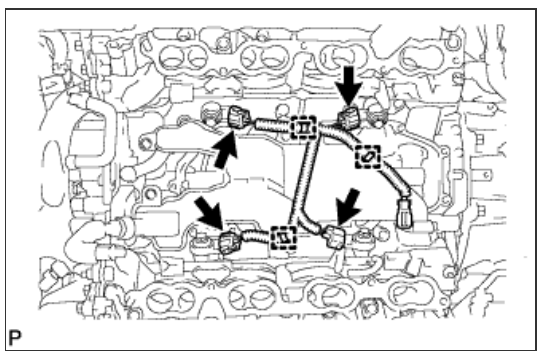
Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	6 mm (0.236 in.)
Bolt B and C	16 mm (0.630 in.)	6 mm (0.236 in.)



8. INSTALL SENSOR WIRE

a. Connect the 3 clamps and 4 knock sensor connectors.



9. INSTALL NO. 3 AIR TUBE

a. Install a new gasket and the No. 3 air tube with the 2 bolts.

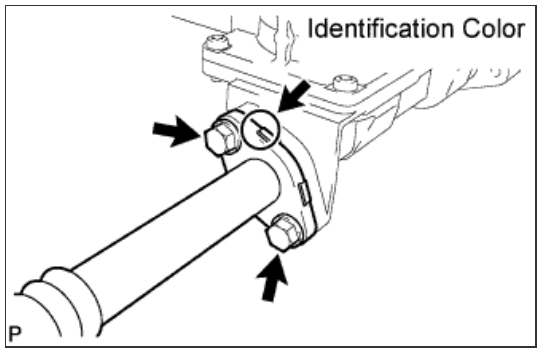
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is orange.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.



10. INSTALL NO. 2 AIR TUBE

a. Install a new gasket and the No. 2 air tube with the 2 bolts.

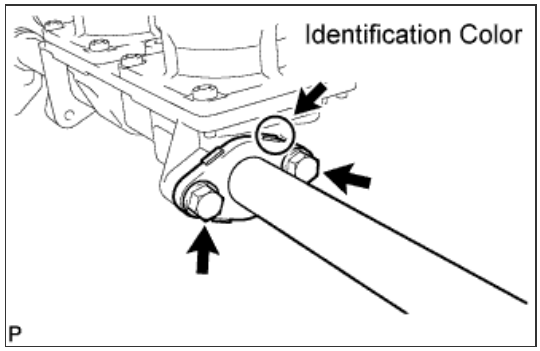
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is blue.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.

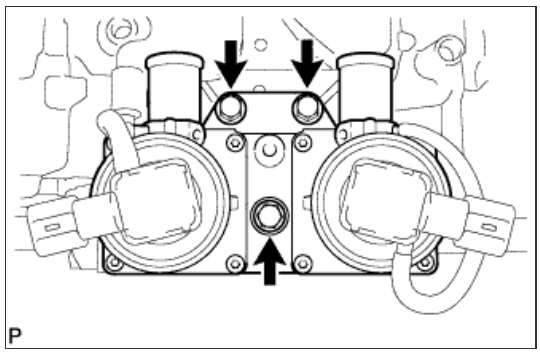


11. INSTALL AIR SWITCHING VALVE ASSEMBLY

a. Install the air switching valve with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

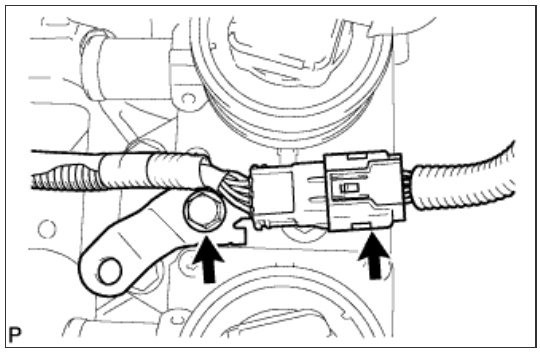
b. Connect the 2 air switching valve connectors.



c. Install the bracket with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

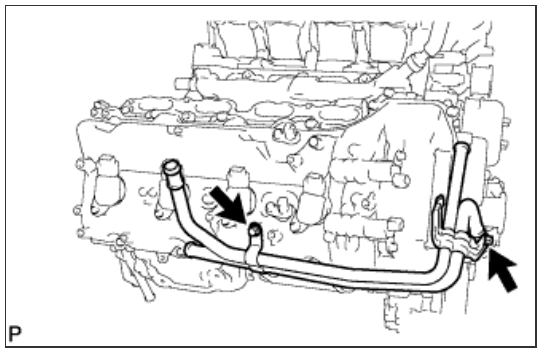
d. Connect the knock sensor connector.



12. INSTALL WATER BY-PASS PIPE SUB-ASSEMBLY

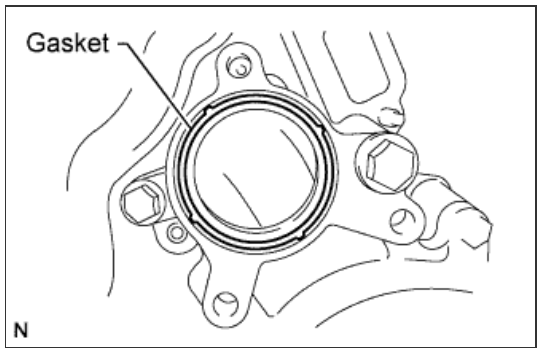
a. Install the water by-pass pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



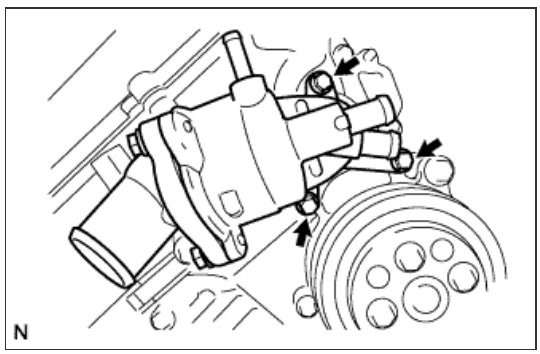
13. INSTALL WATER INLET HOUSING

a. Install a new gasket to the timing chain cover.



b. Install the water inlet with the 3 bolts.

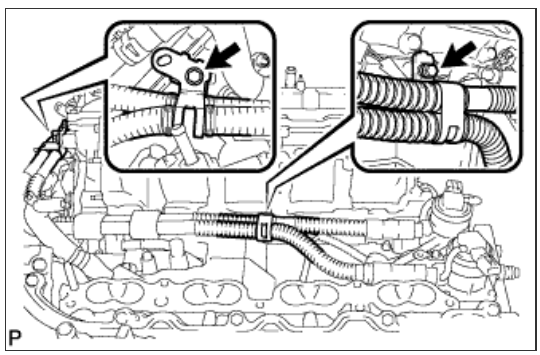
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



14. INSTALL AIR PIPE SUB-ASSEMBLY

a. Install the 2 No. 1 air hoses and air pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

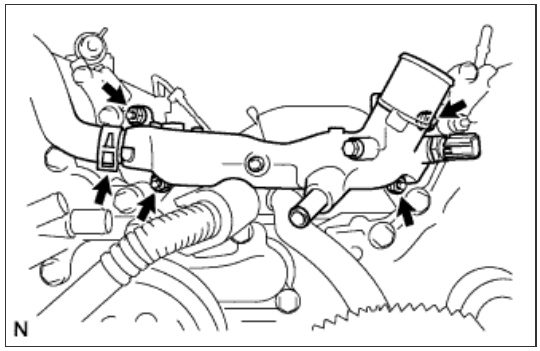


15. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the water by-pass joint with the 4 nuts.

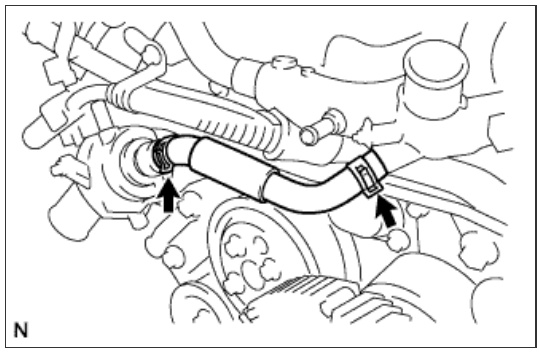
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the No. 2 water by-pass hose to the water by-pass joint.



16. INSTALL NO. 1 WATER BY-PASS HOSE

a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.

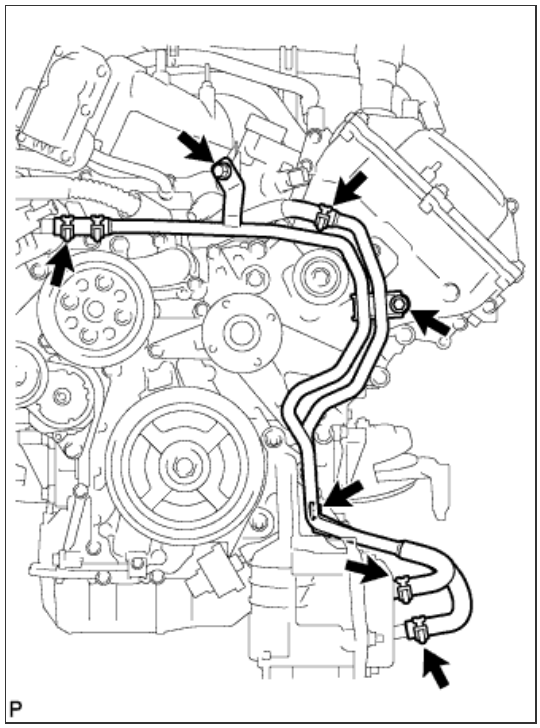


17. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



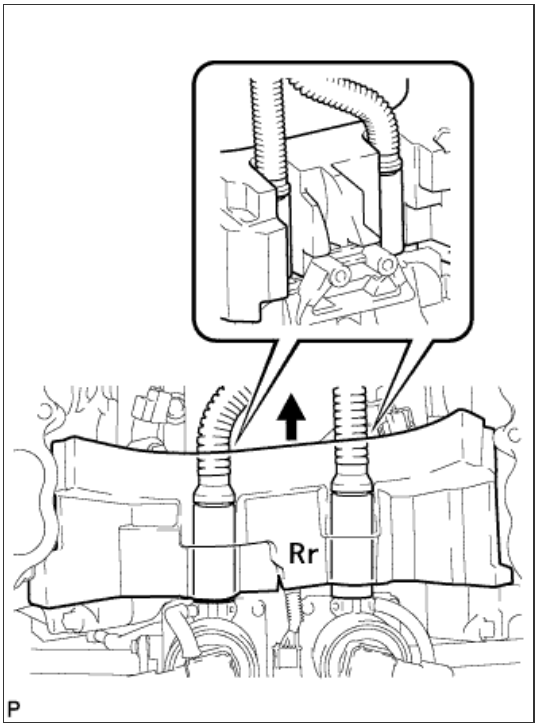
18. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



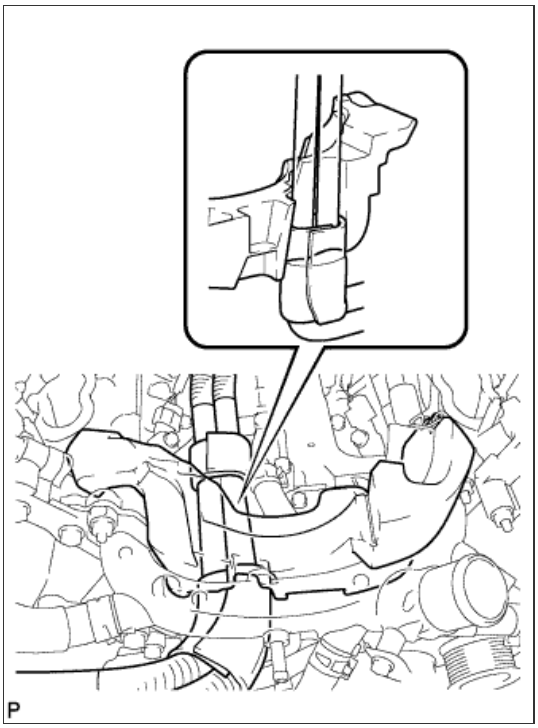
19. INSTALL NO. 2 ENGINE COVER

HINT:

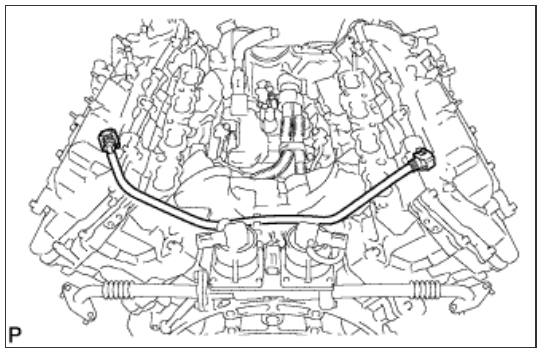
- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.



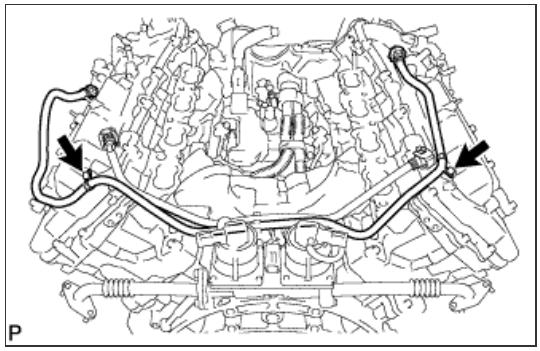
20. INSTALL NO. 1 FUEL TUBE



21. INSTALL NO. 2 FUEL TUBE

a. Install the No. 2 fuel tube with the 2 bolts.

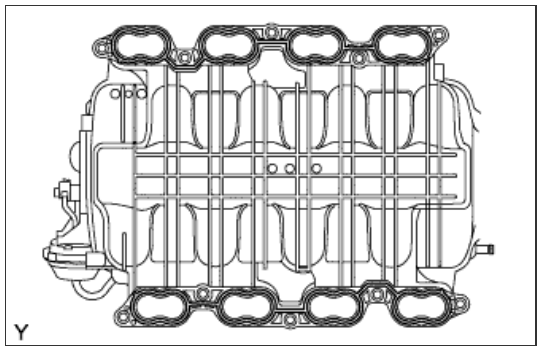
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



22. INSTALL INTAKE MANIFOLD

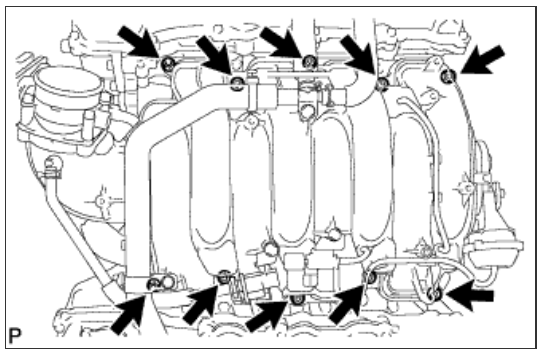
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



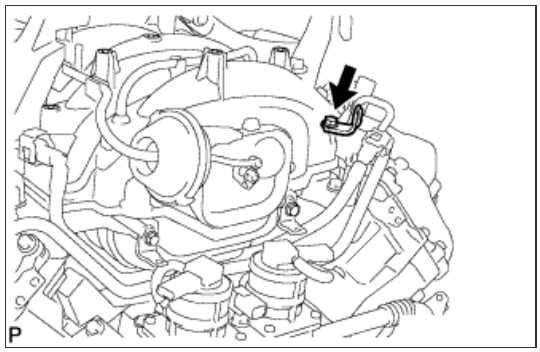
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

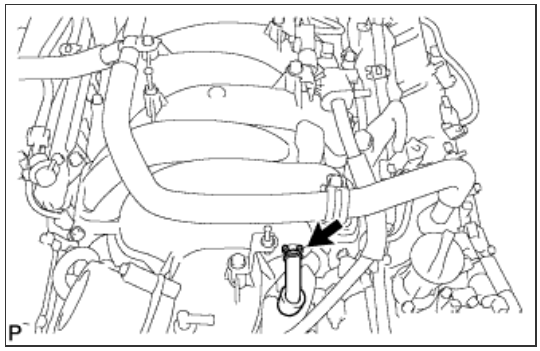


d. Install the wire bracket to the intake manifold with the bolt.

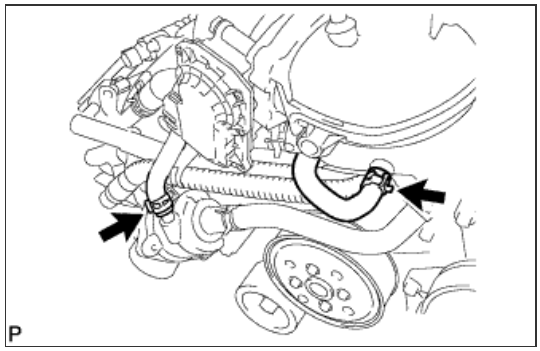
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



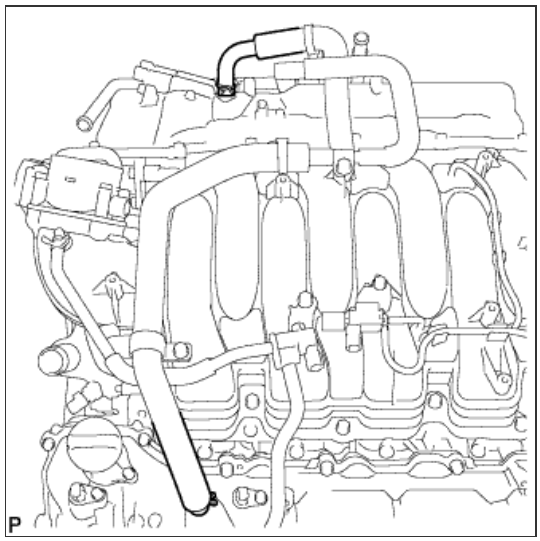
e. Connect the No. 1 ventilation hose.



f. Connect the 2 water by-pass hoses.

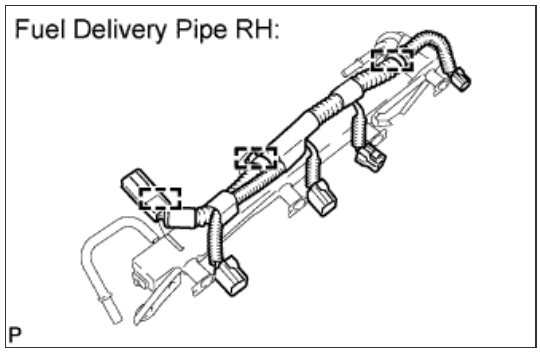


g. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.

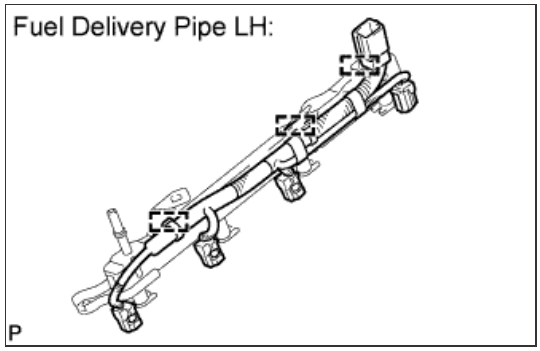


23. INSTALL FUEL INJECTOR ASSEMBLY

a. Attach the 3 clamps to install the No. 6 wire harness to the delivery pipe RH.



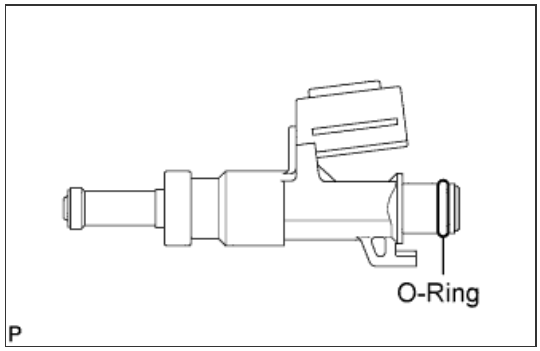
b. Attach the 3 clamps to install the No. 7 wire harness to the delivery pipe LH.



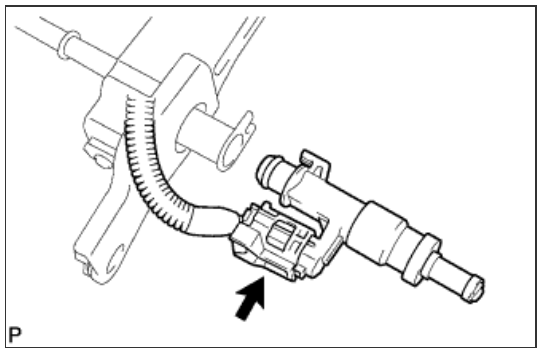
c. Apply gasoline or spindle oil to a new O-ring and install it to the injector.

NOTICE:

Make sure that there is no damage or foreign material in the groove of the injector when installing the O-ring.



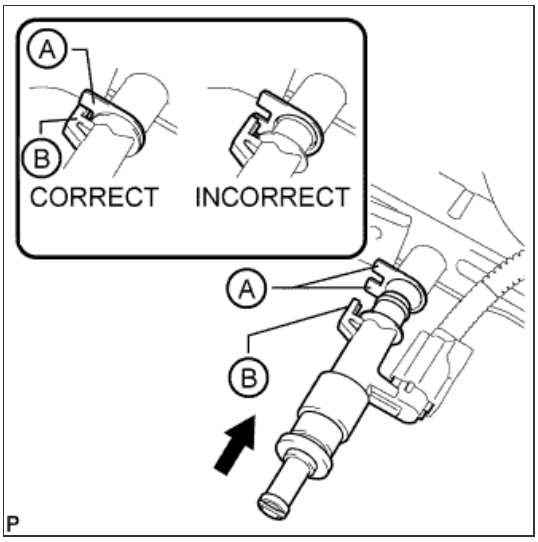
d. Connect the injector connector.



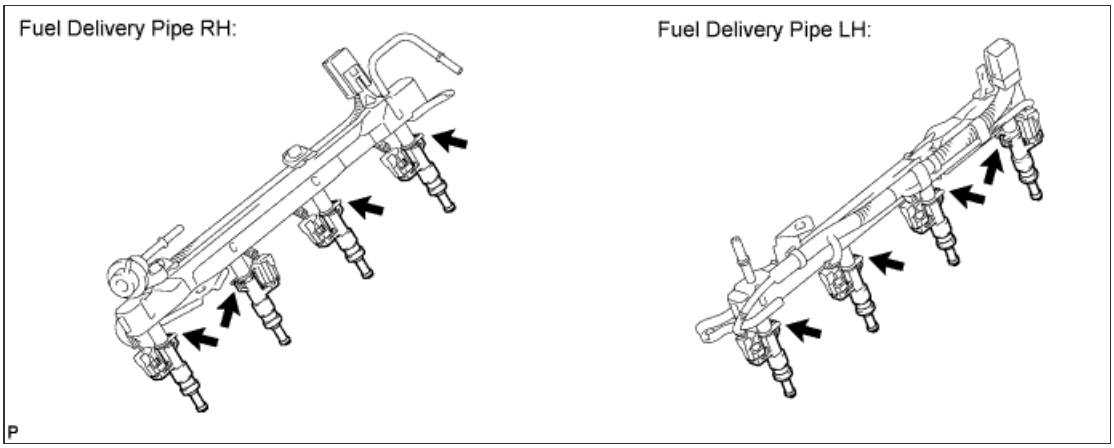
e. Install the injector to the delivery pipe as shown in the illustration.

NOTICE:

- **Make sure that there are no scratches or foreign matter in or around the insertion hole of the delivery pipe.**
- **When inserting the injector, be careful not to damage the O-ring.**
- **Attach the part of the injector labeled B between the parts of the delivery pipe labeled A.**



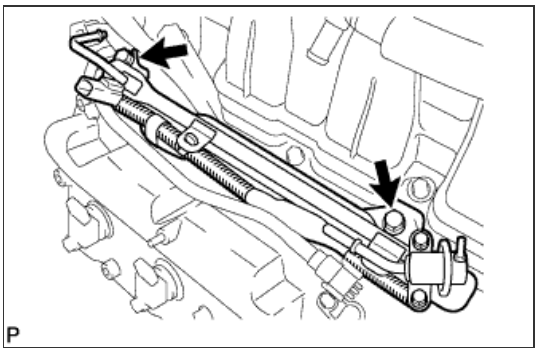
f. Check that each injector is installed to the delivery pipe facing the direction shown in the illustration.



24. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head RH.

b. Install the delivery pipe (with injectors) to the cylinder head RH.

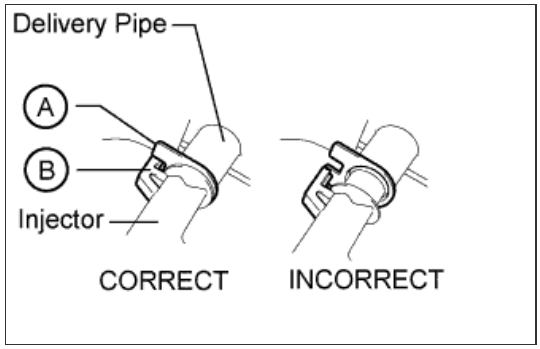


c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

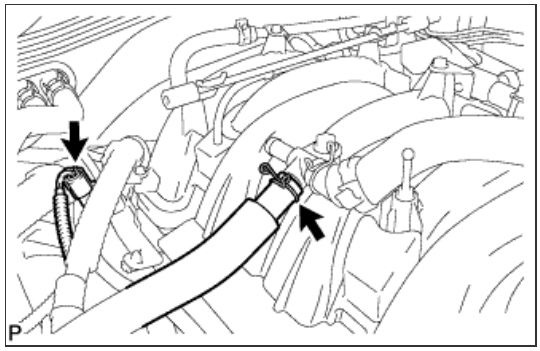
NOTICE:

Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.



d. Connect the No. 6 wire harness connector.

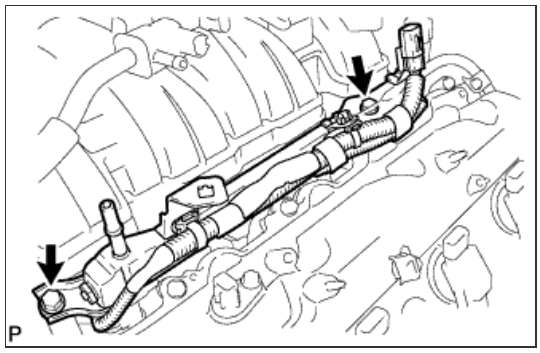
e. Connect the ventilation hose.



25. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head LH.

b. Install the delivery pipe (with injectors) to the cylinder head LH.

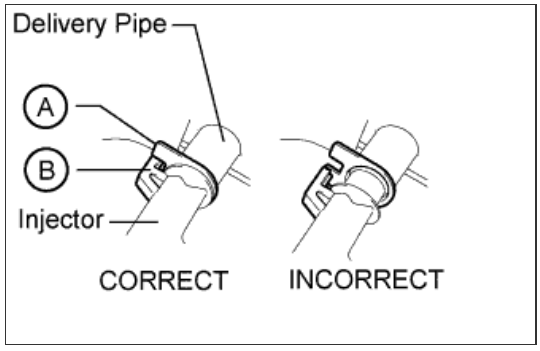


c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

NOTICE:

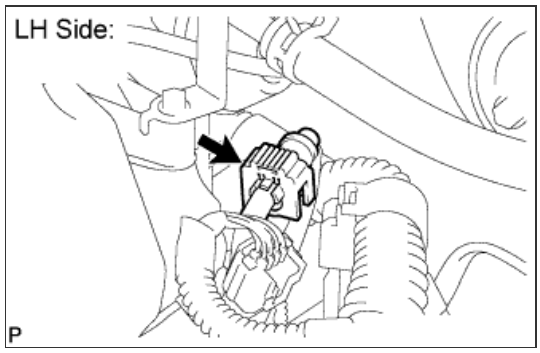
Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.



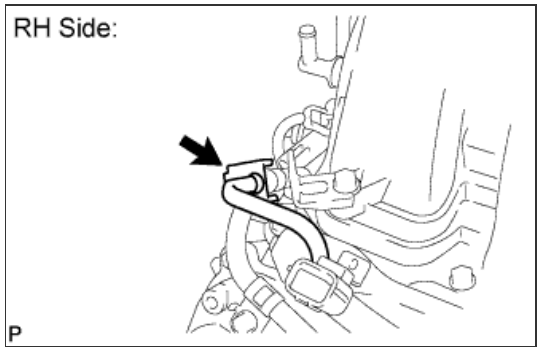
d. Connect the No. 7 wire harness connector.

26. CONNECT NO. 1 FUEL TUBE

a. LH Side:
Connect the No. 1 fuel tube to the delivery pipe LH (Click here).

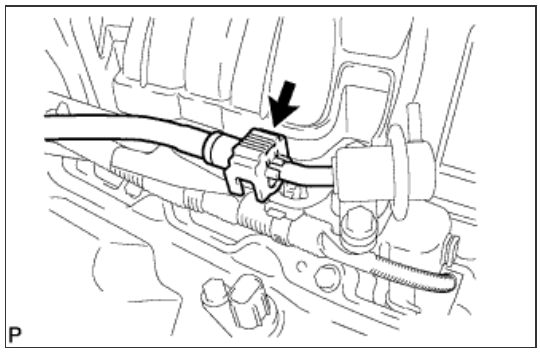


b. RH Side:
Connect the No. 1 fuel tube to the delivery pipe RH (Click here).



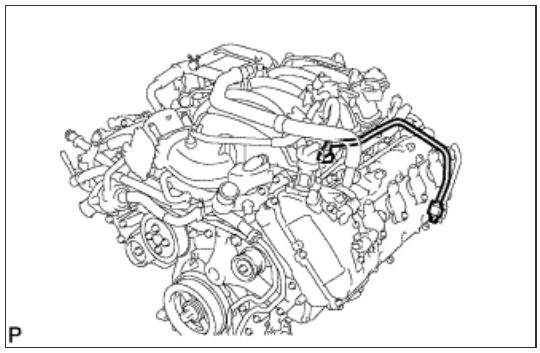
27. CONNECT NO. 2 FUEL TUBE

a. Connect the No. 2 fuel tube to the fuel pressure regulator (Click here).



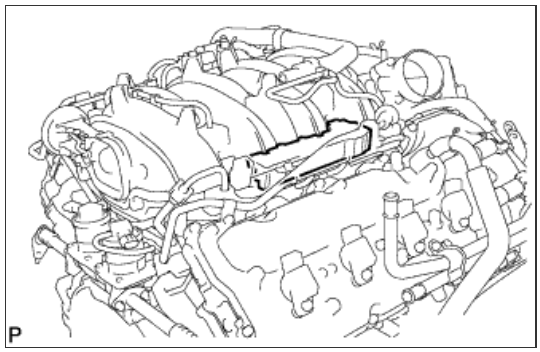
28. INSTALL NO. 1 FUEL HOSE

a. Install the fuel hose (Click here).



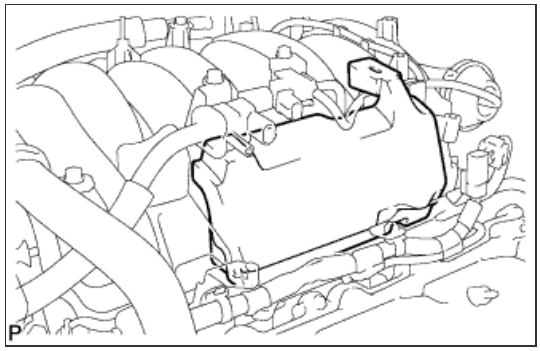
29. INSTALL NO. 3 ENGINE COVER

a. Install the No. 3 engine cover.



30. INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Install the No. 1 engine cover sub-assembly.



31. INSTALL ENGINE WIRE

a. Install the engine wire.

b. Engine Rear Side:

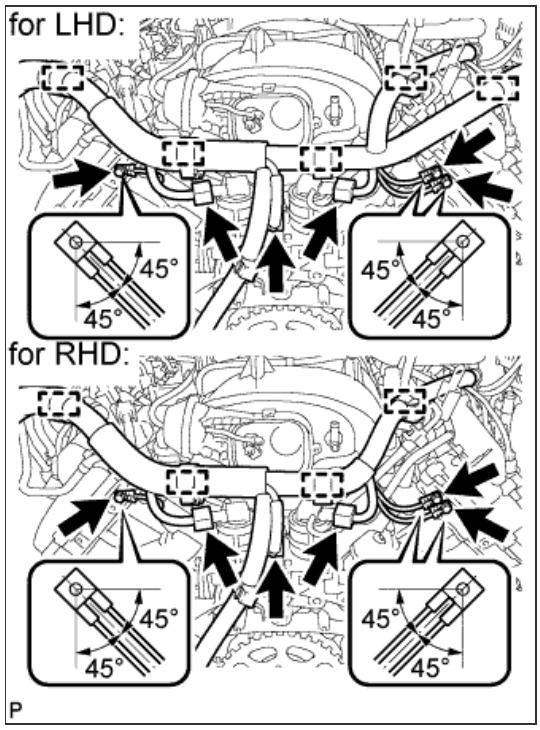
i. Install the 3 bolts as shown in the illustration.

Torque:
8.5 N*m{ 87 kgf*cm , 75 in.*lbf }

ii. for RHD:
Connect the 4 clamps.

iii. for LHD:
Connect the 5 clamps.

iv. Connect the 2 air switching valve connectors.



c. Engine RH Side:

i. Connect the 9 clamps.

ii. Connect the oil level sensor connector.

iii. Connect the oil pressure sender gauge connector.

iv. Connect the throttle sensor connector.

v. Connect the noise filter connector.

vi. Connect the fuel injector connector.

vii. Connect the 2 VVT sensor connectors.

HINT:

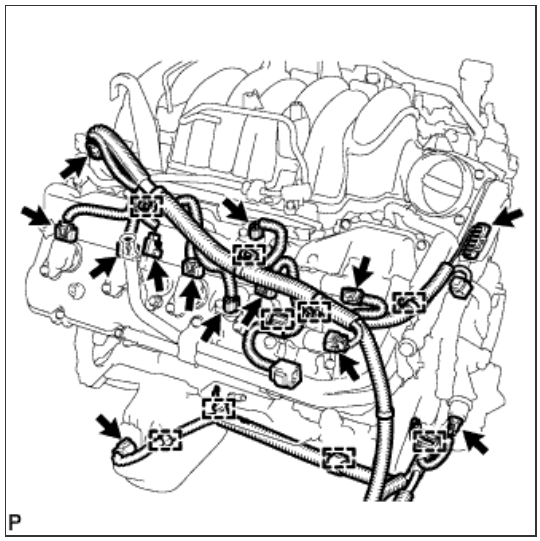
The wire harnesses on the exhaust side are wrapped with white tape.

viii. Connect the 4 ignition coil connectors.

ix. Connect the 2 camshaft timing control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



d. Engine LH Side:

i. Connect the 7 clamps and install the engine wire with the bolt.

Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }

ii. Connect the noise filter connector.

iii. Connect the fuel injector connector.

iv. Connect the engine coolant temperature sensor connector.

v. Connect the purge VSV connector.

vi. Connect the vacuum switching valve connector (for ACIS).

vii. Connect the camshaft position sensor connector.

viii. Connect the 2 VVT sensor connectors.

HINT:

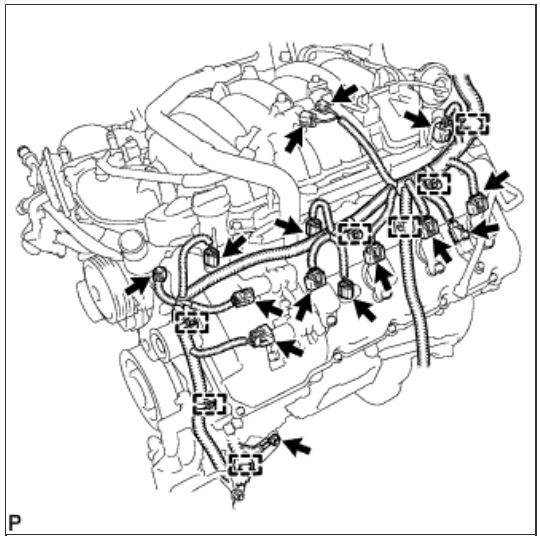
The wire harnesses on the exhaust side are wrapped with white tape.

ix. Connect the 4 ignition coil connectors.

x. Connect the 2 camshaft timing control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



for Preparation Click here

1. INSTALL NOISE FILTER

a. RH:
Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }

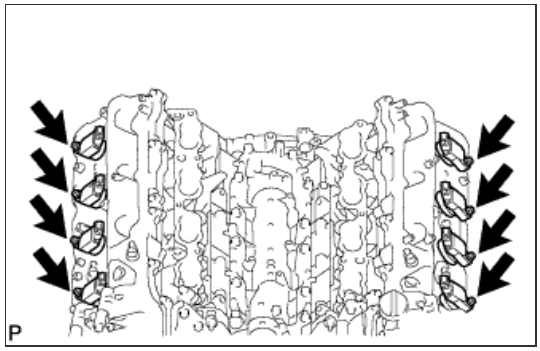
b. LH:
Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }

2. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

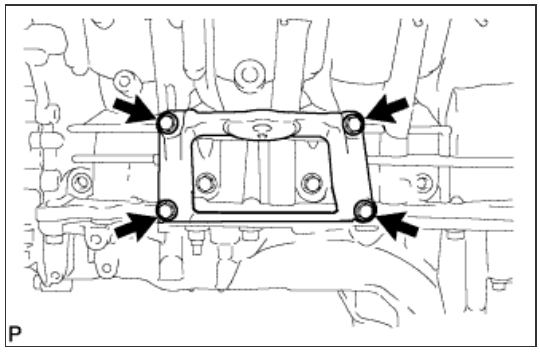
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



3. INSTALL FRONT NO. 1 ENGINE MOUNTING BRACKET LH

a. Install the mounting bracket with the 4 bolts.

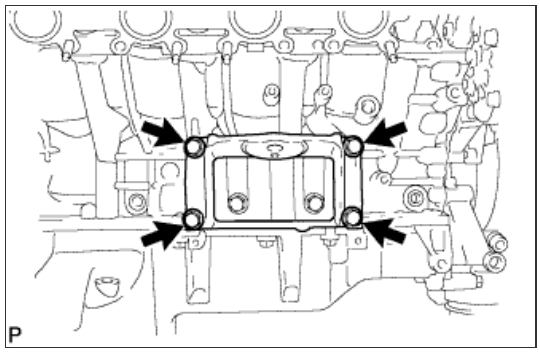
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



4. INSTALL FRONT NO. 1 ENGINE MOUNTING BRACKET RH

a. Install the mounting bracket with the 4 bolts.

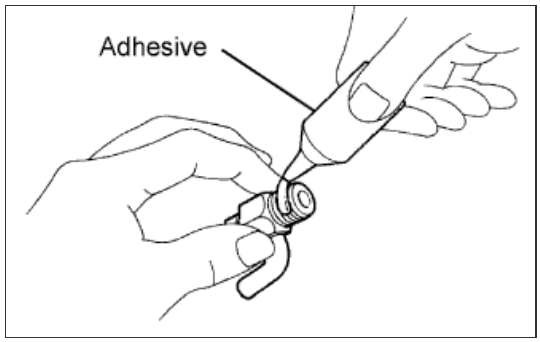
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



5. INSTALL CYLINDER BLOCK WATER DRAIN COCK SUB-ASSEMBLY

a. Apply adhesive to 2 or 3 threads of the drain cocks.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



b. Install the water drain cocks as shown in the illustration.

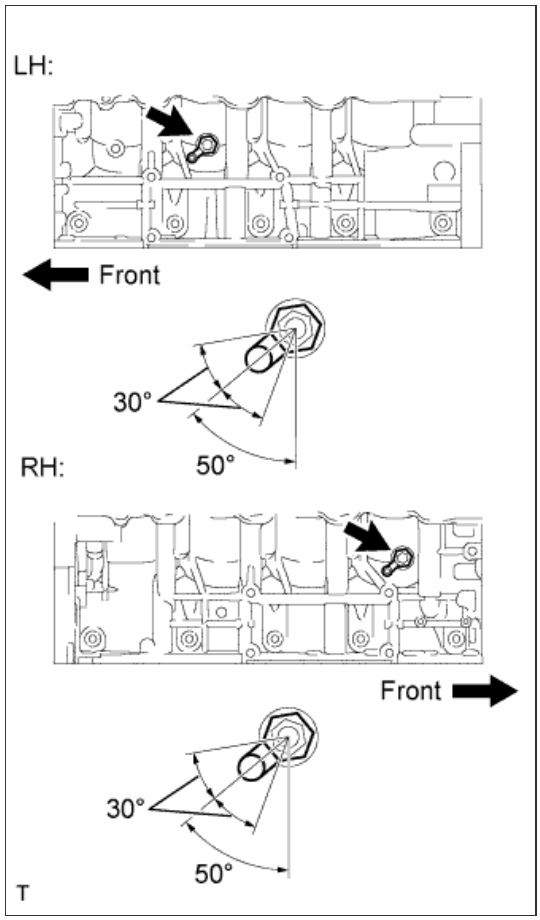
Torque:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

NOTICE:

- **Do not rotate the drain cocks more than 1 revolution (360°) after tightening the drain cocks to the specified torque.**
- **Do not loosen the drain cocks to adjust them. If an adjustment is necessary, remove the drain cocks and reinstall them.**

c. Install the water drain cock plugs to the water drain cocks.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }



6. INSTALL KNOCK SENSOR

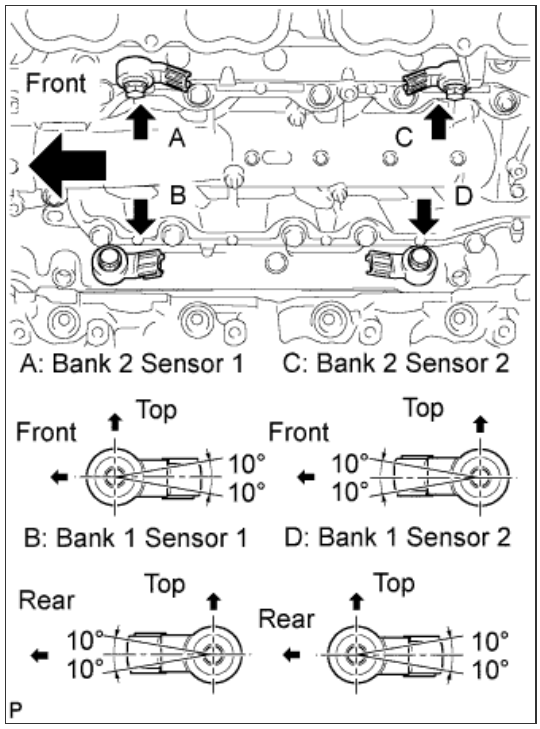
a. Install the 4 sensors with the 4 bolts so that the sensors are angled as shown in the illustration.

Torque:

20 N*m{ 204 kgf*cm , 15 ft.*lbf }

NOTICE:

The acceptable installation angle of the sensor is between 10° upward and downward from the horizontal position.



7. INSTALL SEPARATOR CASE

a. After inserting the pipe on the rear of the separator case into the oil return pipe and the pipe on the front into the ventilation pipe, temporarily install bolt A.

b. Temporarily install bolt B and tighten bolt A.

Torque:

10 N*m{ 102 kgf*cm , 7 ft.*lbf }

c. Install the bolts labeled C.

Torque:

10 N*m{ 102 kgf*cm , 7 ft.*lbf }

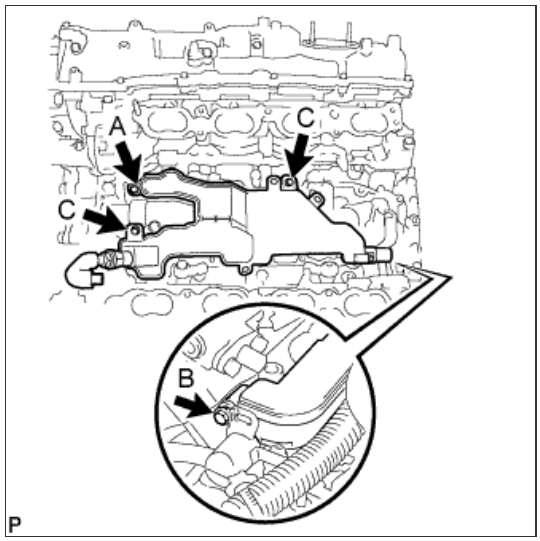
d. Tighten bolt B.

Torque:

10 N*m{ 102 kgf*cm , 7 ft.*lbf }

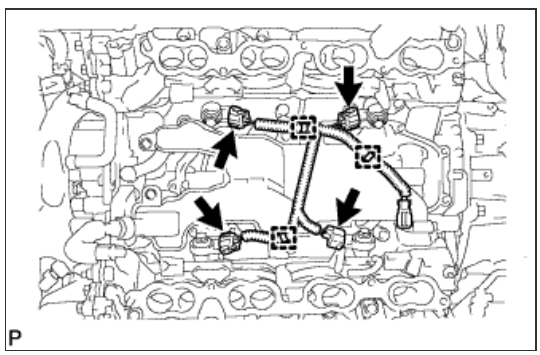
Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	6 mm (0.236 in.)
Bolt B and C	16 mm (0.630 in.)	6 mm (0.236 in.)



8. INSTALL SENSOR WIRE

a. Connect the 3 clamps and 4 knock sensor connectors.



9. INSTALL NO. 3 AIR TUBE (w/ Secondary Air Injection System)

a. Install a new gasket and the No. 3 air tube with the 2 bolts.

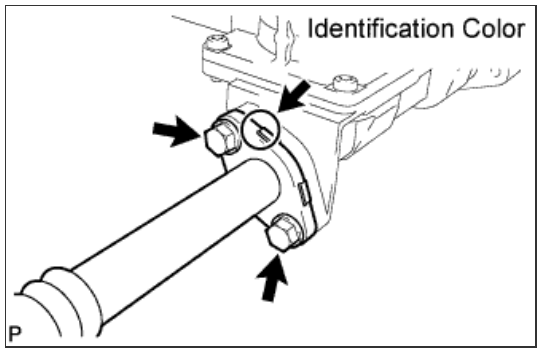
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is orange.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.



10. INSTALL NO. 2 AIR TUBE (w/ Secondary Air Injection System)

a. Install a new gasket and the No. 2 air tube with the 2 bolts.

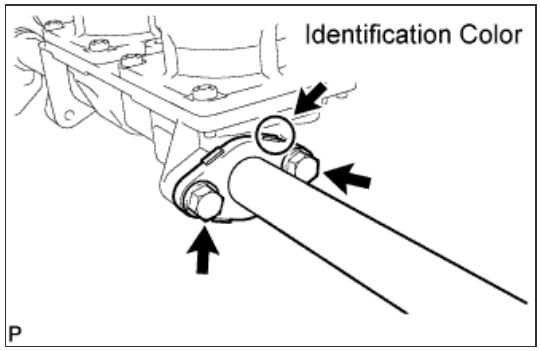
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is blue.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.

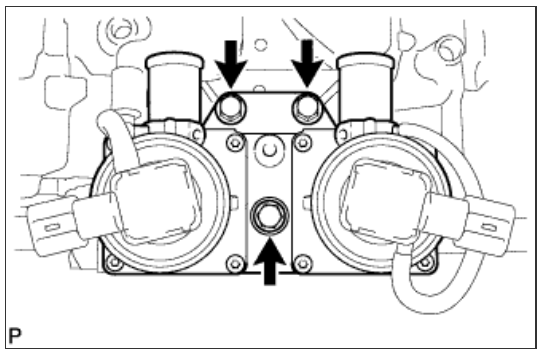


11. INSTALL AIR SWITCHING VALVE ASSEMBLY (w/ Secondary Air Injection System)

a. Install the air switching valve with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

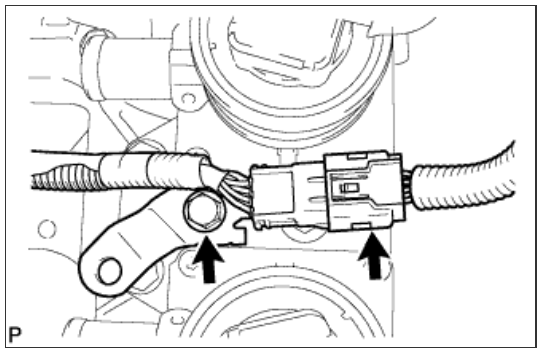
b. Connect the 2 air switching valve connectors.



c. Install the bracket with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

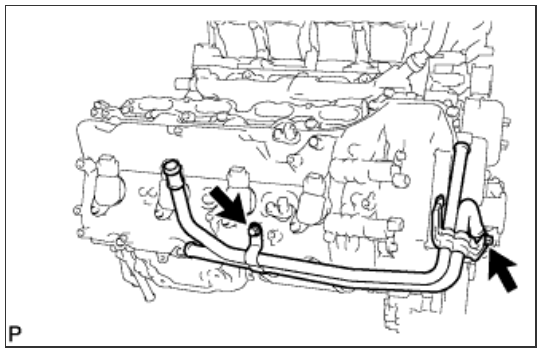
d. Connect the knock sensor connector.



12. INSTALL WATER BY-PASS PIPE SUB-ASSEMBLY

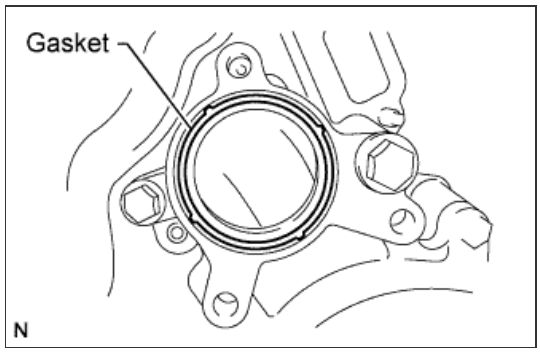
a. Install the water by-pass pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



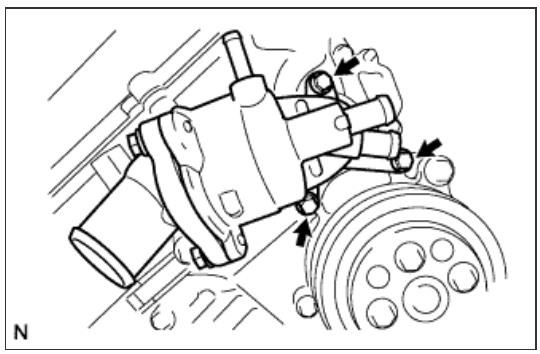
13. INSTALL WATER INLET HOUSING

a. Install a new gasket to the timing chain cover.



b. Install the water inlet with the 3 bolts.

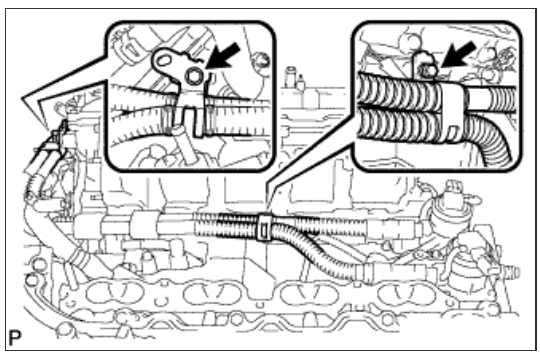
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



14. INSTALL AIR PIPE SUB-ASSEMBLY (w/ Secondary Air Injection System)

a. Install the 2 No. 1 air hoses and air pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

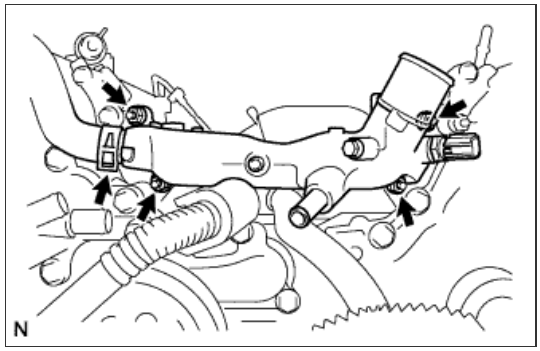


15. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the water by-pass joint with the 4 nuts.

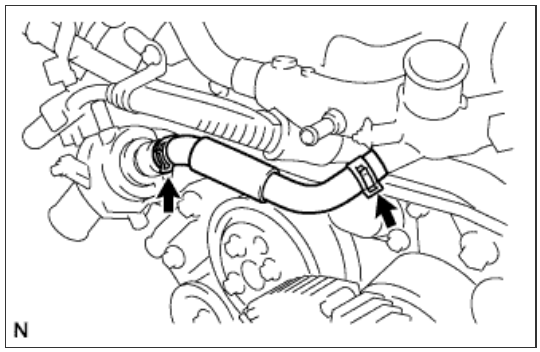
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the No. 2 water by-pass hose to the water by-pass joint.



16. INSTALL NO. 1 WATER BY-PASS HOSE

a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.

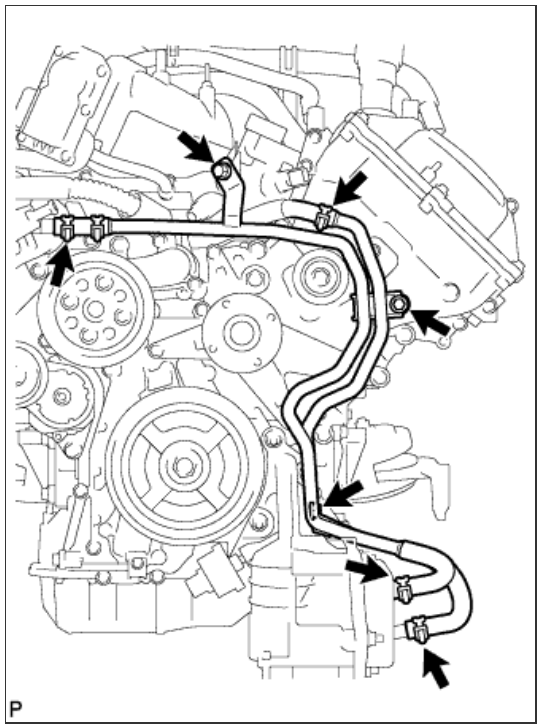


17. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



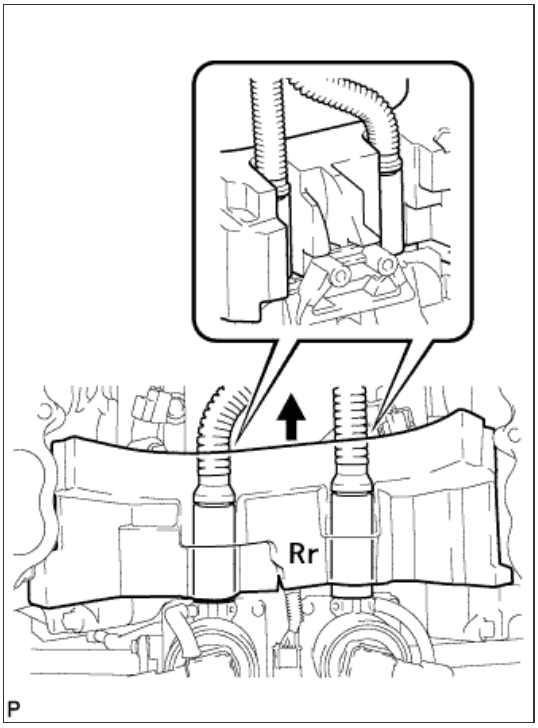
18. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



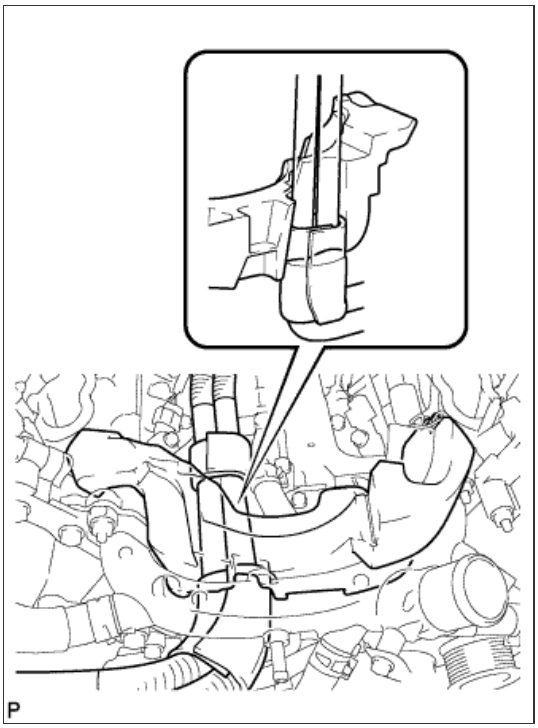
19. INSTALL NO. 2 ENGINE COVER

HINT:

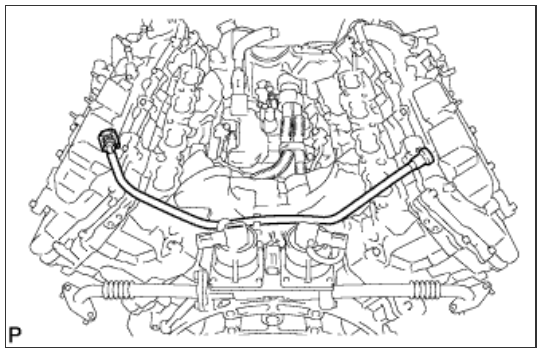
- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.



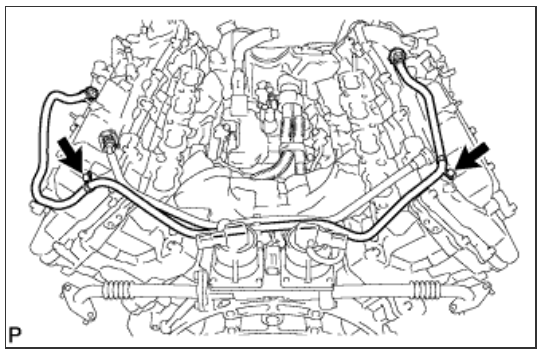
20. INSTALL NO. 1 FUEL TUBE



21. INSTALL NO. 2 FUEL TUBE

a. Install the No. 2 fuel tube with the 2 bolts.

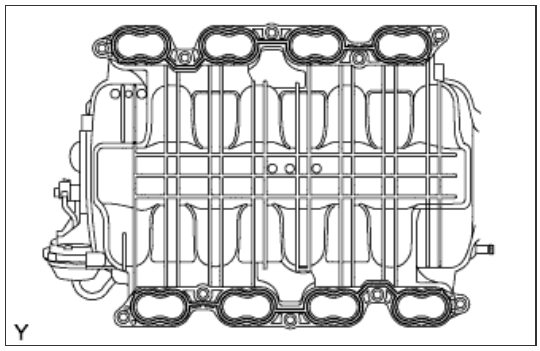
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



22. INSTALL INTAKE MANIFOLD

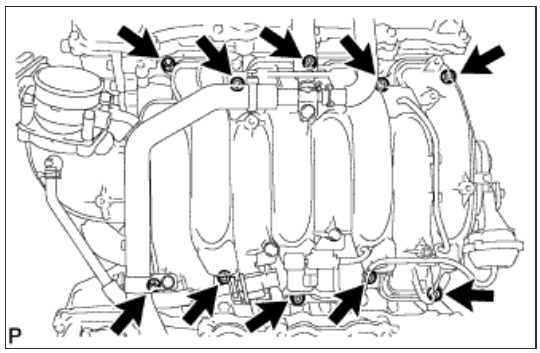
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



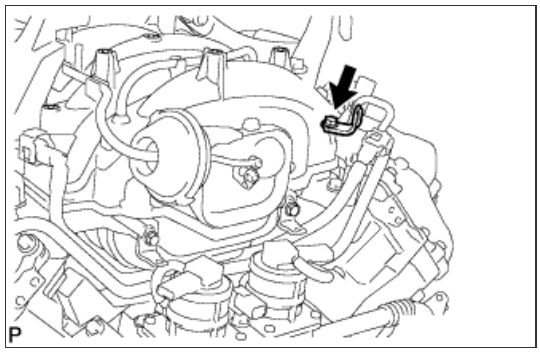
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

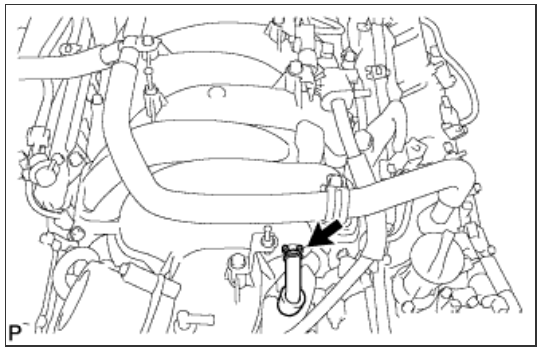


d. Install the wire bracket to the intake manifold with the bolt.

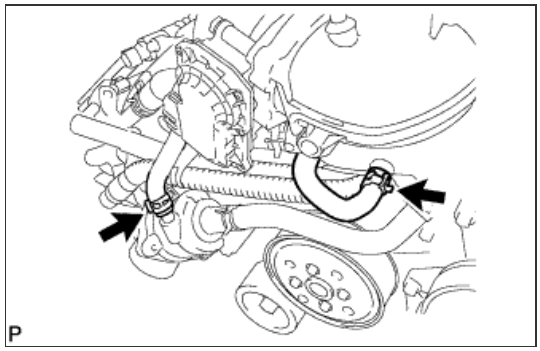
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



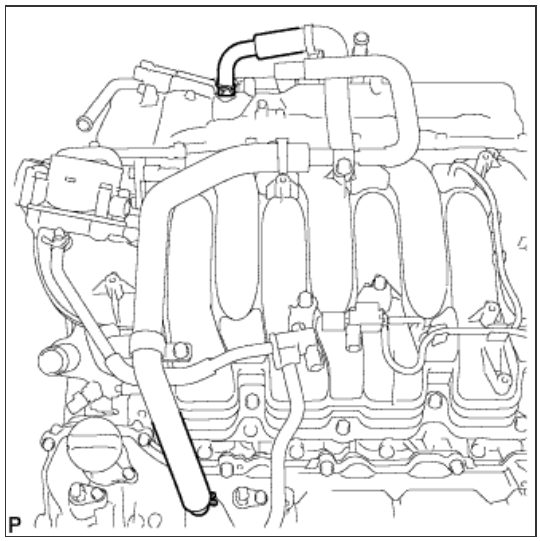
e. Connect the No. 1 ventilation hose.



f. Connect the 2 water by-pass hoses.

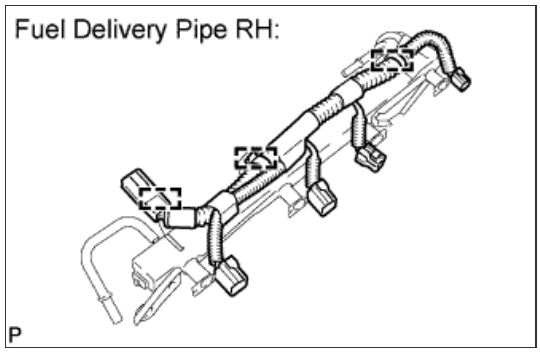


g. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.

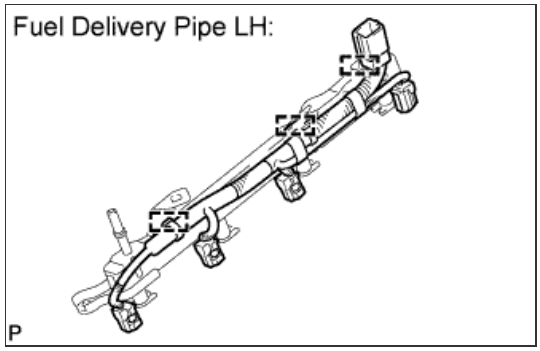


23. INSTALL FUEL INJECTOR ASSEMBLY

a. Attach the 3 clamps to install the No. 6 wire harness to the delivery pipe RH.



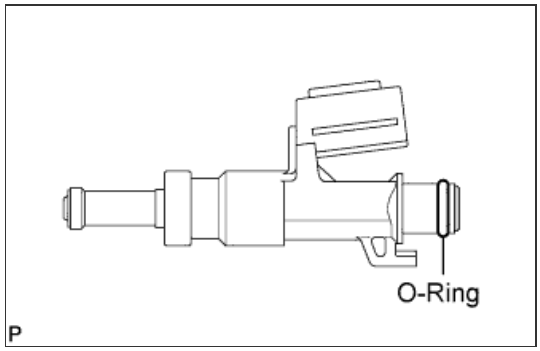
b. Attach the 3 clamps to install the No. 7 wire harness to the delivery pipe LH.



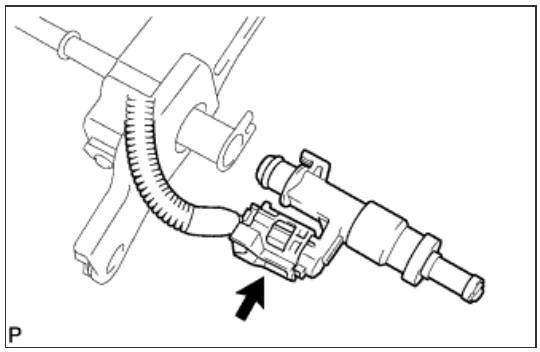
c. Apply gasoline or spindle oil to a new O-ring and install it to the injector.

NOTICE:

Make sure that there is no damage or foreign material in the groove of the injector when installing the O-ring.



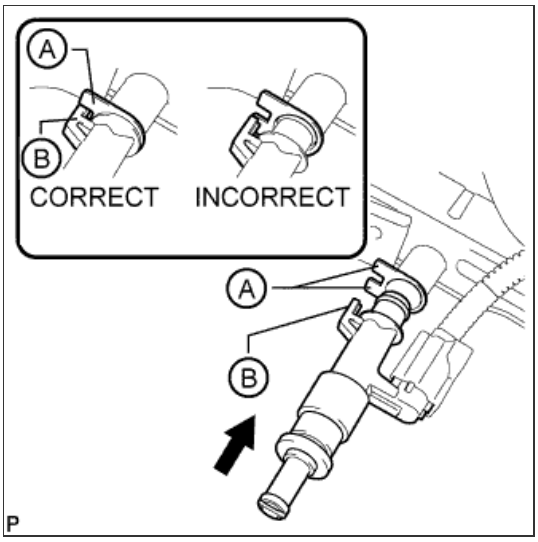
d. Connect the injector connector.



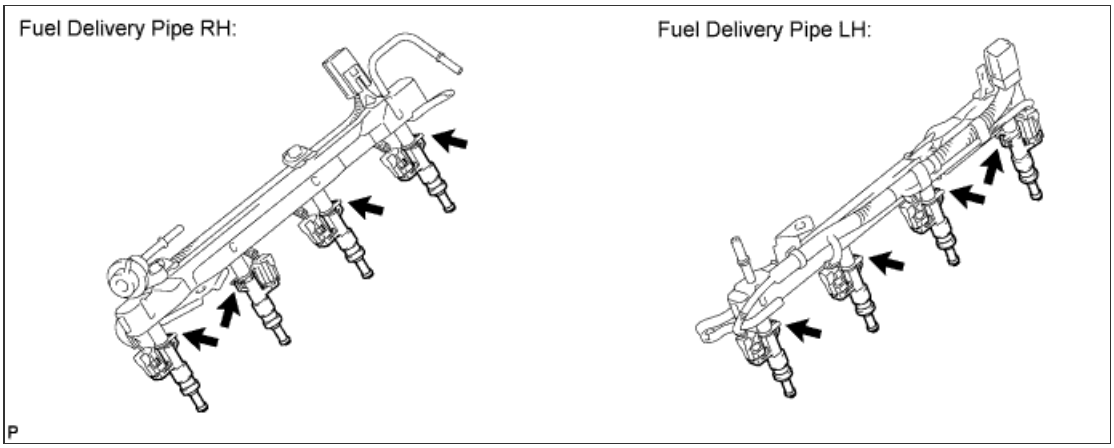
e. Install the injector to the delivery pipe as shown in the illustration.

NOTICE:

- **Make sure that there are no scratches or foreign matter in or around the insertion hole of the delivery pipe.**
- **When inserting the injector, be careful not to damage the O-ring.**
- **Attach the part of the injector labeled B between the parts of the delivery pipe labeled A.**



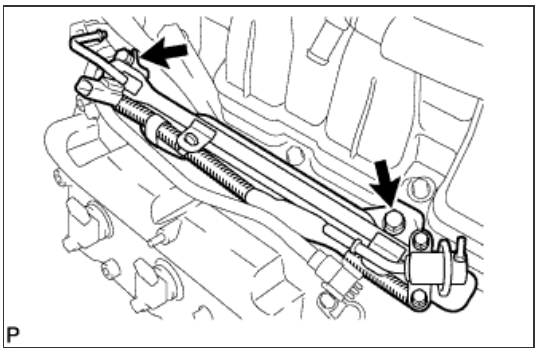
f. Check that each injector is installed to the delivery pipe facing the direction shown in the illustration.



24. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head RH.

b. Install the delivery pipe (with injectors) to the cylinder head RH.

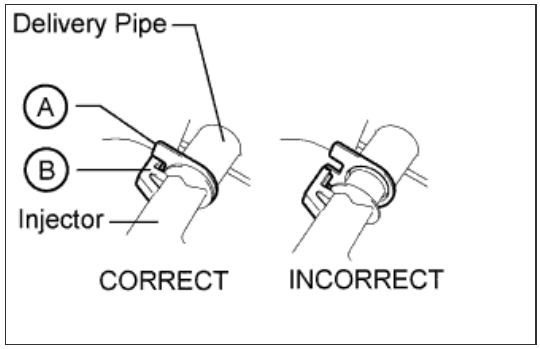


c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

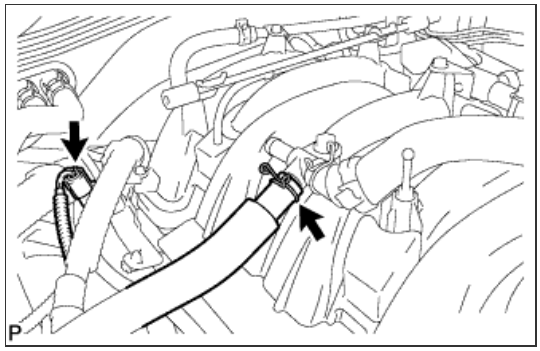
NOTICE:

Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.



d. Connect the No. 6 wire harness connector.

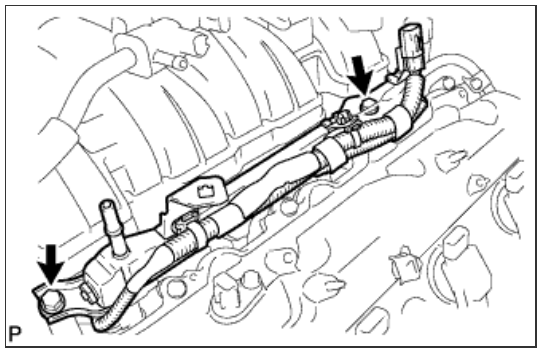
e. Connect the ventilation hose.



25. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head LH.

b. Install the delivery pipe (with injectors) to the cylinder head LH.

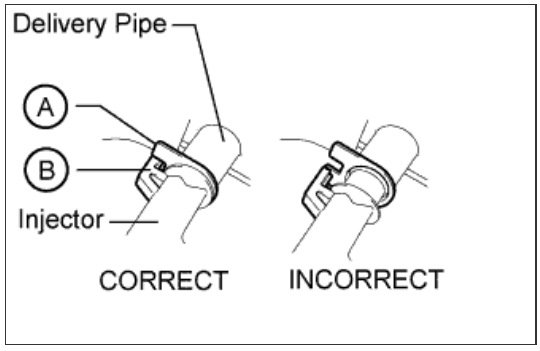


c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

NOTICE:

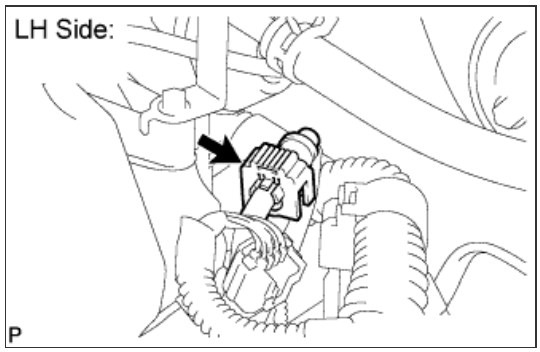
Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.



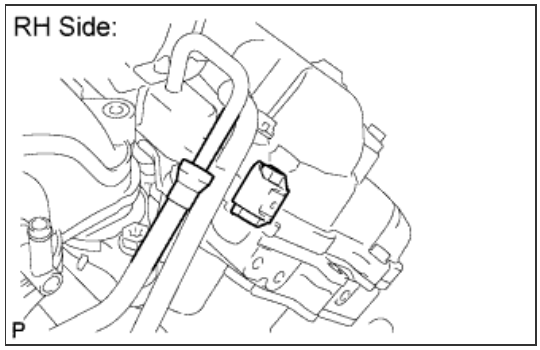
d. Connect the No. 7 wire harness connector.

26. CONNECT NO. 1 FUEL TUBE

a. LH Side:
Connect the No. 1 fuel tube to the delivery pipe LH (Click here).

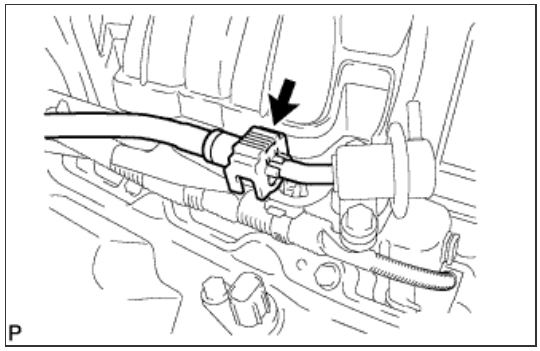


b. RH Side:
Connect the No. 1 fuel tube to the delivery pipe RH (for metallic type) (Click here).



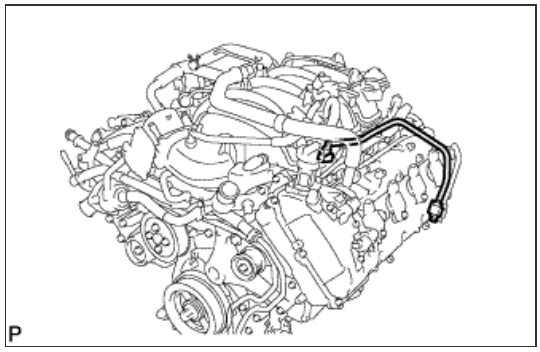
27. CONNECT NO. 2 FUEL TUBE

a. Connect the No. 2 fuel tube to the fuel pressure regulator (Click here).



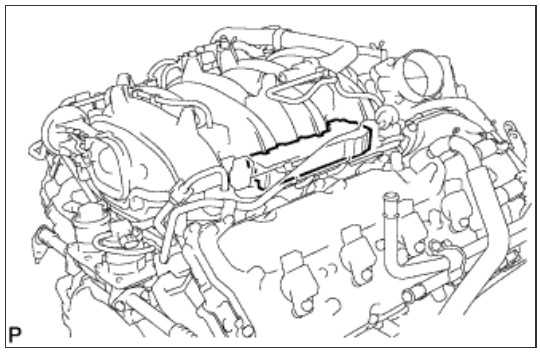
28. INSTALL NO. 1 FUEL HOSE

a. Install the fuel hose (Click here).



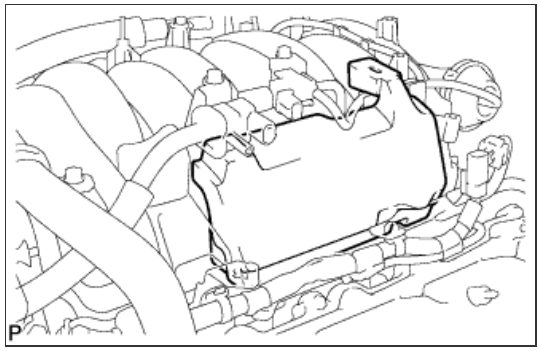
29. INSTALL NO. 3 ENGINE COVER

a. Install the No. 3 engine cover.



30. INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Install the No. 1 engine cover sub-assembly.



31. INSTALL ENGINE WIRE

a. Install the engine wire.

b. Engine Rear Side:

i. Install the 3 bolts as shown in the illustration.

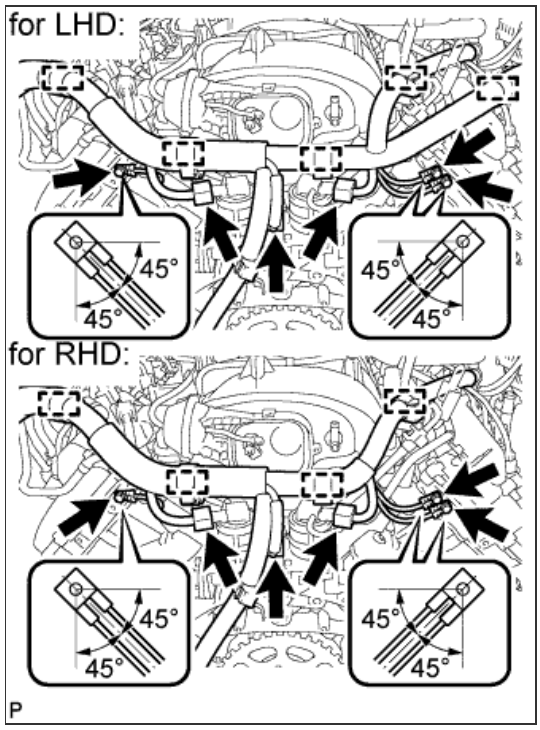
Torque:
8.5 N*m{ 87 kgf*cm , 75 in.*lbf }

ii. for RHD:
Connect the 4 clamps.

iii. for LHD:
Connect the 5 clamps.

iv. Connect the sensor wire connector.

v. w/ Secondary Air Injection System:
Connect the 2 air switching valve connectors.



c. Engine RH Side:

i. Connect the 9 clamps.

ii. Connect the oil pressure sender gauge connector.

iii. Connect the throttle sensor connector.

iv. Connect the noise filter connector.

v. Connect the fuel injector connector.

vi. Connect the 2 VVT sensor connectors.

HINT:

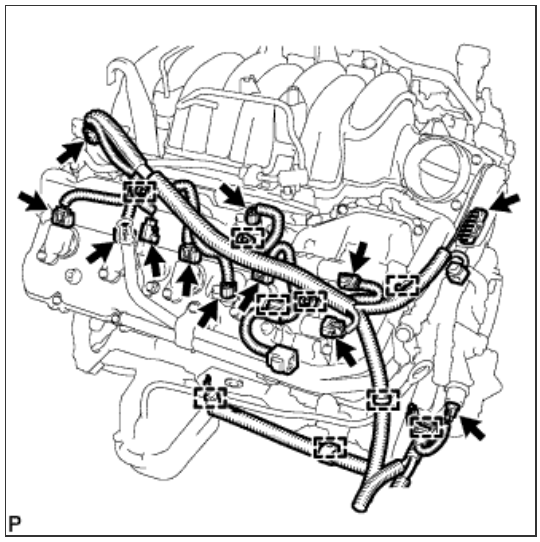
The wire harnesses on the exhaust side are wrapped with white tape.

vii. Connect the 4 ignition coil connectors.

viii. Connect the 2 camshaft timing control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



d. Engine LH Side:

i. Connect the 7 clamps and install the engine wire with the bolt.

Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }

ii. Connect the noise filter connector.

iii. Connect the fuel injector connector.

iv. Connect the engine coolant temperature sensor connector.

v. Connect the purge VSV connector.

vi. Connect the vacuum switching valve connector (for ACIS).

vii. Connect the camshaft position sensor connector.

viii. Connect the 2 VVT sensor connectors.

HINT:

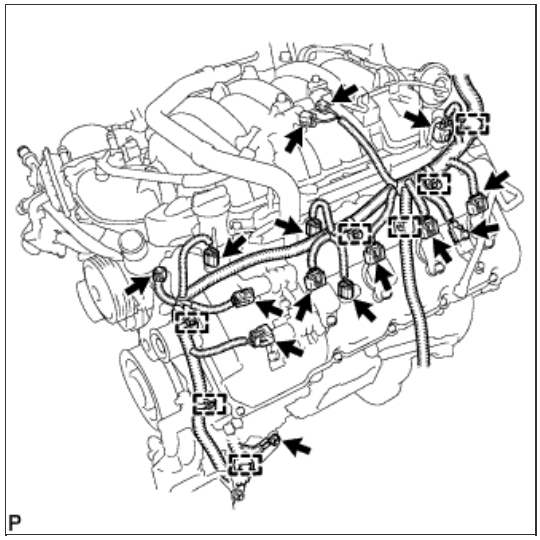
The wire harnesses on the exhaust side are wrapped with white tape.

ix. Connect the 4 ignition coil connectors.

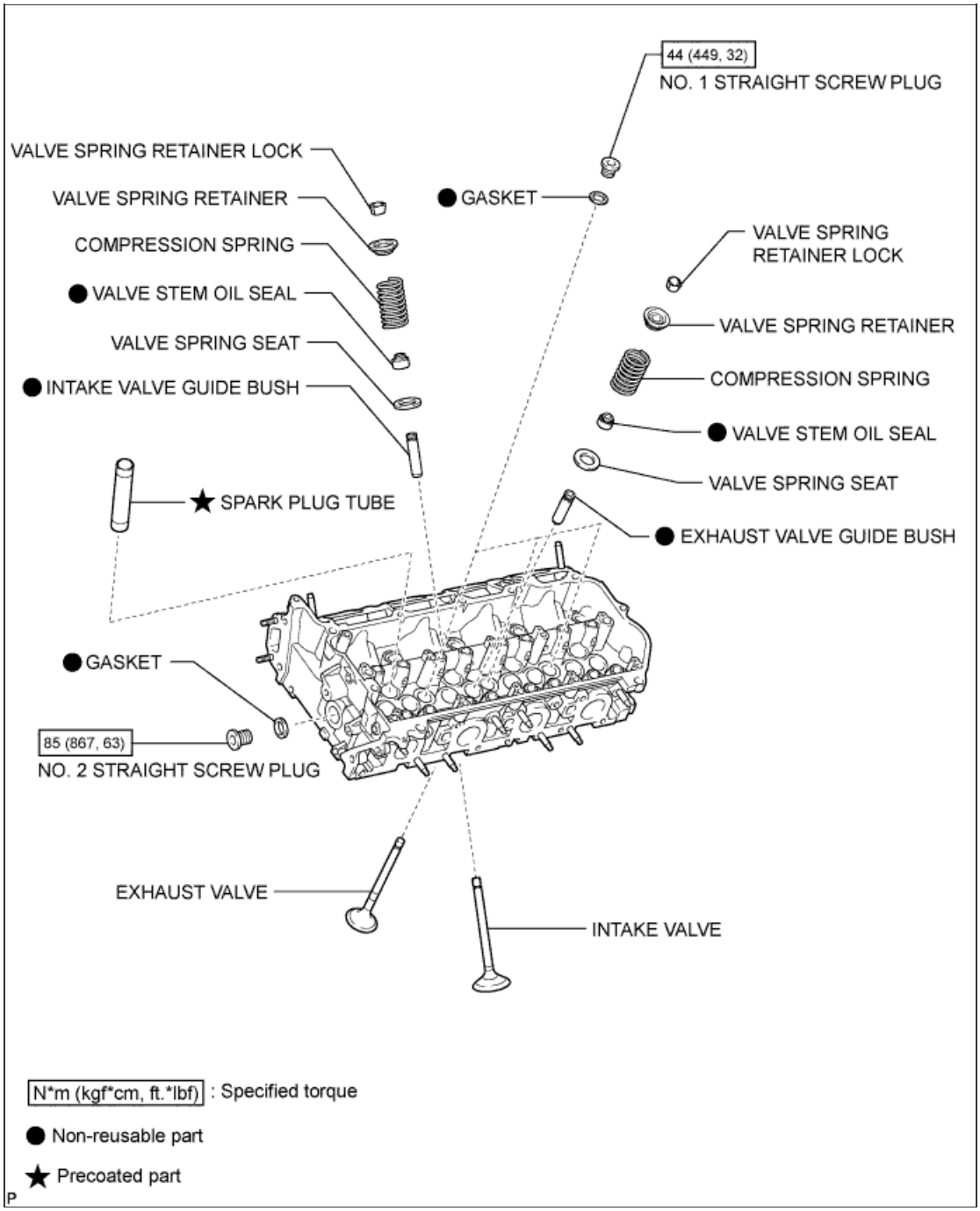
x. Connect the 2 camshaft timing control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



for Preparation Click here



for Preparation Click here

1. REMOVE INTAKE VALVE

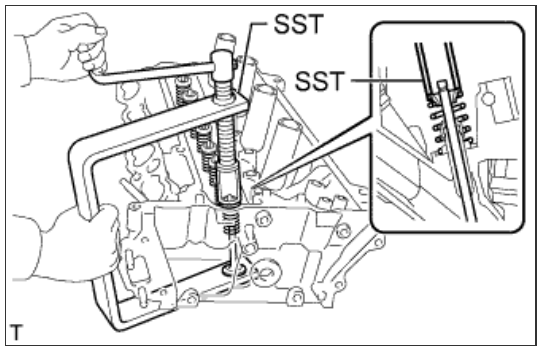
a. Using SST and wooden blocks, compress the compression spring and remove the valve spring retainer locks.

SST
09202-70020 (09202-00010, 09202-01010, 09202-01020)

b. Remove the retainer, compression spring and valve.

HINT:

Arrange the removed parts in the correct order.



2. REMOVE EXHAUST VALVE

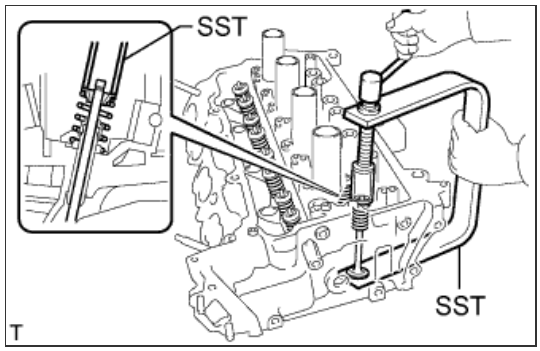
a. Using SST and wooden blocks, compress the compression spring and remove the valve spring retainer locks.

SST
09202-70020 (09202-00010, 09202-01010, 09202-01020)

b. Remove the retainer, compression spring and valve.

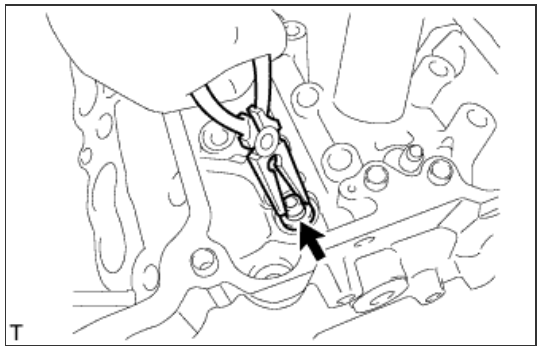
HINT:

Arrange the removed parts in the correct order.



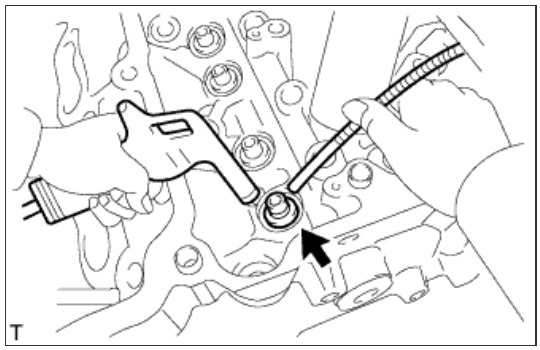
3. REMOVE VALVE STEM OIL SEAL

a. Using needle-nose pliers, remove the oil seals.



4. REMOVE VALVE SPRING SEAT

a. Using compressed air and a magnetic finger, remove the valve spring seat by blowing air onto it.

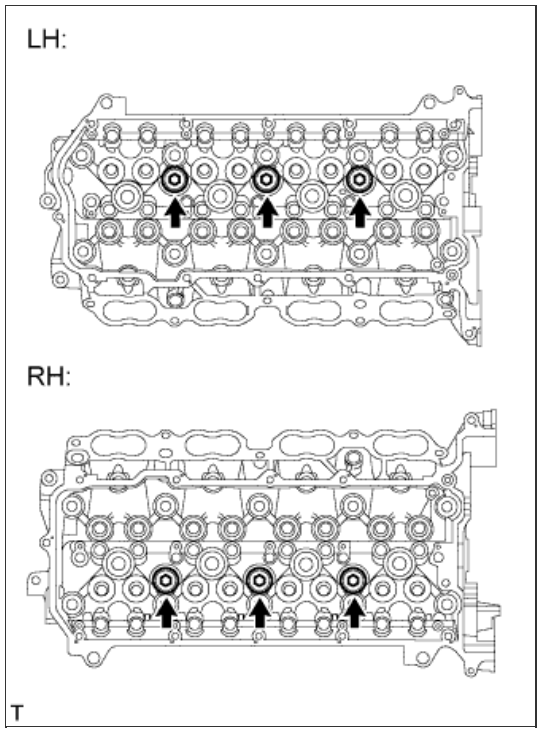


5. REMOVE NO. 1 STRAIGHT SCREW PLUG

NOTICE:

If water leaks from the No. 1 straight screw plug or the plug is corroded, replace it.

a. Using a 10 mm hexagon wrench, remove the 6 screw plugs and 6 gaskets.

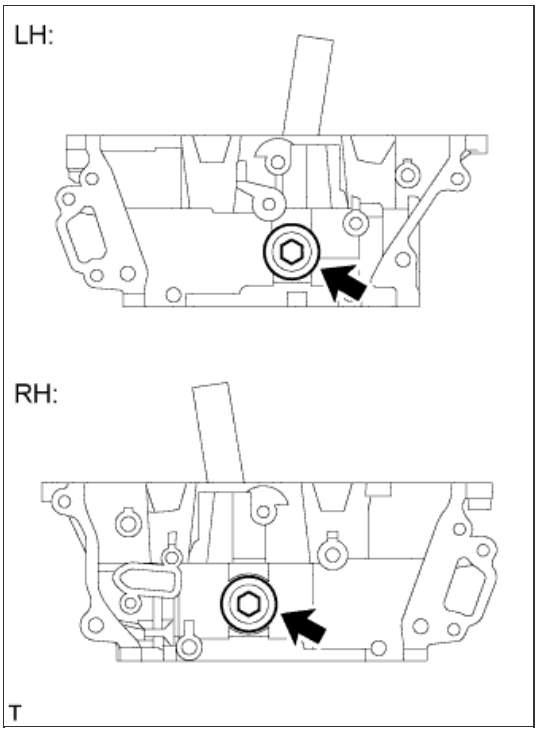


6. REMOVE NO. 2 STRAIGHT SCREW PLUG

NOTICE:

If water leaks from the No. 2 straight screw plug or the plug is corroded, replace it.

a. Using a 14 mm hexagon wrench, remove the 2 screw plugs and 2 gaskets.



7. REMOVE STUD BOLT

NOTICE:

If the stud bolt is deformed or its threads are damaged, replace it.

for Preparation Click here

1. INSPECT CYLINDER HEAD SUB-ASSEMBLY

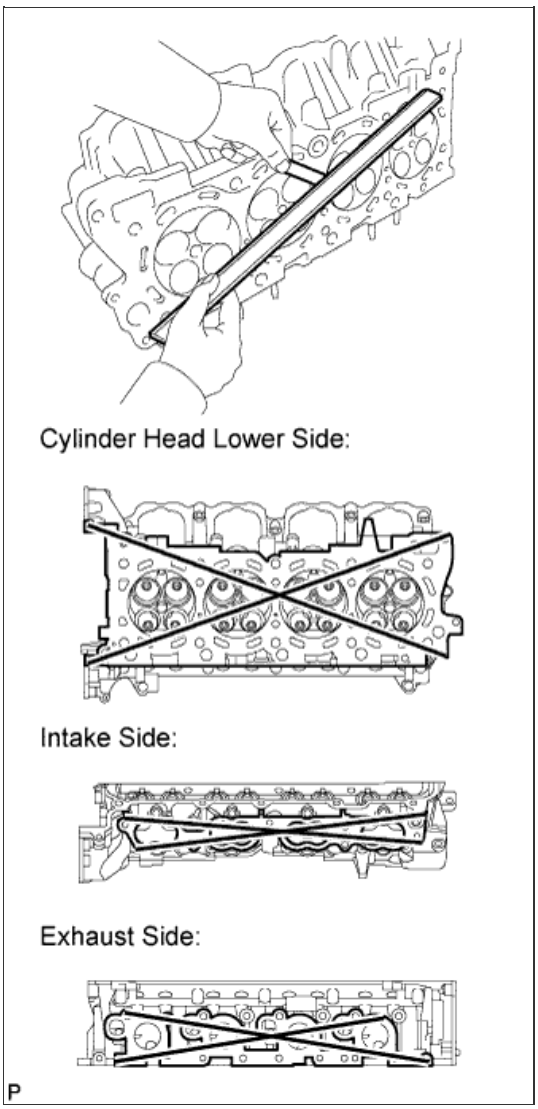
a. Using a precision straightedge and feeler gauge, measure the warpage of the surfaces where the cylinder head contacts the cylinder block and manifold.

Standard Warpage:

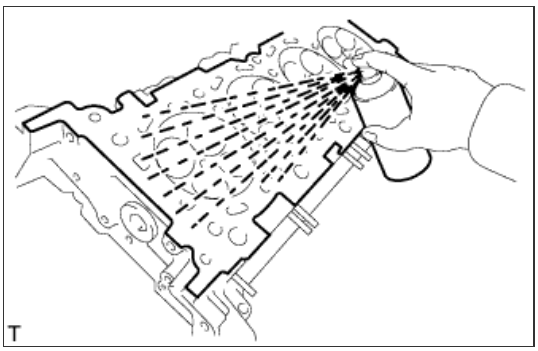
Item	Specified Condition
Cylinder head lower side	0.05 mm (0.00197 in.)
Intake side	0.08 mm (0.00315 in.)
Exhaust side	0.05 mm (0.00197 in.)

Maximum warpage:
0.10 mm (0.00394 in.)

If the warpage is more than the maximum, replace the cylinder head.



b. Using a dye penetrant, check the intake ports, exhaust ports and cylinder surface for cracks.
If cracked, replace the cylinder head.

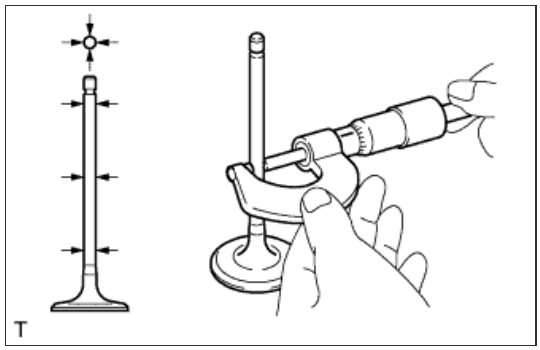


2. INSPECT INTAKE VALVE

a. Using a micrometer, measure the diameter of the valve stem.

Standard valve stem diameter:
5.470 to 5.485 mm (0.215 to 0.216 in.)

If the diameter is not as specified, replace the valve and guide bush.

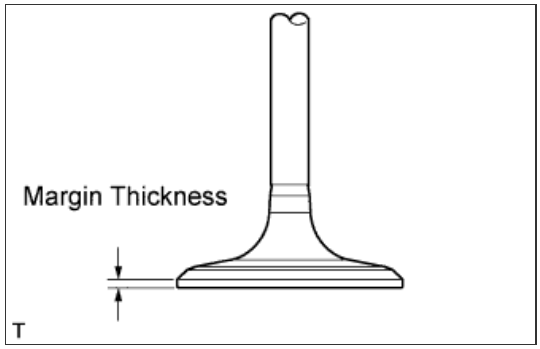


b. Using a vernier caliper, measure the valve head margin thickness.

Standard margin thickness:
1.25 mm (0.0492 in.)

Minimum margin thickness:
0.50 mm (0.0197 in.)

If the margin thickness is less than the minimum, replace the intake valve.

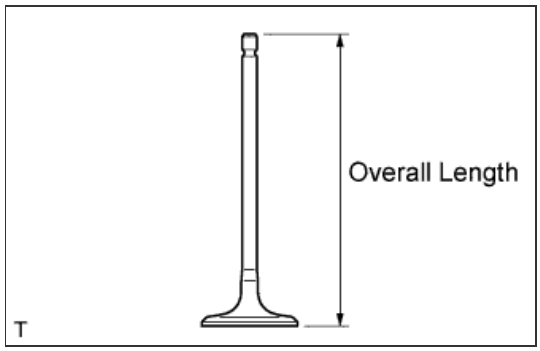


c. Using a vernier caliper, measure the valve overall length.

Standard overall length:
105.85 mm (4.17 in.)

Minimum overall length:
105.35 mm (4.15 in.)

If the overall length is less than the minimum, replace the intake valve.

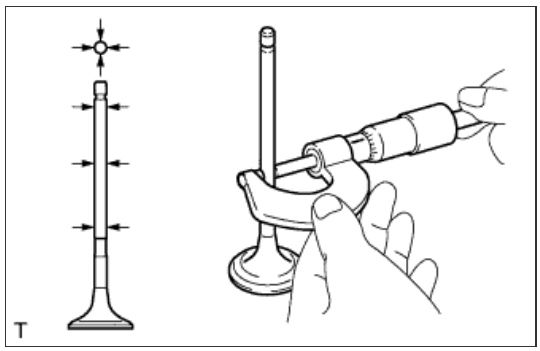


3. INSPECT EXHAUST VALVE

a. Using a micrometer, measure the diameter of the valve stem.

Standard valve stem diameter:
5.465 to 5.480 mm (0.215 to 0.216 in.)

If the diameter is not as specified, replace the valve and guide bush.

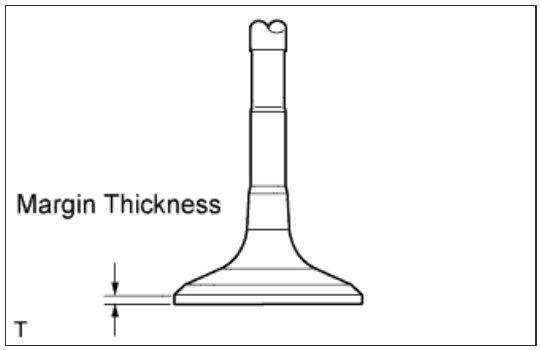


b. Using a vernier caliper, measure the valve head margin thickness.

Standard margin thickness:
1.4 mm (0.0551 in.)

Minimum margin thickness:
0.50 mm (0.0197 in.)

If the margin thickness is less than the minimum, replace the exhaust valve.

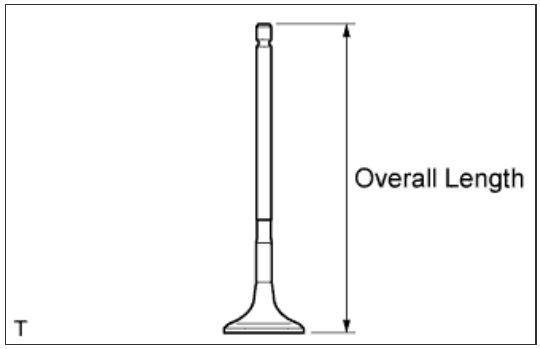


c. Using a vernier caliper, measure the valve overall length.

Standard overall length:
110.40 mm (4.35 in.)

Minimum overall length:
109.90 mm (4.33 in.)

If the overall length is less than the minimum, replace the exhaust valve.



4. INSPECT INTAKE VALVE SEAT

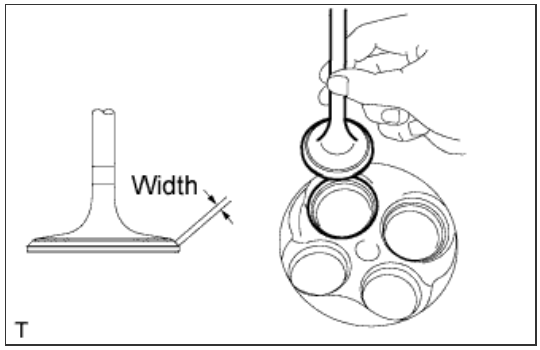
a. Apply a light coat of Prussian blue to the valve face.

b. Lightly press the valve face against the valve seat.

HINT:

Do not rotate the valve while pressing the valve.

c. Check the valve face and valve seat.



i. Check that the contact surfaces of the valve seat and valve face are in the middle area of their respective surfaces, with the width between 1.1 and 1.5 mm (0.0433 and 0.0591 in.).
If not, correct the valve seat.

ii. Check that the contact surfaces of the valve seat and valve face are even around the entire valve seat.
If not, correct the valve seat.

5. INSPECT EXHAUST VALVE SEAT

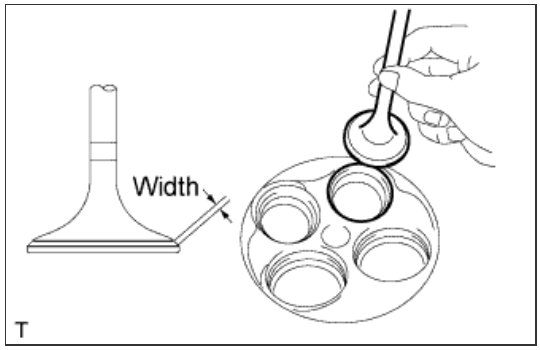
a. Apply a light coat of Prussian blue to the valve face.

b. Lightly press the valve face against the valve seat.

HINT:

Do not rotate the valve while pressing the valve.

c. Check the valve face and valve seat.



i. Check that the contact surfaces of the valve seat and valve face are in the middle area of their respective surfaces, with the width between 1.1 and 1.5 mm (0.0433 and 0.0591 in.).
If not, correct the valve seat.

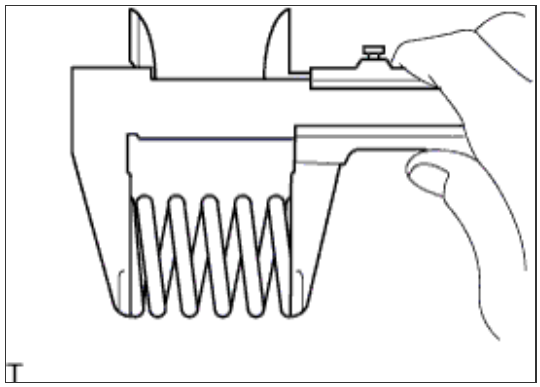
ii. Check that the contact surfaces of the valve seat and valve face are even around the entire valve seat.
If not, correct the valve seat.

6. INSPECT COMPRESSION SPRING

a. Using a vernier caliper, measure the free length of the inner compression spring.

Standard free length:
49.39 mm (1.94 in.)

If the free length is not as specified, replace the spring.

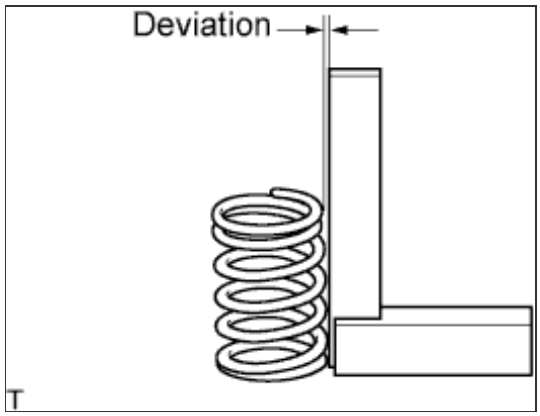


b. Using a steel square, measure the deviation of the inner compression spring.

Maximum deviation:
1.0 mm (0.0394 in.)

Maximum angle (reference):
2°

If the deviation is more than the maximum, replace the spring.



7. INSPECT VALVE GUIDE BUSH OIL CLEARANCE

a. Using a caliper gauge, measure the inside diameter of the guide bush.

Standard bush inside diameter:
5.51 to 5.53 mm (0.217 to 0.218 in.)

b. Subtract the valve stem diameter measurement from the guide bush inside diameter measurement.

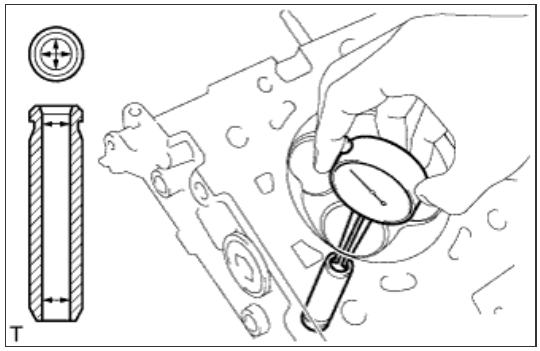
Standard Oil Clearance:

Item	Specified Condition
Intake	0.025 to 0.060 mm (0.000984 to 0.00236 in.)
Exhaust	0.030 to 0.065 mm (0.00118 to 0.00256 in.)

Maximum Oil Clearance:

Item	Specified Condition
Intake	0.08 mm (0.00315 in.)
Exhaust	0.10 mm (0.00394 in.)

If the oil clearance is more than the maximum, replace the valve and guide bush.



8. INSPECT CAMSHAFT THRUST CLEARANCE

a. Inspect the bank 1 camshafts.

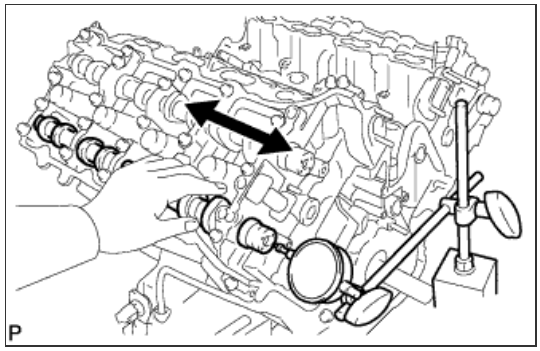
i. Install the bank 1 camshafts.

ii. Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard thrust clearance:
0.08 to 0.135 mm (0.00315 to 0.00531 in.)

Maximum thrust clearance:
0.15 mm (0.00591 in.)

If the thrust clearance is more than the maximum, replace the camshaft housing. If the thrust surface is damaged, replace the camshaft.



b. Inspect the bank 2 camshafts.

i. Install the bank 2 camshafts.

ii. Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard thrust clearance:
0.08 to 0.135 mm (0.00315 to 0.00531 in.)

Maximum thrust clearance:
0.15 mm (0.00591 in.)

If the thrust clearance is more than the maximum, replace the camshaft housing. If the thrust surface is damaged, replace the camshaft.

for Preparation Click here

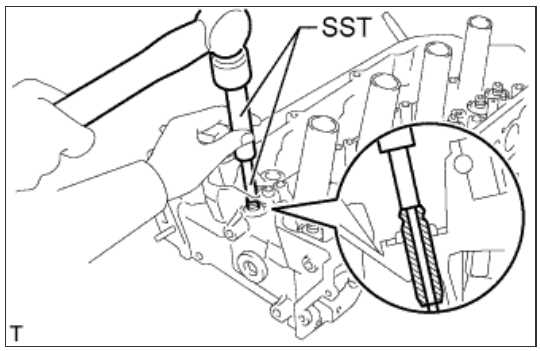
1. REPLACE INTAKE VALVE GUIDE BUSH

a. Heat the cylinder head to approximately 80 to 100°C (176 to 212°F).

b. Place the cylinder head on wooden blocks.

c. Using SST and a hammer, tap out the valve guide bush.

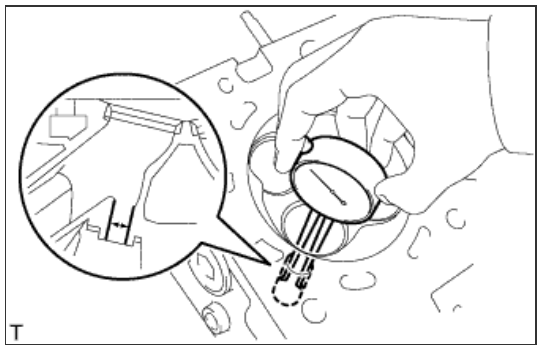
SST
09201-10000 (09201-01050)
09950-70010 (09951-07100)



d. Using a caliper gauge, measure the bush bore diameter of the cylinder head side.

Standard bush bore diameter:
10.285 to 10.306 mm (0.405 to 0.406 in.)

If the bush bore diameter of the cylinder head is between 10.285 and 10.306 mm (0.405 and 0.406 in.), proceed to the next step.
If the bush bore diameter of the cylinder head is 10.356 mm (0.408 in.) or more, replace the cylinder head.



e. Select a new guide bush (STD or O/S 0.05), and measure its diameter.

f. Machine the bush bore diameter of the cylinder head side to the diameter of the selected guide bush.

Bush Bore Diameter:

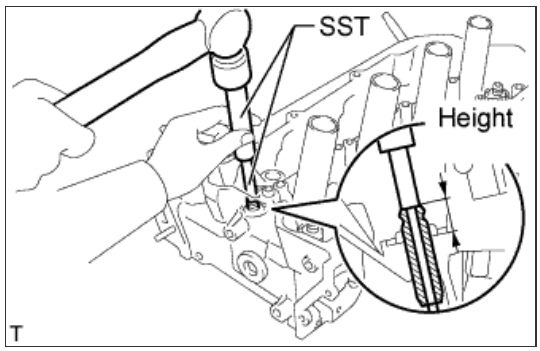
Bush Size	Specified Condition
STD	10.333 to 10.344 mm (0.4068 to 0.4072 in.)
O/S 0.05	10.383 to 10.394 mm (0.4088 to 0.4092 in.)

Standard bush length:
41.3 to 41.7 mm (1.63 to 1.64 in.)

g. Using SST and a hammer, tap in a new guide bush to the standard protrusion height.

SST
09201-10000 (09201-01050)
09950-70010 (09951-07100)

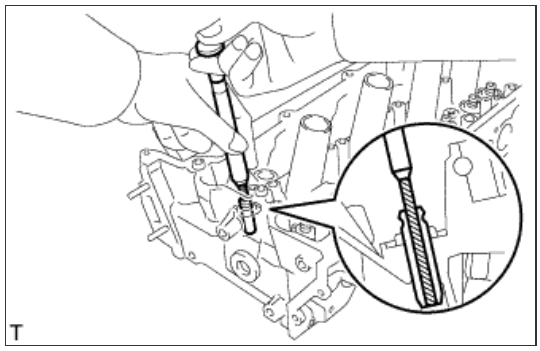
Standard protrusion height:
14.3 to 14.7 mm (0.563 to 0.579 in.)



h. Using a sharp 5.5 mm reamer, ream the guide bush to obtain the standard oil

clearance between the guide bush and valve stem.

Standard oil clearance:
0.025 to 0.060 mm (0.000984 to 0.00236 in.)



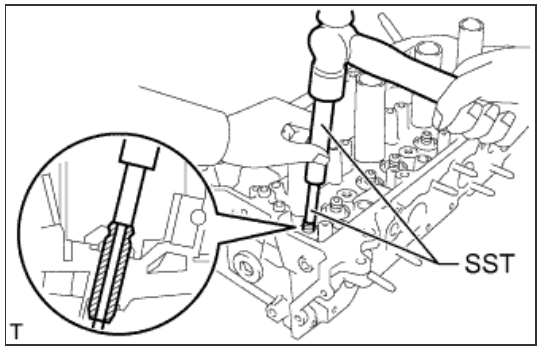
2. REPLACE EXHAUST VALVE GUIDE BUSH

a. Heat the cylinder head to approximately 80 to 100°C (176 to 212°F).

b. Place the cylinder head on wooden blocks.

c. Using SST and a hammer, tap out the valve guide bush.

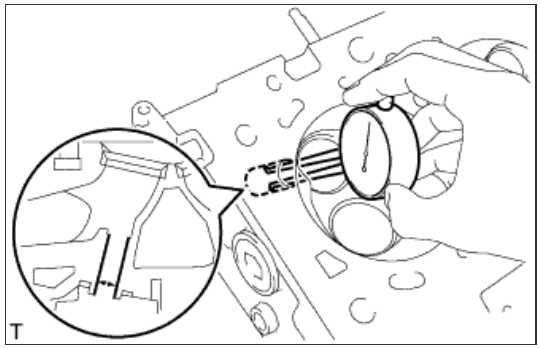
SST
09201-10000 (09201-01050)
09950-70010 (09951-07100)



d. Using a caliper gauge, measure the bush bore diameter of the cylinder head.

Standard bush bore diameter:
10.285 to 10.306 mm (0.405 to 0.406 in.)

If the bush bore diameter of the cylinder head is between 10.285 and 10.306 mm (0.405 and 0.406 in.), proceed to the next step.
If the bush bore diameter of the cylinder head is 10.356 mm (0.408 in.) or more, replace the cylinder head.



e. Select a new guide bush (STD or O/S 0.05), and measure its diameter.

f. Machine the bush bore diameter of the cylinder head side to the diameter of the selected guide bush.

Bush Bore Diameter:

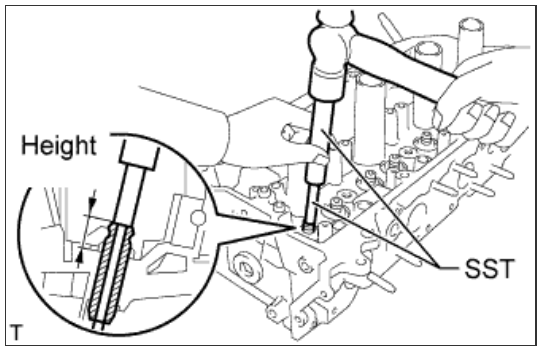
Bush Size	Specified Condition
STD	10.333 to 10.344 mm (0.4068 to 0.4072 in.)
O/S 0.05	10.383 to 10.394 mm (0.4088 to 0.4092 in.)

Standard bush length:
46.8 to 47.2 mm (1.84 to 1.86 in.)

g. Using SST and a hammer, tap in a new guide bush to the standard protrusion height.

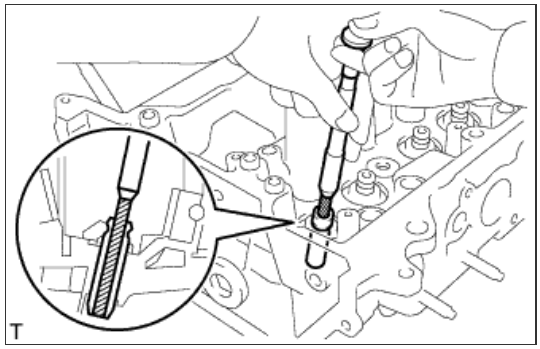
SST
09201-10000 (09201-01050)
09950-70010 (09951-07100)

Standard protrusion height:
14.3 to 14.7 mm (0.563 to 0.579 in.)



h. Using a sharp 5.5 mm reamer, ream the guide bush to obtain the standard oil clearance between the guide bush and valve stem.

Standard oil clearance:
0.030 to 0.065 mm (0.00118 to 0.00256 in.)



3. REPLACE SPARK PLUG TUBE

HINT:

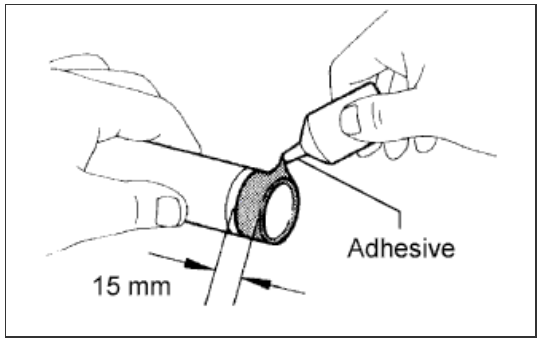
When using a new cylinder head, the spark plug tubes must be replaced.

a. Remove the spark plug tube.

b. Apply adhesive to the end of a new spark plug tube.

Adhesive:
Toyota Genuine Adhesive 1324, Three Bond 1324 or equivalent.

Standard seal diameter:
15 mm (0.591 in.)



NOTICE:

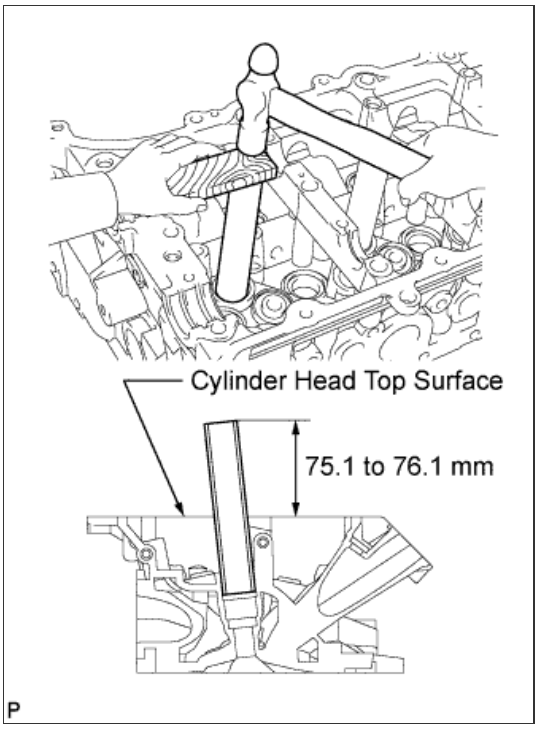
- **Install the spark plug tube within 3 minutes after applying adhesive.**
- **Be careful not to deform the spark plug tube.**
- **Be careful not to expose the seal to coolant for at least 1 hour after installing it.**

c. Using a wooden block and hammer, tap in the spark plug tube to the specified protrusion height.

Standard protrusion height:
75.1 to 76.1 mm (2.96 to 3.00 in.)

NOTICE:

To avoid tapping in the spark plug tube too far, measure the protrusion height while tapping it.



4. REPLACE RING PIN

NOTICE:

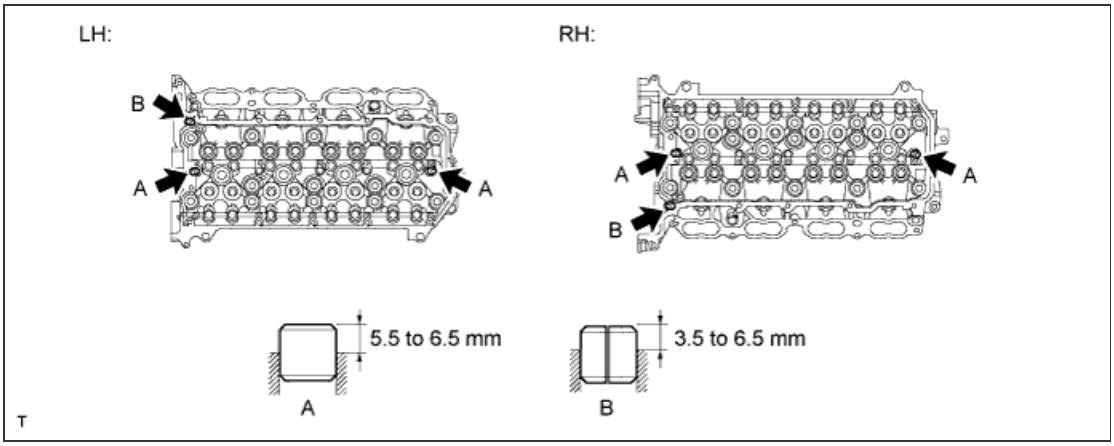
It is not necessary to remove the ring pin unless it is being replaced.

a. Remove the ring pins.

b. Using a plastic-faced hammer, tap in new ring pins to the cylinder head.

Standard Protrusion:

Item	Specified Condition
Ring pin A	5.5 to 6.5 mm (0.217 to 0.256 in.)
Ring pin B	3.5 to 6.5 mm (0.138 to 0.256 in.)

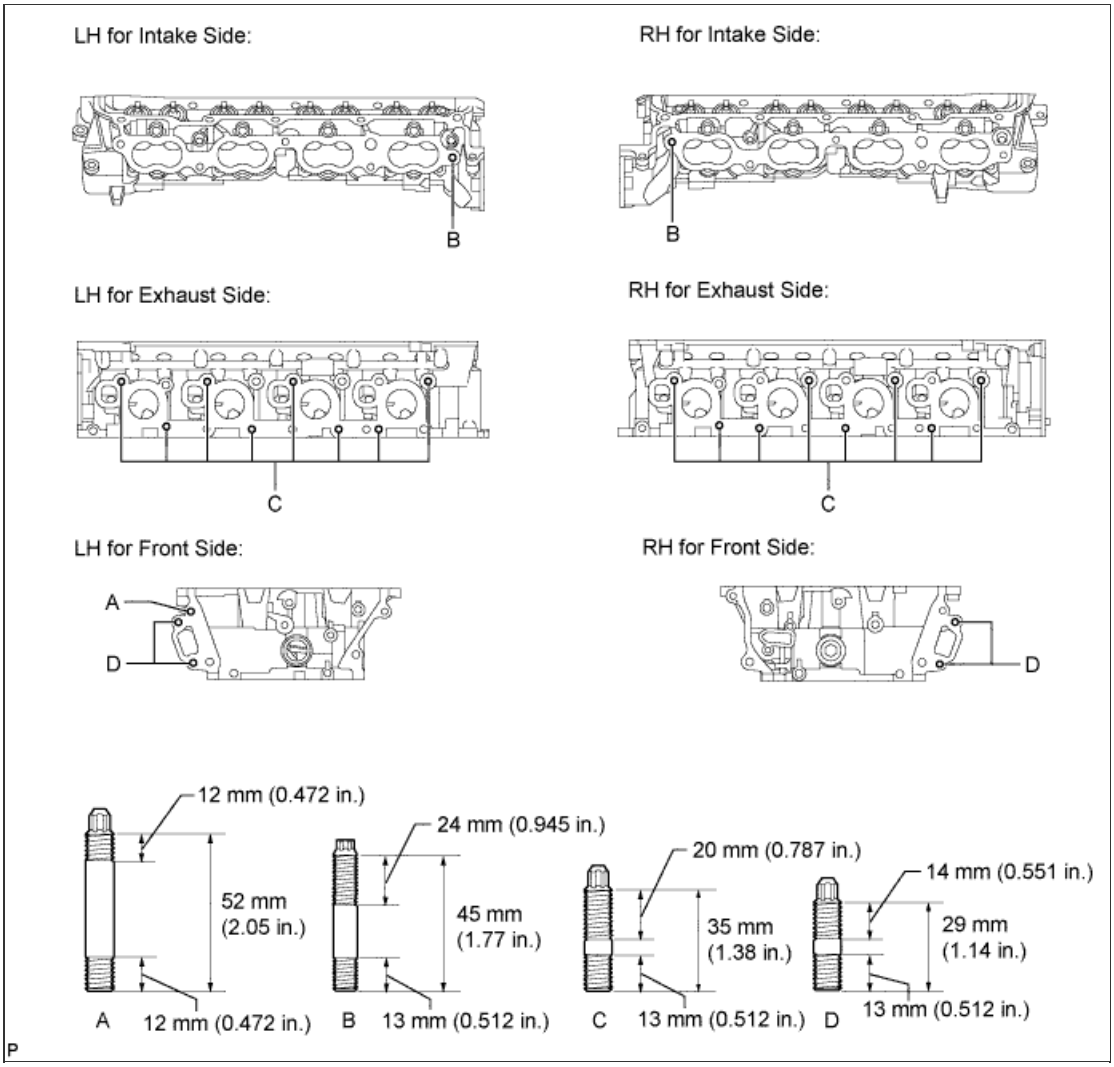


for Preparation Click here

1. INSTALL STUD BOLT

a. Using E7 and E8 "TORX" socket wrenches, install the stud bolts.

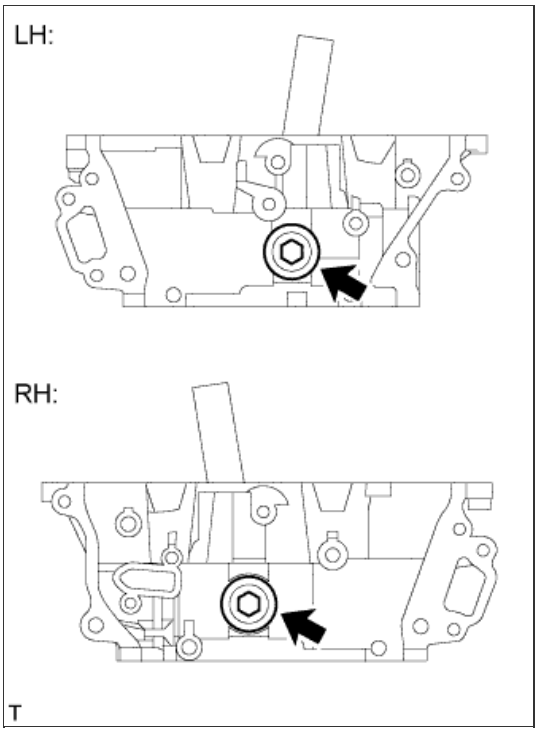
Torque:
for stud bolts A, B, C and D:
9.0 N*m{ 92 kgf*cm , 80 in.*lbf }



2. INSTALL NO. 2 STRAIGHT SCREW PLUG

a. Using a 14 mm hexagon wrench, install 2 new gaskets and the 2 straight screw plugs.

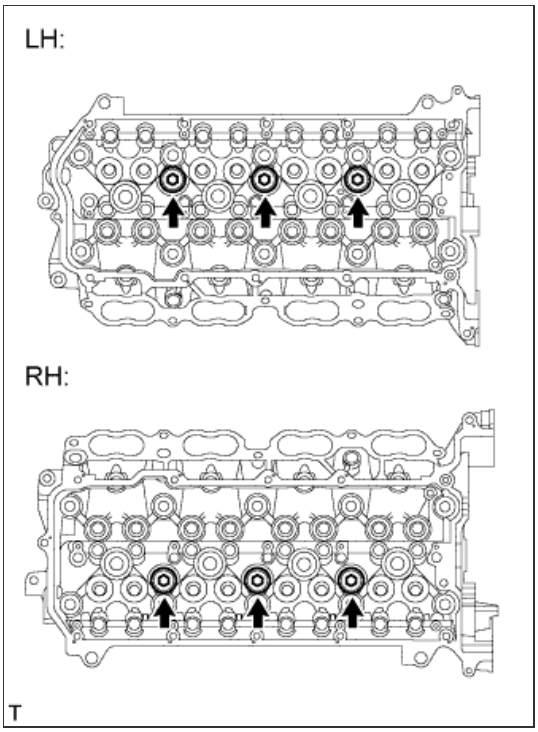
Torque:
85 N*m{ 867 kgf*cm , 63 ft.*lbf }



3. INSTALL NO. 1 STRAIGHT SCREW PLUG

a. Using a 10 mm hexagon wrench, install 6 new gaskets and the 6 straight screw plugs.

Torque:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }



4. INSTALL VALVE SPRING SEAT

a. Install the valve spring seats to the cylinder head.

5. INSTALL VALVE STEM OIL SEAL

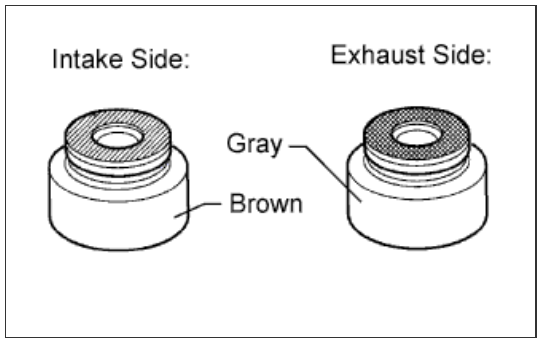
a. Apply a light coat of engine oil to new oil seals.

NOTICE:

Pay attention when installing the intake and exhaust oil seals. For example, installing the intake oil seal into the exhaust side or installing the exhaust oil seal into the intake side can cause installation problems later.

HINT:

The intake valve oil seals are brown and the exhaust valve oil seals are gray.

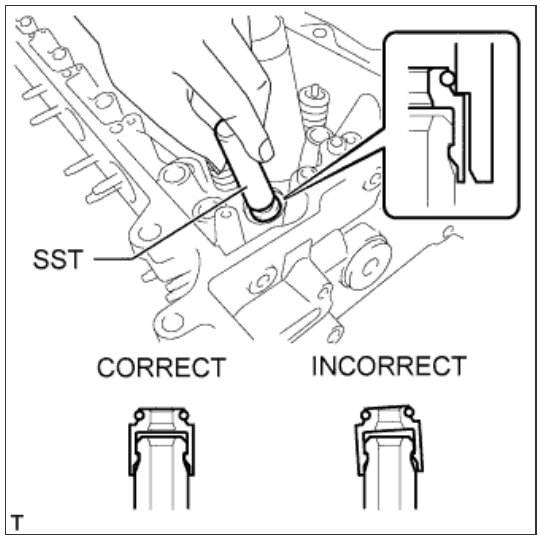


b. Using SST, push in the oil seals.

SST
09201-41020

NOTICE:

Failure to use SST will cause the seal to be damaged or improperly seated.



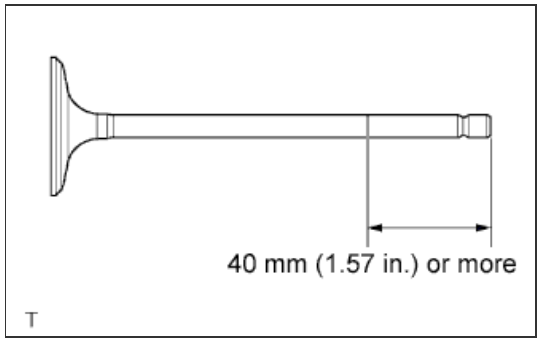
6. INSTALL INTAKE VALVE

a. Apply plenty of engine oil to the tip area of the intake valve shown in the illustration.

b. Install the valve, compression spring and spring retainer to the cylinder head.

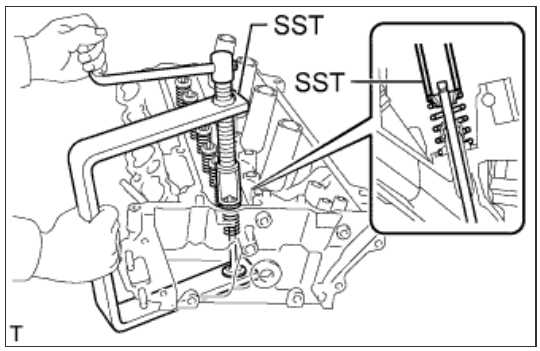
NOTICE:

Install the same parts in the same combination to their original locations.



c. Using SST and wooden blocks, compress the spring and install the retainer locks.

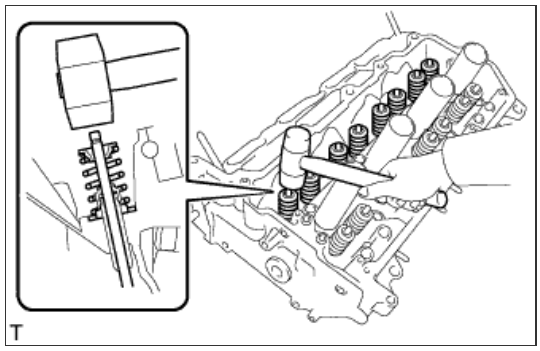
SST
09202-70020 (09202-00010, 09202-01010, 09202-01020)



d. Using a plastic-faced hammer, lightly tap the valve stem tip to ensure a proper fit.

NOTICE:

Be careful not to damage the retainer.



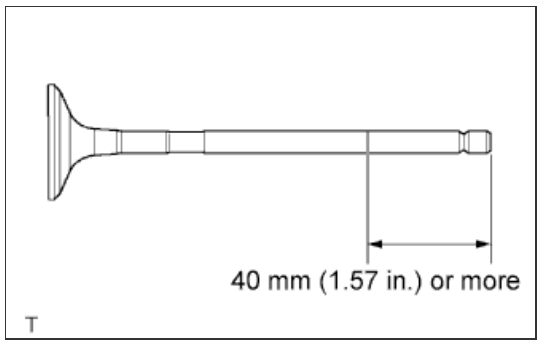
7. INSTALL EXHAUST VALVE

a. Apply plenty of engine oil to the tip area of the exhaust valve shown in the illustration.

b. Install the valve, compression spring and spring retainer to the cylinder head.

NOTICE:

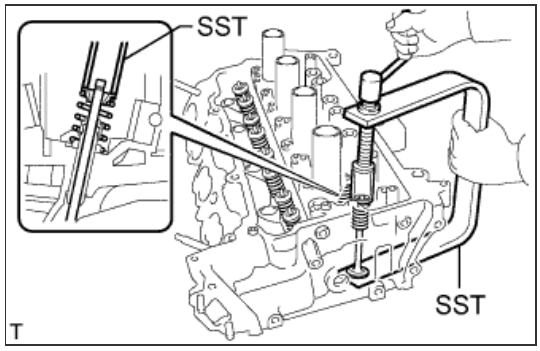
Install the same parts in the same combination to their original locations.



c. Using SST and wooden blocks, compress the spring and install the retainer locks.

SST

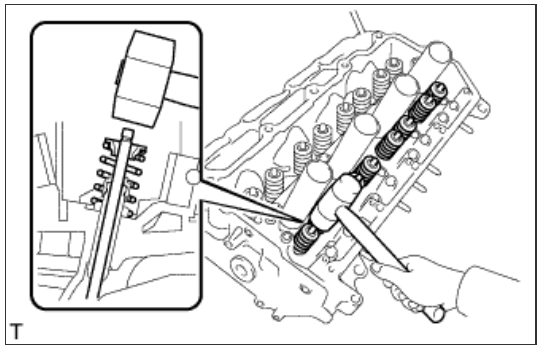
09202-70020 (09202-00010, 09202-01010, 09202-01020)



d. Using a plastic-faced hammer, lightly tap the valve stem tip to ensure a proper fit.

NOTICE:

Be careful not to damage the retainer.



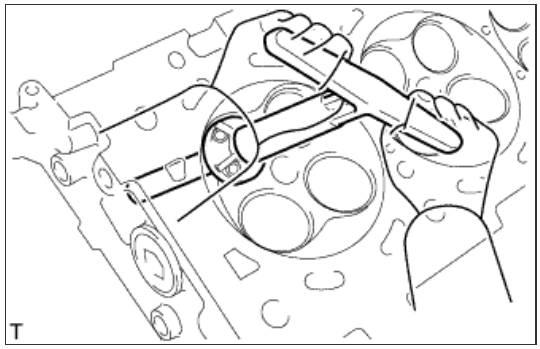
for Preparation Click here

1. REPAIR INTAKE VALVE SEAT

NOTICE:

- **Repair the seat while checking the seating position.**
- **Keep the lip free of foreign matter.**

a. Using a 45° cutter, resurface the valve seat so that the valve seat width is more than the specification.

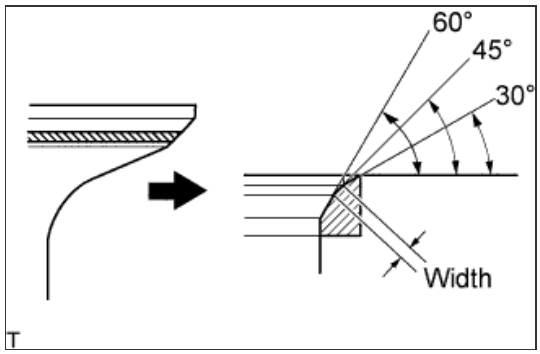


b. Using 30° and 60° cutters, correct the valve seat so that the valve contacts the entire circumference of the seat. The contact should be in the center of the valve seat, and the valve seat width should be maintained within the specified range around the entire circumference of the seat.

Standard width:
1.1 to 1.5 mm (0.0433 to 0.0591 in.)

c. Hand-lap the valve and valve seat with an abrasive compound.

d. Check the valve seating position.

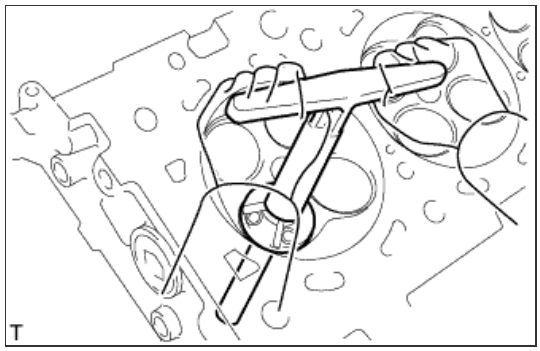


2. REPAIR EXHAUST VALVE SEAT

NOTICE:

- **Repair the seat while checking the seating position.**
- **Keep the lip free of foreign matter.**

a. Using a 45° cutter, resurface the valve seat so that the valve seat width is more than the specification.

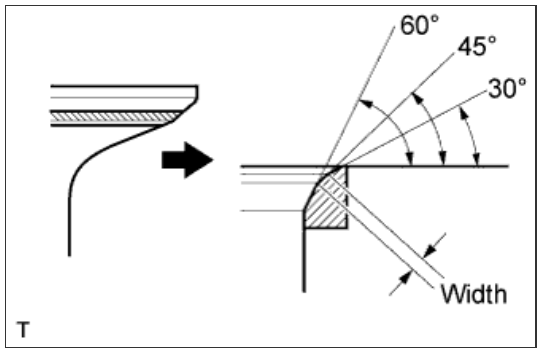


b. Using 30° and 60° cutters, correct the valve seat so that the valve contacts the entire circumference of the seat. The contact should be in the center of the valve seat, and the valve seat width should be maintained within the specified range around the entire circumference of the seat.

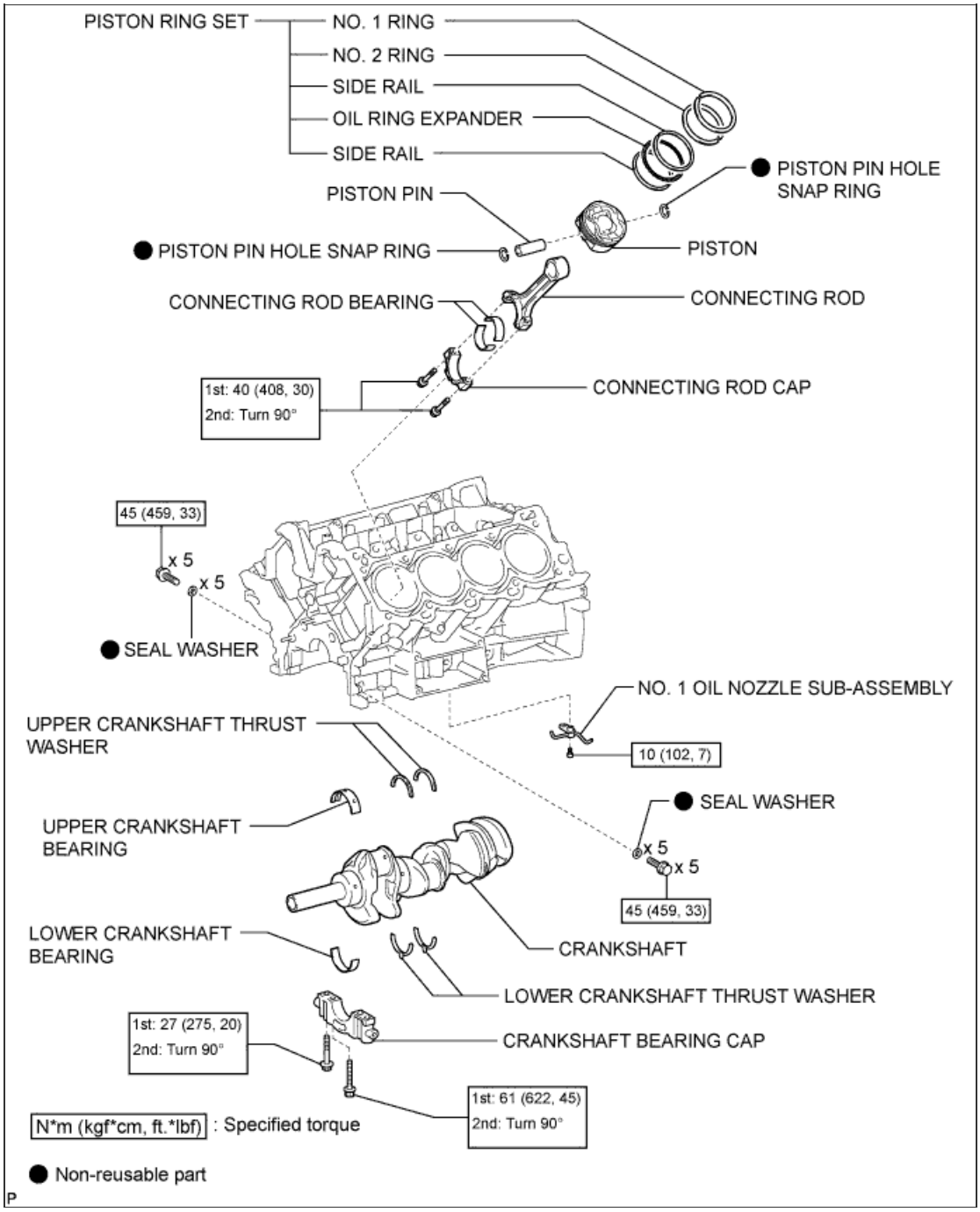
Standard width:
1.1 to 1.5 mm (0.0433 to 0.0591 in.)

c. Hand-lap the valve and valve seat with an abrasive compound.

d. Check the valve seating position.



for Preparation Click here



for Preparation Click here

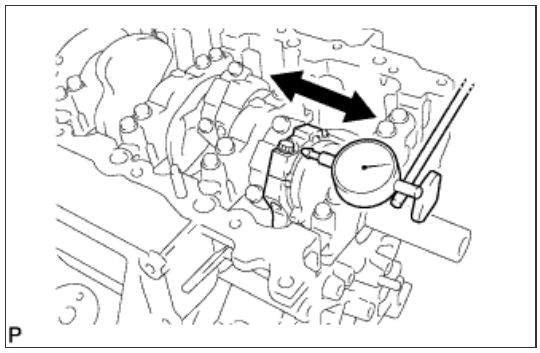
1. INSPECT CONNECTING ROD THRUST CLEARANCE

a. Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

Standard thrust clearance:
0.15 to 0.55 mm (0.00591 to 0.0217 in.)

Maximum thrust clearance:
0.70 mm (0.0276 in.)

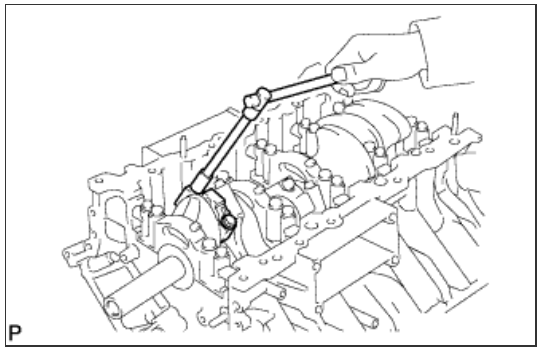
If the thrust clearance is more than the maximum, replace one or more connecting rods as necessary.
If necessary, replace the crankshaft.



2. INSPECT CONNECTING ROD OIL CLEARANCE

a. Check that the front mark on the connecting rod and cap are aligned to ensure correct reassembly.

b. Remove the 2 connecting rod cap bolts.



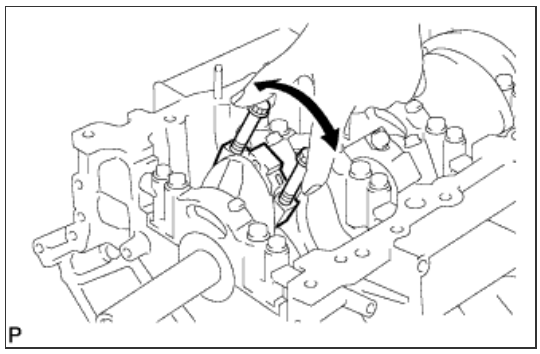
c. Using the 2 removed connecting rod cap bolts, remove the connecting rod cap and lower bearing by wiggling the connecting rod cap right and left.

HINT:

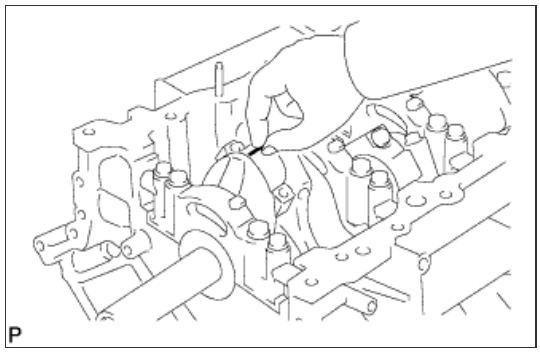
Keep the lower bearing inserted to the connecting rod cap.

d. Check the crank pin and bearing for pitting and scratches.
If the crank pin or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.

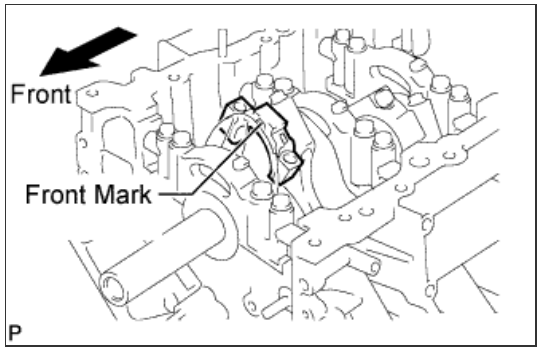
e. Clean the crank pin and bearing.



f. Lay a strip of Plastigage on the crank pin.



g. Place the connecting rod cap on the connecting rod with the front mark facing forward.



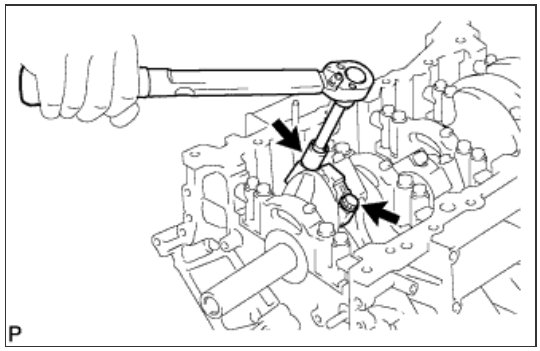
h. Install and alternately tighten the bolts of the connecting rod cap in several steps.

Torque:

40 N*m{ 408 kgf*cm , 30 ft.*lbf }

NOTICE:

Do not turn the crankshaft.



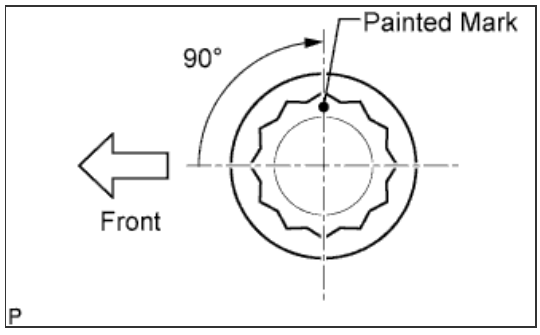
i. Mark the front side of each connecting rod cap bolt with paint.

j. Tighten the cap bolts 90° as shown in the illustration.

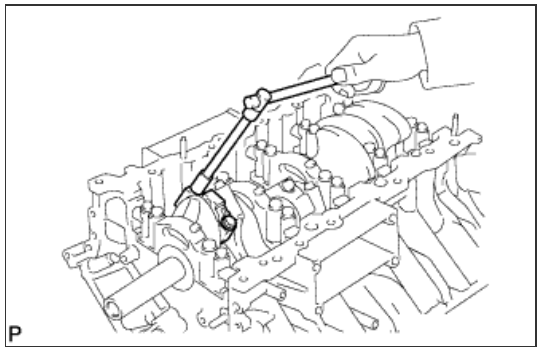
k. Check that the painted marks are now at a 90° angle to the front.

NOTICE:

Do not turn the crankshaft.



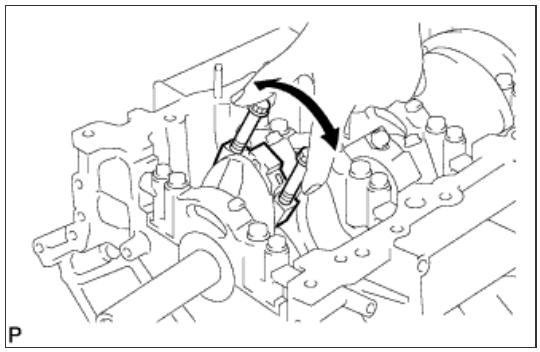
l. Remove the 2 connecting rod cap bolts.



m. Using the 2 removed connecting rod cap bolts, remove the connecting rod cap and lower bearing by wiggling the connecting rod cap right and left.

HINT:

Keep the lower bearing inserted to the connecting rod cap.



n. Measure the Plastigage at its widest point.

Standard oil clearance:
0.025 to 0.050 mm (0.000984 to 0.00197 in.)

Maximum oil clearance:
0.070 mm (0.00276 in.)

If the oil clearance is more than the maximum, replace the bearings. If necessary, replace the crankshaft.

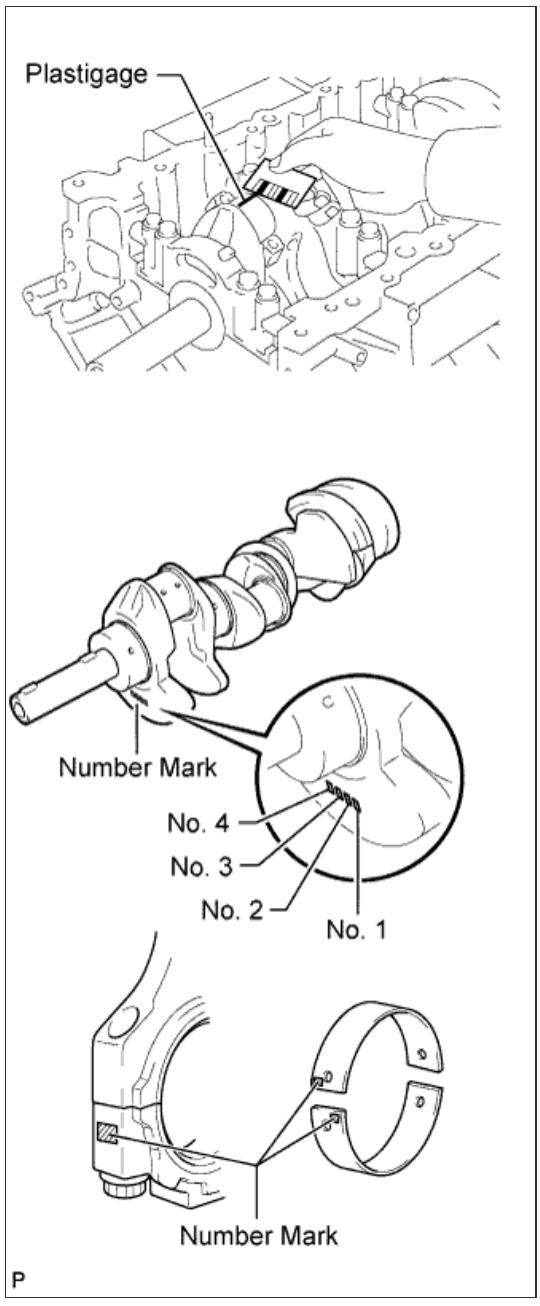
HINT:

- **If replacing a bearing, replace it with one that has the same number as its respective connecting rod cap. The standard thickness of each bearing is indicated by a 1, 2, 3 or 4 mark on its surface.**
- **Select the correct bearing by adding together the number marks imprinted on the connecting rod big end and crank pin.**

Example:

Connecting rod "1" + Crank pin "2" = 3 (Use bearing "3")

Reference:



Standard Sized Bearing Center Wall Thickness:

Mark	Thickness
2	1.489 to 1.492 mm (0.0586 to 0.0587 in.)
3	1.492 to 1.495 mm (0.0587 to 0.0589 in.)
4	1.495 to 1.498 mm (0.0589 to 0.0590 in.)
5	1.498 to 1.501 mm (0.0590 to 0.0591 in.)
6	1.501 to 1.504 mm (0.0591 to 0.0592 in.)
7	1.504 to 1.507 mm (0.0592 to 0.0593 in.)

Connecting Rod Big End Inside Diameter:

Mark	Thickness
1	59.000 to 59.006 mm (2.32283 to 2.32307 in.)
2	59.006 to 59.012 mm (2.32307 to 2.32330 in.)
3	59.012 to 59.018 mm (2.32330 to 2.32354 in.)
4	59.018 to 59.024 mm (2.32354 to 2.32377 in.)

Crankshaft Pin Diameter:

Mark	Thickness
1	55.994 to 56.000 mm (2.20448 to 2.20472 in.)
2	55.988 to 55.994 mm (2.20425 to 2.20448 in.)

3	55.982 to 55.988 mm (2.20401 to 2.20425 in.)

o. Completely remove the Plastigage.

p. Perform the inspection above for each cylinder.

3. REMOVE PISTON AND CONNECTING ROD

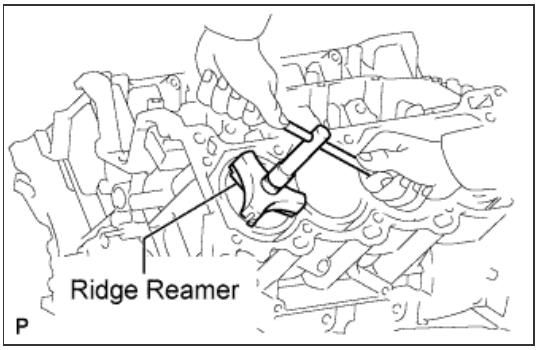
a. Using a ridge reamer, remove all the carbon from the top of the cylinder.

b. Remove the 16 cap bolts, 8 connecting rod caps and 8 lower bearings.

c. Push the 8 pistons and 8 connecting rods through the top of the cylinder block.

HINT:

- **Keep the bearing, connecting rod and cap together.**
- **Arrange the piston and connecting rods in the correct order.**



4. REMOVE CONNECTING ROD BEARING

a. Remove the connecting rod bearings from the connecting rods and connecting rod caps.

HINT:

Arrange the removed parts in the correct order.

5. INSPECT CRANKSHAFT THRUST CLEARANCE

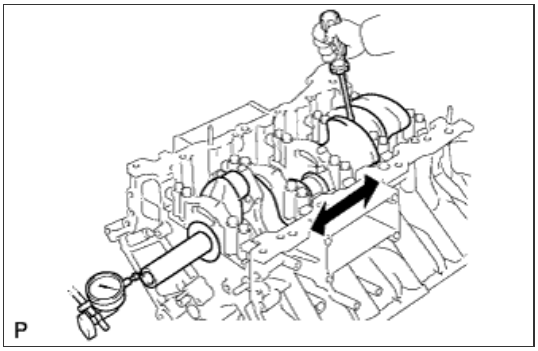
a. Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance:
0.020 to 0.220 mm (0.000787 to 0.00866 in.)

Maximum thrust clearance:
0.30 mm (0.0118 in.)

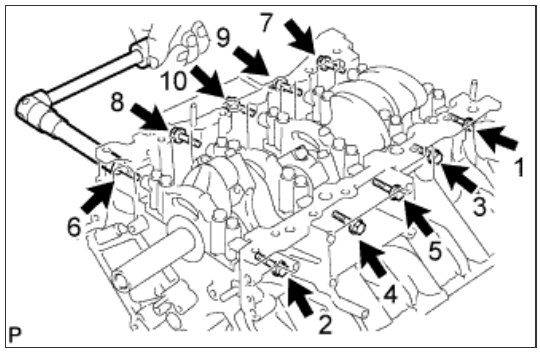
If the thrust clearance is more than the maximum, replace the thrust washers as a set. If necessary, replace the crankshaft.

Standard thrust washer thickness:
2.44 to 2.49 mm (0.0961 to 0.0980 in.)

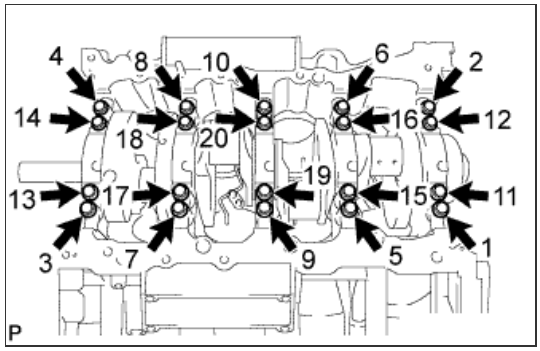


6. REMOVE CRANKSHAFT

a. Uniformly loosen and remove the 10 bearing cap bolts and 10 seal washers in several steps in the sequence shown in the illustration.



b. Uniformly loosen and remove the 20 bearing cap bolts in several steps in the sequence shown in the illustration.



c. Using a screwdriver, slightly pry up the 5 main bearing caps.

HINT:

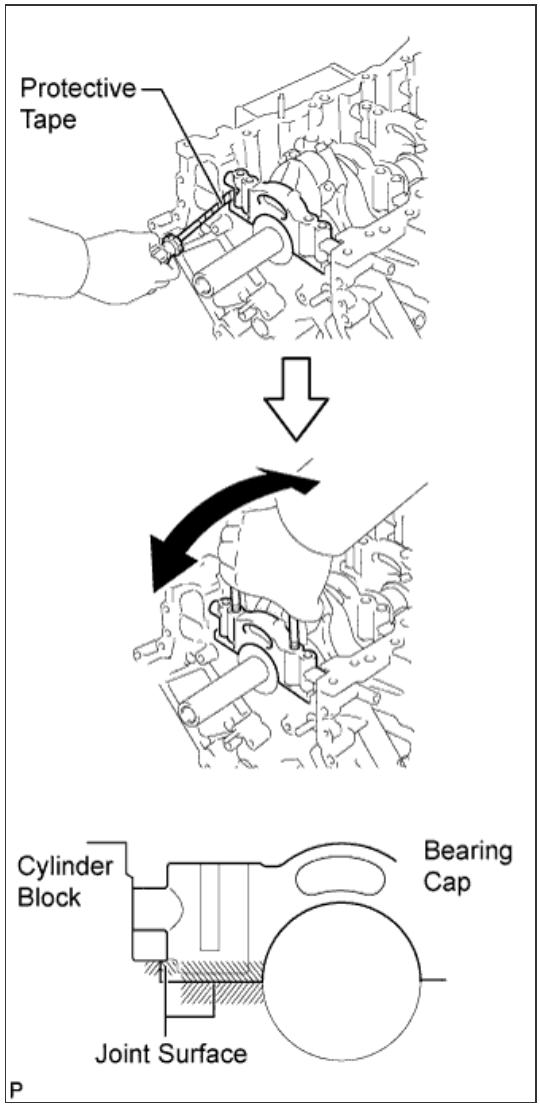
Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the joint surface of the cylinder block and main bearing caps.**
- **Pry up the left and right side of the cap little by little.**

d. Using the 2 inside position crankshaft bearing cap bolts, loosen each crankshaft bearing cap by moving it forward and backward, and remove each crankshaft bearing cap.

e. Remove the crankshaft.



7. REMOVE CRANKSHAFT BEARING

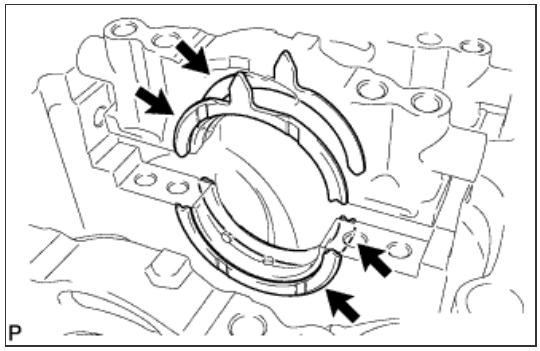
a. Remove the crankshaft bearings from the bearing caps and cylinder block.

HINT:

Arrange the removed parts in the correct order.

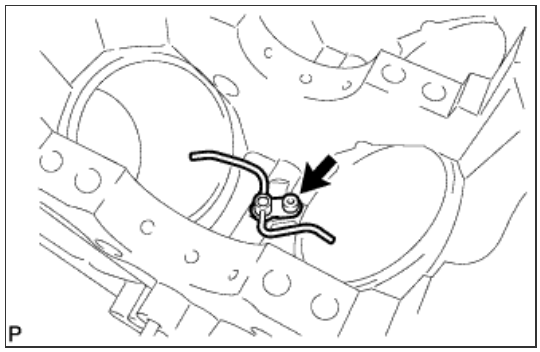
8. REMOVE CRANKSHAFT THRUST WASHER SET

a. Remove the thrust washer set from the cylinder block and No. 3 bearing cap.



9. REMOVE NO. 1 OIL NOZZLE SUB-ASSEMBLY

a. Using a 5 mm hexagon wrench, remove the 4 bolts and 4 oil nozzles.



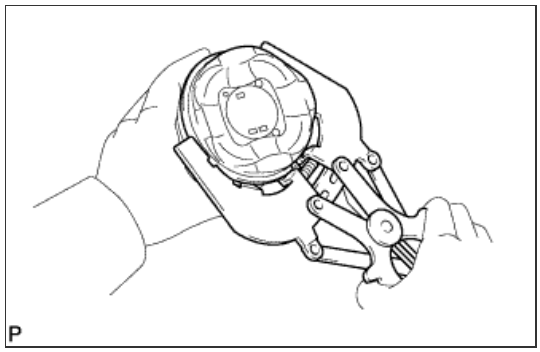
10. REMOVE PISTON RING SET

HINT:

Arrange the piston rings in the correct order.

a. Using a piston ring expander, remove the 2 compression rings.

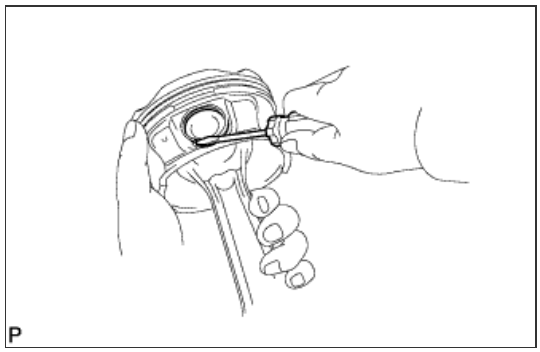
b. Remove the 2 side rails and oil ring expander by hand.



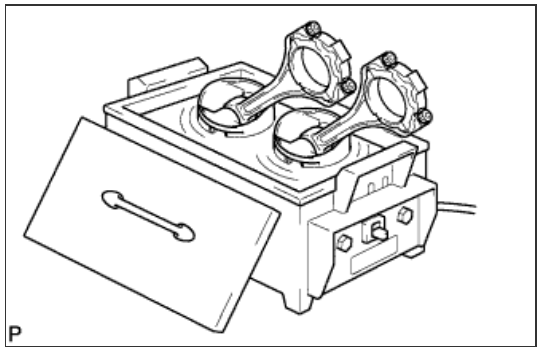
11. REMOVE PISTON WITH PIN SUB-ASSEMBLY

a. Disconnect the connecting rod from the piston.

i. Using a small screwdriver, pry off the 2 snap rings from the piston.



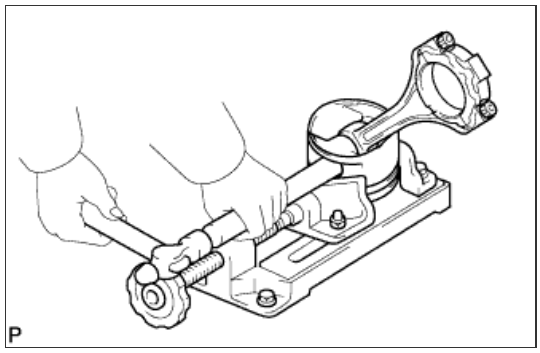
ii. Gradually heat the piston to approximately 80°C (176°F).



iii. Using a brass bar and plastic-faced hammer, lightly tap out the piston pin. Then remove the connecting rod.

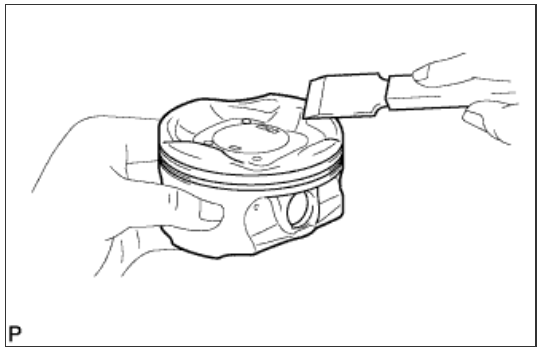
HINT:

- **The piston and pin are a matched set.**
- **Arrange the pistons, pins, rings, connecting rods and bearings in the correct order.**

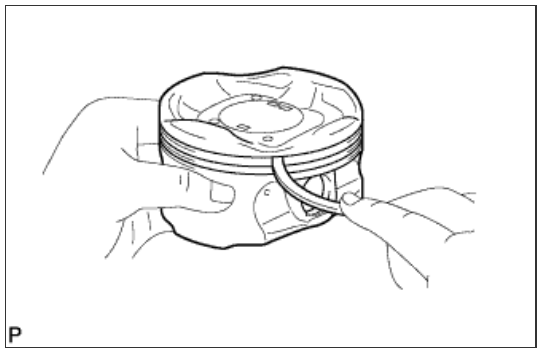


b. Clean the piston.

i. Using a gasket scraper, remove the carbon from the piston top.



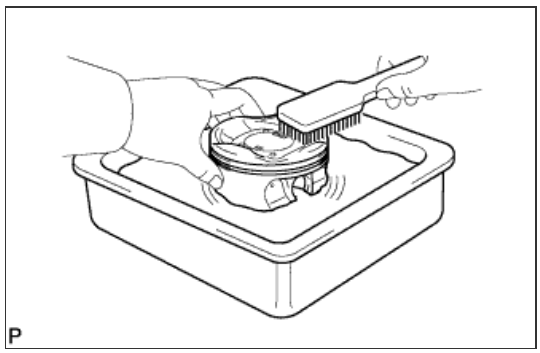
ii. Using a groove cleaning tool or broken ring, clean the piston ring grooves.



iii. Using solvent and a brush, thoroughly clean the piston.

NOTICE:

Do not use a wire brush.



12. REMOVE STUD BOLT

NOTICE:

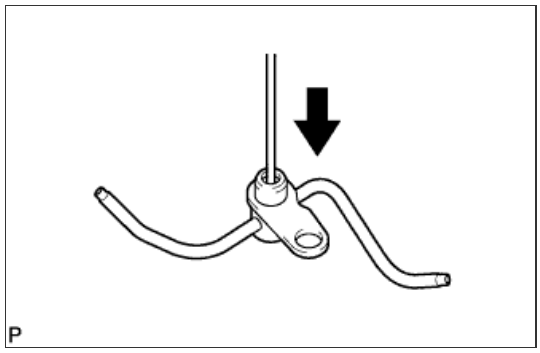
If the stud bolt is deformed or its threads are damaged, replace it.

for Preparation Click here

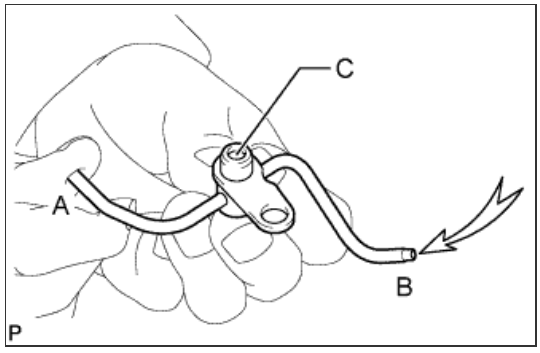
1. INSPECT NO. 1 OIL NOZZLE SUB-ASSEMBLY

a. Push the check valve with a pin to check if it is stuck.
If stuck, replace the No. 1 oil nozzle sub-assembly.

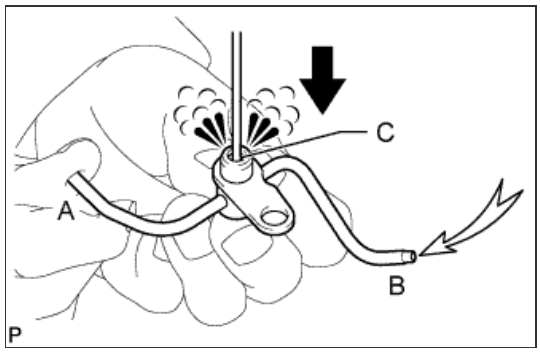
b. Push the check valve with a pin to check if it moves smoothly.
If it does not move smoothly, clean or replace the No. 1 oil nozzle sub-assembly.



c. While covering A, apply air into B. Check that air does not leak through C.
Perform the check again while covering B and applying air into A.
If air leaks, clean or replace the No. 1 oil nozzle sub-assembly.

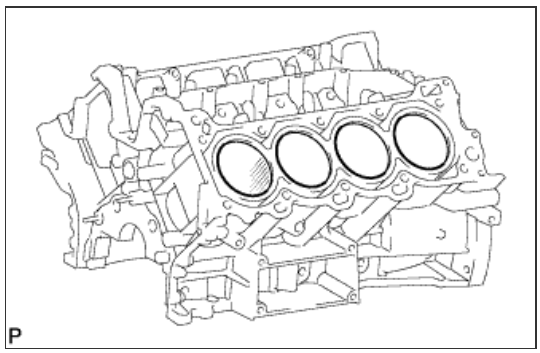


d. Push the check valve while covering A, and apply air into B. Check that air passes through C. Perform the check again while covering B, pushing the check valve and applying air into A.
If air does not pass through C, clean or replace the No. 1 oil nozzle sub-assembly.



2. CHECK CYLINDER BLOCK SUB-ASSEMBLY

a. Visually check the cylinder for vertical scratches. If deep scratches are present, rebore all 8 cylinders. If necessary, replace the cylinder block.

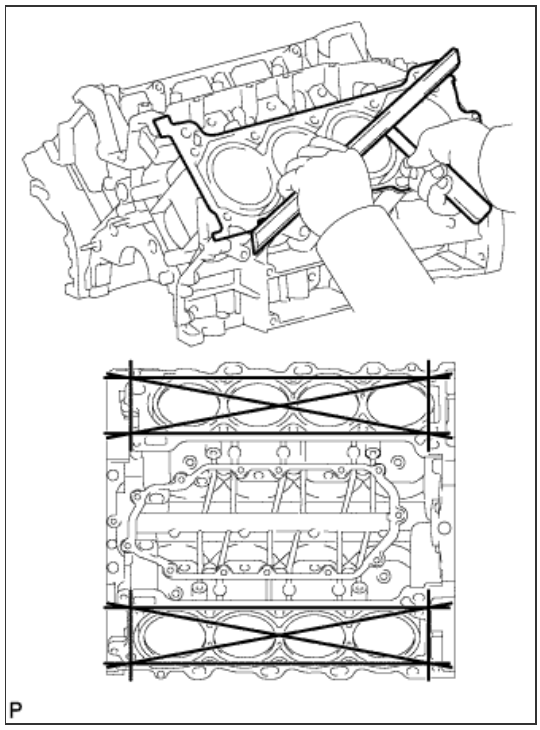


3. INSPECT CYLINDER BLOCK FOR WARPAGE

a. Using a precision straightedge and feeler gauge, measure the warpage of the surfaces where the cylinder head gaskets contact the cylinder block.

Maximum warpage:
0.07 mm (0.00276 in.)

If the warpage is more than the maximum, replace the cylinder block.



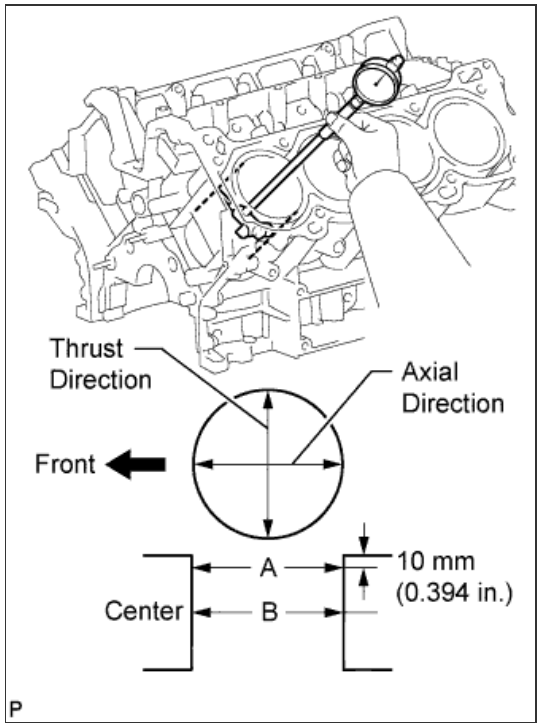
4. INSPECT CYLINDER BORE

a. Using a cylinder gauge, measure the cylinder bore diameter at positions A and B in the thrust and axial directions.

Standard diameter:
94.000 to 94.012 mm (3.7008 to 3.7013 in.)

Maximum diameter:
94.200 mm (3.7087 in.)

If the diameter is more than the maximum, replace the cylinder block.



5. INSPECT PISTON SUB-ASSEMBLY WITH PIN

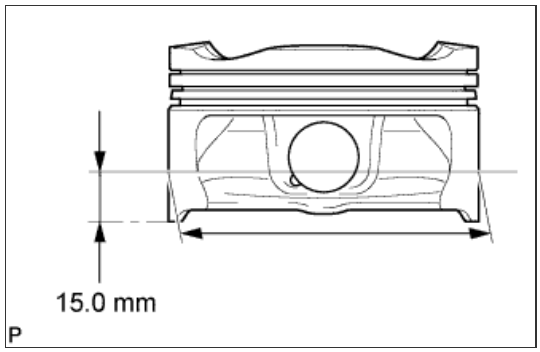
a. Using a micrometer, measure the piston diameter at a position that is 15.0 mm (0.591 in.) from the bottom of the piston (refer to the illustration).

Standard diameter:

93.950 to 93.960 mm (3.6988 to 3.6992 in.)

Minimum diameter:
93.815 mm (3.6935 in.)

If the diameter is less than the minimum, replace the piston.



6. INSPECT PISTON OIL CLEARANCE

a. Measure the cylinder bore diameter in the thrust direction.

b. Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance:
0.040 to 0.062 mm (0.00157 to 0.00244 in.)

Maximum oil clearance:
0.385 mm (0.0152 in.)

If the oil clearance is more than the maximum, replace all the pistons. If necessary, replace the cylinder block.

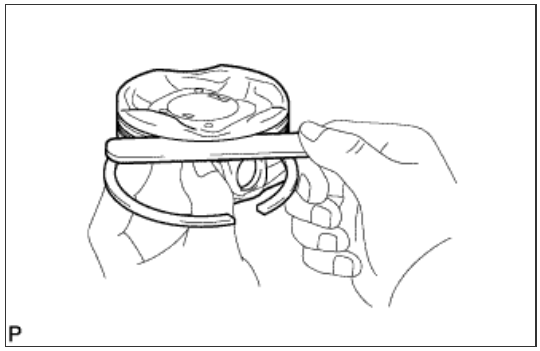
7. INSPECT RING GROOVE CLEARANCE

a. Using a feeler gauge, measure the clearance between a new piston ring and the wall of the ring groove.

Standard Ring Groove Clearance:

Item	Specified Condition
No. 1 ring	0.020 to 0.070 mm (0.000787 to 0.00276 in.)
No. 2 ring	0.020 to 0.060 mm (0.000787 to 0.00236 in.)
Oil ring expander	0.070 to 0.145 mm (0.00276 to 0.00571 in.)

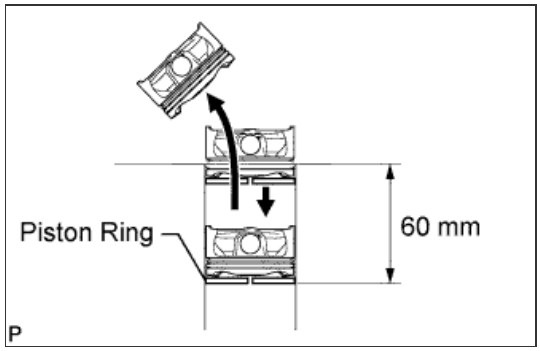
If the clearance is not as specified, replace the piston.



8. INSPECT PISTON RING END GAP

a. Insert the piston ring into the cylinder bore.

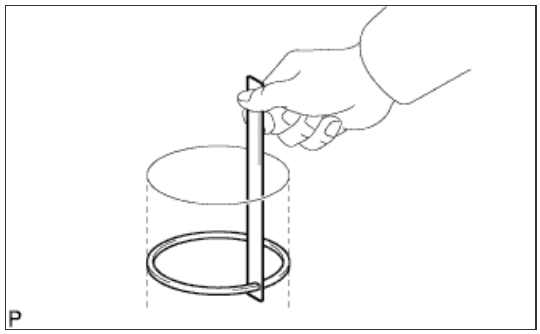
b. Using a piston, push the piston ring a little beyond the bottom of the ring travel, 60 mm (2.36 in.) from the top of the cylinder block.



c. Using a feeler gauge, measure the end gap.

Standard End Gap:

Item	Specified Condition
No. 1 ring	0.25 to 0.35 mm (0.00984 to 0.0138 in.)
No. 2 ring	0.40 to 0.50 mm (0.0157 to 0.0197 in.)
Oil ring expander	0.10 to 0.40 mm (0.00394 to 0.0157 in.)



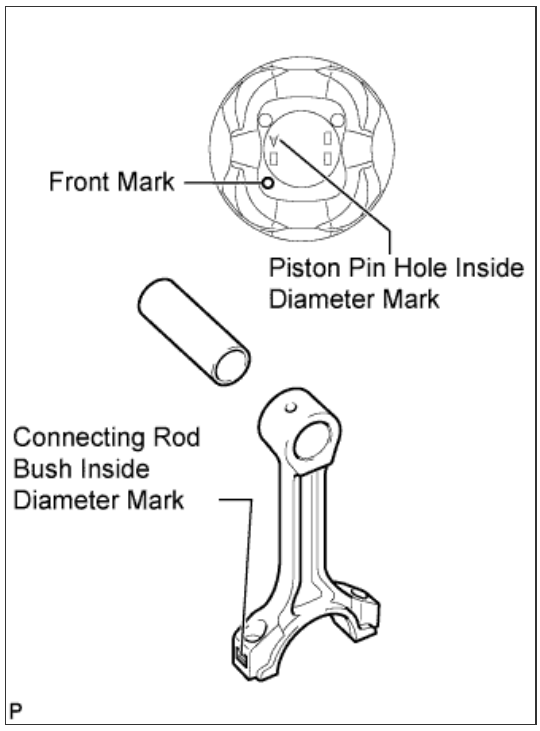
Maximum End Gap:

Item	Specified Condition
No. 1 ring	0.42 mm (0.0165 in.)
No. 2 ring	0.55 mm (0.0217 in.)
Oil ring expander	0.45 mm (0.0177 in.)

If the end gap is more than the maximum, replace the piston ring. If the end gap is more than the maximum even with a new piston ring, replace the cylinder block.

9. INSPECT PISTON PIN OIL CLEARANCE

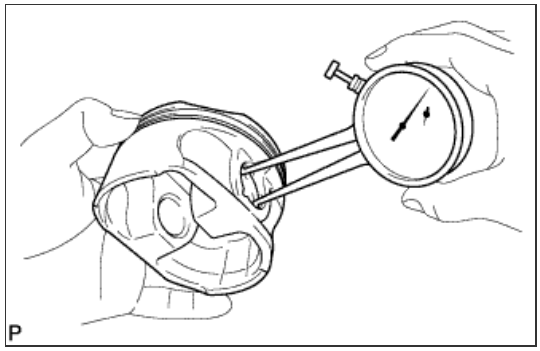
a. Check each mark on the piston, piston pin and connecting rod.



b. Using a caliper gauge, measure the inside diameter of the piston pin hole.

Standard Piston Pin Hole Inside Diameter:

Mark	Specified Condition
A	21.998 to 22.001 mm (0.86606 to 0.86618 in.)
B	22.001 to 22.004 mm (0.86618 to 0.86630 in.)
C	22.004 to 22.007 mm (0.86630 to 0.86642 in.)

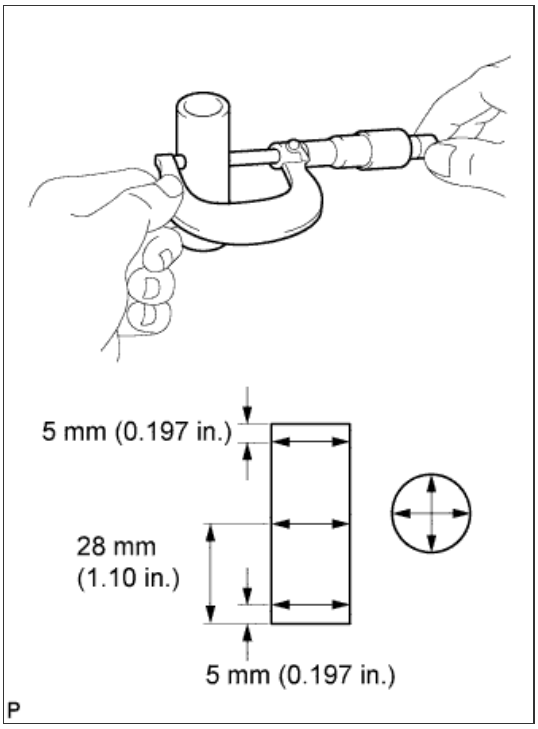


c. Using a micrometer, measure the piston pin diameter.

Standard Piston Pin Diameter:

Mark	Specified Condition

A	21.998 to 22.001 mm (0.86606 to 0.86618 in.)
B	22.001 to 22.004 mm (0.86618 to 0.86630 in.)
C	22.004 to 22.007 mm (0.86630 to 0.86642 in.)



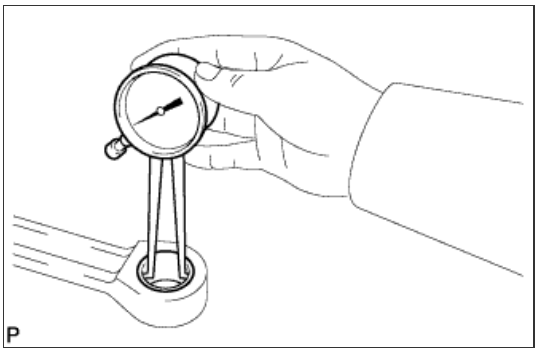
d. Subtract the piston pin diameter measurement from the piston pin hole diameter measurement.

Standard oil clearance:
-0.002 to 0.004 mm (-0.0000787 to 0.000157 in.)

Maximum oil clearance:
0.015 mm (0.000591 in.)

If the oil clearance is more than the maximum, replace the piston and piston pin as a set.

e. Using a caliper gauge, measure the inside diameter of the connecting rod bush.



Standard Bush Inside Diameter:

Mark	Specified Condition
A	22.005 to 22.008 mm (0.86634 to 0.86645 in.)
B	22.008 to 22.011 mm (0.86645 to 0.86657 in.)
C	22.011 to 22.014 mm (0.86657 to 0.86669 in.)

f. Subtract the piston pin diameter measurement from the bush inside diameter measurement.

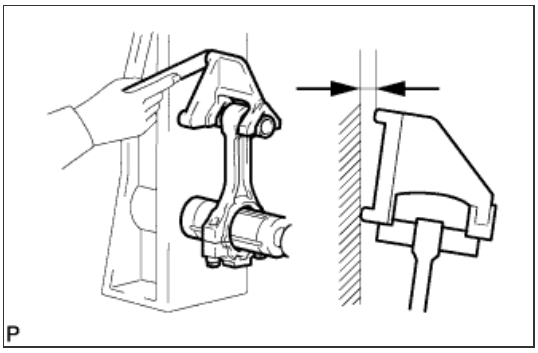
Standard oil clearance:
0.005 to 0.011 mm (0.000197 to 0.000433 in.)

Maximum oil clearance:
0.03 mm (0.00118 in.)

If the oil clearance is more than the maximum, replace the connecting rod, and replace the piston and pin as a set.

10. INSPECT CONNECTING ROD SUB-ASSEMBLY

a. Using a rod aligner and feeler gauge, check the connecting rod alignment.



i. Check for bend.

Maximum bend:
0.05 mm (0.00197 in.) per 100 mm (3.94 in.)

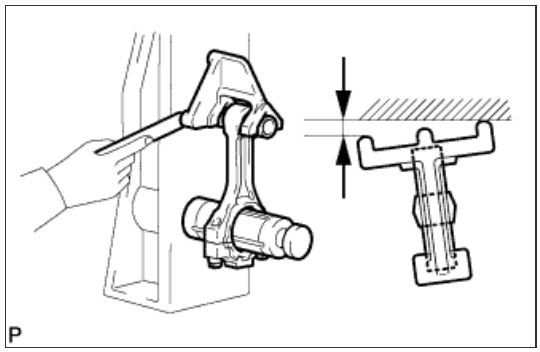
If the bend is more than the maximum, replace the connecting rod.

ii. Check for twist.

Maximum twist:

0.15 mm (0.00591 in.) per 100 mm (3.94 in.)

If the twist is more than the maximum, replace the connecting rod.



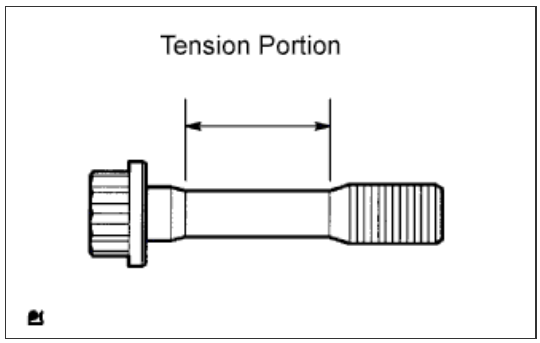
11. INSPECT CONNECTING ROD BOLT

a. Using a vernier caliper, measure the tension portion diameter of the bolt.

Standard diameter:
8.5 to 8.6 mm (0.335 to 0.339 in.)

Minimum diameter:
8.3 mm (0.327 in.)

If the diameter is less than the minimum, replace the bolt.



12. INSPECT CRANKSHAFT

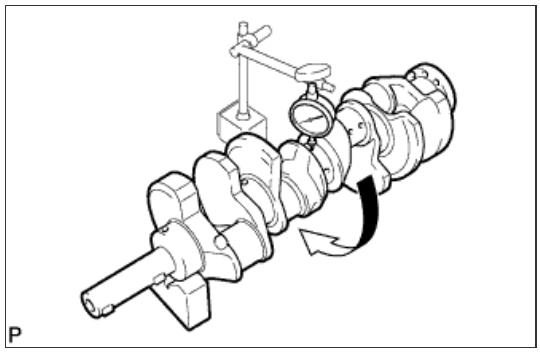
a. Inspect circle runout.

i. Place the crankshaft on V-blocks.

ii. Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout:
0.06 mm (0.00236 in.)

If the circle runout is more than the maximum, replace the crankshaft.



b. Inspect the main journals.

i. Using a micrometer, measure the diameter of each main journal.

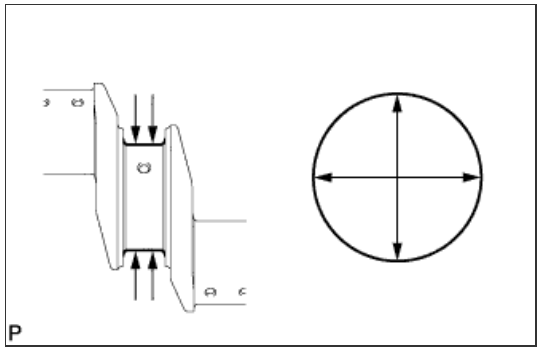
Standard journal diameter:
66.988 to 67.000 mm (2.6373 to 2.6378 in.)

If the diameter is not as specified, check the oil clearance. If necessary, replace the crankshaft.

ii. Check each main journal for taper and out-of-round as shown in the illustration.

Maximum taper and out-of-round:
0.02 mm (0.000787 in.)

If the taper and out-of-round is more than the maximum, replace the crankshaft.

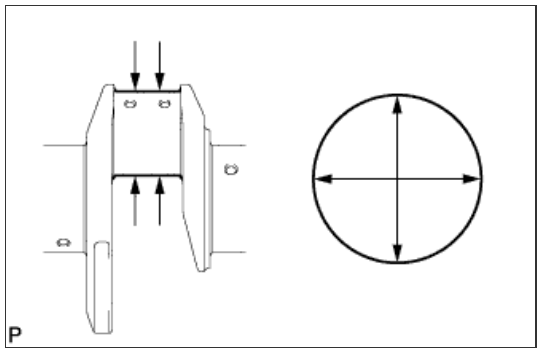


c. Inspect the crank pins.

i. Using a micrometer, measure the diameter of each crank pin.

Standard crank pin diameter:
55.982 to 56.000 mm (2.2040 to 2.2047 in.)

If the diameter is not as specified, check the oil clearance. If necessary, replace the crankshaft.



ii. Check each crank pin for taper and out-of-round as shown in the illustration.

Maximum taper and out-of-round:
0.02 mm (0.000787 in.)

If the taper and out-of-round is more than the maximum, replace the crankshaft.

13. INSPECT CRANKSHAFT OIL CLEARANCE

a. Clean each main journal and bearing.

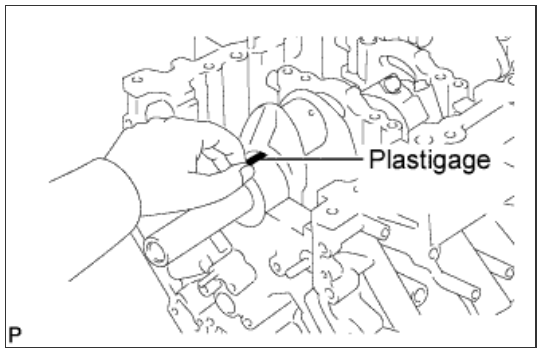
b. Check each main journal and bearing for pitting and scratches.
If the journal or bearing is damaged, replace the bearing.

c. Place the crankshaft on the cylinder block.

d. Lay a strip of Plastigage across each journal.

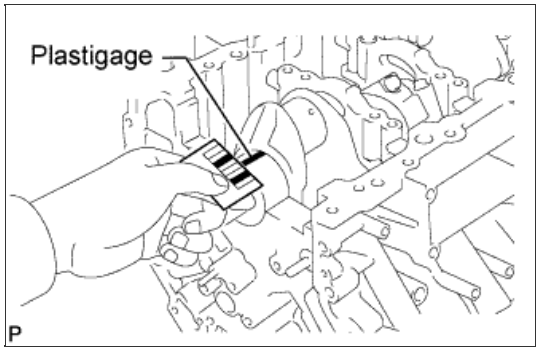
e. Install the crankshaft bearing caps (Click here).

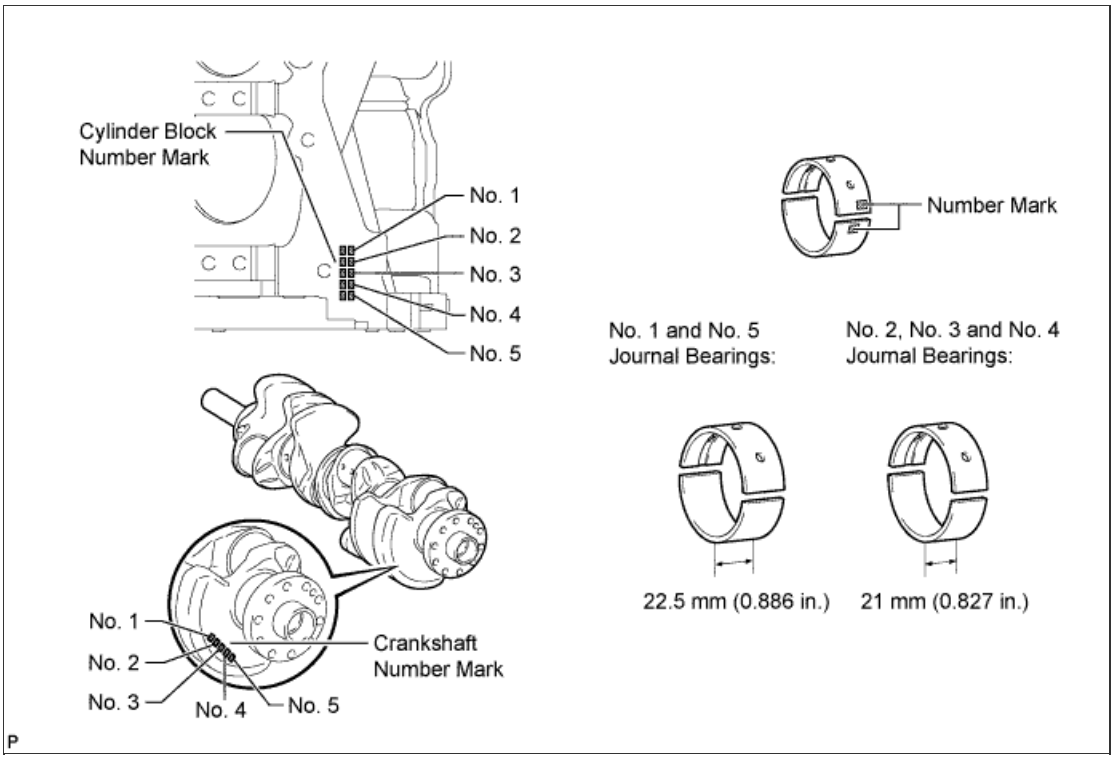
f. Remove the 30 bolts and bearing caps.



g. Measure the Plastigage at its widest point.

Standard Oil Clearance:





Number Mark	Specified Condition
No. 1 and No. 5 journals	0.017 to 0.030 mm (0.000669 to 0.00118 in.)
Other journals	0.024 to 0.037 mm (0.000945 to 0.00146 in.)

Maximum Oil Clearance:

Number Mark	Specified Condition
No. 1 and No. 5 journals	0.050 mm (0.00197 in.)
Other journals	0.060 mm (0.00236 in.)

If the oil clearance is more than the maximum, replace the bearings. If necessary, replace the crankshaft.

HINT:

If replacing a bearing, replace it with one that has the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the cylinder block and crankshaft. Refer to the table below for the appropriate bearing number. There are 6 sizes of standard bearings. For the No. 1 and No. 5 position bearings, use bearings marked 4, 5, 6, 7, 8 or 9. For other bearings, use bearings marked 3, 4, 5, 6, 7 or 8.

Example:
Cylinder block "07" + Crankshaft "06" = Total number 13 (Use upper bearing "6" and lower bearing "7")

HINT:

A = Cylinder block number mark

B = Crankshaft number mark

Standard Bearing Center Wall Thickness:

No. 1 and No. 5 Journals

(A) + (B)	Upper Bearing		Lower Bearing	
	Number Mark	Specified Condition	Number Mark	Specified Condition
00 to 02	4	2.501 to 2.504 (0.0985 to 0.0986 in.)	5	2.488 to 2.491 (0.0980 to 0.0981 in.)
03 to 05	5	2.504 to 2.507 (0.0986 to 0.0987 in.)	5	2.488 to 2.491 (0.0980 to 0.0981 in.)
06 to 08	5	2.504 to 2.507 (0.0986 to 0.0987 in.)	6	2.491 to 2.494 (0.0981 to 0.0982 in.)
09 to 11	6	2.507 to 2.510 (0.0987 to 0.0988 in.)	6	2.491 to 2.494 (0.0981 to 0.0982 in.)
12 to 14	6	2.507 to 2.510 (0.0987 to 0.0988	7	2.494 to 2.497 (0.0982 to 0.0983

		in.)		in.)
15 to 17	7	2.510 to 2.513 (0.0988 to 0.0989 in.)	7	2.494 to 2.497 (0.0982 to 0.0983 in.)
18 to 20	7	2.510 to 2.513 (0.0988 to 0.0989 in.)	8	2.497 to 2.500 (0.0983 to 0.0984 in.)
21 to 23	8	2.513 to 2.516 (0.0989 to 0.0991 in.)	8	2.497 to 2.500 (0.0983 to 0.0984 in.)
24 to 26	8	2.513 to 2.516 (0.0989 to 0.0991 in.)	9	2.500 to 2.503 (0.0984 to 0.0985 in.)
27 to 28	9	2.516 to 2.519 (0.0991 to 0.0992 in.)	9	2.500 to 2.503 (0.0984 to 0.0985 in.)

Other Journals:

(A) + (B)	Upper Bearing		Lower Bearing	
	Number Mark	Specified Condition	Number Mark	Specified Condition
00 to 02	3	2.482 to 2.485 (0.0977 to 0.0978 in.)	4	2.501 to 2.504 (0.0985 to 0.0986 in.)
03 to 05	4	2.485 to 2.488 (0.0978 to 0.0980 in.)	4	2.501 to 2.504 (0.0985 to 0.0986 in.)
06 to 08	4	2.485 to 2.488 (0.0978 to 0.0980 in.)	5	2.504 to 2.507 (0.0986 to 0.0987 in.)
09 to 11	5	2.488 to 2.491 (0.0980 to 0.0981 in.)	5	2.504 to 2.507 (0.0986 to 0.0987 in.)
12 to 14	5	2.488 to 2.491 (0.0980 to 0.0981 in.)	6	2.507 to 2.510 (0.0987 to 0.0988 in.)
15 to 17	6	2.491 to 2.494 (0.0981 to 0.0982 in.)	6	2.507 to 2.510 (0.0987 to 0.0988 in.)
18 to 20	6	2.491 to 2.494 (0.0981 to 0.0982 in.)	7	2.510 to 2.513 (0.0988 to 0.0989 in.)
21 to 23	7	2.494 to 2.497 (0.0982 to 0.0983 in.)	7	2.510 to 2.513 (0.0988 to 0.0989 in.)
24 to 26	7	2.494 to 2.497 (0.0982 to 0.0983 in.)	8	2.513 to 2.516 (0.0989 to 0.0991 in.)
27 to 28	8	2.497 to 2.500 (0.0983 to 0.0984 in.)	8	2.513 to 2.516 (0.0989 to 0.0991 in.)

h. Completely remove the Plastigage.

14. INSPECT CRANKSHAFT BEARING CAP SET BOLT

a. Using a vernier caliper, measure the minimum diameter of the elongated thread at the measuring point.

Measuring point:
54.5 mm (2.15 in.)

Standard Diameter:

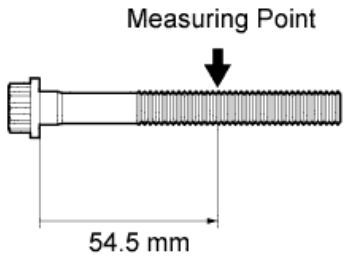
Item	Specified Condition
Bolt A	10.5 to 11.0 mm (0.413 to 0.433 in.)
Bolt B	9.5 to 10.0 mm (0.374 to 0.394 in.)

Minimum Diameter:

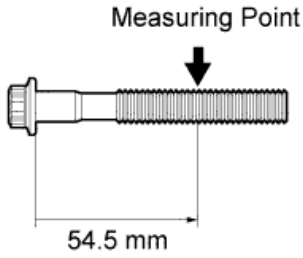
Item	Specified Condition
Bolt A	10.4 mm (0.409 in.)
Bolt B	9.4 mm (0.370 in.)

If the diameter is less than the minimum, replace the bolt.

Bolt A:



Bolt B:



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for Preparation Click here

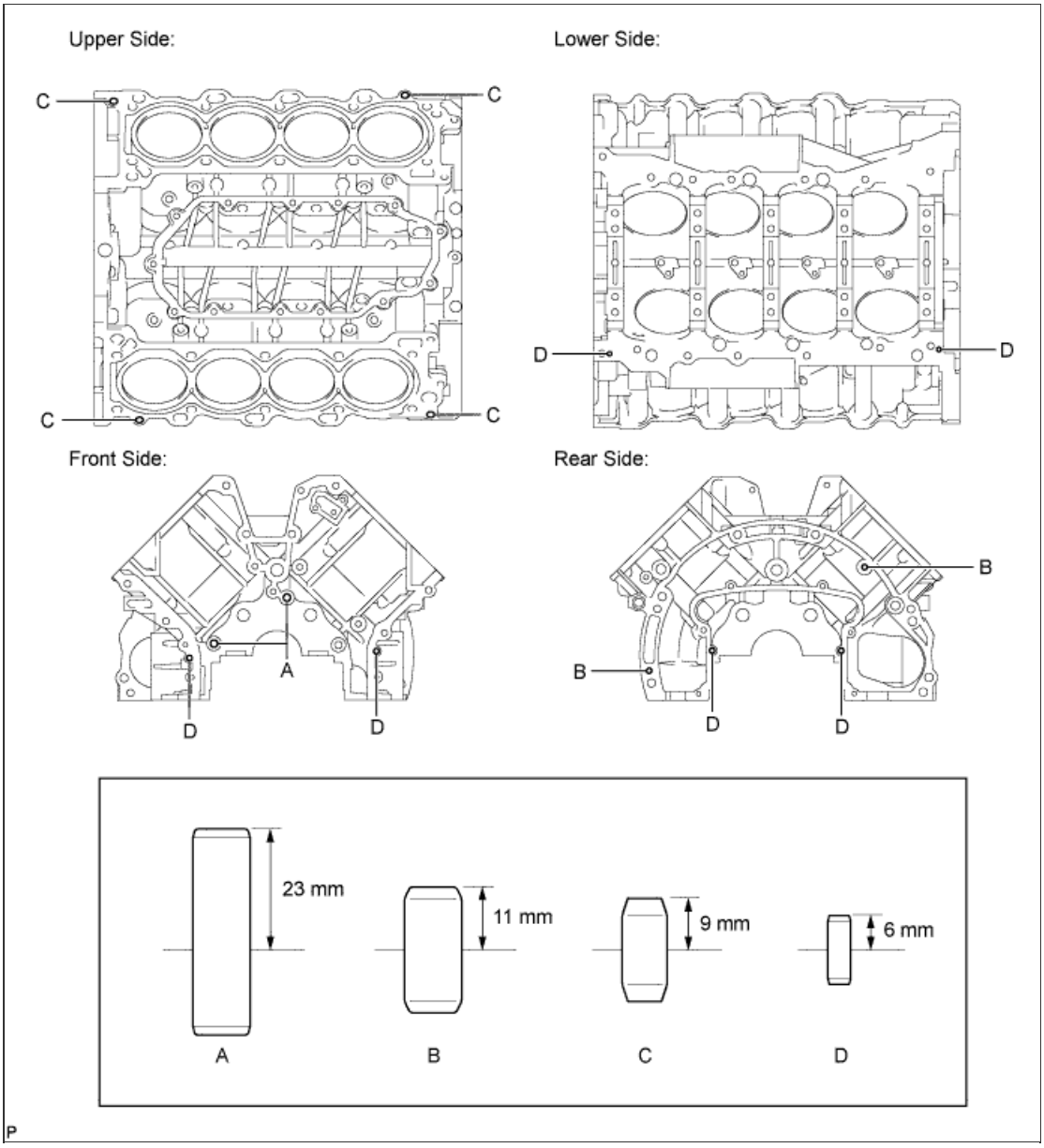
1. REPLACE STRAIGHT PIN

NOTICE:

It is not necessary to remove the straight pin unless it is being replaced.

a. Remove the straight pins.

b. Using a plastic-faced hammer, tap in new straight pins to the cylinder block.



Standard Protrusion:

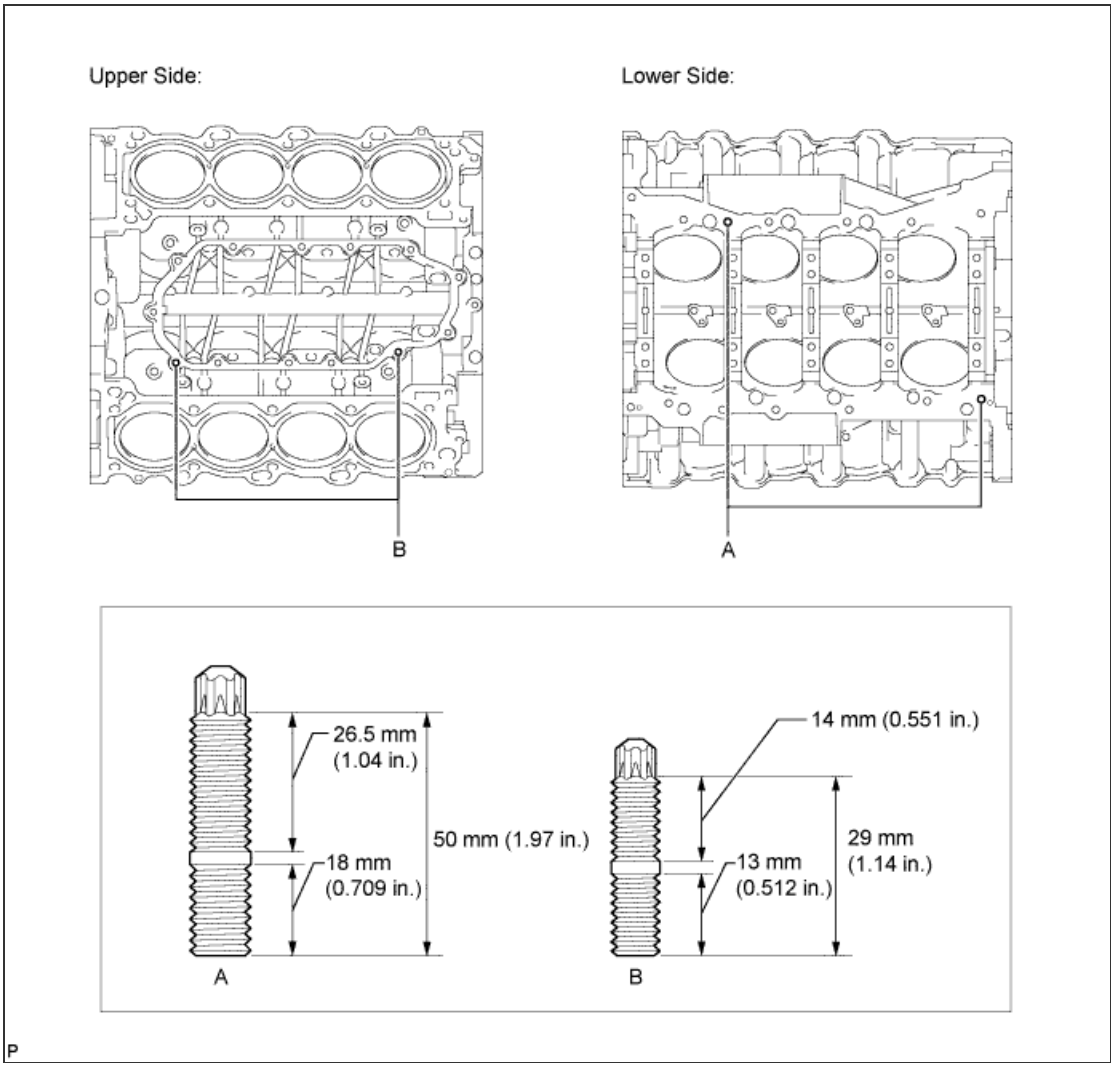
Item	Pin Diameter	Specified Condition
Pin A	10 mm (0.394 in.)	23 mm (0.906 in.)
Pin B	10 mm (0.394 in.)	11 mm (0.433 in.)
Pin C	8 mm (0.315 in.)	9 mm (0.354 in.)

Pin D	4 mm (0.157 in.)	6 mm (0.236 in.)

for Preparation Click here

1. INSTALL STUD BOLT

a. Using an E8 "TORX" socket wrench, install the stud bolts.

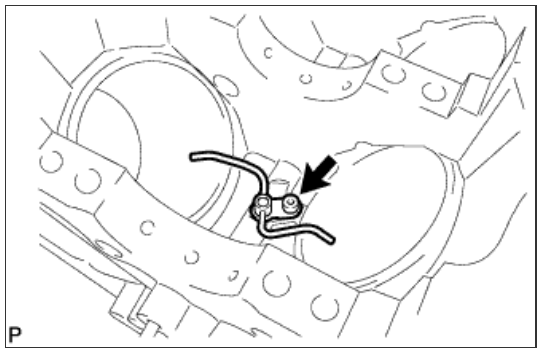


Torque:
for stud bolt A:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }
for stud bolt B:
9.0 N*m{ 92 kgf*cm , 80 in.*lbf }

2. INSTALL NO. 1 OIL NOZZLE SUB-ASSEMBLY

a. Using a 5 mm hexagon wrench, install the 4 oil nozzles with the 4 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

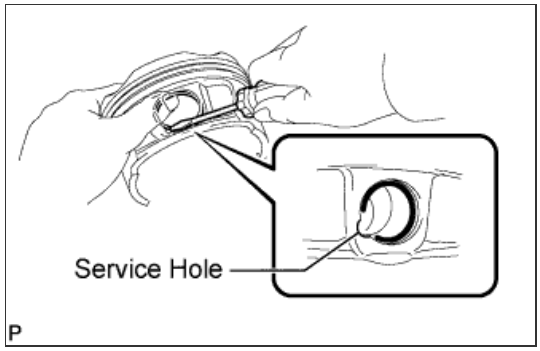


3. INSTALL PISTON WITH PIN SUB-ASSEMBLY

a. Using a small screwdriver, install a new snap ring at one end of the piston pin hole.

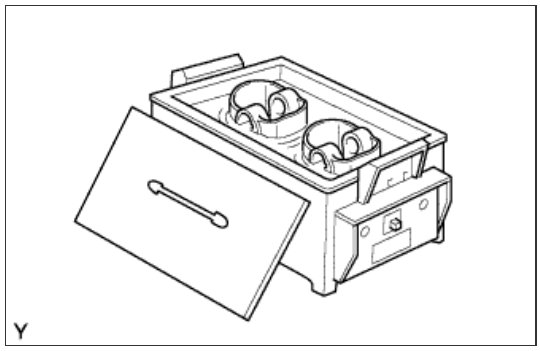
HINT:

Be sure that the end gap of the snap ring is not aligned with the service hole of the piston.



b. Gradually heat the piston to approximately 80°C (176°F).

c. Coat the piston pin and connecting rod with engine oil.



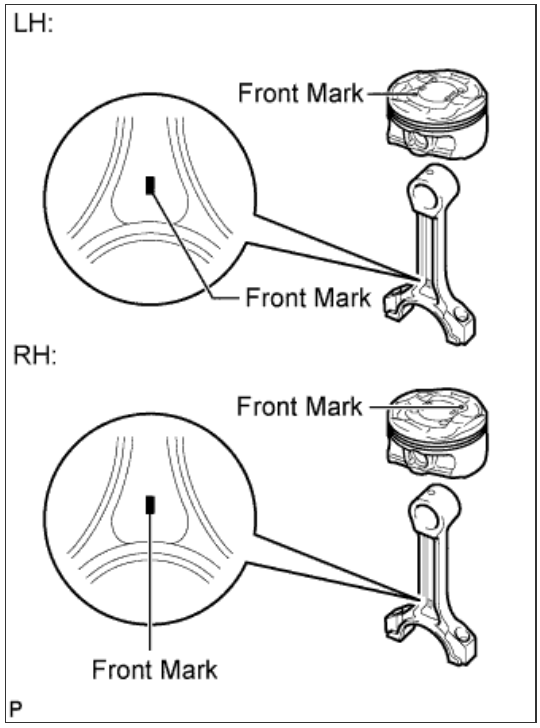
d. Align the front marks of the piston and connecting rod as shown in the illustration. Then push in the piston pin with your thumb until the piston pin contacts the snap ring.

HINT:

The piston and pin are a matched set.

NOTICE:

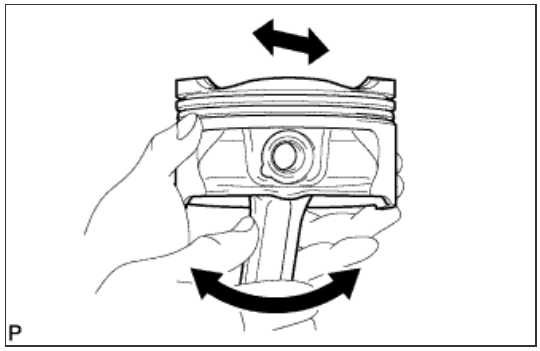
For the LH side, perform the assembly so that the front marks of the piston and connecting rod are on the same side. For the RH side, perform the assembly so that the front marks of the piston and connecting rod are on opposite sides.



e. Check the fitting condition between the piston and piston pin.

i. Move the connecting rod back and forth on the piston pin. Check the fitting condition.
If abnormal movement is felt, replace the piston and pin as a set.

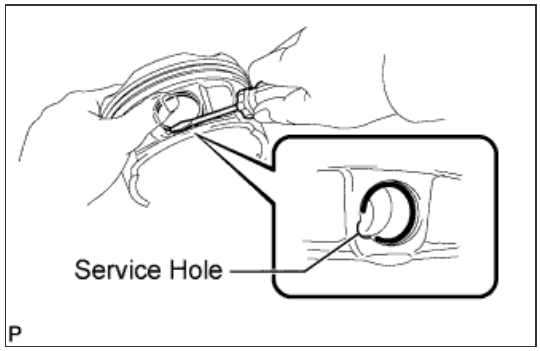
ii. Rotate the piston back and forth on the piston pin. Check the fitting condition.
If abnormal movement is felt, replace the piston and pin as a set.



f. Using a small screwdriver, install a new snap ring at the other end of the piston pin hole.

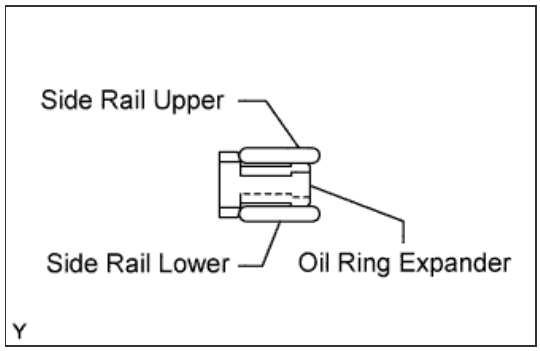
HINT:

Be sure that the end gap of the snap ring is not aligned with the service hole of the piston.



4. INSTALL PISTON RING SET

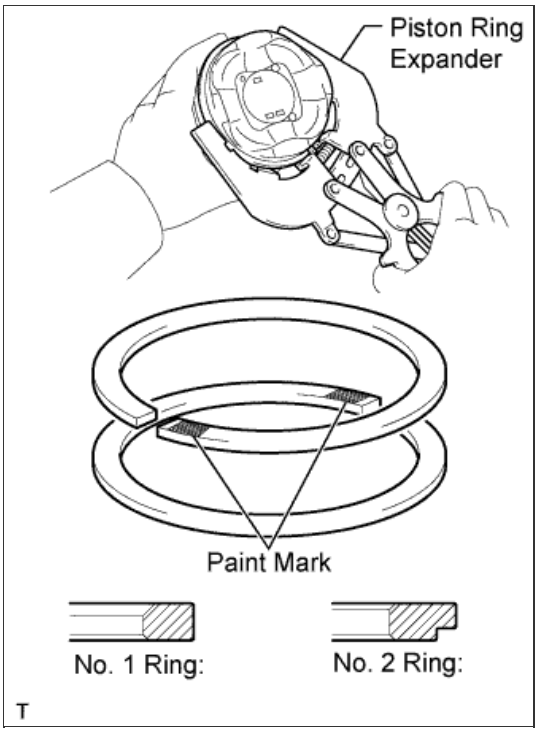
a. Install the oil ring expander and 2 side rails by hand.



b. Using a piston ring expander, install the 2 compression rings so that the paint marks are positioned as shown in the illustration.

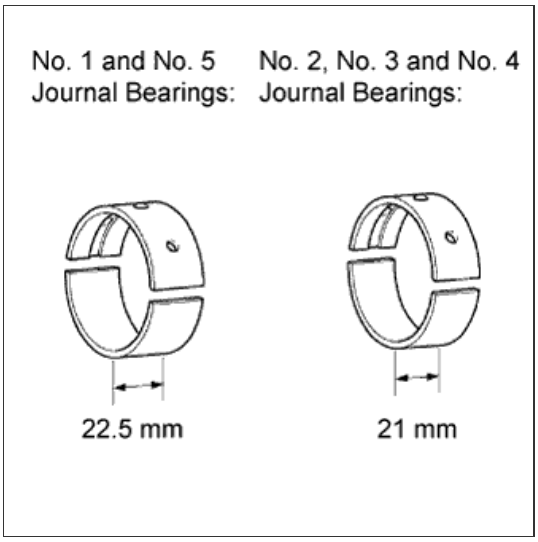
Paint Mark:

Piston Ring	Paint Mark
No. 1	Blue
No. 2	Orange



5. INSTALL CRANKSHAFT BEARING

a. Clean the main journal and both surfaces of the bearing.



b. Install the upper bearing.

NOTICE:

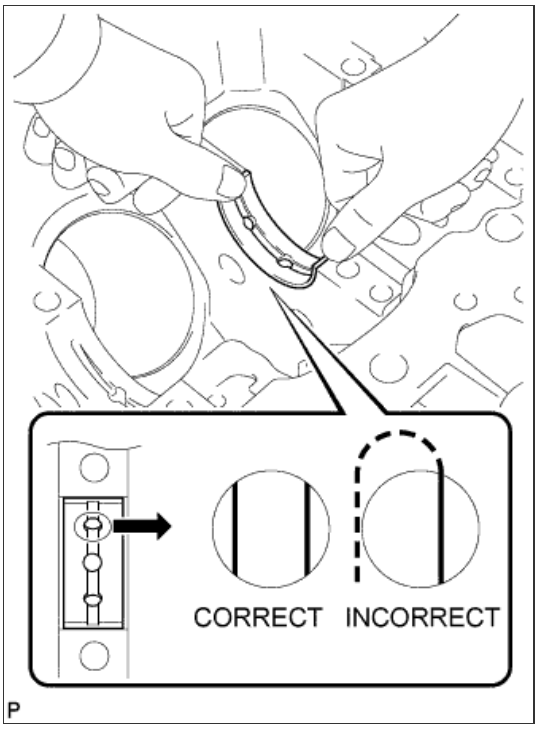
Main bearings come in widths of 21 mm (0.827 in.) and 22.5 mm (0.886 in.). Install the 22.5 mm (0.886 in.) bearings in the No. 1 and No. 5 cylinder block journal positions with the main bearing caps. Install the 21 mm (0.827 in.) bearings in the No. 2, No. 3 and No. 4 positions.

i. Install the upper bearing to the cylinder block as shown in the illustration.

NOTICE:

- **Do not apply engine oil to the bearings and the contact surfaces.**
- **Both sides of the oil groove in the cylinder block should be visible through the oil feed holes in the bearing. The amount visible on each side of the holes should be equal.**

- **Do not allow coolant to come into contact with the bearing inner surface.**
- **If any coolant comes into contact with the bearing inner surface, replace the bearing with a new one.**



c. Install the lower bearing.

NOTICE:

- **Be sure to install the selected bearing.**
- **Main bearings come in widths of 21 mm (0.827 in.) and 22.5 mm (0.886 in.). Install the 22.5 mm (0.886 in.) bearings in the No. 1 and No. 5 cylinder block journal positions with the main bearing caps. Install the 21 mm (0.827 in.) bearings in the No. 2, No. 3 and No. 4 positions.**

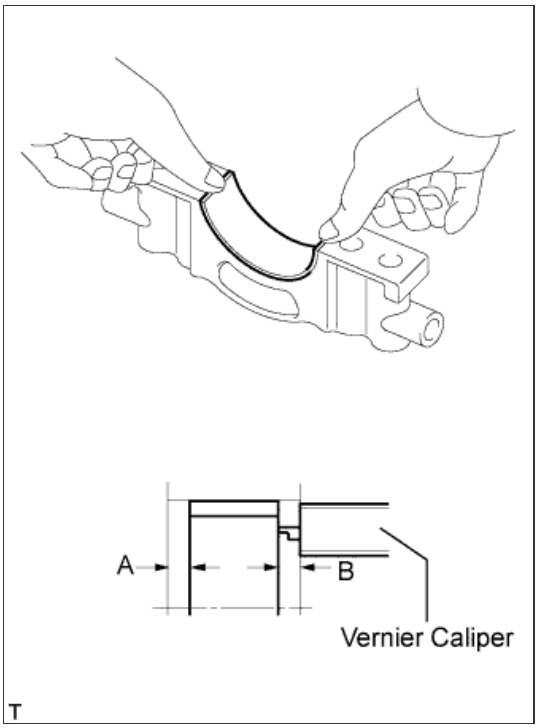
i. Install the lower bearings to the crankshaft bearing caps.

ii. Using a vernier caliper, measure the distance between the crankshaft bearing cap edge and the lower bearing edge.

Dimension A - B or B - A:
0 to 0.7 mm (0 to 0.0276 in.)

NOTICE:

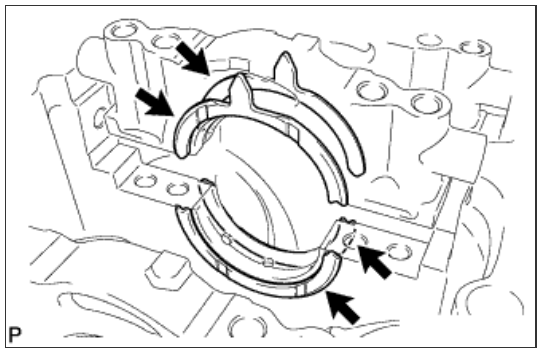
- **Do not apply engine oil to the bearings and the contact surfaces.**
- **Do not allow coolant to come into contact with the bearing inner surface.**
- **If any coolant comes into contact with the bearing inner surface, replace the bearing with a new one.**



6. INSTALL CRANKSHAFT THRUST WASHER SET

a. Apply engine oil to the thrust washer set.

b. Install the 4 thrust washers to the No. 3 journal position of the cylinder block and crankshaft bearing cap with the oil grooves facing outward.



7. INSTALL CRANKSHAFT

a. Apply engine oil to the upper bearing and lower bearing, then place the crankshaft on the cylinder block.

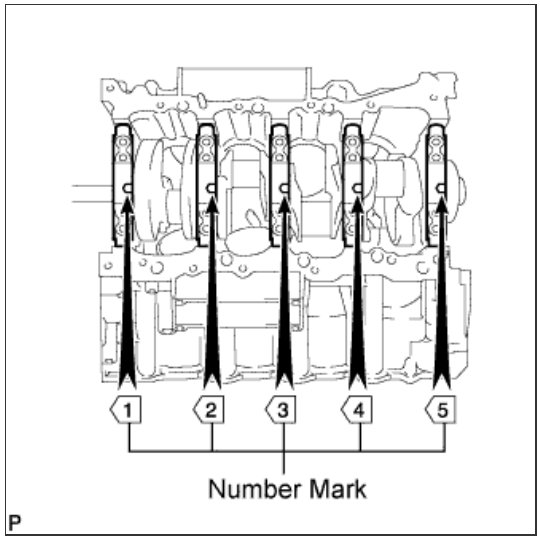
b. Confirm the front marks and numbers of the crankshaft bearing caps, and install the crankshaft bearing caps on the cylinder block.

HINT:

A number is marked on each main bearing cap to indicate the installation position.

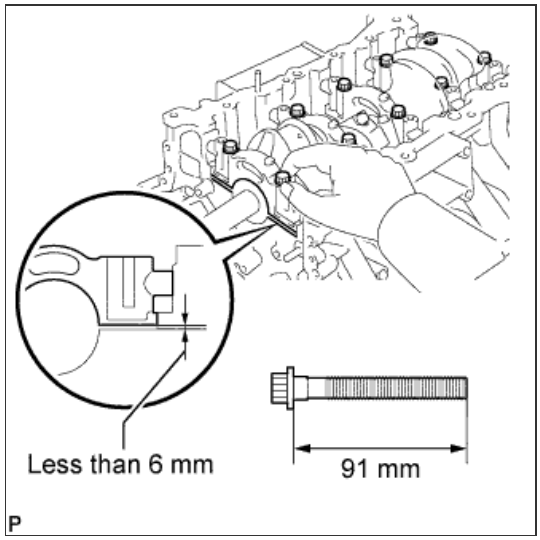
c. Apply a light coat of engine oil to the threads and under the heads of the bearing cap bolts.

d. Temporarily install the 10 crankshaft bearing cap bolts to the inside positions.



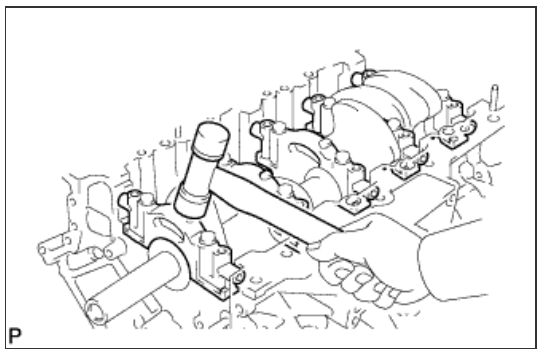
e. Push the crankshaft bearing cap by hand until the clearance between the crankshaft bearing cap and cylinder block is less than 6 mm (0.236 in.).

Standard Bolt length:
91 mm (3.58 in.)



f. Using a plastic-faced hammer, lightly tap the crankshaft bearing cap to ensure a proper fit.

g. Apply a light coat of engine oil to the threads and under the heads of the 10 crankshaft bearing cap bolts.

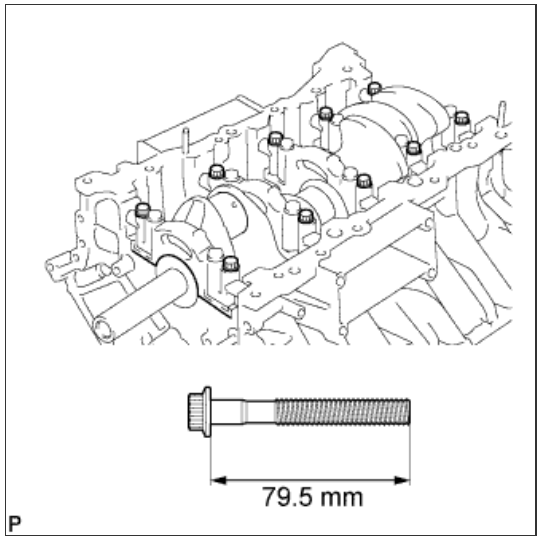


h. Temporarily install the 10 crankshaft bearing cap bolts to the outside positions.

Standard Bolt length:
79.5 mm (3.13 in.)

HINT:

The main bearing cap bolts are tightened in 2 progressive steps.

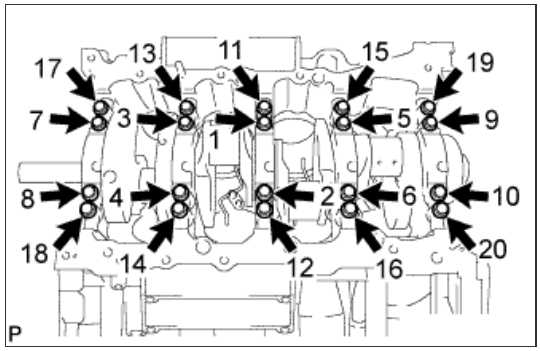


i. Step 1:

i. Uniformly tighten the 20 crankshaft bearing cap bolts in the sequence shown in the illustration.

Torque:
for inside position:
61 N*m{ 622 kgf*cm , 45 ft.*lbf }
for outside position:
27 N*m{ 275 kgf*cm , 20 ft.*lbf }

If any of the main bearing cap bolts does not meet the specified torque, replace it.

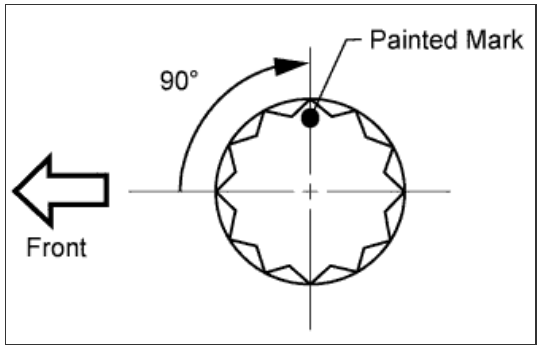


j. Step 2:

i. Mark the front of the bearing cap bolts with paint.

ii. Tighten the bearing cap bolts 90° in the order shown in step 1.

iii. Check that the painted marks are now at a 90° angle to the front.

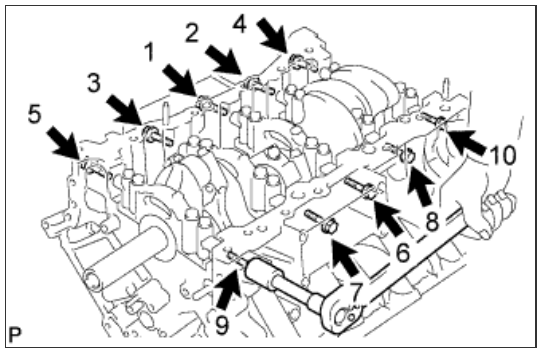


k. Check that the crankshaft turns smoothly.

l. Install and uniformly tighten the 10 crankshaft bearing cap bolts and 10 new seal washers in several steps in the sequence shown in the illustration.

Torque:
45 N*m{ 459 kgf*cm , 33 ft.*lbf }

m. Check that the crankshaft turns smoothly.



8. INSTALL CONNECTING ROD BEARING

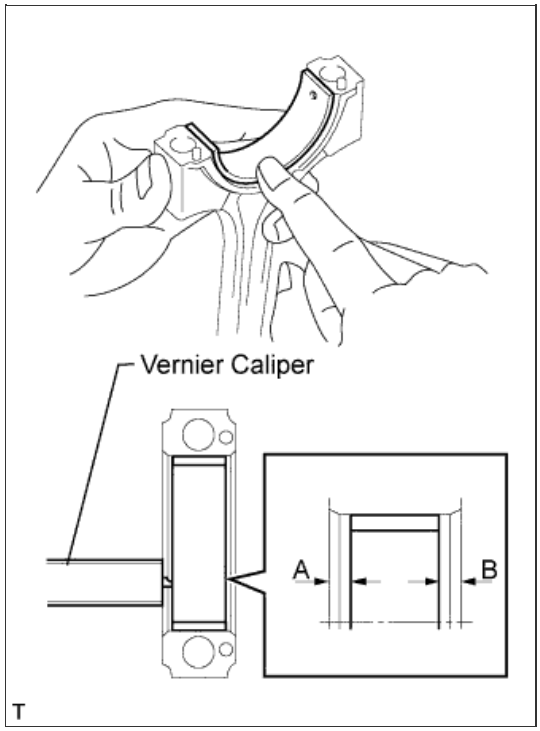
a. Install the connecting rod bearings to the connecting rods and bearing caps.

b. Using a vernier caliper, measure the distance between the connecting rod and bearing cap edges, and each connecting rod bearing edge.

Dimension A - B or B - A:
0 to 0.7 mm (0 to 0.0276 in.)

NOTICE:

- **Do not apply engine oil to the bearings and the contact surfaces.**
- **Do not allow coolant to come into contact with the bearing inner surface.**
- **If any coolant comes into contact with the bearing inner surface, replace the bearing with a new one.**



9. INSTALL PISTON AND CONNECTING ROD

a. Apply engine oil to the cylinder walls, the pistons, and the surfaces of the connecting rod bearings.

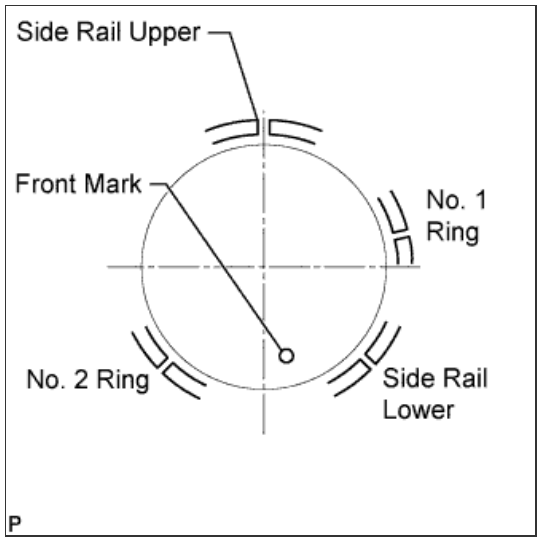
b. Position the piston rings so that the ring ends are as shown in the illustration.

HINT:

The expander ends can be placed anywhere.

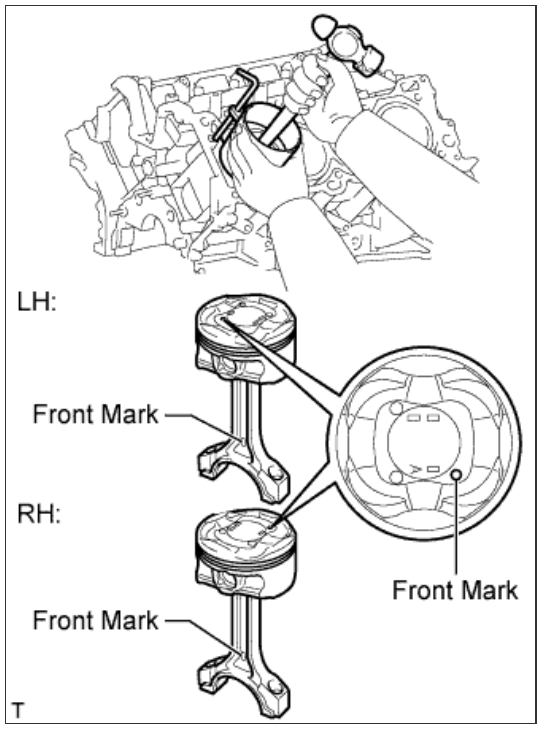
NOTICE:

Do not align the ring ends.



c. Using a hammer handle and piston ring compressor, push the correctly numbered piston and connecting rod into the cylinder with the front mark of the

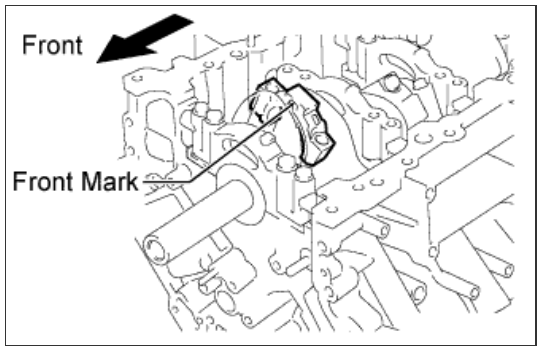
piston facing forward.



d. Place the connecting rod cap on the connecting rod.

i. Match the numbered connecting rod cap with the connecting rod.

ii. Place the connecting rod cap on the connecting rod, and check that the front mark of the connecting rod cap is facing the direction indicated in the chart below.



Front Mark:

Item	Front Mark
Bank 1	Front side
Bank 2	Rear side

e. Apply a light coat of engine oil to the threads and under the heads of the connecting rod cap bolts.

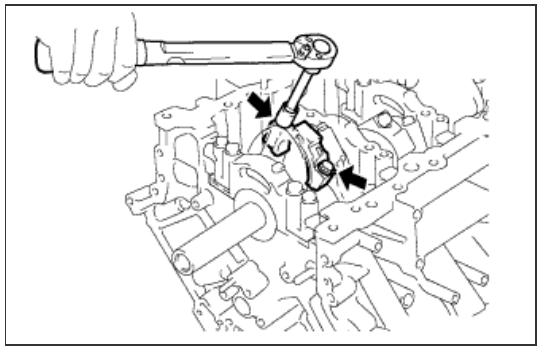
f. Temporarily install the connecting rod cap bolts.

HINT:

The connecting rod cap bolts are tightened in 2 progressive steps.

g. Step 1:

i. Install and alternately tighten the bolts of the connecting rod cap in several steps.



Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

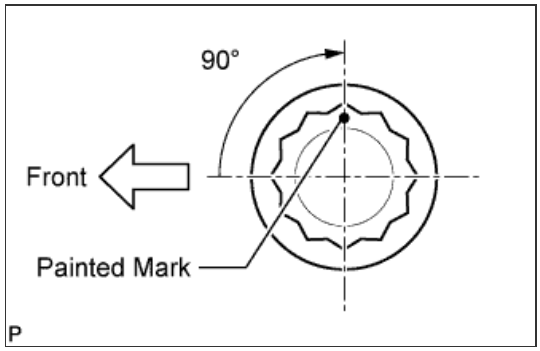
h. Step 2:

   i. Mark the front side of each connecting rod cap bolt with paint.

   ii. Tighten the cap bolts 90° as shown in the illustration in the order in step 1.

   iii. Check that the painted marks are now at a 90° angle to the front.

i. Check that the crankshaft turns smoothly.



for Preparation Click here

CAUTION:

- **Before working on the fuel system, disconnect the cable from the negative (-) battery terminal.**
- **Do not smoke or be near an open flame when working on the fuel system.**
- **Keep gasoline away from rubber and leather parts.**

1.DISCHARGE FUEL SYSTEM PRESSURE

CAUTION:

- **Do not disconnect any part of the fuel system until you have discharged the fuel system pressure.**
- **After discharging the fuel pressure, place a cloth or equivalent over fittings as you separate them to reduce the risk of fuel spray on yourself or in the engine compartment.**

a. Remove the engine room side cover LH.

b. Remove the engine room relay block cover.

c. Remove the circuit opening relay (C/OPN).

d. Start the engine. After the engine has stopped on its own, turn the engine switch off.

HINT:

If DTC P0230 is output, clear the DTC (Click here).

e. Crank the engine, then check that the engine does not start.

f. Loosen the fuel tank cap, then discharge the pressure in the fuel tank completely.

g. Disconnect the cable from the negative (-) battery terminal.

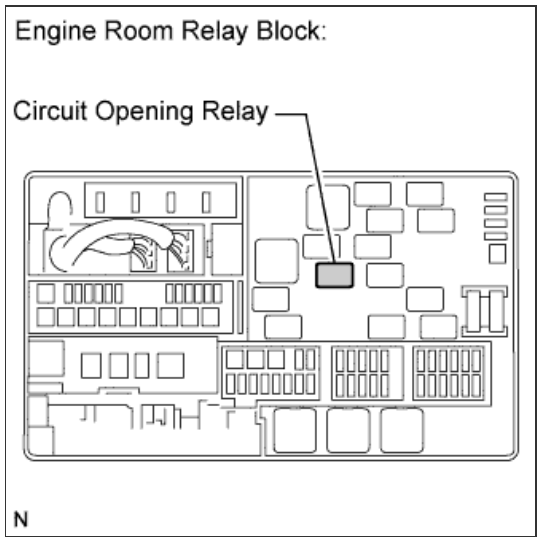
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

h. Install the circuit opening relay (C/OPN).

i. Install the engine room relay block cover.

j. Install the engine room side cover LH.



2.FUEL SYSTEM

a. When disconnecting the high fuel pressure line, a large amount of gasoline will spill out. Follow these procedures.

i. Perform the "Discharge Fuel System Pressure" procedures above.

ii. Put a container under the connecting part of the pressure line.

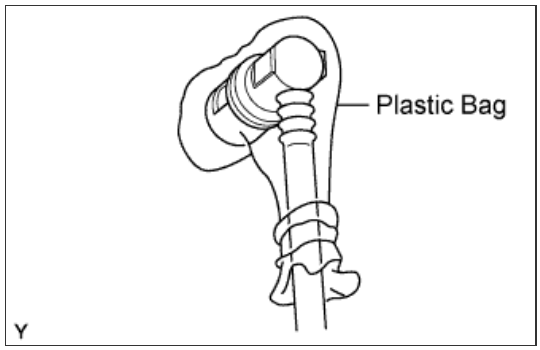
iii. Slowly loosen the connection.

iv. Disconnect the connection.

v. Plug the connection with a rubber plug and cover it with a plastic bag.

b. Observe these precautions when installing the injectors:

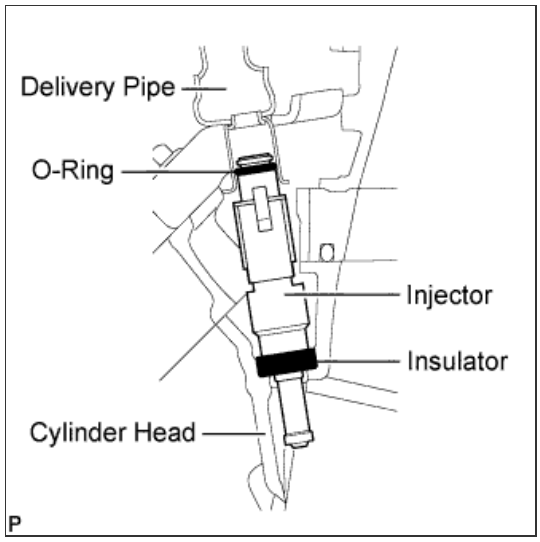
- Never reuse the O-ring.
- When placing a new O-ring on the injector, do not damage it.
- Coat a new O-ring with spindle oil or gasoline before installing it. Do not use engine oil, gear oil or brake oil.



c. Install the injector to the delivery pipe and cylinder head as shown in the illustration.

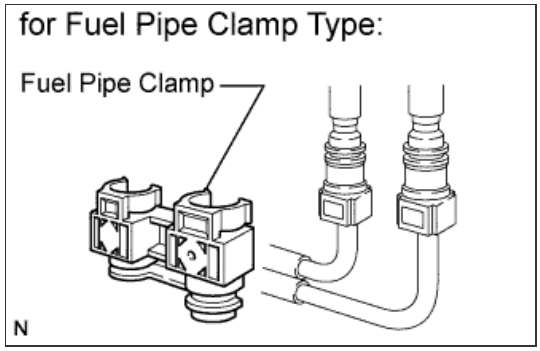
NOTICE:

Before installing the injector, apply spindle oil or gasoline on the place where the delivery pipe contacts the O-ring of the injector.



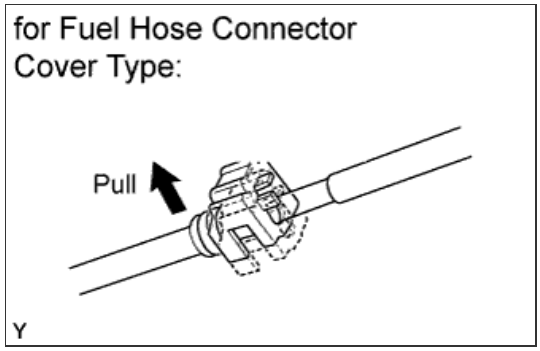
d. Observe these precautions when disconnecting the fuel tube connector (for quick type A).

i. for Fuel Pipe Clamp Type:
Remove the fuel pipe clamp from the fuel tube connector.



ii. for Fuel Hose Connector Cover Type:
Detach the lock claw by lifting up the cover, as shown in the illustration.

iii. Check for dirt or mud on the pipe and around the connector before disconnection. Clean if necessary.

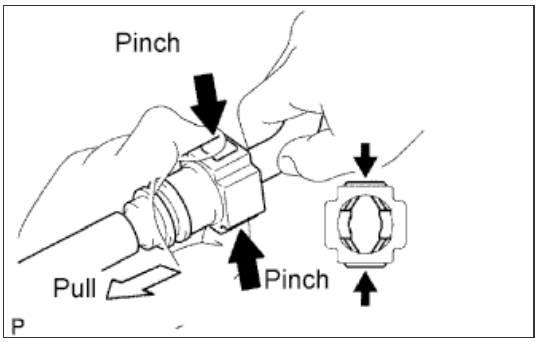


iv. Pinch the connector and disconnect the connector and pipe.
If the connector and the pipe are stuck together, pinch the connector, then push and pull the pipe to disconnect the pipe and pull it out.

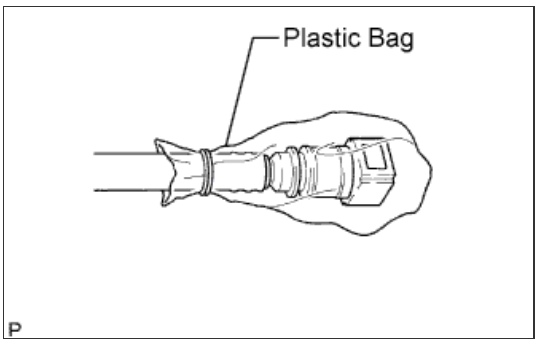
NOTICE:

Do not use any tools in this procedure.

v. Check for dirt or mud on the seal surface of the disconnected pipe. Clean if necessary.

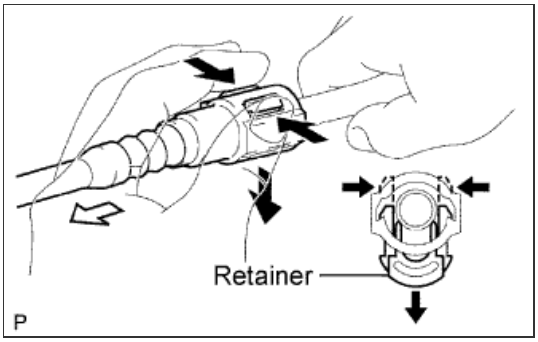


vi. To protect the disconnected pipe and connector from damage and contamination, cover it with a plastic bag.



e. Observe these precautions when disconnecting the fuel tube connector (for quick type B).

i. Check that there is no damage or foreign matter on the part of the pipe that contacts the connector.



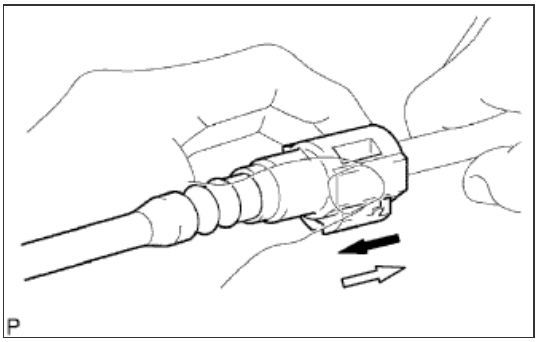
ii. Detach the 2 claws of the connector retainer. Push down on the connector and disconnect it from the pipe.

HINT:

If the connector and pipe are stuck, pinch the fuel pipe by hand, and push and pull the connector to disconnect it.

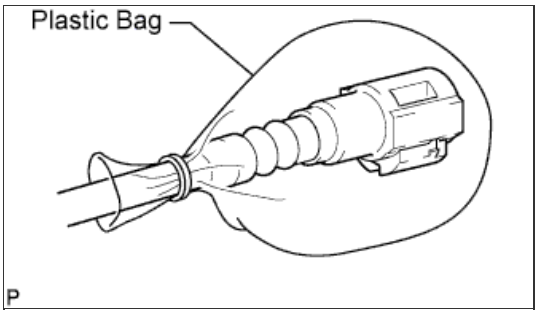
NOTICE:

Do not use any tools in this procedure.



iii. Check for foreign matter on the seal surface of the disconnected pipe. Clean it if necessary.

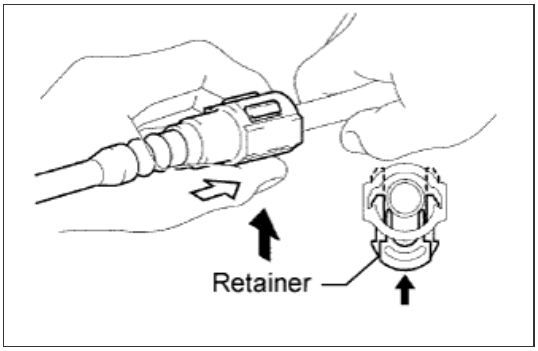
iv. To protect the disconnected pipe and connector from damage and foreign matter, cover it with a plastic bag.



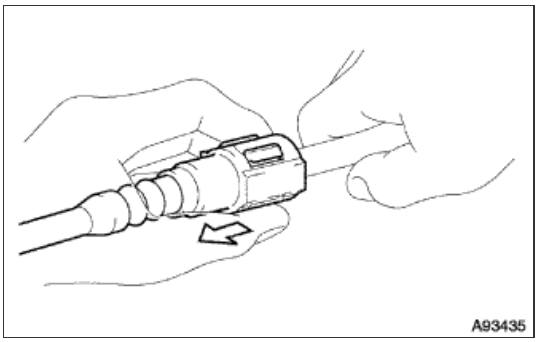
f. Observe these precautions when connecting the fuel tube connector (for quick type B).

i. Check for foreign matter on the pipe and around the connector before connecting it. Clean it if necessary.

ii. Align the axis of the connector with the axis of the pipe. Push the pipe into the connector, and push up on the retainer.



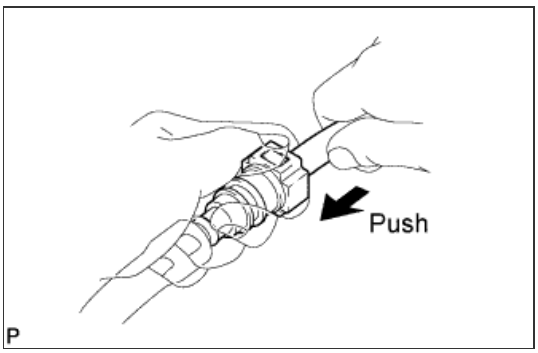
iii. After connecting the pipe and connector, try to pull them apart to confirm that they are securely connected.



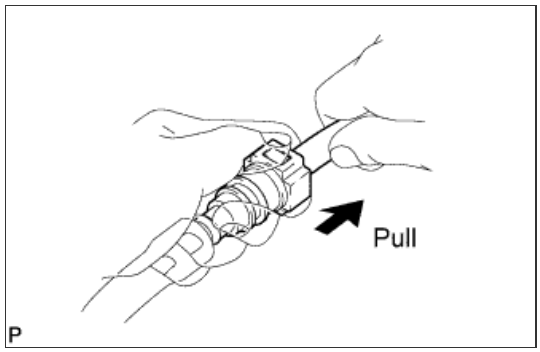
g. Observe these precautions when connecting the fuel tube connector (for quick type A).

i. Check that there is no damage or contamination in the connection part of the pipe.

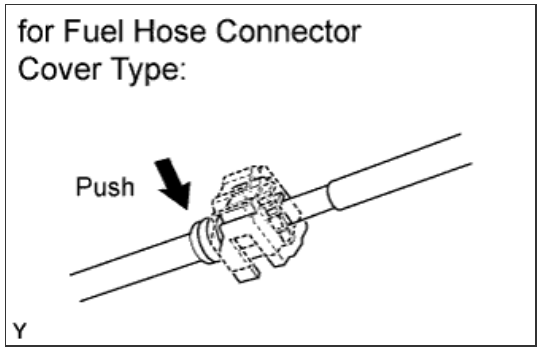
ii. Align the axis of the connector with the axis of the pipe. Push the pipe into the connector until the connector makes a "click" sound. If the connection is tight, apply a small amount of fresh spindle oil or gasoline on the tip of the pipe.



iii. After having finished the connection, try to pull apart the pipe and the connector to confirm that they are securely connected.

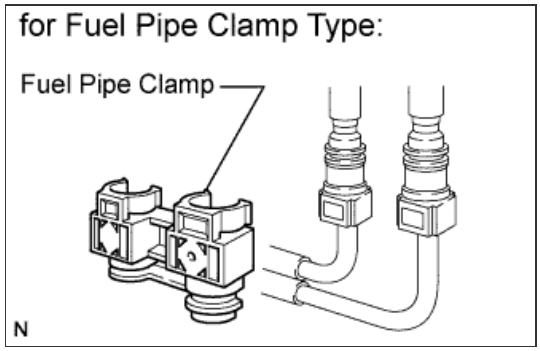


iv. for Fuel Hose Connector Cover Type:
Attach the lock claw to the connector by pushing down on the cover, as shown in the illustration.



v. for Fuel Pipe Clamp Type:
Install the fuel pipe clamp to the connector.

vi. Check that there is no fuel leakage.



3.CHECK FOR FUEL LEAK

a. Check that there are no fuel leaks after performing maintenance anywhere on the fuel system (Click here).

for Preparation Click here

CAUTION:

- **Before working on the fuel system, disconnect the cable from the negative (-) battery terminal.**
- **Do not smoke or be near an open flame when working on the fuel system.**
- **Keep gasoline away from rubber and leather parts.**

1.DISCHARGE FUEL SYSTEM PRESSURE

CAUTION:

- **Do not disconnect any part of the fuel system until you have discharged the fuel system pressure.**
- **After discharging the fuel pressure, place a cloth or equivalent over fittings as you separate them to reduce the risk of fuel spray on yourself or in the engine compartment.**

a. Remove the engine room side cover LH.

b. Remove the engine room relay block cover.

c. Remove the circuit opening relay (C/OPN).

d. Start the engine. After the engine has stopped on its own, turn the engine switch off.

HINT:

If DTC P0230 is output, clear the DTC (Click here).

e. Crank the engine, then check that the engine does not start.

f. Loosen the fuel tank cap, then discharge the pressure in the fuel tank completely.

g. Disconnect the cable from the negative (-) battery terminal.

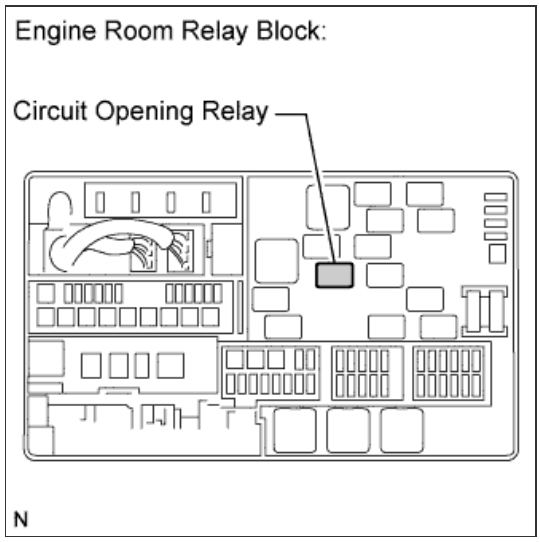
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

h. Install the circuit opening relay (C/OPN).

i. Install the engine room relay block cover.

j. Install the engine room side cover LH.



2.FUEL SYSTEM

a. When disconnecting the high fuel pressure line, a large amount of gasoline will spill out. Follow these procedures.

i. Perform the "Discharge Fuel System Pressure" procedures above.

ii. Put a container under the connecting part of the pressure line.

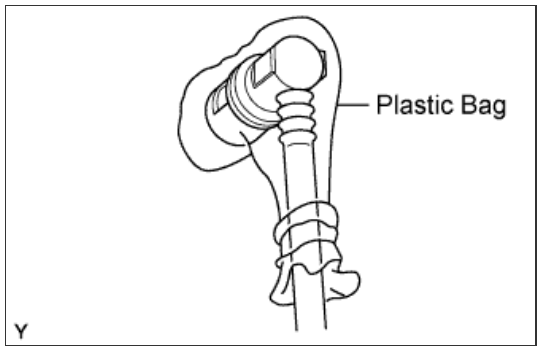
iii. Slowly loosen the connection.

iv. Disconnect the connection.

v. Plug the connection with a rubber plug and cover it with a plastic bag.

b. Observe these precautions when installing the injectors:

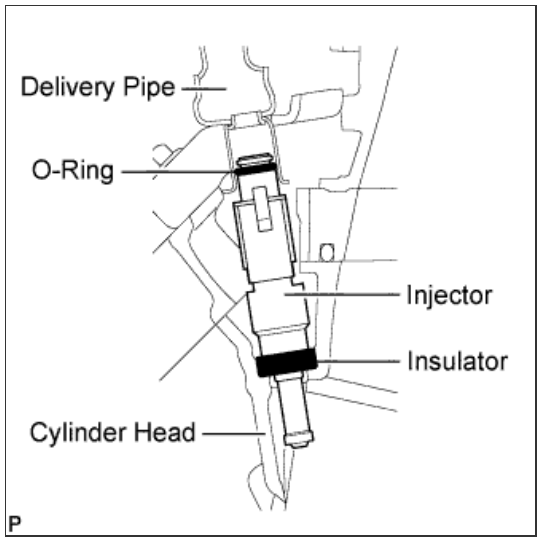
- Never reuse the O-ring.
- When placing a new O-ring on the injector, do not damage it.
- Coat a new O-ring with spindle oil or gasoline before installing it. Do not use engine oil, gear oil or brake oil.



c. Install the injector to the delivery pipe and cylinder head as shown in the illustration.

NOTICE:

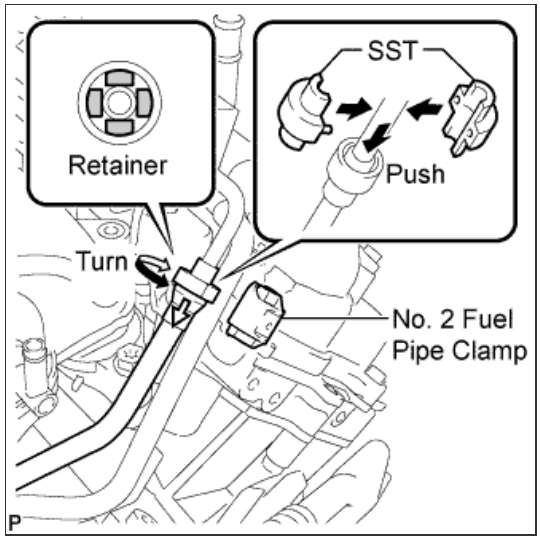
Before installing the injector, apply spindle oil or gasoline on the place where the delivery pipe contacts the O-ring of the injector.



d. Observe these precautions when disconnecting the fuel tube connector (for metallic type):

NOTICE:

Do not forcibly bend or twist the fuel main tube.



i. Remove the No. 2 fuel pipe clamp.

NOTICE:

Do not reuse the No. 2 fuel pipe clamp.

ii. Wipe off any dirt on the fuel tube connector.

iii. Hold the fuel tube connector and install SST.

SST
09268-21011

iv. Turn SST to align the retainer inside the fuel tube connector with the chamfered part of SST.

v. Insert SST into the fuel tube connector and hold it. Then push the fuel tube connector toward SST.

vi. Mount the retainer of the fuel tube connector onto the chamfered part of SST.

vii. Slide SST and the fuel tube connector together towards the fuel tube until they make a "click" sound, and then disconnect the fuel tube.

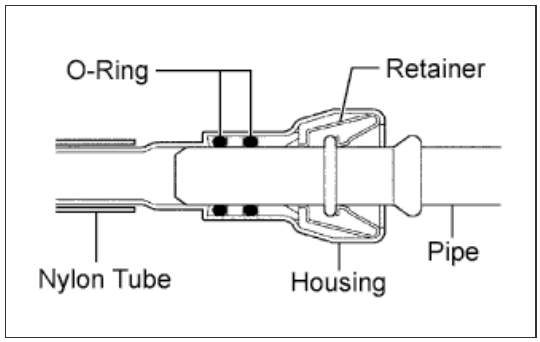
HINT:

The structure of a fuel tube connector is as shown in the illustration.

viii. Drain the fuel remaining inside the fuel tube.

ix. Cover the fuel tube and fuel pipe with a plastic bag to protect the

disconnected parts.



e. Observe these precautions when connecting the fuel tube connector (for metallic type):

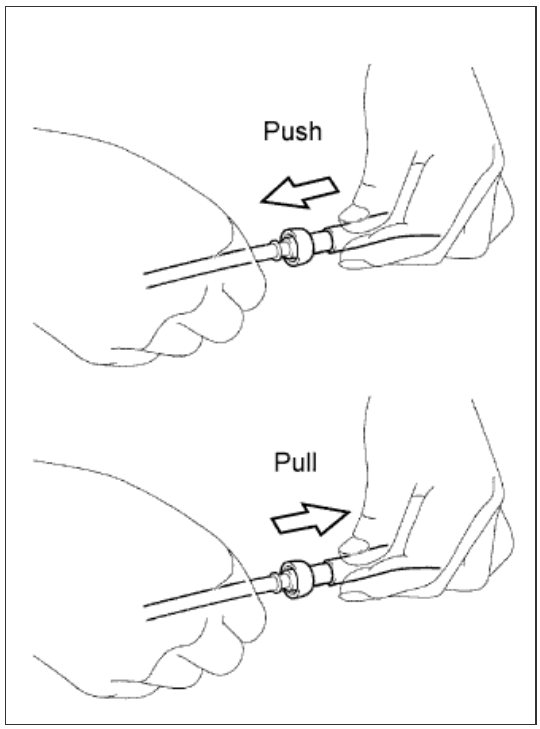
i. Check if there is any damage or foreign objects on the pipe connection area.

ii. Match the axis of the connector with the axis of the pipe, and push the pipe into the connector until the connector makes a "click" sound. If the pipe is difficult to push into the connector, apply a small amount of clean engine oil to the tip of the pipe.

iii. After connecting, check if the pipe and the connector are securely connected by pulling on them.

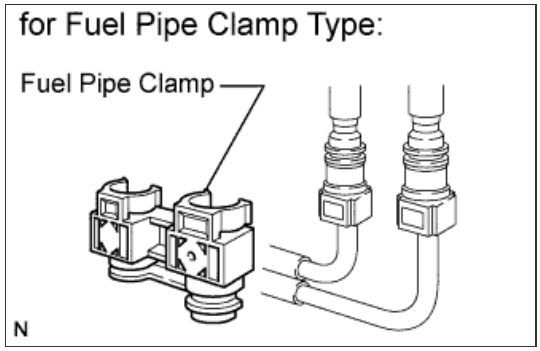
iv. Install a new No. 2 fuel pipe clamp.

v. Check that there is no fuel leakage.



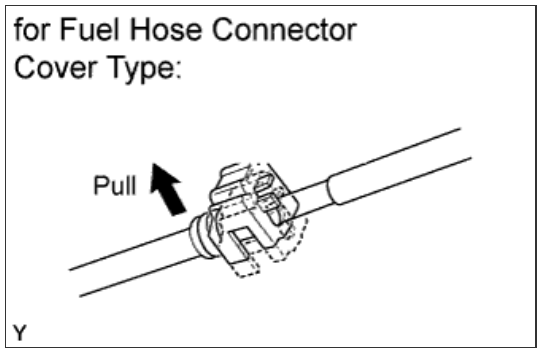
f. Observe these precautions when disconnecting the fuel tube connector (for quick type A).

i. for Fuel Pipe Clamp Type:
Remove the fuel pipe clamp from the fuel tube connector.



ii. for Fuel Hose Connector Cover Type:
Detach the lock claw by lifting up the cover, as shown in the illustration.

iii. Check for dirt or mud on the pipe and around the connector before disconnection. Clean if necessary.

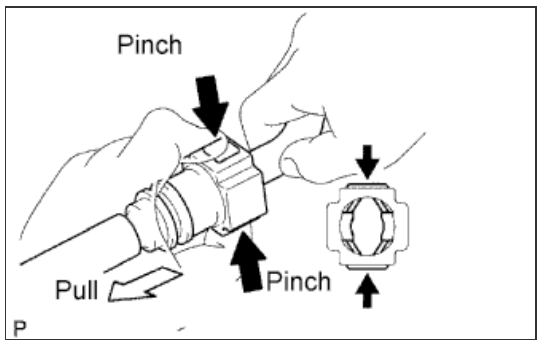


iv. Pinch the connector and disconnect the connector and pipe.
If the connector and the pipe are stuck together, pinch the connector, then push and pull the pipe to disconnect the pipe and pull it out.

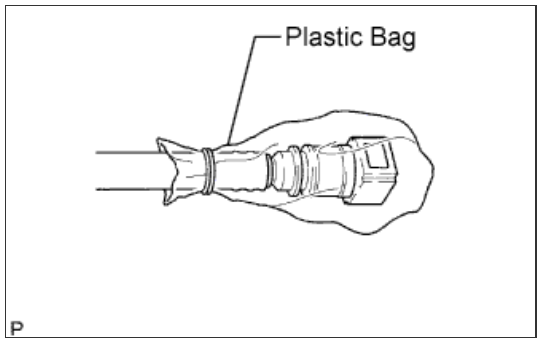
NOTICE:

Do not use any tools in this procedure.

v. Check for dirt or mud on the seal surface of the disconnected pipe. Clean if necessary.

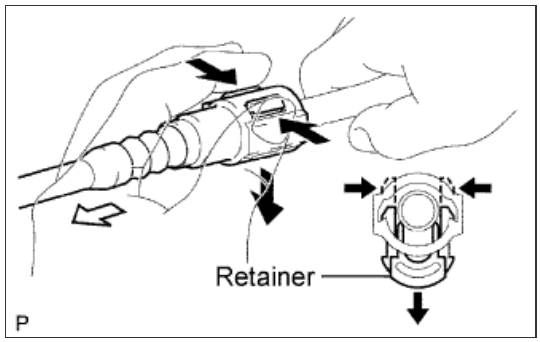


vi. To protect the disconnected pipe and connector from damage and contamination, cover it with a plastic bag.



g. Observe these precautions when disconnecting the fuel tube connector (for quick type B).

i. Check that there is no damage or foreign matter on the part of the pipe that contacts the connector.



ii. Detach the 2 claws of the connector retainer. Push down on the connector and disconnect it from the pipe.

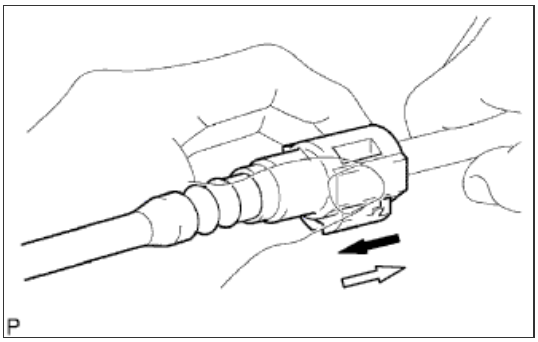
HINT:

If the connector and pipe are stuck, pinch the fuel pipe by hand, and push and pull the connector to disconnect it.

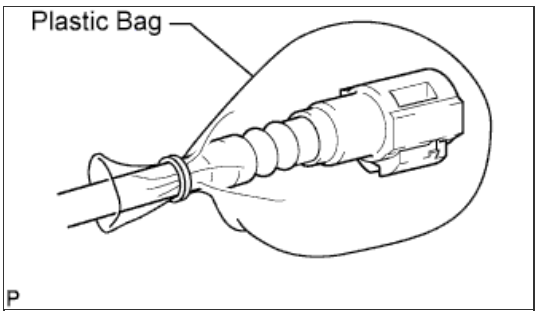
NOTICE:

Do not use any tools in this procedure.

iii. Check for foreign matter on the seal surface of the disconnected pipe. Clean it if necessary.



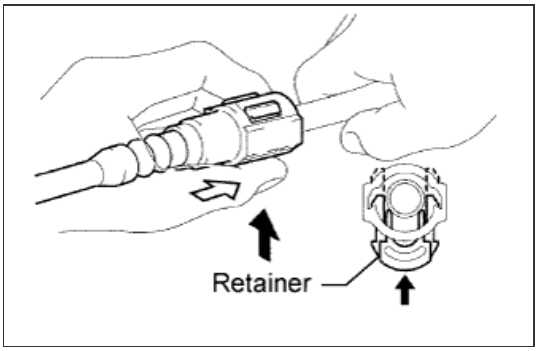
iv. To protect the disconnected pipe and connector from damage and foreign matter, cover it with a plastic bag.



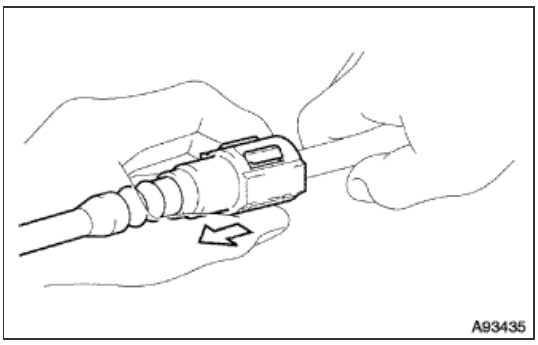
h. Observe these precautions when connecting the fuel tube connector (for quick type B).

i. Check for foreign matter on the pipe and around the connector before connecting it. Clean it if necessary.

ii. Align the axis of the connector with the axis of the pipe. Push the pipe into the connector, and push up on the retainer.



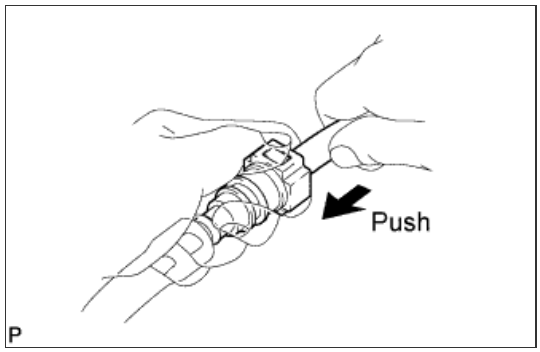
iii. After connecting the pipe and connector, try to pull them apart to confirm that they are securely connected.



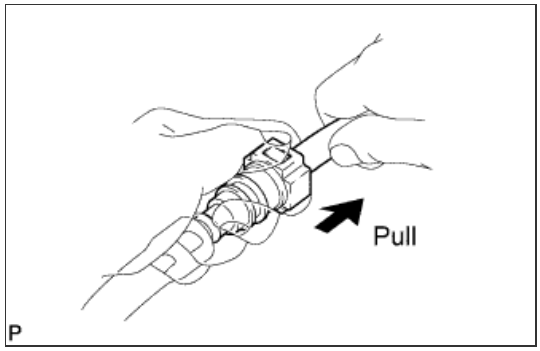
i. Observe these precautions when connecting the fuel tube connector (for quick type A).

i. Check that there is no damage or contamination in the connection part of the pipe.

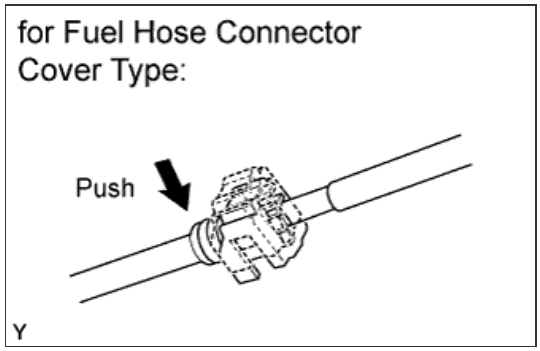
ii. Align the axis of the connector with the axis of the pipe. Push the pipe into the connector until the connector makes a "click" sound. If the connection is tight, apply a small amount of fresh spindle oil or gasoline on the tip of the pipe.



iii. After having finished the connection, try to pull apart the pipe and the connector to confirm that they are securely connected.

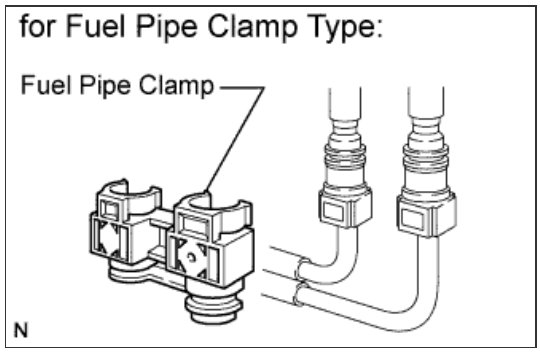


iv. for Fuel Hose Connector Cover Type:
Attach the lock claw to the connector by pushing down on the cover, as shown in the illustration.



v. for Fuel Pipe Clamp Type:
Install the fuel pipe clamp to the connector.

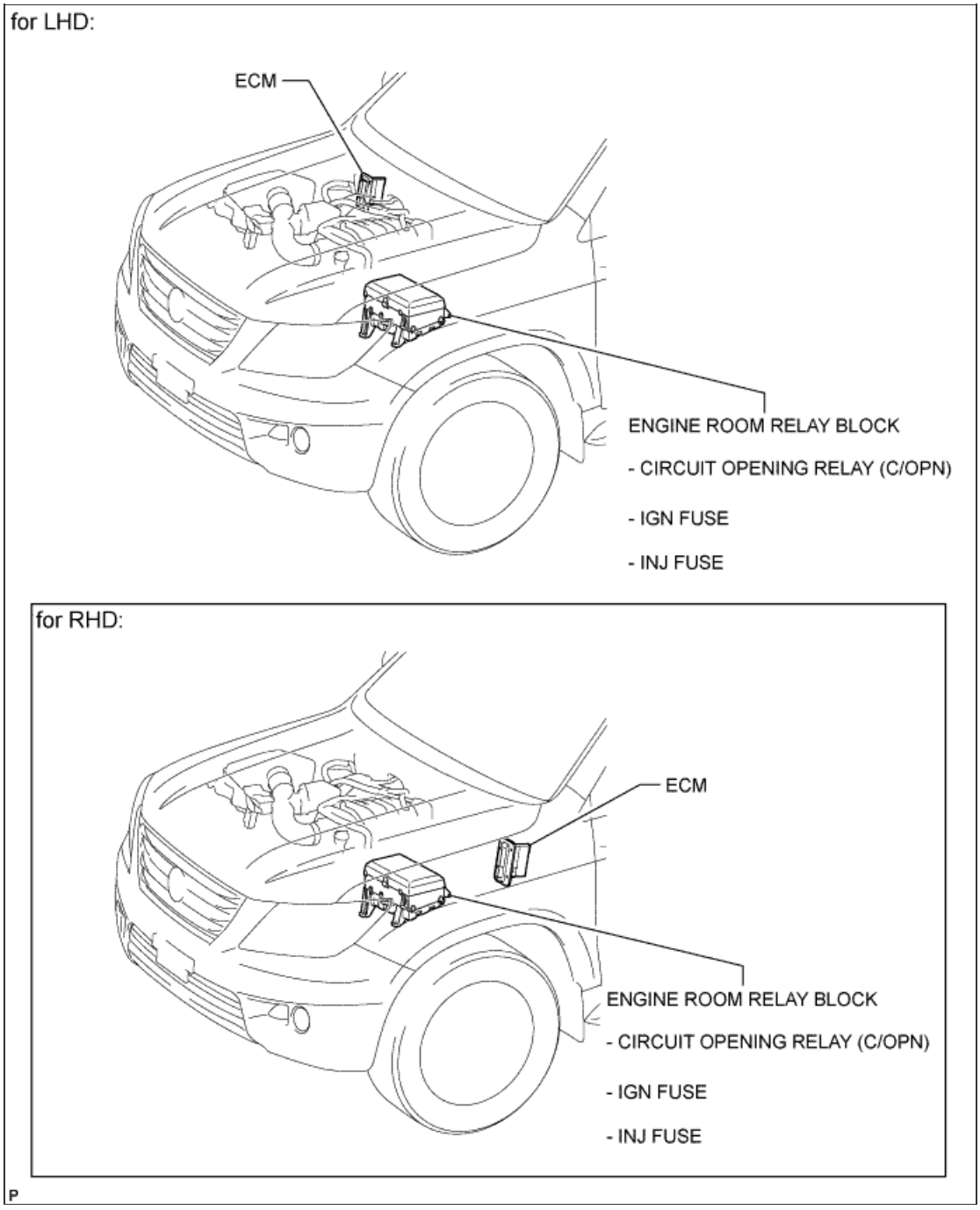
vi. Check that there is no fuel leakage.

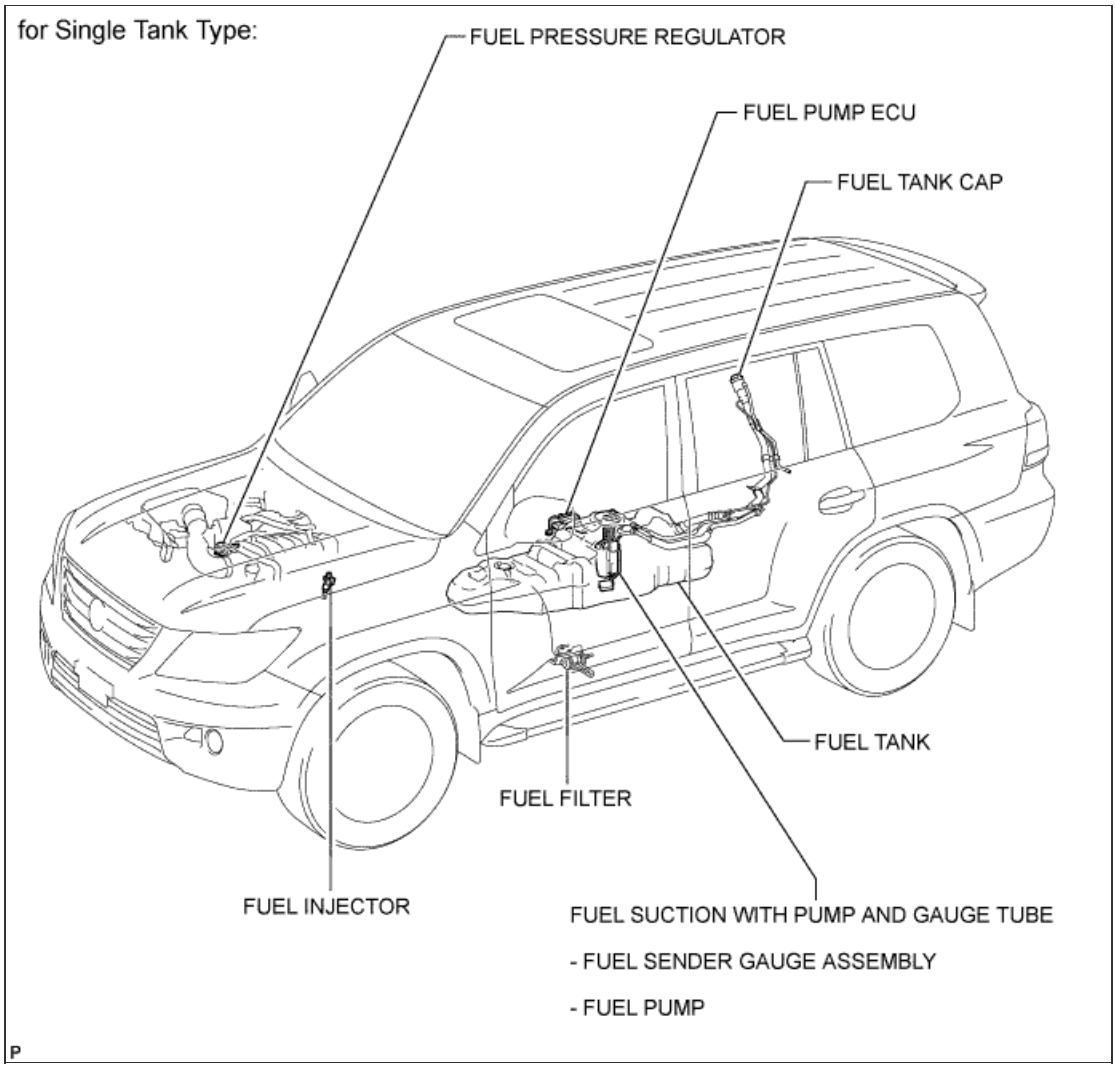


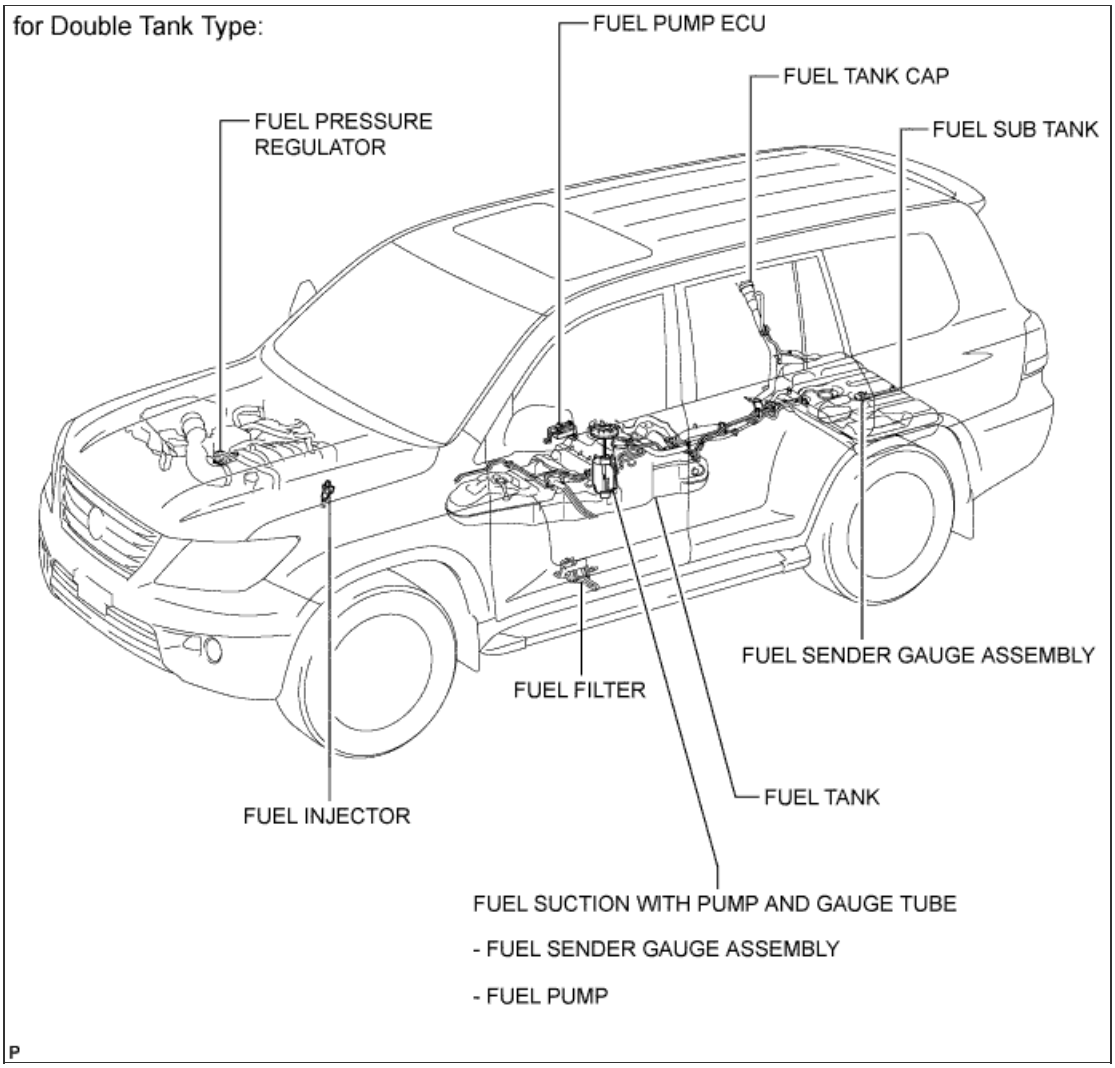
3.CHECK FOR FUEL LEAK

a. Check that there are no fuel leaks after performing maintenance anywhere on the fuel system (Click here).

for Preparation Click here

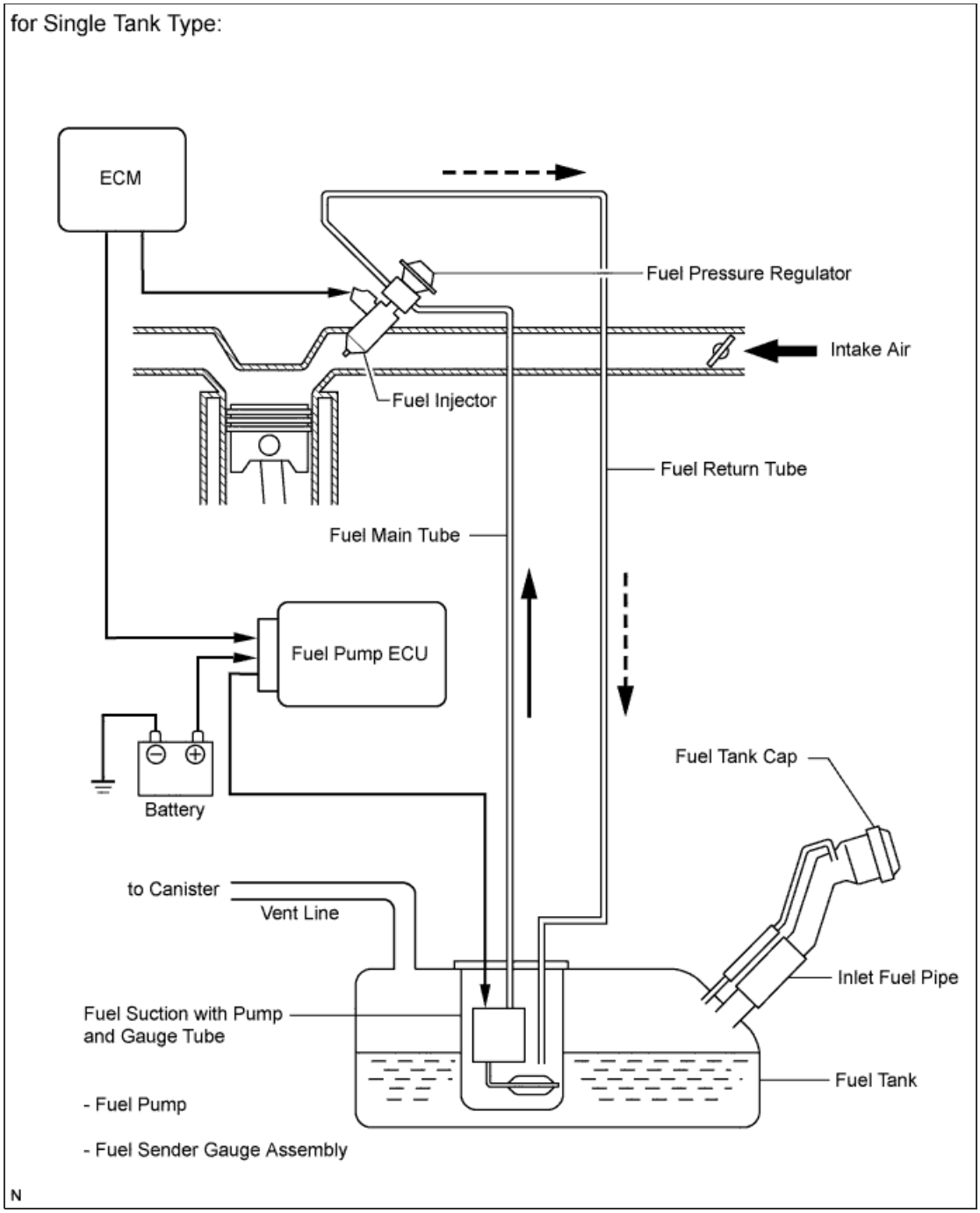



for Single Tank Type:
FUEL PRESSURE REGULATOR
FUEL PUMP ECU
FUEL TANK CAP
FUEL TANK
FUEL FILTER
FUEL INJECTOR
FUEL SUCTION WITH PUMP AND GAUGE TUBE
- FUEL SENDER GAUGE ASSEMBLY
- FUEL PUMP
P

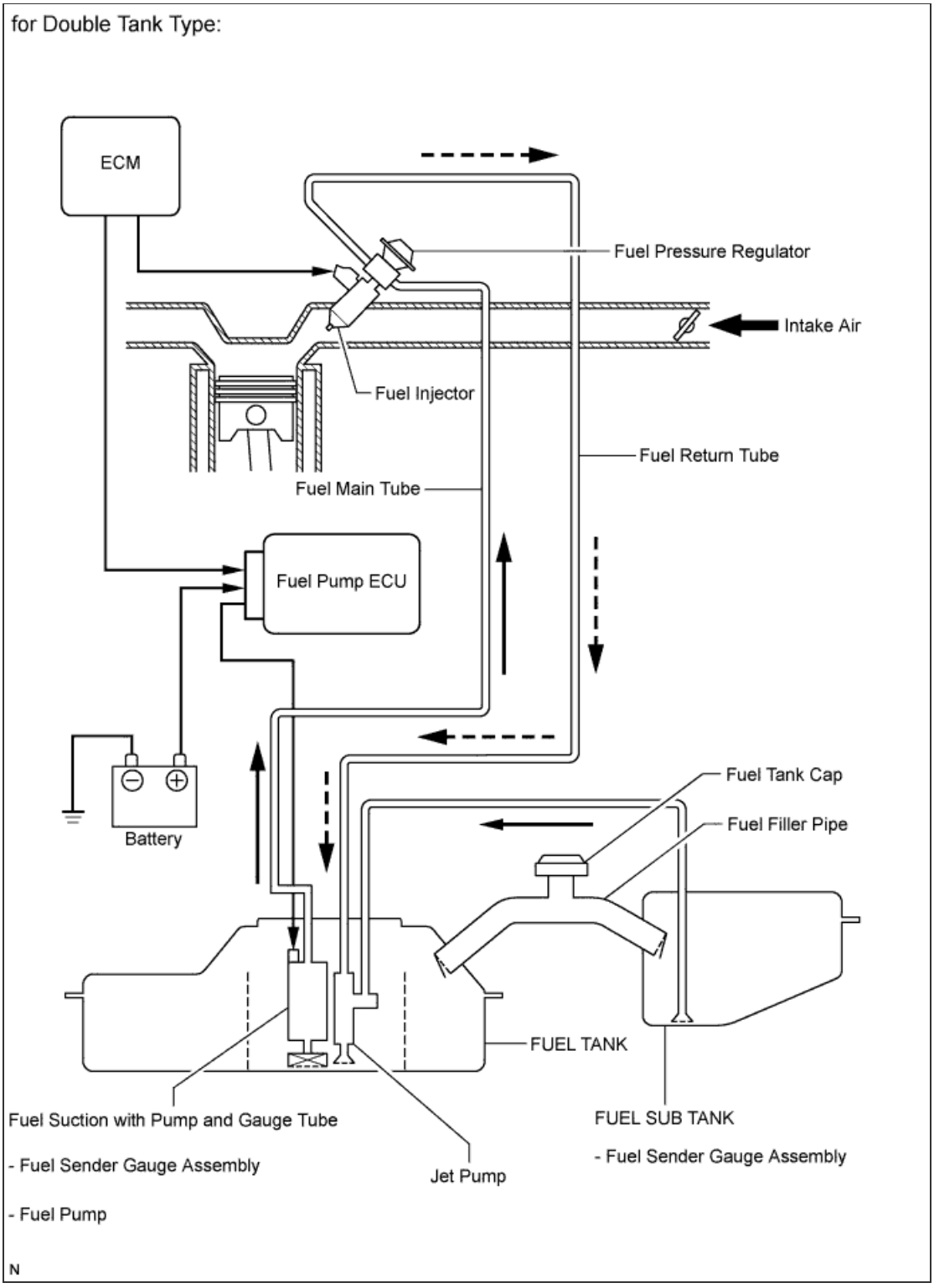

for Double Tank Type:
FUEL PUMP ECU
FUEL TANK CAP
FUEL PRESSURE REGULATOR
FUEL SUB TANK
FUEL SENDER GAUGE ASSEMBLY
FUEL FILTER
FUEL TANK
FUEL INJECTOR
FUEL SUCTION WITH PUMP AND GAUGE TUBE
- FUEL SENDER GAUGE ASSEMBLY
- FUEL PUMP
P

for Preparation Click here

FUEL FLOW DIAGRAM

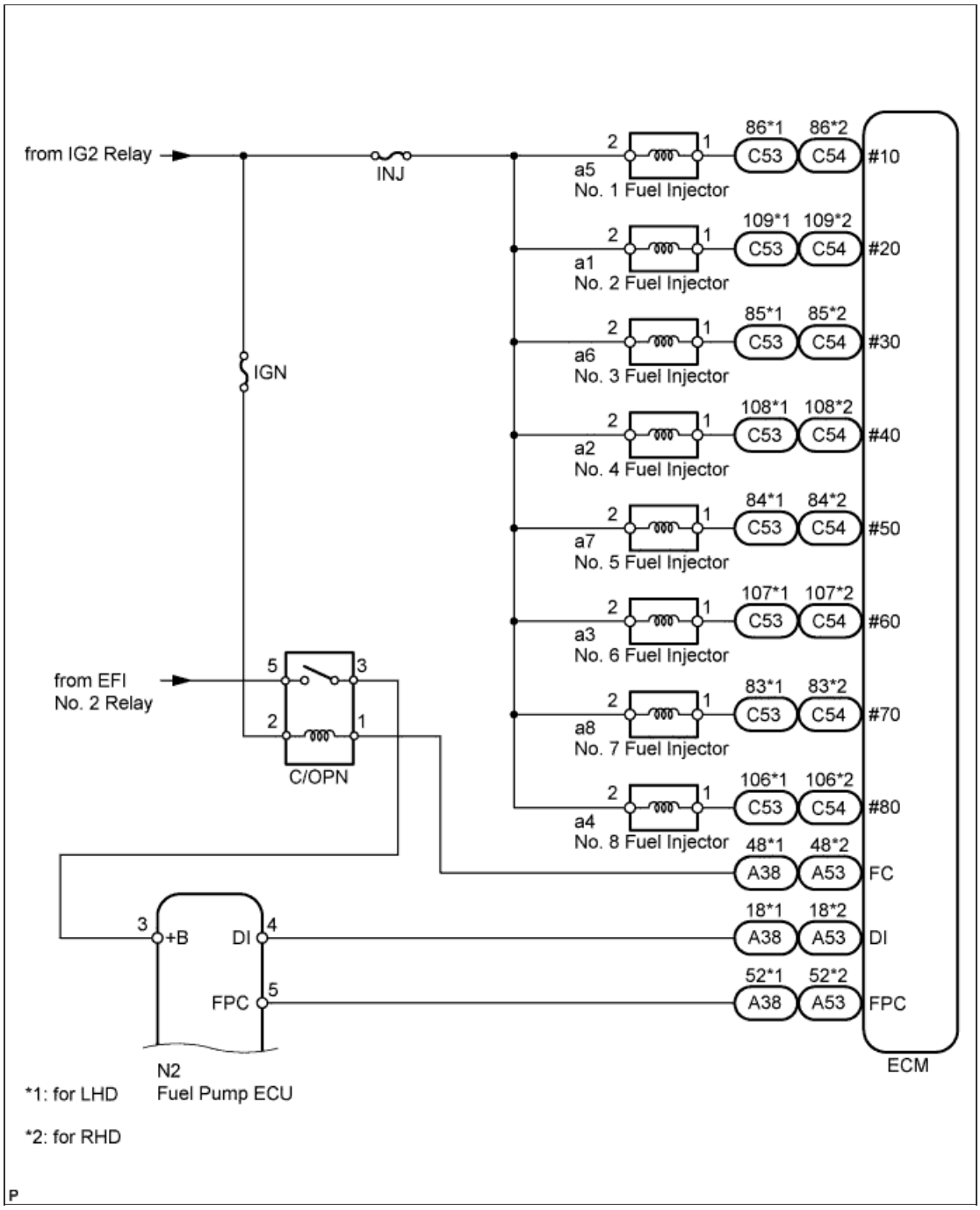


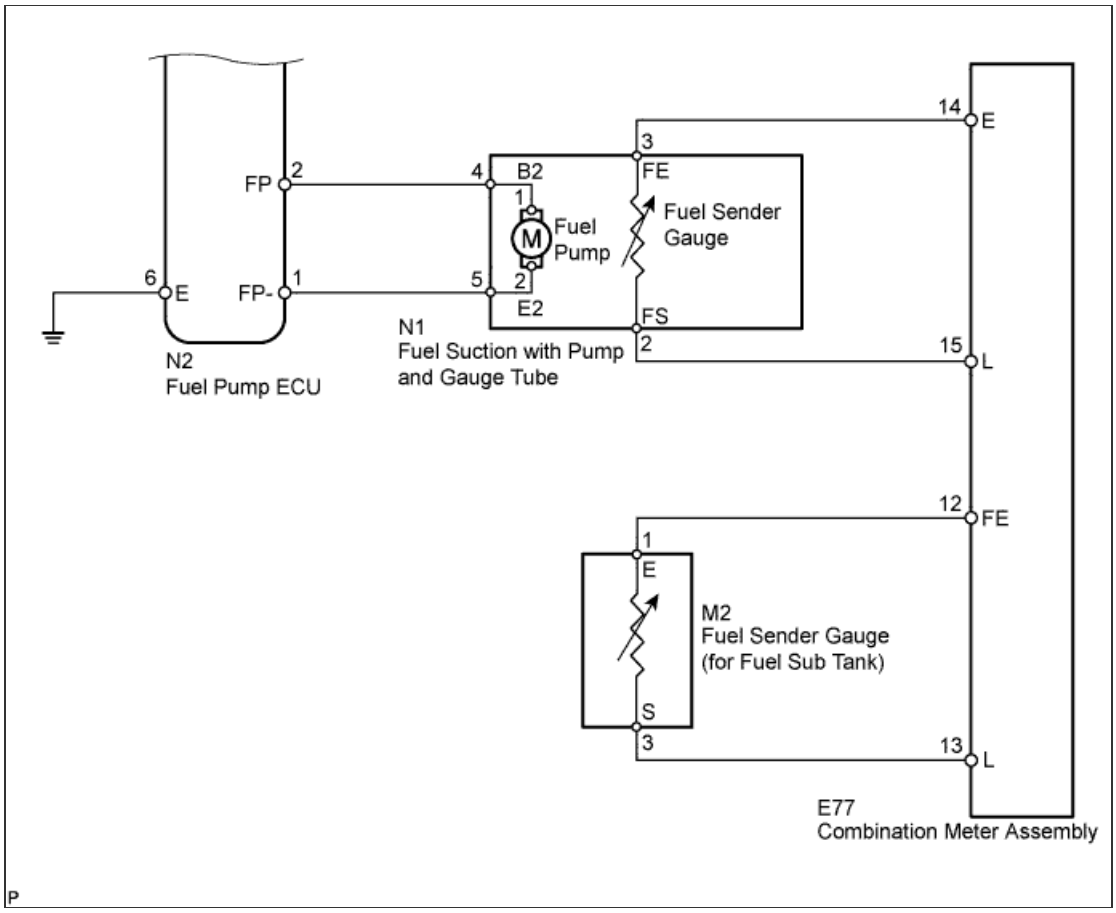
for Double Tank Type:



N

ELECTRICAL CONTROL DIAGRAM


from IG2 Relay
INJ
IGN
from EFI
No. 2 Relay
C/OPN
a5
No. 1 Fuel Injector
a1
No. 2 Fuel Injector
a6
No. 3 Fuel Injector
a2
No. 4 Fuel Injector
a7
No. 5 Fuel Injector
a3
No. 6 Fuel Injector
a8
No. 7 Fuel Injector
a4
No. 8 Fuel Injector
86*1 86*2 C53 C54 #10
109*1 109*2 C53 C54 #20
85*1 85*2 C53 C54 #30
108*1 108*2 C53 C54 #40
84*1 84*2 C53 C54 #50
107*1 107*2 C53 C54 #60
83*1 83*2 C53 C54 #70
106*1 106*2 C53 C54 #80
48*1 48*2 A38 A53 FC
18*1 18*2 A38 A53 DI
52*1 52*2 A38 A53 FPC
ECM
+B
DI
FPC
N2
Fuel Pump ECU
*1: for LHD
*2: for RHD
P


14
E
3
FE
FP
2
4
B2
1
Fuel
Pump
M
Fuel Sender
Gauge
6
E
FP-
1
5
2
E2
FS
N2
Fuel Pump ECU
N1
Fuel Suction with Pump
and Gauge Tube
2
15
L
12
FE
1
E
M2
Fuel Sender Gauge
(for Fuel Sub Tank)
S
3
13
L
E77
Combination Meter Assembly
P

for Preparation Click here

1. CHECK FUEL PUMP OPERATION AND FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

NOTICE:

Do not start the engine.

c. Turn the intelligent tester on.

d. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

e. Check the fuel pump operation.

i. Check for pressure in the fuel inlet tube from the fuel line. Check that the sound of fuel flowing in the fuel tank can be heard.
If there is no sound, check the integration relay, fuel pump, ECM and wiring connector.

f. Check for fuel leak.

i. Check that there are no fuel leaks after performing maintenance anywhere on the system.
If there are fuel leaks, repair or replace parts as necessary.

2. CHECK FUEL PRESSURE

a. Check that the battery voltage is 11 to 14 V.

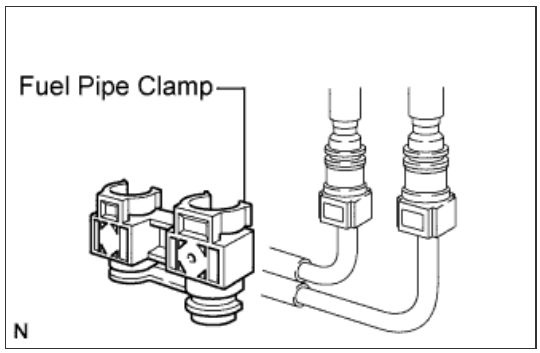
b. Perform the "Discharge Fuel System Pressure" procedures (Click here).

c. Disconnect the cable from the negative (-) battery terminal.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

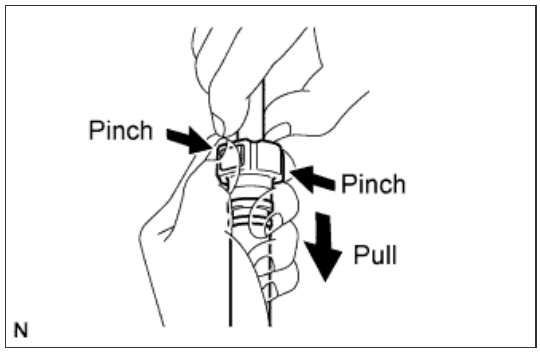
d. Remove the fuel pipe clamp from the fuel tube connector.



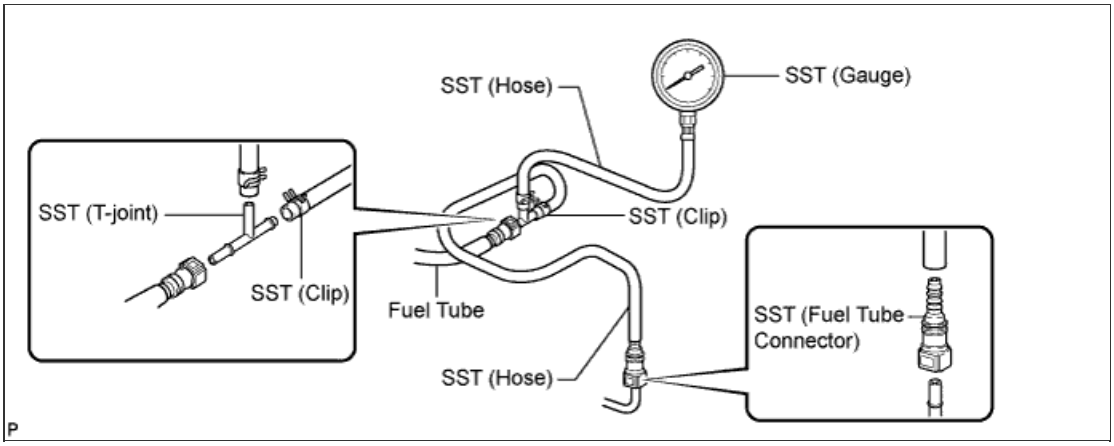
e. Pinch and pull the fuel tube (fuel tube connector) to disconnect it.

CAUTION:

- **Always read the precautions (Click here) before disconnecting the fuel tube connector (quick type).**
- **The fuel tube may spray fuel as a result of pressure that remains in it. Do not allow fuel to be sprayed in the engine compartment.**



f. Install SST (pressure gauge) as shown in the illustration.



SST
09268-31012 (09268-41120, 09268-41500, 90467-13001, 95336-08070)
09268-45014 (09268-41200, 09268-41220)

g. Wipe off any gasoline.

h. Reconnect the cable to the negative (-) battery terminal.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

i. Operate the fuel pump.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

NOTICE:

Do not start the engine.

iii. Turn the intelligent tester on.

iv. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

j. Measure the fuel pressure.

Standard fuel pressure:
281 to 287 kPa (2.87 to 2.93 kgf/cm ^{2}, 41 to 42 psi)

If the pressure is higher than the specification, replace the fuel pressure regulator.
If the pressure is below the specification, check the fuel hoses and connections, fuel pump, fuel filter and fuel pressure regulator assembly.

k. Start the engine.

l. Measure the fuel pressure.

Standard fuel pressure:
281 to 287 kPa (2.87 to 2.93 kgf/cm ^{2}, 41 to 42 psi)

If the pressure is not as specified, check the fuel pump, pressure regulator and/or injectors.

m. Stop the engine.

n. Check that the fuel pressure remains as specified for 5 minutes after the engine has stopped.

Standard fuel pressure:
147 kPa (1.5 kgf/cm^2, 21 psi) or more

If the pressure is not as specified, check the fuel pump, pressure regulator and/or injectors.

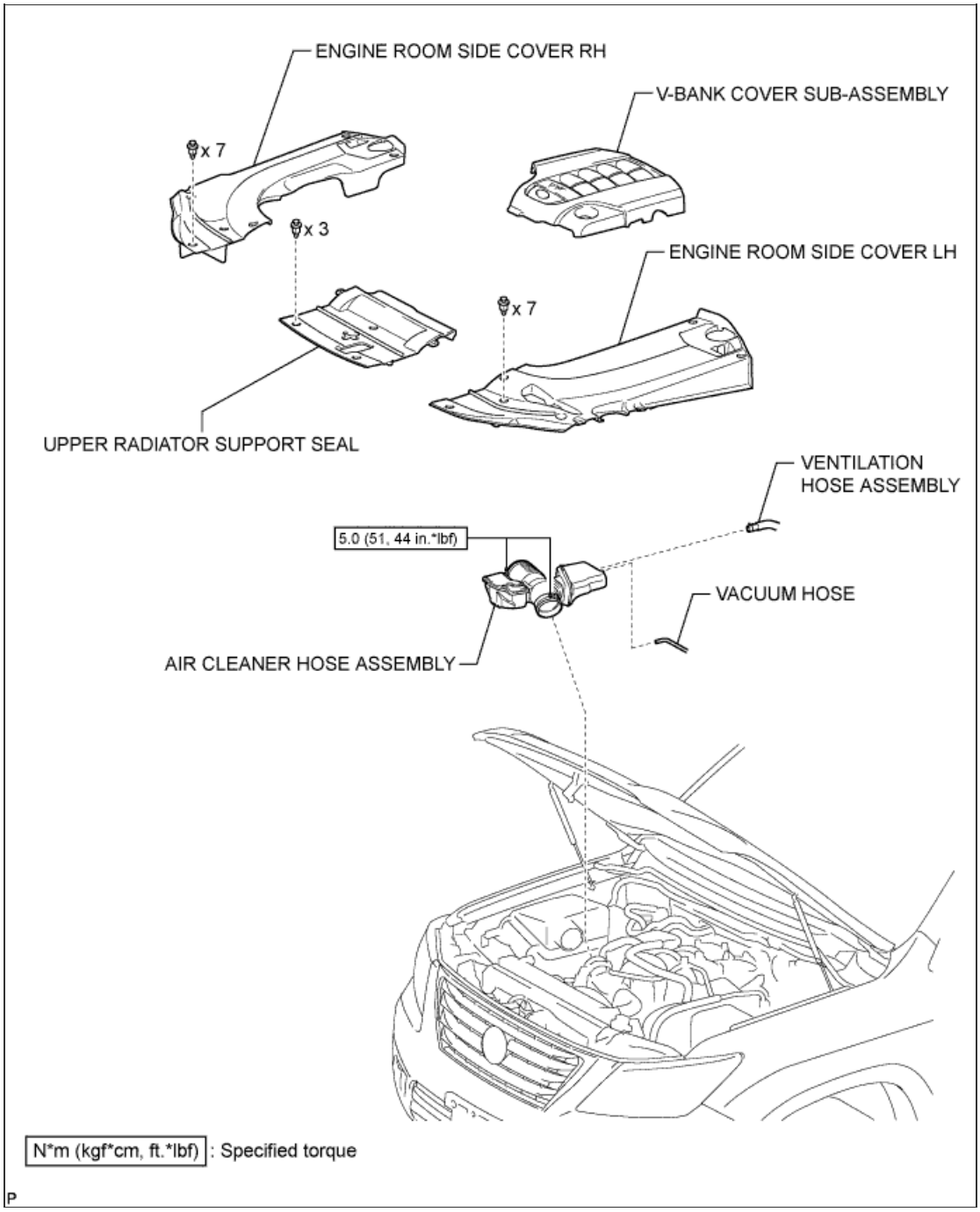
o. Disconnect the cable from the negative (-) battery terminal and carefully remove SST and the fuel tube connector to prevent gasoline from spraying.

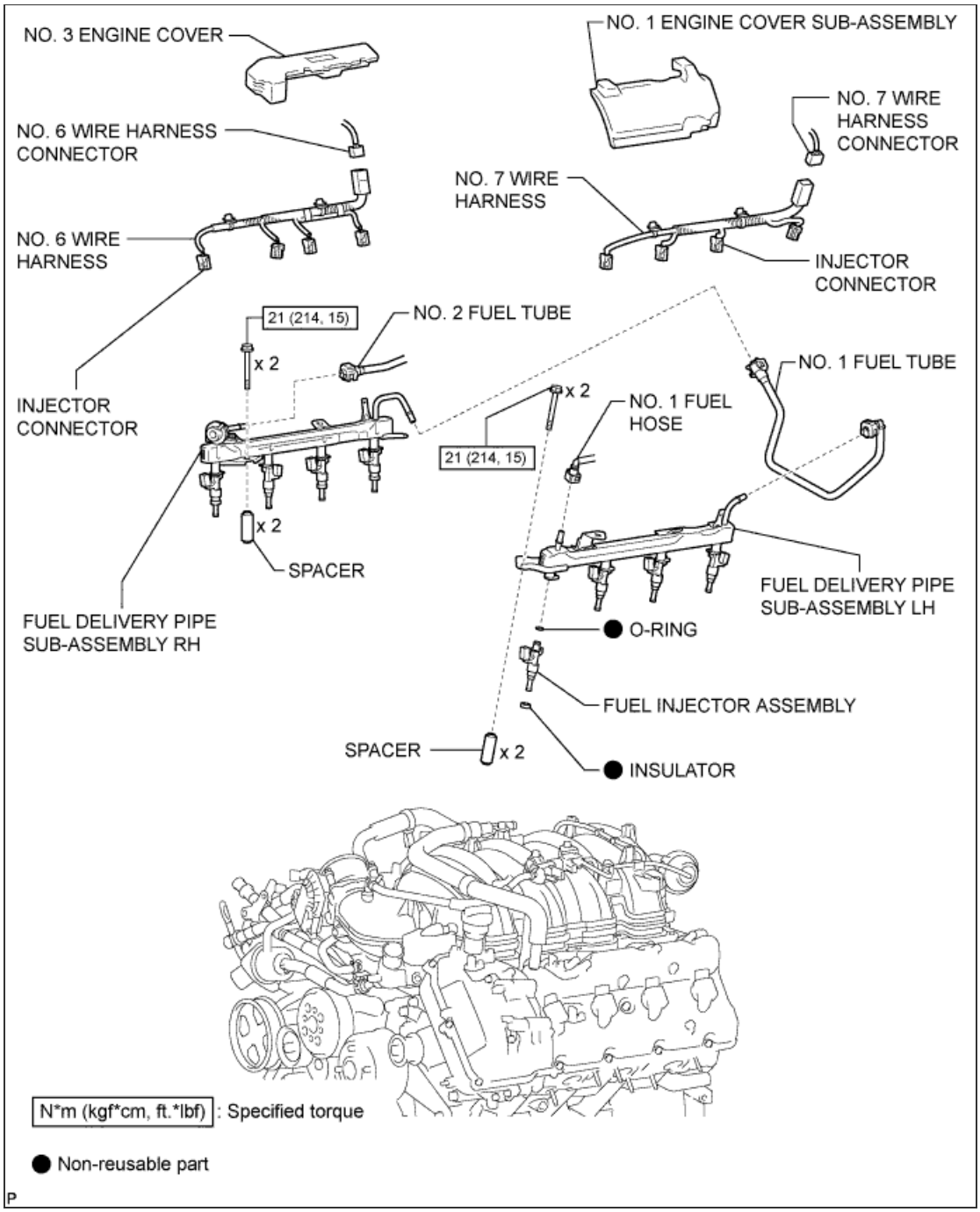
p. Reconnect the fuel tube (fuel tube connector).

q. Check for fuel leaks.

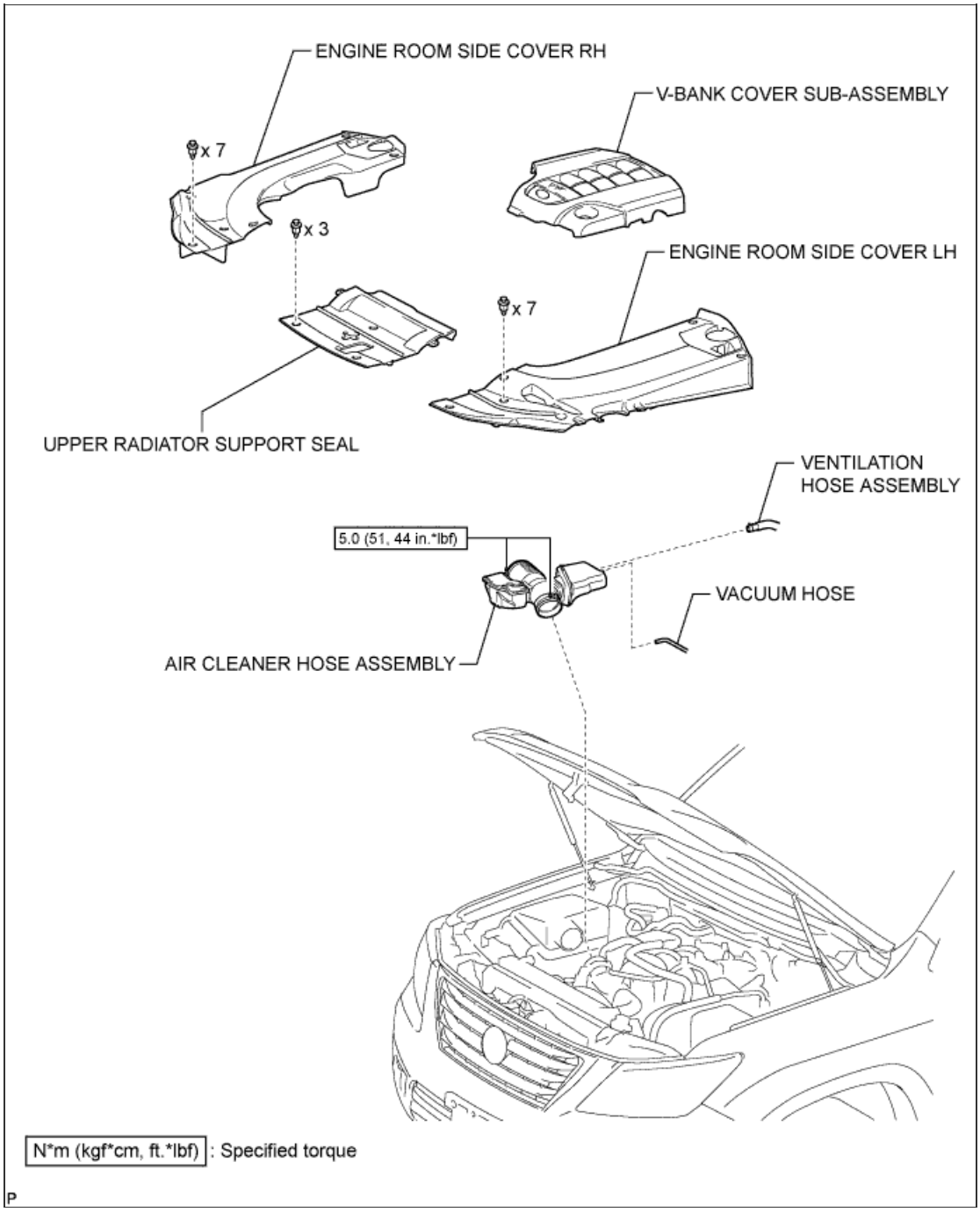
i. Check that there are no fuel leaks after performing maintenance anywhere on the system.
If there are fuel leaks, repair or replace parts as necessary.

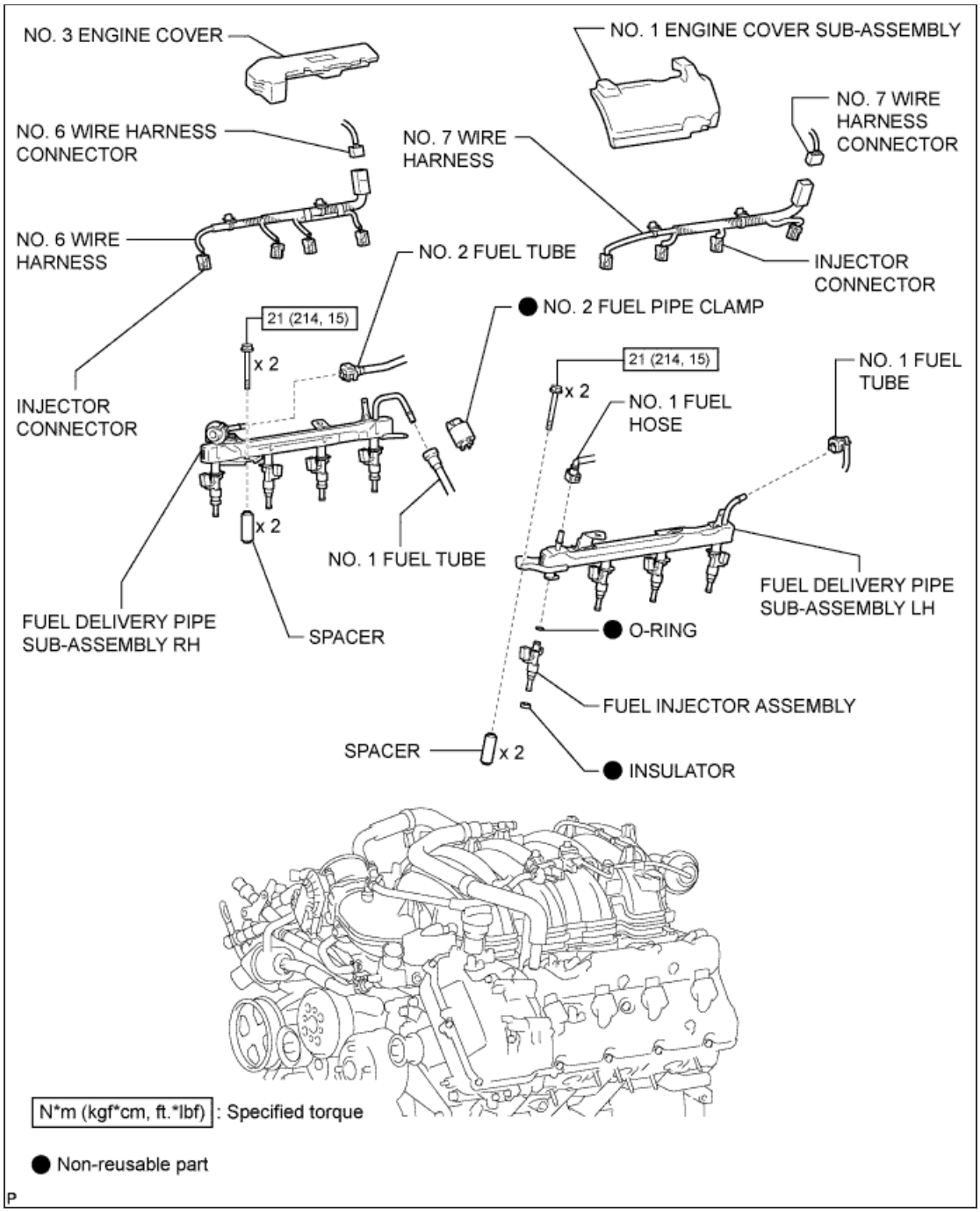
for Preparation Click here




NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
NO. 7 WIRE HARNESS CONNECTOR
NO. 6 WIRE HARNESS CONNECTOR
NO. 7 WIRE HARNESS
NO. 6 WIRE HARNESS
INJECTOR CONNECTOR
21 (214, 15)
NO. 2 FUEL TUBE
x 2
NO. 1 FUEL TUBE
INJECTOR CONNECTOR
x 2
NO. 1 FUEL HOSE
21 (214, 15)
x 2
SPACER
FUEL DELIVERY PIPE SUB-ASSEMBLY LH
FUEL DELIVERY PIPE SUB-ASSEMBLY RH
O-RING
FUEL INJECTOR ASSEMBLY
SPACER
x 2
INSULATOR
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

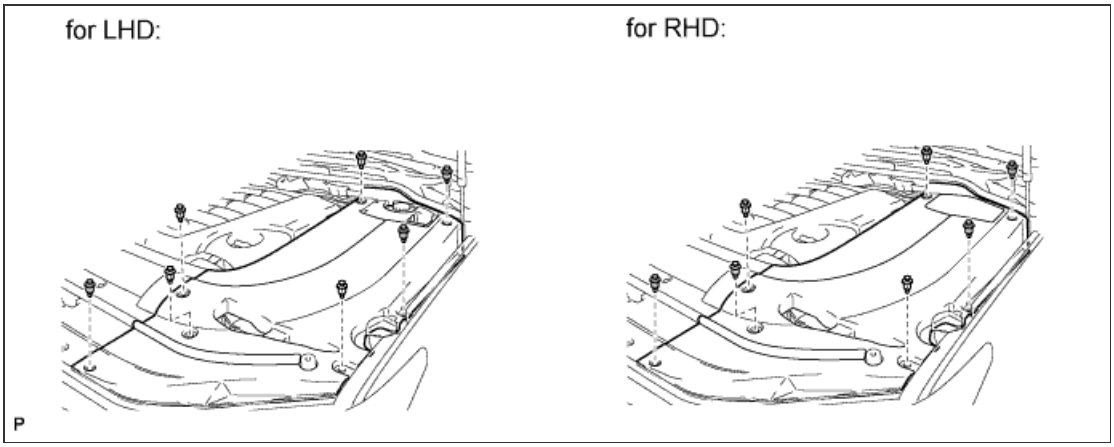



NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
NO. 7 WIRE HARNESS CONNECTOR
NO. 6 WIRE HARNESS CONNECTOR
NO. 7 WIRE HARNESS
NO. 6 WIRE HARNESS
NO. 2 FUEL TUBE
INJECTOR CONNECTOR
21 (214, 15)
NO. 2 FUEL PIPE CLAMP
x 2
21 (214, 15)
x 2
NO. 1 FUEL TUBE
INJECTOR CONNECTOR
NO. 1 FUEL HOSE
x 2
NO. 1 FUEL TUBE
FUEL DELIVERY PIPE SUB-ASSEMBLY LH
NO. 1 FUEL TUBE
FUEL DELIVERY PIPE SUB-ASSEMBLY RH
SPACER
O-RING
FUEL INJECTOR ASSEMBLY
SPACER
x 2
INSULATOR
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

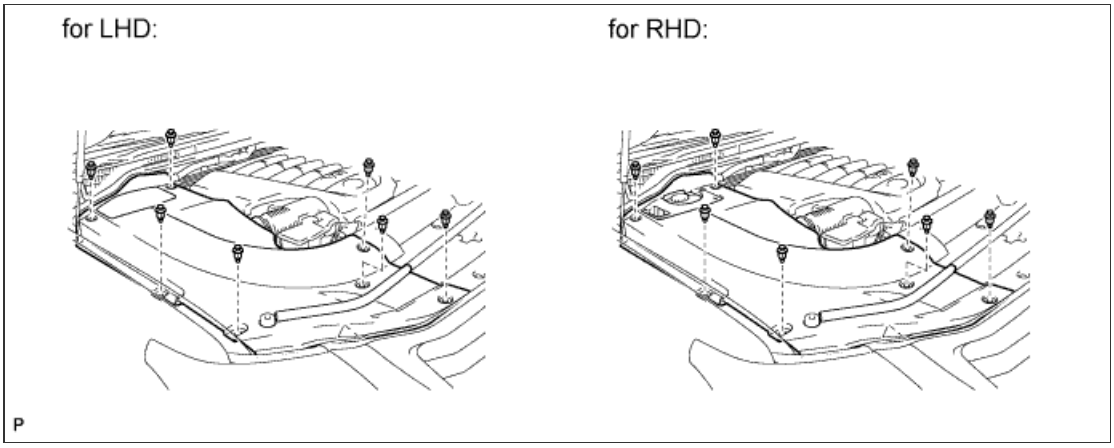
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



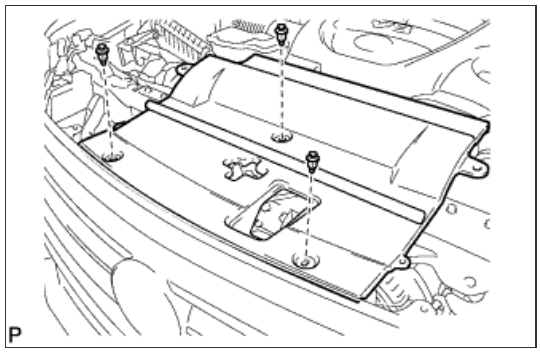
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



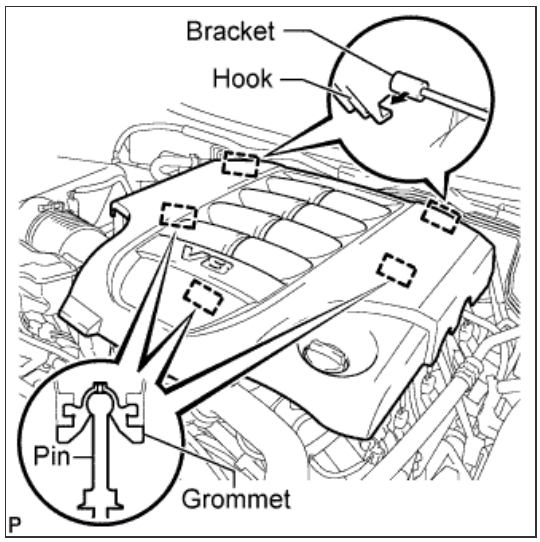
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

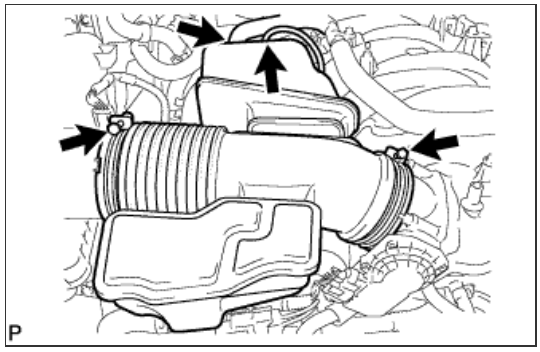
When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

7. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

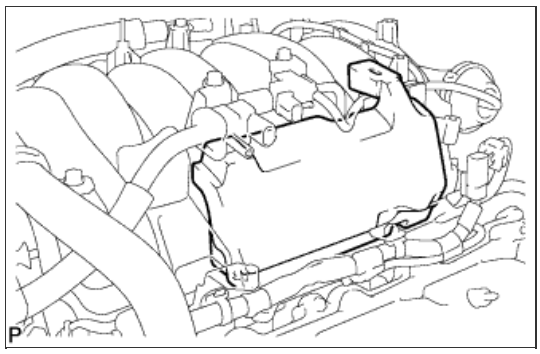
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



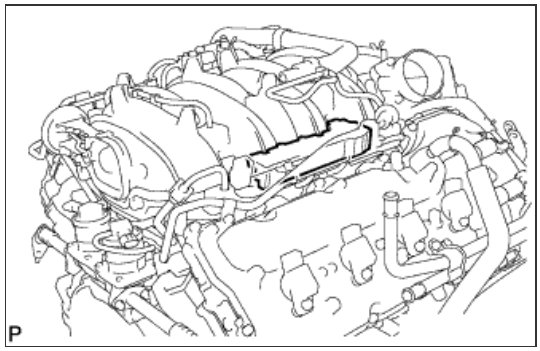
8. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Remove the No. 1 engine cover sub-assembly.



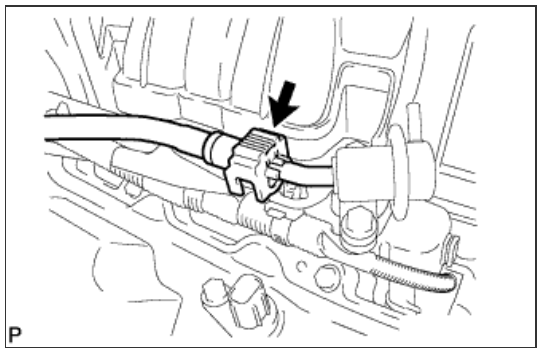
9. REMOVE NO. 3 ENGINE COVER

a. Remove the No. 3 engine cover.



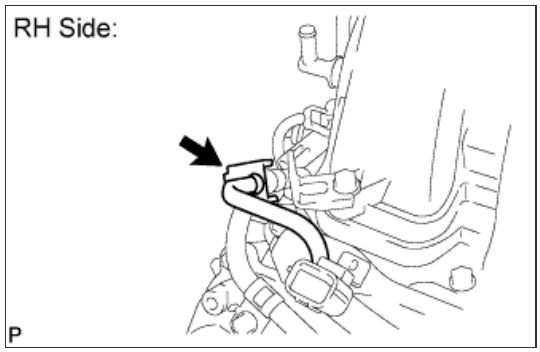
10. DISCONNECT NO. 2 FUEL TUBE

a. Disconnect the No. 2 fuel tube from the fuel pressure regulator (Click here).

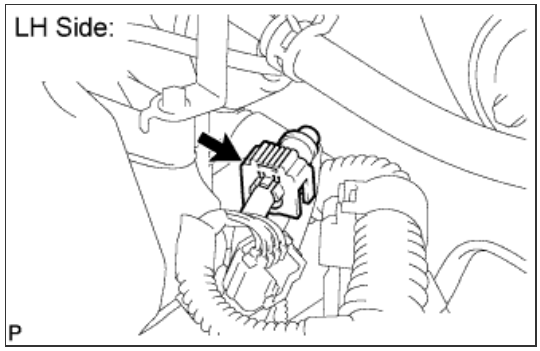


11. DISCONNECT NO. 1 FUEL TUBE

a. RH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe RH (Click here).

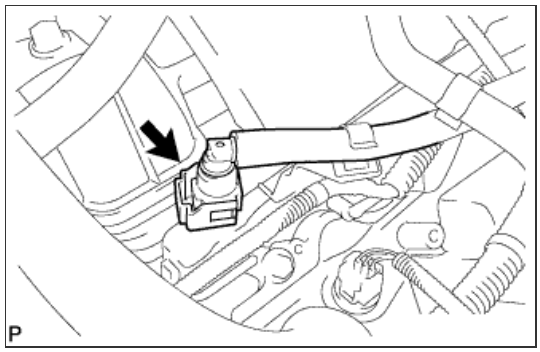


b. LH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe LH (Click here).



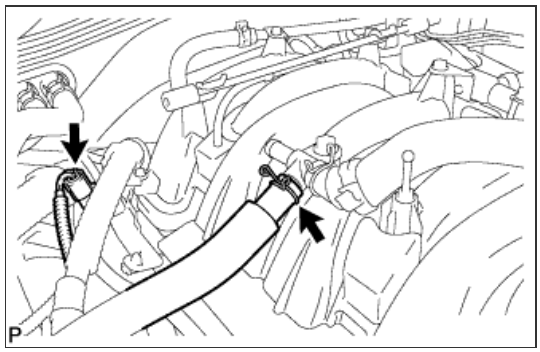
12. DISCONNECT NO. 1 FUEL HOSE

a. Disconnect the fuel hose from the fuel delivery pipe LH (Click here).



13. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Disconnect the ventilation hose and No. 6 wire harness connector.

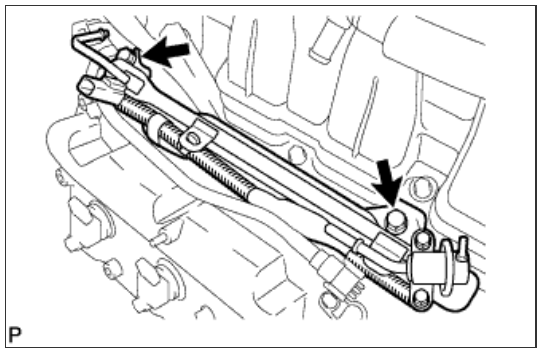


b. Remove the 2 bolts and fuel delivery pipe RH.

NOTICE:

When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.

c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head RH.



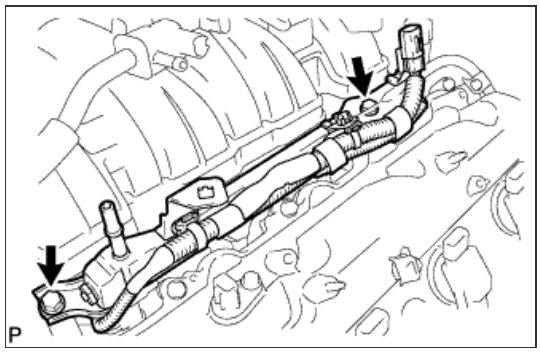
14. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Disconnect the No. 7 wire harness connector.

b. Remove the 2 bolts and fuel delivery pipe LH.

NOTICE:

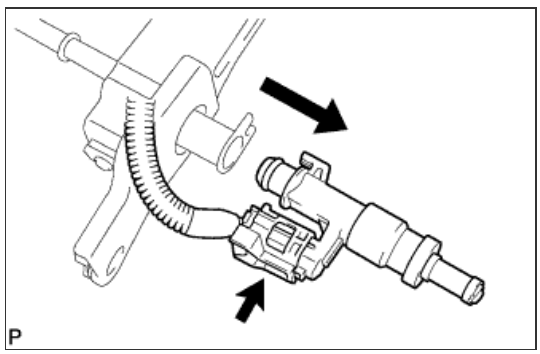
When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.



c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head LH.

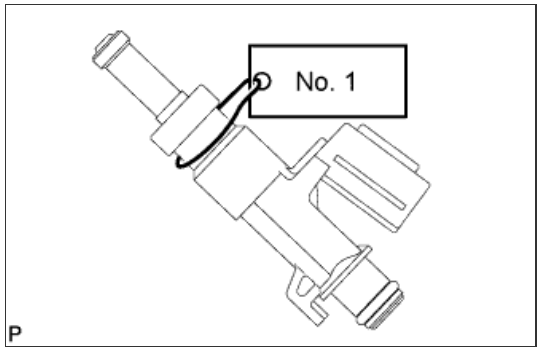
15. REMOVE FUEL INJECTOR ASSEMBLY

a. Remove the fuel injector from the fuel delivery pipe, and then disconnect the injector connector.

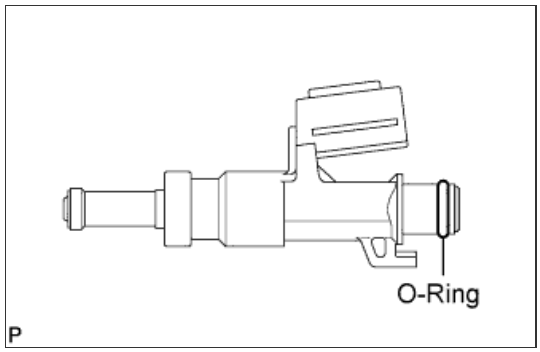


NOTICE:

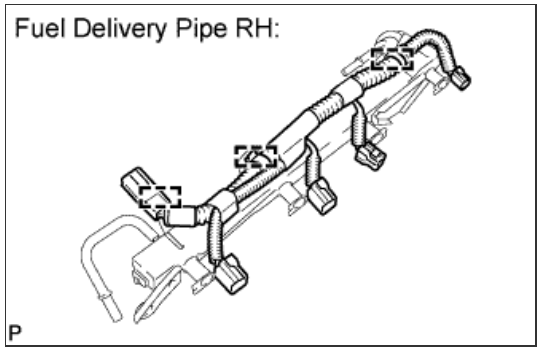
For reinstallation, attach a tag or label to the injector shaft.



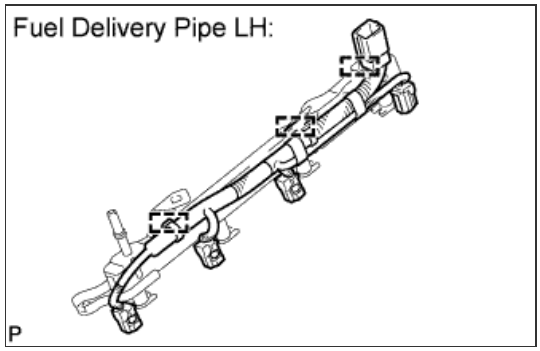
b. Remove the O-ring from the fuel injector.



c. Detach the 3 clamps and then remove the No. 6 wire harness from the delivery pipe RH.



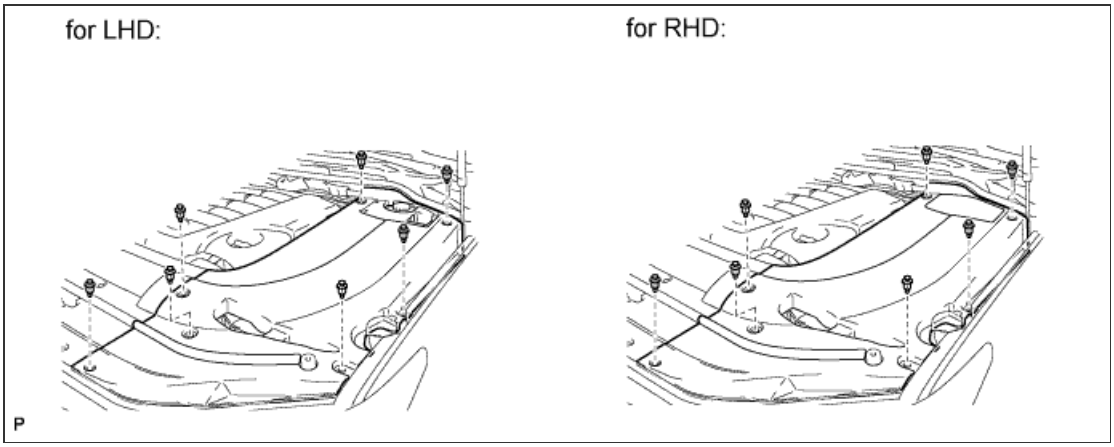
d. Detach the 3 clamps and then remove the No. 7 wire harness from the delivery pipe LH.



for Preparation Click here

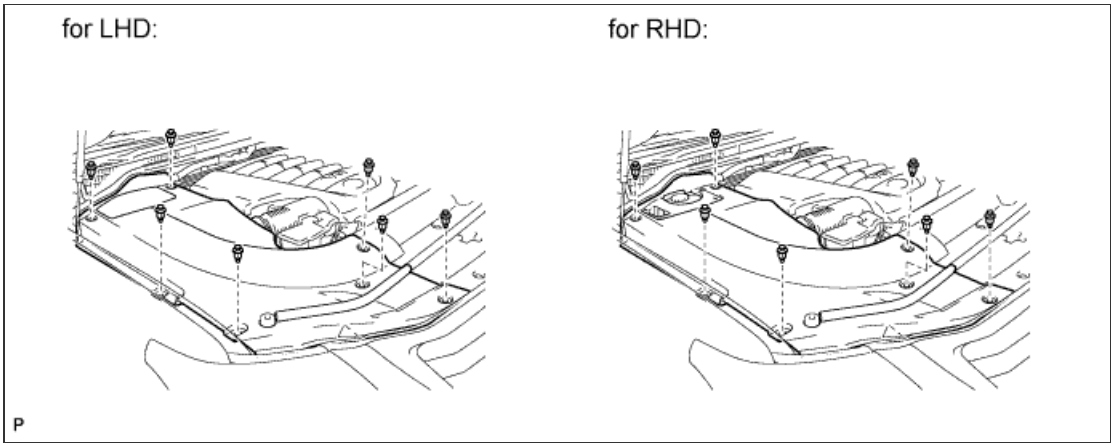
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



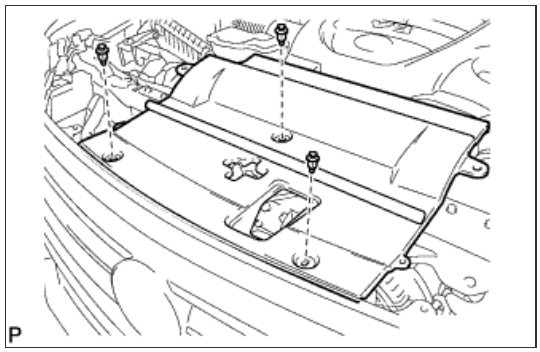
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



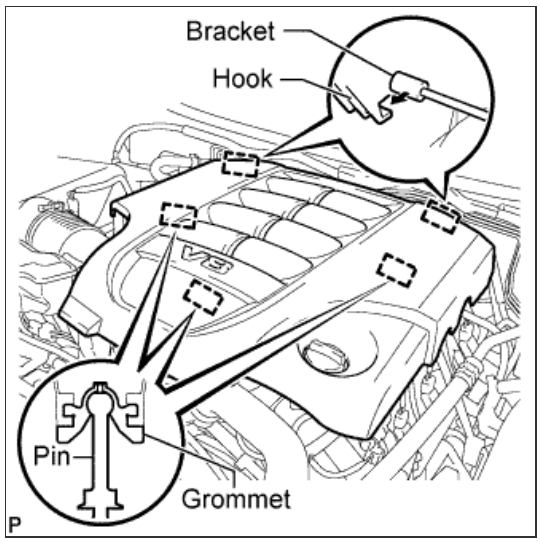
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

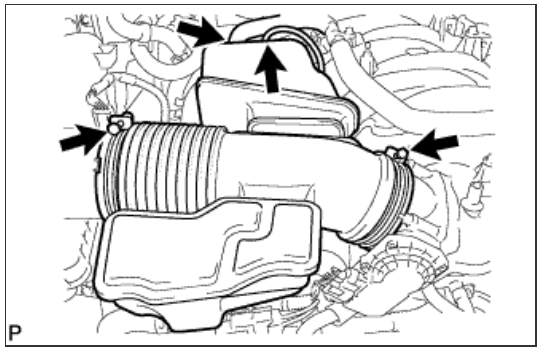
When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

7. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

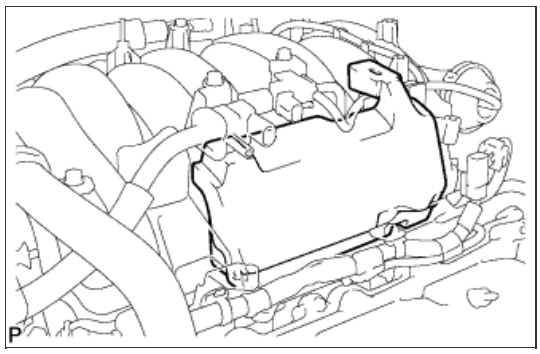
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



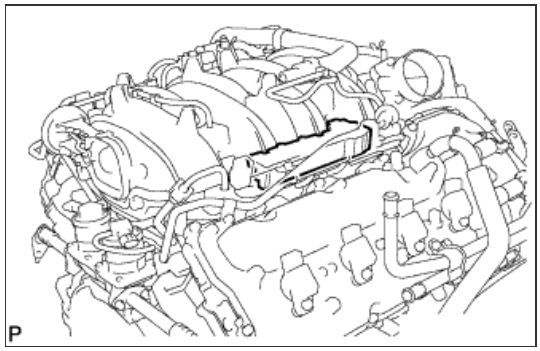
8. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Remove the No. 1 engine cover sub-assembly.



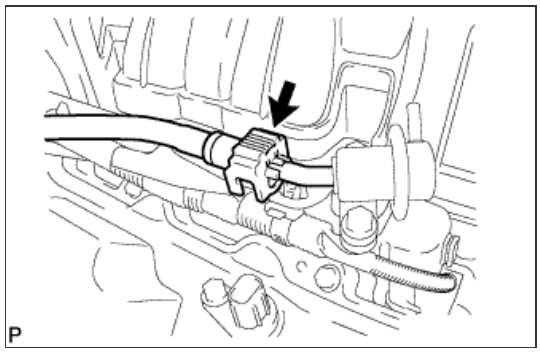
9. REMOVE NO. 3 ENGINE COVER

a. Remove the No. 3 engine cover.



10. DISCONNECT NO. 2 FUEL TUBE

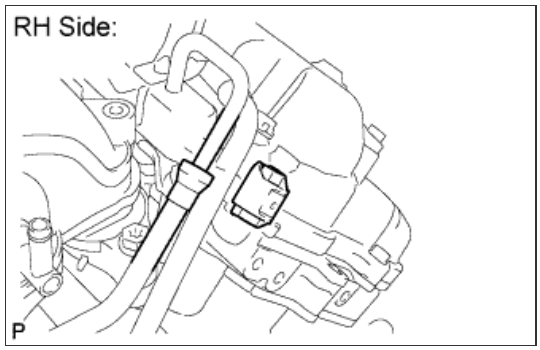
a. Disconnect the No. 2 fuel tube from the fuel pressure regulator (Click here).



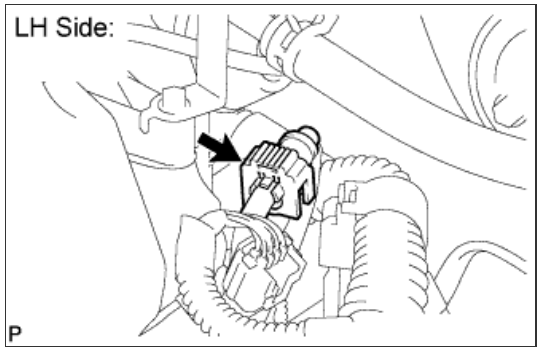
11. DISCONNECT NO. 1 FUEL TUBE

a. RH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe RH (for metallic type) (Click here).

SST
09268-21011

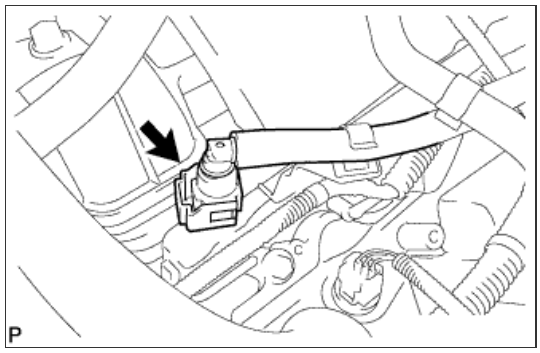


b. LH Side:
Disconnect the No. 1 fuel tube from the fuel delivery pipe LH (Click here).



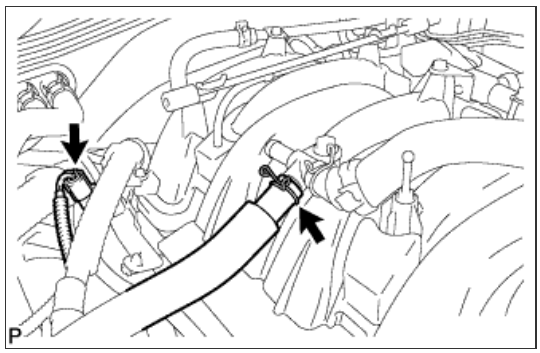
12. DISCONNECT NO. 1 FUEL HOSE

a. Disconnect the fuel hose from the fuel delivery pipe LH (Click here).



13. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Disconnect the ventilation hose and No. 6 wire harness connector.

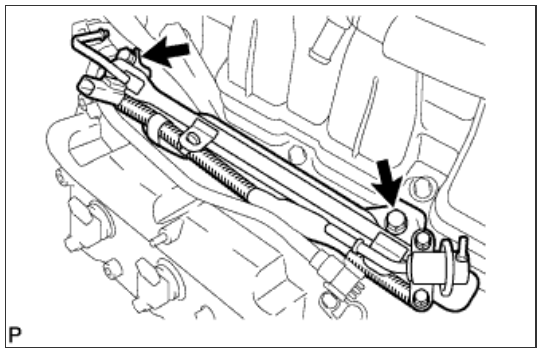


b. Remove the 2 bolts and fuel delivery pipe RH.

NOTICE:

When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.

c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head RH.



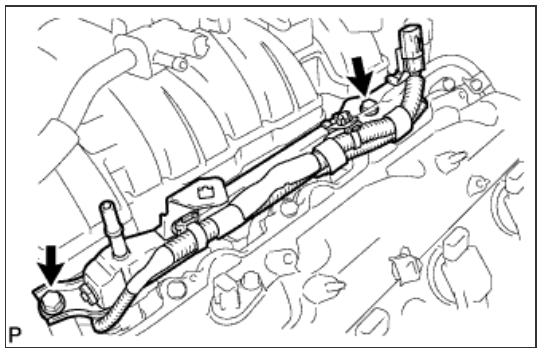
14. REMOVE FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Disconnect the No. 7 wire harness connector.

b. Remove the 2 bolts and fuel delivery pipe LH.

NOTICE:

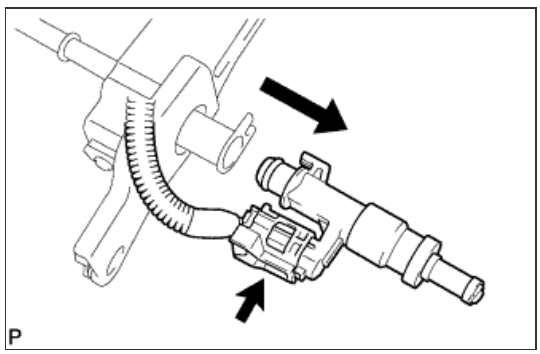
When removing the delivery pipe, hold the pipe by both ends and pull it straight upward.



c. Remove the 2 delivery pipe spacers and 4 insulators from the cylinder head LH.

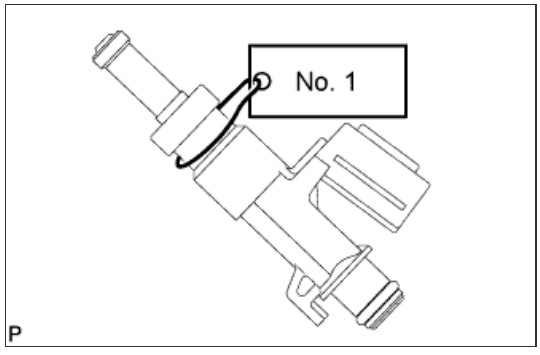
15. REMOVE FUEL INJECTOR ASSEMBLY

a. Remove the fuel injector from the fuel delivery pipe, and then disconnect the injector connector.

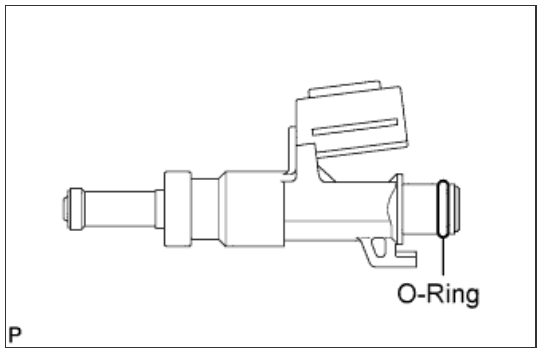


NOTICE:

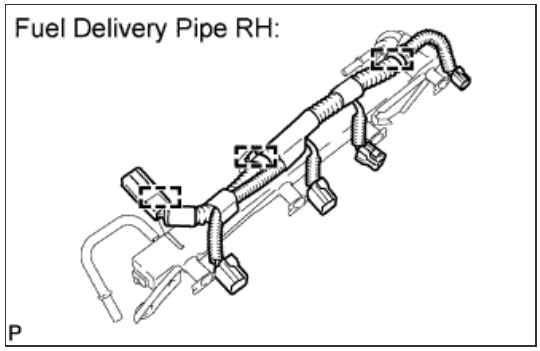
For reinstallation, attach a tag or label to the injector shaft.



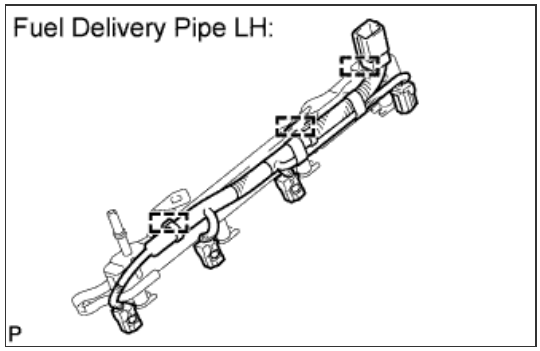
b. Remove the O-ring from the fuel injector.



c. Detach the 3 clamps and then remove the No. 6 wire harness from the delivery pipe RH.



d. Detach the 3 clamps and then remove the No. 7 wire harness from the delivery pipe LH.



for Preparation Click here

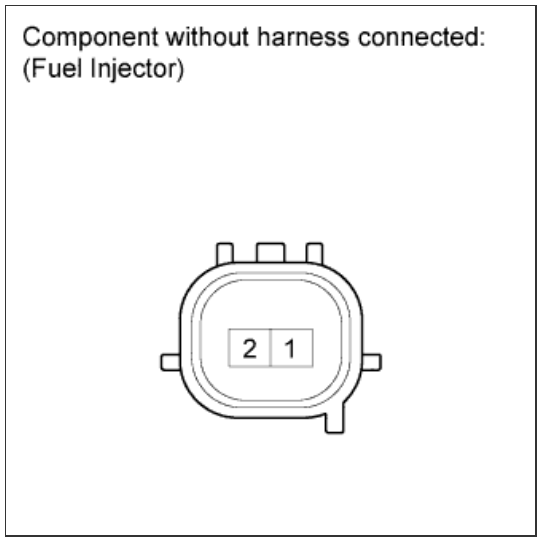
1. INSPECT FUEL INJECTOR ASSEMBLY

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	11.6 to 12.4 Ω

If the result is not as specified, replace the injector assembly.

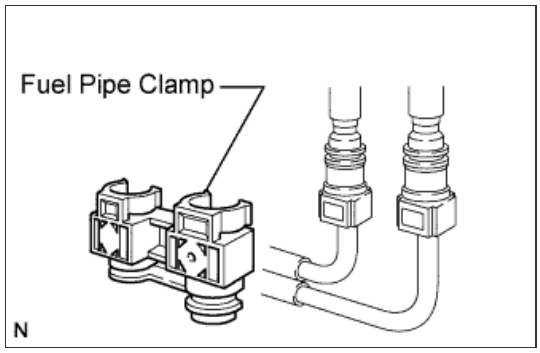


b. Inspect the injection volume.

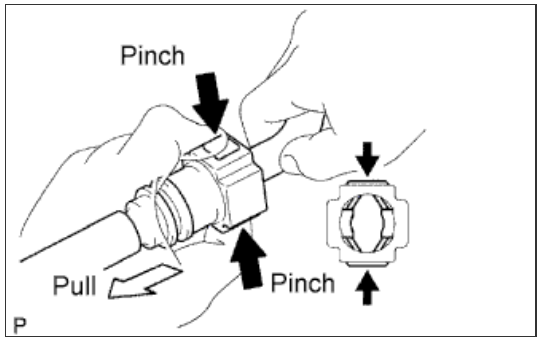
CAUTION:

This test involves high-pressure fuel and electricity. Take all precautions regarding safe handling of both the fuel and the electricity. Perform this test in a safe area, and avoid any sparks or flames. Do not smoke.

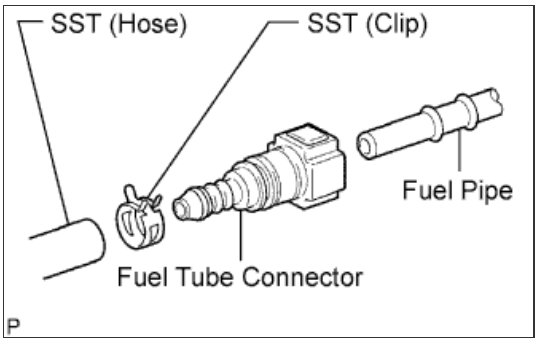
i. Remove the fuel pipe clamp.



ii. Disconnect the fuel tube.



iii. Connect SST to the fuel pipe (the vehicle side).

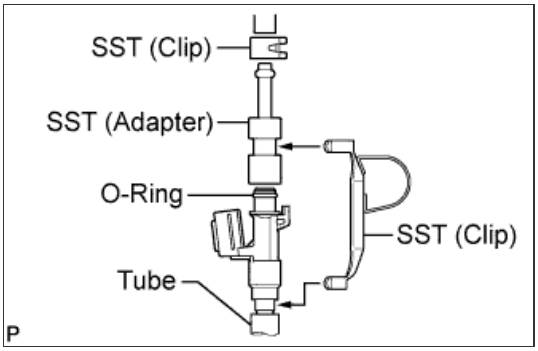


iv. Install the O-ring to the fuel injector.

v. Install SST and the tube to the fuel injector.

SST

09268-31012 (09268-41300, 09268-41500, 09268-41600, 90467-13001, 95336-08070)



vi. Put the injector into a graduated cylinder.

CAUTION:

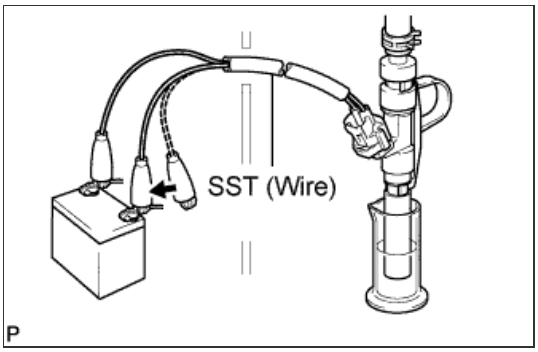
Install a strong rubber tube onto the injector to prevent gasoline from splashing.

vii. Operate the fuel pump (turn the engine switch on (IG)).

viii. Connect SST (wire) to the injector and the battery for 15 seconds, and measure the injection volume with the graduated cylinder. Test each injector 2 or 3 times.

SST

09842-30090



Standard injection volume:

83 to 99 cm^3 (5.0 to 6.0 cu in.) per 15 seconds

Difference between each injector:

16 cm^3 (1.0 cu in.) or less

If the injection volume is not as specified, replace the injector assembly.

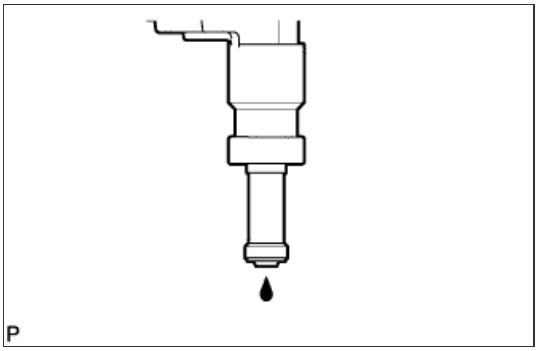
c. Check for fuel drop.

i. In the condition above, disconnect the tester probes of SST (wire) from the battery and check for fuel drop from the injector.

Standard fuel drop:

1 drop or less in 12 minutes

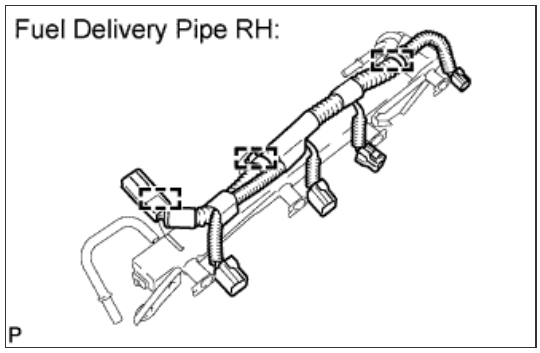
If the fuel drop is not as specified, replace the injector assembly.



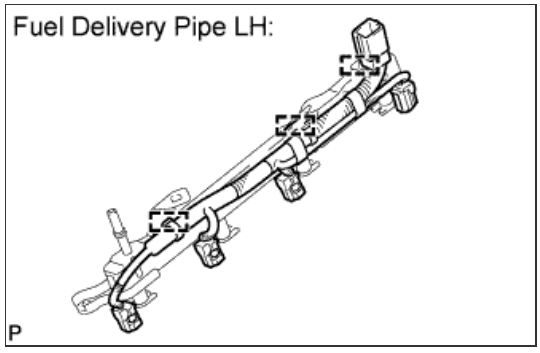
for Preparation Click here

1. INSTALL FUEL INJECTOR ASSEMBLY

a. Attach the 3 clamps to install the No. 6 wire harness to the delivery pipe RH.



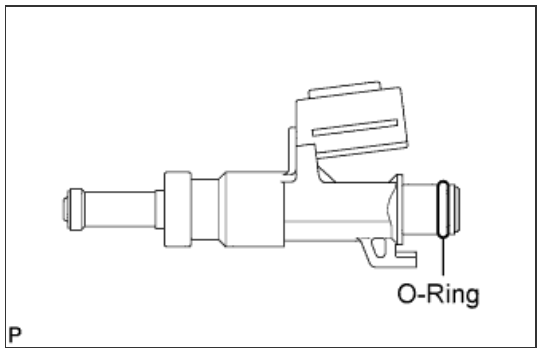
b. Attach the 3 clamps to install the No. 7 wire harness to the delivery pipe LH.



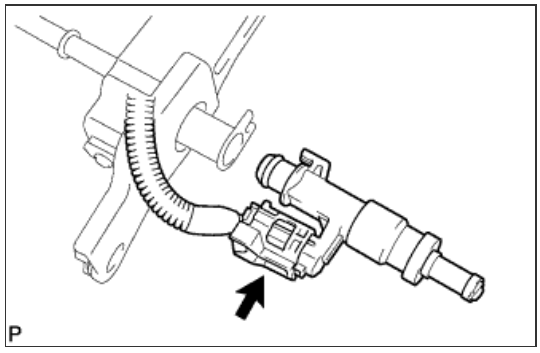
c. Apply gasoline or spindle oil to a new O-ring and install it to the injector.

NOTICE:

Make sure that there is no damage or foreign material in the groove of the injector when installing the O-ring.



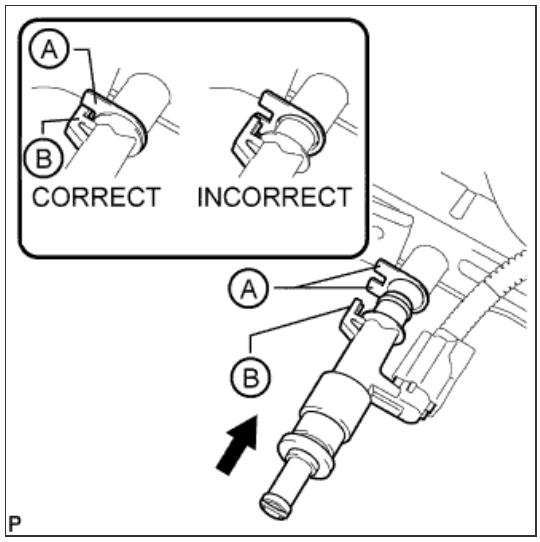
d. Connect the injector connector.



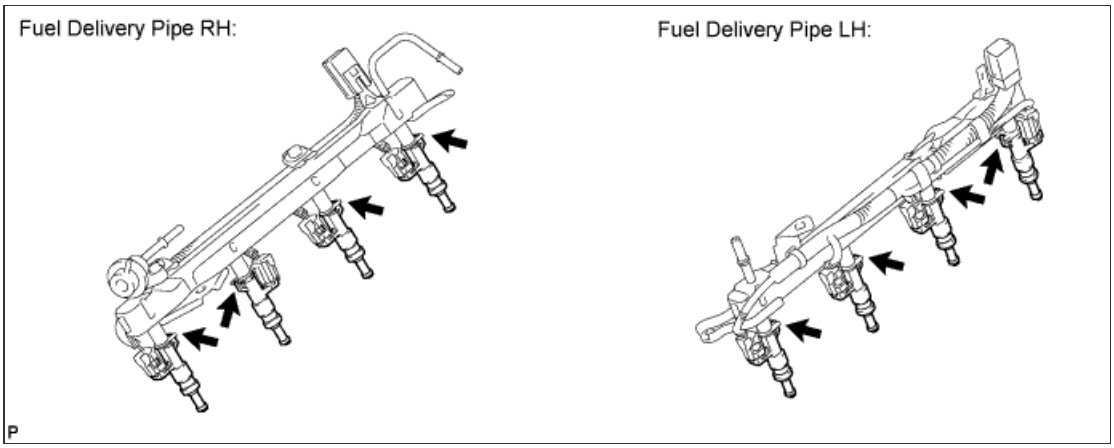
e. Install the injector to the delivery pipe as shown in the illustration.

NOTICE:

- **Make sure that there are no scratches or foreign matter in or around the insertion hole of the delivery pipe.**
- **When inserting the injector, be careful not to damage the O-ring.**
- **Attach the part of the injector labeled B between the parts of the delivery pipe labeled A.**



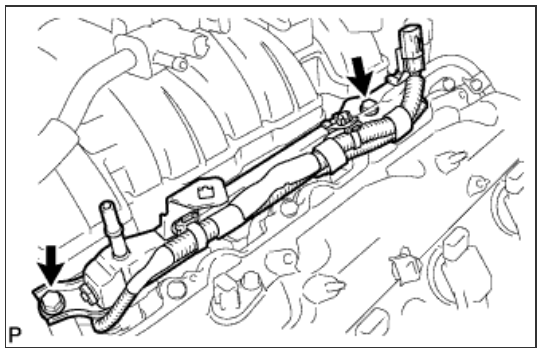
f. Check that each injector is installed to the delivery pipe facing the direction shown in the illustration.



2. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head LH.

b. Install the delivery pipe (with injectors) to the cylinder head LH.



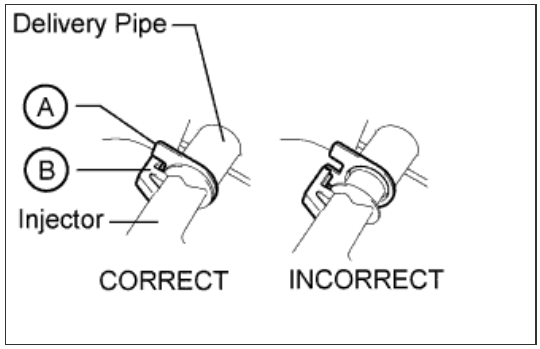
c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

NOTICE:

Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.

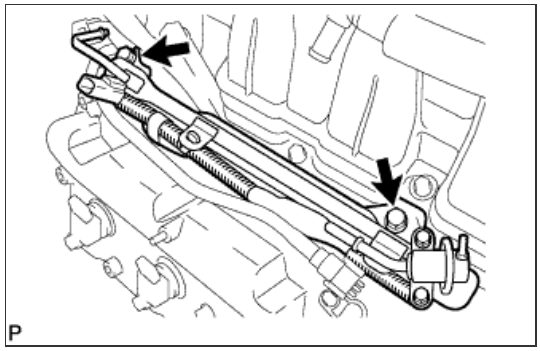
d. Connect the No. 7 wire harness connector.



3. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head RH.

b. Install the delivery pipe (with injectors) to the cylinder head RH.

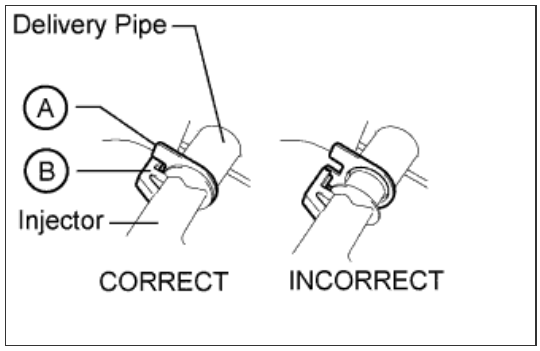


c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

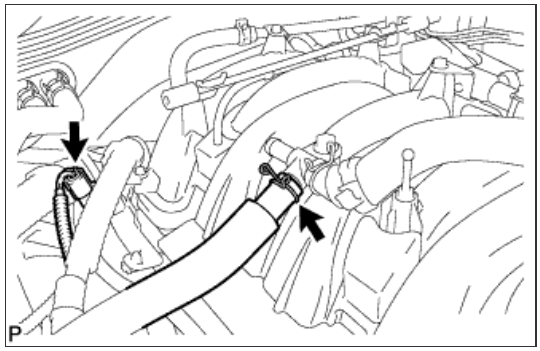
NOTICE:

Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.



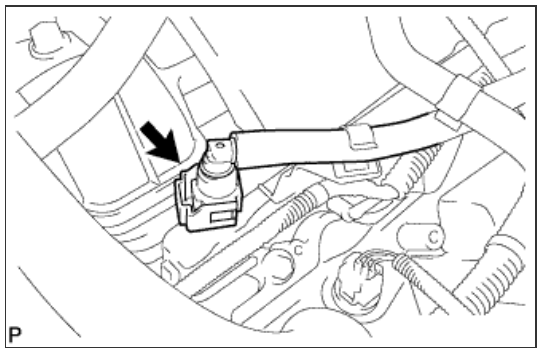
d. Connect the No. 6 wire harness connector.

e. Connect the ventilation hose.



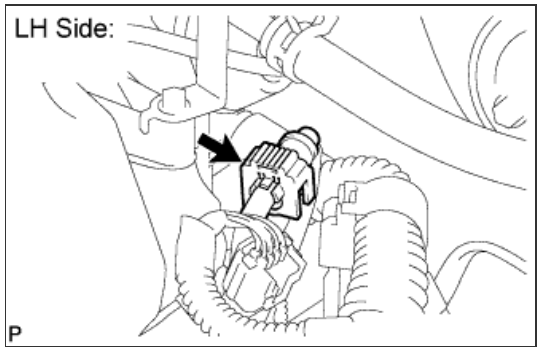
4. CONNECT NO. 1 FUEL HOSE

a. Connect the No. 1 fuel hose to the fuel delivery pipe LH (Click here).

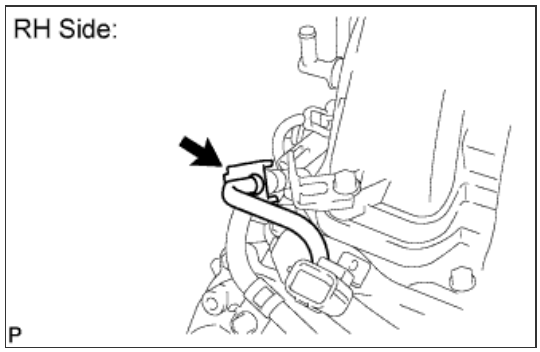


5. CONNECT NO. 1 FUEL TUBE

a. LH Side:
Connect the No. 1 fuel tube to the delivery pipe LH (Click here).

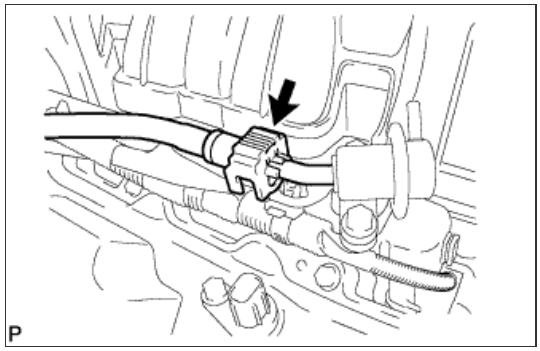


b. RH Side:
Connect the No. 1 fuel tube to the delivery pipe RH (Click here).



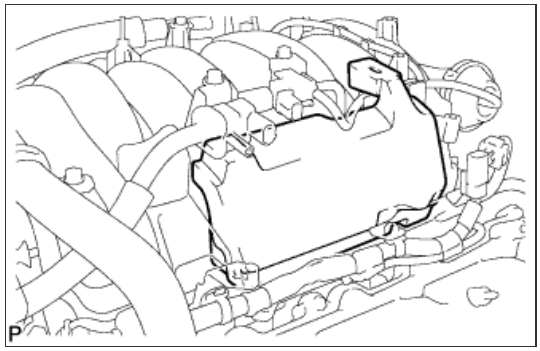
6. CONNECT NO. 2 FUEL TUBE

a. Connect the No. 2 fuel tube to the fuel pressure regulator (Click here).



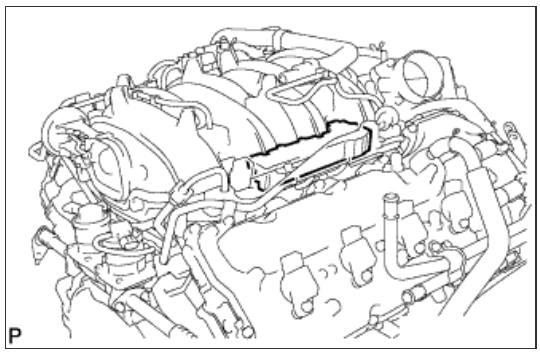
7. INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Install the No. 1 engine cover sub-assembly.



8. INSTALL NO. 3 ENGINE COVER

a. Install the No. 3 engine cover.



9. INSTALL AIR CLEANER HOSE ASSEMBLY

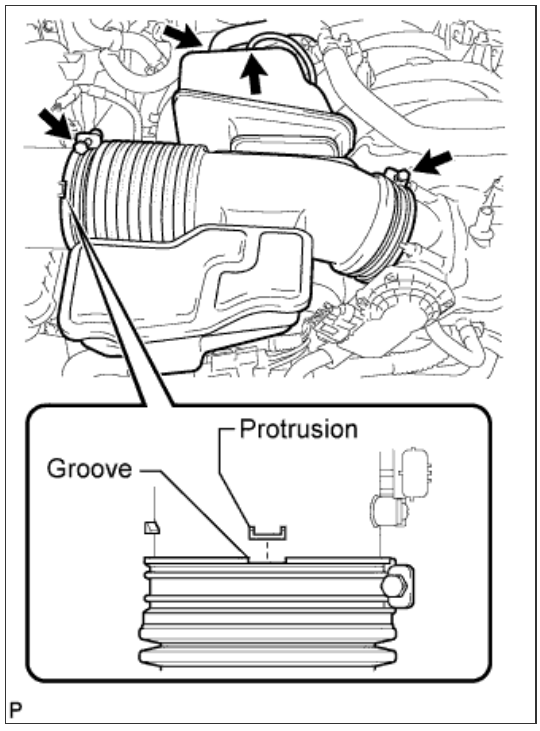
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



10. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

11. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

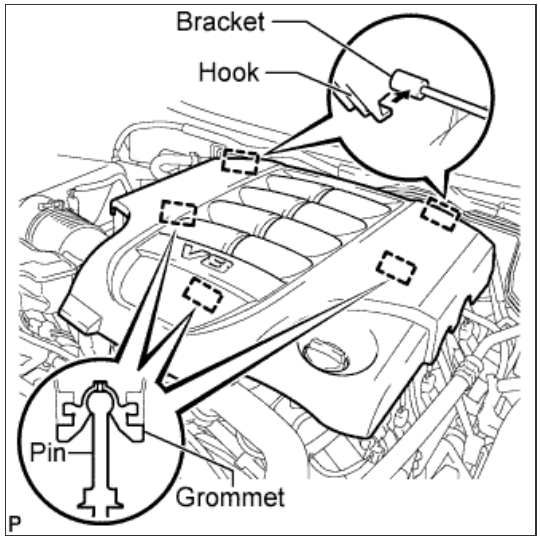
Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

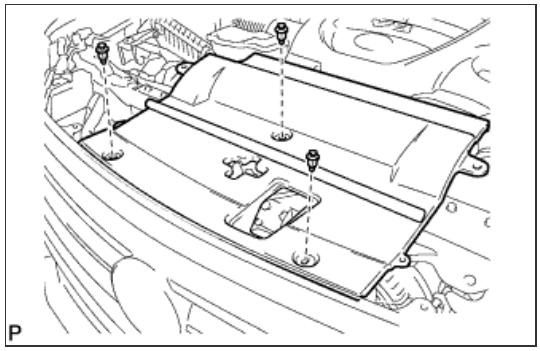
12. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



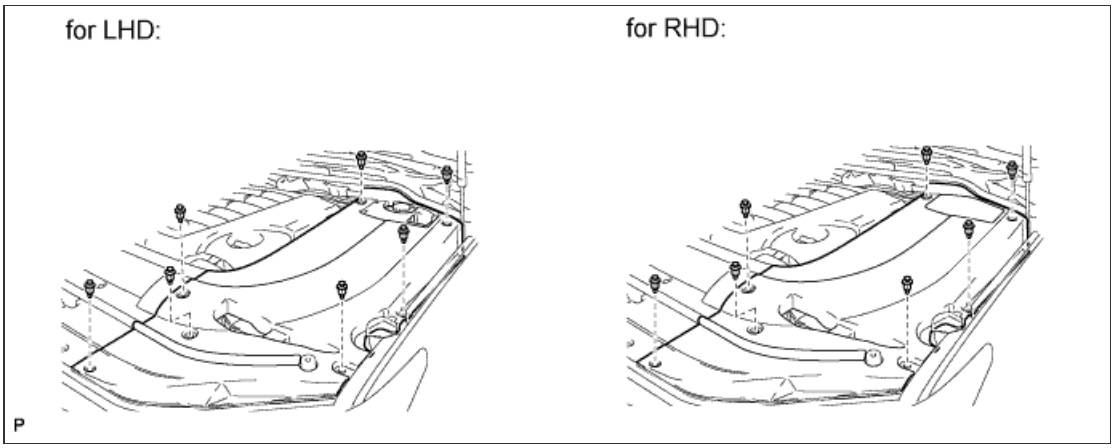
13. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



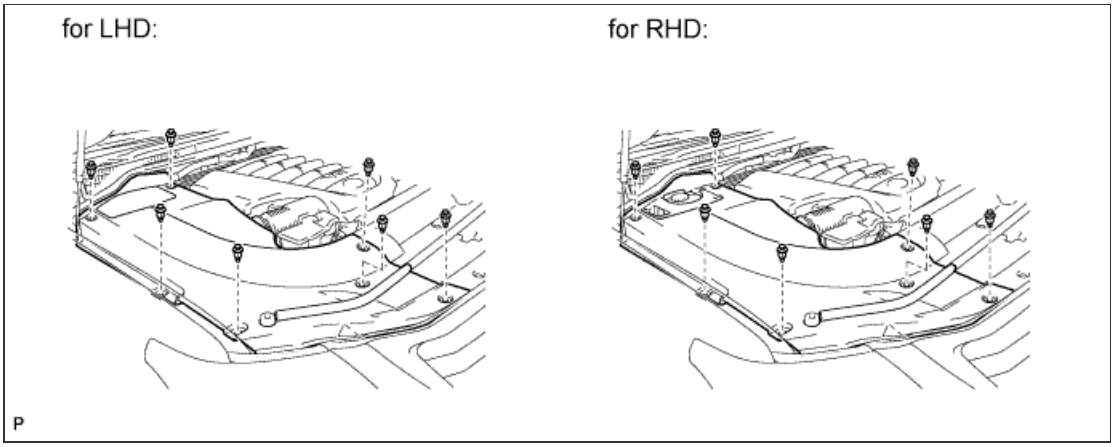
14. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



15. INSTALL ENGINE ROOM SIDE COVER RH

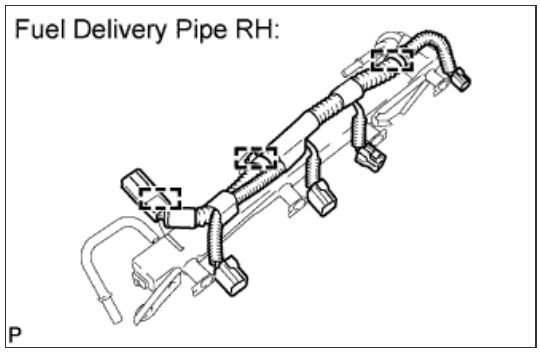
a. Install the engine room side cover with the 7 clips.



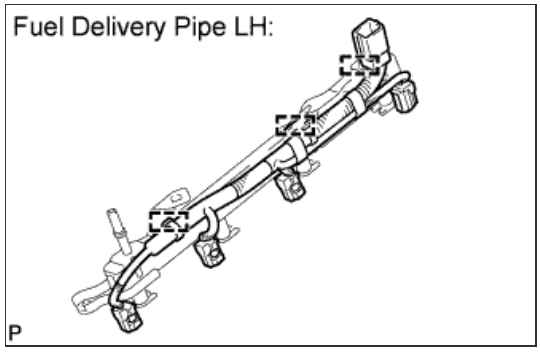
for Preparation Click here

1. INSTALL FUEL INJECTOR ASSEMBLY

a. Attach the 3 clamps to install the No. 6 wire harness to the delivery pipe RH.



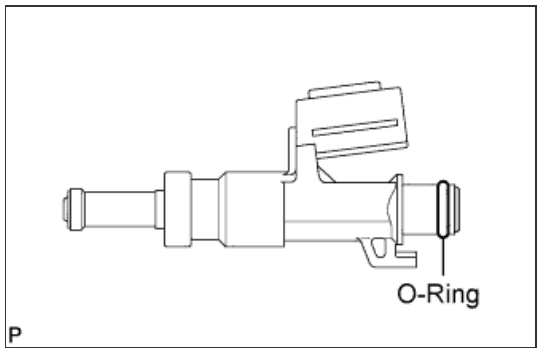
b. Attach the 3 clamps to install the No. 7 wire harness to the delivery pipe LH.



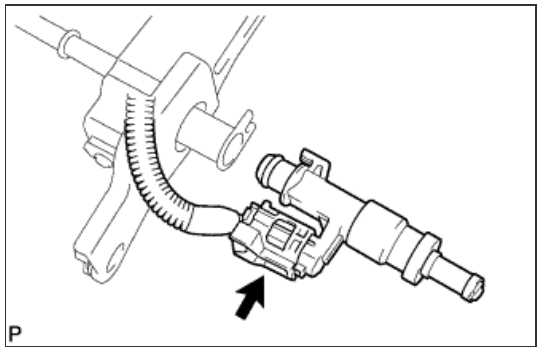
c. Apply gasoline or spindle oil to a new O-ring and install it to the injector.

NOTICE:

Make sure that there is no damage or foreign material in the groove of the injector when installing the O-ring.



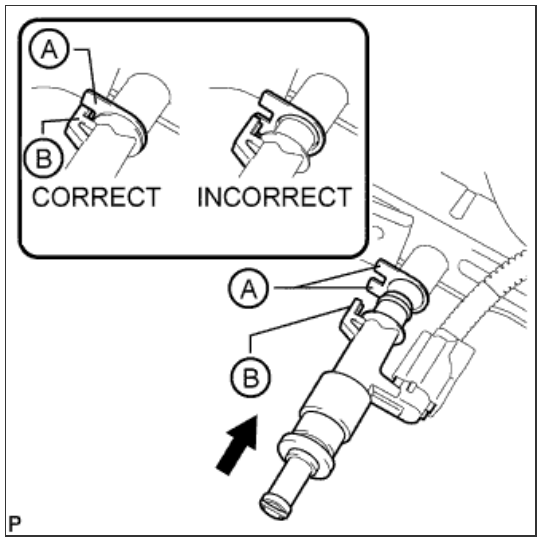
d. Connect the injector connector.



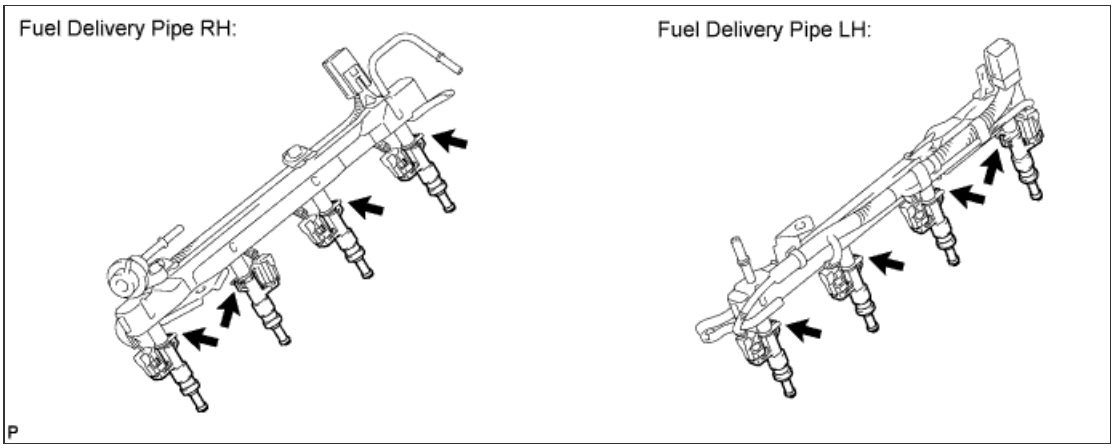
e. Install the injector to the delivery pipe as shown in the illustration.

NOTICE:

- **Make sure that there are no scratches or foreign matter in or around the insertion hole of the delivery pipe.**
- **When inserting the injector, be careful not to damage the O-ring.**
- **Attach the part of the injector labeled B between the parts of the delivery pipe labeled A.**



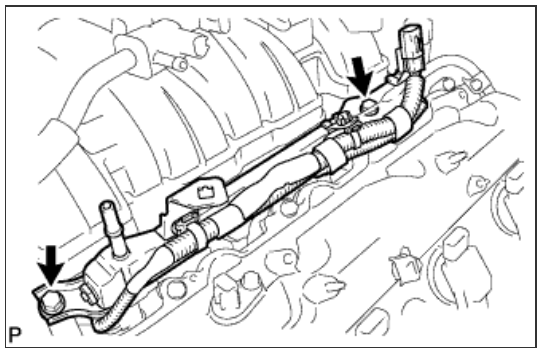
f. Check that each injector is installed to the delivery pipe facing the direction shown in the illustration.



2. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY LH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head LH.

b. Install the delivery pipe (with injectors) to the cylinder head LH.



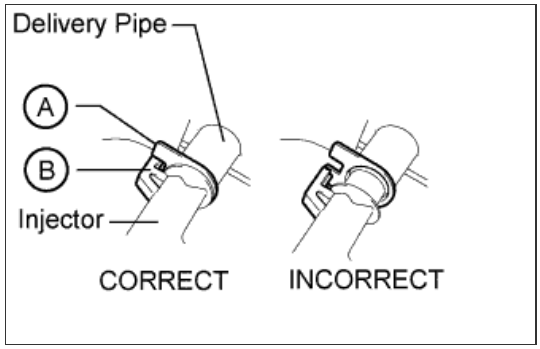
c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

NOTICE:

Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.

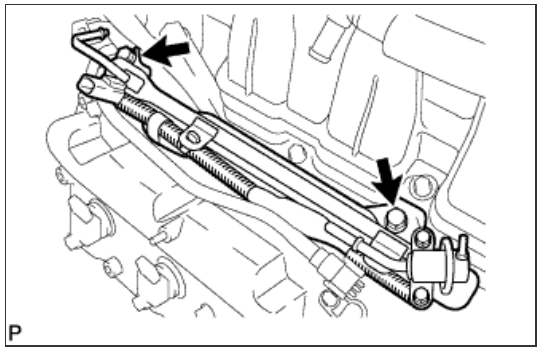
d. Connect the No. 7 wire harness connector.



3. INSTALL FUEL DELIVERY PIPE SUB-ASSEMBLY RH

a. Install the 2 delivery pipe spacers and 4 insulators to the cylinder head RH.

b. Install the delivery pipe (with injectors) to the cylinder head RH.

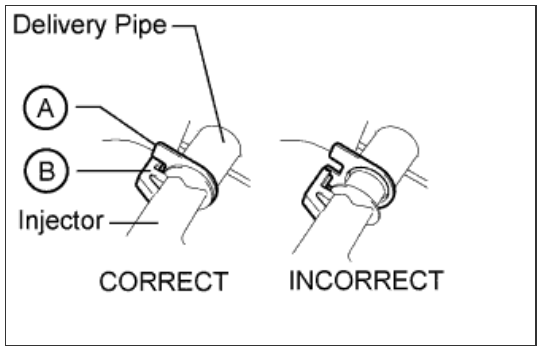


c. Install the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

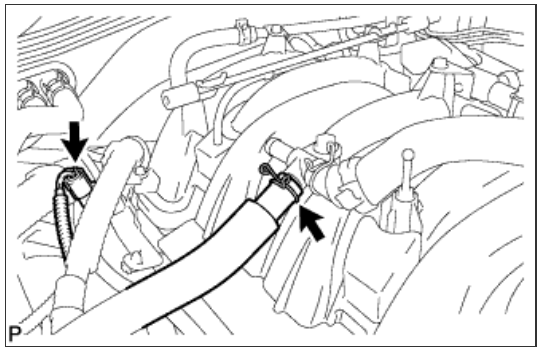
NOTICE:

Make sure that the part of the injector labeled B is between the parts of the delivery pipe labeled A.



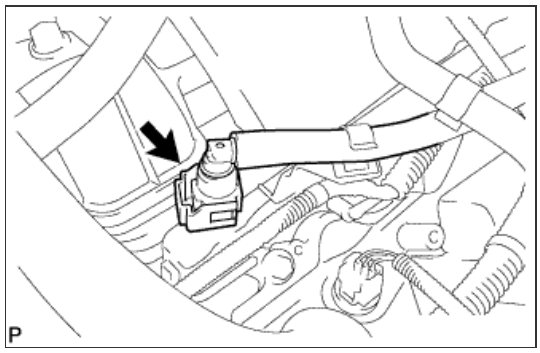
d. Connect the No. 6 wire harness connector.

e. Connect the ventilation hose.



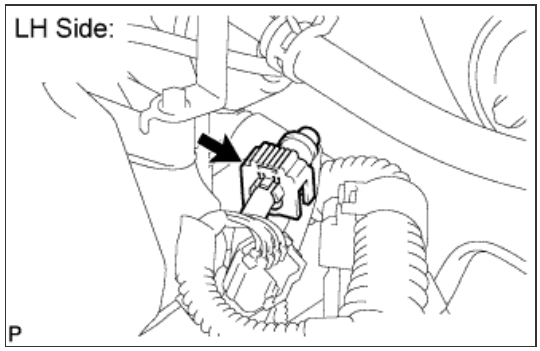
4. CONNECT NO. 1 FUEL HOSE

a. Connect the No. 1 fuel hose to the fuel delivery pipe LH (Click here).

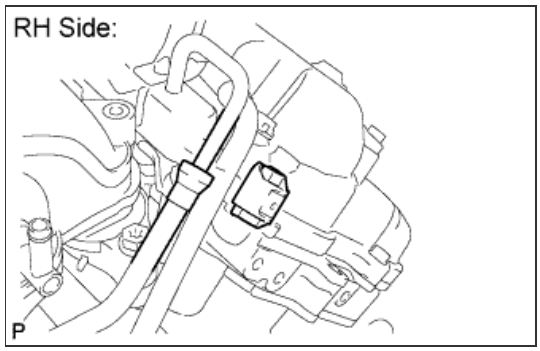


5. CONNECT NO. 1 FUEL TUBE

a. LH Side:
Connect the No. 1 fuel tube to the delivery pipe LH (Click here).

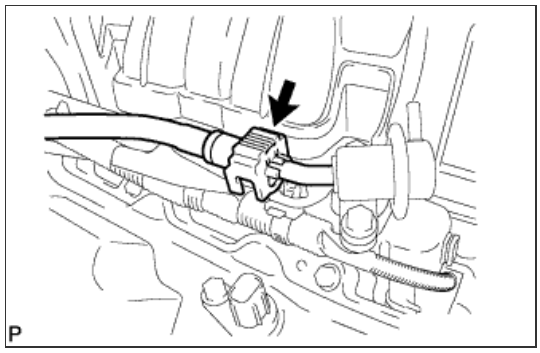


b. RH Side:
Connect the No. 1 fuel tube to the delivery pipe RH (for metallic type) (Click here).



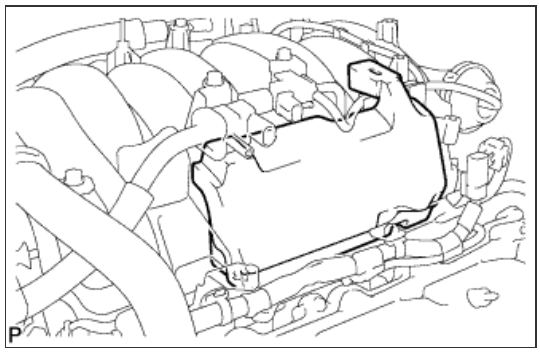
6. CONNECT NO. 2 FUEL TUBE

a. Connect the No. 2 fuel tube to the fuel pressure regulator (Click here).



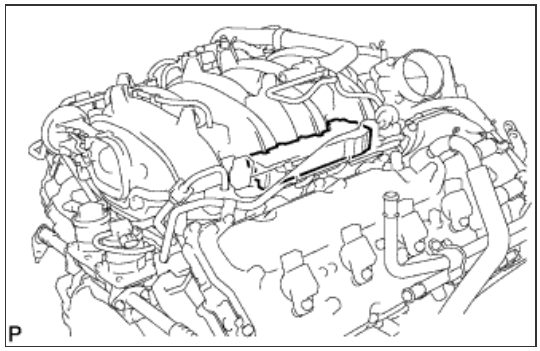
7. INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY

a. Install the No. 1 engine cover sub-assembly.



8. INSTALL NO. 3 ENGINE COVER

a. Install the No. 3 engine cover.



9. INSTALL AIR CLEANER HOSE ASSEMBLY

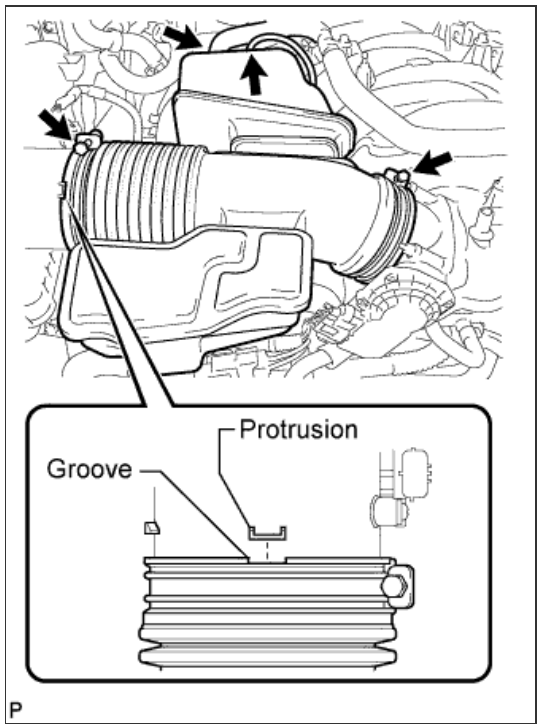
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



10. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

11. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

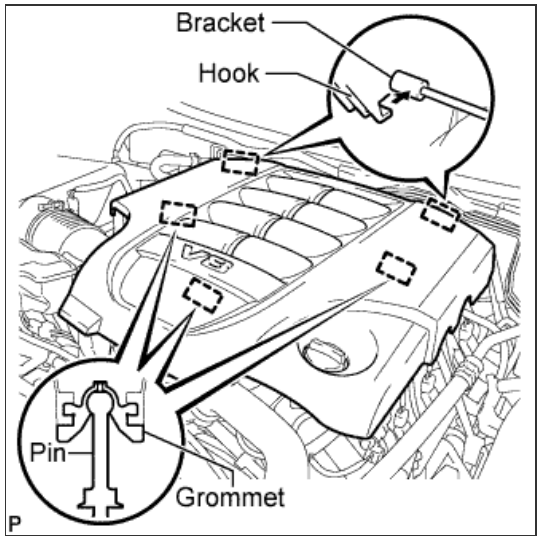
Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

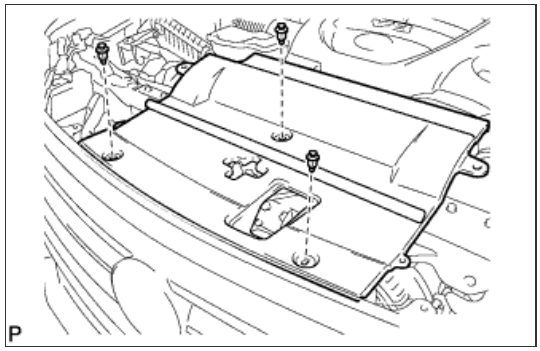
12. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



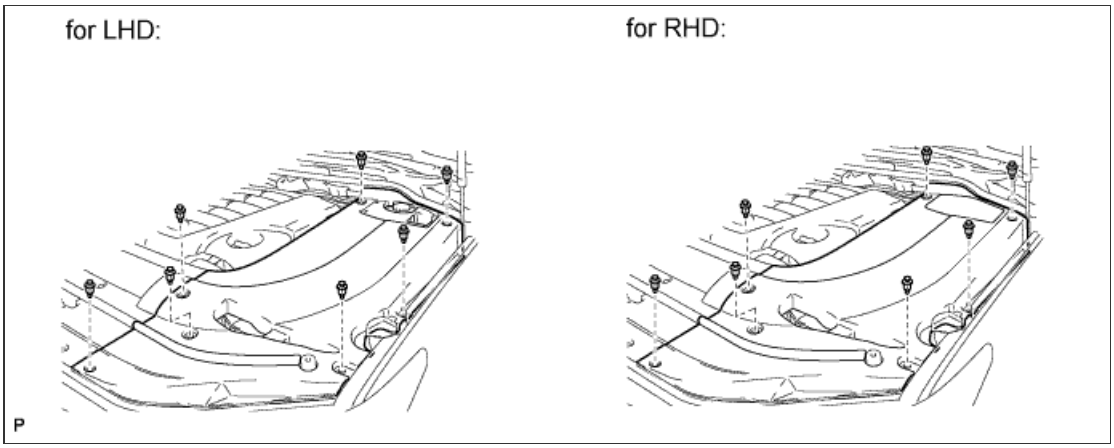
13. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



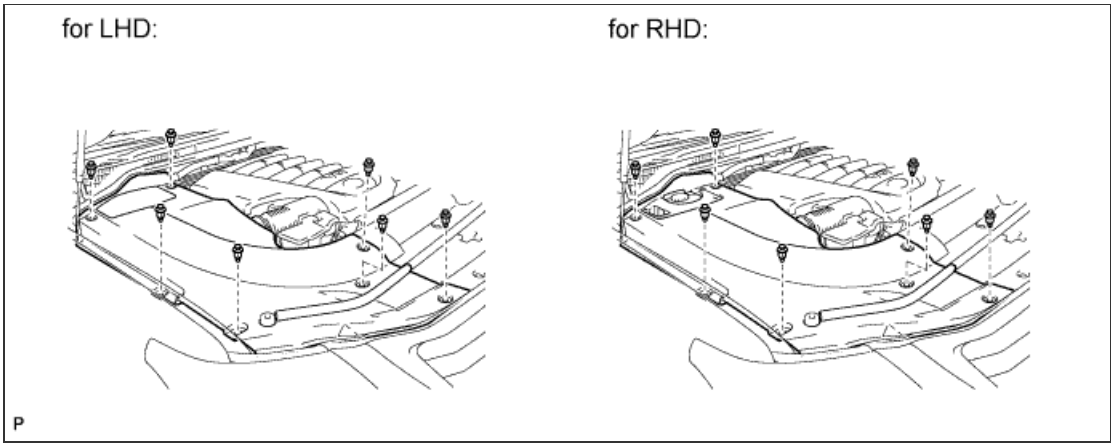
14. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

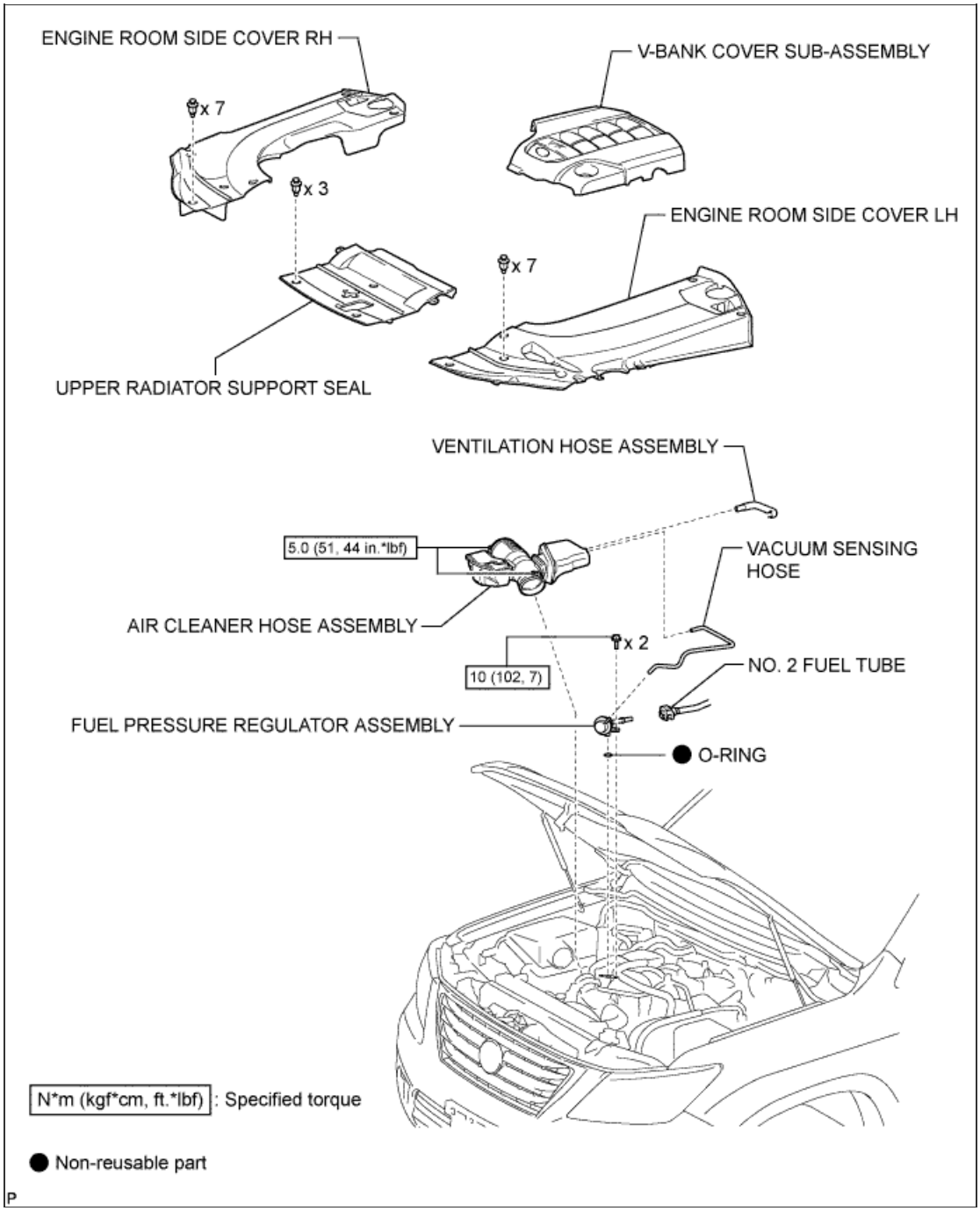


15. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



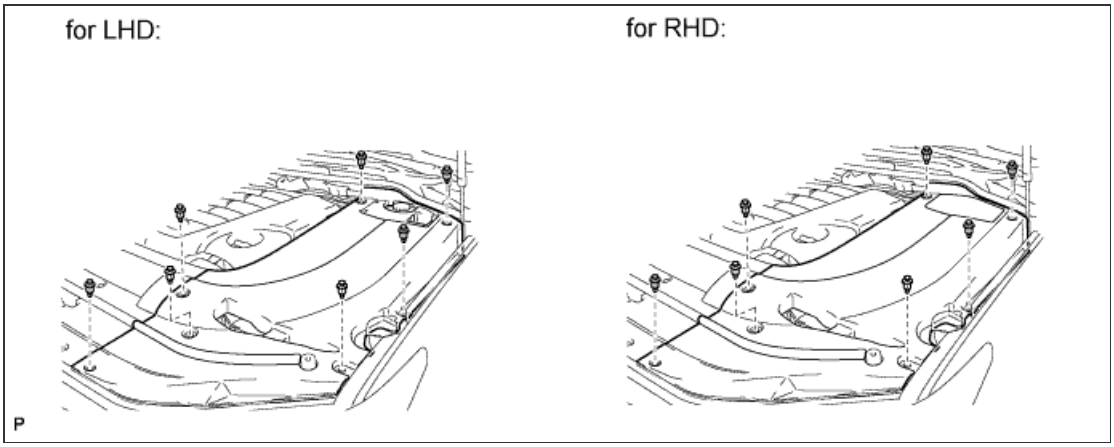
for Preparation Click here



for Preparation Click here

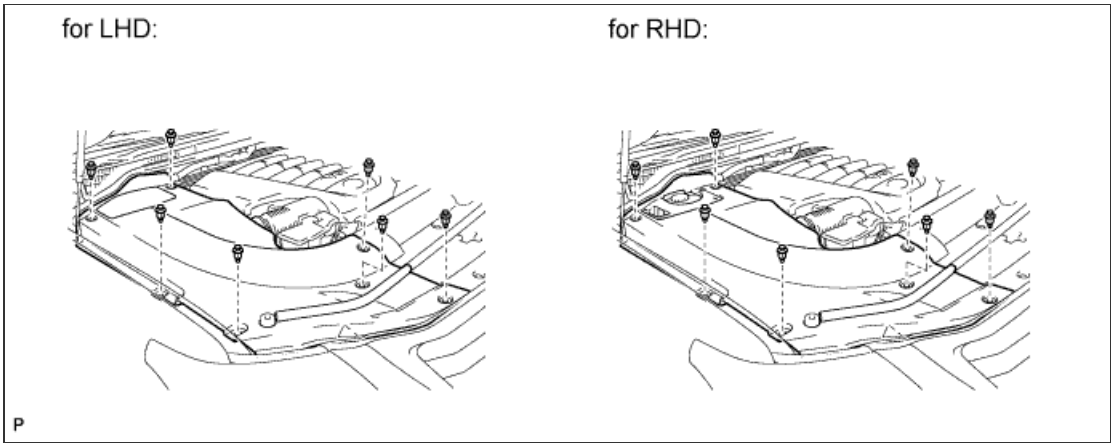
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



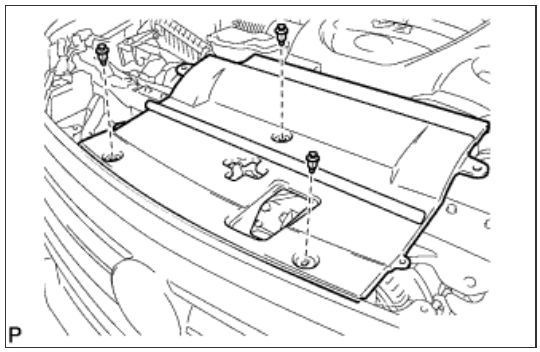
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



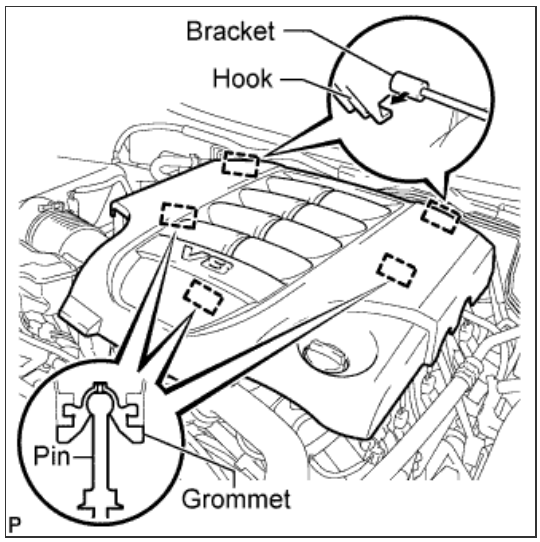
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

6. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

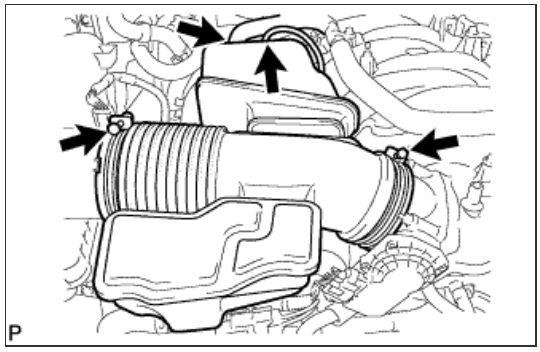
When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

7. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.

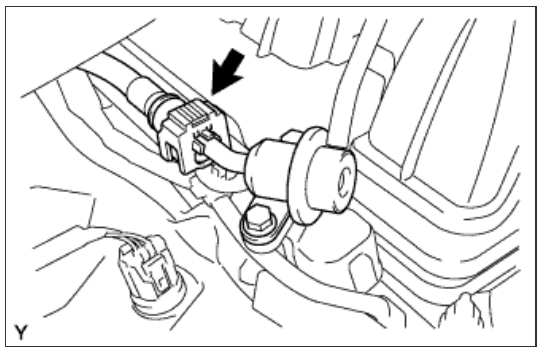


8. REMOVE FUEL PRESSURE REGULATOR ASSEMBLY

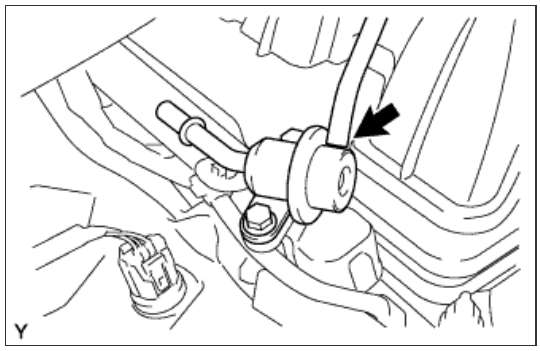
a. Disconnect the No. 2 fuel tube from the pressure regulator (Click here).

CAUTION:

Put a cloth or equivalent under the pressure regulator.

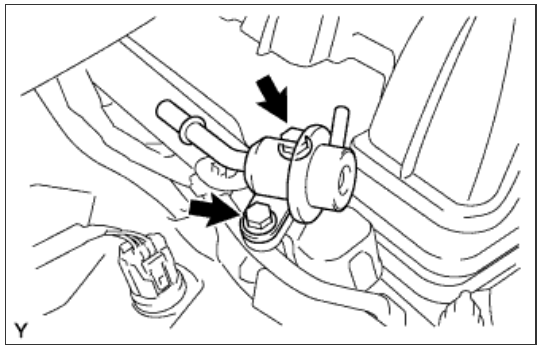


b. Disconnect the vacuum sensing hose from the pressure regulator.



c. Remove the 2 bolts, and pull out the pressure regulator.

d. Remove the O-ring from the pressure regulator.



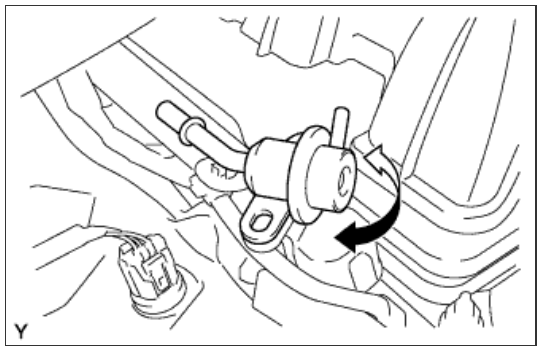
for Preparation Click here

1. INSTALL FUEL PRESSURE REGULATOR ASSEMBLY

a. Apply a light coat of gasoline or spindle oil to a new O-ring, and install it to the pressure regulator.

NOTICE:

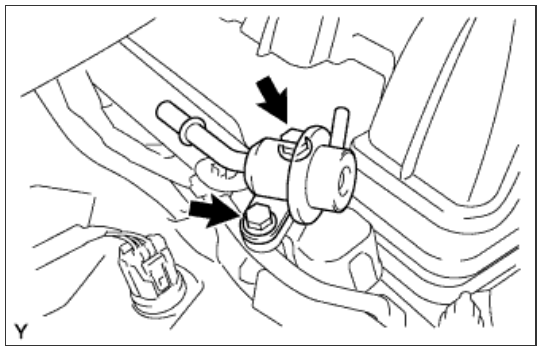
- **Make sure that there are no scratches or foreign matter in or around the insertion hole of the delivery pipe.**
- **When inserting the injector, be careful not to damage the O-ring.**



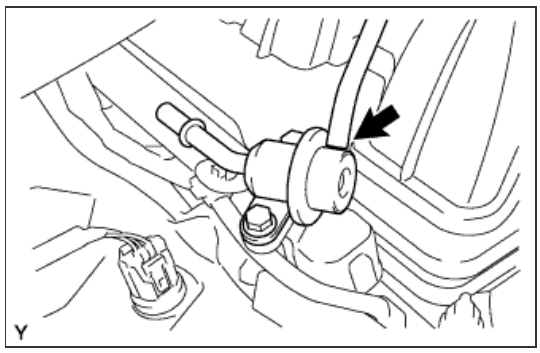
b. While turning the pressure regulator left and right, install it to the delivery pipe.

c. Install the 2 bolts.

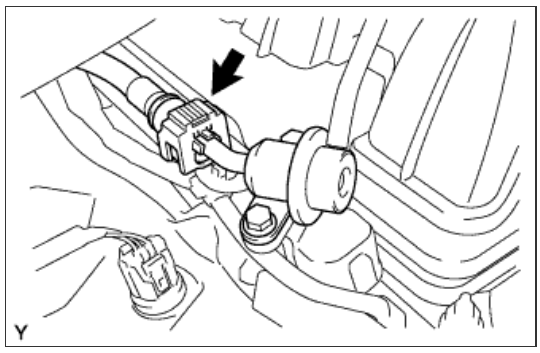
Torque:
10 N*m{ 107 kgf*cm , 7 ft.*lbf }



d. Connect the vacuum sensing hose to the pressure regulator.



e. Connect the No. 2 fuel tube to the pressure regulator (Click here).



2. INSTALL AIR CLEANER HOSE ASSEMBLY

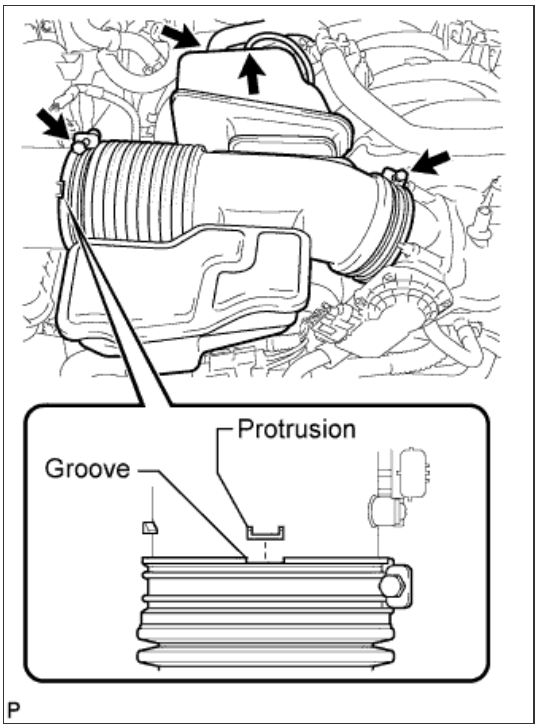
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



3. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

4. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

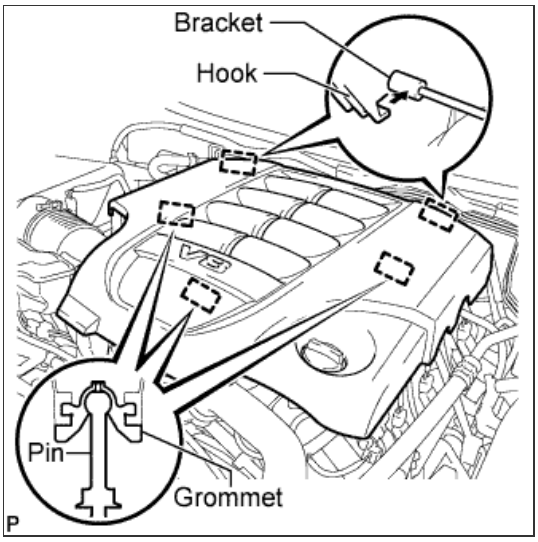
Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

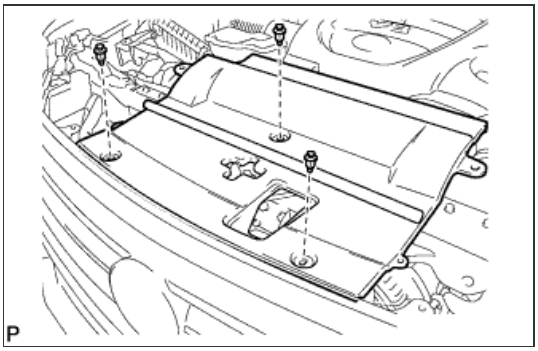
5. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



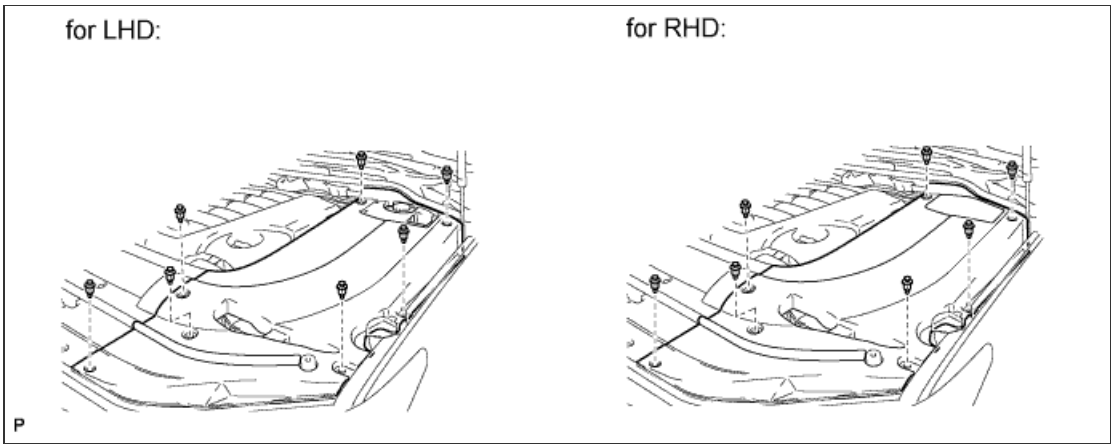
6. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



7. INSTALL ENGINE ROOM SIDE COVER LH

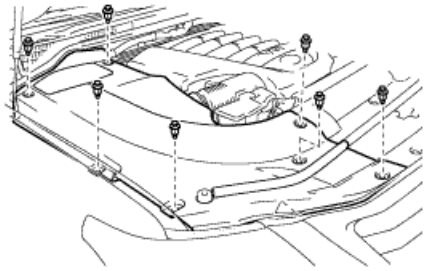
a. Install the engine room side cover with the 7 clips.



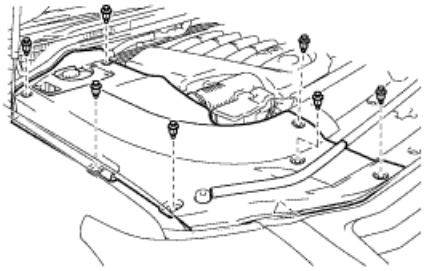
8. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

for LHD:

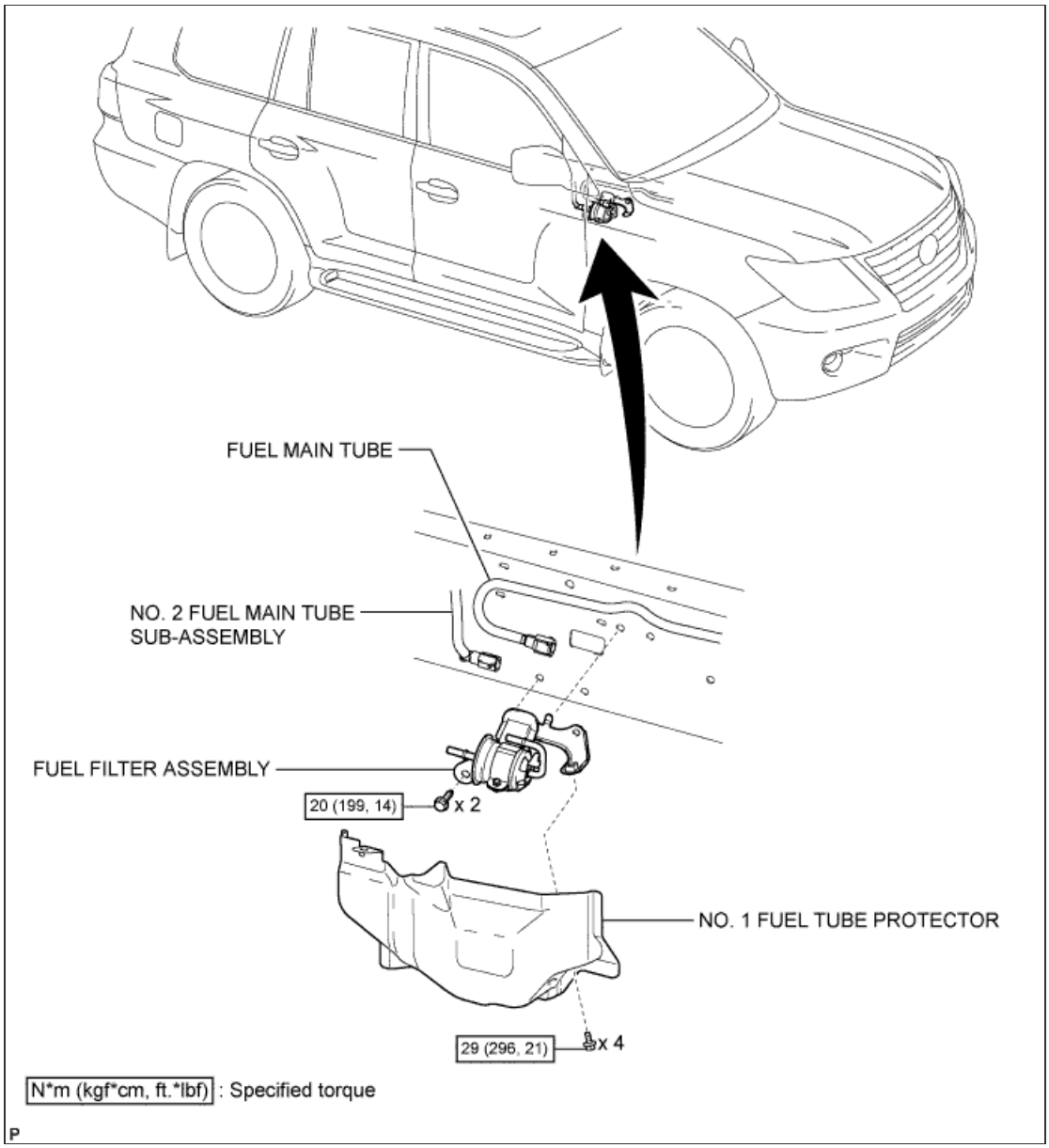


for RHD:



P

for Preparation [Click here]



for Preparation Click here

1. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

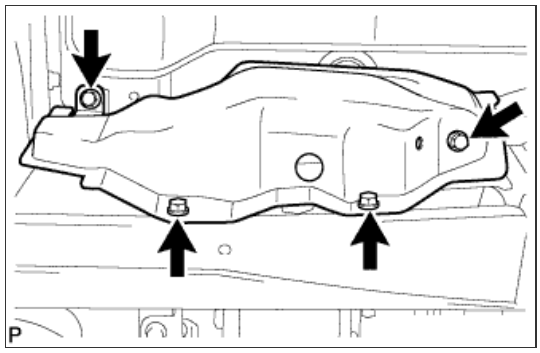
2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

3. REMOVE NO. 1 FUEL TUBE PROTECTOR

a. Remove the 4 bolts and No. 1 fuel tube protector.

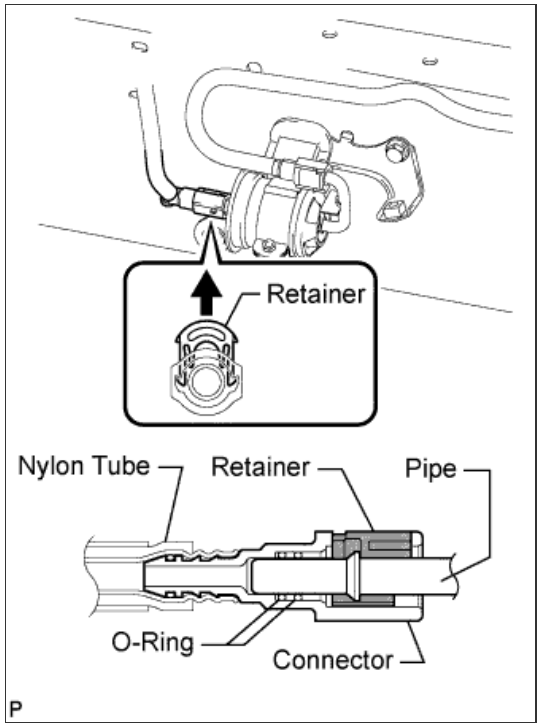


4. DISCONNECT NO. 2 FUEL MAIN TUBE SUB-ASSEMBLY

a. Pull up the retainer and disconnect the No. 2 fuel main tube.

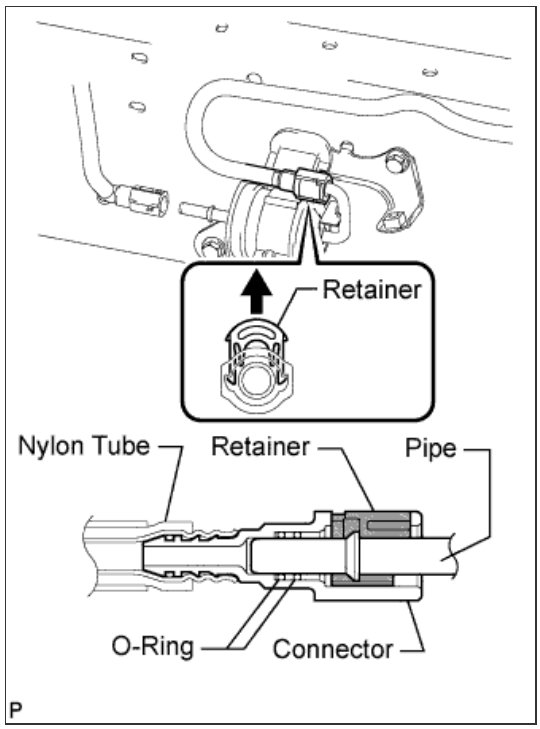
NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



5. DISCONNECT FUEL MAIN TUBE

a. Pull up the retainer and disconnect the fuel main tube.

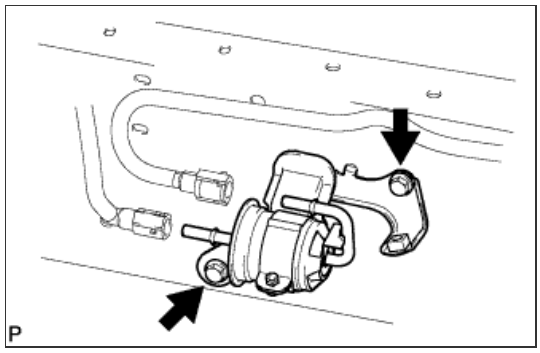


NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**

6. REMOVE FUEL FILTER ASSEMBLY

a. Remove the 2 bolts and fuel filter.



7. INSTALL FUEL FILTER ASSEMBLY

a. Install the fuel filter with the 2 bolts.

Torque:
20 N*m{ 199 kgf*cm , 14 ft.*lbf }

8. CONNECT FUEL MAIN TUBE

a. Connect the fuel main tube and push the retainer.

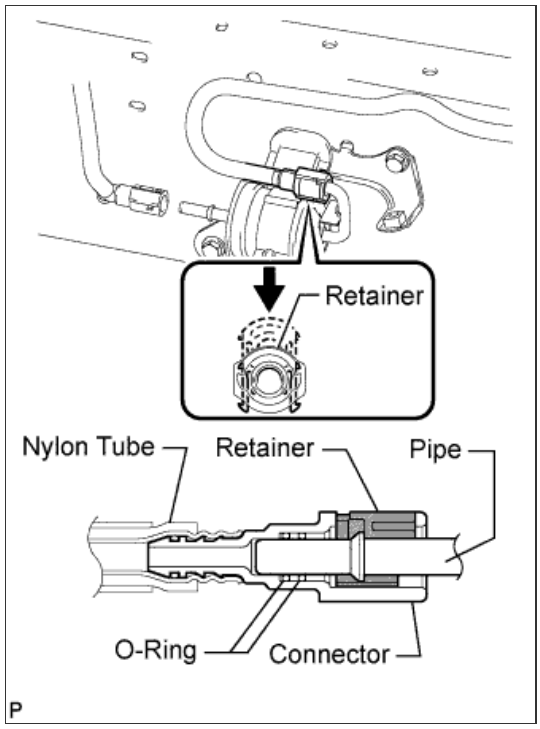
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**

- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**



9. CONNECT NO. 2 FUEL MAIN TUBE SUB-ASSEMBLY

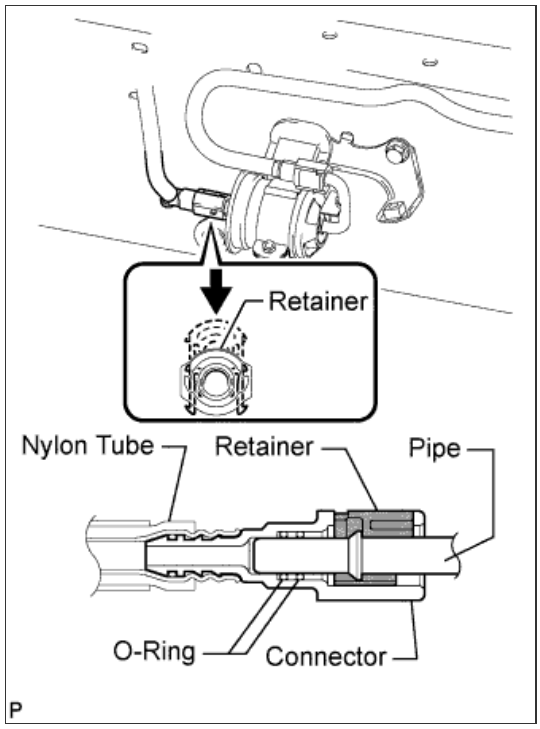
a. Connect the No. 2 fuel main tube and push the retainer.

HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**



10. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

11. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

Do not start the engine.

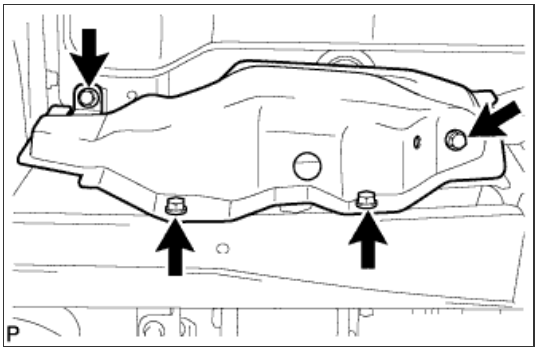
c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

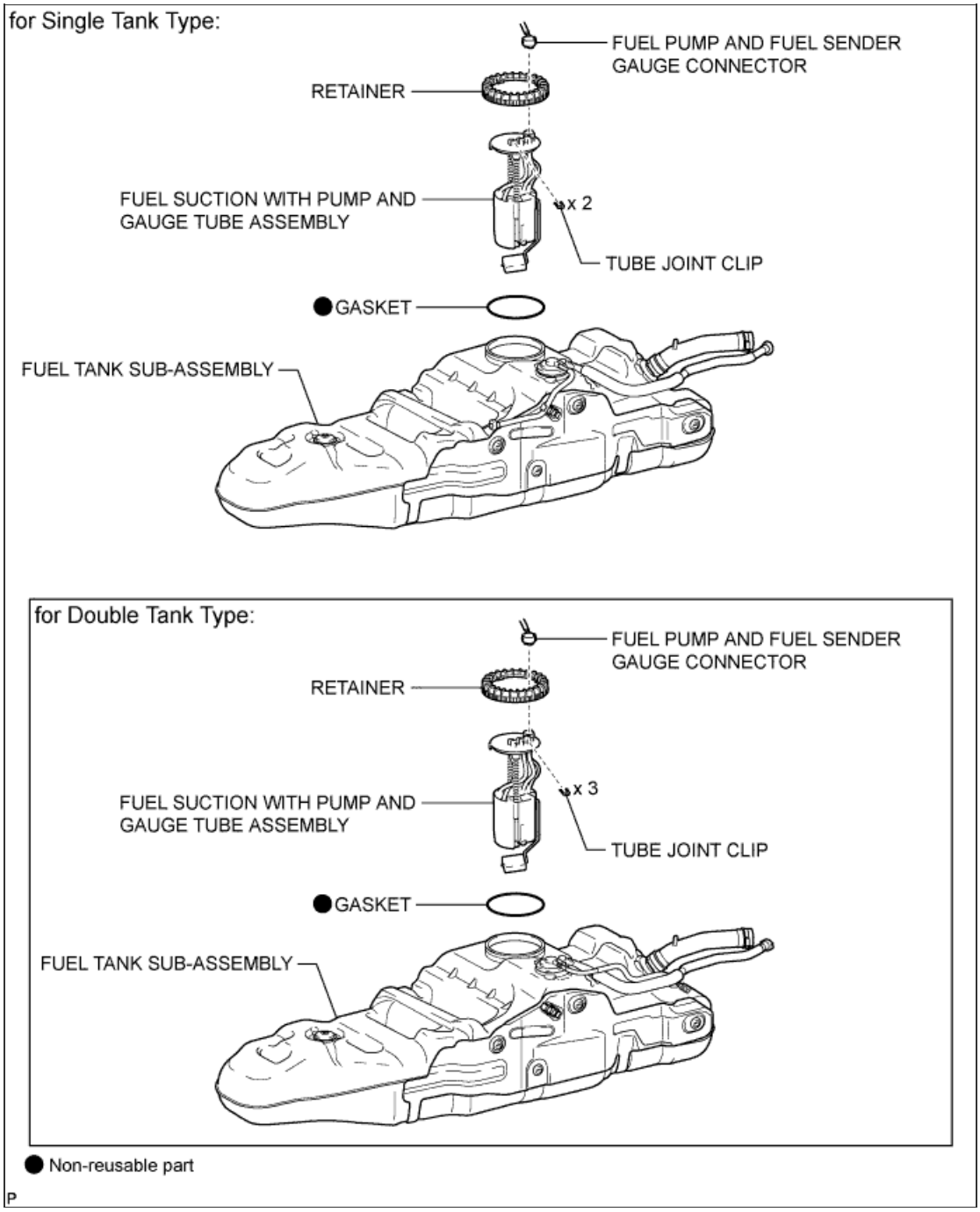
12. INSTALL NO. 1 FUEL TUBE PROTECTOR

a. Install the No. 1 fuel tube protector with the 4 bolts.

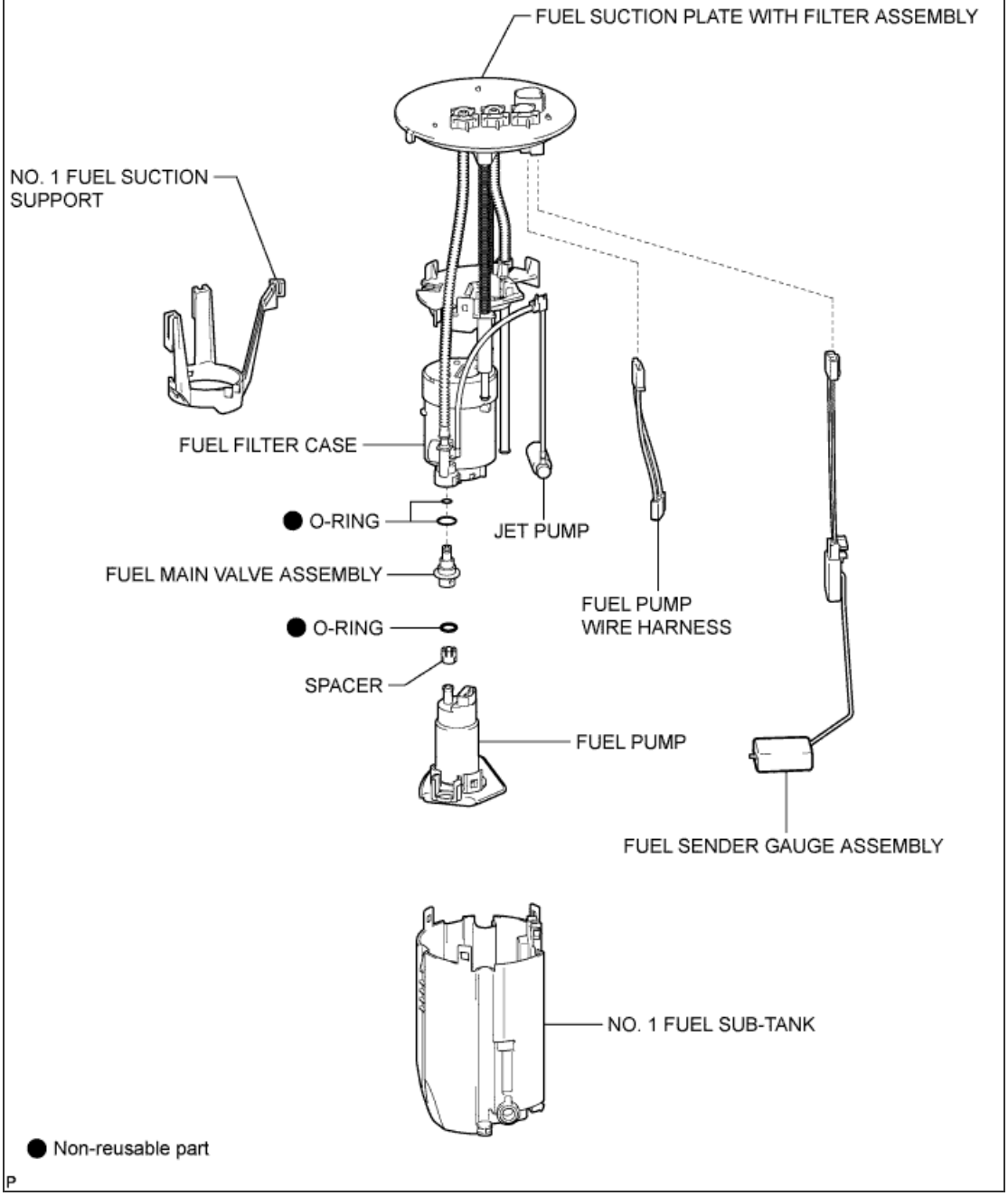
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



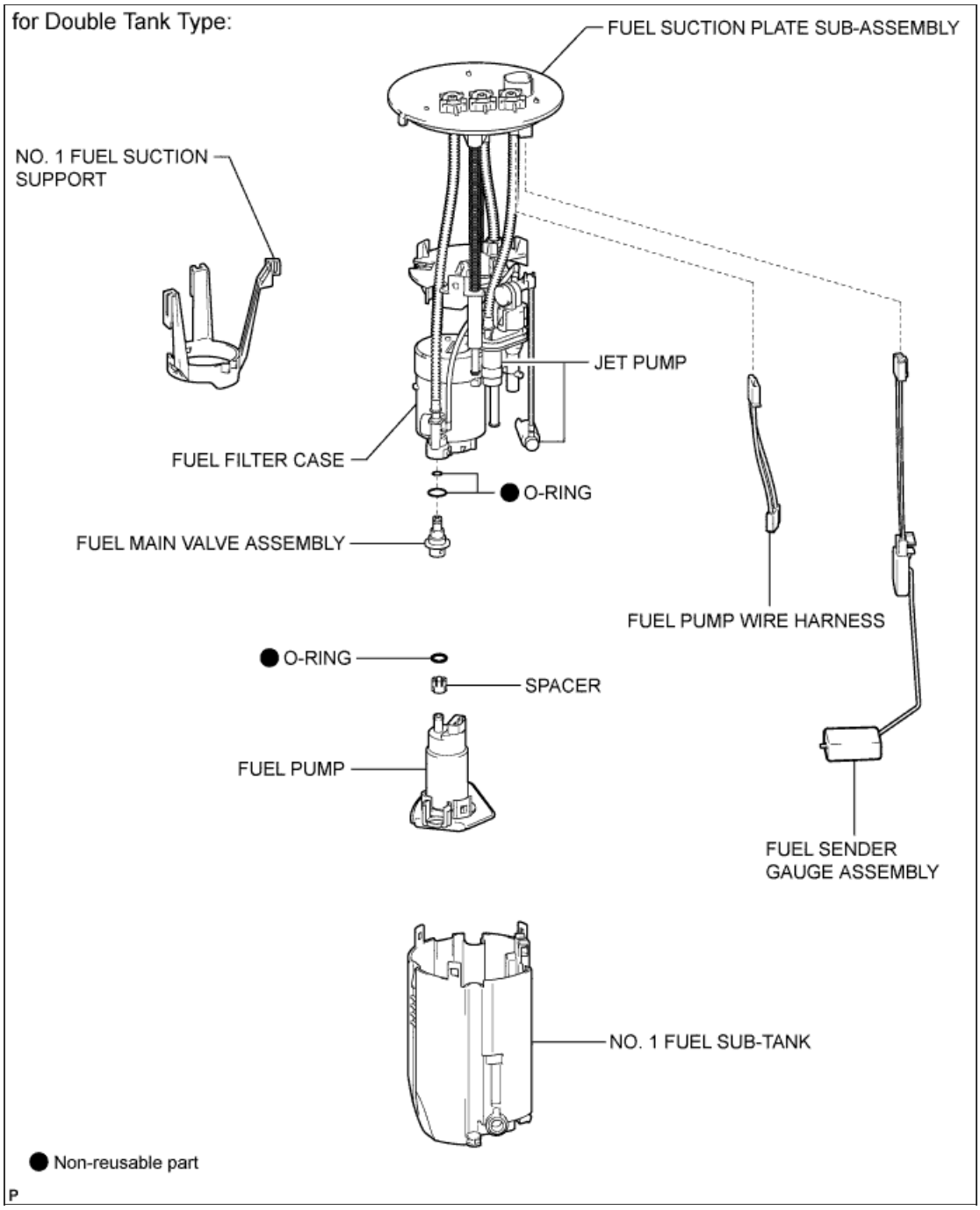
for Preparation Click here



for Single Tank Type:



P


for Double Tank Type:
FUEL SUCTION PLATE SUB-ASSEMBLY
NO. 1 FUEL SUCTION SUPPORT
JET PUMP
FUEL FILTER CASE
O-RING
FUEL MAIN VALVE ASSEMBLY
FUEL PUMP WIRE HARNESS
O-RING
SPACER
FUEL PUMP
FUEL SENDER GAUGE ASSEMBLY
NO. 1 FUEL SUB-TANK
Non-reusable part
P

for Preparation Click here

1. REMOVE FUEL TANK SUB-ASSEMBLY

a. Remove the fuel tank sub-assembly (Click here).

2. REMOVE FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Using SST, loosen the retainer.

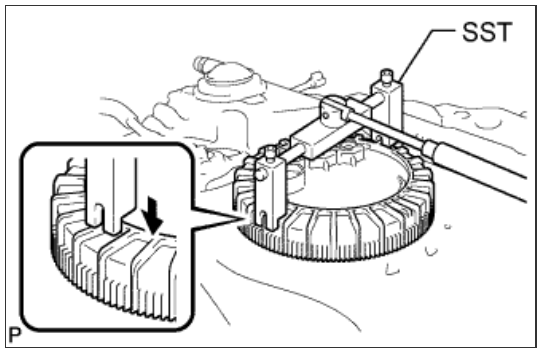
SST
09808-14020 (09808-01410, 09808-01420, 09808-01430)

HINT:

Fit the tips of SST onto the ribs of the retainer.

NOTICE:

- **When the retainer is loosened, be careful as the pump and gauge tube will spring upward from the force of the spring.**
- **Remove foreign matter around the fuel suction with pump and gauge before this operation.**



b. Remove the retainer.

c. Remove the fuel suction with pump and gauge tube assembly from the fuel tank.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

d. Remove the gasket from the fuel tank.

for Preparation Click here

1. REMOVE FUEL TANK SUB-ASSEMBLY

a. Remove the fuel tank sub-assembly (Click here).

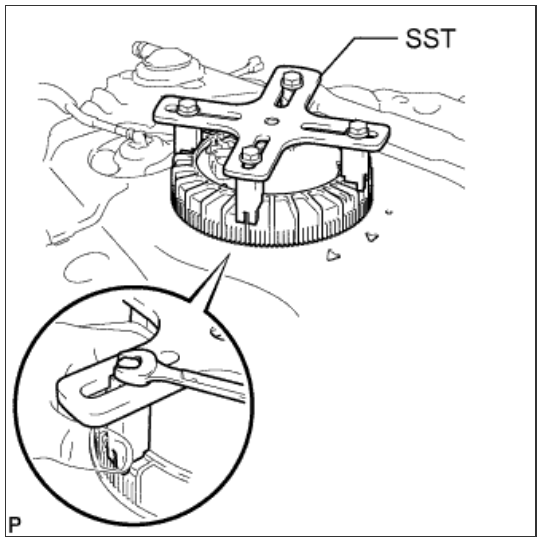
2. REMOVE FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Set SST on the fuel pump gauge retainer.

SST
09808-14030

HINT:

- **Engage the claws of SST securely with the fuel pump gauge retainer holes to secure SST.**
- **Install SST while pressing the claws of SST against the fuel pump gauge retainer (towards the center of SST).**



b. Using SST, loosen the retainer.

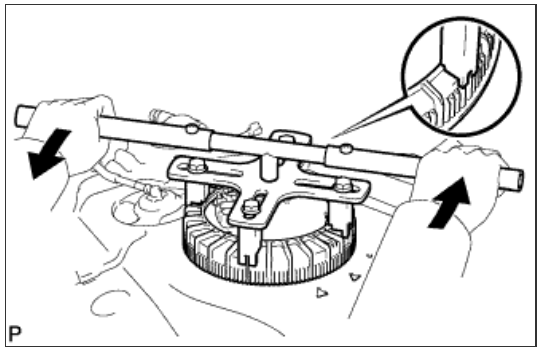
SST
09808-14030

Text in Illustration

➡	Turn

HINT:

Fit the tips of SST onto the ribs of the retainer.



NOTICE:

- **When the retainer is loosened, be careful as the pump and gauge tube will spring upward from the force of the spring.**
- **Remove foreign matter around the fuel suction with pump and gauge before this operation.**

c. Remove the retainer.

d. Remove the fuel suction with pump and gauge tube assembly from the fuel tank.

NOTICE:

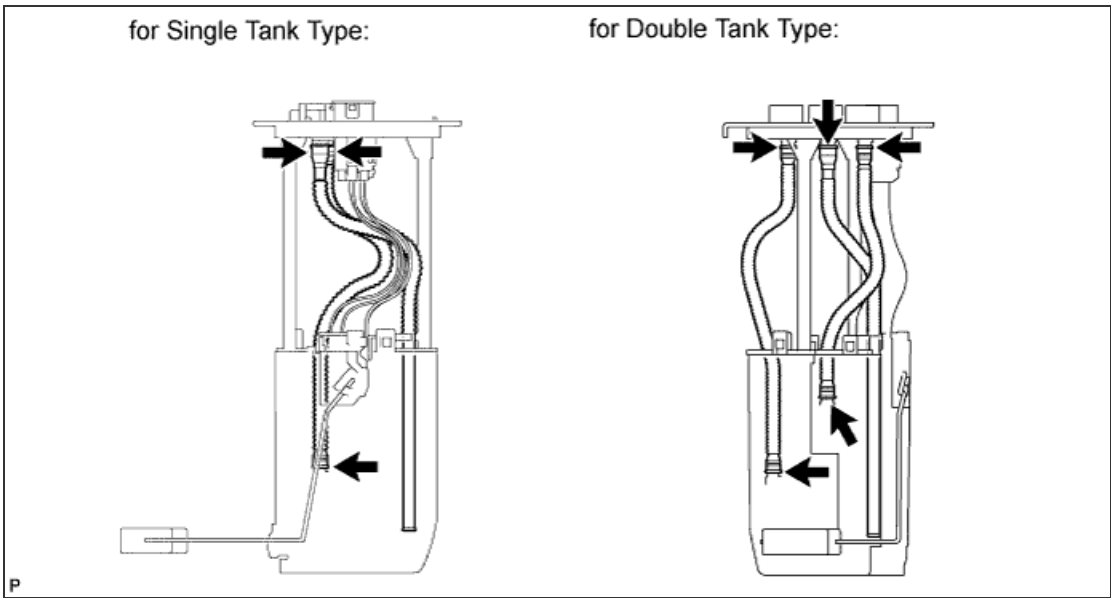
Be careful not to bend the arm of the fuel sender gauge.

e. Remove the gasket from the fuel tank.

for Preparation Click here

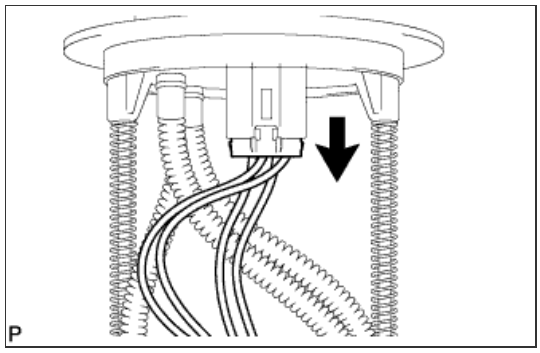
NOTICE:

Do not disconnect the hoses indicated in the illustration.

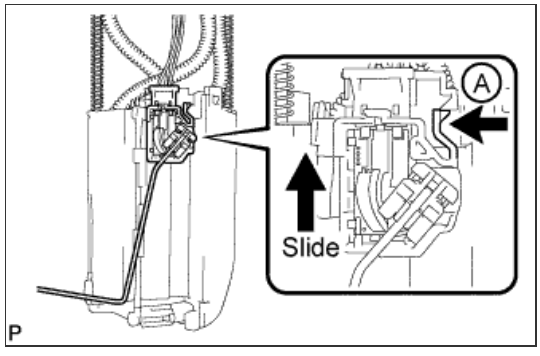


1. REMOVE FUEL SENDER GAUGE ASSEMBLY

a. Disconnect the fuel sender gauge connector.

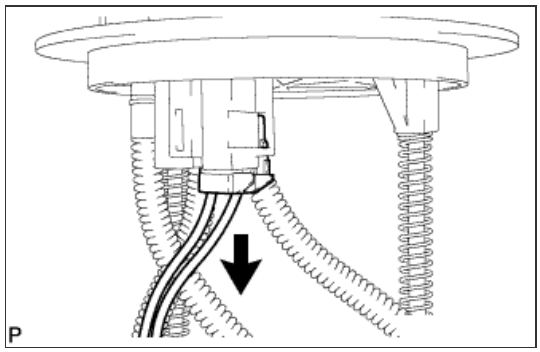


b. Press down on the sender gauge claw labeled A. Then slide the sender gauge upward to remove it.



2. REMOVE NO. 1 FUEL SUB-TANK (for Single Tank Type)

a. Disconnect the fuel pump connector.



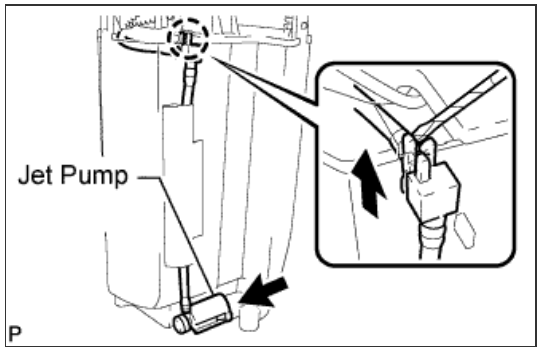
b. Disconnect the jet pump from the sub-tank.

c. Using a small screwdriver, detach the claw from the sub-tank.

HINT:

Tape the screwdriver tip before use.

d. Detach the tube from the 2 clamps on the sub-tank.



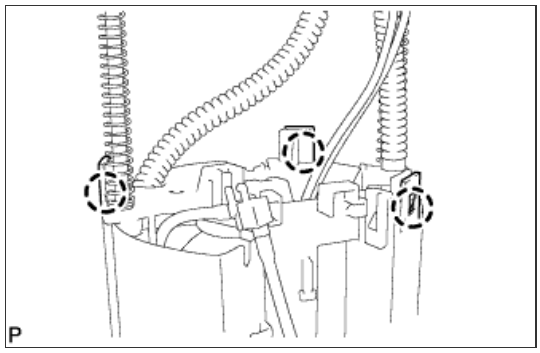
e. Using a screwdriver, detach the 3 claws from the claw holes.

NOTICE:

Do not damage the fuel sub-tank.

HINT:

Tape the screwdriver tip before use.



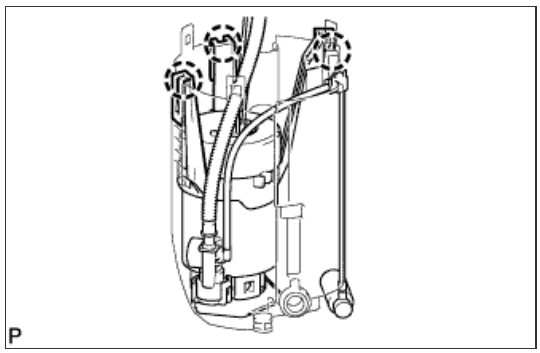
f. Using a screwdriver, detach the 3 claws from the claw holes and remove the No. 1 fuel sub-tank.

NOTICE:

Do not damage the fuel sub-tank.

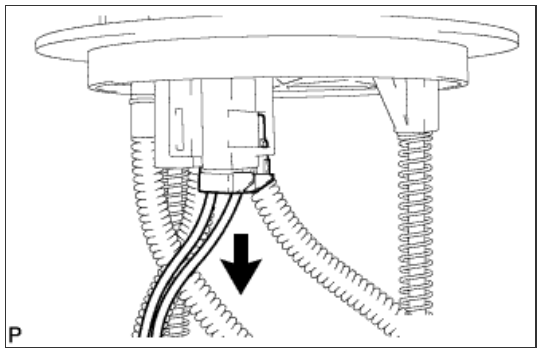
HINT:

Tape the screwdriver tip before use.



3. REMOVE NO. 1 FUEL SUB-TANK (for Double Tank Type)

a. Disconnect the fuel pump connector.



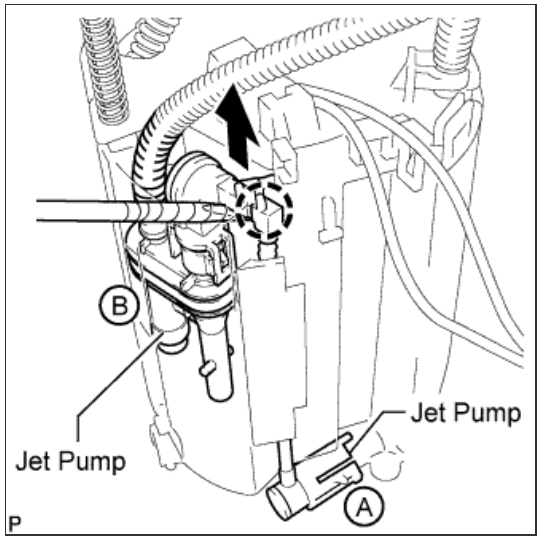
b. Disconnect the jet pump (labeled A) from the sub-tank.

c. Disconnect the jet pump (labeled B) from the sub-tank.

i. Using a small screwdriver, detach the claw from the sub-tank.

HINT:

Tape the screwdriver tip before use.



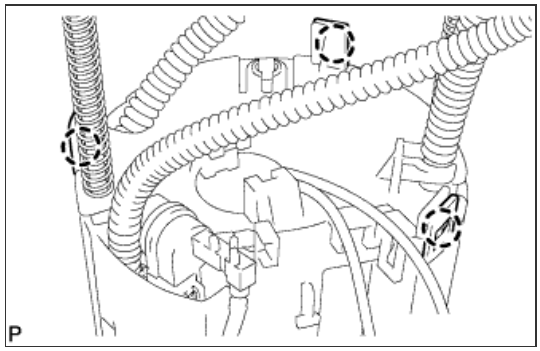
d. Using a screwdriver, detach the 3 claws from the claw holes.

NOTICE:

Do not damage the fuel sub-tank.

HINT:

Tape the screwdriver tip before use.



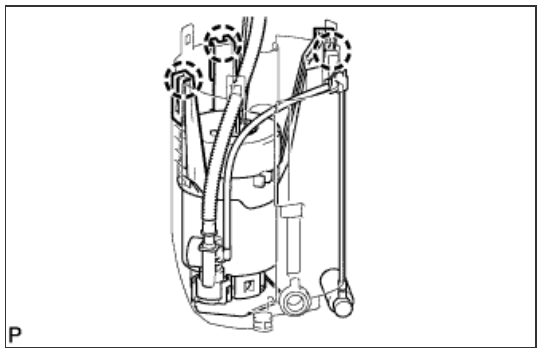
e. Using a screwdriver, detach the 3 claws from the claw holes.

NOTICE:

Do not damage the fuel sub-tank.

HINT:

Tape the screwdriver tip before use.

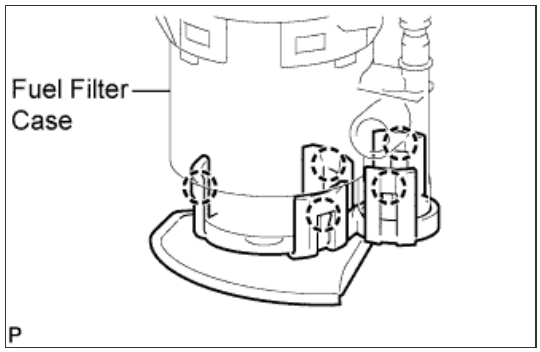


4. REMOVE FUEL PUMP

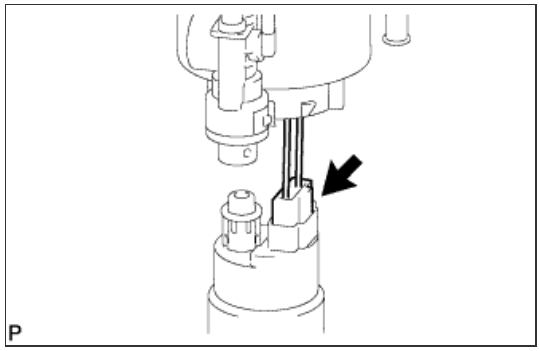
a. Using a screwdriver, detach the 5 claws from the claw holes and disconnect the fuel pump from the fuel filter case.

HINT:

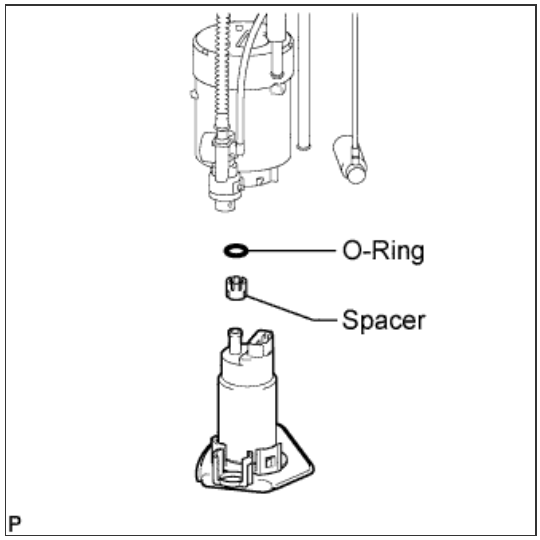
Tape the screwdriver tip before use.



b. Disconnect the fuel pump wire harness connector from the fuel pump to remove it.



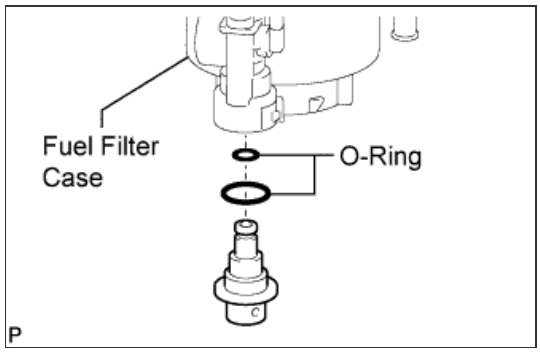
c. Remove the O-ring and spacer from the fuel pump.



5. REMOVE FUEL MAIN VALVE ASSEMBLY

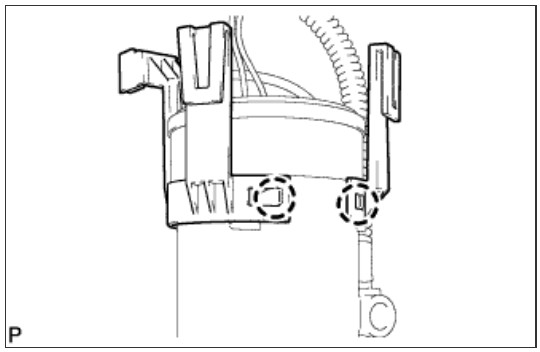
a. Remove the fuel main valve from the fuel filter case.

b. Remove the 2 O-rings from the fuel main valve.



6. REMOVE NO. 1 FUEL SUCTION SUPPORT

a. Detach the 2 claws from the claw holes to remove the fuel suction support.



for Preparation Click here

1. INSPECT FUEL PUMP

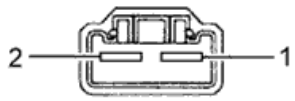
a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	0.2 to 3.0 Ω

If the result is not as specified, replace the fuel pump assembly.

Component without harness connected:
(Fuel Pump)



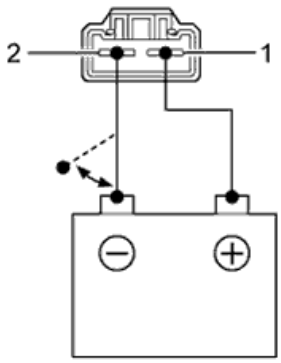
b. Inspect the operation of the fuel pump.

i. Connect the positive (+) lead of the battery to terminal 1 of the connector, and the negative (-) lead to terminal 2. Check that the fuel pump operates.
If the result is not as specified, replace the fuel pump and fuel pump ECU.

NOTICE:

- **These tests must be performed within 10 seconds to prevent the coil from burning out.**
- **Keep the fuel pump as far away from the battery as possible.**
- **Always turn the voltage on and off on the battery side, not the fuel pump side.**
- **When the pump is locked and does not operate due to foreign matter being stuck, etc., replace the fuel pump ECU together with the fuel pump, as the fuel pump ECU may be damaged electrically.**

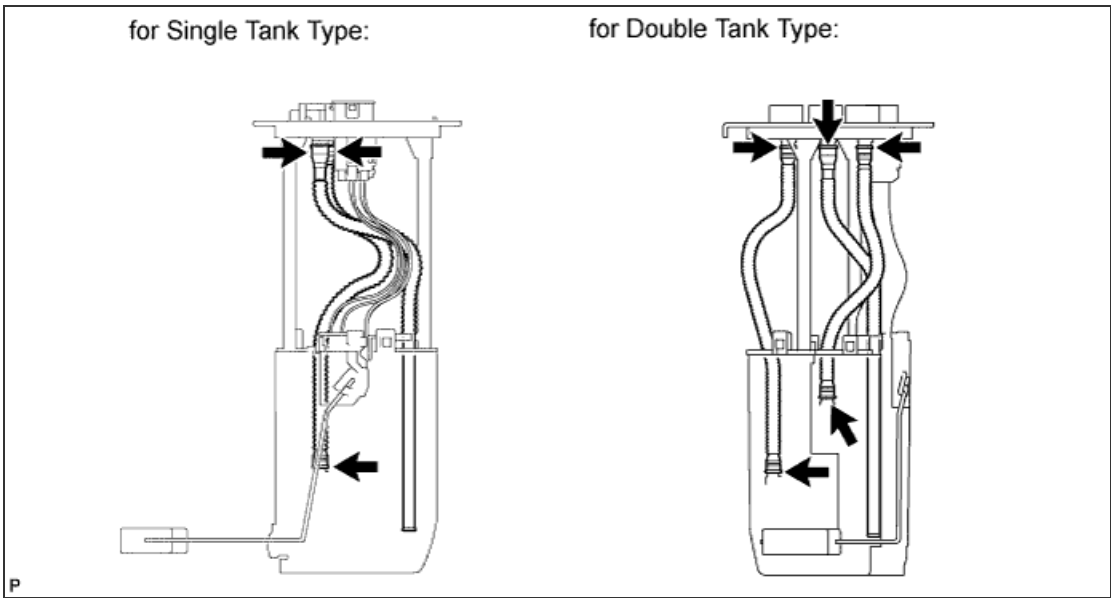
Component without harness connected:
(Fuel Pump)



for Preparation Click here

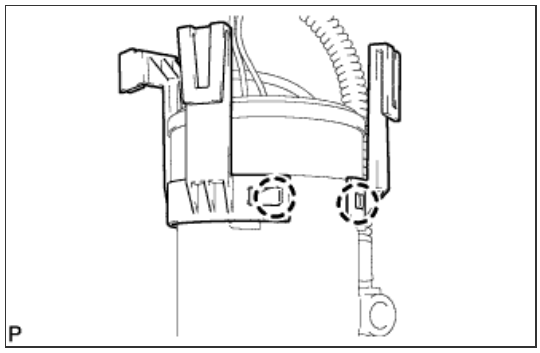
NOTICE:

Do not disconnect the hoses indicated in the illustration.



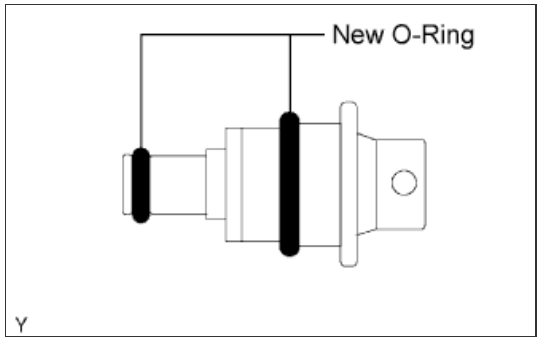
1. INSTALL NO. 1 FUEL SUCTION SUPPORT

a. Attach the 2 claws to the claw holes to install the fuel suction support.



2. INSTALL FUEL MAIN VALVE ASSEMBLY

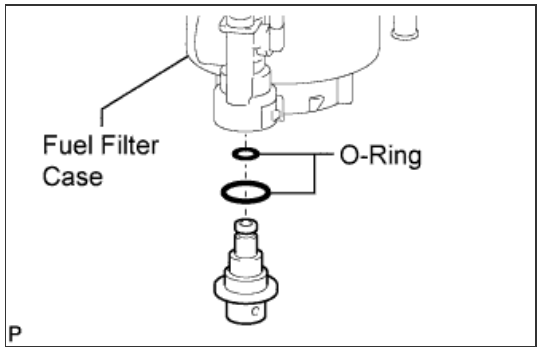
a. Apply a light coat of gasoline to 2 new O-rings, and install them onto the fuel main valve.



b. Install the fuel main valve to the fuel filter case.

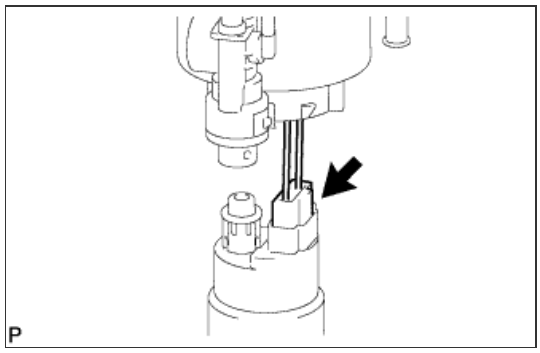
NOTICE:

Make sure the O-rings are not cut or pinched during the installation.

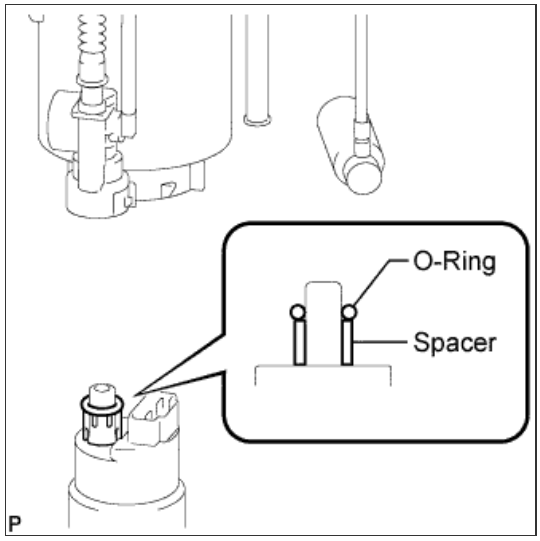


3. INSTALL FUEL PUMP

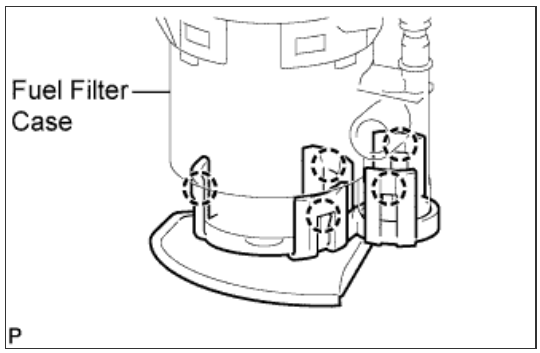
a. Connect the fuel pump wire harness connector to the fuel pump.



b. Apply a light coat of gasoline to a new O-ring. Then install the O-ring and spacer to the fuel pump.



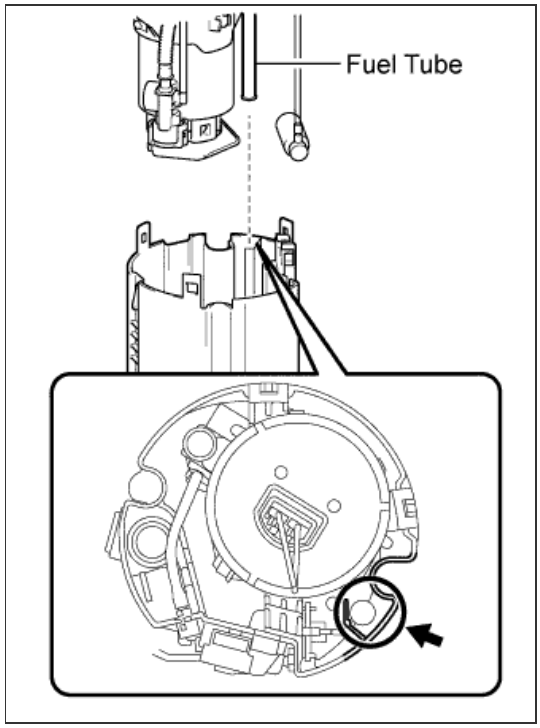
c. Attach the 5 claws to the claw holes and install the fuel pump to the fuel filter case.



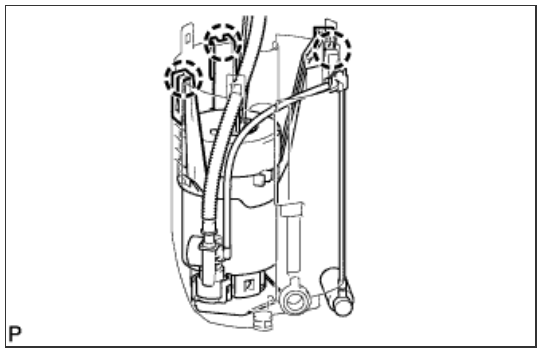
4. INSTALL NO. 1 FUEL SUB-TANK (for Single Tank Type)

NOTICE:

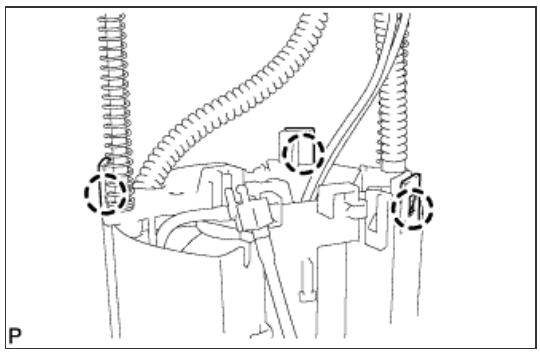
Make sure that the fuel tube passes into the section marked by the circle.



a. Attach the 3 claws to the claw holes to install the fuel sub-tank.



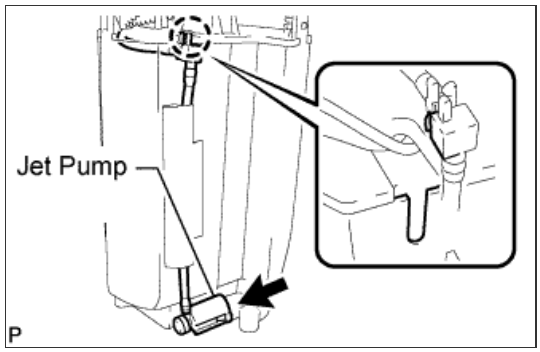
b. Attach the 3 claws to the claw holes.



c. Install the tube part to the sub-tank.

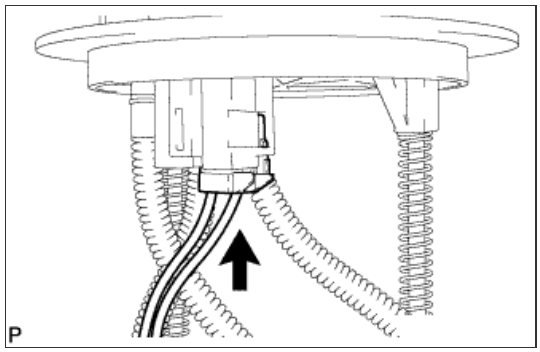
i. Attach the claw on the end of the tube to the claw hole. Install the tube to the 2 clamps on the sub-tank.

d. Connect the jet pump to the sub-tank.



e. Connect the fuel pump connector.

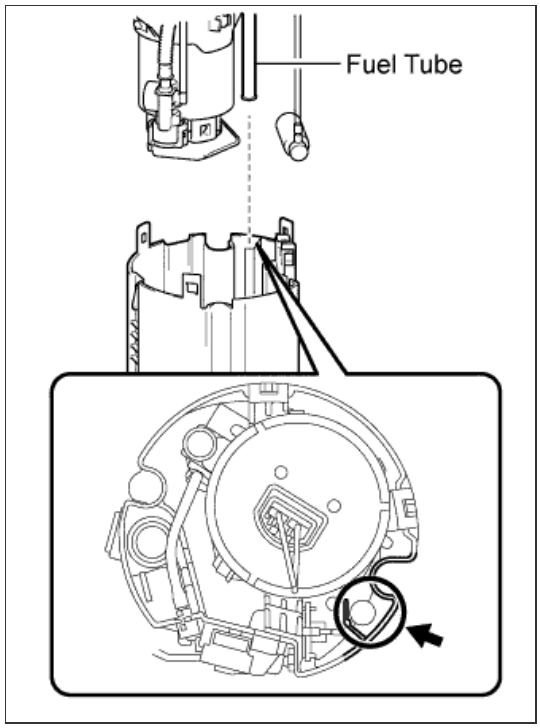
e. Connect the fuel pump connector.



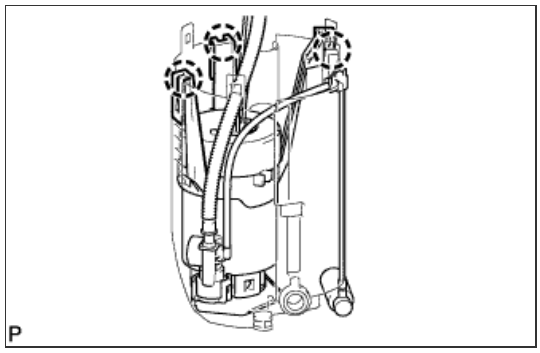
5. INSTALL NO. 1 FUEL SUB-TANK (for Double Tank Type)

NOTICE:

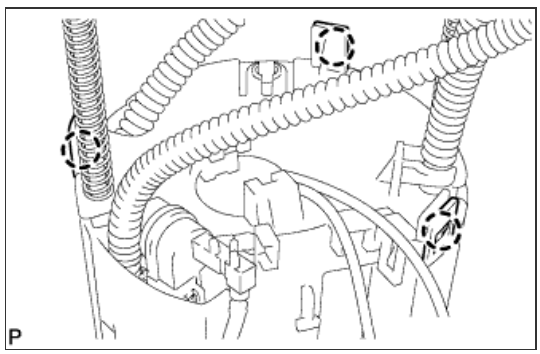
Make sure that the fuel tube passes into the section marked by the circle.



a. Attach the 3 claws to the claw holes and install the fuel sub-tank.



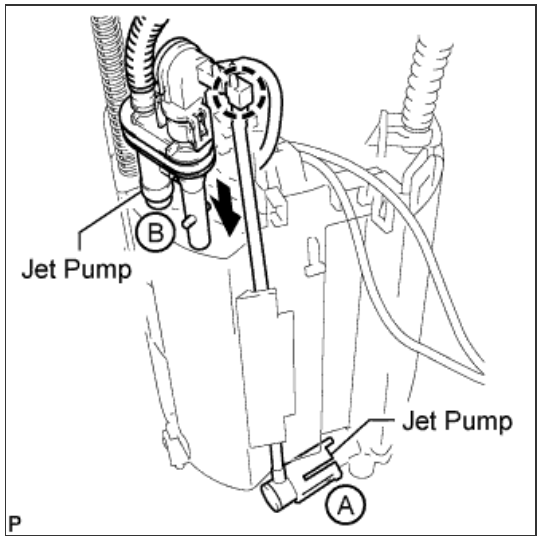
b. Attach the 3 claws to the claw holes.



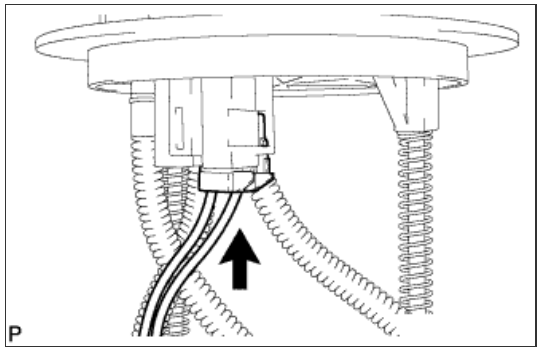
c. Connect the jet pump (labeled B) to the sub-tank.

i. Attach the claw on the end of the tube to the claw hole.

d. Connect the jet pump (labeled A) to the sub-tank.

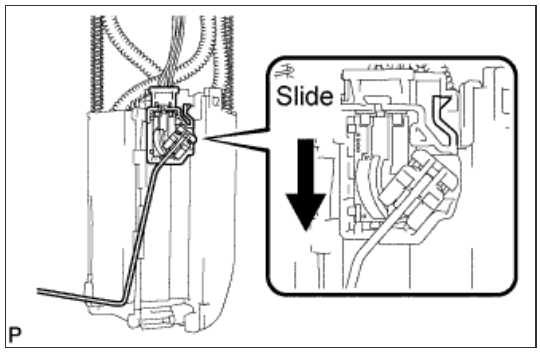


e. Connect the fuel pump connector.

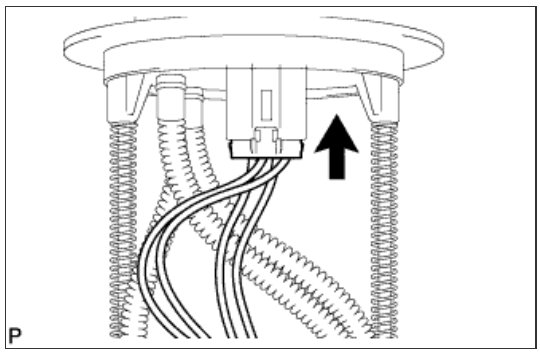


6. INSTALL FUEL SENDER GAUGE ASSEMBLY

a. Set the sender gauge to the fuel sub-tank. Then slide the sender gauge downward to install it.



b. Connect the fuel sender gauge connector.



for Preparation Click here

1. INSTALL FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Apply a light coat of gasoline or grease to a new gasket, and install it to the fuel tank.

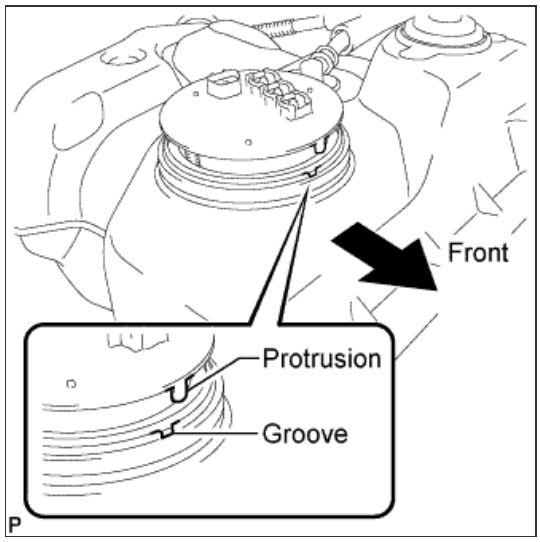
b. Install the fuel suction with pump and gauge tube into the fuel tank.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

HINT:

Align the protrusion of the fuel suction with pump and gauge tube with the groove of the fuel tank.



c. Put the retainer on the fuel tank. While holding the fuel suction with pump and gauge tube, tighten the retainer 1 complete turn by hand.

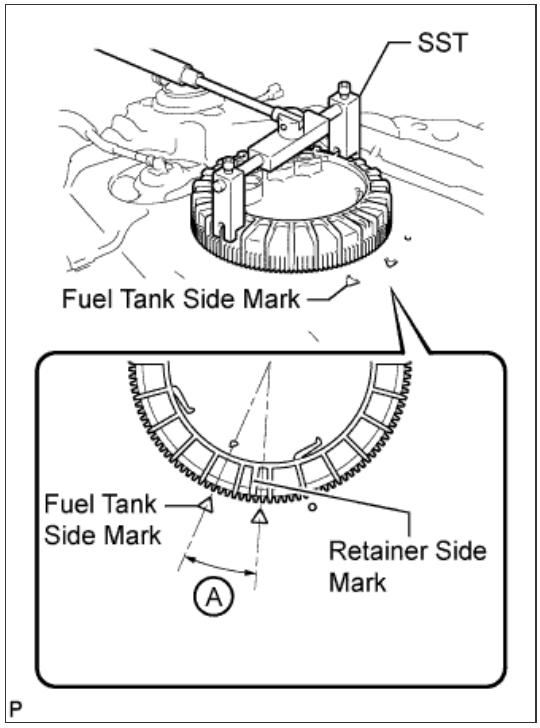
d. Using SST, tighten the retainer until the mark on the retainer is within range A on the fuel tank, as shown in the illustration.

SST

09808-14020 (09808-01410, 09808-01420, 09808-01430)

HINT:

Fit the tips of SST onto the ribs of the retainer.



2. INSTALL FUEL TANK SUB-ASSEMBLY

a. Install the fuel tank sub-assembly (Click here).

for Preparation Click here

1. INSTALL FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Apply a light coat of gasoline or grease to a new gasket, and install it to the fuel tank.

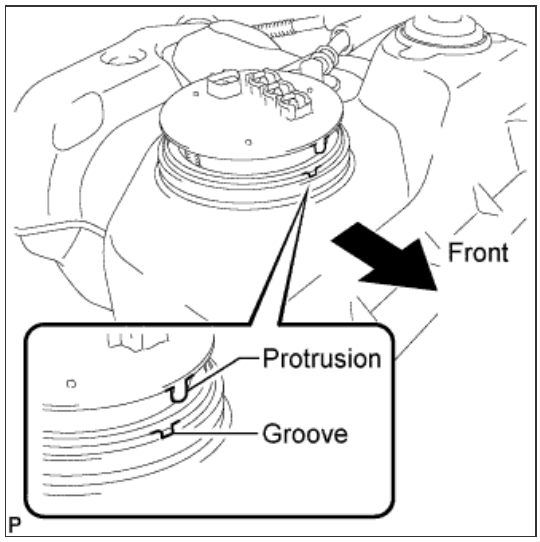
b. Install the fuel suction with pump and gauge tube into the fuel tank.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

HINT:

Align the protrusion of the fuel suction with pump and gauge tube with the groove of the fuel tank.



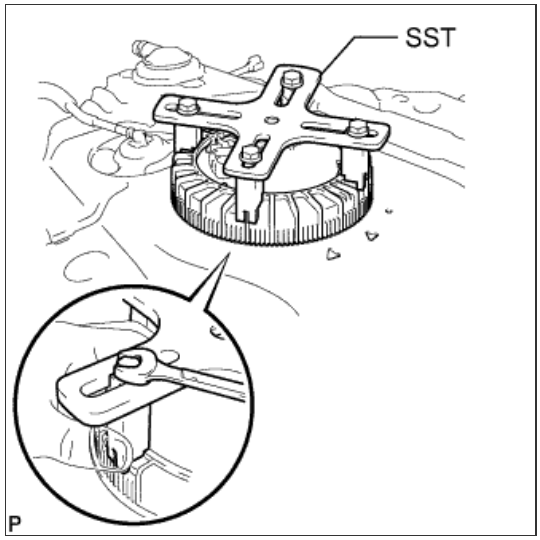
c. Put the retainer on the fuel tank. While holding the fuel suction with pump and gauge tube, tighten the retainer 1 complete turn by hand.

d. Set SST on the retainer.

SST
09808-14030

HINT:

- **Hold the fuel suction tube assembly upright by hand to ensure that the fuel suction tube gasket is not moved out of position.**
- **Engage the claws of SST securely with the fuel pump gauge retainer holes to secure SST.**
- **Install SST while pressing the claws of SST against the fuel pump gauge retainer (toward the center of SST).**

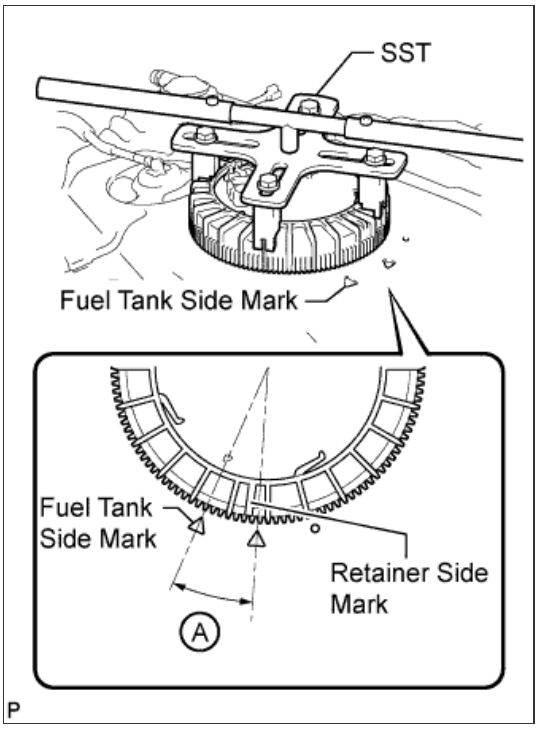


e. Using SST, tighten the retainer until the mark on the retainer is within range A on the fuel tank, as shown in the illustration.

SST
09808-14030

HINT:

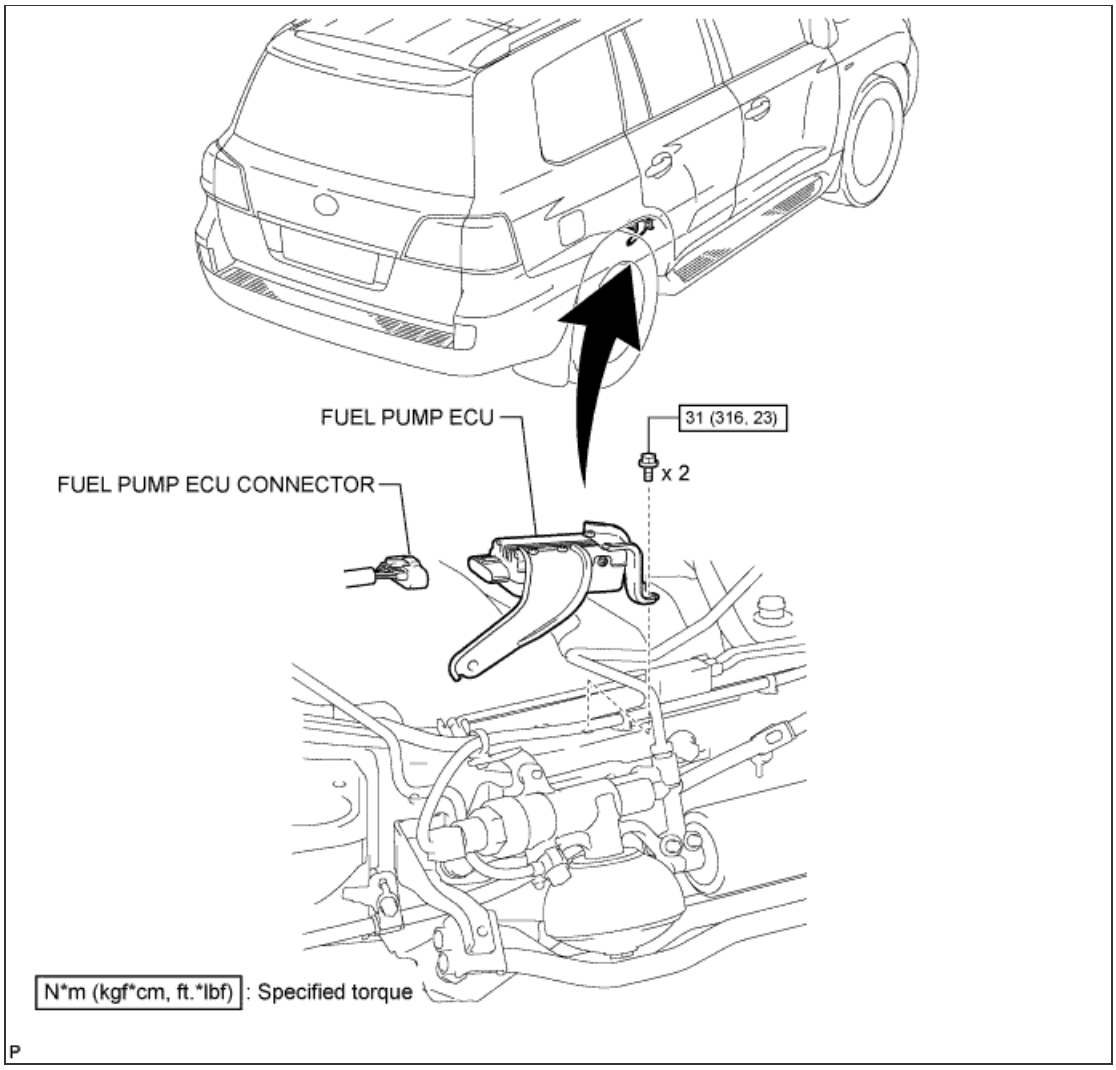
Fit the tips of SST onto the ribs of the retainer.



2. INSTALL FUEL TANK SUB-ASSEMBLY

a. Install the fuel tank sub-assembly (Click here).

for Preparation Click here



for Preparation Click here

1. REMOVE FUEL TANK SUB-ASSEMBLY

a. Remove the fuel tank sub-assembly (Click here).

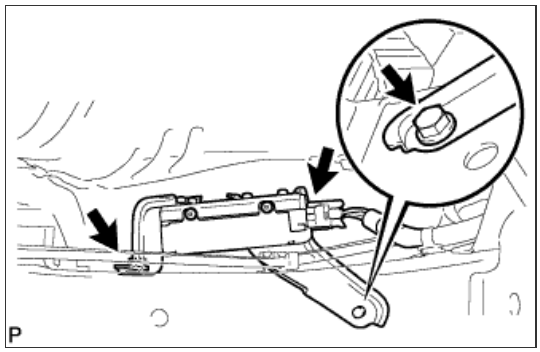
2. REMOVE FUEL PUMP ECU

a. Disconnect the ECU connector.

b. Remove the 2 bolts and ECU.

NOTICE:

Make sure the ECU is not subjected to physical shocks such as being dropped, etc.



for Preparation Click here

1. INSTALL FUEL PUMP ECU

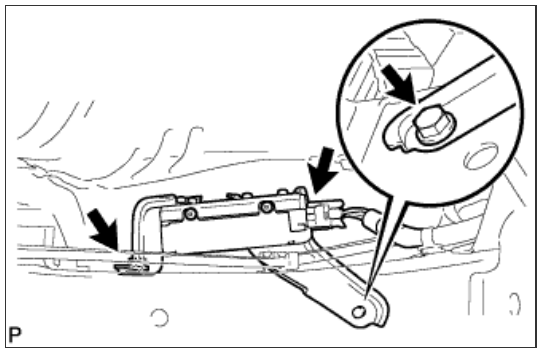
a. Install the ECU with the 2 bolts.

Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }

NOTICE:

Do not use the ECU if it has been subjected to physical shocks such as being dropped, etc.

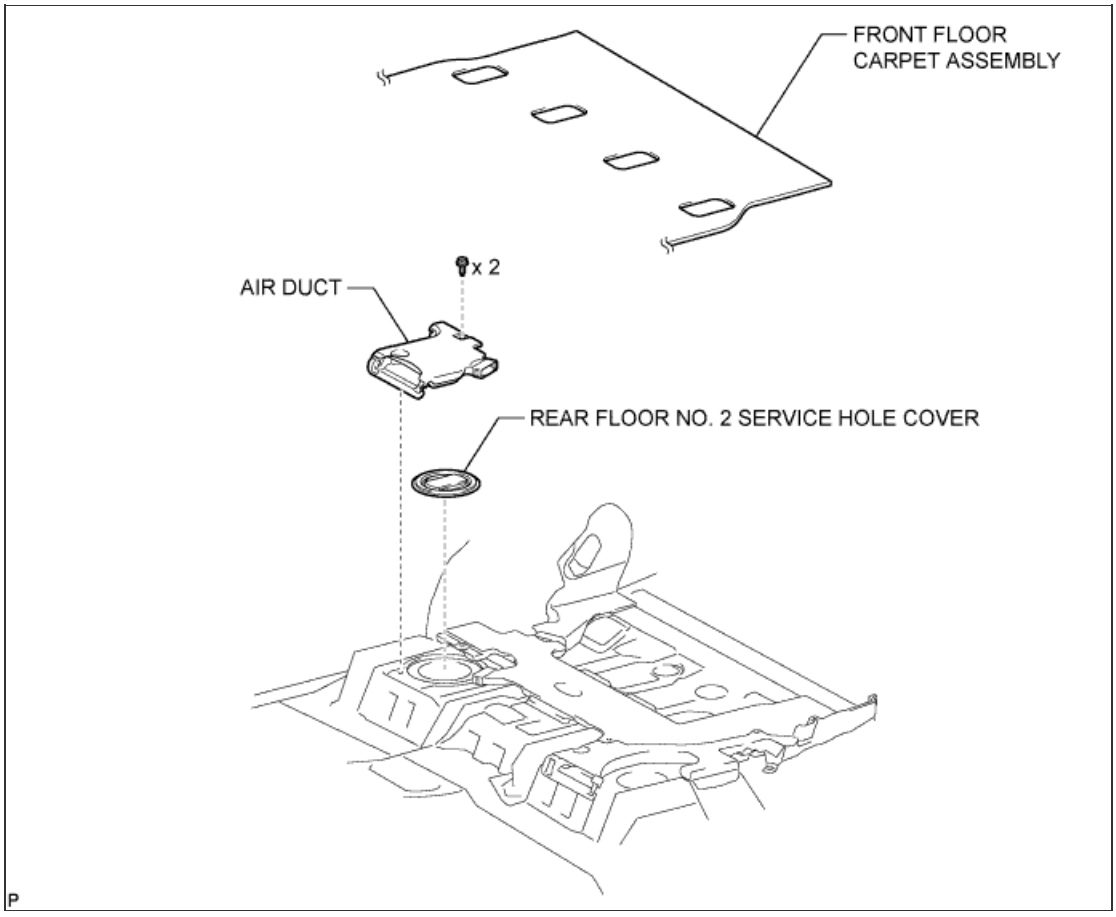
b. Connect the ECU connector.

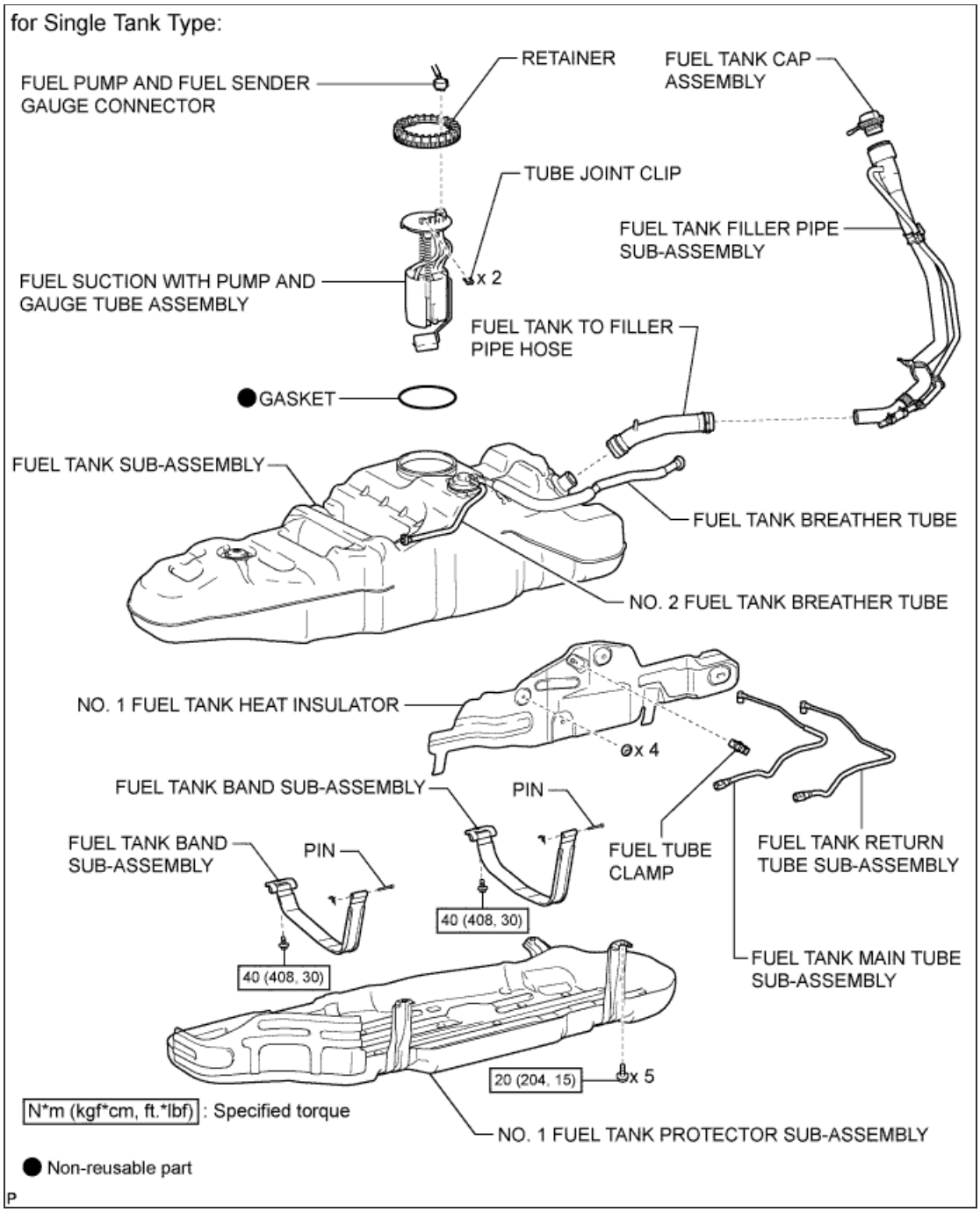


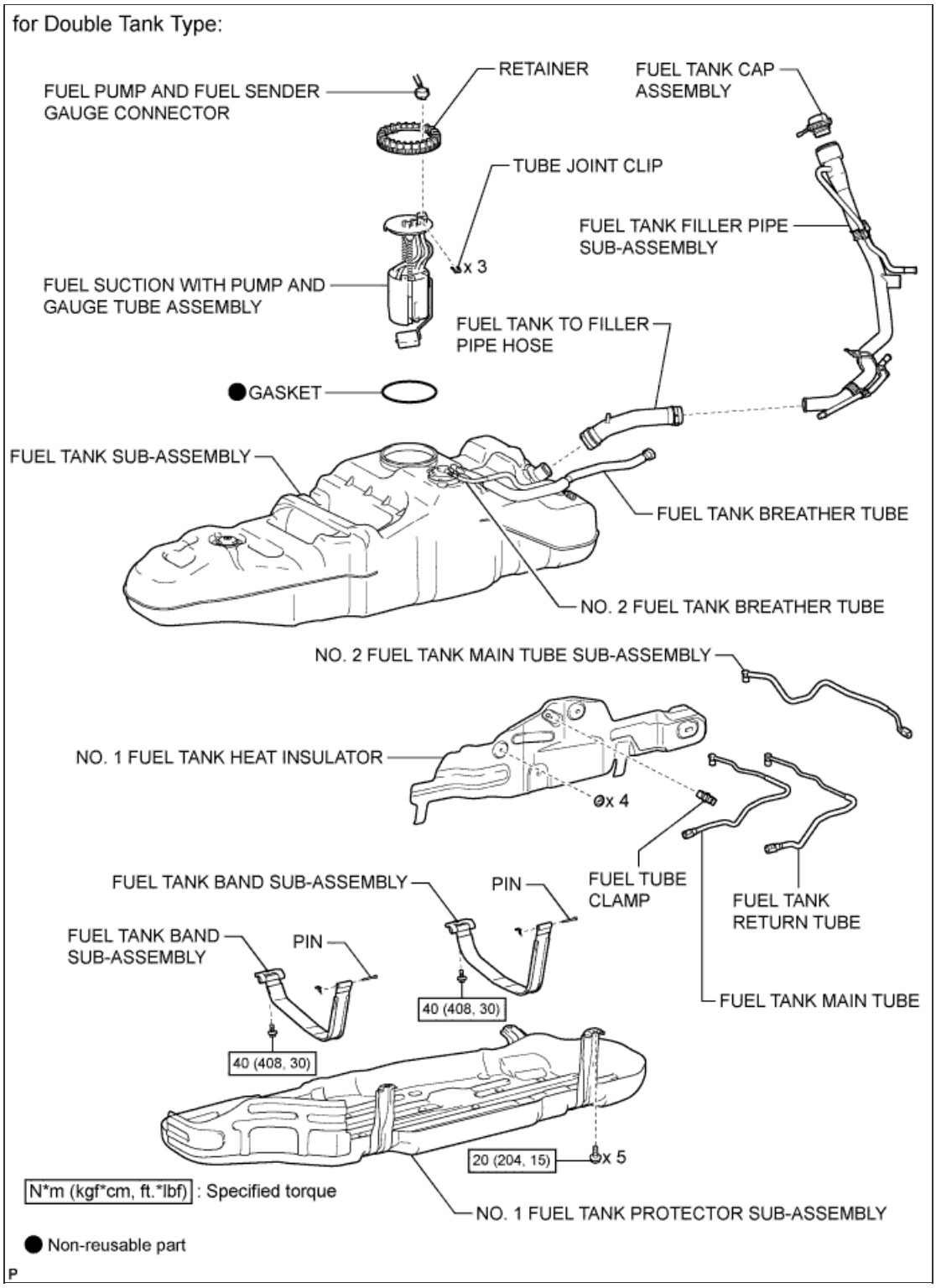
2. INSTALL FUEL TANK SUB-ASSEMBLY

a. Install the fuel tank sub-assembly (Click here).

for Preparation [Click here]




for Single Tank Type:
FUEL PUMP AND FUEL SENDER GAUGE CONNECTOR
RETAINER
FUEL TANK CAP ASSEMBLY
TUBE JOINT CLIP
FUEL TANK FILLER PIPE SUB-ASSEMBLY
FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY
x 2
FUEL TANK TO FILLER PIPE HOSE
GASKET
FUEL TANK SUB-ASSEMBLY
FUEL TANK BREATHER TUBE
NO. 2 FUEL TANK BREATHER TUBE
NO. 1 FUEL TANK HEAT INSULATOR
x 4
FUEL TANK BAND SUB-ASSEMBLY
PIN
FUEL TANK BAND SUB-ASSEMBLY
PIN
FUEL TUBE CLAMP
FUEL TANK RETURN TUBE SUB-ASSEMBLY
40 (408, 30)
40 (408, 30)
FUEL TANK MAIN TUBE SUB-ASSEMBLY
20 (204, 15)
x 5
N*m (kgf*cm, ft.*lbf) : Specified torque
NO. 1 FUEL TANK PROTECTOR SUB-ASSEMBLY
Non-reusable part
P


for Double Tank Type:
FUEL PUMP AND FUEL SENDER GAUGE CONNECTOR
RETAINER
FUEL TANK CAP ASSEMBLY
TUBE JOINT CLIP
x 3
FUEL TANK FILLER PIPE SUB-ASSEMBLY
FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY
FUEL TANK TO FILLER PIPE HOSE
GASKET
FUEL TANK SUB-ASSEMBLY
FUEL TANK BREATHER TUBE
NO. 2 FUEL TANK BREATHER TUBE
NO. 2 FUEL TANK MAIN TUBE SUB-ASSEMBLY
NO. 1 FUEL TANK HEAT INSULATOR
x 4
FUEL TUBE CLAMP
FUEL TANK RETURN TUBE
FUEL TANK BAND SUB-ASSEMBLY
PIN
FUEL TANK BAND SUB-ASSEMBLY
PIN
FUEL TANK MAIN TUBE
40 (408, 30)
40 (408, 30)
20 (204, 15)
x 5
N*m (kgf*cm, ft.*lbf) : Specified torque
NO. 1 FUEL TANK PROTECTOR SUB-ASSEMBLY
Non-reusable part
P

for Preparation Click here

1. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

CAUTION:

Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

3. REMOVE REAR SEAT ASSEMBLY

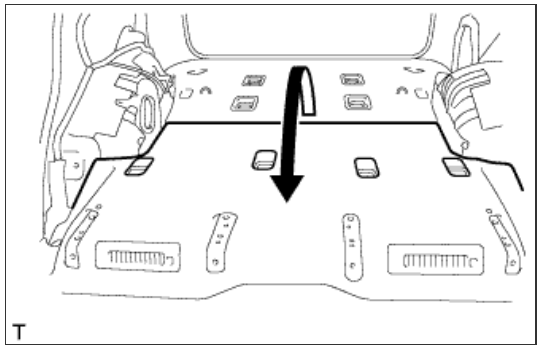
a. Remove the rear No. 1 seat assembly and rear No. 2 seat assembly (Click here).

4. REMOVE FRONT FLOOR CARPET ASSEMBLY

a. Turn over the floor carpet.

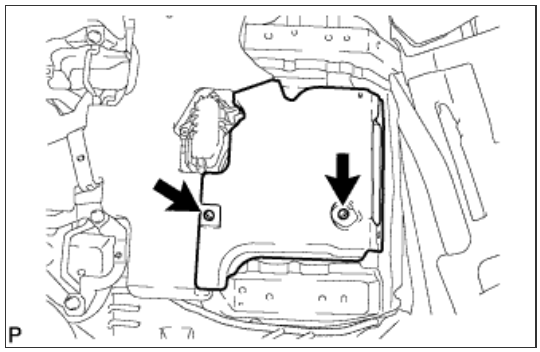
HINT:

Fold back the floor carpet so that the air duct can be removed.

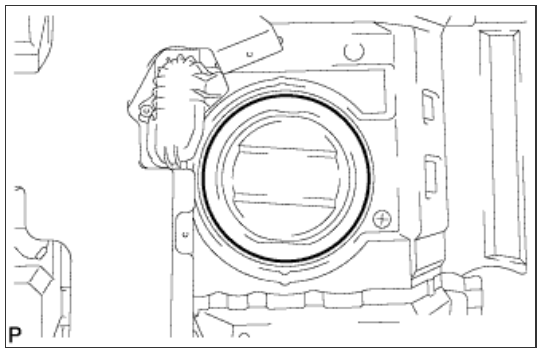


5. REMOVE REAR FLOOR NO. 2 SERVICE HOLE COVER

a. Remove the 2 screws and air duct.



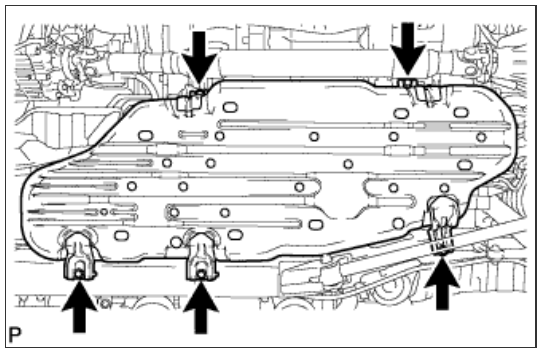
b. Remove the service hole cover.



6. REMOVE FUEL TANK CAP ASSEMBLY

7. REMOVE NO. 1 FUEL TANK PROTECTOR SUB-ASSEMBLY

a. Remove the 5 bolts and fuel tank protector.



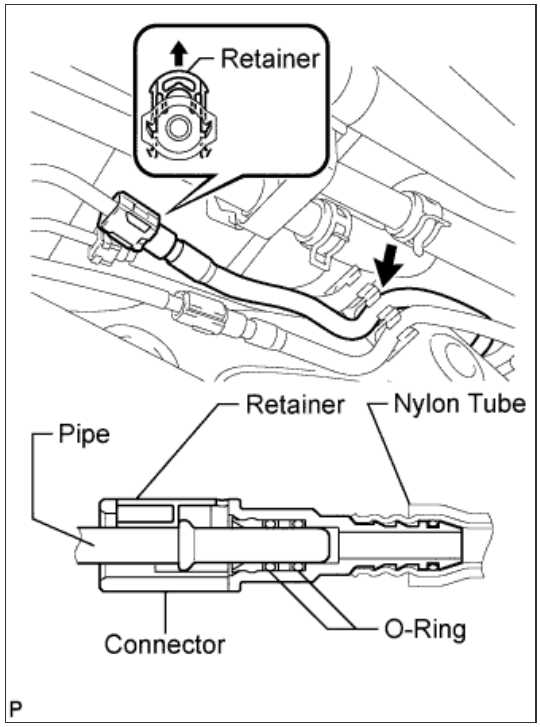
8. DISCONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Single Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank main tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



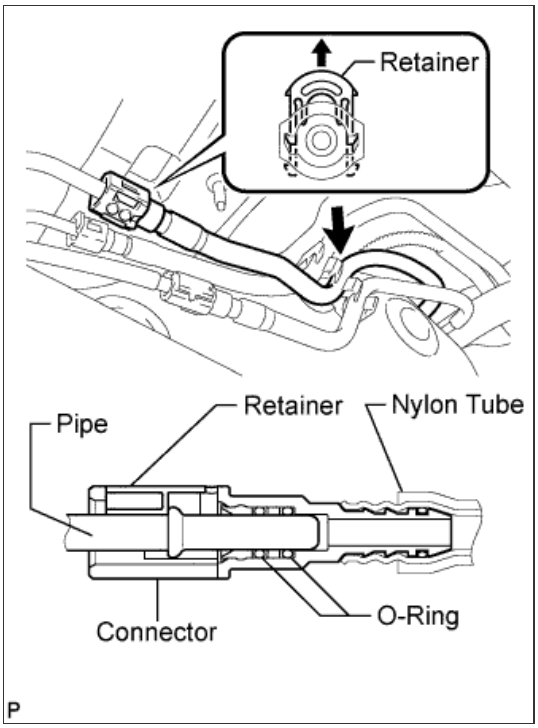
9. DISCONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank main tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



10. DRAIN FUEL

a. Connect the cable to the negative (-) battery terminal.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

NOTICE:

Do not start the engine.

d. Turn the intelligent tester ON.

e. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

CAUTION:

- **Do not smoke or be near an open flame when working on the fuel system.**
- **Secure good ventilation.**
- **Keep gasoline away from rubber or leather parts.**

HINT:

If the fuel pump does not operate, remove the fuel tube joint clip and disconnect the fuel tank return tube, and drain fuel from the port shown in the illustration.

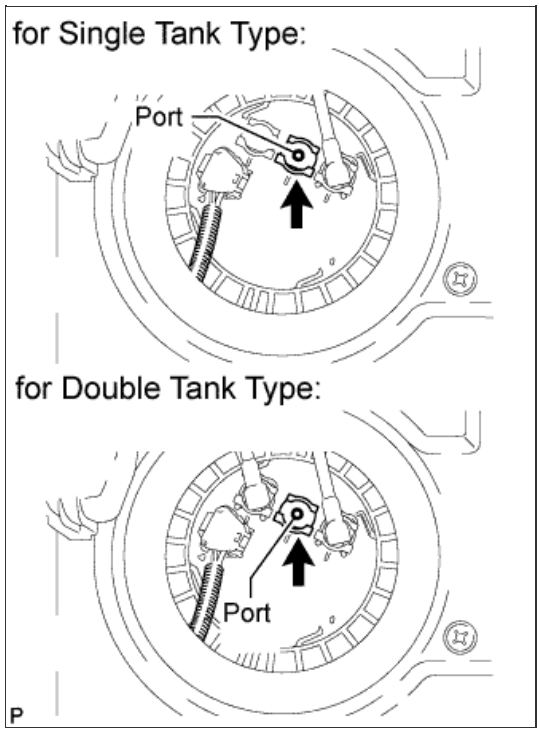
f. Disconnect the cable from the negative (-) battery terminal.

CAUTION:

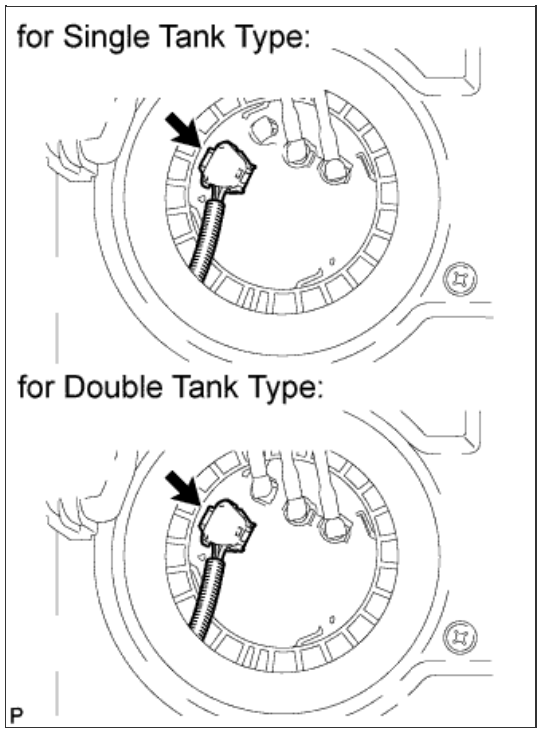
Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).



g. Disconnect the fuel pump and fuel sender gauge connector.



11. DISCONNECT NO. 2 FUEL TANK BREATHER TUBE (for Single Tank Type)

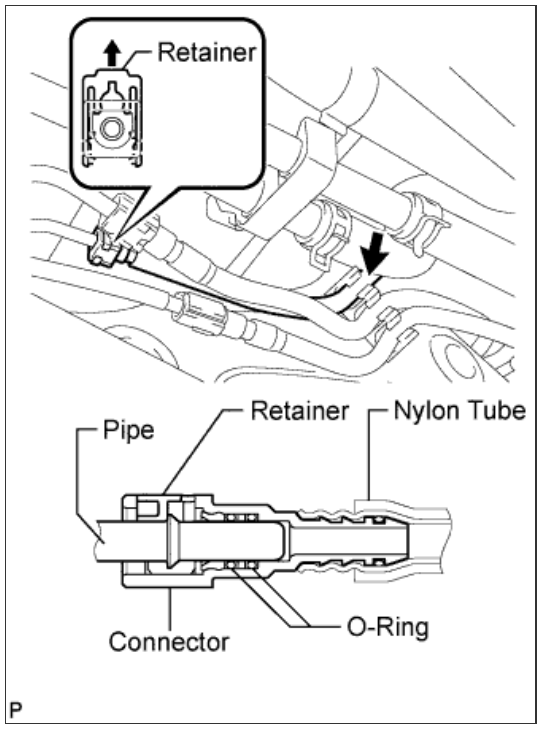
a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**

- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



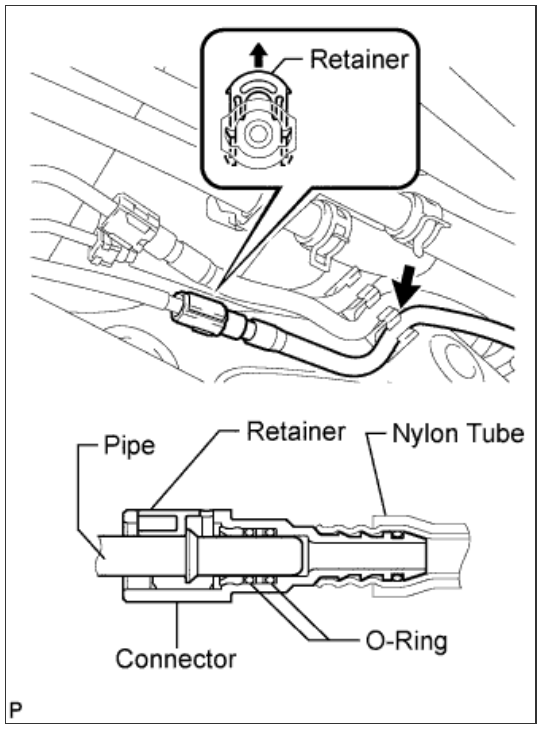
12. DISCONNECT FUEL TANK RETURN TUBE (for Single Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank return tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



13. DISCONNECT FUEL TANK RETURN TUBE (for Double Tank Type)

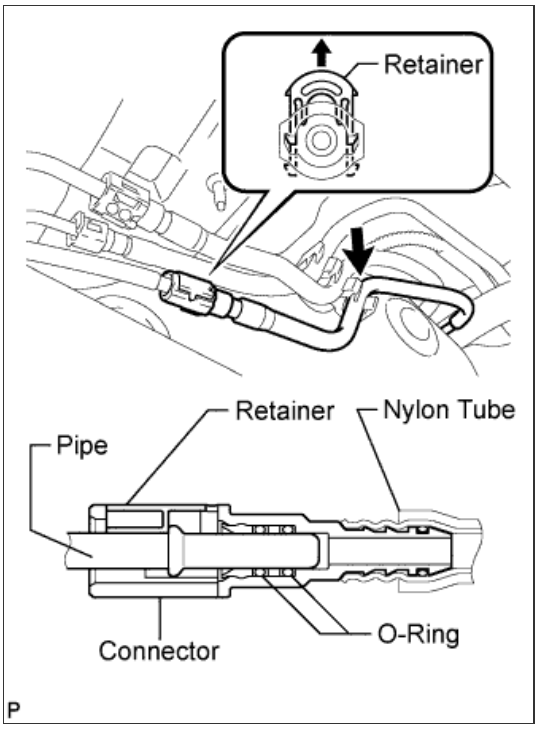
a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank return tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**

- Do not forcefully bend or twist the nylon tube.
- Check for foreign matter on the pipe seal surface. Clean if necessary.
- Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.
- If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.



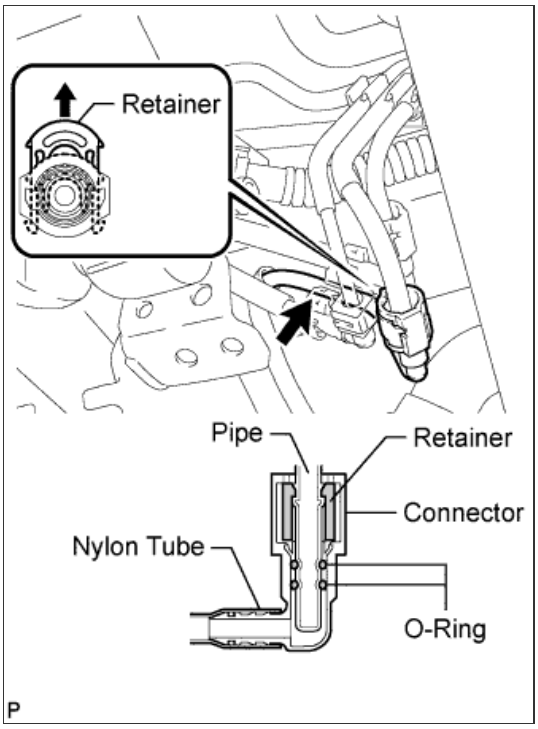
14. DISCONNECT NO. 2 FUEL MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank main tube.

NOTICE:

- Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.
- Do not use any tools to separate the pipe and connector.
- Do not forcefully bend or twist the nylon tube.
- Check for foreign matter on the pipe seal surface. Clean if necessary.
- Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.
- If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.



15. DISCONNECT NO. 2 FUEL TANK BREATHER TUBE (for Double Tank Type)

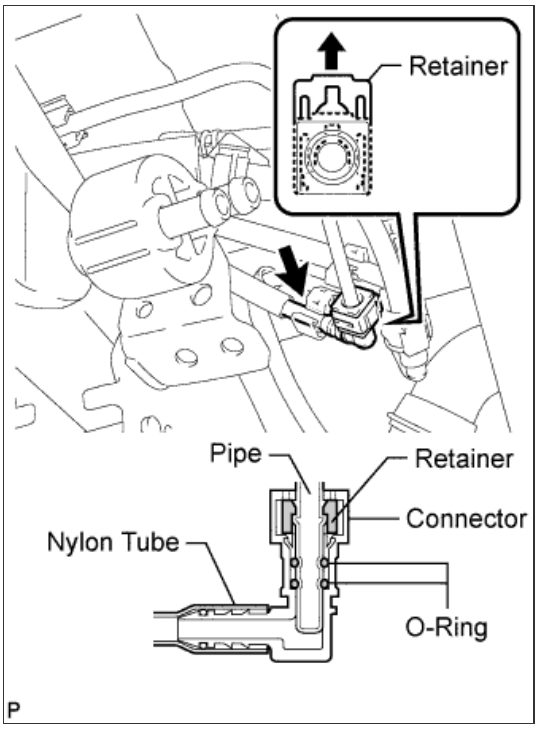
a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube.

NOTICE:

- Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.
- Do not use any tools to separate the pipe and connector.

- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



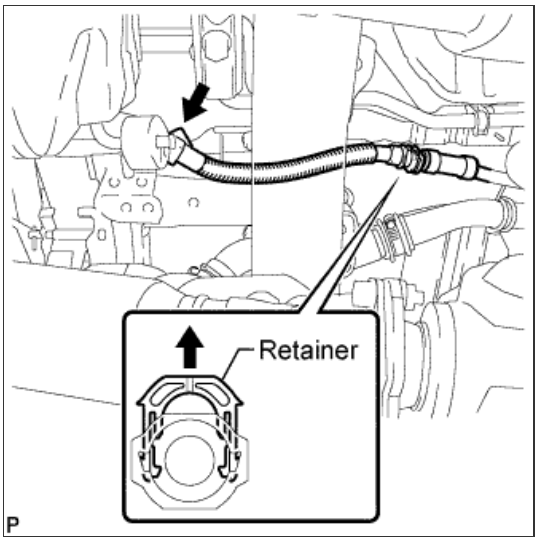
16. DISCONNECT FUEL TANK BREATHER TUBE (for Single Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube from the filler pipe.

NOTICE:

- **Do not use any tools in this procedure.**
- **Check for any dirt and foreign matter contamination in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**



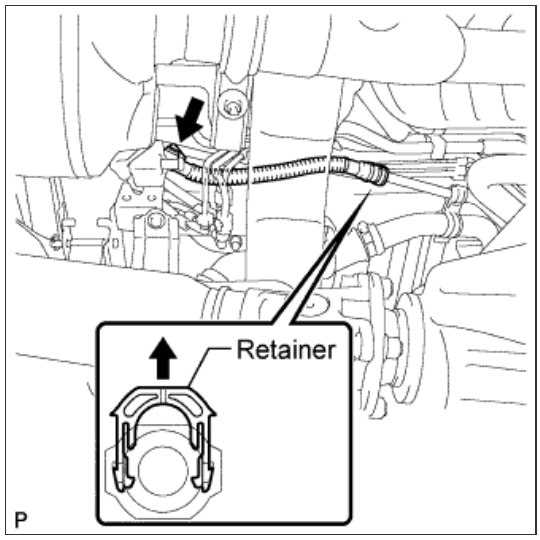
17. DISCONNECT FUEL TANK BREATHER TUBE (for Double Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube from the filler pipe.

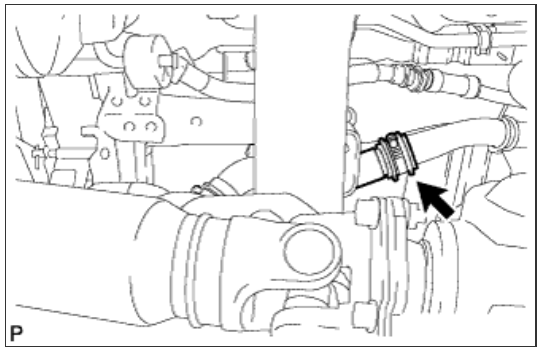
NOTICE:

- **Do not use any tools in this procedure.**
- **Check for any dirt and foreign matter contamination in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**



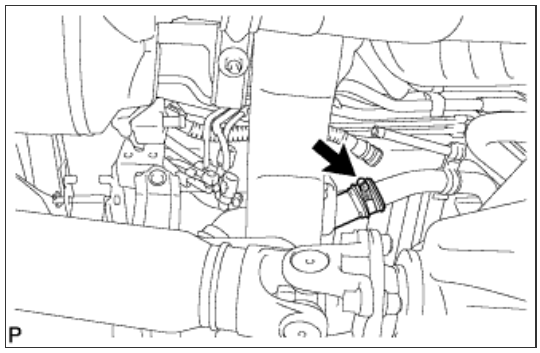
18. DISCONNECT FUEL TANK TO FILLER PIPE HOSE (for Single Tank Type)

a. Disconnect the hose from the filler pipe.



19. DISCONNECT FUEL TANK TO FILLER PIPE HOSE (for Double Tank Type)

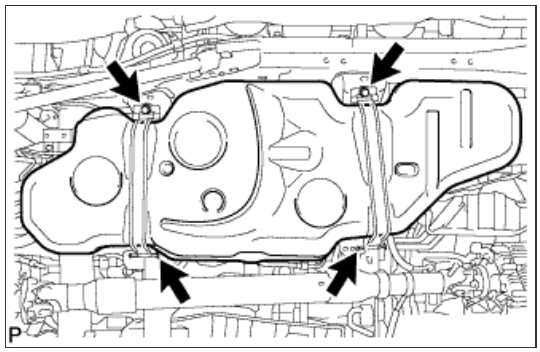
a. Disconnect the hose from the filler pipe.



20. REMOVE FUEL TANK SUB-ASSEMBLY

a. Place a transmission jack under the fuel tank.

b. Remove the 2 bolts, 2 clips, 2 pins and 2 fuel tank bands.

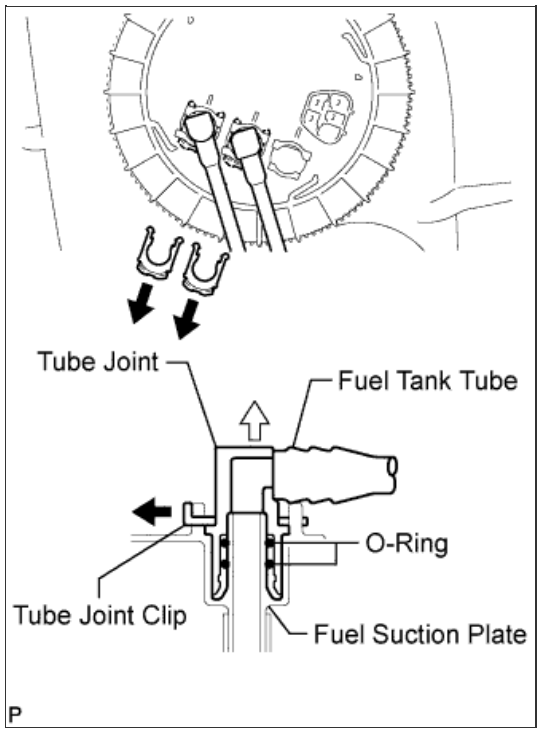


21. REMOVE FUEL TANK MAIN TUBE SUB-ASSEMBLY AND FUEL TANK RETURN TUBE SUB-ASSEMBLY (for Single Tank Type)

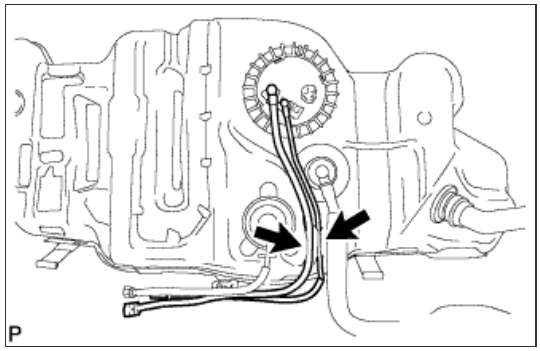
a. Remove the 2 fuel tube joint clips and pull out the 2 fuel tubes.

NOTICE:

- **Remove any dirt and foreign matter on the fuel tube joint before performing this work.**
- **Do not allow any scratches or foreign matter on the parts when disconnecting them, as the fuel tube joint contains the O-rings that seal the plug.**
- **Perform this work by hand. Do not use any tools.**
- **Do not forcibly bend, twist or turn the nylon tube.**
- **Protect the disconnected part by covering it with a plastic bag and tape after disconnecting the fuel tubes.**



b. Remove the 2 fuel tubes from the fuel tank.



22. REMOVE FUEL TANK MAIN TUBE, FUEL TANK RETURN TUBE AND NO. 2 FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

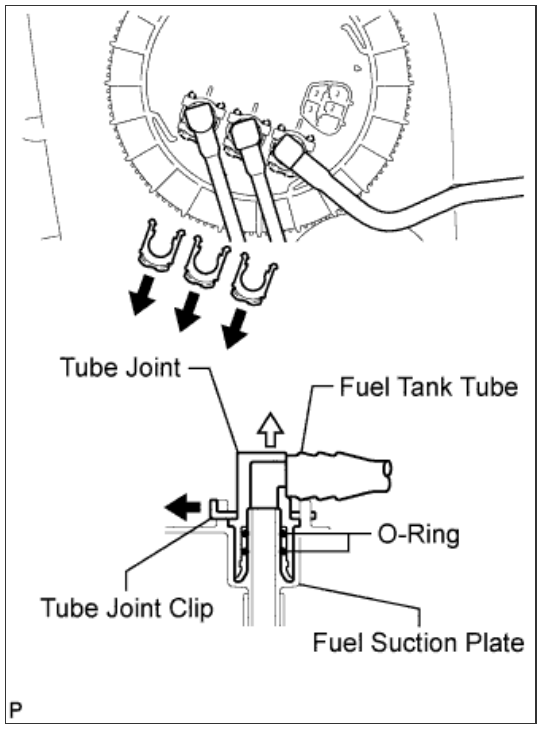
a. Remove the 3 fuel tube joint clips and pull out the 3 fuel tubes.

NOTICE:

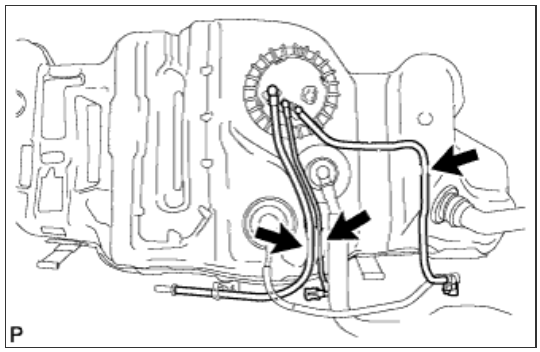
- **Remove any dirt and foreign matter on the fuel tube joint before performing this work.**
- **Do not allow any scratches or foreign matter on the parts when**

disconnecting them, as the fuel tube joint contains the O-rings that seal the plug.

- **Perform this work by hand. Do not use any tools.**
- **Do not forcibly bend, twist or turn the nylon tube.**
- **Protect the disconnected part by covering it with a plastic bag and tape after disconnecting the fuel tubes.**



b. Remove the 3 fuel tubes from the fuel tank.



23. REMOVE FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Using SST, loosen the retainer.

SST

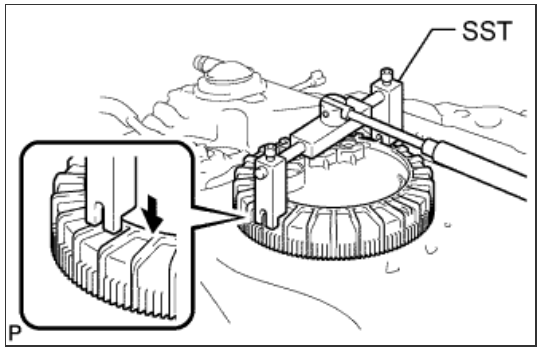
09808-14020 (09808-01410, 09808-01420, 09808-01430)

HINT:

Fit the tips of SST onto the ribs of the retainer.

NOTICE:

- **When the retainer is loosened, be careful as the pump and gauge tube will spring upward from the force of the spring.**
- **Remove foreign matter around the fuel suction with pump and gauge before this operation.**



b. Remove the retainer.

c. Remove the fuel suction with pump and gauge tube assembly from the fuel tank.

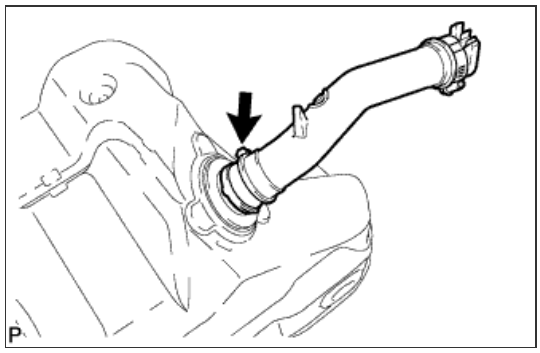
NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

d. Remove the gasket from the fuel tank.

24. REMOVE FUEL TANK TO FILLER PIPE HOSE

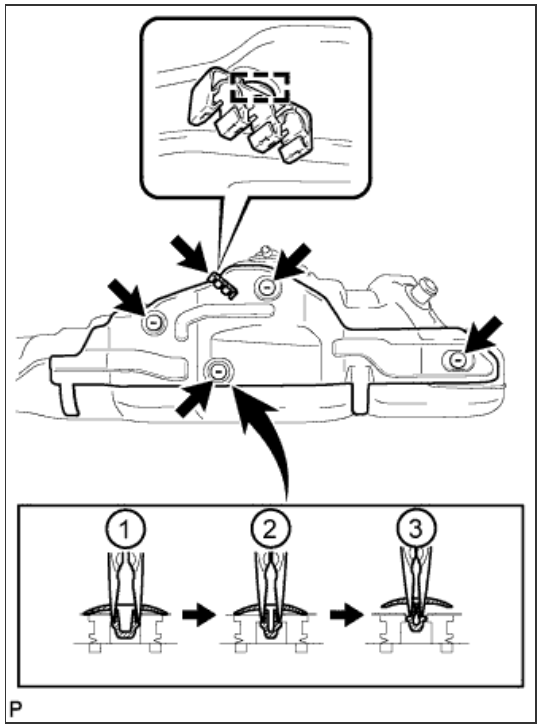
a. Remove the hose from the fuel tank.



25. REMOVE NO. 1 FUEL TANK HEAT INSULATOR

a. Remove the fuel tube clamp from the heat insulator.

b. Using needle-nose pliers, remove the 4 clips shown in the illustration and then remove the heat insulator.



for Preparation Click here

1. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

CAUTION:

Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

3. REMOVE REAR SEAT ASSEMBLY

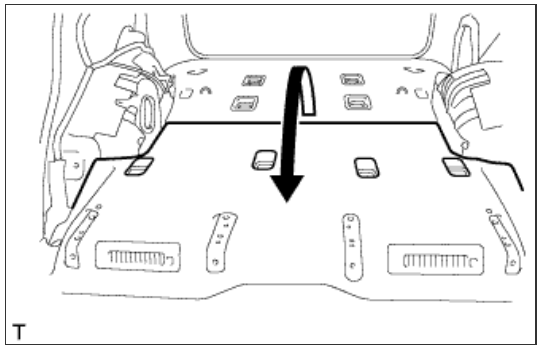
a. Remove the rear No. 1 seat assembly and rear No. 2 seat assembly (Click here).

4. REMOVE FRONT FLOOR CARPET ASSEMBLY

a. Turn over the floor carpet.

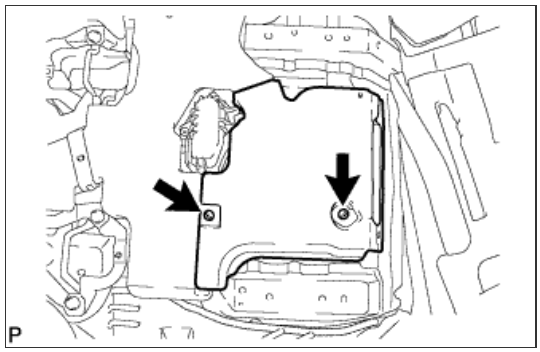
HINT:

Fold back the floor carpet so that the air duct can be removed.

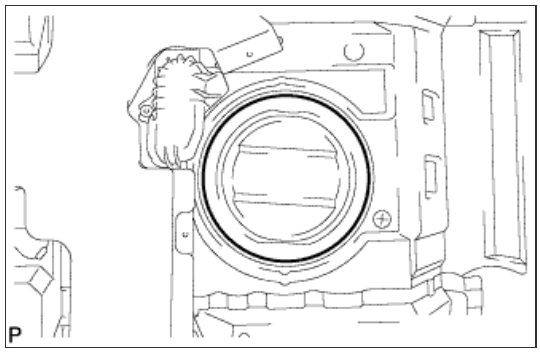


5. REMOVE REAR FLOOR NO. 2 SERVICE HOLE COVER

a. Remove the 2 screws and air duct.



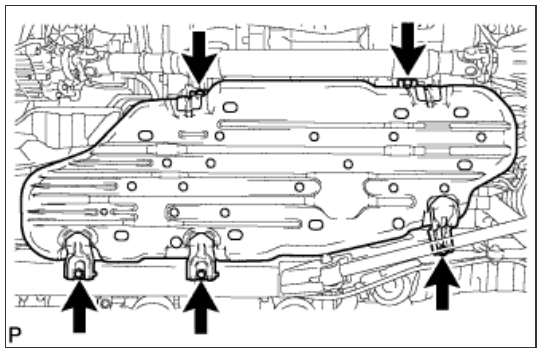
b. Remove the service hole cover.



6. REMOVE FUEL TANK CAP ASSEMBLY

7. REMOVE NO. 1 FUEL TANK PROTECTOR SUB-ASSEMBLY

a. Remove the 5 bolts and fuel tank protector.



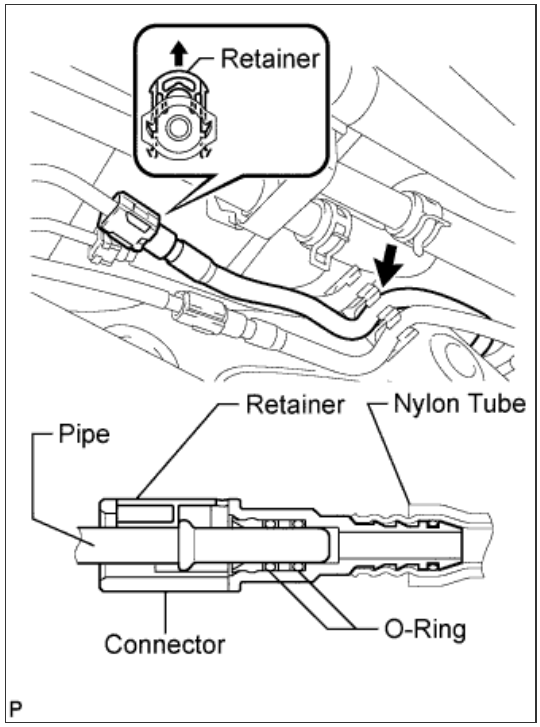
8. DISCONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Single Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank main tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



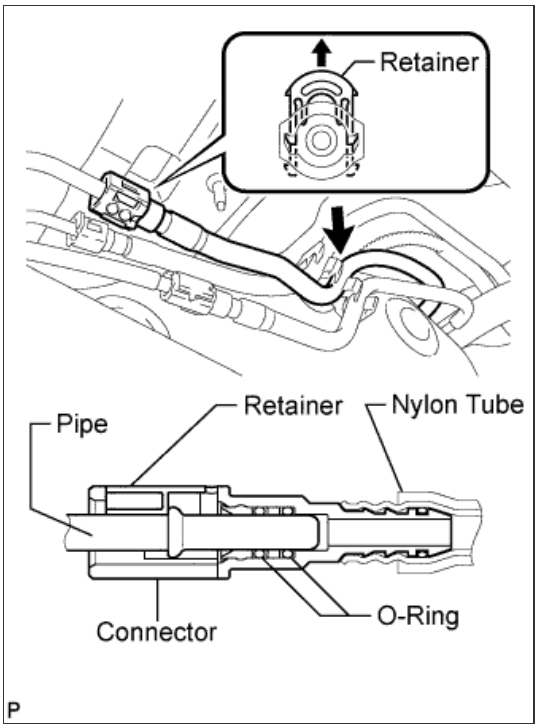
9. DISCONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank main tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



10. DRAIN FUEL

a. Connect the cable to the negative (-) battery terminal.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG).

NOTICE:

Do not start the engine.

d. Turn the intelligent tester ON.

e. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump / Speed.

CAUTION:

- **Do not smoke or be near an open flame when working on the fuel system.**
- **Secure good ventilation.**
- **Keep gasoline away from rubber or leather parts.**

HINT:

If the fuel pump does not operate, remove the fuel tube joint clip and disconnect the fuel tank return tube, and drain fuel from the port shown in the illustration.

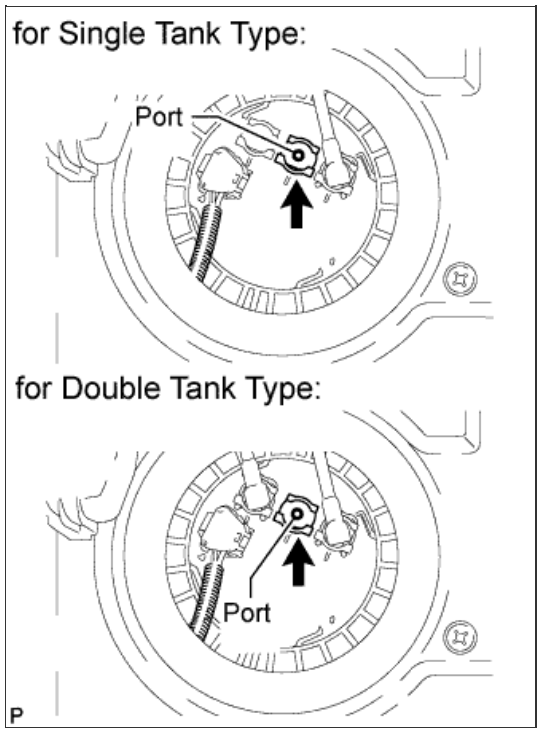
f. Disconnect the cable from the negative (-) battery terminal.

CAUTION:

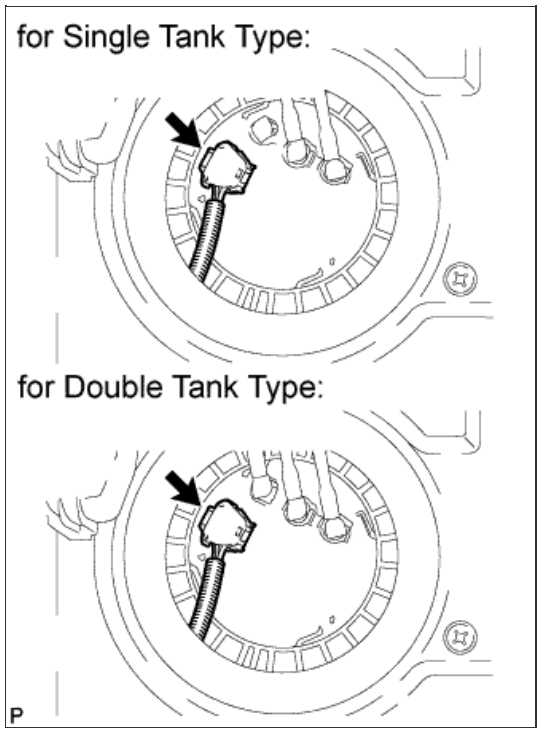
Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).



g. Disconnect the fuel pump and fuel sender gauge connector.



11. DISCONNECT NO. 2 FUEL TANK BREATHER TUBE (for Single Tank Type)

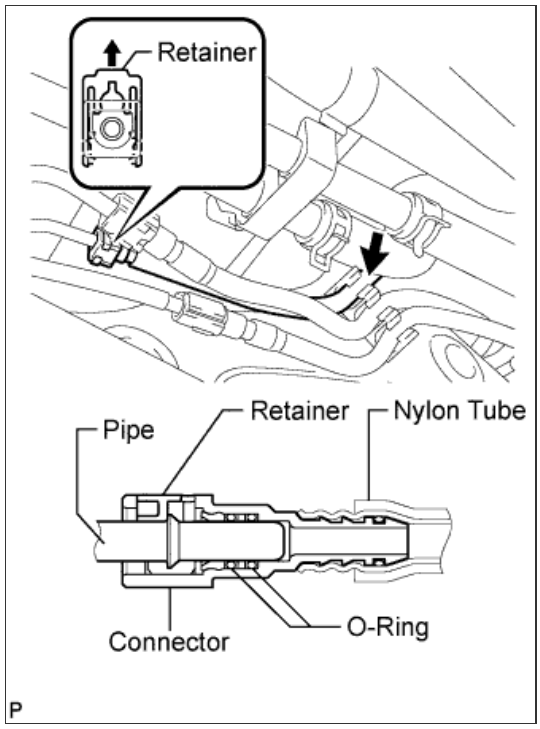
a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**

- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



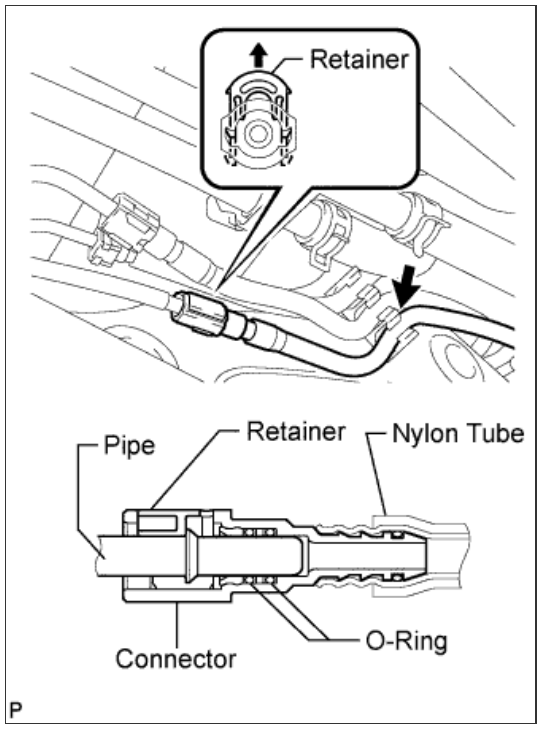
12. DISCONNECT FUEL TANK RETURN TUBE (for Single Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank return tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**
- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



13. DISCONNECT FUEL TANK RETURN TUBE (for Double Tank Type)

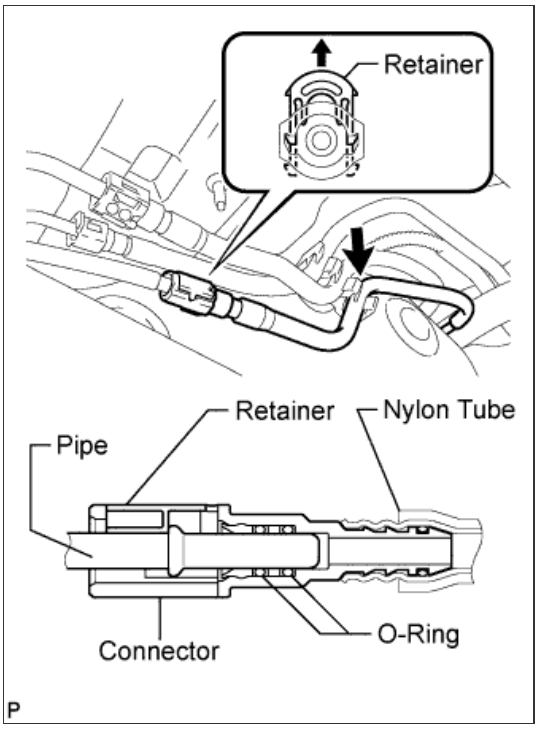
a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank return tube.

NOTICE:

- **Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**
- **Do not use any tools to separate the pipe and connector.**

- Do not forcefully bend or twist the nylon tube.
- Check for foreign matter on the pipe seal surface. Clean if necessary.
- Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.
- If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.



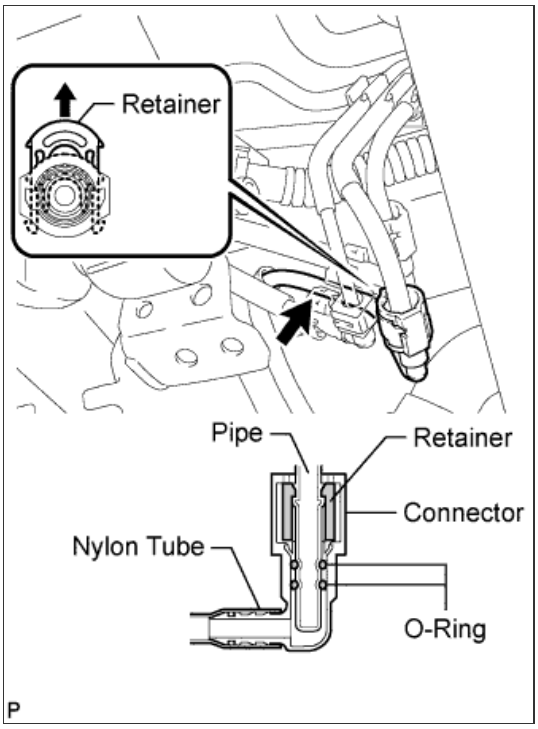
14. DISCONNECT NO. 2 FUEL MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank main tube.

NOTICE:

- Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.
- Do not use any tools to separate the pipe and connector.
- Do not forcefully bend or twist the nylon tube.
- Check for foreign matter on the pipe seal surface. Clean if necessary.
- Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.
- If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.



15. DISCONNECT NO. 2 FUEL TANK BREATHER TUBE (for Double Tank Type)

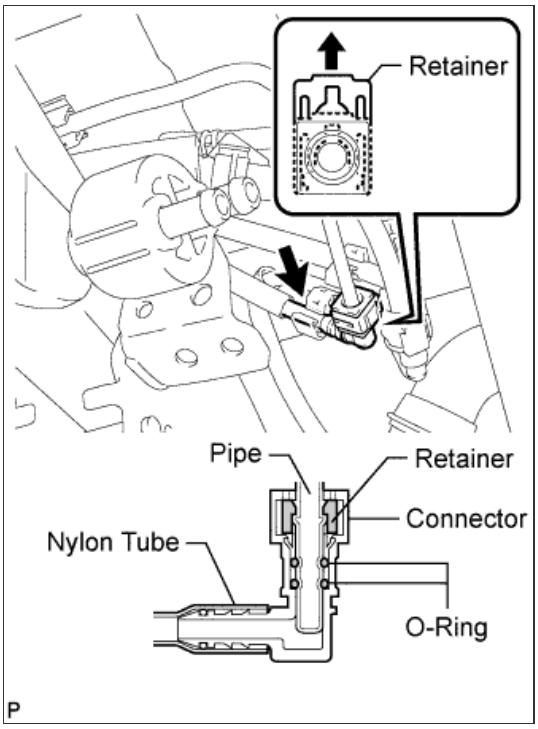
a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube.

NOTICE:

- Check for foreign matter in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.
- Do not use any tools to separate the pipe and connector.

- **Do not forcefully bend or twist the nylon tube.**
- **Check for foreign matter on the pipe seal surface. Clean if necessary.**
- **Put the pipe and connector ends in plastic bags to prevent damage and foreign matter contamination.**
- **If the pipe and connector are stuck together, pinch the connector between your fingers and turn it carefully to disconnect it.**



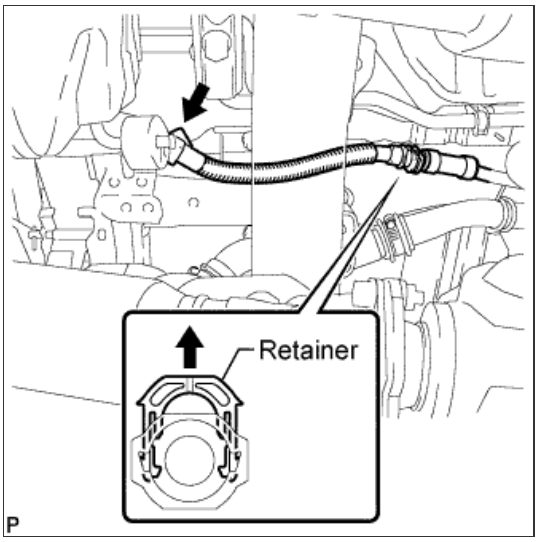
16. DISCONNECT FUEL TANK BREATHER TUBE (for Single Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube from the filler pipe.

NOTICE:

- **Do not use any tools in this procedure.**
- **Check for any dirt and foreign matter contamination in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**



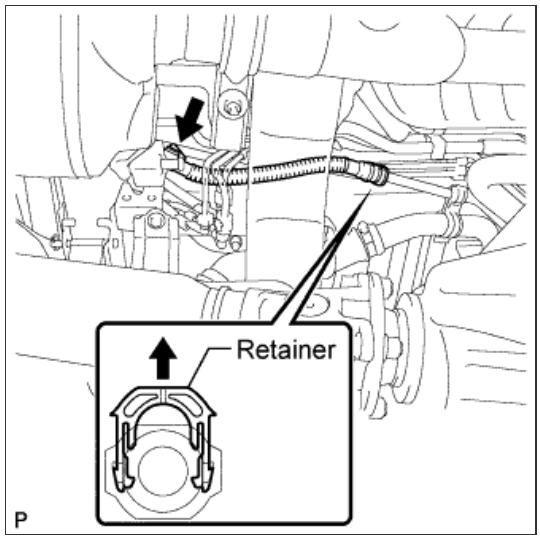
17. DISCONNECT FUEL TANK BREATHER TUBE (for Double Tank Type)

a. Detach the fuel tube clamp.

b. Pull up the retainer and disconnect the fuel tank breather tube from the filler pipe.

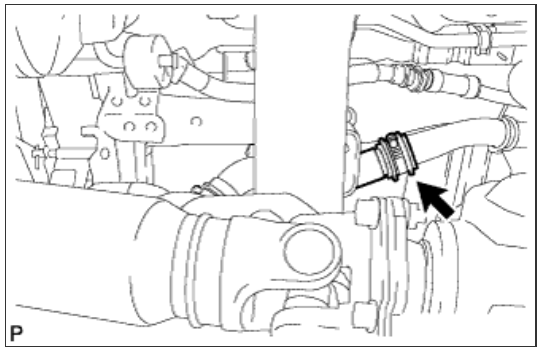
NOTICE:

- **Do not use any tools in this procedure.**
- **Check for any dirt and foreign matter contamination in the pipe and around the connector. Clean if necessary. Foreign matter may damage the O-ring or cause leaks in the seal between the pipe and connector.**



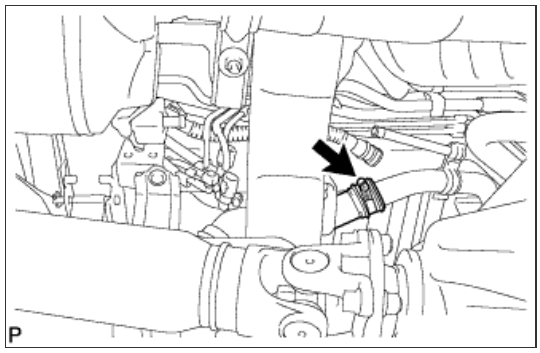
18. DISCONNECT FUEL TANK TO FILLER PIPE HOSE (for Single Tank Type)

a. Disconnect the hose from the filler pipe.



19. DISCONNECT FUEL TANK TO FILLER PIPE HOSE (for Double Tank Type)

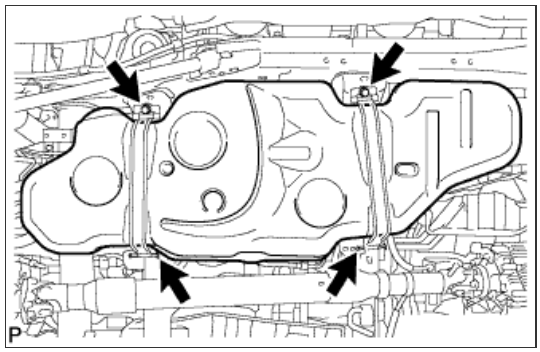
a. Disconnect the hose from the filler pipe.



20. REMOVE FUEL TANK SUB-ASSEMBLY

a. Place a transmission jack under the fuel tank.

b. Remove the 2 bolts, 2 clips, 2 pins and 2 fuel tank bands.

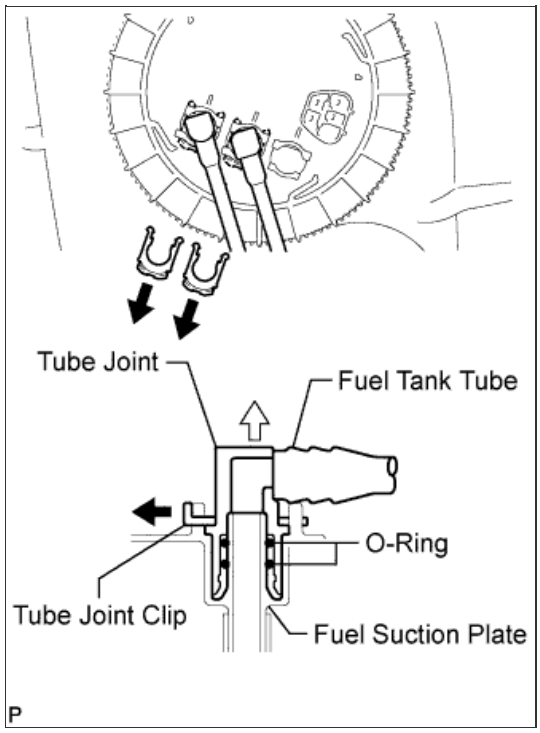


21. REMOVE FUEL TANK MAIN TUBE SUB-ASSEMBLY AND FUEL TANK RETURN TUBE SUB-ASSEMBLY (for Single Tank Type)

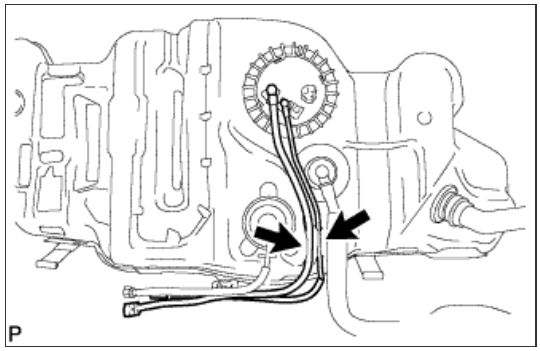
a. Remove the 2 fuel tube joint clips and pull out the 2 fuel tubes.

NOTICE:

- **Remove any dirt and foreign matter on the fuel tube joint before performing this work.**
- **Do not allow any scratches or foreign matter on the parts when disconnecting them, as the fuel tube joint contains the O-rings that seal the plug.**
- **Perform this work by hand. Do not use any tools.**
- **Do not forcibly bend, twist or turn the nylon tube.**
- **Protect the disconnected part by covering it with a plastic bag and tape after disconnecting the fuel tubes.**



b. Remove the 2 fuel tubes from the fuel tank.



22. REMOVE FUEL TANK MAIN TUBE, FUEL TANK RETURN TUBE AND NO. 2 FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

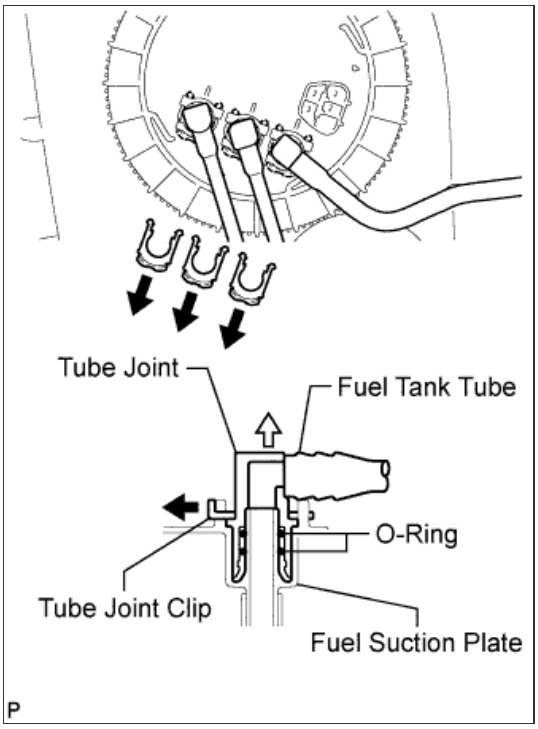
a. Remove the 3 fuel tube joint clips and pull out the 3 fuel tubes.

NOTICE:

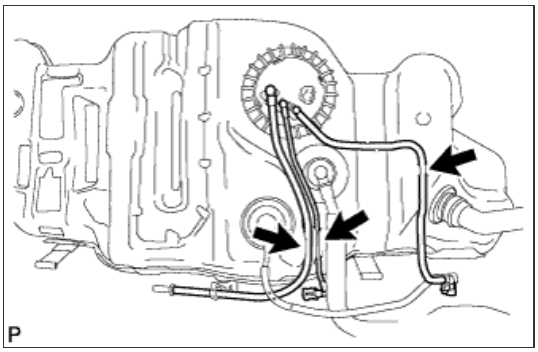
- **Remove any dirt and foreign matter on the fuel tube joint before performing this work.**
- **Do not allow any scratches or foreign matter on the parts when**

disconnecting them, as the fuel tube joint contains the O-rings that seal the plug.

- Perform this work by hand. Do not use any tools.
- Do not forcibly bend, twist or turn the nylon tube.
- Protect the disconnected part by covering it with a plastic bag and tape after disconnecting the fuel tubes.



b. Remove the 3 fuel tubes from the fuel tank.



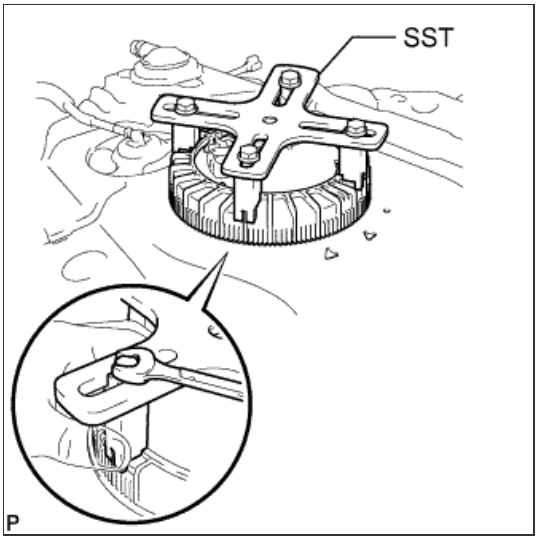
23. REMOVE FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Set SST on the fuel pump gauge retainer.

SST
09808-14030

HINT:

- Engage the claws of SST securely with the fuel pump gauge retainer holes to secure SST.
- Install SST while pressing the claws of SST against the fuel pump gauge retainer (towards the center of SST).



b. Using SST, loosen the retainer.

SST
09808-14030

Text in Illustration

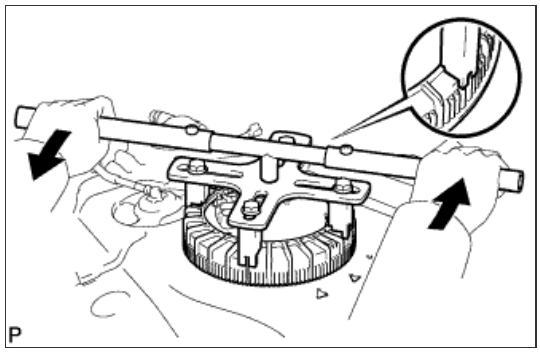
➡	Turn

HINT:

Fit the tips of SST onto the ribs of the retainer.

NOTICE:

- **When the retainer is loosened, be careful as the pump and gauge tube will spring upward from the force of the spring.**
- **Remove foreign matter around the fuel suction with pump and gauge before this operation.**



c. Remove the retainer.

d. Remove the fuel suction with pump and gauge tube assembly from the fuel tank.

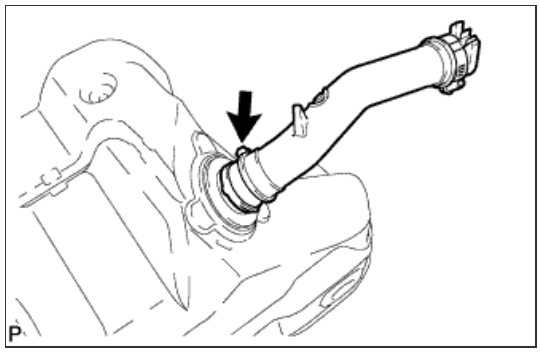
NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

e. Remove the gasket from the fuel tank.

24. REMOVE FUEL TANK TO FILLER PIPE HOSE

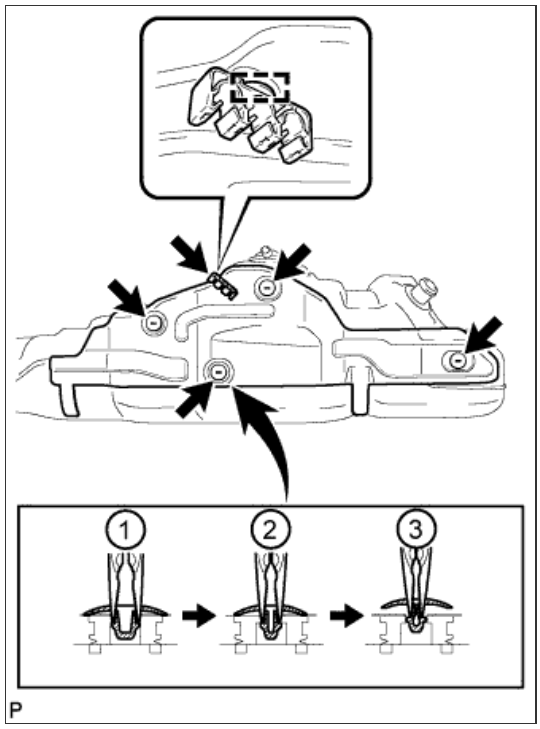
a. Remove the hose from the fuel tank.



25. REMOVE NO. 1 FUEL TANK HEAT INSULATOR

a. Remove the fuel tube clamp from the heat insulator.

b. Using needle-nose pliers, remove the 4 clips shown in the illustration and then remove the heat insulator.

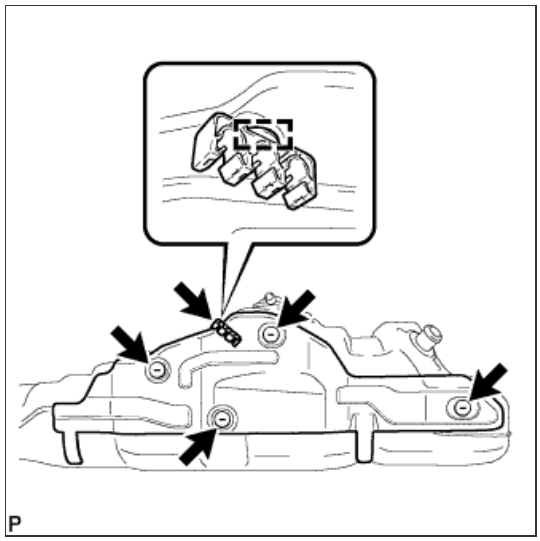

1
2
3
P

for Preparation Click here

1. INSTALL NO. 1 FUEL TANK HEAT INSULATOR

a. Install the heat insulator with the 4 clips.

b. Install the fuel tube clamp to the heat insulator.

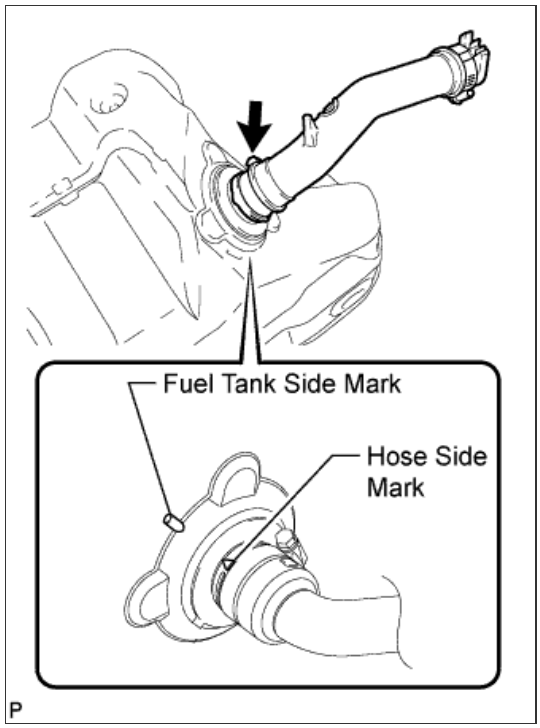


2. INSTALL FUEL TANK TO FILLER PIPE HOSE

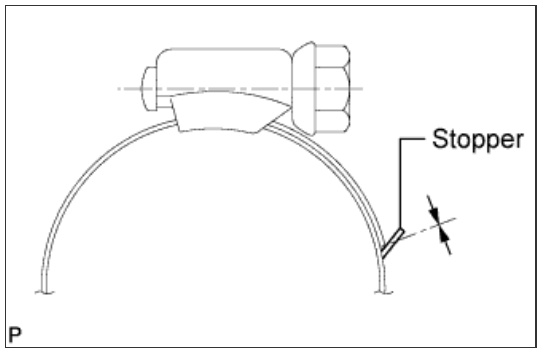
a. Install the hose to the fuel tank as shown in the illustration.

HINT:

- **Align the fuel tank side mark with the hose side mark when installing the hose.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**



3. INSTALL FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Apply a light coat of gasoline or grease to a new gasket, and install it to the fuel tank.

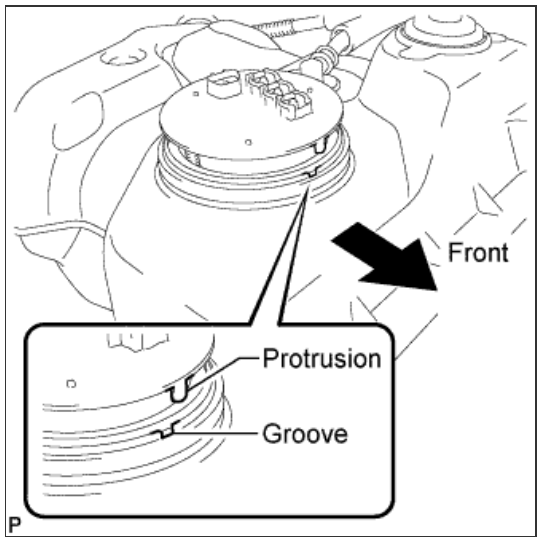
b. Install the fuel suction with pump and gauge tube into the fuel tank.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

HINT:

Align the protrusion of the fuel suction with pump and gauge tube with the groove of the fuel tank.



c. Put the retainer on the fuel tank. While holding the fuel suction with pump and gauge tube, tighten the retainer 1 complete turn by hand.

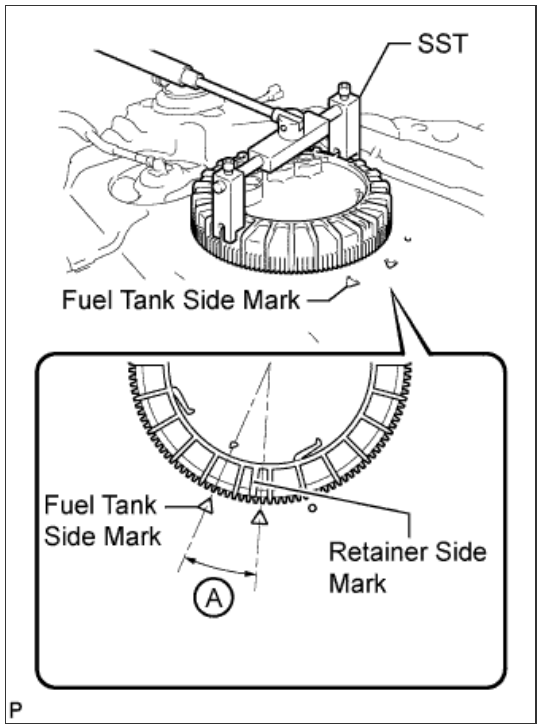
d. Using SST, tighten the retainer until the mark on the retainer is within range A on the fuel tank, as shown in the illustration.

SST

09808-14020 (09808-01410, 09808-01420, 09808-01430)

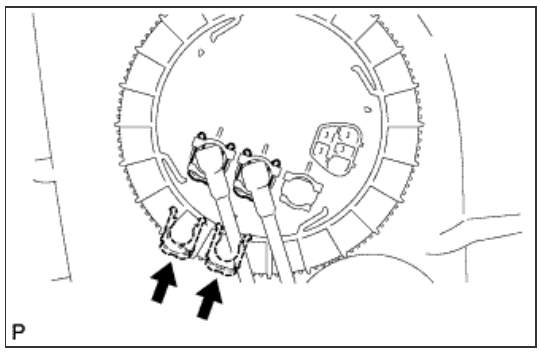
HINT:

Fit the tips of SST onto the ribs of the retainer.



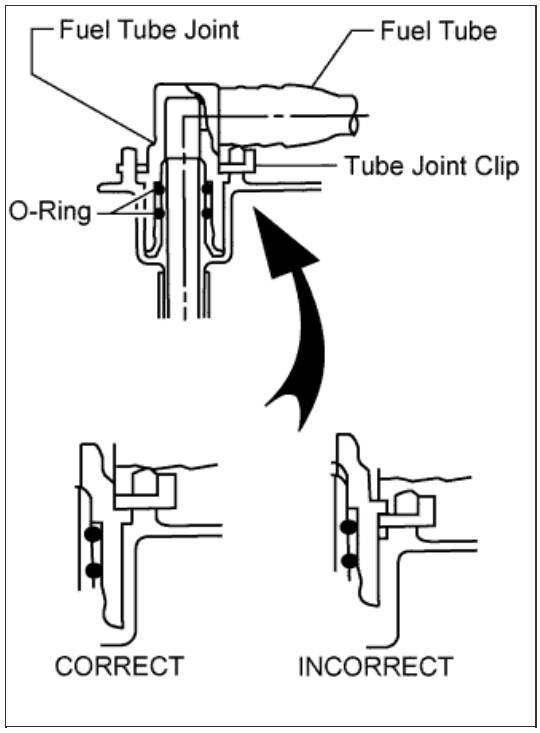
4. INSTALL FUEL TANK MAIN TUBE SUB-ASSEMBLY AND FUEL TANK RETURN TUBE SUB-ASSEMBLY (for Single Tank Type)

a. Install the 2 fuel tank tubes with the 2 tube joint clips.

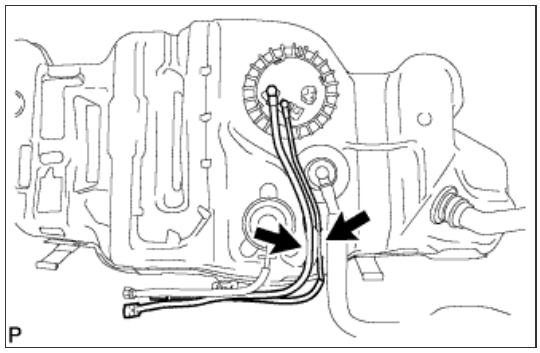


NOTICE:

- **Check that there are no scratches or foreign objects on the connecting parts.**
- **Check that the fuel tube joints are inserted securely.**
- **Check that the tube joint clips are on the collars of the fuel tube joints.**
- **After installing the tube joint clips, check that the fuel tube joints cannot be pulled off.**

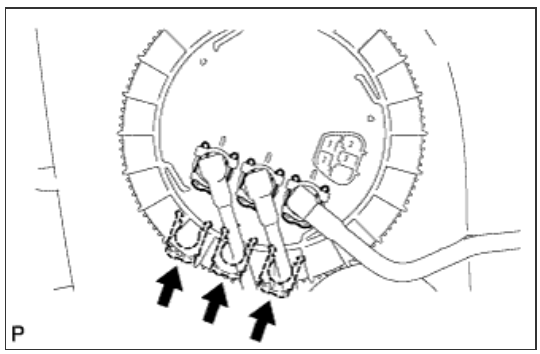


b. Install the 2 fuel tank tubes to the fuel tank.



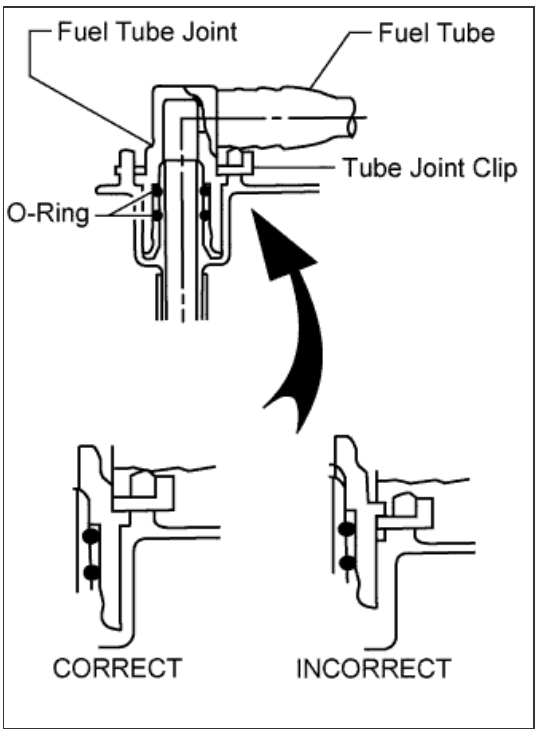
5. INSTALL FUEL TANK MAIN TUBE, FUEL TANK RETURN TUBE AND NO. 2 FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Install the 3 fuel tank tubes with the 3 tube joint clips.

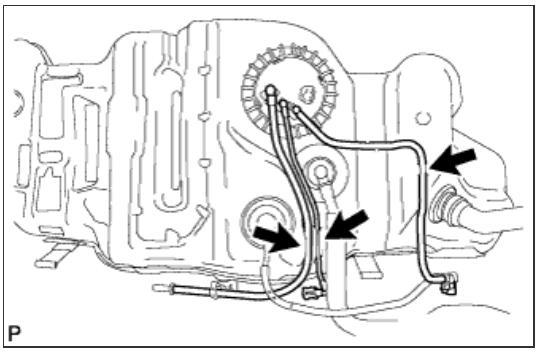


NOTICE:

- **Check that there are no scratches or foreign objects on the connecting parts.**
- **Check that the fuel tube joints are inserted securely.**
- **Check that the tube joint clips are on the collars of the fuel tube joints.**
- **After installing the tube joint clips, check that the fuel tube joints cannot be pulled off.**



b. Install the 3 fuel tank tubes to the fuel tank.



6. INSTALL FUEL TANK SUB-ASSEMBLY

a. Set the fuel tank on a transmission jack and raise the fuel tank.

NOTICE:

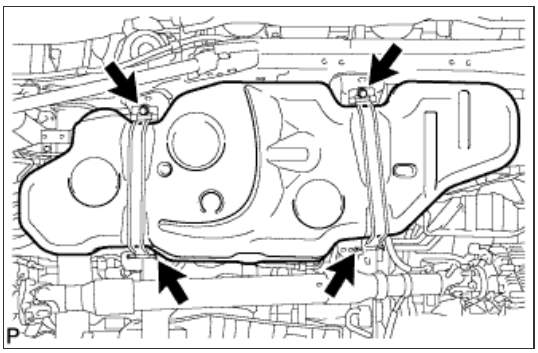
Do not allow the fuel tank to contact the vehicle, especially the differential.

b. Raise the transmission jack.

c. Install the 2 fuel tank bands with the 2 pins and 2 clips.

d. Connect the 2 fuel tank bands with the 2 bolts.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

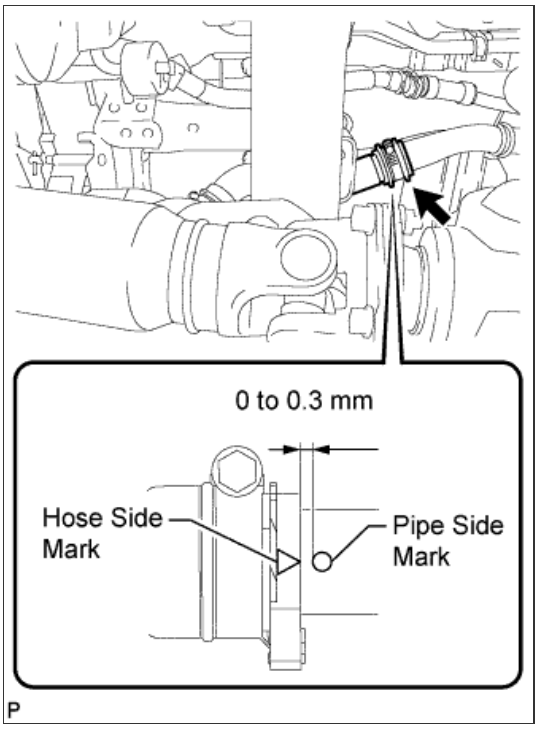


7. CONNECT FUEL TANK TO FILLER PIPE HOSE (for Single Tank Type)

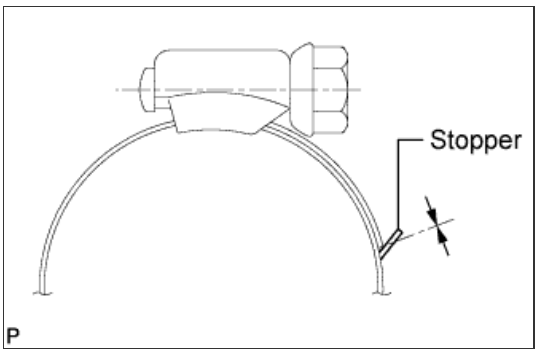
a. Connect the hose to the filler pipe as shown in the illustration.

HINT:

- **Install the hose so that the distance between the fuel tank inlet pipe side mark and fuel tank to filler pipe hose side mark is 0 to 0.3 mm (0 to 0.0118 in.) as shown in the illustration.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**

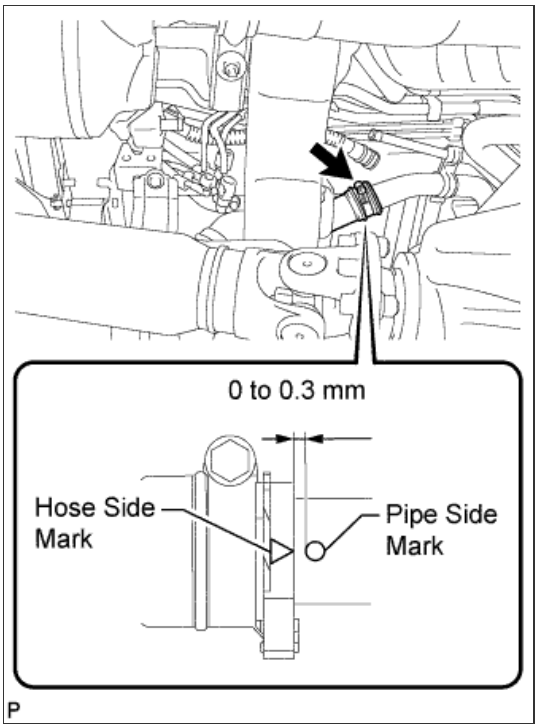


8. CONNECT FUEL TANK TO FILLER PIPE HOSE (for Double Tank Type)

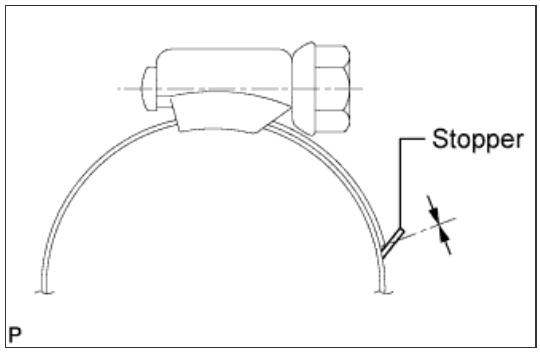
a. Connect the hose to the filler pipe as shown in the illustration.

HINT:

- **Install the hose so that the distance between the fuel tank inlet pipe side mark and fuel tank to filler pipe hose side mark is 0 to 0.3 mm (0 to 0.0118 in.) as shown in the illustration.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**



9. CONNECT FUEL TANK BREATHER TUBE (for Single Tank Type)

a. Connect the fuel tank breather tube to the filler pipe and push the retainer.

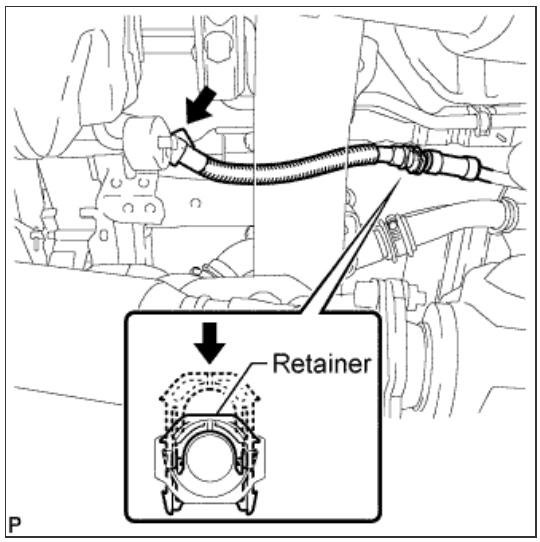
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



10. CONNECT FUEL TANK BREATHER TUBE (for Double Tank Type)

a. Connect the fuel tank breather tube to the filler pipe and push the retainer.

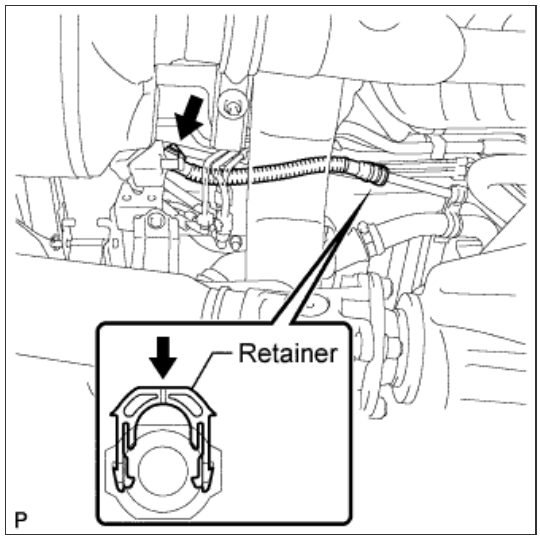
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



11. CONNECT NO. 2 FUEL MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Connect the fuel main tube and push the retainer.

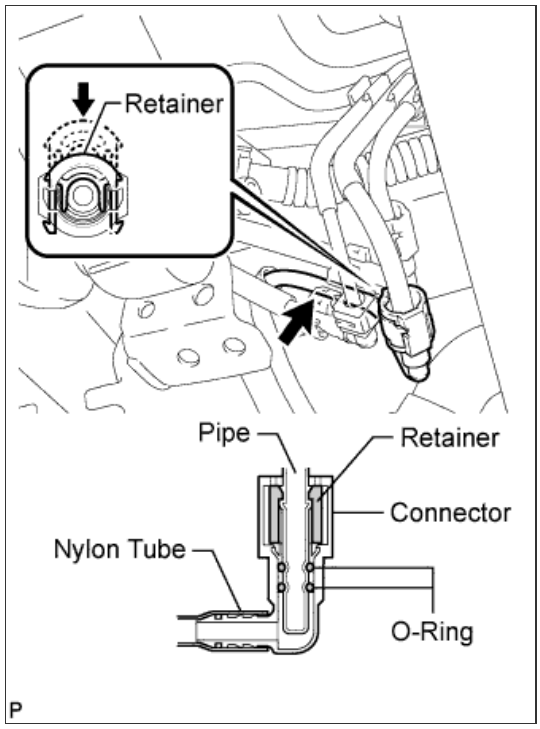
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



12. CONNECT NO. 2 FUEL TANK BREATHER TUBE (for Double Tank Type)

a. Connect the fuel tank breather tube and push the retainer.

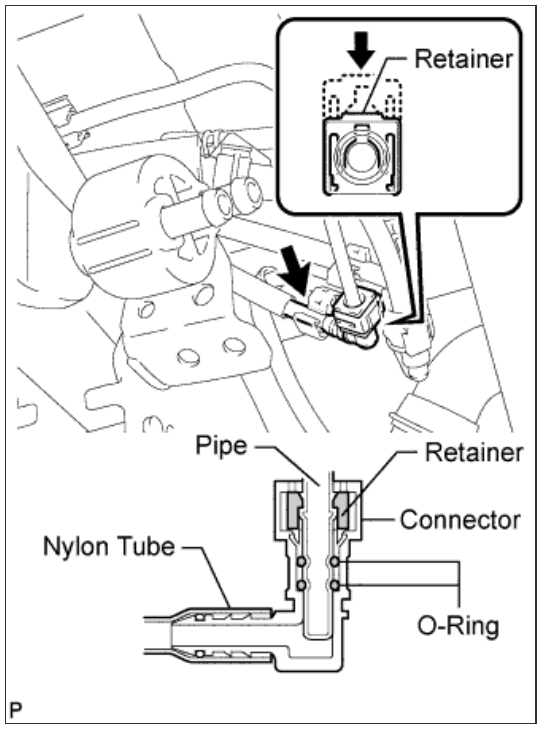
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



13. CONNECT FUEL TANK RETURN TUBE (for Single Tank Type)

a. Connect the fuel tank return tube and push the retainer.

HINT:

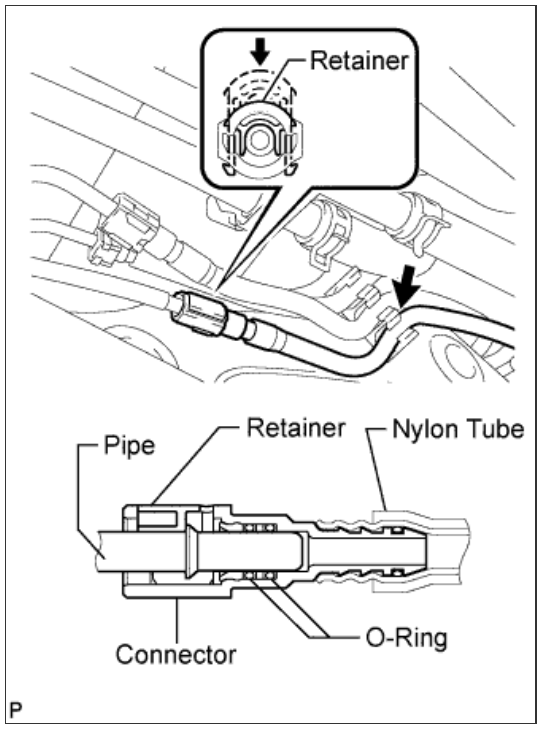
Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**

- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



14. CONNECT FUEL TANK RETURN TUBE (for Double Tank Type)

a. Connect the fuel tank return tube and push the retainer.

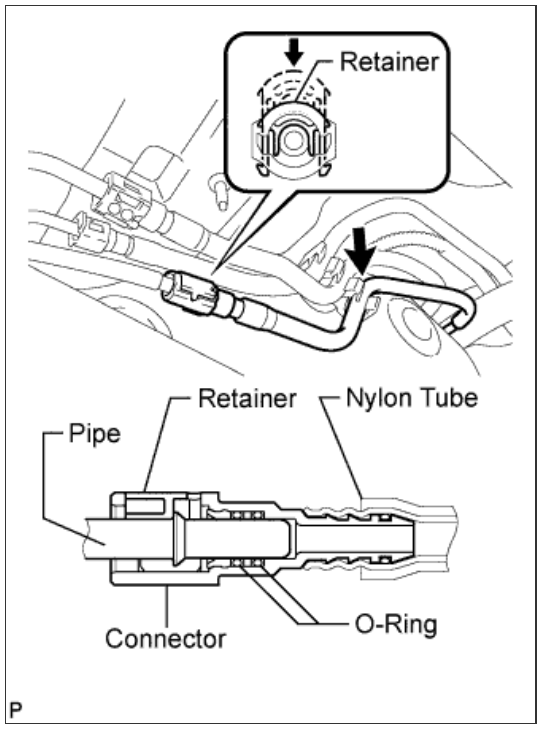
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



15. CONNECT NO. 2 FUEL TANK BREATHER TUBE (for Single Tank Type)

a. Connect the fuel tank breather tube and push the retainer.

HINT:

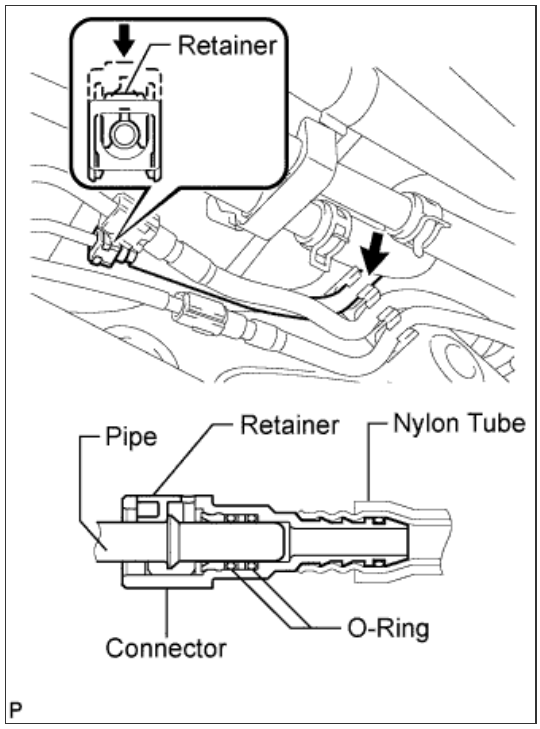
Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**

- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



16. CONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Single Tank Type)

a. Connect the fuel tank main tube and push the retainer.

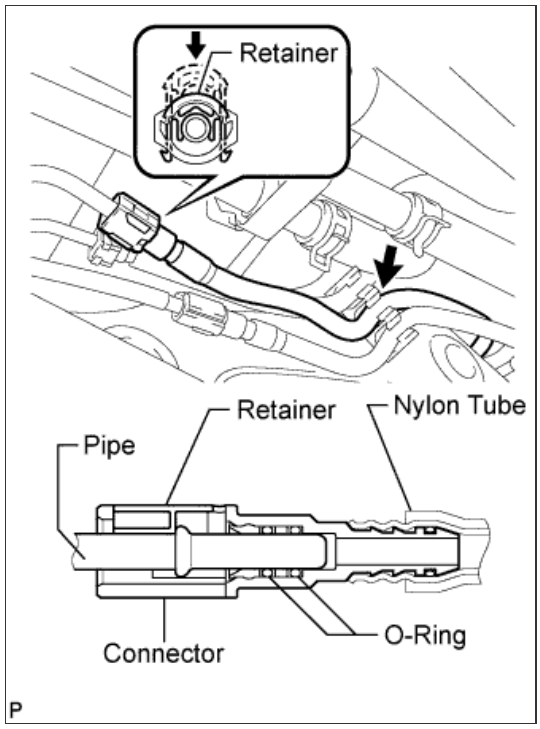
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



17. CONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Connect the fuel tank main tube and push the retainer.

HINT:

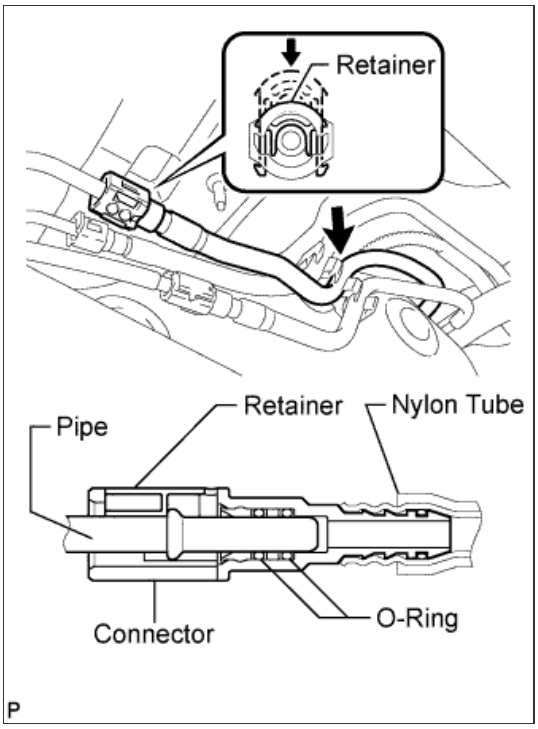
Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**

- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

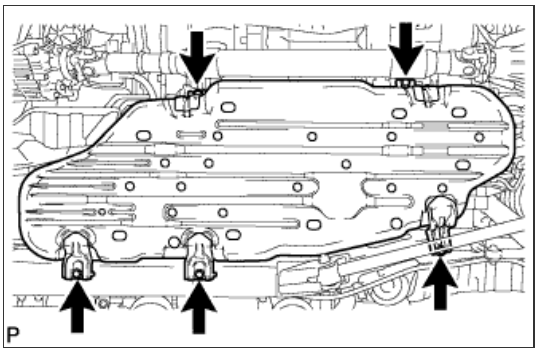
b. Attach the fuel tube clamp.



18. INSTALL NO. 1 FUEL TANK PROTECTOR SUB-ASSEMBLY

a. Install the tank protector with the 5 bolts.

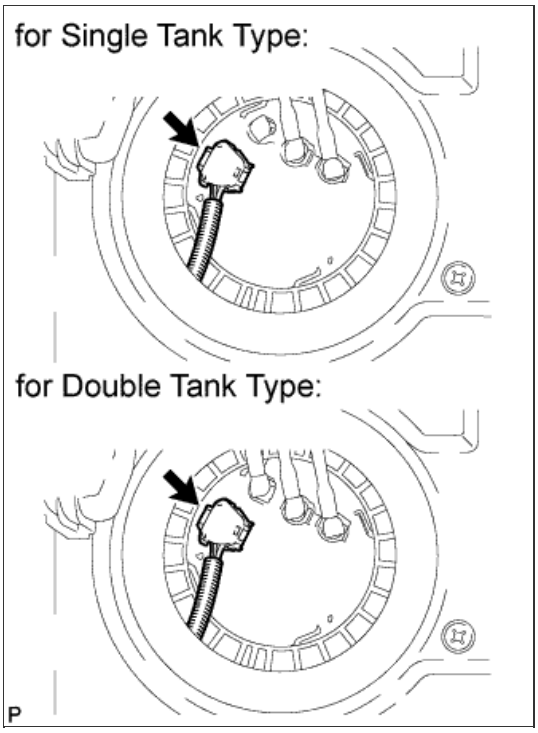
Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }



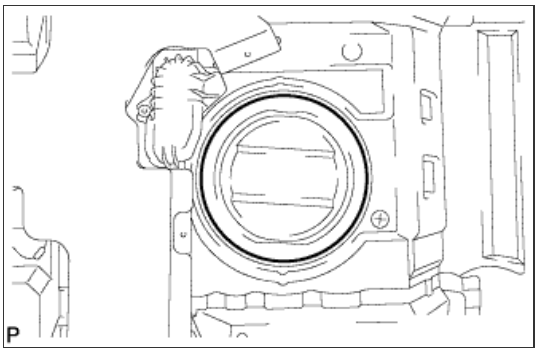
19. INSTALL FUEL TANK CAP ASSEMBLY

20. INSTALL REAR FLOOR NO. 2 SERVICE HOLE COVER

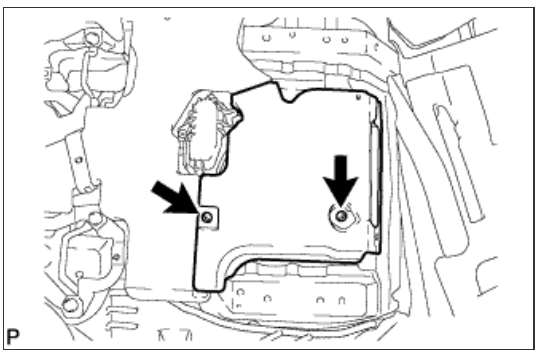
a. Connect the fuel pump and fuel sender gauge connector.



b. Install the service hole cover with new butyl tape.



c. Install the air duct and 2 screws.



21. INSTALL FRONT FLOOR CARPET ASSEMBLY

22. INSTALL REAR SEAT ASSEMBLY

a. Install the rear No. 1 seat assembly and rear No. 2 seat assembly (Click here).

23. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

24. ADD FUEL

25. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

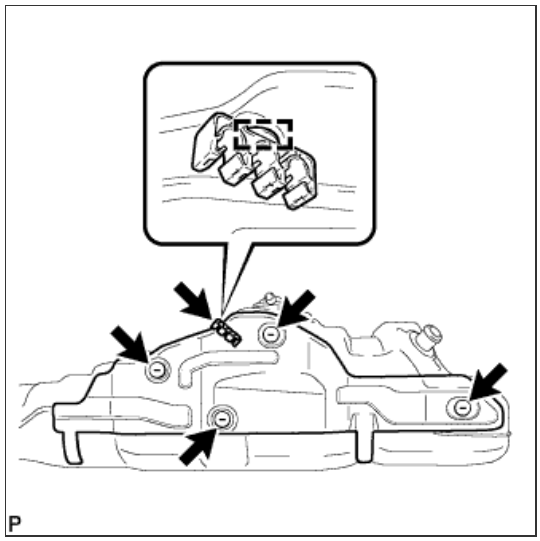
d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

for Preparation Click here

1. INSTALL NO. 1 FUEL TANK HEAT INSULATOR

a. Install the heat insulator with the 4 clips.

b. Install the fuel tube clamp to the heat insulator.

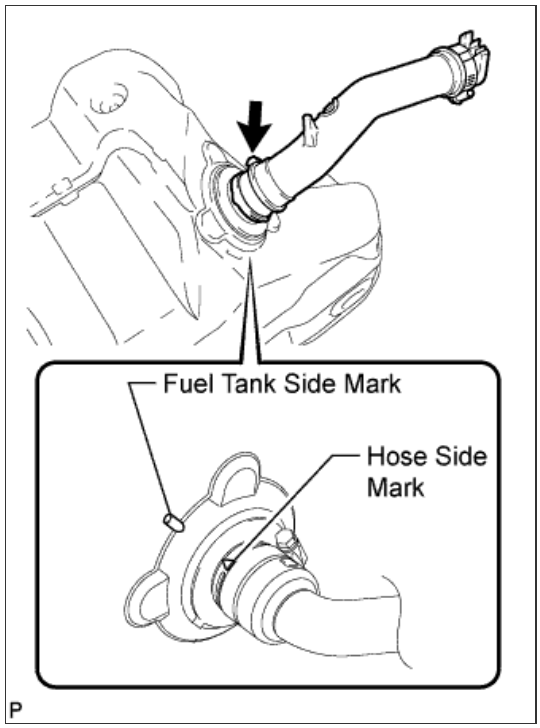


2. INSTALL FUEL TANK TO FILLER PIPE HOSE

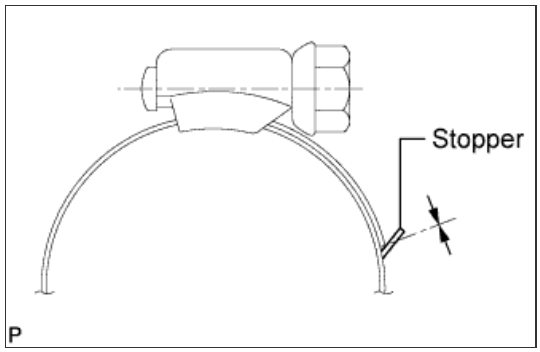
a. Install the hose to the fuel tank as shown in the illustration.

HINT:

- **Align the fuel tank side mark with the hose side mark when installing the hose.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**



3. INSTALL FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Apply a light coat of gasoline or grease to a new gasket, and install it to the fuel tank.

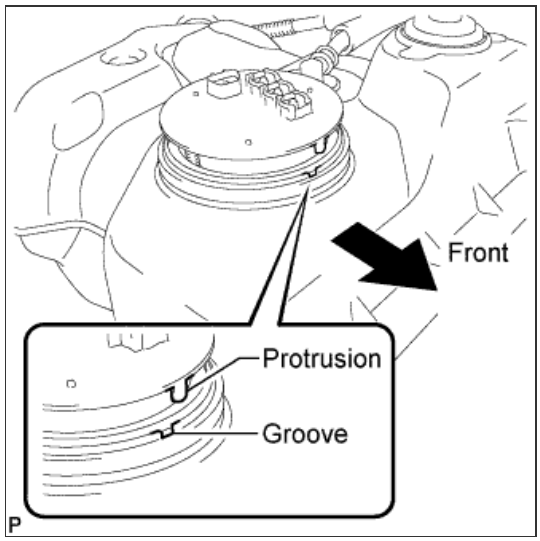
b. Install the fuel suction with pump and gauge tube into the fuel tank.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

HINT:

Align the protrusion of the fuel suction with pump and gauge tube with the groove of the fuel tank.



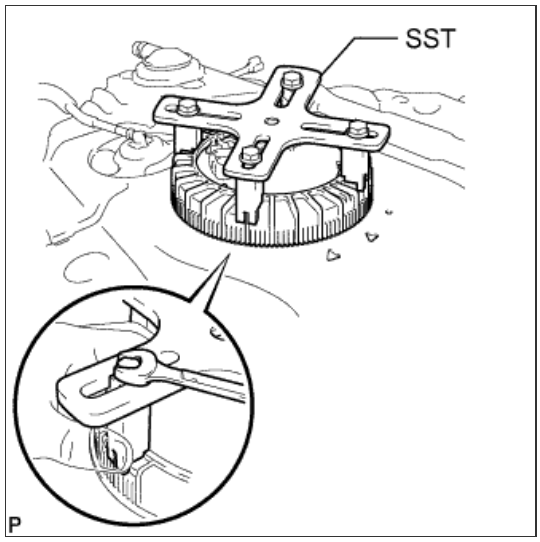
c. Put the retainer on the fuel tank. While holding the fuel suction with pump and gauge tube, tighten the retainer 1 complete turn by hand.

d. Set SST on the retainer.

SST
09808-14030

HINT:

- **Hold the fuel suction tube assembly upright by hand to ensure that the fuel suction tube gasket is not moved out of position.**
- **Engage the claws of SST securely with the fuel pump gauge retainer holes to secure SST.**
- **Install SST while pressing the claws of SST against the fuel pump gauge retainer (toward the center of SST).**

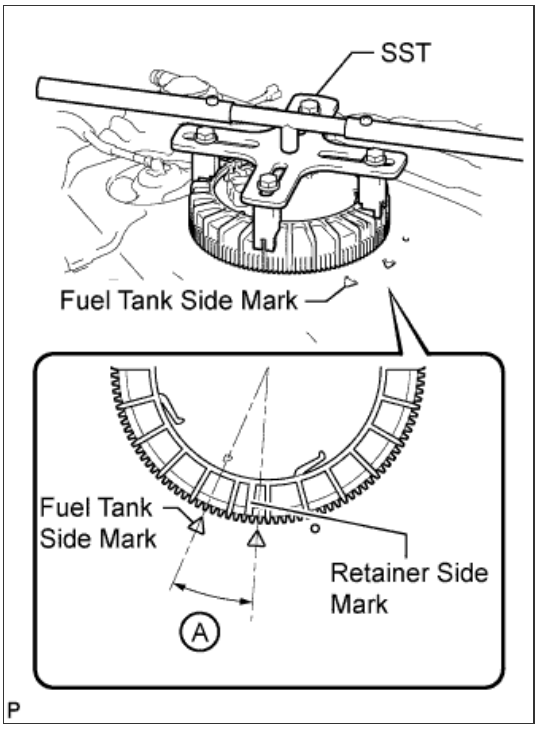


e. Using SST, tighten the retainer until the mark on the retainer is within range A on the fuel tank, as shown in the illustration.

SST
09808-14030

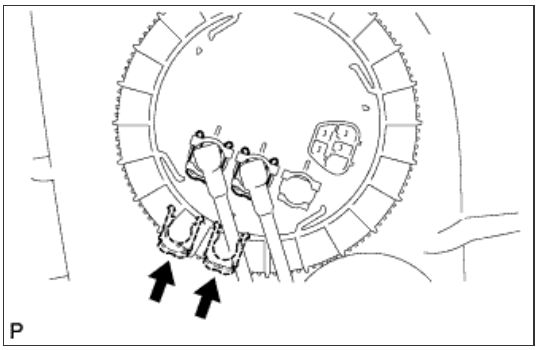
HINT:

Fit the tips of SST onto the ribs of the retainer.



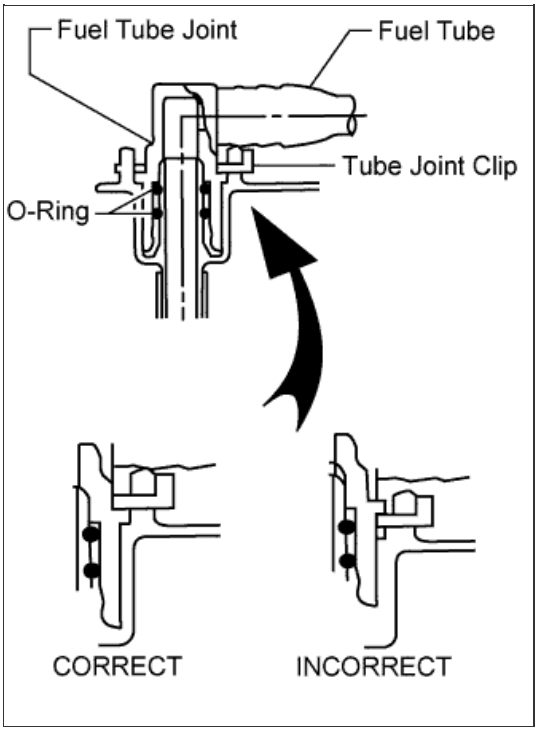
4. INSTALL FUEL TANK MAIN TUBE SUB-ASSEMBLY AND FUEL TANK RETURN TUBE SUB-ASSEMBLY (for Single Tank Type)

a. Install the 2 fuel tank tubes with the 2 tube joint clips.

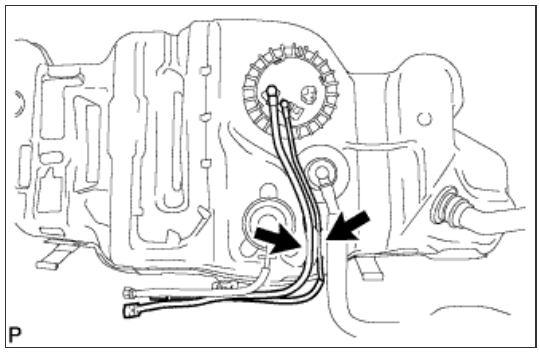


NOTICE:

- **Check that there are no scratches or foreign objects on the connecting parts.**
- **Check that the fuel tube joints are inserted securely.**
- **Check that the tube joint clips are on the collars of the fuel tube joints.**
- **After installing the tube joint clips, check that the fuel tube joints cannot be pulled off.**

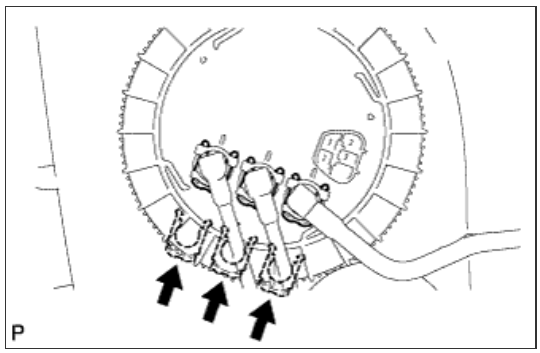


b. Install the 2 fuel tank tubes to the fuel tank.



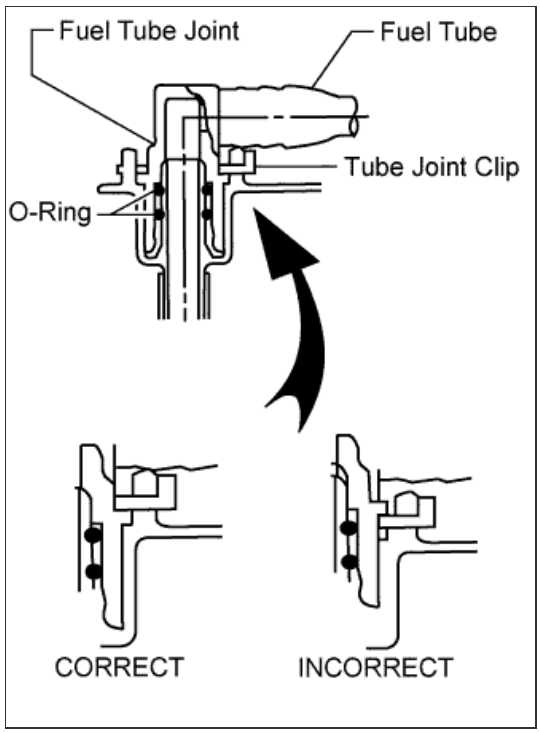
5. INSTALL FUEL TANK MAIN TUBE, FUEL TANK RETURN TUBE AND NO. 2 FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Install the 3 fuel tank tubes with the 3 tube joint clips.

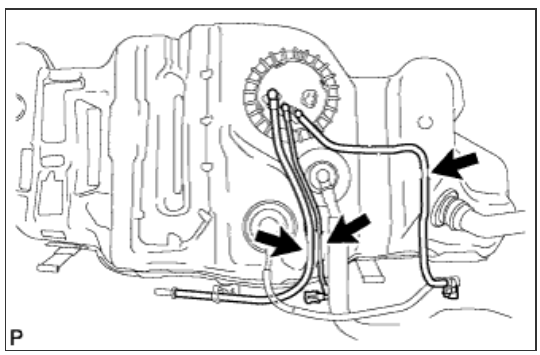


NOTICE:

- **Check that there are no scratches or foreign objects on the connecting parts.**
- **Check that the fuel tube joints are inserted securely.**
- **Check that the tube joint clips are on the collars of the fuel tube joints.**
- **After installing the tube joint clips, check that the fuel tube joints cannot be pulled off.**



b. Install the 3 fuel tank tubes to the fuel tank.



6. INSTALL FUEL TANK SUB-ASSEMBLY

a. Set the fuel tank on a transmission jack and raise the fuel tank.

NOTICE:

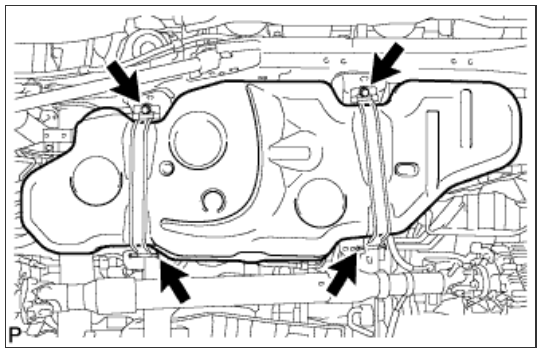
Do not allow the fuel tank to contact the vehicle, especially the differential.

b. Raise the transmission jack.

c. Install the 2 fuel tank bands with the 2 pins and 2 clips.

d. Connect the 2 fuel tank bands with the 2 bolts.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

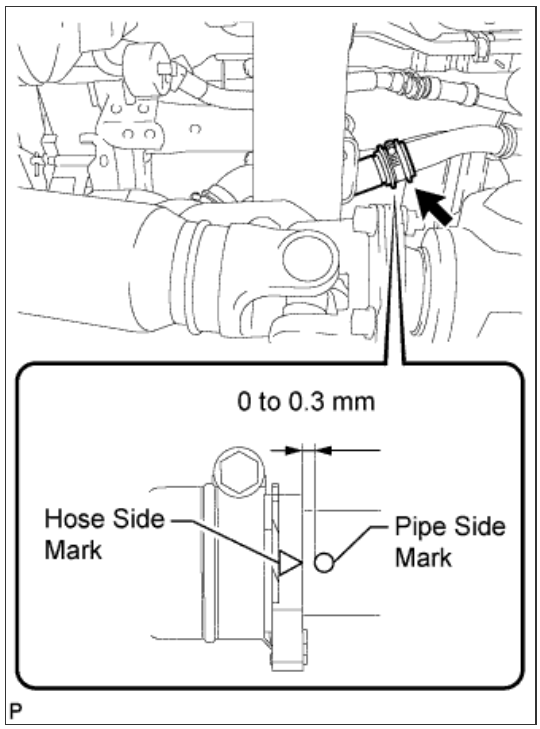


7. CONNECT FUEL TANK TO FILLER PIPE HOSE (for Single Tank Type)

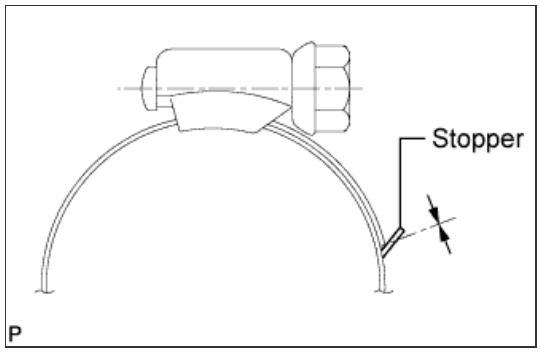
a. Connect the hose to the filler pipe as shown in the illustration.

HINT:

- **Install the hose so that the distance between the fuel tank inlet pipe side mark and fuel tank to filler pipe hose side mark is 0 to 0.3 mm (0 to 0.0118 in.) as shown in the illustration.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**

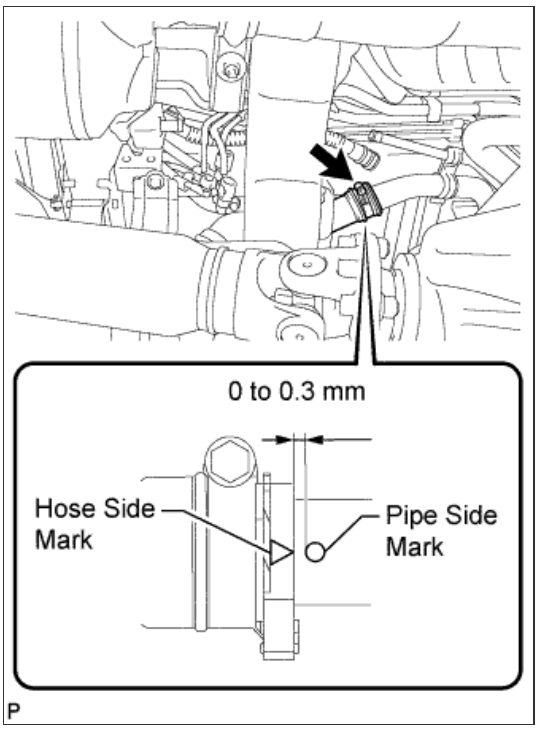


8. CONNECT FUEL TANK TO FILLER PIPE HOSE (for Double Tank Type)

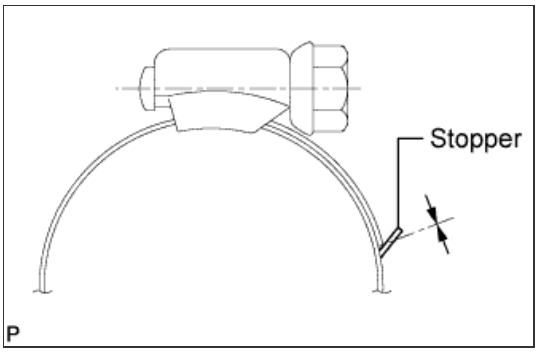
a. Connect the hose to the filler pipe as shown in the illustration.

HINT:

- **Install the hose so that the distance between the fuel tank inlet pipe side mark and fuel tank to filler pipe hose side mark is 0 to 0.3 mm (0 to 0.0118 in.) as shown in the illustration.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**



9. CONNECT FUEL TANK BREATHER TUBE (for Single Tank Type)

a. Connect the fuel tank breather tube to the filler pipe and push the retainer.

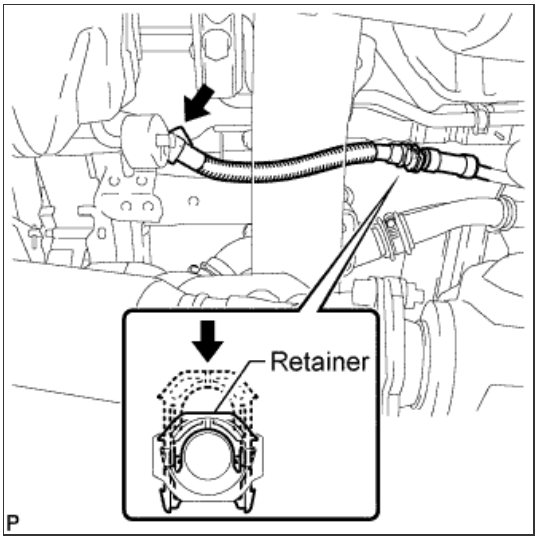
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



10. CONNECT FUEL TANK BREATHER TUBE (for Double Tank Type)

a. Connect the fuel tank breather tube to the filler pipe and push the retainer.

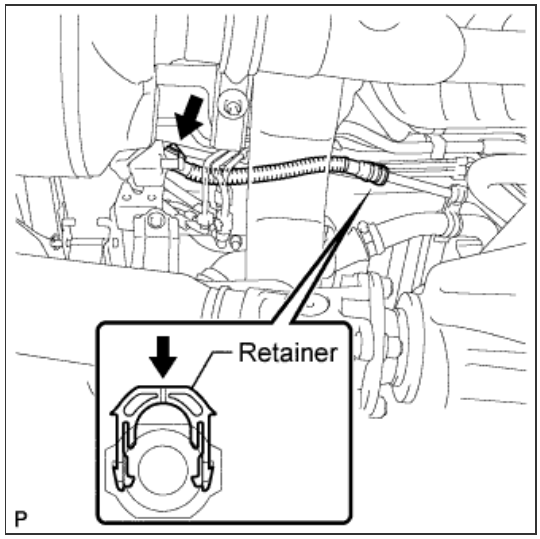
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



11. CONNECT NO. 2 FUEL MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Connect the fuel main tube and push the retainer.

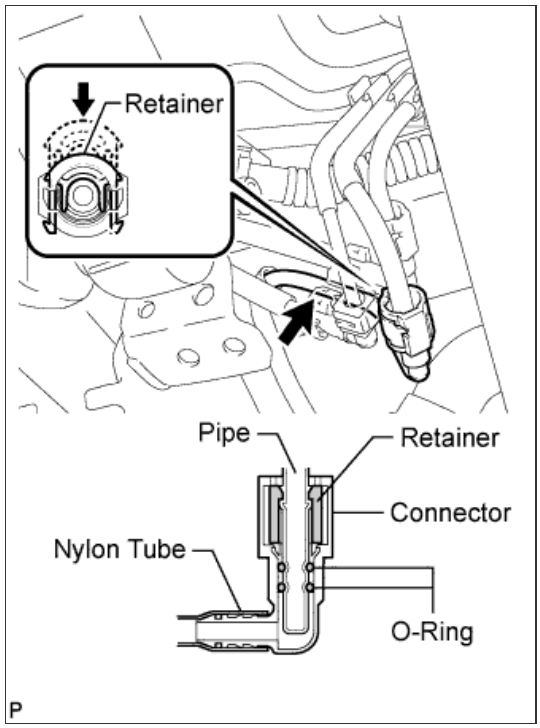
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



12. CONNECT NO. 2 FUEL TANK BREATHER TUBE (for Double Tank Type)

a. Connect the fuel tank breather tube and push the retainer.

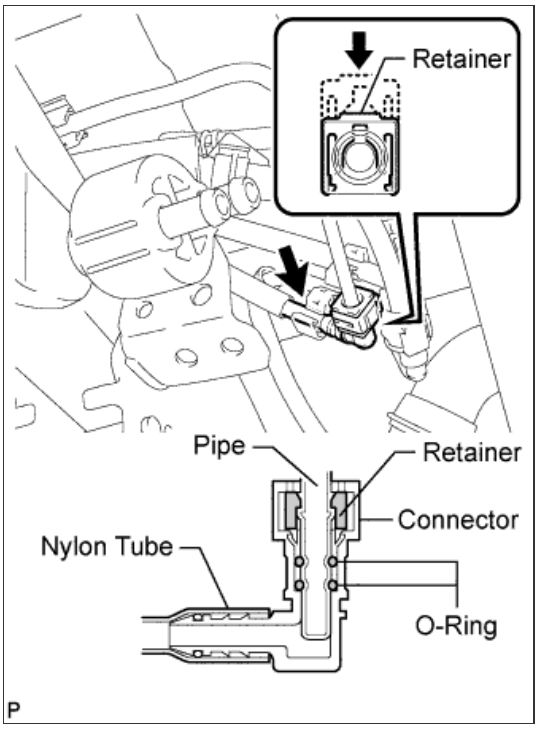
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



13. CONNECT FUEL TANK RETURN TUBE (for Single Tank Type)

a. Connect the fuel tank return tube and push the retainer.

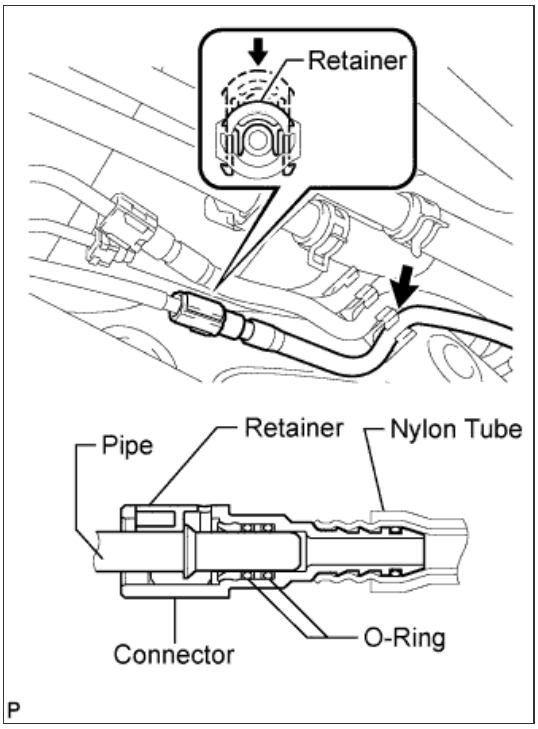
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



14. CONNECT FUEL TANK RETURN TUBE (for Double Tank Type)

a. Connect the fuel tank return tube and push the retainer.

HINT:

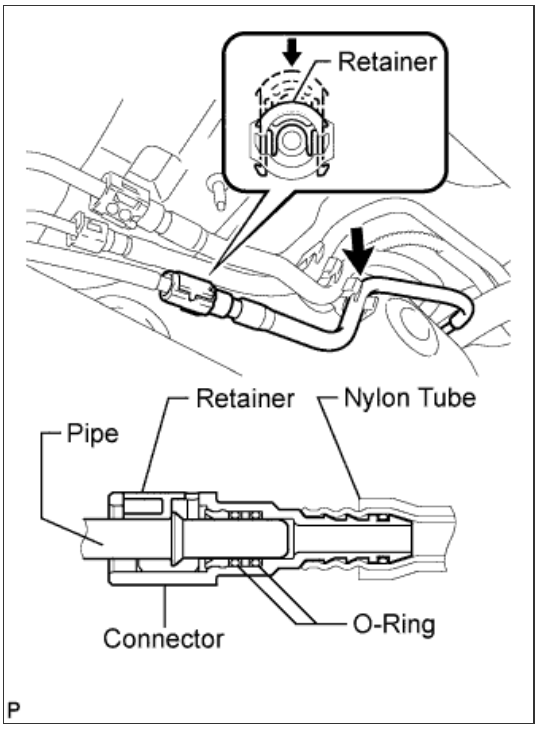
Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**

- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



15. CONNECT NO. 2 FUEL TANK BREATHER TUBE (for Single Tank Type)

a. Connect the fuel tank breather tube and push the retainer.

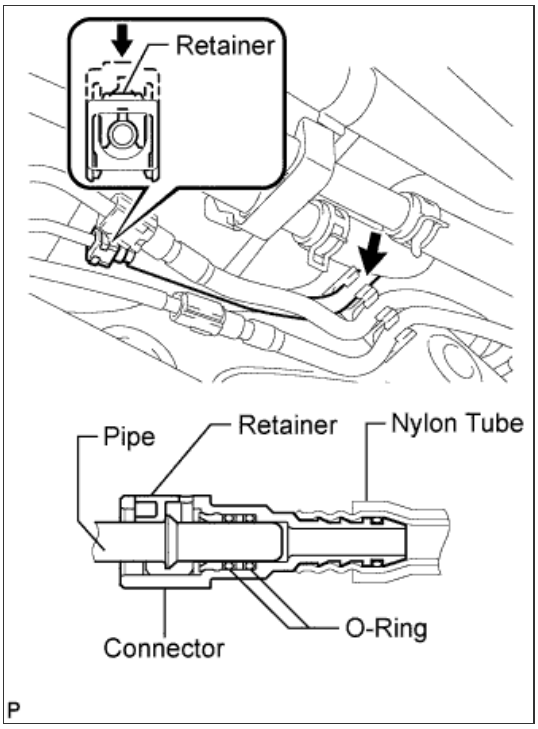
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



16. CONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Single Tank Type)

a. Connect the fuel tank main tube and push the retainer.

HINT:

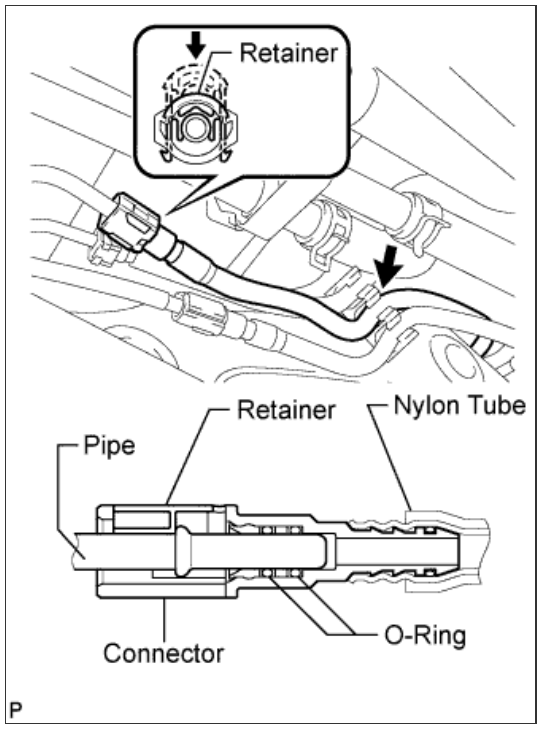
Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**

- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

b. Attach the fuel tube clamp.



17. CONNECT FUEL TANK MAIN TUBE SUB-ASSEMBLY (for Double Tank Type)

a. Connect the fuel tank main tube and push the retainer.

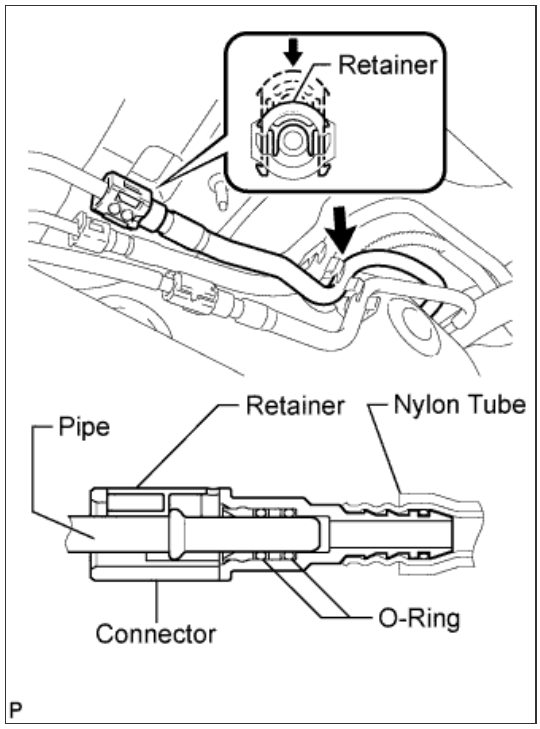
HINT:

Push the parts together firmly until a "click" sound is heard.

NOTICE:

- **Before installing the tube connectors to the pipes, check if there is any damage or foreign matter in the connectors.**
- **After the connection, check if the connectors and pipes are securely connected by trying to pull them apart.**

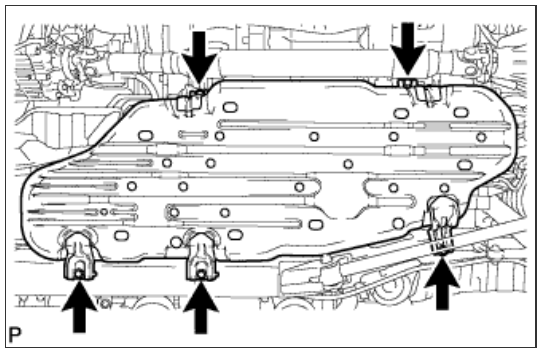
b. Attach the fuel tube clamp.



18. INSTALL NO. 1 FUEL TANK PROTECTOR SUB-ASSEMBLY

a. Install the tank protector with the 5 bolts.

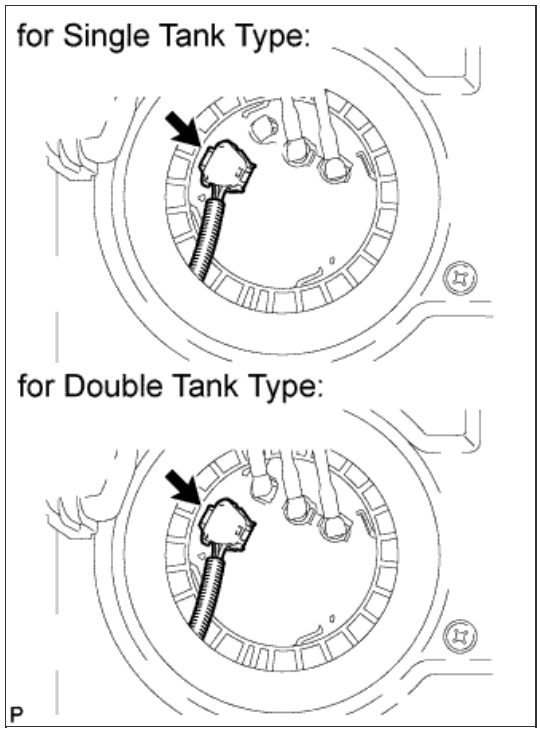
Torque:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }



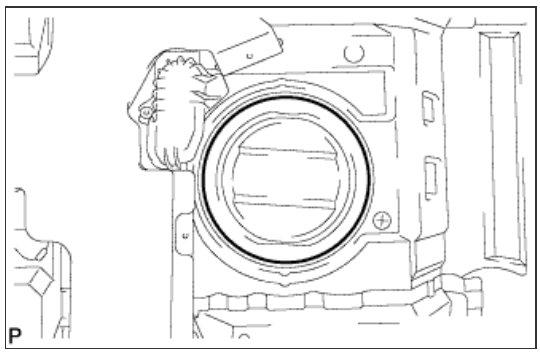
19. INSTALL FUEL TANK CAP ASSEMBLY

20. INSTALL REAR FLOOR NO. 2 SERVICE HOLE COVER

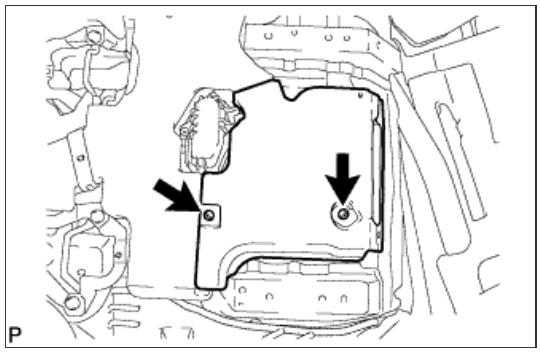
a. Connect the fuel pump and fuel sender gauge connector.



b. Install the service hole cover with new butyl tape.



c. Install the air duct and 2 screws.



21. INSTALL FRONT FLOOR CARPET ASSEMBLY

22. INSTALL REAR SEAT ASSEMBLY

a. Install the rear No. 1 seat assembly and rear No. 2 seat assembly (Click here).

23. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

24. ADD FUEL

25. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

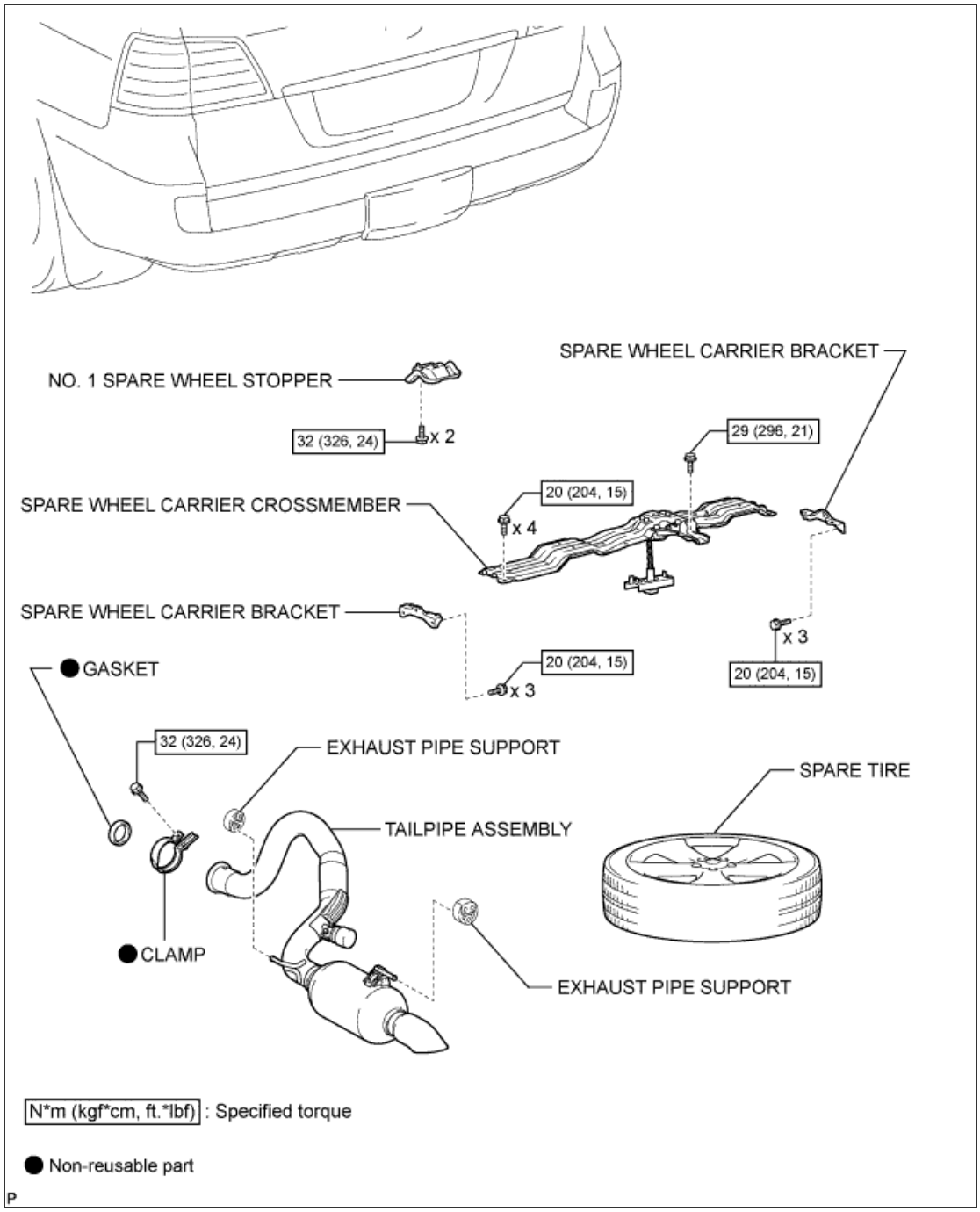
NOTICE:

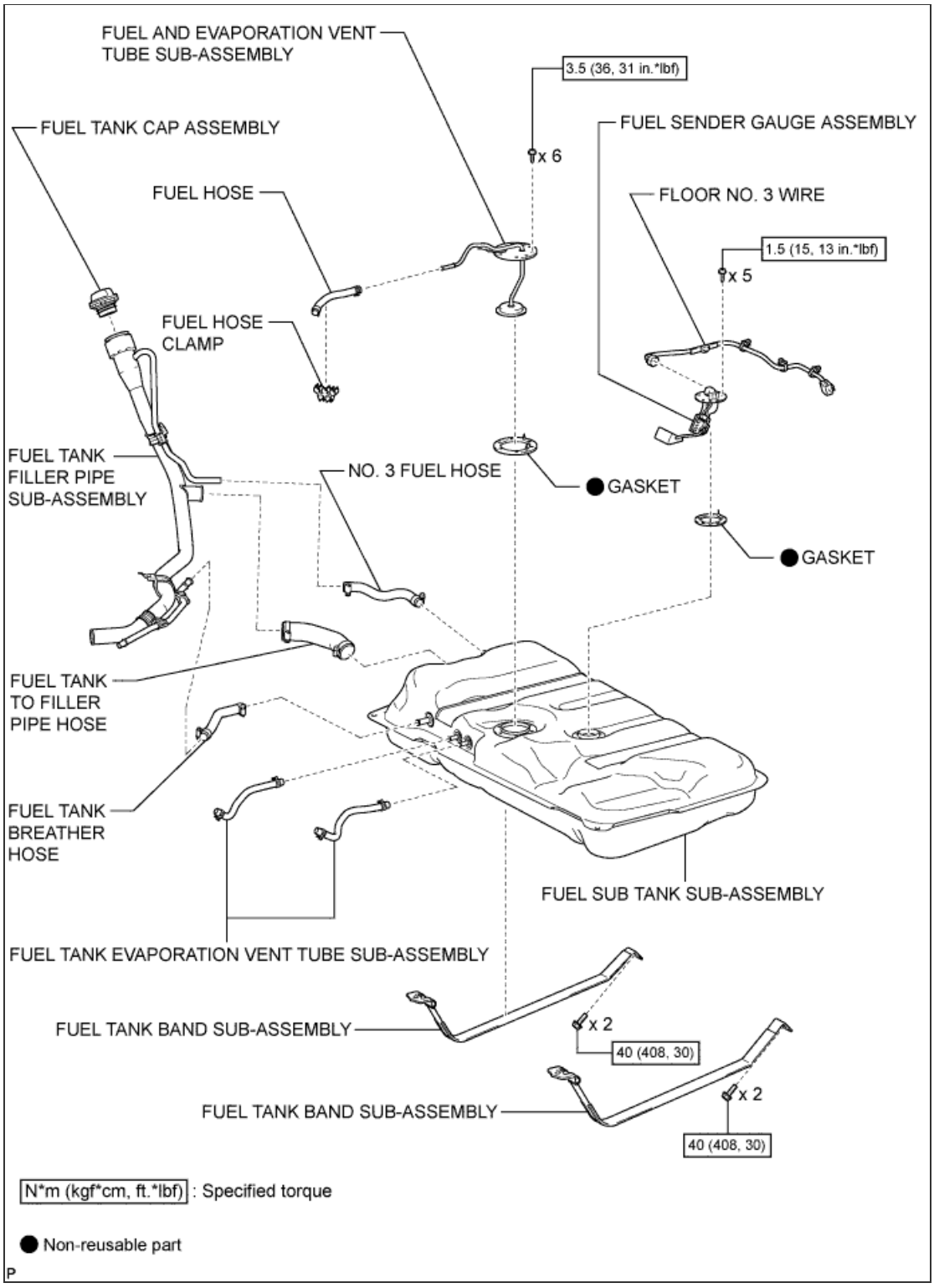
Do not start the engine.

c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

for Preparation [Click here]




FUEL AND EVAPORATION VENT TUBE SUB-ASSEMBLY
3.5 (36, 31 in.*lbf)
FUEL TANK CAP ASSEMBLY
x 6
FUEL SENDER GAUGE ASSEMBLY
FUEL HOSE
FLOOR NO. 3 WIRE
1.5 (15, 13 in.*lbf)
x 5
FUEL HOSE CLAMP
FUEL TANK FILLER PIPE SUB-ASSEMBLY
NO. 3 FUEL HOSE
GASKET
GASKET
FUEL TANK TO FILLER PIPE HOSE
FUEL TANK BREATHER HOSE
FUEL SUB TANK SUB-ASSEMBLY
FUEL TANK EVAPORATION VENT TUBE SUB-ASSEMBLY
FUEL TANK BAND SUB-ASSEMBLY
x 2
40 (408, 30)
FUEL TANK BAND SUB-ASSEMBLY
x 2
40 (408, 30)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

1. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

3. REMOVE SPARE TIRE

4. REMOVE TAILPIPE ASSEMBLY

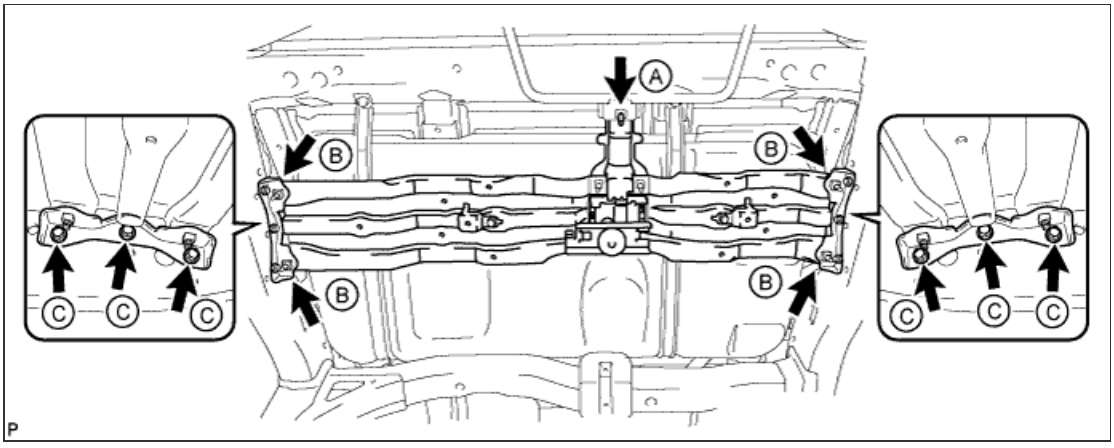
a. Remove the bolt, clamp and gasket.

b. Remove the tailpipe from the 2 exhaust pipe supports.

c. Remove the bolt and clamp, and then disconnect the tailpipe from the center exhaust pipe.

5. REMOVE SPARE WHEEL CARRIER CROSSMEMBER AND SPARE WHEEL CARRIER BRACKET

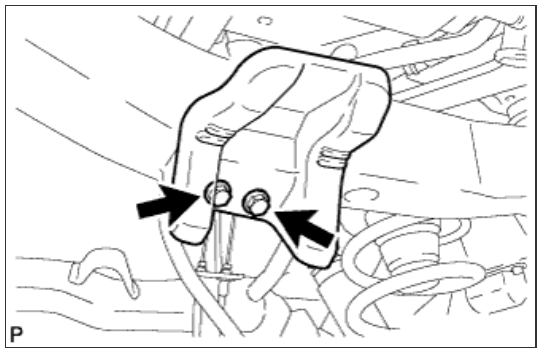
a. Remove the bolt labeled A, and then loosen the 4 bolts labeled B.



b. Slightly raise the spare wheel carrier crossmember, and then remove the 6 bolts labeled C, spare wheel carrier crossmember and 2 brackets.

6. REMOVE NO. 1 SPARE WHEEL STOPPER

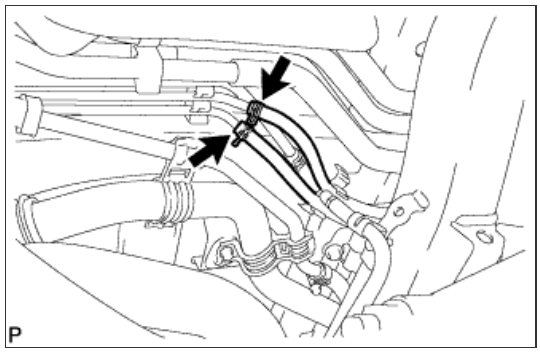
a. Remove the 2 bolts and spare wheel stopper.



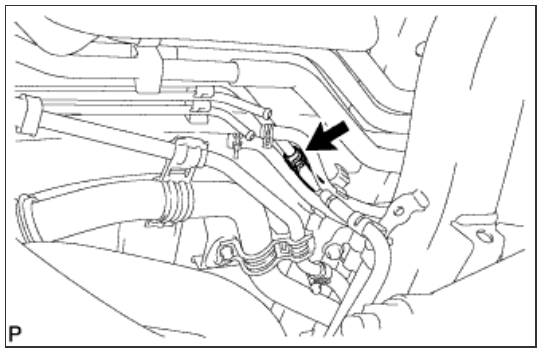
7. REMOVE FUEL TANK CAP ASSEMBLY

8. DISCONNECT FUEL TANK EVAPORATION VENT TUBE SUB-ASSEMBLY

a. Disconnect the 2 fuel tank evaporation vent tubes.

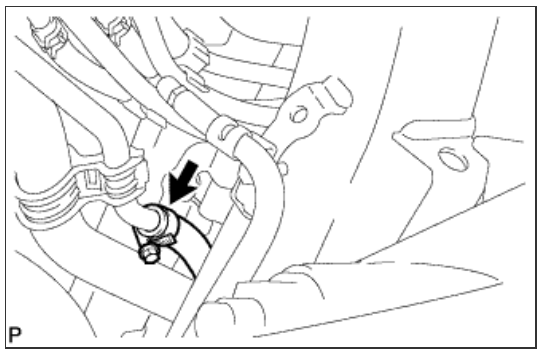


9. DISCONNECT FUEL HOSE



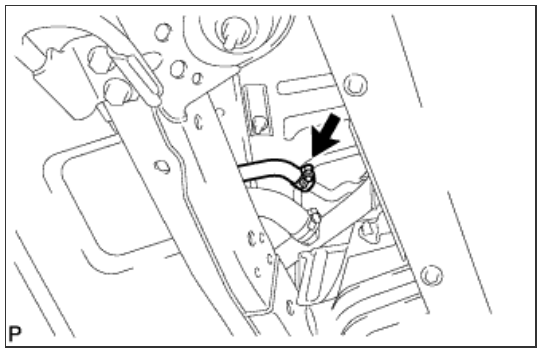
10. DISCONNECT FUEL TANK BREATHER HOSE

a. Disconnect the breather hose from the filler pipe.



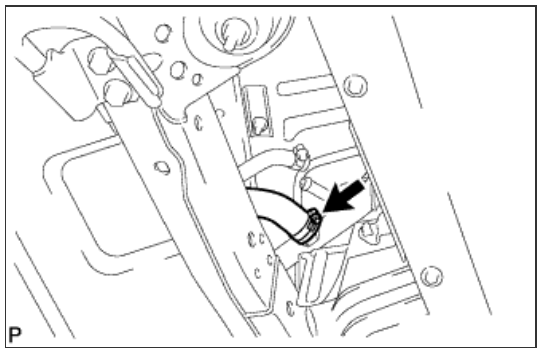
11. DISCONNECT NO. 3 FUEL HOSE

a. Disconnect the fuel hose from the filler pipe.



12. DISCONNECT FUEL TANK TO FILLER PIPE HOSE

a. Disconnect the hose from the filler pipe.

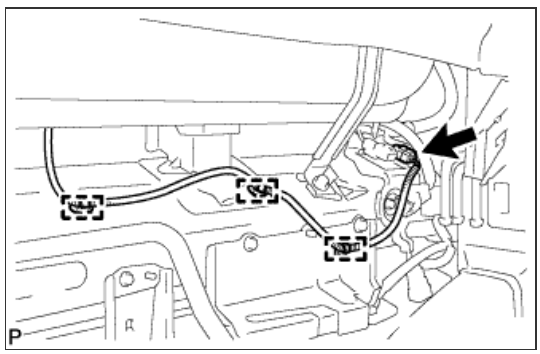


13. REMOVE FUEL SUB TANK SUB-ASSEMBLY

a. Disconnect the floor No. 3 wire connector.

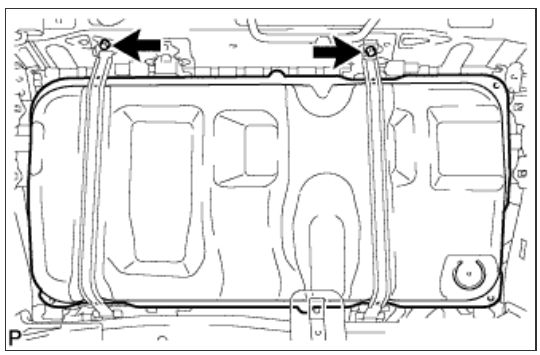
b. Using a clip remover, detach the 3 wire harness clamps.

c. Set a transmission jack underneath the fuel sub tank.



d. Remove the 2 bolts and disconnect the 2 fuel tank bands.

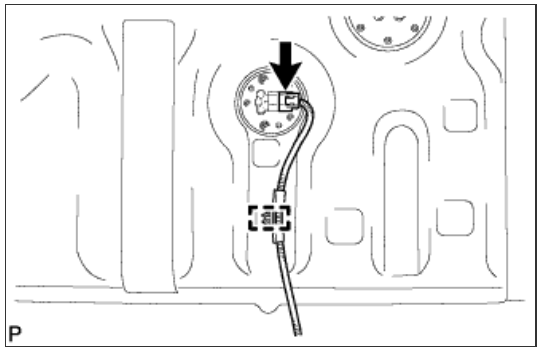
e. Remove the fuel sub tank.



14. REMOVE FLOOR NO. 3 WIRE

a. Disconnect the sender gauge connector.

b. Using a clip remover, detach the wire harness clamp.



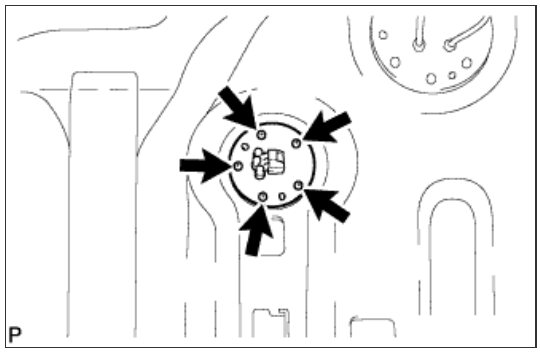
15. REMOVE FUEL SENDER GAUGE ASSEMBLY

a. Remove the 5 screws and sender gauge.

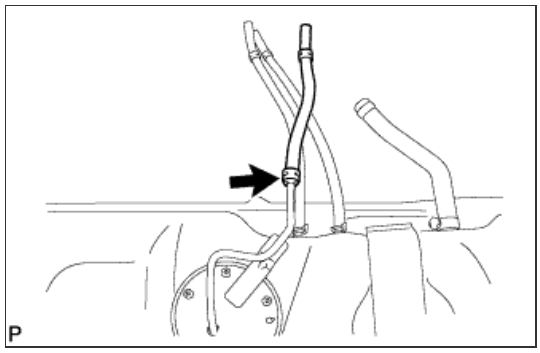
NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

b. Remove the gasket from the sender gauge.

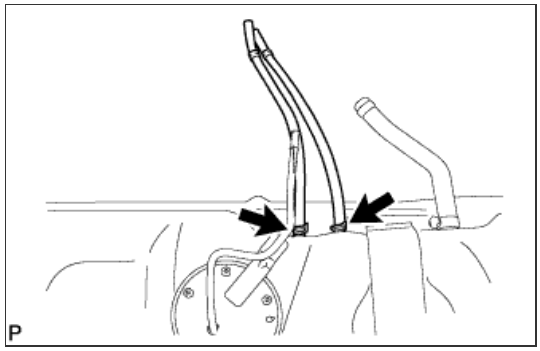


16. REMOVE FUEL HOSE



17. REMOVE FUEL TANK EVAPORATION VENT TUBE SUB-ASSEMBLY

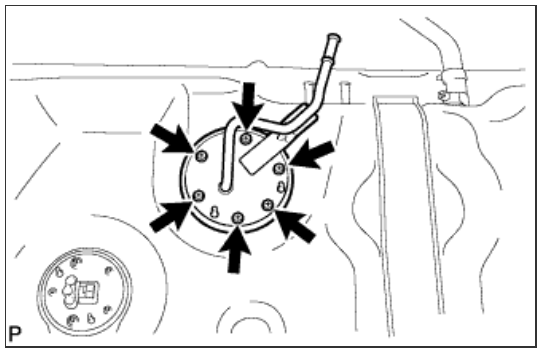
a. Remove the 2 fuel tank evaporation vent tubes.



18. REMOVE FUEL AND EVAPORATION VENT TUBE SUB-ASSEMBLY

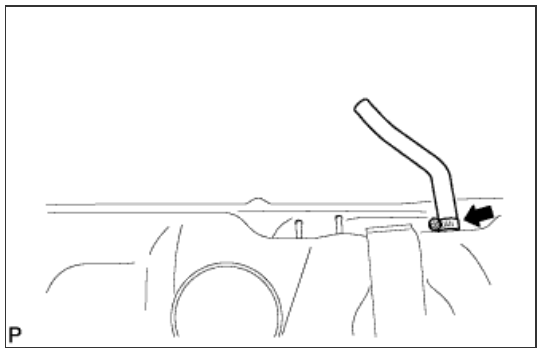
a. Remove the 6 bolts and fuel and evaporation vent tube.

b. Remove the gasket from the fuel and evaporation vent tube.



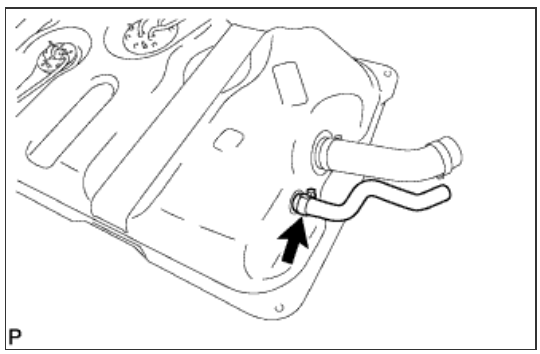
19. REMOVE FUEL TANK BREATHER HOSE

a. Remove the breather hose from the fuel sub tank.



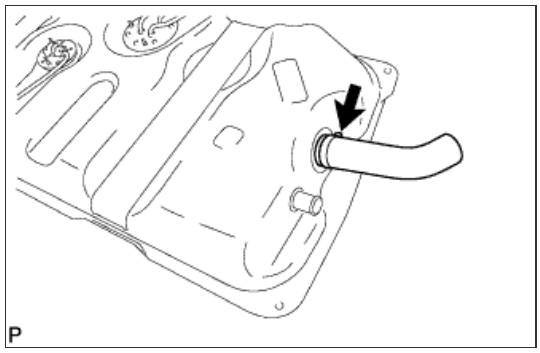
20. REMOVE NO. 3 FUEL HOSE

a. Remove the fuel hose from the fuel sub tank.



21. REMOVE FUEL TANK TO FILLER PIPE HOSE

a. Remove the hose from the fuel sub tank.


P

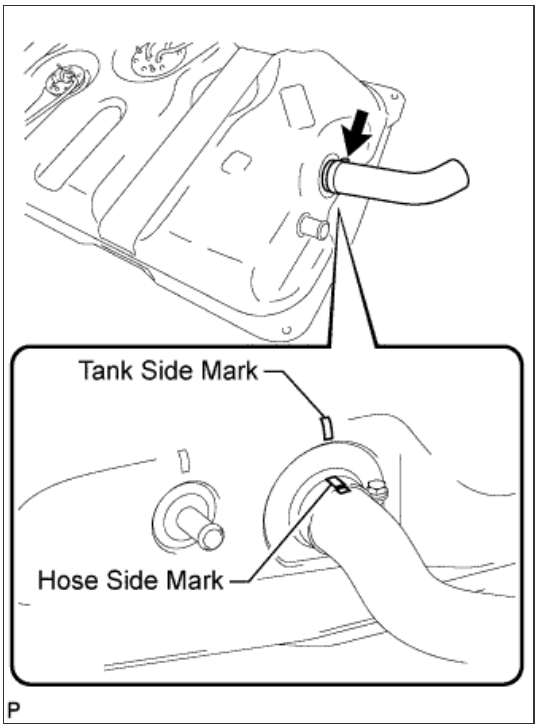
for Preparation Click here

1. INSTALL FUEL TANK TO FILLER PIPE HOSE

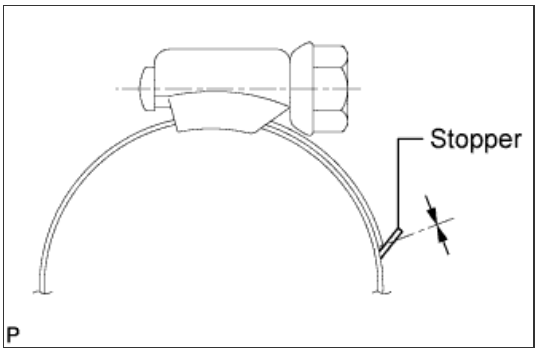
a. Install the hose to the fuel sub tank as shown in the illustration.

HINT:

- **Align the fuel sub tank side mark with the hose side mark when installing the hose.**



- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**

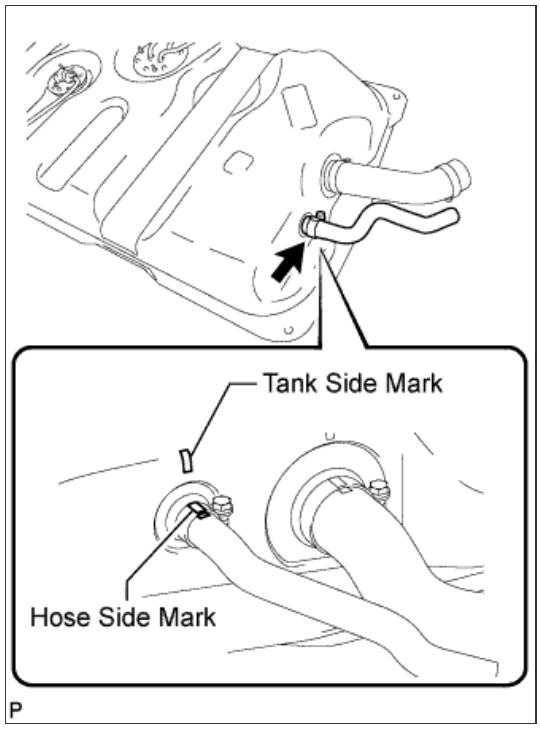


2. INSTALL NO. 3 FUEL HOSE

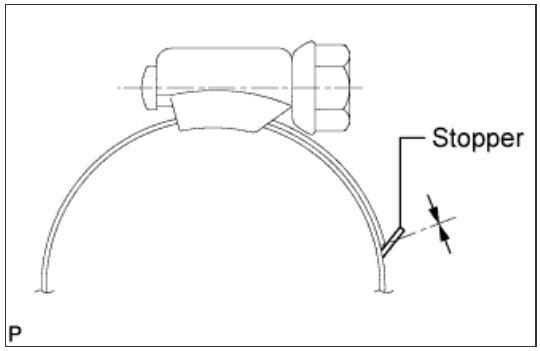
a. Install the fuel hose to the fuel sub tank as shown in the illustration.

HINT:

- **Align the fuel sub tank side mark with the hose side mark when installing the hose.**

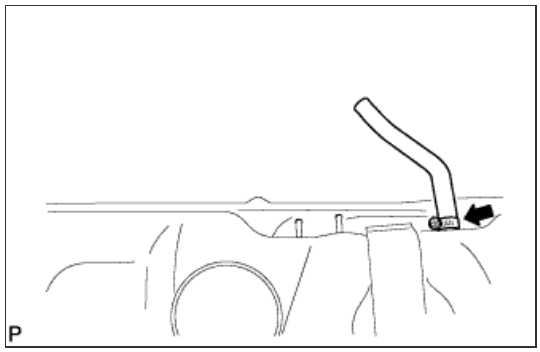


- **Tighten the hose clamp until the end of the hose clamp contacts the stopper as shown in the illustration.**



3. INSTALL FUEL TANK BREATHER HOSE

a. Install the breather hose to the fuel sub tank.

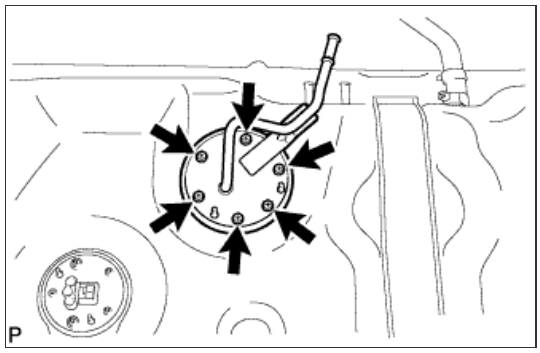


4. INSTALL FUEL AND EVAPORATION VENT TUBE SUB-ASSEMBLY

a. Install a new gasket to the fuel and evaporation vent tube.

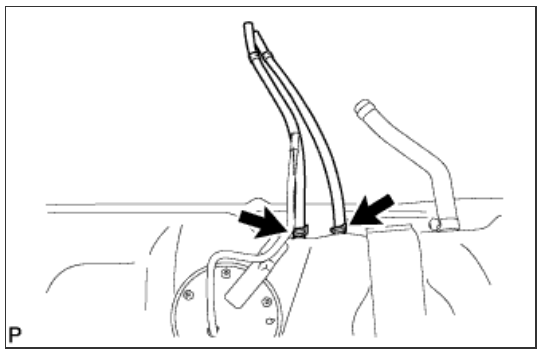
b. Install the fuel and evaporation vent tube with the 6 bolts.

Torque:
3.5 N*m{ 36 kgf*cm , 31 in.*lbf }

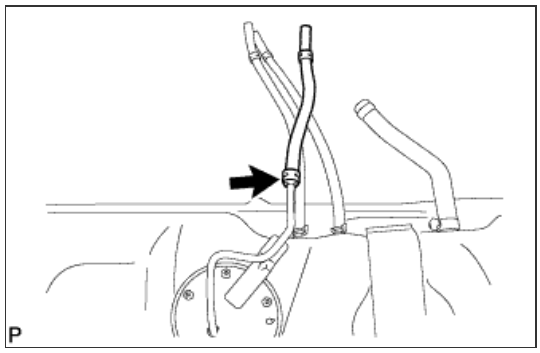


5. INSTALL FUEL TANK EVAPORATION VENT TUBE SUB-ASSEMBLY

a. Install the 2 fuel tank evaporation vent tubes.



6. INSTALL FUEL HOSE



7. INSTALL FUEL SENDER GAUGE ASSEMBLY

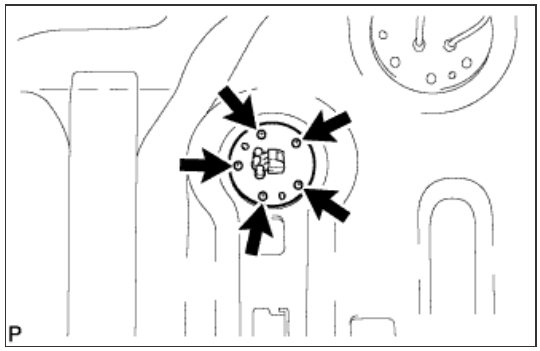
a. Install a new gasket to the sender gauge.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

b. Install the sender gauge with the 5 screws.

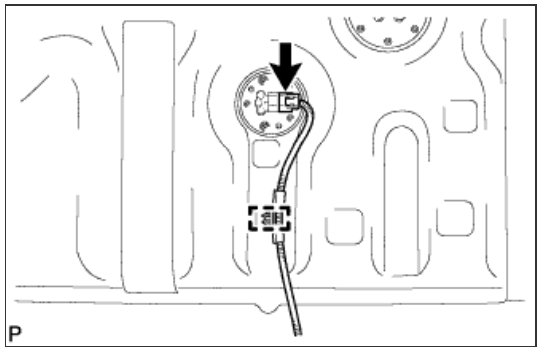
Torque:
1.5 N*m{ 15 kgf*cm , 13 in.*lbf }



8. INSTALL FLOOR NO. 3 WIRE

a. Attach the wire harness clamp to the fuel sub tank.

b. Connect the sender gauge connector.

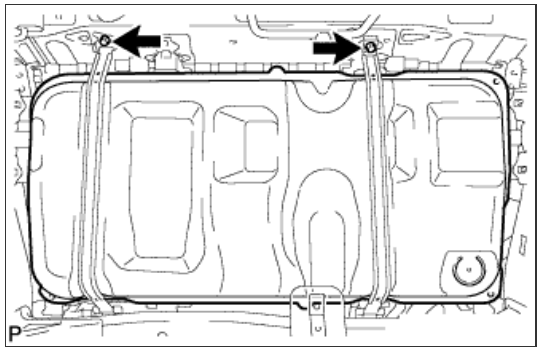


9. INSTALL FUEL SUB TANK SUB-ASSEMBLY

a. Set the fuel sub tank on a transmission jack and raise the fuel sub tank.

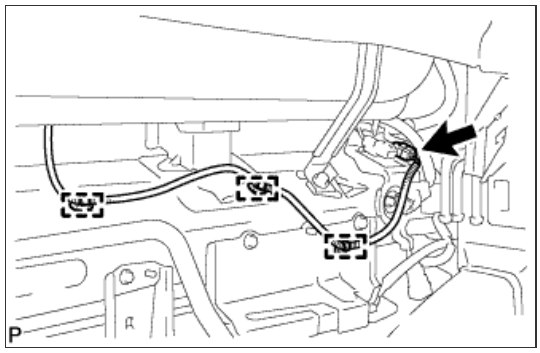
b. Connect the 2 fuel tank bands with the 2 bolts.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



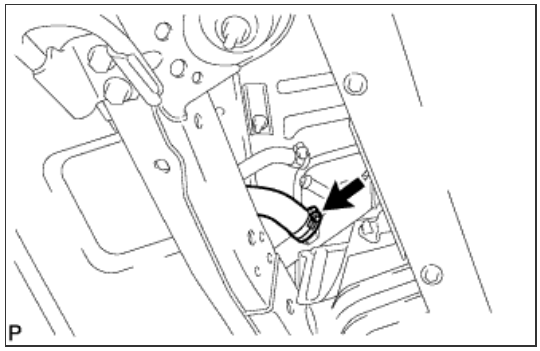
c. Connect the floor No. 3 wire connector.

d. Attach the 3 wire harness clamps.



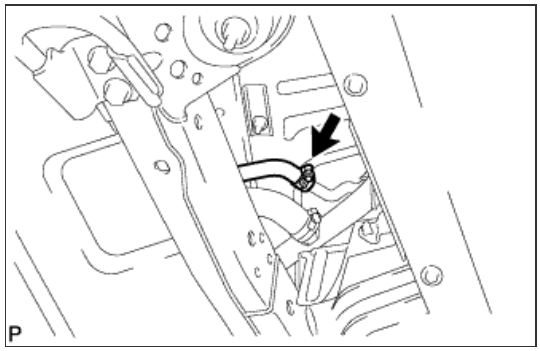
10. CONNECT FUEL TANK TO FILLER PIPE HOSE

a. Connect the hose to the filler pipe.



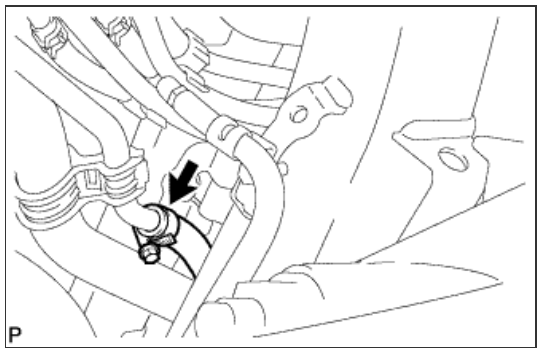
11. CONNECT NO. 3 FUEL HOSE

a. Connect the fuel hose to the filler pipe.

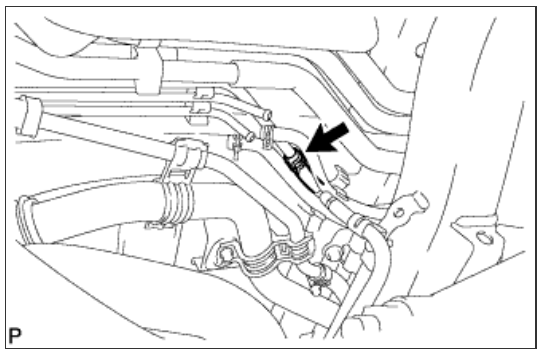


12. CONNECT FUEL TANK BREATHER HOSE

a. Connect the breather hose to the filler pipe.

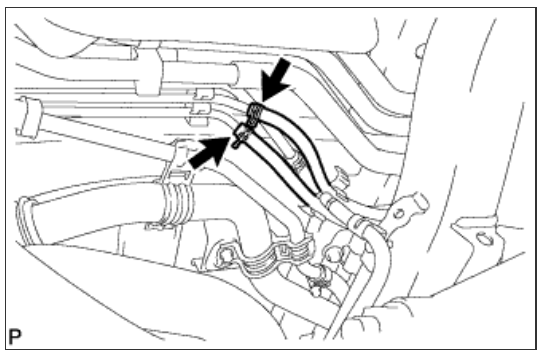


13. CONNECT FUEL HOSE



14. CONNECT FUEL TANK EVAPORATION VENT TUBE SUB-ASSEMBLY

a. Connect the 2 fuel tubes.

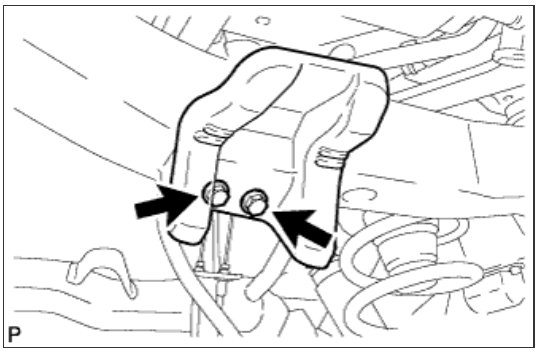


15. INSTALL FUEL TANK CAP ASSEMBLY

16. INSTALL NO. 1 SPARE WHEEL STOPPER

a. Install the spare wheel stopper with the 2 bolts.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }



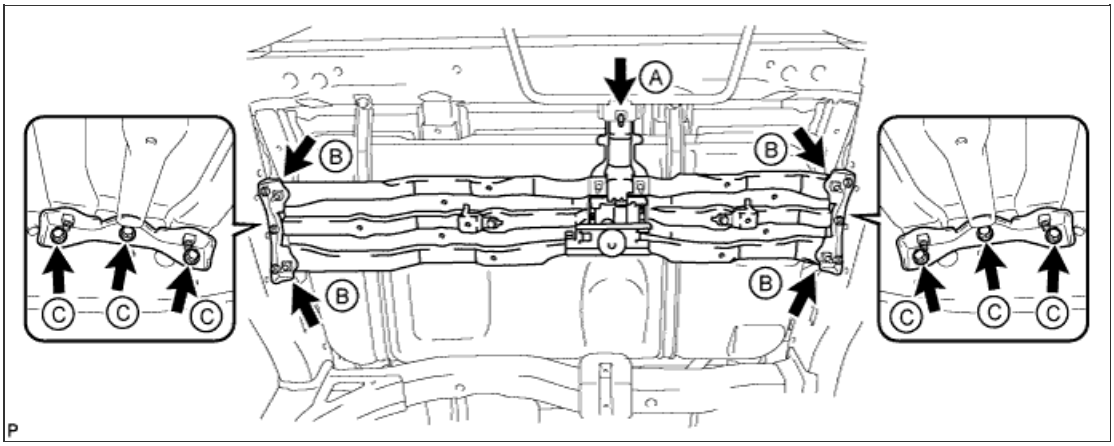
17. INSTALL SPARE WHEEL CARRIER CROSSMEMBER AND SPARE WHEEL CARRIER BRACKET

a. Install the spare wheel carrier crossmember and 2 brackets to the vehicle with the 6 bolts labeled C.

Torque:
for bolt C:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }

b. Temporarily install the bolt labeled A, and then tighten the bolt labeled A and bolts labeled B.

Torque:
for bolt A:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }
for bolt B:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }



18. INSTALL TAILPIPE ASSEMBLY

a. Install the tailpipe to the 2 exhaust pipe supports.

b. Install a new gasket to the center exhaust pipe.

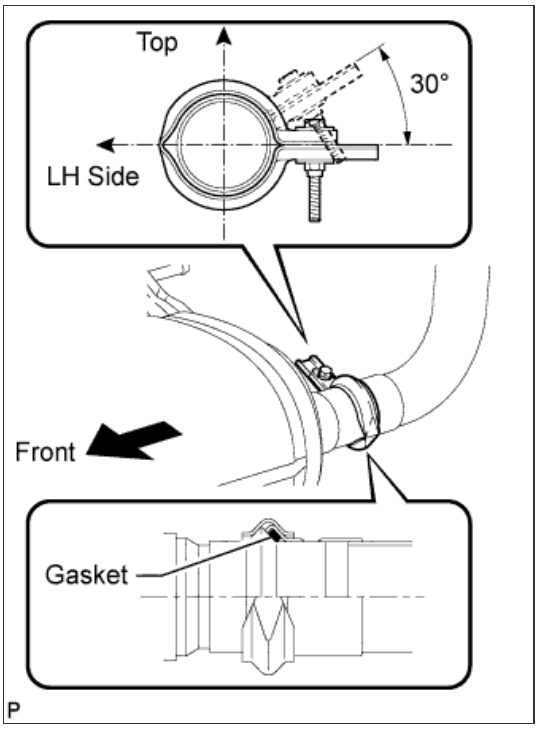
c. Connect the tailpipe to the center exhaust pipe.

d. Attach a new clamp to the tailpipe and center exhaust pipe. Then install the bolt to the clamp.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }

HINT:

Install the clamp within the angle range shown in the illustration.



19. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

20. INSPECT FOR FUEL LEAK

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG) and intelligent tester on.

NOTICE:

Do not start the engine.

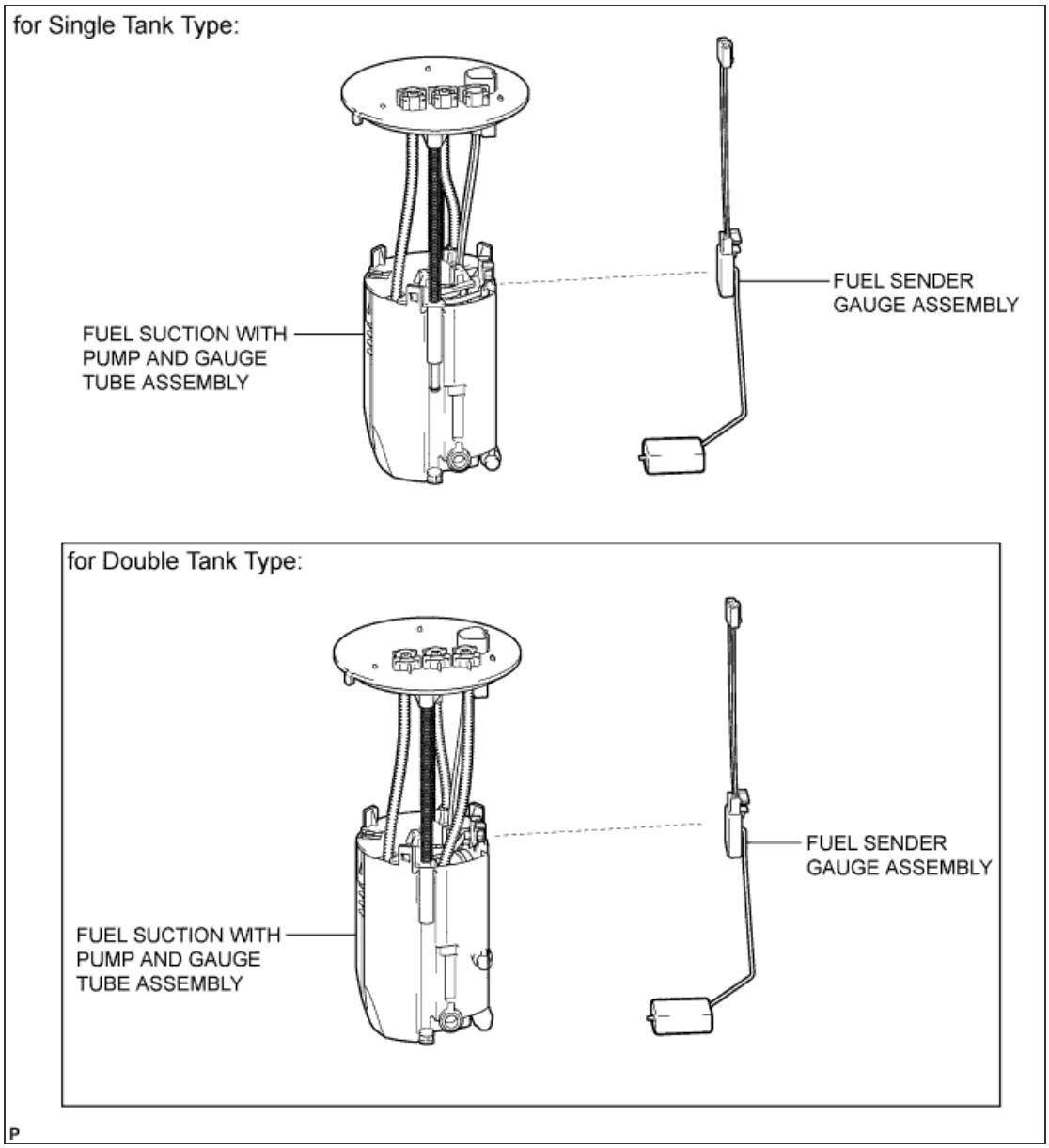
c. Enter the following menus: Powertrain / Engine and ECT / Active Test / Control the Fuel Pump Speed Control.

d. Check that there are no fuel leaks after doing maintenance anywhere on the fuel system.

21. INSPECT FOR EXHAUST GAS LEAK

22. INSTALL SPARE TIRE

for Preparation Click here



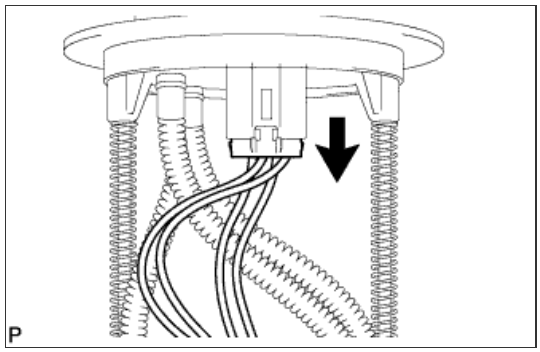
for Preparation Click here

1. REMOVE FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

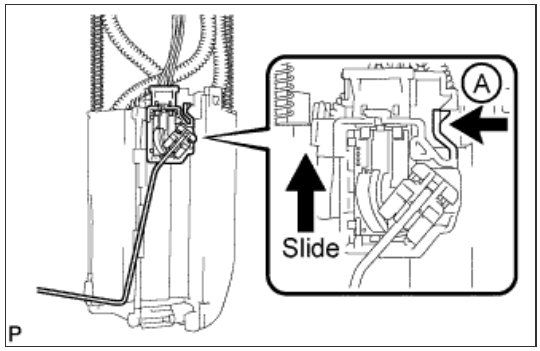
a. Remove the fuel suction with pump and gauge tube assembly (Click here).

2. REMOVE FUEL SENDER GAUGE ASSEMBLY

a. Disconnect the fuel sender gauge connector.



b. Press down on the sender gauge claw labeled A. Then slide the sender gauge upward to remove it.



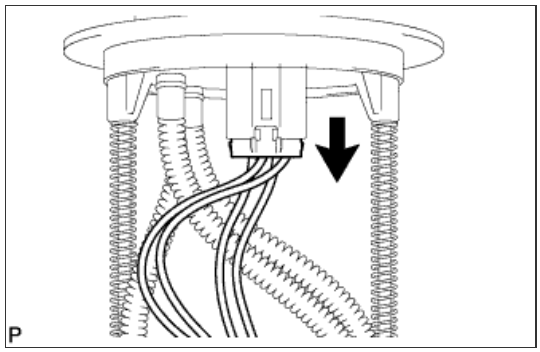
for Preparation Click here

1. REMOVE FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

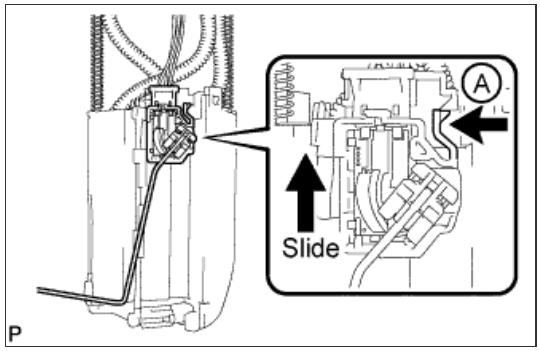
a. Remove the fuel suction with pump and gauge tube assembly (Click here).

2. REMOVE FUEL SENDER GAUGE ASSEMBLY

a. Disconnect the fuel sender gauge connector.



b. Press down on the sender gauge claw labeled A. Then slide the sender gauge upward to remove it.



for Preparation Click here

1. INSPECT FUEL SENDER GAUGE ASSEMBLY

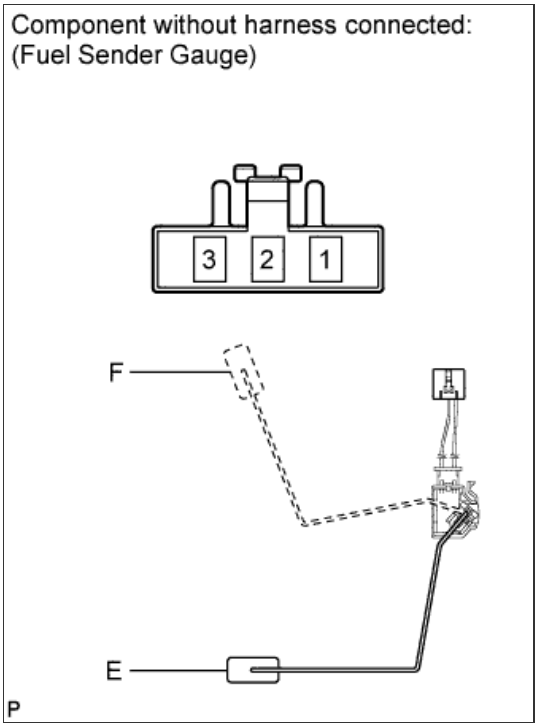
a. Check that the float moves smoothly between F and E.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 3	Float level is F (upper)	12 to 18 Ω
	Float level is E (lower)	405 to 415 Ω

If the result is not as specified, replace the fuel sender gauge assembly.

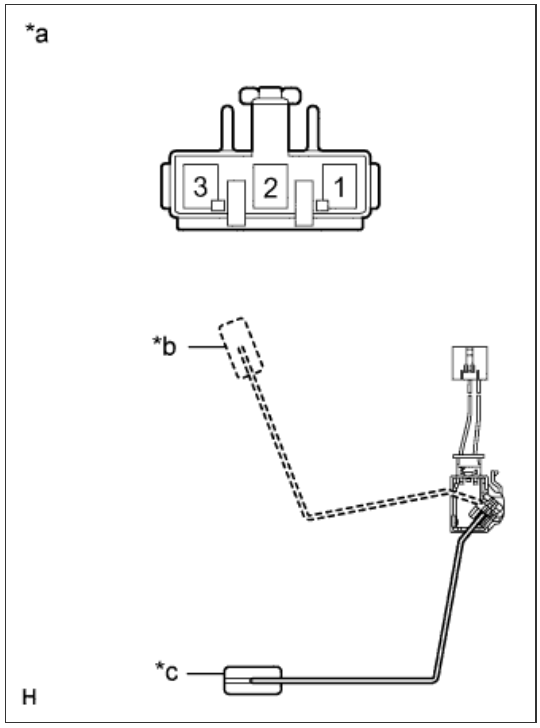


for Preparation Click here

1. INSPECT FUEL SENDER GAUGE ASSEMBLY

Text in Illustration

*a	Component without harness connected (Fuel Sender Gauge)
*b	F (Upper)
*c	E (Lower)



a. Check that the float moves smoothly between F and E.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

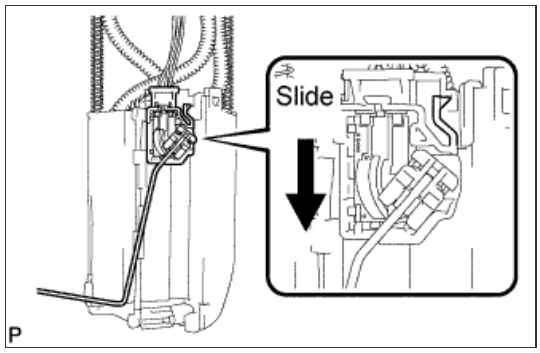
Tester Connection	Condition	Specified Condition
2 - 3	Float level is F (upper)	13.5 to 16.5 Ω
	Float level is E (lower)	405.5 to 414.5 Ω

If the result is not as specified, replace the fuel sender gauge assembly.

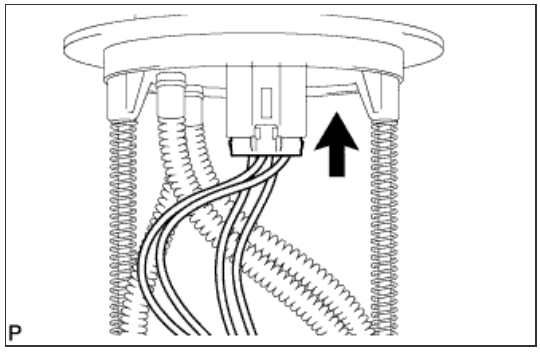
for Preparation Click here

1. INSTALL FUEL SENDER GAUGE ASSEMBLY

a. Set the sender gauge to the fuel sub-tank. Then slide the sender gauge downward to install it.



b. Connect the fuel sender gauge connector.



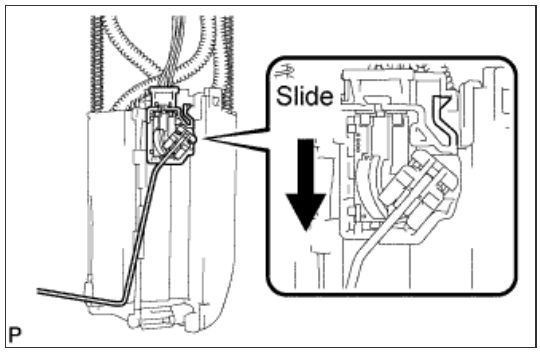
2. INSTALL FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Install the fuel suction with pump and gauge tube assembly (Click here).

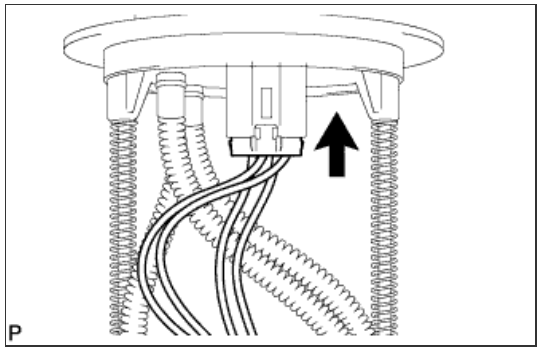
for Preparation Click here

1. INSTALL FUEL SENDER GAUGE ASSEMBLY

a. Set the sender gauge to the fuel sub-tank. Then slide the sender gauge downward to install it.



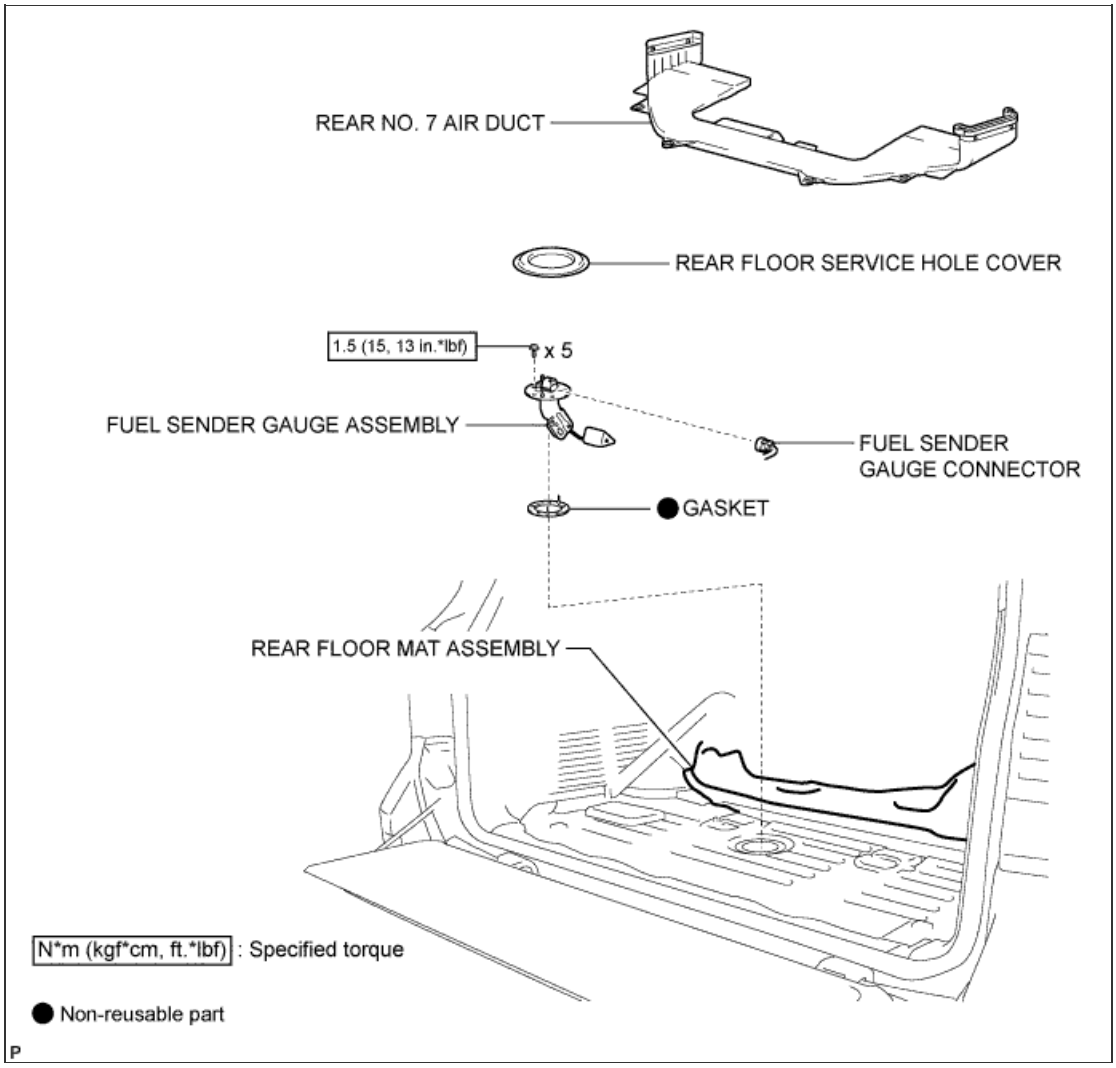
b. Connect the fuel sender gauge connector.



2. INSTALL FUEL SUCTION WITH PUMP AND GAUGE TUBE ASSEMBLY

a. Install the fuel suction with pump and gauge tube assembly (Click here).

for Preparation Click here



FUEL SENDER GAUGE ASSEMBLY (for Fuel Sub Tank) > REMOVAL

for Preparation Click here

1. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

CAUTION:

Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

2. REMOVE REAR SEAT ASSEMBLY

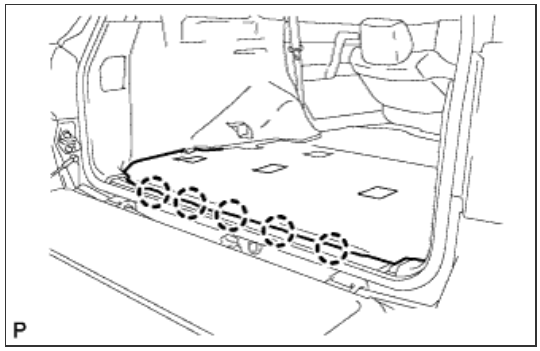
a. Remove the rear No. 1 seat assembly and rear No. 2 seat assembly (Click here).

3. REMOVE REAR FLOOR MAT ASSEMBLY

a. Detach the 5 clips and fold back the floor mat toward the front of the vehicle.

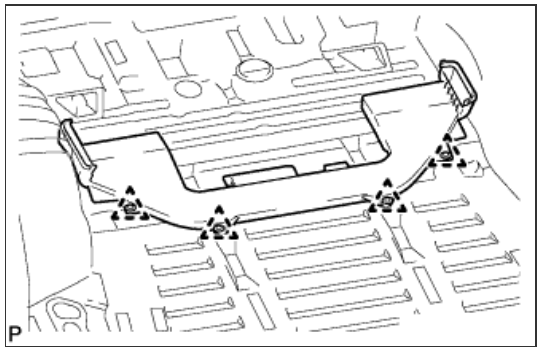
HINT:

Fold back the floor mat so that the rear No. 7 air duct can be removed.

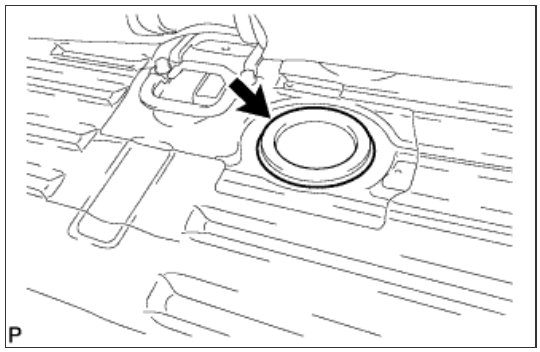


4. REMOVE REAR NO. 7 AIR DUCT

a. Detach the 4 clips and remove the air duct.



5. REMOVE REAR FLOOR SERVICE HOLE COVER



6. REMOVE FUEL SENDER GAUGE ASSEMBLY

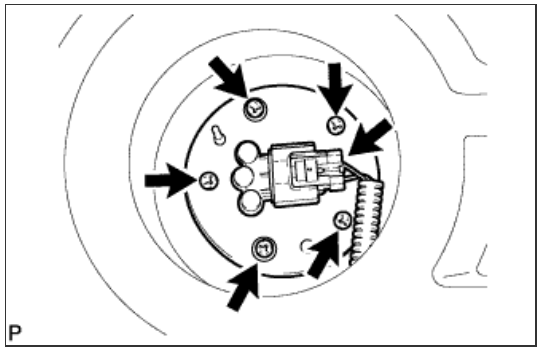
a. Disconnect the sender gauge connector.

b. Remove the 5 screws and sender gauge.

NOTICE:

Be careful not to bend the arm of the fuel sender gauge.

c. Remove the gasket from the sender gauge.



for Preparation Click here

1. INSPECT FUEL SENDER GAUGE ASSEMBLY

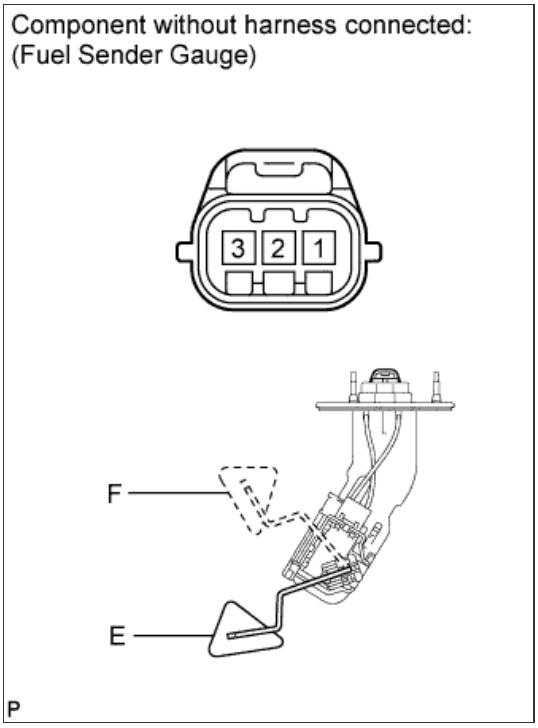
a. Check that the float moves smoothly between F and E.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2 - 3	Float level is F (upper)	12 to 18 Ω
	Float level is E (lower)	405 to 415 Ω

If the result is not as specified, replace the fuel sender gauge assembly.



for Preparation Click here

1. INSTALL FUEL SENDER GAUGE ASSEMBLY

a. Install a new gasket to the sender gauge.

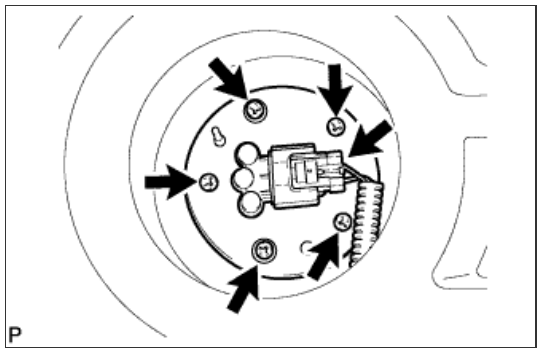
b. Install the sender gauge with the 5 screws.

Torque:
1.5 N*m{ 15 kgf*cm , 13 in.*lbf }

NOTICE:

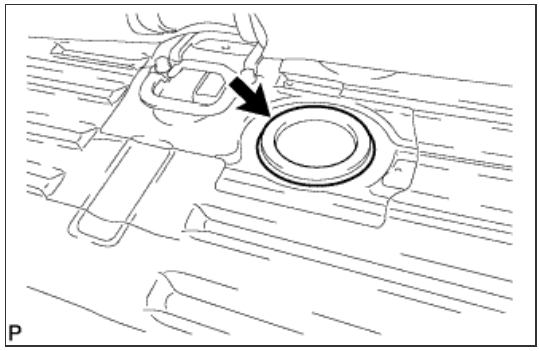
Be careful not to bend the arm of the fuel sender gauge.

c. Connect the sender gauge connector.



2. INSTALL REAR FLOOR SERVICE HOLE COVER

a. Install the service hole cover with new butyl tape.

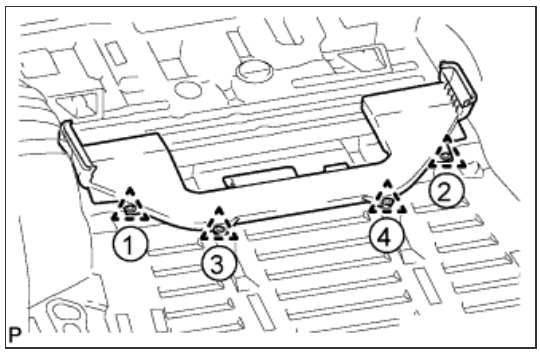


3. INSTALL REAR NO. 7 AIR DUCT

a. Attach the 4 clips to install the air duct.

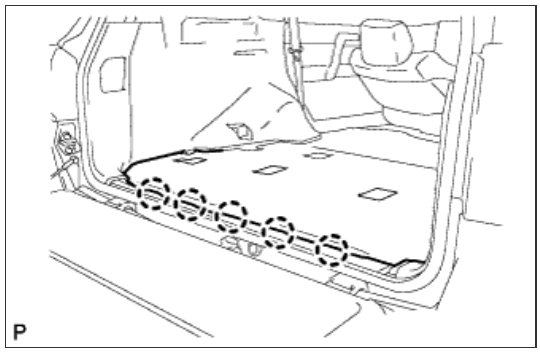
HINT:

Attach the clips in the order shown in the illustration.



4. INSTALL REAR FLOOR MAT ASSEMBLY

a. Attach the 5 clips to install the floor mat.



5. INSTALL REAR SEAT ASSEMBLY

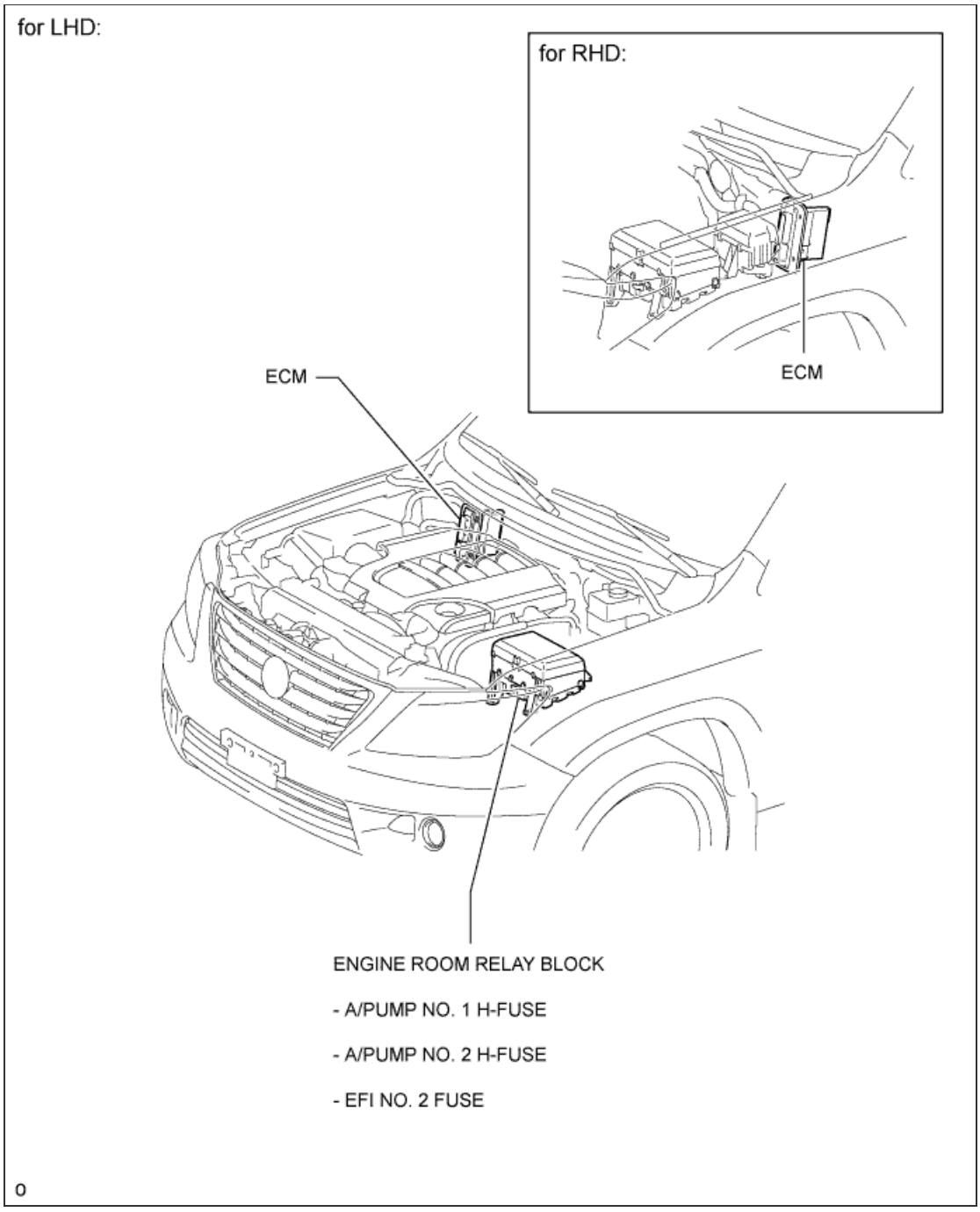
a. Install the rear No. 1 seat assembly and rear No. 2 seat assembly (Click here).

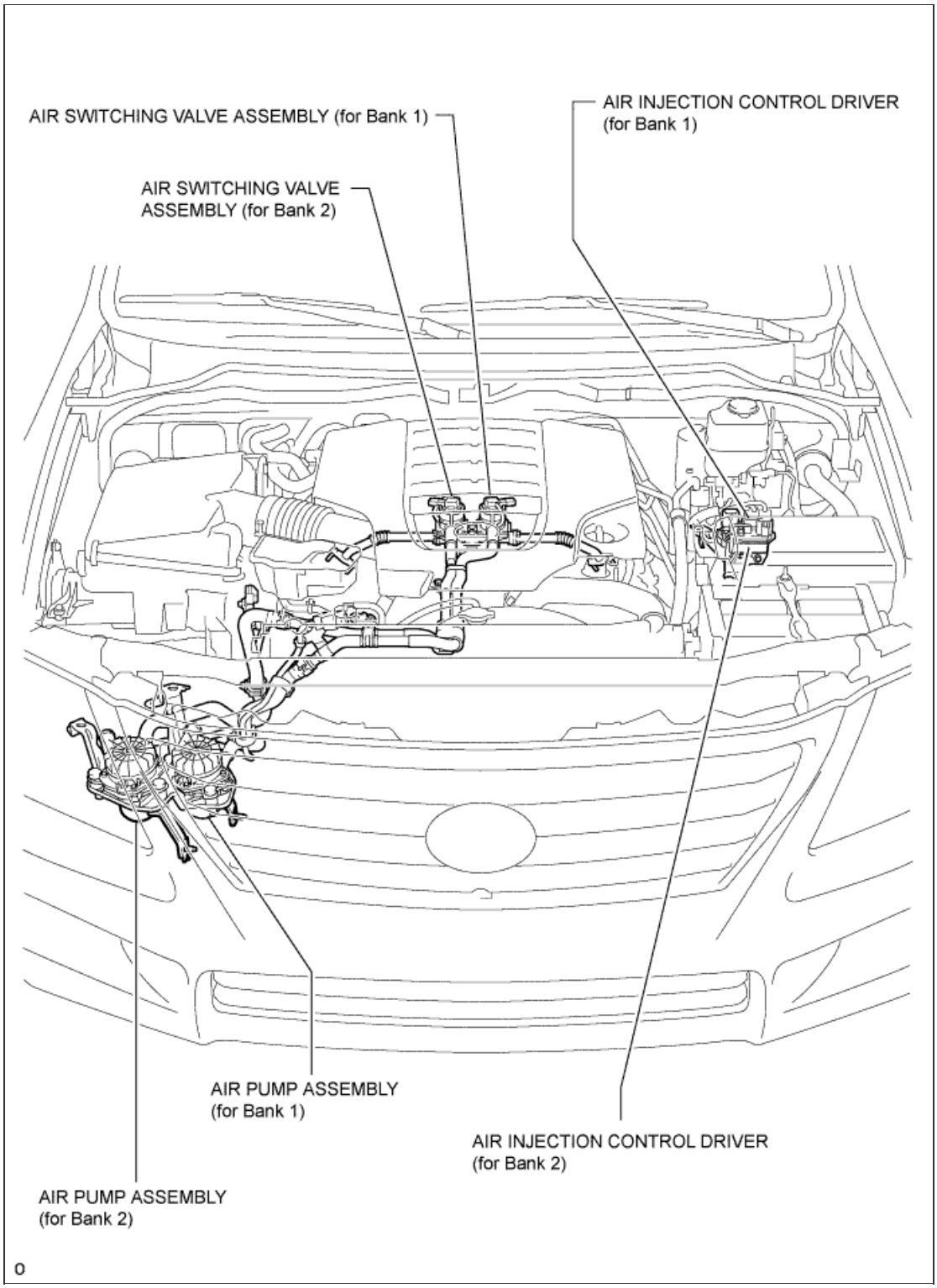
6. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

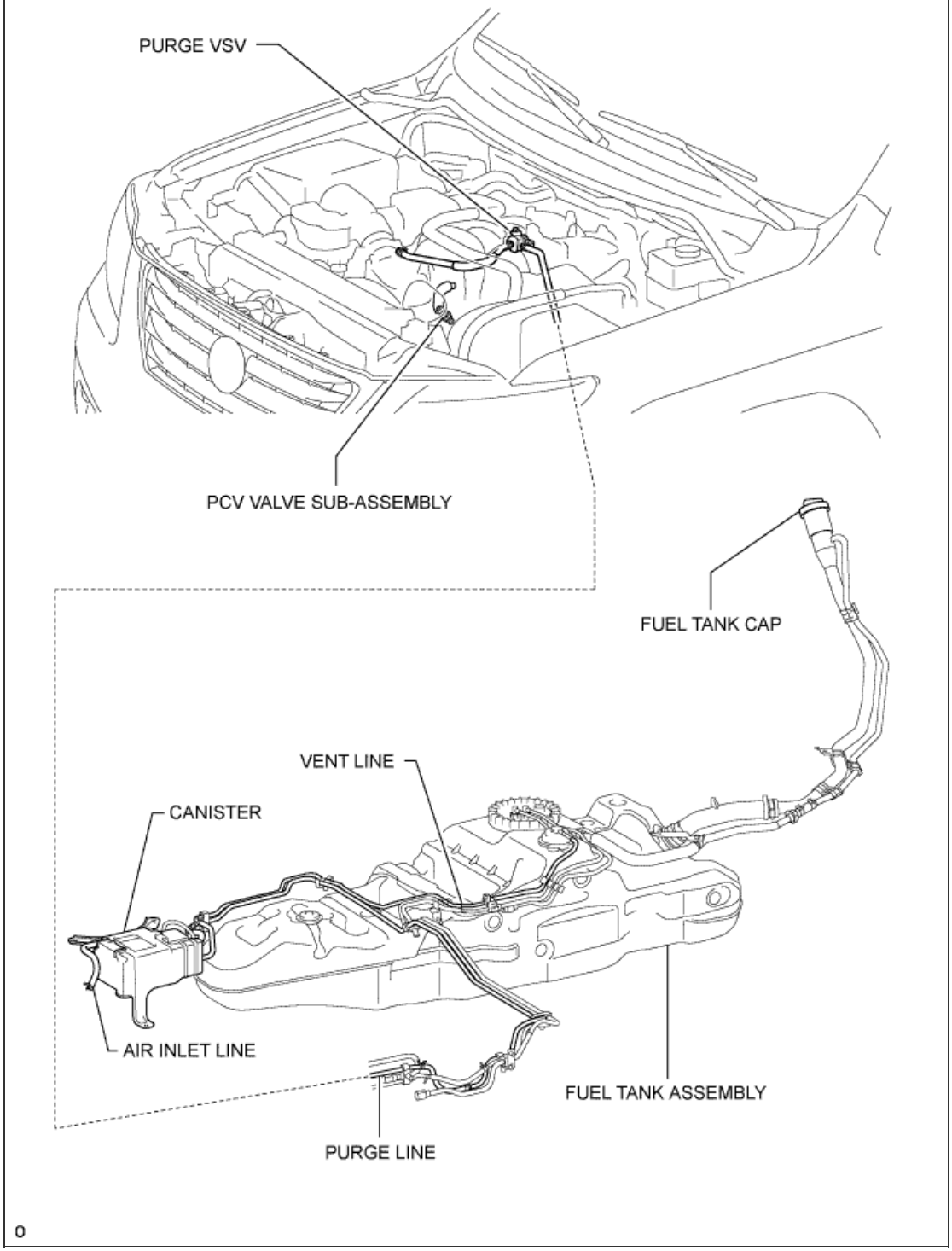
for Preparation Click here




AIR SWITCHING VALVE ASSEMBLY (for Bank 1)
AIR INJECTION CONTROL DRIVER (for Bank 1)
AIR SWITCHING VALVE ASSEMBLY (for Bank 2)
AIR PUMP ASSEMBLY (for Bank 1)
AIR INJECTION CONTROL DRIVER (for Bank 2)
AIR PUMP ASSEMBLY (for Bank 2)

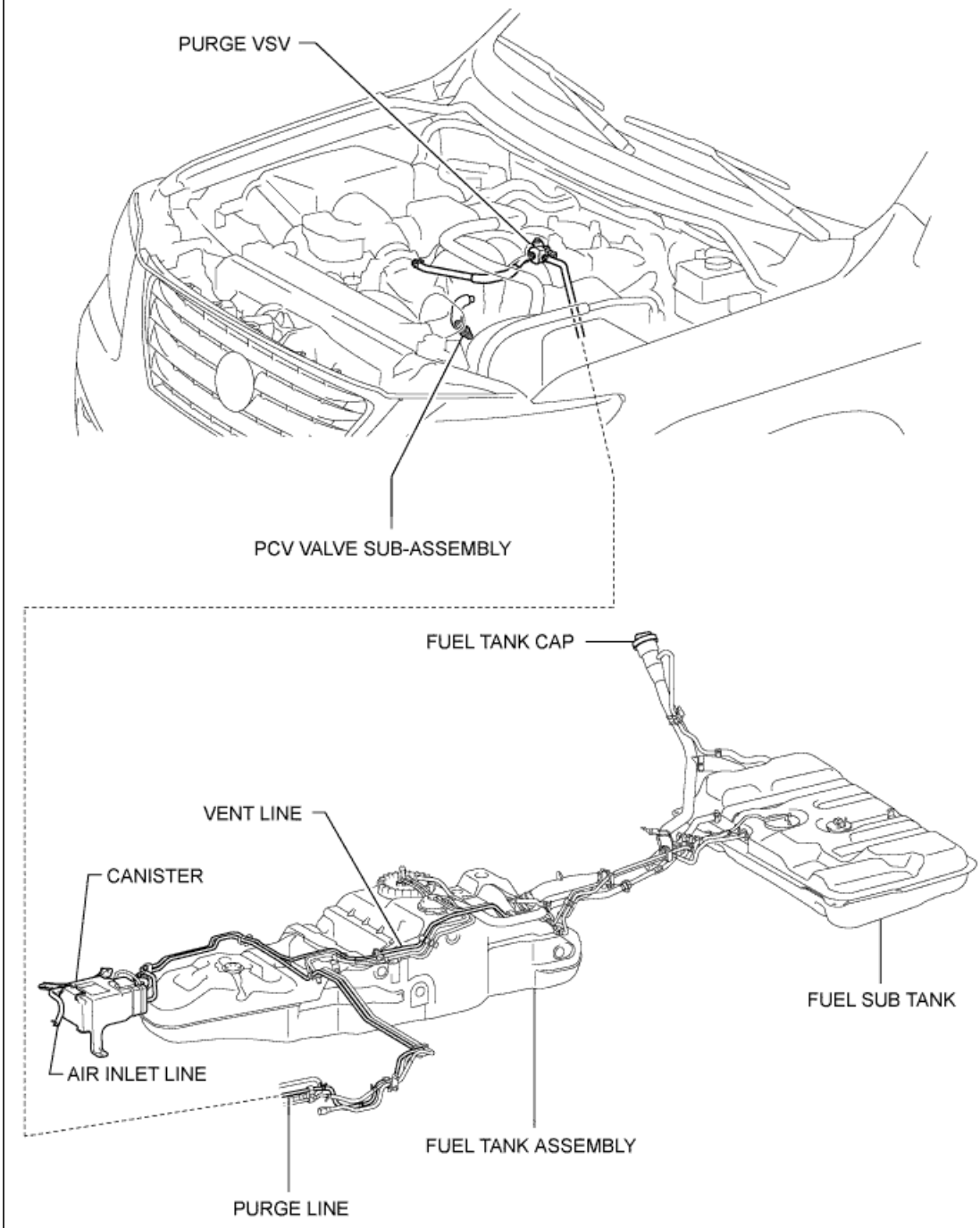
o

for Single Tank Type:



o

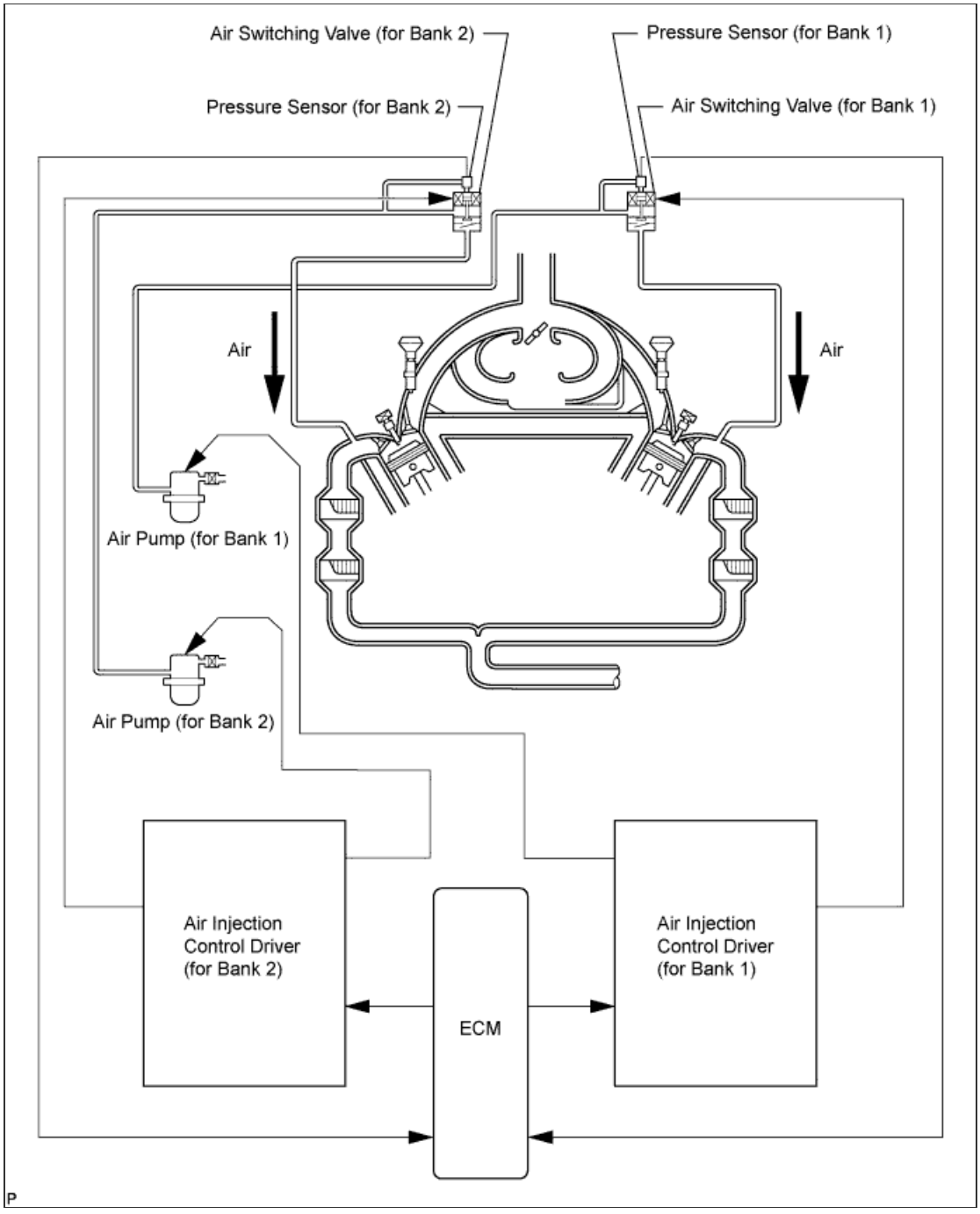
for Double Tank Type:



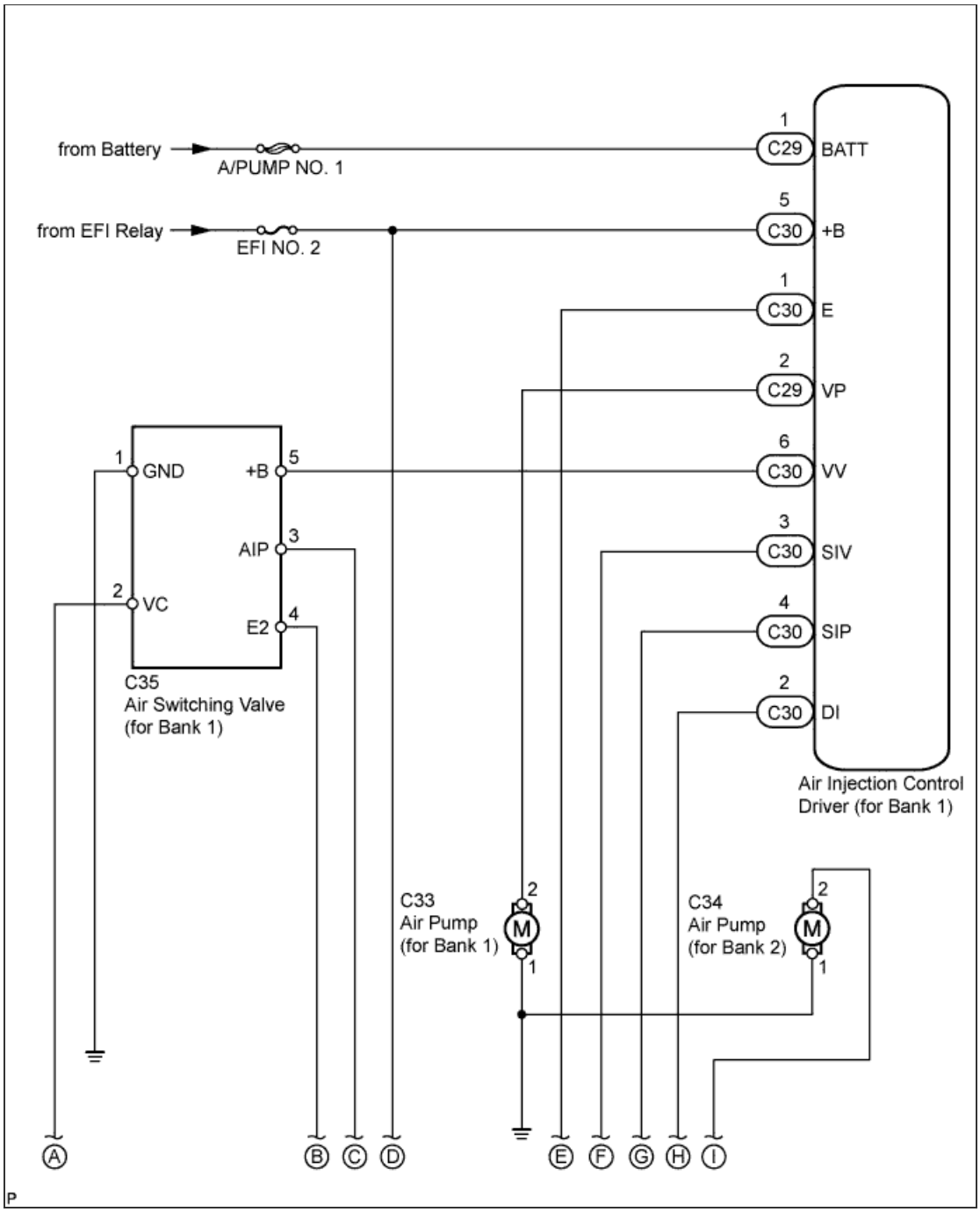
o

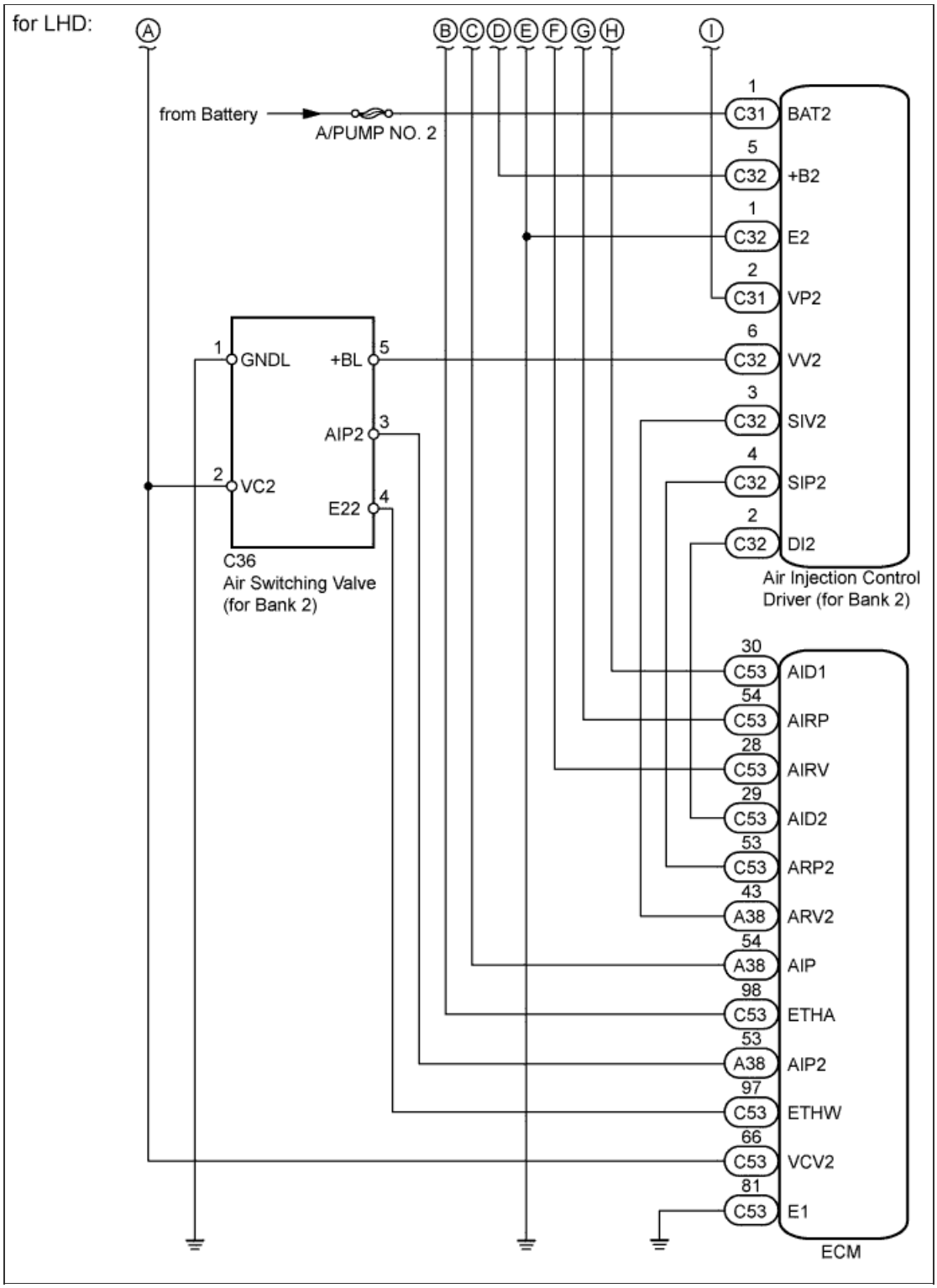
for Preparation Click here

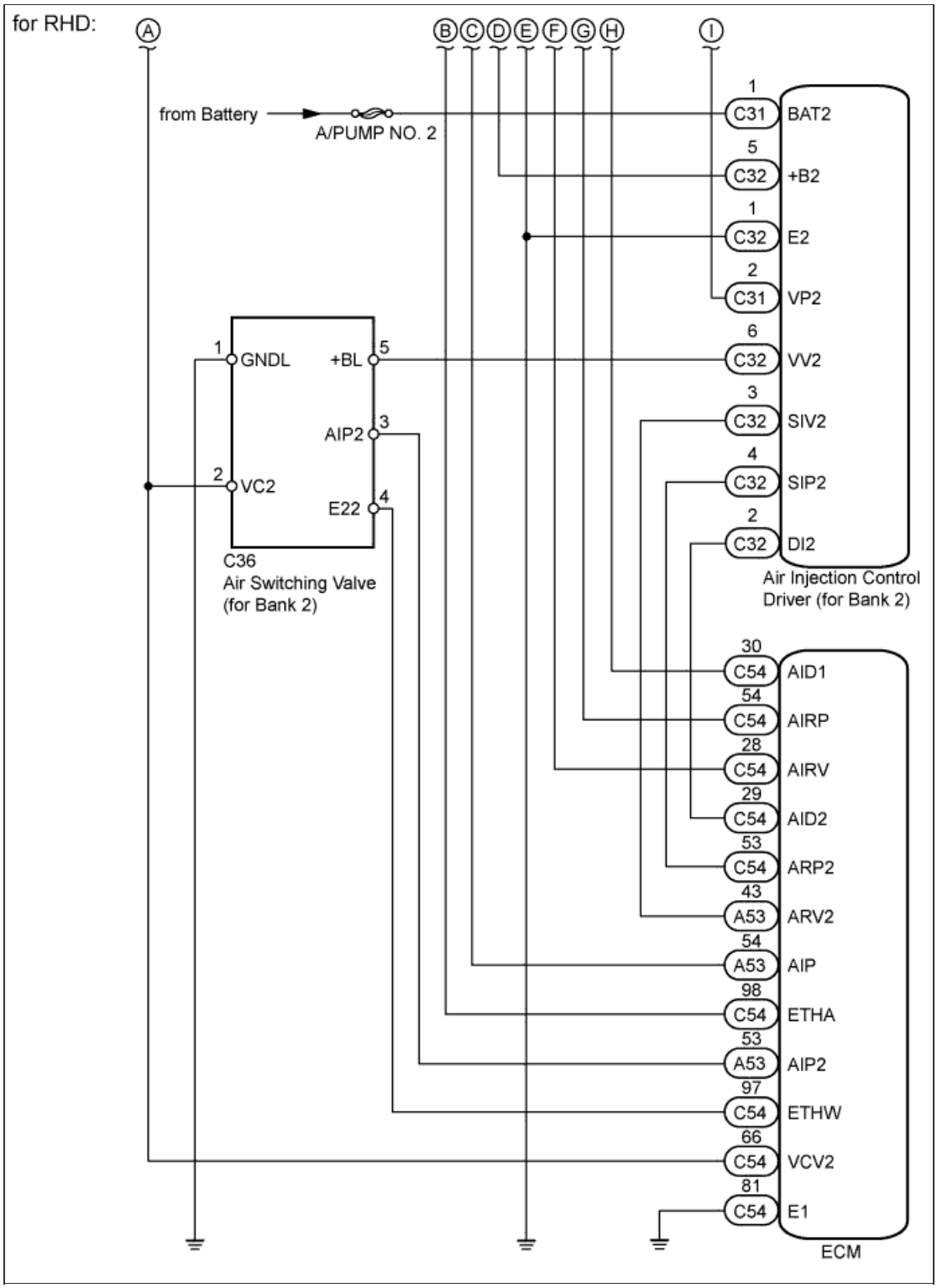
SECONDARY AIR INJECTION CONTROL SYSTEM DIAGRAM



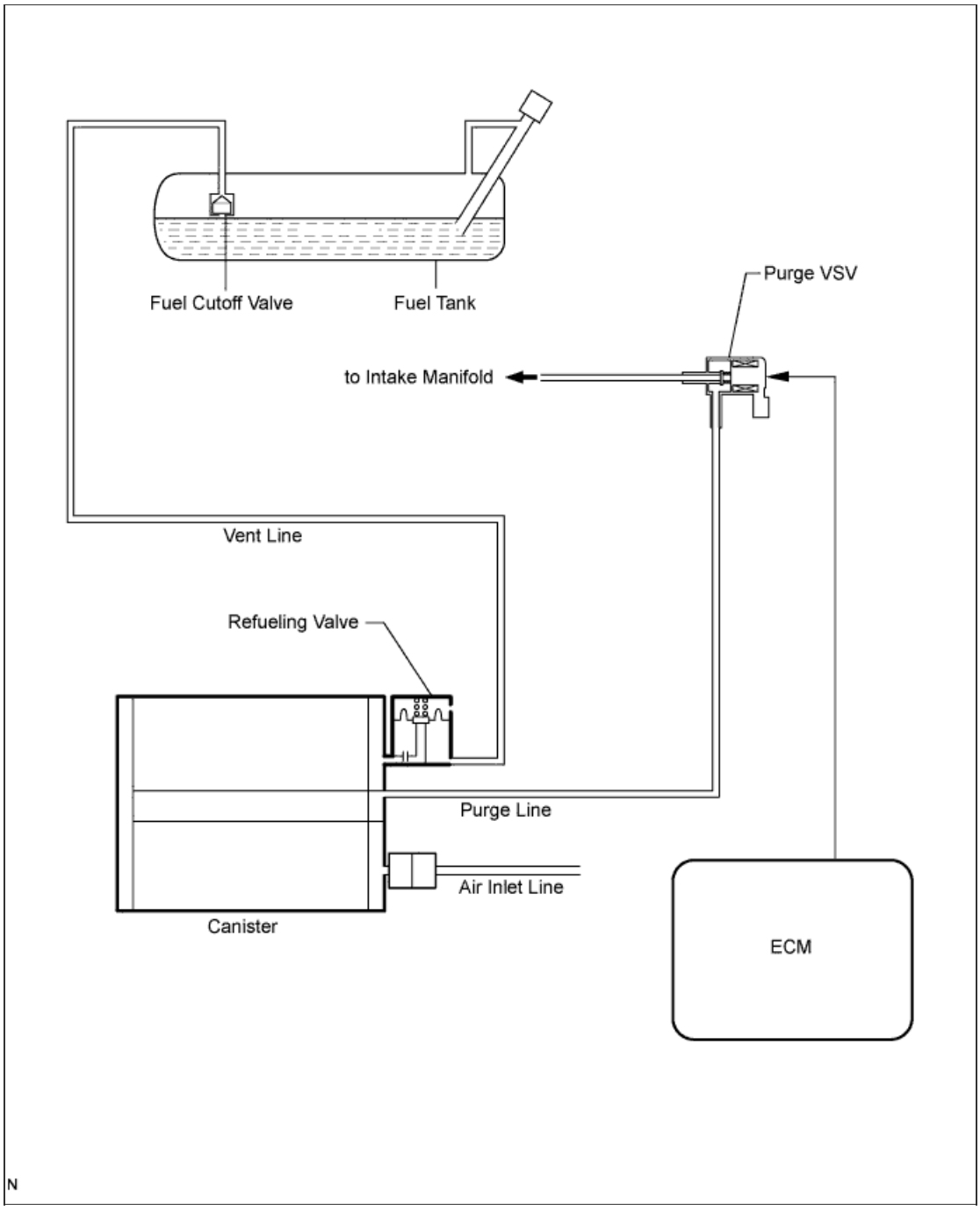
SECONDARY AIR INJECTION SYSTEM WIRING DIAGRAM


from Battery
A/PUMP NO. 1
from EFI Relay
EFI NO. 2
1
C29
BATT
5
C30
+B
1
C30
E
2
C29
VP
6
C30
VV
3
C30
SIV
4
C30
SIP
2
C30
DI
Air Injection Control
Driver (for Bank 1)
1
GND
+B
5
AIP
3
2
VC
E2
4
C35
Air Switching Valve
(for Bank 1)
C33
Air Pump
(for Bank 1)
2
M
1
C34
Air Pump
(for Bank 2)
2
M
1
A
B
C
D
E
F
G
H
I
P

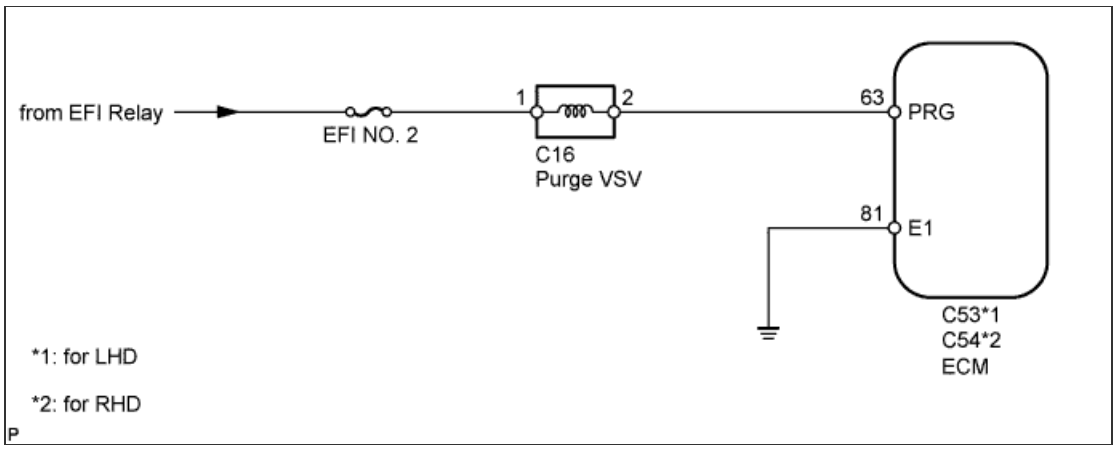

for LHD:
Ⓐ
Ⓑ Ⓒ Ⓓ Ⓔ Ⓕ Ⓖ Ⓗ
Ⓘ
from Battery
A/PUMP NO. 2
1 C31 BAT2
5 C32 +B2
1 C32 E2
2 C31 VP2
6 C32 VV2
3 C32 SIV2
4 C32 SIP2
2 C32 DI2
Air Injection Control Driver (for Bank 2)
1 GNDL
+BL 5
AIP2 3
2 VC2
E22 4
C36
Air Switching Valve (for Bank 2)
30 C53 AID1
54 C53 AIRP
28 C53 AIRV
29 C53 AID2
53 C53 ARP2
43 A38 ARV2
54 A38 AIP
98 C53 ETHA
53 A38 AIP2
97 C53 ETHW
66 C53 VCV2
81 C53 E1
ECM



EVAP CONTROL SYSTEM DIAGRAM



EVAP SYSTEM WIRING DIAGRAM



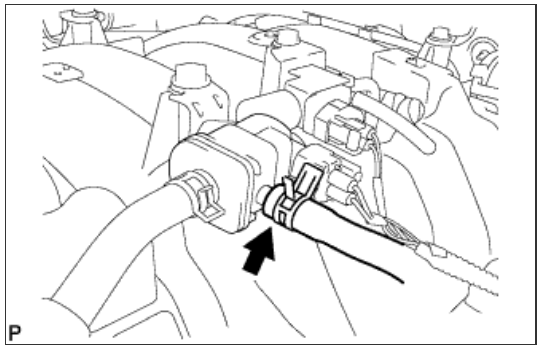
for Preparation Click here

1. CHECK PURGE VSV

a. Connect the intelligent tester to the DLC3.

b. Remove the V-bank cover (Click here).

c. Disconnect the hose (connected to the canister) from the purge VSV.



d. Start the engine and turn the tester main switch on.

e. Enter the following menus: Powertrain / Engine and ECT / Active Test / Activate the VSV for Evap Control.

OK:

Tester Operation	Specified Condition
Activate the VSV for Evap Control: OFF	Purge VSV has no suction
Activate the VSV for Evap Control: ON	Purge VSV has suction

f. Connect the hose (connected to the canister) to the purge VSV.

g. Install the V-bank cover (Click here).

2. INSPECT FUEL CUT-OFF RPM

a. Start and warm up the engine.

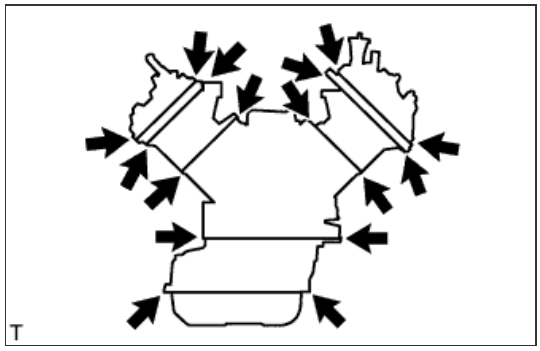
b. Open the throttle valve and keep the engine speed at 3000 rpm.

c. Use a sound scope to check for injector operating noise.

d. Check that when the accelerator pedal is released, the injector operation noise stops momentarily and then resumes.
If the result is as not specified, check the injector, wiring and ECM.

3. VISUALLY INSPECT HOSES, CONNECTIONS AND GASKETS

a. Check that there are no cracks, leaks or damage.



HINT:

Separation of the engine oil dipstick, oil filler cap, ventilation hose, etc. may cause an engine failure or engine malfunctions. Disconnection, looseness or cracks in the parts of the air induction system between the throttle body and cylinder head will allow air suction and cause an engine failure or engine malfunctions.

NOTICE:

- **Detachment or other problems with the engine oil dipstick, filler cap, ventilation hose and other components may cause the engine to run improperly.**
- **Disconnection, looseness or cracks in the parts of the air induction system between the throttle body and cylinder head will allow air suction and cause an engine failure or engine malfunctions.**

If the result is not as specified, replace parts as necessary.

4. CHECK HOSES AND CONNECTORS

a. Visually check for loose connections, sharp bends or damage.

5. CHECK FUEL TANK ASSEMBLY

a. Visually check for deformation, cracks or fuel leakage.

6. INSPECT PRESSURE SENSOR

a. Connect a pressure gauge to the air pressure sensor as shown in the illustration.

b. Connect the intelligent tester to the DLC3.

c. Turn the engine switch on (IG) and turn the tester main switch on.

d. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Air pump pressure (absolute).

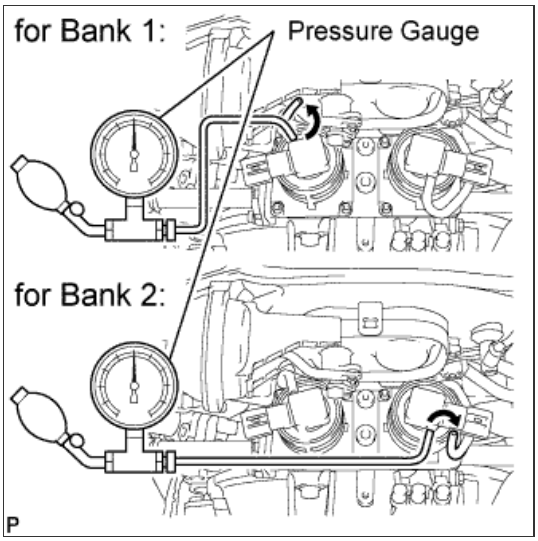
e. Check that the pressure displayed on the intelligent tester fluctuates when applying pressure to the pressure sensor with the pressure gauge.

NOTICE:

Do not let foreign matter enter the sensor when applying pressure.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.



f. Check the power source voltage.

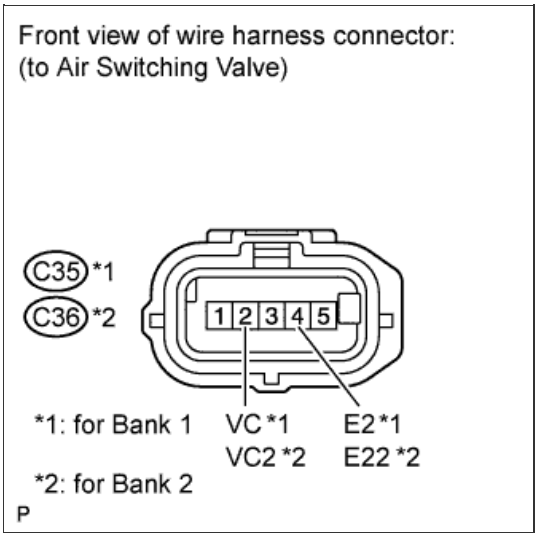
i. Disconnect the connector.

ii. Measure the voltage according to the value(s) in the table below.

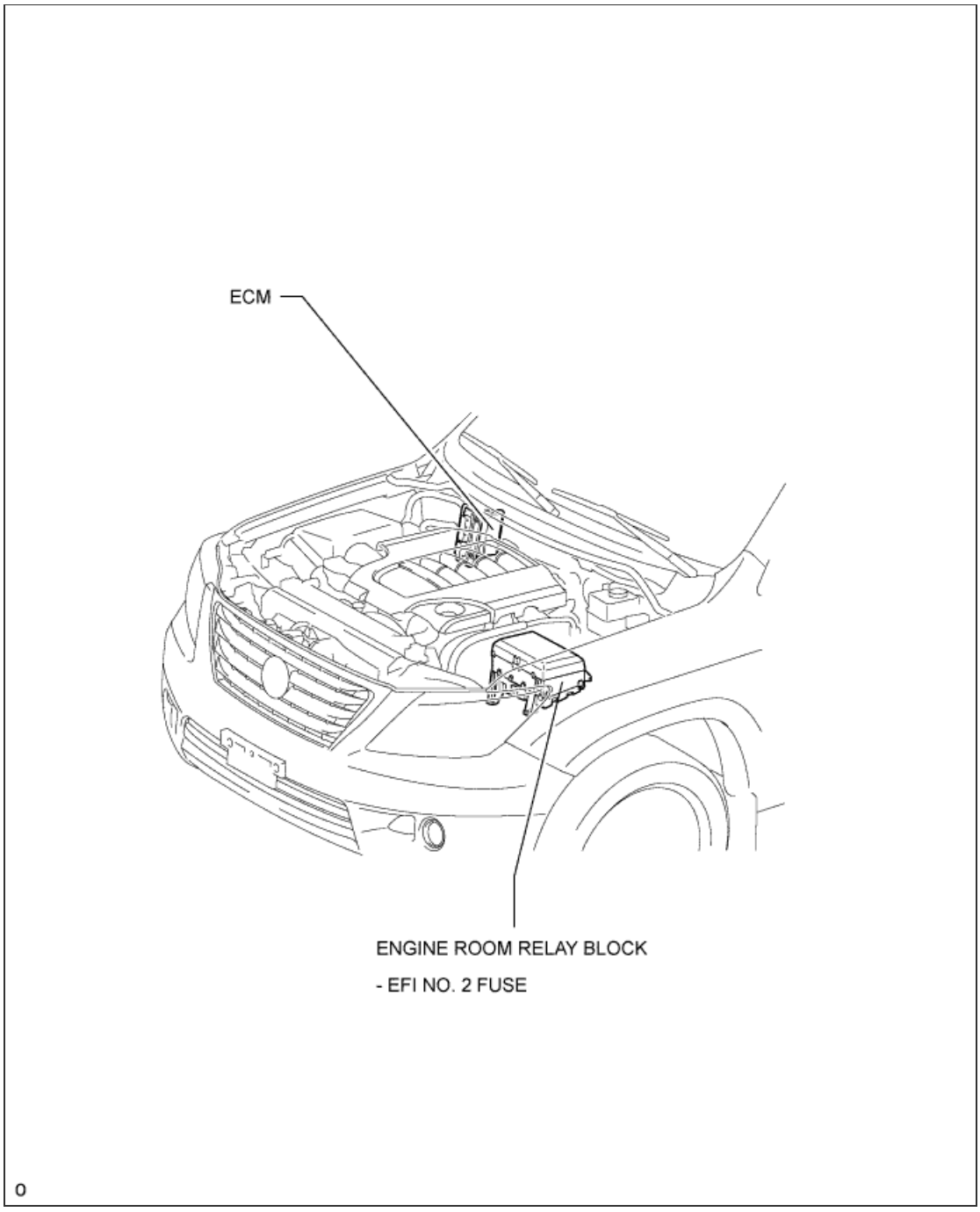
Standard Voltage:

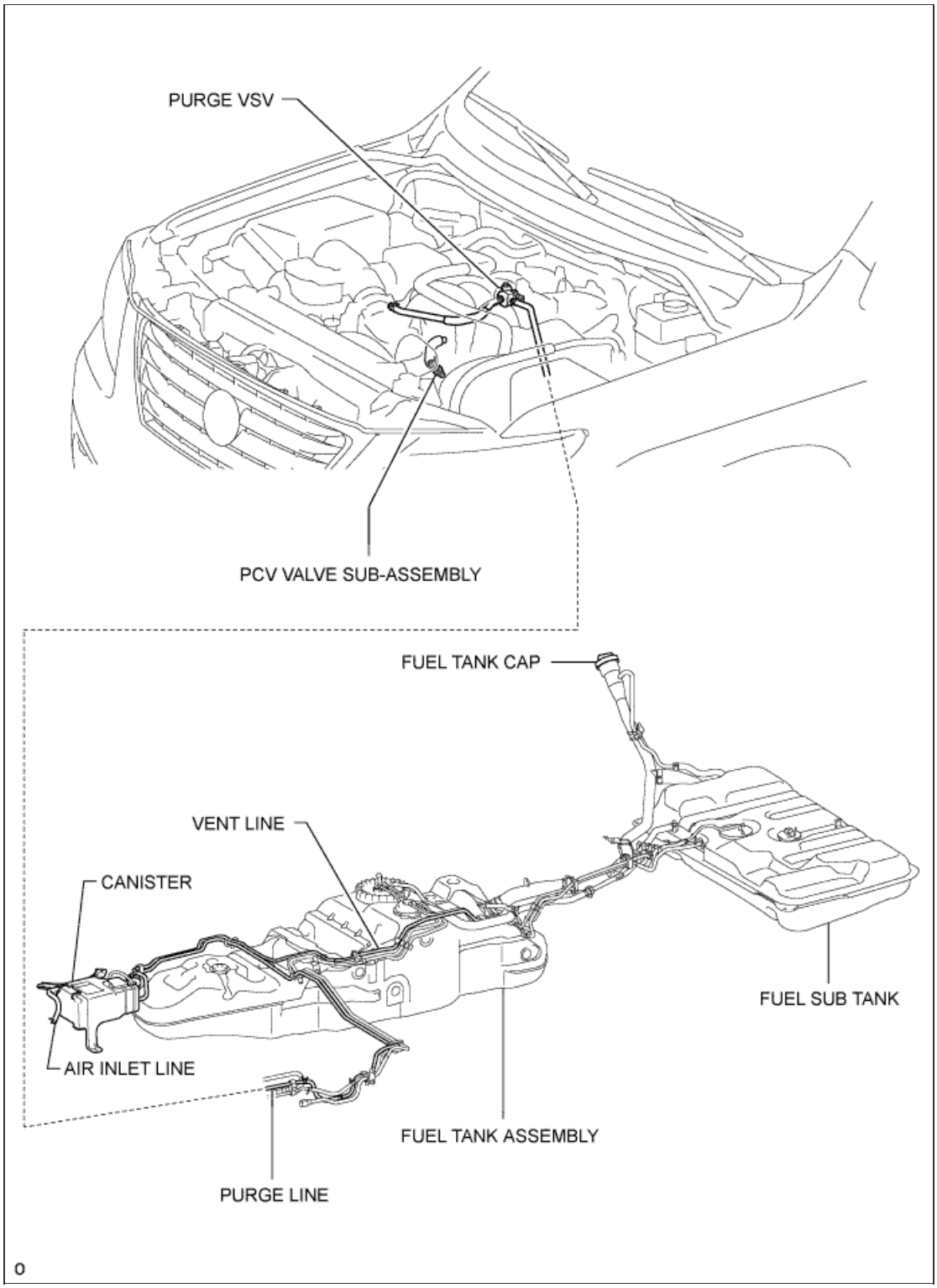
Tester Connection	Switch Condition	Specified Condition
C35-2 (VC) - C35-4 (E2)	Engine switch on (IG)	4.75 to 5.25 V
C36-2 (VC2) - C36-4 (E22)		

If the result is not as specified, check the wiring and ECM (Click here).



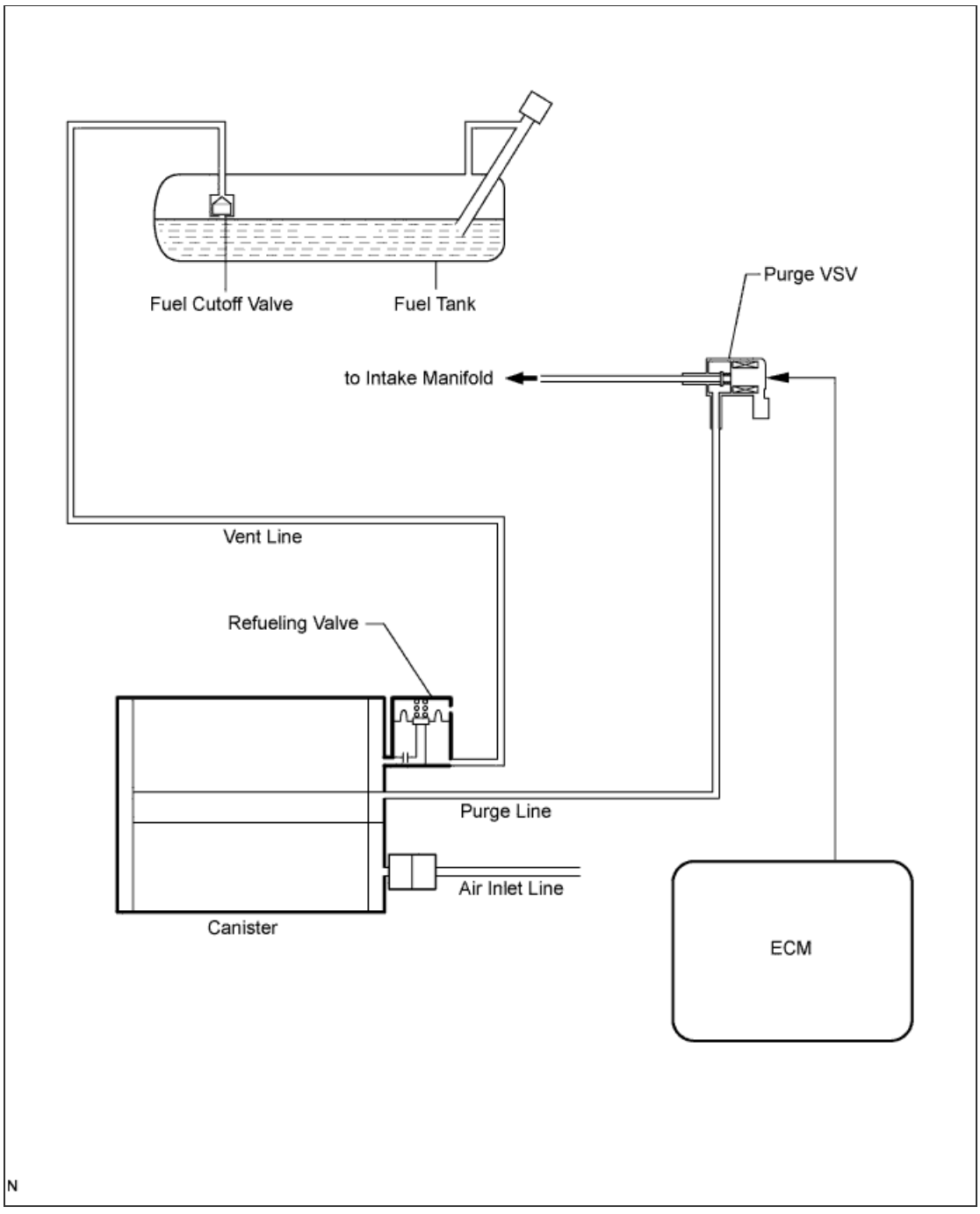
for Preparation Click here



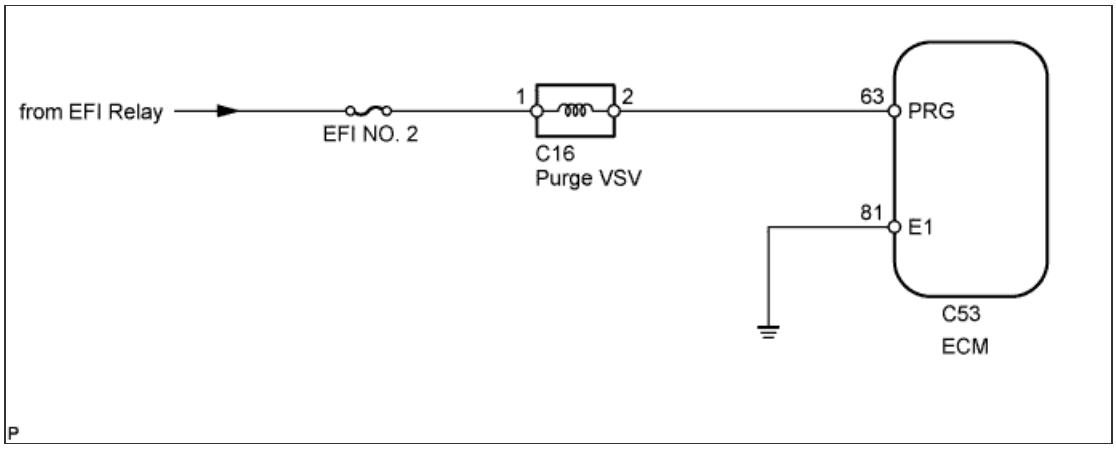

PURGE VSV
PCV VALVE SUB-ASSEMBLY
FUEL TANK CAP
VENT LINE
CANISTER
FUEL SUB TANK
AIR INLET LINE
FUEL TANK ASSEMBLY
PURGE LINE

for Preparation Click here

EVAP CONTROL SYSTEM DIAGRAM



EVAP SYSTEM WIRING DIAGRAM


from EFI Relay
EFI NO. 2
1
2
C16
Purge VSV
63
PRG
81
E1
C53
ECM
P

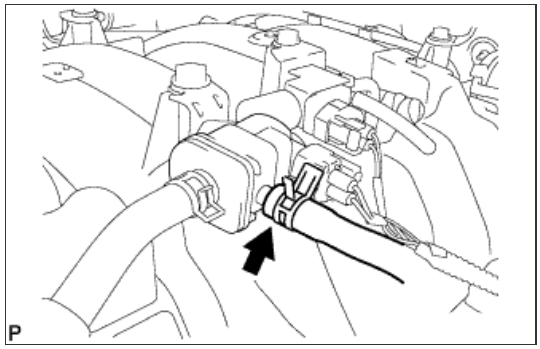
for Preparation Click here

1. CHECK PURGE VSV

a. Connect the intelligent tester to the DLC3.

b. Remove the V-bank cover (Click here).

c. Disconnect the hose (connected to the canister) from the purge VSV.



d. Start the engine and turn the tester main switch on.

e. Enter the following menus: Powertrain / Engine and ECT / Active Test / Activate the VSV for Evap Control.

OK:

Tester Operation	Specified Condition
Activate the VSV for Evap Control: OFF	Purge VSV has no suction
Activate the VSV for Evap Control: ON	Purge VSV has suction

f. Connect the hose (connected to the canister) to the purge VSV.

g. Install the V-bank cover (Click here).

2. INSPECT FUEL CUT-OFF RPM

a. Start and warm up the engine.

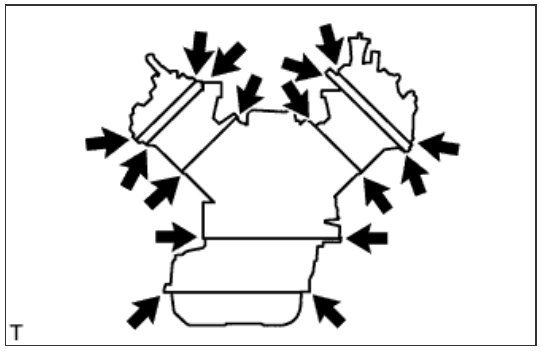
b. Open the throttle valve and keep the engine speed at 3000 rpm.

c. Use a sound scope to check for injector operating noise.

d. Check that when the accelerator pedal is released, the injector operation noise stops momentarily and then resumes.
If the result is as not specified, check the injector, wiring and ECM.

3. VISUALLY INSPECT HOSES, CONNECTIONS AND GASKETS

a. Check that there are no cracks, leaks or damage.



HINT:

Separation of the engine oil dipstick, oil filler cap, ventilation hose, etc. may cause an engine failure or engine malfunctions. Disconnection, looseness or cracks in the parts of the air induction system between the throttle body and cylinder head will allow air suction and cause an engine failure or engine malfunctions.

NOTICE:

- **Detachment or other problems with the engine oil dipstick, filler cap, ventilation hose and other components may cause the engine to run improperly.**
- **Disconnection, looseness or cracks in the parts of the air induction system between the throttle body and cylinder head will allow air suction and cause an engine failure or engine malfunctions.**

If the result is not as specified, replace parts as necessary.

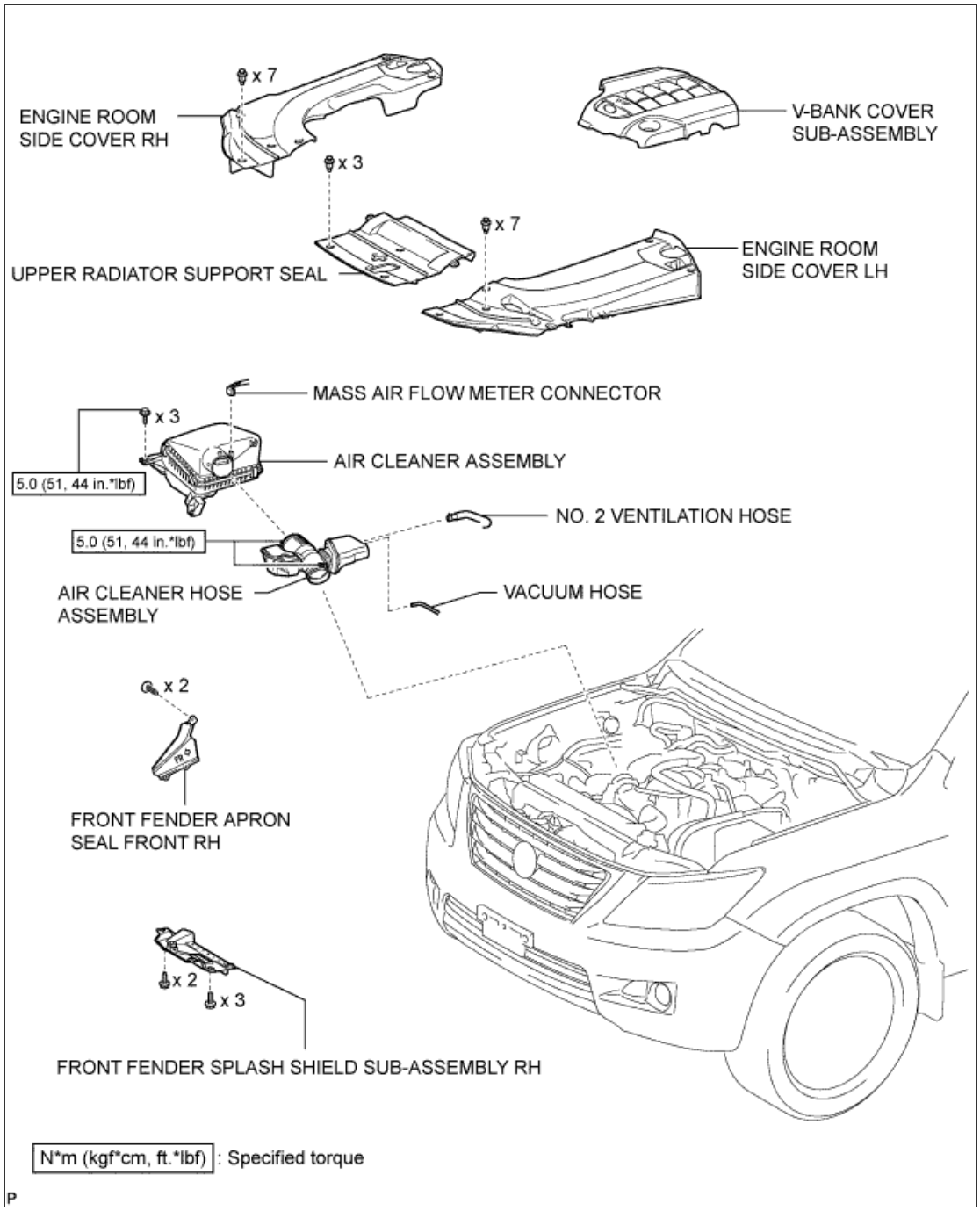
4. CHECK HOSES AND CONNECTORS

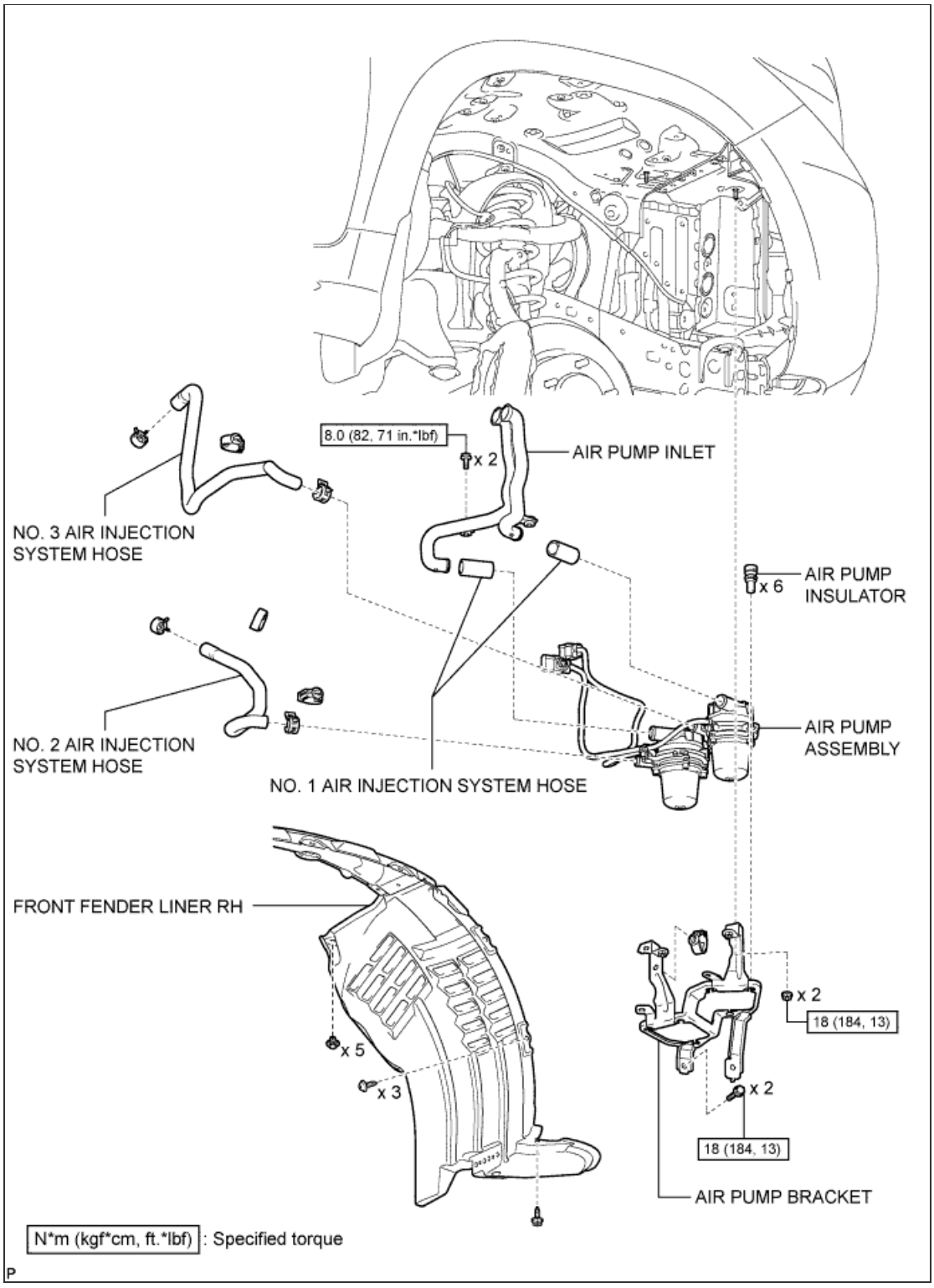
a. Visually check for loose connections, sharp bends or damage.

5. CHECK FUEL TANK ASSEMBLY

a. Visually check for deformation, cracks or fuel leakage.

for Preparation Click here

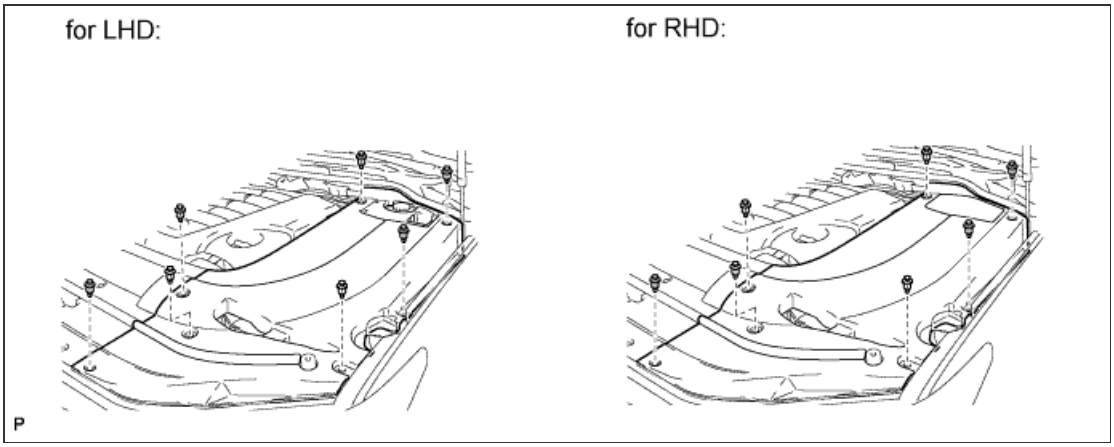



8.0 (82, 71 in.*lbf)
x 2
AIR PUMP INLET
NO. 3 AIR INJECTION SYSTEM HOSE
x 6
AIR PUMP INSULATOR
NO. 2 AIR INJECTION SYSTEM HOSE
AIR PUMP ASSEMBLY
NO. 1 AIR INJECTION SYSTEM HOSE
FRONT FENDER LINER RH
x 5
x 3
x 2
18 (184, 13)
x 2
18 (184, 13)
AIR PUMP BRACKET
N*m (kgf*cm, ft.*lbf) : Specified torque
P

for Preparation Click here

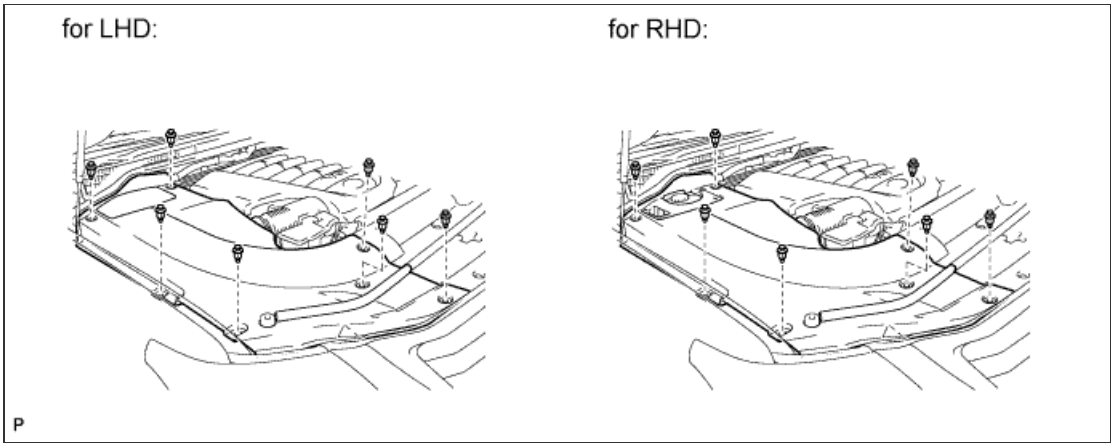
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



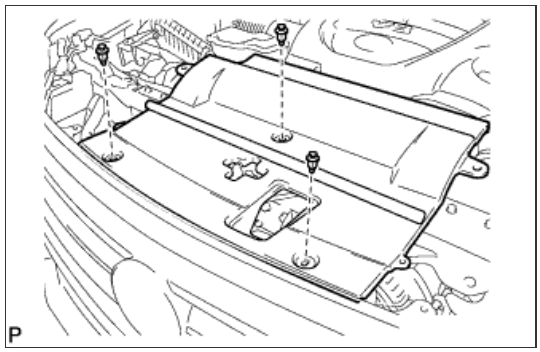
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



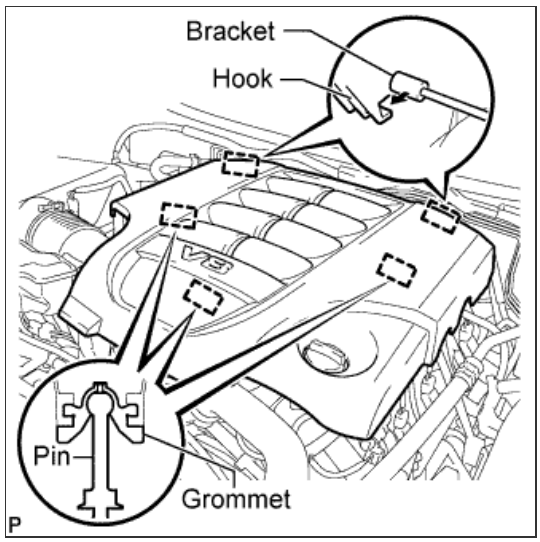
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

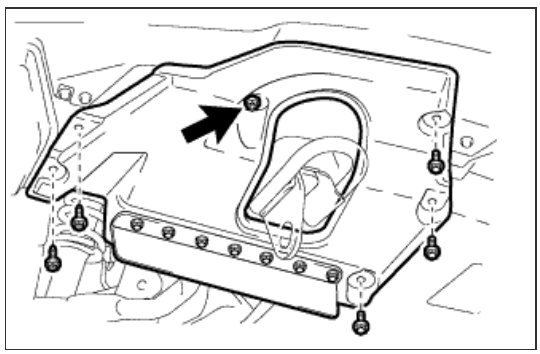
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



7. REMOVE FRONT FENDER LINER RH

a. Remove the screw, and disconnect the liner from the front bumper cover.

b. Using a T30 "TORX" socket, remove the 3 screws.

c. Remove the 5 clips.

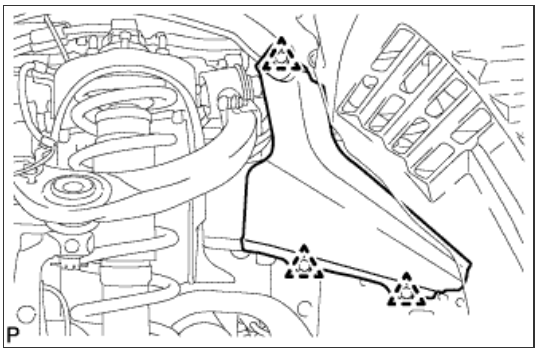
d. Partially remove the fender liner.

HINT:

It is not necessary to fully remove the fender liner. Partially remove it so that the air pump can be removed.

8. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.

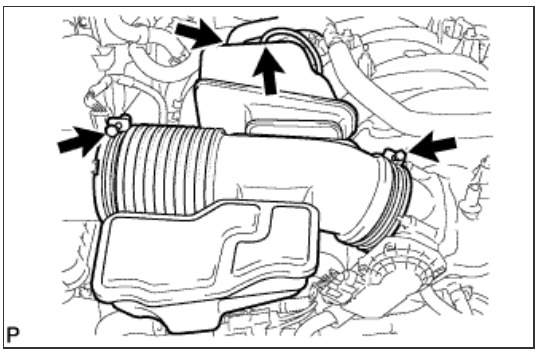


9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

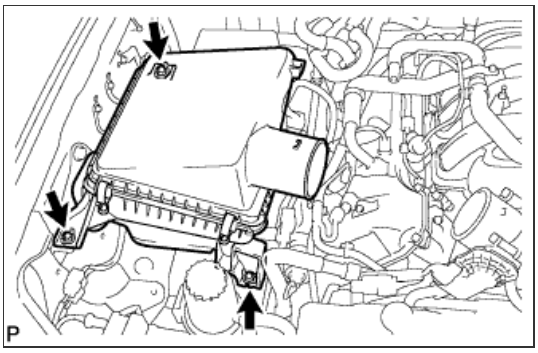
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



10. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



11. REMOVE NO. 2 AIR INJECTION SYSTEM HOSE

a. Engine Room Side:

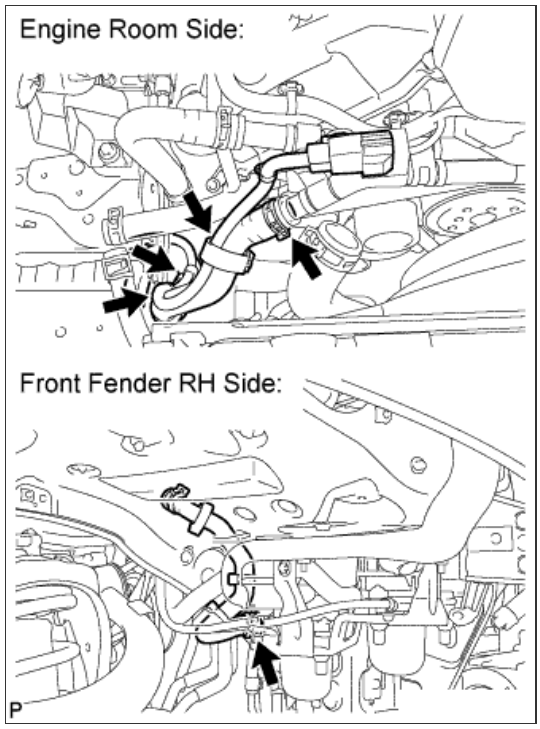
i. Disconnect the 3 clamps.

ii. Disconnect the No. 2 hose.

iii. Using a clip remover, remove the clamp from the body panel.

b. Front Fender RH Inside:

i. Disconnect the No. 2 hose from the air pump.



12. REMOVE NO. 3 AIR INJECTION SYSTEM HOSE

a. Engine Room Side:

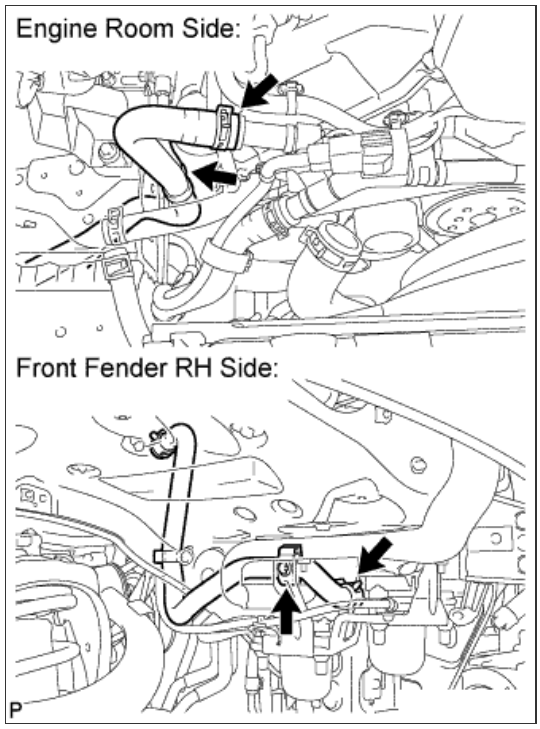
i. Disconnect the clamp and No. 3 hose.

ii. Using a clip remover, remove the clamp from the body panel.

b. Front Fender RH Inside:

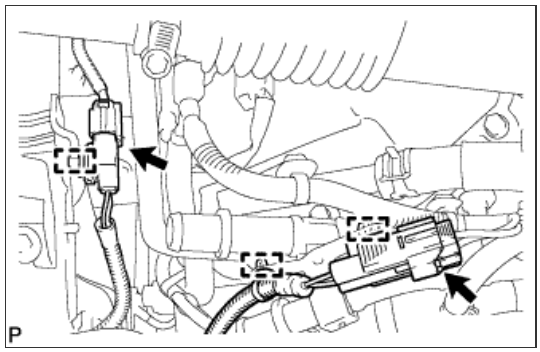
i. Disconnect the clamp and No. 3 hose from the air pump.

ii. Using a clip remover, remove the clamp from the bracket.

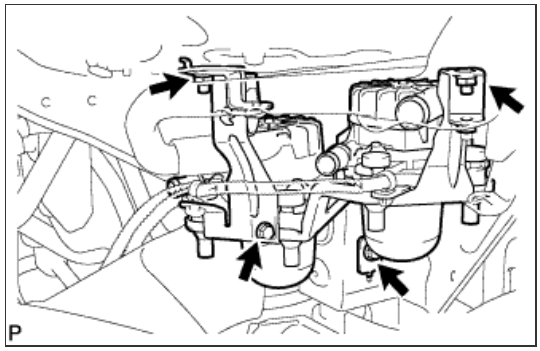


13. REMOVE AIR PUMP ASSEMBLY WITH BRACKET

a. Disconnect the 2 air pump connectors and detach the 3 wire harness claws.

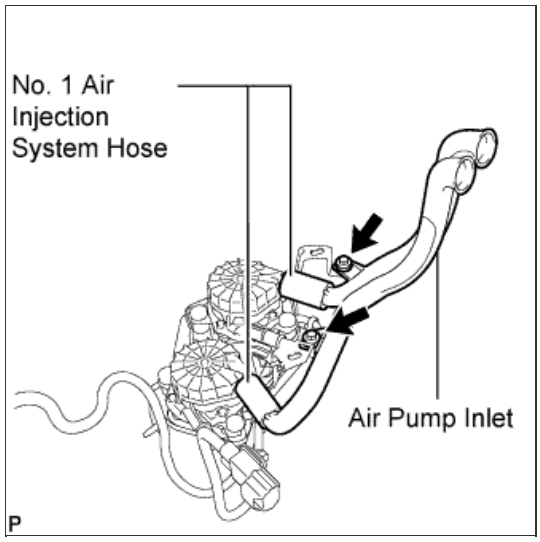


b. Remove the 2 bolts, 2 nuts and air pump assembly with bracket.



14. REMOVE AIR PUMP INLET

a. Remove the 2 bolts and air pump inlet.



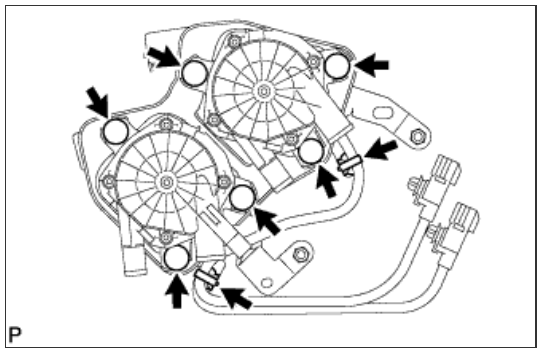
15. DISCONNECT NO. 1 AIR INJECTION SYSTEM HOSE

a. Disconnect the 2 hoses.

16. REMOVE AIR PUMP ASSEMBLY

a. Using a clip remover, detach the 2 clamps and remove the air pump from the bracket.

b. Disconnect the 6 air pump insulators.


P

for Preparation Click here

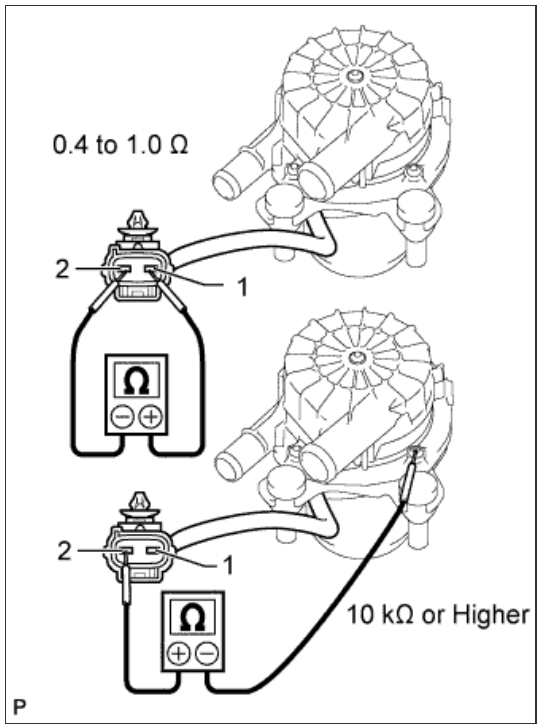
1. INSPECT AIR PUMP ASSEMBLY

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

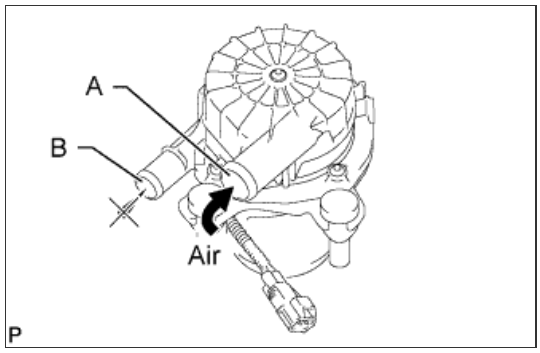
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	0.4 to 1.0 Ω
1 - Body ground	Always	10 kΩ or higher
2 - Body ground		

If the result is not as specified, replace the air pump assembly.



b. Check the operation of the air pump.

i. Check that air does not flow from port A to port B.

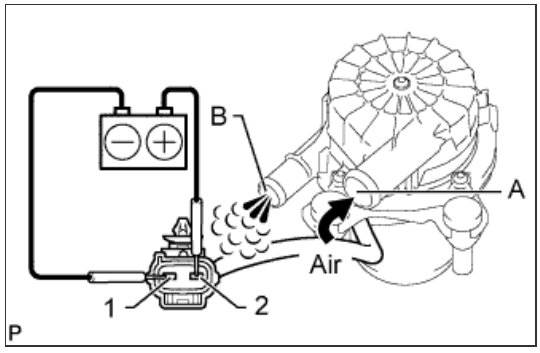


ii. Apply battery voltage to the connector, and check the air pump operation.

OK:

Measurement Condition	Specified Condition
Battery positive (+) → Terminal 2 Battery negative (-) → Terminal 1	Air flows from port A to port B

If the result is not as specified, replace the air pump assembly.



NOTICE:

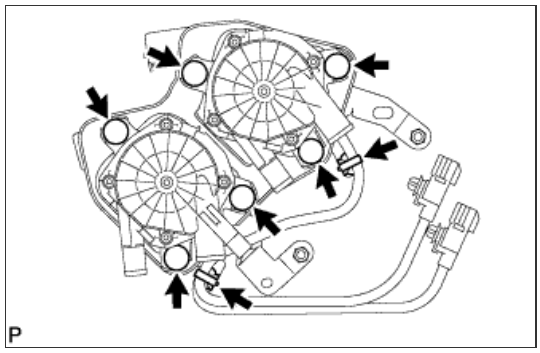
- **Do not operate the air pump continuously for 2 minutes or more.**
- **When operating the air pump, wait 5 minutes until the pump has cooled down between each operation. If the pump has not cooled down sufficiently, the motor will burn out.**

for Preparation Click here

1. INSTALL AIR PUMP ASSEMBLY

a. Connect the 6 air pump insulators to the air pump and install the air pump to the bracket.

b. Attach the 2 wire harness clamps to the bracket.

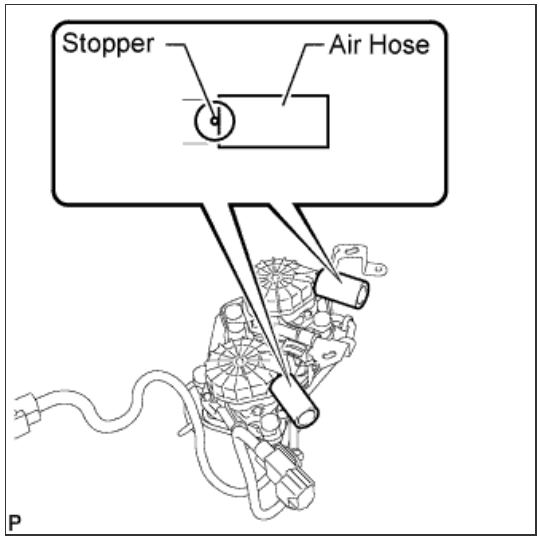


2. CONNECT NO. 1 AIR INJECTION SYSTEM HOSE

a. Connect the 2 hoses to the air pump.

HINT:

Connect the hoses so that the hose ends are aligned with the stoppers.



3. INSTALL AIR PUMP INLET

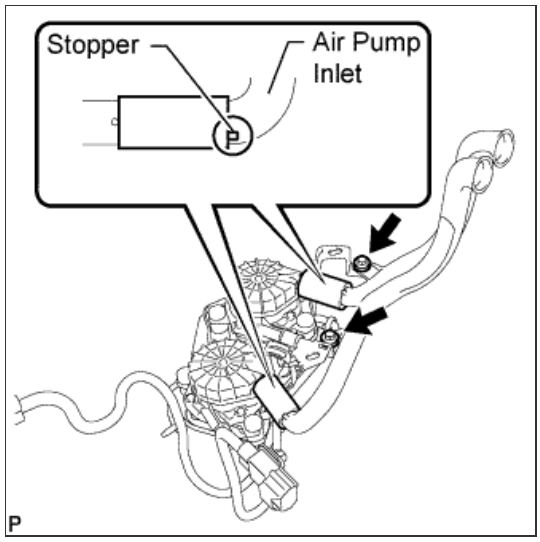
a. Connect the air pump inlet to the 2 No. 1 air injection system hoses.

HINT:

Insert the inlet until the inlet stoppers are aligned with the hose ends.

b. Install the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



4. INSTALL AIR PUMP ASSEMBLY WITH BRACKET

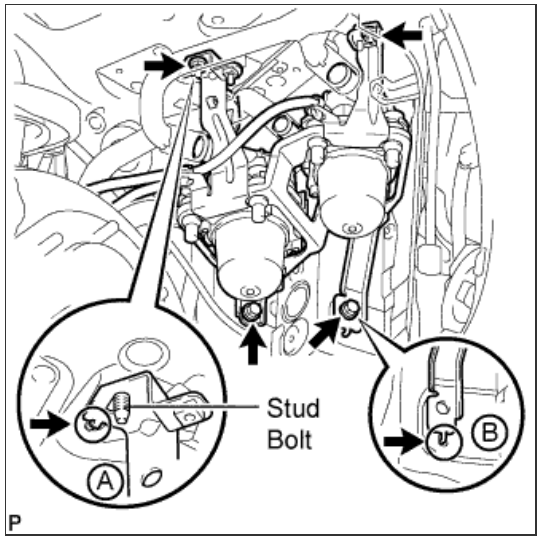
a. Install the air pump assembly with bracket to the vehicle.

i. Insert the bracket tab into the slot and insert the stud bolt into the bracket hole as shown in illustration A. Then slide the bracket.

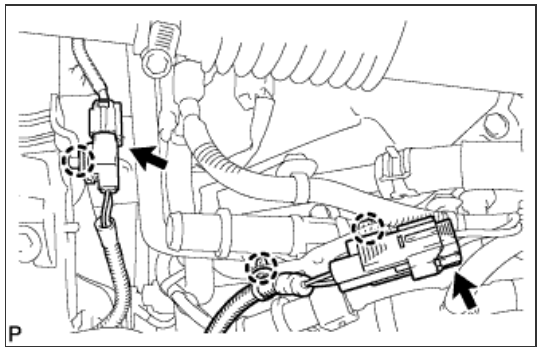
ii. Insert the bracket tab into the slot shown in illustration B.

iii. Install the 2 bolts and 2 nuts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



b. Connect the 2 air pump connectors and attach the 3 wire harness claws.



5. INSTALL NO. 3 AIR INJECTION SYSTEM HOSE

a. Connect the No. 3 hose so that its paint mark aligns with the rib of the air pump as shown in the illustration below labeled A.

HINT:

Make sure the direction of the hose clamp is as shown in the illustration.

b. Connect the clamp to the No. 3 hose shown in the illustration below labeled B. Then insert the clip of the clamp into the bracket.

HINT:

Align the paint mark of the No. 3 hose with the edge of the clamp.

c. Connect the No. 3 hose to the air tube shown in the illustration below labeled C.

HINT:

- **Make sure the paint mark of the No. 3 hose is facing upward.**
- **Make sure the direction of the hose clamp is as shown in the illustration.**

d. Connect the clamp to the No. 3 hose and wire harness shown in the illustration below labeled D. Then insert the clip of the clamp into the body hole.

HINT:

Align the paint mark of the No. 3 hose and paint mark of the wire harness with the edge of the clamp.

6. INSTALL NO. 2 AIR INJECTION SYSTEM HOSE

a. Connect the No. 2 hose so that its paint mark aligns with the rib of the air pump as shown in the illustration below labeled E.

HINT:

Make sure the direction of the hose clamp is as shown in the illustration.

b. Connect the No. 2 hose to the air tube shown in the illustration below labeled F.

HINT:

- **Make sure the paint mark of the No. 2 hose is facing upward.**
- **Make sure the direction of the hose clamp is as shown in the illustration.**

c. Connect the 2 white colored clamps to the No. 2 hose and wire harness shown in the illustration below labeled G.

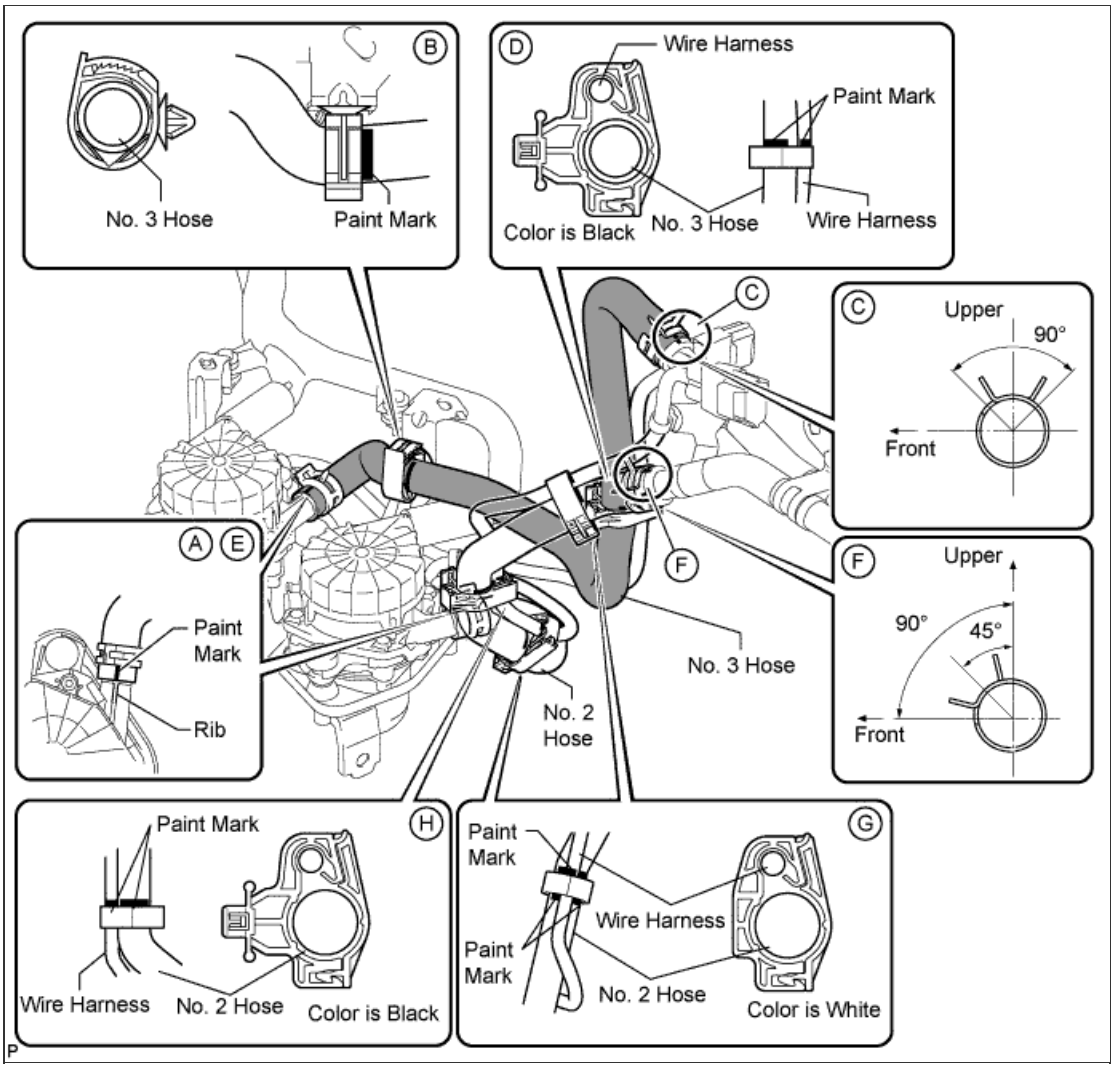
HINT:

- **Make sure the paint mark of the No. 2 hose is facing upward.**
- **Make sure the position of the hose clamp is as shown in the illustration.**

d. Connect the black colored clamp to the No. 2 hose and wire harness shown in the illustration below labeled H. Then insert the clip of the clamp into the body hole.

HINT:

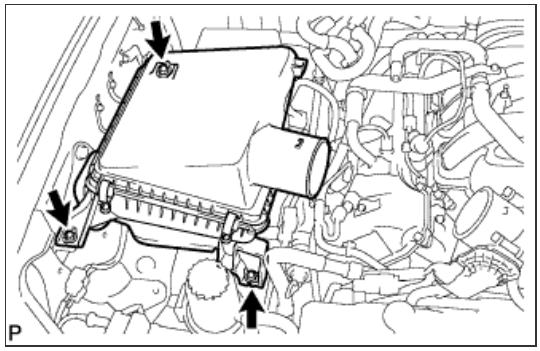
Align the paint mark of the No. 2 hose and paint mark of the wire harness with the edge of the clamp.



7. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



8. INSTALL AIR CLEANER HOSE ASSEMBLY

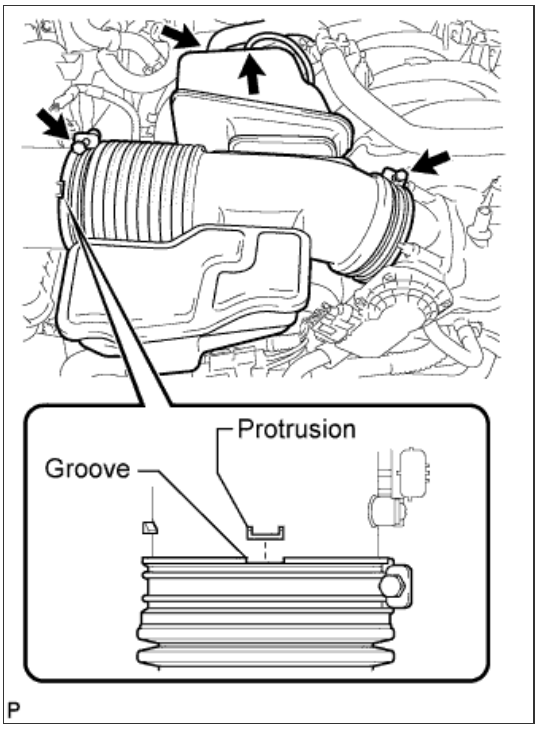
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

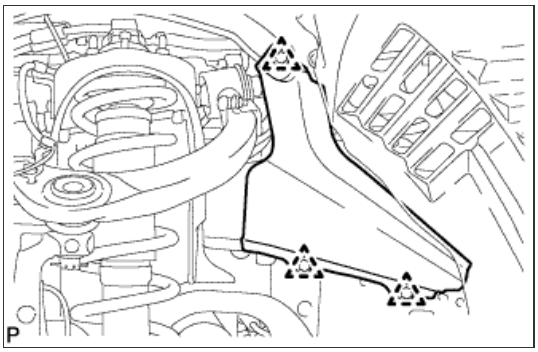
c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



9. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



10. INSTALL FRONT FENDER LINER RH

a. Install the fender liner with the 5 clips.

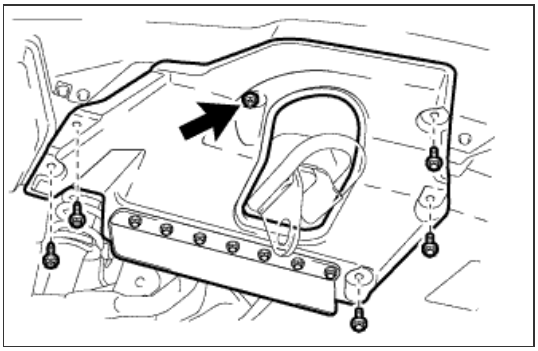
b. Using a T30 "TORX" socket, install the 3 screws.

c. Connect the liner to the front bumper cover with the screw.

11. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



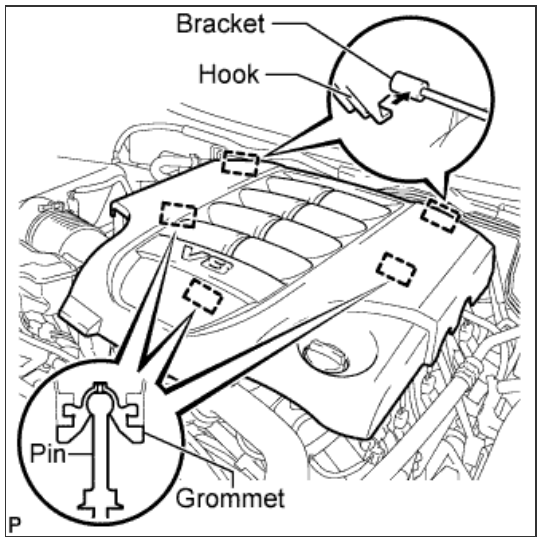
12. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

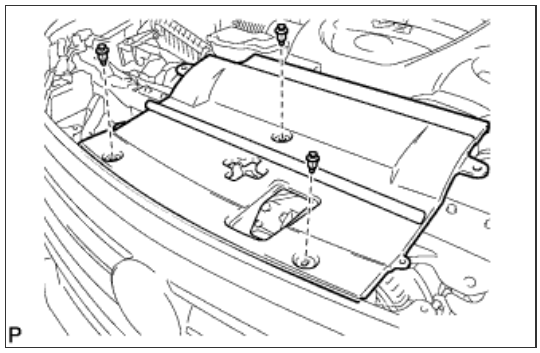
13. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



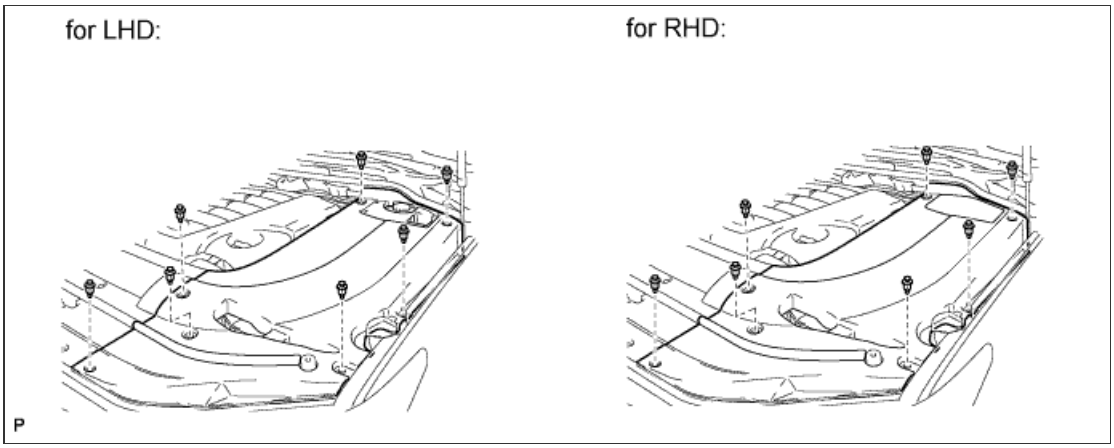
14. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



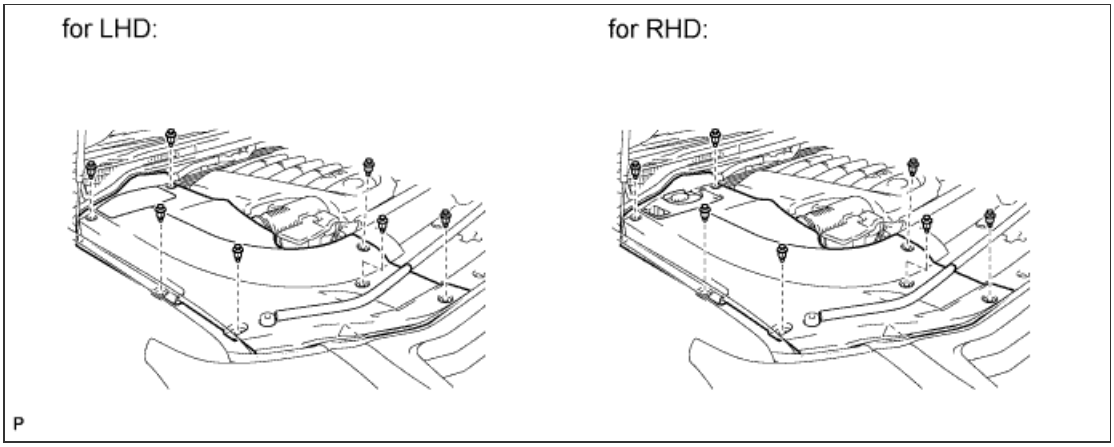
15. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

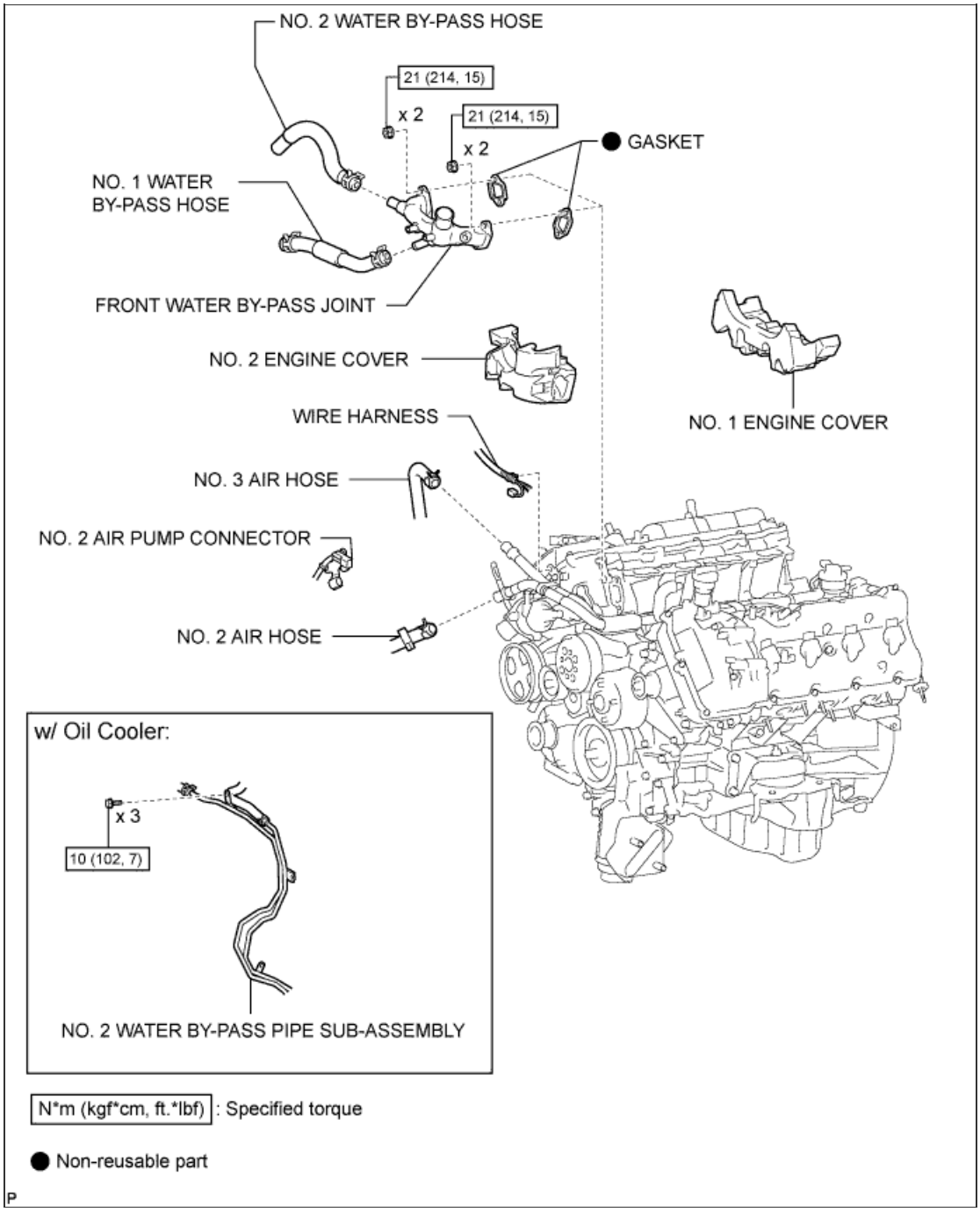


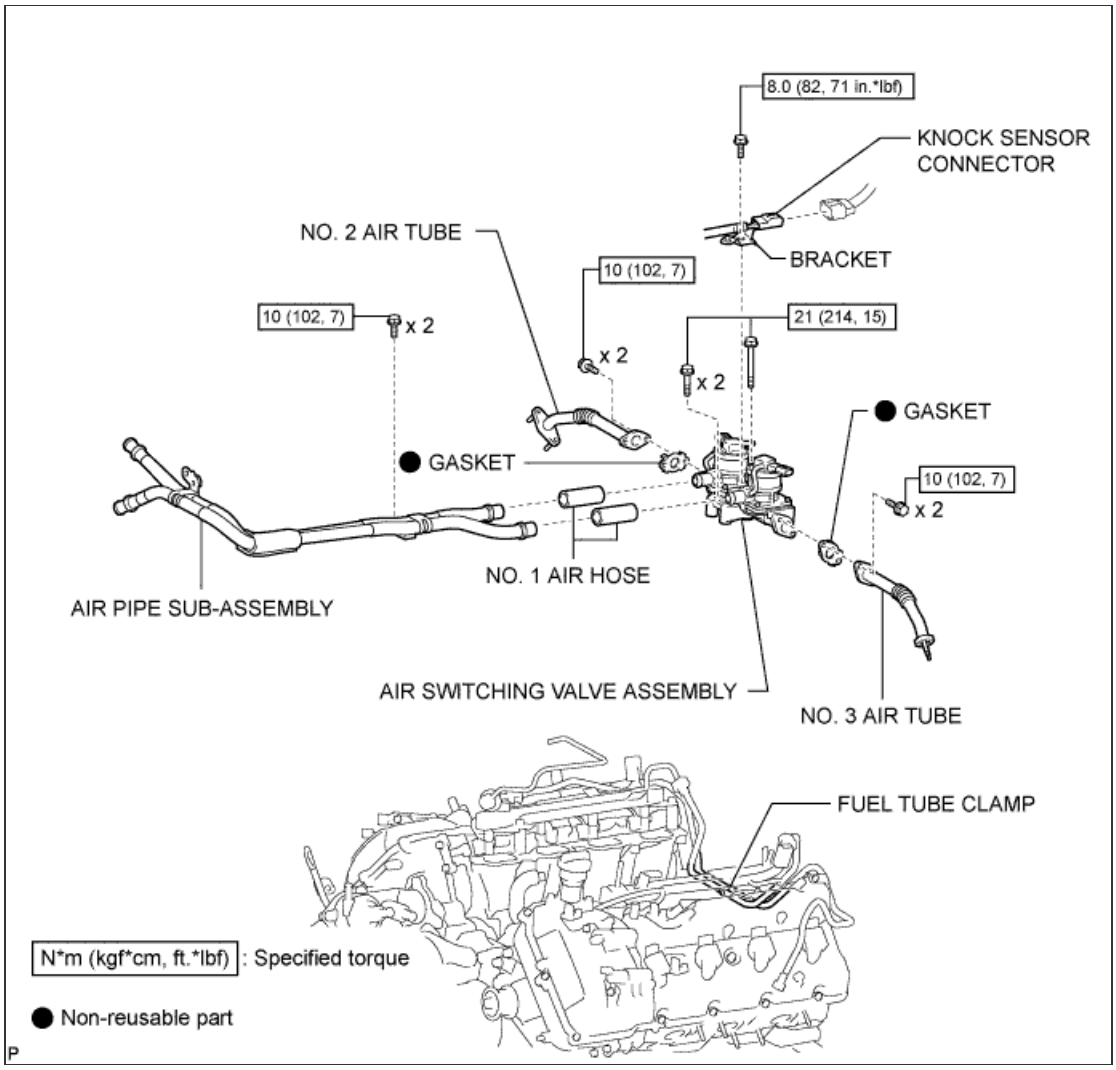
16. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



for Preparation Click here




8.0 (82, 71 in.*lbf)
KNOCK SENSOR CONNECTOR
BRACKET
NO. 2 AIR TUBE
10 (102, 7)
x 2
10 (102, 7)
x 2
21 (214, 15)
x 2
GASKET
GASKET
10 (102, 7)
x 2
NO. 1 AIR HOSE
AIR PIPE SUB-ASSEMBLY
AIR SWITCHING VALVE ASSEMBLY
NO. 3 AIR TUBE
FUEL TUBE CLAMP
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

1. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY

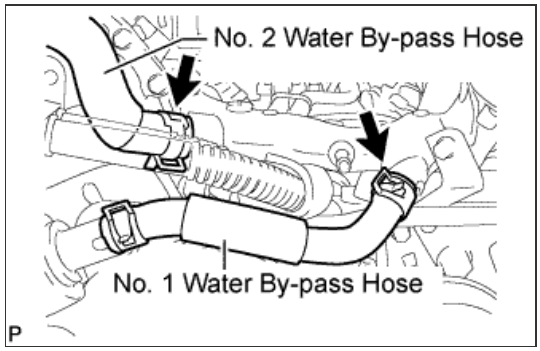
a. Remove the exhaust manifold (Click here).

2. REMOVE INTAKE MANIFOLD

a. Remove the intake manifold (Click here).

3. DISCONNECT NO. 1 WATER BY-PASS HOSE

a. Disconnect the No. 1 water by-pass hose from the water by-pass joint and water inlet housing.

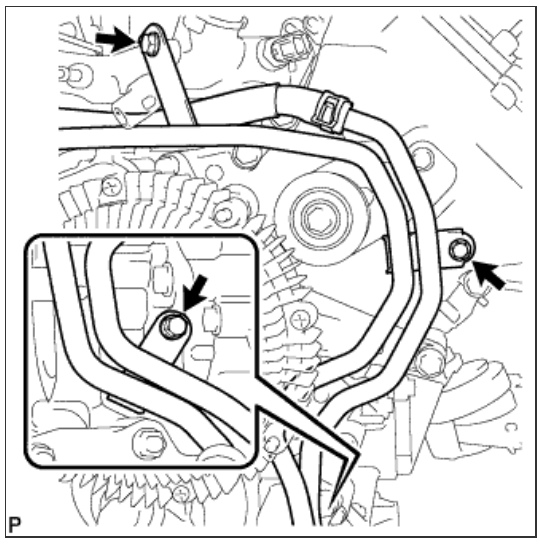


4. DISCONNECT NO. 2 WATER BY-PASS HOSE

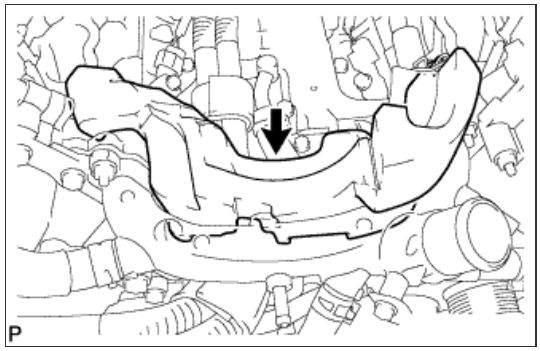
a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

5. DISCONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe.

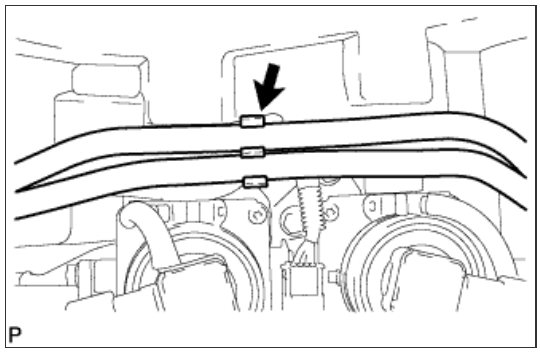


6. REMOVE NO. 2 ENGINE COVER

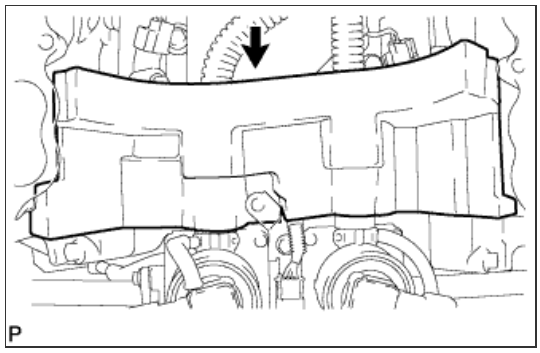


7. DISCONNECT FUEL TUBE CLAMP

a. Disconnect the fuel tube clamp from the bracket.



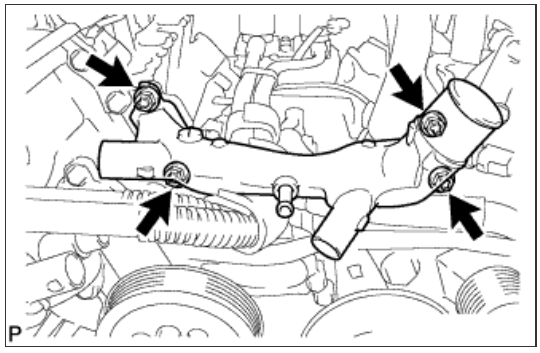
8. REMOVE NO. 1 ENGINE COVER



9. REMOVE FRONT WATER BY-PASS JOINT

a. Disconnect the engine coolant temperature sensor connector.

b. Remove the 4 nuts, front water by-pass joint and 2 gaskets.



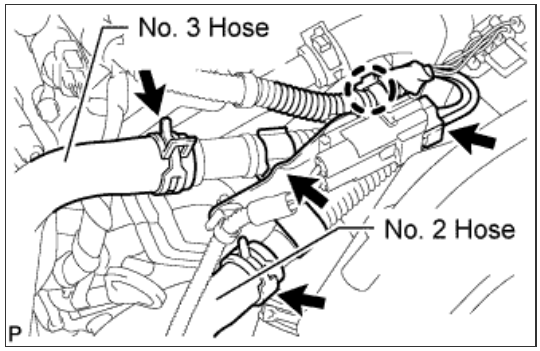
10. REMOVE AIR PIPE SUB-ASSEMBLY

a. Disconnect the No. 2 and No. 3 hoses.

b. Disconnect the air pump connector.

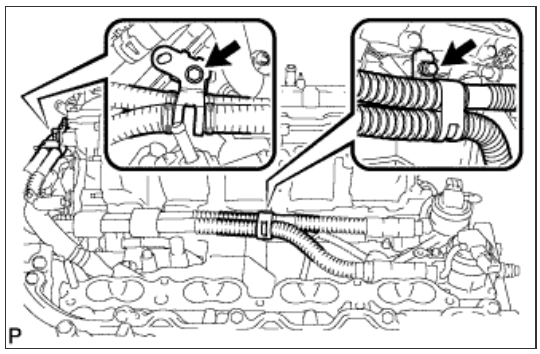
c. Disconnect the air pump connector clamp holder.

d. Using a clip remover, detach the wire harness claw.



e. Remove the 2 bolts and air pipe.

f. Disconnect the 2 No. 1 air hoses from the air pipe.

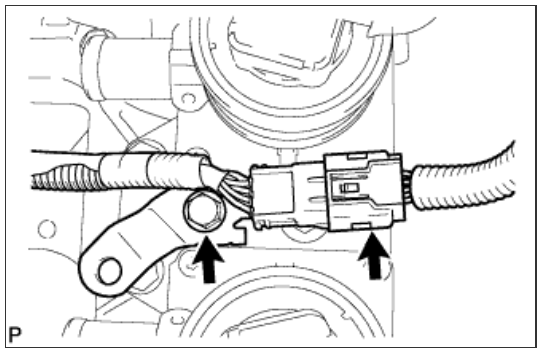


11. REMOVE AIR SWITCHING VALVE ASSEMBLY

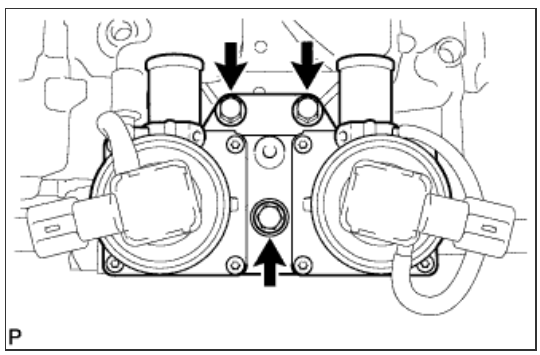
a. Disconnect the knock sensor connector.

b. Remove the bolt and bracket.

c. Disconnect the 2 air switching valve connectors.



d. Remove the 3 bolts and air switching valve.

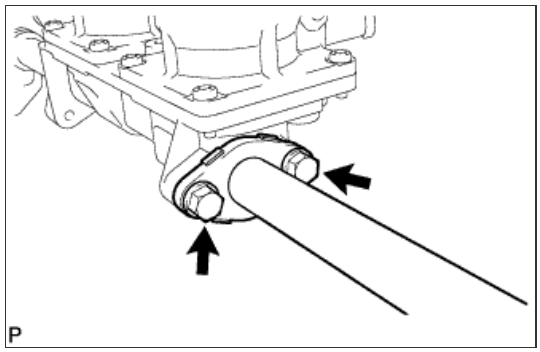


12. REMOVE NO. 2 AIR TUBE

a. Remove the 2 bolts, No. 2 air tube and gasket.

NOTICE:

Be careful not to damage the installation surface of the gaskets.

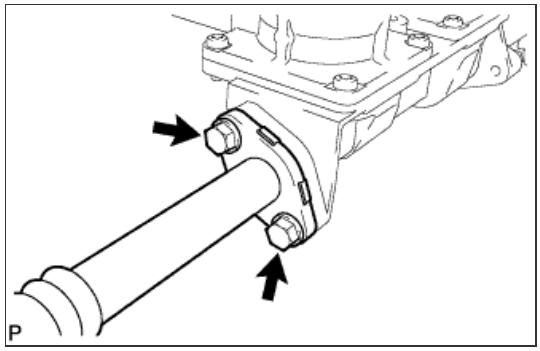


13. REMOVE NO. 3 AIR TUBE

a. Remove the 2 bolts, No. 3 air tube and gasket.

NOTICE:

Be careful not to damage the installation surface of the gaskets.



for Preparation Click here

1. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY

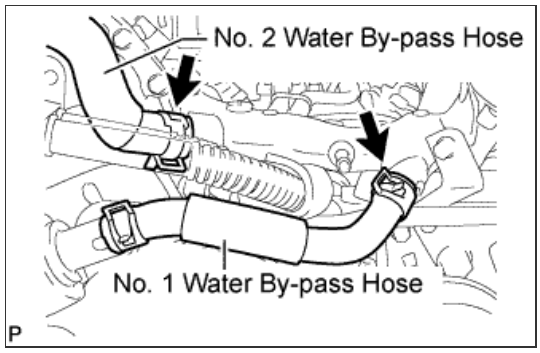
(Click here)

2. REMOVE INTAKE MANIFOLD

(Click here)

3. DISCONNECT NO. 1 WATER BY-PASS HOSE

a. Disconnect the No. 1 water by-pass hose from the water by-pass joint and water inlet housing.

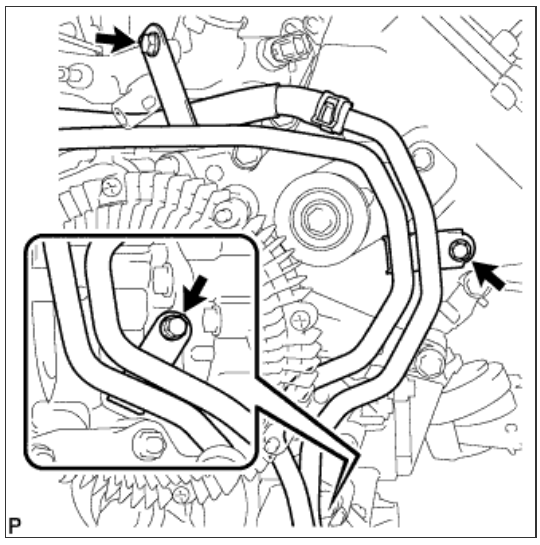


4. DISCONNECT NO. 2 WATER BY-PASS HOSE

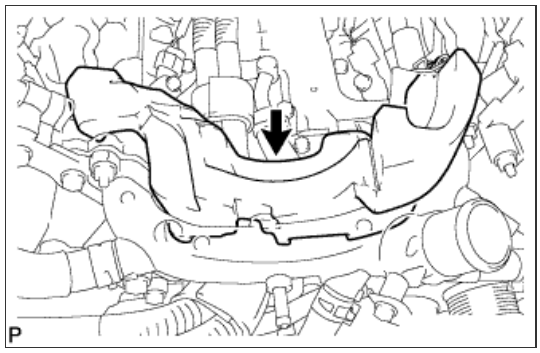
a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

5. DISCONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe.

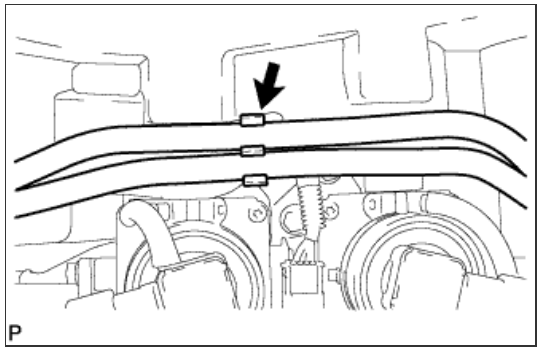


6. REMOVE NO. 2 ENGINE COVER

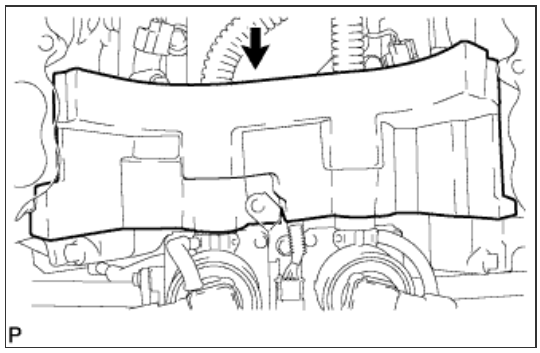


7. DISCONNECT FUEL TUBE CLAMP

a. Disconnect the fuel tube clamp from the bracket.



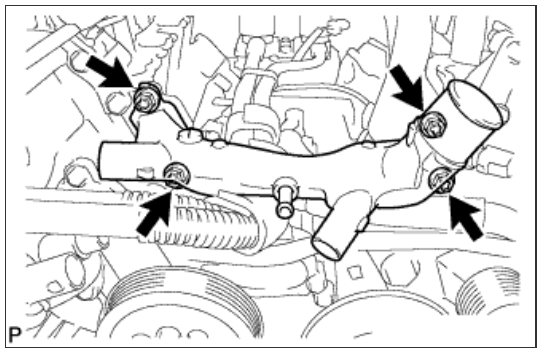
8. REMOVE NO. 1 ENGINE COVER



9. REMOVE FRONT WATER BY-PASS JOINT

a. Disconnect the engine coolant temperature sensor connector.

b. Remove the 4 nuts, front water by-pass joint and 2 gaskets.



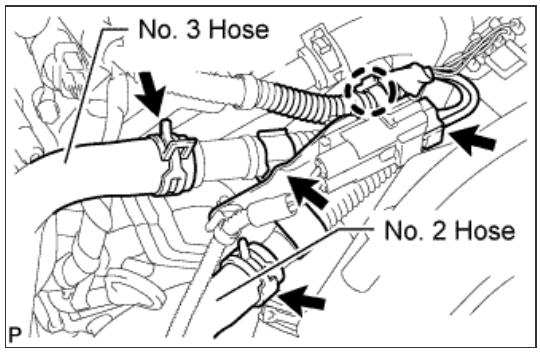
10. REMOVE AIR PIPE SUB-ASSEMBLY

a. Disconnect the No. 2 and No. 3 hoses.

b. Disconnect the air pump connector.

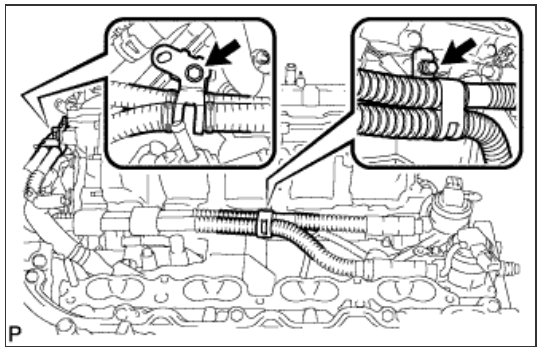
c. Disconnect the air pump connector clamp holder.

d. Using a clip remover, detach the wire harness claw.



e. Remove the 2 bolts and air pipe.

f. Disconnect the 2 No. 1 air hoses from the air pipe.

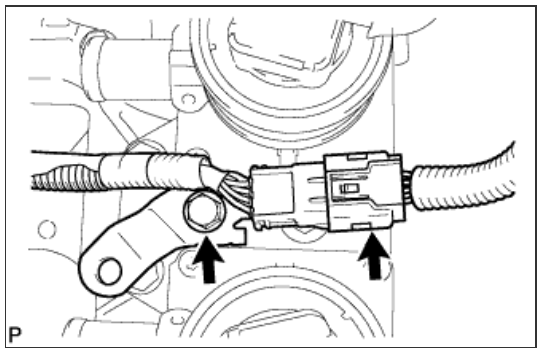


11. REMOVE AIR SWITCHING VALVE ASSEMBLY

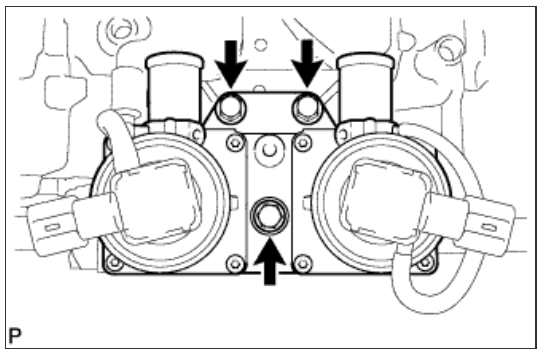
a. Disconnect the knock sensor connector.

b. Remove the bolt and bracket.

c. Disconnect the 2 air switching valve connectors.



d. Remove the 3 bolts and air switching valve.

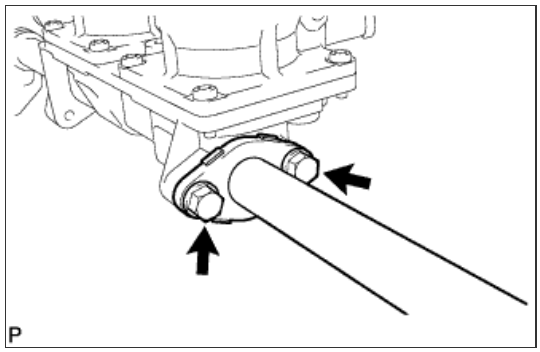


12. REMOVE NO. 2 AIR TUBE

a. Remove the 2 bolts, No. 2 air tube and gasket.

NOTICE:

Be careful not to damage the installation surface of the gaskets.

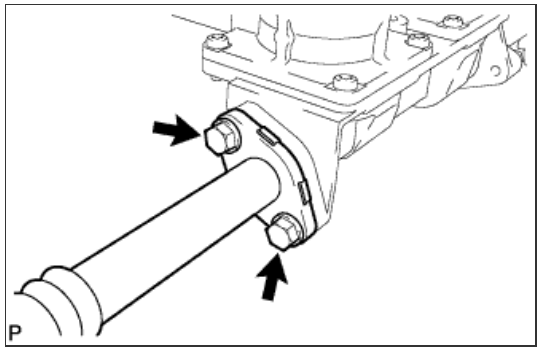


13. REMOVE NO. 3 AIR TUBE

a. Remove the 2 bolts, No. 3 air tube and gasket.

NOTICE:

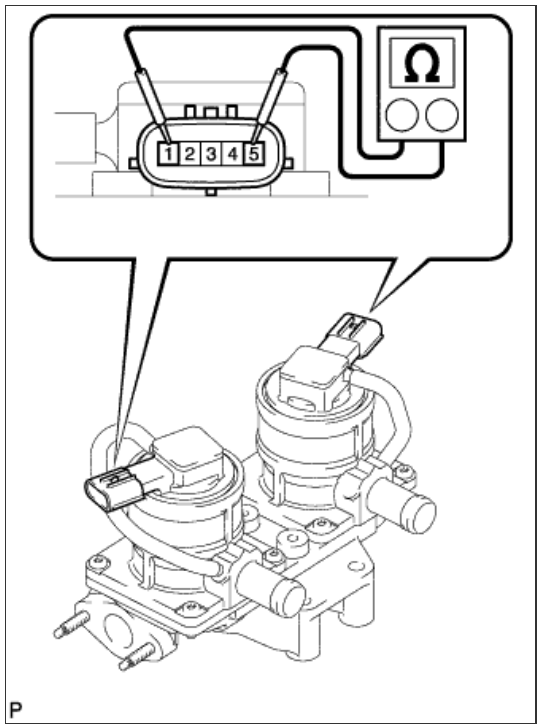
Be careful not to damage the installation surface of the gaskets.



for Preparation Click here

1. INSPECT AIR SWITCHING VALVE ASSEMBLY

a. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 5	20°C (68°F)*	4.5 to 5.5 Ω
1 - Body ground	Always	1 MΩ or higher
5 - Body ground		

HINT:

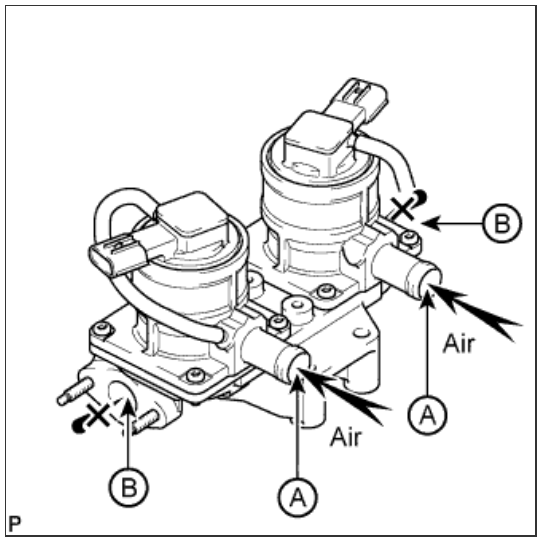
*: Make sure that the air switching valve is at ambient temperature before measuring the resistance.

NOTICE:

When measuring the resistance, do not touch terminals 2, 3 and 4.

If the result is not as specified, replace the air switching valve assembly.

b. Check the operation of the air switching valve.



i. Check that air does not flow from port A to port B.

NOTICE:

Make sure the applied pressure is 30 kPa (0.3 kgf/cm^2, 4.4 psi) or less

If the result is not as specified, replace the air switching valve assembly.

ii. Apply battery voltage to the connector, and check the air switching valve operation.

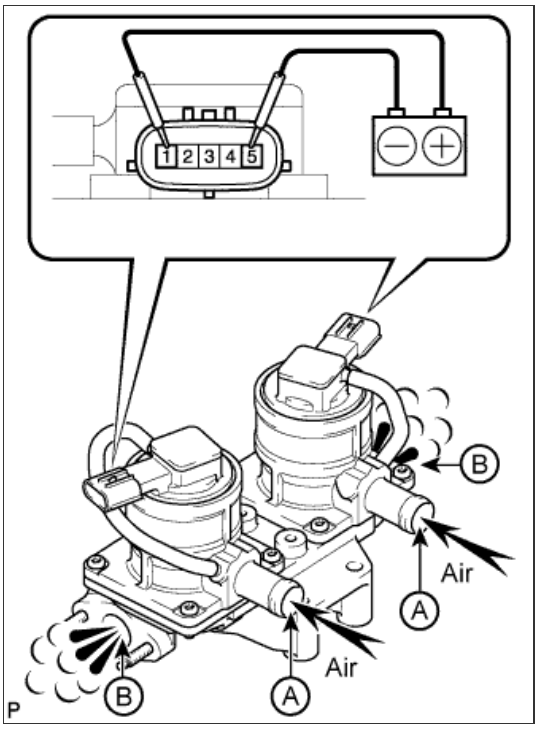
OK:

Measurement Condition	Specified Condition
Battery positive (+) → Terminal 1 Battery negative (-) → Terminal 5	Air flows from port A to port B

NOTICE:

When applying voltage, do not touch terminals 2, 3 and 4.

If the result is not as specified, replace the air switching valve assembly.



for Preparation Click here

1. INSTALL NO. 3 AIR TUBE

a. Install a new gasket and the No. 3 air tube with the 2 bolts.

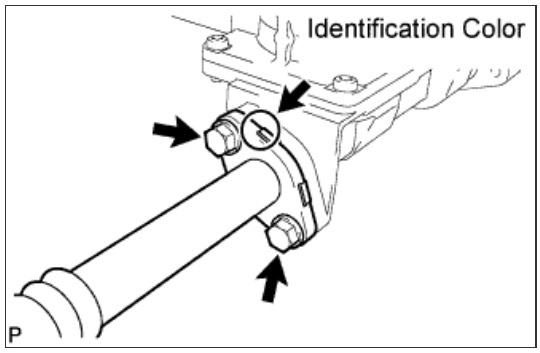
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is orange.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.



2. INSTALL NO. 2 AIR TUBE

a. Install a new gasket and the No. 2 air tube with the 2 bolts.

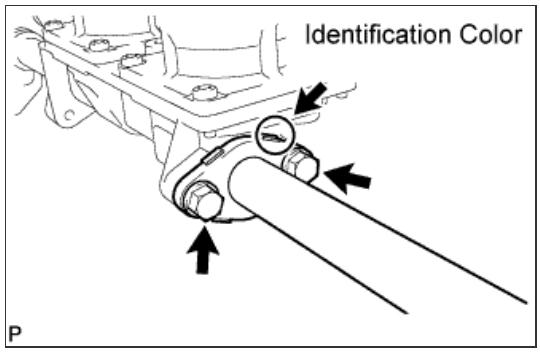
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is blue.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.

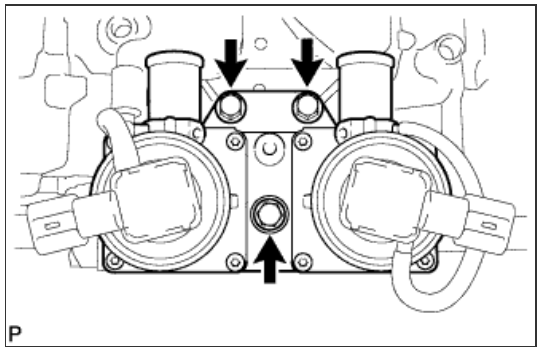


3. INSTALL AIR SWITCHING VALVE ASSEMBLY

a. Install the air switching valve with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

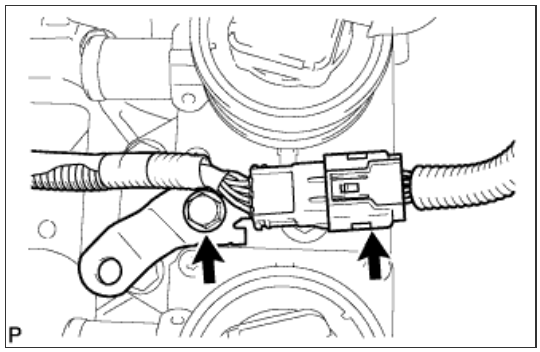
b. Connect the 2 air switching valve connectors.



c. Install the bracket with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

d. Connect the knock sensor connector.

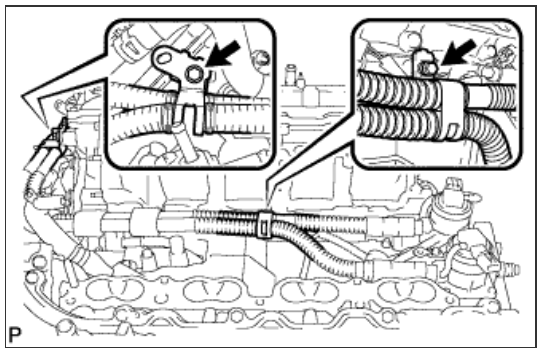


4. INSTALL AIR PIPE SUB-ASSEMBLY

a. Connect the 2 No. 1 air hoses to the air pipe.

b. Connect the air pipe to the air switching valve, and install the air pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

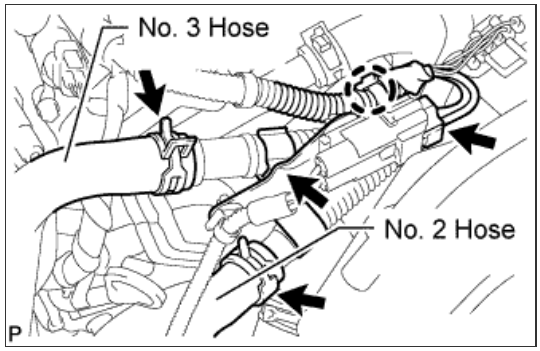


c. Connect the air pump connector clamp holder.

d. Attach the wire harness claw.

e. Connect the air pump connector.

f. Connect the No. 2 and No. 3 hoses.

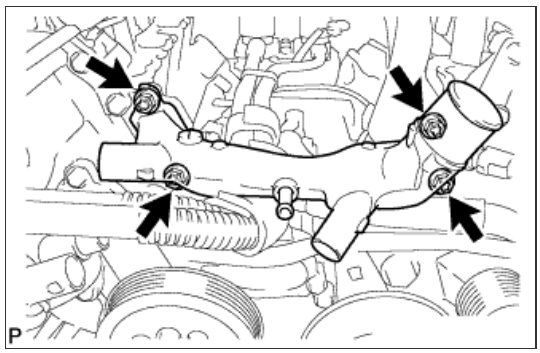


5. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the front water by-pass joint with the 4 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the engine coolant temperature sensor connector.

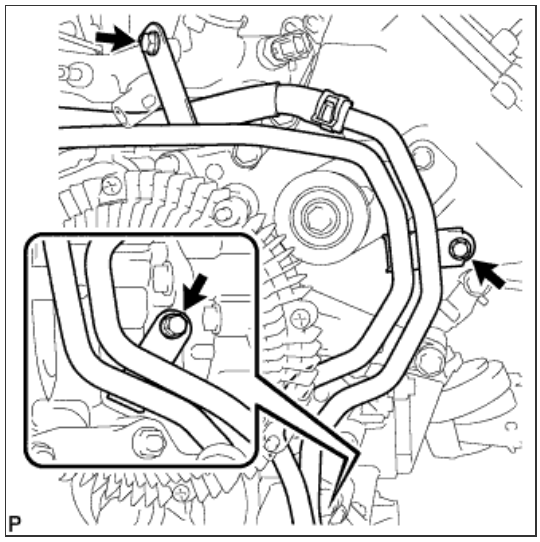


6. CONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the No. 2 water by-pass pipe with the 3 bolts.

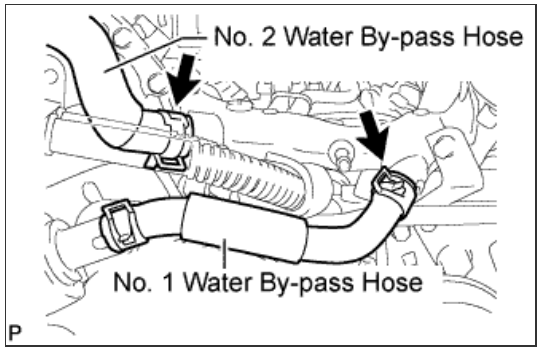
a. Connect the No. 2 water by-pass pipe with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



7. CONNECT NO. 2 WATER BY-PASS HOSE

a. Connect the No. 2 water by-pass hose to the water by-pass joint.



8. CONNECT NO. 1 WATER BY-PASS HOSE

a. Connect the No. 1 water by-pass hose to the water by-pass joint and water inlet housing.

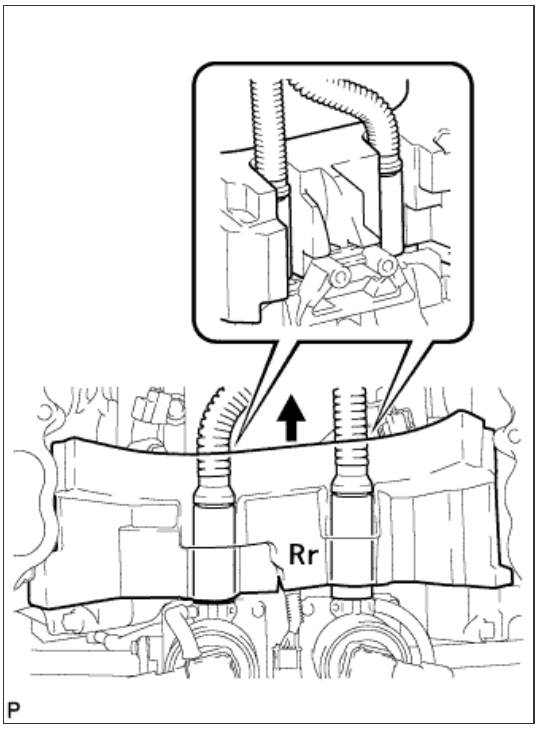
9. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

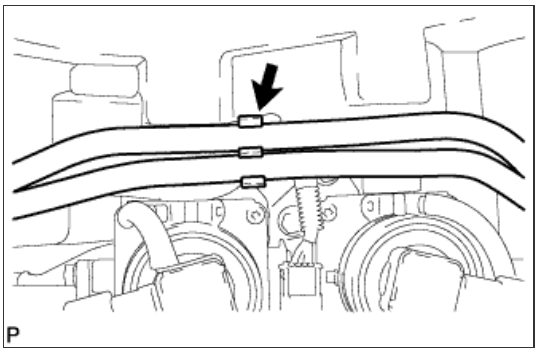
NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



10. CONNECT FUEL TUBE CLAMP

a. Connect the fuel tube clamp to the bracket.



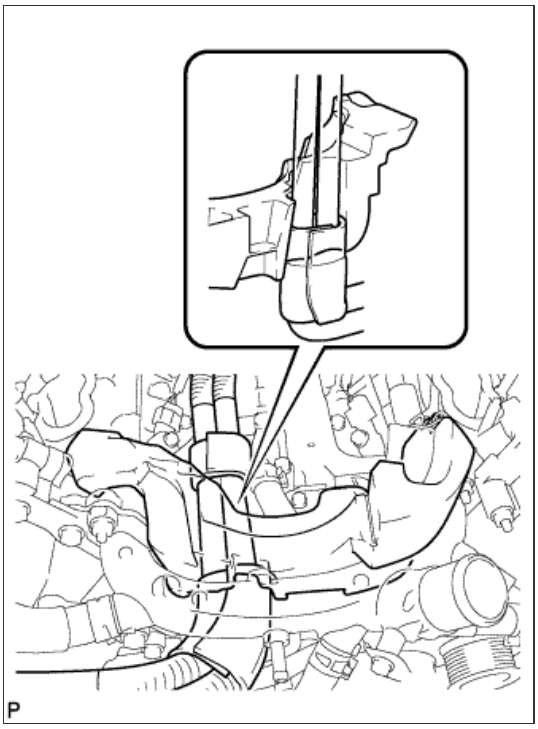
11. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.



12. INSTALL INTAKE MANIFOLD

a. Install the intake manifold (Click here).

13. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY

a. Install the exhaust manifold (Click here).

for Preparation Click here

1. INSTALL NO. 3 AIR TUBE

a. Install a new gasket and the No. 3 air tube with the 2 bolts.

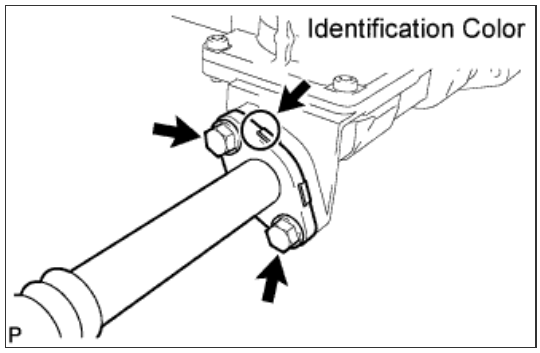
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is orange.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.



2. INSTALL NO. 2 AIR TUBE

a. Install a new gasket and the No. 2 air tube with the 2 bolts.

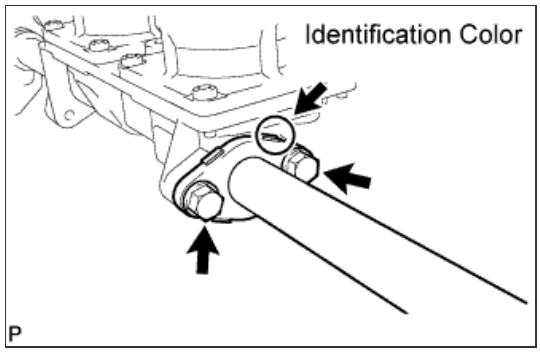
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

HINT:

The identification color on the flange is blue.

NOTICE:

Make sure the claws on the gasket are not caught between the air tube and air switching valve.

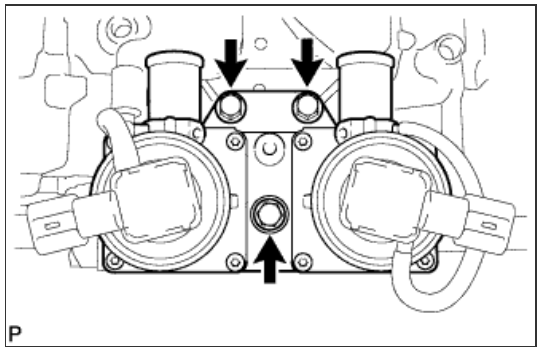


3. INSTALL AIR SWITCHING VALVE ASSEMBLY

a. Install the air switching valve with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

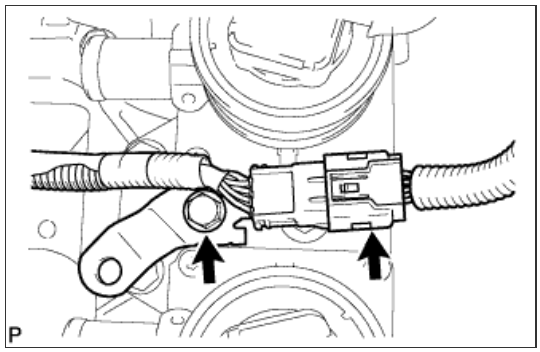
b. Connect the 2 air switching valve connectors.



c. Install the bracket with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

d. Connect the knock sensor connector.

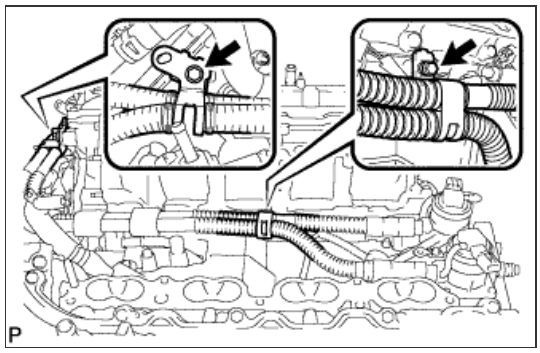


4. INSTALL AIR PIPE SUB-ASSEMBLY

a. Connect the 2 No. 1 air hoses to the air pipe.

b. Connect the air pipe to the air switching valve, and install the air pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

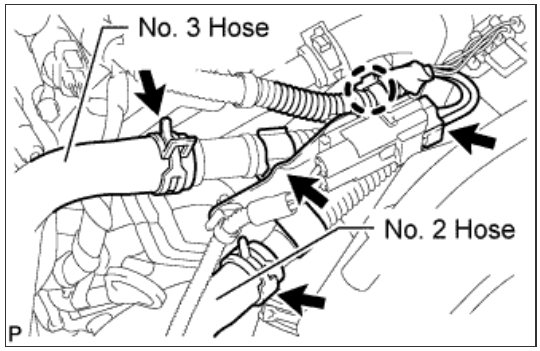


c. Connect the air pump connector clamp holder.

d. Attach the wire harness claw.

e. Connect the air pump connector.

f. Connect the No. 2 and No. 3 hoses.

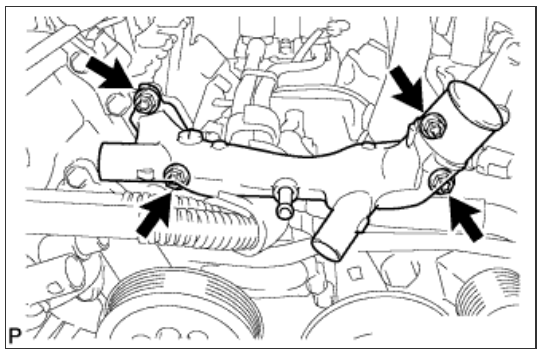


5. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the front water by-pass joint with the 4 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the engine coolant temperature sensor connector.

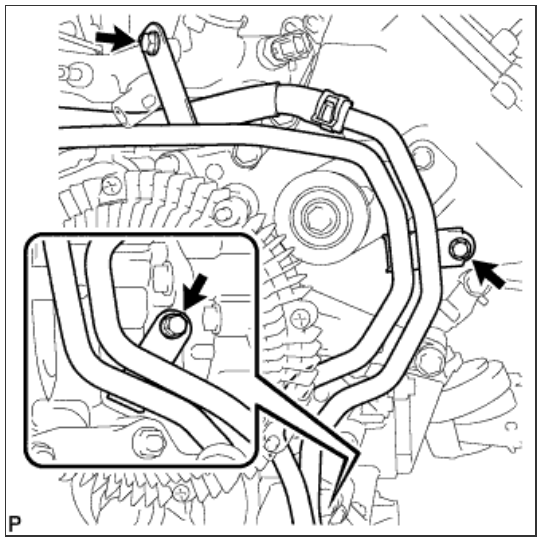


6. CONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the No. 2 water by-pass pipe with the 3 bolts.

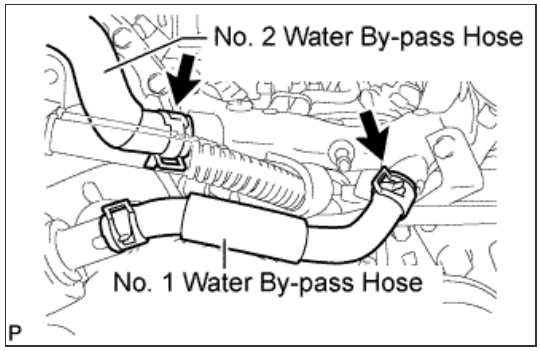
a. Connect the No. 2 water by-pass pipe with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



7. CONNECT NO. 2 WATER BY-PASS HOSE

a. Connect the No. 2 water by-pass hose to the water by-pass joint.



8. CONNECT NO. 1 WATER BY-PASS HOSE

a. Connect the No. 1 water by-pass hose to the water by-pass joint and water inlet housing.

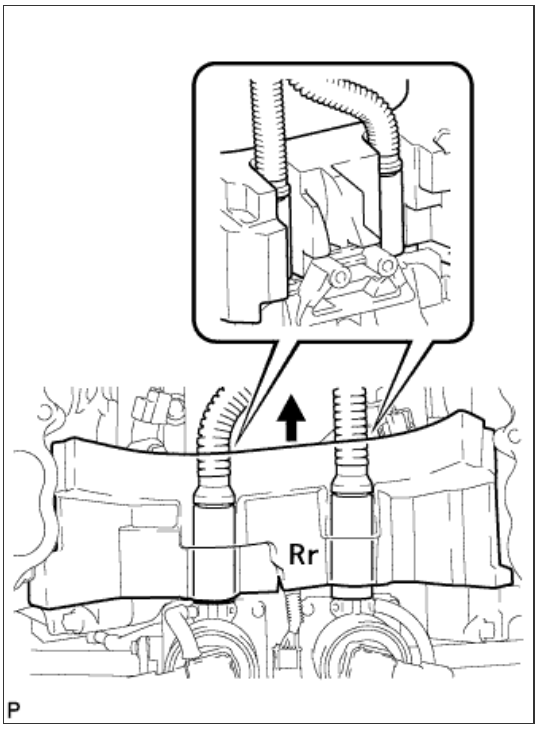
9. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

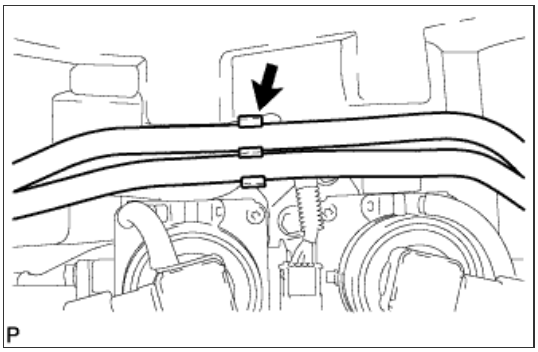
NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



10. CONNECT FUEL TUBE CLAMP

a. Connect the fuel tube clamp to the bracket.



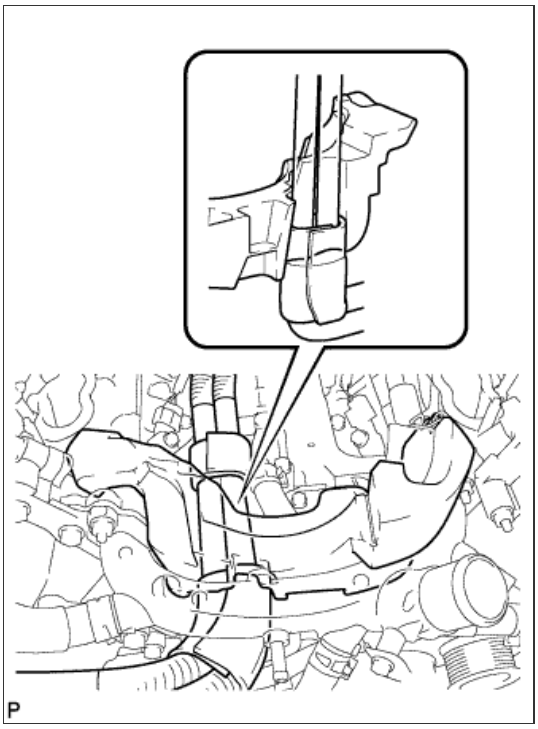
11. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.



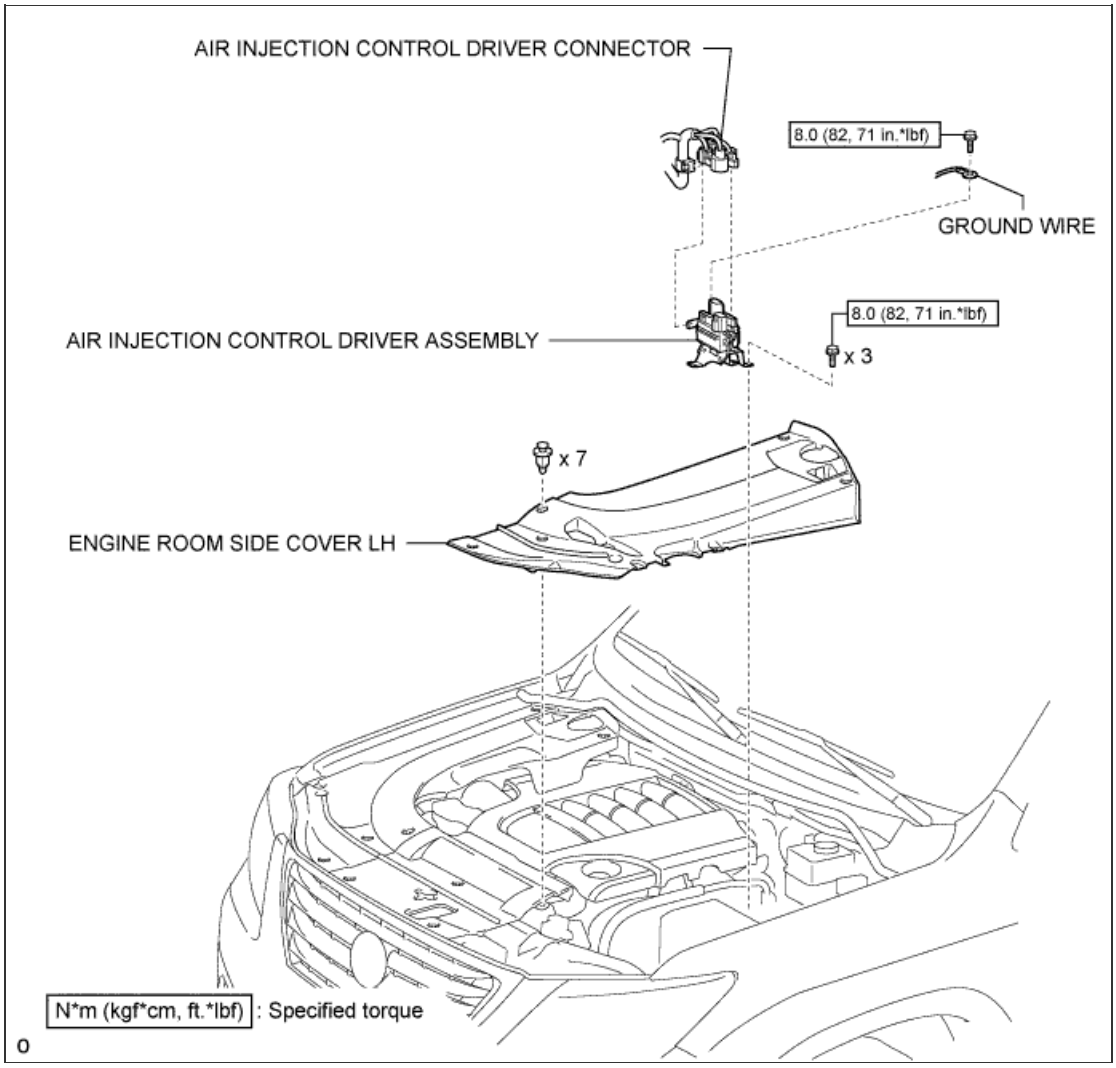
12. INSTALL INTAKE MANIFOLD

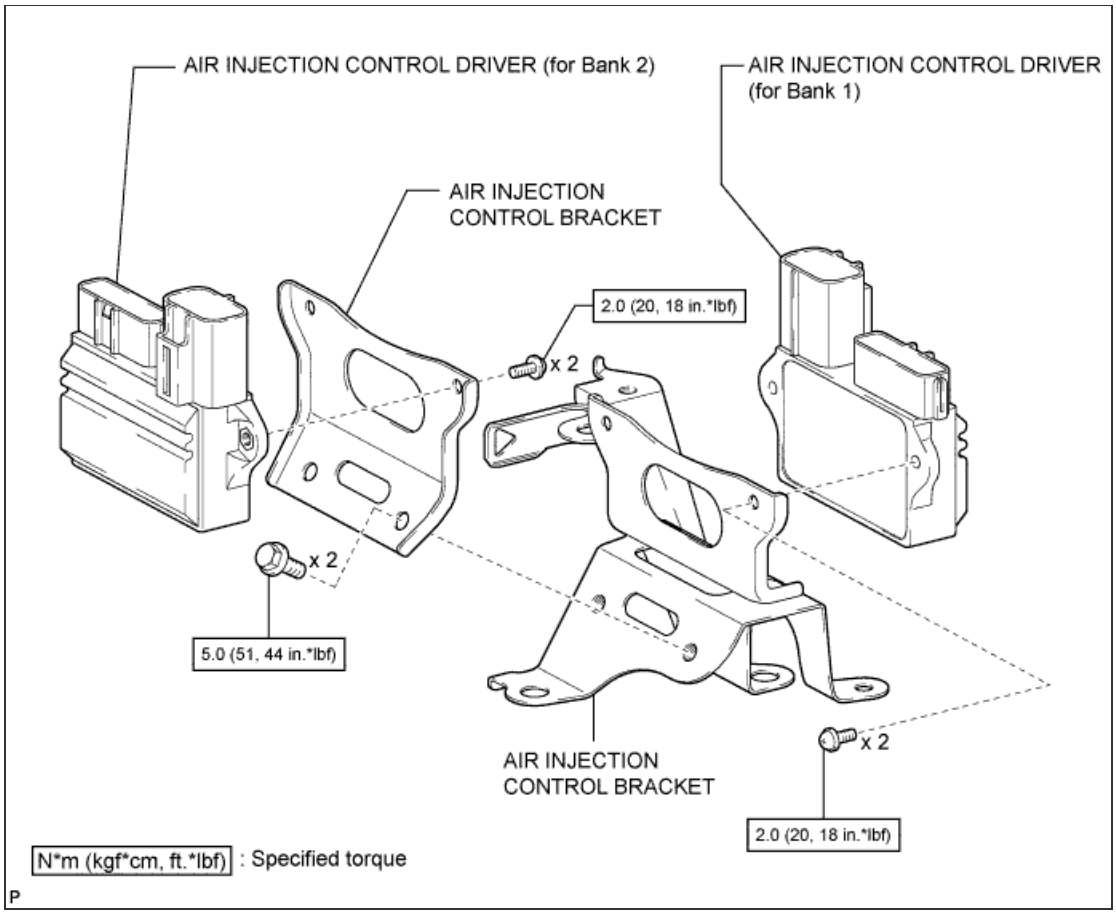
(Click here)

13. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY

(Click here)

for Preparation Click here

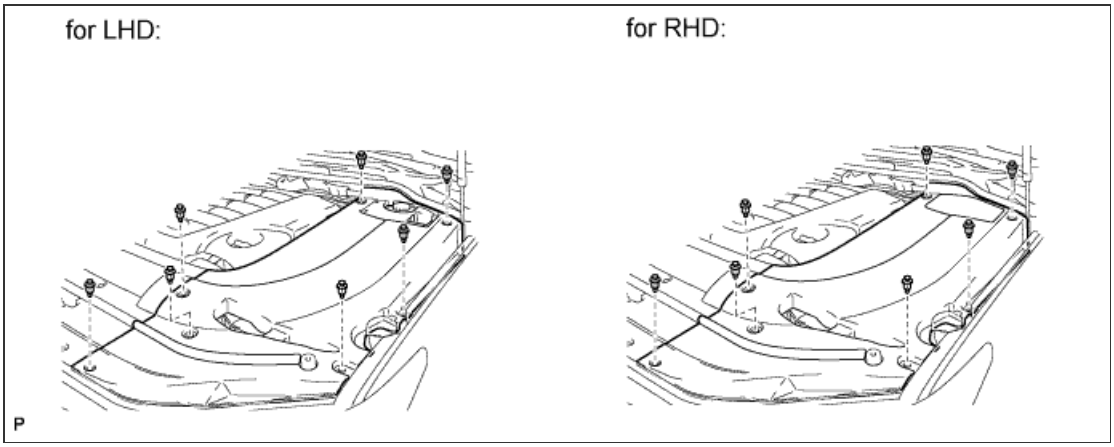



AIR INJECTION CONTROL DRIVER (for Bank 2)
AIR INJECTION CONTROL DRIVER (for Bank 1)
AIR INJECTION CONTROL BRACKET
2.0 (20, 18 in.*lbf)
x 2
x 2
5.0 (51, 44 in.*lbf)
AIR INJECTION CONTROL BRACKET
x 2
2.0 (20, 18 in.*lbf)
N*m (kgf*cm, ft.*lbf) : Specified torque
P

for Preparation Click here

1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

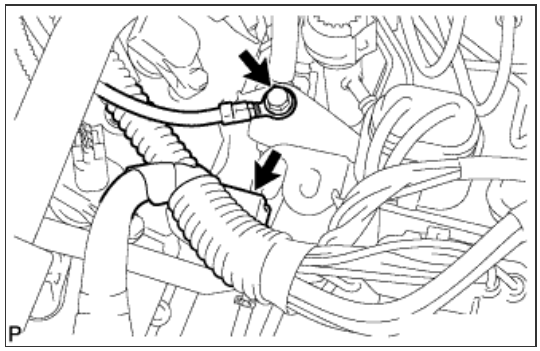
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

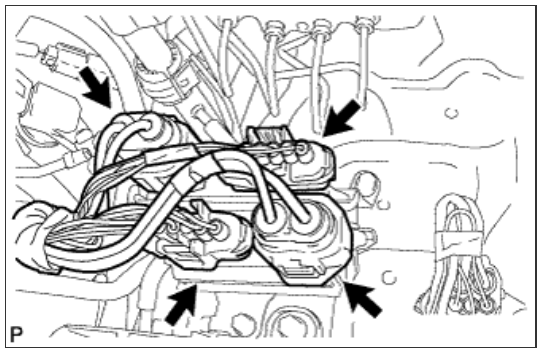
3. REMOVE AIR INJECTION CONTROL DRIVER ASSEMBLY

a. Remove the bolt and disconnect the ground wire.

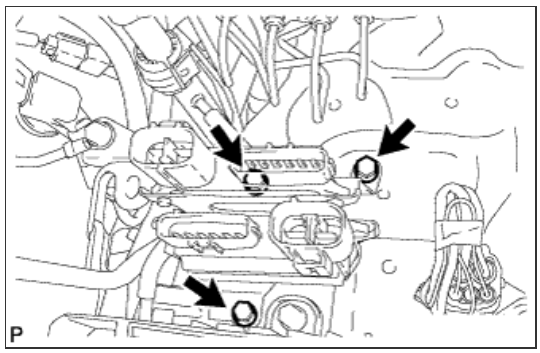
b. Disconnect the wire harness clamp.



c. Disconnect the 4 air injection control driver connectors.



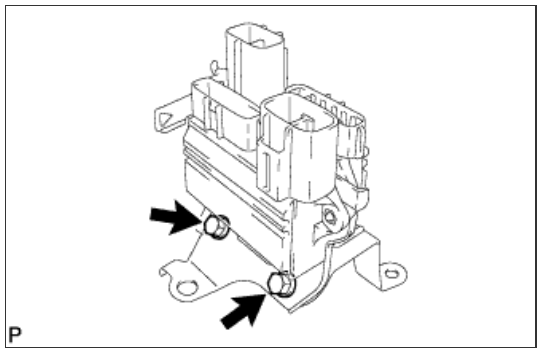
d. Remove the 3 bolts and air injection control driver.



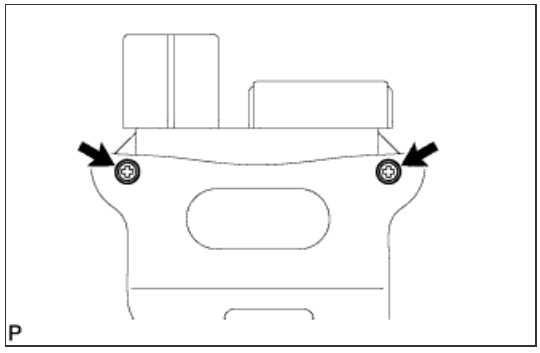
for Preparation Click here

1. REMOVE AIR INJECTION CONTROL DRIVER (for Bank 2)

a. Remove the 2 bolts.

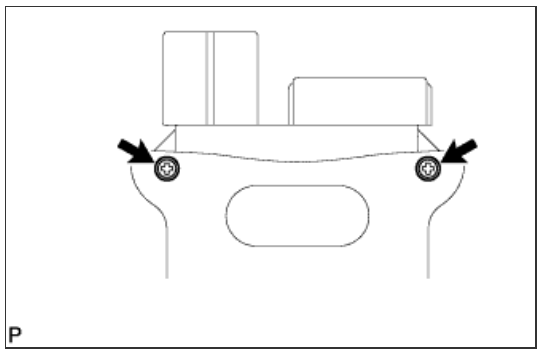


b. Remove the 2 screws and air injection control driver.



2. REMOVE AIR INJECTION CONTROL DRIVER (for Bank 1)

a. Remove the 2 screws and air injection control driver.

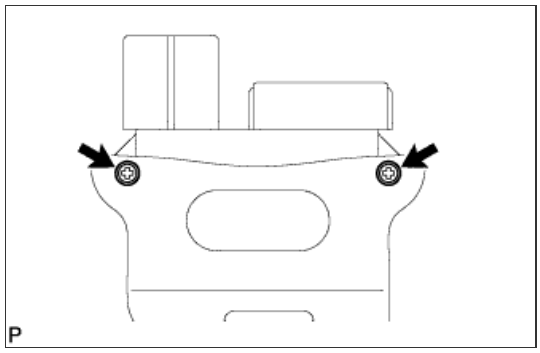


for Preparation Click here

1. INSTALL AIR INJECTION CONTROL DRIVER (for Bank 1)

a. Install the air injection control driver with the 2 screws.

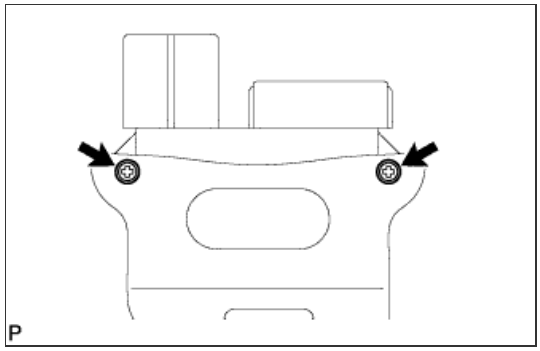
Torque:
2.0 N*m{ 20 kgf*cm , 18 in.*lbf }



2. INSTALL AIR INJECTION CONTROL DRIVER (for Bank 2)

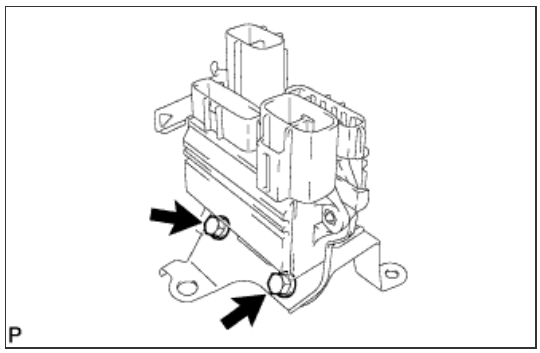
a. Install the air injection control driver with the 2 screws.

Torque:
2.0 N*m{ 20 kgf*cm , 18 in.*lbf }



b. Install the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

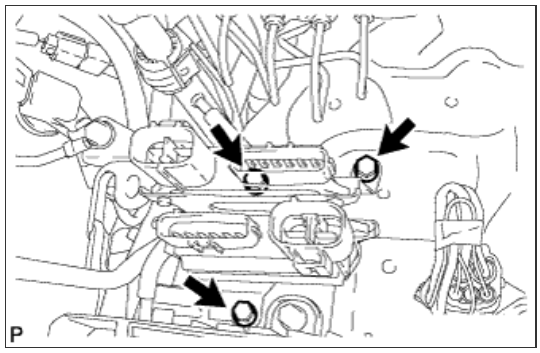


for Preparation Click here

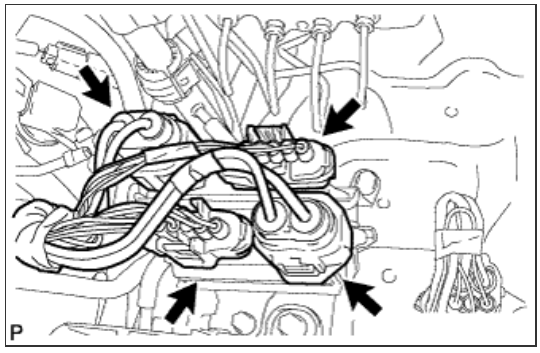
1. INSTALL AIR INJECTION CONTROL DRIVER ASSEMBLY

a. Install the air injection control driver with the 3 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



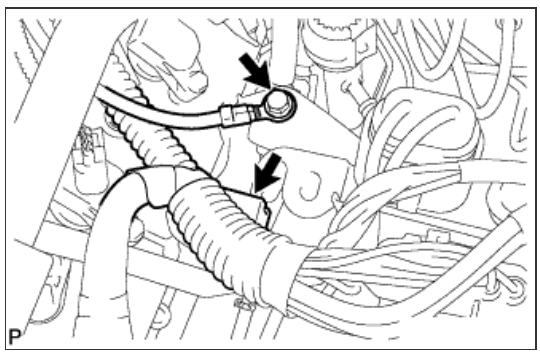
b. Connect the 4 air injection control driver connectors.



c. Connect the wire harness clamp.

d. Connect the ground wire with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



2. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

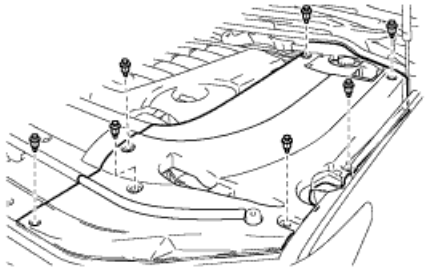
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

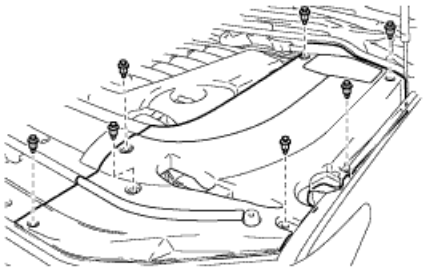
3. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

for LHD:

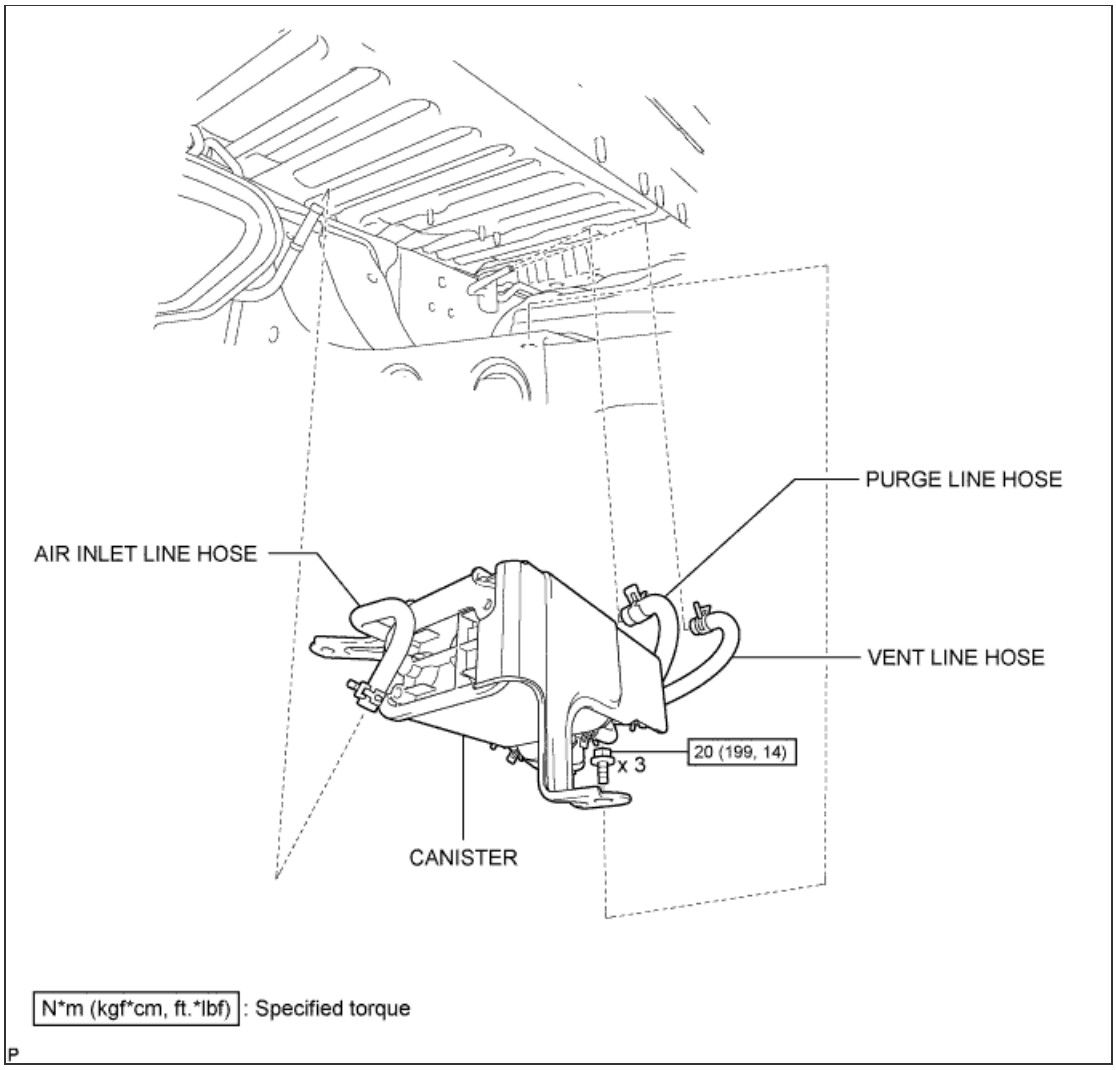


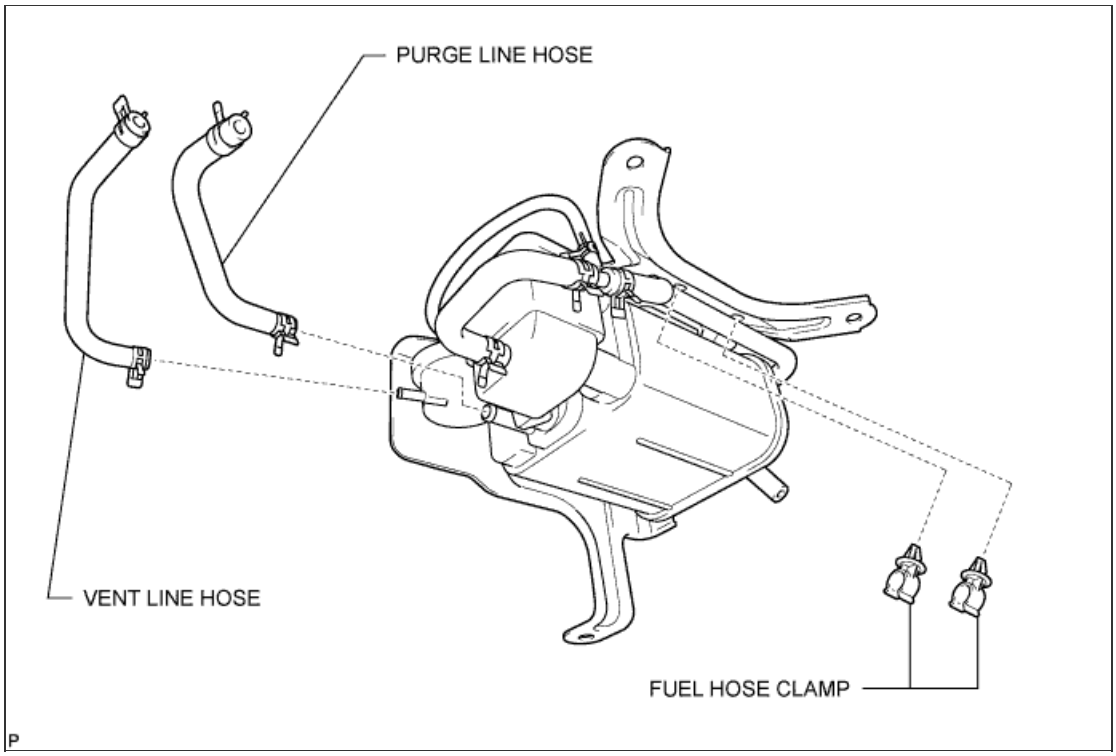
for RHD:



P

for Preparation Click here

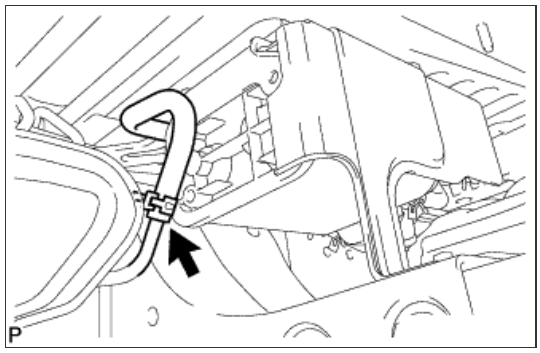



PURGE LINE HOSE
VENT LINE HOSE
FUEL HOSE CLAMP
P

for Preparation Click here

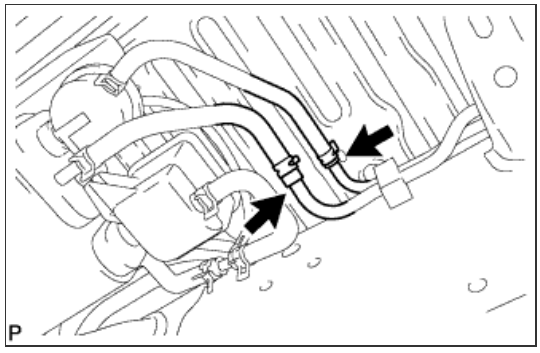
1. REMOVE CANISTER

a. Disconnect the air inlet line hose.



b. Disconnect the vent line hose.

c. Disconnect the purge line hose.

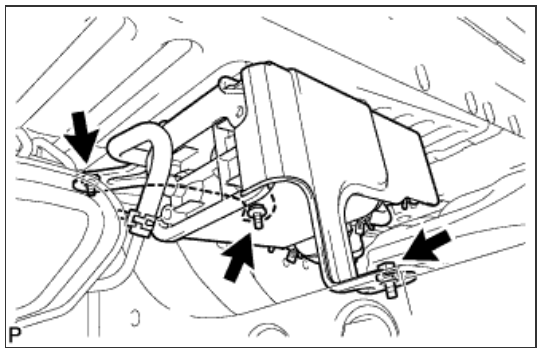


d. Remove the 3 bolts and canister.

e. Remove the 2 fuel hose clamps from the canister.

f. Remove the purge line hose.

g. Remove the vent line hose.



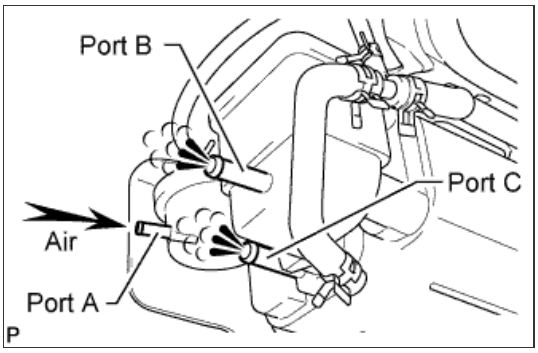
for Preparation Click here

1. INSPECT CANISTER

a. Visually check the canister for cracks or damage.

b. Blow compressed air of 4.9 kPa (50 gf/cm ^{2}, 0.71 psi) into port A and check that air flows without resistance from port B and port C.
If the result is not as specified, replace the canister.

c. Apply a vacuum of 1.96 kPa (20 gf/cm^2, 0.28 psi) to port A. Check that the vacuum does not decrease when ports B and C are closed, and check that the vacuum does not decrease when port B is released.
If the result is not as specified, replace the canister.

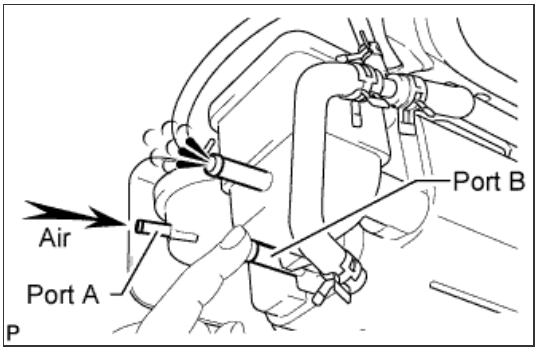


2. CLEAN FILTER IN CANISTER

a. Clean the filter by blowing compressed air of 4.9 kPa (50 gf/cm ^{2}, 0.71 psi) into port A while holding port B closed.

NOTICE:

Do not attempt to wash the canister.



for Preparation Click here

1. INSTALL CANISTER

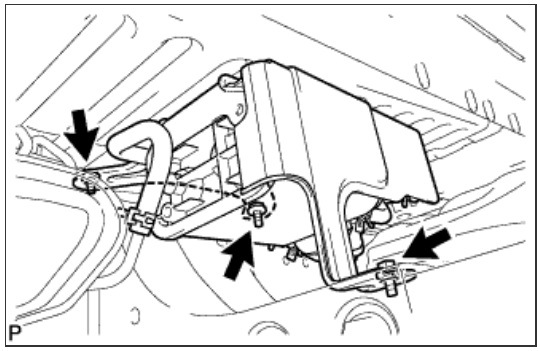
a. Install the vent line hose to the canister.

b. Install the purge line hose to the canister.

c. Install the 2 fuel hose clamps to the canister.

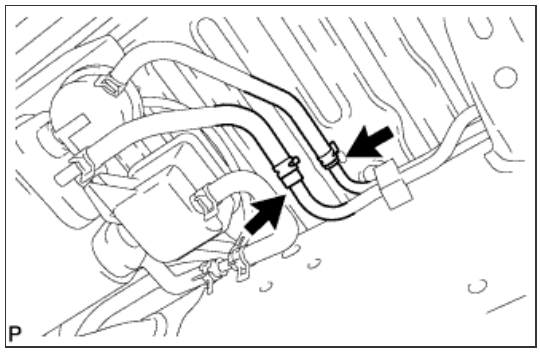
d. Install the canister with the 3 bolts.

Torque:
20 N*m{ 199 kgf*cm , 14 ft.*lbf }

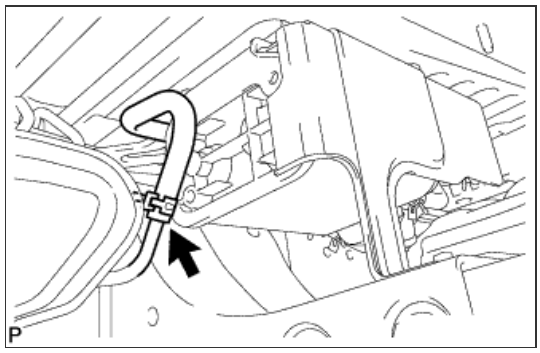


e. Connect the vent line hose.

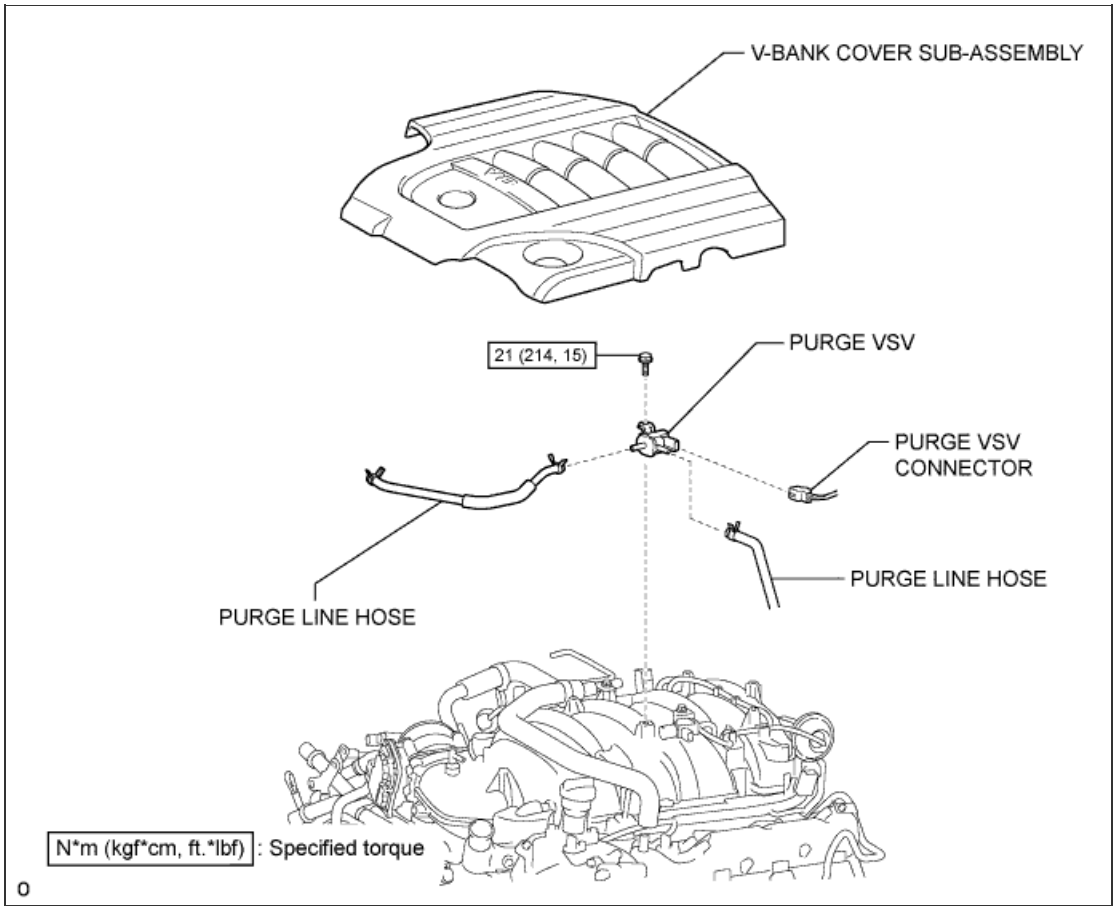
f. Connect the purge line hose.



g. Connect the air inlet line hose.



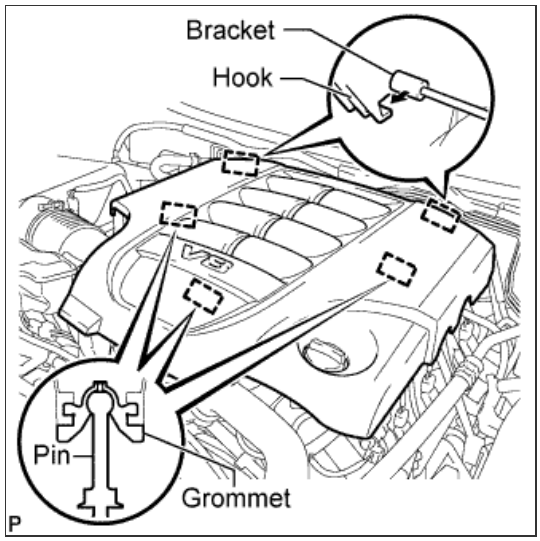
for Preparation Click here



for Preparation Click here

1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



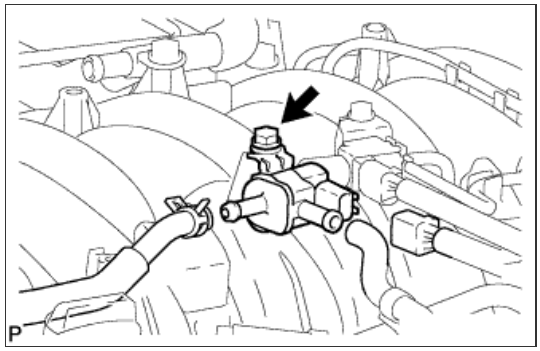
2. DISCONNECT PURGE LINE HOSE

a. Disconnect the 2 purge line hoses.

3. REMOVE PURGE VSV

a. Disconnect the purge VSV connector.

b. Remove the bolt and purge VSV.



for Preparation Click here

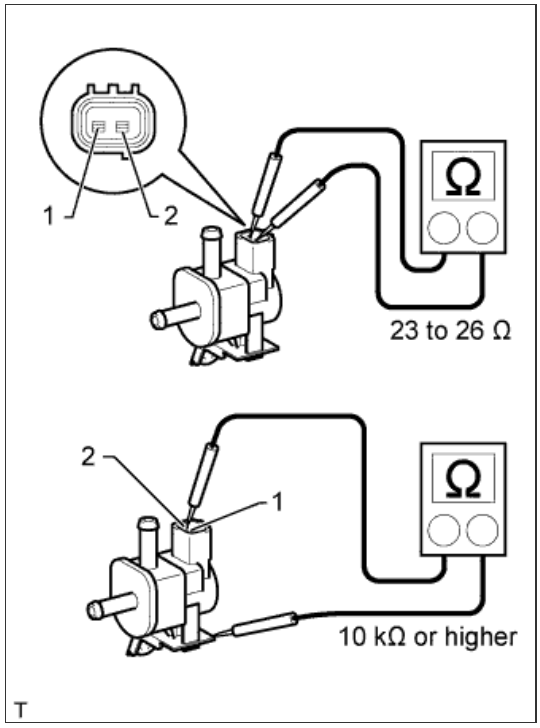
1. INSPECT PURGE VSV

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

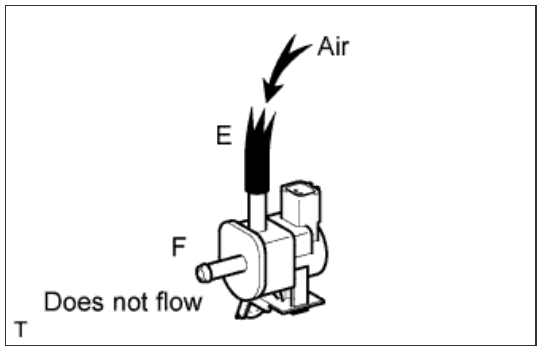
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	23 to 26 Ω
1 - VSV body ground	Always	10 kΩ or higher
2 - VSV body ground		10 kΩ or higher

If the result is not as specified, replace the purge VSV.



b. Check the operation of the purge VSV.

i. Check that air does not flow from port F when air is applied to port E.

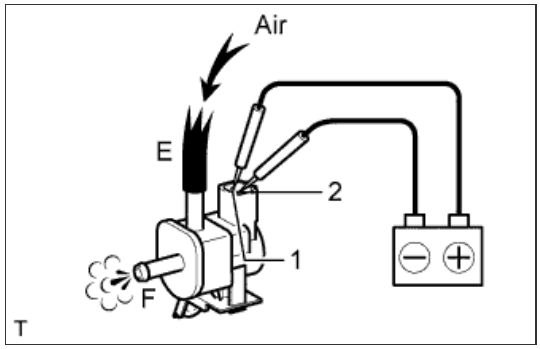


ii. Apply battery voltage to the connector, and check the VSV operation.

OK:

Measurement Condition	Specified Condition
Battery positive (+) → Terminal 1 Battery negative (-) → Terminal 2	Air flows from port E to port F

If the result is not as specified, replace the purge VSV.



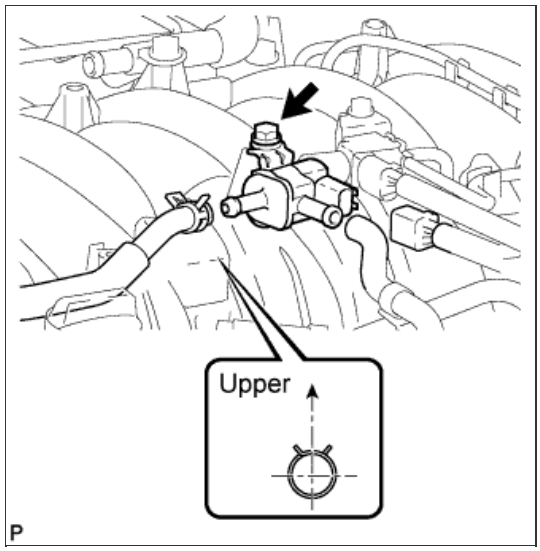
for Preparation Click here

1. INSTALL PURGE VSV

a. Install the purge VSV with the bolt.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the purge VSV connector.



2. CONNECT PURGE LINE HOSE

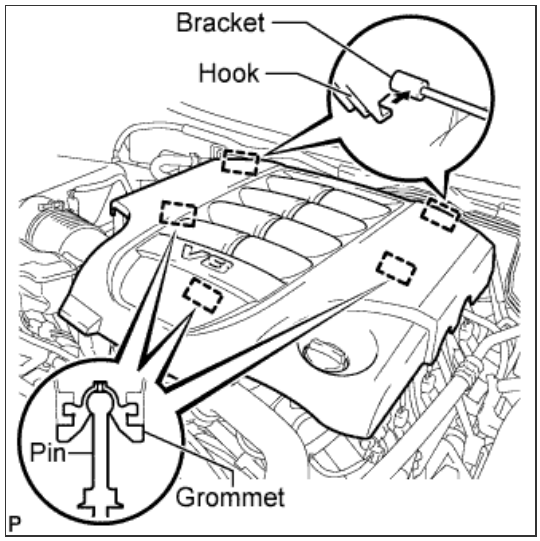
a. Connect the 2 hoses.

HINT:

Turn the claw of the clip to the upper side.

3. INSTALL V-BANK COVER SUB-ASSEMBLY

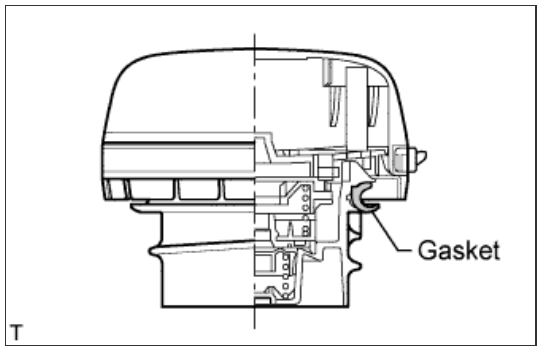
a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



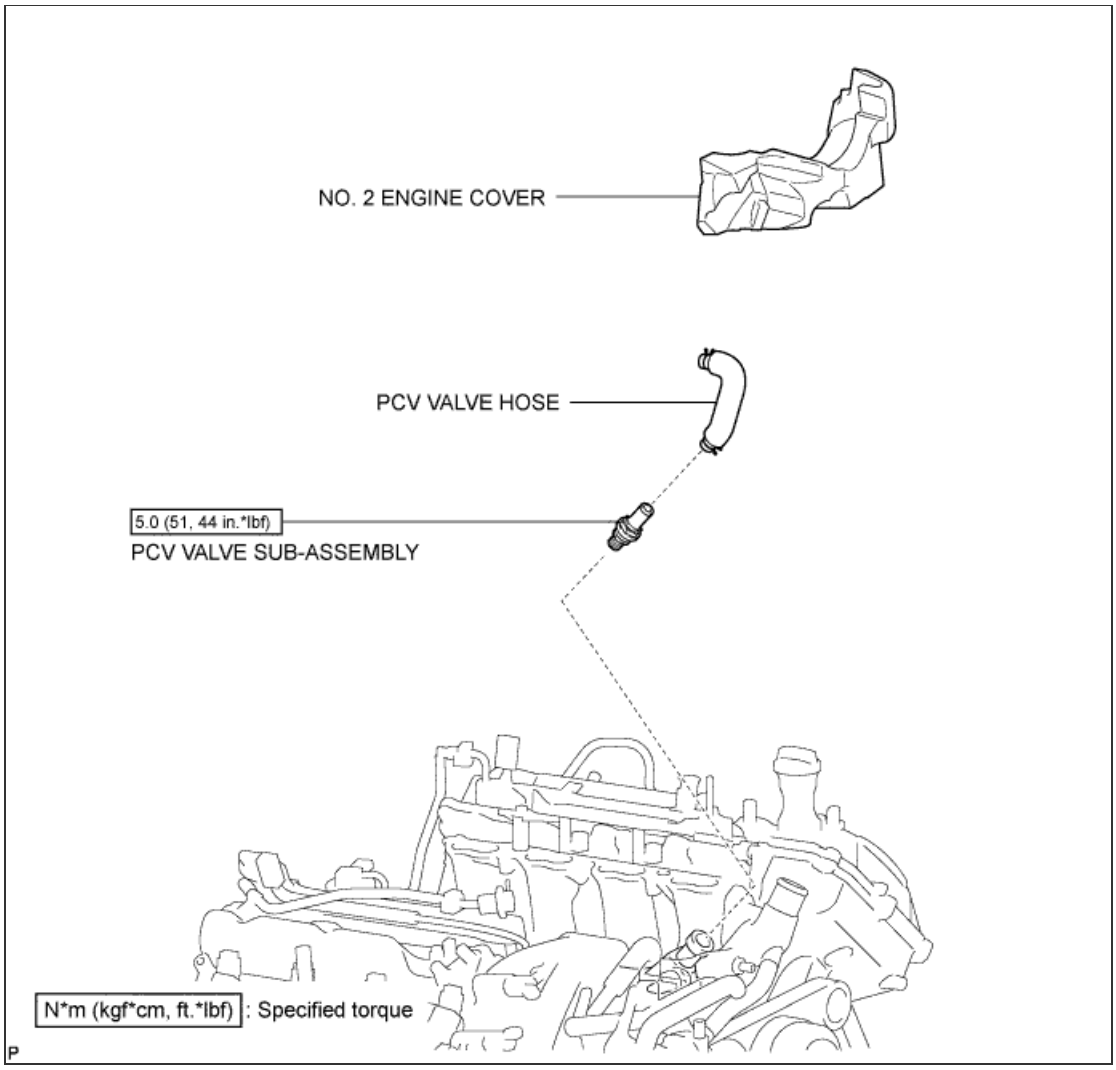
for Preparation Click here

1. INSPECT FUEL TANK CAP ASSEMBLY

a. Visually check if the cap and/or gasket are deformed or damaged.
If the result is not as specified, replace the fuel tank cap assembly.



for Preparation Click here

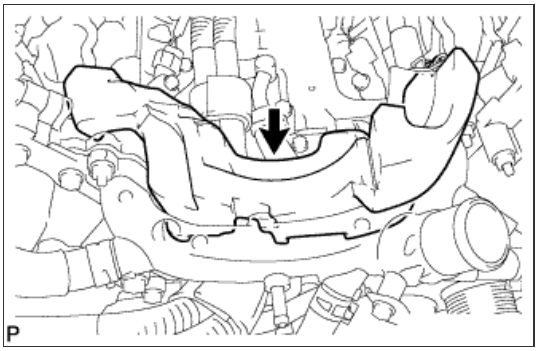


for Preparation Click here

1. REMOVE INTAKE MANIFOLD

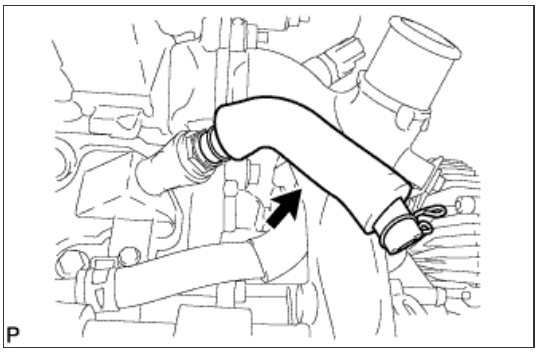
a. Remove the intake manifold (Click here).

2. REMOVE NO. 2 ENGINE COVER



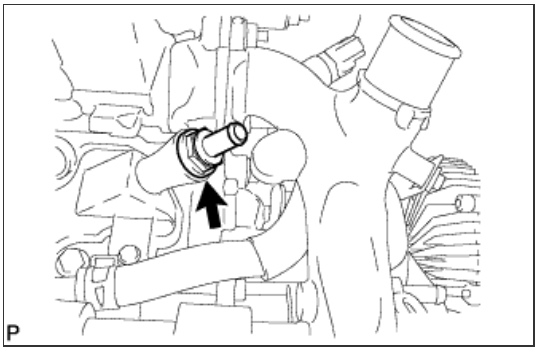
3. REMOVE PCV VALVE HOSE

a. Remove the hose from the PCV valve.



4. REMOVE PCV VALVE SUB-ASSEMBLY

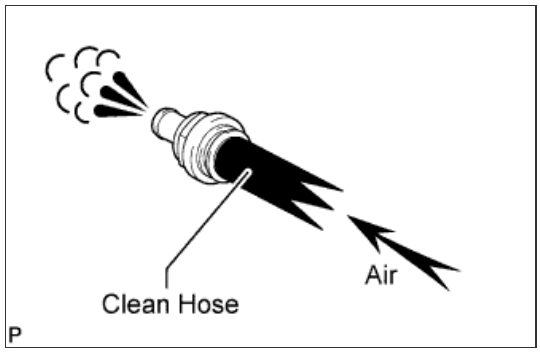
a. Remove the PCV valve.



for Preparation Click here

1. INSPECT PCV VALVE SUB-ASSEMBLY

a. Install a clean hose to the PCV valve.



b. Check the PCV valve operation.

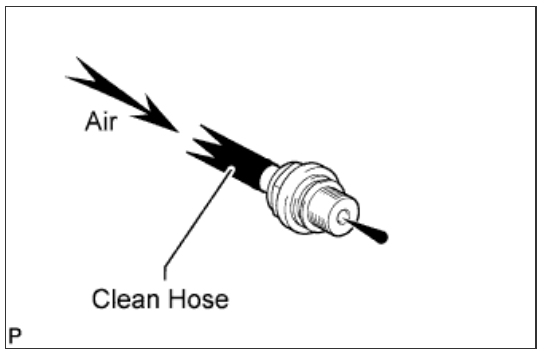
i. Blow air into the cylinder head side, and check that air passes through easily.

CAUTION:

Do not suck air through the valve.

Petroleum substances inside the valve are hazardous to your health.

ii. Blow air into the intake manifold side, and check that air passes through with difficulty.
If the result is not as specified, replace the PCV valve sub-assembly.



c. Remove the hose from the PCV valve.

for Preparation Click here

1. INSTALL PCV VALVE SUB-ASSEMBLY

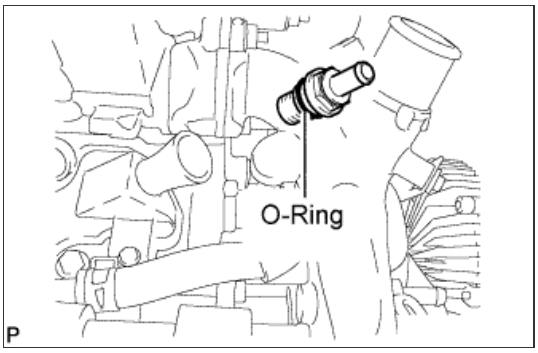
a. Apply a light coat of engine oil to the O-ring of the valve.

HINT:

When reusing the PCV valve, inspect the O-ring. If the O-ring has scratches or cuts, replace the PCV valve.

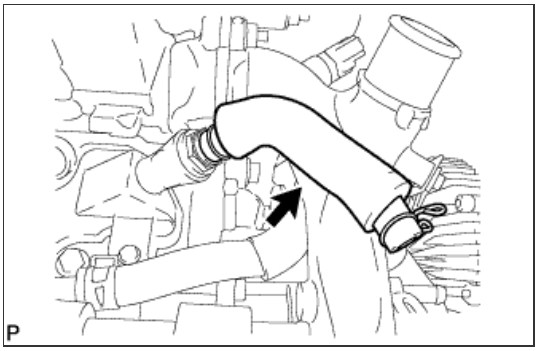
b. Install the PCV valve.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



2. INSTALL PCV VALVE HOSE

a. Install the hose to the PCV valve.



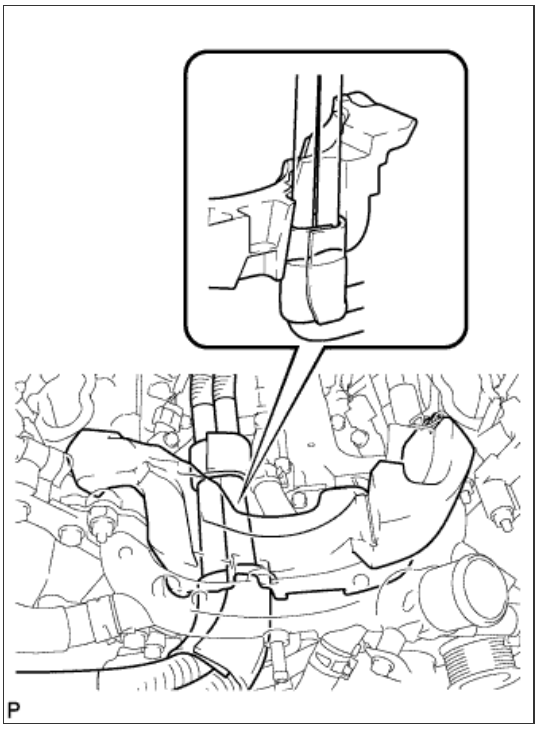
3. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

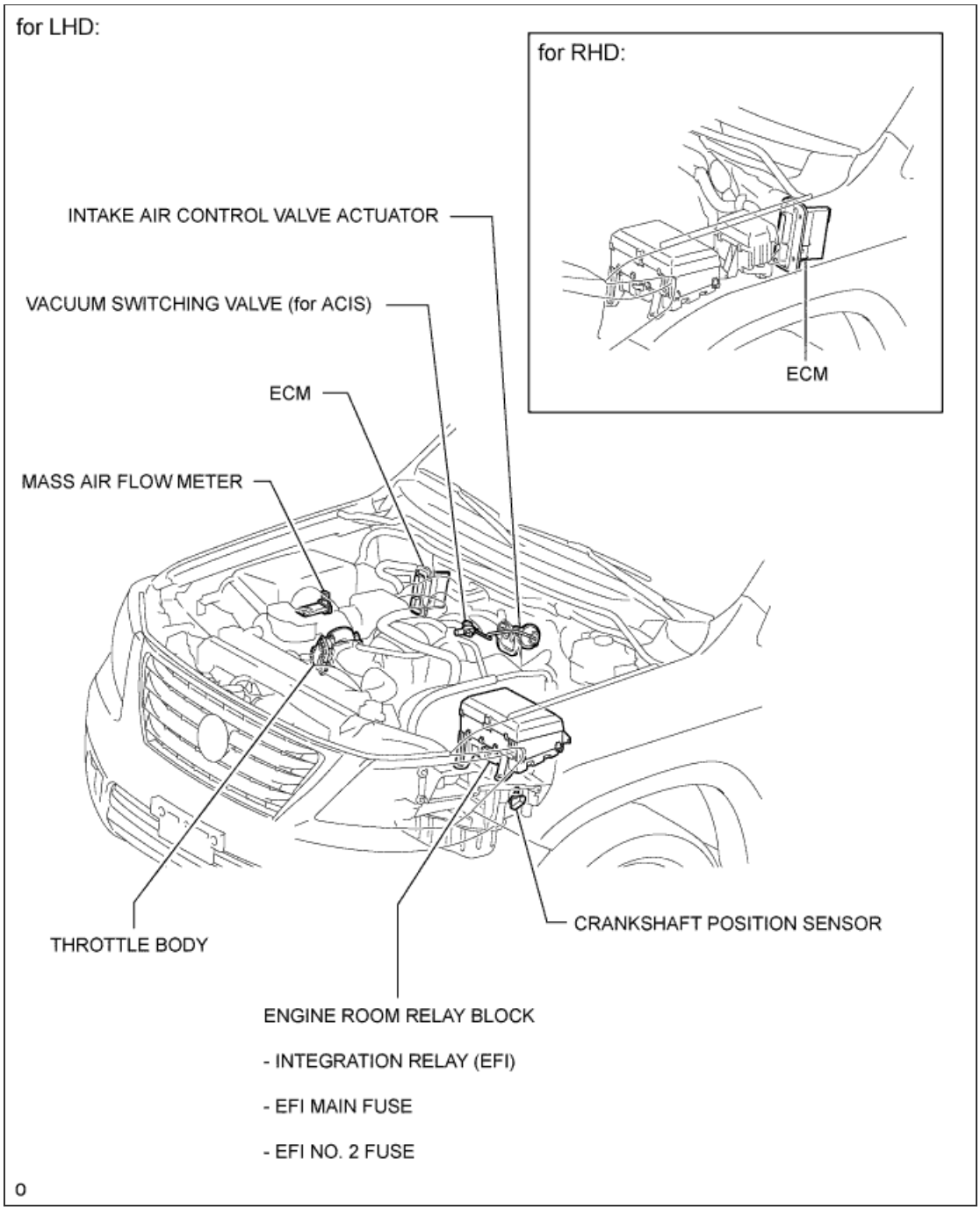
Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.



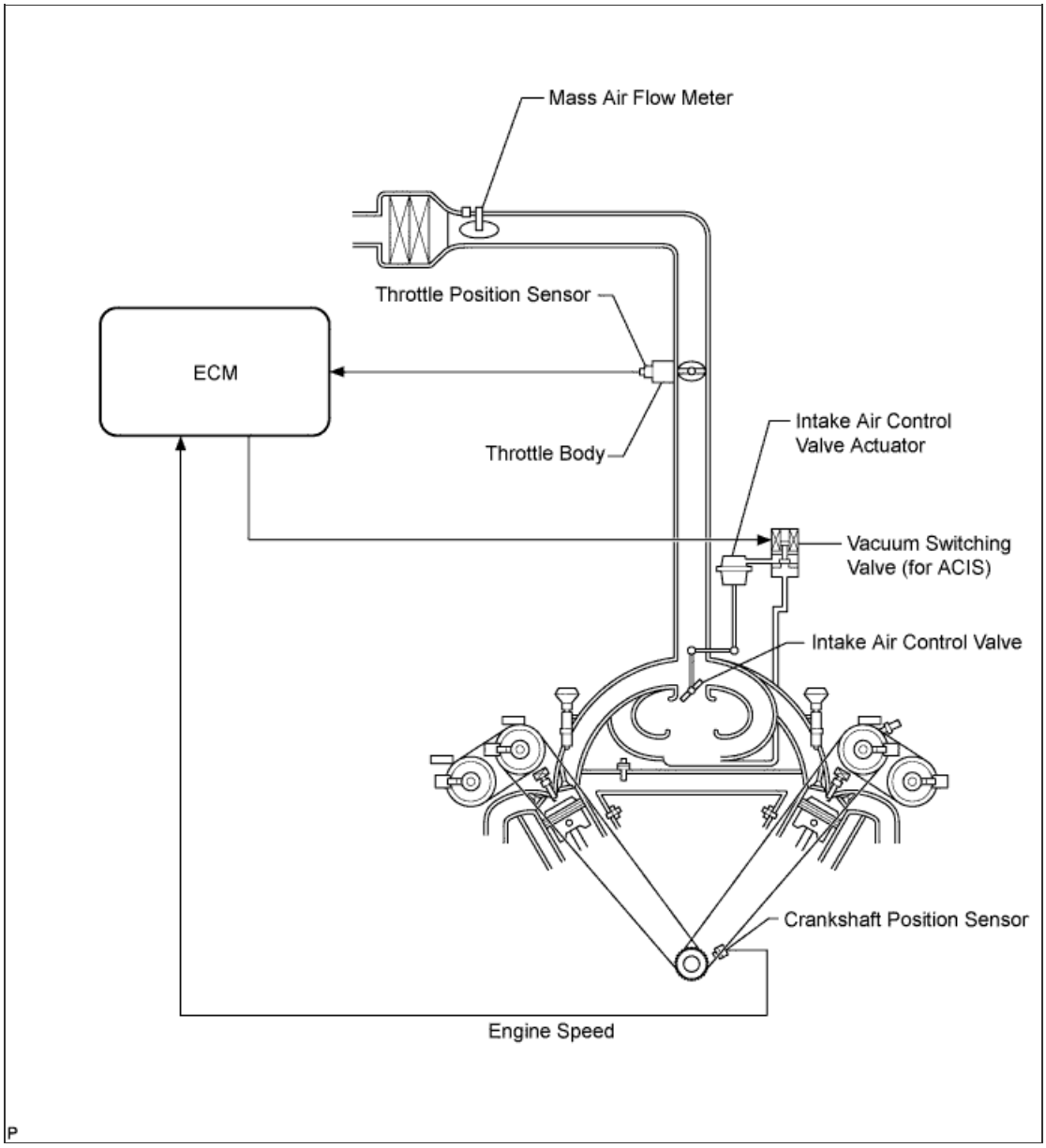
4. INSTALL INTAKE MANIFOLD

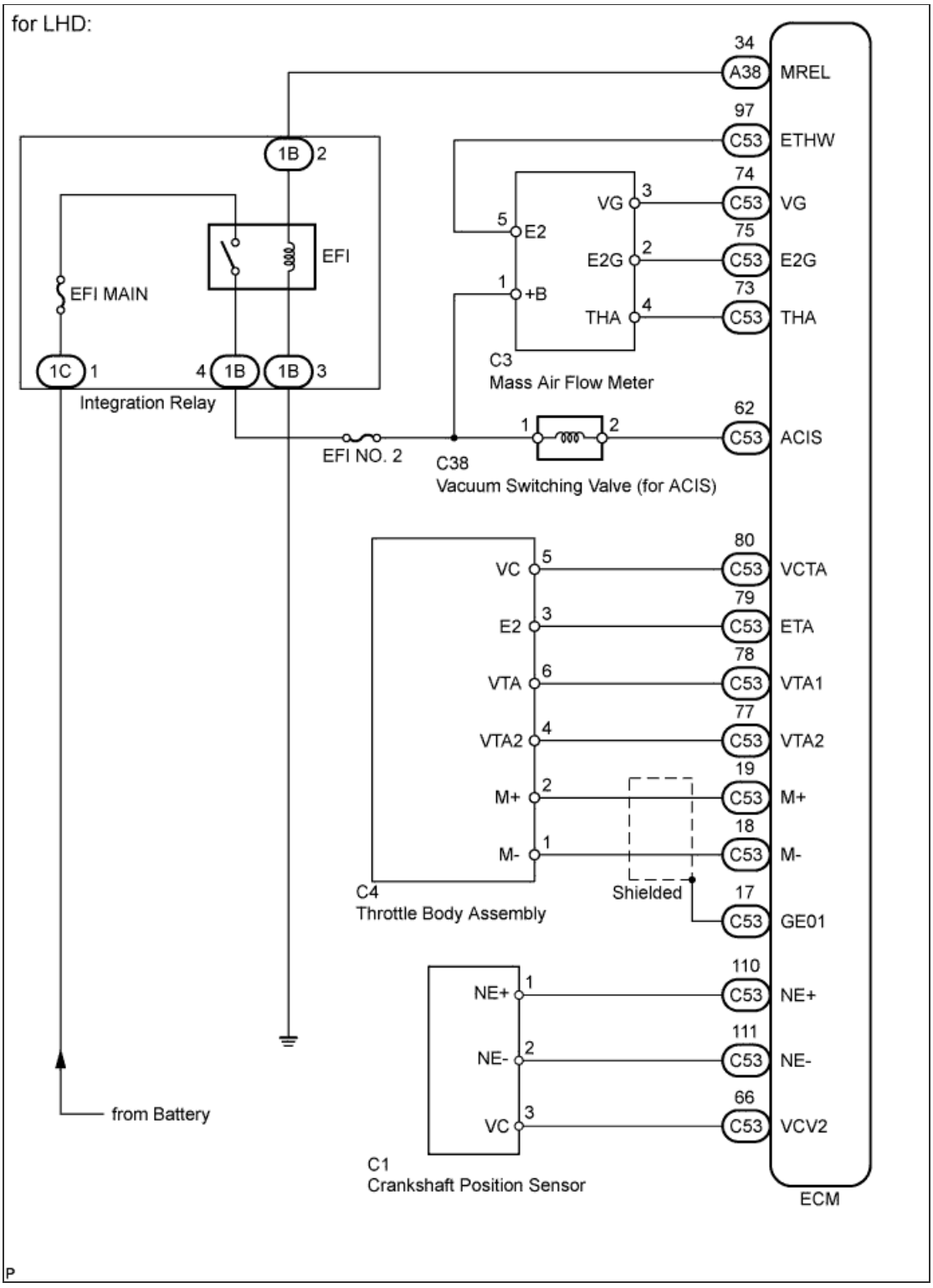
a. Install the intake manifold (Click here).

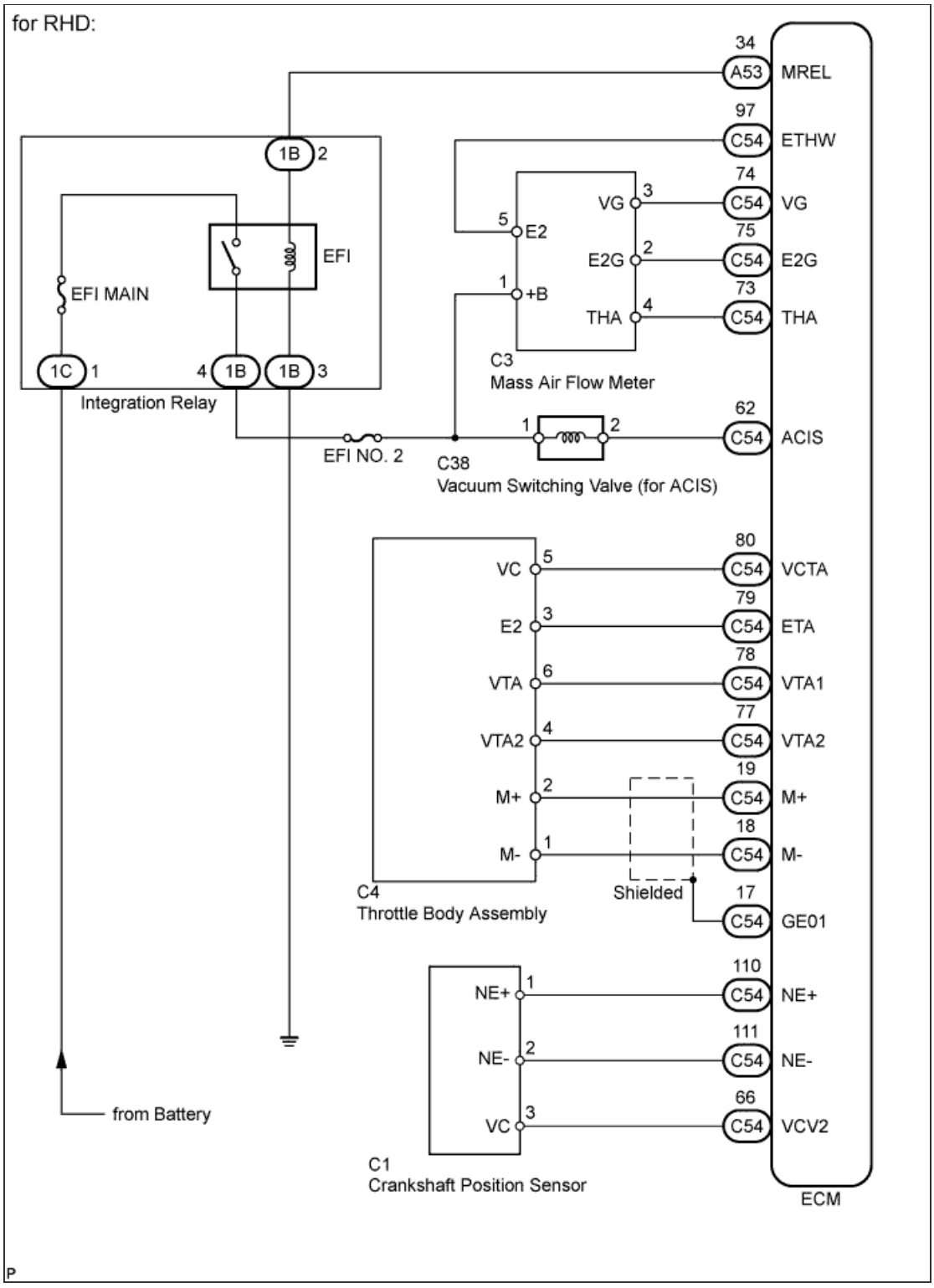
for Preparation Click here



for Preparation Click here




for LHD:
34
A38
MREL
97
C53
ETHW
74
C53
VG
75
C53
E2G
73
C53
THA
62
C53
ACIS
80
C53
VCTA
79
C53
ETA
78
C53
VTA1
77
C53
VTA2
19
C53
M+
18
C53
M-
17
C53
GE01
110
C53
NE+
111
C53
NE-
66
C53
VCV2
ECM
1B 2
EFI
EFI MAIN
1C 1
4 1B
1B 3
Integration Relay
EFI NO. 2
VG 3
E2G 2
THA 4
5 E2
1 +B
C3
Mass Air Flow Meter
1 2
C38
Vacuum Switching Valve (for ACIS)
VC 5
E2 3
VTA 6
VTA2 4
M+ 2
M- 1
C4
Throttle Body Assembly
Shielded
NE+ 1
NE- 2
VC 3
C1
Crankshaft Position Sensor
from Battery
P


for RHD:
34
A53
MREL
97
C54
ETHW
74
C54
VG
75
C54
E2G
73
C54
THA
62
C54
ACIS
80
C54
VCTA
79
C54
ETA
78
C54
VTA1
77
C54
VTA2
19
C54
M+
18
C54
M-
17
C54
GE01
110
C54
NE+
111
C54
NE-
66
C54
VCV2
ECM
1B 2
EFI
EFI MAIN
1C 1
4 1B
1B 3
Integration Relay
EFI NO. 2
5 E2
1 +B
VG 3
E2G 2
THA 4
C3
Mass Air Flow Meter
1 2
C38
Vacuum Switching Valve (for ACIS)
VC 5
E2 3
VTA 6
VTA2 4
M+ 2
M- 1
Shielded
C4
Throttle Body Assembly
NE+ 1
NE- 2
VC 3
C1
Crankshaft Position Sensor
from Battery
P

for Preparation Click here

1. INSPECT INTAKE AIR CONTROL VALVE

a. Remove the V-bank cover.

b. Start the engine.

c. Check that the VSV (for ACIS) is ON (seal) under both of the following conditions:

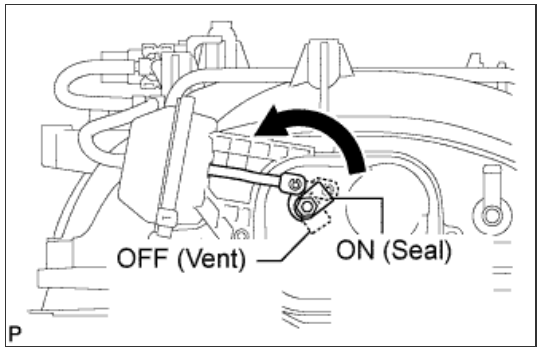
- Depressing the accelerator pedal to achieve a throttle valve opening angle of 50° or more.
- Racing the engine to 4700 rpm or less.

NOTICE:

Do not increase the engine speed to 5400 rpm or more.

d. Check that the VSV (for ACIS) is OFF (vent) under the following conditions:

- After releasing the accelerator pedal while under the VSV (for ACIS) ON condition.
- The engine is idling.



e. Connect the intelligent tester to the DLC3.

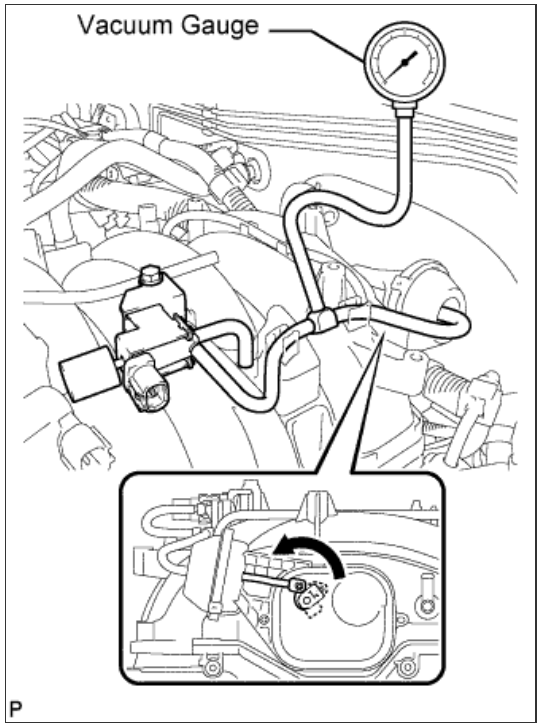
f. Perform the Active Test, and then check that the actuator rod operates.
If the result is not as specified, inspect the intake air control valve, vacuum tank and VSV (for ACIS) for normal operation. Replace malfunctioning parts as necessary.

g. Install the V-bank cover.

2. CHECK INTAKE AIR CONTROL VALVE OPERATION

a. Remove the V-bank cover.

b. Using a 3-way connector, connect a vacuum gauge to the actuator hose.



c. Start the engine.

d. While the engine is idling, check that the vacuum gauge indicates 0 kPa (0 mmHg, 0 in.Hg) and the rod is at the OFF position

e. Fully depress the accelerator pedal quickly. Check that the VSV (for ACIS) turns ON and the rod moves in the ON direction.

NOTICE:

Make sure to fully depress and release the accelerator pedal within 1 second.

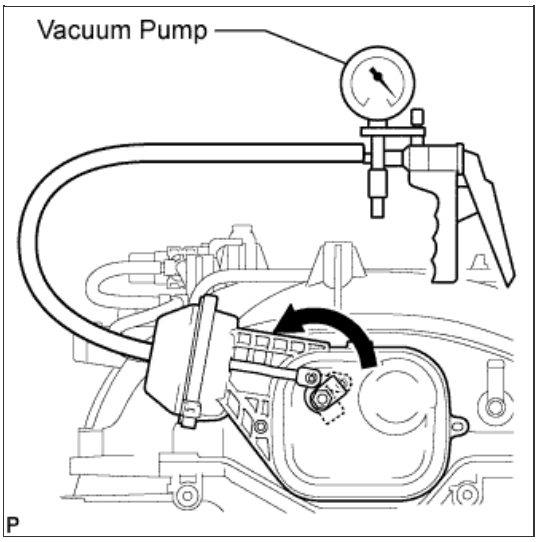
f. Remove the vacuum gauge, and connect the vacuum hose to the actuator.

g. Install the V-bank cover.

3. INSPECT INTAKE AIR CONTROL VALVE

a. Inspect the diaphragm.

i. Using a vacuum pump, apply a vacuum of 27 kPa (200 mmHg, 7.85 in.Hg). Check that the lever moves.
If the result is not as specified, replace the intake air surge tank.



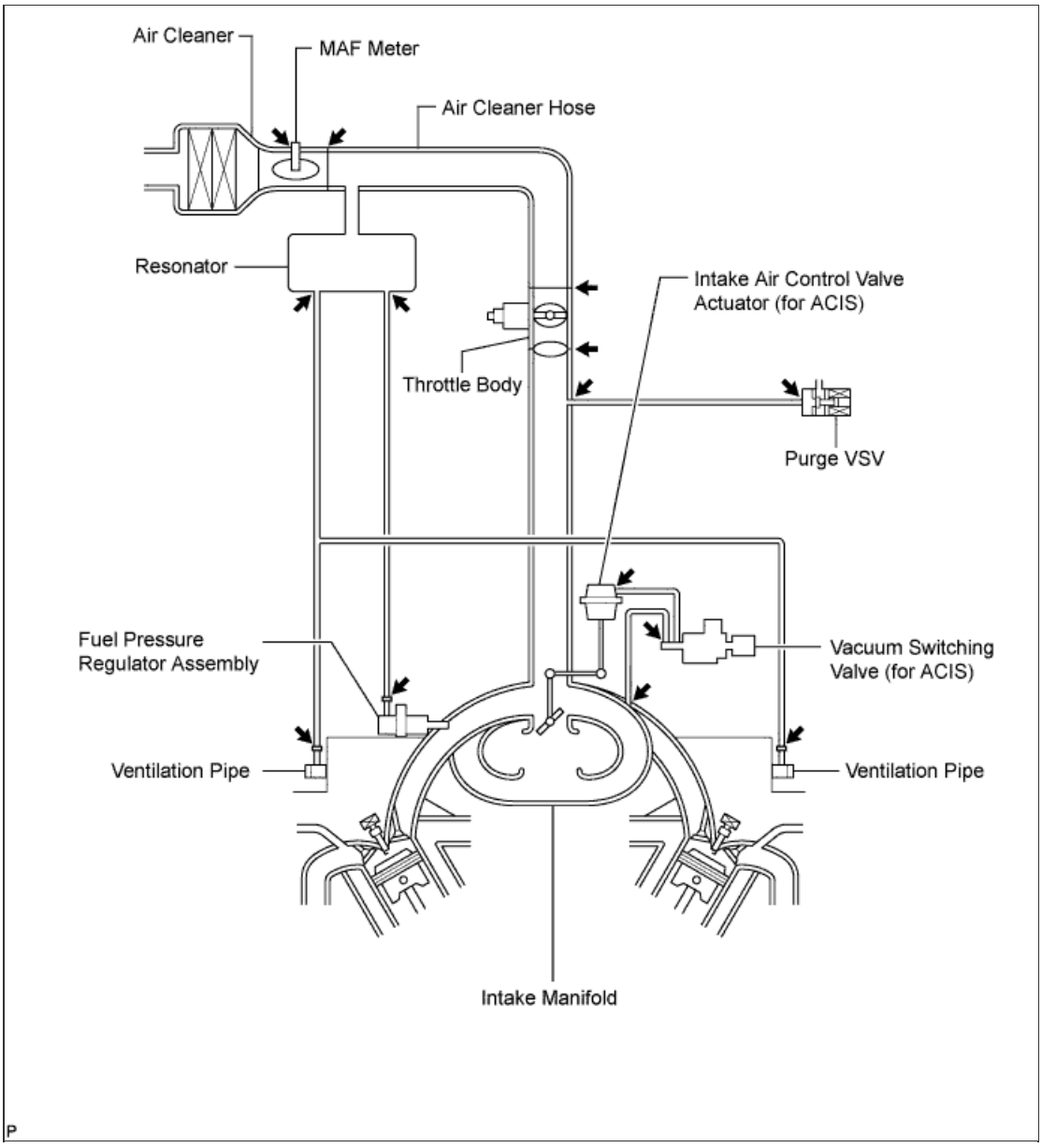
4. CHECK AIR INDUCTION SYSTEM

HINT:

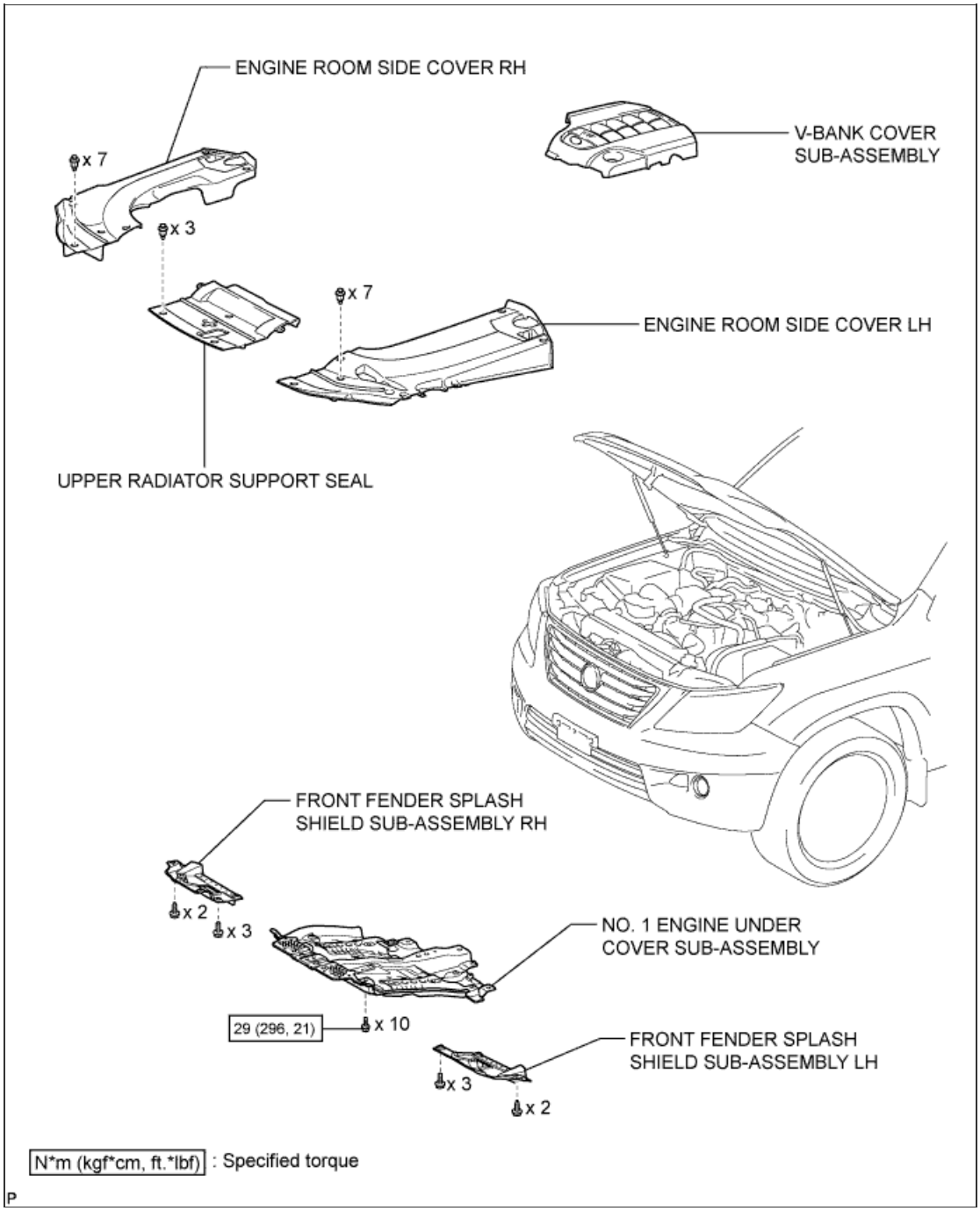
The illustration shows the areas that may draw in secondary air, which could lead to idling problems.

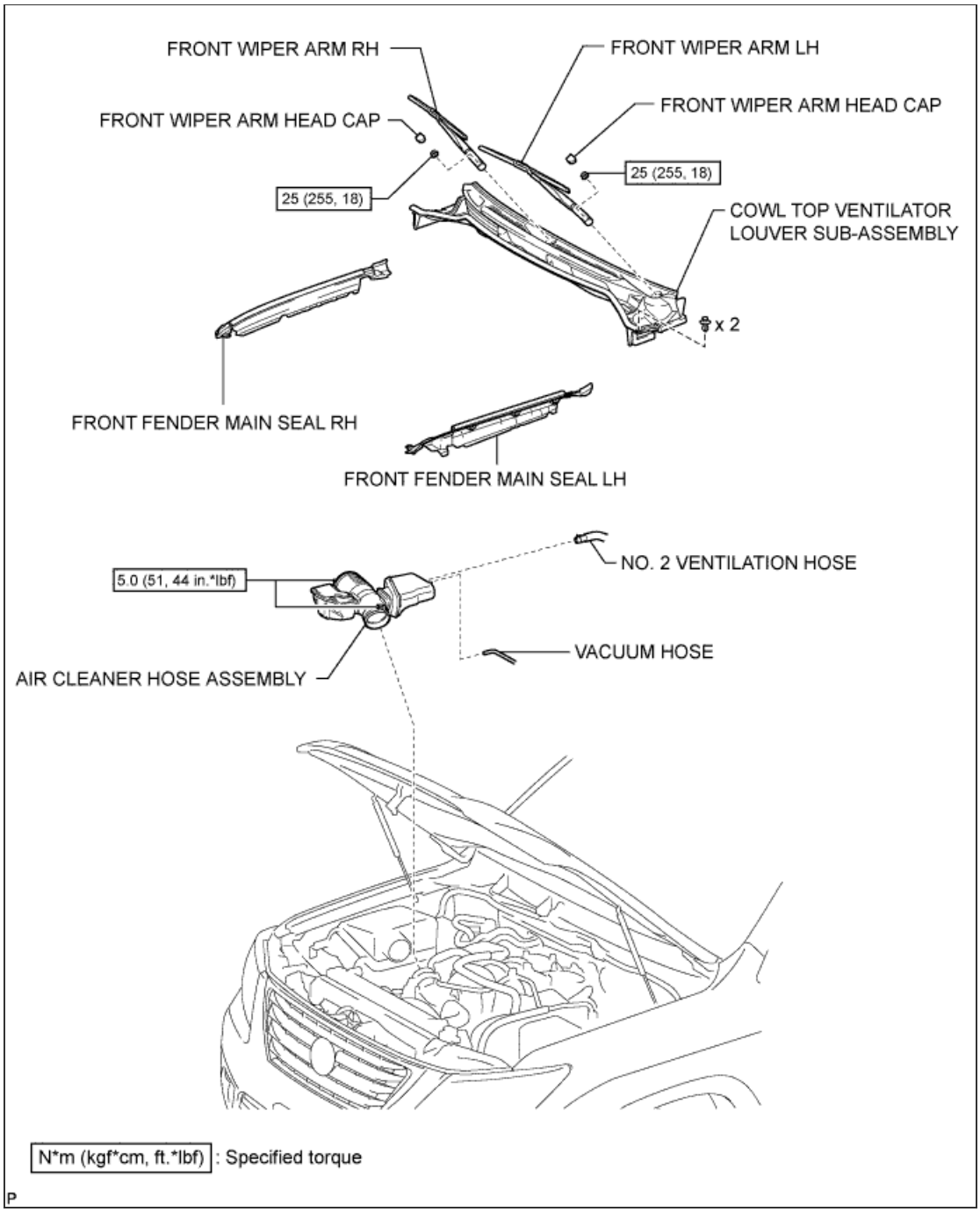
a. Check that the hoses are installed correctly.

b. Check for cracks, etc. in the hoses.

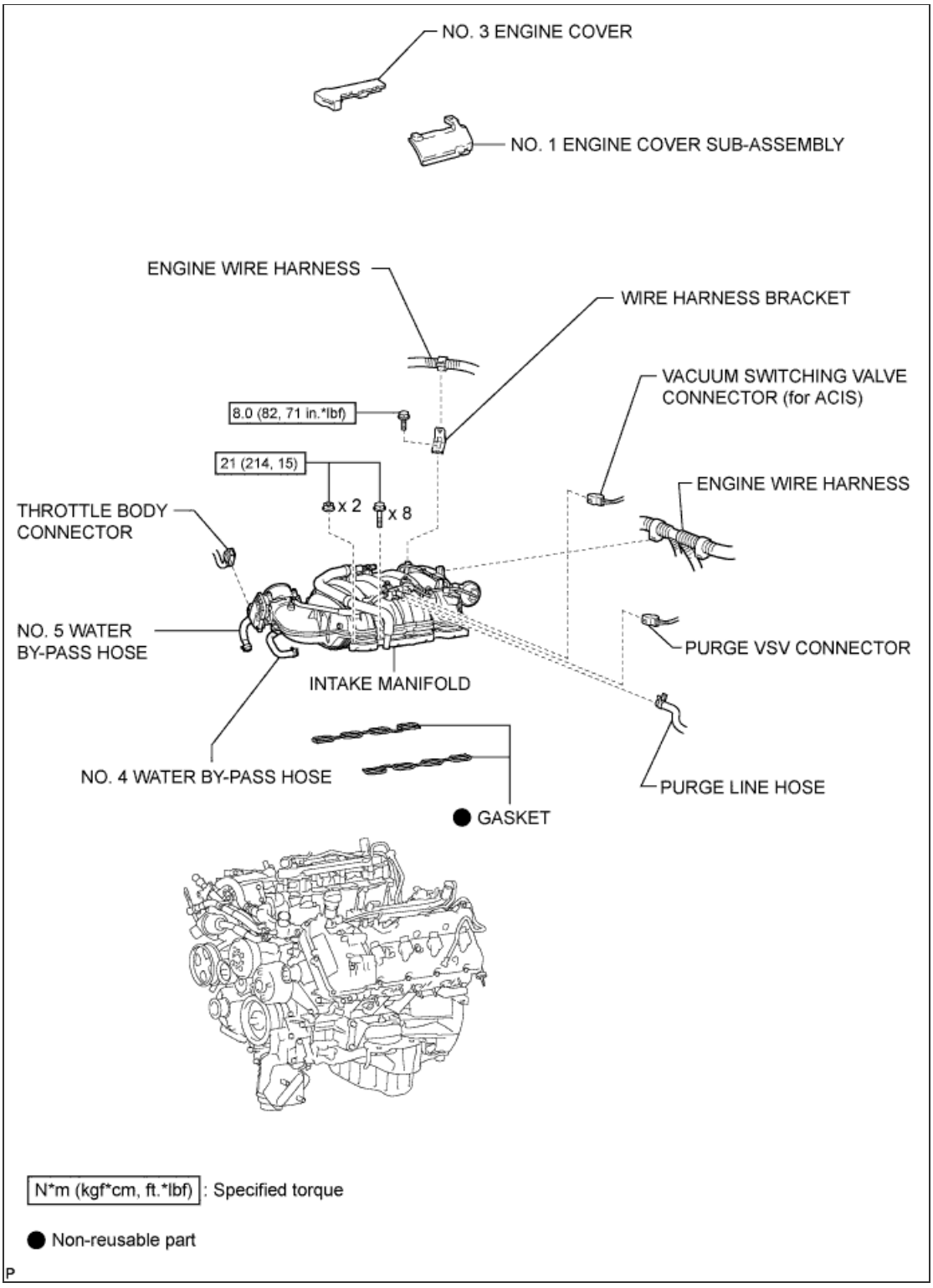

Air Cleaner
MAF Meter
Air Cleaner Hose
Resonator
Intake Air Control Valve
Actuator (for ACIS)
Throttle Body
Purge VSV
Fuel Pressure
Regulator Assembly
Vacuum Switching
Valve (for ACIS)
Ventilation Pipe
Ventilation Pipe
Intake Manifold
P

for Preparation Click here

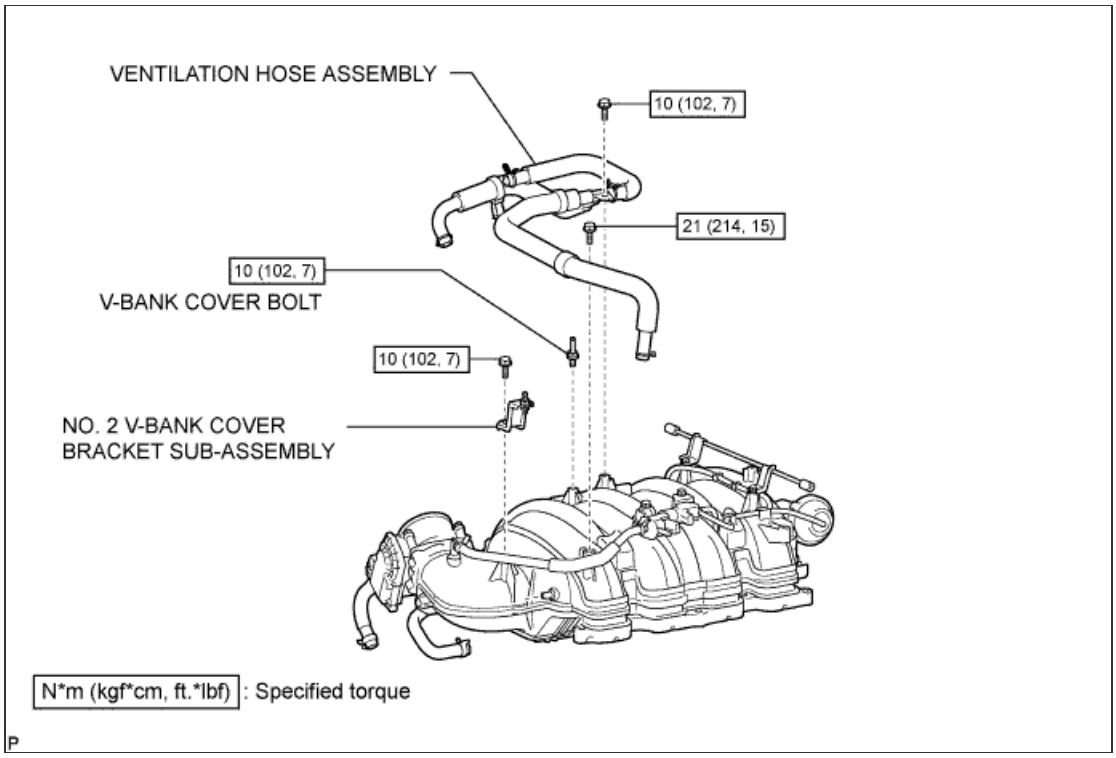


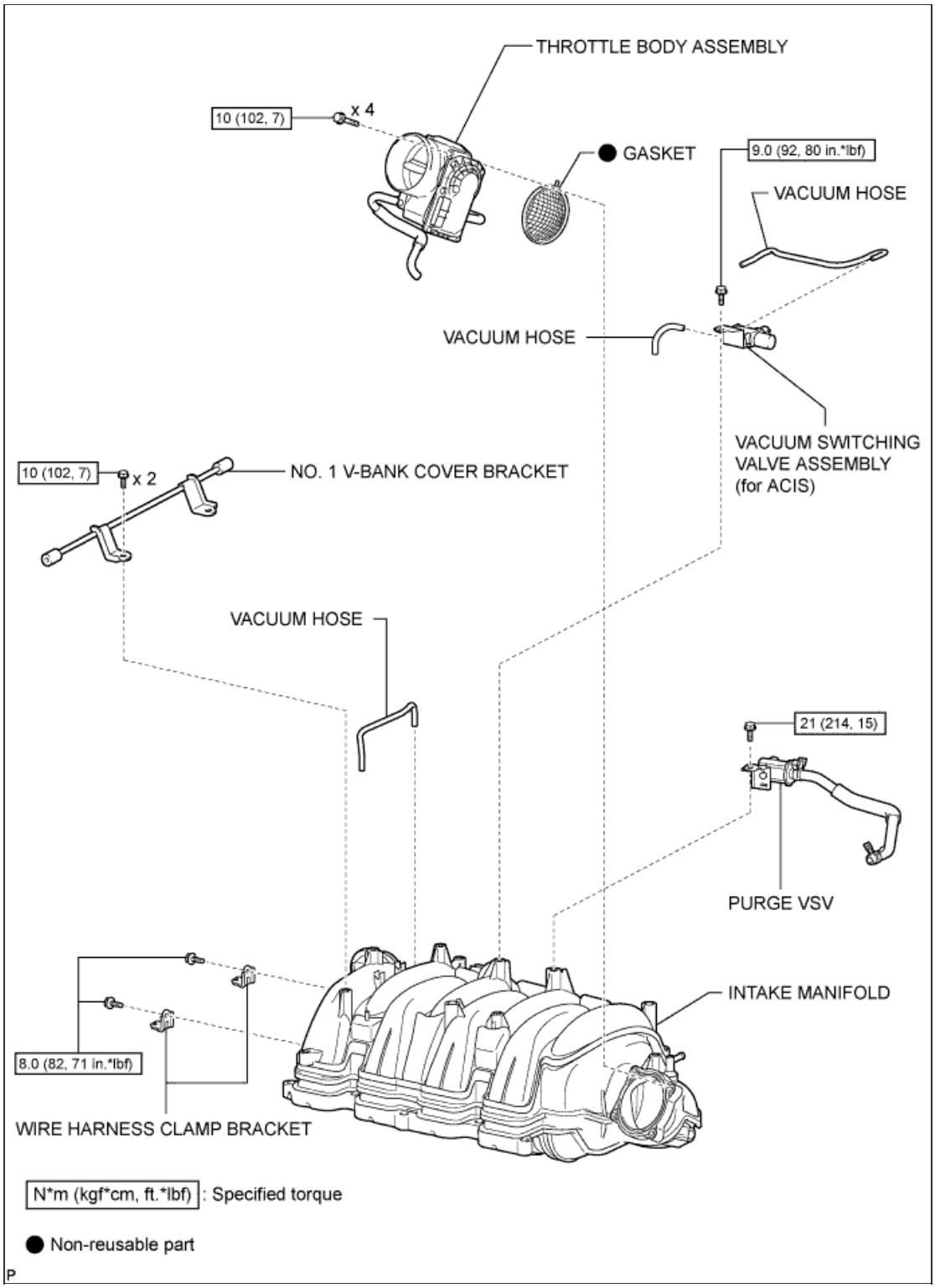

FRONT WIPER ARM RH
FRONT WIPER ARM LH
FRONT WIPER ARM HEAD CAP
FRONT WIPER ARM HEAD CAP
25 (255, 18)
25 (255, 18)
COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY
x 2
FRONT FENDER MAIN SEAL RH
FRONT FENDER MAIN SEAL LH
5.0 (51, 44 in.*lbf)
NO. 2 VENTILATION HOSE
VACUUM HOSE
AIR CLEANER HOSE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque

P


NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
ENGINE WIRE HARNESS
WIRE HARNESS BRACKET
VACUUM SWITCHING VALVE CONNECTOR (for ACIS)
8.0 (82, 71 in.*lbf)
21 (214, 15)
x 2
x 8
ENGINE WIRE HARNESS
THROTTLE BODY CONNECTOR
NO. 5 WATER BY-PASS HOSE
INTAKE MANIFOLD
PURGE VSV CONNECTOR
NO. 4 WATER BY-PASS HOSE
PURGE LINE HOSE
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

P

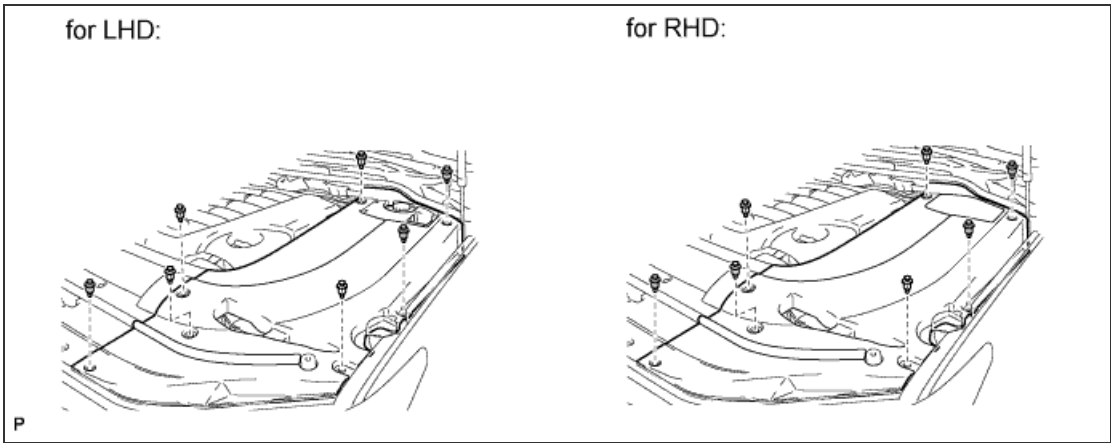

VENTILATION HOSE ASSEMBLY
10 (102, 7)
21 (214, 15)
10 (102, 7)
V-BANK COVER BOLT
10 (102, 7)
NO. 2 V-BANK COVER
BRACKET SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
P


THROTTLE BODY ASSEMBLY
10 (102, 7)
x 4
GASKET
9.0 (92, 80 in.*lbf)
VACUUM HOSE
VACUUM HOSE
VACUUM SWITCHING VALVE ASSEMBLY (for ACIS)
10 (102, 7)
x 2
NO. 1 V-BANK COVER BRACKET
VACUUM HOSE
21 (214, 15)
PURGE VSV
INTAKE MANIFOLD
8.0 (82, 71 in.*lbf)
WIRE HARNESS CLAMP BRACKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

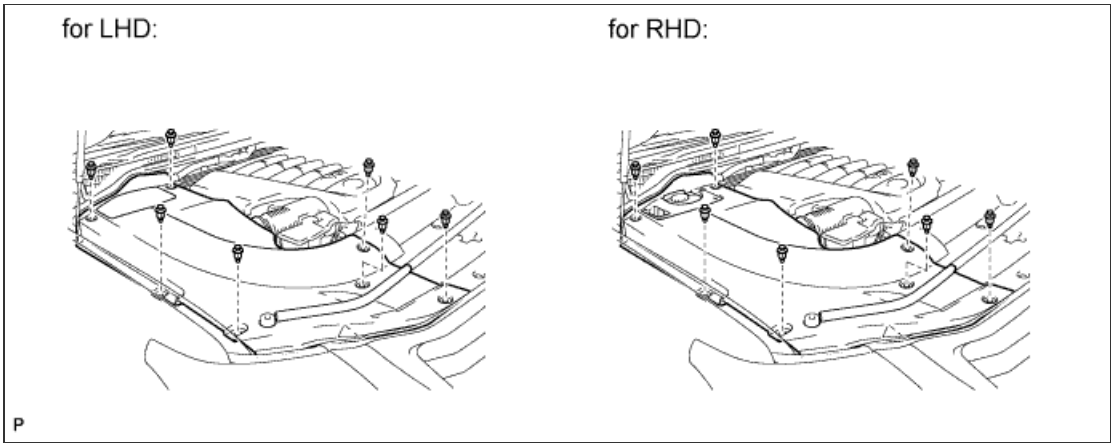
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



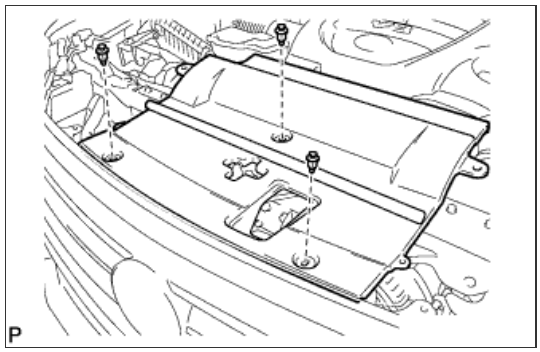
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



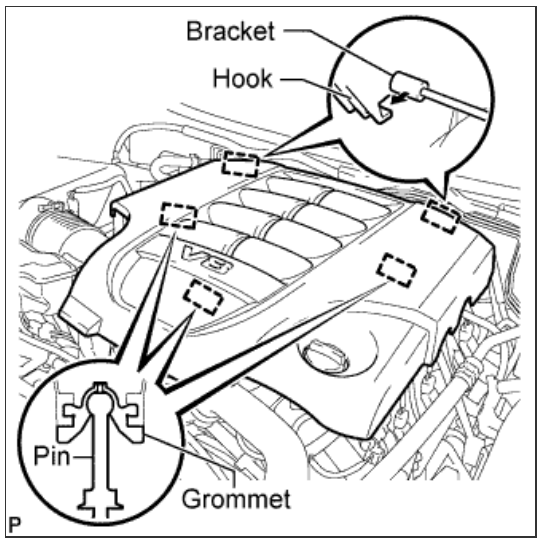
3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



5. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

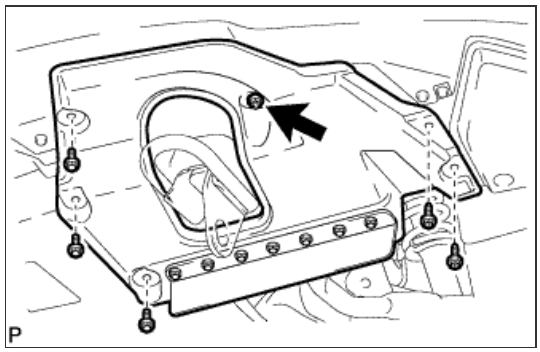
6. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Remove the cowl top ventilator louver (Click here).

7. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



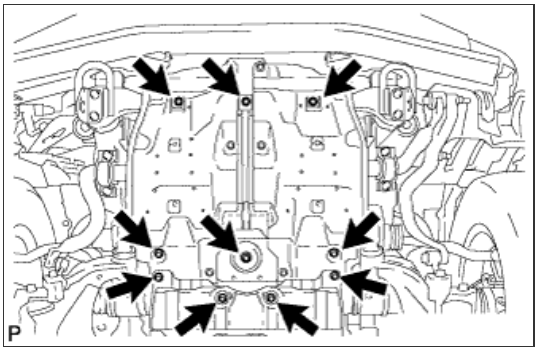
8. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

9. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

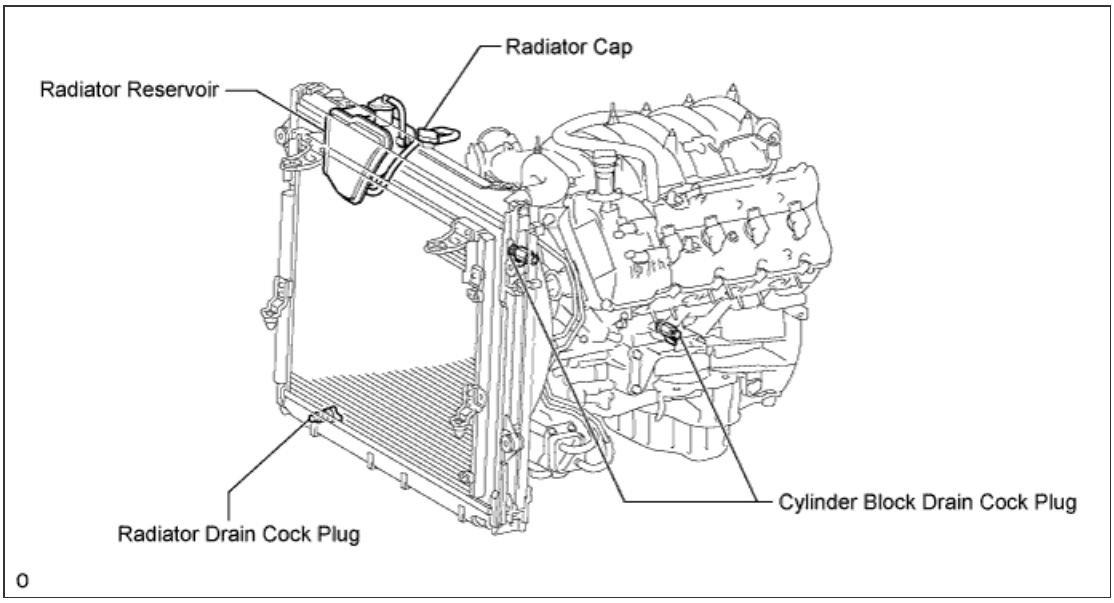
a. Remove the 10 bolts and No. 1 engine under cover.



10. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

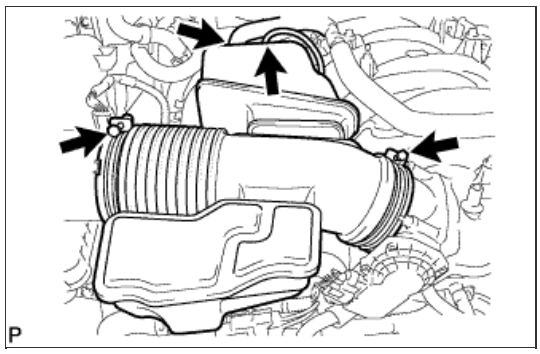
e. Tighten the radiator drain cock plug by hand.

11. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

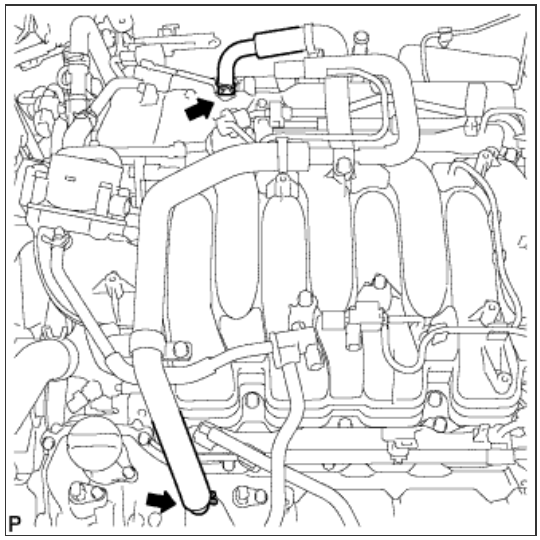
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



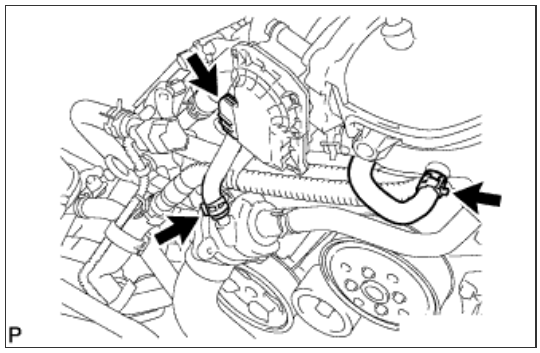
12. REMOVE INTAKE MANIFOLD

a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.

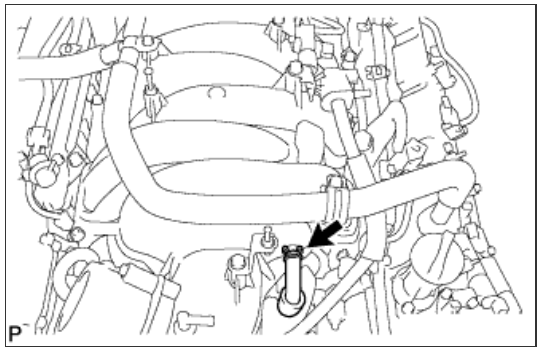


b. Disconnect the 2 water by-pass hoses.

c. Disconnect the throttle body connector.



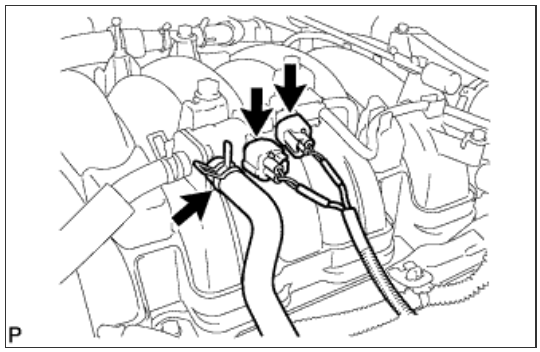
d. Disconnect the No. 1 ventilation hose.



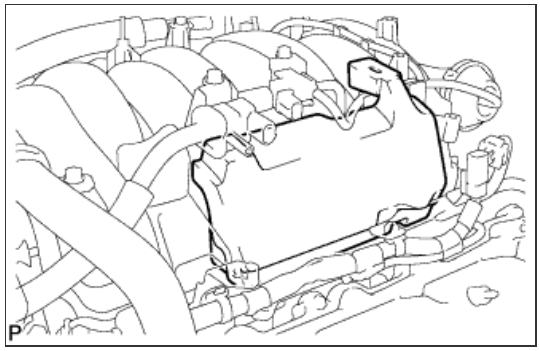
e. Disconnect the purge VSV connector.

f. Disconnect the purge line hose from the purge VSV.

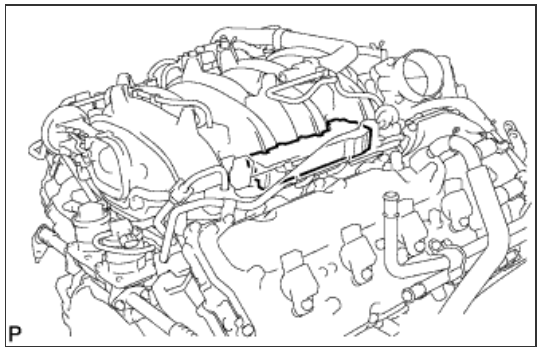
g. Disconnect the vacuum switching valve connector (for ACIS).



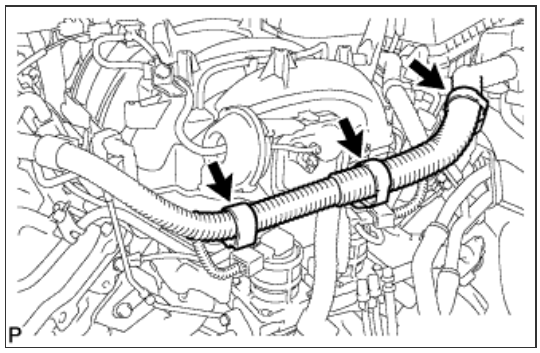
h. Remove the No. 1 engine cover sub-assembly.



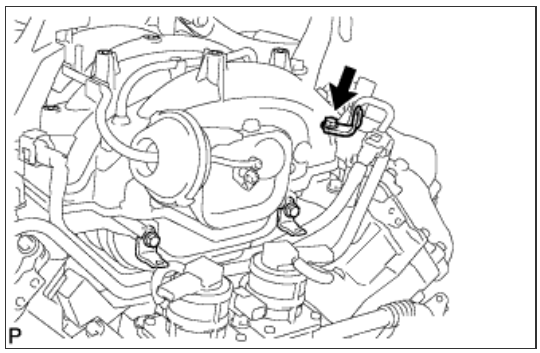
i. Remove the No. 3 engine cover.



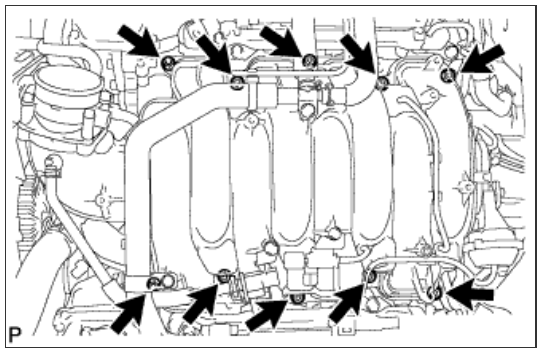
j. Disconnect the 3 wire clamps from the 3 wire brackets.



k. Remove the bolt and wire bracket from the intake manifold.

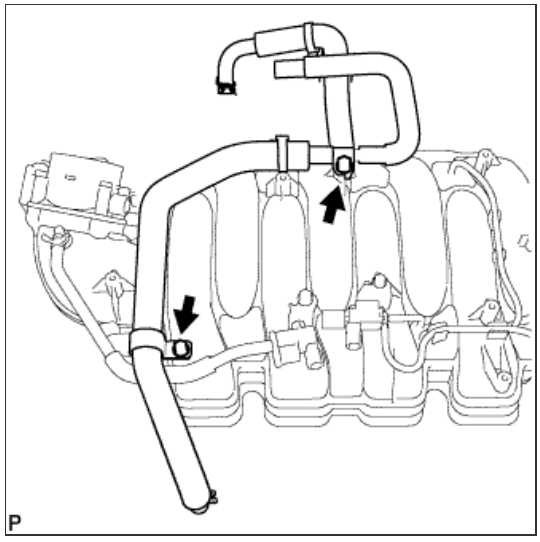


l. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.



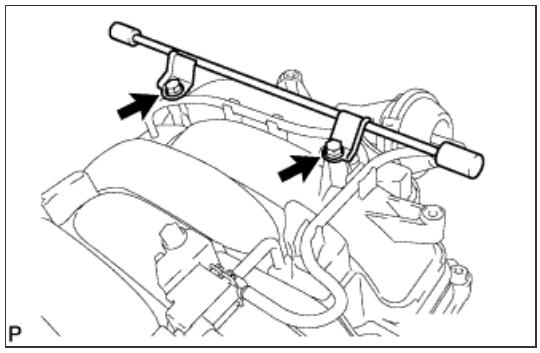
13. REMOVE VENTILATION HOSE ASSEMBLY

a. Remove the 2 bolts and ventilation hose from the intake manifold.



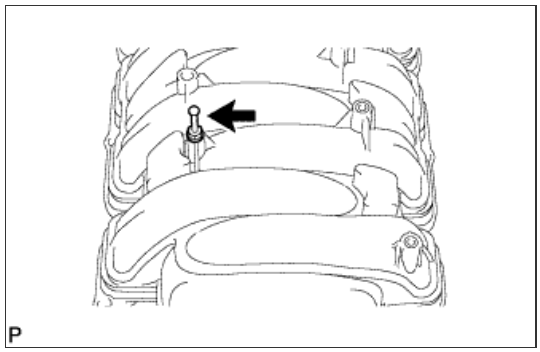
14. REMOVE NO. 1 V-BANK COVER BRACKET

a. Remove the 2 bolts and bracket.



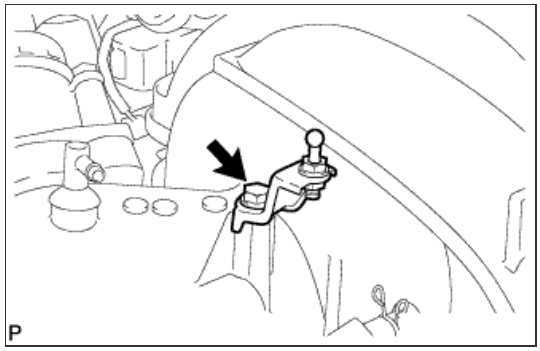
15. REMOVE V-BANK COVER BOLT

a. Remove the cover bolt from the intake manifold.



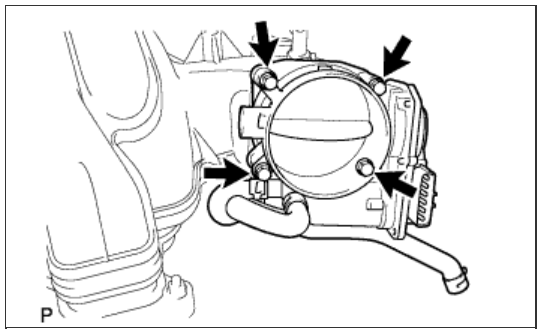
16. REMOVE NO. 2 V-BANK COVER BRACKET SUB-ASSEMBLY

a. Remove the bolt and bracket.



17. REMOVE THROTTLE BODY ASSEMBLY

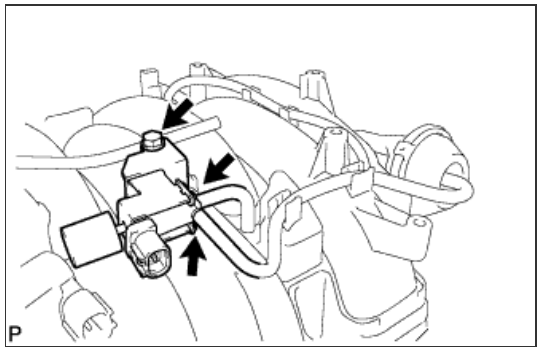
a. Remove the 4 bolts, throttle body and gasket.



18. REMOVE VACUUM SWITCHING VALVE ASSEMBLY (for ACIS)

a. Disconnect the 2 vacuum hoses from the vacuum switching valve.

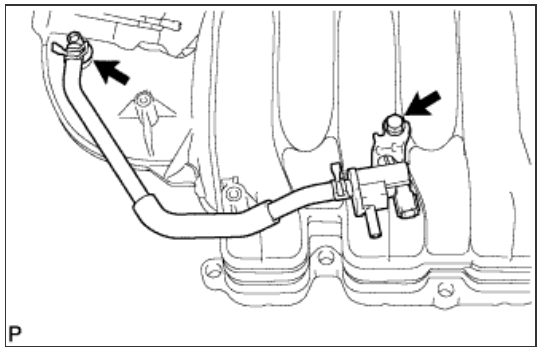
b. Remove the bolt and vacuum switching valve.



19. REMOVE PURGE VSV

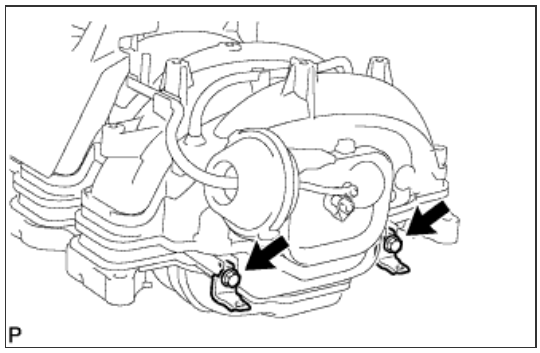
a. Disconnect the purge line hose from the intake manifold.

b. Remove the bolt and purge VSV.



20. REMOVE WIRE HARNESS CLAMP BRACKET

a. Remove the 2 bolts and 2 wire harness clamp brackets.

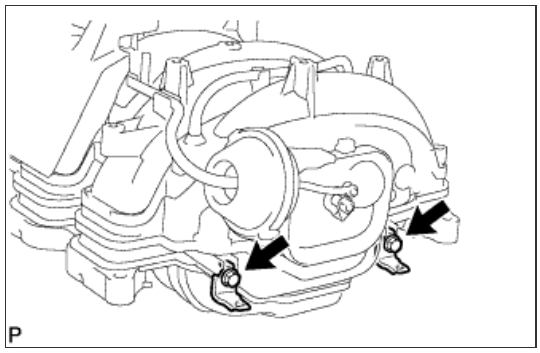


for Preparation Click here

1. INSTALL WIRE HARNESS CLAMP BRACKET

a. Install the 2 wire harness clamp brackets with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

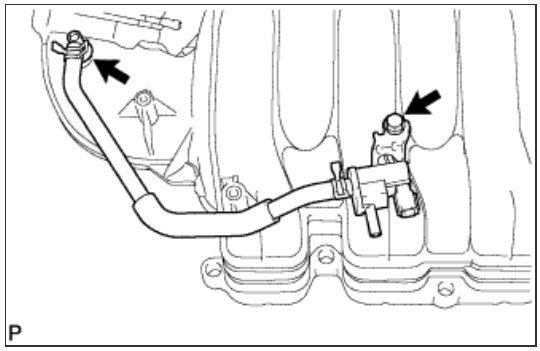


2. INSTALL PURGE VSV

a. Connect the purge line hose to the intake manifold.

b. Install the purge VSV to the intake manifold with the bolt.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

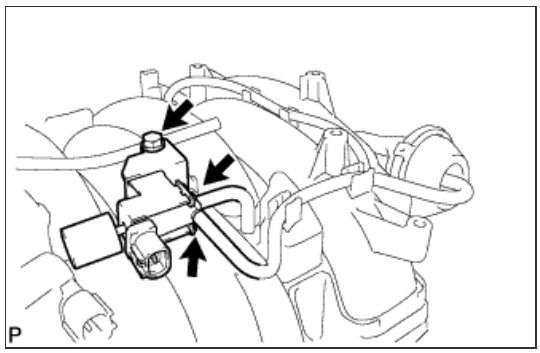


3. INSTALL VACUUM SWITCHING VALVE ASSEMBLY (for ACIS)

a. Install the vacuum switching valve to the intake manifold with the bolt.

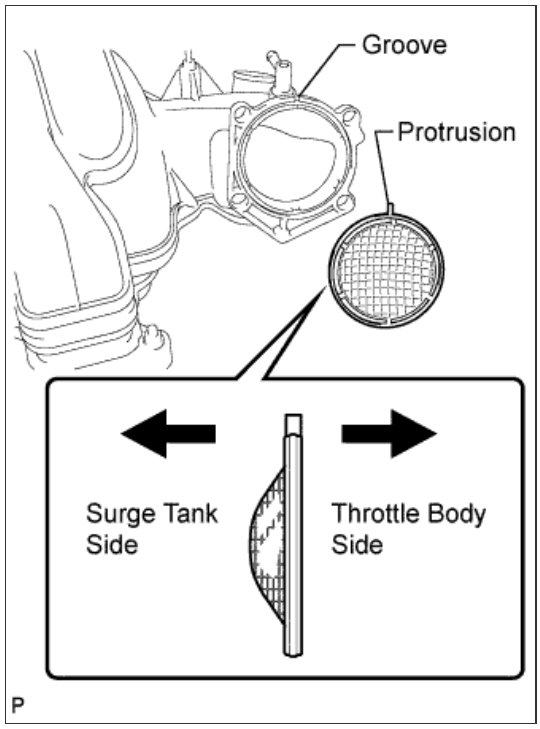
Torque:
9.0 N*m{ 92 kgf*cm , 80 in.*lbf }

b. Connect the 2 vacuum hoses to the vacuum switching valve.



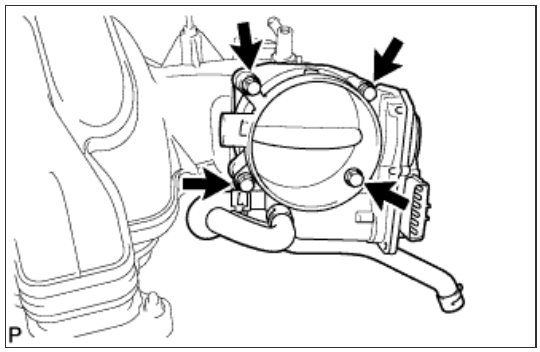
4. INSTALL THROTTLE BODY ASSEMBLY

a. Align the protrusion of a new gasket with the groove of the intake manifold, and install the gasket.



b. Install the throttle body with the 4 bolts.

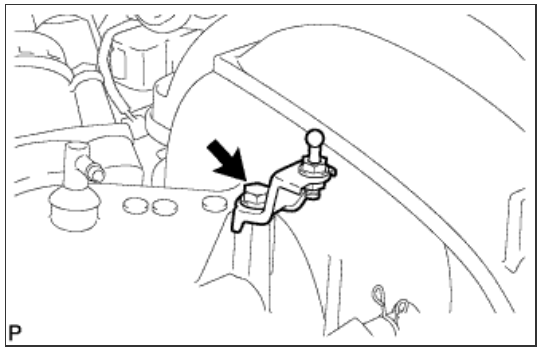
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



5. INSTALL NO. 2 V-BANK COVER BRACKET SUB-ASSEMBLY

a. Install the bracket with the bolt.

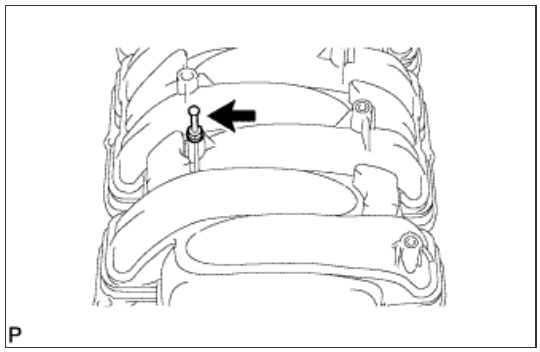
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



6. INSTALL V-BANK COVER BOLT

a. Install the cover bolt to the intake manifold.

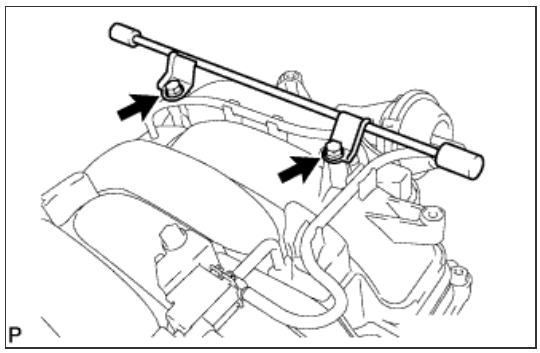
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



7. INSTALL NO. 1 V-BANK COVER BRACKET

a. Install the bracket with the 2 bolts.

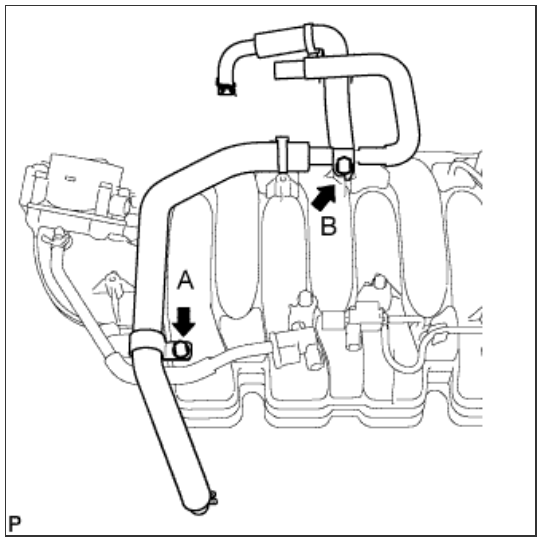
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



8. INSTALL VENTILATION HOSE ASSEMBLY

a. Install the ventilation hose to the intake manifold with the 2 bolts.

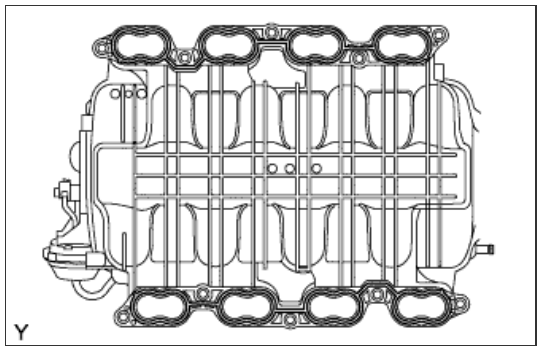
Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
for bolt B:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



9. INSTALL INTAKE MANIFOLD

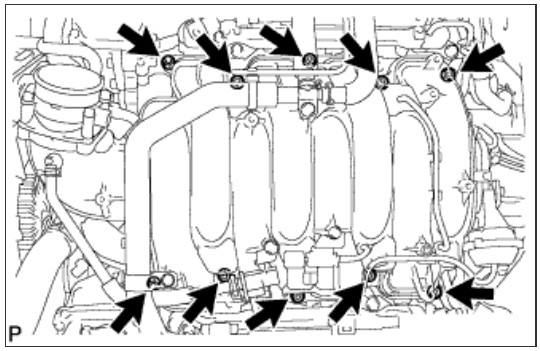
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



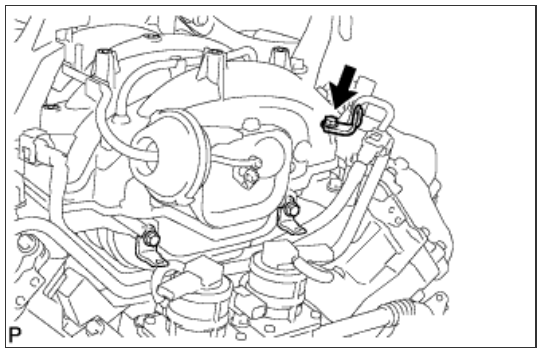
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

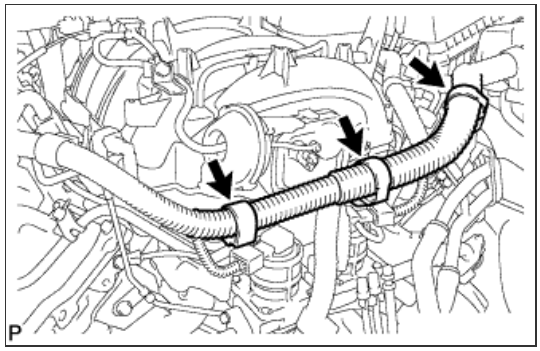


d. Install the wire bracket to the intake manifold with the bolt.

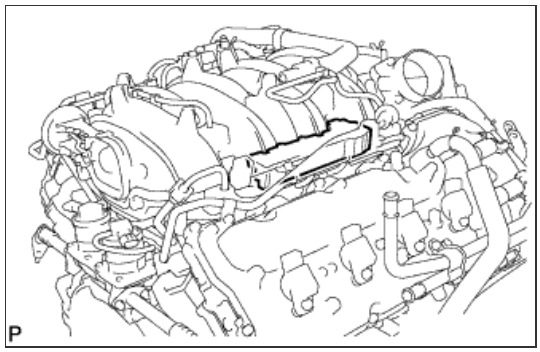
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



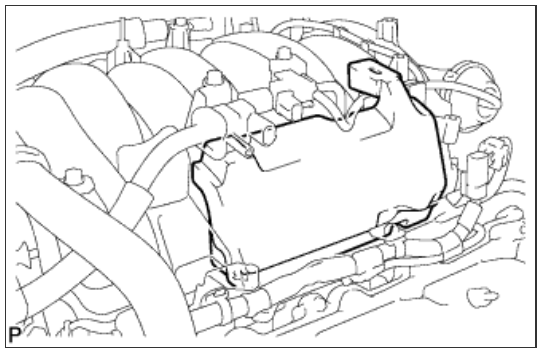
e. Connect the 3 wire clamps to the 3 wire brackets.



f. Install the No. 3 engine cover.



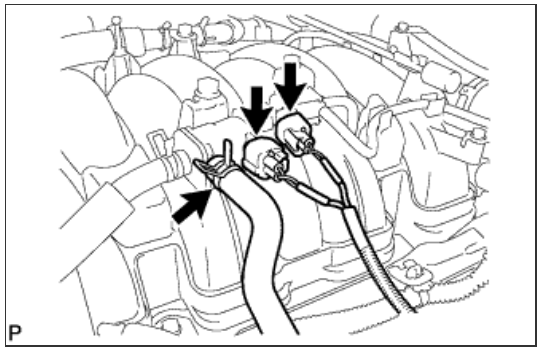
g. Install the No. 1 engine cover sub-assembly.



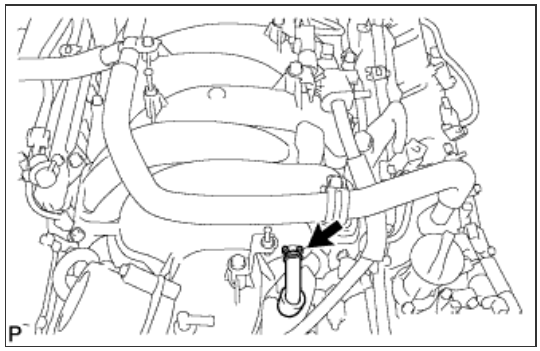
h. Connect the purge VSV connector.

i. Connect the purge line hose to the purge VSV.

j. Connect the vacuum switching valve connector (for ACIS).

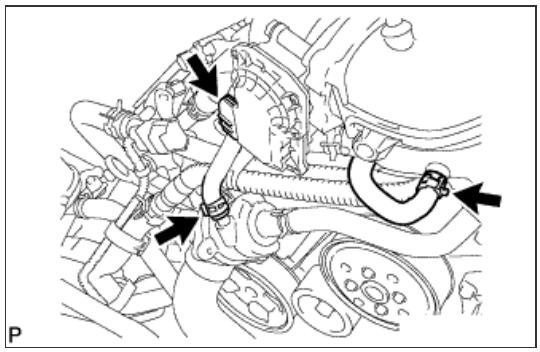


k. Connect the No. 1 ventilation hose.

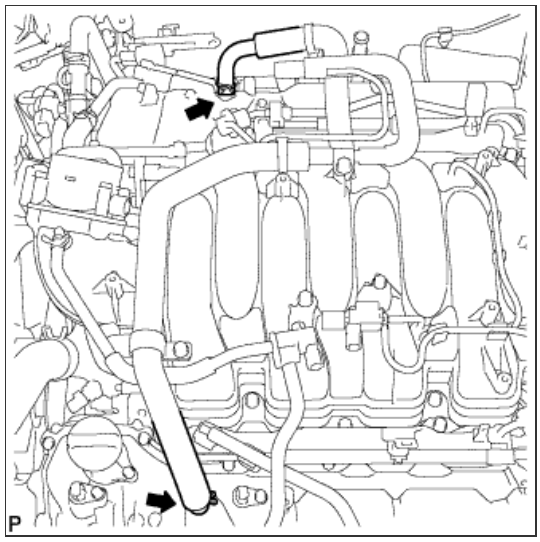


l. Connect the 2 water by-pass hoses.

m. Connect the throttle body connector.



n. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.



10. INSTALL AIR CLEANER HOSE ASSEMBLY

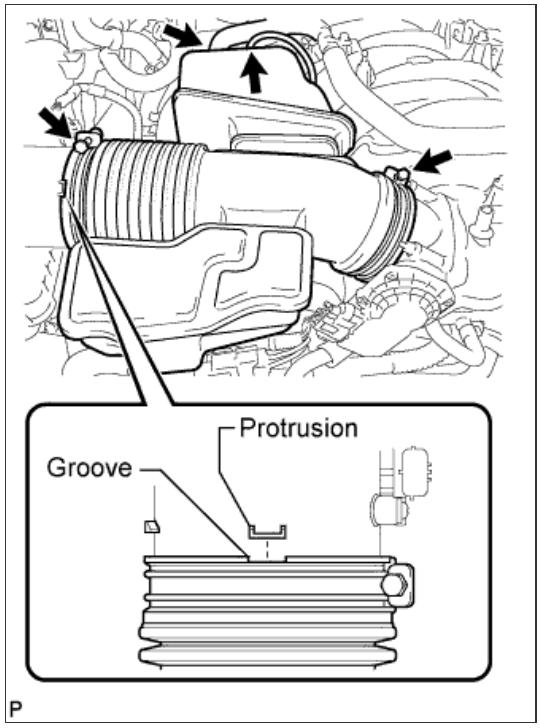
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



11. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

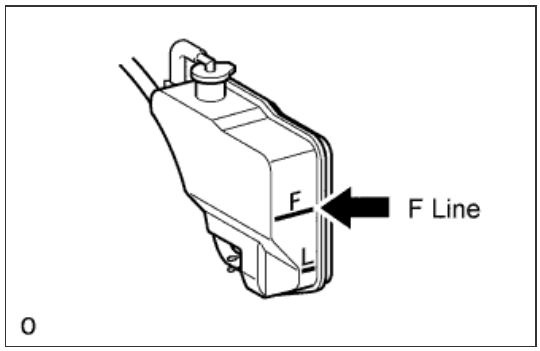
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

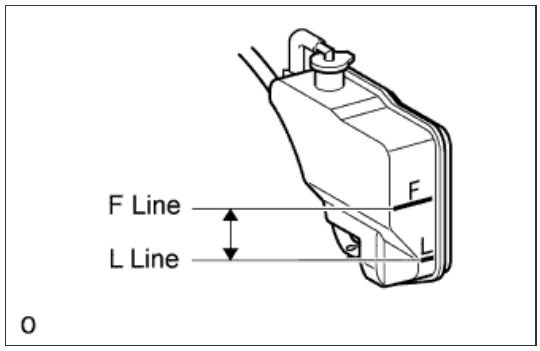
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

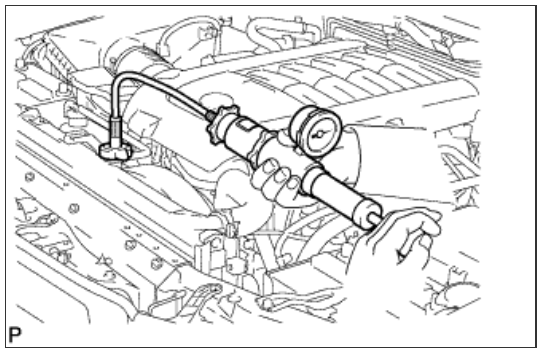


12. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

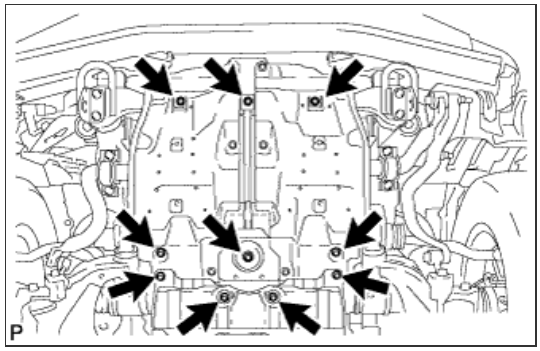
c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



13. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

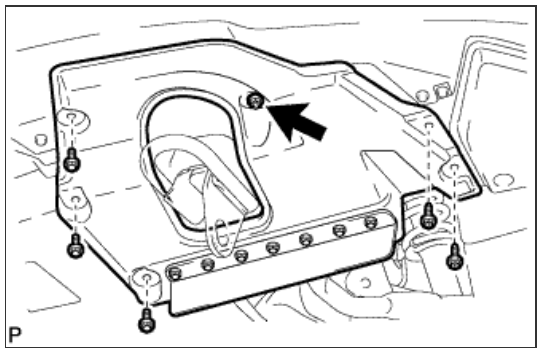
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



14. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



15. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

16. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Install the cowl top ventilator louver (Click here).

17. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable from the cable is reconnected (Click here).

18. CHECK THROTTLE BODY ASSEMBLY

a. Check the throttle control motor operating sounds.

i. Turn the engine switch on (IG).

ii. When depressing the accelerator pedal, check the operating sound of the running motor. Make sure that no friction noises are emitted from the motor.
If friction noise exists, replace the throttle body.

b. Check the throttle position sensor.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch on.

iv. Enter the following menus: Powertrain / Engine and ECT / Data List / All Data / Throttle Sensor Position.

v. Depress the accelerator pedal. When the throttle valve is fully opened, check that the value of "Throttle Sensor Position" is within the specification.

Standard throttle valve opening percentage:
60% or more

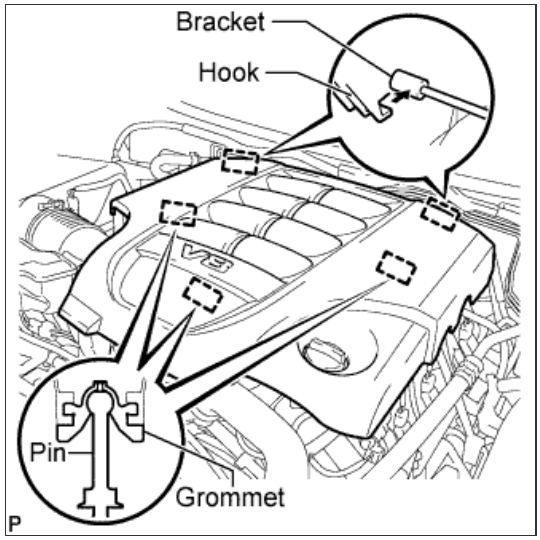
HINT:

When checking the standard throttle valve opening percentage, the shift lever should be in N.

If the percentage is less than 60%, replace the throttle body assembly.

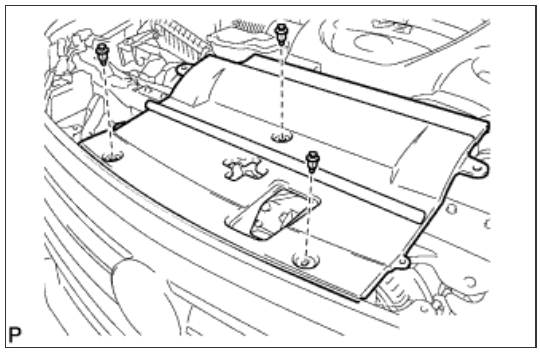
19. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



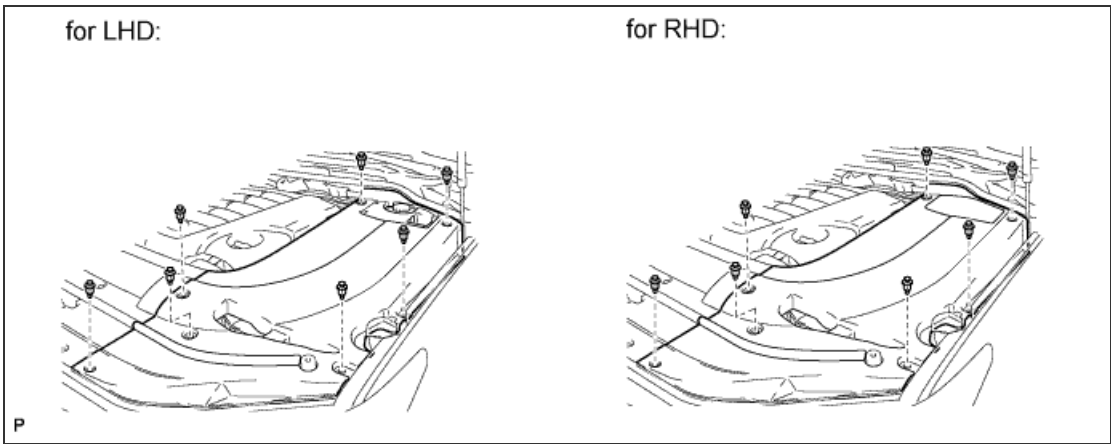
20. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



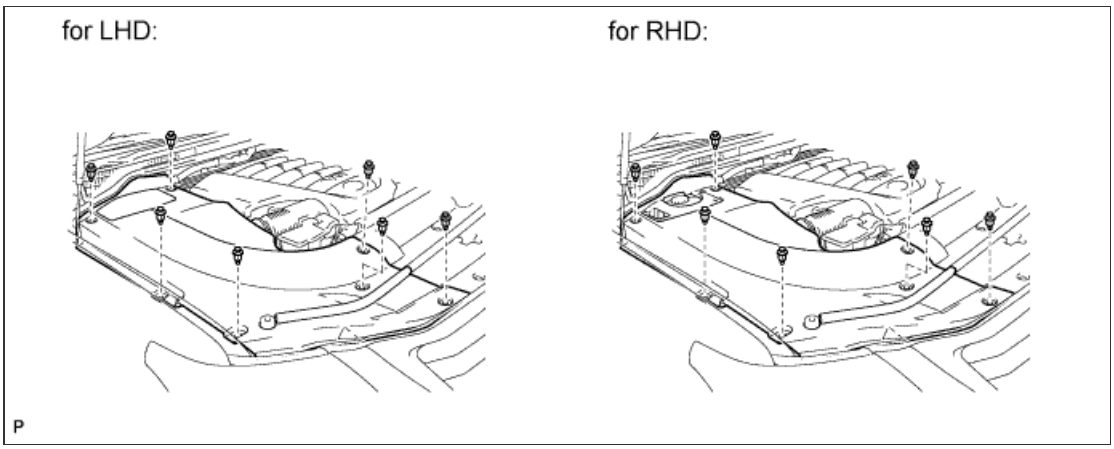
21. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



22. INSTALL ENGINE ROOM SIDE COVER RH

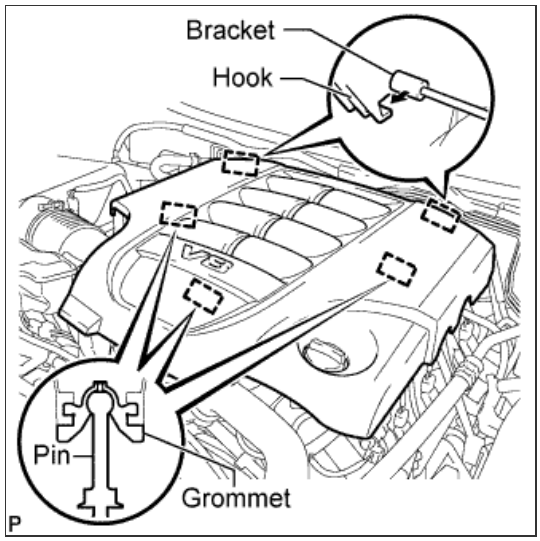
a. Install the engine room side cover with the 7 clips.



for Preparation Click here

1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



2. INSPECT VACUUM SWITCHING VALVE ASSEMBLY (for ACIS)

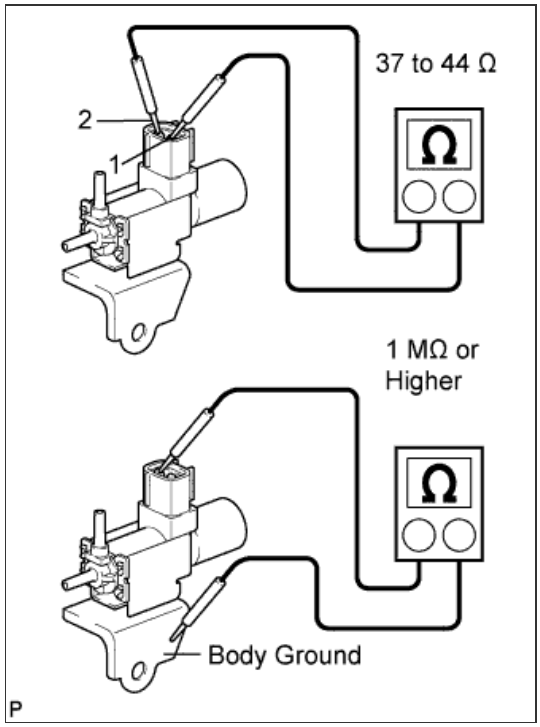
a. Disconnect the vacuum switching valve connector.

b. Measure the resistance according to the value(s) in the table below.

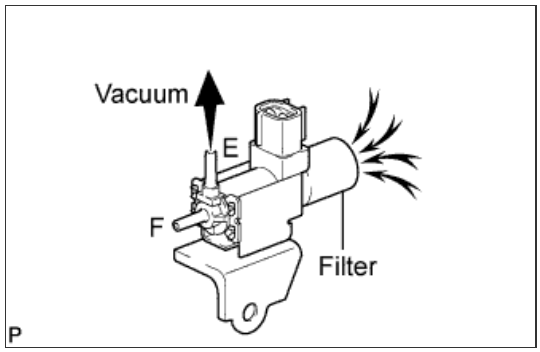
Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	37 to 44 Ω
1 - Body ground	Always	1 MΩ or higher
2 - Body ground		

If the result is not as specified, replace the vacuum switching valve assembly.



c. When applying vacuum to port E, check that air is sucked into the filter.
If the result is not as specified, replace the vacuum switching valve assembly.

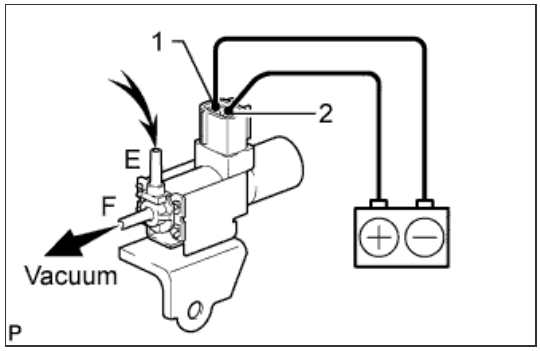


d. Apply battery voltage to the connector, and check the VSV operation.

OK:

Measurement Condition	Specified Condition
Battery positive (+) → Terminal 1 Battery negative (-) → Terminal 2	Air is sucked into port E when a vacuum is applied to port F

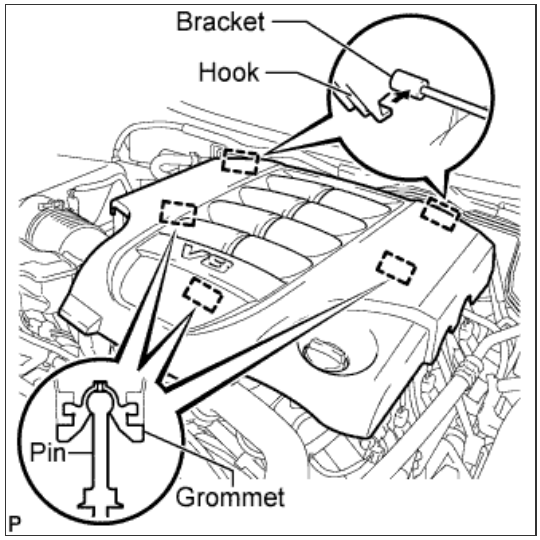
If the result is not as specified, replace the vacuum switching valve assembly.



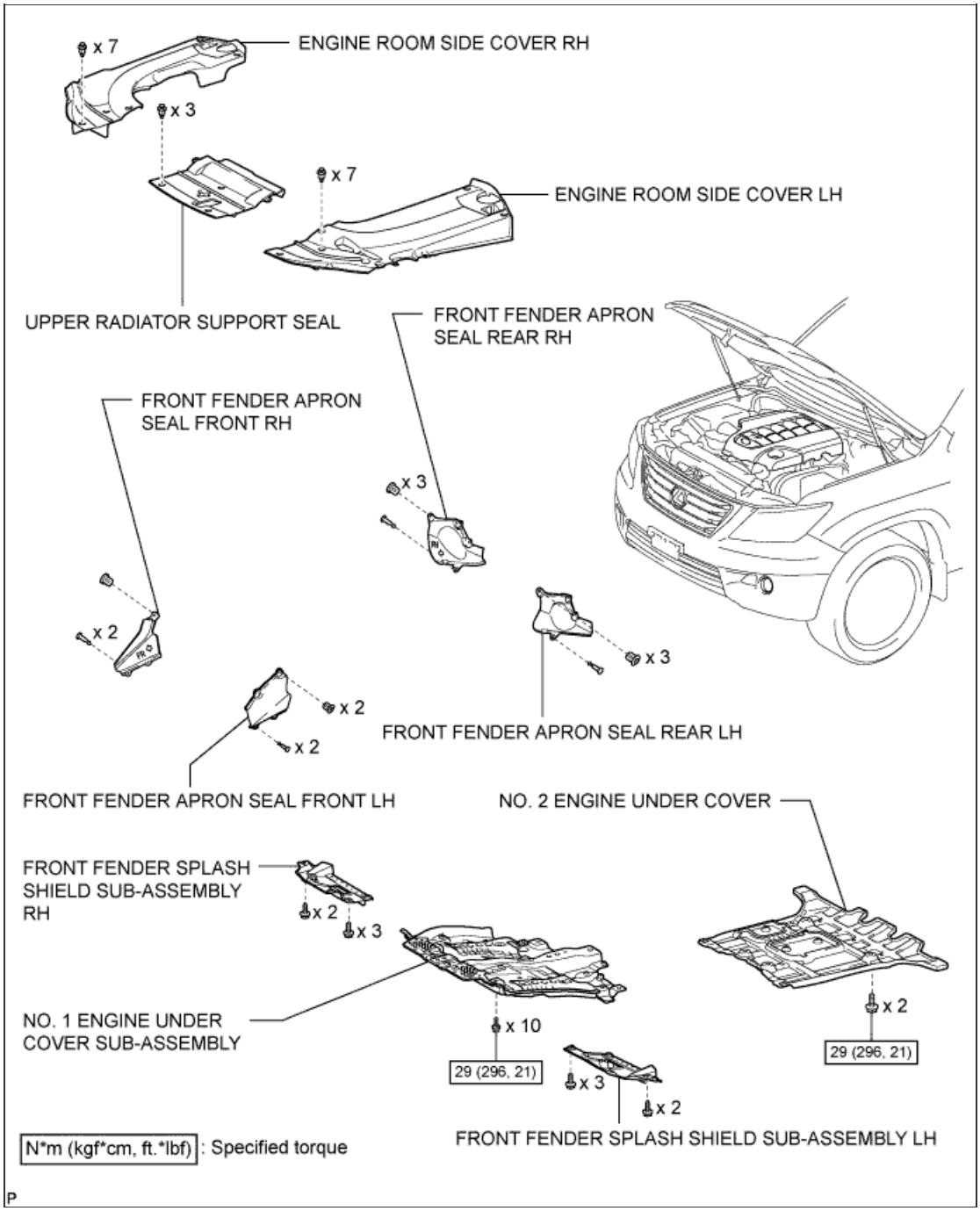
e. Connect the vacuum switching valve connector.

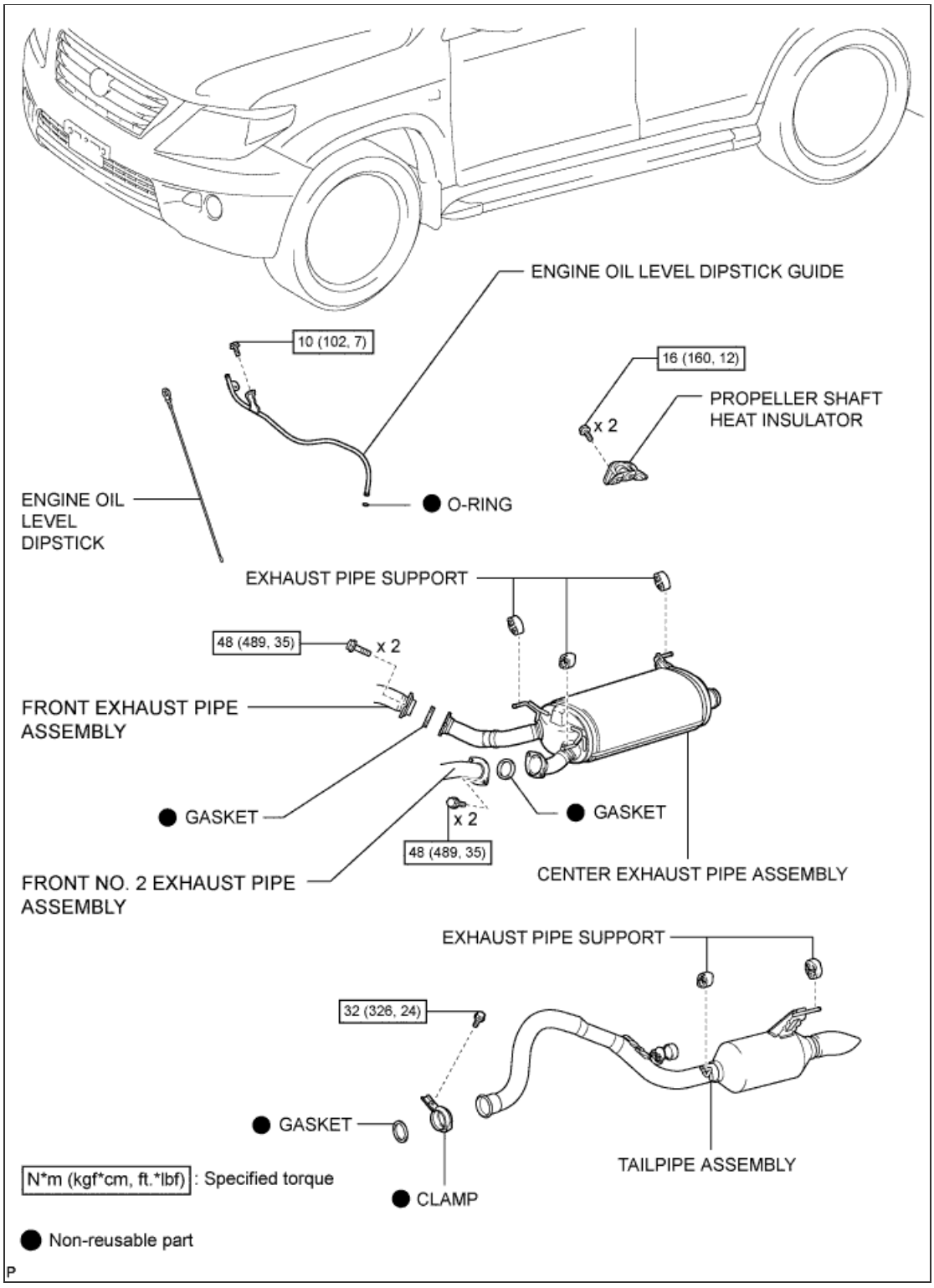
3. INSTALL V-BANK COVER SUB-ASSEMBLY

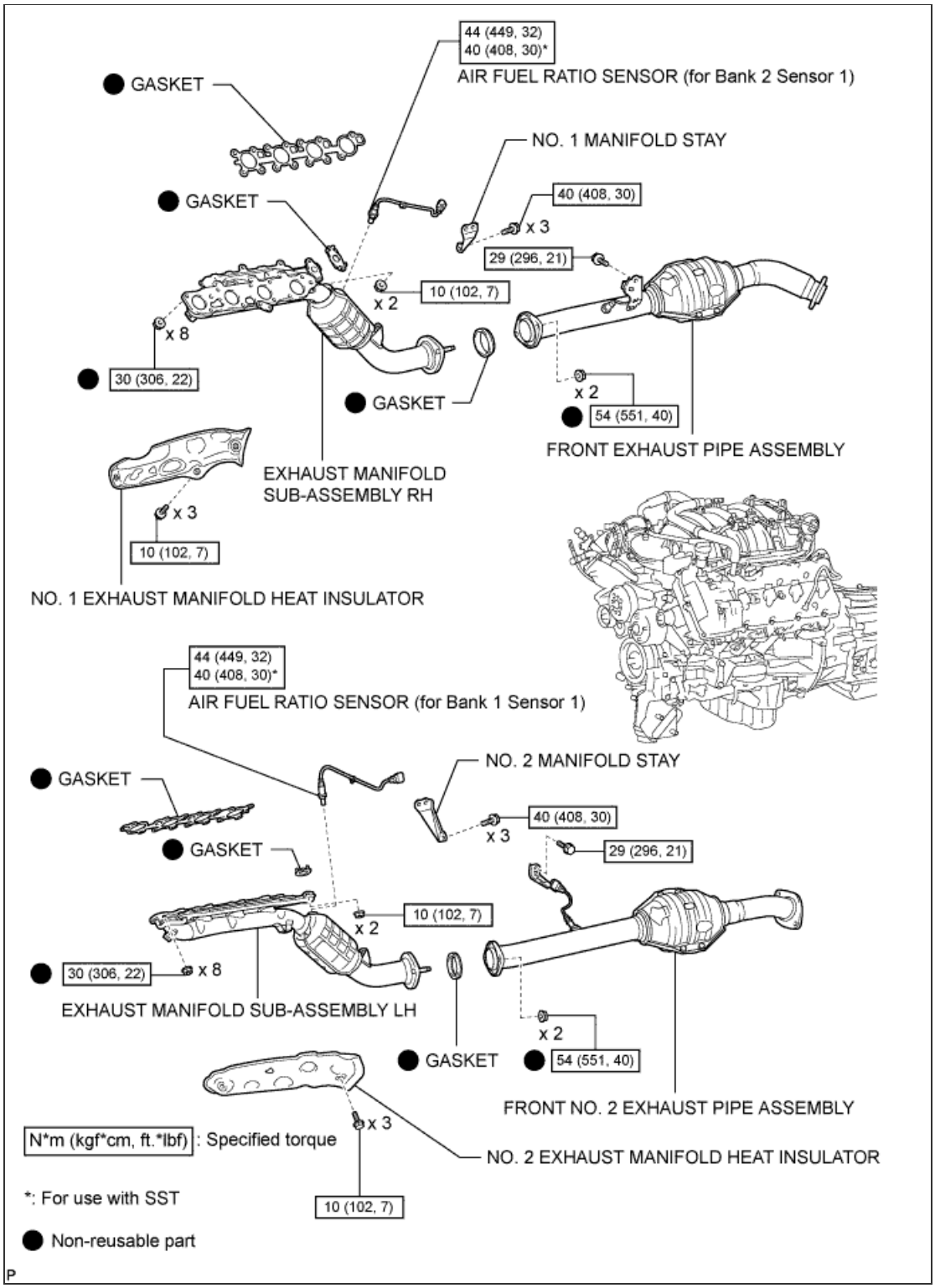
a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



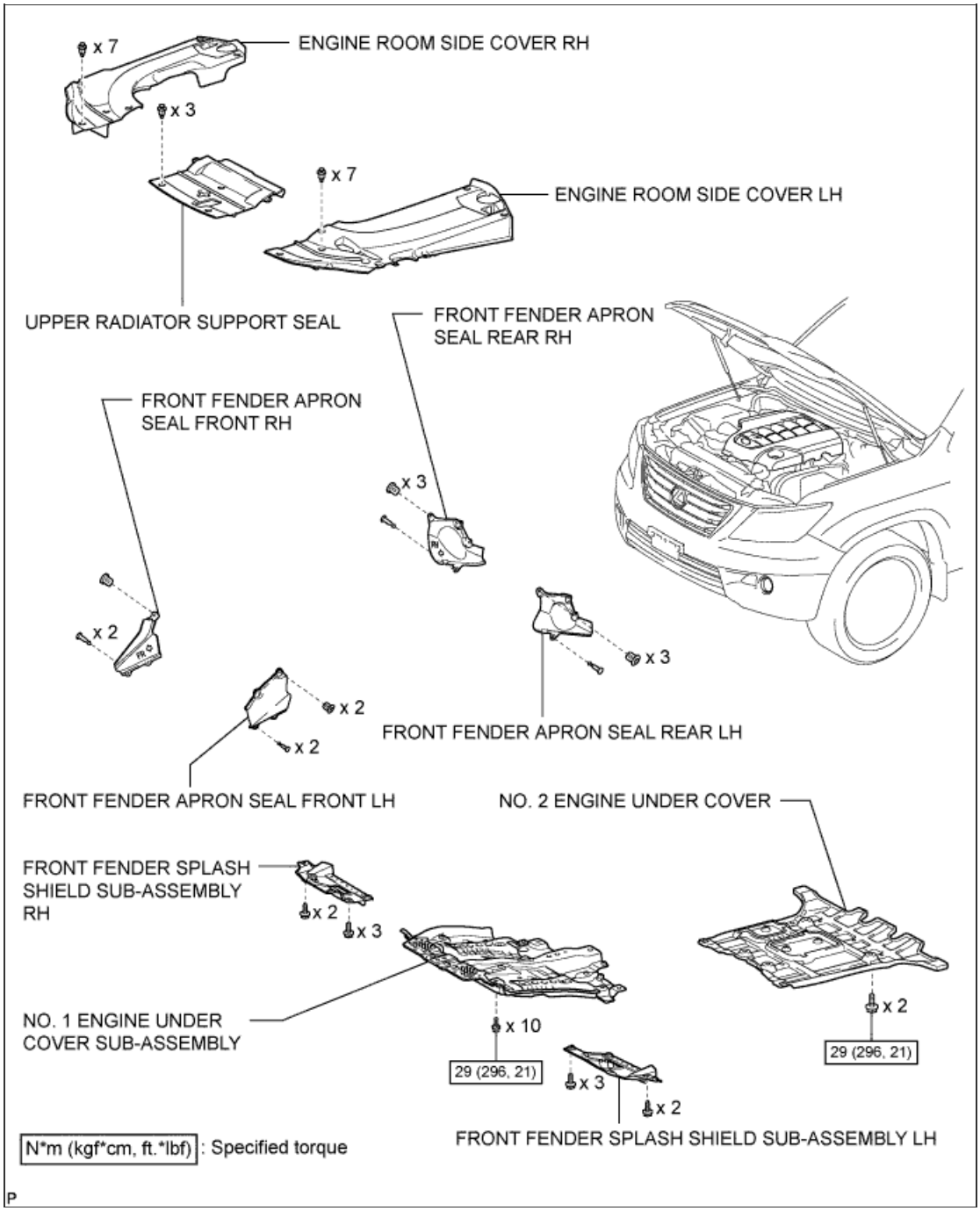
for Preparation Click here

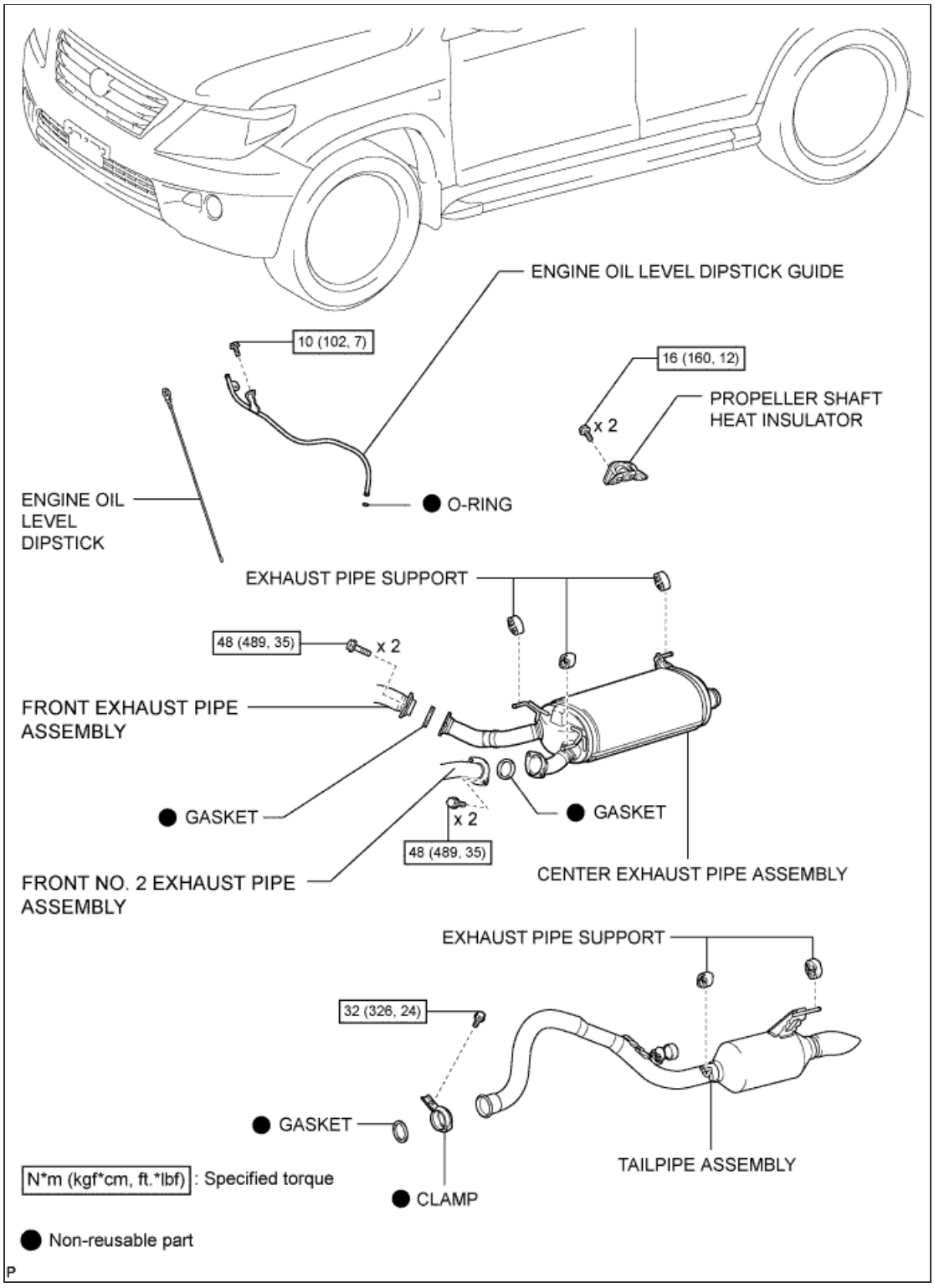


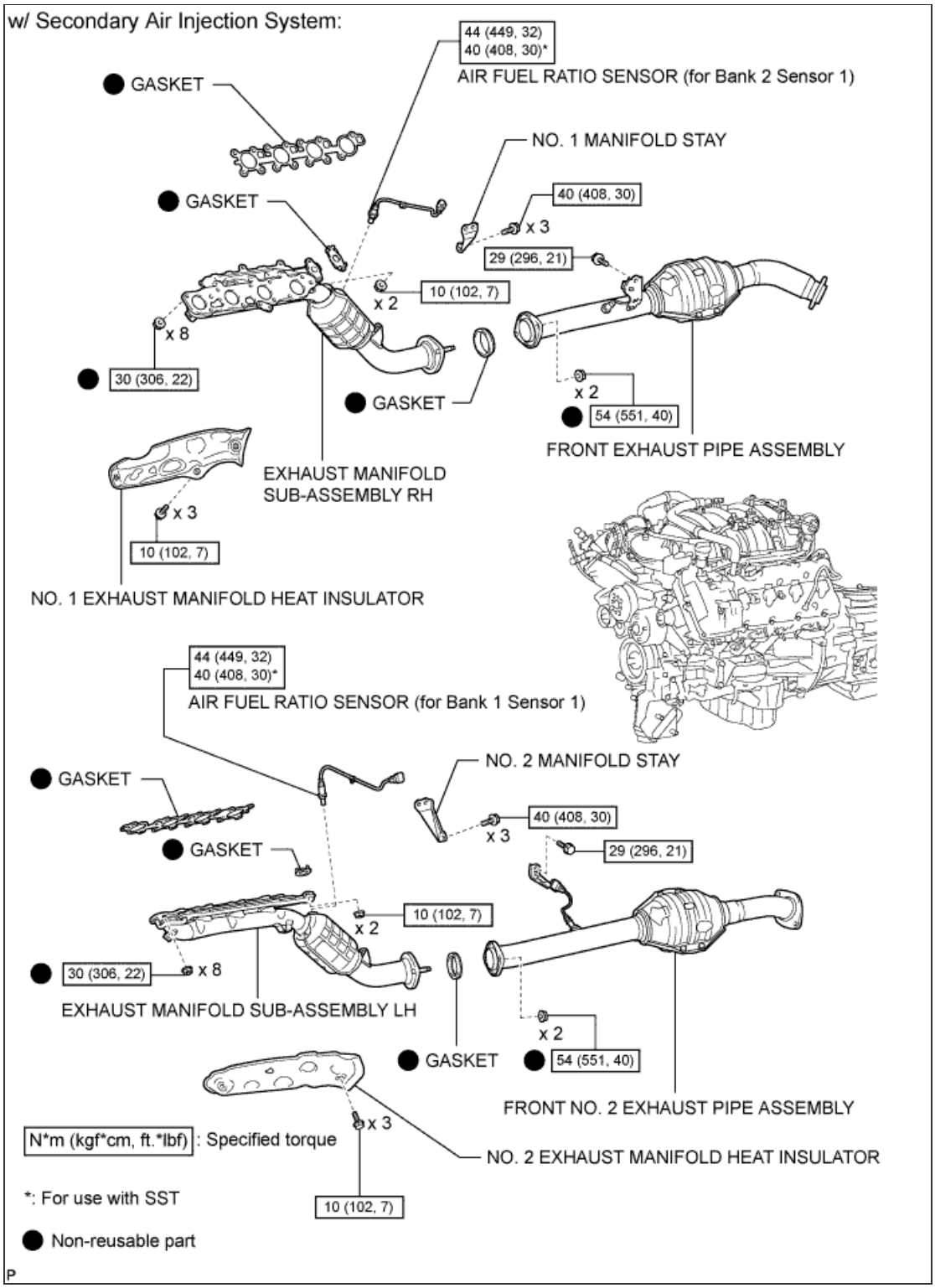

ENGINE OIL LEVEL DIPSTICK GUIDE
10 (102, 7)
16 (160, 12)
x 2
PROPELLER SHAFT HEAT INSULATOR
ENGINE OIL LEVEL DIPSTICK
O-RING
EXHAUST PIPE SUPPORT
48 (489, 35)
x 2
FRONT EXHAUST PIPE ASSEMBLY
GASKET
GASKET
x 2
48 (489, 35)
FRONT NO. 2 EXHAUST PIPE ASSEMBLY
CENTER EXHAUST PIPE ASSEMBLY
EXHAUST PIPE SUPPORT
32 (326, 24)
GASKET
TAILPIPE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
CLAMP
Non-reusable part
P

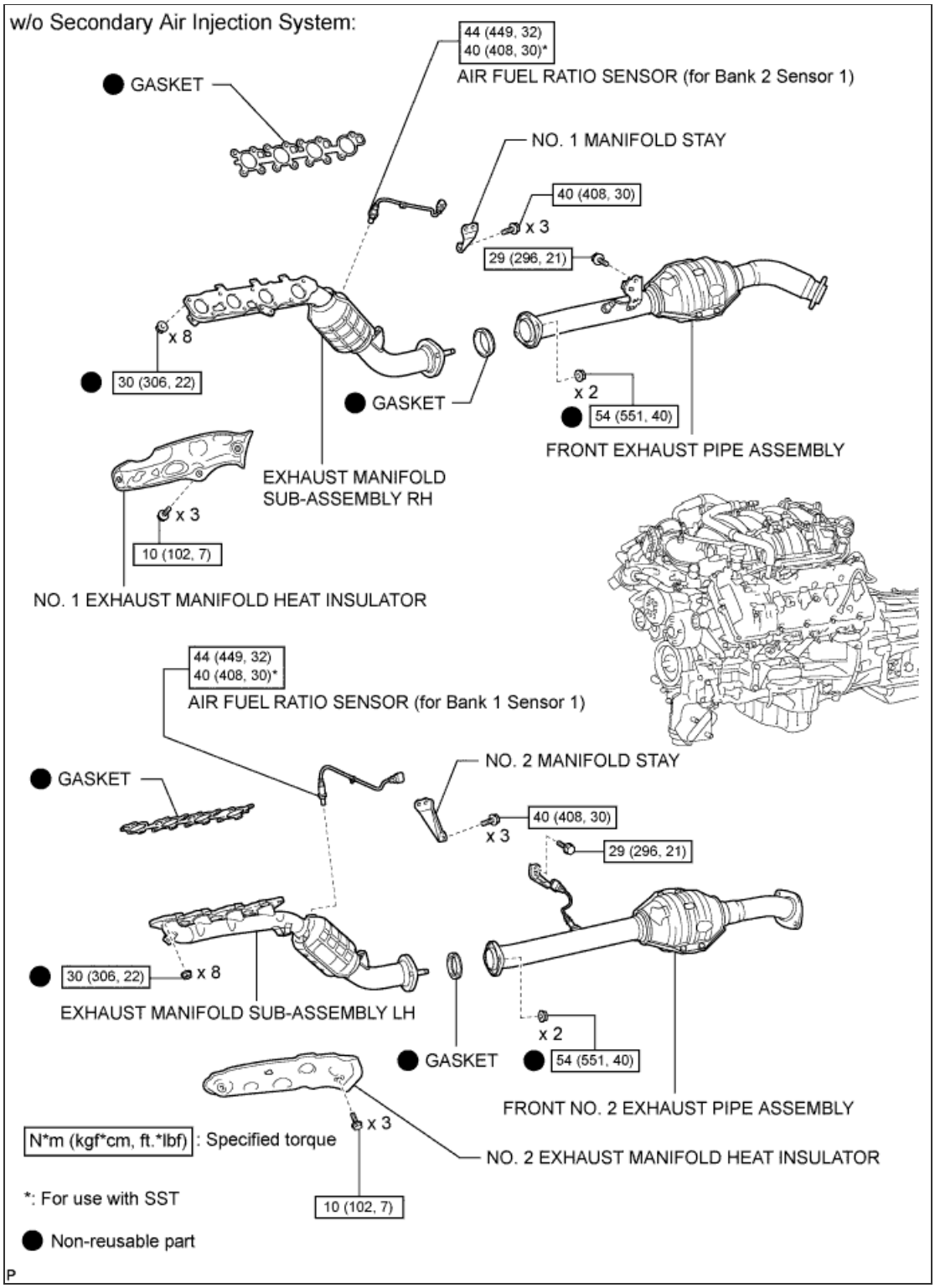

44 (449, 32)
40 (408, 30)*
AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)
GASKET
NO. 1 MANIFOLD STAY
GASKET
40 (408, 30)
x 3
29 (296, 21)
10 (102, 7)
x 2
x 8
30 (306, 22)
GASKET
x 2
54 (551, 40)
FRONT EXHAUST PIPE ASSEMBLY
EXHAUST MANIFOLD
SUB-ASSEMBLY RH
x 3
10 (102, 7)
NO. 1 EXHAUST MANIFOLD HEAT INSULATOR
44 (449, 32)
40 (408, 30)*
AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)
NO. 2 MANIFOLD STAY
GASKET
40 (408, 30)
x 3
GASKET
29 (296, 21)
10 (102, 7)
x 2
30 (306, 22)
x 8
EXHAUST MANIFOLD SUB-ASSEMBLY LH
x 2
GASKET
54 (551, 40)
FRONT NO. 2 EXHAUST PIPE ASSEMBLY
x 3
N*m (kgf*cm, ft.*lbf) : Specified torque
NO. 2 EXHAUST MANIFOLD HEAT INSULATOR
*: For use with SST
10 (102, 7)
Non-reusable part
P

for Preparation Click here




ENGINE OIL LEVEL DIPSTICK GUIDE
10 (102, 7)
16 (160, 12)
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PROPELLER SHAFT HEAT INSULATOR
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N*m (kgf*cm, ft.*lbf) : Specified torque
CLAMP
Non-reusable part
P

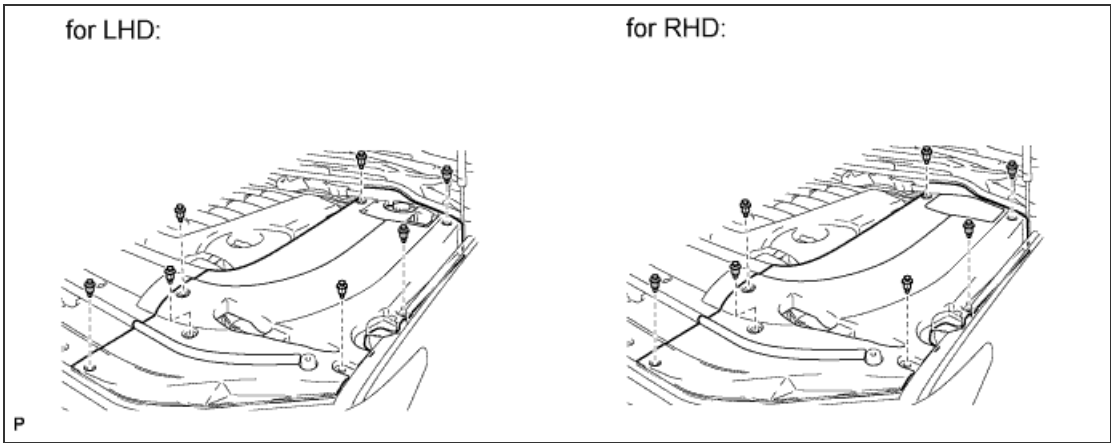

w/ Secondary Air Injection System:
44 (449, 32)
40 (408, 30)*
AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)
GASKET
NO. 1 MANIFOLD STAY
GASKET
40 (408, 30)
x 3
29 (296, 21)
10 (102, 7)
x 2
x 8
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GASKET
x 2
54 (551, 40)
FRONT EXHAUST PIPE ASSEMBLY
EXHAUST MANIFOLD
SUB-ASSEMBLY RH
x 3
10 (102, 7)
NO. 1 EXHAUST MANIFOLD HEAT INSULATOR
44 (449, 32)
40 (408, 30)*
AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)
NO. 2 MANIFOLD STAY
GASKET
40 (408, 30)
x 3
GASKET
29 (296, 21)
10 (102, 7)
x 2
30 (306, 22)
x 8
EXHAUST MANIFOLD SUB-ASSEMBLY LH
x 2
GASKET
54 (551, 40)
FRONT NO. 2 EXHAUST PIPE ASSEMBLY
x 3
N*m (kgf*cm, ft.*lbf) : Specified torque
NO. 2 EXHAUST MANIFOLD HEAT INSULATOR
*: For use with SST
10 (102, 7)
Non-reusable part
P


w/o Secondary Air Injection System:
44 (449, 32)
40 (408, 30)*
AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)
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NO. 1 MANIFOLD STAY
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EXHAUST MANIFOLD SUB-ASSEMBLY LH
x 2
GASKET
54 (551, 40)
FRONT NO. 2 EXHAUST PIPE ASSEMBLY
x 3
N*m (kgf*cm, ft.*lbf) : Specified torque
NO. 2 EXHAUST MANIFOLD HEAT INSULATOR
*: For use with SST
10 (102, 7)
Non-reusable part
P

for Preparation Click here

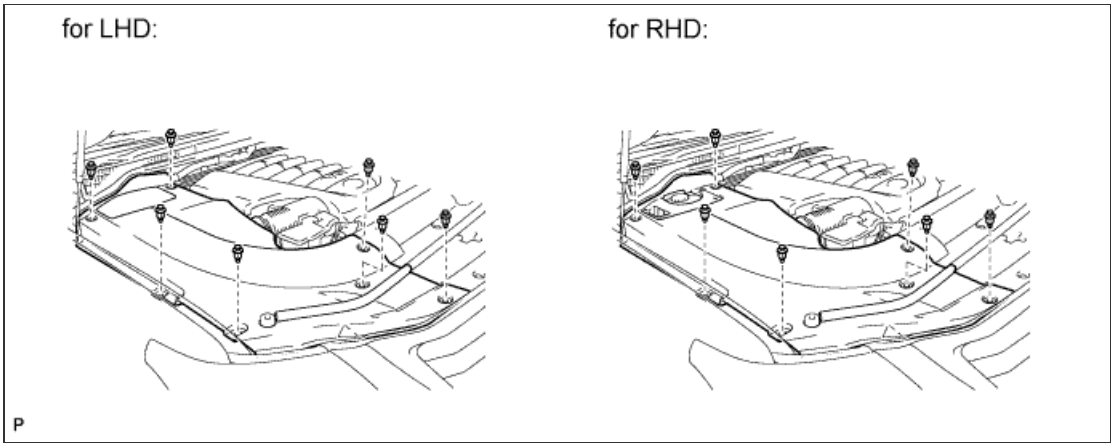
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



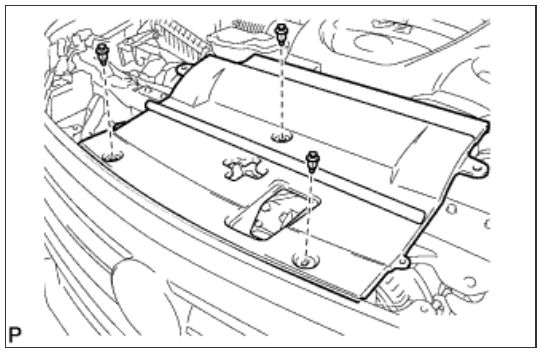
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

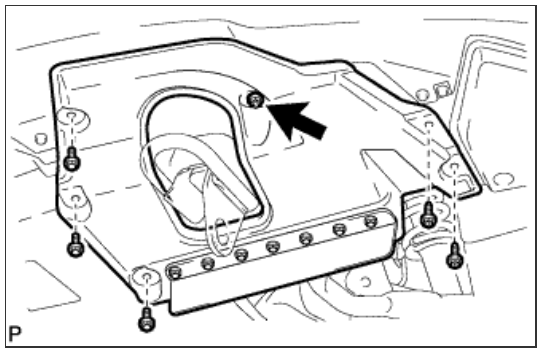
a. Remove the 3 clips and upper radiator support seal.



4. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



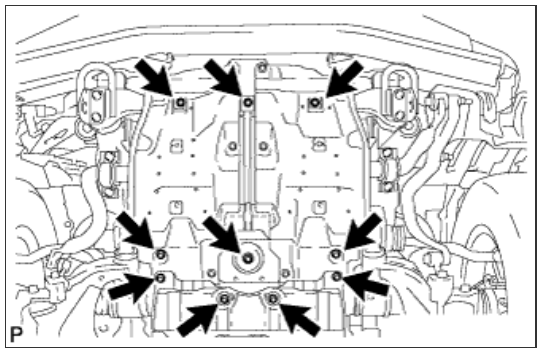
5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

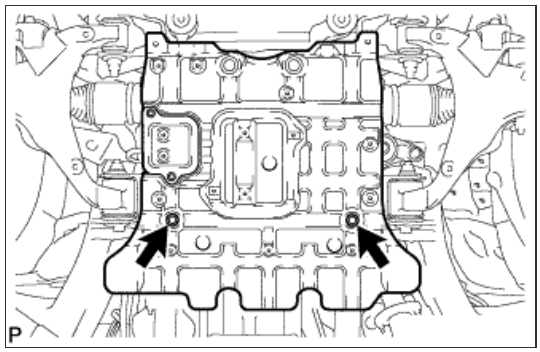
6. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



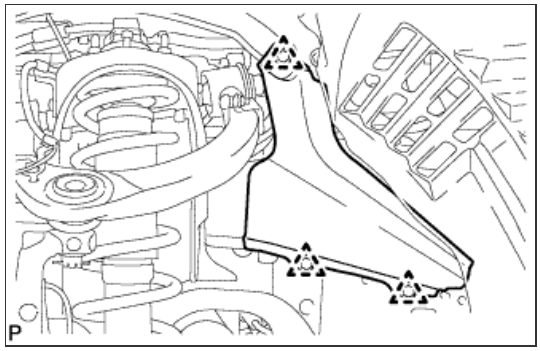
7. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



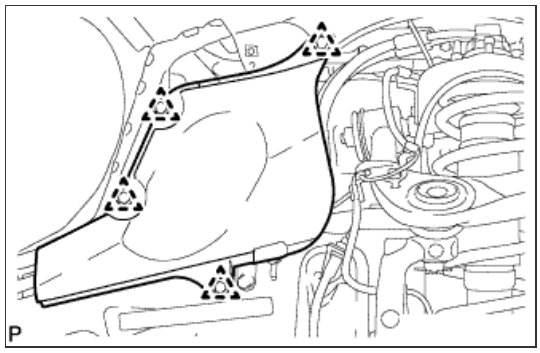
8. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.



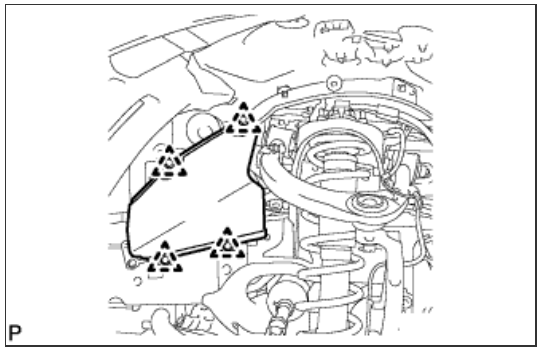
9. REMOVE FRONT FENDER APRON SEAL REAR RH

a. Using a clip remover, remove the 4 clips and fender apron seal.



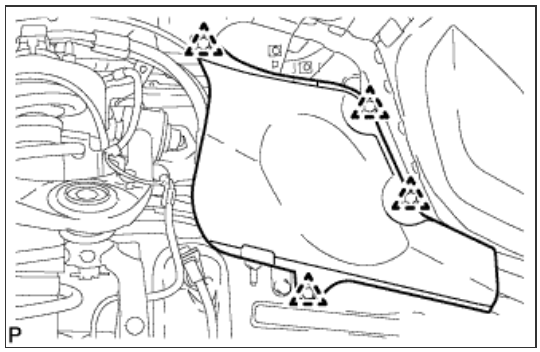
10. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



11. REMOVE FRONT FENDER APRON SEAL REAR LH

a. Using a clip remover, remove the 4 clips and fender apron seal.

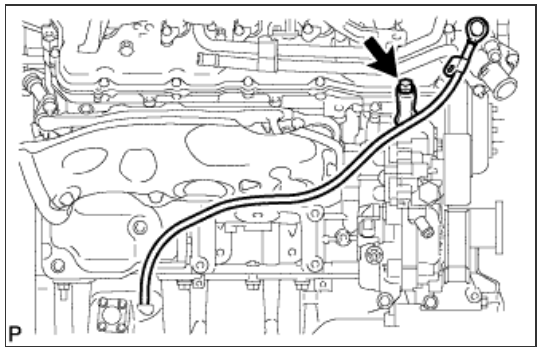


12. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.



13. REMOVE TAILPIPE ASSEMBLY

a. Remove the bolt, clamp and gasket.

b. Remove the tailpipe from the 2 exhaust pipe supports.

c. Remove the bolt and clamp, and then disconnect the tailpipe from the center exhaust pipe.

14. REMOVE CENTER EXHAUST PIPE ASSEMBLY

a. Remove the 4 bolts.

b. Remove the center exhaust pipe from the 3 exhaust pipe supports.

c. Remove the 2 gaskets from the front exhaust pipe and front No. 2 exhaust pipe.

15. REMOVE FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front No. 2 exhaust pipe and gasket from the exhaust manifold LH.

16. REMOVE FRONT EXHAUST PIPE ASSEMBLY

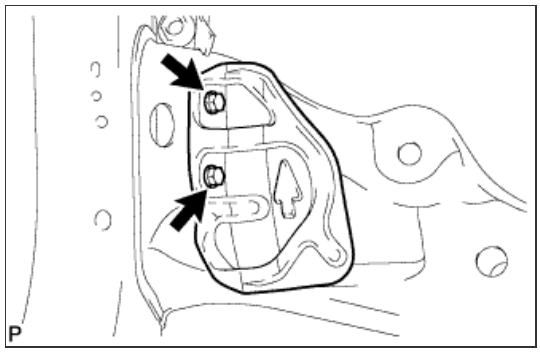
a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front exhaust pipe and gasket from the exhaust manifold RH.

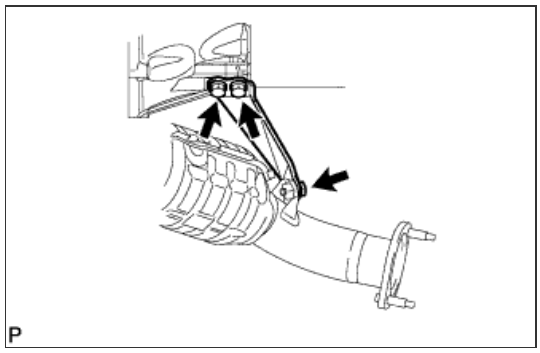
17. REMOVE PROPELLER SHAFT HEAT INSULATOR

a. Remove the 2 bolts and heat insulator.



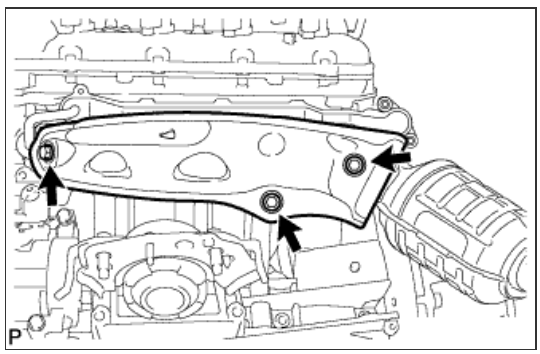
18. REMOVE NO. 2 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



19. REMOVE NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

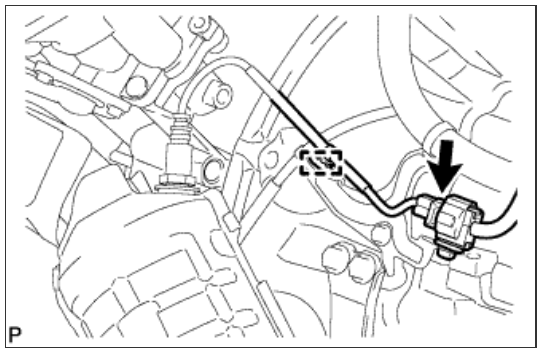
a. Remove the 3 bolts and heat insulator.



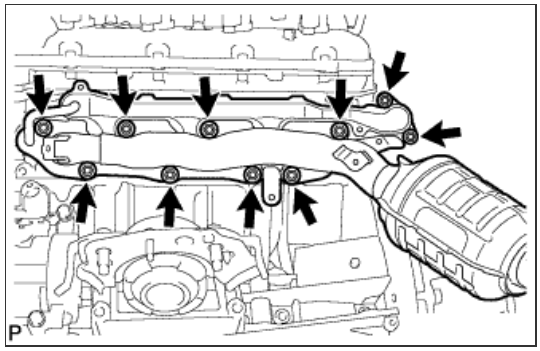
20. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Disconnect the connector.

b. Using a clip remover, detach the wire harness clamp.

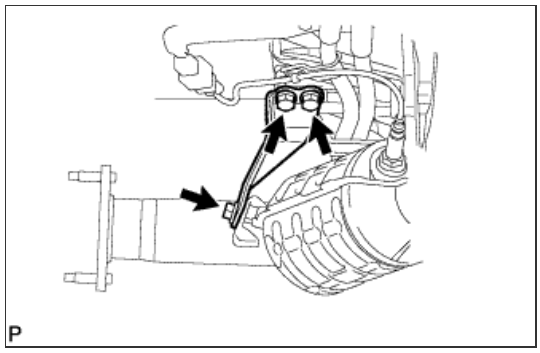


c. Remove the 10 nuts, exhaust manifold and 2 gaskets.



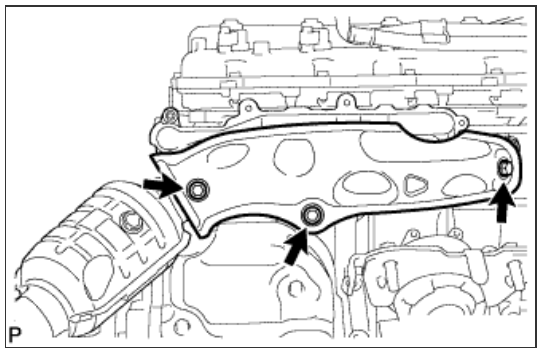
21. REMOVE NO. 1 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



22. REMOVE NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

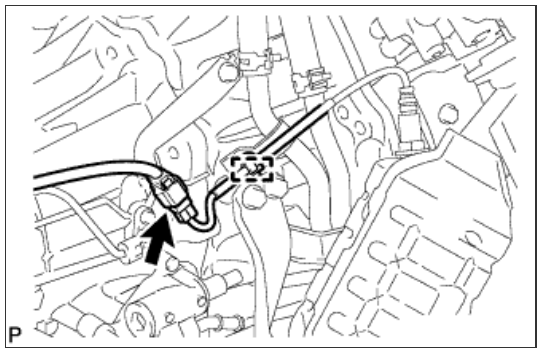
a. Remove the 3 bolts and heat insulator.



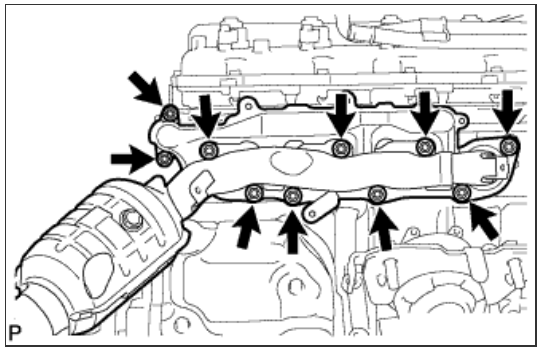
23. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Disconnect the connector.

b. Using a clip remover, detach the wire harness clamp.



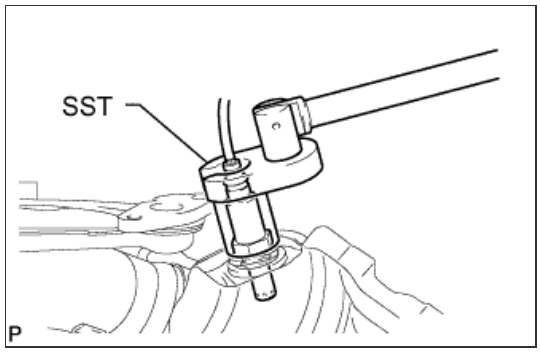
c. Remove the 10 nuts, exhaust manifold and 2 gaskets.



24. REMOVE AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Using SST, remove the sensor.

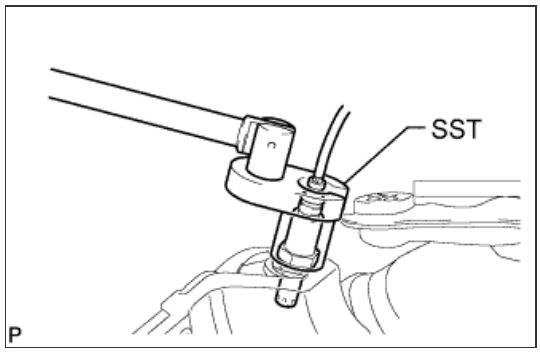
SST
09224-00010



25. REMOVE AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Using SST, remove the sensor.

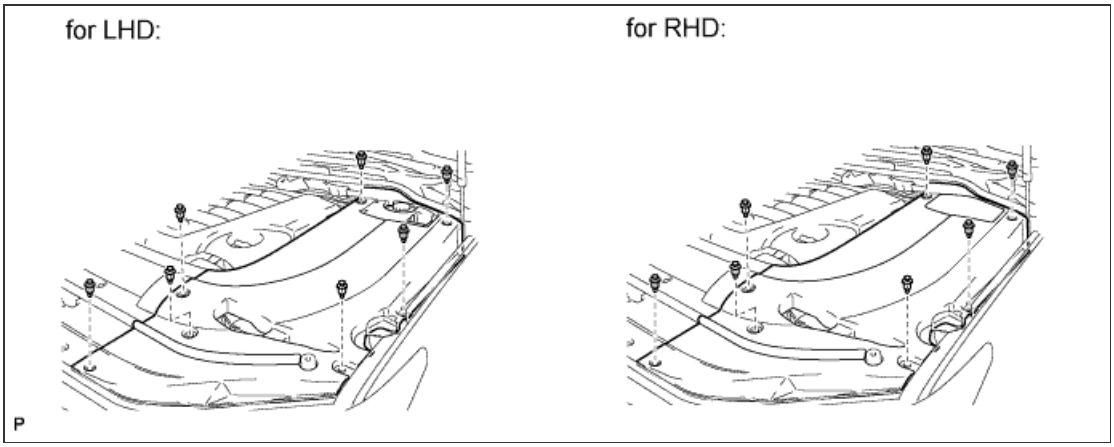
SST
09224-00010



for Preparation Click here

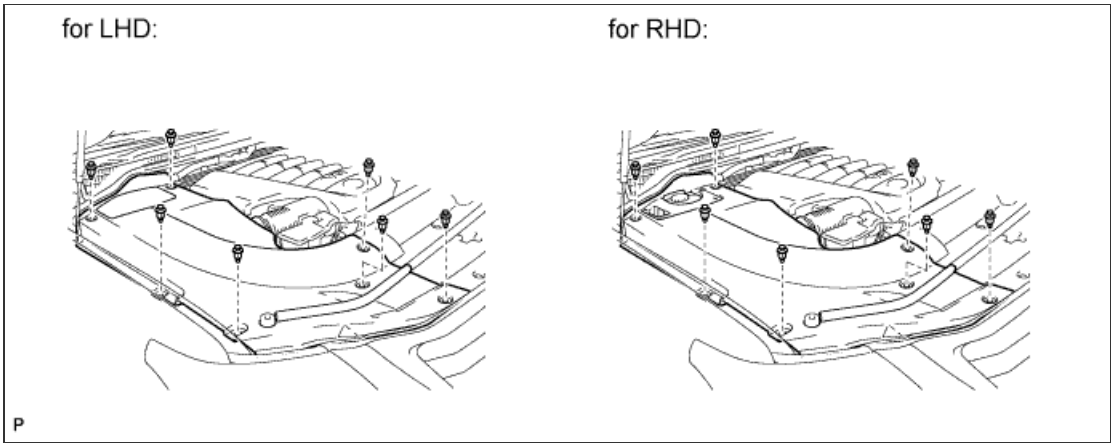
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



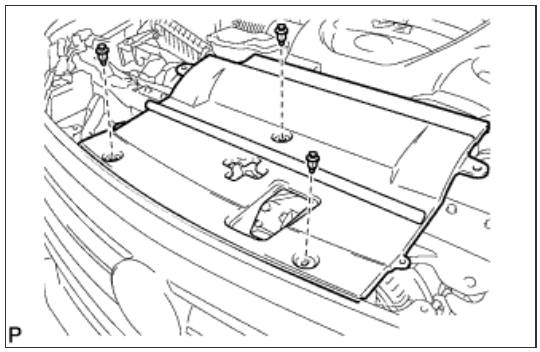
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

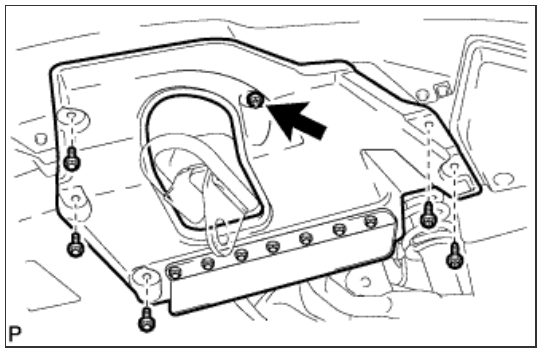
a. Remove the 3 clips and upper radiator support seal.



4. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



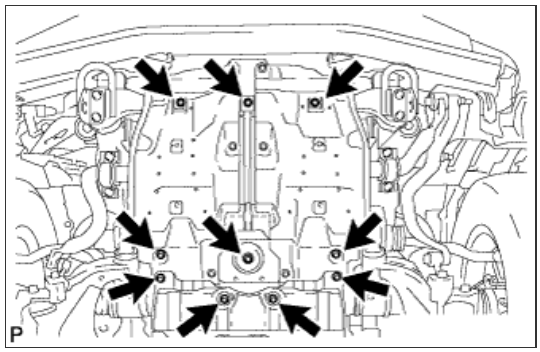
5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

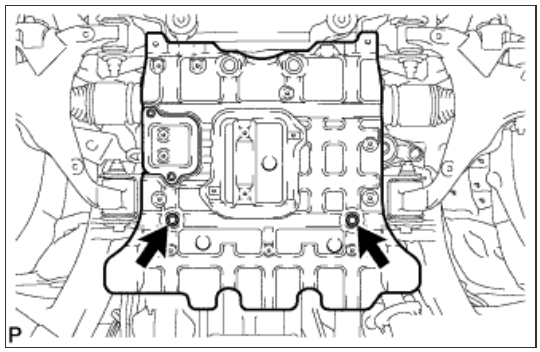
6. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



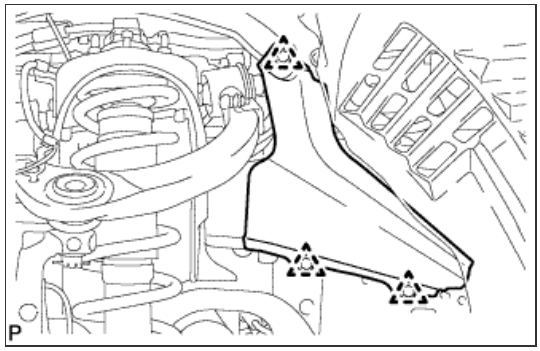
7. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



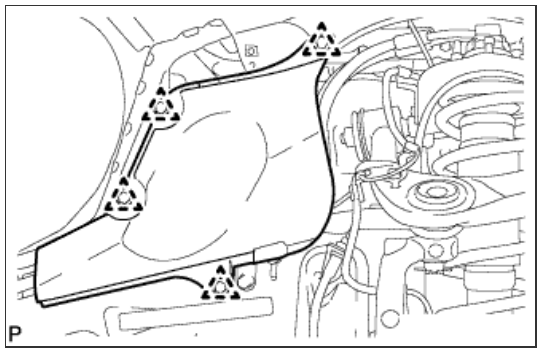
8. REMOVE FRONT FENDER APRON SEAL FRONT RH

a. Using a clip remover, remove the 3 clips and fender apron seal.



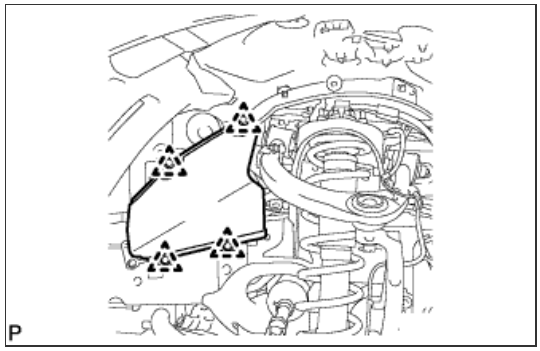
9. REMOVE FRONT FENDER APRON SEAL REAR RH

a. Using a clip remover, remove the 4 clips and fender apron seal.



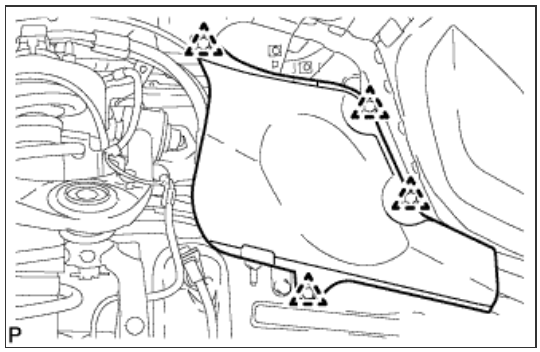
10. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



11. REMOVE FRONT FENDER APRON SEAL REAR LH

a. Using a clip remover, remove the 4 clips and fender apron seal.

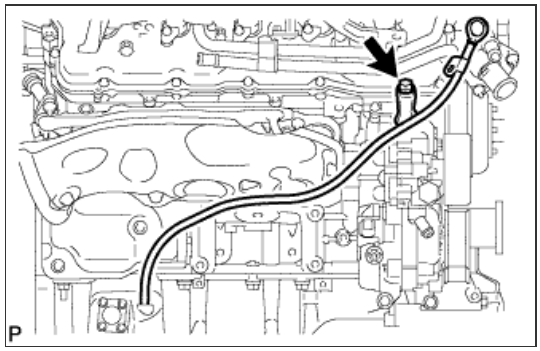


12. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.



13. REMOVE TAILPIPE ASSEMBLY

a. Remove the bolt, clamp and gasket.

b. Remove the tailpipe from the 2 exhaust pipe supports.

c. Remove the bolt and clamp, and then disconnect the tailpipe from the center exhaust pipe.

14. REMOVE CENTER EXHAUST PIPE ASSEMBLY

a. Remove the 4 bolts.

b. Remove the center exhaust pipe from the 3 exhaust pipe supports.

c. Remove the 2 gaskets from the front exhaust pipe and front No. 2 exhaust pipe.

15. REMOVE FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front No. 2 exhaust pipe and gasket from the exhaust manifold LH.

16. REMOVE FRONT EXHAUST PIPE ASSEMBLY

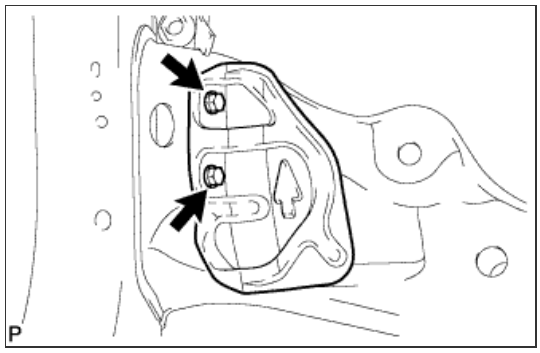
a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front exhaust pipe and gasket from the exhaust manifold RH.

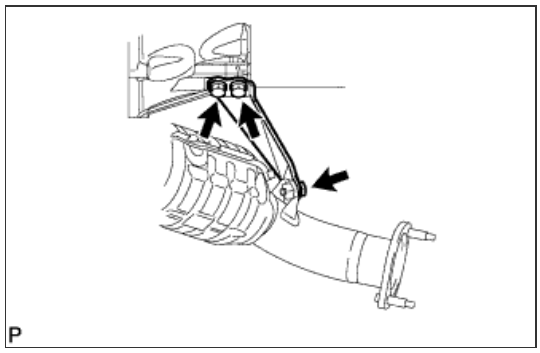
17. REMOVE PROPELLER SHAFT HEAT INSULATOR

a. Remove the 2 bolts and heat insulator.



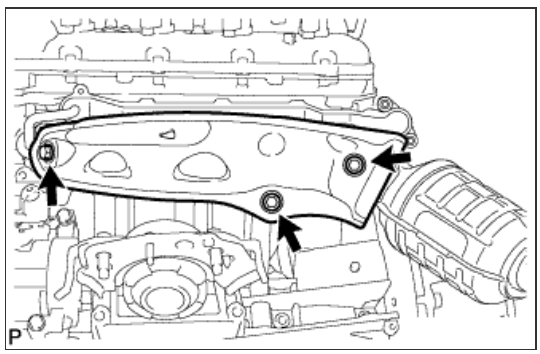
18. REMOVE NO. 2 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



19. REMOVE NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

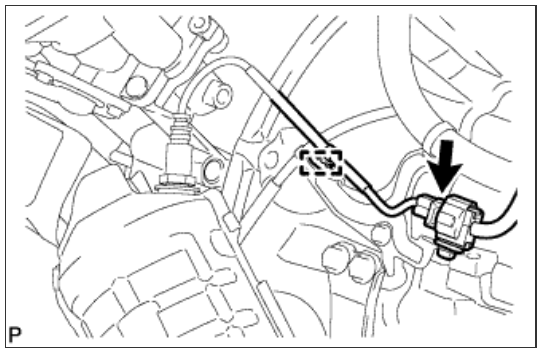
a. Remove the 3 bolts and heat insulator.



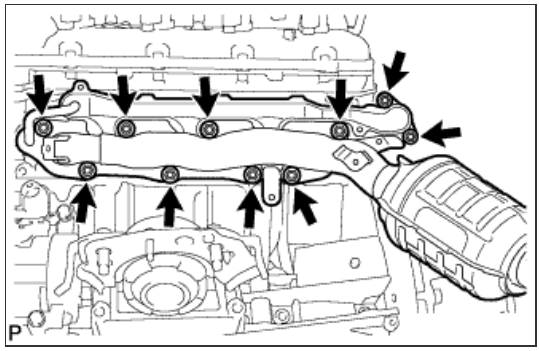
20. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Disconnect the connector.

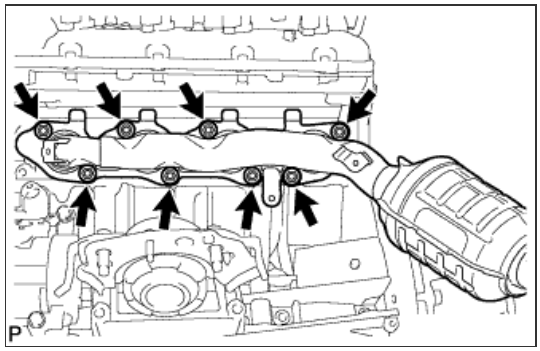
b. Using a clip remover, detach the wire harness clamp.



c. w/ Secondary Air Injection System:
Remove the 10 nuts, exhaust manifold and 2 gaskets.

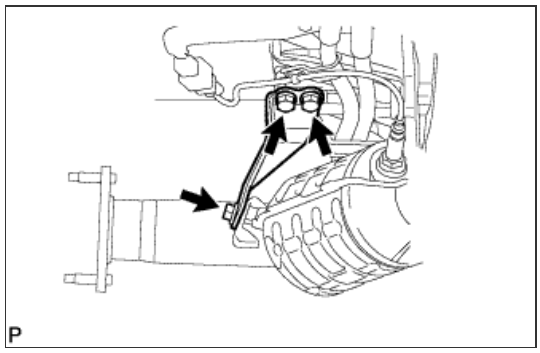


d. w/o Secondary Air Injection System:
Remove the 8 nuts, exhaust manifold and gasket.



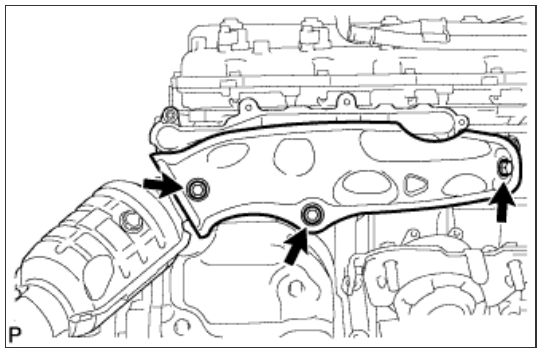
21. REMOVE NO. 1 MANIFOLD STAY

a. Remove the 3 bolts and manifold stay.



22. REMOVE NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

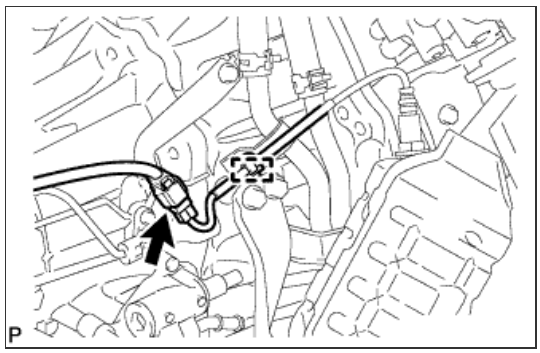
a. Remove the 3 bolts and heat insulator.



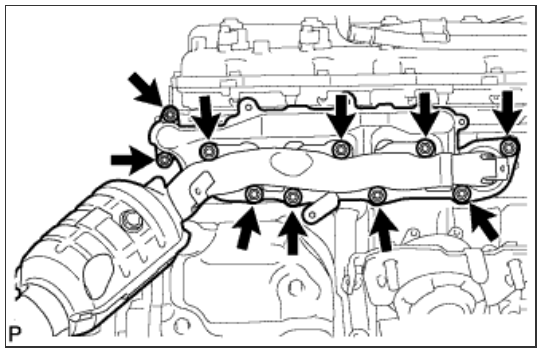
23. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Disconnect the connector.

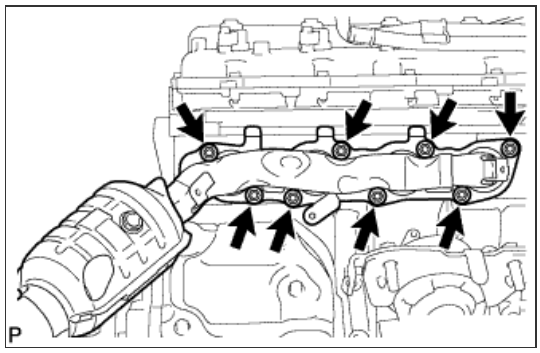
b. Using a clip remover, detach the wire harness clamp.



c. w/ Secondary Air Injection System:
Remove the 10 nuts, exhaust manifold and 2 gaskets.



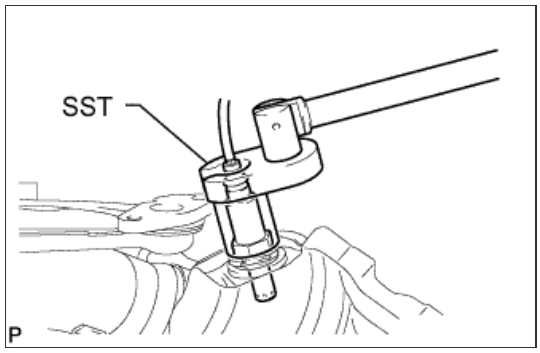
d. w/o Secondary Air Injection System:
Remove the 8 nuts, exhaust manifold and gasket.



24. REMOVE AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Using SST, remove the sensor.

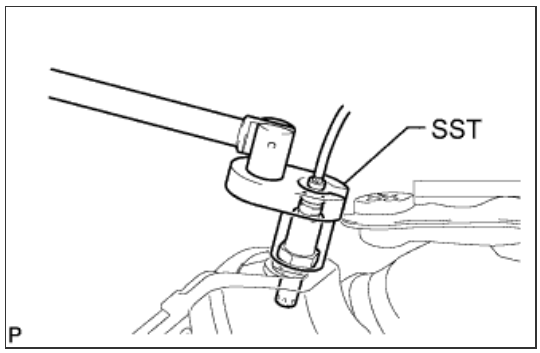
SST
09224-00010



25. REMOVE AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Using SST, remove the sensor.

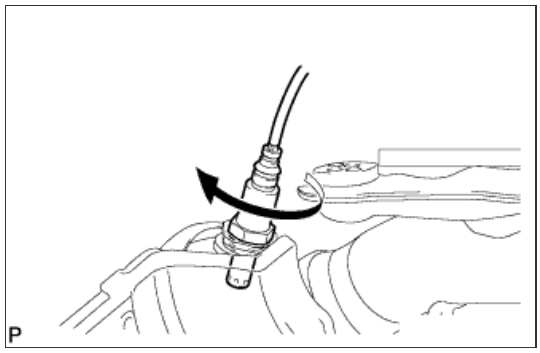
SST
09224-00010



for Preparation Click here

1. INSTALL AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



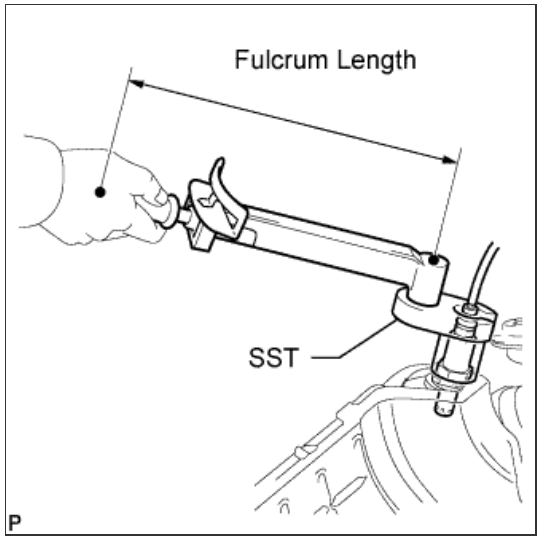
b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

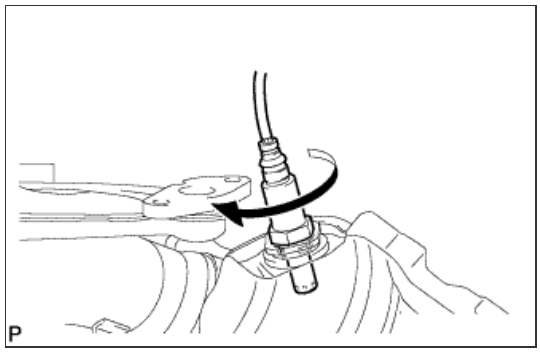
HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



2. INSTALL AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



b. Using SST, tighten the sensor.

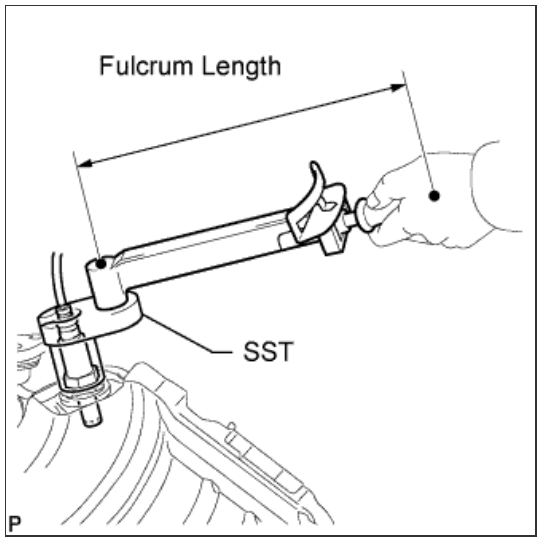
SST
09224-00010

Torque:
without SST:

44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**

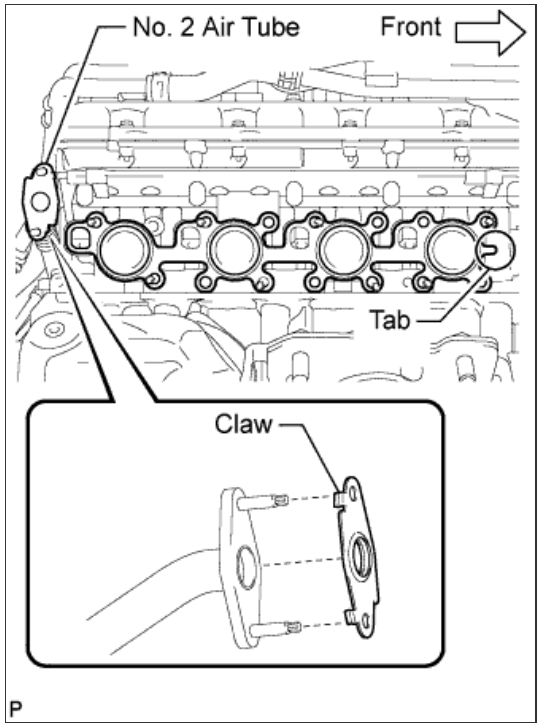


3. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Install a new gasket to the cylinder head and a new gasket to the No. 2 air tube.

HINT:

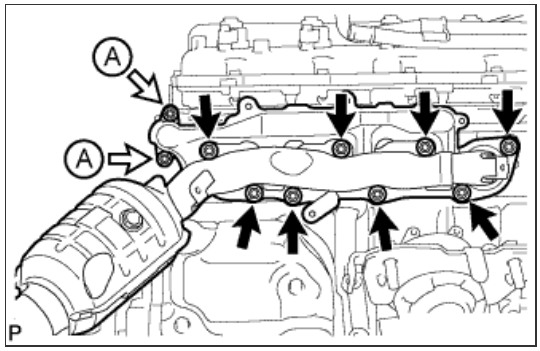
- **Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



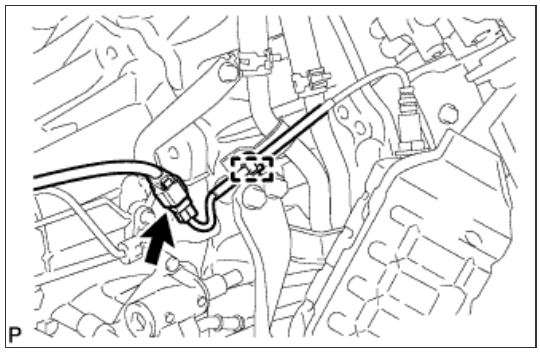
b. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

c. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



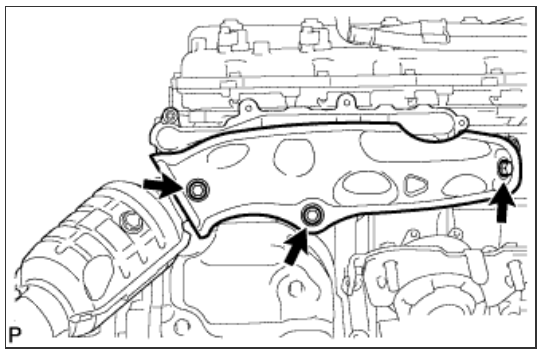
d. Attach the wire harness clamp to the bracket and connect the connector.



4. INSTALL NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

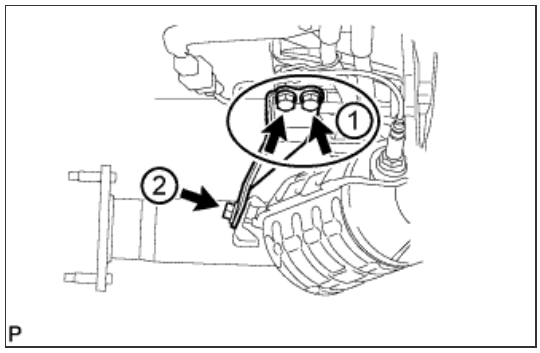


5. INSTALL NO. 1 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

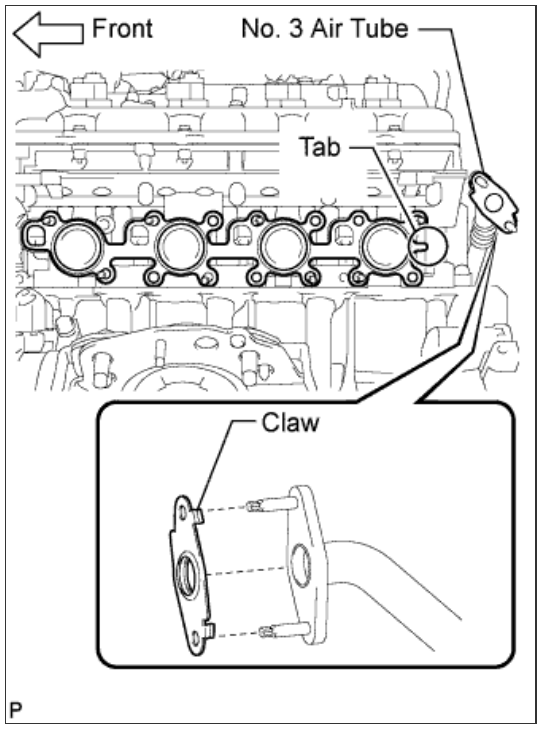


6. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. Install a new gasket to the cylinder head and a new gasket to the No. 3 air tube.

HINT:

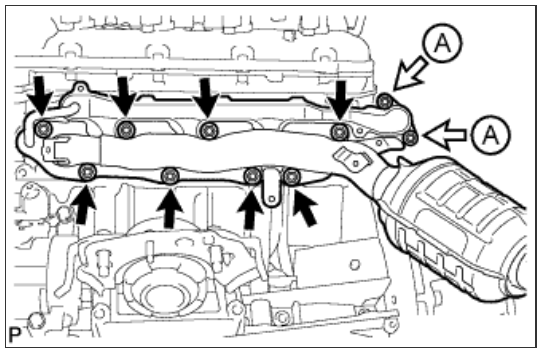
- **Install the exhaust manifold gasket with the gasket tab facing toward the rear of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



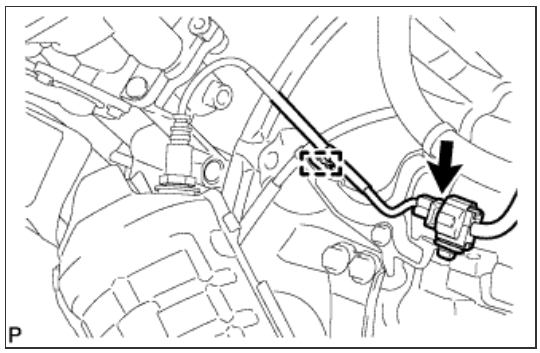
b. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

c. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



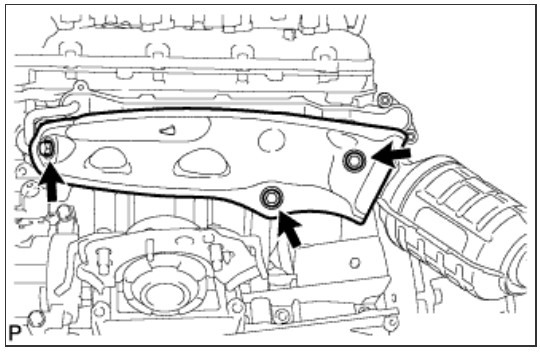
d. Attach the wire harness clamp to the bracket and connect the connector.



7. INSTALL NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

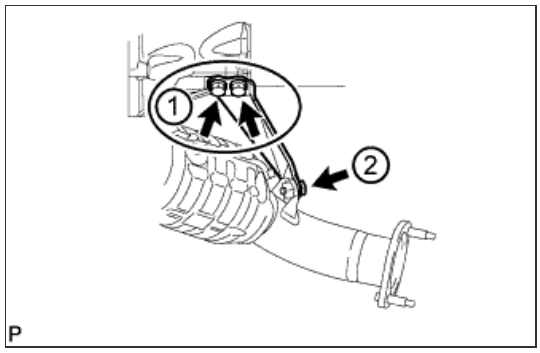


8. INSTALL NO. 2 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

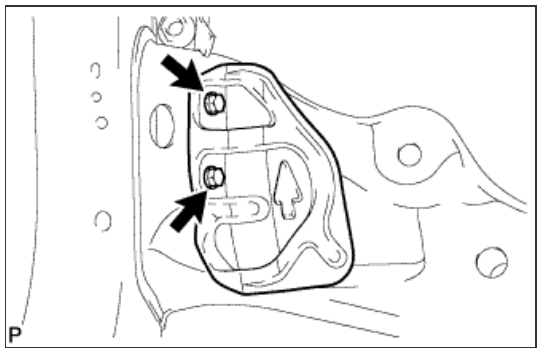
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



9. INSTALL PROPELLER SHAFT HEAT INSULATOR

a. Install the heat insulator with the 2 bolts.

Torque:
16 N*m{ 160 kgf*cm , 12 ft.*lbf }



10. INSTALL FRONT EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front exhaust pipe to the exhaust manifold RH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

11. INSTALL FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front No. 2 exhaust pipe to the exhaust manifold LH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

12. INSTALL CENTER EXHAUST PIPE ASSEMBLY

a. Install 2 new gaskets to the front exhaust pipe and front No. 2 exhaust pipe.

b. Install the center exhaust pipe to the 3 exhaust pipe supports, and then install the 4 bolts.

Torque:
48 N*m{ 489 kgf*cm , 35 ft.*lbf }

13. INSTALL TAILPIPE ASSEMBLY

a. Install the tailpipe to the 2 exhaust pipe supports.

b. Install a new gasket to the center exhaust pipe.

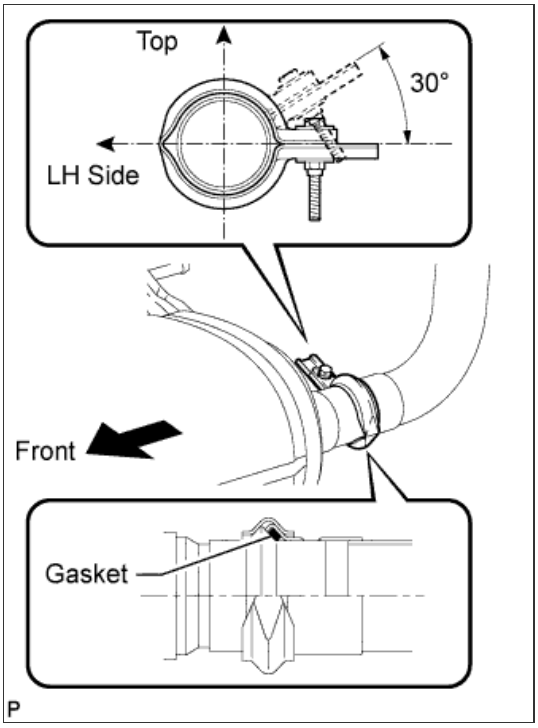
c. Connect the tailpipe to the center exhaust pipe.

d. Attach a new clamp to the tailpipe and center exhaust pipe. Then install the bolt to the clamp.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }

HINT:

Install the clamp within the angle range shown in the illustration.



14. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

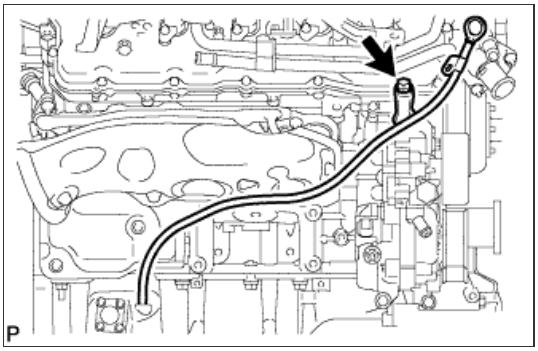
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

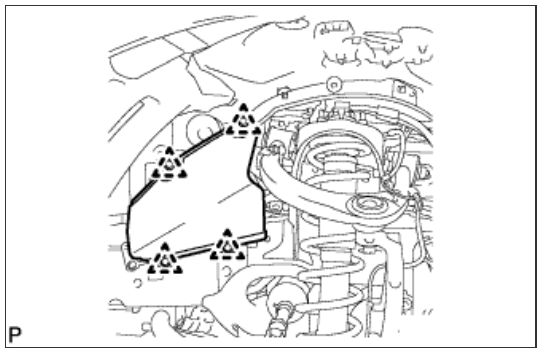
d. Install the dipstick.



15. INSPECT FOR EXHAUST GAS LEAK

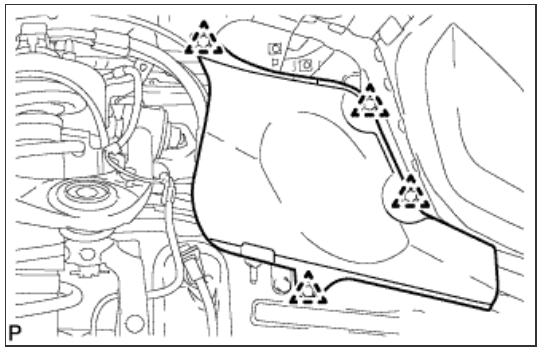
16. INSTALL FRONT FENDER APRON SEAL FRONT LH

a. Install the fender apron seal with the 4 clips.



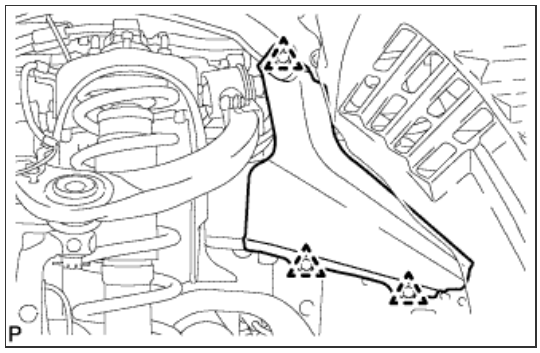
17. INSTALL FRONT FENDER APRON SEAL REAR LH

a. Install the fender apron seal with the 4 clips.



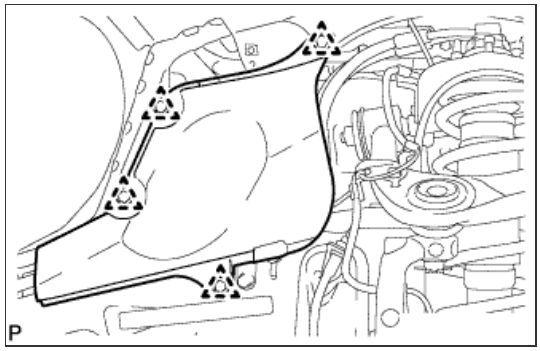
18. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



19. INSTALL FRONT FENDER APRON SEAL REAR RH

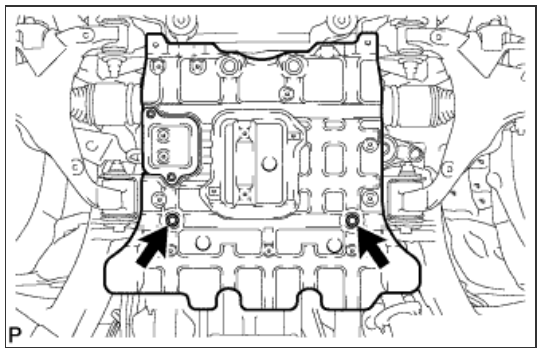
a. Install the fender apron seal with the 4 clips.



20. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

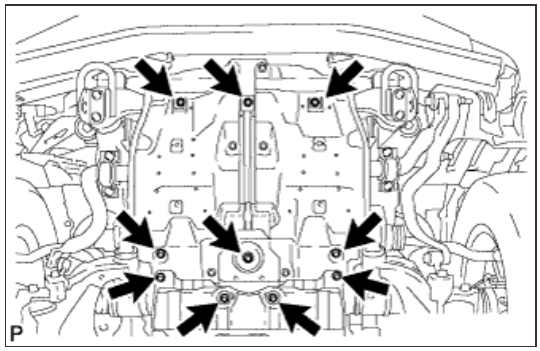
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



21. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

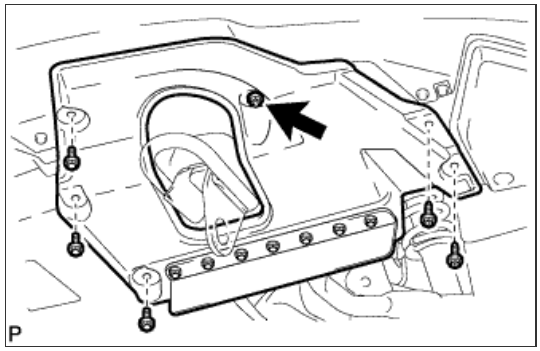
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



22. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



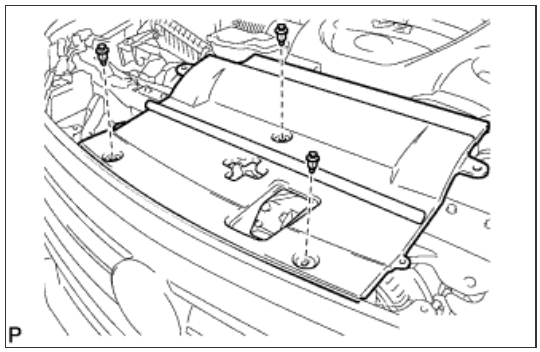
23. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

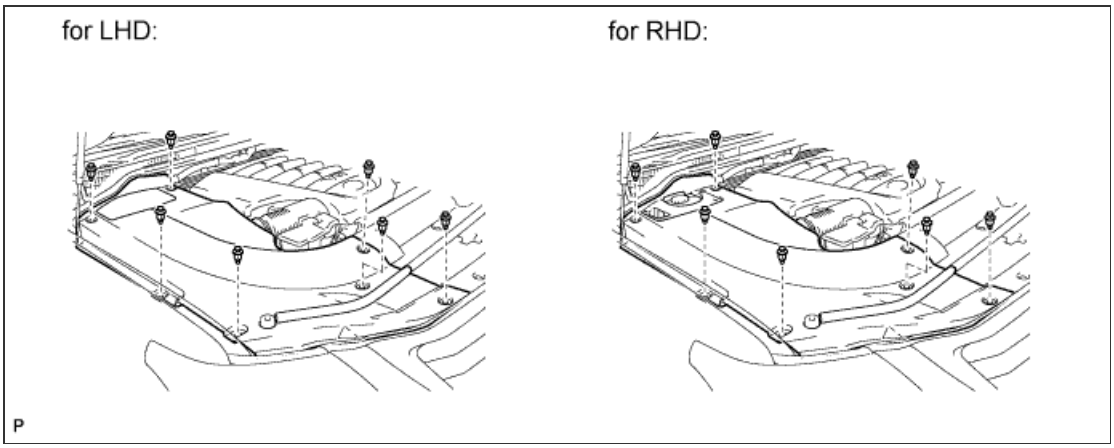
24. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



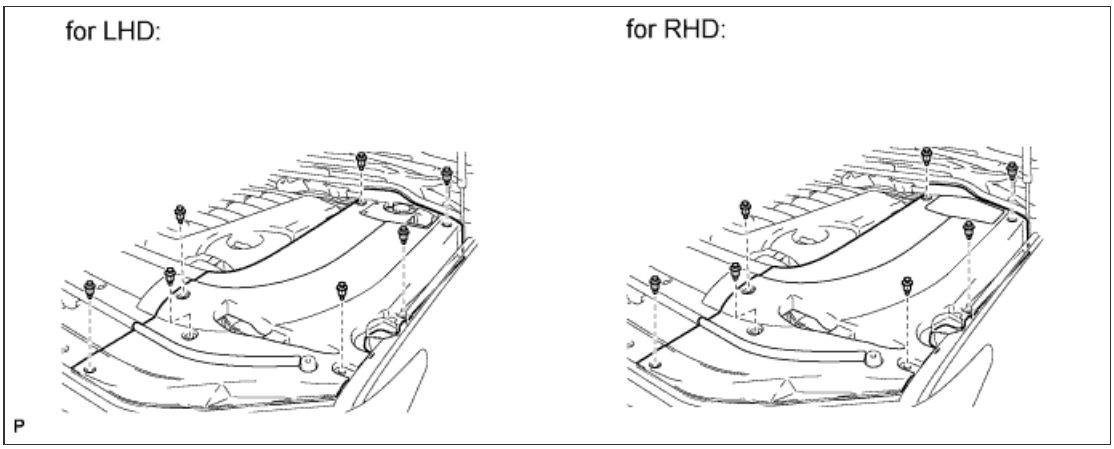
25. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



26. INSTALL ENGINE ROOM SIDE COVER LH

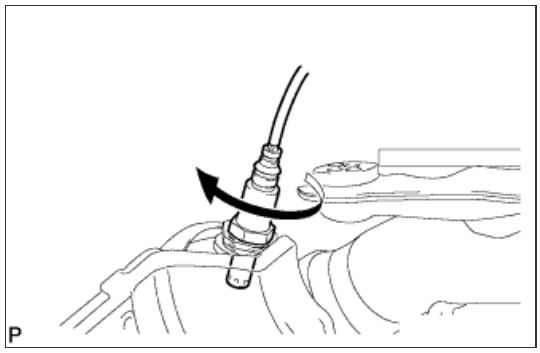
a. Install the engine room side cover with the 7 clips.



for Preparation Click here

1. INSTALL AIR FUEL RATIO SENSOR (for Bank 2 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



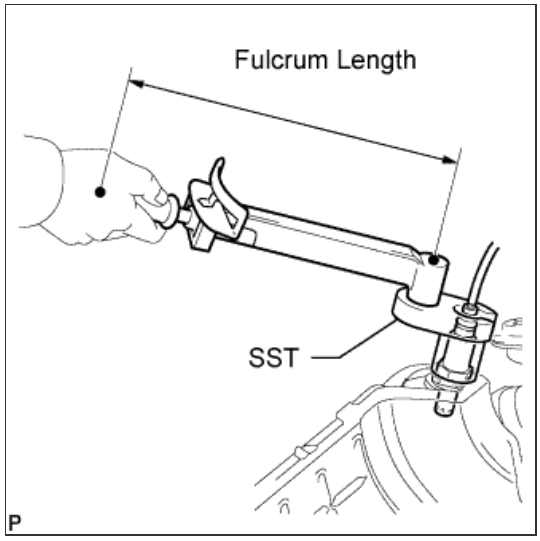
b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

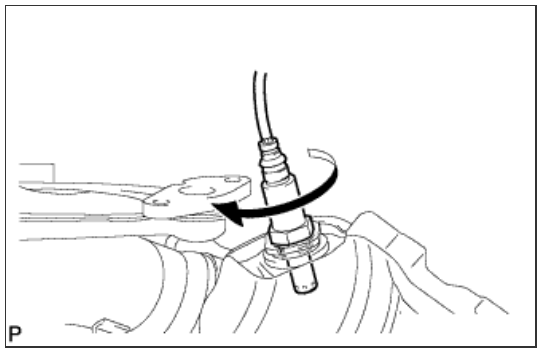
HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



2. INSTALL AIR FUEL RATIO SENSOR (for Bank 1 Sensor 1)

a. Temporarily install the sensor to the exhaust pipe by hand.



b. Using SST, tighten the sensor.

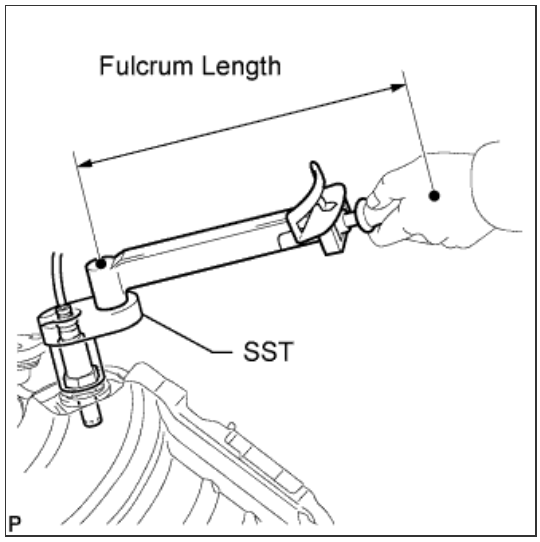
SST
09224-00010

Torque:
without SST:

44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



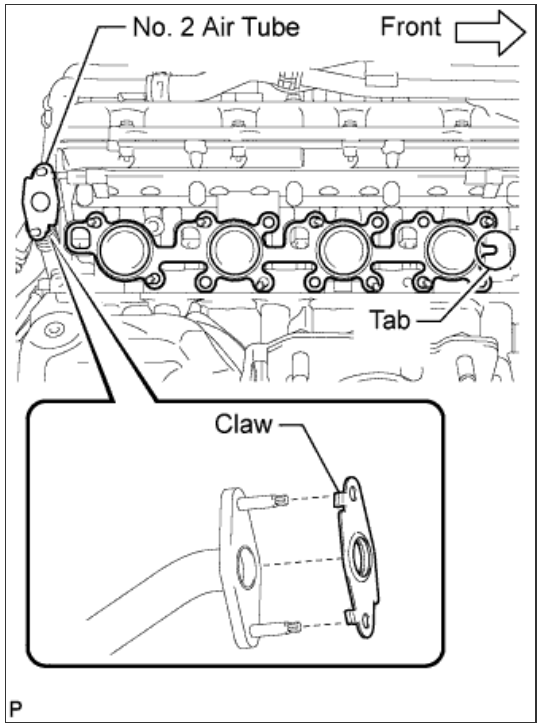
3. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. w/ Secondary Air Injection System:

i. Install a new gasket to the cylinder head and a new gasket to the No. 2 air tube.

HINT:

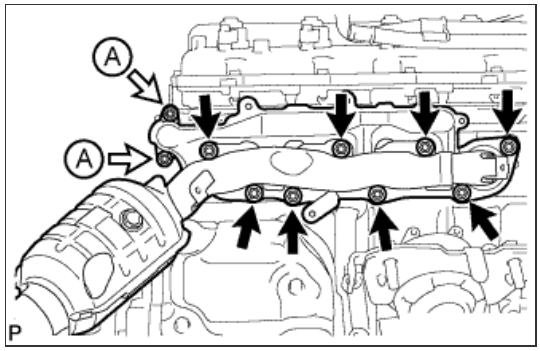
- **Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



ii. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

iii. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

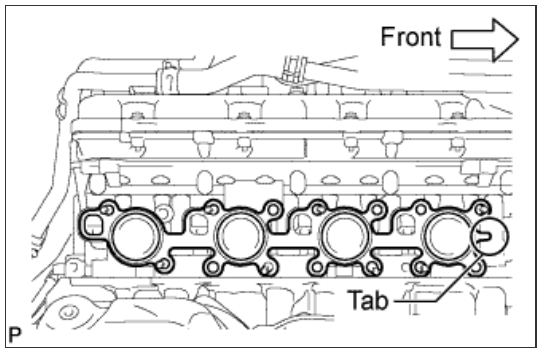


b. w/o Secondary Air Injection System:

i. Install a new gasket to the cylinder head.

HINT:

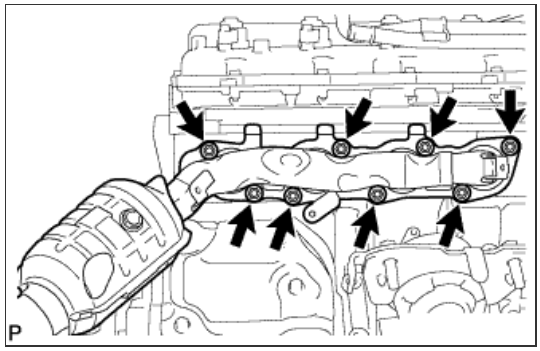
Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.



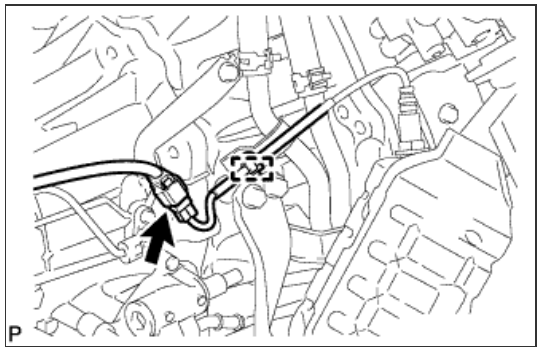
ii. Temporarily install the exhaust manifold with the 8 new nuts.

iii. Uniformly tighten the 8 nuts.

Torque:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



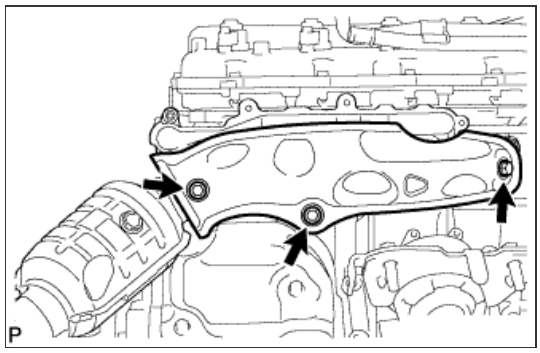
c. Attach the wire harness clamp to the bracket and connect the connector.



4. INSTALL NO. 1 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

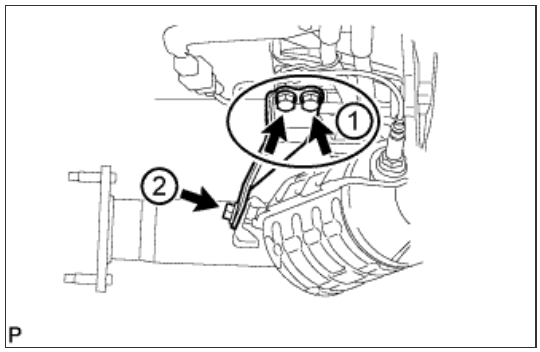


5. INSTALL NO. 1 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



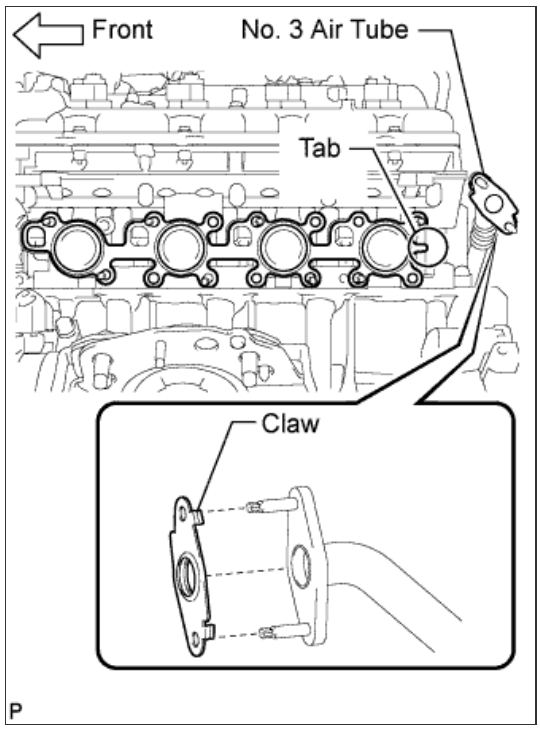
6. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY LH

a. w/ Secondary Air Injection System:

i. Install a new gasket to the cylinder head and a new gasket to the No. 3 air tube.

HINT:

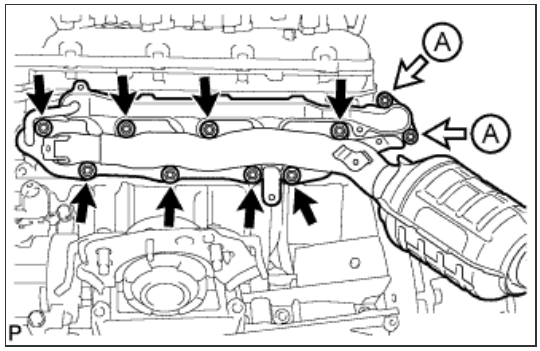
- **Install the exhaust manifold gasket with the gasket tab facing toward the rear of the engine.**
- **Install the air tube gasket with the gasket claws facing the tube side.**



ii. Temporarily install the exhaust manifold with the 2 nuts labeled A and 8 new nuts.

iii. Uniformly tighten the nuts that are not labeled A, and then tighten the 2 nuts labeled A.

Torque:
for nut A:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }
except nut A:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }

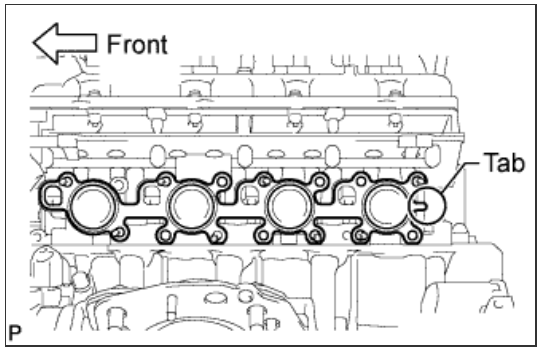


b. w/o Secondary Air Injection System:

i. Install a new gasket to the cylinder head.

HINT:

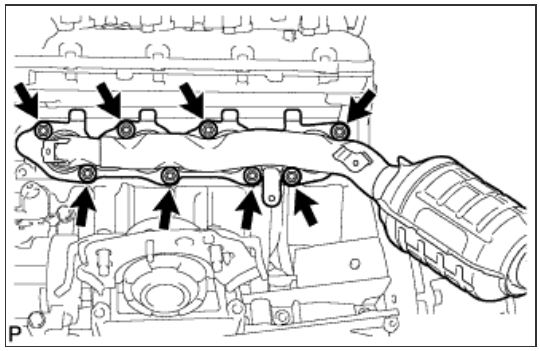
Install the exhaust manifold gasket with the gasket tab facing toward the front of the engine.



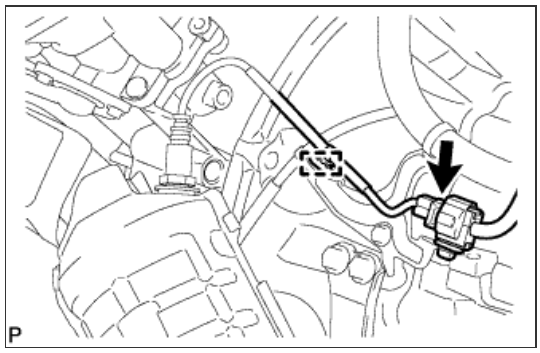
ii. Temporarily install the exhaust manifold with the 8 new nuts.

iii. Uniformly tighten the 8 nuts.

Torque:
30 N*m{ 306 kgf*cm , 22 ft.*lbf }



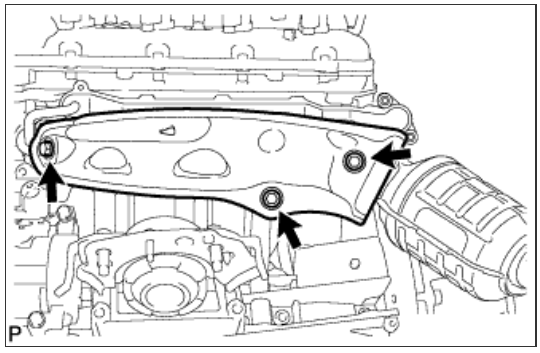
c. Attach the wire harness clamp to the bracket and connect the connector.



7. INSTALL NO. 2 EXHAUST MANIFOLD HEAT INSULATOR

a. Install the heat insulator with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

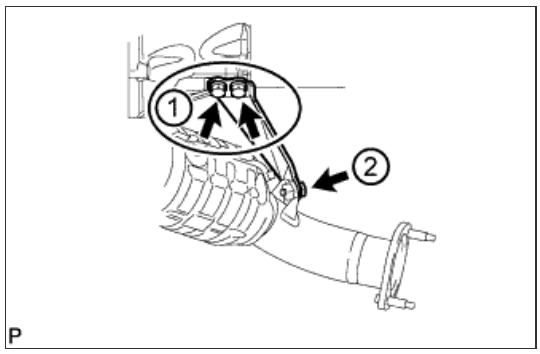


8. INSTALL NO. 2 MANIFOLD STAY

a. Temporarily install the manifold stay with the 3 bolts.

b. Tighten the 3 bolts in the order shown in the illustration.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

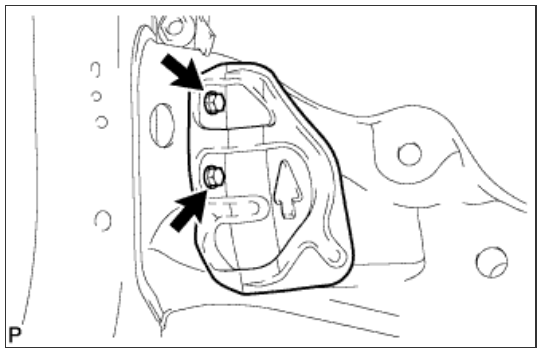


9. INSTALL PROPELLER SHAFT HEAT INSULATOR

a. Install the heat insulator with the 2 bolts.

d. Install the heat insulator with the 2 bolts.

Torque:
16 N*m{ 160 kgf*cm , 12 ft.*lbf }



10. INSTALL FRONT EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front exhaust pipe to the exhaust manifold RH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

11. INSTALL FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front No. 2 exhaust pipe to the exhaust manifold LH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

12. INSTALL CENTER EXHAUST PIPE ASSEMBLY

a. Install 2 new gaskets to the front exhaust pipe and front No. 2 exhaust pipe.

b. Install the center exhaust pipe to the 3 exhaust pipe supports, and then install the 4 bolts.

Torque:
48 N*m{ 489 kgf*cm , 35 ft.*lbf }

13. INSTALL TAILPIPE ASSEMBLY

a. Install the tailpipe to the 2 exhaust pipe supports.

b. Install a new gasket to the center exhaust pipe.

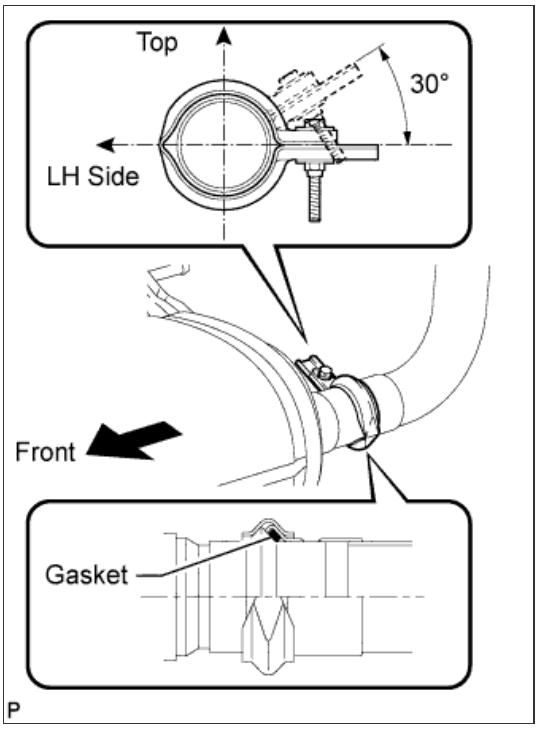
c. Connect the tailpipe to the center exhaust pipe.

d. Attach a new clamp to the tailpipe and center exhaust pipe. Then install the bolt to the clamp.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }

HINT:

Install the clamp within the angle range shown in the illustration.



14. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

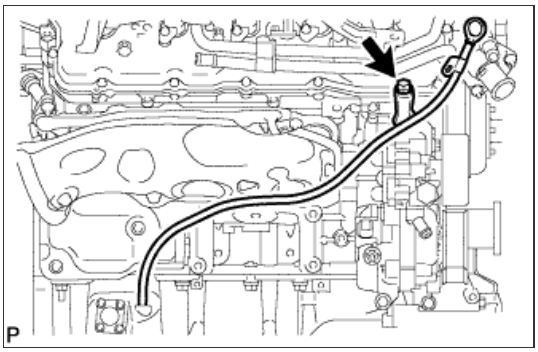
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

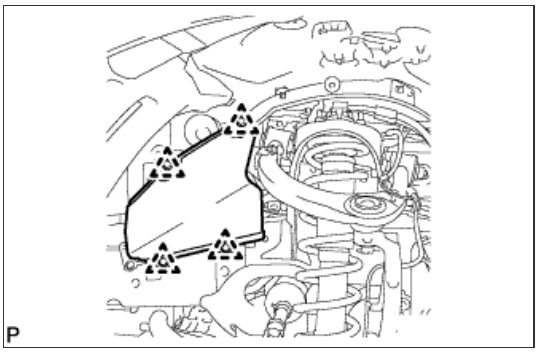
d. Install the dipstick.



15. INSPECT FOR EXHAUST GAS LEAK

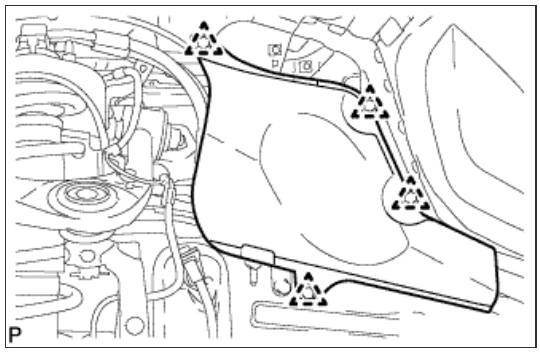
16. INSTALL FRONT FENDER APRON SEAL FRONT LH

a. Install the fender apron seal with the 4 clips.



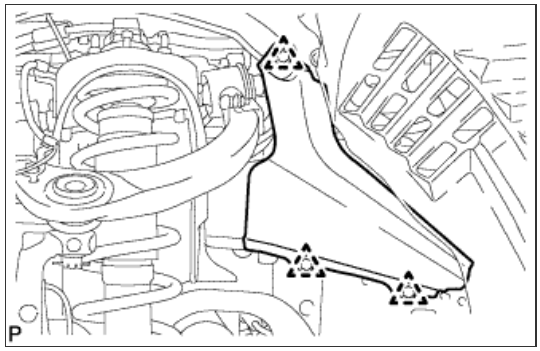
17. INSTALL FRONT FENDER APRON SEAL REAR LH

a. Install the fender apron seal with the 4 clips.



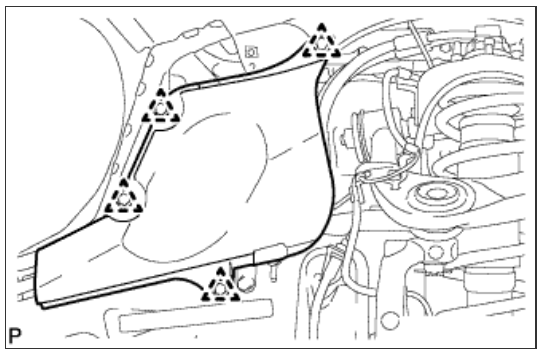
18. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



19. INSTALL FRONT FENDER APRON SEAL REAR RH

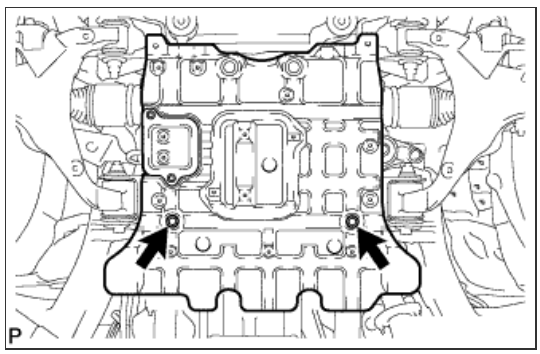
a. Install the fender apron seal with the 4 clips.



20. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

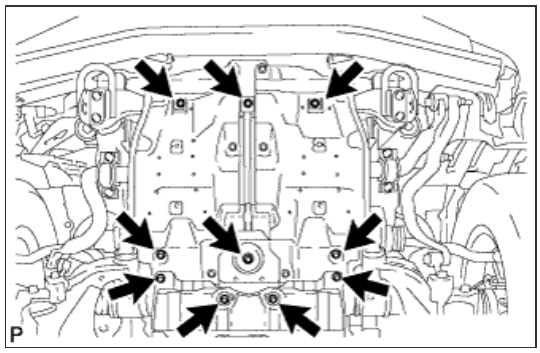
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



21. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

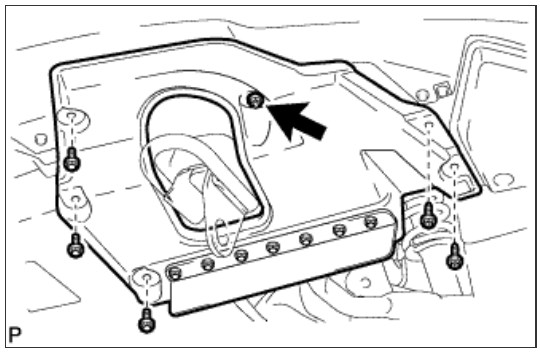
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



22. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



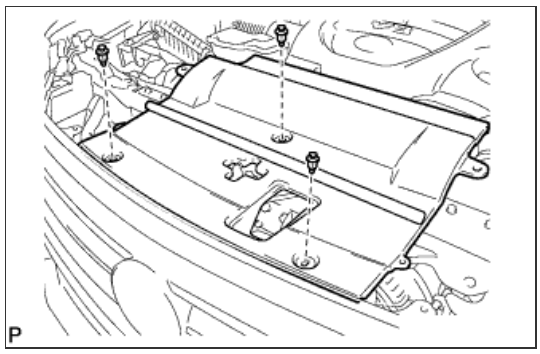
23. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

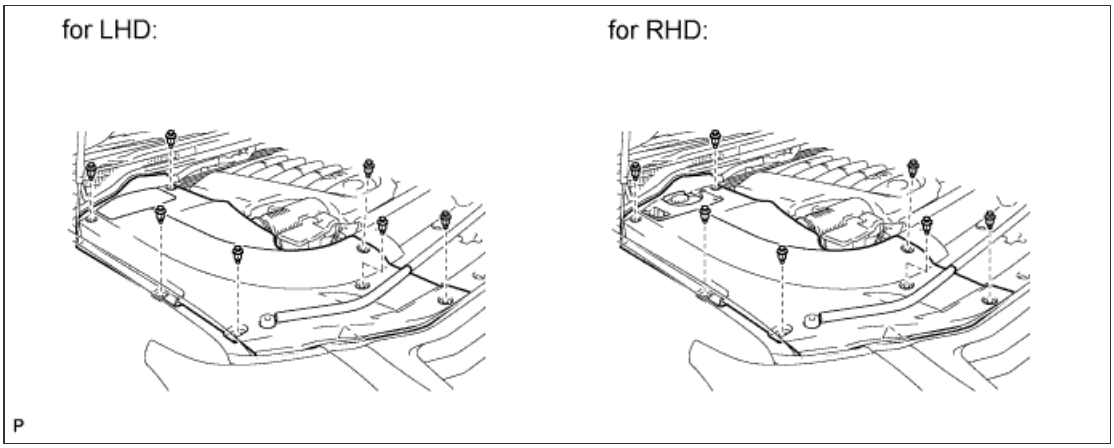
24. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



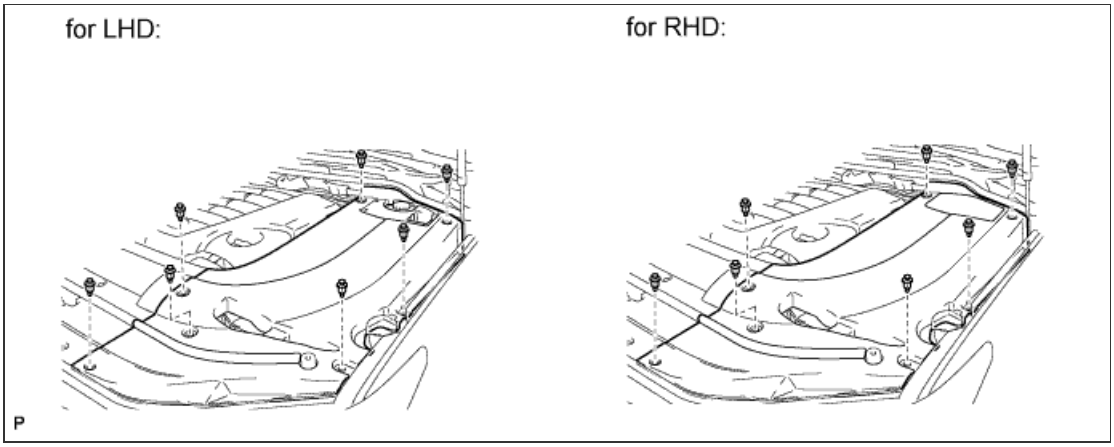
25. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

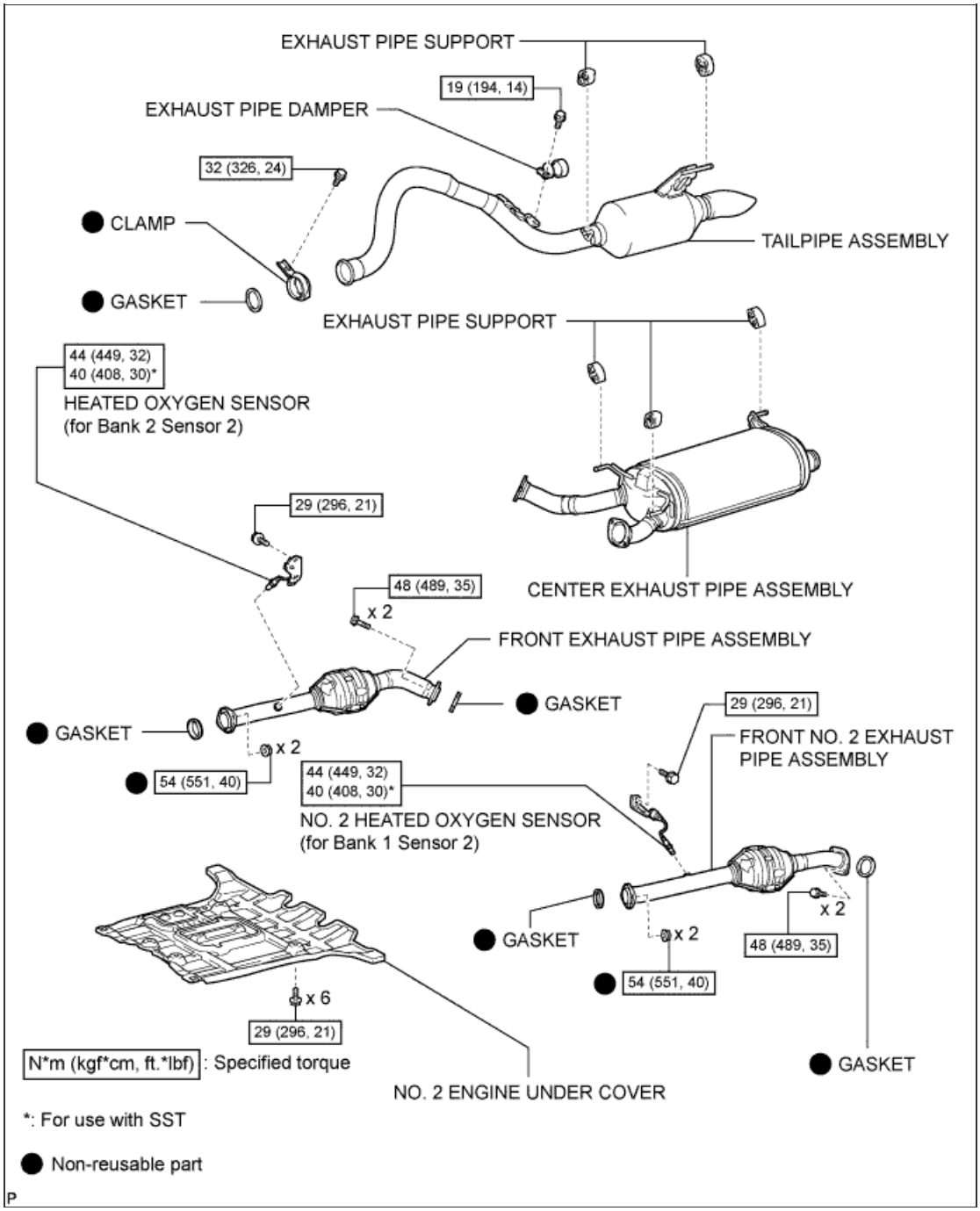


26. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



for Preparation Click here



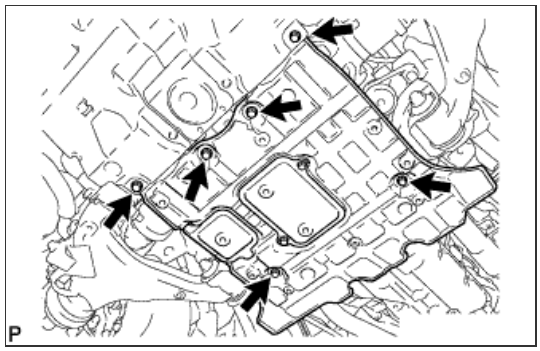
for Preparation Click here

CAUTION:

- **Wear protective gloves when removing the exhaust pipe.**
- **The exhaust pipe is extremely hot immediately after the engine has stopped.**
- **Confirm that the exhaust pipe has cooled down before removing it.**

1. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 6 bolts and under cover.



2. REMOVE TAILPIPE ASSEMBLY

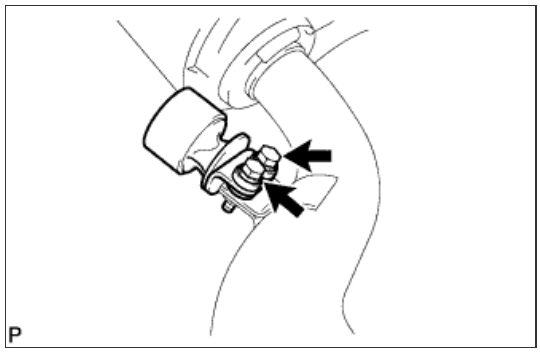
a. Remove the bolt, clamp and gasket.

b. Remove the tailpipe from the 2 exhaust pipe supports.

c. Remove the bolt and clamp, and then disconnect the tailpipe from the center exhaust pipe.

3. REMOVE EXHAUST PIPE DAMPER

a. Remove the 2 bolts and exhaust pipe damper from the tailpipe.



4. REMOVE CENTER EXHAUST PIPE ASSEMBLY

a. Remove the 4 bolts.

b. Remove the center exhaust pipe from the 3 exhaust pipe supports.

c. Remove the 2 gaskets from the front exhaust pipe and front No. 2 exhaust pipe.

5. REMOVE FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front No. 2 exhaust pipe and gasket from the exhaust manifold LH.

6. REMOVE FRONT EXHAUST PIPE ASSEMBLY

a. Disconnect the heated oxygen sensor connector.

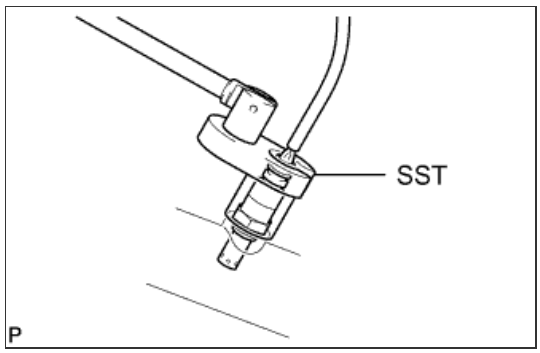
b. Remove the bolt and disconnect the wire harness clamp bracket of the oxygen sensor from the transmission.

c. Remove the 2 nuts, front exhaust pipe and gasket from the exhaust manifold RH.

7. REMOVE NO. 2 HEATED OXYGEN SENSOR (for Bank 1 Sensor 2)

a. Using SST, remove the sensor.

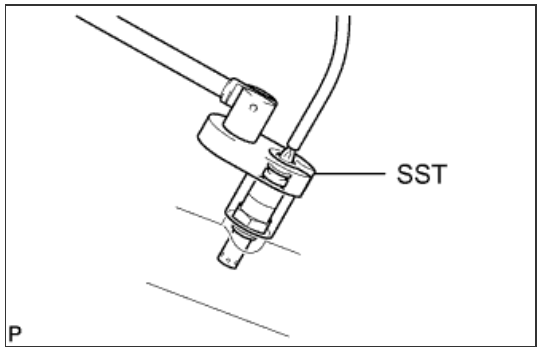
SST
09224-00010



8. REMOVE HEATED OXYGEN SENSOR (for Bank 2 Sensor 2)

a. Using SST, remove the sensor.

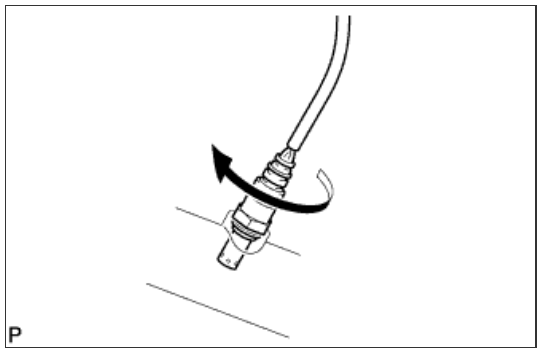
SST
09224-00010



for Preparation Click here

1. INSTALL NO. 2 HEATED OXYGEN SENSOR (for Bank 1 Sensor 2)

a. Temporarily install the sensor to the exhaust pipe by hand.



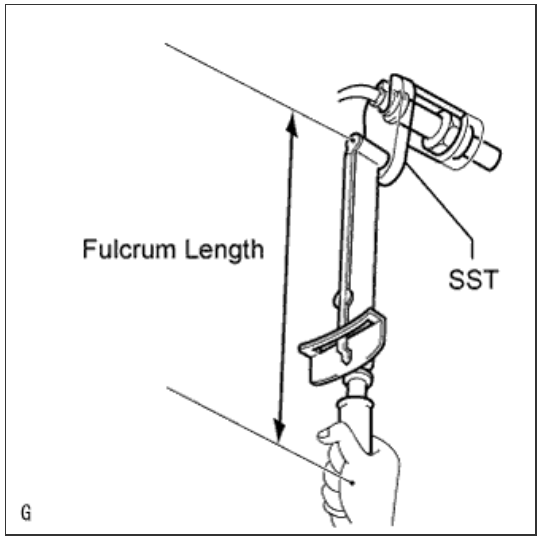
b. Using SST, tighten the sensor.

SST
09224-00010

Torque:
without SST:
44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

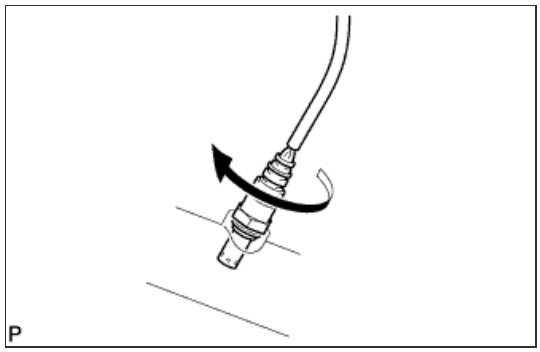
HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



2. INSTALL HEATED OXYGEN SENSOR (for Bank 2 Sensor 2)

a. Temporarily install the sensor to the exhaust pipe by hand.



b. Using SST, tighten the sensor.

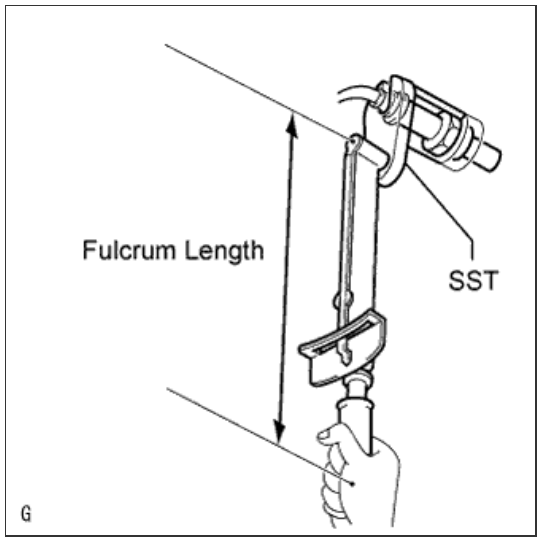
SST
09224-00010

Torque:
without SST:

44 N*m{ 449 kgf*cm , 32 ft.*lbf }
with SST:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

HINT:

- **Use a torque wrench with a fulcrum length of 300 mm (11.8 in.). If using a torque wrench with a length that is not 300 mm (11.8 in.), calculate the torque specification for the torque wrench and SST based on the "without SST" torque specification (Click here).**
- **Make sure SST and the wrench are connected in a straight line.**



3. INSTALL FRONT EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front exhaust pipe to the exhaust manifold RH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

4. INSTALL FRONT NO. 2 EXHAUST PIPE ASSEMBLY

a. Install a new gasket and the front No. 2 exhaust pipe to the exhaust manifold LH with 2 new nuts.

Torque:
54 N*m{ 551 kgf*cm , 40 ft.*lbf }

b. Install the wire harness clamp bracket of the oxygen sensor to the transmission with the bolt.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }

c. Connect the heated oxygen sensor connector.

5. INSTALL CENTER EXHAUST PIPE ASSEMBLY

a. Install 2 new gaskets to the front exhaust pipe and front No. 2 exhaust pipe.

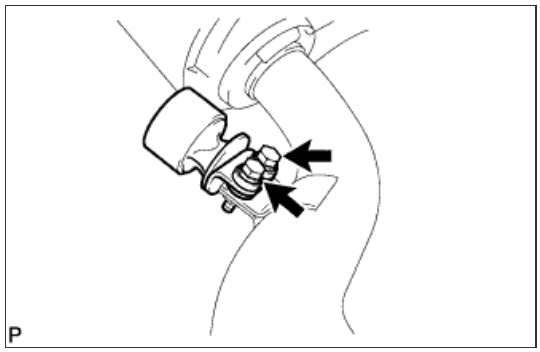
b. Install the center exhaust pipe to the 3 exhaust pipe supports, and then install the 4 bolts.

Torque:
48 N*m{ 489 kgf*cm , 35 ft.*lbf }

6. INSTALL EXHAUST PIPE DAMPER

a. Install the exhaust pipe damper to the tailpipe with the 2 bolts.

Torque:
19 N*m{ 194 kgf*cm , 14 ft.*lbf }



7. INSTALL TAILPIPE ASSEMBLY

a. Install the tailpipe to the 2 exhaust pipe supports.

b. Install a new gasket to the center exhaust pipe.

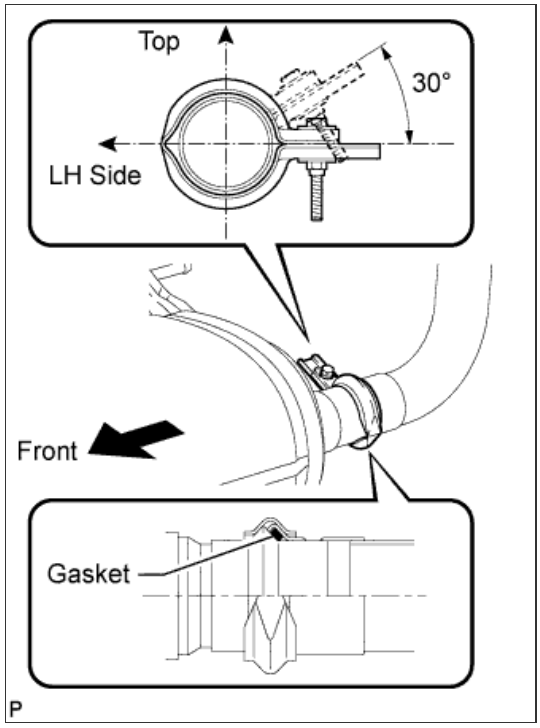
c. Connect the tailpipe to the center exhaust pipe.

d. Attach a new clamp to the tailpipe and center exhaust pipe. Then install the bolt to the clamp.

Torque:
32 N*m{ 326 kgf*cm , 24 ft.*lbf }

HINT:

Install the clamp within the angle range shown in the illustration.

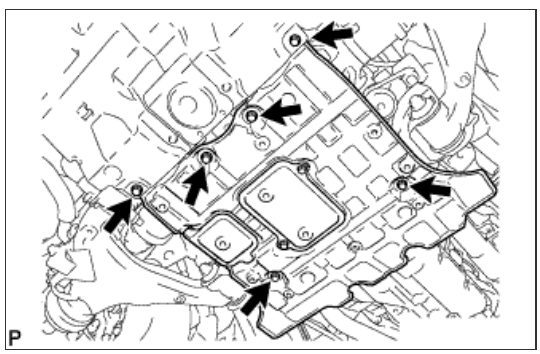


8. INSPECT FOR EXHAUST GAS LEAK

9. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the under cover with the 6 bolts.

Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



for Preparation Click here

CAUTION:

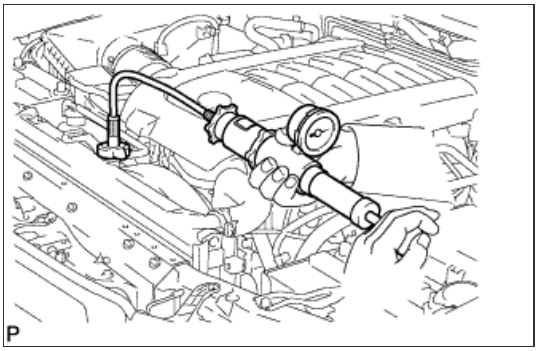
Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

1. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



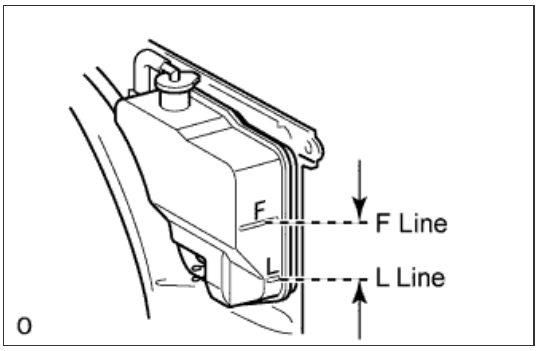
2. INSPECT ENGINE COOLANT LEVEL

a. Check that the engine coolant level is between the L and F lines when the engine is cold.
If the engine coolant is below the L line, check for leaks and add "TOYOTA Super Long Life Coolant" or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology to the F line.

NOTICE:

Do not substitute plain water for engine coolant.

b. Remove the radiator cap, and check that the coolant level is up to the radiator filler hole.



3. INSPECT ENGINE COOLANT QUALITY

a. Remove the radiator cap.

b. Check if there are any excessive deposits of rust or scales around the radiator cap and radiator filler hole. Also, the coolant should be free of oil.
If excessively dirty, clean the coolant passage and replace the coolant.

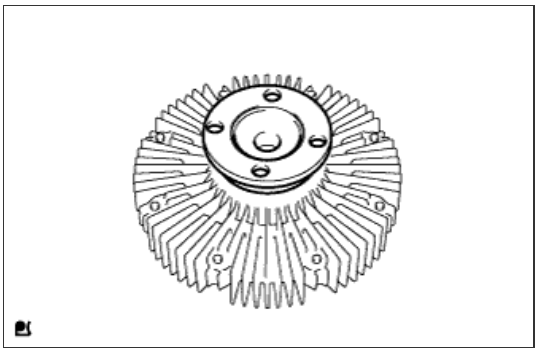
c. Install the radiator cap.

4. INSPECT FLUID COUPLING ASSEMBLY

a. Check the turning smoothness of the fluid coupling.
If necessary, replace the fluid coupling assembly.

b. Check the fluid coupling for damage or silicon oil leaks.

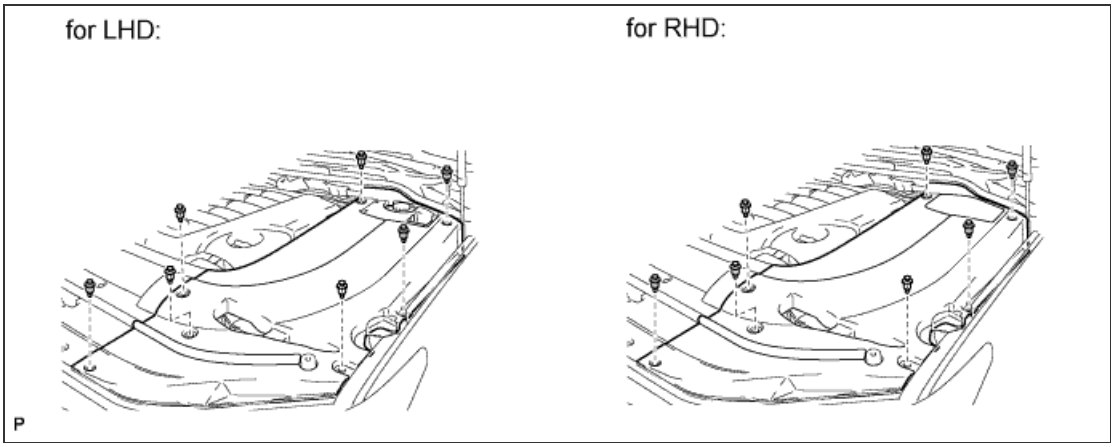
If necessary, replace the fluid coupling assembly.



for Preparation Click here

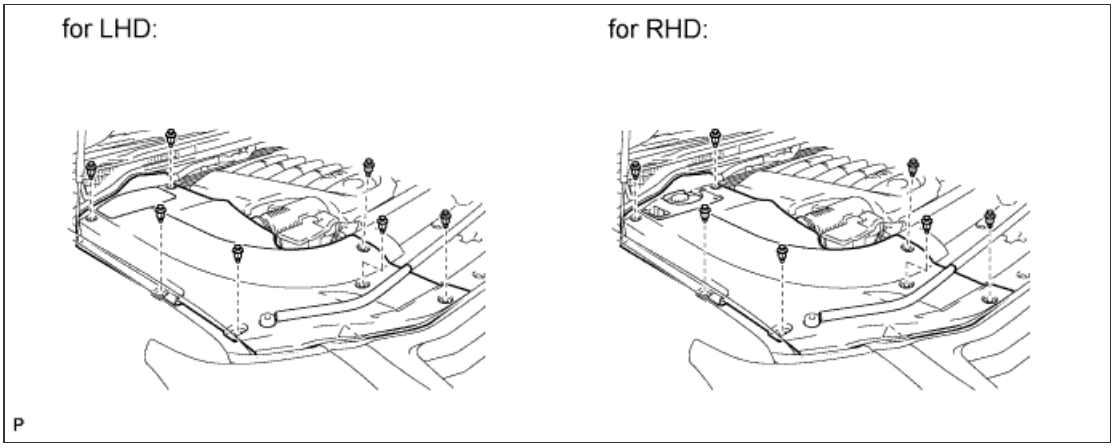
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



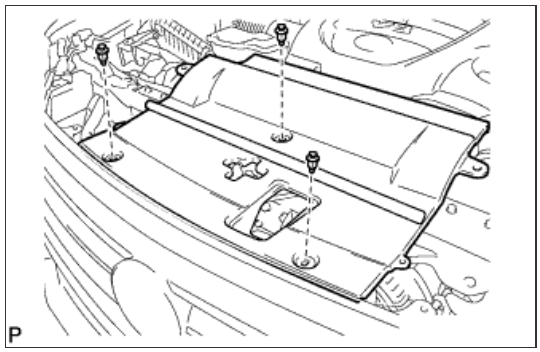
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

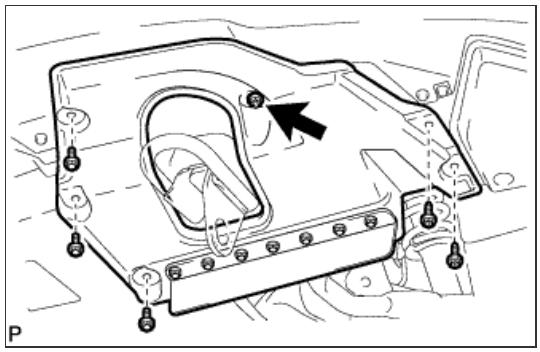
a. Remove the 3 clips and upper radiator support seal.



4. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



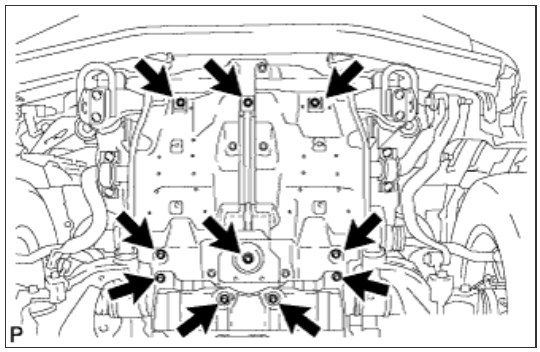
5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

6. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

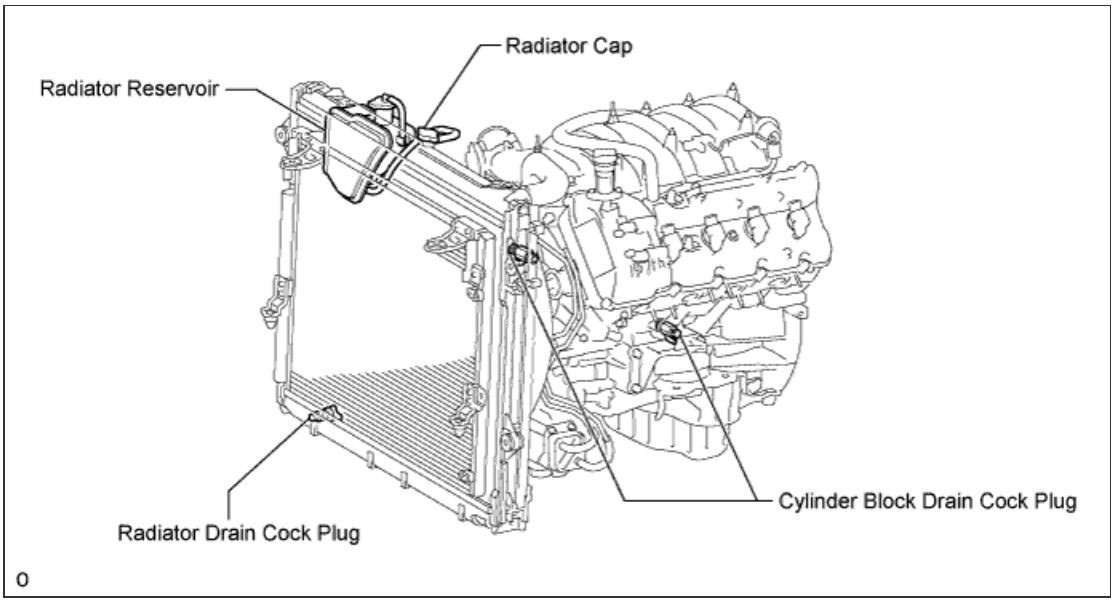
a. Remove the 10 bolts and No. 1 engine under cover.



7. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

e. Tighten the radiator drain cock plug by hand.

8. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

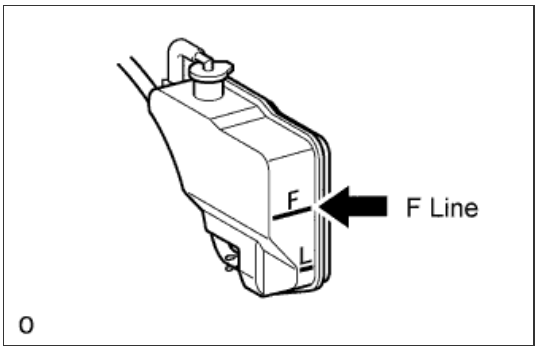
NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**



h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

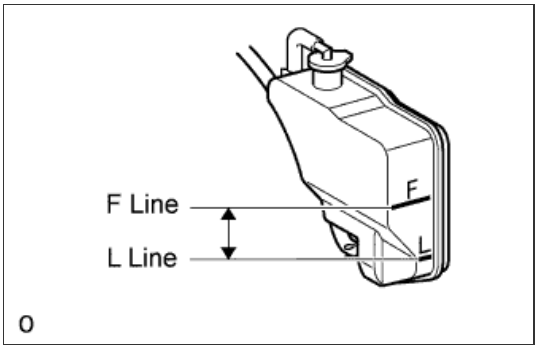
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

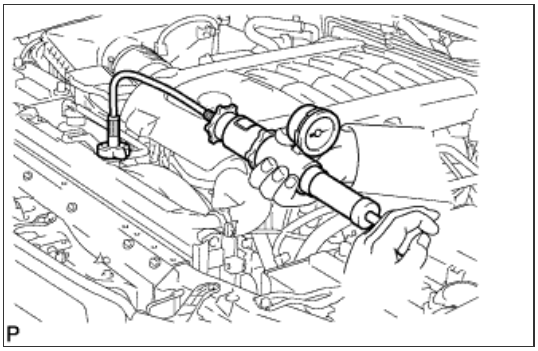


9. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

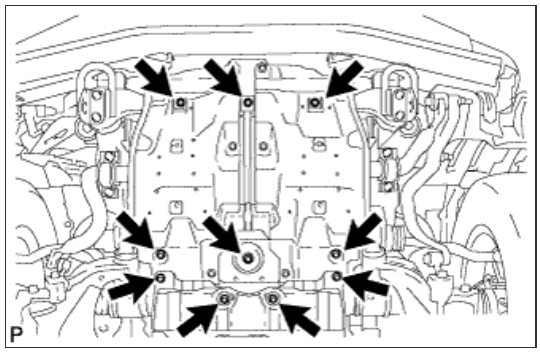
c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



10. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

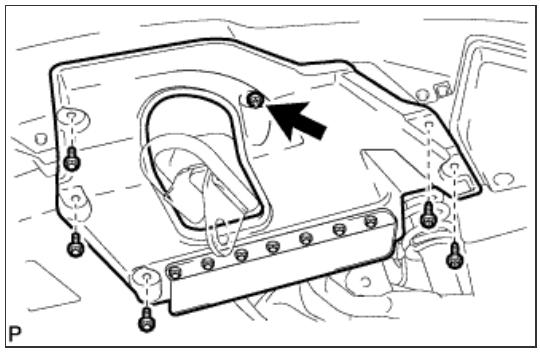
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



11. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



12. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

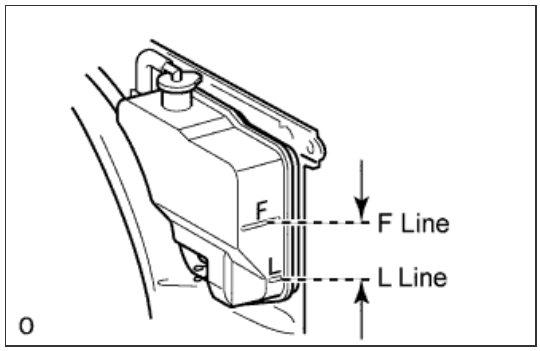
13. INSPECT ENGINE COOLANT LEVEL

a. Check that the engine coolant level is between the L and F lines when the engine is cold.
If the engine coolant is below the L line, check for leaks and add "TOYOTA Super Long Life Coolant" or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology to the F line.

NOTICE:

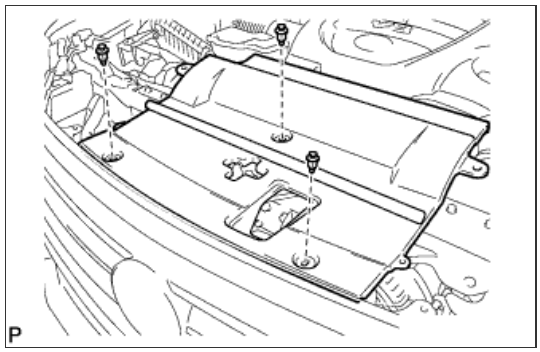
Do not substitute plain water for engine coolant.

b. Remove the radiator cap, and check that the coolant level is up to the radiator filler hole.



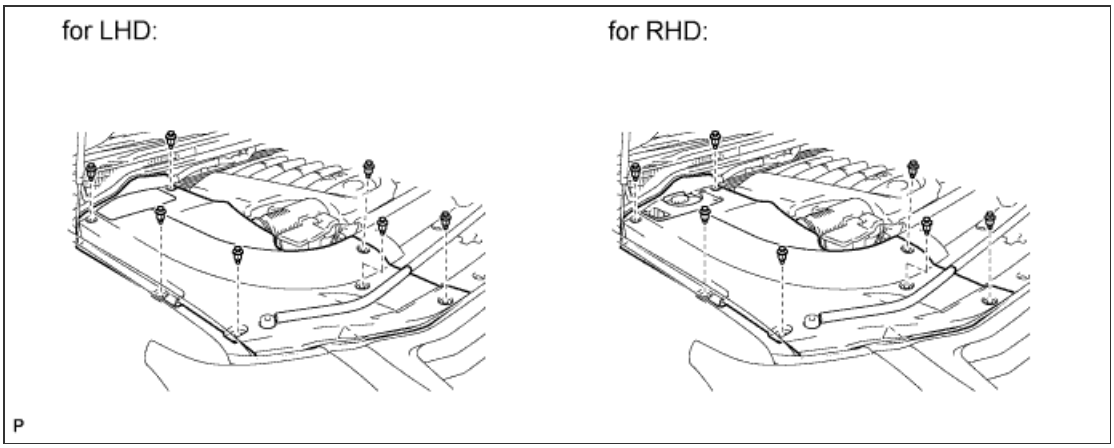
14. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



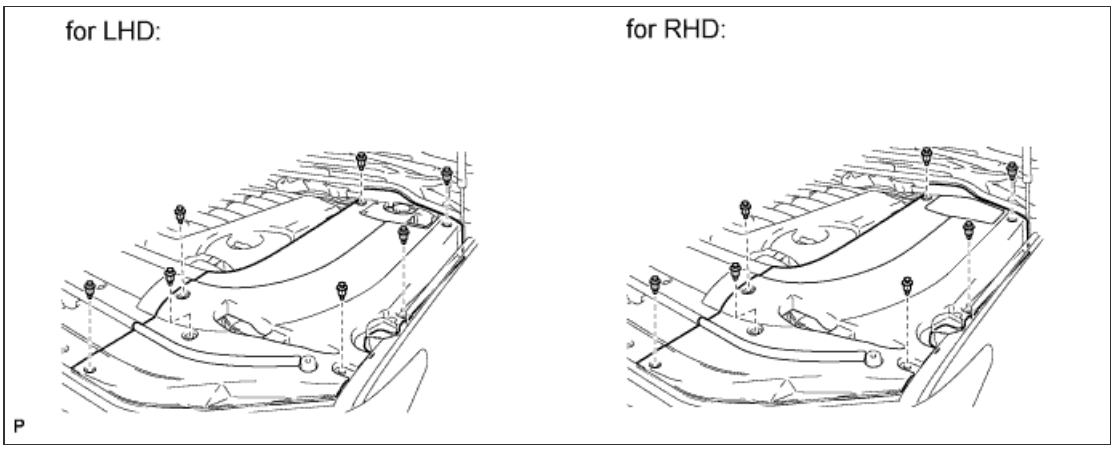
15. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

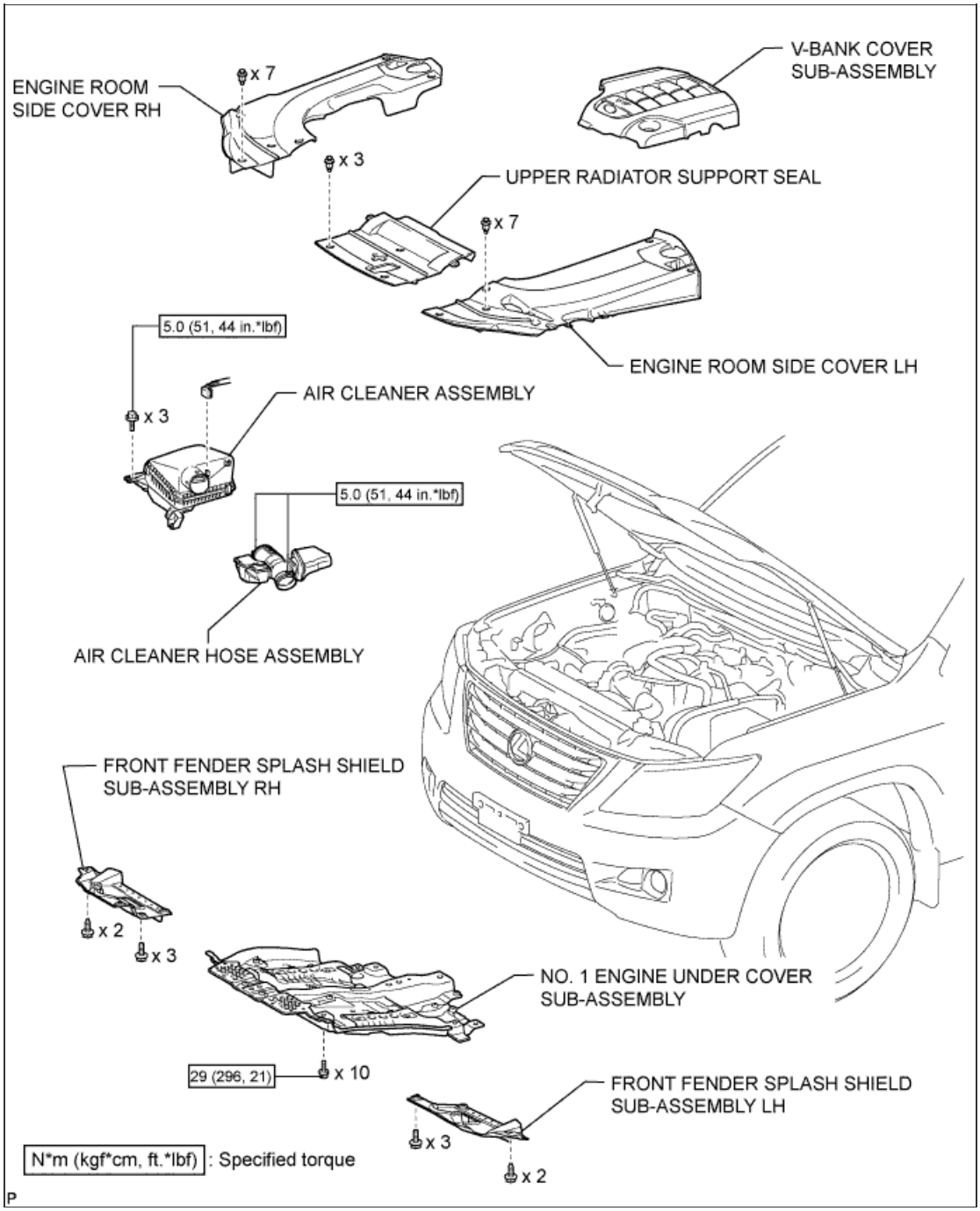


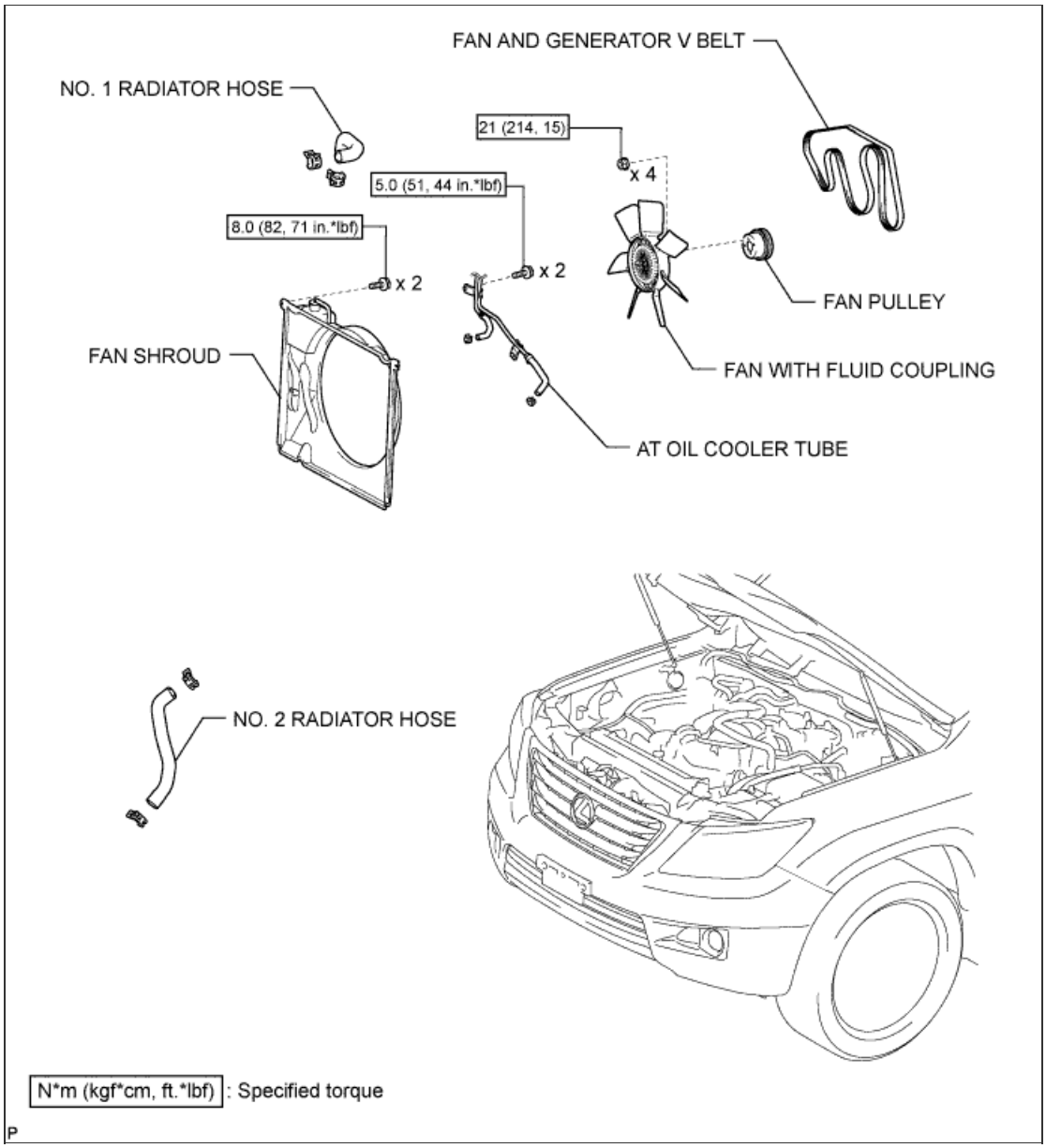
16. INSTALL ENGINE ROOM SIDE COVER LH

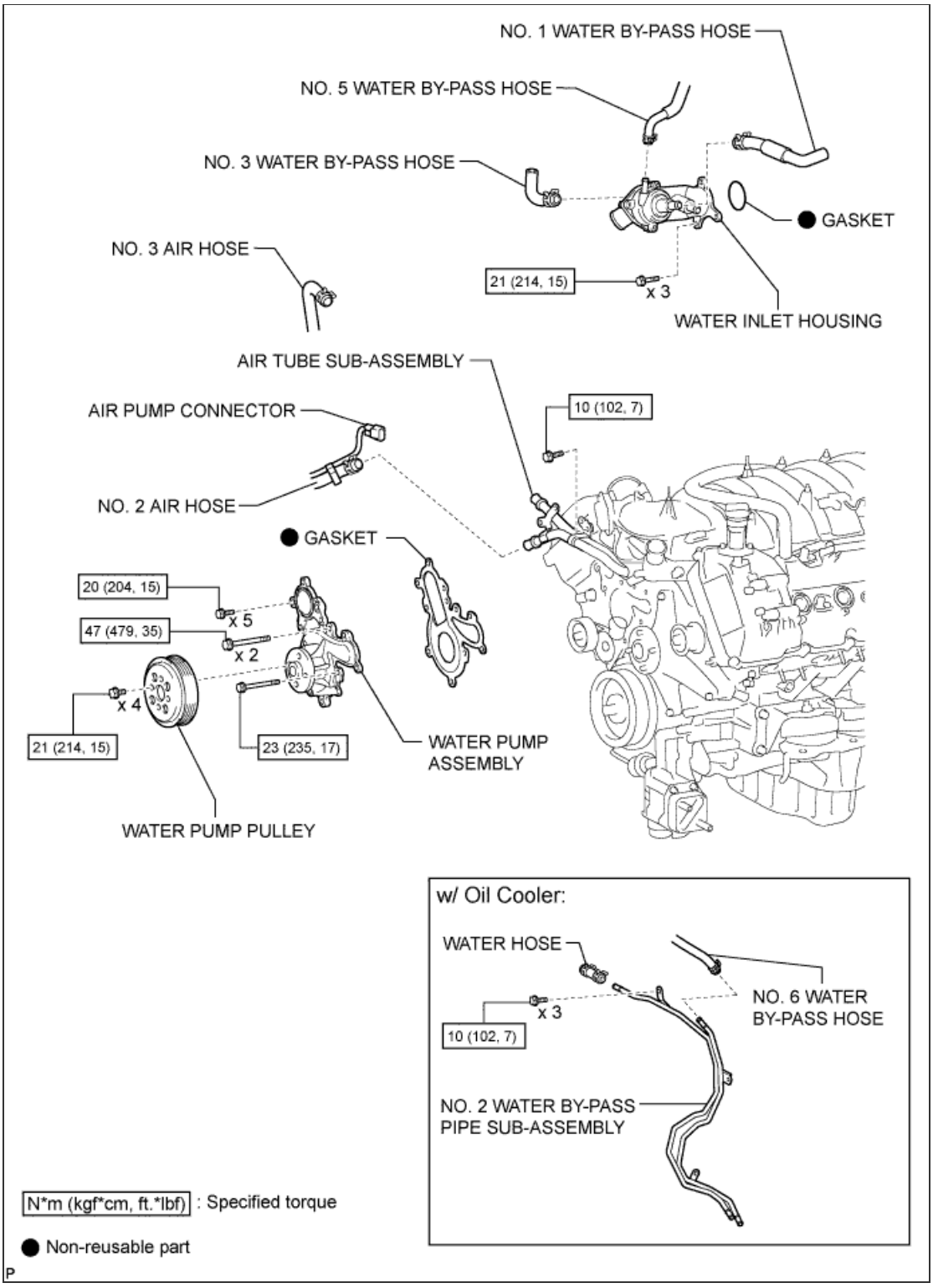
a. Install the engine room side cover with the 7 clips.



for Preparation Click here

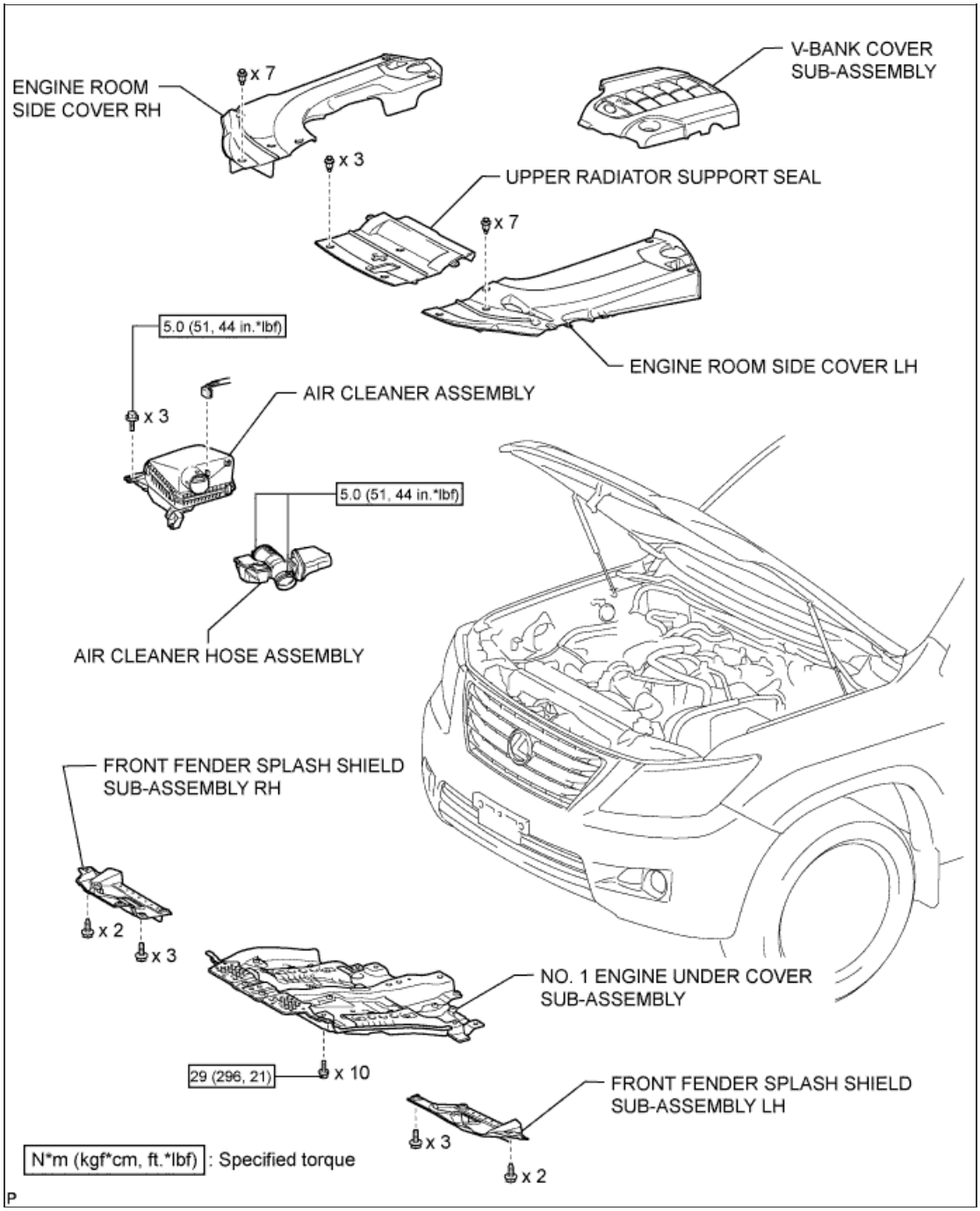


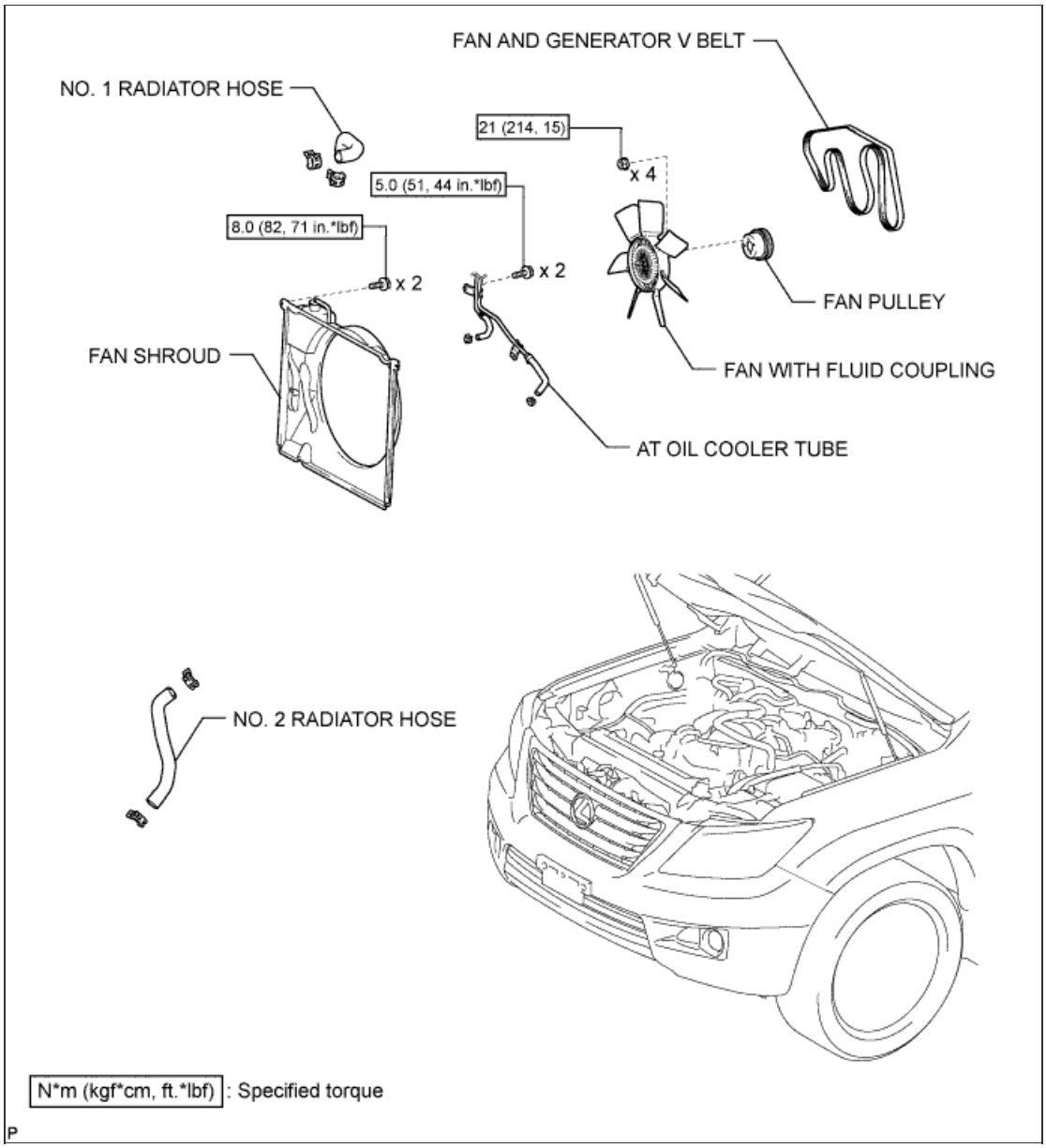

FAN AND GENERATOR V BELT
NO. 1 RADIATOR HOSE
21 (214, 15)
x 4
5.0 (51, 44 in.*lbf)
8.0 (82, 71 in.*lbf)
x 2
x 2
FAN PULLEY
FAN SHROUD
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P

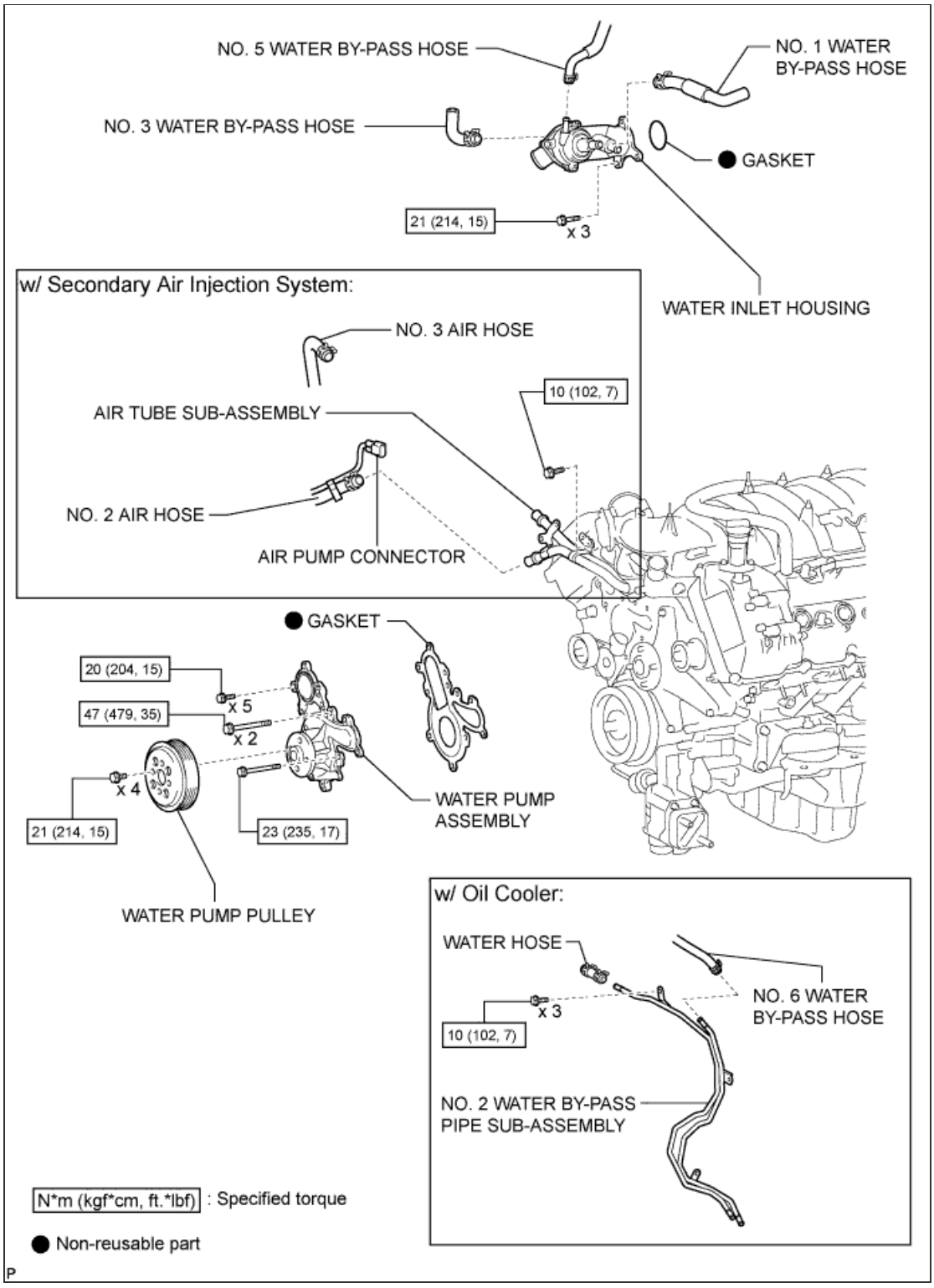

NO. 1 WATER BY-PASS HOSE
NO. 5 WATER BY-PASS HOSE
NO. 3 WATER BY-PASS HOSE
GASKET
NO. 3 AIR HOSE
21 (214, 15)
x 3
WATER INLET HOUSING
AIR TUBE SUB-ASSEMBLY
10 (102, 7)
AIR PUMP CONNECTOR
NO. 2 AIR HOSE
GASKET
20 (204, 15)
x 5
47 (479, 35)
x 2
x 4
21 (214, 15)
23 (235, 17)
WATER PUMP ASSEMBLY
WATER PUMP PULLEY
w/ Oil Cooler:
WATER HOSE
x 3
10 (102, 7)
NO. 6 WATER BY-PASS HOSE
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

P

for Preparation Click here



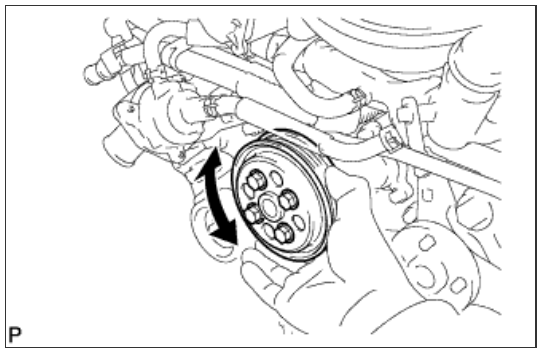

FAN AND GENERATOR V BELT
NO. 1 RADIATOR HOSE
21 (214, 15)
x 4
5.0 (51, 44 in.*lbf)
8.0 (82, 71 in.*lbf)
x 2
x 2
FAN PULLEY
FAN SHROUD
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P


NO. 5 WATER BY-PASS HOSE
NO. 1 WATER BY-PASS HOSE
NO. 3 WATER BY-PASS HOSE
GASKET
21 (214, 15)
x 3
WATER INLET HOUSING
w/ Secondary Air Injection System:
NO. 3 AIR HOSE
10 (102, 7)
AIR TUBE SUB-ASSEMBLY
NO. 2 AIR HOSE
AIR PUMP CONNECTOR
GASKET
20 (204, 15)
x 5
47 (479, 35)
x 2
x 4
21 (214, 15)
23 (235, 17)
WATER PUMP ASSEMBLY
WATER PUMP PULLEY
w/ Oil Cooler:
WATER HOSE
x 3
10 (102, 7)
NO. 6 WATER BY-PASS HOSE
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

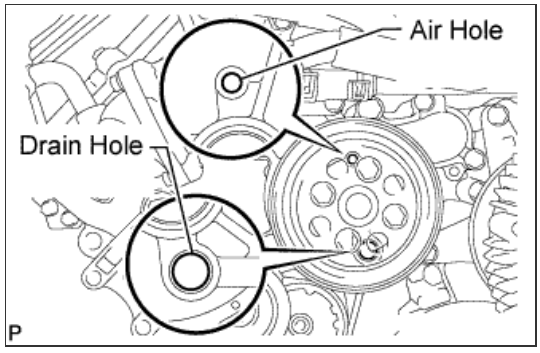
for Preparation Click here

1. INSPECT WATER PUMP ASSEMBLY

a. Turn the pulley and check that the water pump bearing moves smoothly and quietly.
If necessary, replace the water pump assembly.



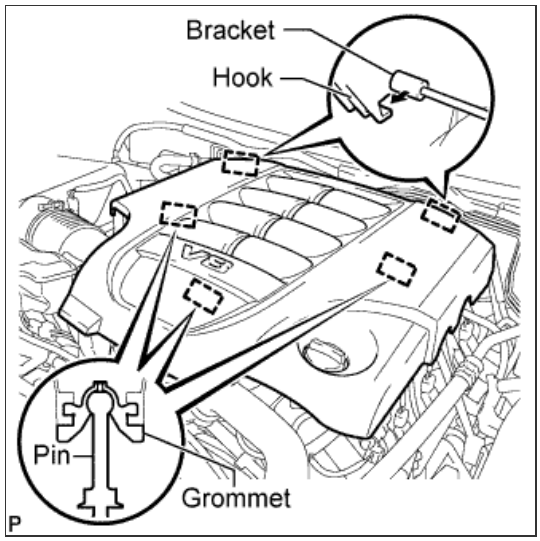
b. Visually check the air hole and drain hole for coolant leakage.
If leakage is found, replace the water pump assembly.



for Preparation Click here

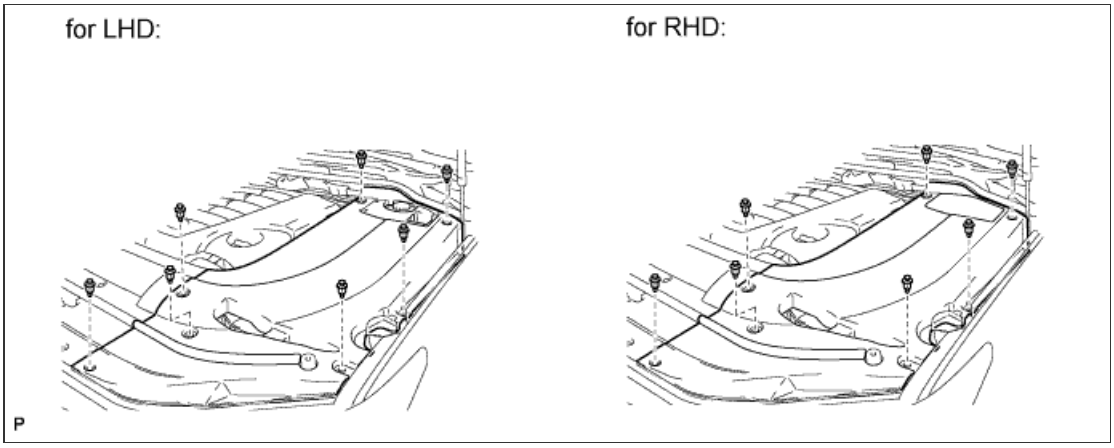
1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



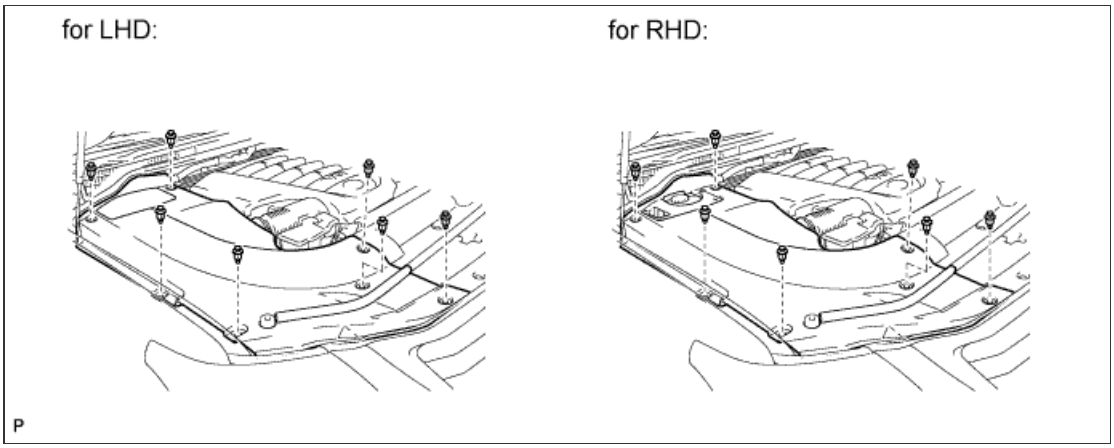
2. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



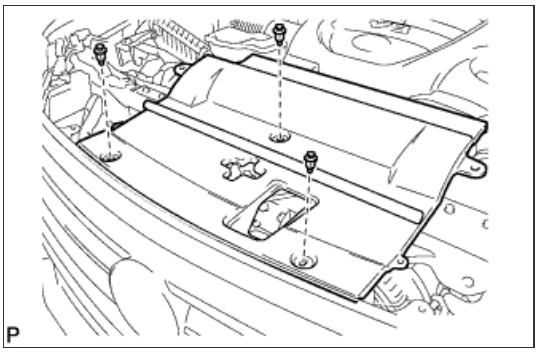
3. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



4. REMOVE UPPER RADIATOR SUPPORT SEAL

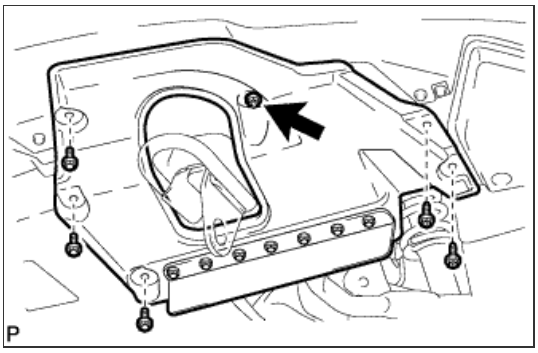
a. Remove the 3 clips and upper radiator support seal.



5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



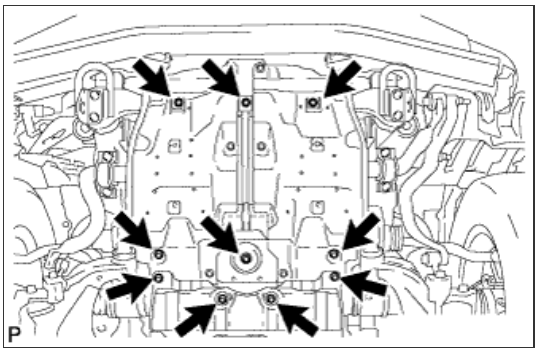
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

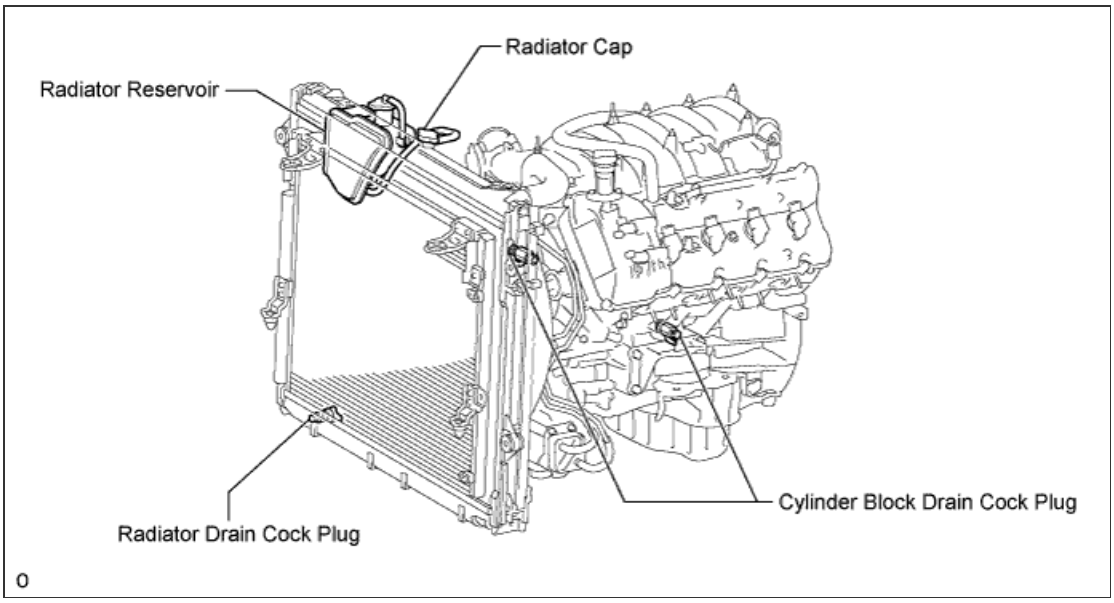
a. Remove the 10 bolts and No. 1 engine under cover.



8. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

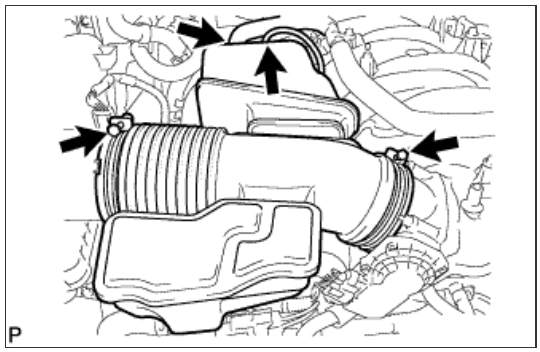
e. Tighten the radiator drain cock plug by hand.

9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

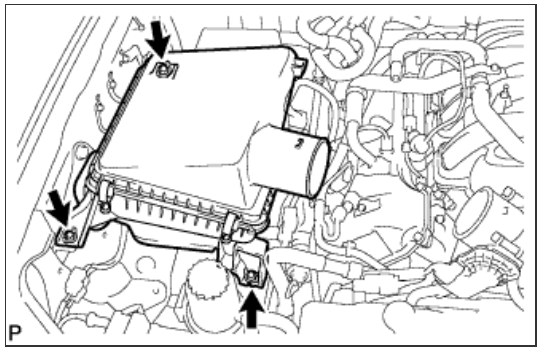
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



10. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



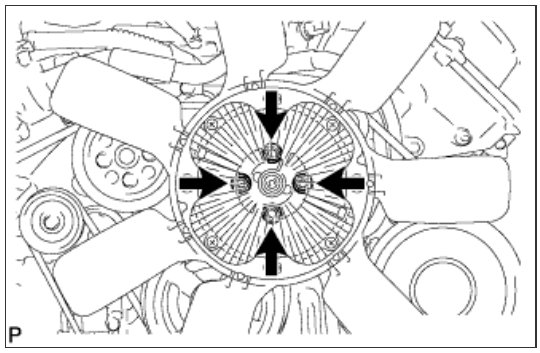
11. REMOVE NO. 1 RADIATOR HOSE

12. REMOVE NO. 2 RADIATOR HOSE

13. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

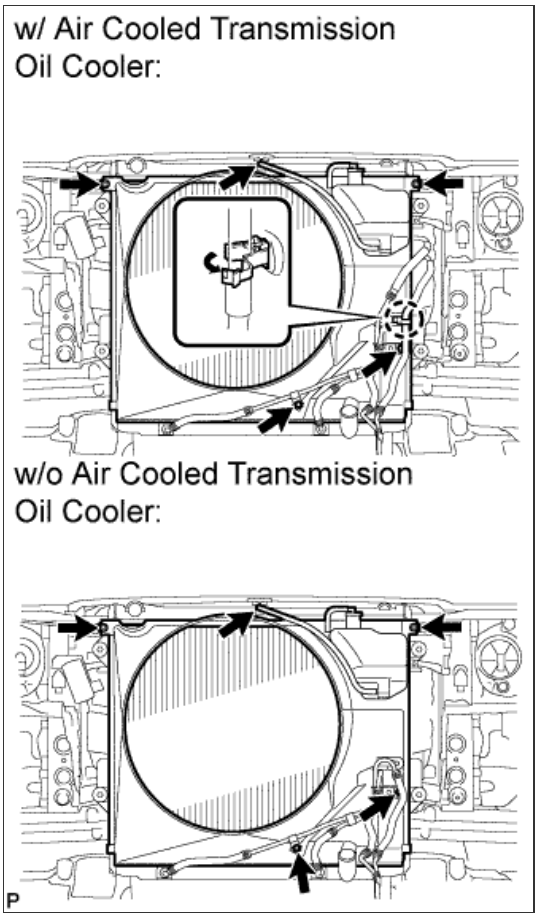
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

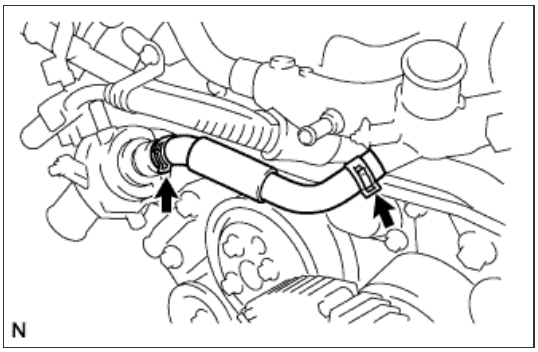
Be careful not to damage the radiator core.

h. Remove the fan pulley.



14. REMOVE NO. 1 WATER BY-PASS HOSE

a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.

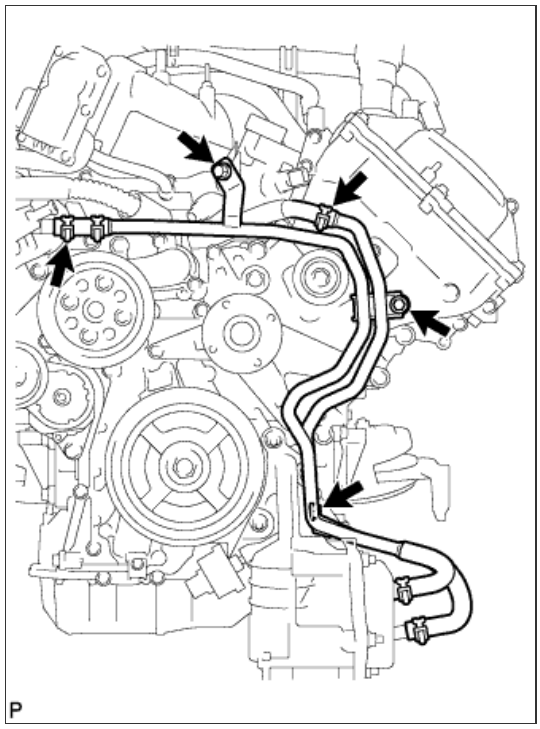


15. DISCONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Disconnect the No. 6 water by-pass hose.

b. Remove the 3 bolts.

c. Disconnect the water by-pass pipe with water hose.



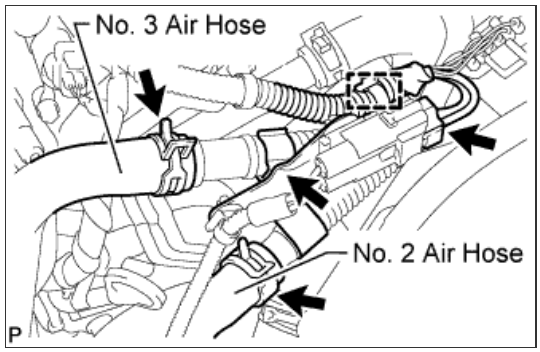
16. REMOVE WATER INLET HOUSING

a. Disconnect the No. 2 and No. 3 air hoses.

b. Disconnect the air pump connector.

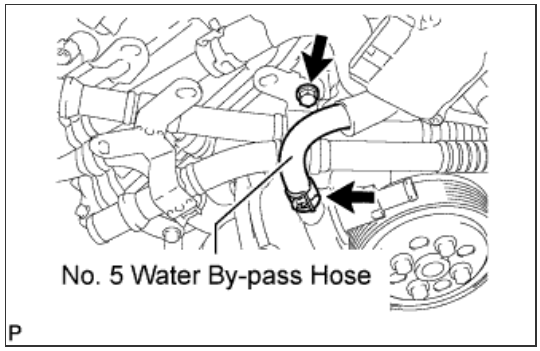
c. Disconnect the air pump connector clamp holder.

d. Using a clip remover, detach the wire harness clamp.



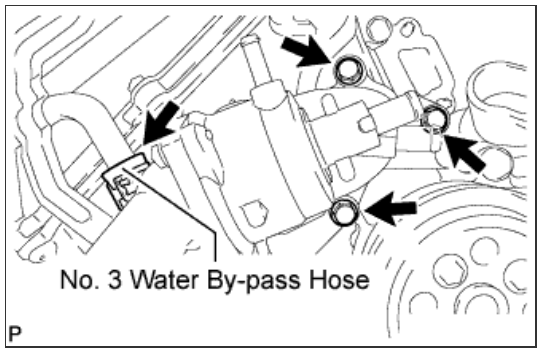
e. Disconnect the No. 5 water by-pass hose.

f. Remove the air tube bracket bolt.



g. Disconnect the No. 3 water by-pass hose and remove the 3 bolts and water inlet housing.

h. Remove the gasket from the water pump.

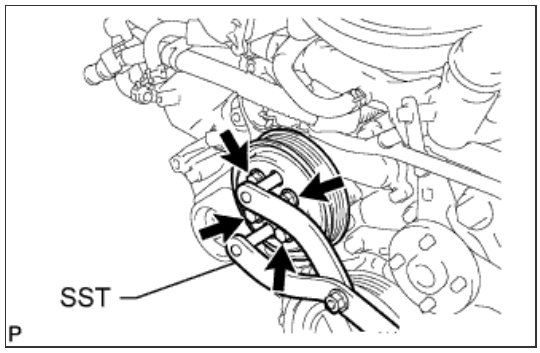


17. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

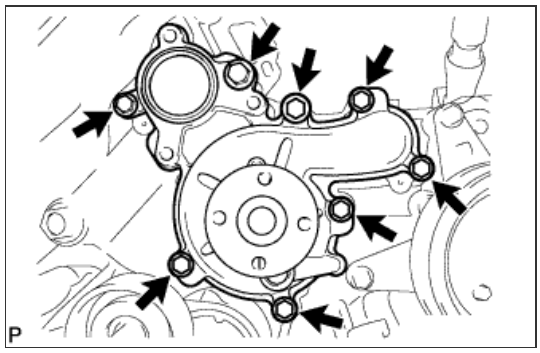
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



18. REMOVE WATER PUMP ASSEMBLY

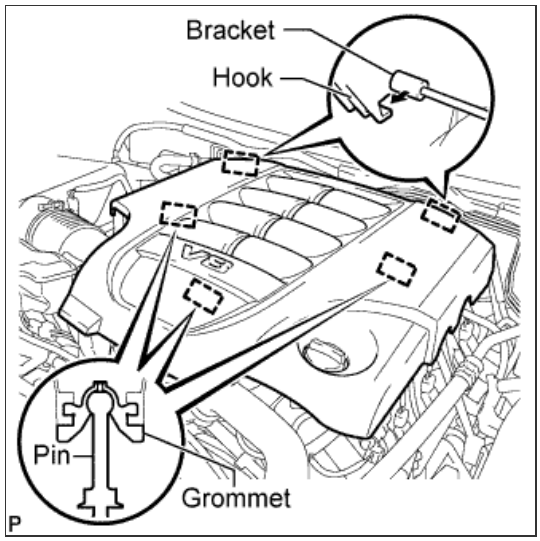
a. Remove the 8 bolts, water pump and gasket.



for Preparation Click here

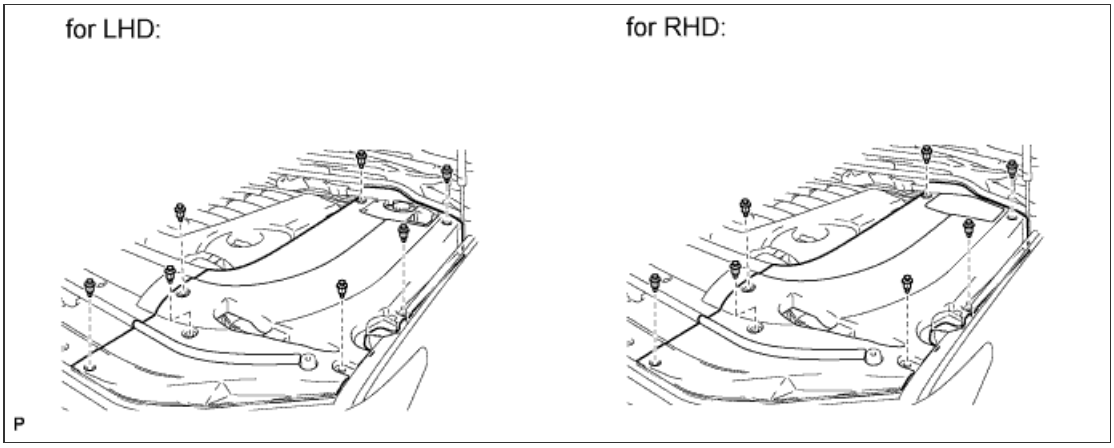
1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



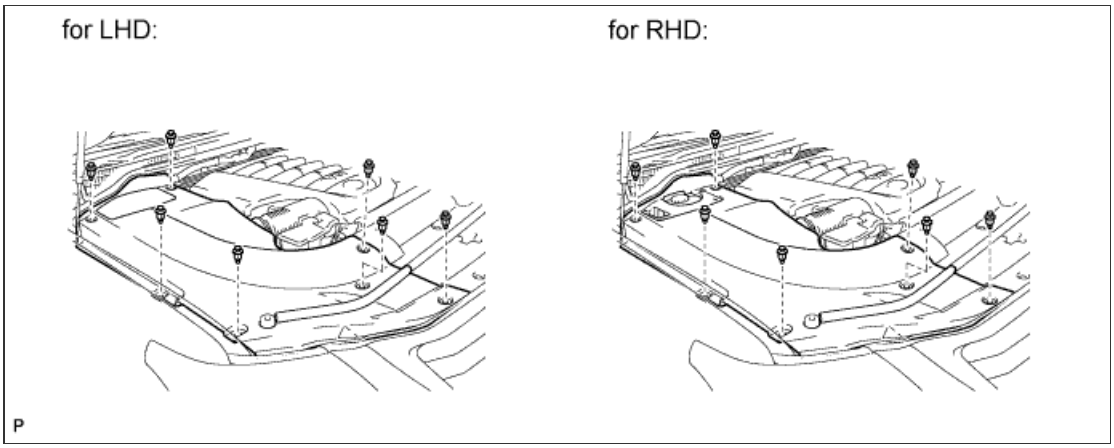
2. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



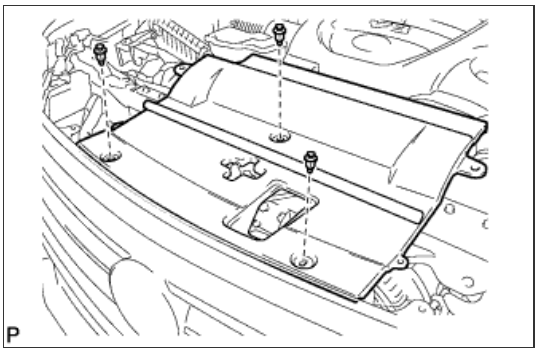
3. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



4. REMOVE UPPER RADIATOR SUPPORT SEAL

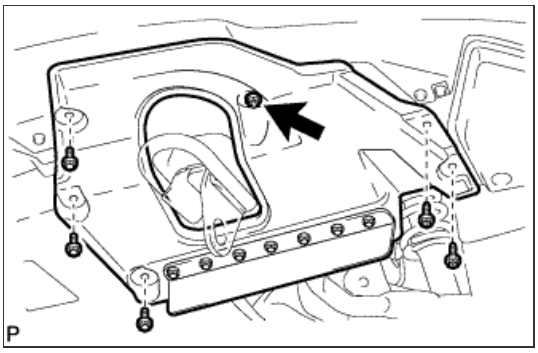
a. Remove the 3 clips and upper radiator support seal.



5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



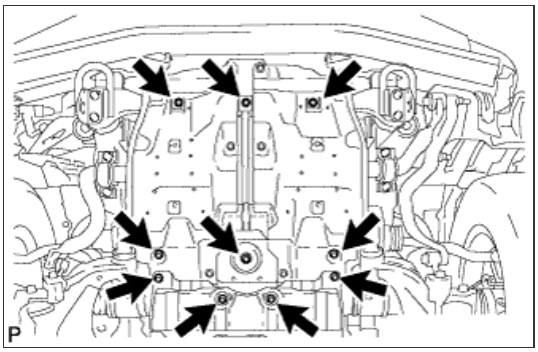
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

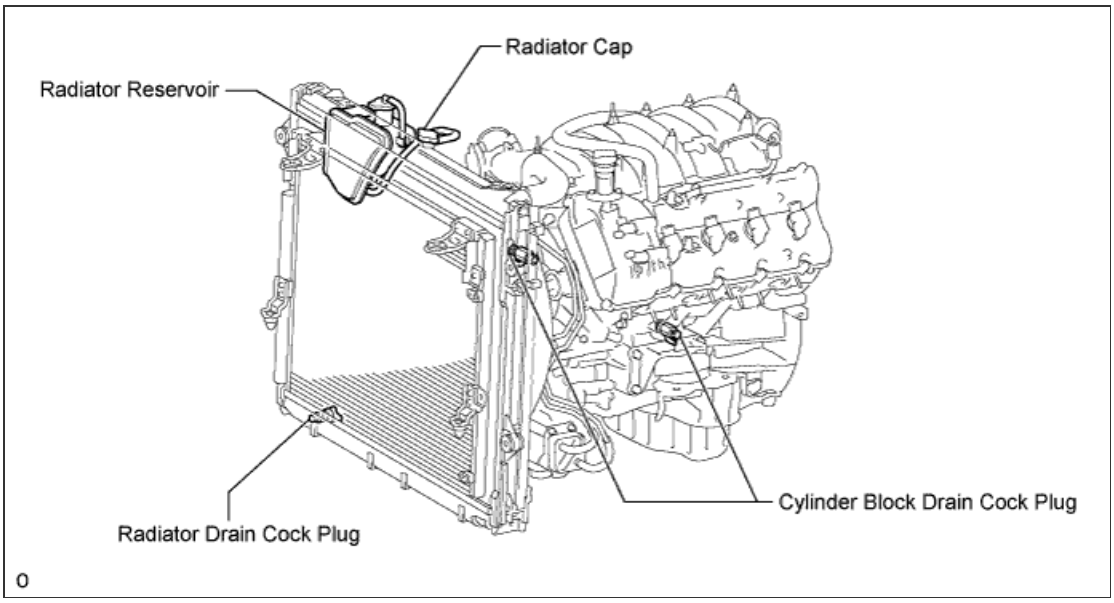
a. Remove the 10 bolts and No. 1 engine under cover.



8. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

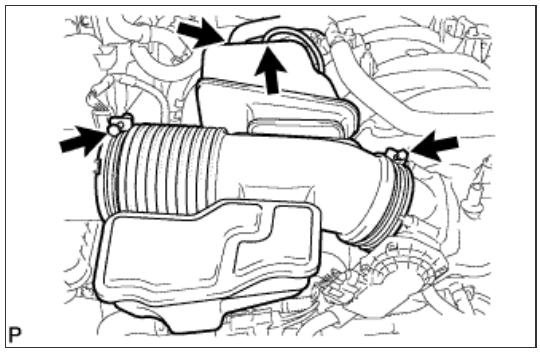
e. Tighten the radiator drain cock plug by hand.

9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

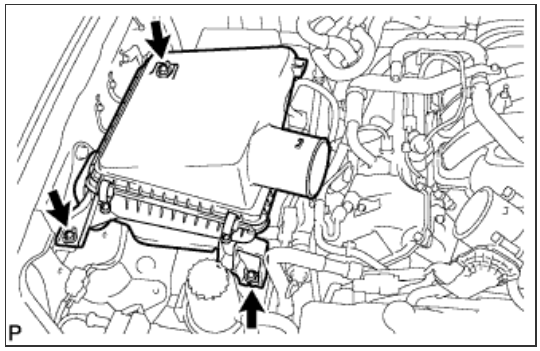
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



10. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



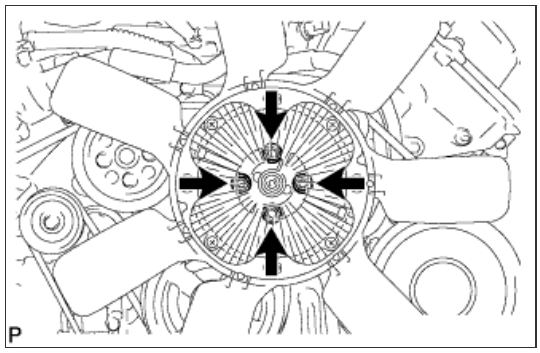
11. REMOVE NO. 1 RADIATOR HOSE

12. REMOVE NO. 2 RADIATOR HOSE

13. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

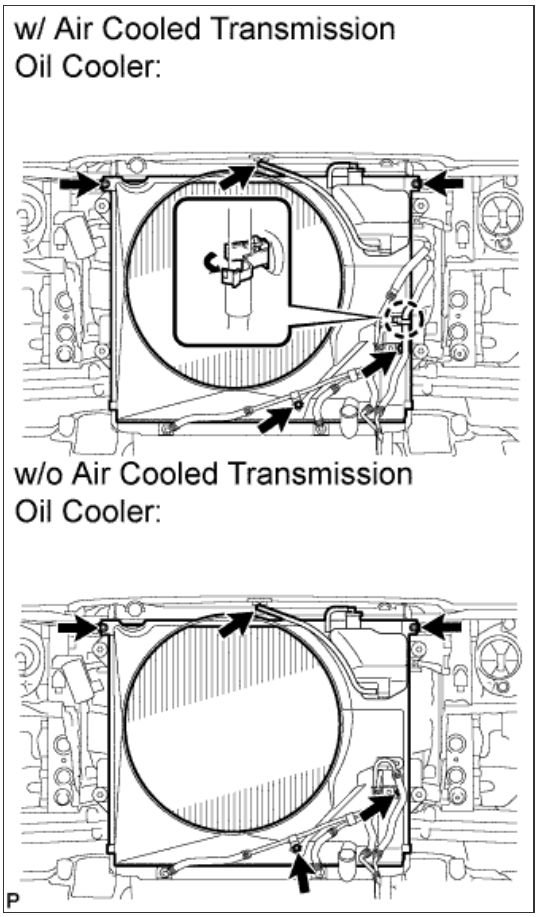
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

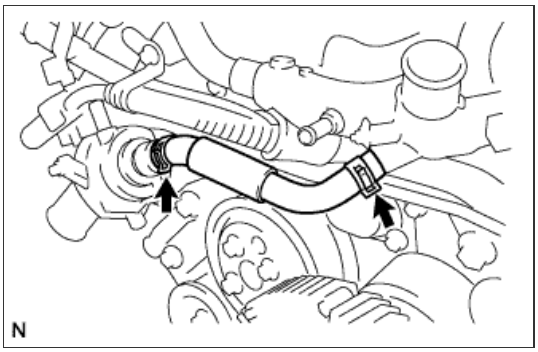
Be careful not to damage the radiator core.

h. Remove the fan pulley.



14. REMOVE NO. 1 WATER BY-PASS HOSE

a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.

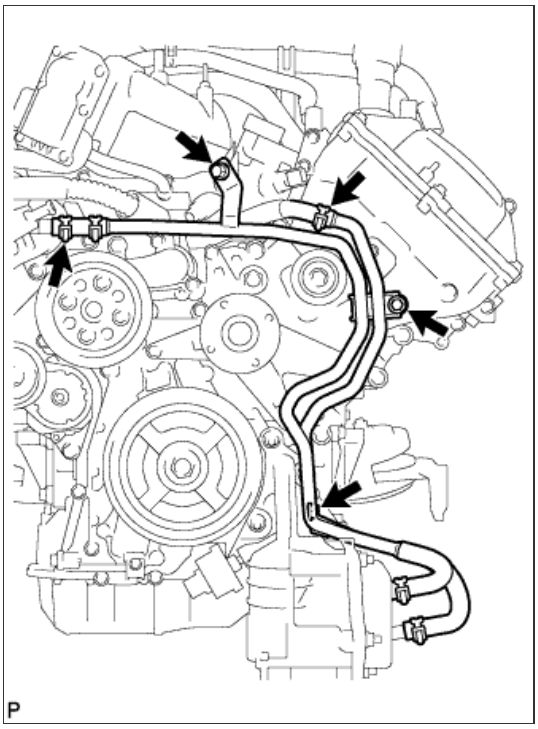


15. DISCONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Disconnect the No. 6 water by-pass hose.

b. Remove the 3 bolts.

c. Disconnect the water by-pass pipe with water hose.



16. REMOVE WATER INLET HOUSING

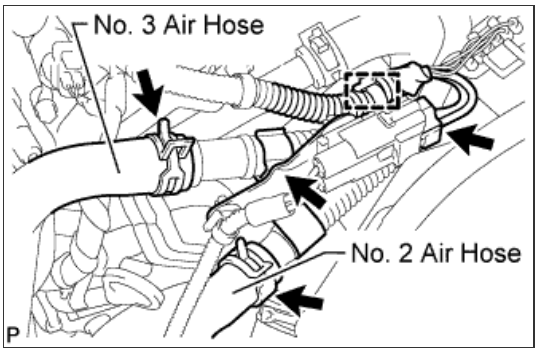
a. w/ Secondary Air Injection System:

i. Disconnect the No. 2 and No. 3 air hoses.

ii. Disconnect the air pump connector.

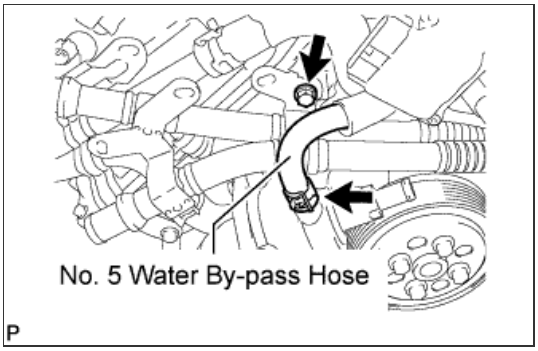
iii. Disconnect the air pump connector clamp holder.

iv. Using a clip remover, detach the wire harness clamp.



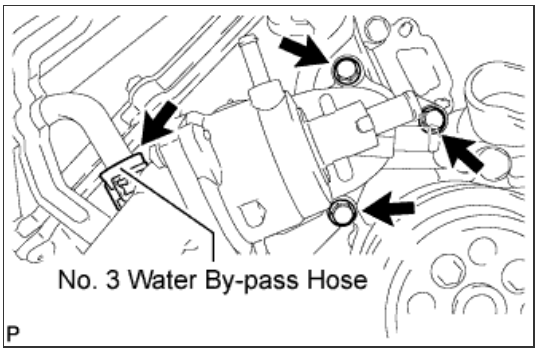
b. Disconnect the No. 5 water by-pass hose.

c. w/ Secondary Air Injection System:
Remove the air tube bracket bolt.



d. Disconnect the No. 3 water by-pass hose and remove the 3 bolts and water inlet housing.

e. Remove the gasket from the water pump.

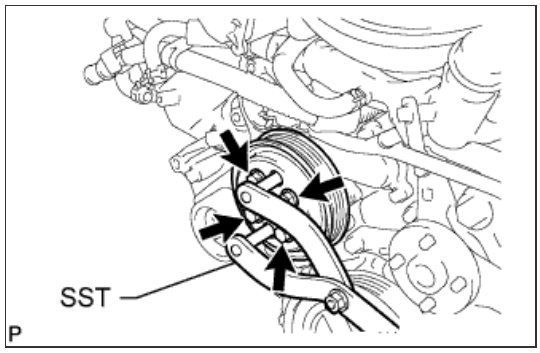


17. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

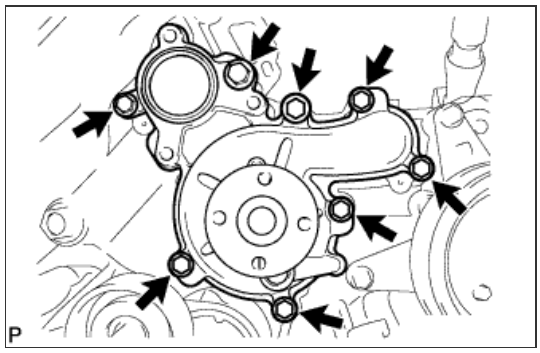
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



18. REMOVE WATER PUMP ASSEMBLY

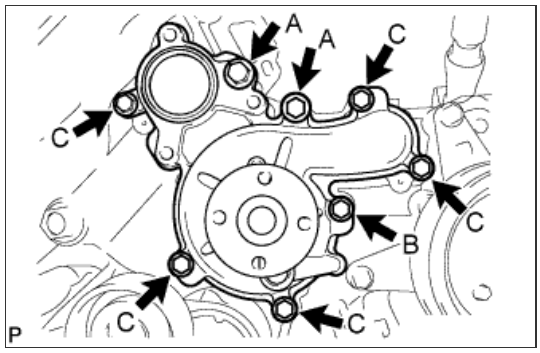
a. Remove the 8 bolts, water pump and gasket.



for Preparation Click here

1. INSTALL WATER PUMP ASSEMBLY

a. Install a new gasket and the water pump with the 8 bolts shown in the illustration.



Torque:
for bolt A:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }
for bolt B:
23 N*m{ 235 kgf*cm , 17 ft.*lbf }
for bolt C:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }

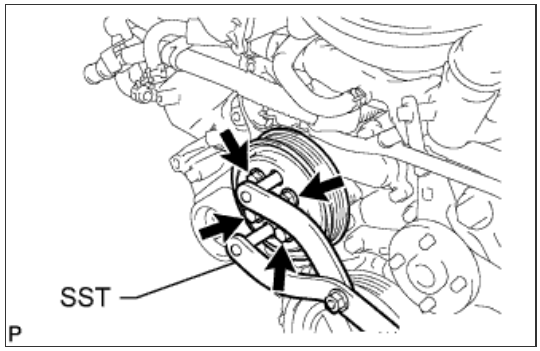
Standard Bolt:

Item	Length	Thread Diameter
Bolt A	80 mm (3.15 in.)	10 mm (0.394 in.)
Bolt B	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt C	25 mm (0.984 in.)	8 mm (0.315 in.)

2. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.



SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

3. INSTALL WATER INLET HOUSING

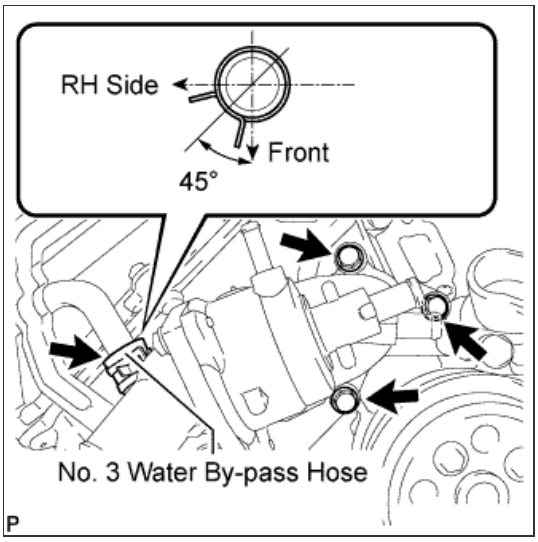
a. Install a new gasket to the water pump.

b. Install the water inlet housing with the 3 bolts and connect the No. 3 water by-pass hose.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.



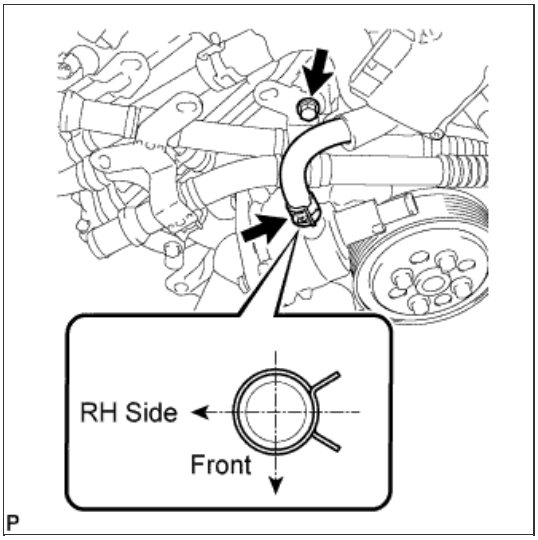
c. Install the air tube bracket bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Connect the No. 5 water by-pass hose.

HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.

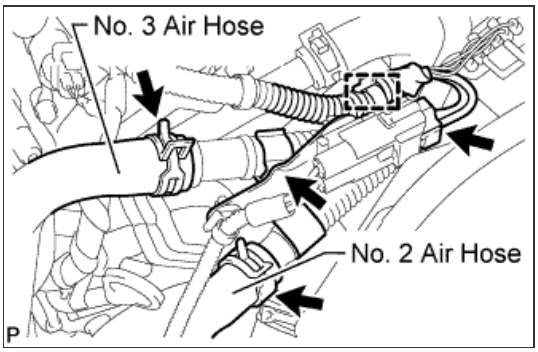


e. Connect the air pump connector clamp holder.

f. Attach the wire harness clamp.

g. Connect the air pump connector.

h. Connect the No. 2 and No. 3 air hoses.



4. CONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the water by-pass pipe with water hose.

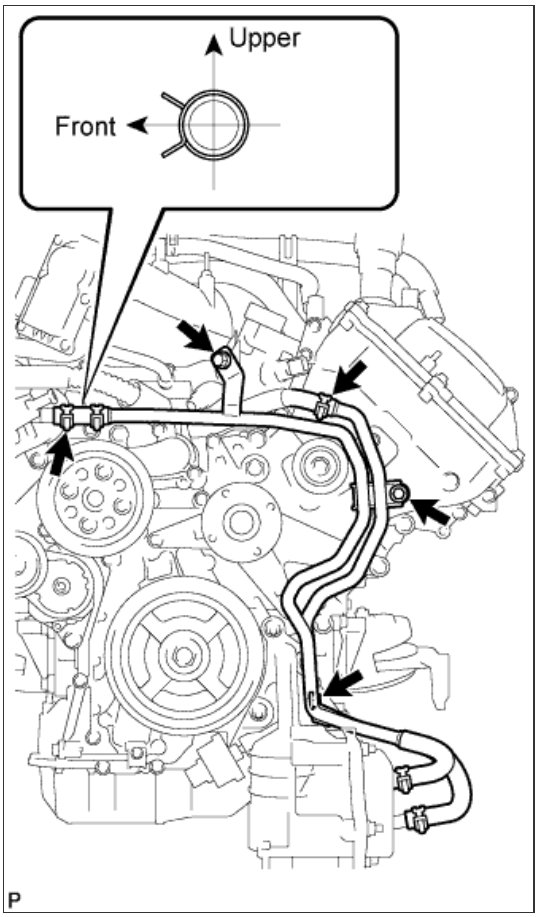
HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.

b. Install the 3 bolts.

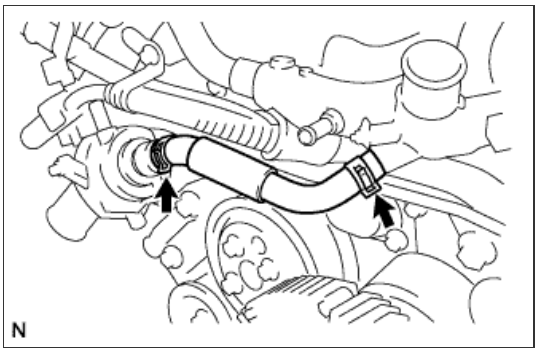
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

c. Connect the No. 6 water by-pass hose.



5. INSTALL NO. 1 WATER BY-PASS HOSE

a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.



6. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

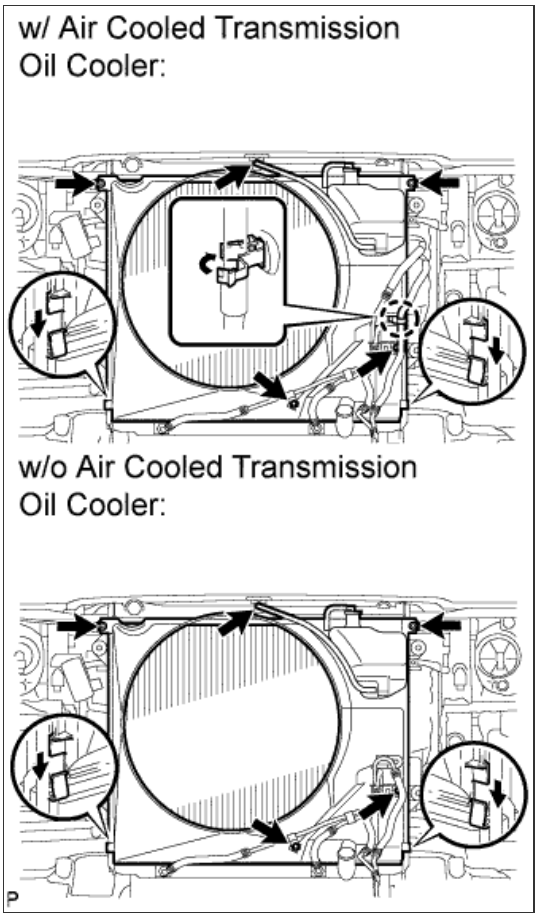
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

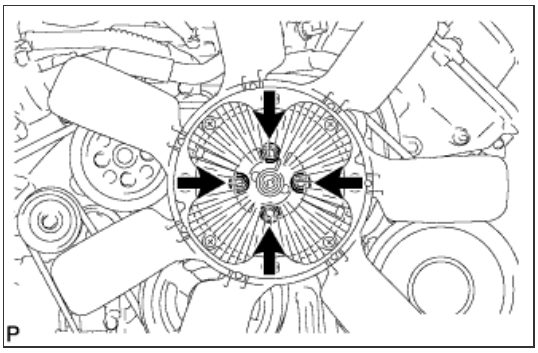
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



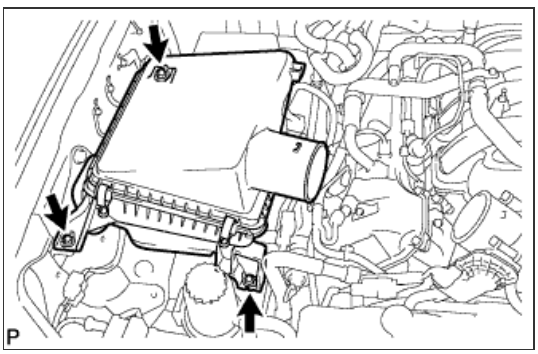
7. INSTALL NO. 1 RADIATOR HOSE

8. INSTALL NO. 2 RADIATOR HOSE

9. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



10. INSTALL AIR CLEANER HOSE ASSEMBLY

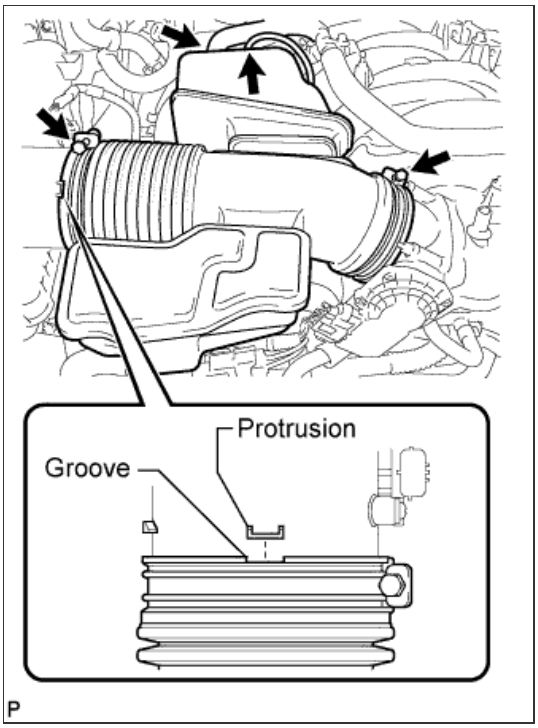
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



11. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

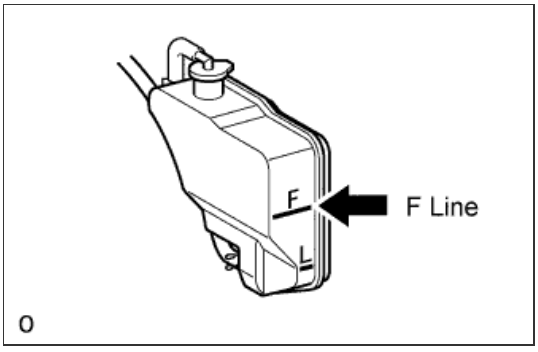
d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

NOTICE:

Switch off the A/C.



g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

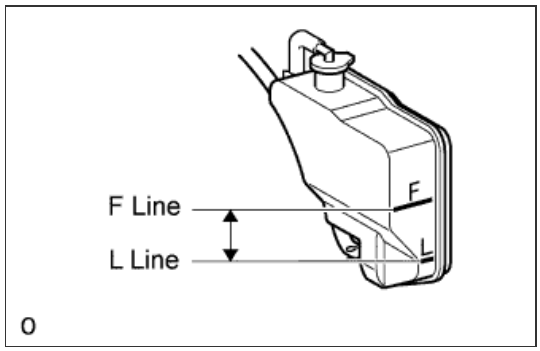
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

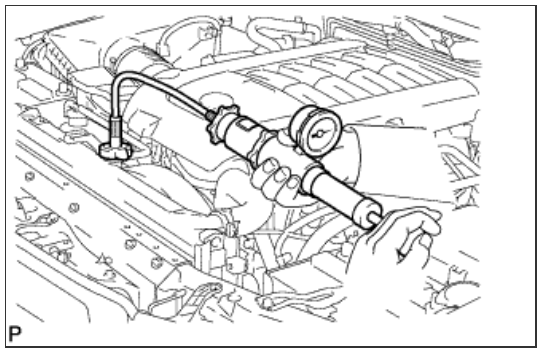


12. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

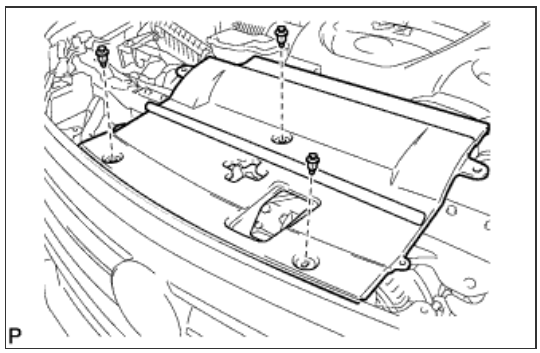
b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



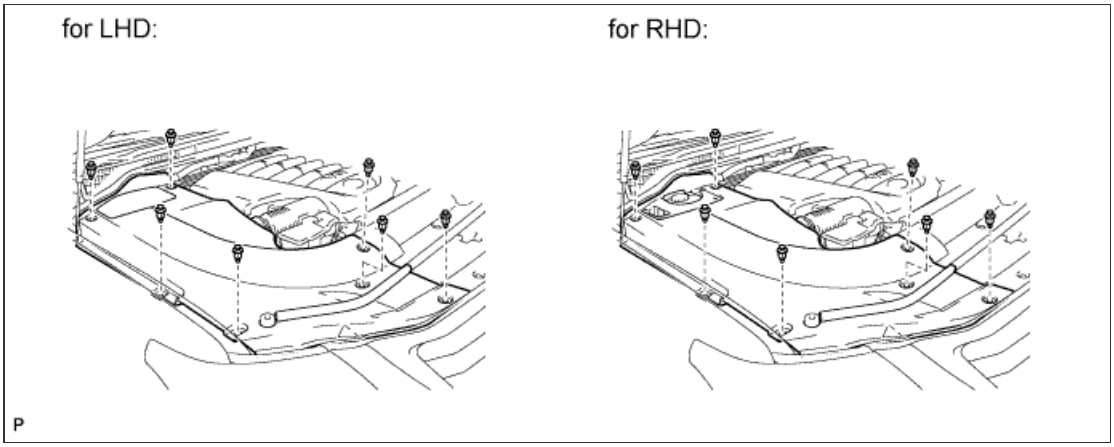
13. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



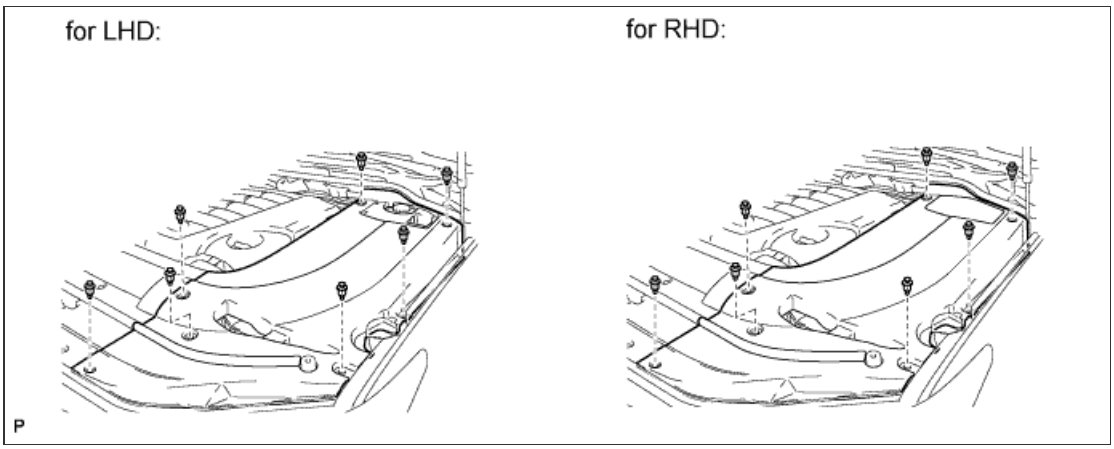
14. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



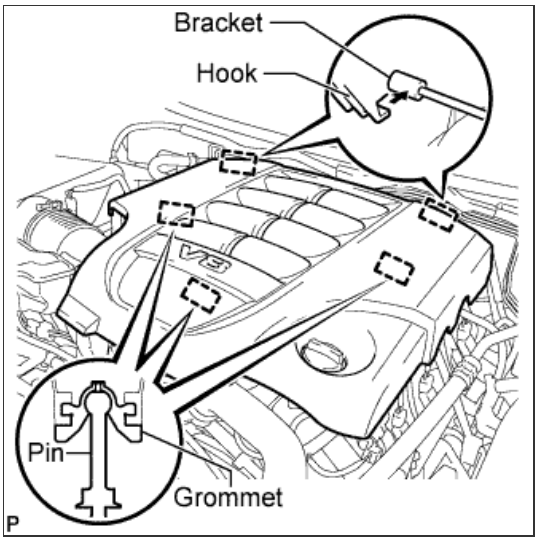
15. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



16. INSTALL V-BANK COVER SUB-ASSEMBLY

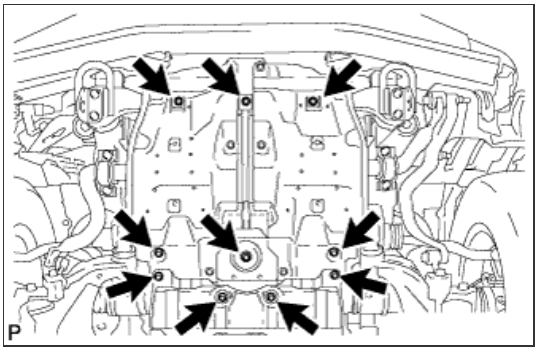
a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



17. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

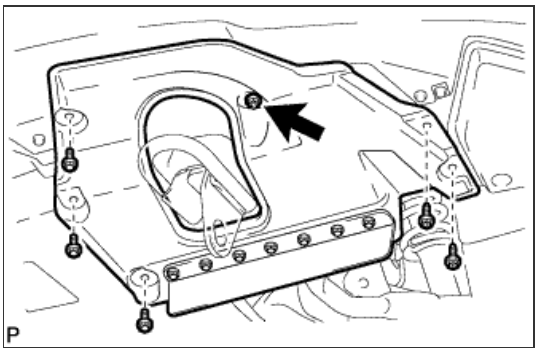
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



18. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



19. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

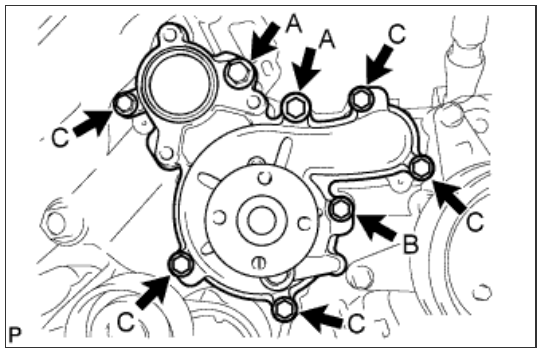
HINT:

Use the same procedures described for the LH side.

for Preparation Click here

1. INSTALL WATER PUMP ASSEMBLY

a. Install a new gasket and the water pump with the 8 bolts shown in the illustration.



Torque:
for bolt A:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }
for bolt B:
23 N*m{ 235 kgf*cm , 17 ft.*lbf }
for bolt C:
20 N*m{ 204 kgf*cm , 15 ft.*lbf }

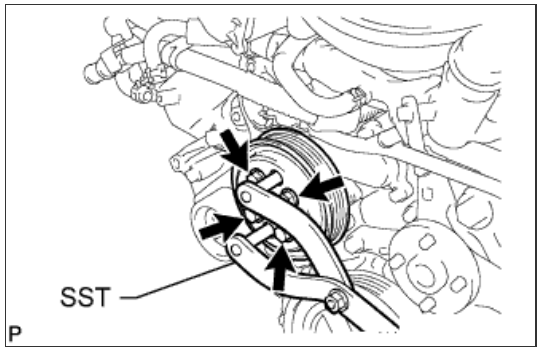
Standard Bolt:

Item	Length	Thread Diameter
Bolt A	80 mm (3.15 in.)	10 mm (0.394 in.)
Bolt B	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt C	25 mm (0.984 in.)	8 mm (0.315 in.)

2. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.



SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

3. INSTALL WATER INLET HOUSING

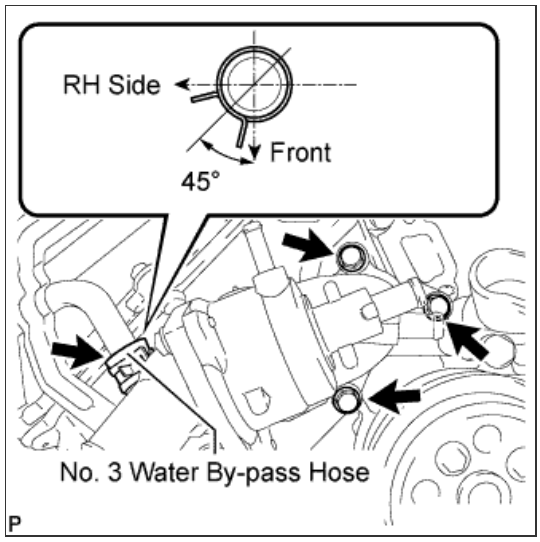
a. Install a new gasket to the water pump.

b. Install the water inlet housing with the 3 bolts and connect the No. 3 water by-pass hose.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.



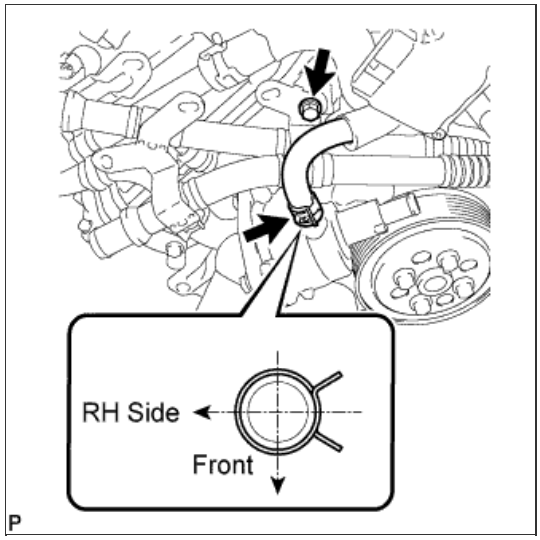
c. w/ Secondary Air Injection System:
Install the air tube bracket bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Connect the No. 5 water by-pass hose.

HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.



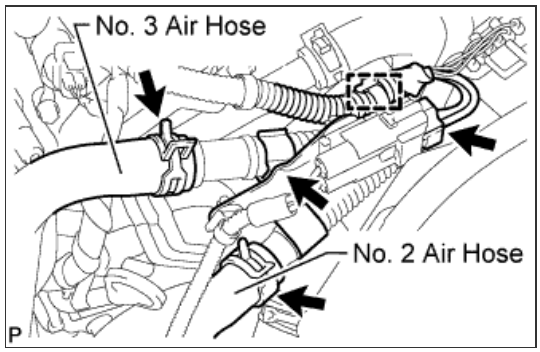
e. w/ Secondary Air Injection System:

i. Connect the air pump connector clamp holder.

ii. Attach the wire harness clamp.

iii. Connect the air pump connector.

iv. Connect the No. 2 and No. 3 air hoses.



4. CONNECT NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the water by-pass pipe with water hose.

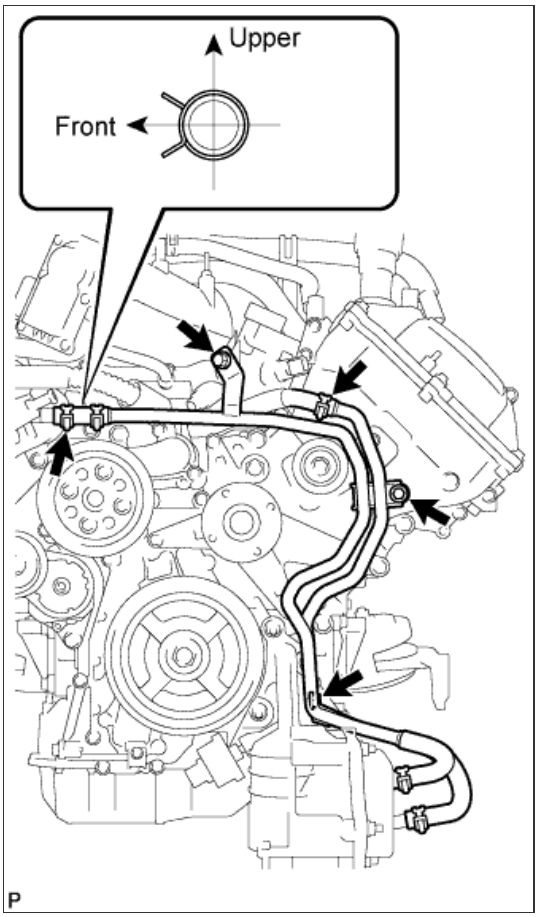
HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.

b. Install the 3 bolts.

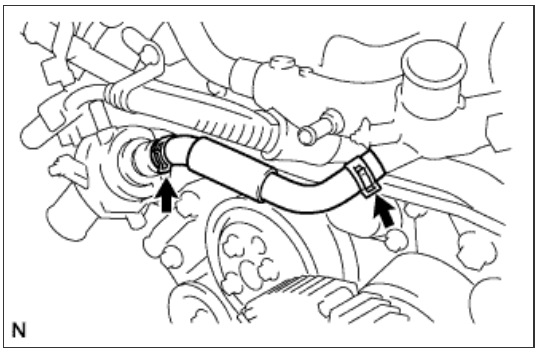
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

c. Connect the No. 6 water by-pass hose.



5. INSTALL NO. 1 WATER BY-PASS HOSE

a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.



6. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

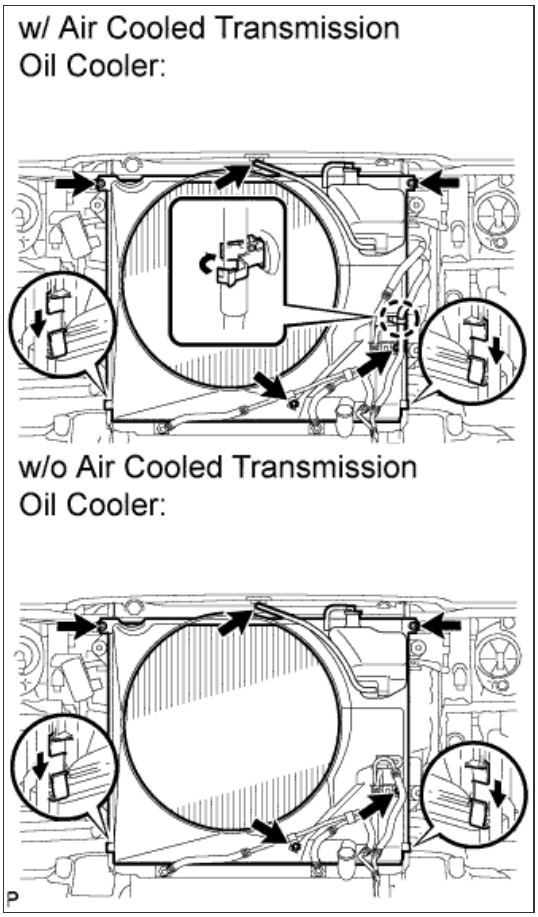
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

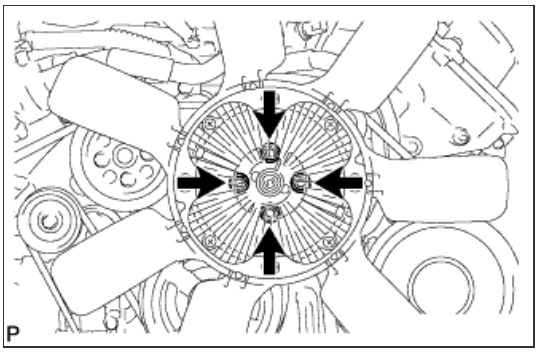
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



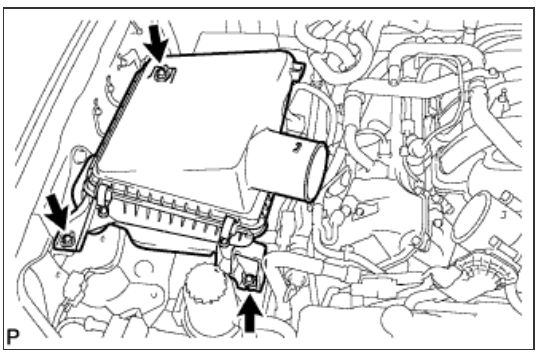
7. INSTALL NO. 1 RADIATOR HOSE

8. INSTALL NO. 2 RADIATOR HOSE

9. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



10. INSTALL AIR CLEANER HOSE ASSEMBLY

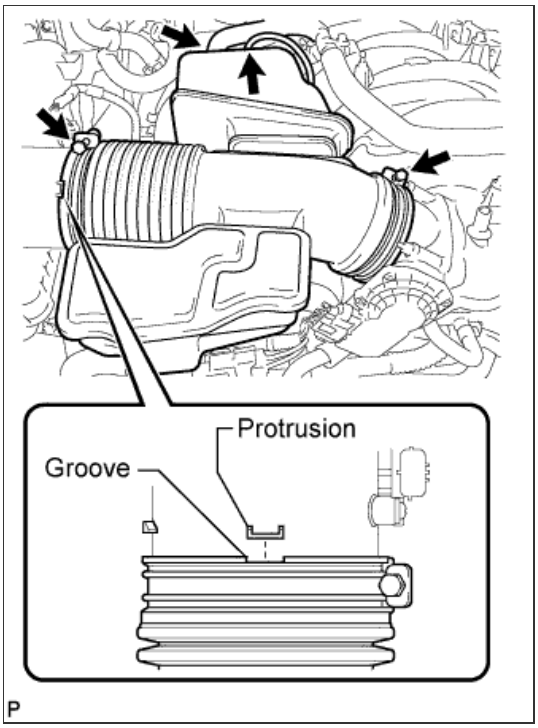
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



11. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

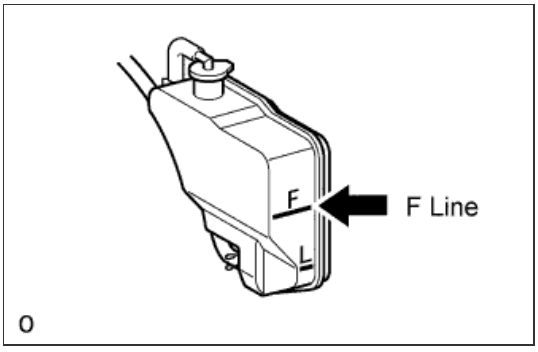
d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

NOTICE:

Switch off the A/C.



g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

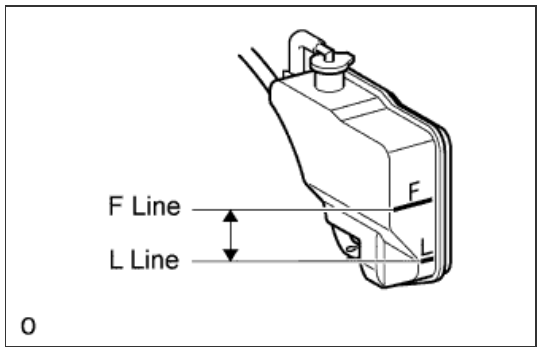
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

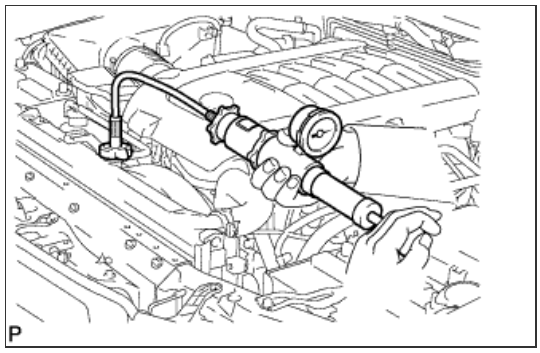


12. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

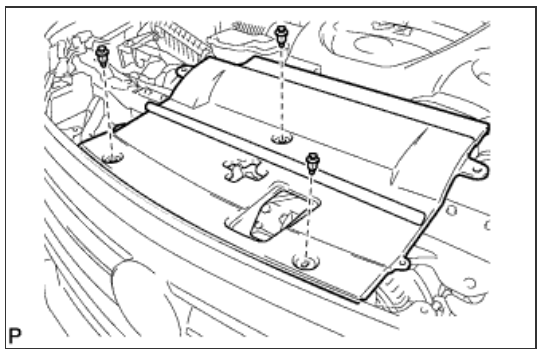
b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



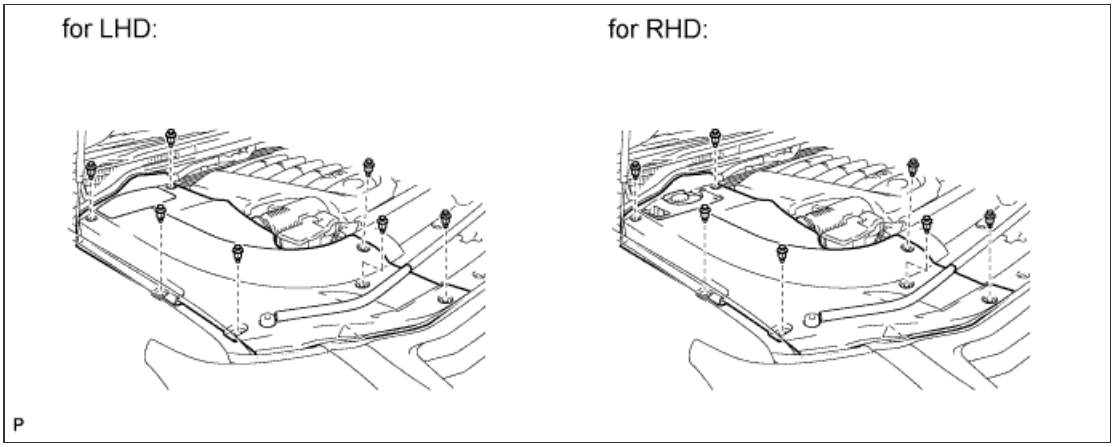
13. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



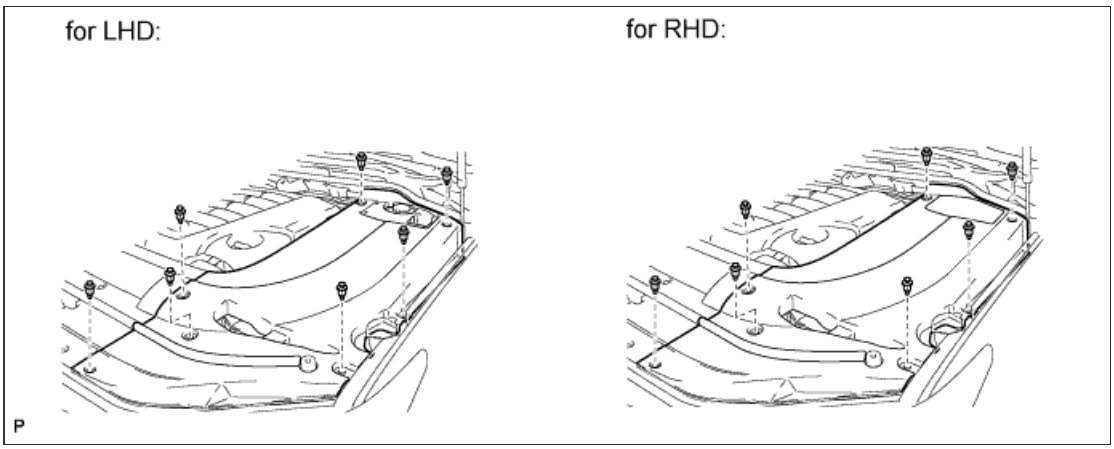
14. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



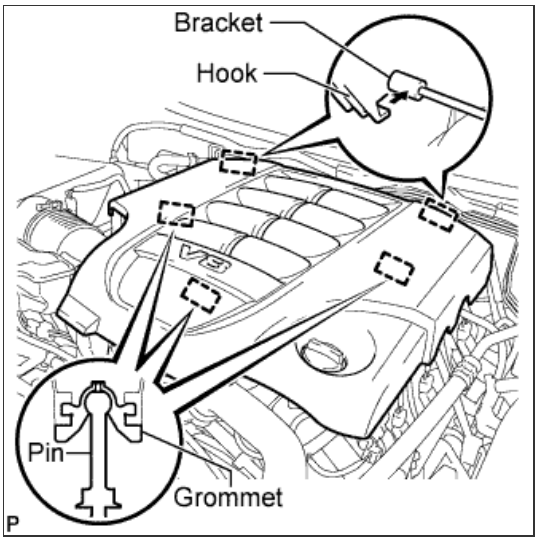
15. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



16. INSTALL V-BANK COVER SUB-ASSEMBLY

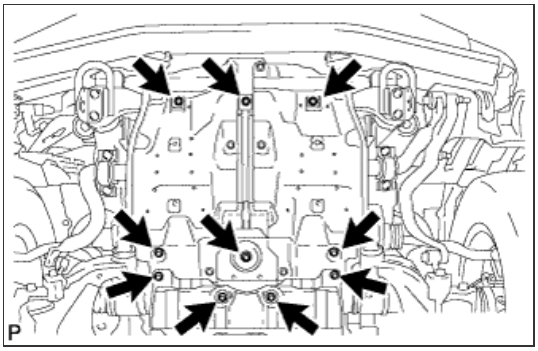
a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



17. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

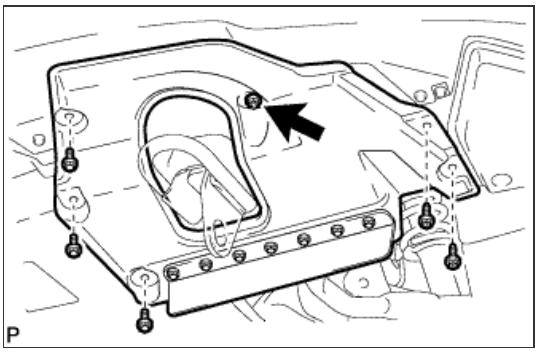
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



18. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.

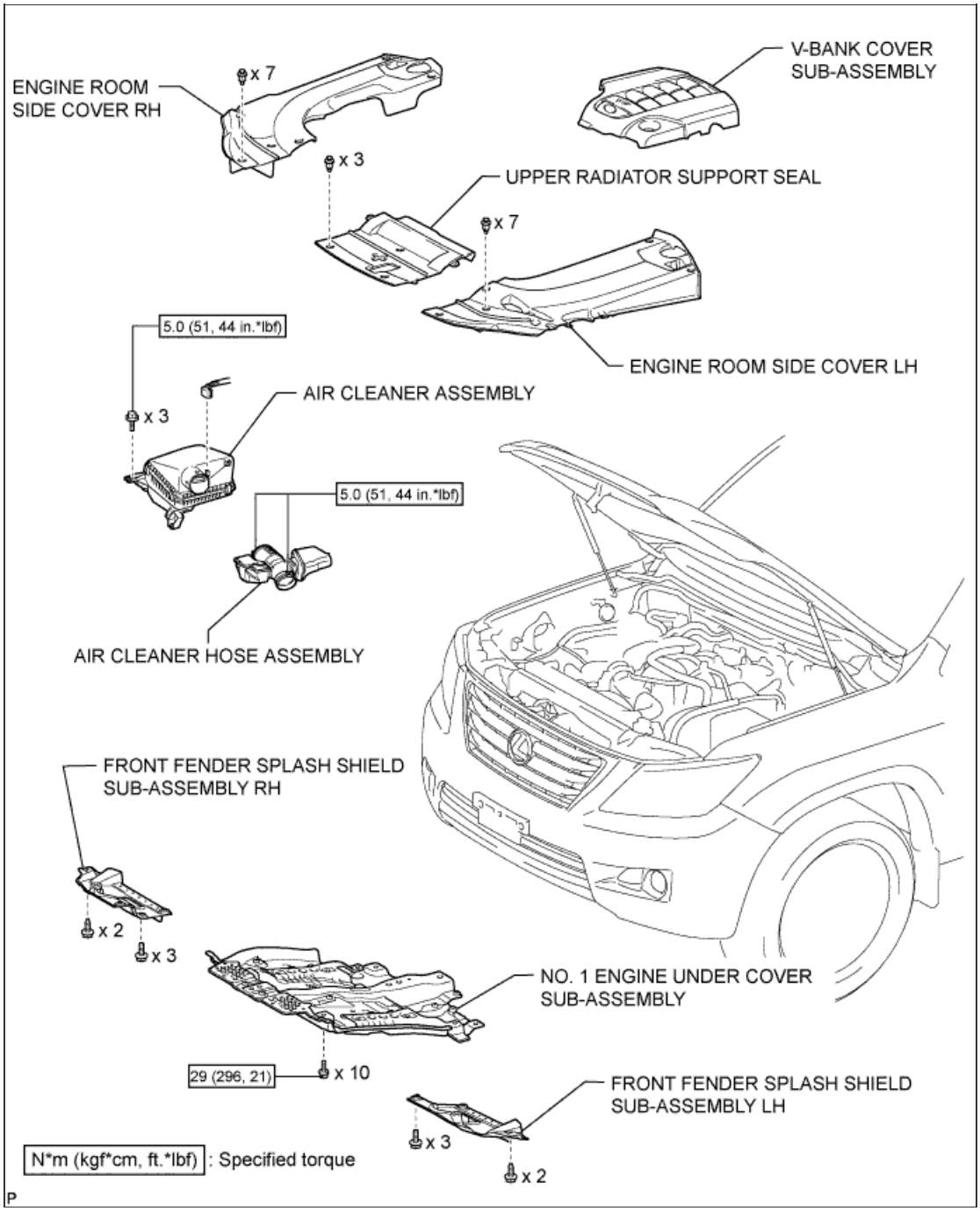


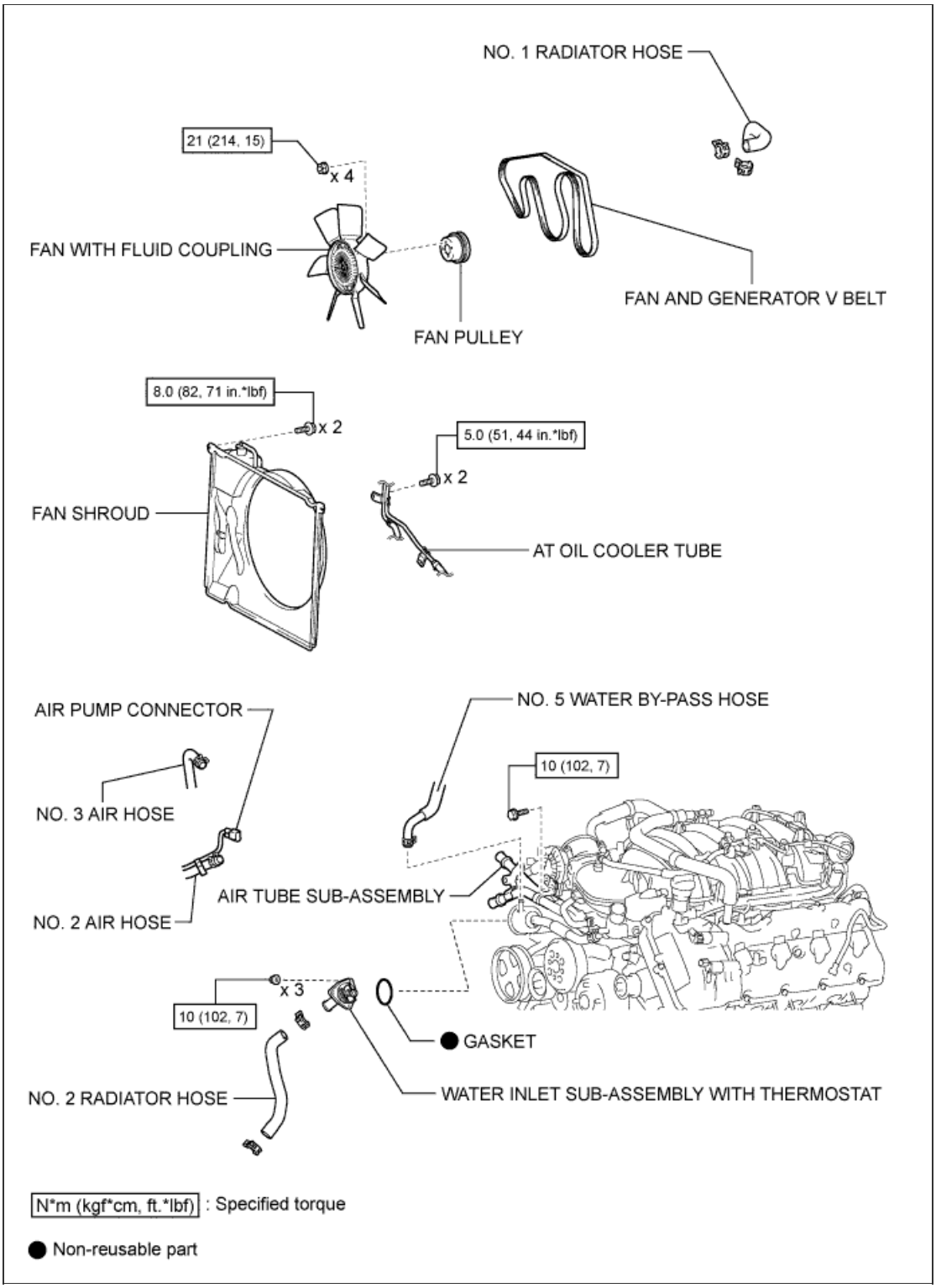
19. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

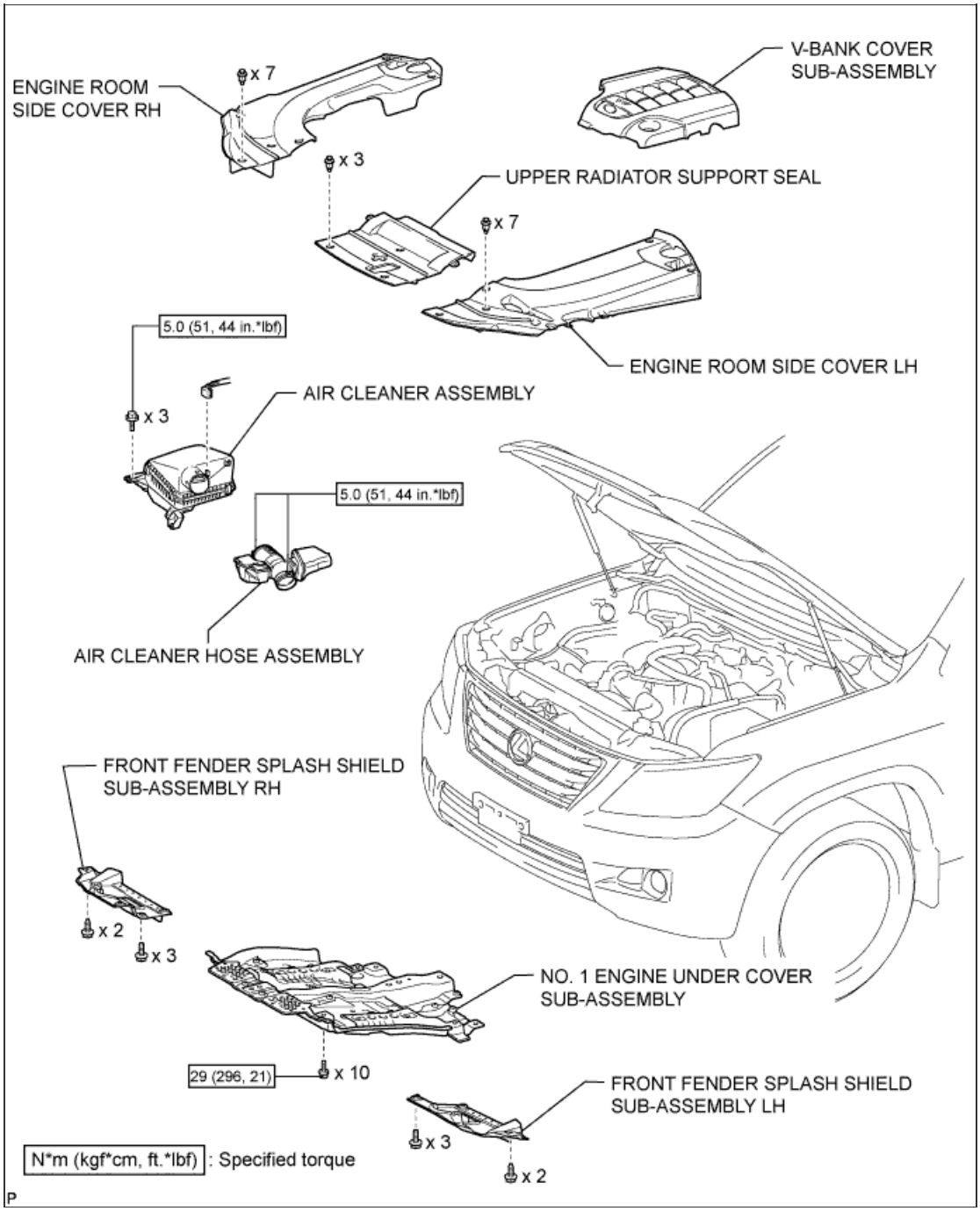
Use the same procedures described for the LH side.

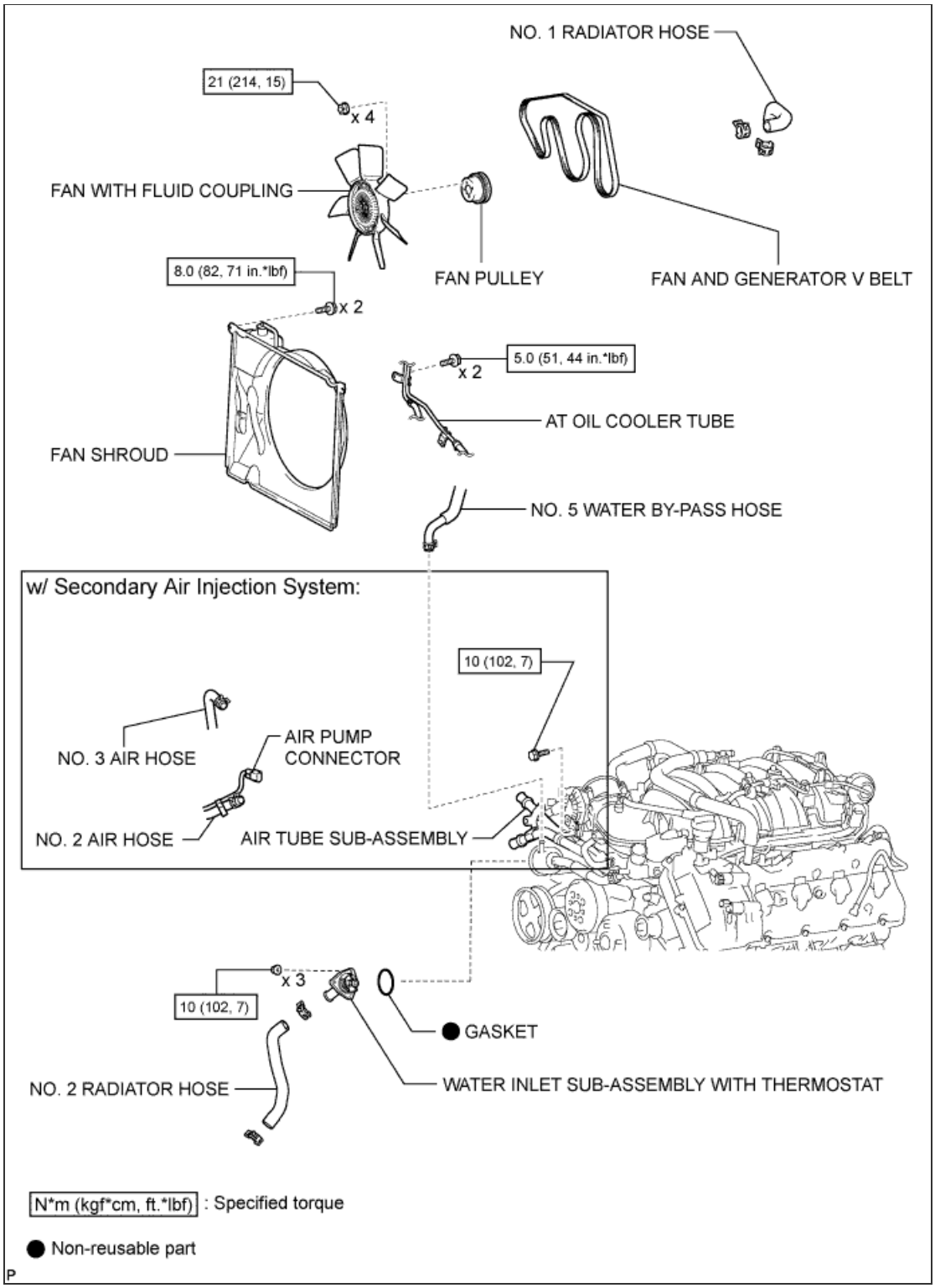
for Preparation Click here




NO. 1 RADIATOR HOSE
21 (214, 15)
x 4
FAN WITH FLUID COUPLING
FAN PULLEY
FAN AND GENERATOR V BELT
8.0 (82, 71 in.*lbf)
x 2
FAN SHROUD
5.0 (51, 44 in.*lbf)
x 2
AT OIL COOLER TUBE
AIR PUMP CONNECTOR
NO. 3 AIR HOSE
NO. 2 AIR HOSE
NO. 5 WATER BY-PASS HOSE
10 (102, 7)
AIR TUBE SUB-ASSEMBLY
x 3
10 (102, 7)
GASKET
NO. 2 RADIATOR HOSE
WATER INLET SUB-ASSEMBLY WITH THERMOSTAT
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

for Preparation Click here




NO. 1 RADIATOR HOSE
21 (214, 15)
x 4
FAN WITH FLUID COUPLING
FAN PULLEY
FAN AND GENERATOR V BELT
8.0 (82, 71 in.*lbf)
x 2
5.0 (51, 44 in.*lbf)
x 2
AT OIL COOLER TUBE
FAN SHROUD
NO. 5 WATER BY-PASS HOSE
w/ Secondary Air Injection System:
10 (102, 7)
NO. 3 AIR HOSE
AIR PUMP CONNECTOR
NO. 2 AIR HOSE
AIR TUBE SUB-ASSEMBLY
x 3
10 (102, 7)
GASKET
NO. 2 RADIATOR HOSE
WATER INLET SUB-ASSEMBLY WITH THERMOSTAT
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

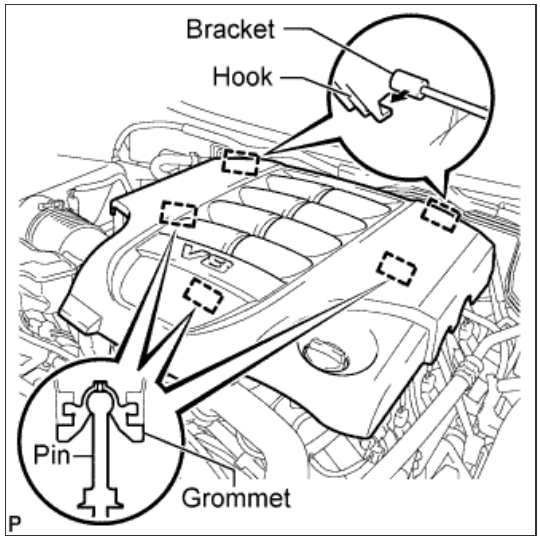
for Preparation Click here

HINT:

If the thermostat is not installed, cooling efficiency decreases. Do not remove the thermostat as this will cause the engine to overheat easily.

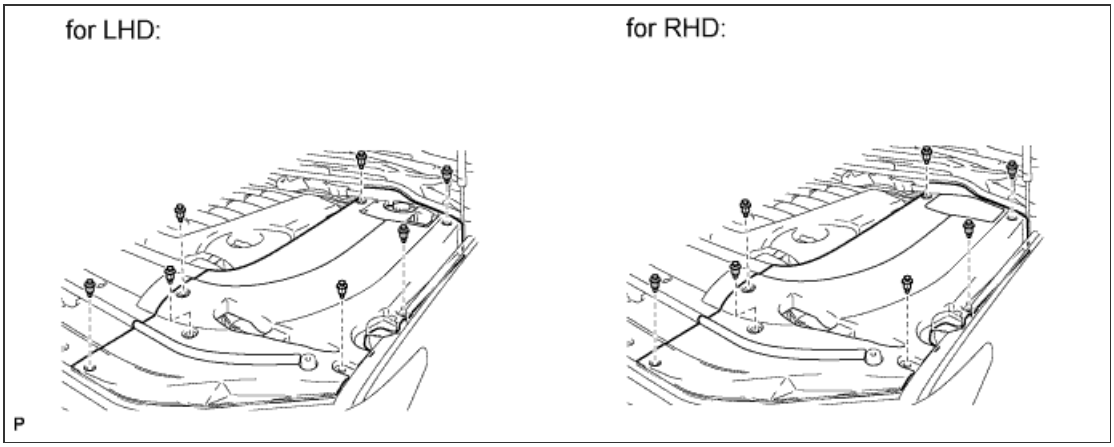
1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



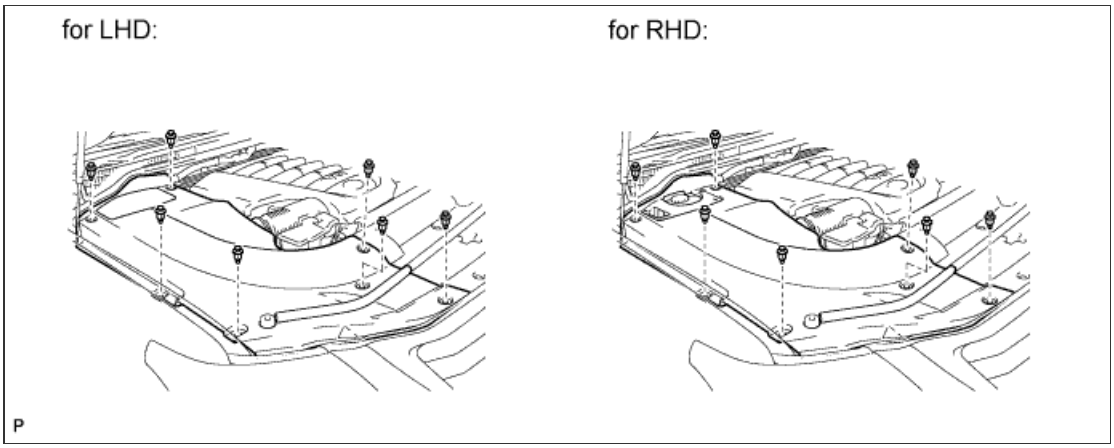
2. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



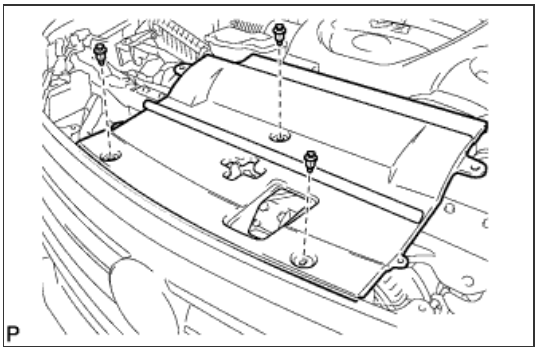
3. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



4. REMOVE UPPER RADIATOR SUPPORT SEAL

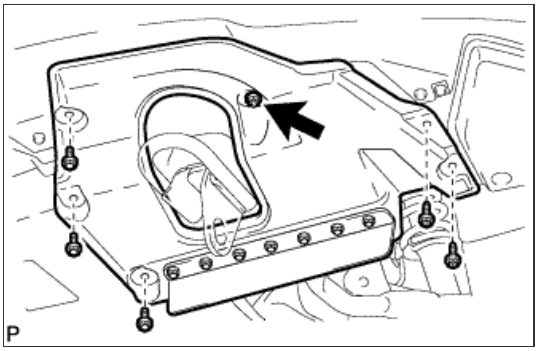
a. Remove the 3 clips and upper radiator support seal.



5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



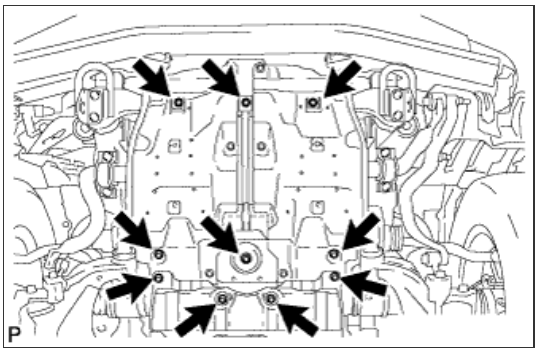
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

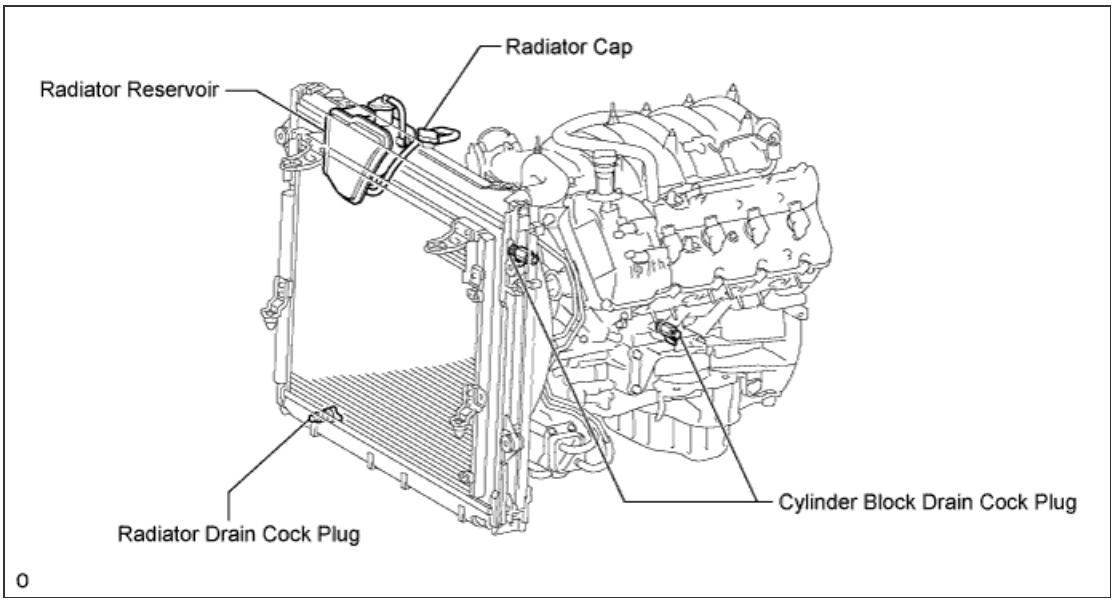
a. Remove the 10 bolts and No. 1 engine under cover.



8. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

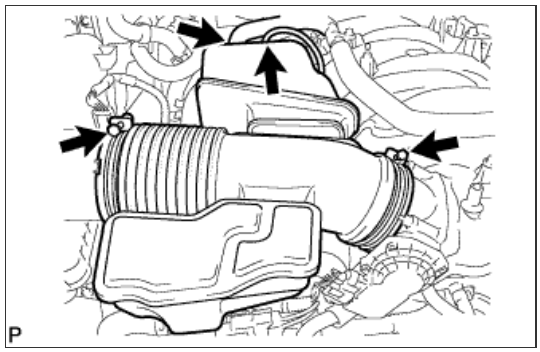
e. Tighten the radiator drain cock plug by hand.

9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

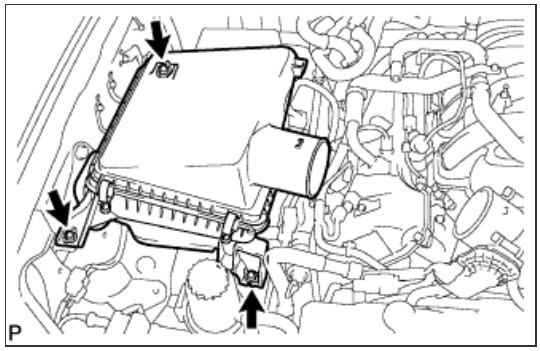
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



10. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



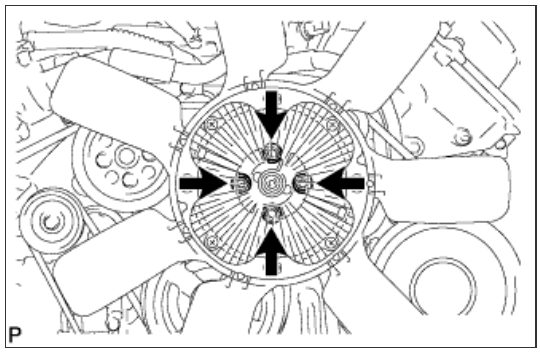
11. REMOVE NO. 1 RADIATOR HOSE

12. REMOVE NO. 2 RADIATOR HOSE

13. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

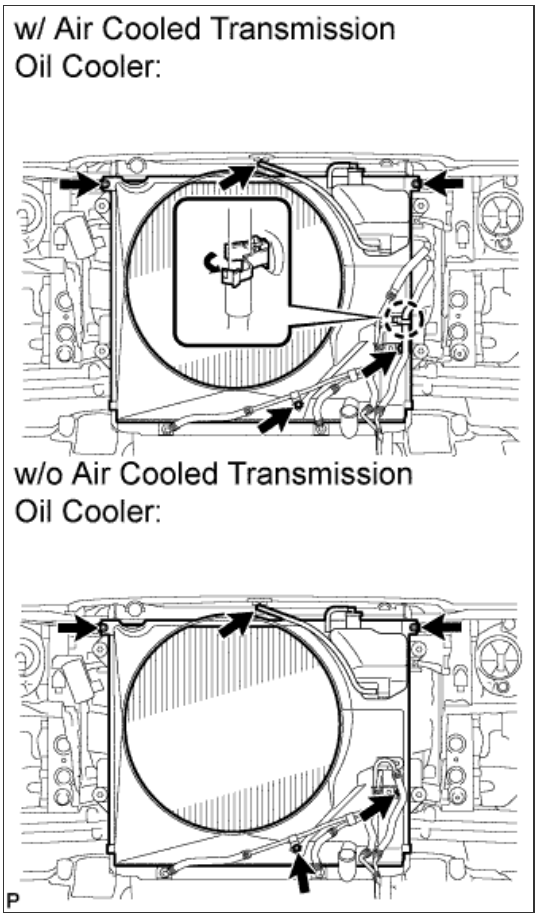
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

Be careful not to damage the radiator core.

h. Remove the fan pulley.



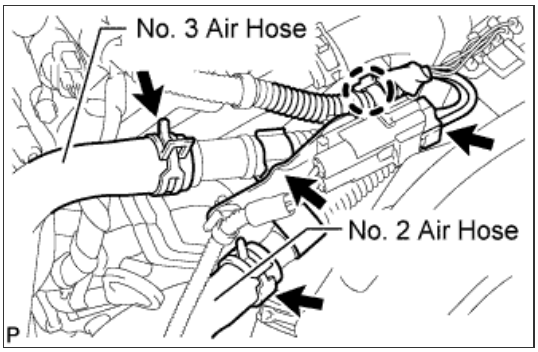
14. REMOVE WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

a. Disconnect the No. 2 and No. 3 air hoses.

b. Disconnect the air pump connector.

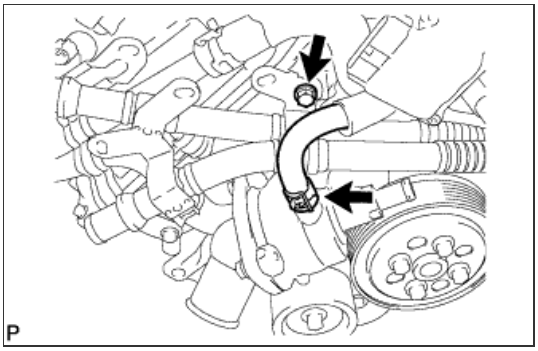
c. Disconnect the air pump connector clamp holder.

d. Using a clip remover, detach the wire harness clamp.

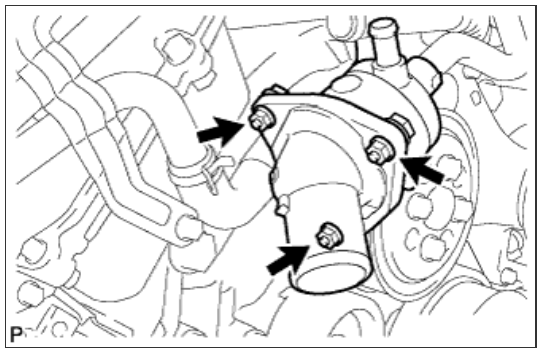


e. Disconnect the No. 5 water by-pass hose.

f. Remove the air tube bracket bolt.



g. Remove the 3 nuts, water inlet with thermostat and gasket.



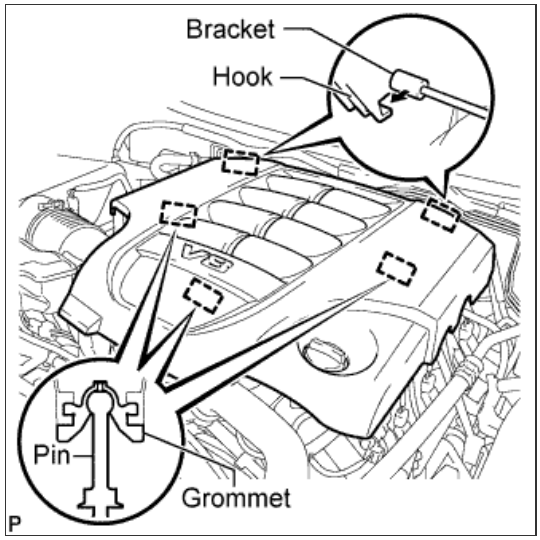
for Preparation Click here

HINT:

If the thermostat is not installed, cooling efficiency decreases. Do not remove the thermostat as this will cause the engine to overheat easily.

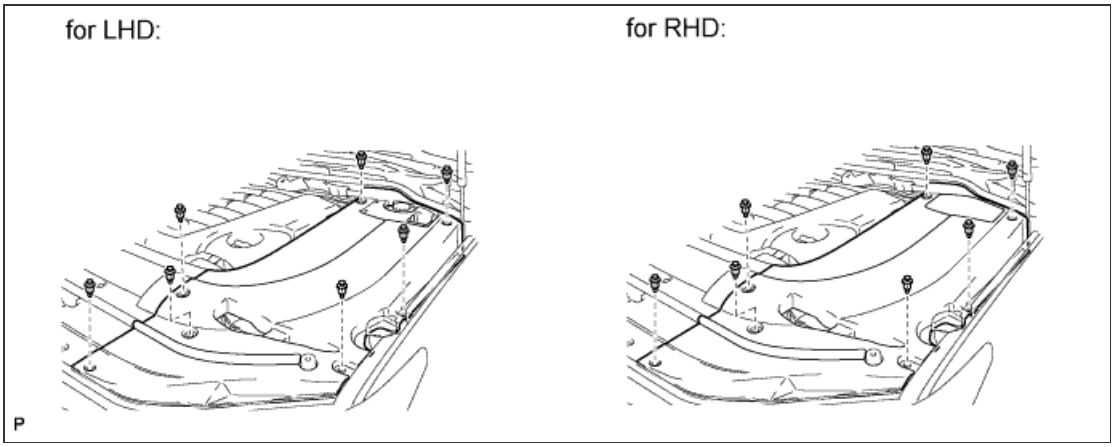
1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



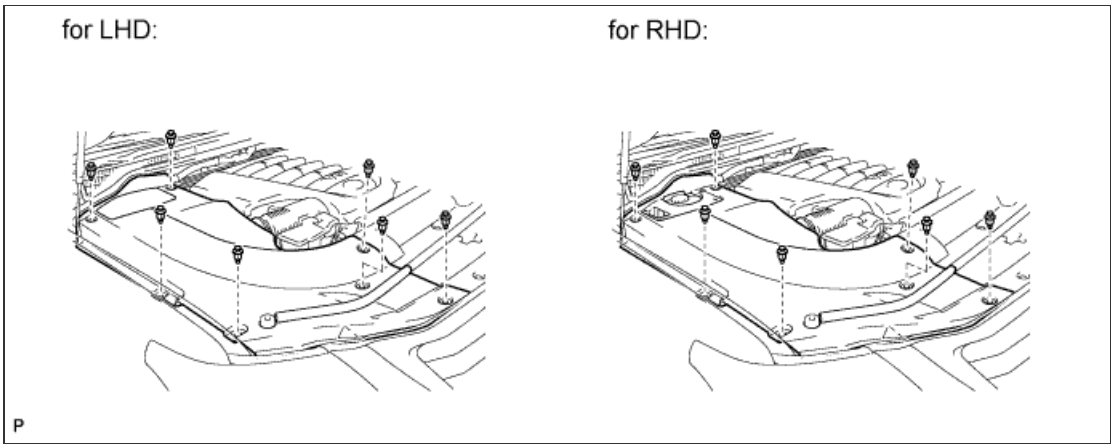
2. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



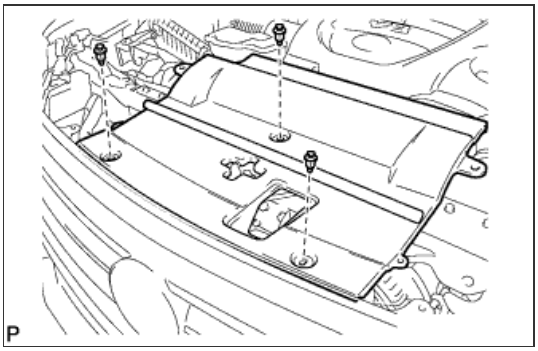
3. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



4. REMOVE UPPER RADIATOR SUPPORT SEAL

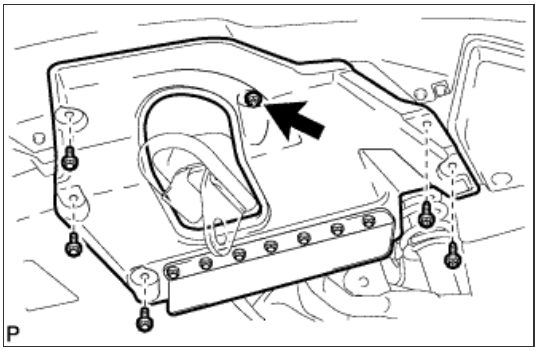
a. Remove the 3 clips and upper radiator support seal.



5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



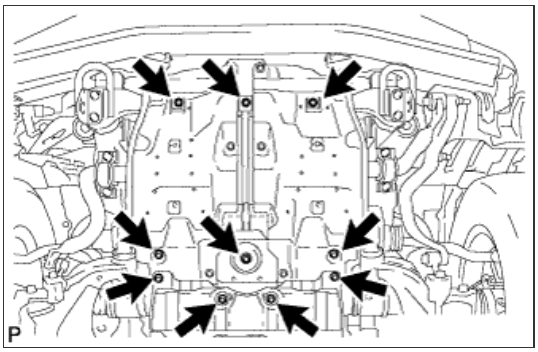
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

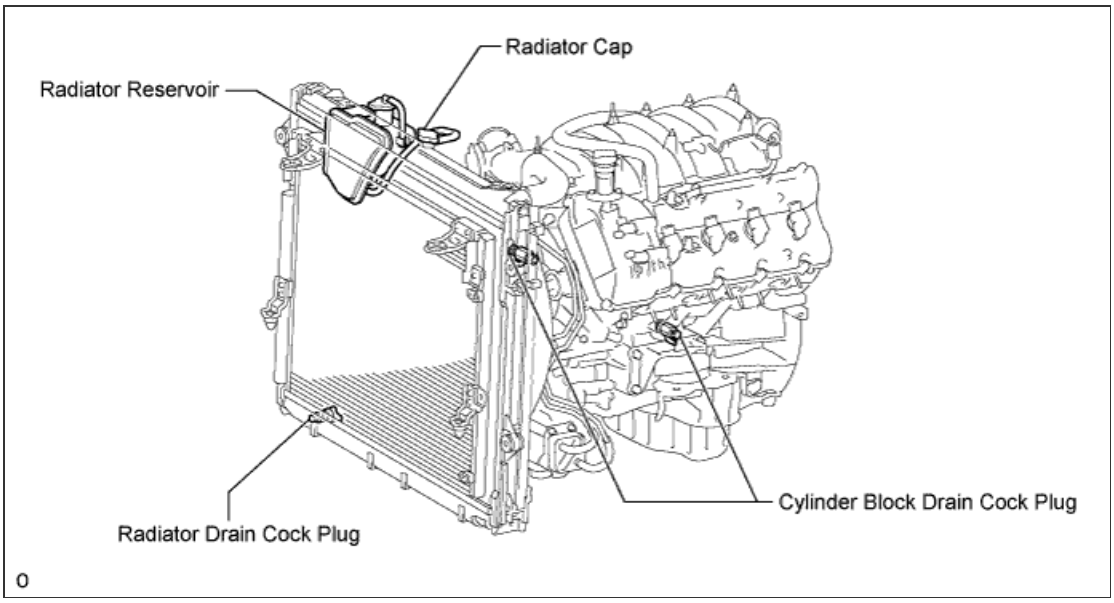
a. Remove the 10 bolts and No. 1 engine under cover.



8. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

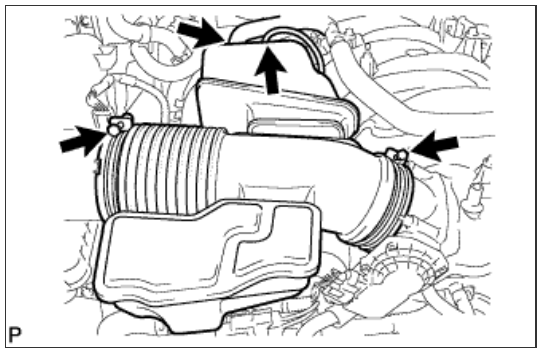
e. Tighten the radiator drain cock plug by hand.

9. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

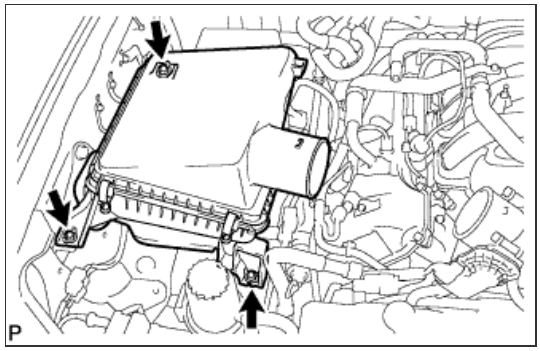
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



10. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



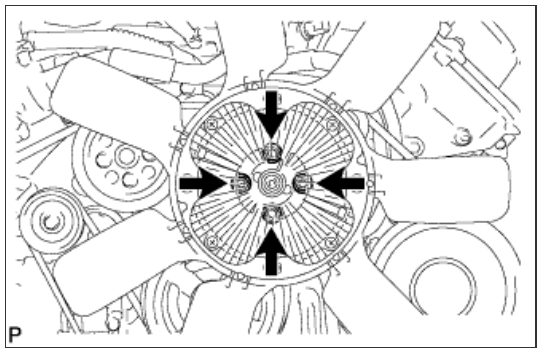
11. REMOVE NO. 1 RADIATOR HOSE

12. REMOVE NO. 2 RADIATOR HOSE

13. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

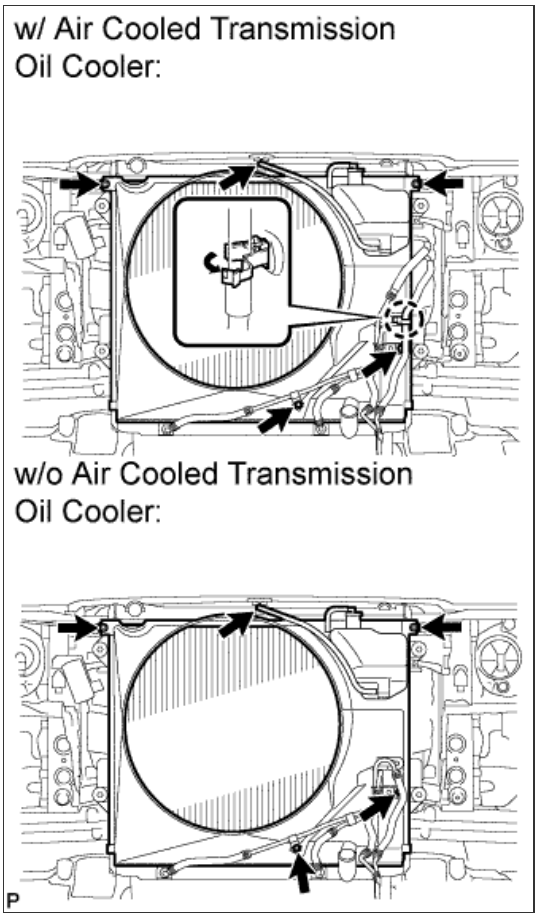
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

Be careful not to damage the radiator core.

h. Remove the fan pulley.



14. REMOVE WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

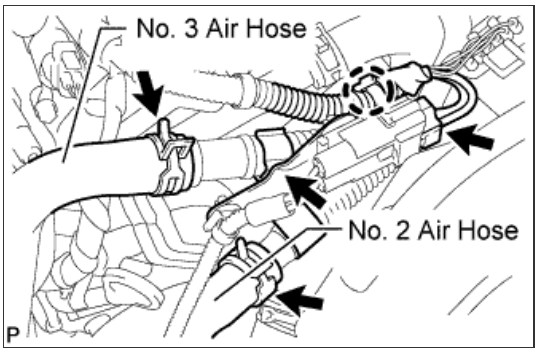
a. w/ Secondary Air Injection System:

i. Disconnect the No. 2 and No. 3 air hoses.

ii. Disconnect the air pump connector.

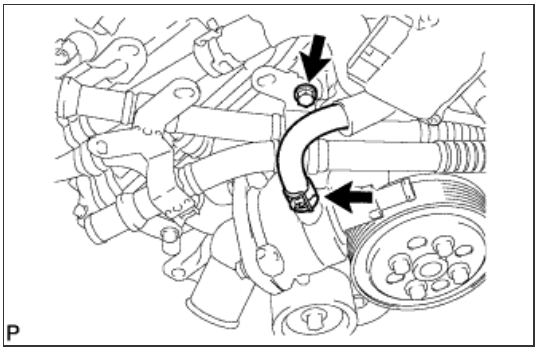
iii. Disconnect the air pump connector clamp holder.

iv. Using a clip remover, detach the wire harness clamp.

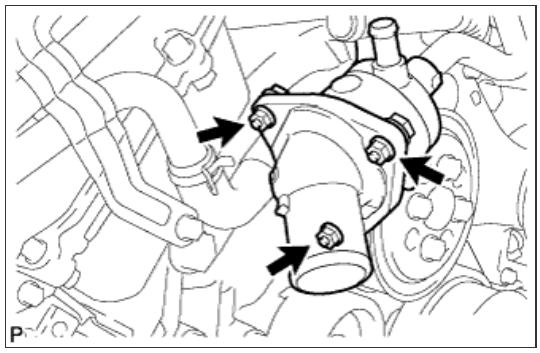


b. Disconnect the No. 5 water by-pass hose.

c. w/ Secondary Air Injection System:
Remove the air tube bracket bolt.



d. Remove the 3 nuts, water inlet with thermostat and gasket.

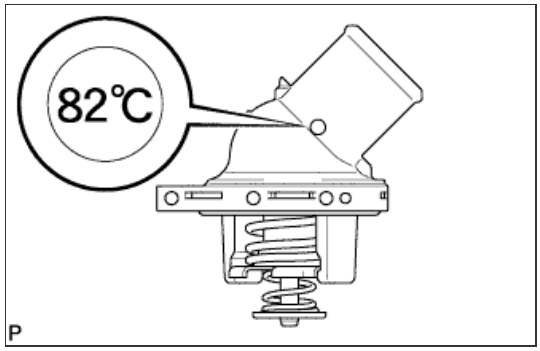


for Preparation Click here

1. INSPECT WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

HINT:

The valve opening temperature is stamped on the water inlet with thermostat.

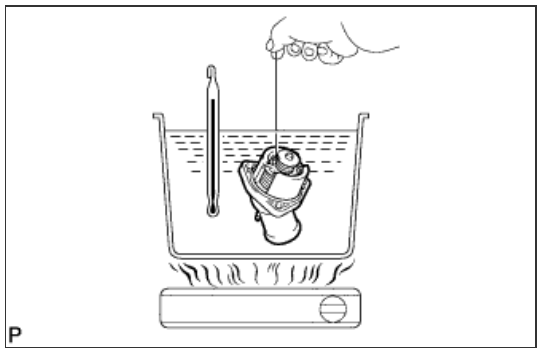


a. Immerse the water inlet with thermostat in water and gradually heat the water.

b. Check the valve opening temperature.

Standard valve opening temperature:
80 to 84°C (176 to 183°F)

If the valve opening temperature is not within the specified range, replace the water inlet sub-assembly with thermostat.

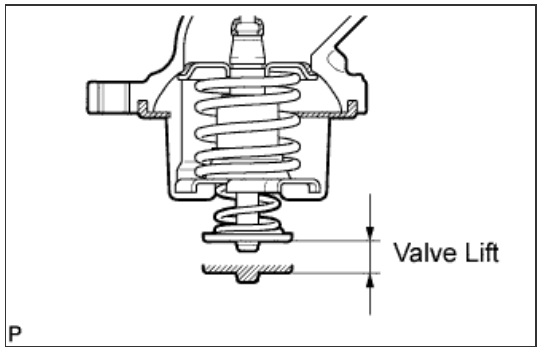


c. Check the valve lift.

Standard valve lift:
10.0 mm (0.394 in.) or more at 95°C (203°F)

If the valve lift is not as specified, replace the water inlet with thermostat.

d. Check that the valve is fully closed when the water inlet with thermostat is at a low temperature (below 77°C (171°F)).
If it is not fully closed, replace the water inlet sub-assembly with thermostat.

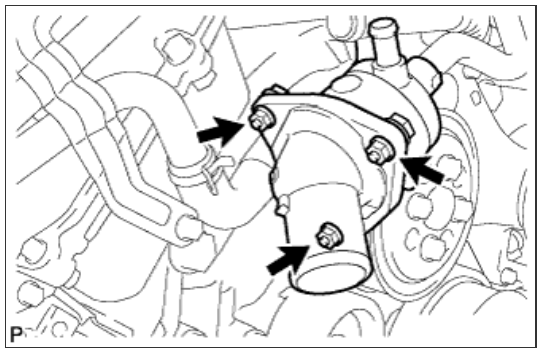


for Preparation Click here

1. INSTALL WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

a. Install a new gasket and the water inlet with thermostat with the 3 nuts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



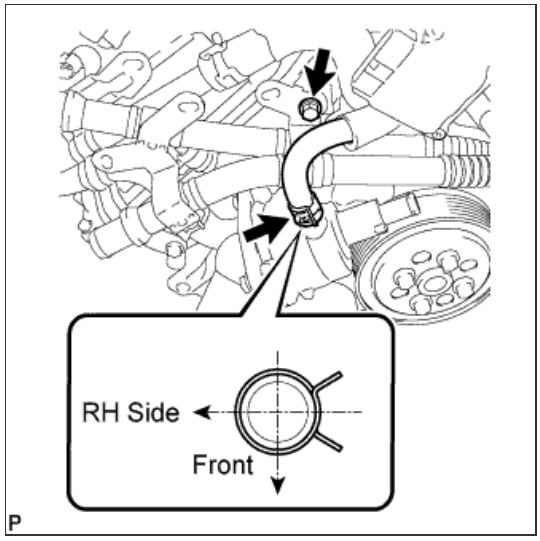
b. Install the air tube bracket bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

c. Connect the No. 5 water by-pass hose.

HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.

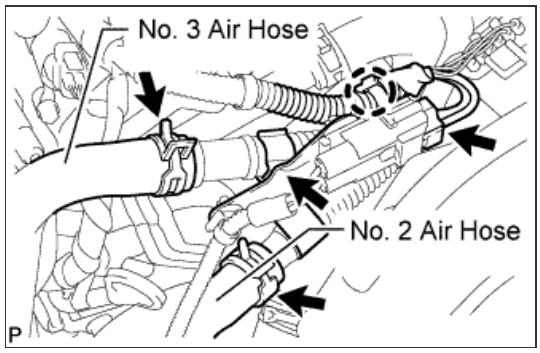


d. Connect the air pump connector clamp holder.

e. Attach the wire harness clamp.

f. Connect the air pump connector.

g. Connect the No. 2 and No. 3 air hoses.



2. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

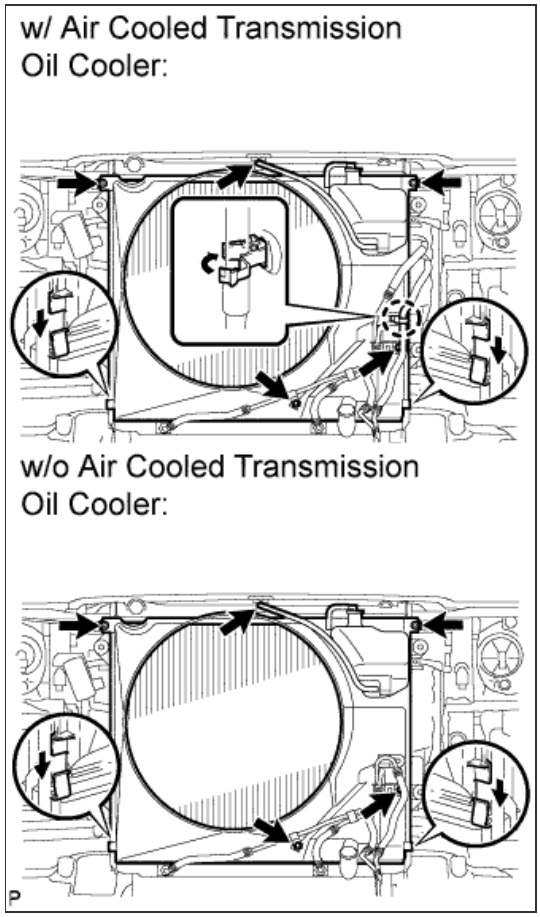
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

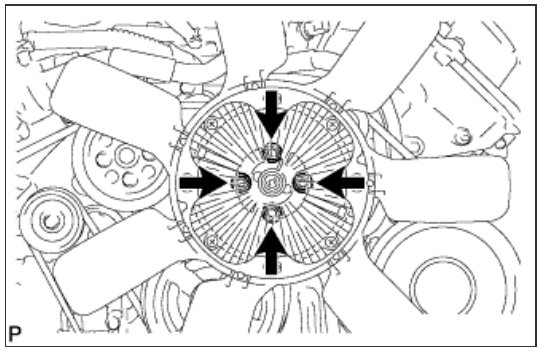
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



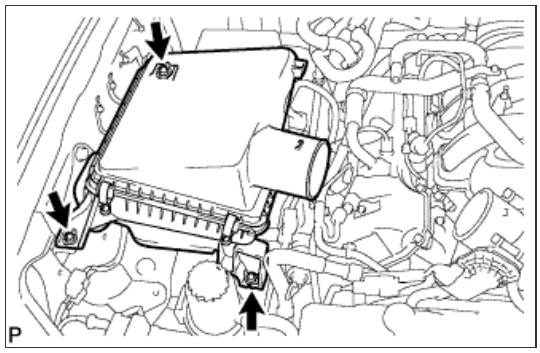
3. INSTALL NO. 2 RADIATOR HOSE

4. INSTALL NO. 1 RADIATOR HOSE

5. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



6. INSTALL AIR CLEANER HOSE ASSEMBLY

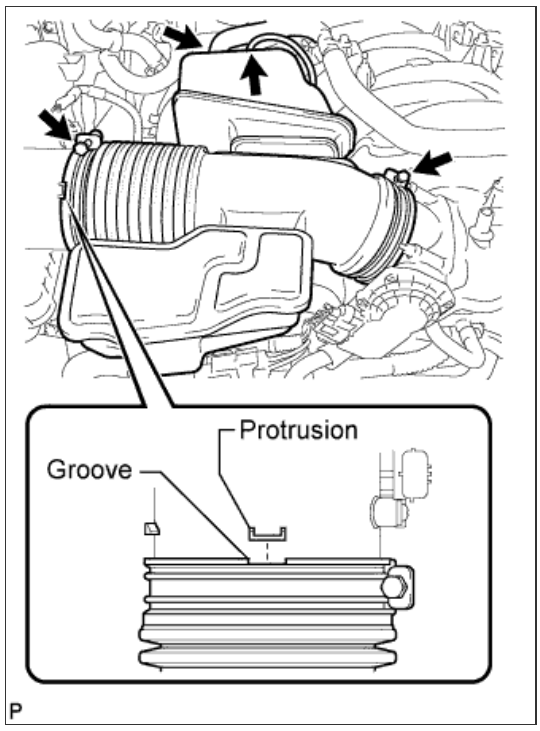
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



7. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

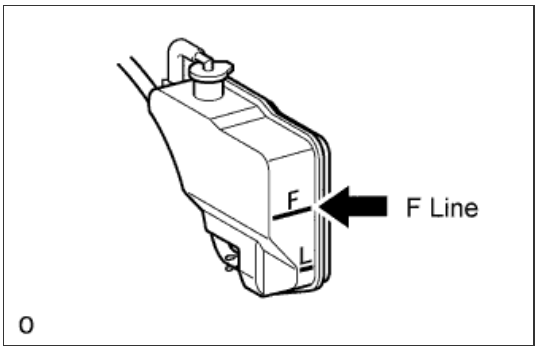
NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**



h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

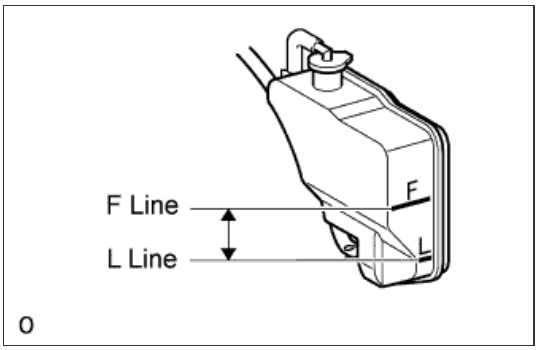
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

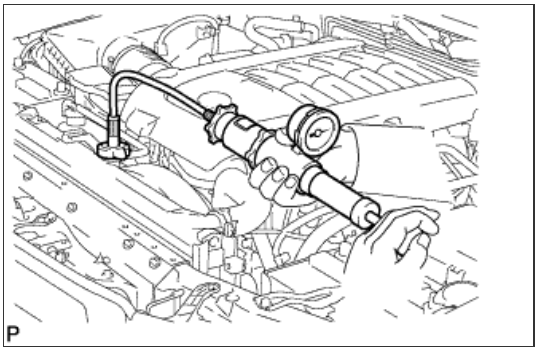


8. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

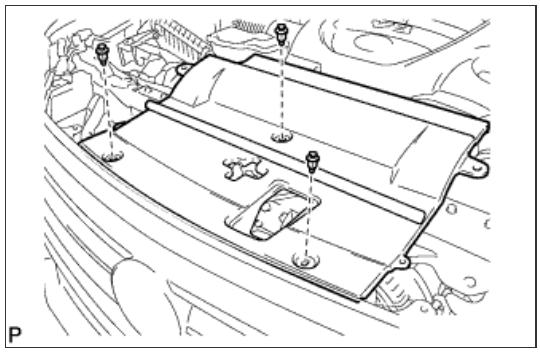
b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



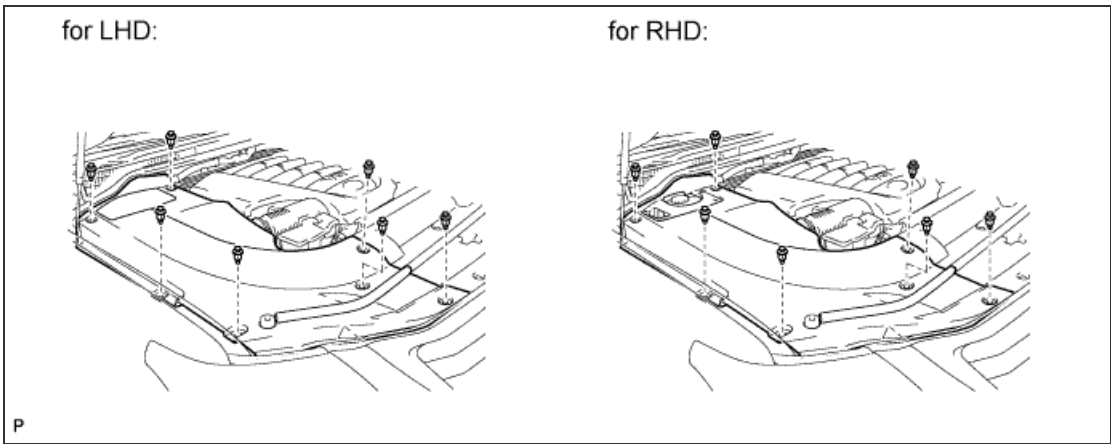
9. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



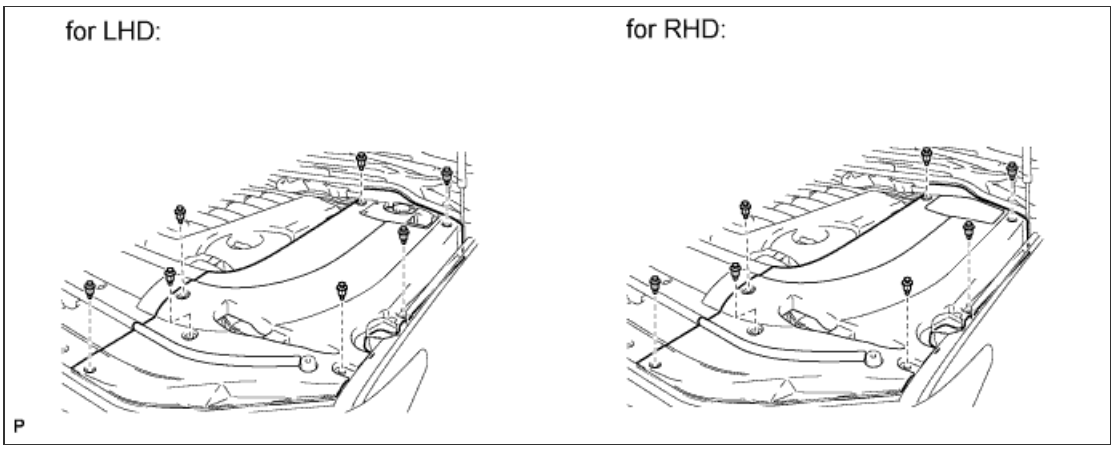
10. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



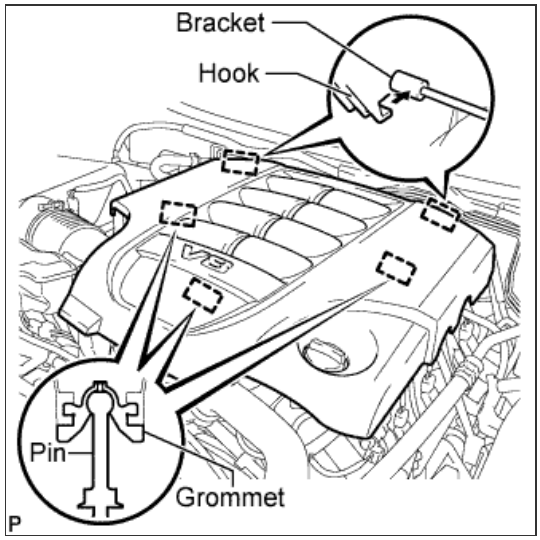
11. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



12. INSTALL V-BANK COVER SUB-ASSEMBLY

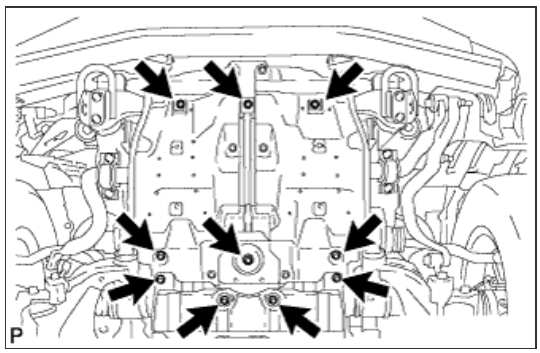
a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



13. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

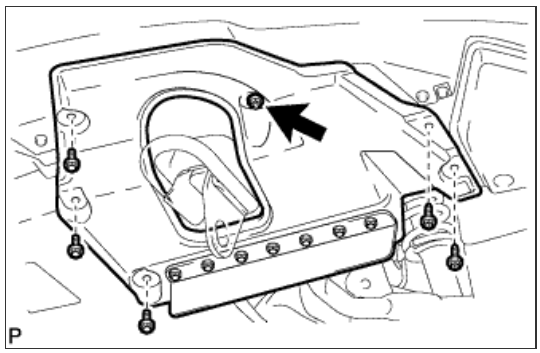
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



14. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



15. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

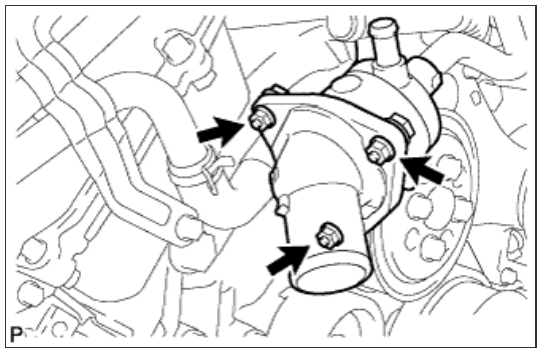
Use the same procedures described for the LH side.

for Preparation Click here

1. INSTALL WATER INLET SUB-ASSEMBLY WITH THERMOSTAT

a. Install a new gasket and the water inlet with thermostat with the 3 nuts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



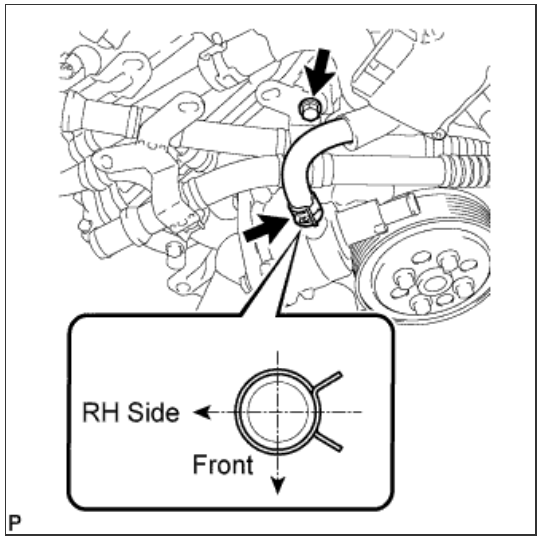
b. w/ Secondary Air Injection System:
Install the air tube bracket bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

c. Connect the No. 5 water by-pass hose.

HINT:

Install the hose so that the direction of the hose clamp is as indicated in the illustration.



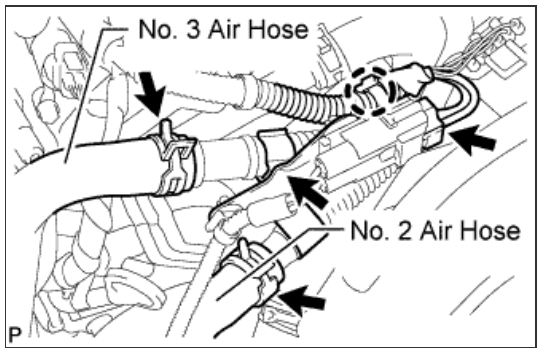
d. w/ Secondary Air Injection System:

i. Connect the air pump connector clamp holder.

ii. Attach the wire harness clamp.

iii. Connect the air pump connector.

iv. Connect the No. 2 and No. 3 air hoses.



2. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

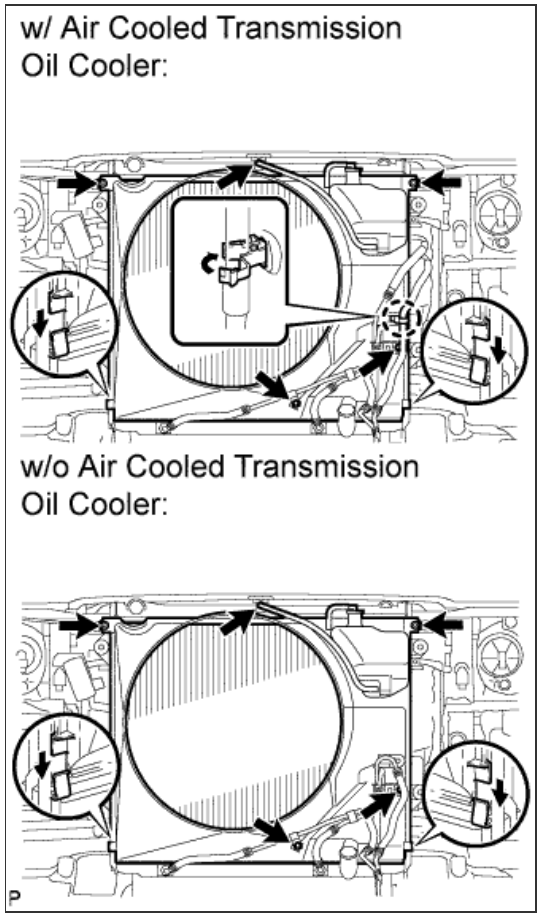
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

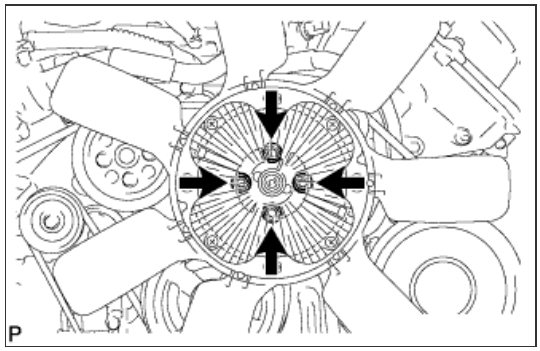
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



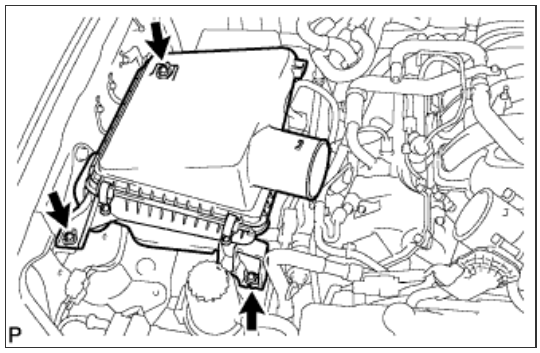
3. INSTALL NO. 2 RADIATOR HOSE

4. INSTALL NO. 1 RADIATOR HOSE

5. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



6. INSTALL AIR CLEANER HOSE ASSEMBLY

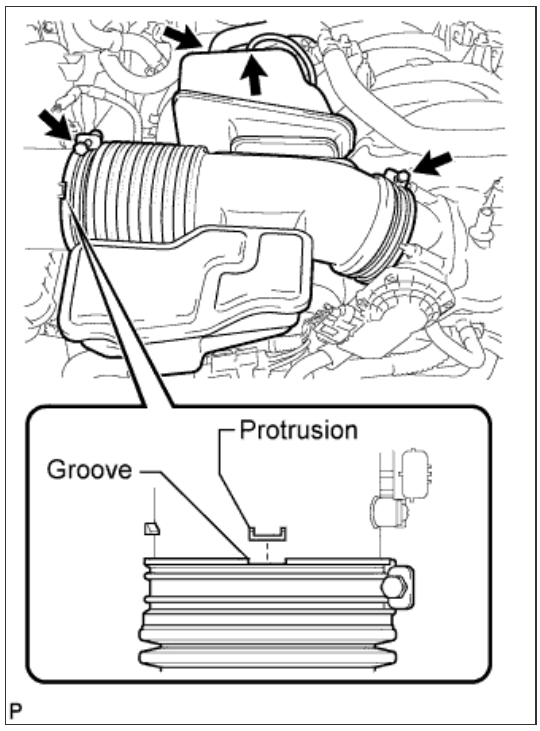
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



7. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.

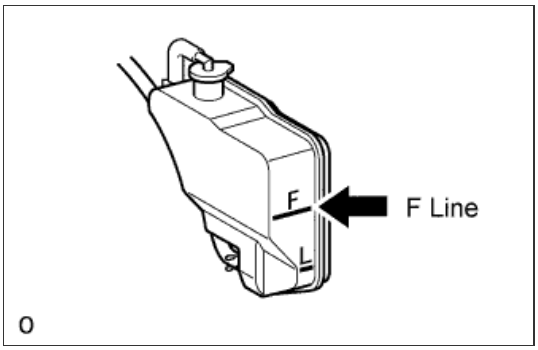
NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**



h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

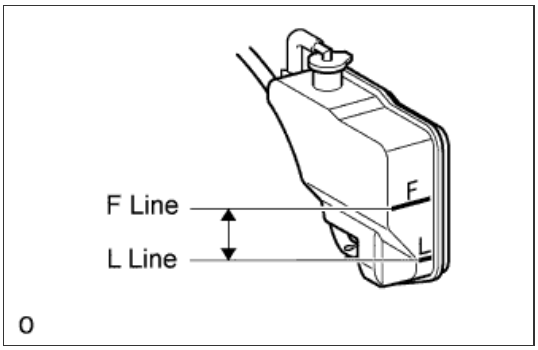
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

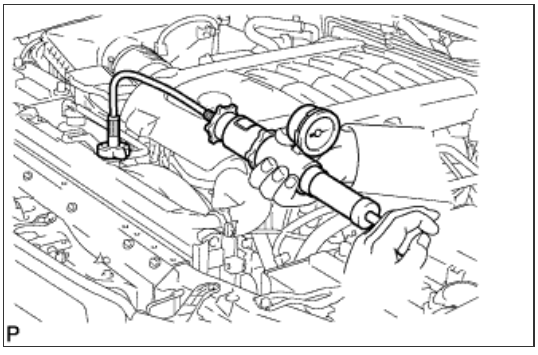


8. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

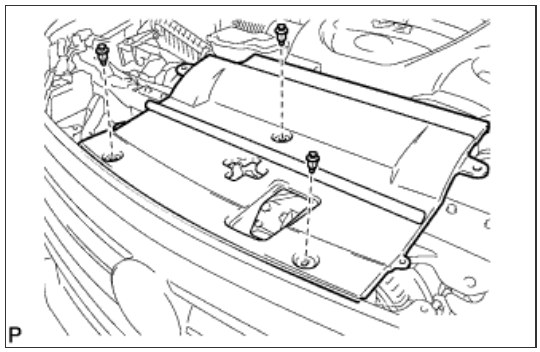
b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



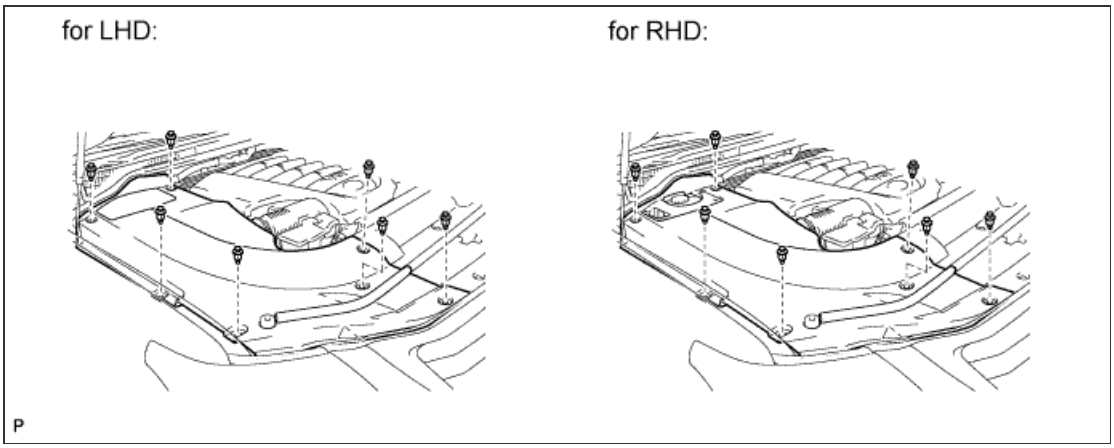
9. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



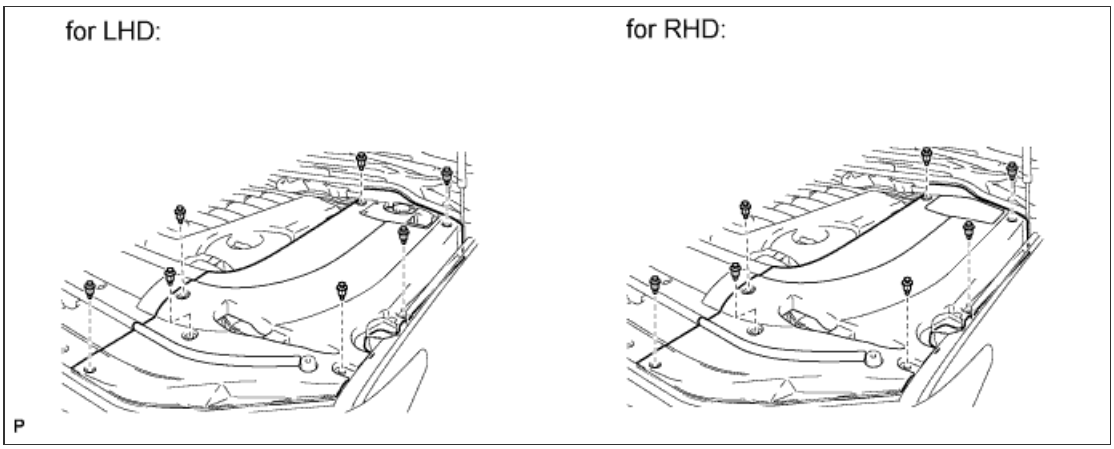
10. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



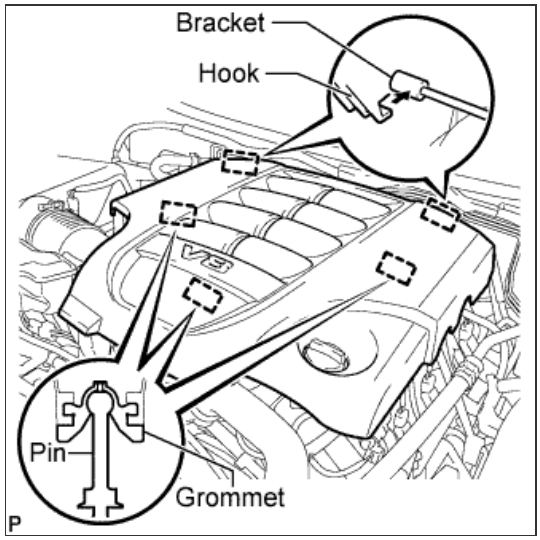
11. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



12. INSTALL V-BANK COVER SUB-ASSEMBLY

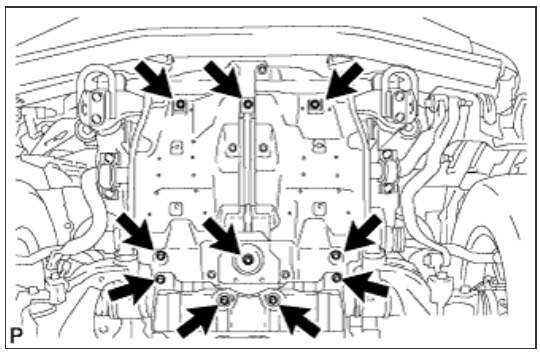
a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



13. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

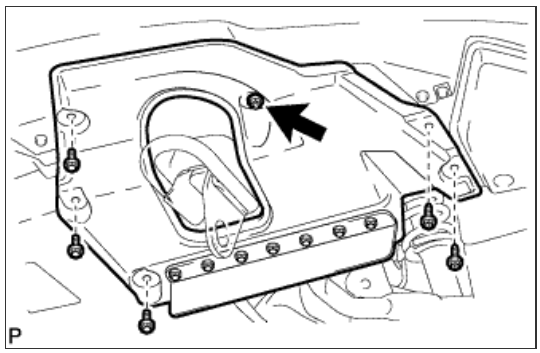
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



14. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.

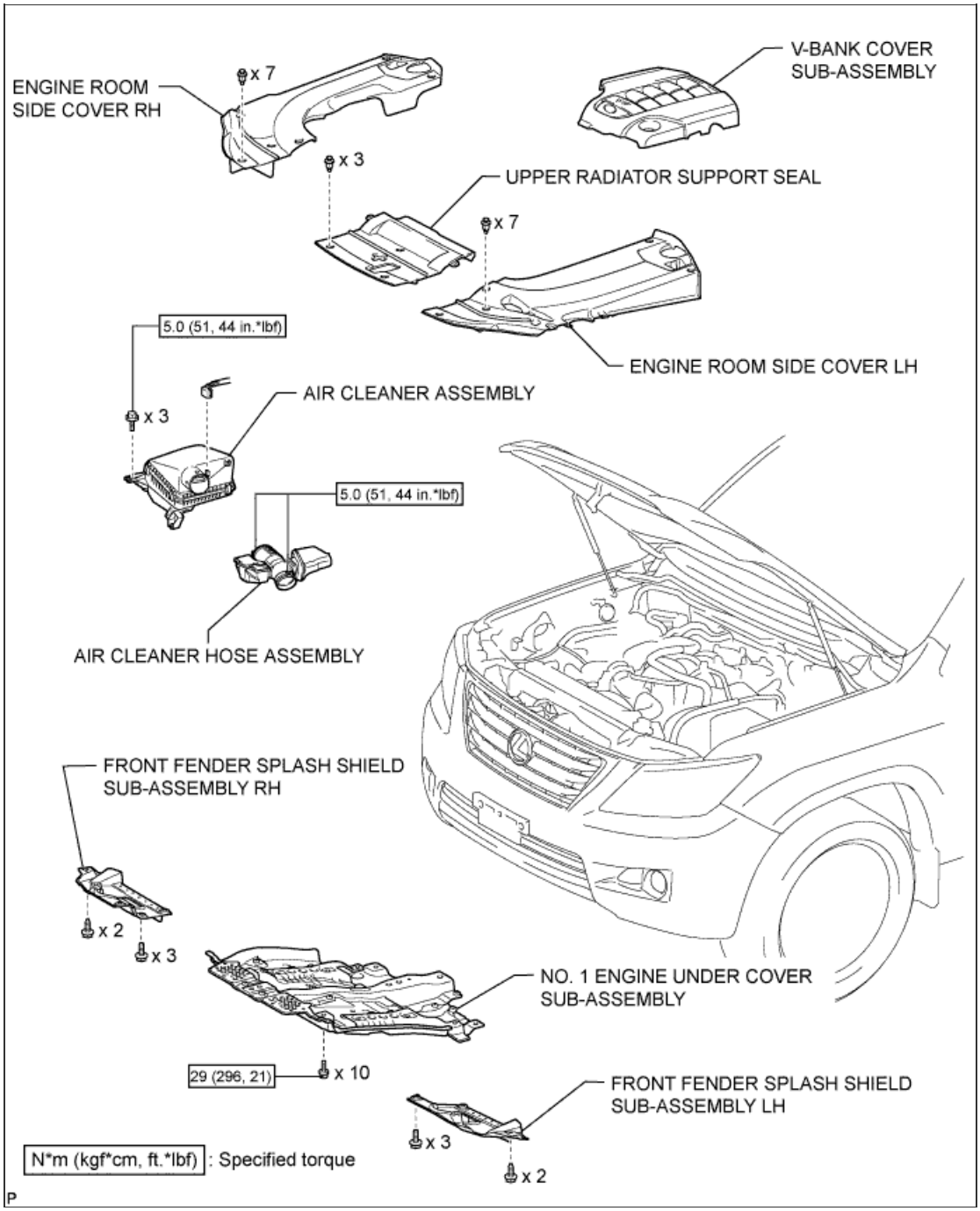


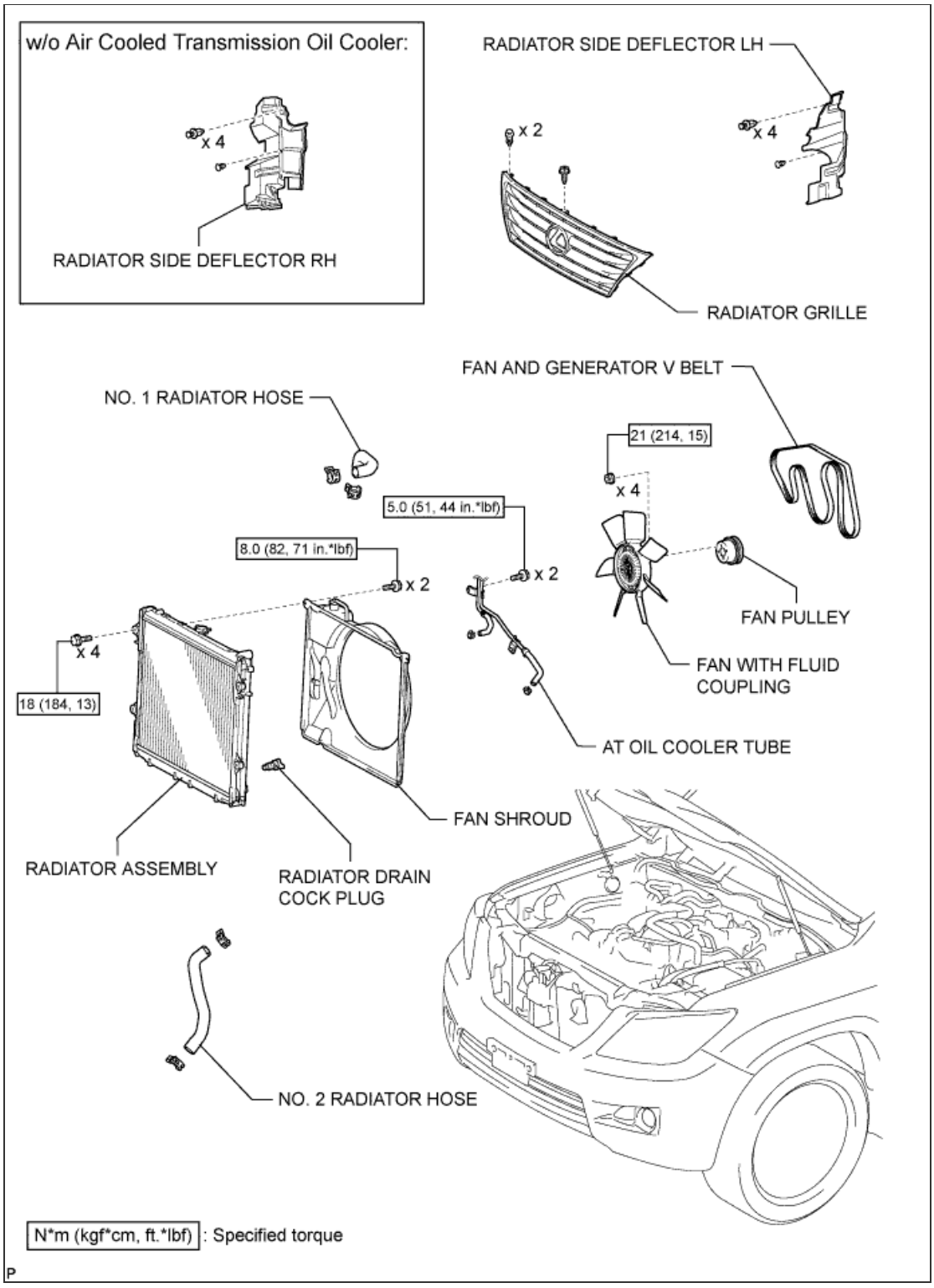
15. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

for Preparation Click here




w/o Air Cooled Transmission Oil Cooler:
x 4
RADIATOR SIDE DEFLECTOR RH
RADIATOR SIDE DEFLECTOR LH
x 2
x 4
RADIATOR GRILLE
FAN AND GENERATOR V BELT
NO. 1 RADIATOR HOSE
21 (214, 15)
x 4
5.0 (51, 44 in.*lbf)
8.0 (82, 71 in.*lbf)
x 2
x 2
FAN PULLEY
FAN WITH FLUID COUPLING
x 4
18 (184, 13)
AT OIL COOLER TUBE
FAN SHROUD
RADIATOR ASSEMBLY
RADIATOR DRAIN COCK PLUG
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque

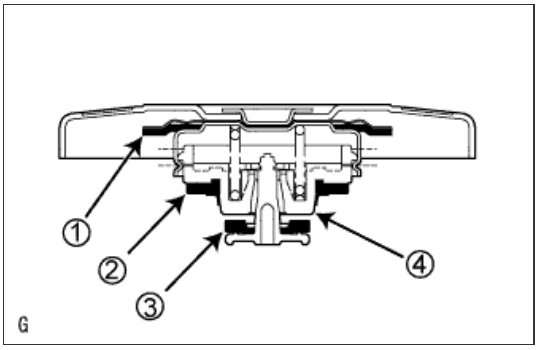
P

for Preparation Click here

1. INSPECT RADIATOR CAP SUB-ASSEMBLY

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



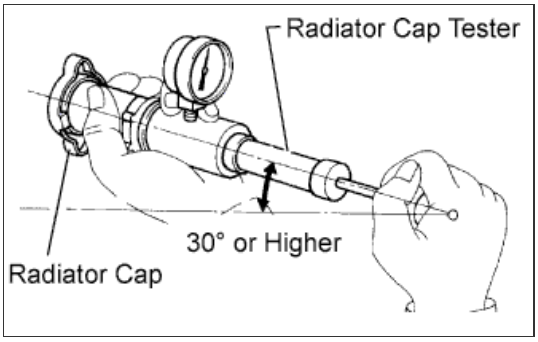
a. Visually check the radiator cap.

i. If there are water stains or foreign matter on rubber packing 1, 2 or 3, clean it with water and finger scouring.

ii. Check that rubber packing 1, 2 and 3 are not deformed, cracked or swollen.

iii. Check that rubber packing 3 and 4 are not stuck together.

b. Measure the valve opening pressure.



i. Apply engine coolant to rubber packing 2 and 3 before using a radiator cap tester.

ii. When using the cap tester, tilt it more than 30°.

iii. Pump the cap tester several times, and check the maximum pressure.

Pumping speed:
1 pump per second

HINT:

Even if the cap cannot maintain the maximum pressure, it is not a defect.

Standard Judgment Criterion:

Item	Specified Condition
Standard value (for brand-new cap)	93 to 123 kPa (1.0 to 1.3 kgf/cm^2, 13.5 to 18 psi)
Minimum standard value (after using cap)	79 kPa (0.8 kgf/cm^2, 11.4 psi)

If the maximum pressure is less than the minimum standard value, replace the radiator cap sub-assembly.

2. INSPECT FINS FOR BLOCKAGE

a. Check that the radiator and condenser are not blocked with leaves, dirt, or insects. Clean the hose connections.
If the fins are blocked, wash them with water or a steam cleaner.

NOTICE:

- **If the distance between the steam cleaner and core is too close, the fins may be damaged.**
- **Keep the following injection distance.**

Standard Injection Distance:

Injection Condition	Injection Pressure
300 mm (11.8 in.)	2942 to 4903 kPa (30.0 to 50.0 kgf/cm^2,

	427 to 711 psi)
500 mm (19.7 in.)	4903 to 7845 kPa (50.0 to 80.0 kgf/cm^2, 711 to 1138 psi)

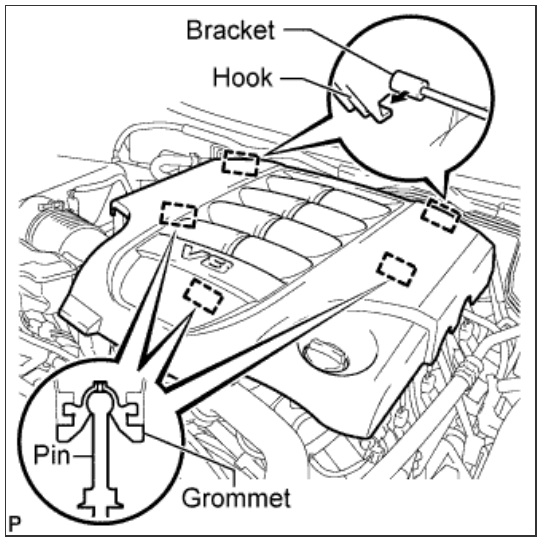
- **If the fins are bent, straighten them with a screwdriver or pliers.**
- **Never apply water directly onto the electric components.**

b. Dry the fins with compressed air.

for Preparation Click here

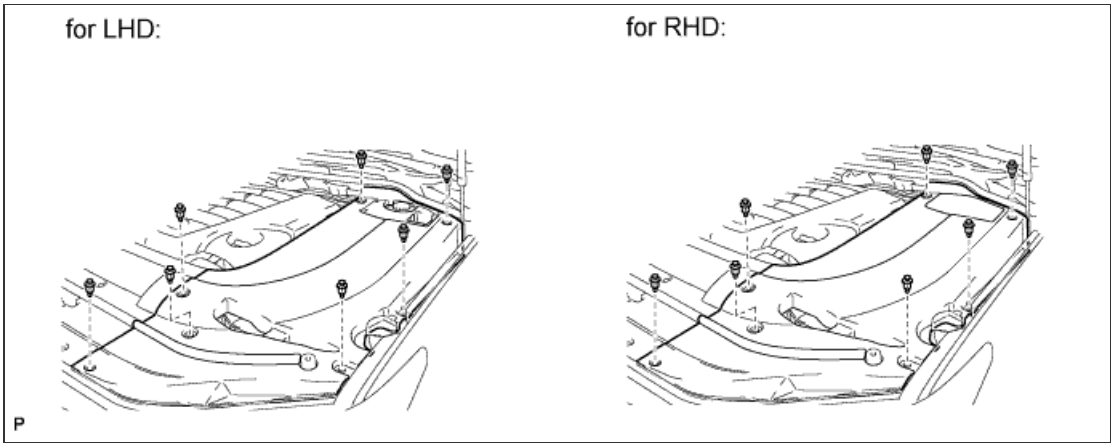
1. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



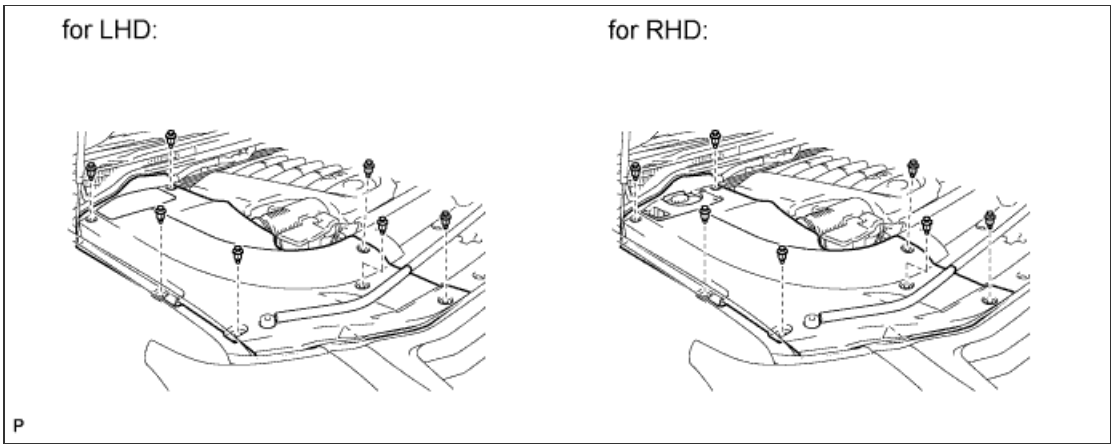
2. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



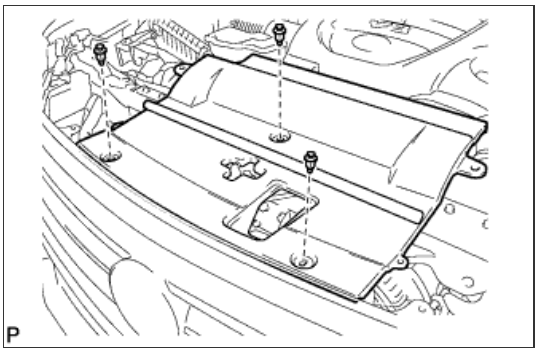
3. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



4. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



5. REMOVE RADIATOR GRILLE

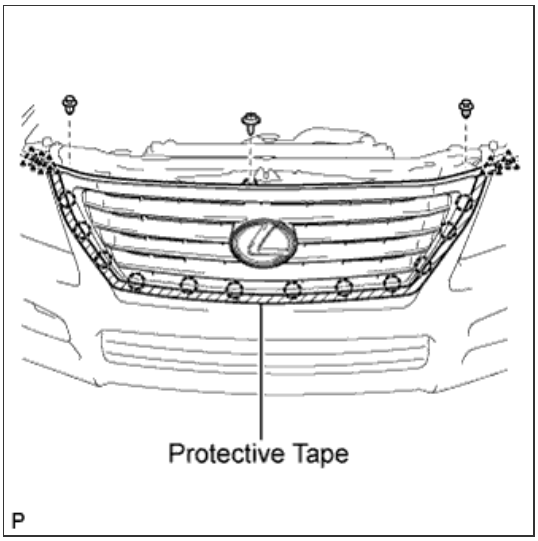
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

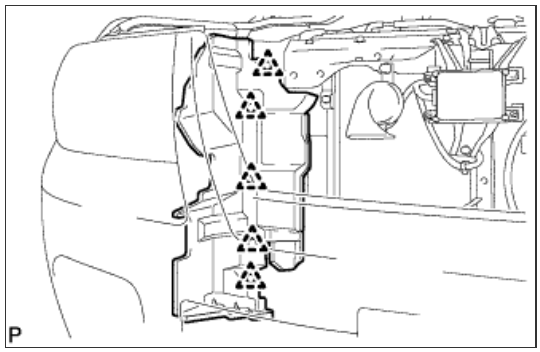
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



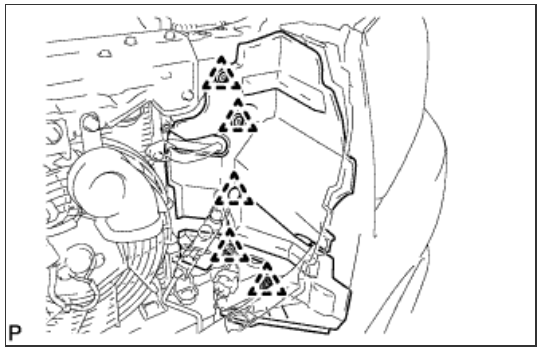
6. REMOVE RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



7. REMOVE RADIATOR SIDE DEFLECTOR LH

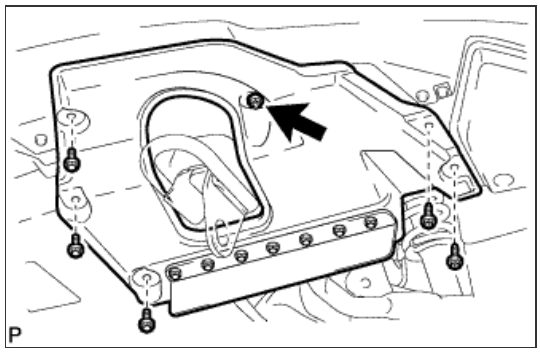
a. Using a clip remover, remove the 5 clips and side deflector.



8. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



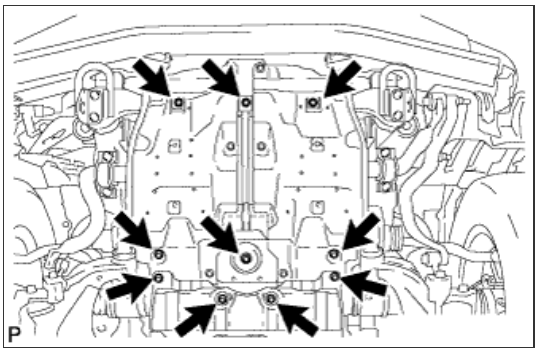
9. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

10. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

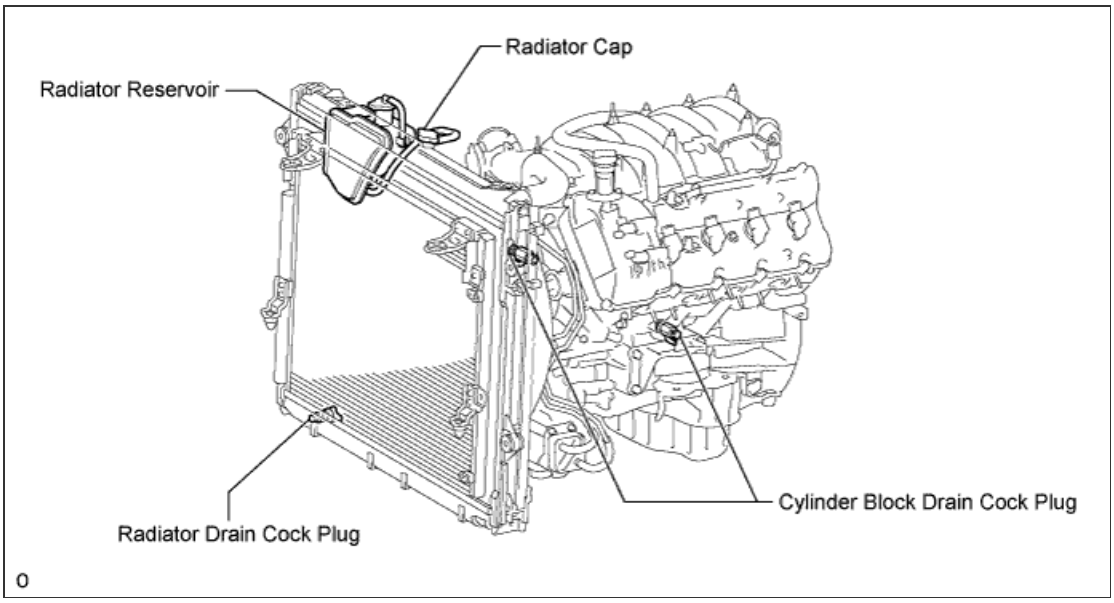
a. Remove the 10 bolts and No. 1 engine under cover.



11. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

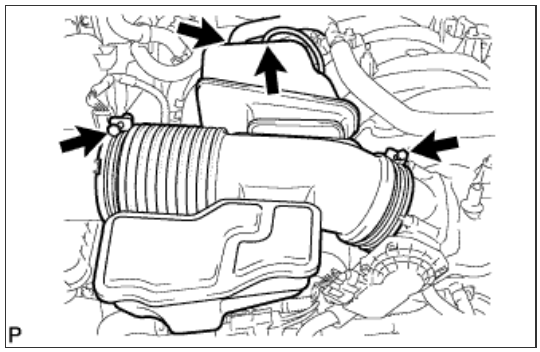
e. Tighten the radiator drain cock plug by hand.

12. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



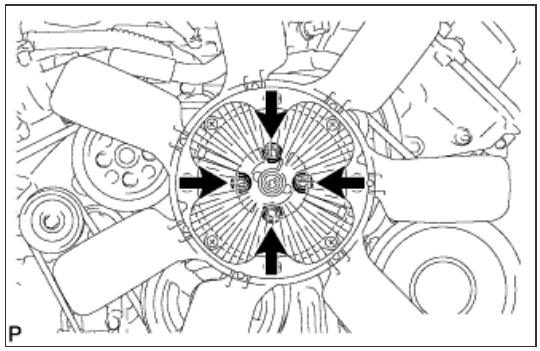
13. REMOVE NO. 1 RADIATOR HOSE

14. REMOVE NO. 2 RADIATOR HOSE

15. REMOVE FAN SHROUD

a. Loosen the 4 nuts holding the fluid coupling fan.

b. Remove the fan and generator V belt (Click here).



c. Disconnect the reservoir hose from the upper radiator tank.

d. w/ Air Cooled Transmission Oil Cooler:
Detach the claw to open the flexible hose clamp.

e. Remove the 2 bolts and disconnect the oil cooler tube from the fan shroud.

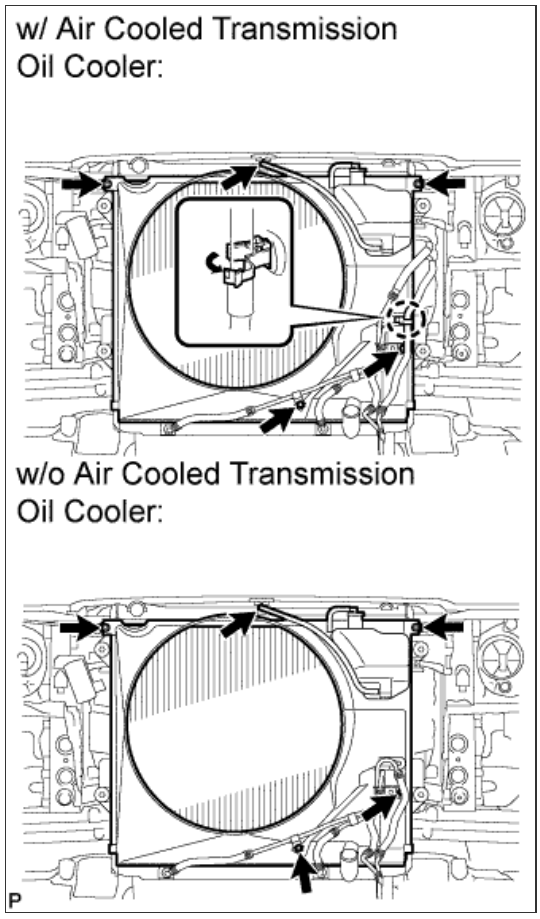
f. Remove the 2 bolts holding the fan shroud.

g. Remove the 4 nuts of the fluid coupling fan, and then remove the shroud together with the coupling fan.

NOTICE:

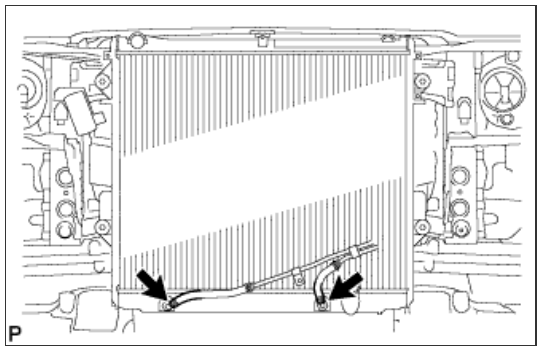
Be careful not to damage the radiator core.

h. Remove the fan pulley.

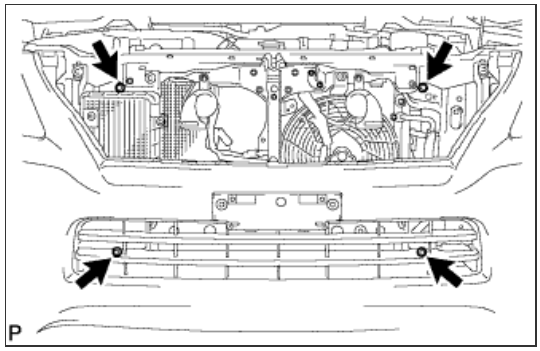


16. REMOVE RADIATOR ASSEMBLY

a. Disconnect the 2 oil cooler hoses.



b. Remove the 4 bolts and radiator.



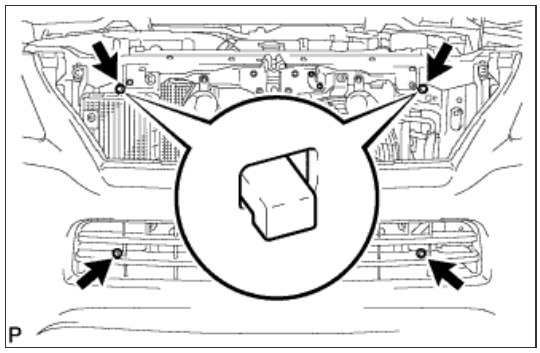
for Preparation Click here

1. INSTALL RADIATOR ASSEMBLY

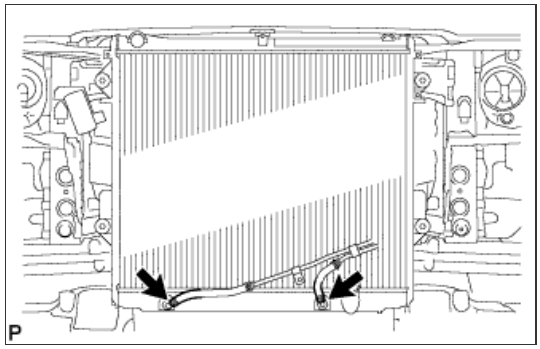
a. Set the radiator bracket hooks to the radiator support holes.

b. Install the radiator with the 4 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }



c. Connect the 2 oil cooler hoses.



2. INSTALL FAN SHROUD

a. Install the fan pulley.

b. Place the shroud together with the coupling fan between the radiator and engine.

NOTICE:

Be careful not to damage the radiator core.

c. Temporarily install the fluid coupling fan to the fluid coupling bracket with the 4 nuts. Tighten the nuts as much as possible by hand.

d. Attach the claws of the shroud to the radiator as shown in the illustration.

e. Install the shroud with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

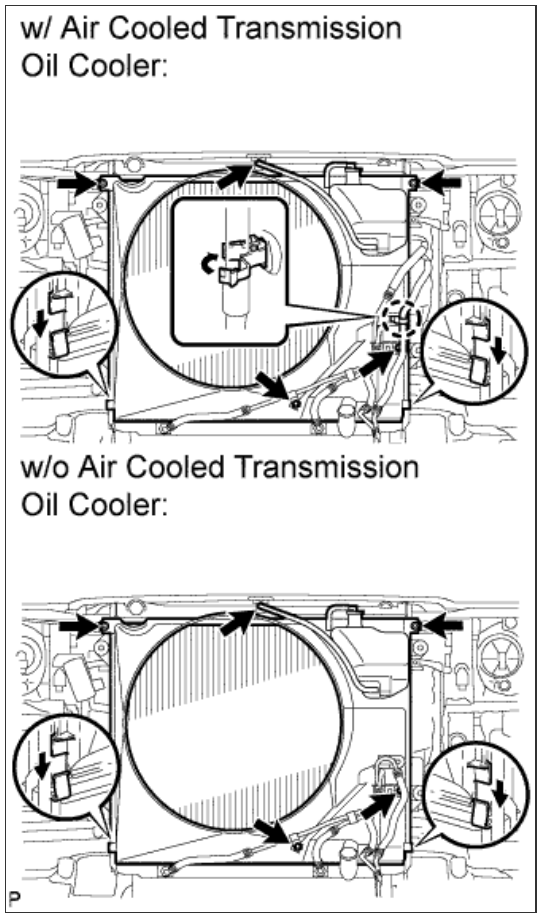
f. Connect the oil cooler tube to the fan shroud with the 2 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

g. w/ Air Cooled Transmission Oil Cooler:
Pass the hose through the flexible hose clamp and close the clamp as shown in the illustration.

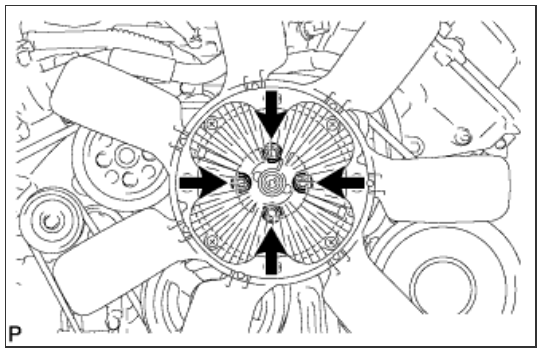
h. Connect the reservoir hose to the upper radiator tank.

i. Install the fan and generator V belt (Click here).



j. Tighten the 4 nuts of the fluid coupling fan.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



3. INSTALL NO. 2 RADIATOR HOSE

4. INSTALL NO. 1 RADIATOR HOSE

5. INSTALL AIR CLEANER HOSE ASSEMBLY

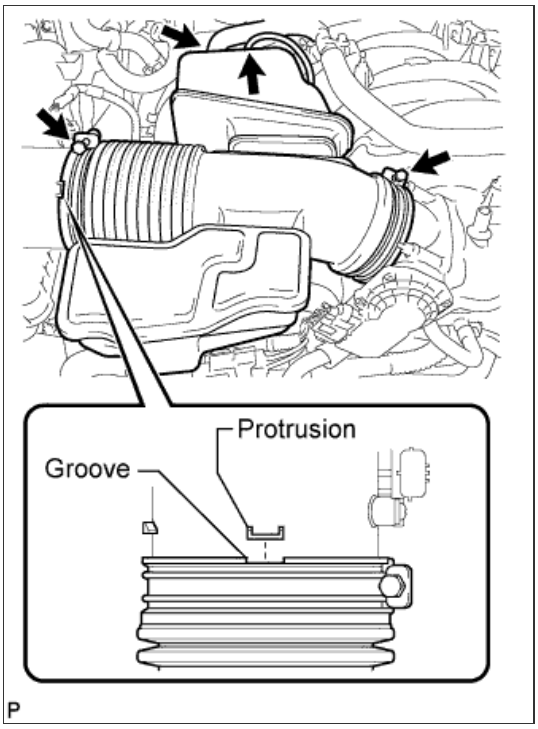
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



6. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

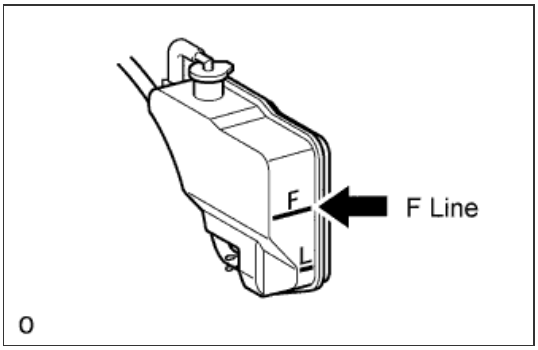
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**

- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

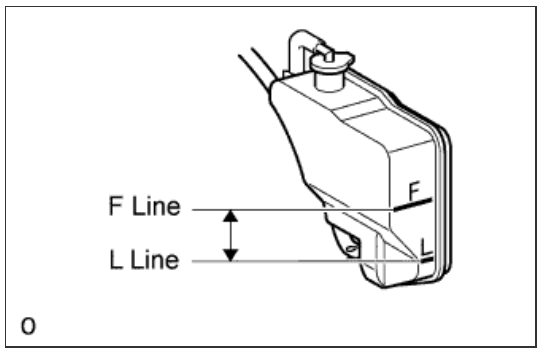
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.

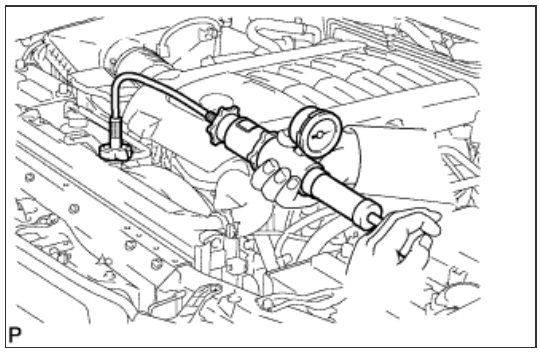


7. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

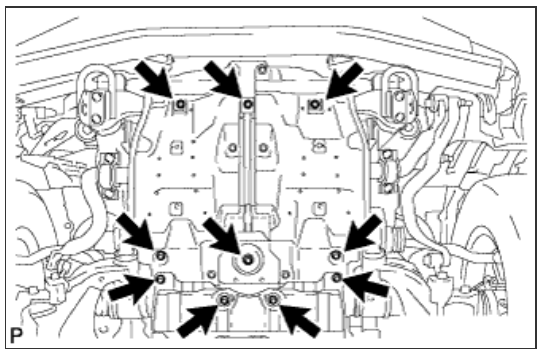
c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



8. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

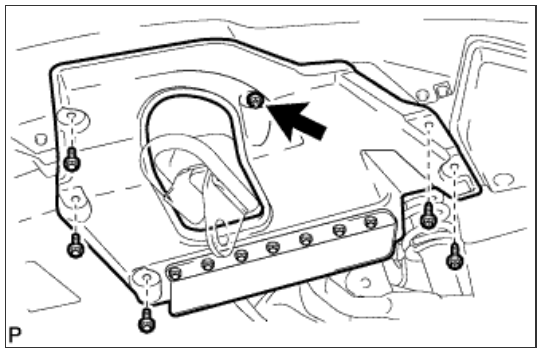
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



9. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



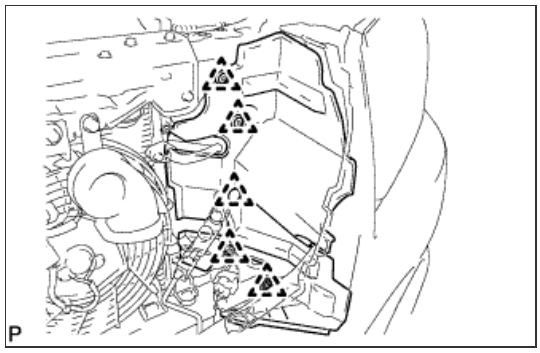
10. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

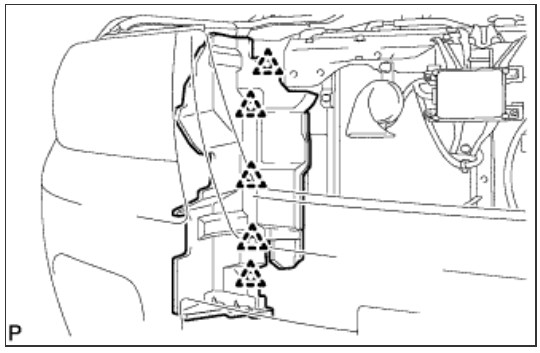
11. INSTALL RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



12. INSTALL RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



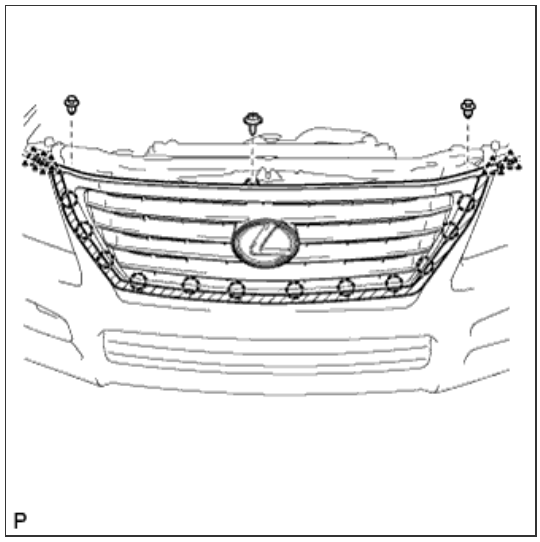
13. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

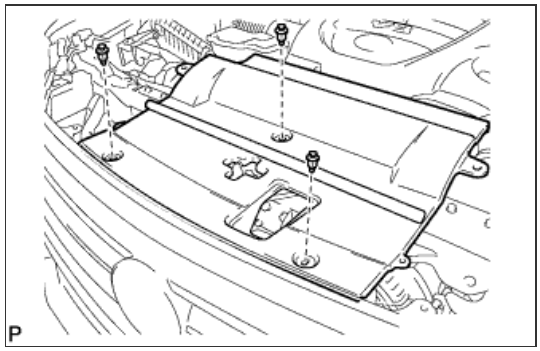
c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



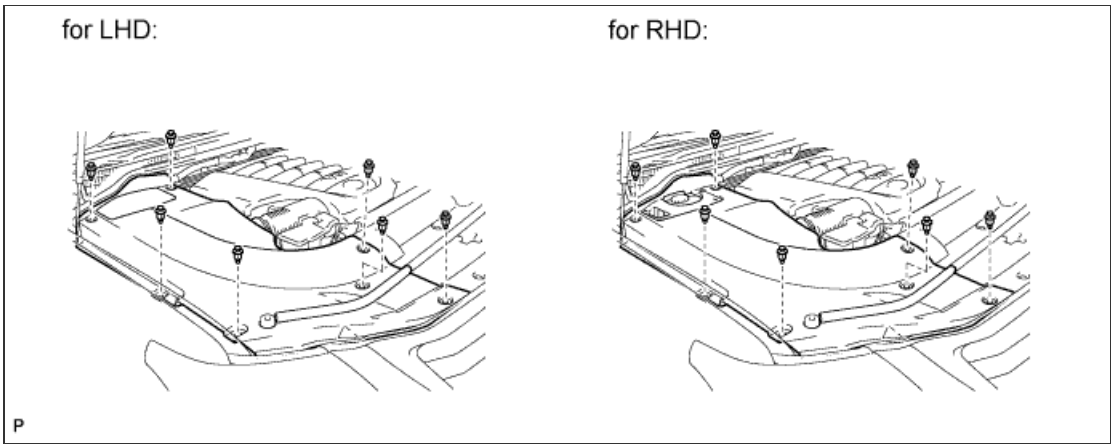
14. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



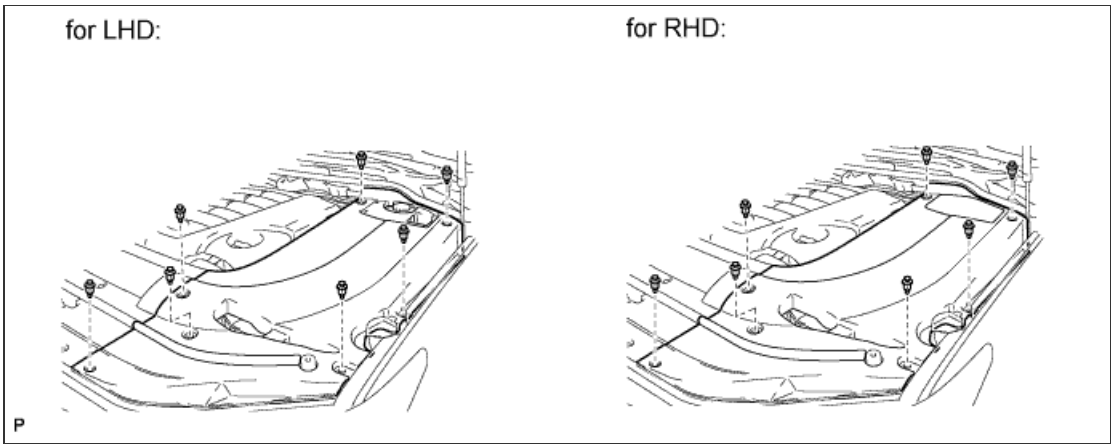
15. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



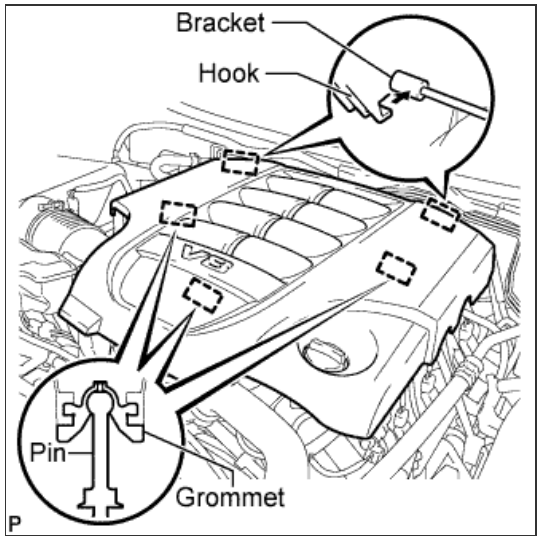
16. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



17. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



for Preparation Click here

1. CHECK OIL QUALITY

a. Check the oil for deterioration, water contamination, discoloring or thinning.
If the quality is visibly poor, replace the oil and filter (Click here).

2. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

NOTICE:

Do not fill engine oil above the full level mark.

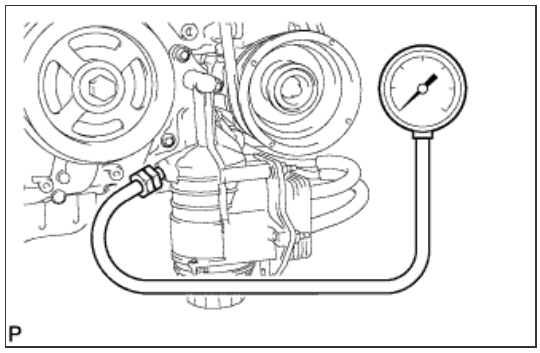
3. INSPECT OIL PRESSURE

a. Remove the oil pressure sender gauge (Click here).

b. Install an oil pressure gauge with an adapter.

c. Warm up the engine.

d. Measure the engine oil pressure.



Standard Oil Pressure:

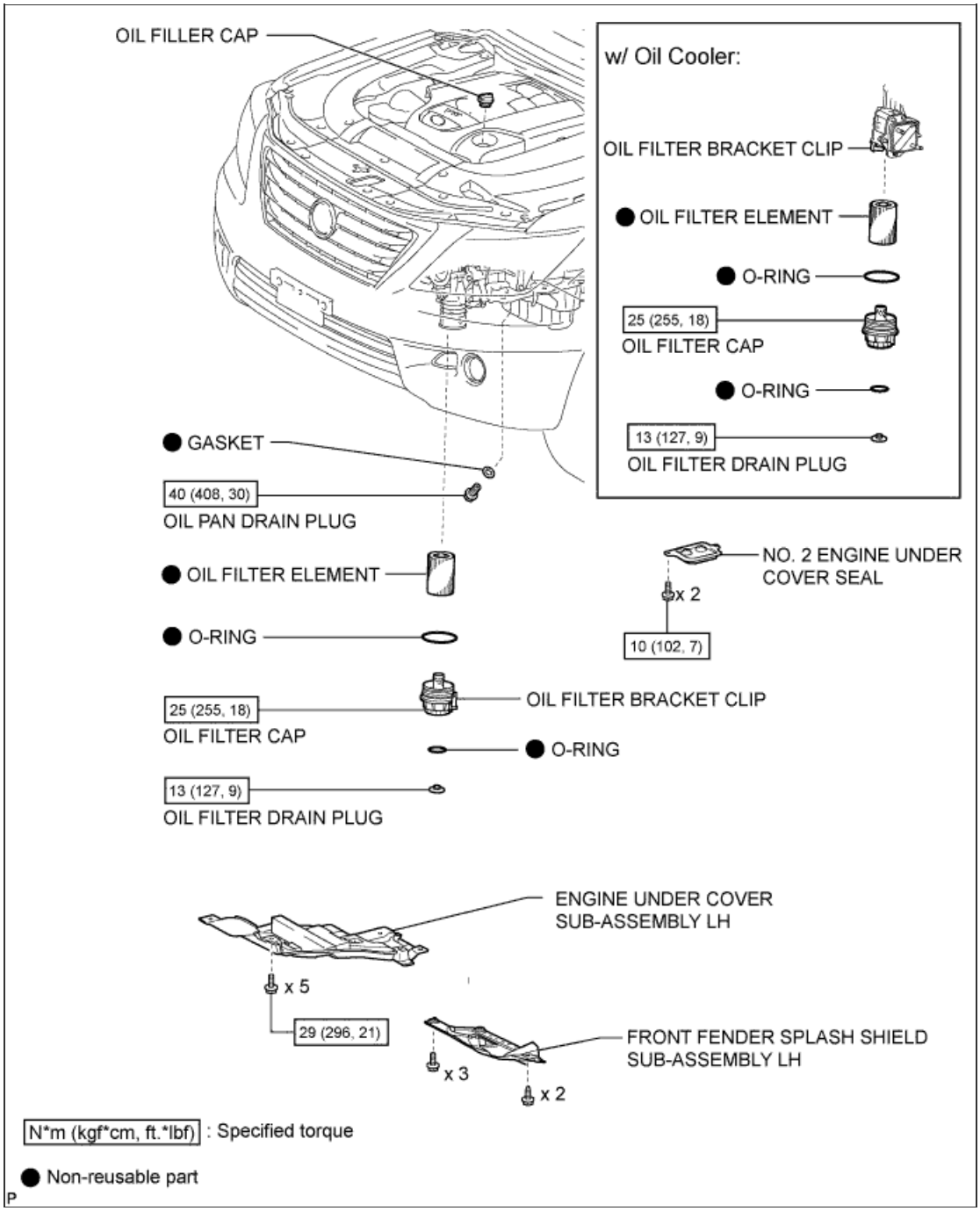
Condition	Specified Condition
Idle	70 kPa (0.7 kgf/cm^2, 10.1 psi) or higher
2500 rpm	220 kPa (2.2 kgf/cm^2, 32 psi) or higher

If the pressure is not as specified, check the oil pump (Click here).

e. Remove the oil pressure gauge and adapter.

f. Install the oil pressure sender gauge (Click here).

for Preparation [Click here]



for Preparation Click here

CAUTION:

- **Prolonged and repeated contact with engine oil will result in the removal of natural oils from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Precautions should be taken when replacing engine oil to minimize the risk of your skin making contact with used engine oil. Protective clothing and gloves that cannot be penetrated by oil should be worn. The skin should be washed with soap and water, or use waterless hand cleaner, to remove any used engine oil thoroughly. Do not use gasoline, thinners, or solvents.**
- **In order to protect the environment, used oil and used oil filters must be disposed of at designated disposal sites.**

1. DRAIN ENGINE OIL

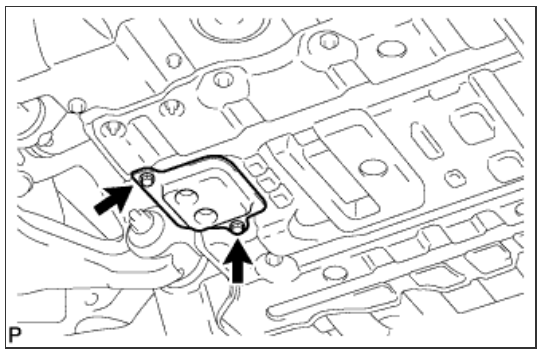
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

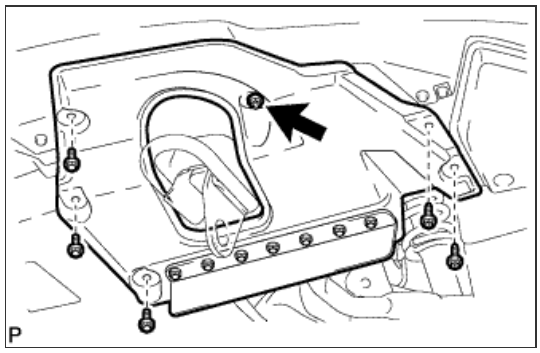
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



2. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

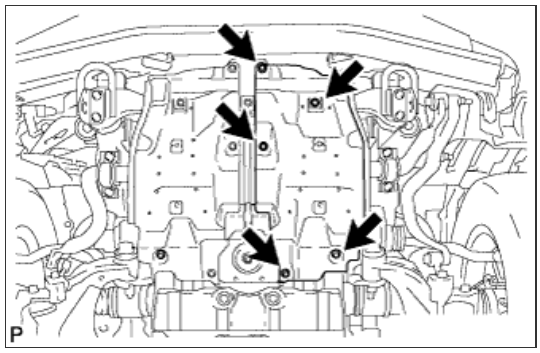
a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



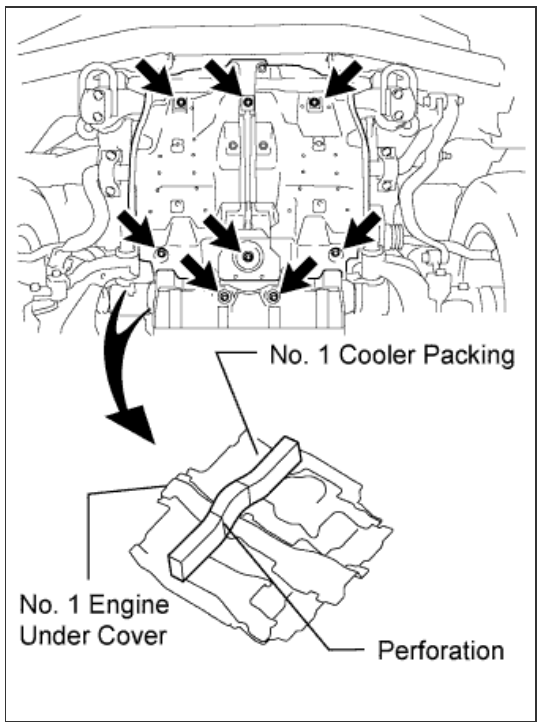
3. REMOVE ENGINE UNDER COVER SUB-ASSEMBLY LH

a. Remove the 5 bolts and engine under cover sub-assembly LH.



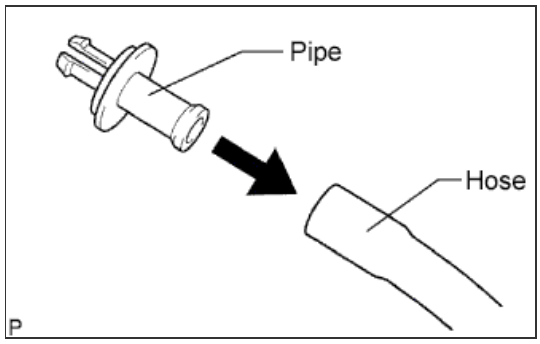
HINT:

If the No. 1 cooler packing is not divided, remove both sides of the engine under cover assembly and cut the packing at the perforation indicated in the illustration.

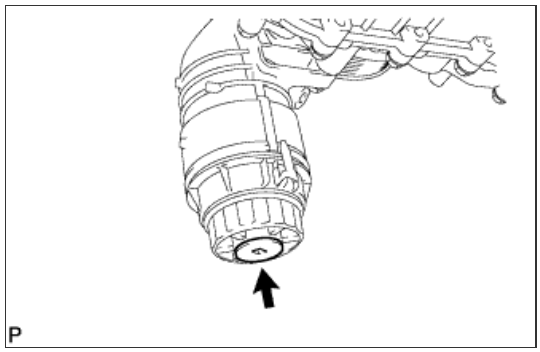


4. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



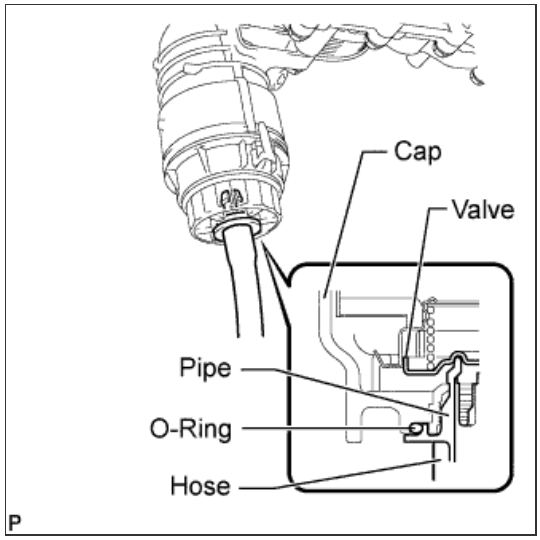
c. Install the pipe to the oil filter cap.

NOTICE:

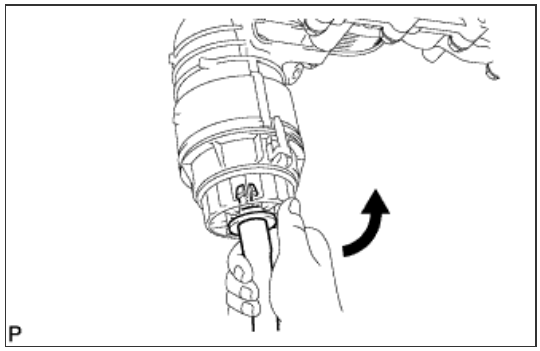
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

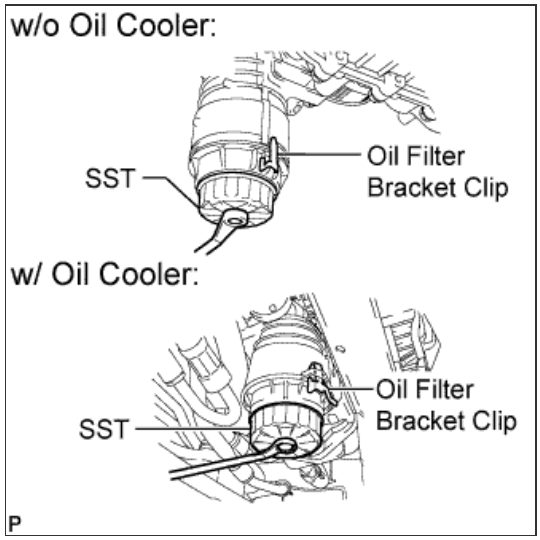


e. Using SST, remove the oil filter cap.

SST
09228-06501

NOTICE:

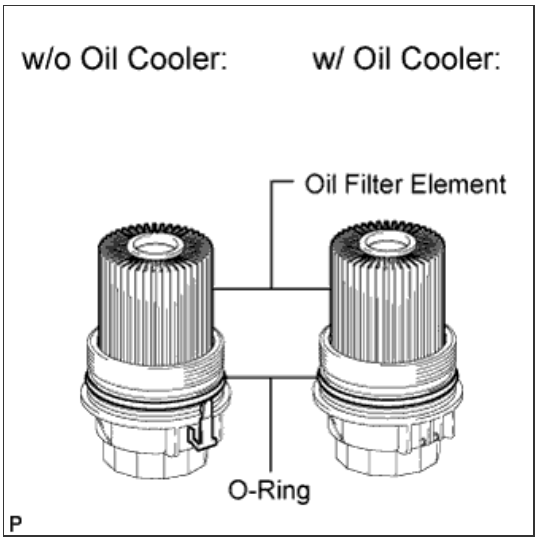
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

NOTICE:

Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.



5. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

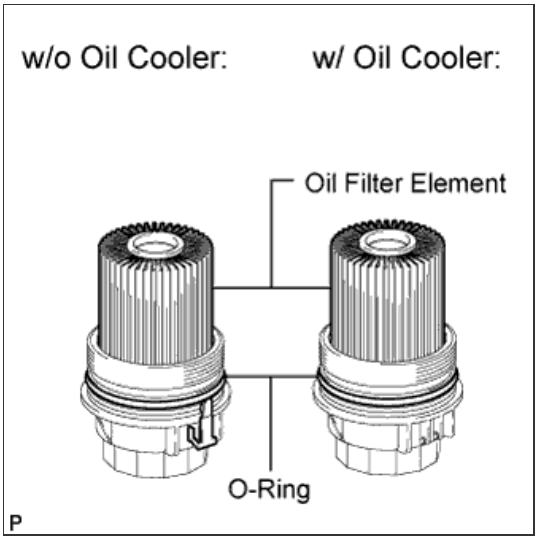
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



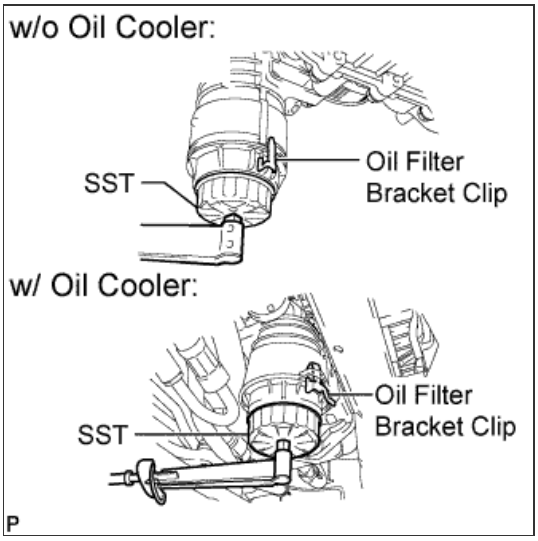
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

Before installing the O-ring, remove any dirt or foreign matter from the

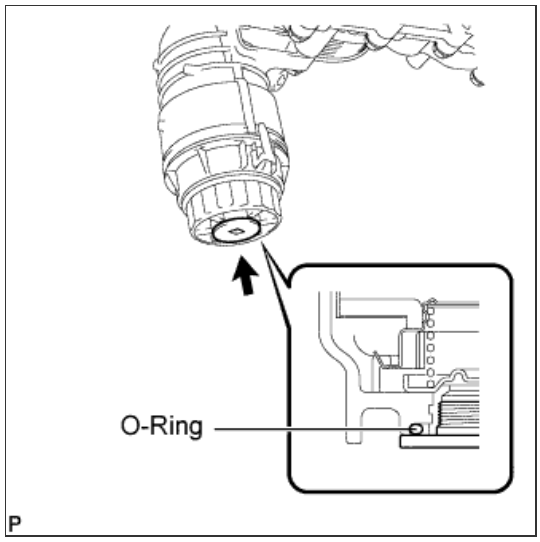
installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

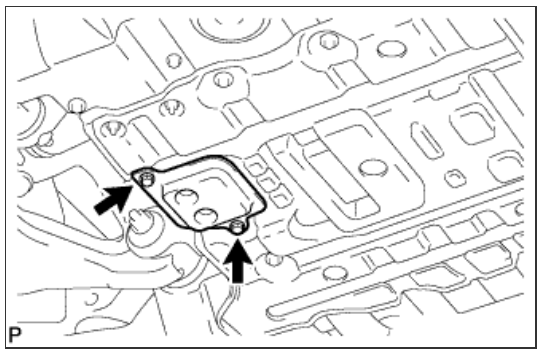
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



6. ADD ENGINE OIL

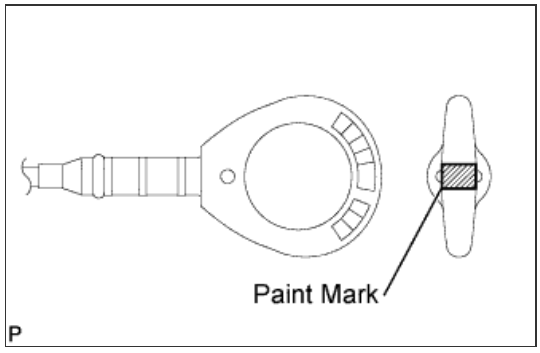
a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)



7. INSPECT FOR OIL LEAK

a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

8. INSPECT ENGINE OIL LEVEL

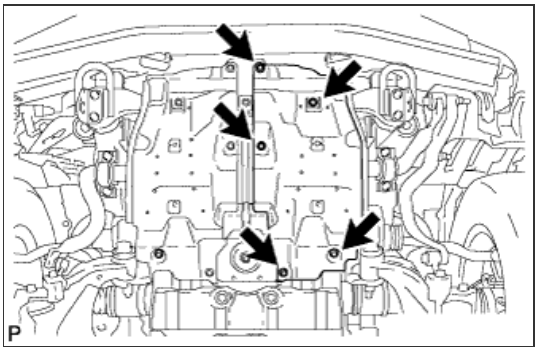
a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark. If low, check for leakage and add oil up to the full level mark.

NOTICE:

Do not fill engine oil above the full level mark.

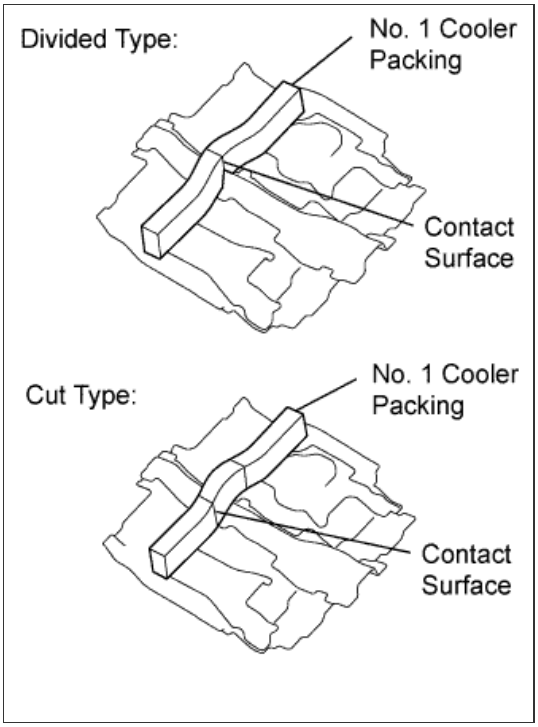
9. INSTALL ENGINE UNDER COVER SUB-ASSEMBLY LH

a. Install the engine under cover sub-assembly LH with the 5 bolts.



HINT:

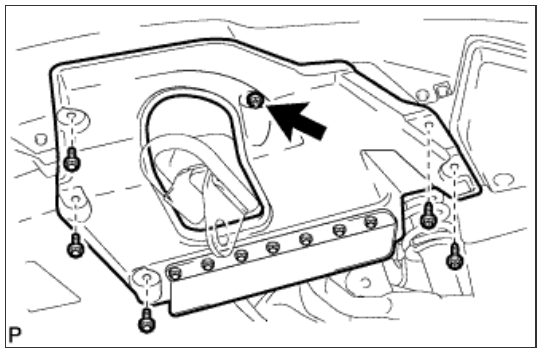
Make sure there is no gap between the ends of the No. 1 cooler packing.



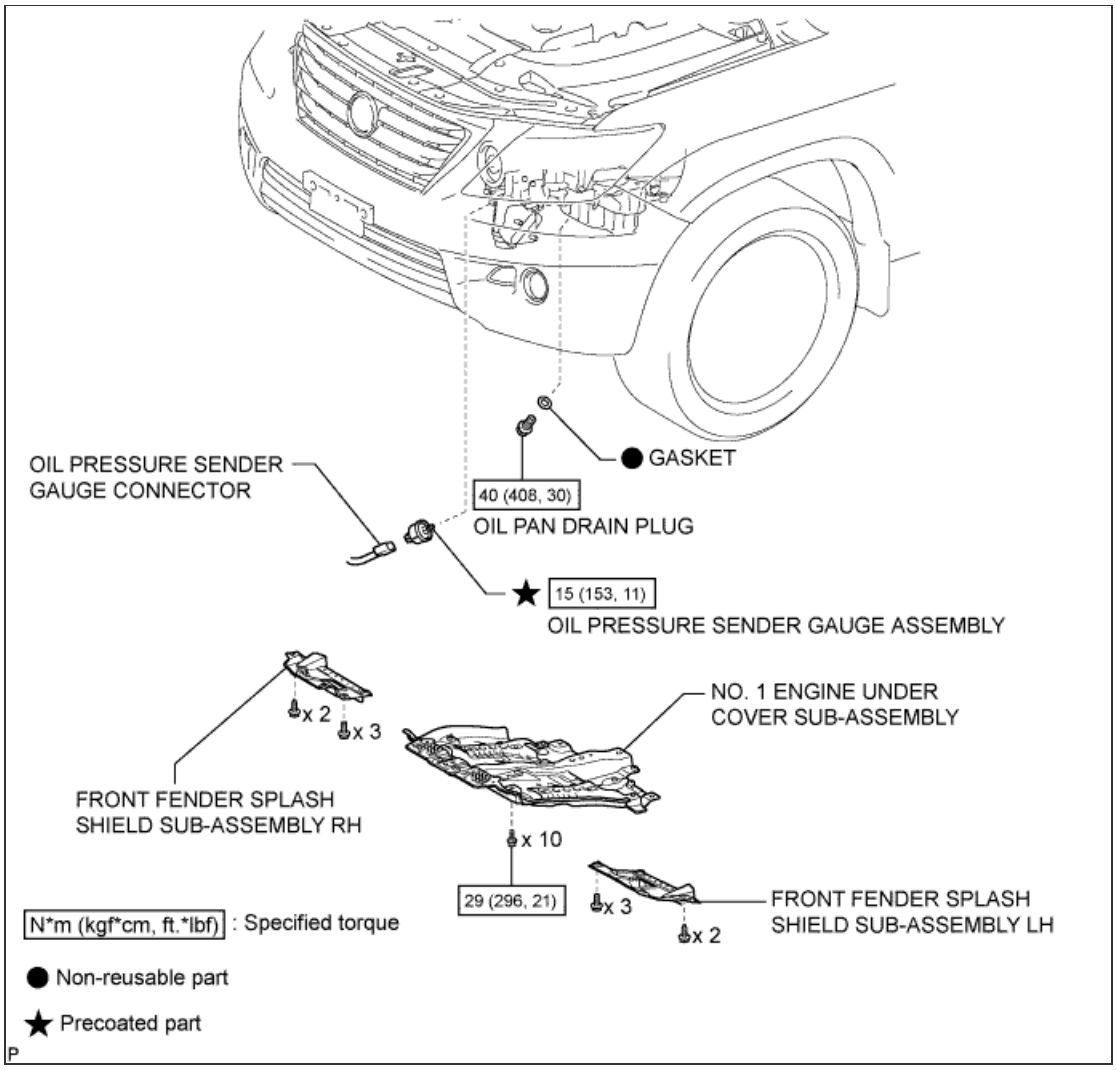
10. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



for Preparation Click here

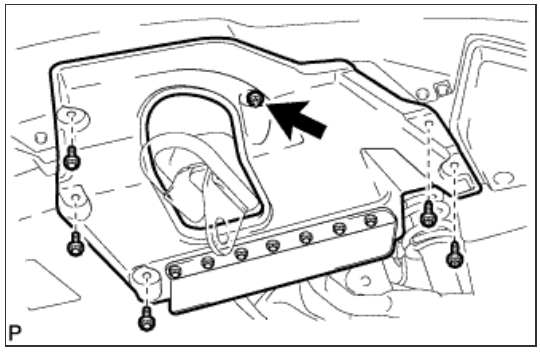


for Preparation Click here

1. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



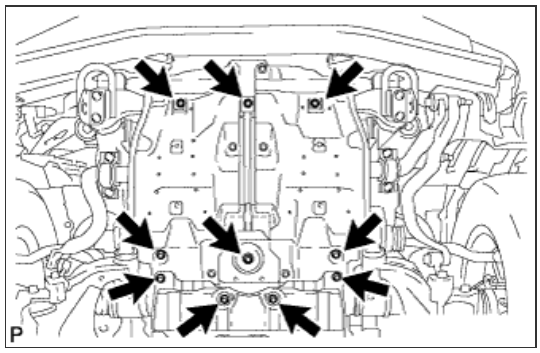
2. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

3. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



4. DRAIN ENGINE OIL

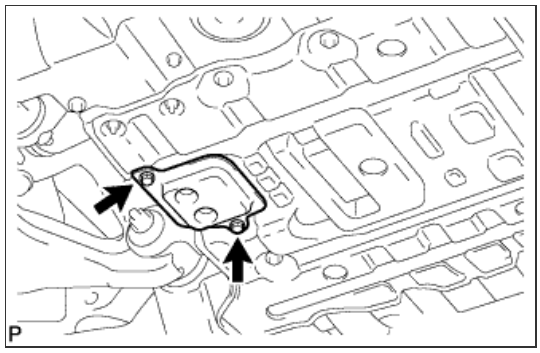
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

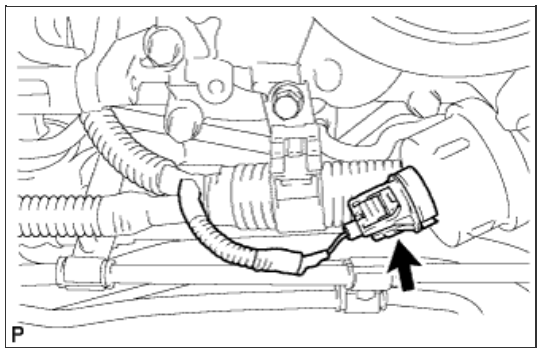
d. Install a new gasket and the oil pan drain plug.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }

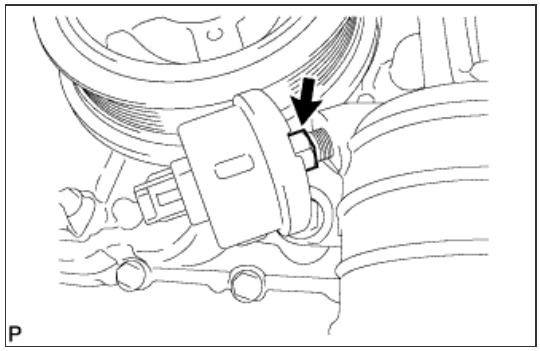


5. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.



b. Remove the oil pressure sender gauge.

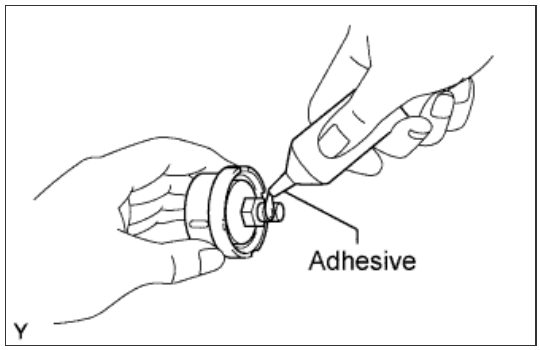


for Preparation Click here

1. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

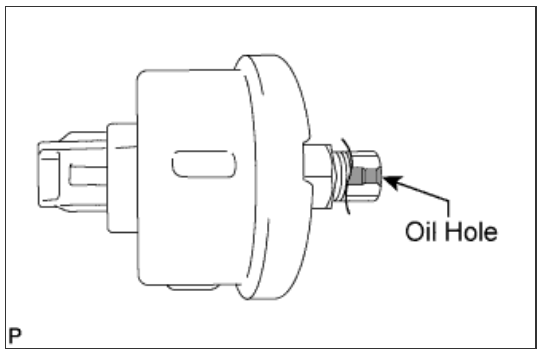
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

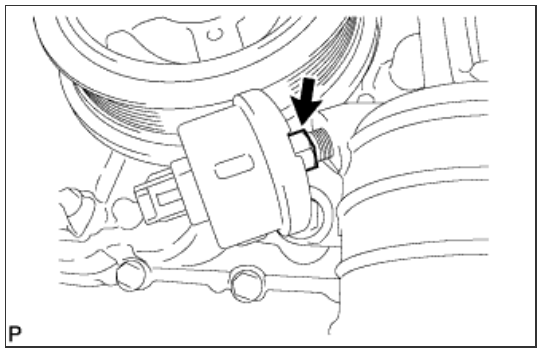


b. Install the oil pressure sender gauge.

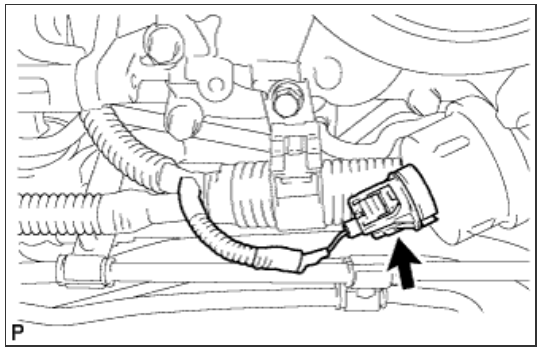
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



2. ADD ENGINE OIL

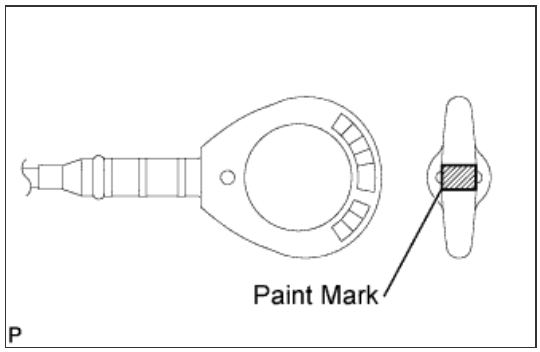
a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)



3. INSPECT FOR OIL LEAK

a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

4. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark. If low, check for leakage and add oil up to the full level mark.

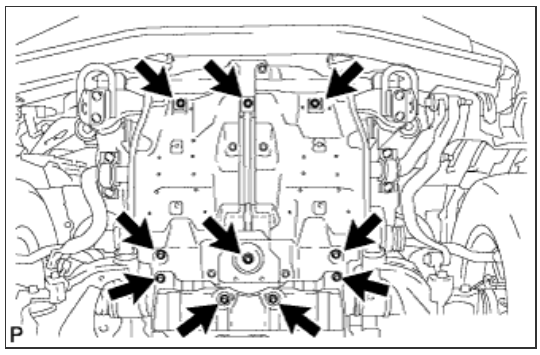
NOTICE:

Do not fill engine oil above the full level mark.

5. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

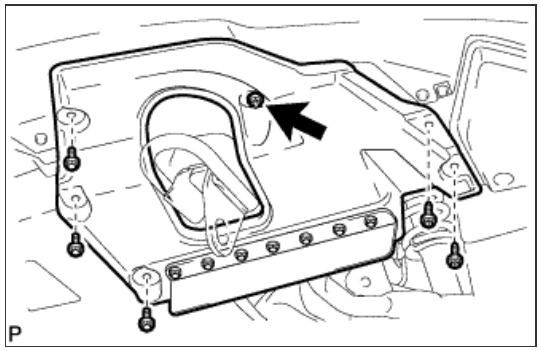
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



6. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.

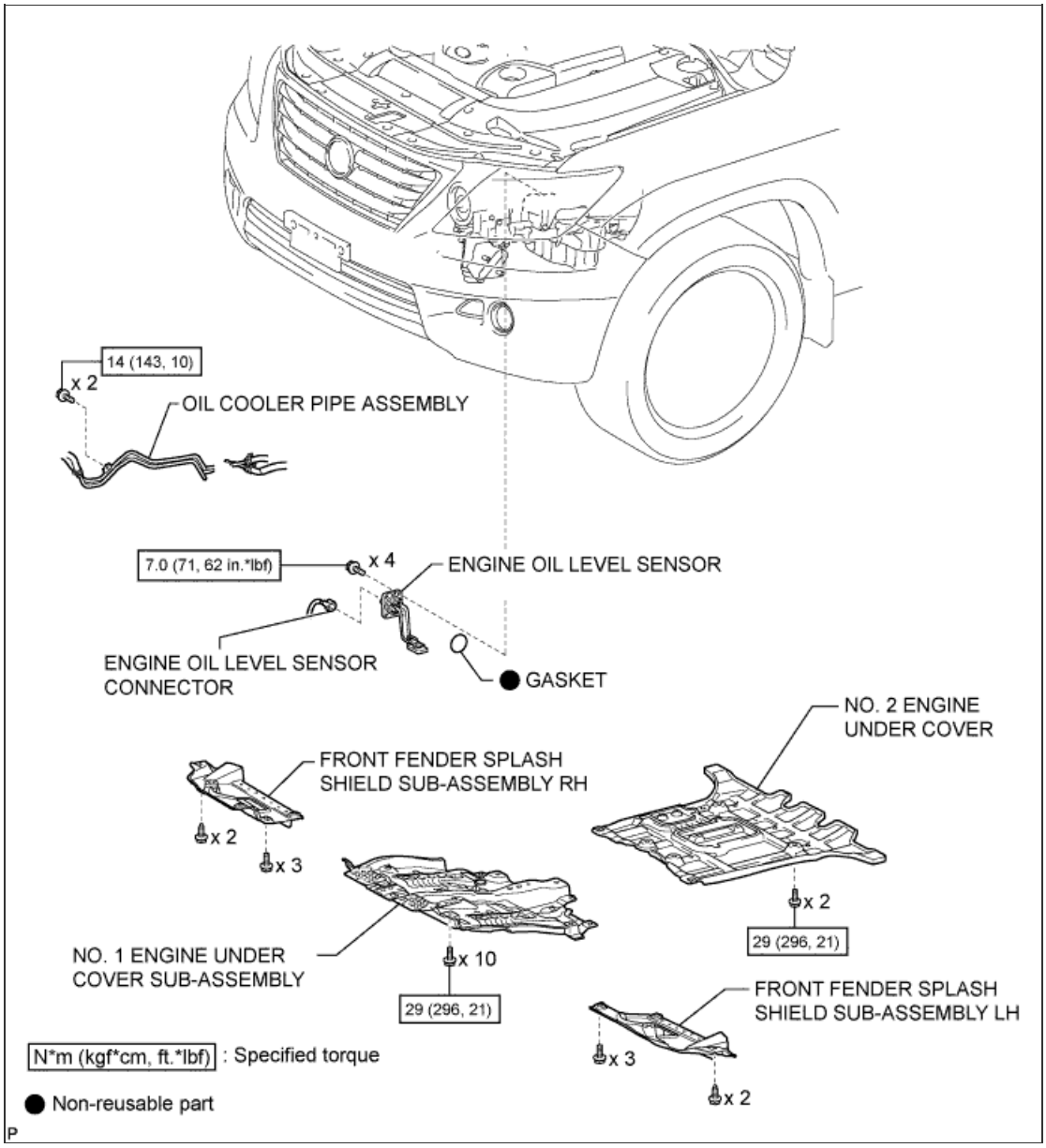


7. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

for Preparation Click here

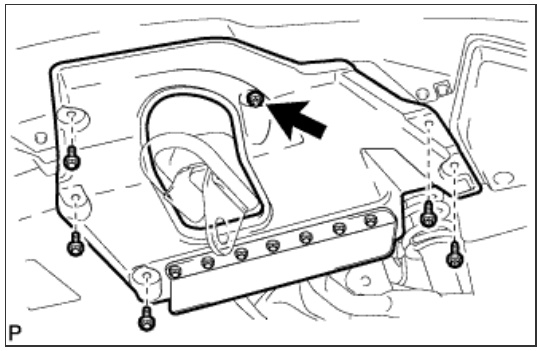


for Preparation Click here

1. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



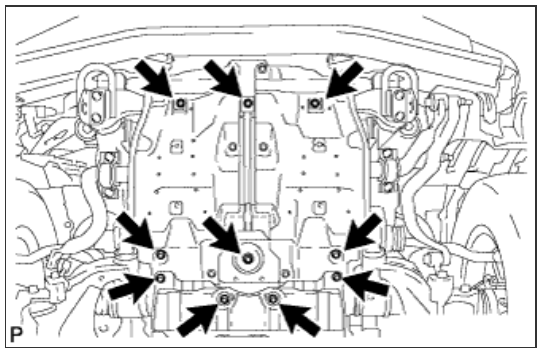
2. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

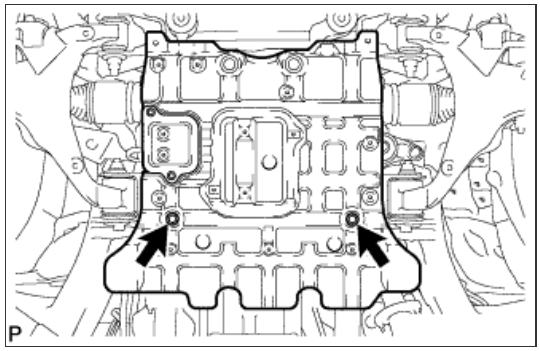
3. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



4. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



5. DRAIN ENGINE OIL

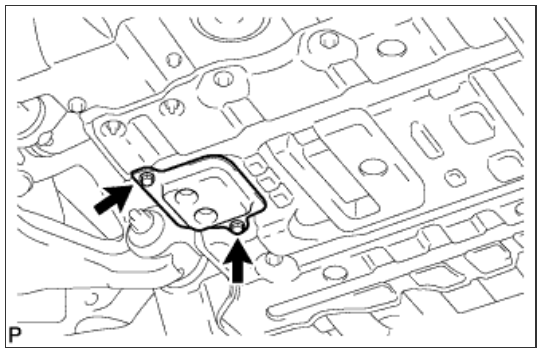
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

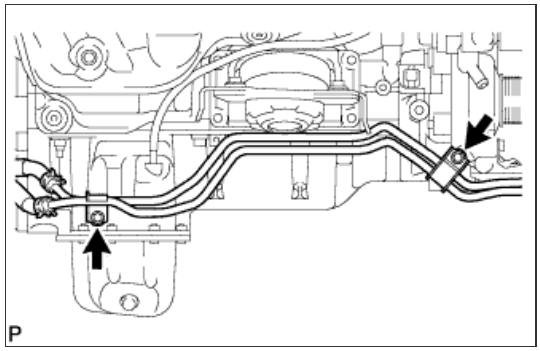
d. Install a new gasket and the oil pan drain plug.

Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



6. DISCONNECT OIL COOLER PIPE ASSEMBLY

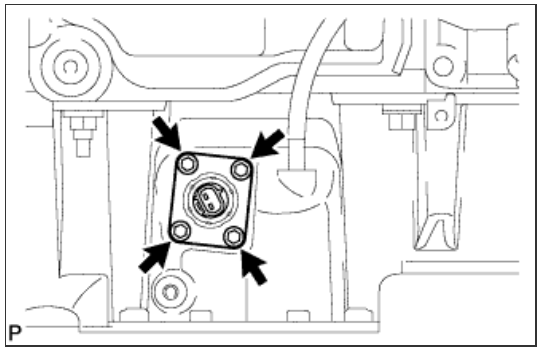
a. Remove the 2 bolts and disconnect the oil cooler pipe.



7. REMOVE ENGINE OIL LEVEL SENSOR

a. Disconnect the oil level sensor connector.

b. Remove the 4 bolts and oil level sensor.

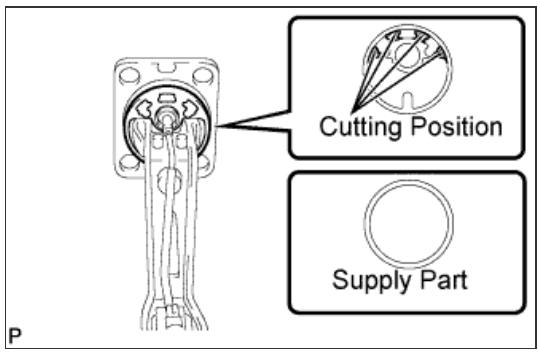


c. Cut off the gasket as shown in the illustration.

d. Remove the gasket from the oil level sensor.

HINT:

After cutting away the parts of the gasket shown in the illustration, remove only the outer part of the gasket.



for Preparation Click here

1. INSPECT ENGINE OIL LEVEL SENSOR

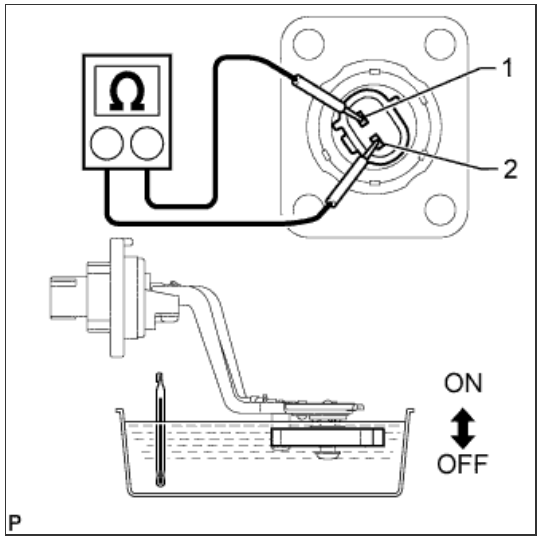
a. Partially immerse the sensor in an oil bath and warm up the oil bath.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
1 - 2	ON, 20°C (68°F)	Below 1 Ω
	OFF, 20°C (68°F)	
	ON, 60°C (140°F)	
	OFF, 60°C (140°F)	10 kΩ or higher

If the result is not as specified, replace the sensor.



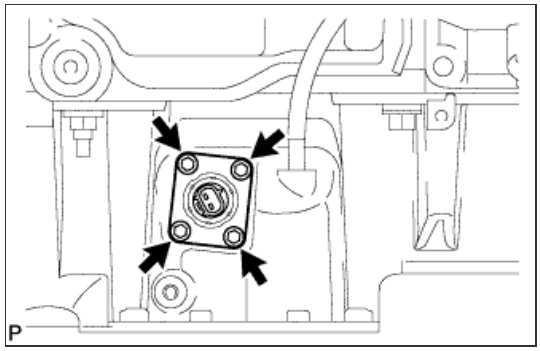
for Preparation Click here

1. INSTALL ENGINE OIL LEVEL SENSOR

a. Install a new gasket and the oil level sensor with the 4 bolts.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }

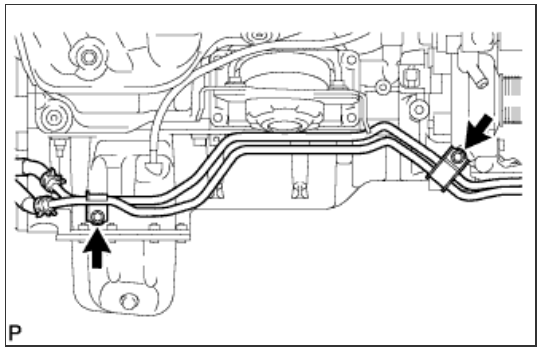
b. Connect the oil level sensor connector.



2. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }



3. ADD ENGINE OIL

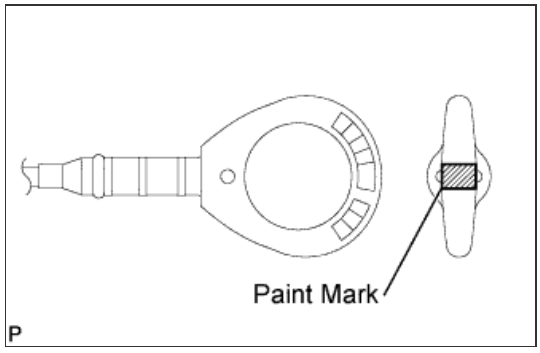
a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
	Drain and refill	



Green	with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

4. INSPECT FOR OIL LEAK

a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

5. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark. If low, check for leakage and add oil up to the full level mark.

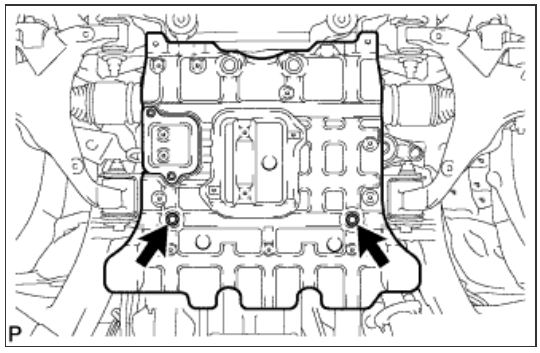
NOTICE:

Do not fill engine oil above the full level mark.

6. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

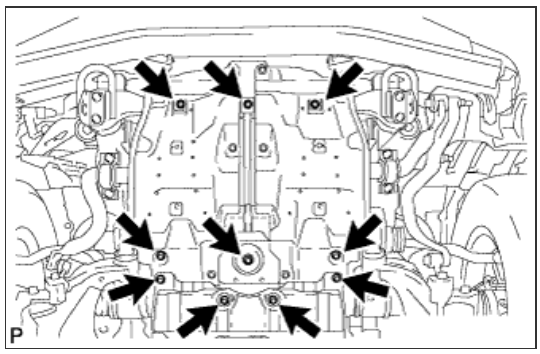
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



7. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

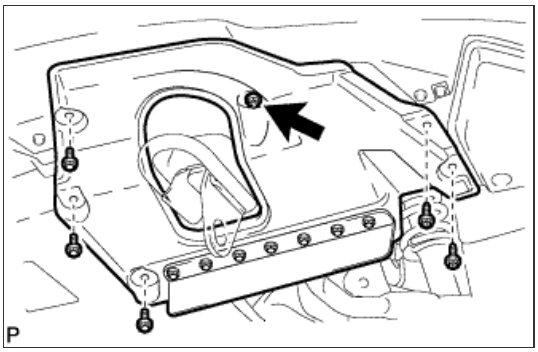
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



8. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.

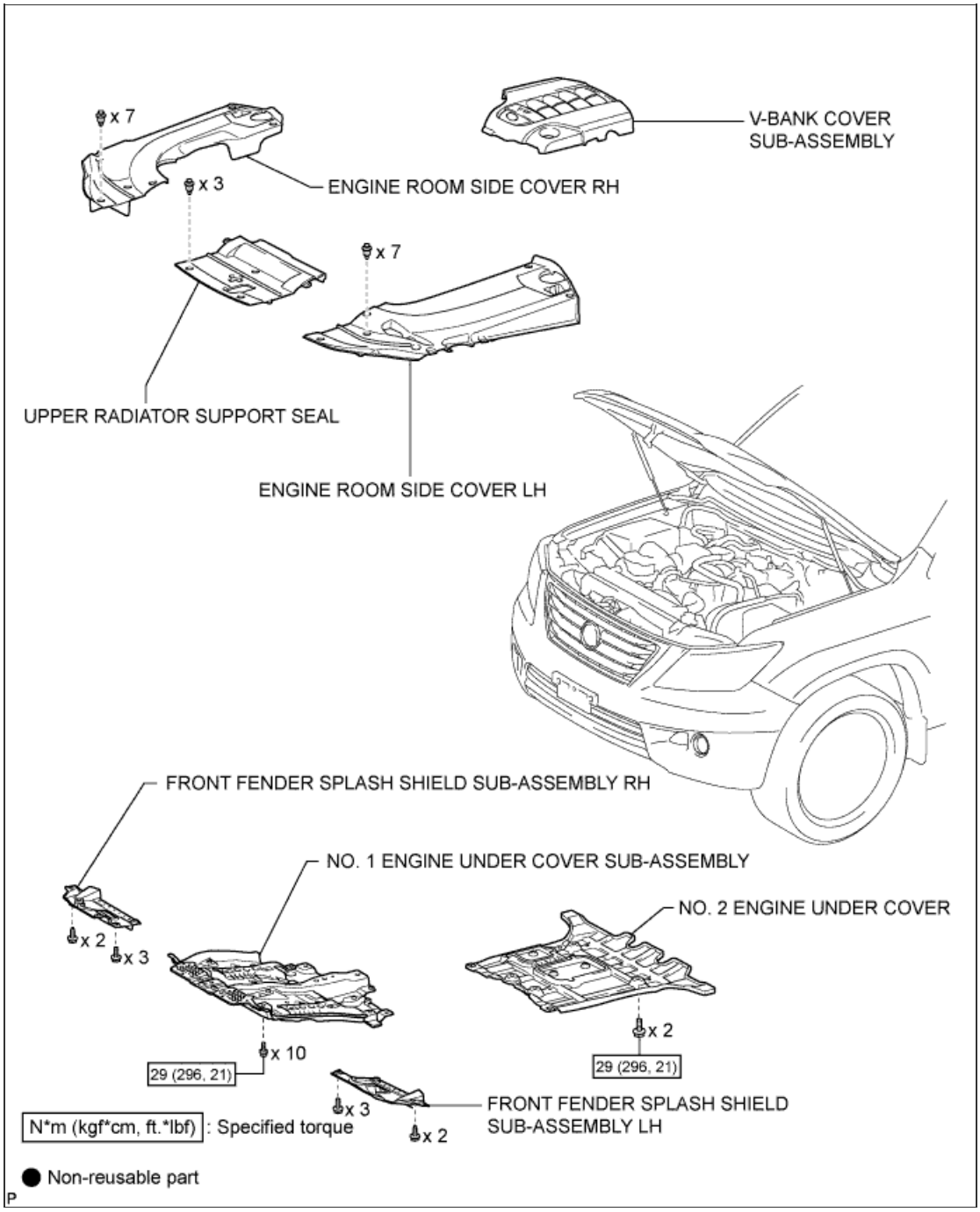


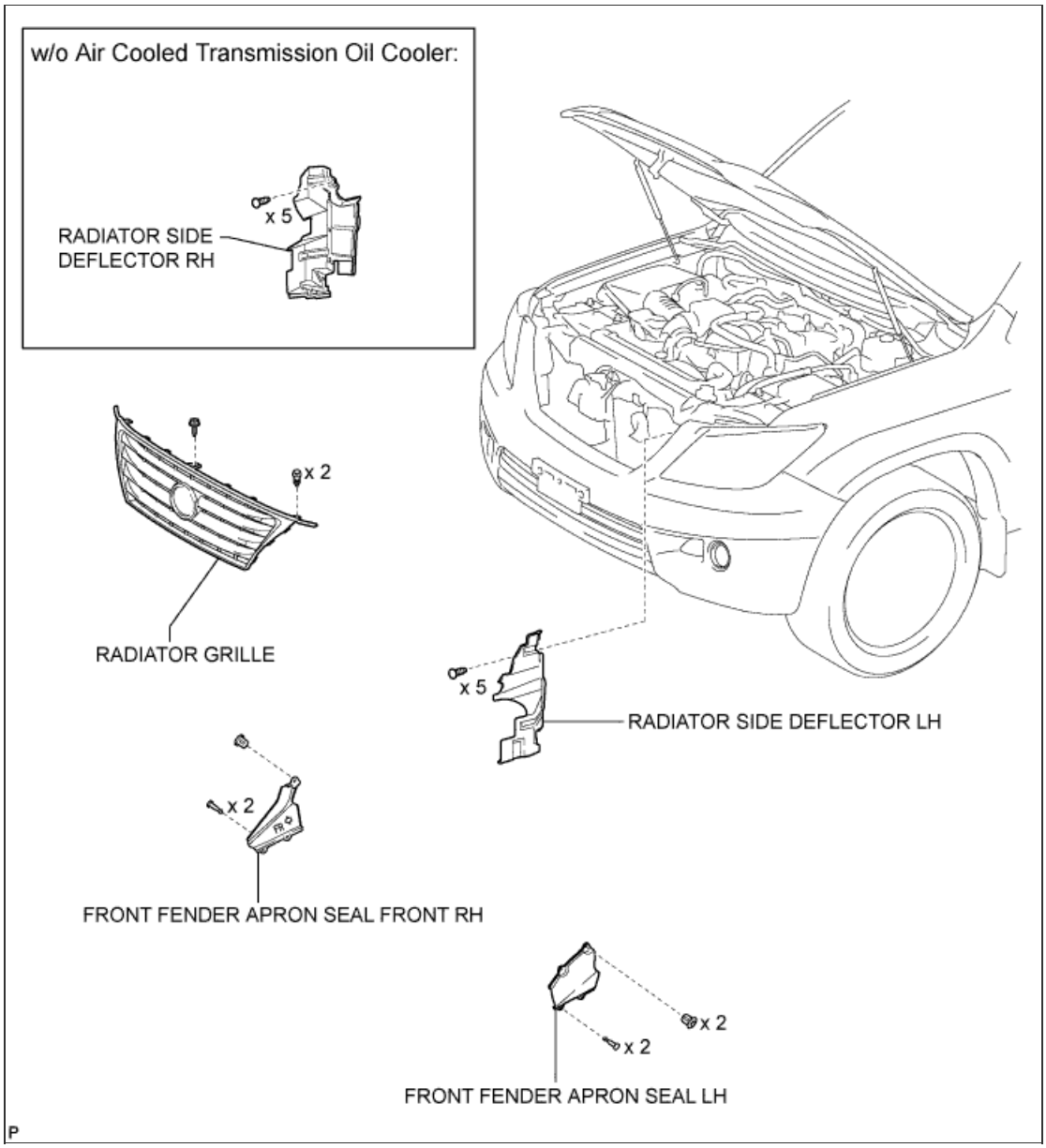
9. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

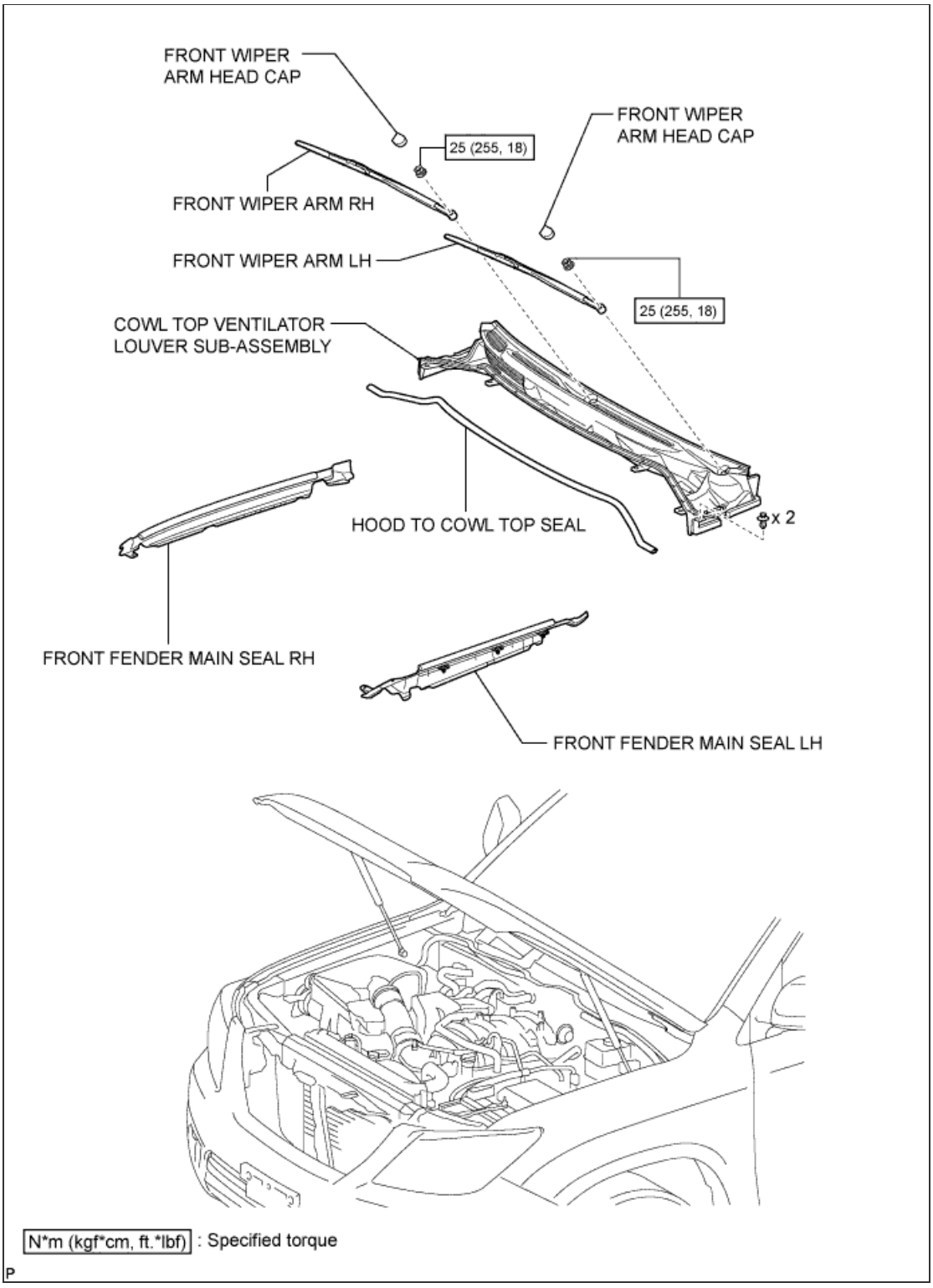
HINT:

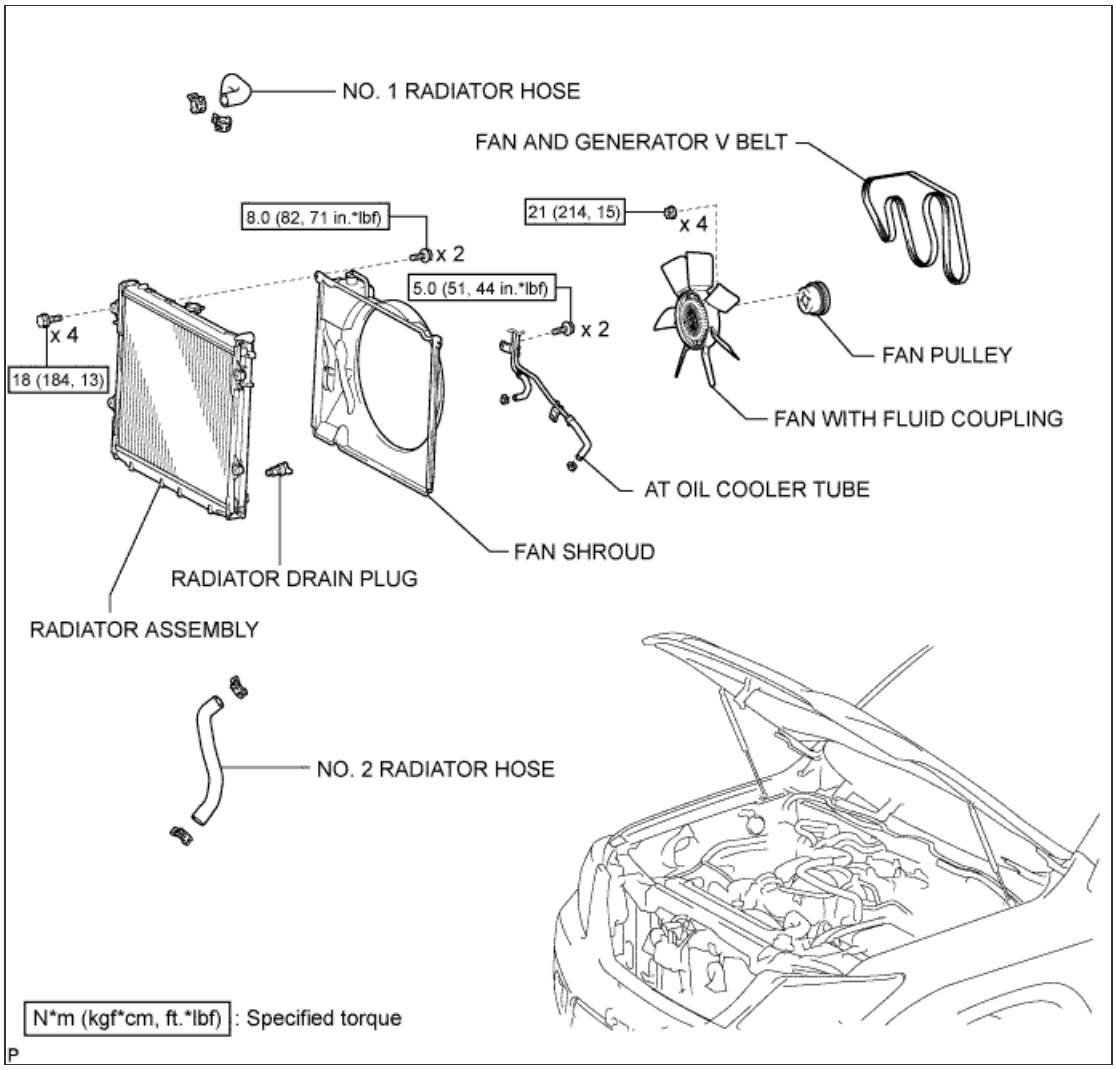
Use the same procedures described for the LH side.

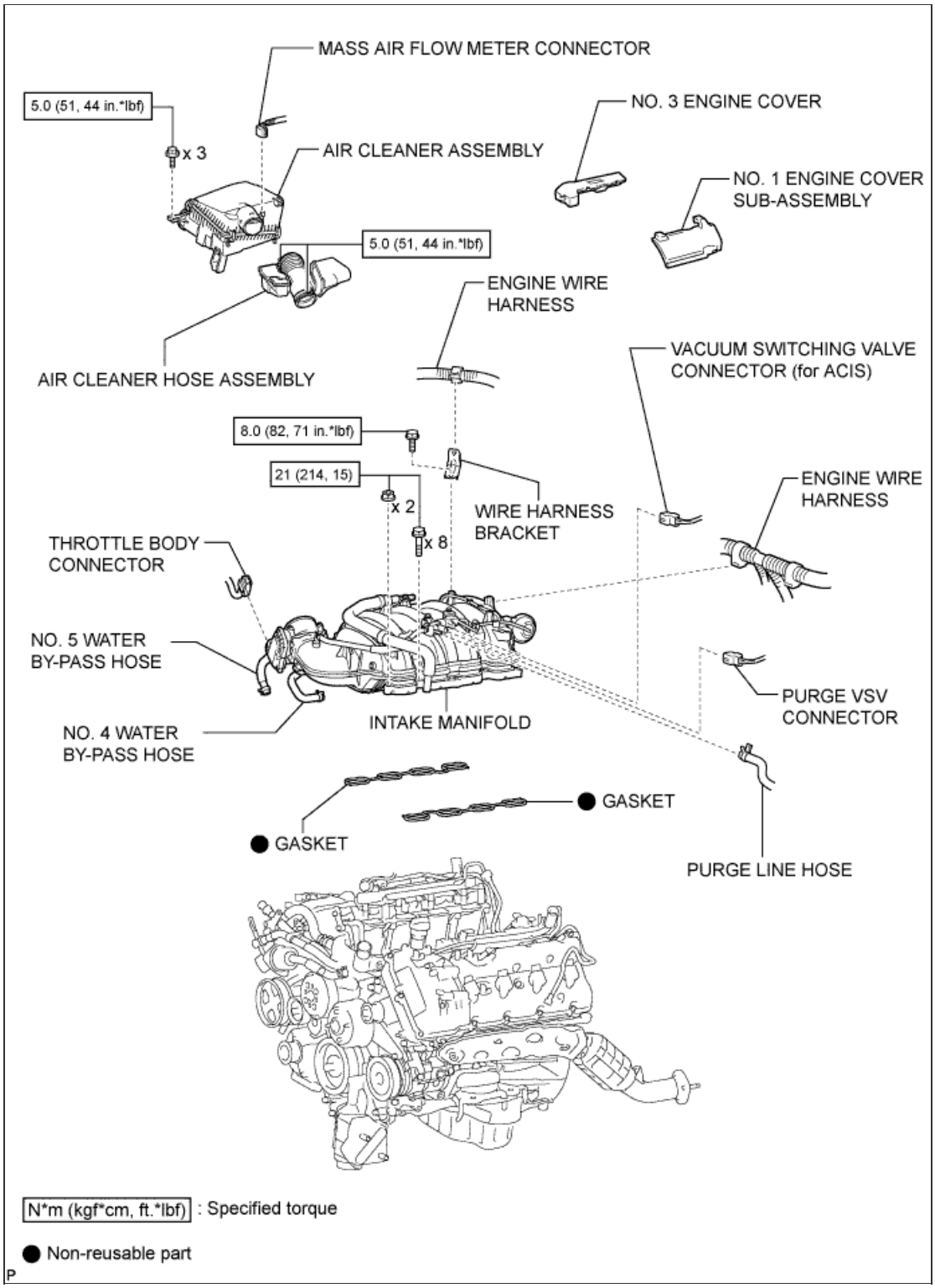
for Preparation Click here



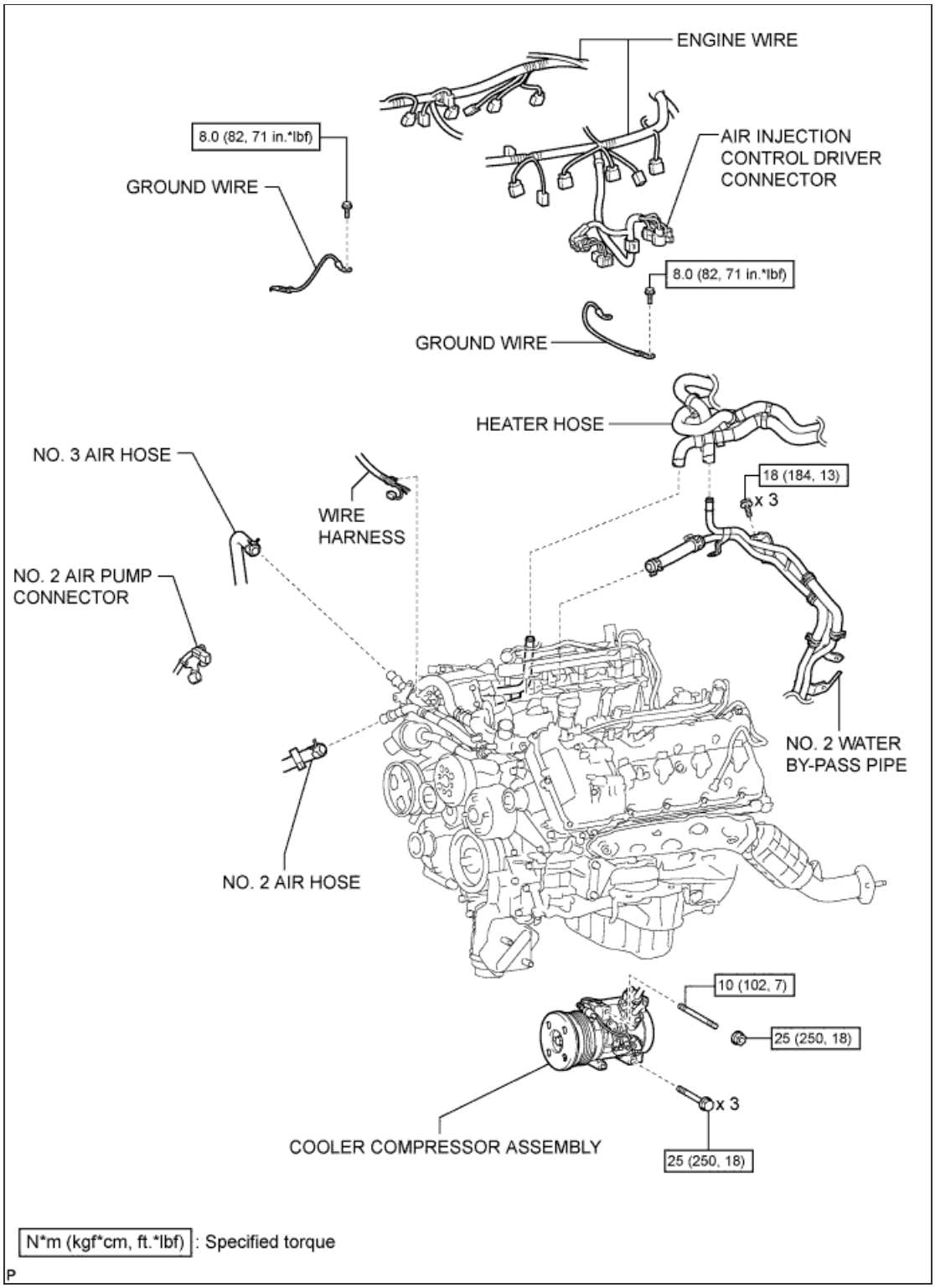

w/o Air Cooled Transmission Oil Cooler:
x 5
RADIATOR SIDE DEFLECTOR RH
x 2
RADIATOR GRILLE
x 5
RADIATOR SIDE DEFLECTOR LH
x 2
FRONT FENDER APRON SEAL FRONT RH
x 2
x 2
FRONT FENDER APRON SEAL LH
P


FRONT WIPER
ARM HEAD CAP
25 (255, 18)
FRONT WIPER
ARM HEAD CAP
FRONT WIPER ARM RH
FRONT WIPER ARM LH
25 (255, 18)
COWL TOP VENTILATOR
LOUVER SUB-ASSEMBLY
x 2
HOOD TO COWL TOP SEAL
FRONT FENDER MAIN SEAL RH
FRONT FENDER MAIN SEAL LH
N*m (kgf*cm, ft.*lbf) : Specified torque
P

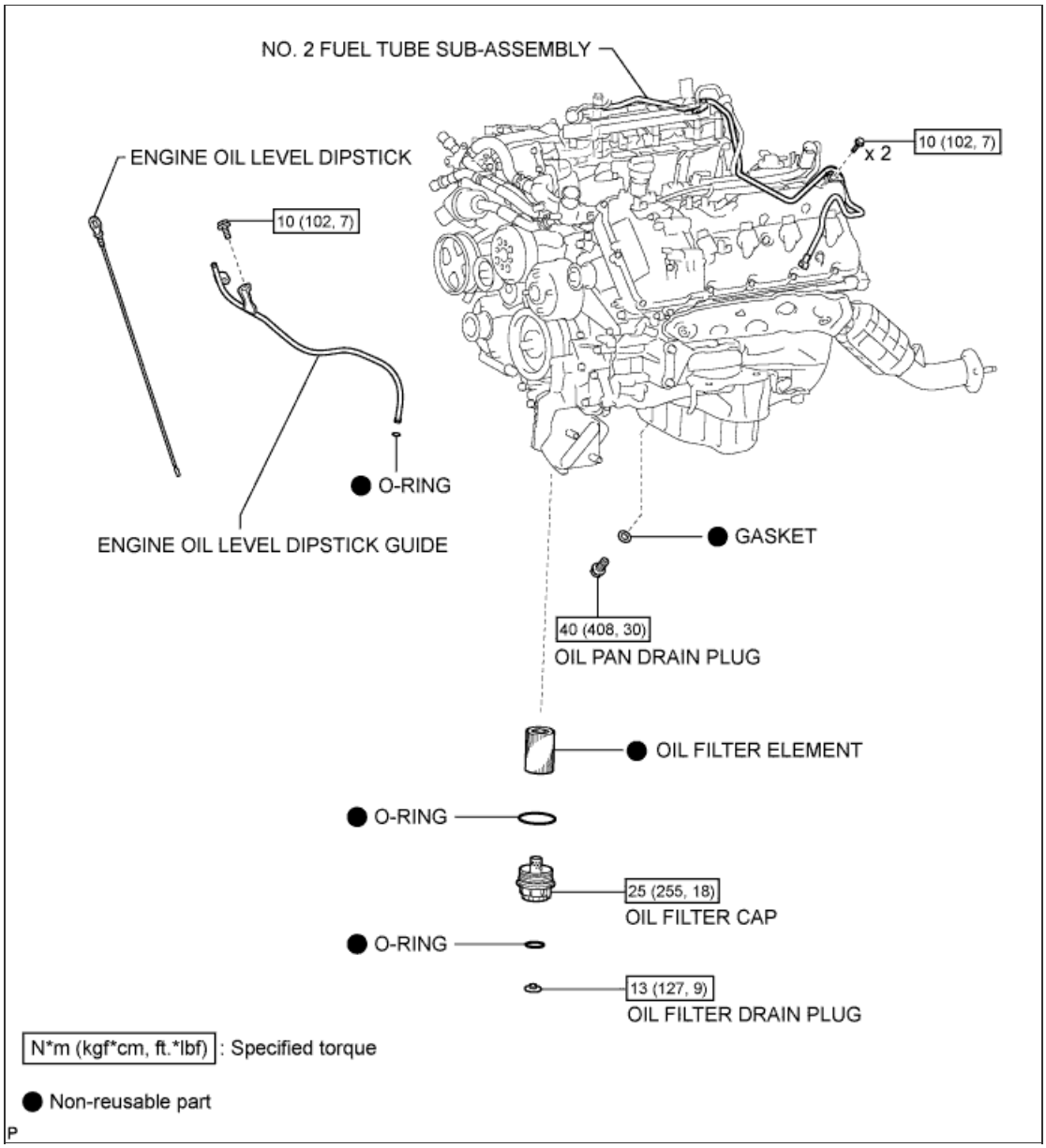

NO. 1 RADIATOR HOSE
FAN AND GENERATOR V BELT
8.0 (82, 71 in.*lbf)
x 2
21 (214, 15)
x 4
5.0 (51, 44 in.*lbf)
x 2
x 4
18 (184, 13)
FAN PULLEY
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
FAN SHROUD
RADIATOR DRAIN PLUG
RADIATOR ASSEMBLY
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P

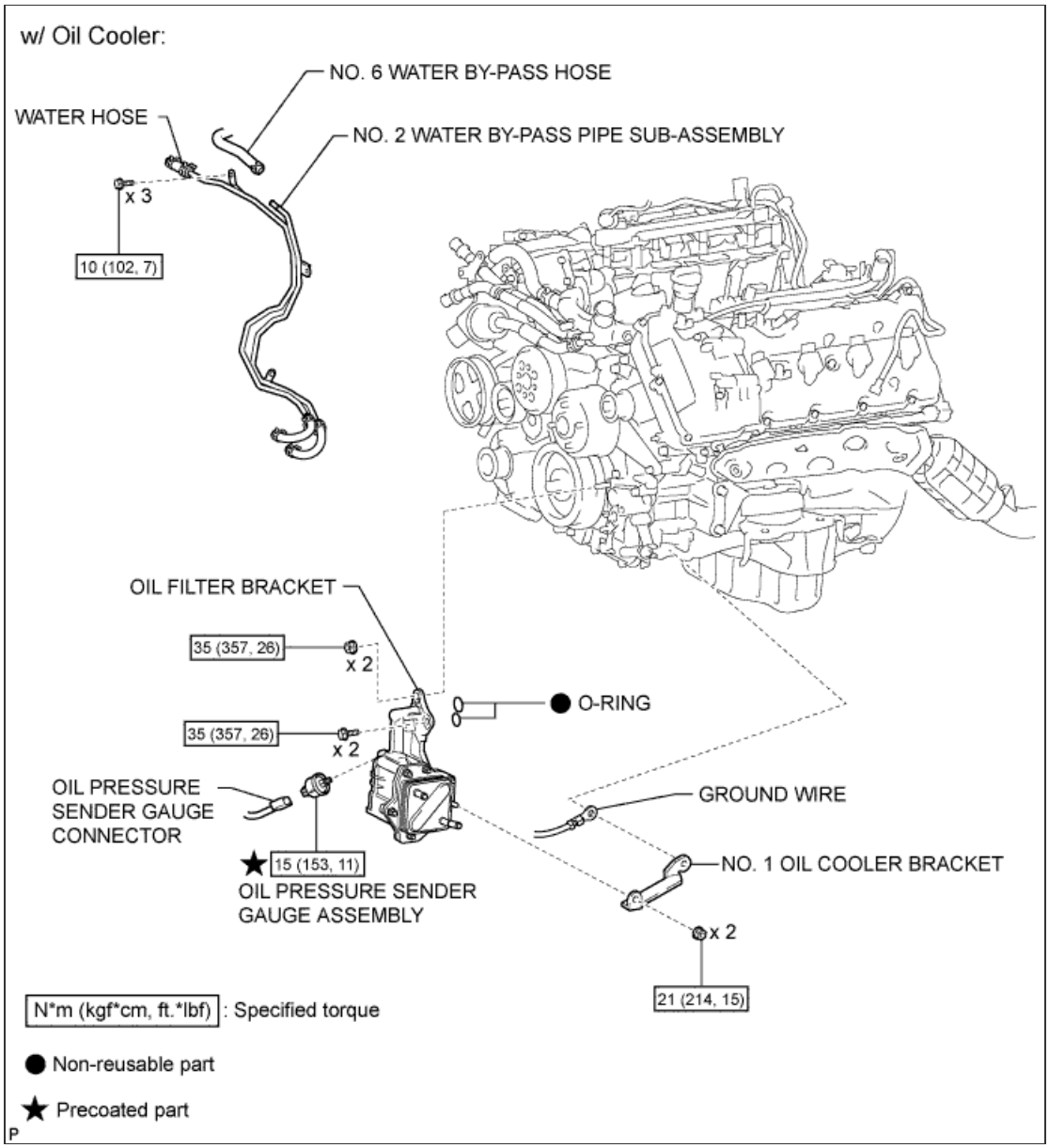

MASS AIR FLOW METER CONNECTOR
5.0 (51, 44 in.*lbf)
x 3
AIR CLEANER ASSEMBLY
NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
5.0 (51, 44 in.*lbf)
ENGINE WIRE HARNESS
AIR CLEANER HOSE ASSEMBLY
VACUUM SWITCHING VALVE CONNECTOR (for ACIS)
8.0 (82, 71 in.*lbf)
21 (214, 15)
x 2
x 8
WIRE HARNESS BRACKET
ENGINE WIRE HARNESS
THROTTLE BODY CONNECTOR
NO. 5 WATER BY-PASS HOSE
PURGE VSV CONNECTOR
INTAKE MANIFOLD
NO. 4 WATER BY-PASS HOSE
GASKET
GASKET
PURGE LINE HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

P

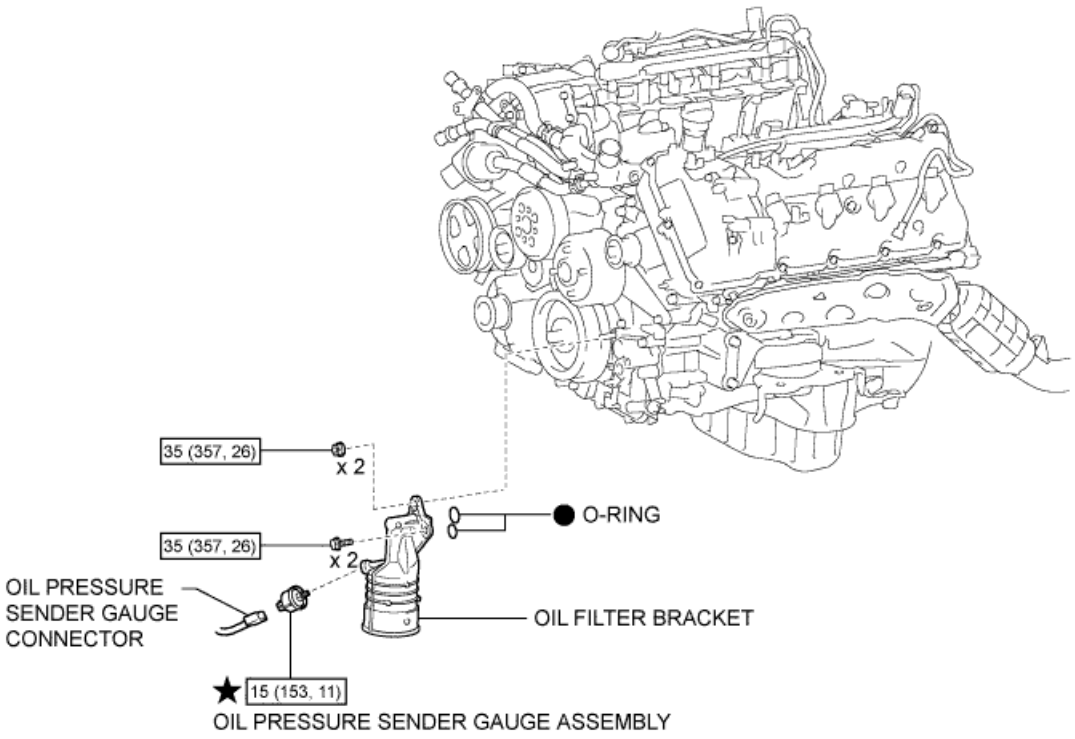

ENGINE WIRE
8.0 (82, 71 in.*lbf)
GROUND WIRE
AIR INJECTION CONTROL DRIVER CONNECTOR
8.0 (82, 71 in.*lbf)
GROUND WIRE
HEATER HOSE
NO. 3 AIR HOSE
WIRE HARNESS
18 (184, 13)
x 3
NO. 2 AIR PUMP CONNECTOR
NO. 2 WATER BY-PASS PIPE
NO. 2 AIR HOSE
10 (102, 7)
25 (250, 18)
x 3
COOLER COMPRESSOR ASSEMBLY
25 (250, 18)
N*m (kgf*cm, ft.*lbf) : Specified torque

P


NO. 2 FUEL TUBE SUB-ASSEMBLY
ENGINE OIL LEVEL DIPSTICK
10 (102, 7)
x 2
10 (102, 7)
O-RING
ENGINE OIL LEVEL DIPSTICK GUIDE
GASKET
40 (408, 30)
OIL PAN DRAIN PLUG
OIL FILTER ELEMENT
O-RING
25 (255, 18)
OIL FILTER CAP
O-RING
13 (127, 9)
OIL FILTER DRAIN PLUG
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


w/ Oil Cooler:
NO. 6 WATER BY-PASS HOSE
WATER HOSE
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
x 3
10 (102, 7)
OIL FILTER BRACKET
35 (357, 26)
x 2
O-RING
35 (357, 26)
x 2
OIL PRESSURE SENDER GAUGE CONNECTOR
GROUND WIRE
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
NO. 1 OIL COOLER BRACKET
x 2
21 (214, 15)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
P

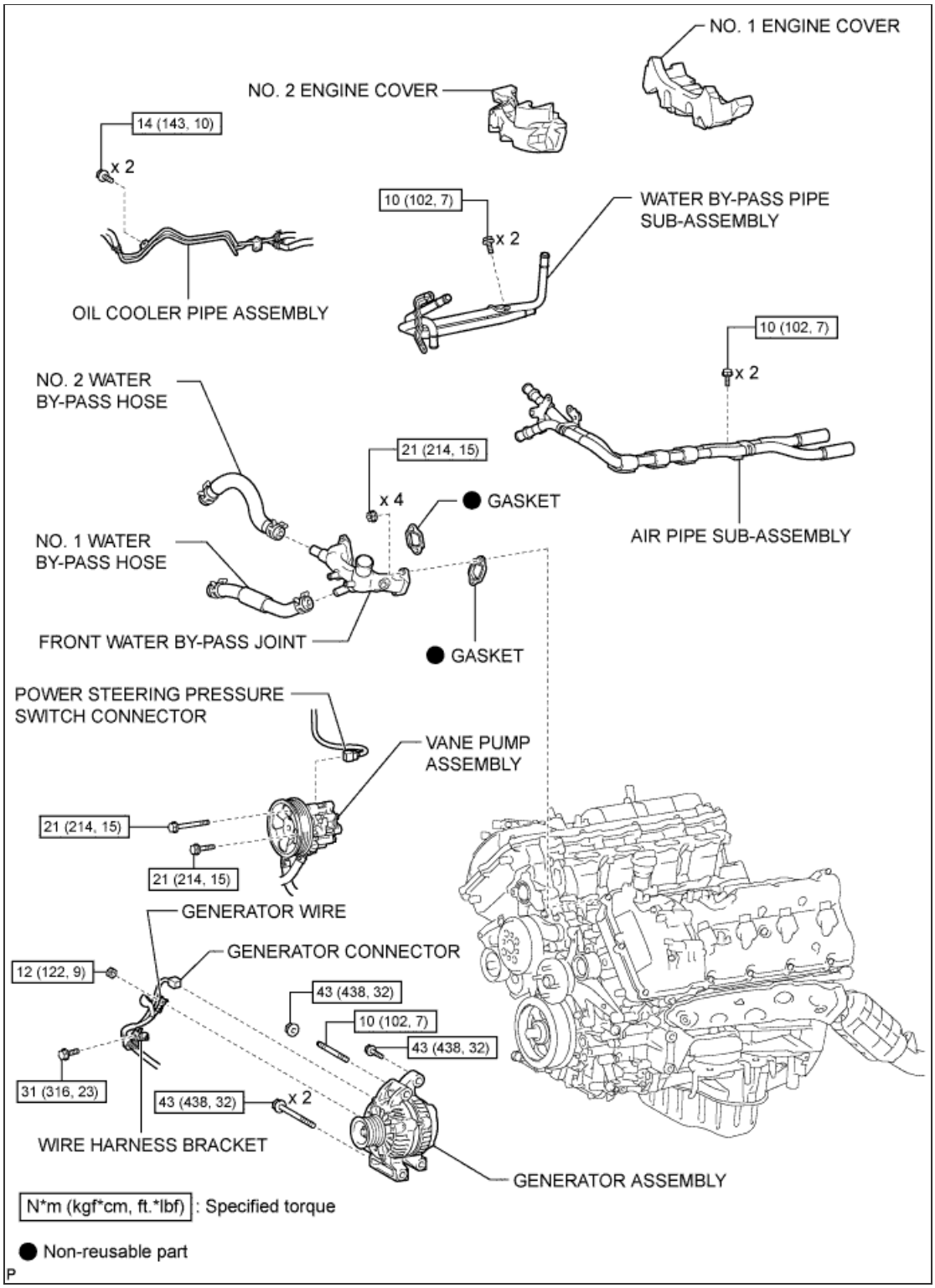
w/o Oil Cooler:

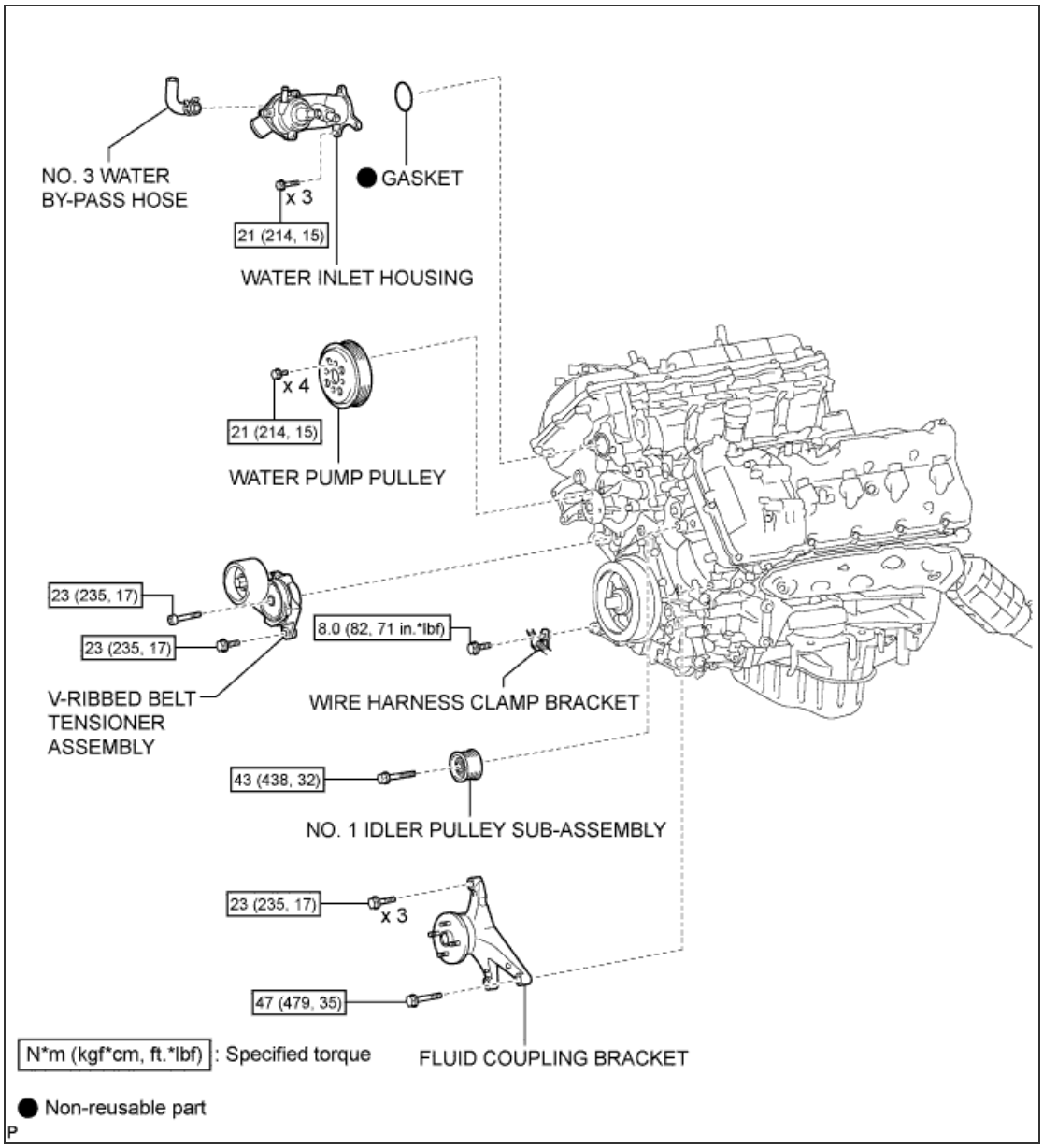


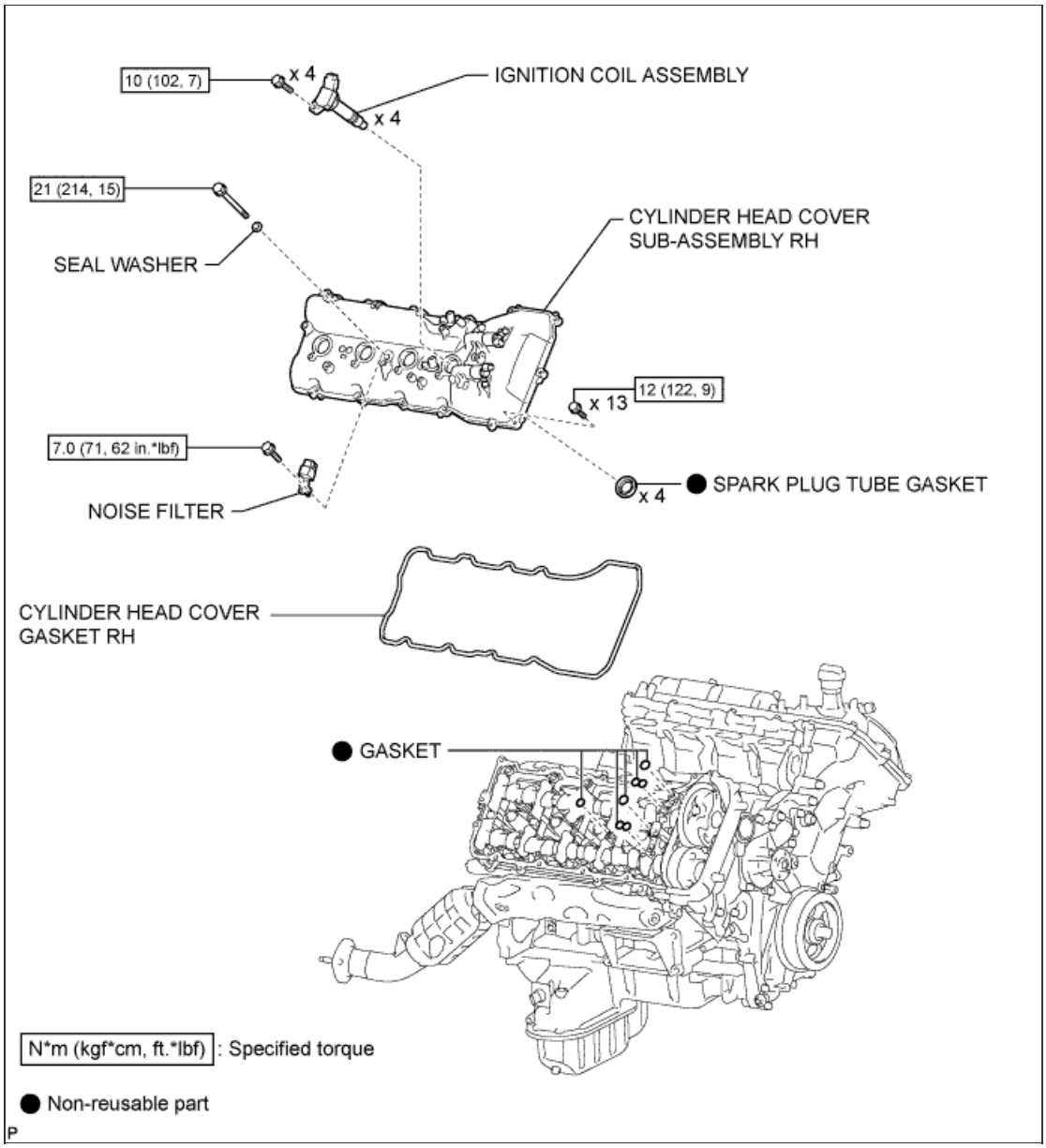
N*m (kgf*cm, ft.*lbf) : Specified torque

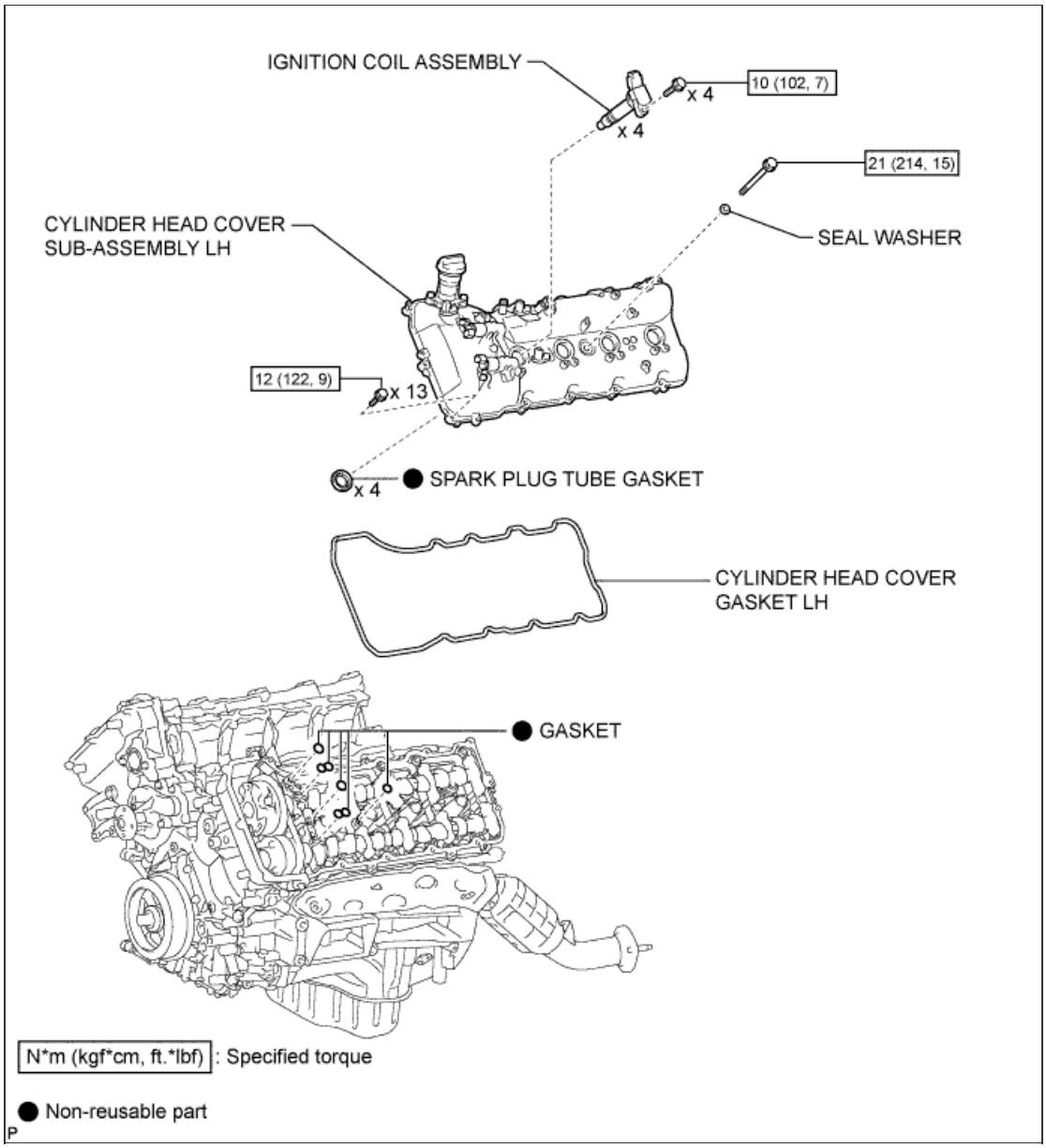
● Non-reusable part

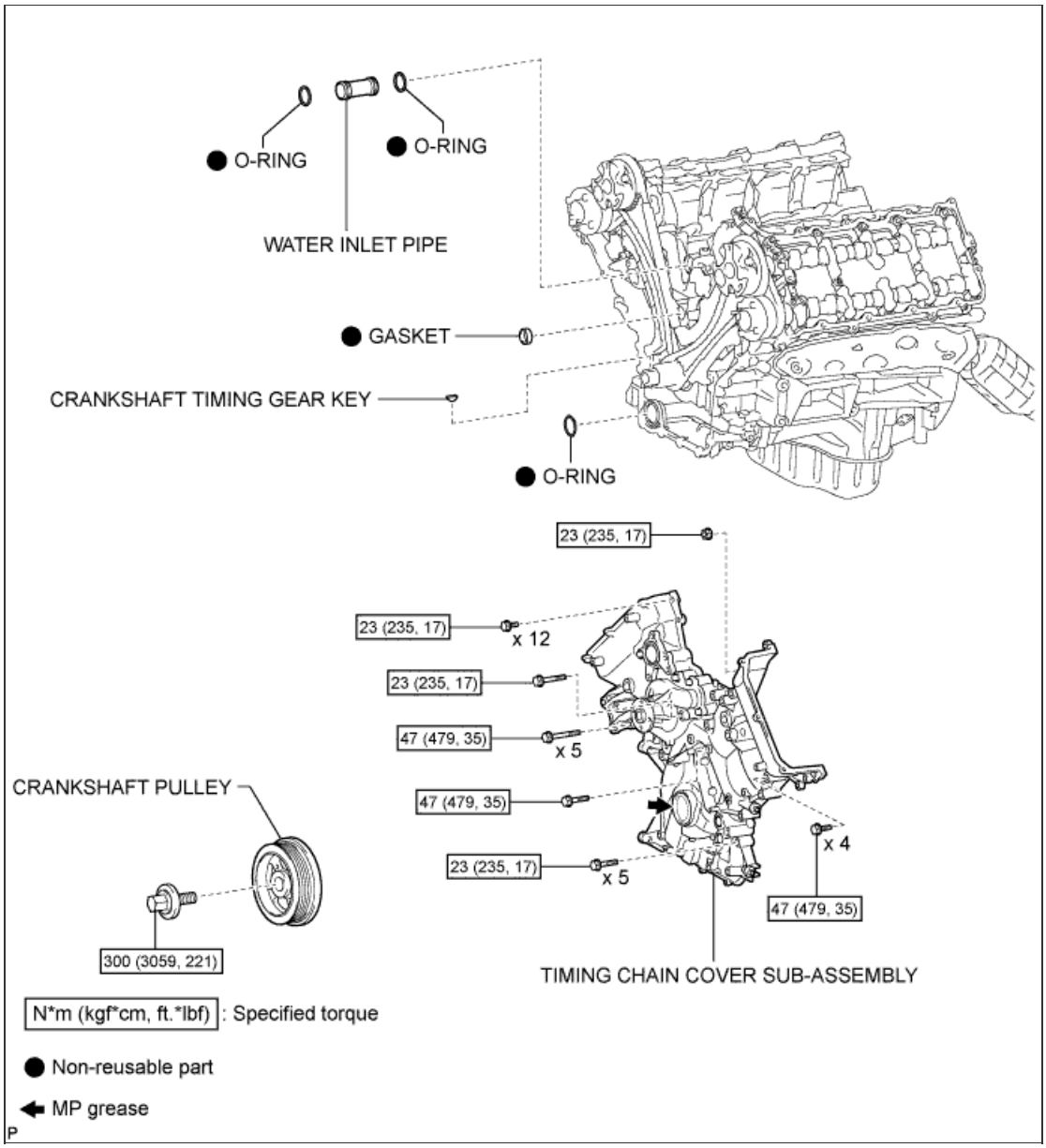
★ Precoated part

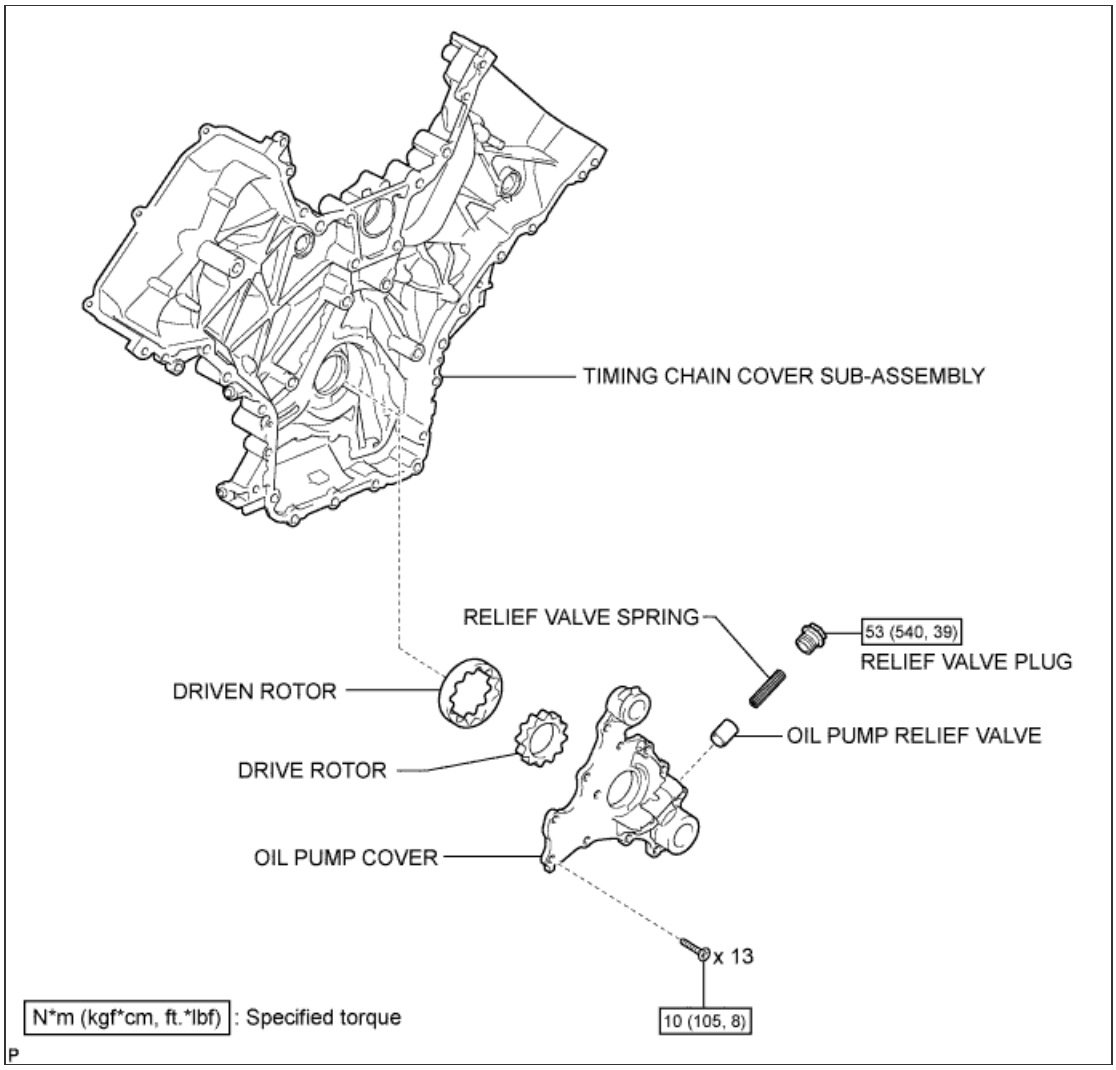

NO. 1 ENGINE COVER
NO. 2 ENGINE COVER
14 (143, 10)
x 2
OIL COOLER PIPE ASSEMBLY
10 (102, 7)
x 2
WATER BY-PASS PIPE SUB-ASSEMBLY
10 (102, 7)
x 2
AIR PIPE SUB-ASSEMBLY
NO. 2 WATER BY-PASS HOSE
21 (214, 15)
x 4
GASKET
NO. 1 WATER BY-PASS HOSE
FRONT WATER BY-PASS JOINT
GASKET
POWER STEERING PRESSURE SWITCH CONNECTOR
VANE PUMP ASSEMBLY
21 (214, 15)
21 (214, 15)
GENERATOR WIRE
GENERATOR CONNECTOR
12 (122, 9)
43 (438, 32)
10 (102, 7)
43 (438, 32)
31 (316, 23)
43 (438, 32)
x 2
WIRE HARNESS BRACKET
GENERATOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


NO. 3 WATER BY-PASS HOSE
x 3
21 (214, 15)
GASKET
WATER INLET HOUSING
x 4
21 (214, 15)
WATER PUMP PULLEY
23 (235, 17)
23 (235, 17)
V-RIBBED BELT TENSIONER ASSEMBLY
8.0 (82, 71 in.*lbf)
WIRE HARNESS CLAMP BRACKET
43 (438, 32)
NO. 1 IDLER PULLEY SUB-ASSEMBLY
23 (235, 17)
x 3
47 (479, 35)
FLUID COUPLING BRACKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

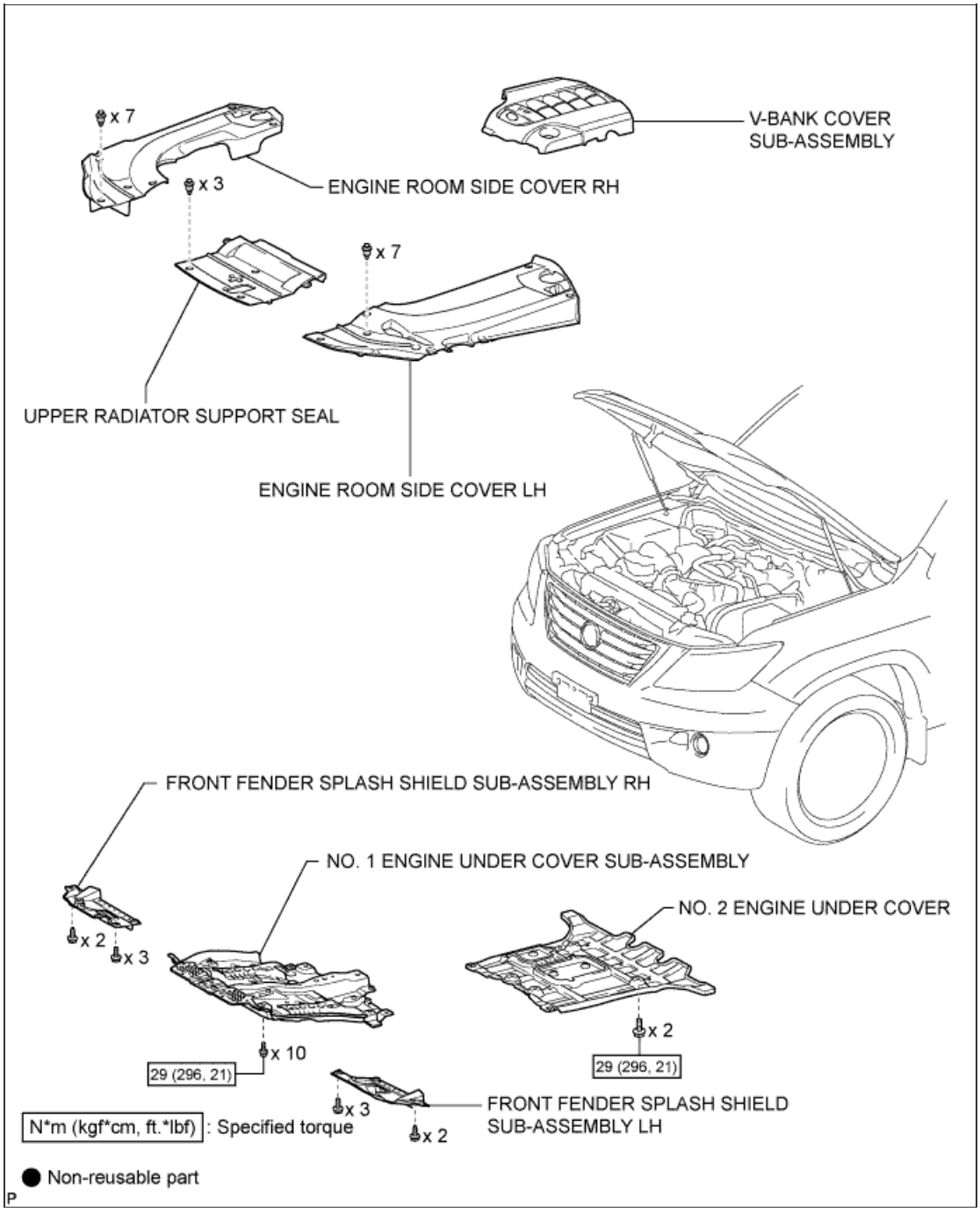

10 (102, 7)
x 4
x 4
IGNITION COIL ASSEMBLY
21 (214, 15)
SEAL WASHER
CYLINDER HEAD COVER
SUB-ASSEMBLY RH
12 (122, 9)
x 13
7.0 (71, 62 in.*lbf)
NOISE FILTER
x 4
SPARK PLUG TUBE GASKET
CYLINDER HEAD COVER
GASKET RH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

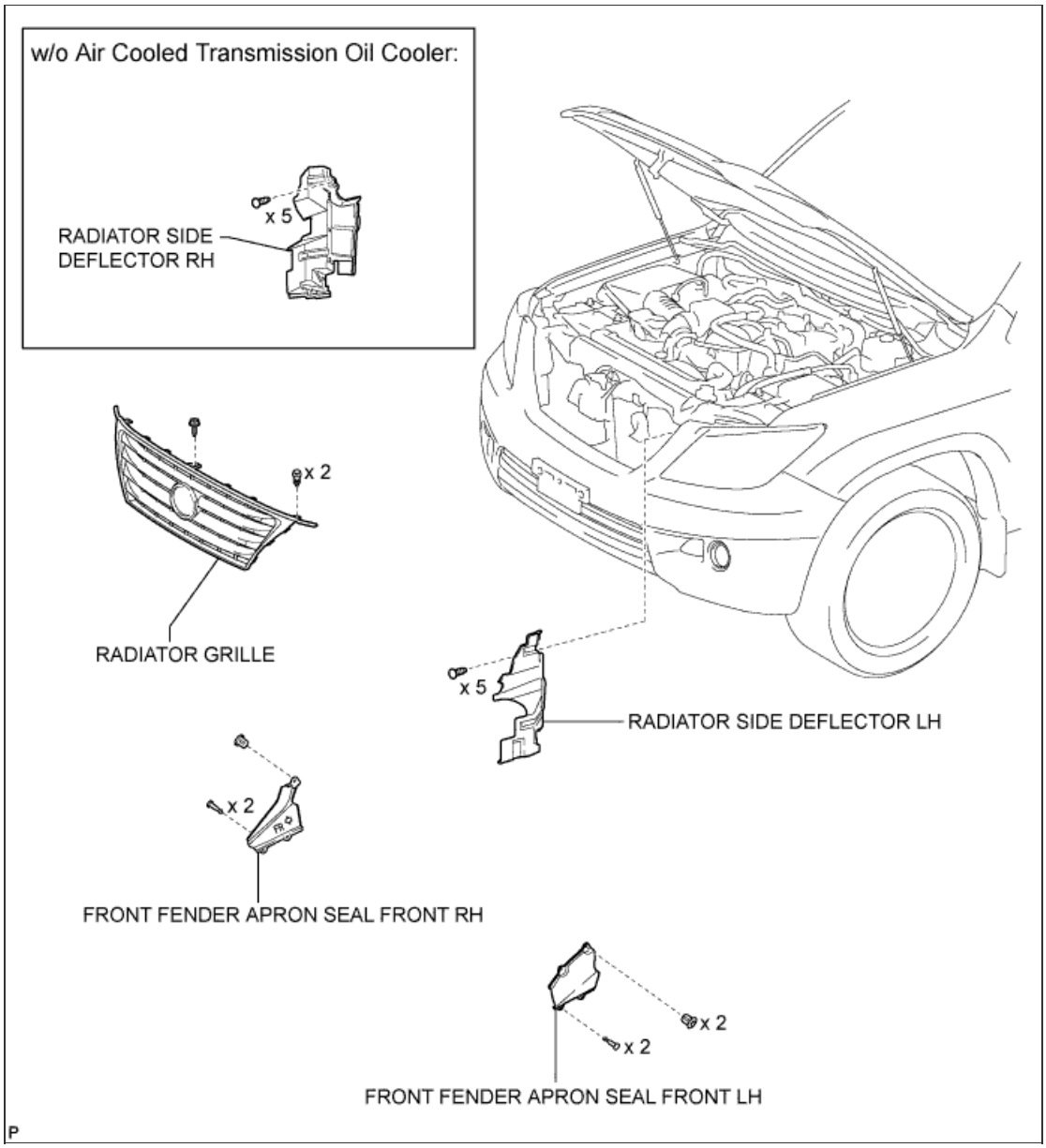

IGNITION COIL ASSEMBLY
x 4
10 (102, 7)
x 4
21 (214, 15)
SEAL WASHER
CYLINDER HEAD COVER
SUB-ASSEMBLY LH
12 (122, 9)
x 13
x 4
● SPARK PLUG TUBE GASKET
CYLINDER HEAD COVER
GASKET LH
● GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
● Non-reusable part
P

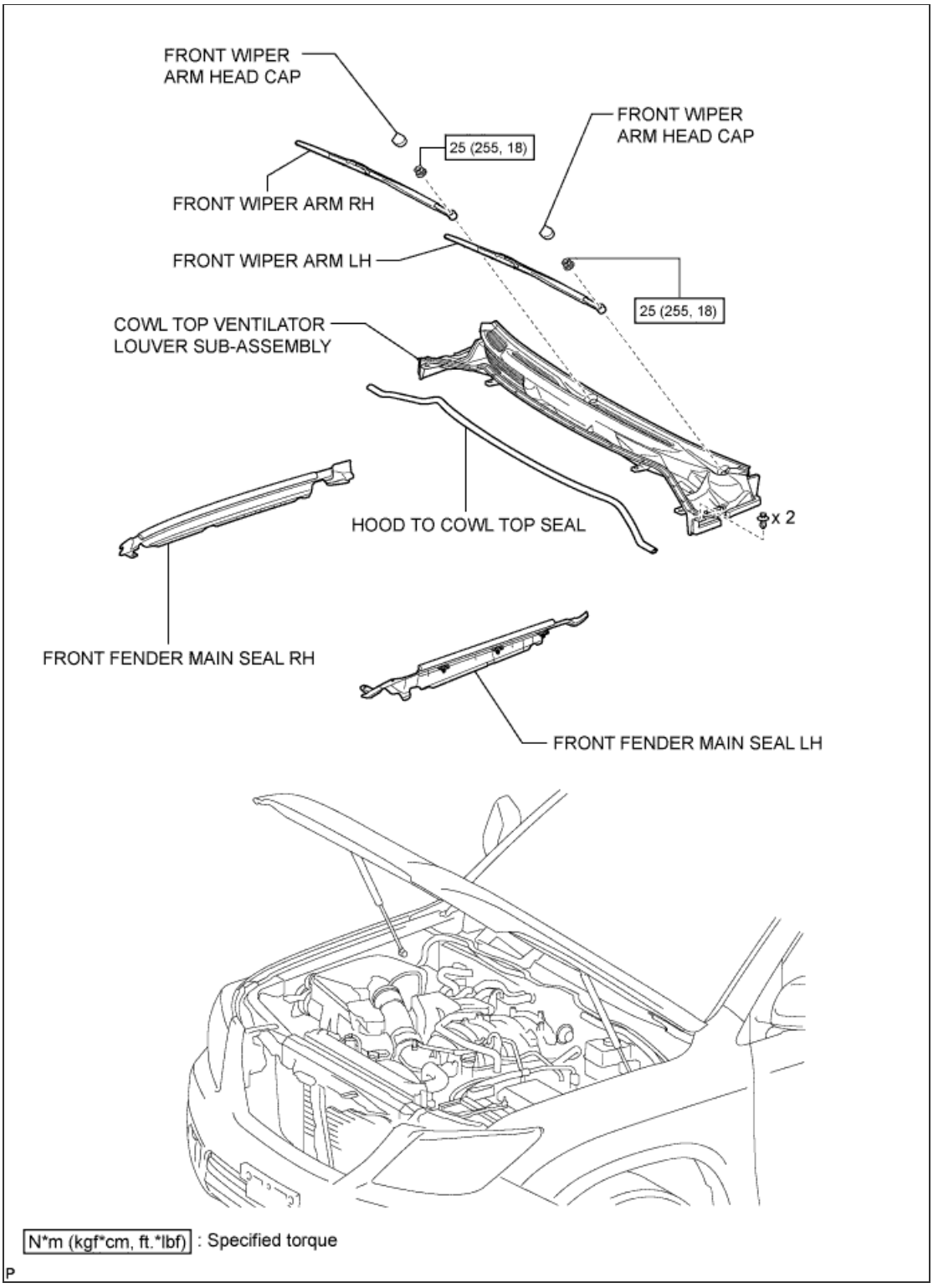

O-RING
O-RING
WATER INLET PIPE
GASKET
CRANKSHAFT TIMING GEAR KEY
O-RING
23 (235, 17)
23 (235, 17)
x 12
23 (235, 17)
47 (479, 35)
x 5
47 (479, 35)
23 (235, 17)
x 5
x 4
47 (479, 35)
CRANKSHAFT PULLEY
300 (3059, 221)
TIMING CHAIN COVER SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P

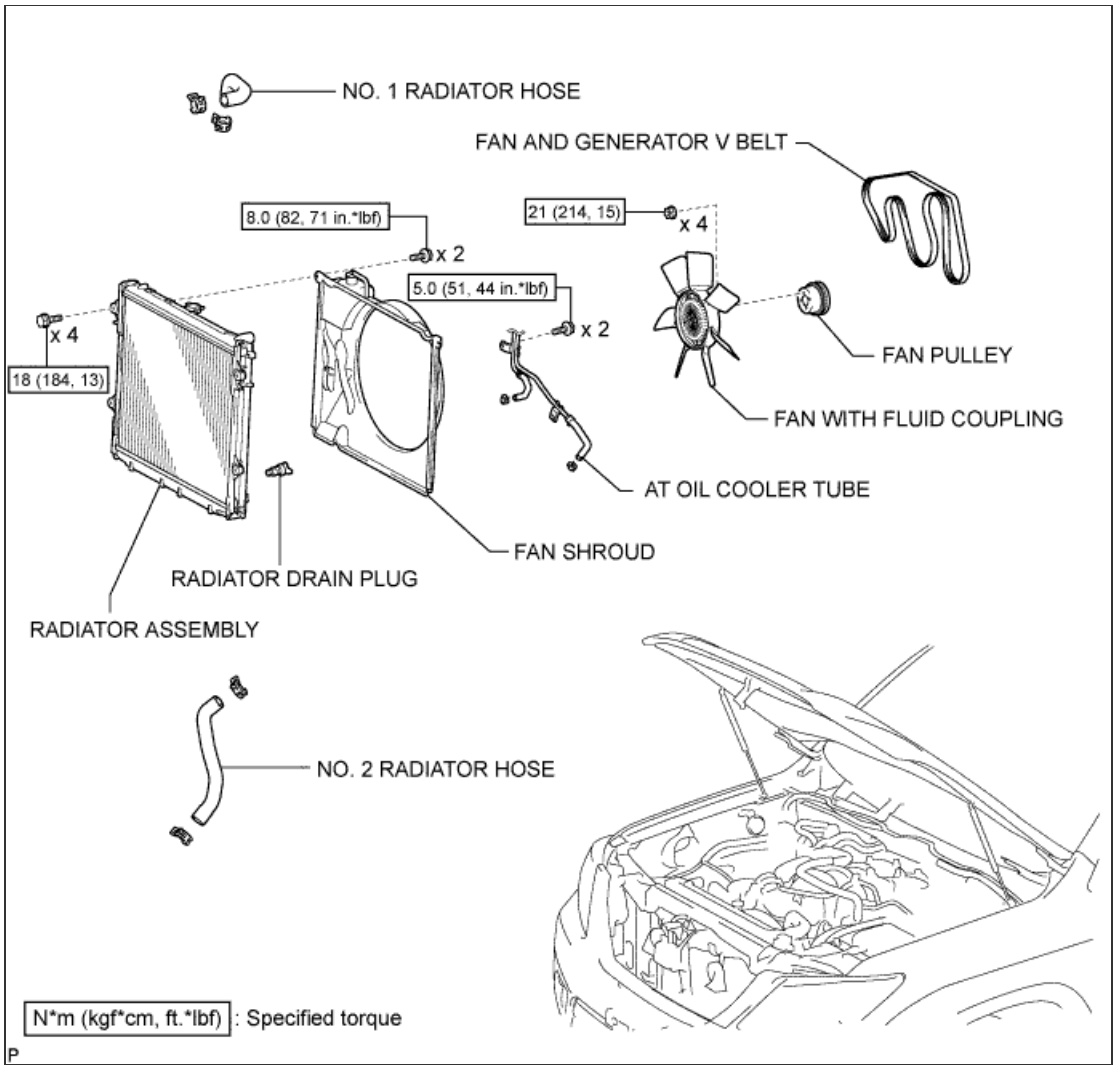

TIMING CHAIN COVER SUB-ASSEMBLY
RELIEF VALVE SPRING
53 (540, 39)
RELIEF VALVE PLUG
DRIVEN ROTOR
OIL PUMP RELIEF VALVE
DRIVE ROTOR
OIL PUMP COVER
x 13
10 (105, 8)
N*m (kgf*cm, ft.*lbf) : Specified torque
P

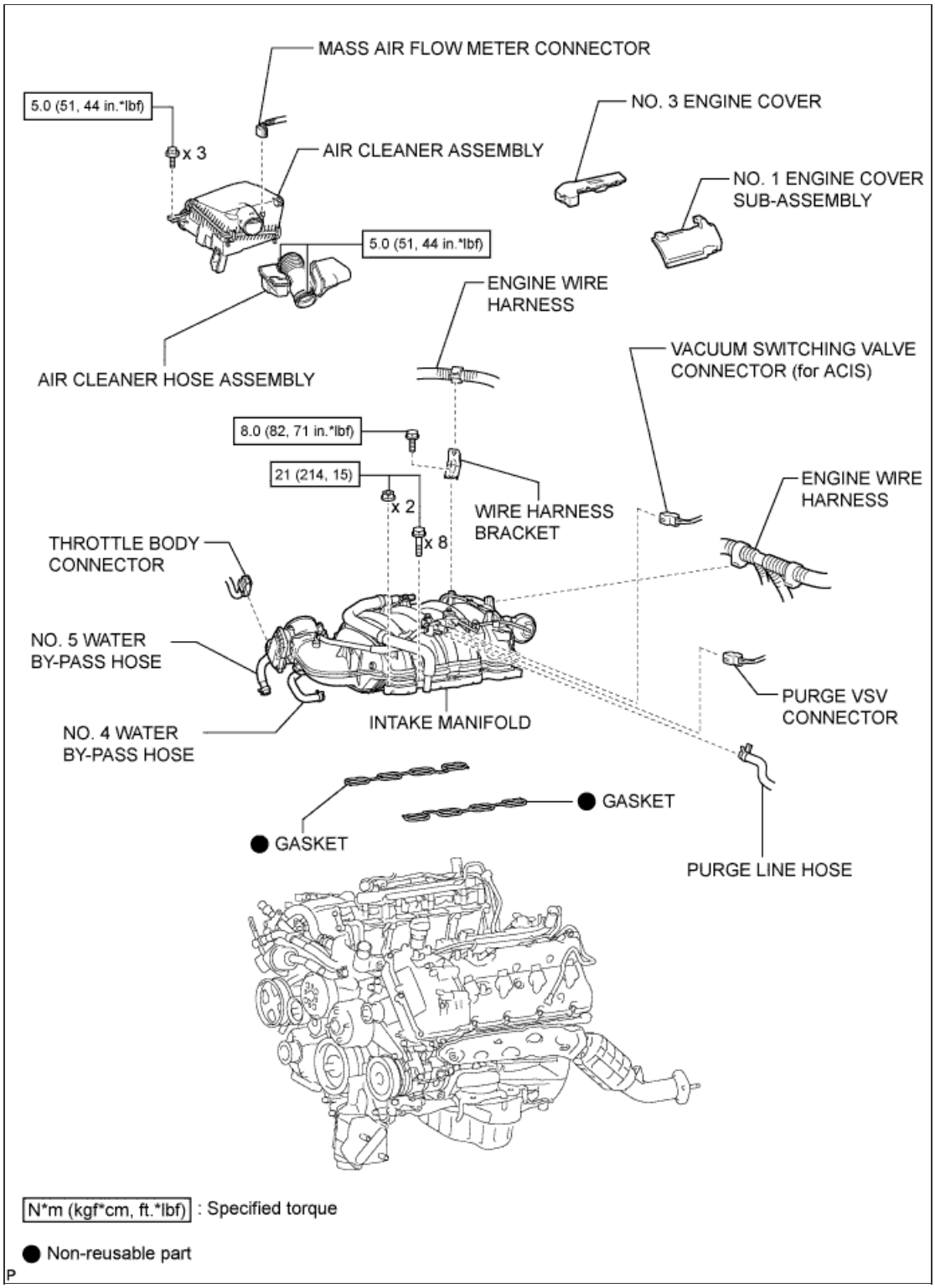
for Preparation Click here



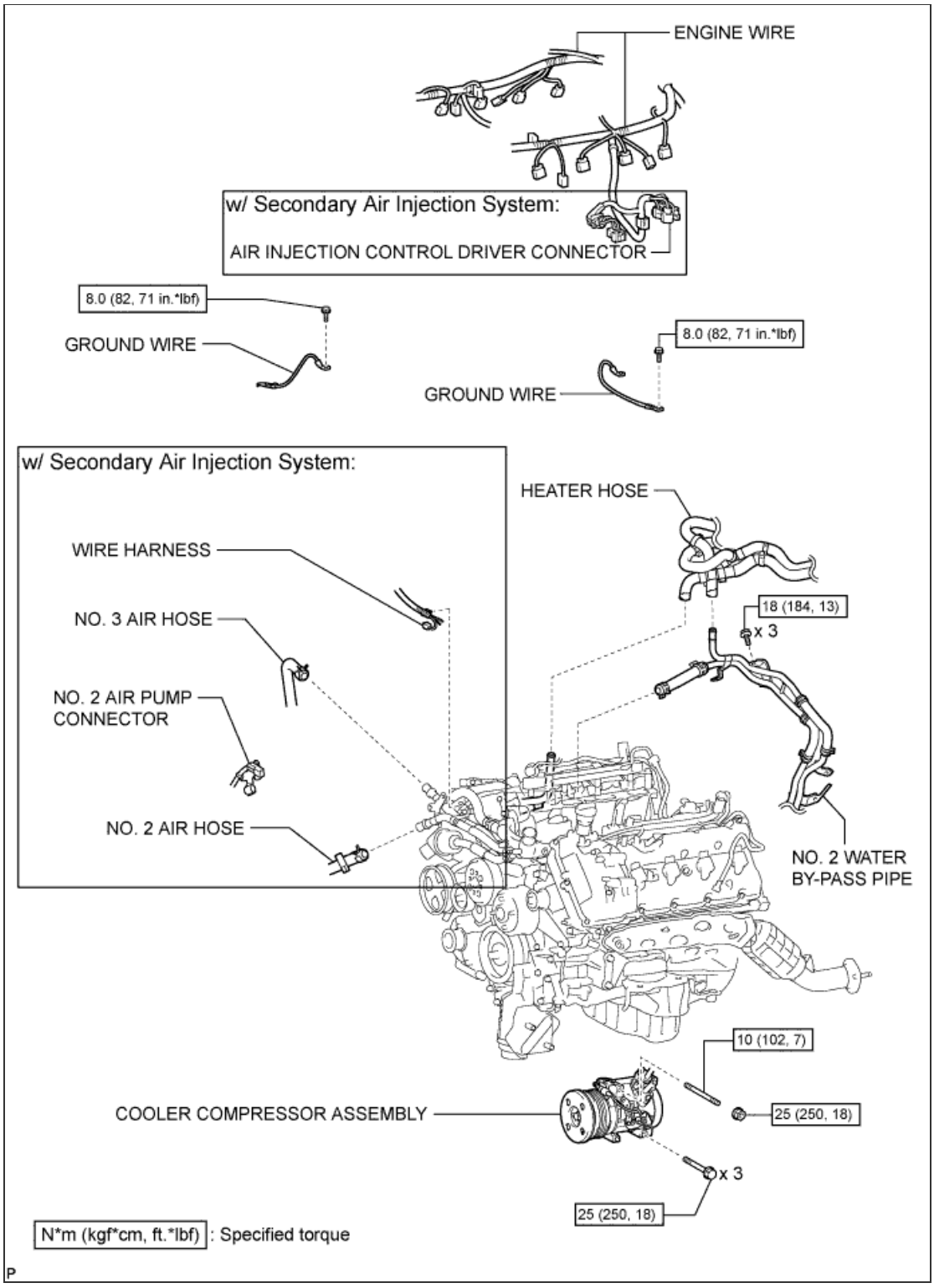

w/o Air Cooled Transmission Oil Cooler:
x 5
RADIATOR SIDE DEFLECTOR RH
x 2
RADIATOR GRILLE
x 5
RADIATOR SIDE DEFLECTOR LH
x 2
FRONT FENDER APRON SEAL FRONT RH
x 2
x 2
FRONT FENDER APRON SEAL FRONT LH
P

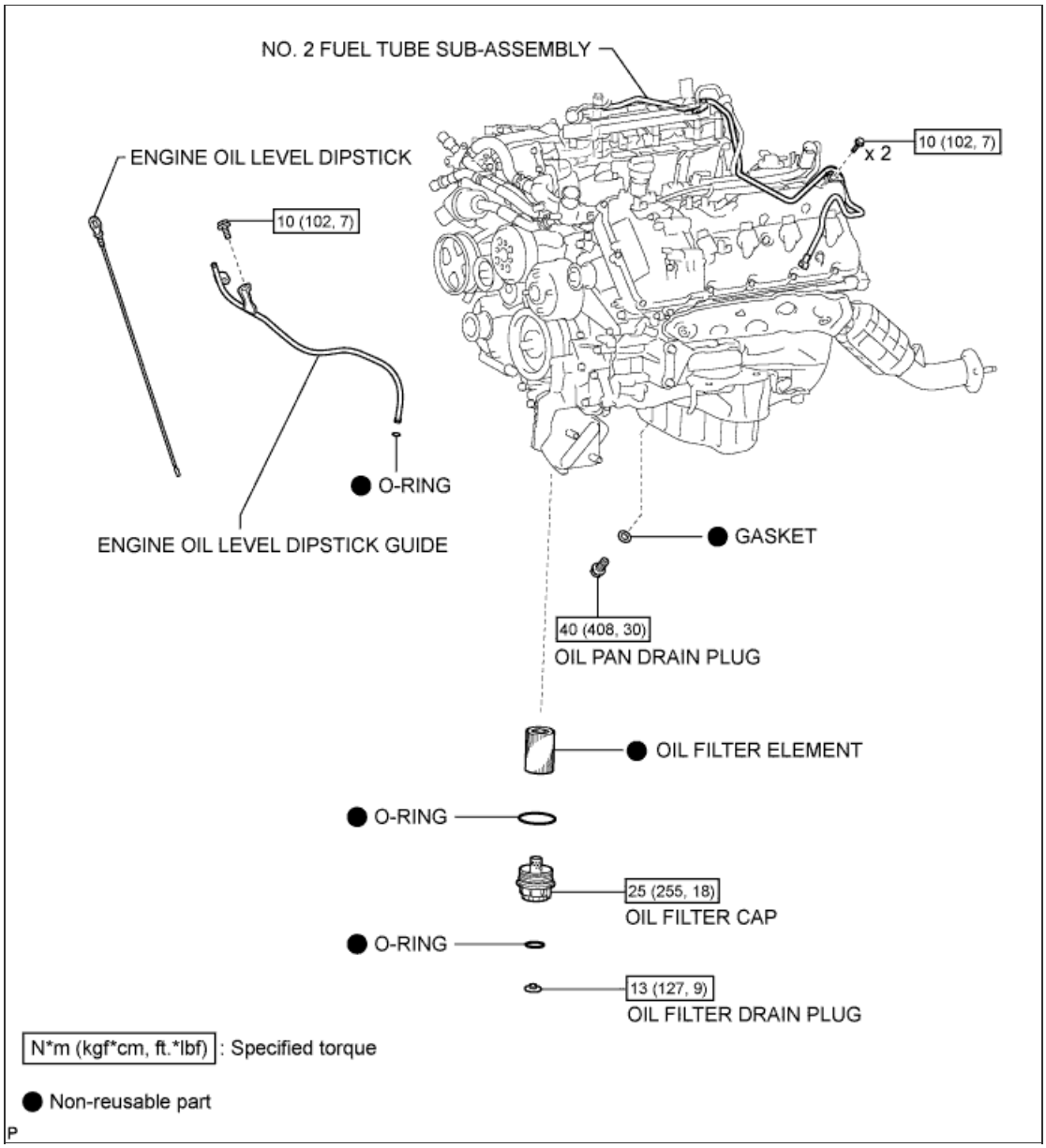

FRONT WIPER
ARM HEAD CAP
25 (255, 18)
FRONT WIPER
ARM HEAD CAP
FRONT WIPER ARM RH
FRONT WIPER ARM LH
25 (255, 18)
COWL TOP VENTILATOR
LOUVER SUB-ASSEMBLY
x 2
HOOD TO COWL TOP SEAL
FRONT FENDER MAIN SEAL RH
FRONT FENDER MAIN SEAL LH
N*m (kgf*cm, ft.*lbf) : Specified torque
P

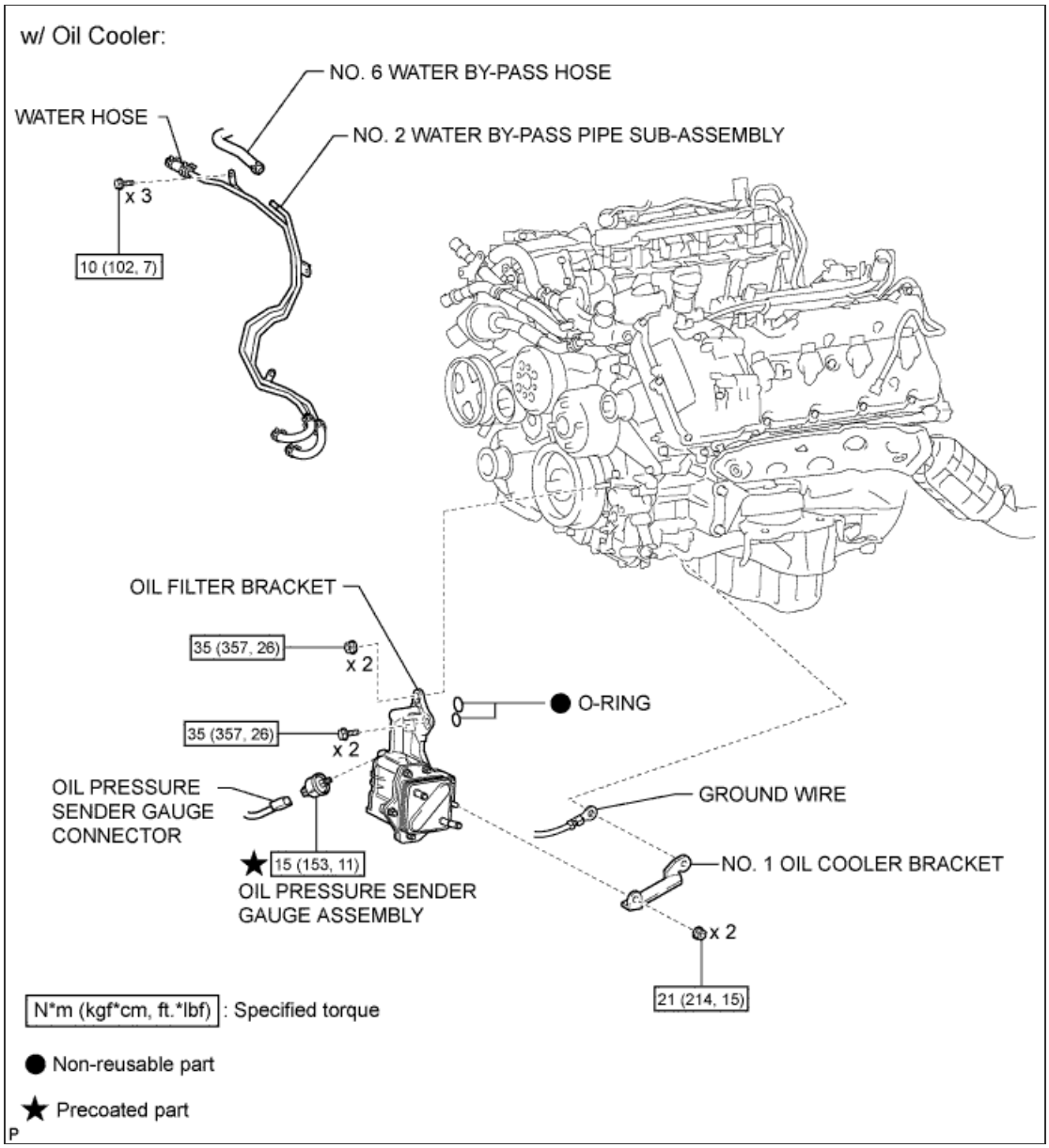

NO. 1 RADIATOR HOSE
FAN AND GENERATOR V BELT
8.0 (82, 71 in.*lbf)
x 2
21 (214, 15)
x 4
5.0 (51, 44 in.*lbf)
x 2
x 4
18 (184, 13)
FAN PULLEY
FAN WITH FLUID COUPLING
AT OIL COOLER TUBE
FAN SHROUD
RADIATOR DRAIN PLUG
RADIATOR ASSEMBLY
NO. 2 RADIATOR HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
P


MASS AIR FLOW METER CONNECTOR
5.0 (51, 44 in.*lbf)
x 3
AIR CLEANER ASSEMBLY
NO. 3 ENGINE COVER
NO. 1 ENGINE COVER SUB-ASSEMBLY
5.0 (51, 44 in.*lbf)
ENGINE WIRE HARNESS
AIR CLEANER HOSE ASSEMBLY
VACUUM SWITCHING VALVE CONNECTOR (for ACIS)
8.0 (82, 71 in.*lbf)
21 (214, 15)
x 2
x 8
WIRE HARNESS BRACKET
ENGINE WIRE HARNESS
THROTTLE BODY CONNECTOR
NO. 5 WATER BY-PASS HOSE
PURGE VSV CONNECTOR
INTAKE MANIFOLD
NO. 4 WATER BY-PASS HOSE
GASKET
GASKET
PURGE LINE HOSE
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part

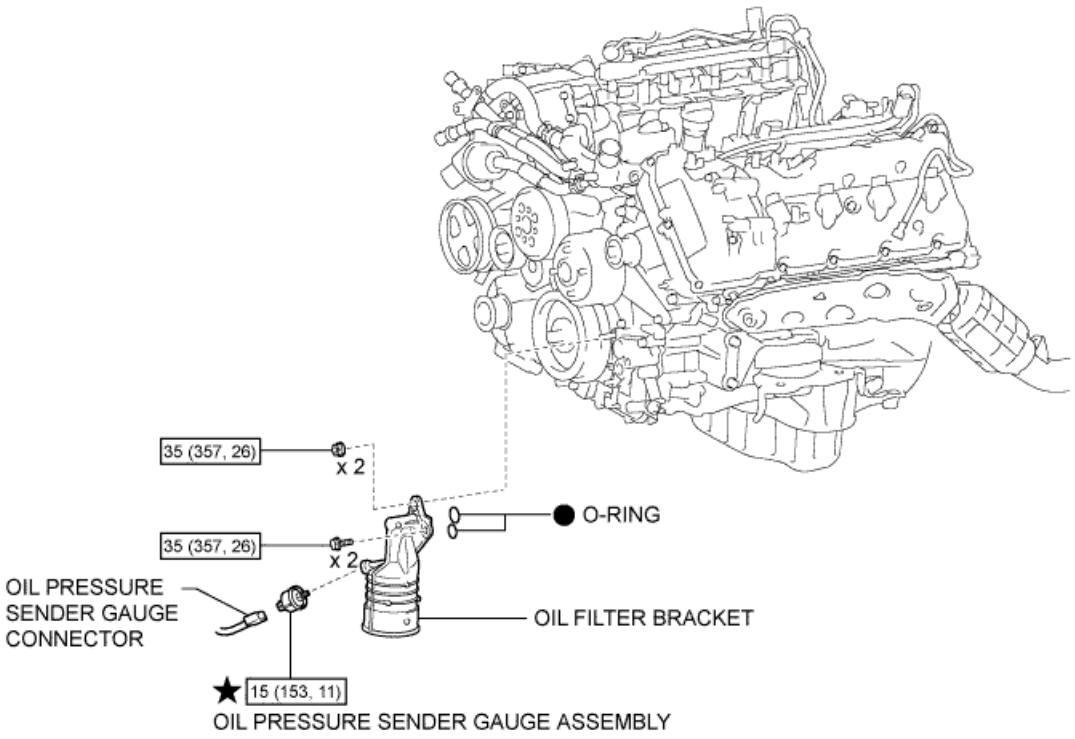
P


ENGINE WIRE
w/ Secondary Air Injection System:
AIR INJECTION CONTROL DRIVER CONNECTOR
8.0 (82, 71 in.*lbf)
GROUND WIRE
8.0 (82, 71 in.*lbf)
GROUND WIRE
w/ Secondary Air Injection System:
HEATER HOSE
WIRE HARNESS
NO. 3 AIR HOSE
NO. 2 AIR PUMP CONNECTOR
NO. 2 AIR HOSE
18 (184, 13)
x 3
NO. 2 WATER BY-PASS PIPE
10 (102, 7)
COOLER COMPRESSOR ASSEMBLY
25 (250, 18)
x 3
25 (250, 18)
N*m (kgf*cm, ft.*lbf) : Specified torque
P


NO. 2 FUEL TUBE SUB-ASSEMBLY
ENGINE OIL LEVEL DIPSTICK
10 (102, 7)
x 2
10 (102, 7)
O-RING
ENGINE OIL LEVEL DIPSTICK GUIDE
GASKET
40 (408, 30)
OIL PAN DRAIN PLUG
OIL FILTER ELEMENT
O-RING
25 (255, 18)
OIL FILTER CAP
O-RING
13 (127, 9)
OIL FILTER DRAIN PLUG
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


w/ Oil Cooler:
NO. 6 WATER BY-PASS HOSE
WATER HOSE
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
x 3
10 (102, 7)
OIL FILTER BRACKET
35 (357, 26)
x 2
O-RING
35 (357, 26)
x 2
OIL PRESSURE SENDER GAUGE CONNECTOR
GROUND WIRE
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
NO. 1 OIL COOLER BRACKET
x 2
21 (214, 15)
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
P

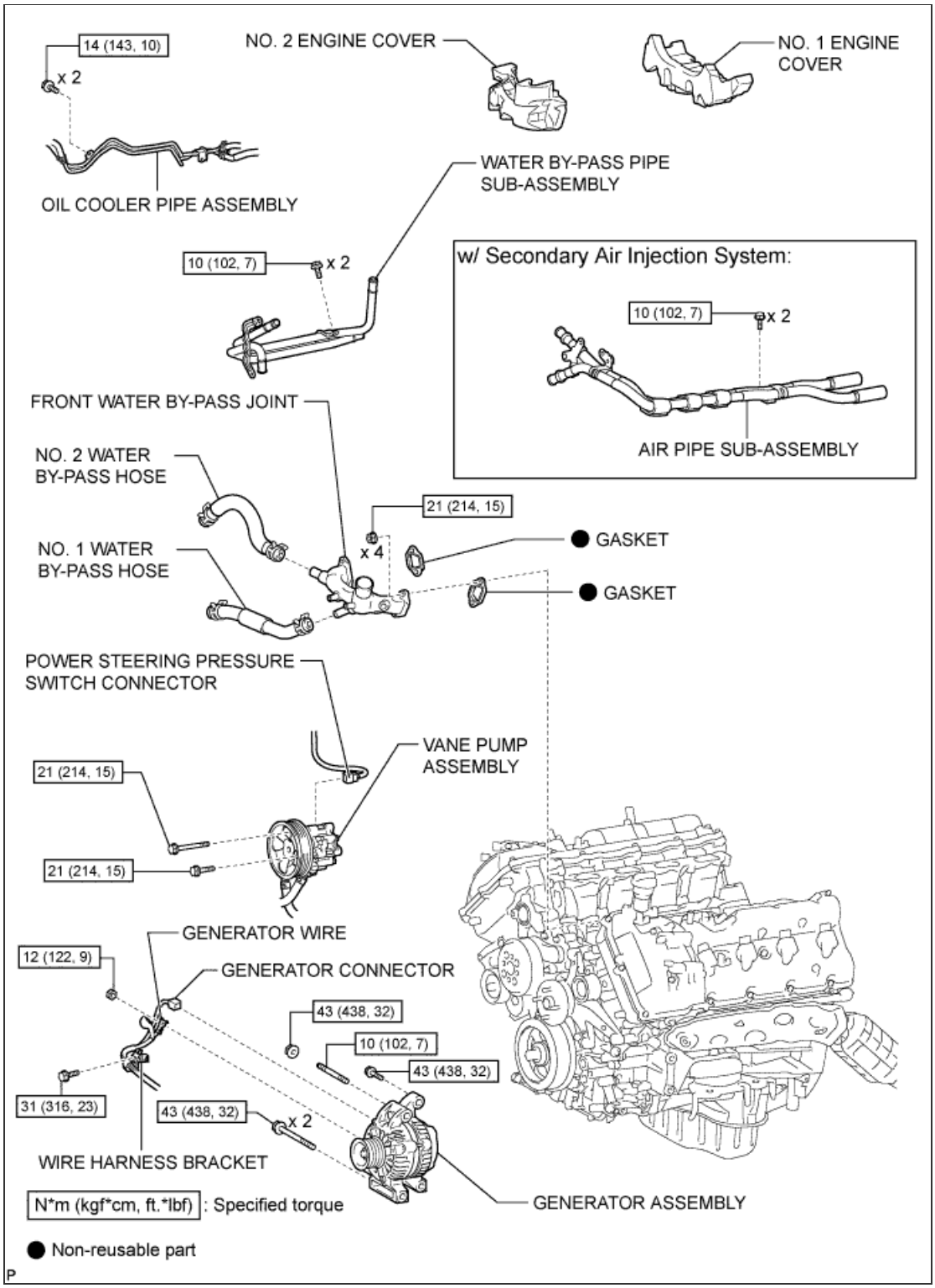
w/o Oil Cooler:

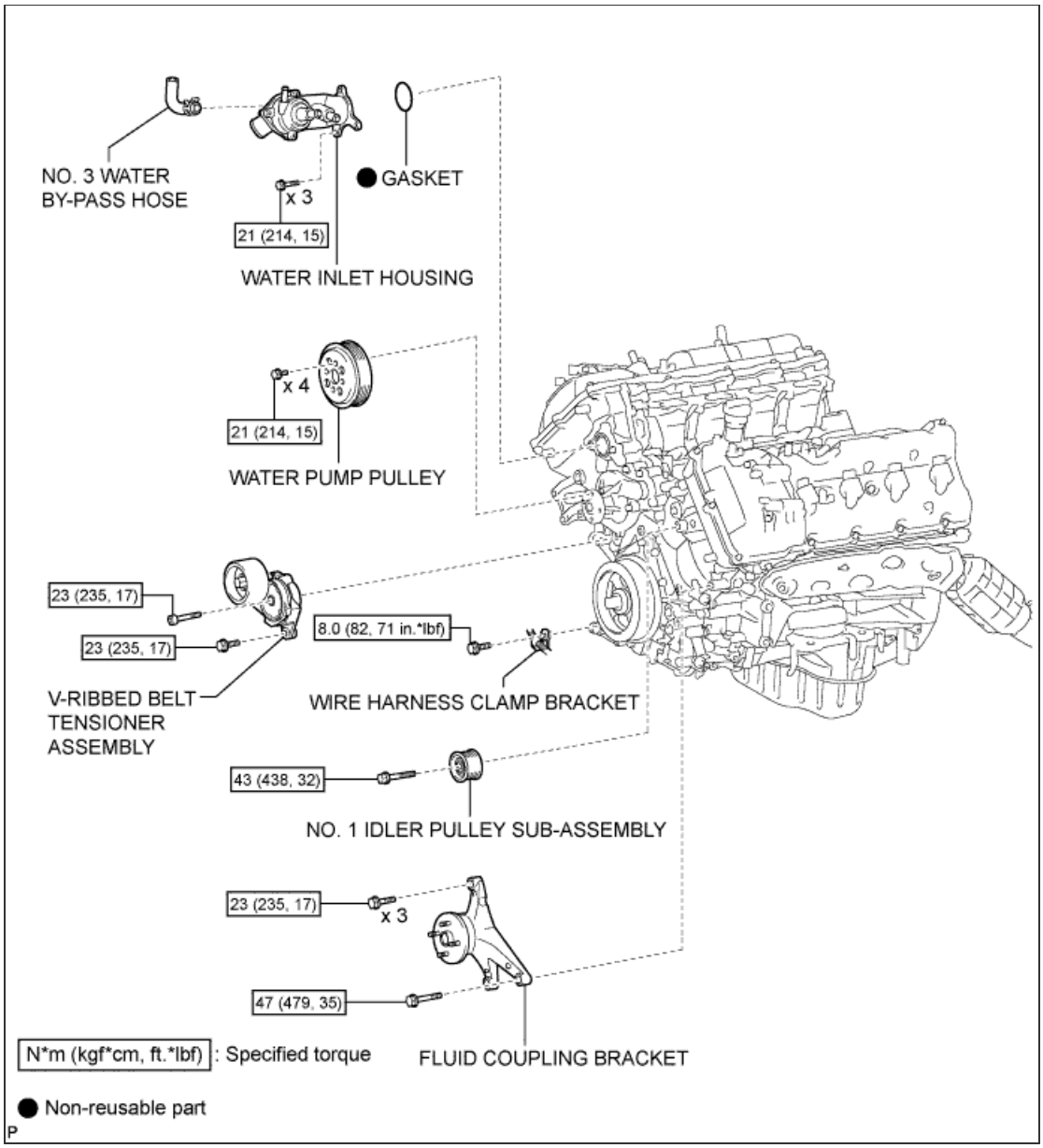


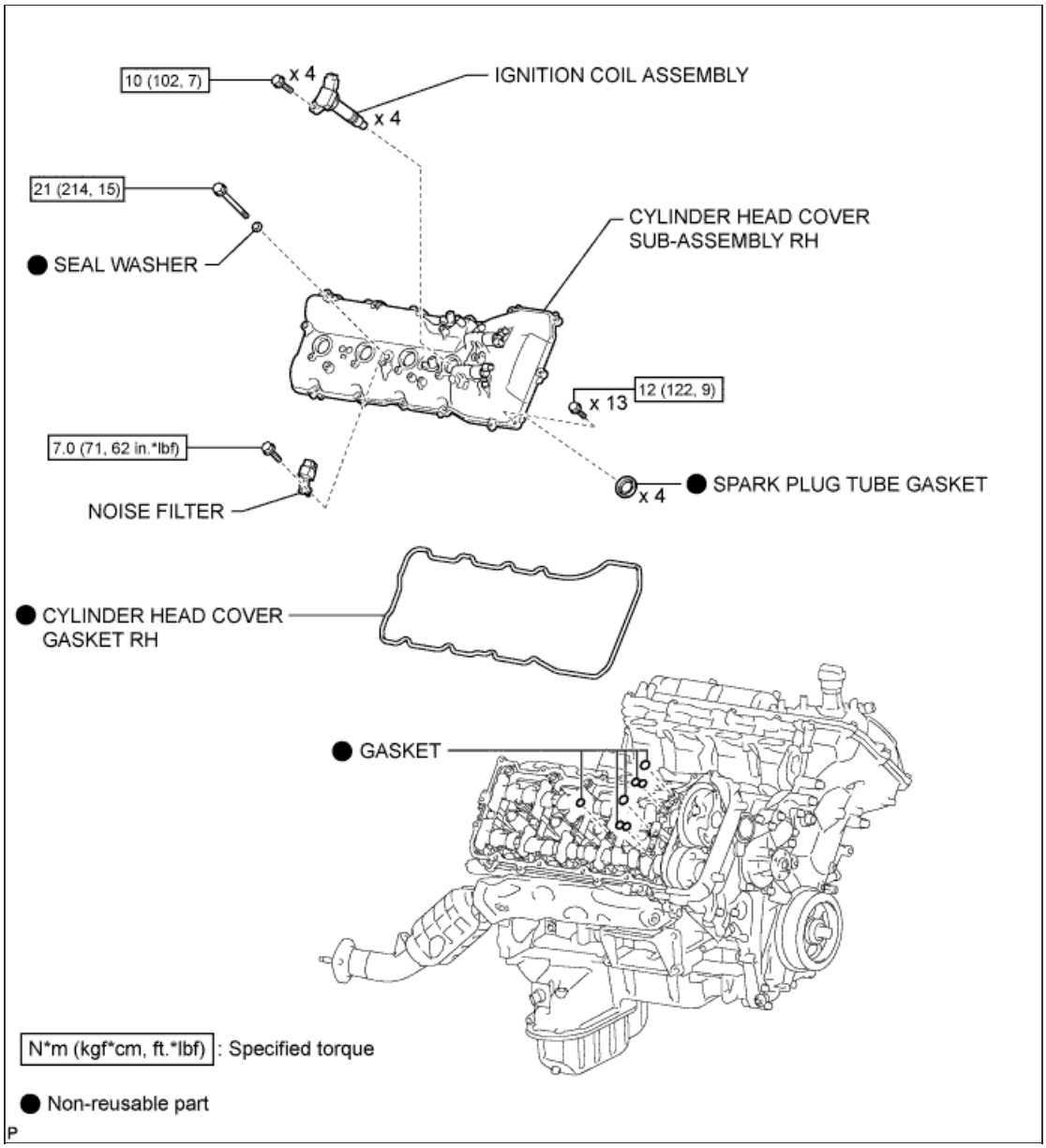
N*m (kgf*cm, ft.*lbf) : Specified torque

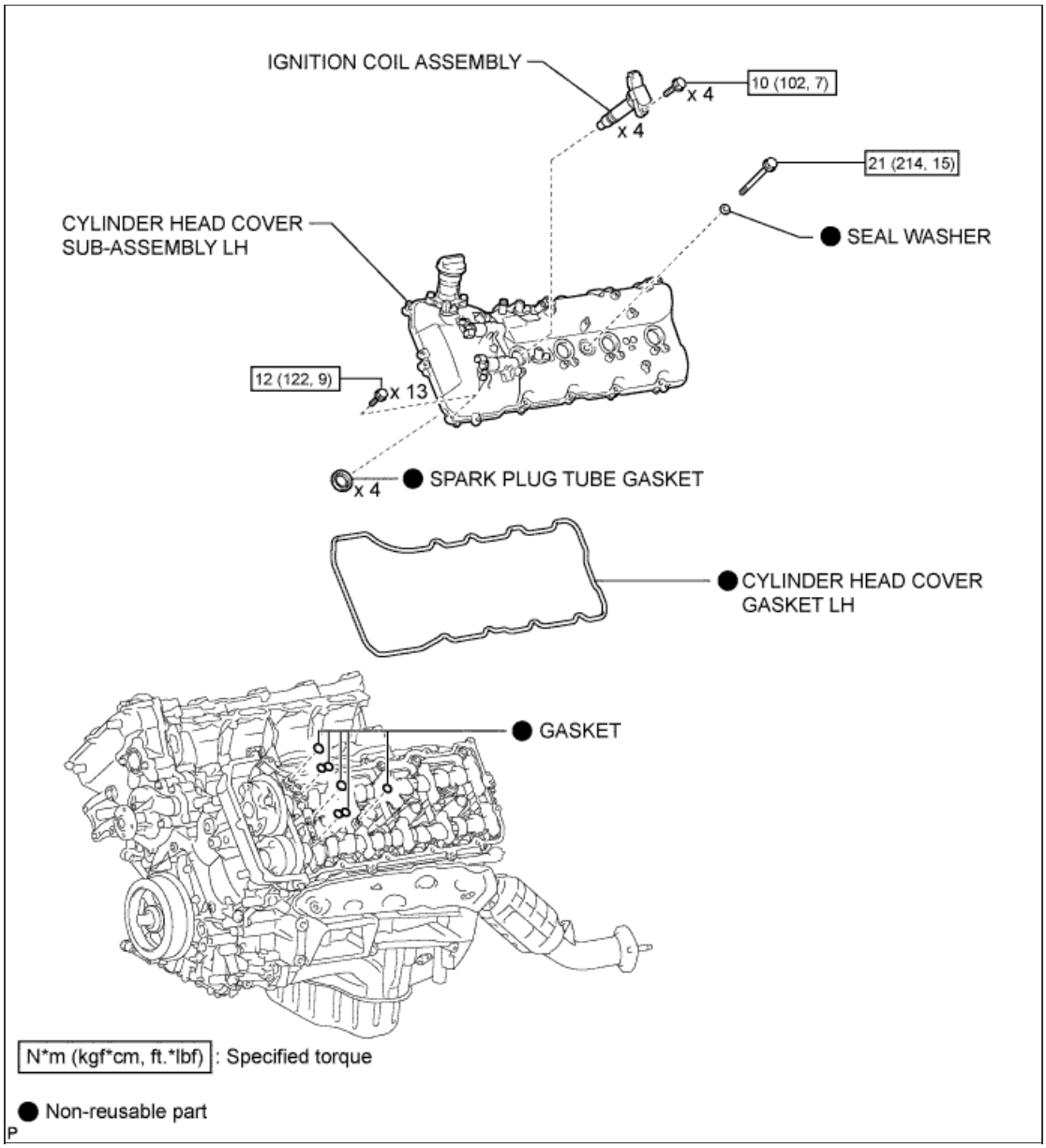
● Non-reusable part

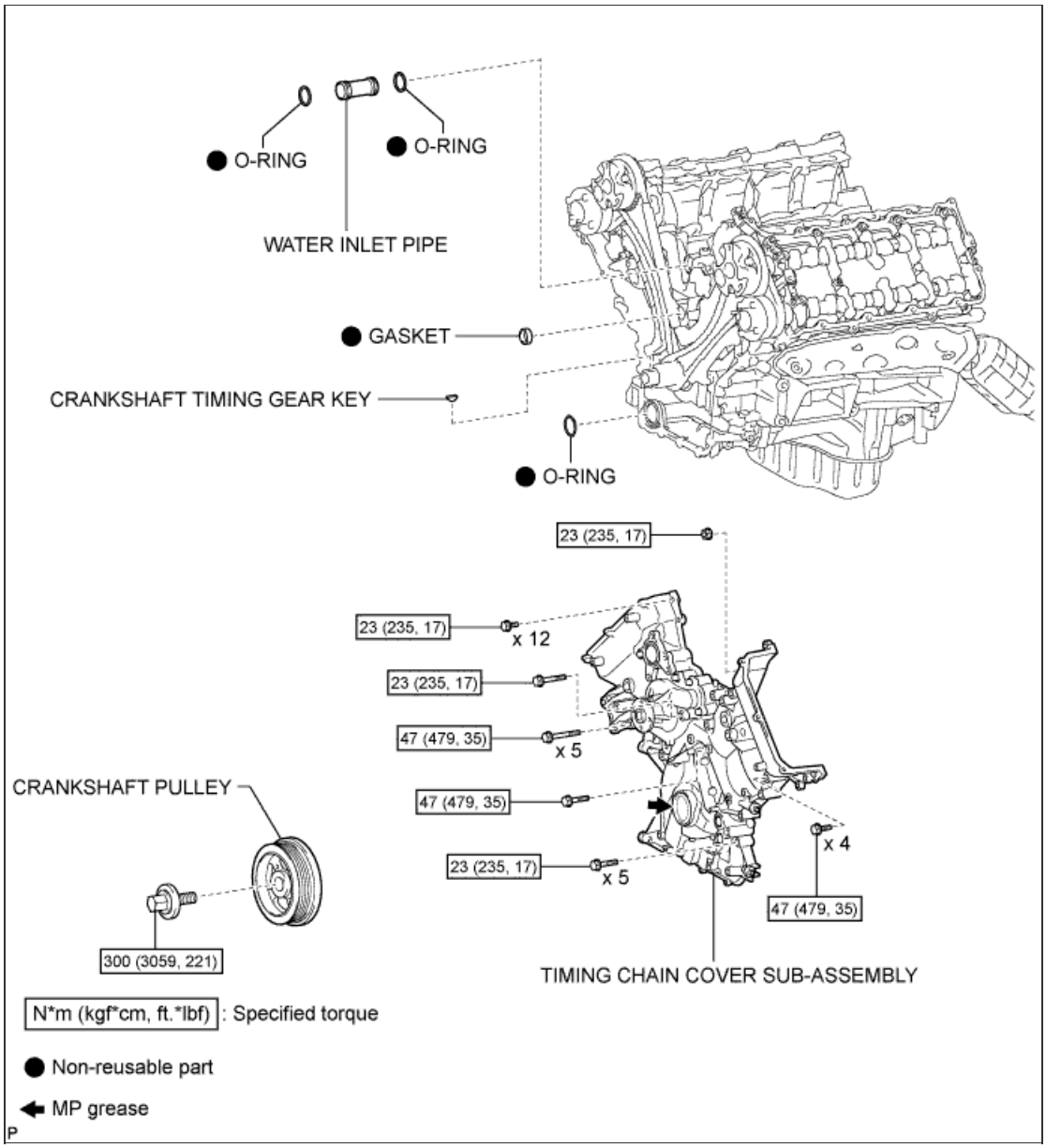
★ Precoated part

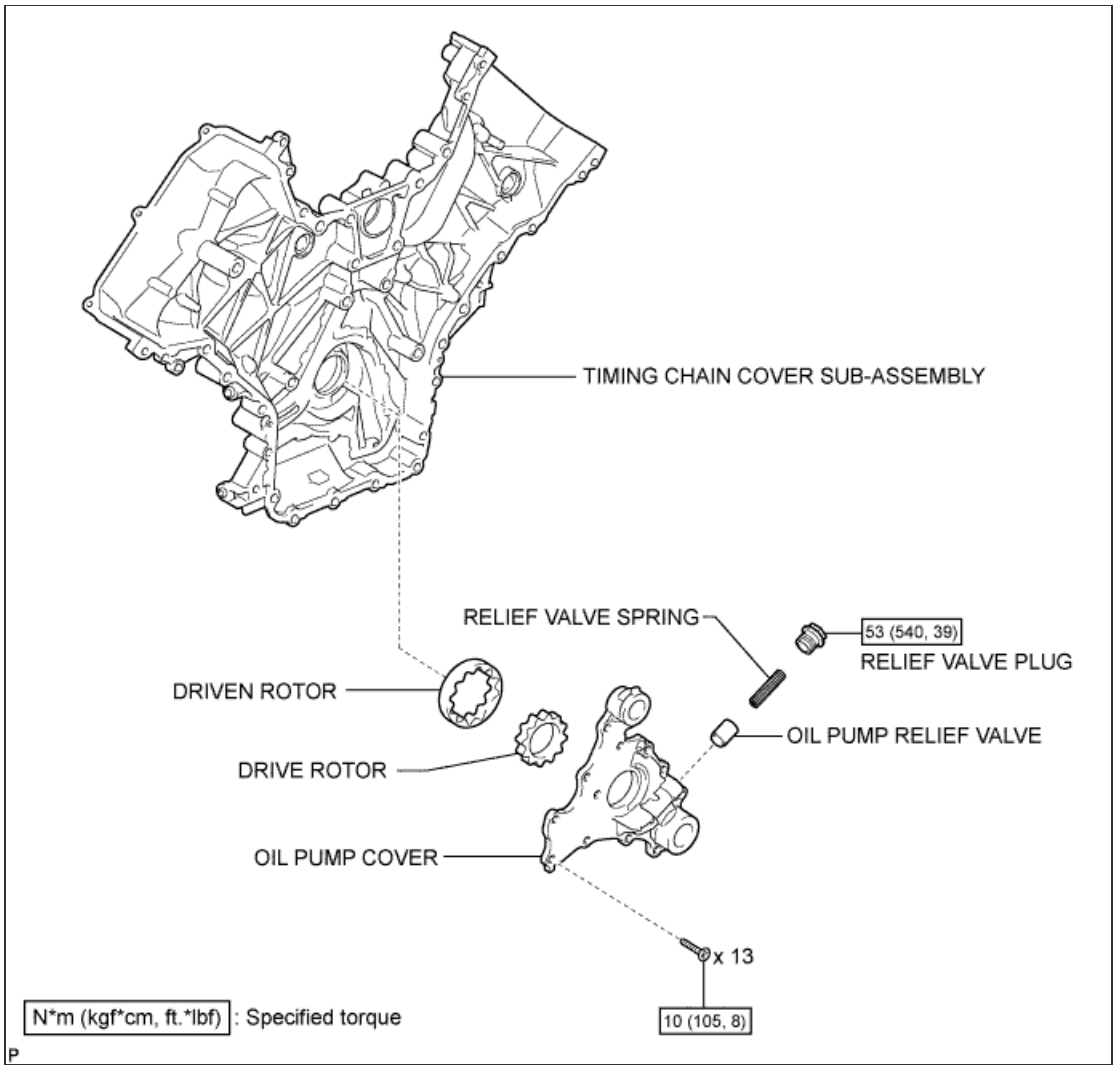

14 (143, 10)
x 2
NO. 2 ENGINE COVER
NO. 1 ENGINE COVER
OIL COOLER PIPE ASSEMBLY
WATER BY-PASS PIPE SUB-ASSEMBLY
10 (102, 7)
x 2
w/ Secondary Air Injection System:
10 (102, 7)
x 2
AIR PIPE SUB-ASSEMBLY
FRONT WATER BY-PASS JOINT
NO. 2 WATER BY-PASS HOSE
NO. 1 WATER BY-PASS HOSE
21 (214, 15)
x 4
GASKET
GASKET
POWER STEERING PRESSURE SWITCH CONNECTOR
VANE PUMP ASSEMBLY
21 (214, 15)
21 (214, 15)
GENERATOR WIRE
12 (122, 9)
GENERATOR CONNECTOR
43 (438, 32)
10 (102, 7)
43 (438, 32)
31 (316, 23)
43 (438, 32)
x 2
WIRE HARNESS BRACKET
GENERATOR ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


NO. 3 WATER BY-PASS HOSE
x 3
21 (214, 15)
GASKET
WATER INLET HOUSING
x 4
21 (214, 15)
WATER PUMP PULLEY
23 (235, 17)
23 (235, 17)
V-RIBBED BELT TENSIONER ASSEMBLY
8.0 (82, 71 in.*lbf)
WIRE HARNESS CLAMP BRACKET
43 (438, 32)
NO. 1 IDLER PULLEY SUB-ASSEMBLY
23 (235, 17)
x 3
47 (479, 35)
FLUID COUPLING BRACKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


10 (102, 7)
x 4
x 4
IGNITION COIL ASSEMBLY
21 (214, 15)
SEAL WASHER
CYLINDER HEAD COVER
SUB-ASSEMBLY RH
12 (122, 9)
x 13
7.0 (71, 62 in.*lbf)
NOISE FILTER
x 4
SPARK PLUG TUBE GASKET
CYLINDER HEAD COVER
GASKET RH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P


IGNITION COIL ASSEMBLY
x 4
10 (102, 7)
x 4
21 (214, 15)
CYLINDER HEAD COVER
SUB-ASSEMBLY LH
SEAL WASHER
12 (122, 9)
x 13
x 4
SPARK PLUG TUBE GASKET
CYLINDER HEAD COVER
GASKET LH
GASKET
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

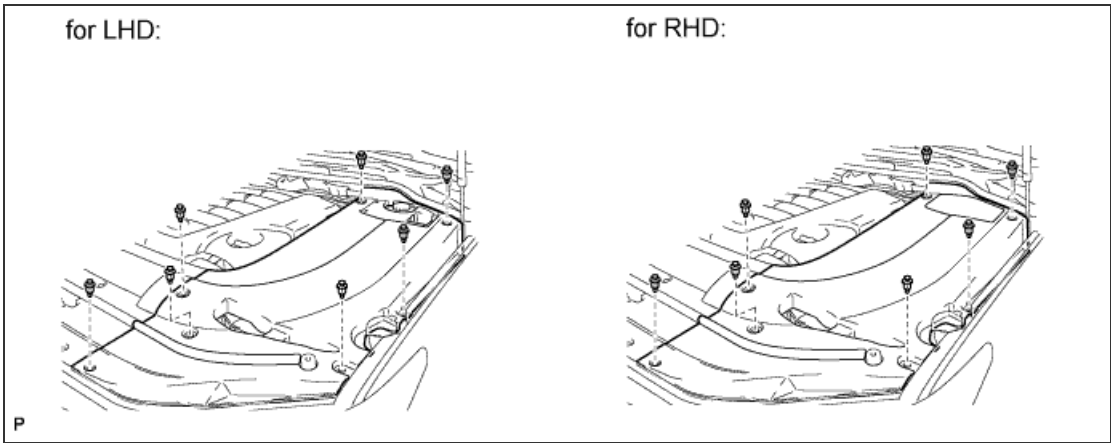

O-RING
O-RING
WATER INLET PIPE
GASKET
CRANKSHAFT TIMING GEAR KEY
O-RING
23 (235, 17)
23 (235, 17)
x 12
23 (235, 17)
47 (479, 35)
x 5
47 (479, 35)
23 (235, 17)
x 5
x 4
47 (479, 35)
CRANKSHAFT PULLEY
300 (3059, 221)
TIMING CHAIN COVER SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
MP grease
P


TIMING CHAIN COVER SUB-ASSEMBLY
RELIEF VALVE SPRING
53 (540, 39)
RELIEF VALVE PLUG
DRIVEN ROTOR
OIL PUMP RELIEF VALVE
DRIVE ROTOR
OIL PUMP COVER
x 13
10 (105, 8)
N*m (kgf*cm, ft.*lbf) : Specified torque
P

for Preparation Click here

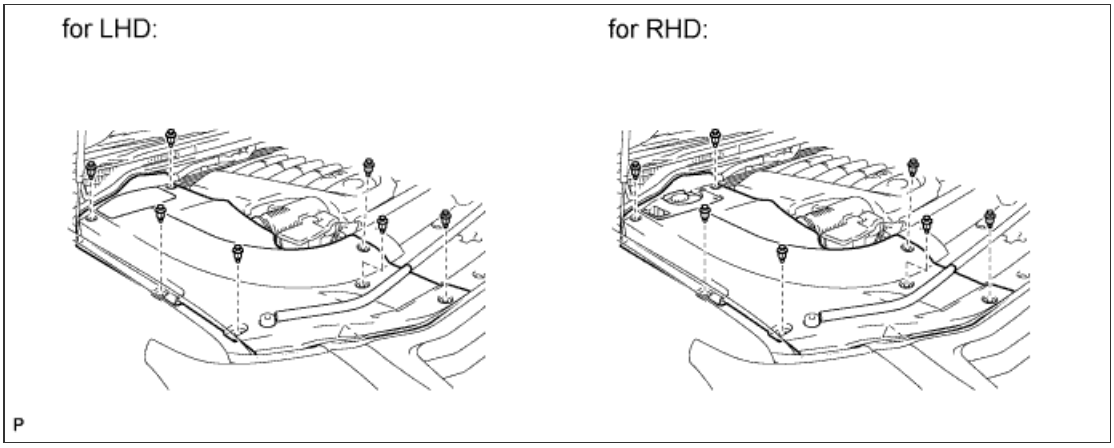
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

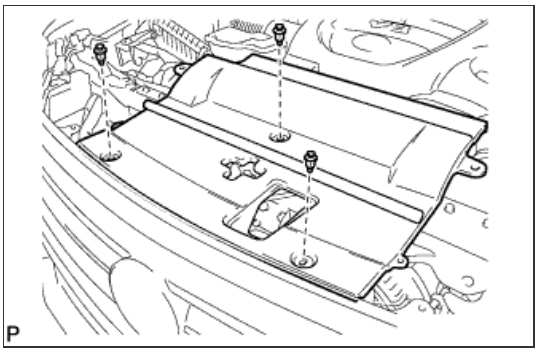
4. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

5. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



6. REMOVE RADIATOR GRILLE

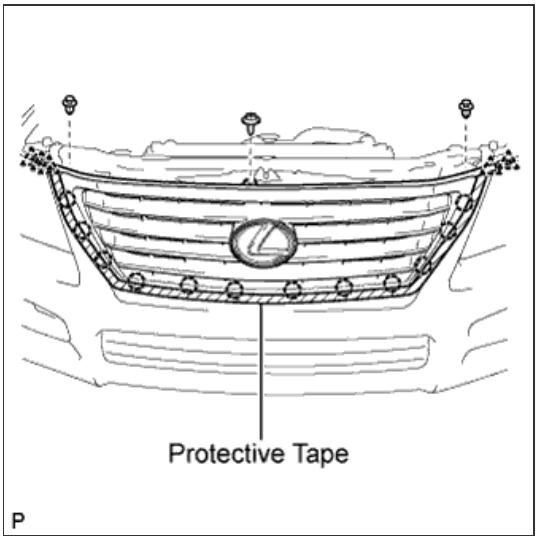
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

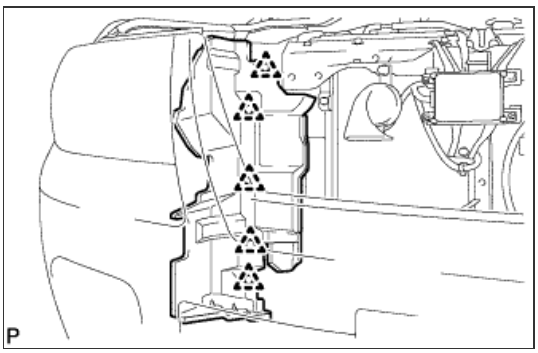
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



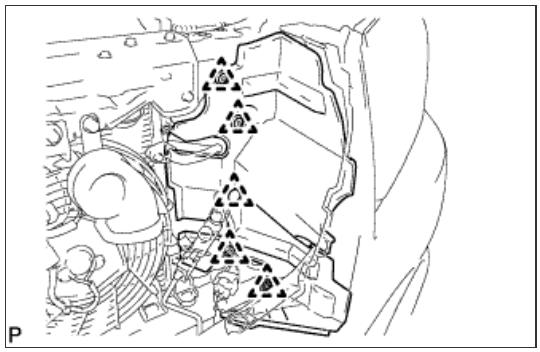
7. DISCONNECT RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



8. DISCONNECT RADIATOR SIDE DEFLECTOR LH

a. Using a clip remover, remove the 5 clips and side deflector.

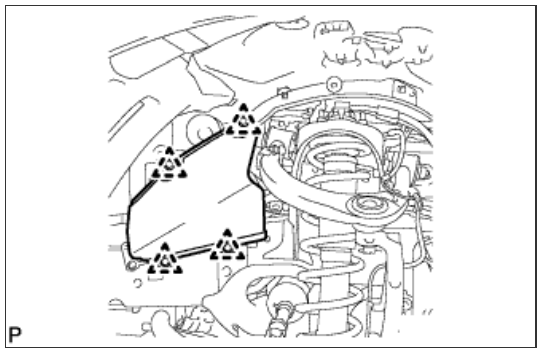


9. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Remove the cowl top ventilator louver (Click here).

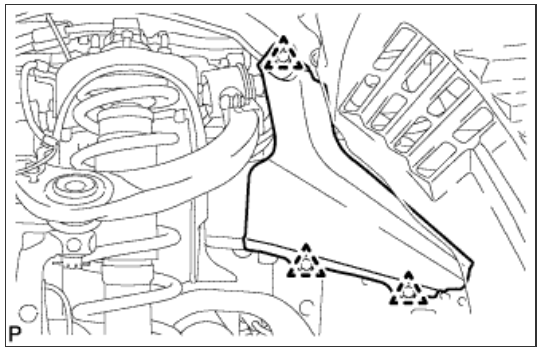
10. REMOVE FRONT FENDER APRON SEAL LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



11. REMOVE FRONT FENDER APRON SEAL FRONT RH

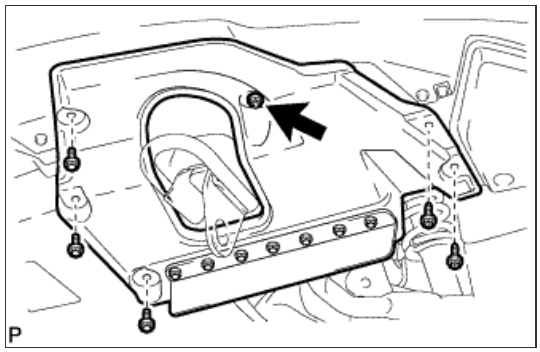
a. Using a clip remover, remove the 3 clips and fender apron seal.



12. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



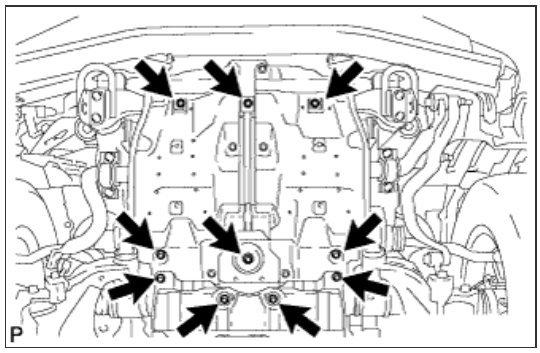
13. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

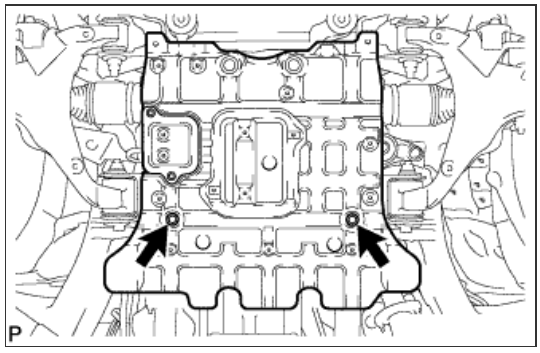
14. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



15. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



16. DRAIN ENGINE OIL

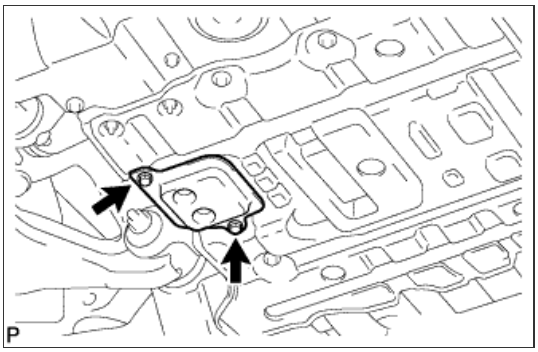
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

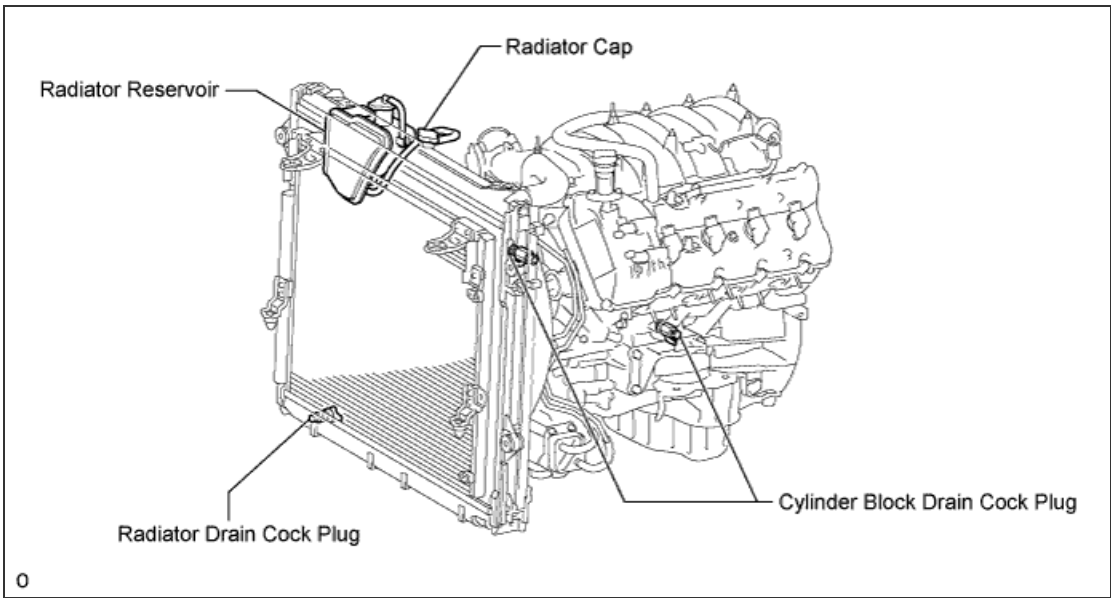
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



17. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

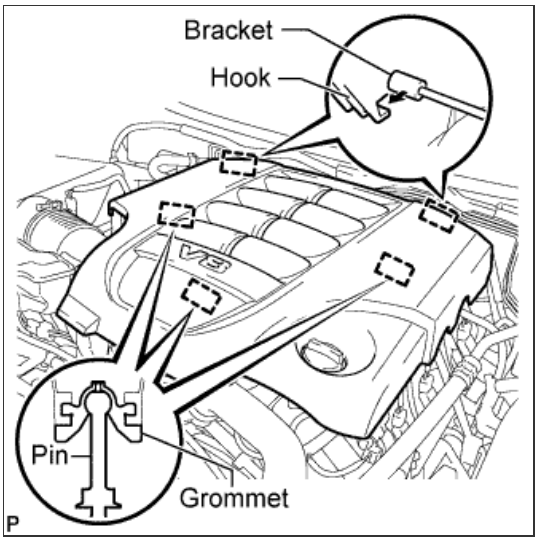
d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

e. Tighten the radiator drain cock plug by hand.

18. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

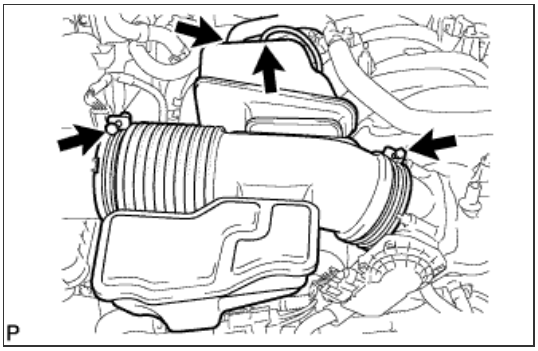


19. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

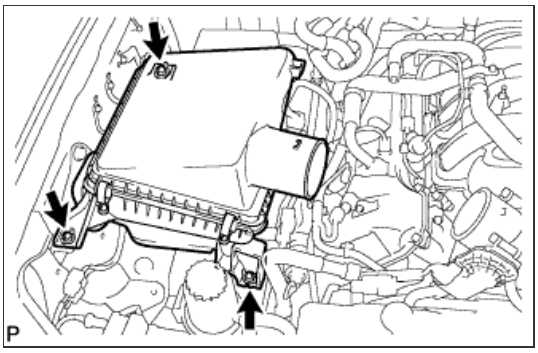
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



20. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



21. REMOVE RADIATOR ASSEMBLY

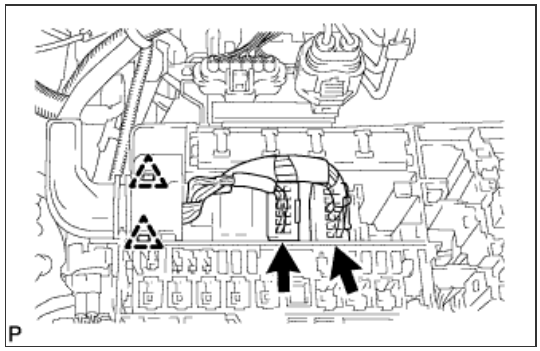
a. Remove the radiator (Click here).

22. DISCONNECT ENGINE WIRE

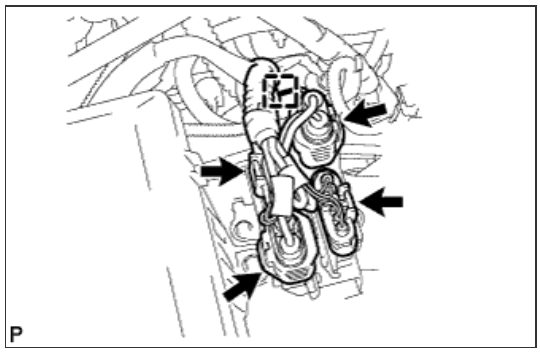
a. Engine Room LH Side:

i. Remove the engine room relay block cover.

ii. Disconnect the 2 connectors and 2 clips from the engine room junction block.



iii. Disconnect the 4 air injection control driver connectors and wire harness clamp.



iv. Disconnect the injector connector.

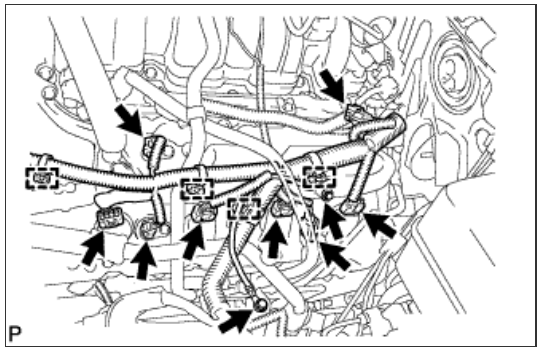
v. Disconnect the 4 ignition coil connectors.

vi. Disconnect the 2 VVT sensor connectors.

vii. Disconnect the 4 clamps.

viii. Remove the 2 bolts and ground wire.

ix. Disconnect the noise filter connector.



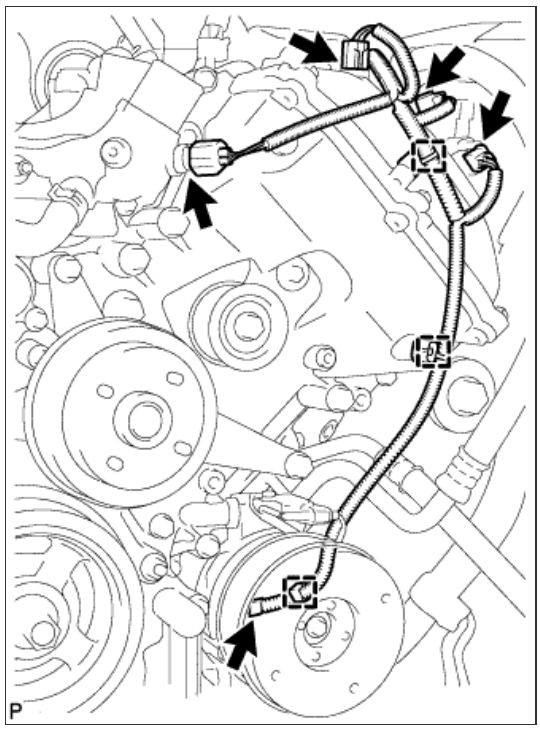
x. Disconnect the engine coolant temperature sensor connector.

xi. Disconnect the 2 camshaft timing oil control valve connectors.

xii. Disconnect the camshaft position sensor connector.

xiii. Disconnect the 3 clamps.

xiv. Disconnect the cooler compressor connector.



b. Engine Room RH Side:

i. Disconnect the 2 camshaft timing oil control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the injector connector.

iv. Disconnect the 2 VVT sensor connectors.

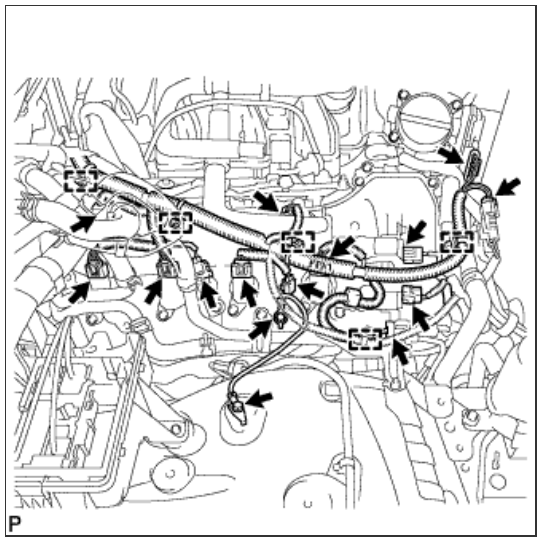
v. Disconnect the noise filter connector.

vi. Remove the 2 bolts and ground wire.

vii. Disconnect the 2 air pump connectors.

viii. Disconnect the throttle position sensor and throttle control motor connector.

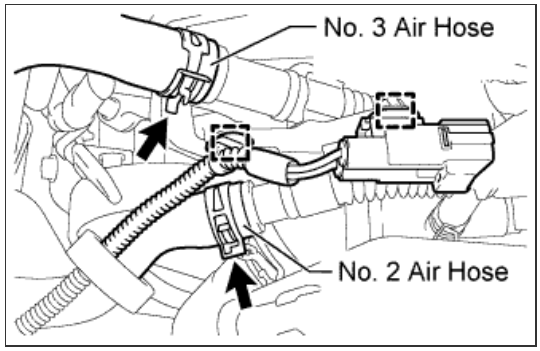
ix. Disconnect the 5 clamps.



23. DISCONNECT AIR PUMP HOSE AND WIRE HARNESS

a. Disconnect the No. 2 and No. 3 air hoses.

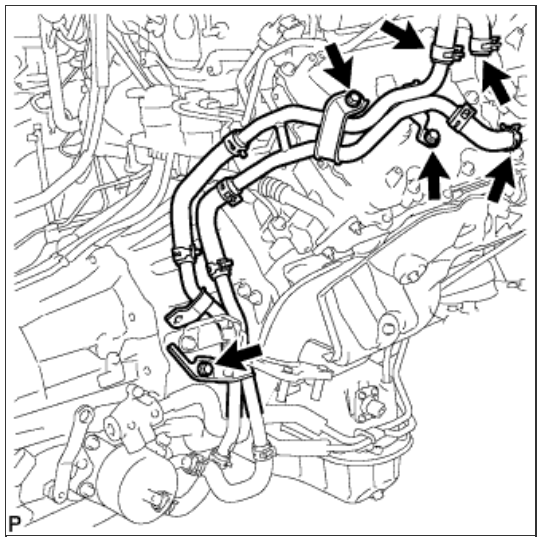
b. Disconnect the 2 clamps.



24. DISCONNECT NO. 2 WATER BY-PASS PIPE

a. Disconnect the 3 hoses.

b. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe from the cylinder head cover.

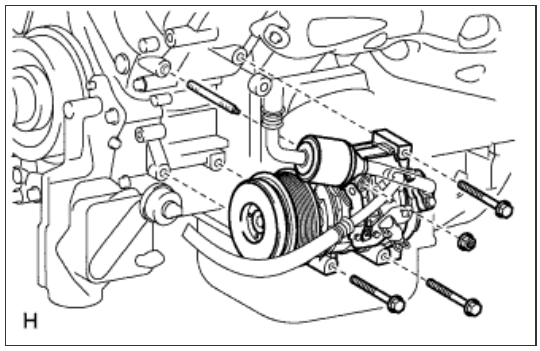


25. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

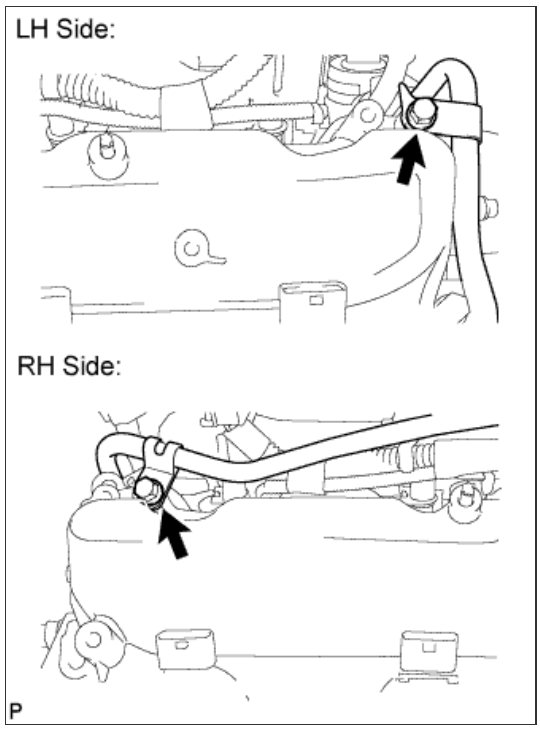
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.



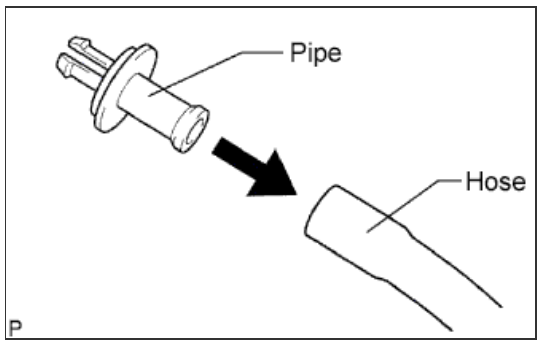
26. DISCONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Remove the 2 bolts and disconnect the fuel tube.

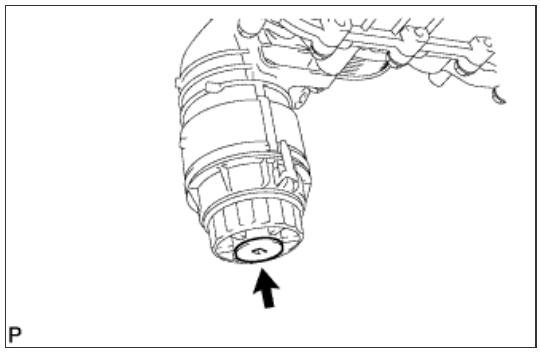


27. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



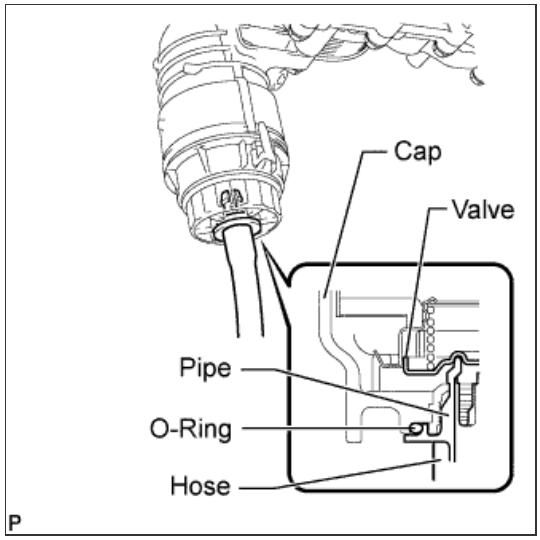
c. Install the pipe to the oil filter cap.

NOTICE:

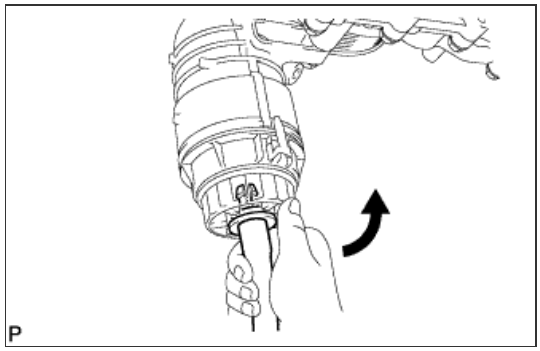
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

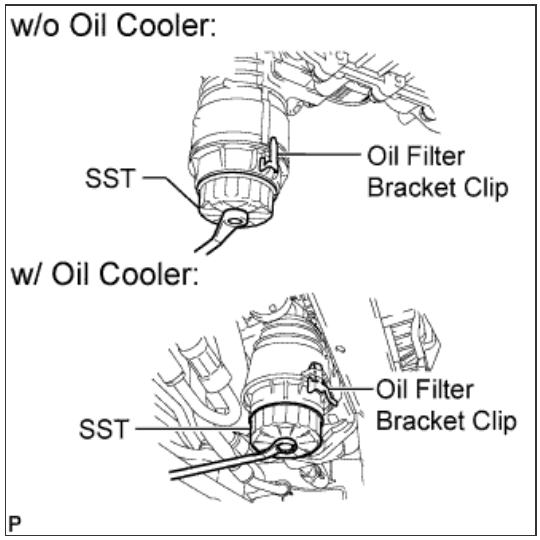


e. Using SST, remove the oil filter cap.

SST
09228-06501

NOTICE:

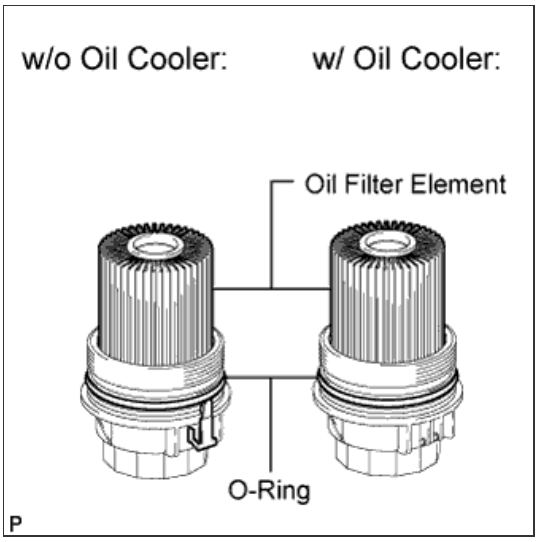
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

NOTICE:

Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.

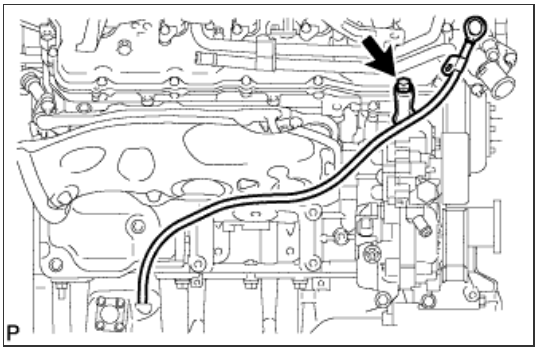


28. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

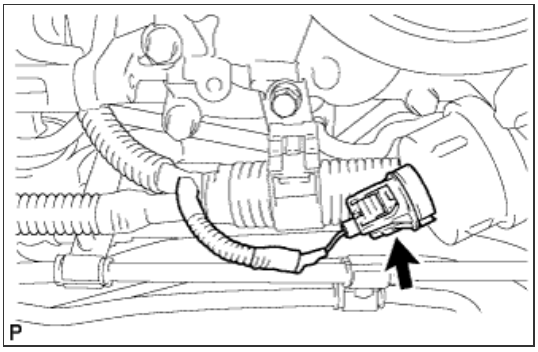
b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.

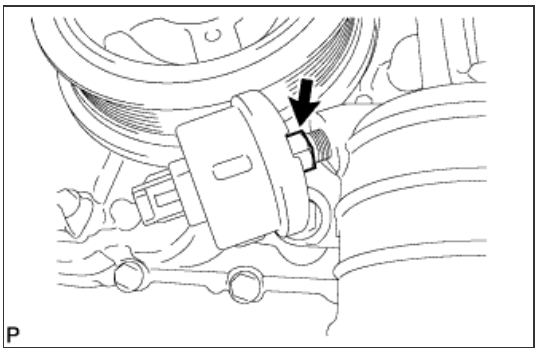


29. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.



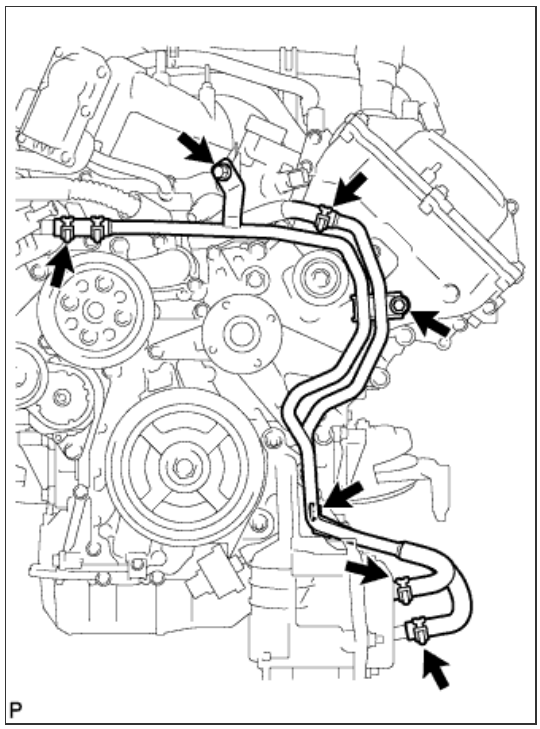
b. Remove the oil pressure sender gauge.



30. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Remove the 3 bolts.

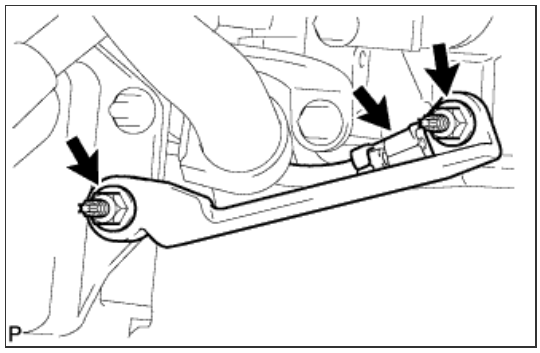
b. Disconnect the 4 hoses and remove the water by-pass pipe.



31. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

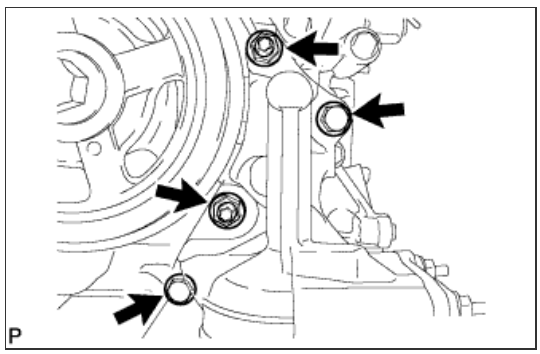
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

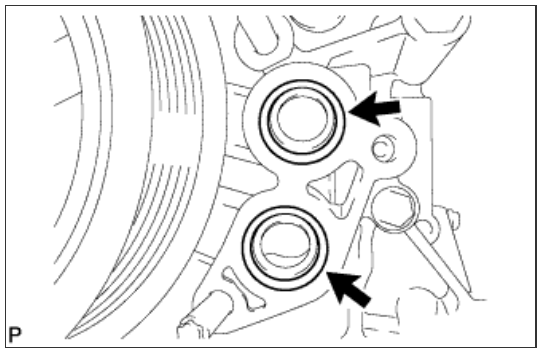


32. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.

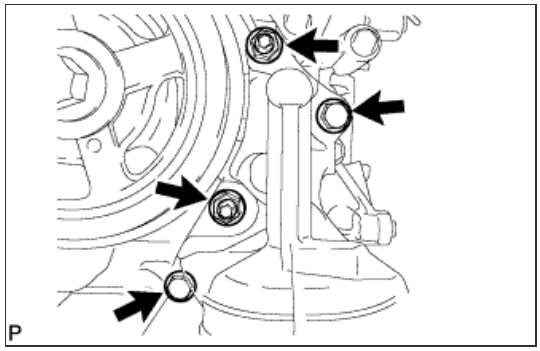


b. Remove the 2 O-rings.

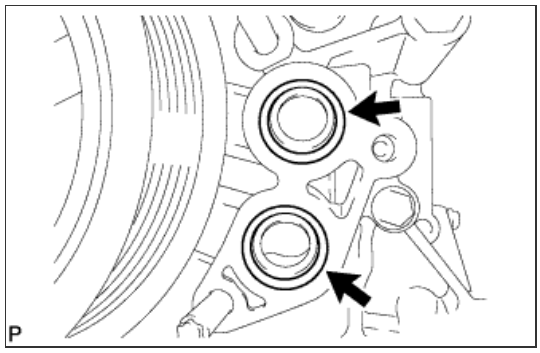


33. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.

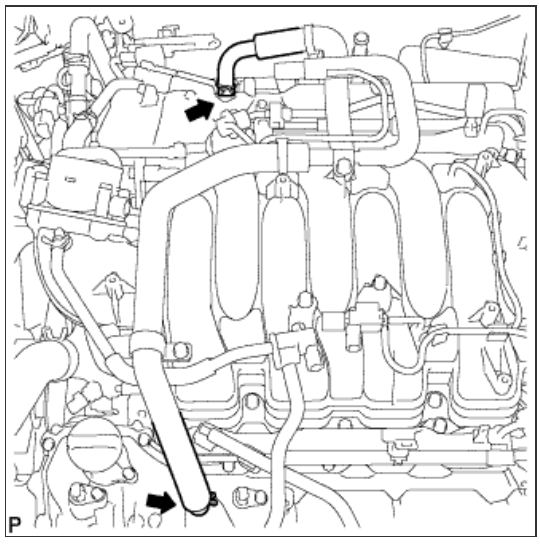


b. Remove the 2 O-rings.



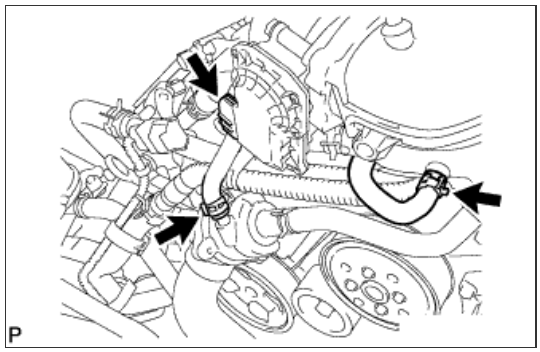
34. REMOVE INTAKE MANIFOLD

a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.

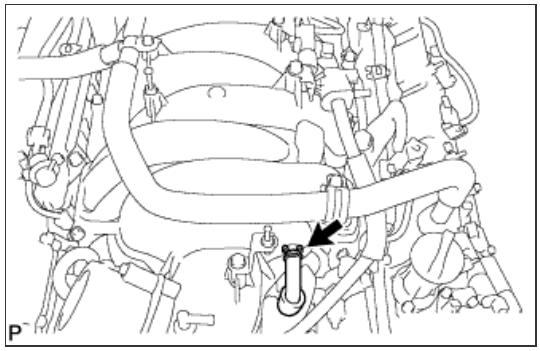


b. Disconnect the 2 water by-pass hoses.

c. Disconnect the throttle body connector.



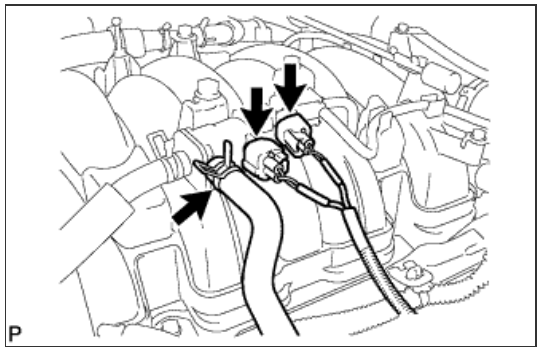
d. Disconnect the No. 1 ventilation hose.



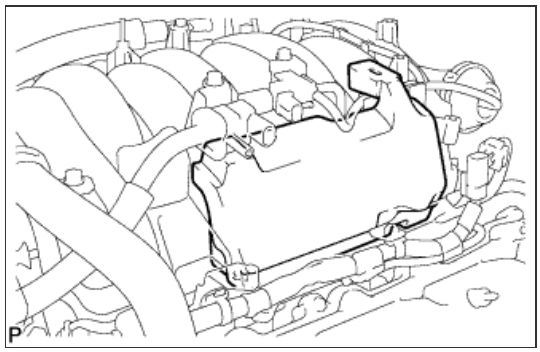
e. Disconnect the purge VSV connector.

f. Disconnect the purge line hose from the purge VSV.

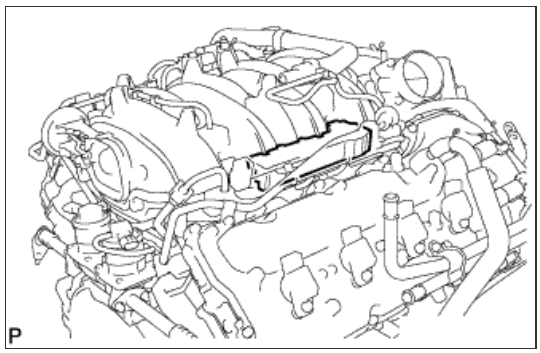
g. Disconnect the vacuum switching valve connector (for ACIS).



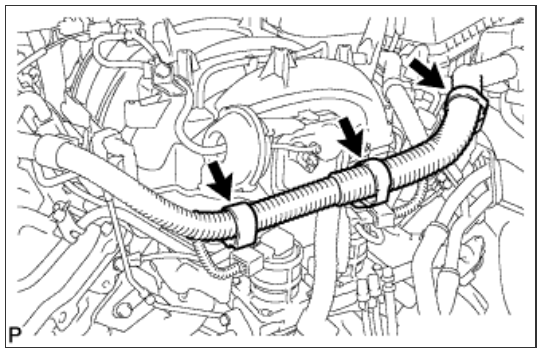
h. Remove the No. 1 engine cover sub-assembly.



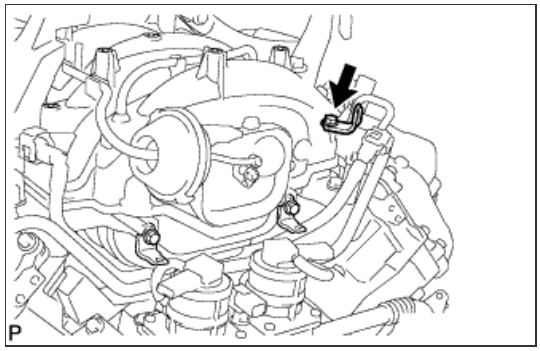
i. Remove the No. 3 engine cover.



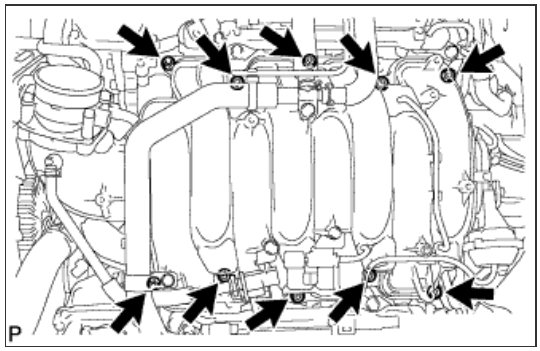
j. Disconnect the 3 wire clamps from the 3 wire brackets.



k. Remove the bolt and wire bracket from the intake manifold.

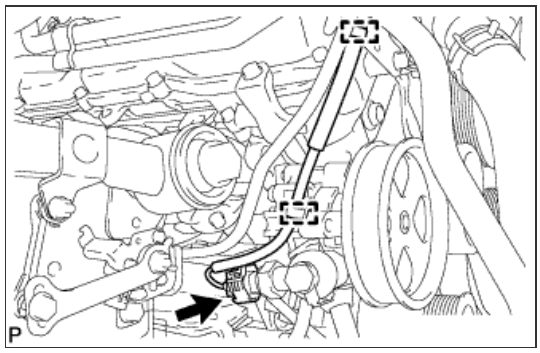


l. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.

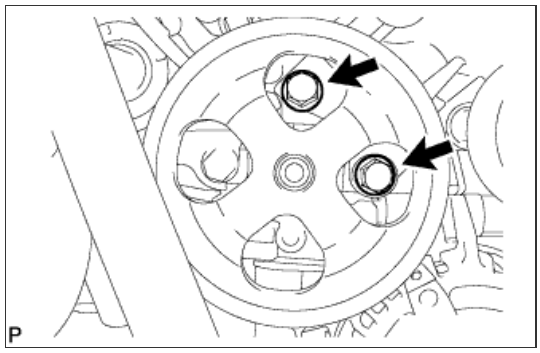


35. DISCONNECT VANE PUMP ASSEMBLY

a. Disconnect the 2 clamps and power steering oil pressure switch connector.

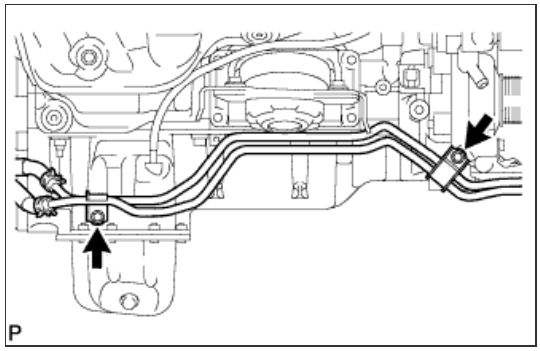


b. Remove the 2 bolts and disconnect the vane pump.



36. DISCONNECT OIL COOLER PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the oil cooler pipe.

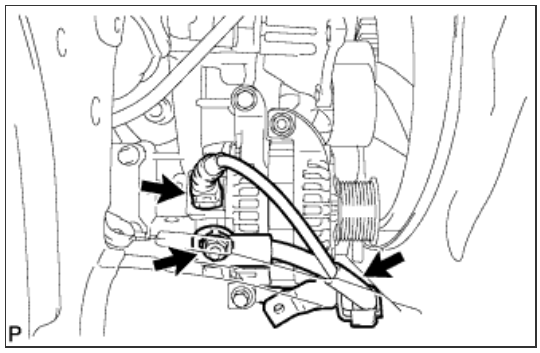


37. REMOVE GENERATOR ASSEMBLY

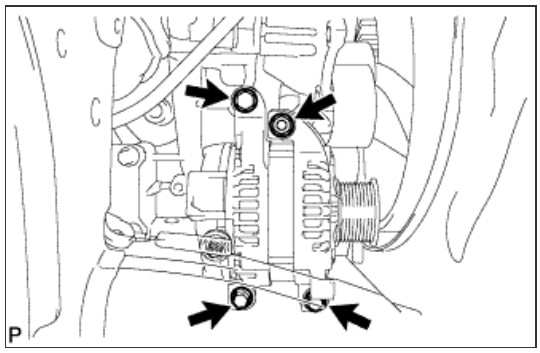
a. Disconnect the generator connector.

b. Remove the terminal cap and nut, and disconnect the generator wire.

c. Remove the bolt and wire harness bracket from the generator.

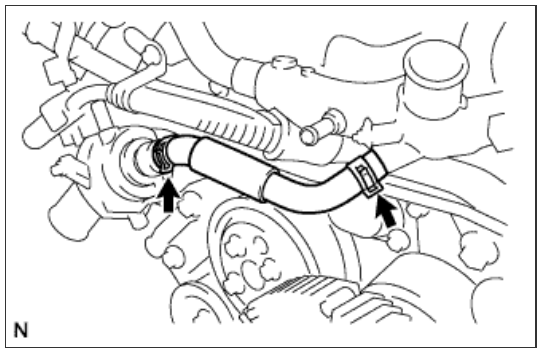


d. Remove the 3 bolts, nut and generator.



38. REMOVE NO. 1 WATER BY-PASS HOSE

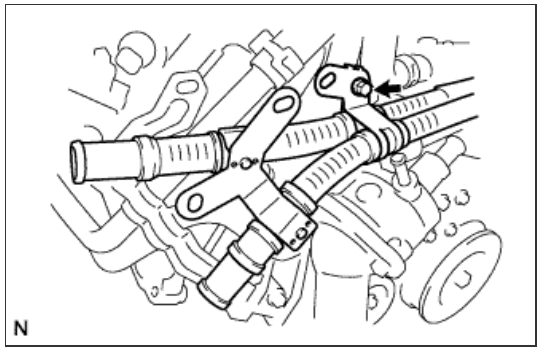
a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.



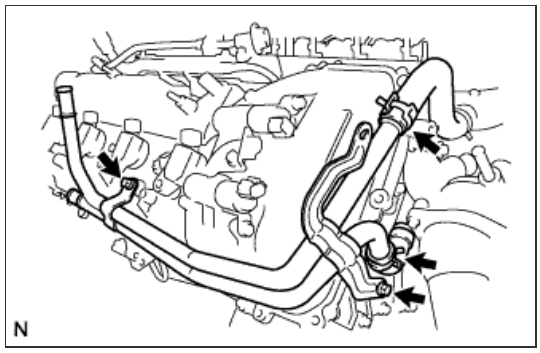
39. REMOVE WATER BY-PASS PIPE SUB-ASSEMBLY

a. Remove the bolt and disconnect the air tube.

b. Disconnect the 2 hoses.



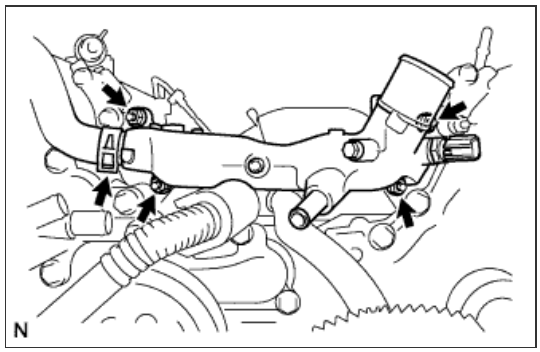
c. Remove the 2 bolts and water by-pass pipe.



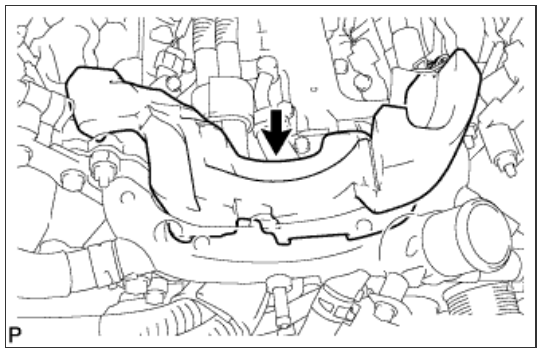
40. REMOVE FRONT WATER BY-PASS JOINT

a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

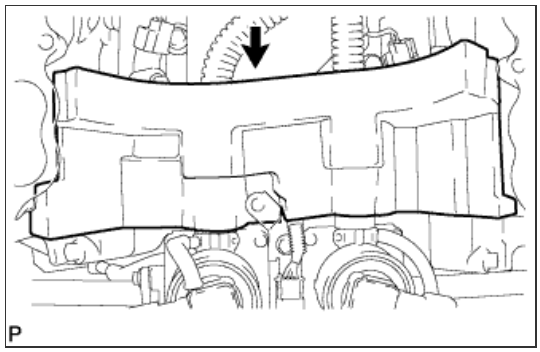
b. Remove the 4 nuts, water by-pass joint and 2 gaskets.



41. REMOVE NO. 2 ENGINE COVER

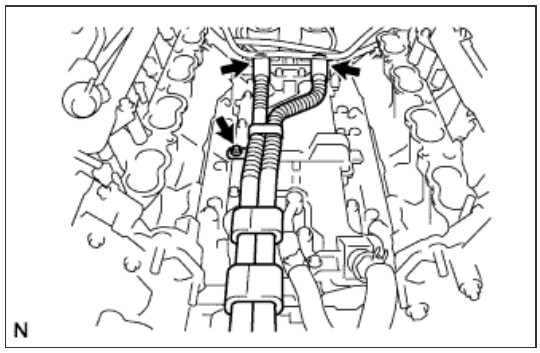


42. REMOVE NO. 1 ENGINE COVER



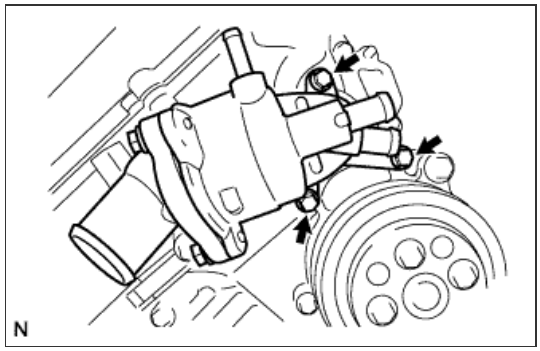
43. REMOVE AIR PIPE SUB-ASSEMBLY

a. Remove the bolt, disconnect the 2 hoses, and remove the air pipe.



44. REMOVE WATER INLET HOUSING

a. Remove the 3 bolts, water inlet housing and gasket.

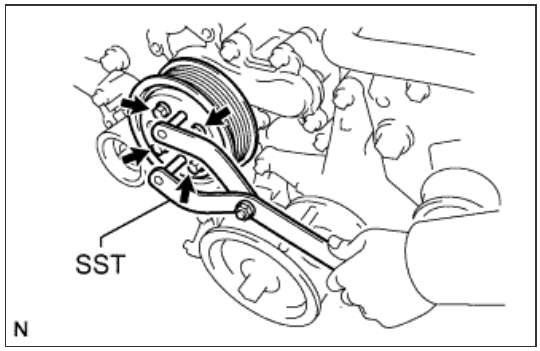


45. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

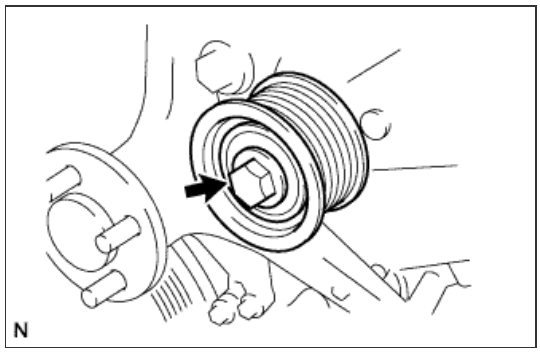
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



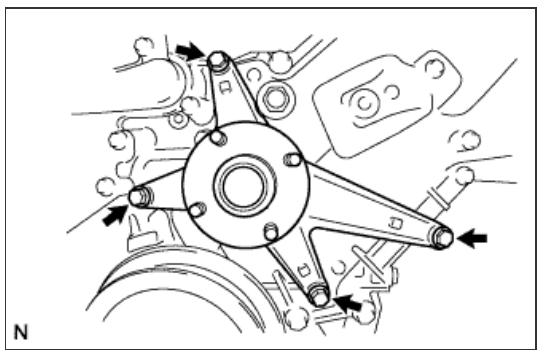
46. REMOVE NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Remove the bolt and idler pulley.



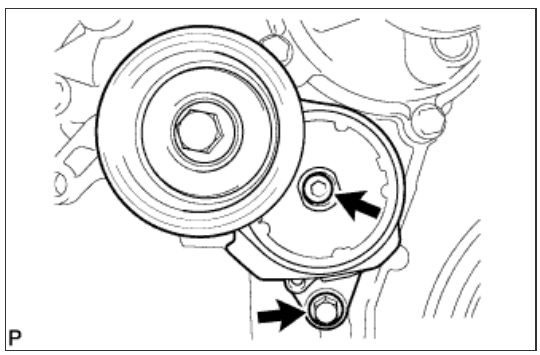
47. REMOVE FLUID COUPLING BRACKET

a. Remove the 4 bolts and fluid coupling bracket.



48. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY

a. Remove the standard bolt, 6 mm hexagon wrench bolt and belt tensioner.



49. REMOVE IGNITION COIL ASSEMBLY

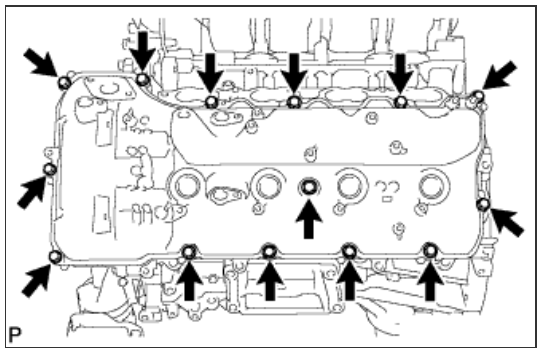
a. Remove the 8 bolts and 8 ignition coils.

50. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY LH

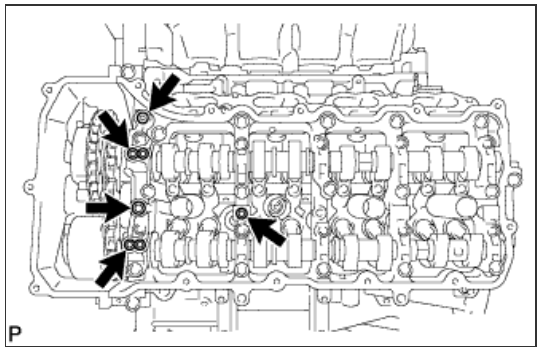
a. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

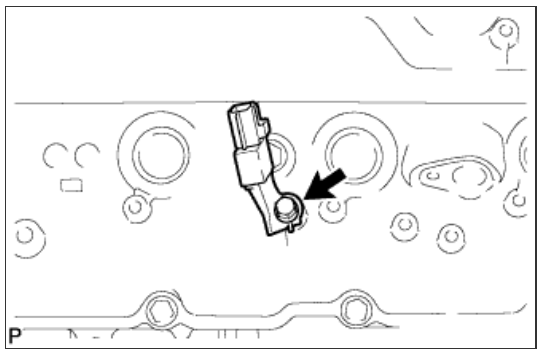


b. Remove the 5 gaskets from the camshaft bearing caps (No. 2, No. 3).



51. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY RH

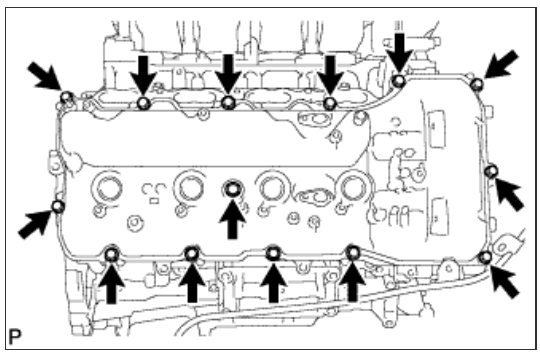
a. Remove the bolt and noise filter.



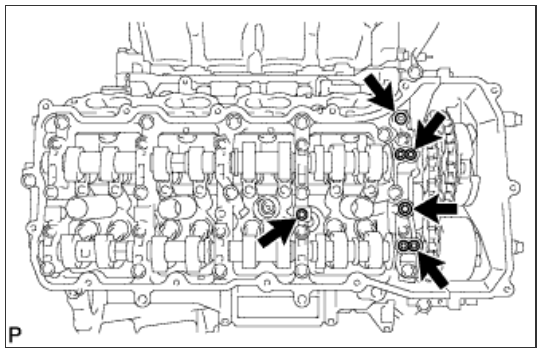
b. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.



c. Remove the 5 gaskets from the camshaft bearing caps (No. 1, No. 3).



52. REMOVE SPARK PLUG TUBE GASKET

a. Bend the 4 ventilation baffle plate claws on the cylinder head cover to an angle of 90° or more.

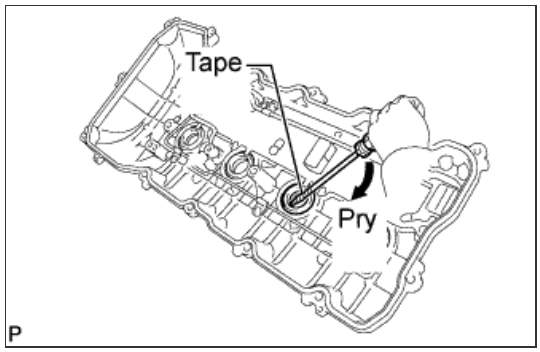
b. Using a screwdriver, pry out the gaskets.

HINT:

Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the cylinder head cover.**
- **Be careful not to damage the gasket when removing it, as the removed gasket needs to be used when installing a new one.**

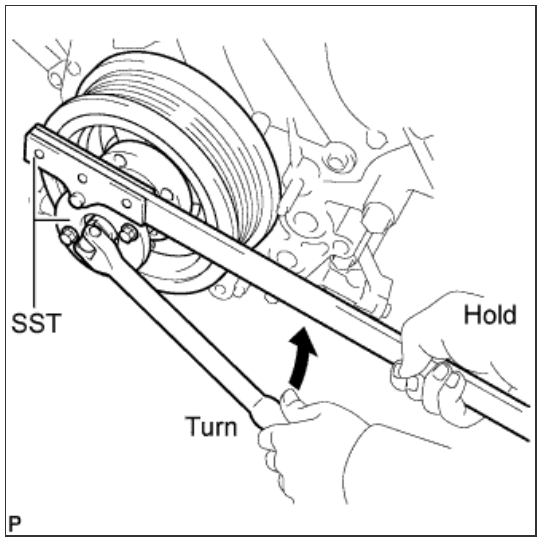


53. REMOVE CRANKSHAFT PULLEY

a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST

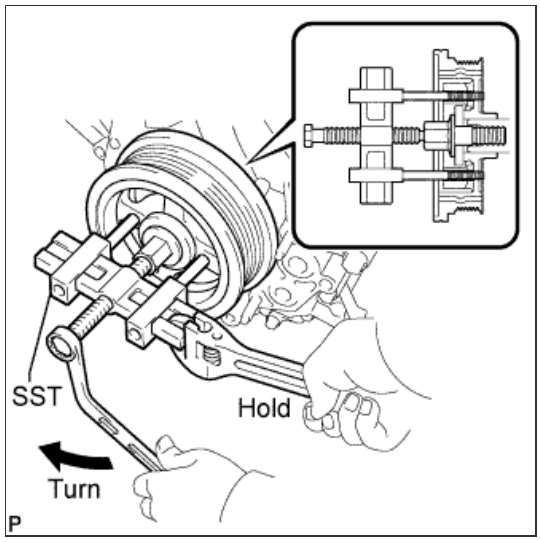
09213-70011 (09213-70020)
09330-00021



b. Using the pulley set bolt and SST, remove the crankshaft pulley.

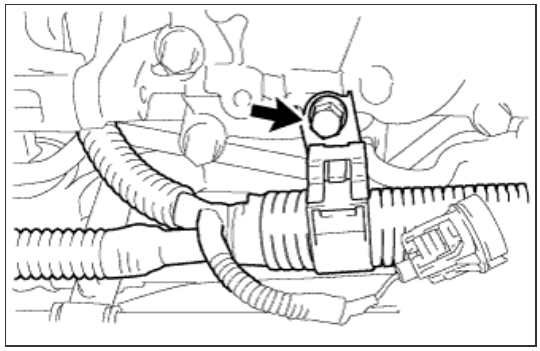
SST

09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



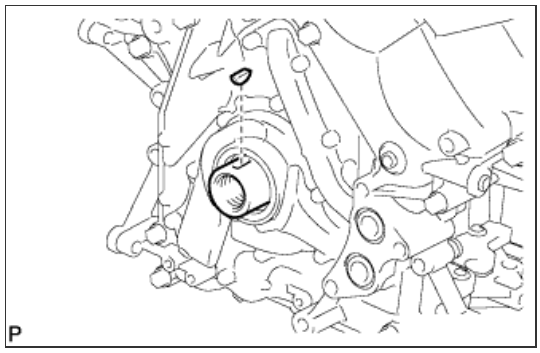
54. DISCONNECT WIRE HARNESS CLAMP BRACKET

a. Remove the bolt and disconnect the bracket.



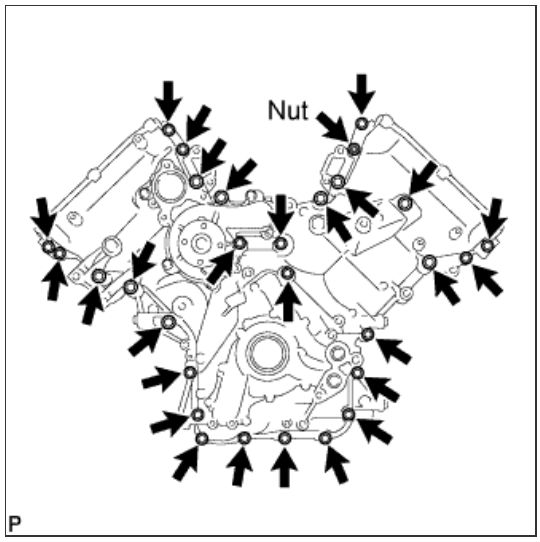
55. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Using a screwdriver, remove the timing gear key from the crankshaft.



56. REMOVE TIMING CHAIN COVER SUB-ASSEMBLY

a. Remove the 28 bolts and nut shown in the illustration.



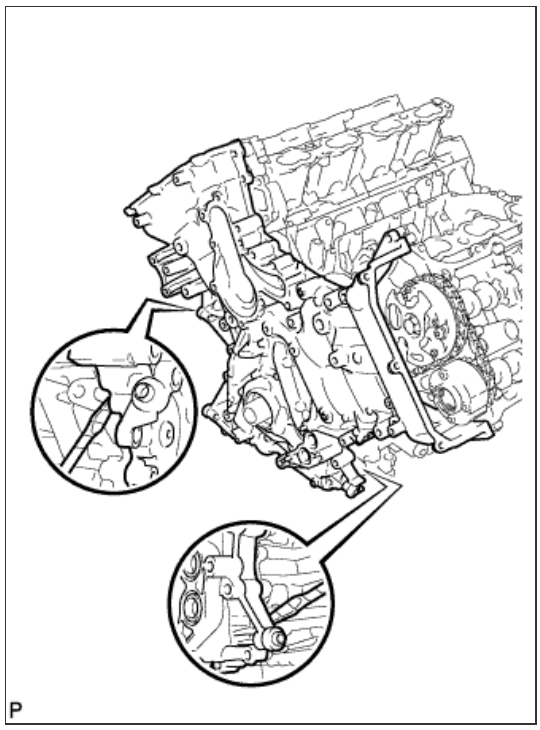
b. Remove the timing chain cover by prying between the timing chain cover and cylinder head or cylinder block with a screwdriver as shown in the illustration.

NOTICE:

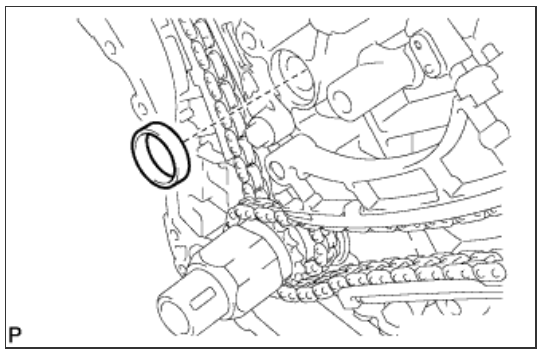
Be careful not to damage the contact surfaces of the cylinder head, cylinder block and chain cover.

HINT:

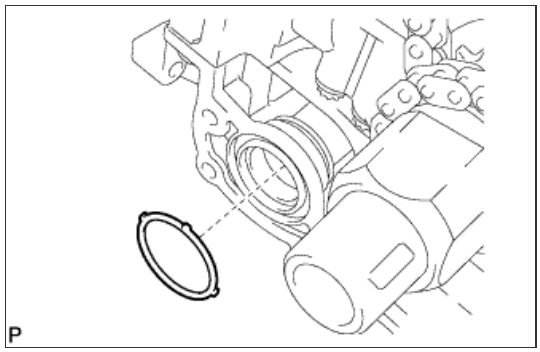
Tape the screwdriver tip before use.



c. Remove the oil pump gasket from the cylinder block.



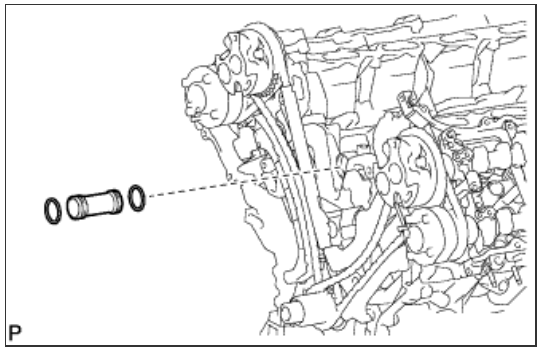
d. Remove the O-ring from the oil pan.



57. REMOVE WATER INLET PIPE

a. Remove the water inlet pipe.

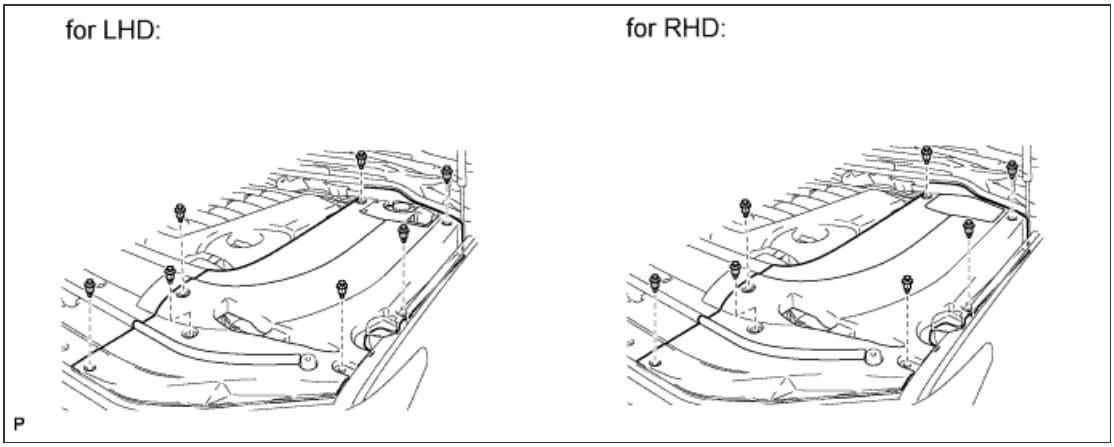
b. Remove the 2 O-rings from the water inlet pipe.



for Preparation Click here

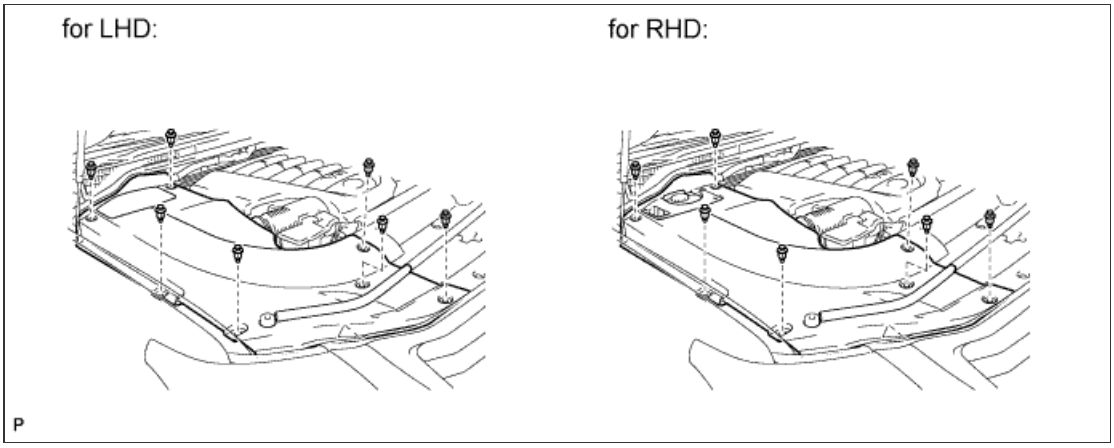
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. DISCHARGE FUEL SYSTEM PRESSURE

a. Discharge the fuel system pressure (Click here).

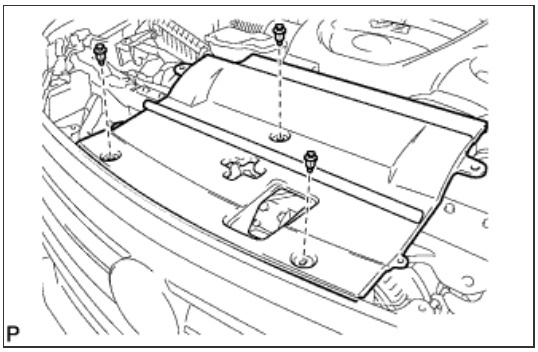
4. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

5. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



6. REMOVE RADIATOR GRILLE

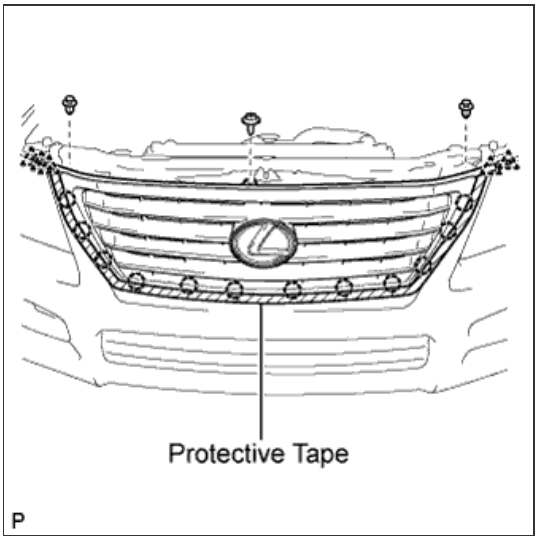
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

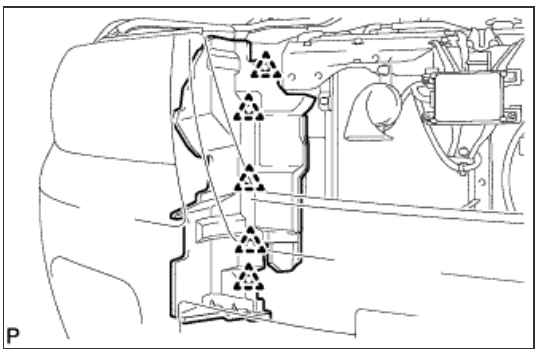
d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



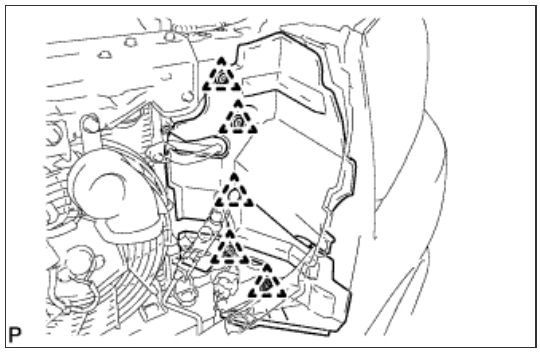
7. DISCONNECT RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Using a clip remover, remove the 5 clips and side deflector.



8. DISCONNECT RADIATOR SIDE DEFLECTOR LH

a. Using a clip remover, remove the 5 clips and side deflector.

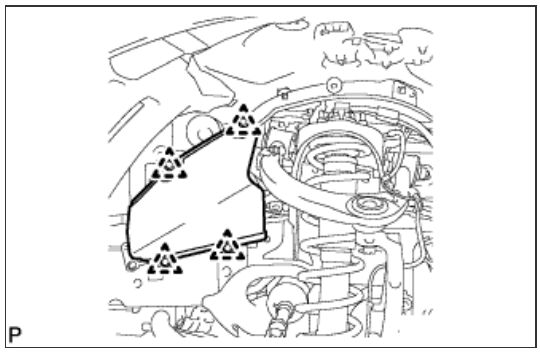


9. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

(Click here)

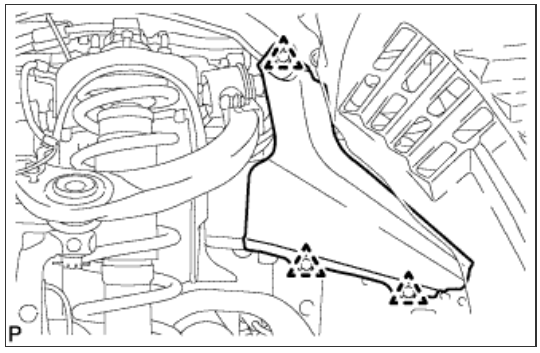
10. REMOVE FRONT FENDER APRON SEAL FRONT LH

a. Using a clip remover, remove the 4 clips and fender apron seal.



11. REMOVE FRONT FENDER APRON SEAL FRONT RH

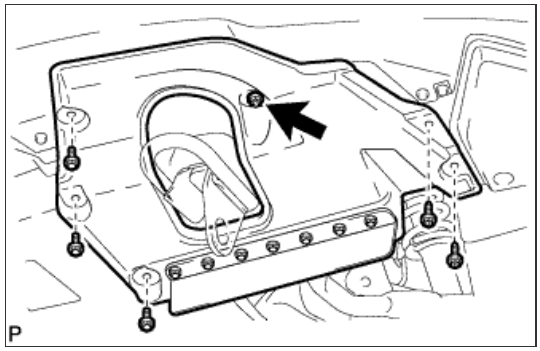
a. Using a clip remover, remove the 3 clips and fender apron seal.



12. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



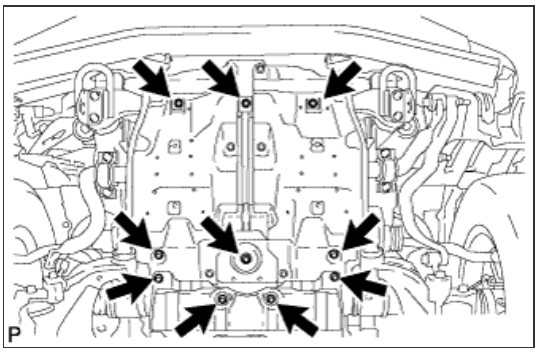
13. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

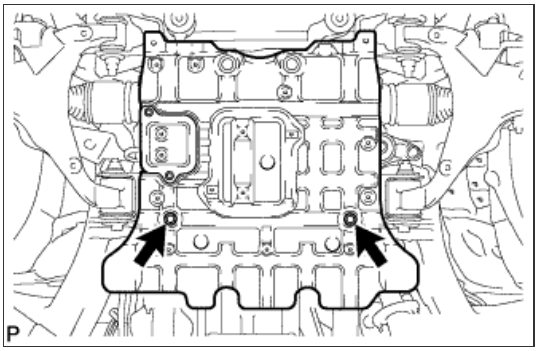
14. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



15. REMOVE NO. 2 ENGINE UNDER COVER

a. Remove the 2 bolts and No. 2 engine under cover.



16. DRAIN ENGINE OIL

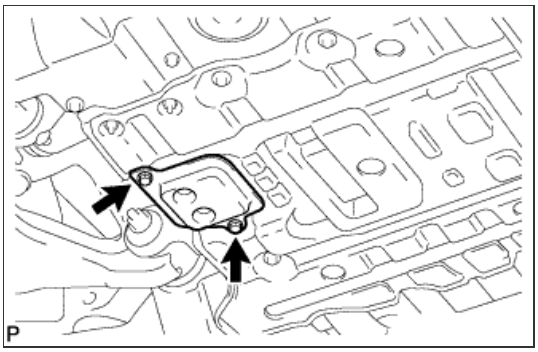
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

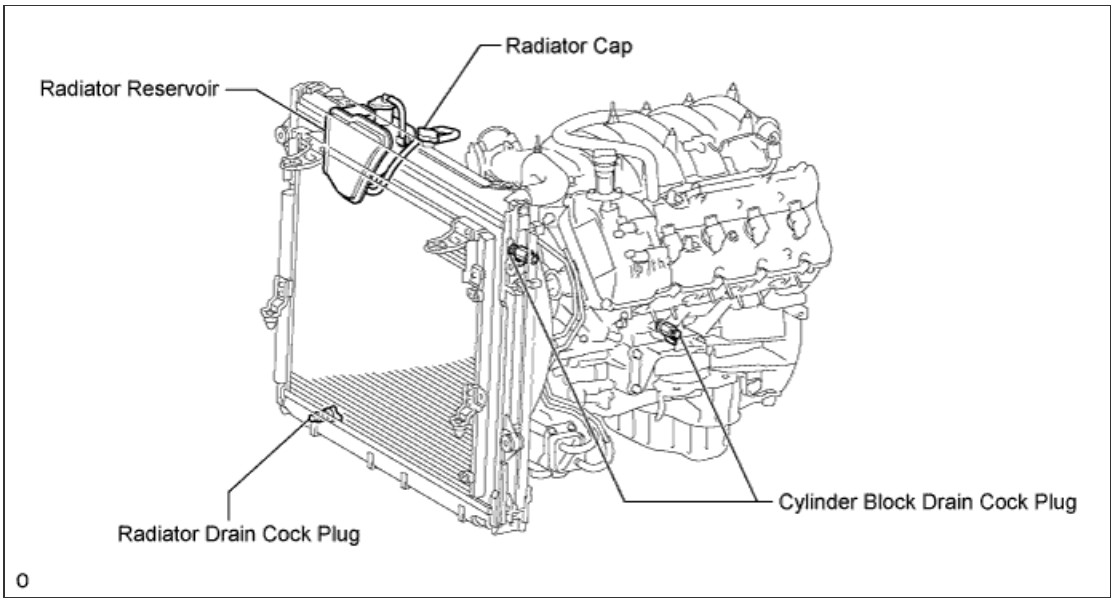
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



17. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

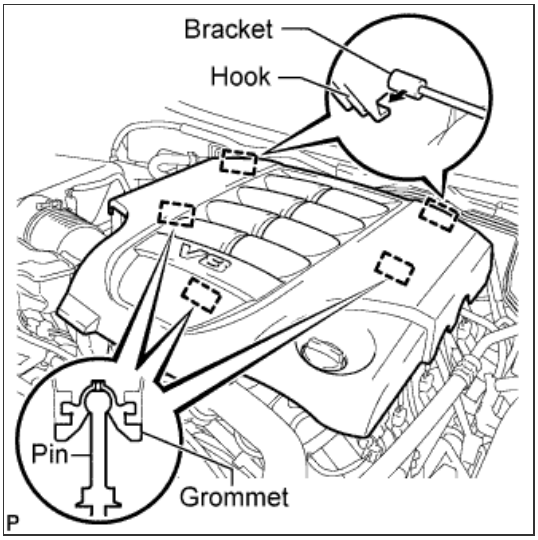
d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

e. Tighten the radiator drain cock plug by hand.

18. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.

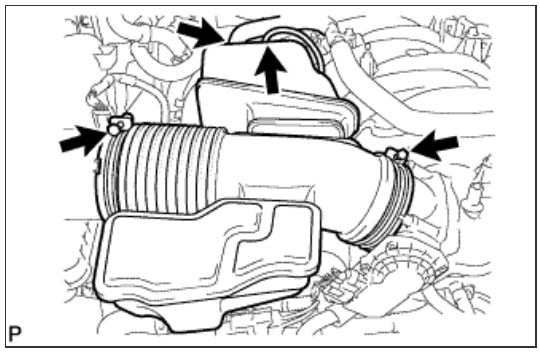


19. REMOVE AIR CLEANER HOSE ASSEMBLY

a. Disconnect the vacuum hose and No. 2 ventilation hose.

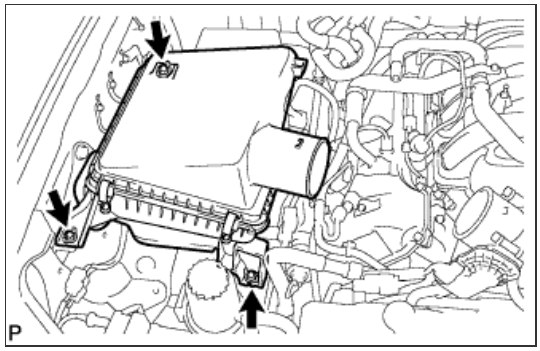
b. Loosen the 2 hose clamps.

c. Remove the air cleaner hose.



20. REMOVE AIR CLEANER ASSEMBLY

a. Remove the 3 bolts and air cleaner.



21. REMOVE RADIATOR ASSEMBLY

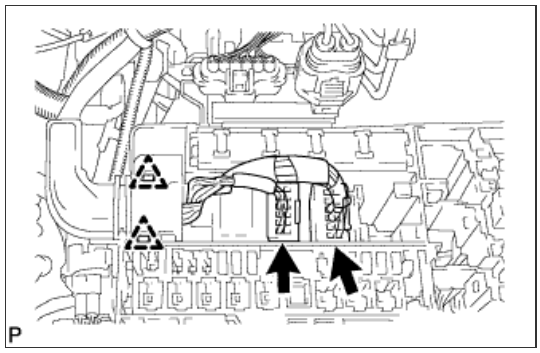
(Click here)

22. DISCONNECT ENGINE WIRE

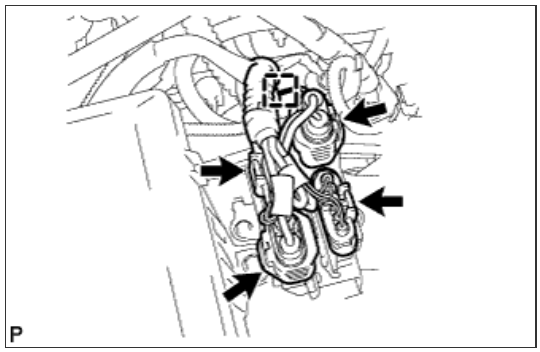
a. Engine Room LH Side:

i. Remove the engine room relay block cover.

ii. Disconnect the 2 connectors and 2 clips from the engine room junction block.



iii. w/ Secondary Air Injection System:
Disconnect the 4 air injection control driver connectors and wire harness clamp.



iv. Disconnect the injector connector.

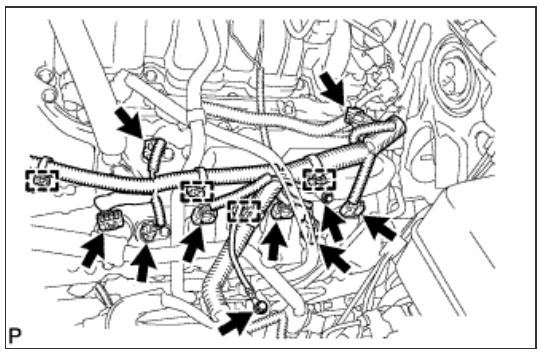
v. Disconnect the 4 ignition coil connectors.

vi. Disconnect the 2 VVT sensor connectors.

vii. Disconnect the 4 clamps.

viii. Remove the 2 bolts and ground wire.

ix. Disconnect the noise filter connector.



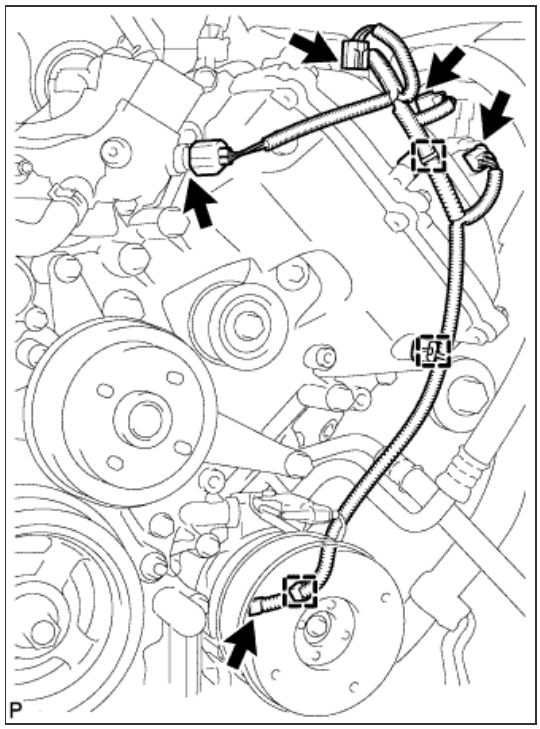
x. Disconnect the engine coolant temperature sensor connector.

xi. Disconnect the 2 camshaft timing oil control valve connectors.

xii. Disconnect the camshaft position sensor connector.

xiii. Disconnect the 3 clamps.

xiv. Disconnect the cooler compressor connector.



b. Engine Room RH Side:

i. Disconnect the 2 camshaft timing oil control valve connectors.

ii. Disconnect the 4 ignition coil connectors.

iii. Disconnect the injector connector.

iv. Disconnect the 2 VVT sensor connectors.

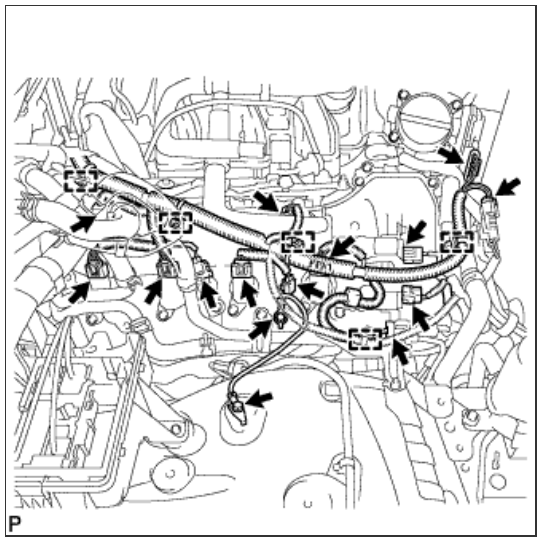
v. Disconnect the noise filter connector.

vi. Remove the 2 bolts and ground wire.

vii. w/ Secondary Air Injection System:
Disconnect the 2 air pump connectors.

viii. Disconnect the throttle position sensor and throttle control motor connector.

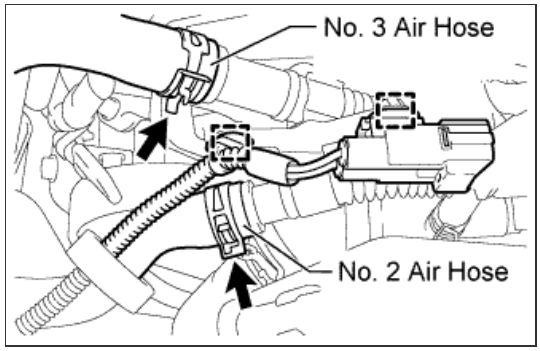
ix. Disconnect the 5 clamps.



23. DISCONNECT AIR PUMP HOSE AND WIRE HARNESS (w/ Secondary Air Injection System)

a. Disconnect the No. 2 and No. 3 air hoses.

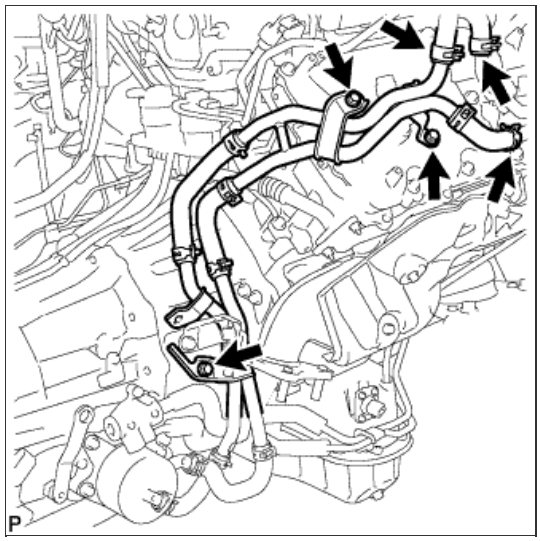
b. Disconnect the 2 clamps.



24. DISCONNECT NO. 2 WATER BY-PASS PIPE

a. Disconnect the 3 hoses.

b. Remove the 3 bolts and disconnect the No. 2 water by-pass pipe from the cylinder head cover.

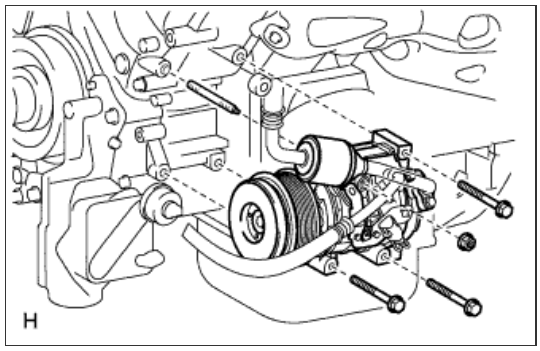


25. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

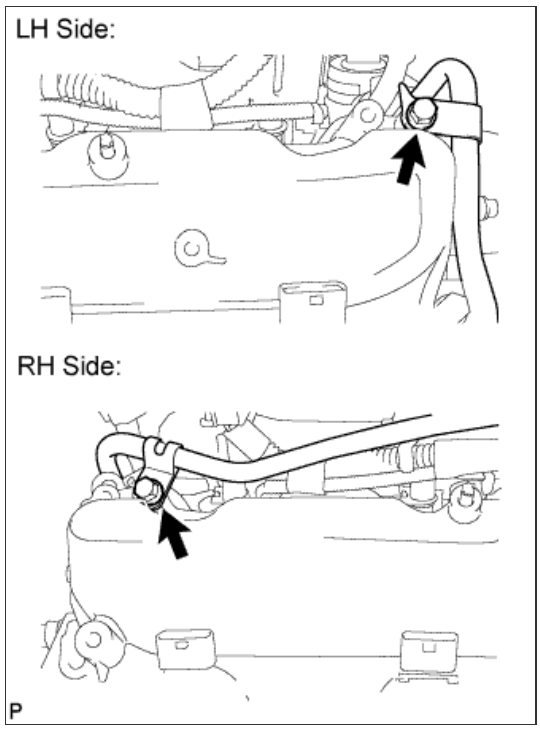
HINT:

It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.



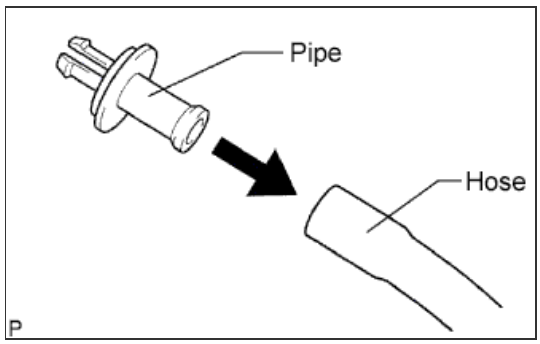
26. DISCONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Remove the 2 bolts and disconnect the fuel tube.

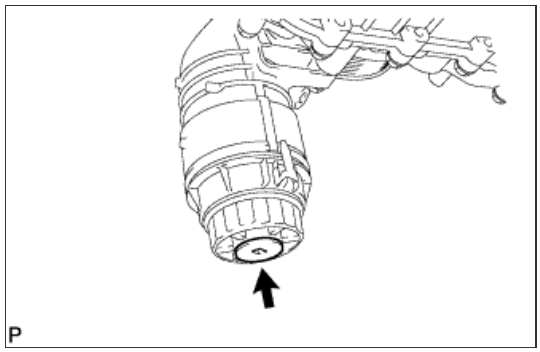


27. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



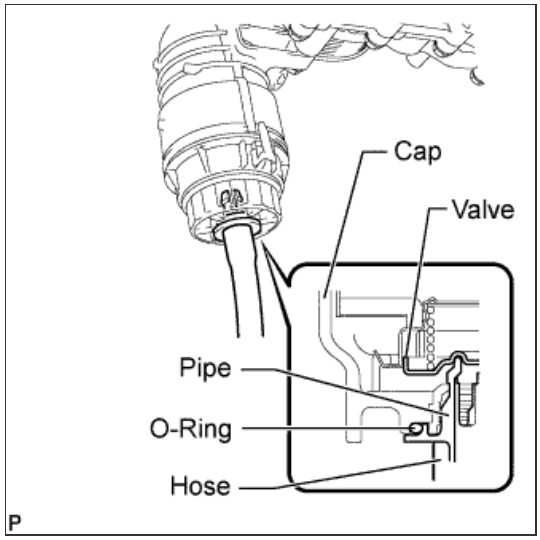
c. Install the pipe to the oil filter cap.

NOTICE:

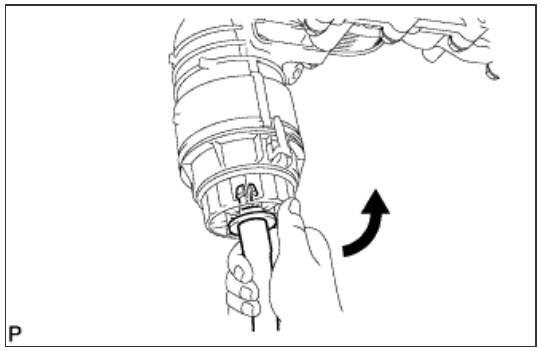
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

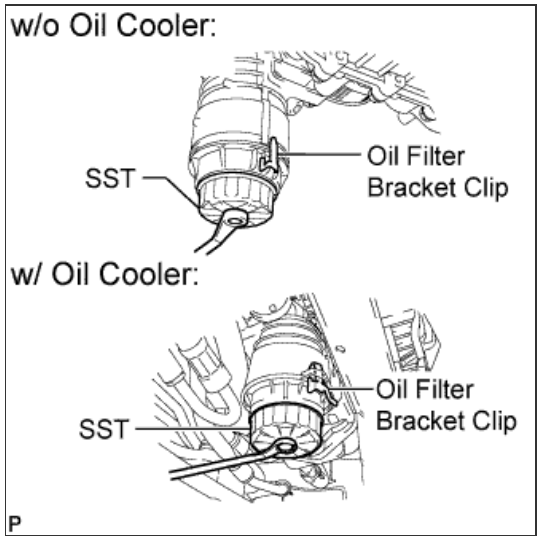


e. Using SST, remove the oil filter cap.

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NOTICE:

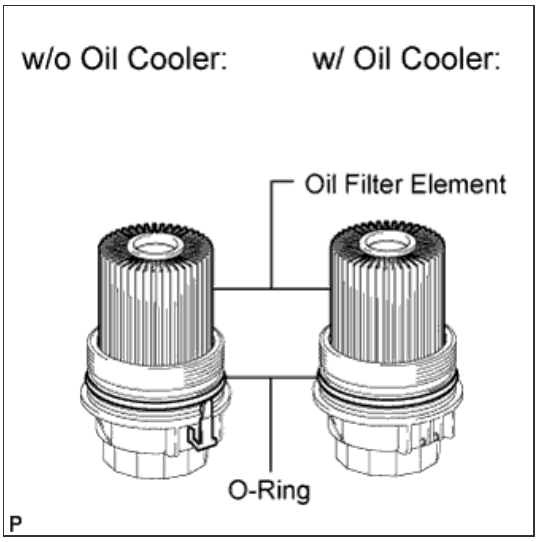
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

NOTICE:

Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.

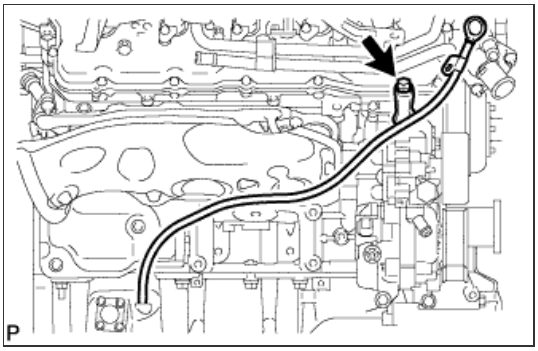


28. REMOVE ENGINE OIL LEVEL DIPSTICK GUIDE

a. Remove the dipstick.

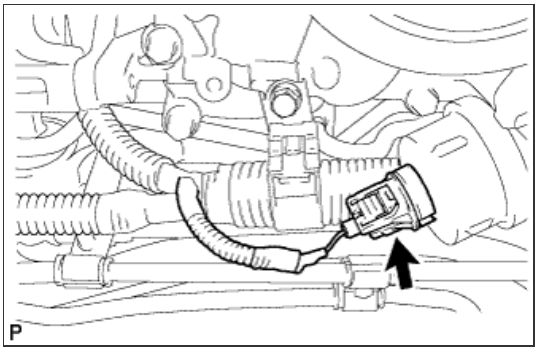
b. Remove the bolt and dipstick guide.

c. Remove the O-ring from the dipstick guide.

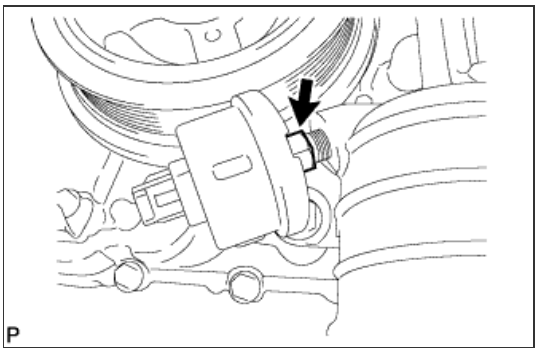


29. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.



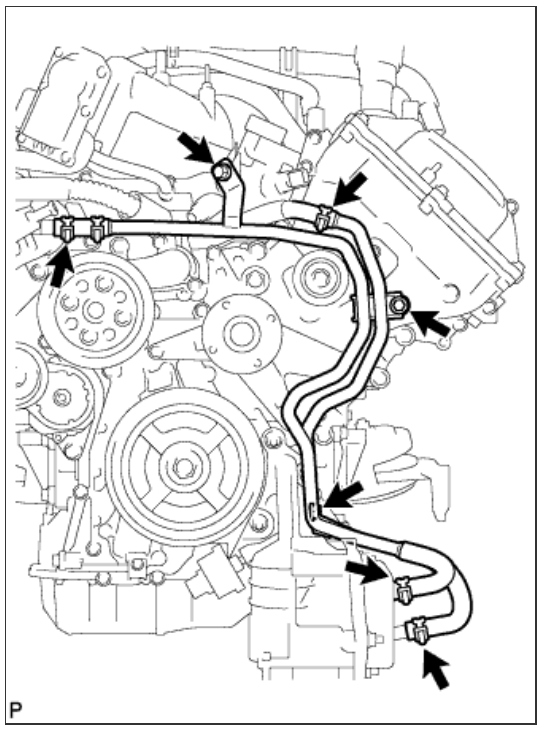
b. Remove the oil pressure sender gauge.



30. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Remove the 3 bolts.

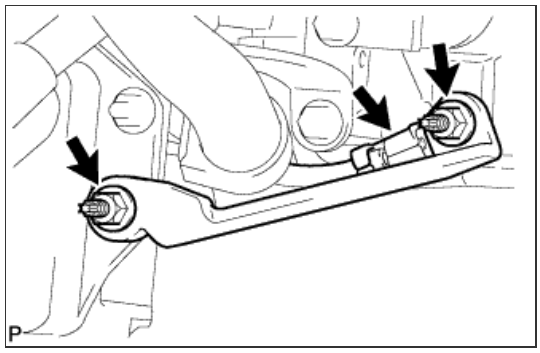
b. Disconnect the 4 hoses and remove the water by-pass pipe.



31. REMOVE NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

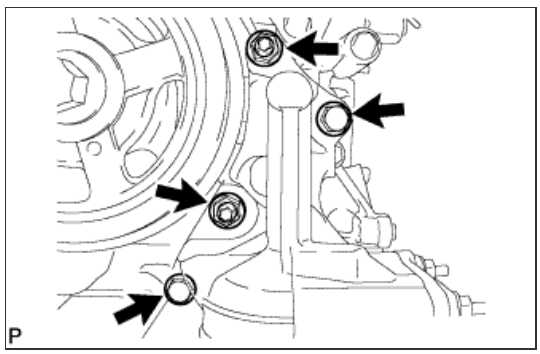
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

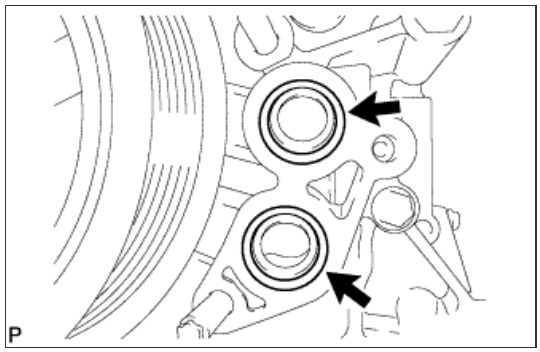


32. REMOVE OIL FILTER BRACKET (w/ Oil Cooler)

a. Remove the 2 bolts, 2 nuts and filter bracket.

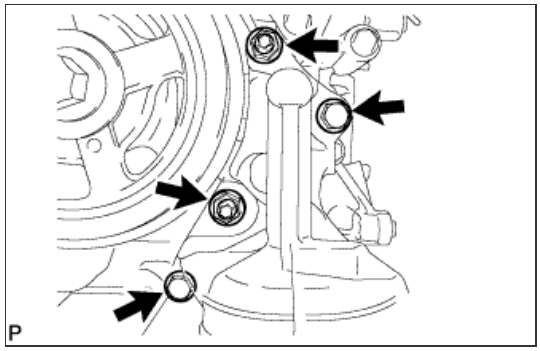


b. Remove the 2 O-rings.

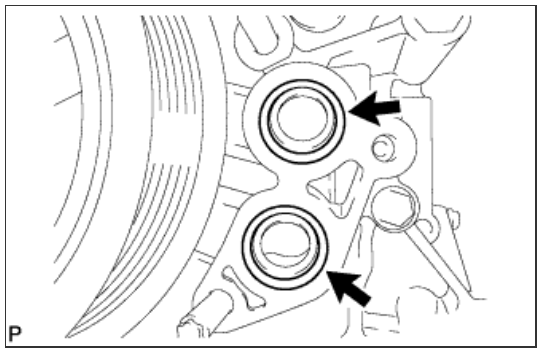


33. REMOVE OIL FILTER BRACKET (w/o Oil Cooler)

a. Remove the 2 bolts, 2 nuts and oil filter bracket.

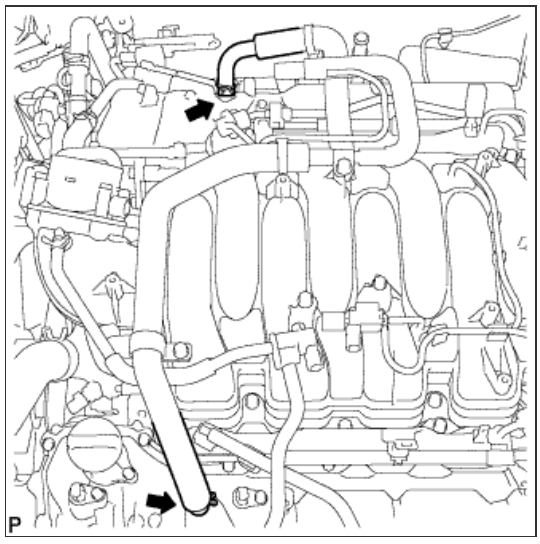


b. Remove the 2 O-rings.



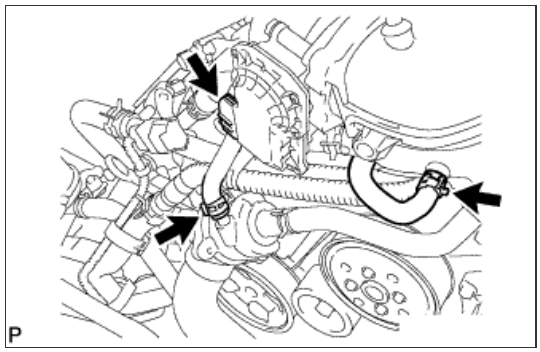
34. REMOVE INTAKE MANIFOLD

a. Disconnect the ventilation hose from the ventilation pipe of the cylinder head cover LH and RH.

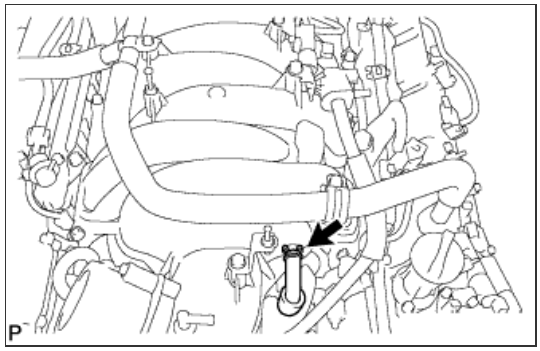


b. Disconnect the 2 water by-pass hoses.

c. Disconnect the throttle body connector.



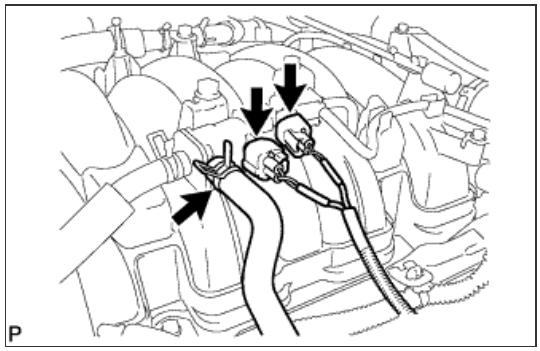
d. Disconnect the No. 1 ventilation hose.



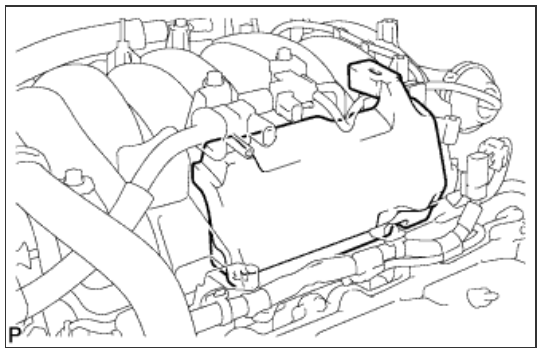
e. Disconnect the purge VSV connector.

f. Disconnect the purge line hose from the purge VSV.

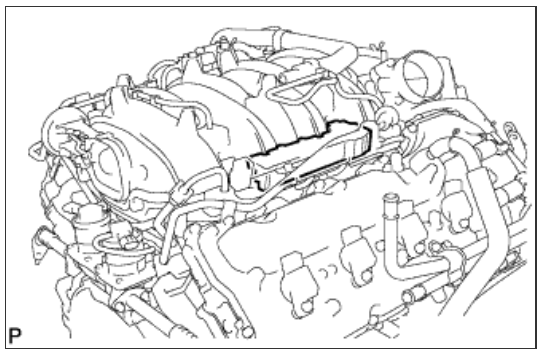
g. Disconnect the vacuum switching valve connector (for ACIS).



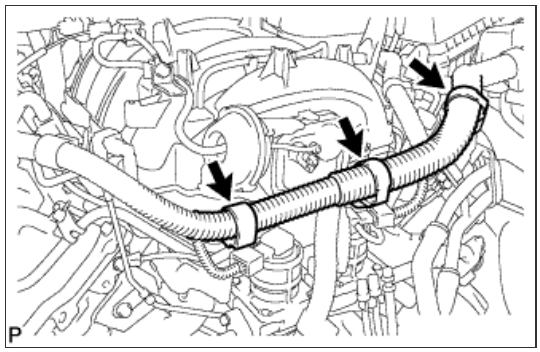
h. Remove the No. 1 engine cover sub-assembly.



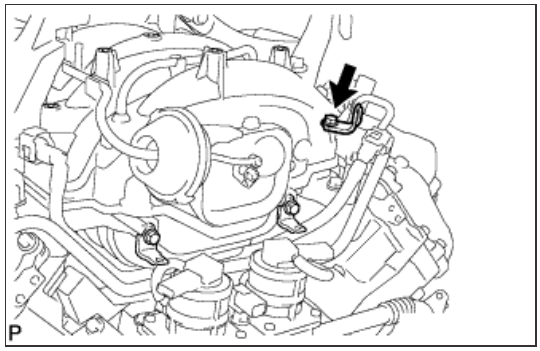
i. Remove the No. 3 engine cover.



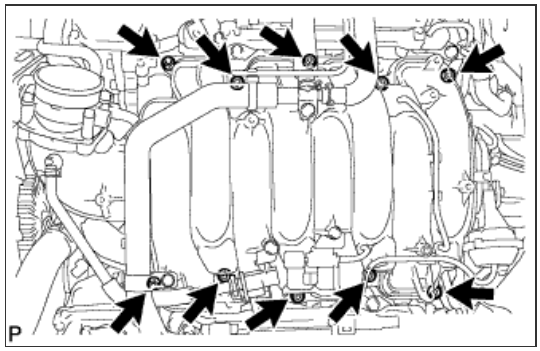
j. Disconnect the 3 wire clamps from the 3 wire brackets.



k. Remove the bolt and wire bracket from the intake manifold.

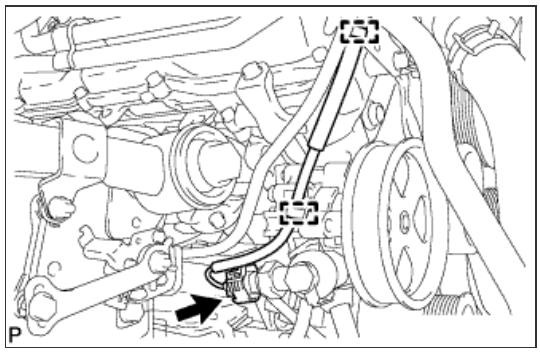


l. Remove the 2 nuts, 8 bolts, intake manifold and 2 gaskets.

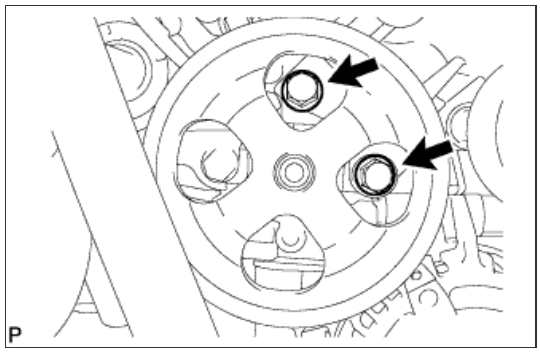


35. DISCONNECT VANE PUMP ASSEMBLY

a. Disconnect the 2 clamps and power steering oil pressure switch connector.

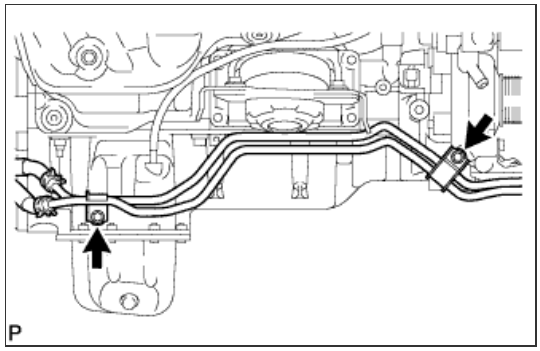


b. Remove the 2 bolts and disconnect the vane pump.



36. DISCONNECT OIL COOLER PIPE ASSEMBLY

a. Remove the 2 bolts and disconnect the oil cooler pipe.

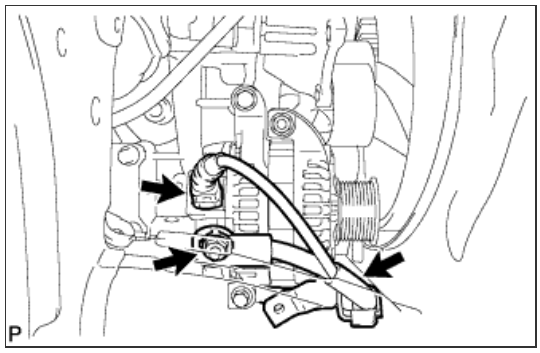


37. REMOVE GENERATOR ASSEMBLY

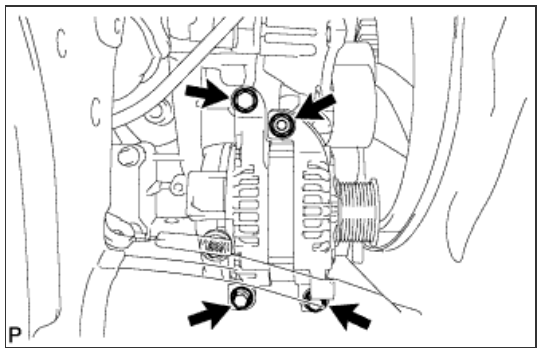
a. Disconnect the generator connector.

b. Remove the terminal cap and nut, and disconnect the generator wire.

c. Remove the bolt and wire harness bracket from the generator.

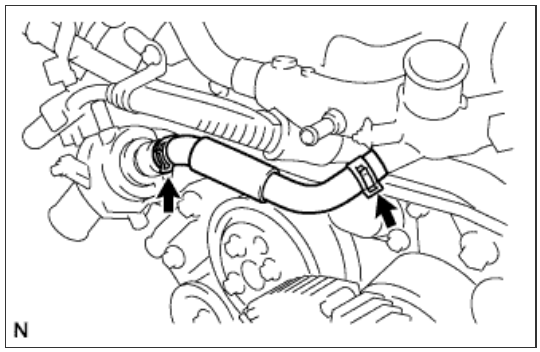


d. Remove the 3 bolts, nut and generator.



38. REMOVE NO. 1 WATER BY-PASS HOSE

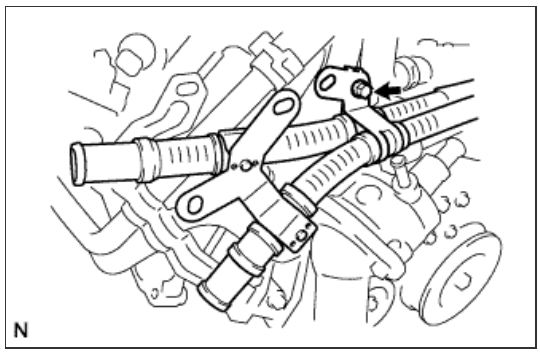
a. Remove the No. 1 water by-pass hose by disconnecting the hose from the water inlet housing and front water by-pass joint.



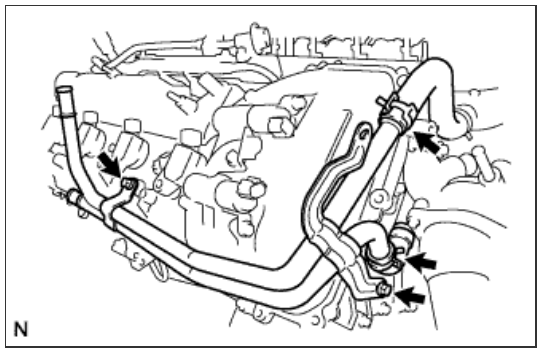
39. REMOVE WATER BY-PASS PIPE SUB-ASSEMBLY

a. w/ Secondary Air Injection System:
Remove the bolt and disconnect the air tube.

b. Disconnect the 2 hoses.



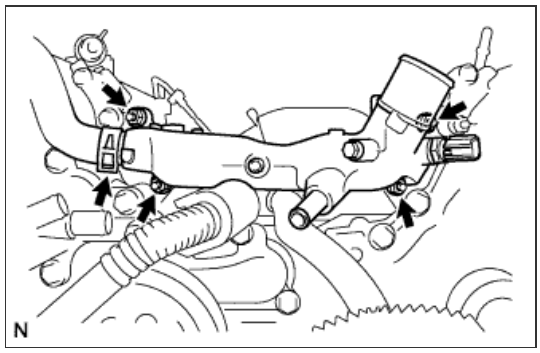
c. Remove the 2 bolts and water by-pass pipe.



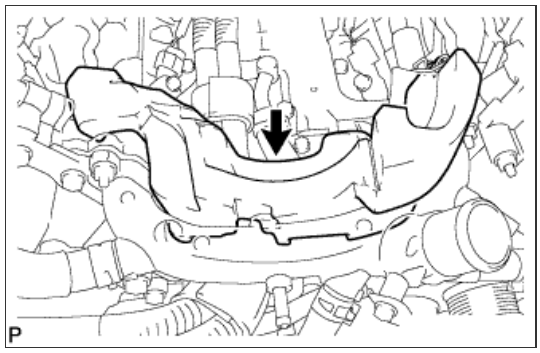
40. REMOVE FRONT WATER BY-PASS JOINT

a. Disconnect the No. 2 water by-pass hose from the water by-pass joint.

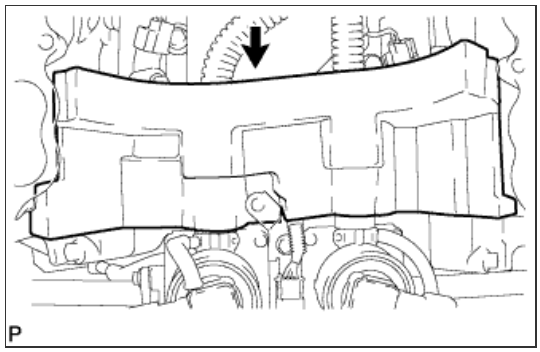
b. Remove the 4 nuts, water by-pass joint and 2 gaskets.



41. REMOVE NO. 2 ENGINE COVER

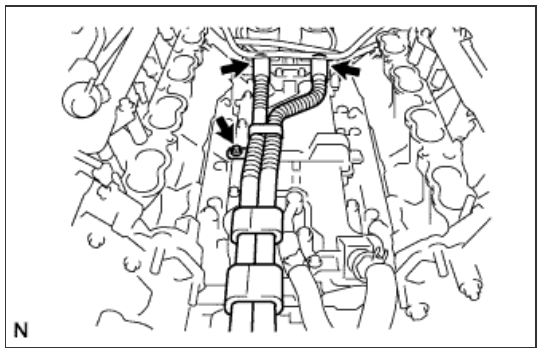


42. REMOVE NO. 1 ENGINE COVER



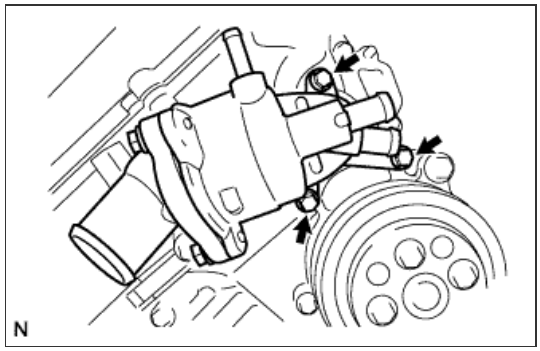
43. REMOVE AIR PIPE SUB-ASSEMBLY (w/ Secondary Air Injection System)

a. Remove the bolt, disconnect the 2 hoses, and remove the air pipe.



44. REMOVE WATER INLET HOUSING

a. Remove the 3 bolts, water inlet housing and gasket.

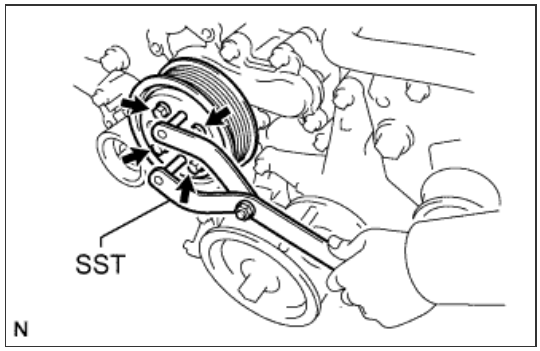


45. REMOVE WATER PUMP PULLEY

a. Using SST, hold the water pump pulley.

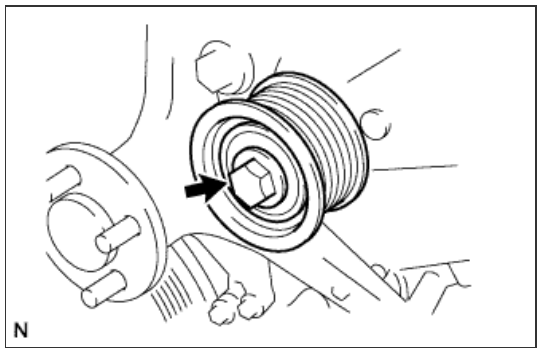
SST
09960-10010 (09962-01000, 09963-01000)

b. Remove the 4 bolts and water pump pulley.



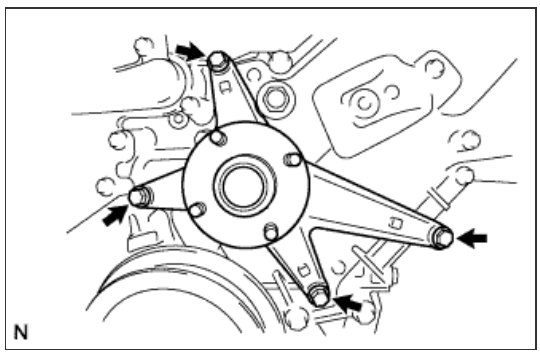
46. REMOVE NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Remove the bolt and idler pulley.



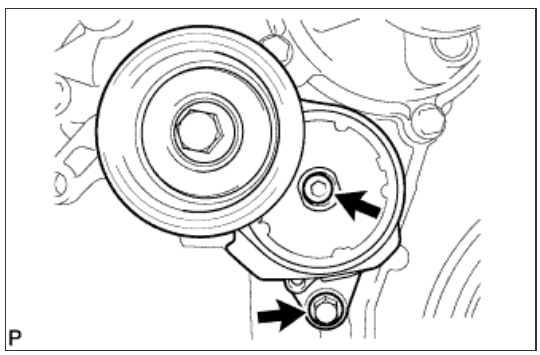
47. REMOVE FLUID COUPLING BRACKET

a. Remove the 4 bolts and fluid coupling bracket.



48. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY

a. Remove the standard bolt, 6 mm hexagon wrench bolt and belt tensioner.



49. REMOVE IGNITION COIL ASSEMBLY

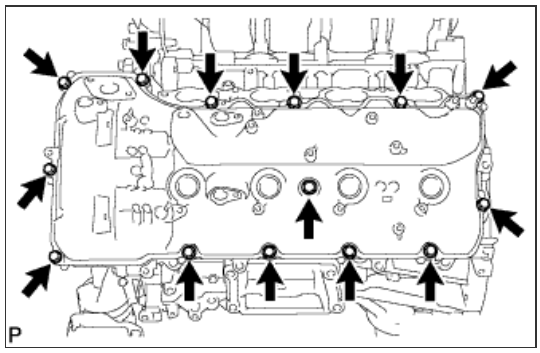
a. Remove the 8 bolts and 8 ignition coils.

50. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY LH

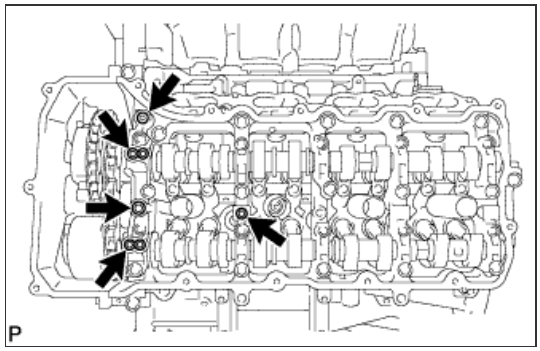
a. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.

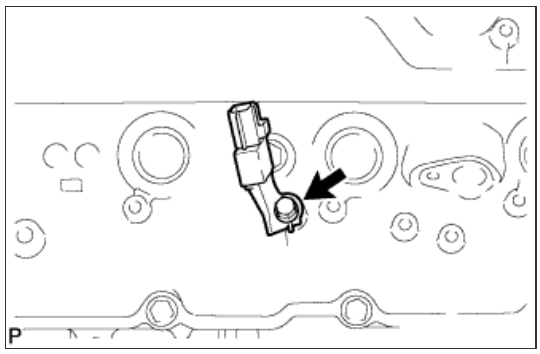


b. Remove the 5 gaskets from the camshaft bearing caps (No. 2, No. 3).



51. REMOVE CYLINDER HEAD COVER SUB-ASSEMBLY RH

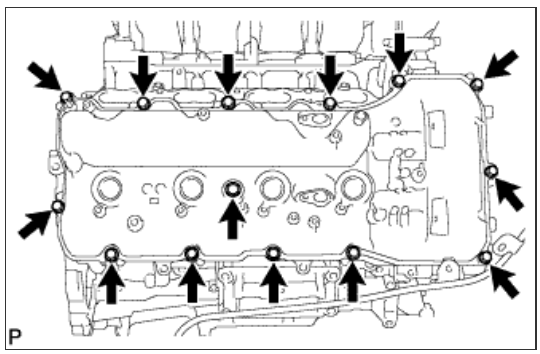
a. Remove the bolt and noise filter.



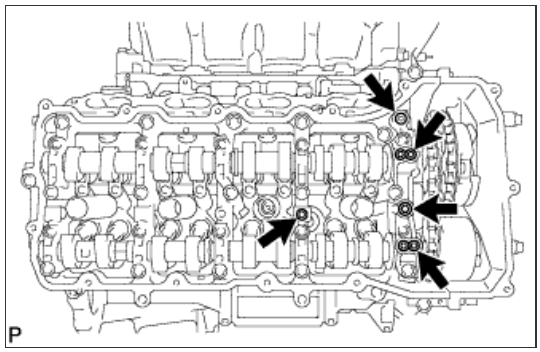
b. Remove the 14 bolts, seal washer, cylinder head cover and gasket.

HINT:

Make sure the removed parts are returned to the same places they were removed from.



c. Remove the 5 gaskets from the camshaft bearing caps (No. 1, No. 3).



52. REMOVE SPARK PLUG TUBE GASKET

a. Bend the 4 ventilation baffle plate claws on the cylinder head cover to an angle of 90° or more.

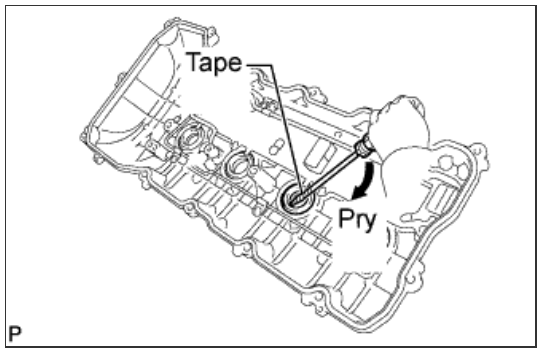
b. Using a screwdriver, pry out the gaskets.

HINT:

Tape the screwdriver tip before use.

NOTICE:

- **Be careful not to damage the cylinder head cover.**
- **Be careful not to damage the gasket when removing it, as the removed gasket needs to be used when installing a new one.**

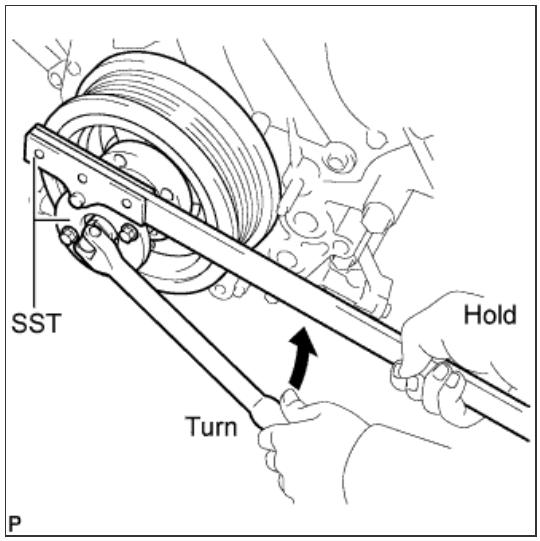


53. REMOVE CRANKSHAFT PULLEY

a. Using SST, loosen the crankshaft pulley set bolt until 2 or 3 threads are engaged.

SST

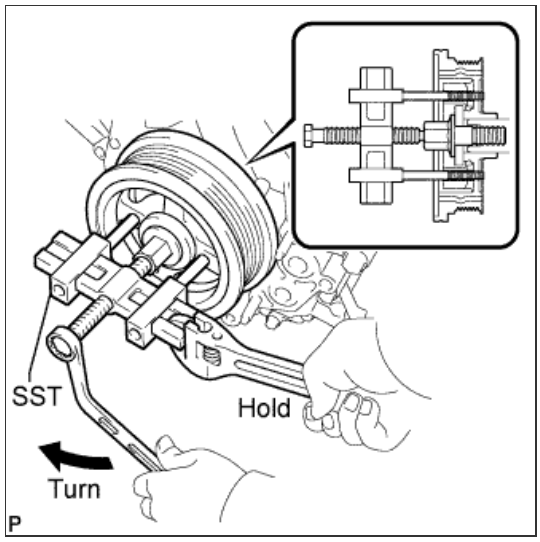
09213-70011 (09213-70020)
09330-00021



b. Using the pulley set bolt and SST, remove the crankshaft pulley.

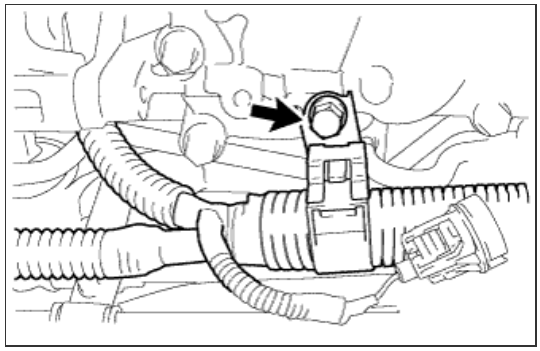
SST

09950-50013 (09951-05010, 09952-05010, 09953-05010, 09954-05011)



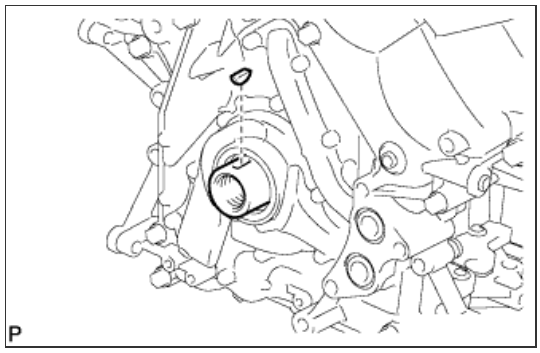
54. DISCONNECT WIRE HARNESS CLAMP BRACKET

a. Remove the bolt and disconnect the bracket.



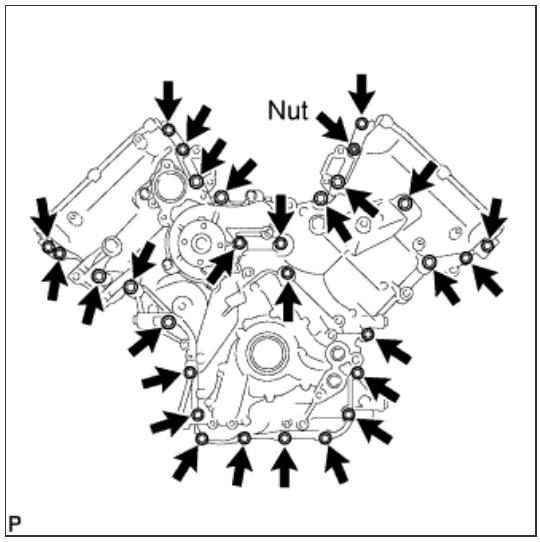
55. REMOVE CRANKSHAFT TIMING GEAR KEY

a. Using a screwdriver, remove the timing gear key from the crankshaft.



56. REMOVE TIMING CHAIN COVER SUB-ASSEMBLY

a. Remove the 28 bolts and nut shown in the illustration.



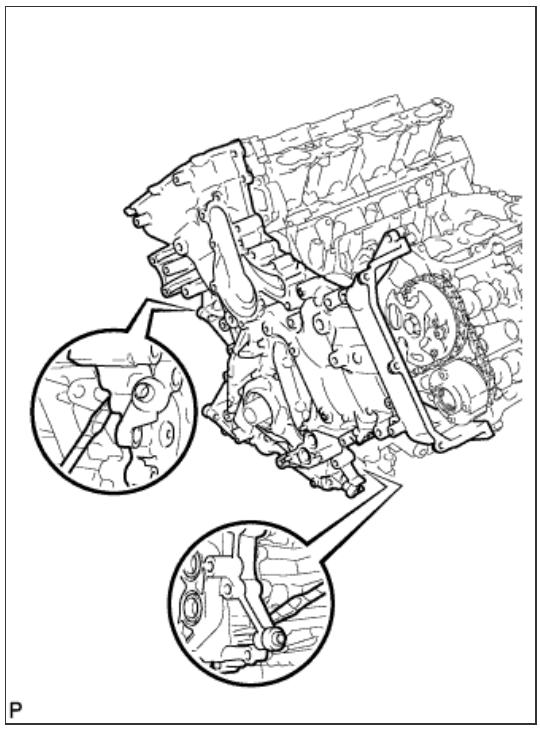
b. Remove the timing chain cover by prying between the timing chain cover and cylinder head or cylinder block with a screwdriver as shown in the illustration.

NOTICE:

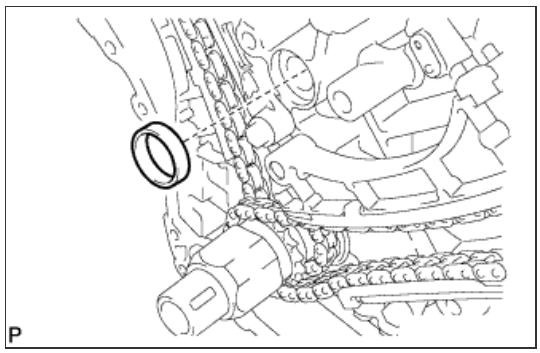
Be careful not to damage the contact surfaces of the cylinder head, cylinder block and chain cover.

HINT:

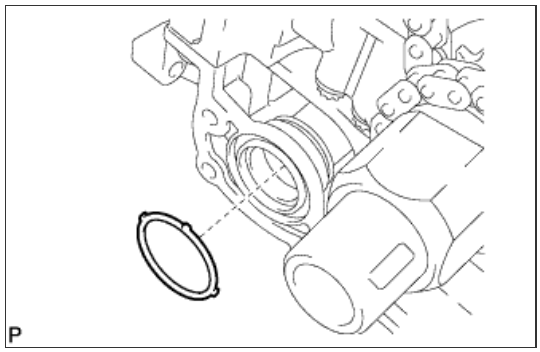
Tape the screwdriver tip before use.



c. Remove the oil pump gasket from the cylinder block.



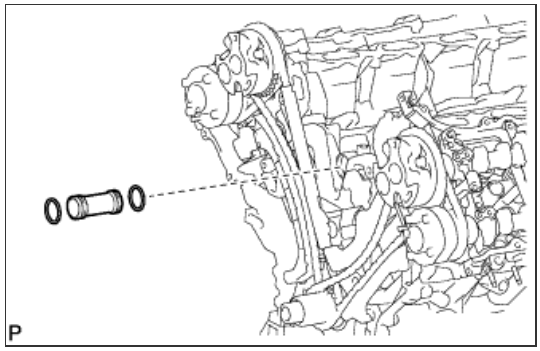
d. Remove the O-ring from the oil pan.



57. REMOVE WATER INLET PIPE

a. Remove the water inlet pipe.

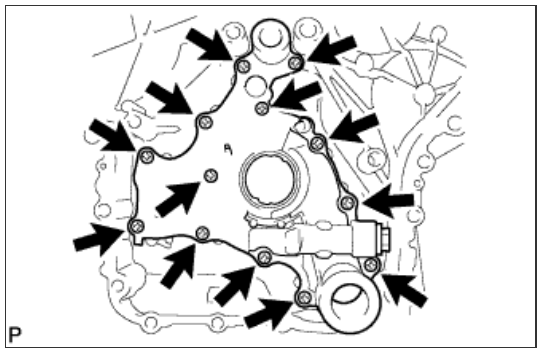
b. Remove the 2 O-rings from the water inlet pipe.



for Preparation Click here

1. REMOVE OIL PUMP COVER

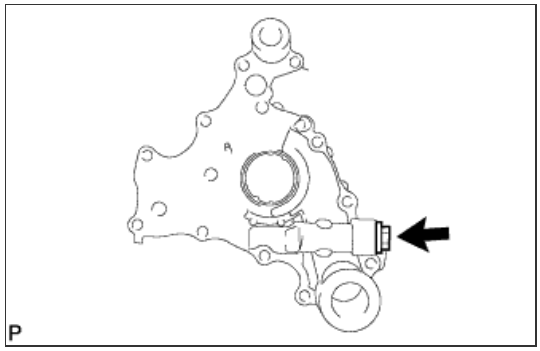
a. Remove the 13 bolts, oil pump cover, drive rotor and driven rotor.



2. REMOVE OIL PUMP RELIEF VALVE

a. Remove the relief valve plug.

b. Remove the valve spring and oil pump relief valve.

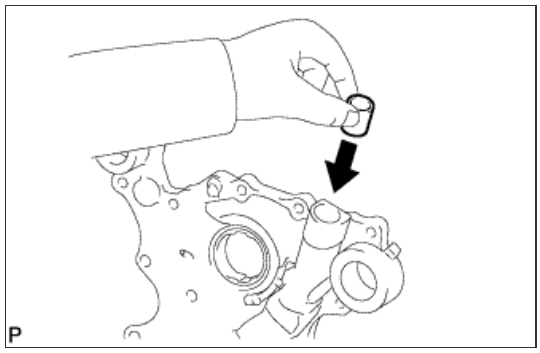


for Preparation Click here

1. INSPECT OIL PUMP RELIEF VALVE

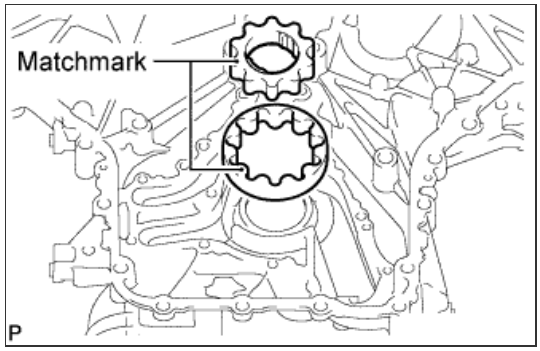
a. Coat the relief valve with engine oil.

b. Check that the relief valve falls smoothly into the valve hole by its own weight. If the relief valve does not fall smoothly, replace it. If necessary, replace the timing chain cover sub-assembly.



2. INSPECT OIL PUMP ROTOR SET

a. Install the rotors to the timing chain cover with the marks of the rotors facing outward. Check that the rotors revolve smoothly.



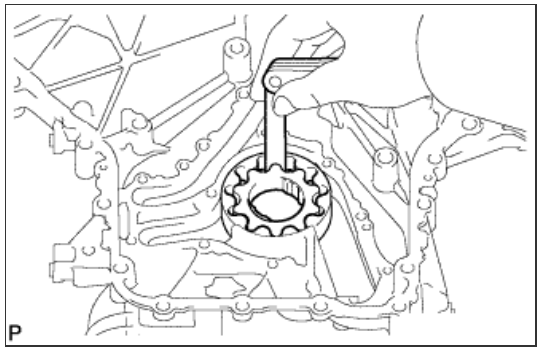
b. Check the tip clearance.

i. Using a feeler gauge, measure the clearance between the drive and driven rotor tips, as shown in the illustration.

Standard tip clearance:
0.180 to 0.300 mm (0.00709 to 0.0118 in.)

Maximum tip clearance:
0.300 mm (0.0118 in.)

If the tip clearance is more than the maximum, replace the drive and driven rotors together.



c. Check the side clearance.

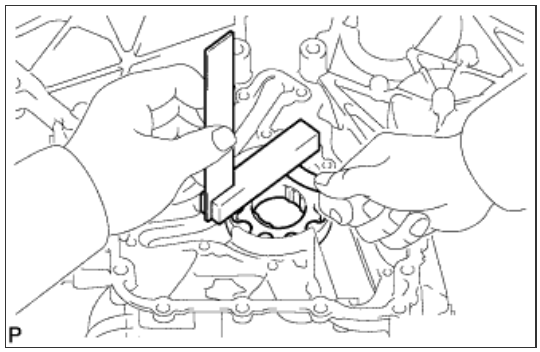
i. Using a feeler gauge and steel square, measure the clearance between the rotors and steel square as shown in the illustration.

Standard side clearance:
0.030 to 0.090 mm (0.00118 to 0.00354 in.)

Maximum side clearance:
0.090 mm (0.00354 in.)

If the side clearance is more than the maximum, replace the timing

chain cover sub-assembly.



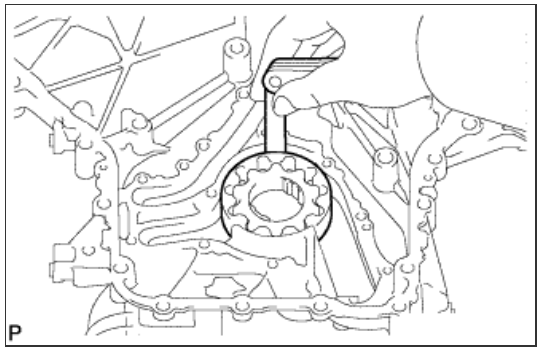
d. Check the body clearance.

i. Using a feeler gauge, measure the clearance between the timing chain cover and driven rotor as shown in the illustration.

Standard body clearance:
0.175 to 0.250 mm (0.00689 to 0.00984 in.)

Maximum body clearance:
0.250 mm (0.00984 in.)

If the body clearance is more than the maximum, replace the timing chain cover sub-assembly.



for Preparation Click here

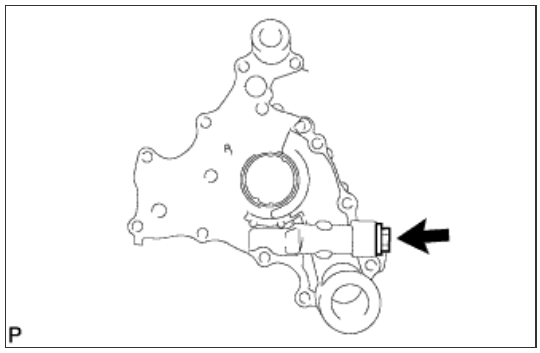
1. INSTALL OIL PUMP RELIEF VALVE

a. Coat the oil pump relief valve with engine oil.

b. Install the relief valve and relief valve spring into the oil pump cover hole.

c. Install the plug.

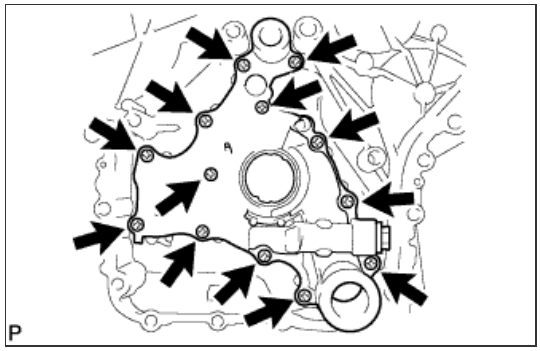
Torque:
53 N*m{ 540 kgf*cm , 39 ft.*lbf }



2. INSTALL OIL PUMP COVER

a. Install the driven rotor, drive rotor and oil pump cover with the 13 bolts.

Torque:
10 N*m{ 105 kgf*cm , 8 ft.*lbf }

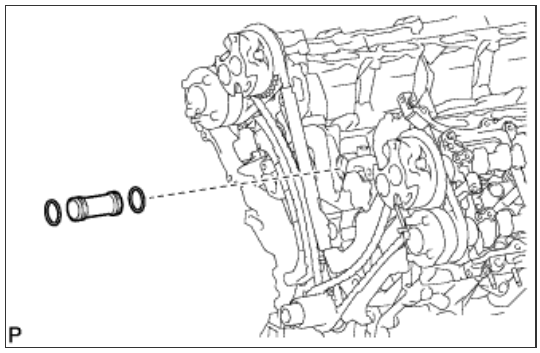


for Preparation Click here

1. INSTALL WATER INLET PIPE

a. Apply soapy water to 2 new O-rings and install them to the inlet pipe.

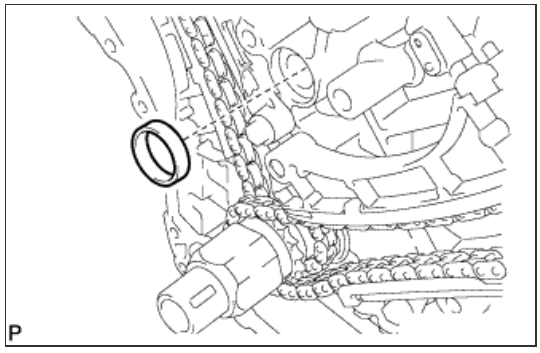
b. Install the inlet pipe to the No. 1 heat exchanger cover.



2. INSTALL TIMING CHAIN COVER SUB-ASSEMBLY

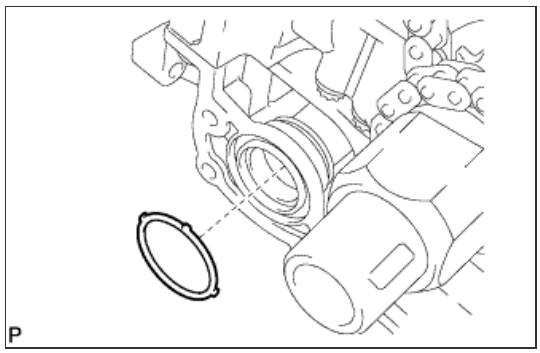
a. Apply a light coat of engine oil to a new oil pump gasket.

b. Install the oil pump gasket.

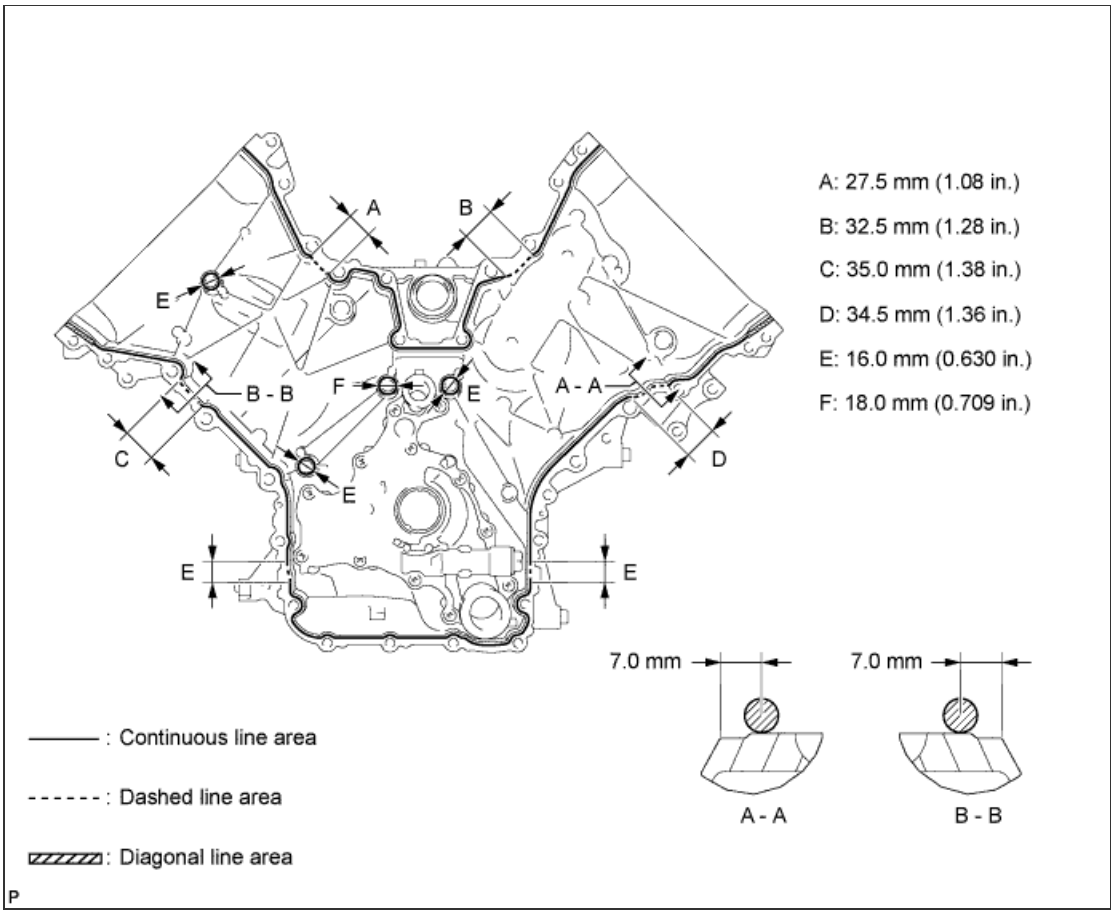


c. Apply a light coat of engine oil to a new O-ring.

d. Install the O-ring.



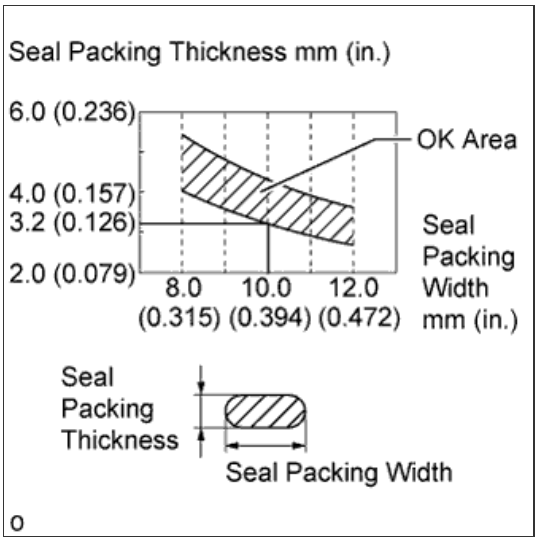
e. Apply seal packing in a continuous line to the timing chain cover as shown in the following illustration.



Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Apply seal packing as follows:

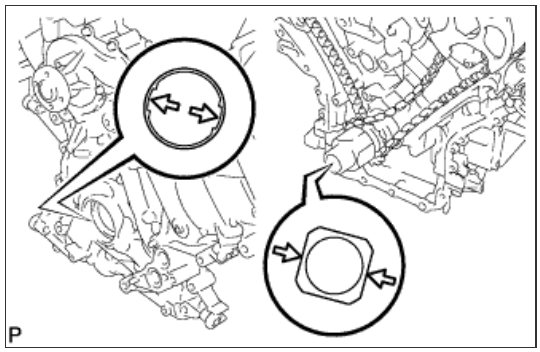
Area	Seal Packing Diameter	Application Position from Inside Edge of Cover
Continuous Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	2.5 mm (0.0984 in.)
Dashed Line Area	6.4 mm (0.252 in.) or more, or within OK area shown in illustration	7.0 mm (0.276 in.)
Diagonal Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	5.5 mm (0.217 in.)



NOTICE:

- **When the contact surfaces are wet, wipe them with an oil-free cloth before applying seal packing.**
- **Install the chain cover within 3 minutes and tighten the bolts within 10 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after installing.**

f. Align the oil pump drive rotor spline and crankshaft as shown in the illustration.
Install the spline and chain cover to the crankshaft.



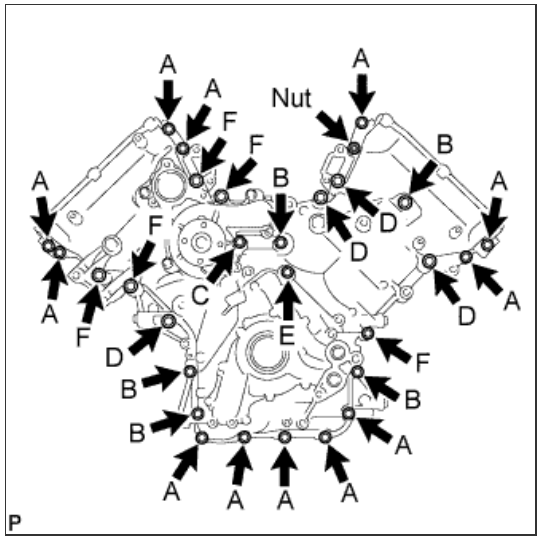
g. Temporarily install the timing chain cover with the 28 bolts and nut.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)

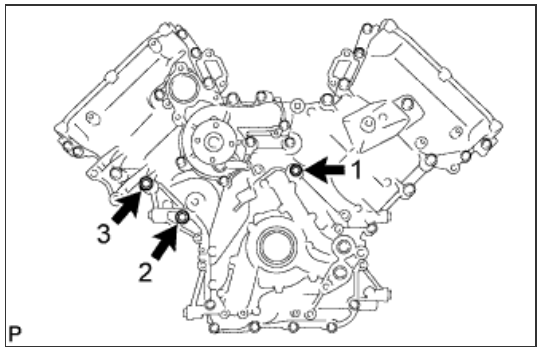
NOTICE:

Make sure that there is no oil on the bolt threads.



h. Tighten the 3 bolts in several steps in the sequence shown in the illustration.

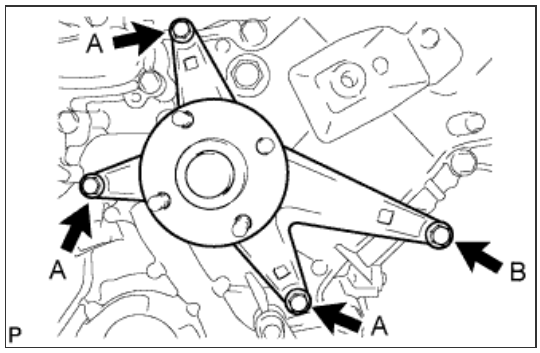
Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



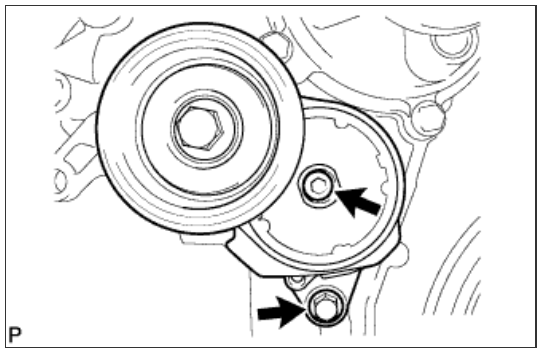
i. Temporarily install the fluid coupling bracket with the 4 bolts.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt B	80 mm (3.15 in.)	10 mm (0.394 in.)

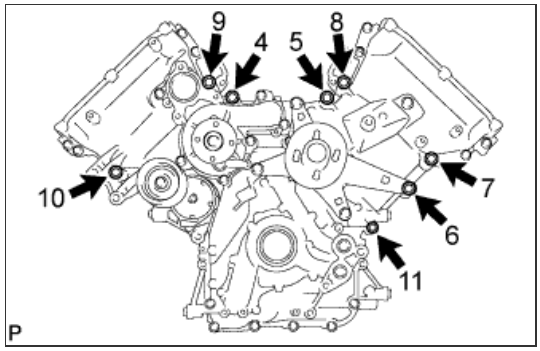


j. Temporarily install the belt tensioner with the standard bolt and 6 mm hexagon wrench bolt.



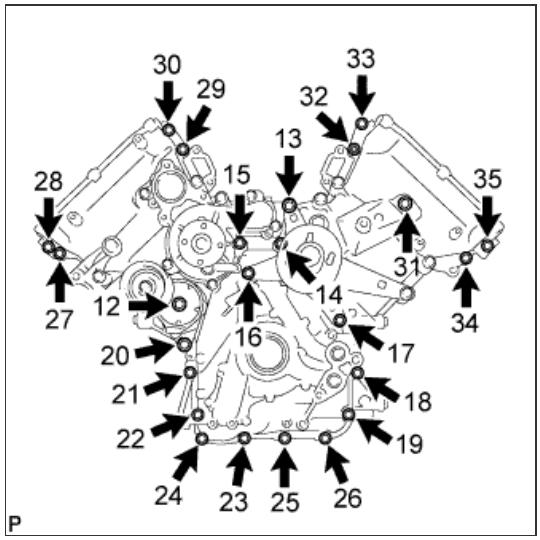
k. Tighten the 8 bolts labeled 4 to 11 in several steps in the sequence shown in the illustration.

Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



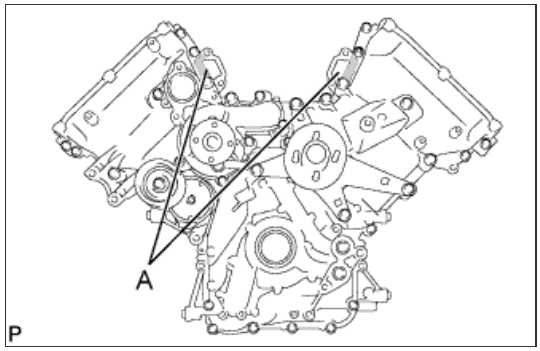
l. Tighten the 23 bolts and nut labeled 12 to 35 in several steps in the sequence shown in the illustration.

Torque:
23 N*m{ 235 kgf*cm , 17 ft.*lbf }



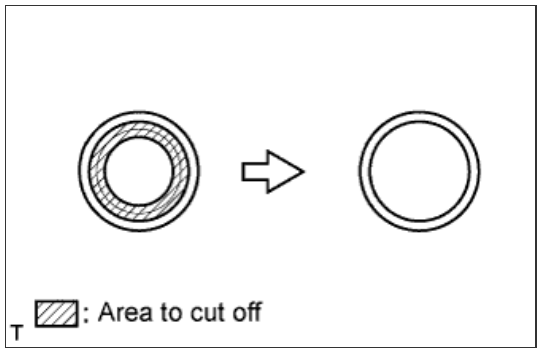
NOTICE:

After the installation, if the seal packing has seeped out at the areas labeled A shown in the illustration, wipe it off.



3. INSTALL SPARK PLUG TUBE GASKET

a. Using a cutter knife, cut off the seal part of the removed gasket.



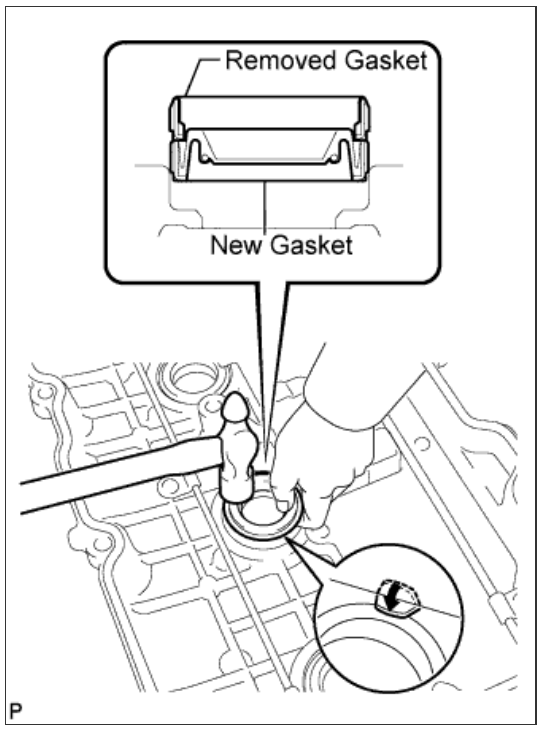
b. Using the removed gasket and a hammer, tap in a new gasket until it stops.

HINT:

If the removed gasket does not fit on the new one, correct the removed one with pliers.

c. Apply a light coat of MP grease to the lip of the gasket.

d. Return the 4 ventilation baffle plate claws to the original positions.



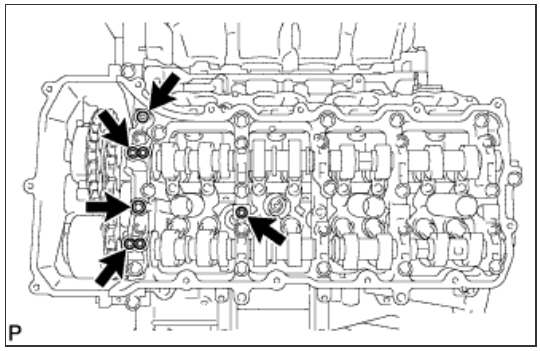
4. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY LH

a. Install 5 new gaskets to the camshaft bearing caps (No. 2, No. 3).

b. Install the gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

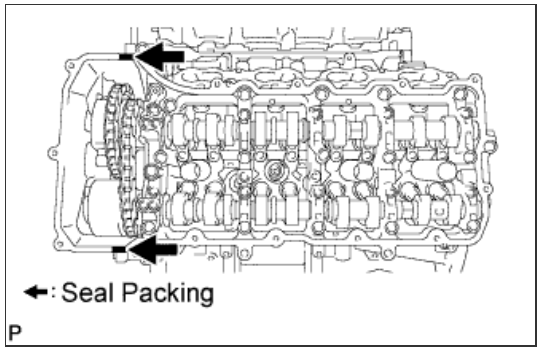


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

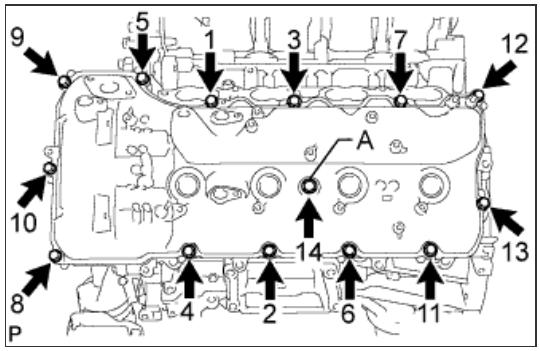
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



d. Install the cylinder head cover and the seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



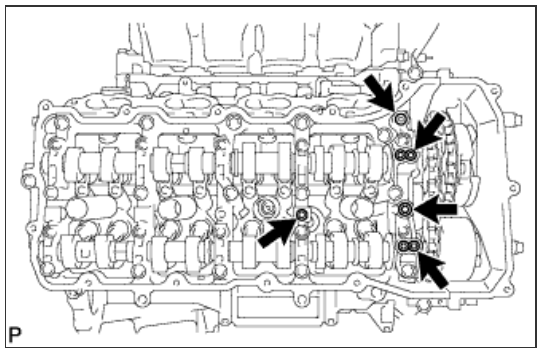
5. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY RH

a. Install 5 new gaskets to the camshaft bearing caps. (No. 1, No. 3).

b. Install the gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

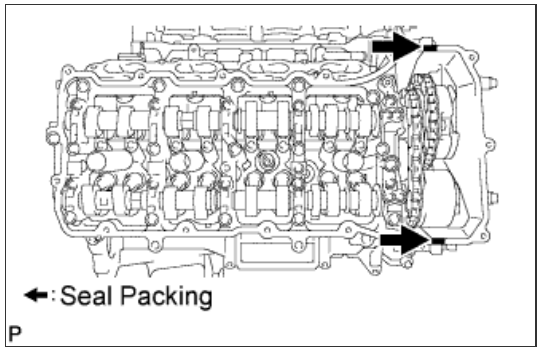


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

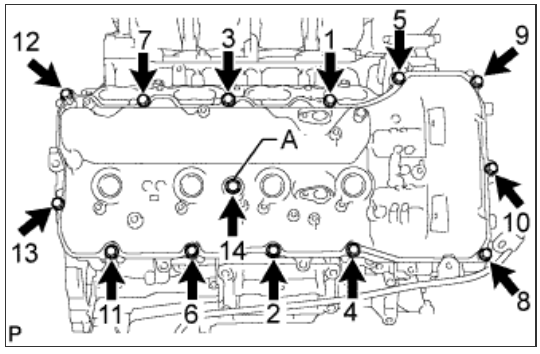
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



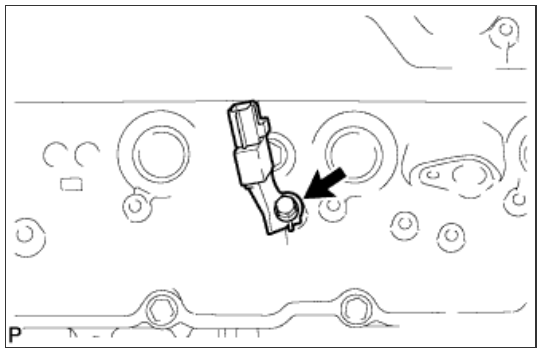
d. Install the cylinder head cover and the seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



e. Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }



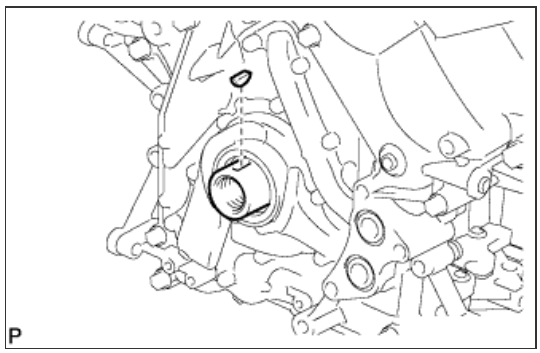
6. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

7. INSTALL CRANKSHAFT TIMING GEAR KEY

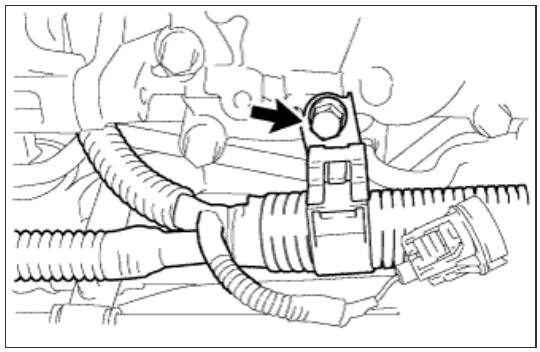
a. Install the crankshaft timing gear key to the crankshaft.



8. CONNECT WIRE HARNESS CLAMP BRACKET

a. Connect the bracket to the timing chain cover with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



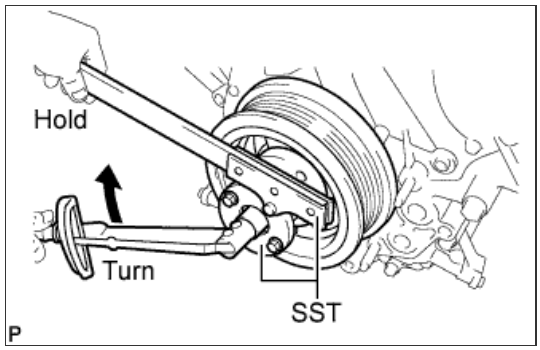
9. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

b. Using SST, install the pulley set bolt.

SST
09213-70011 (09213-70020)
09330-00021

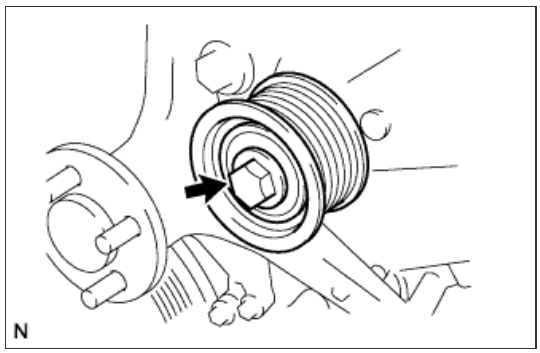
Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



10. INSTALL NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Install the idler pulley with the bolt.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



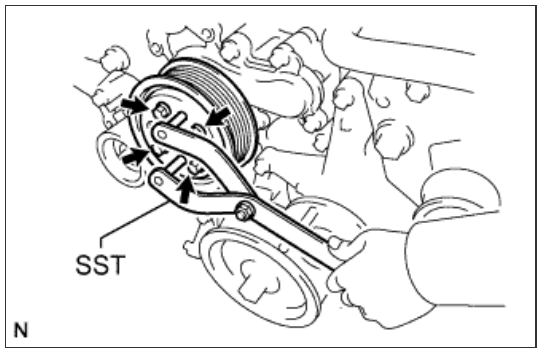
11. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.

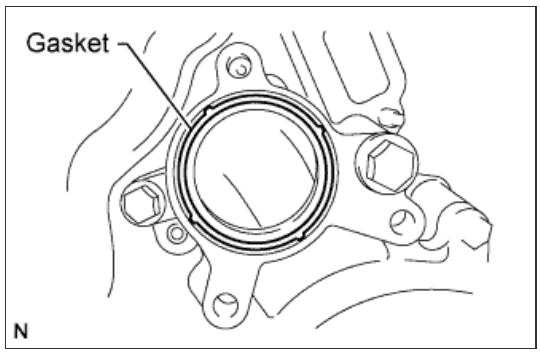
SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



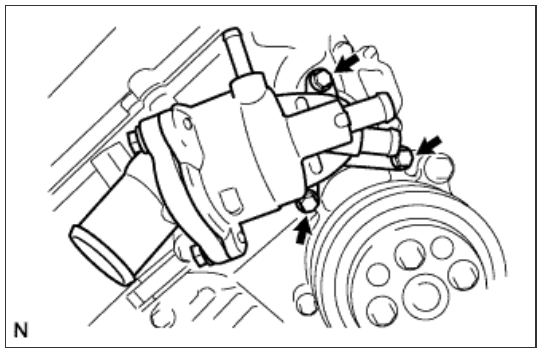
12. INSTALL WATER INLET HOUSING

a. Install a new gasket to the timing chain cover.



b. Install the water inlet with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

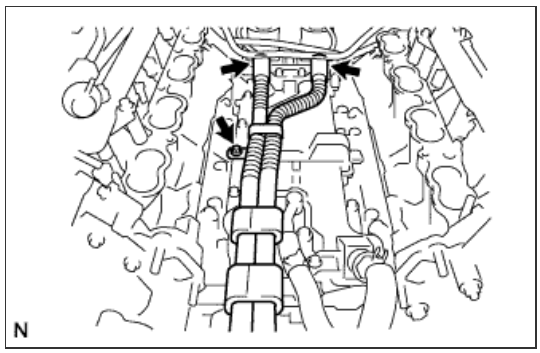


13. INSTALL AIR PIPE SUB-ASSEMBLY

a. Connect the 2 hoses.

b. Install the air pipe with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



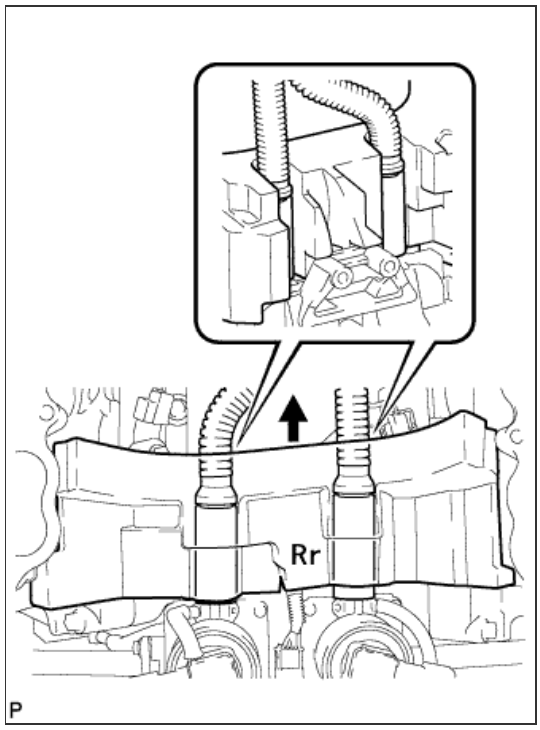
14. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



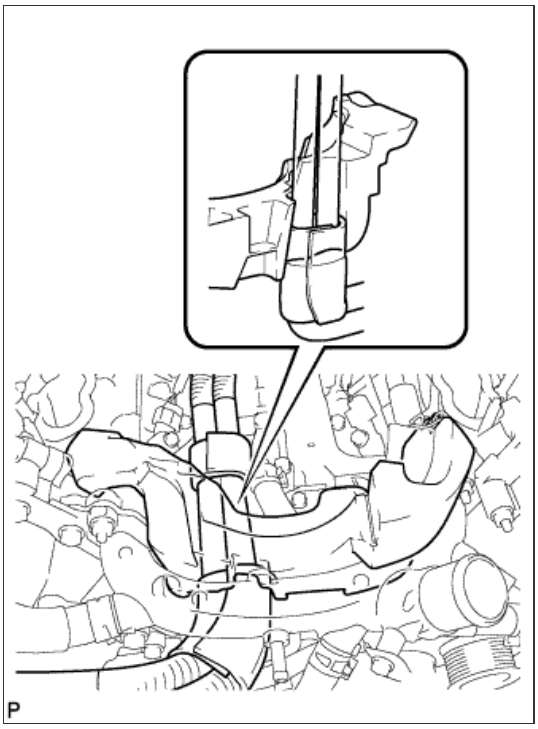
15. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.

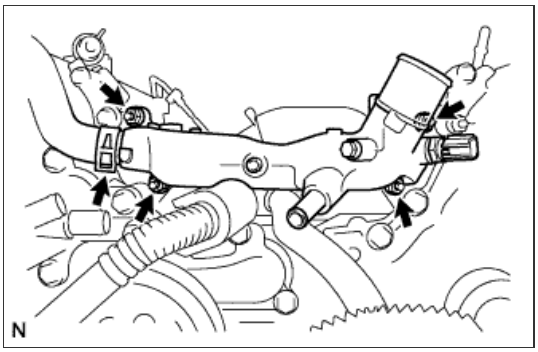


16. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the water by-pass joint with the 4 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the No. 2 water by-pass hose to the water by-pass joint.

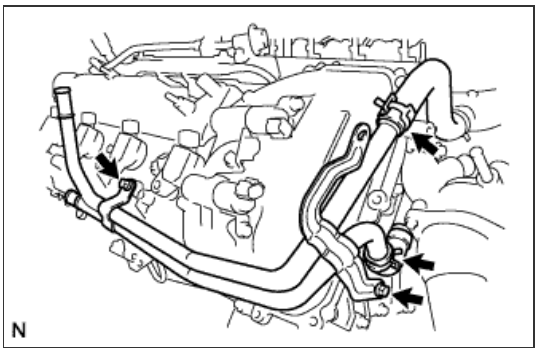


17. INSTALL WATER BY-PASS PIPE SUB-ASSEMBLY

a. Connect the 2 hoses.

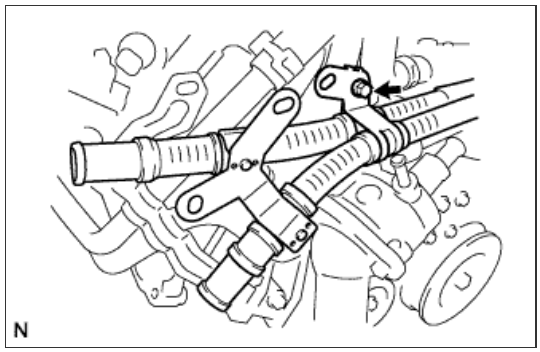
b. Install the water by-pass pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



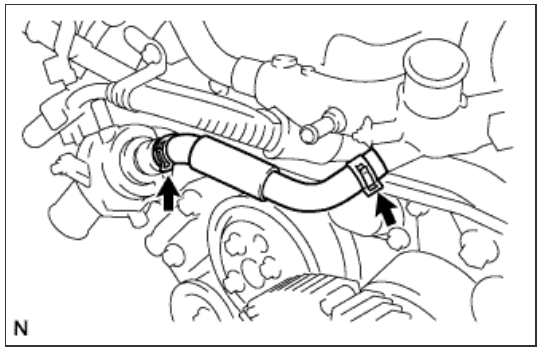
c. Connect the air tube with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



18. INSTALL NO. 1 WATER BY-PASS HOSE

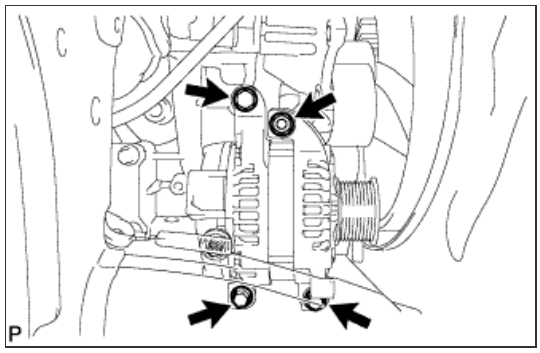
a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.



19. INSTALL GENERATOR ASSEMBLY

a. Install the generator with the 3 bolts and nut.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



b. Connect the generator connector.

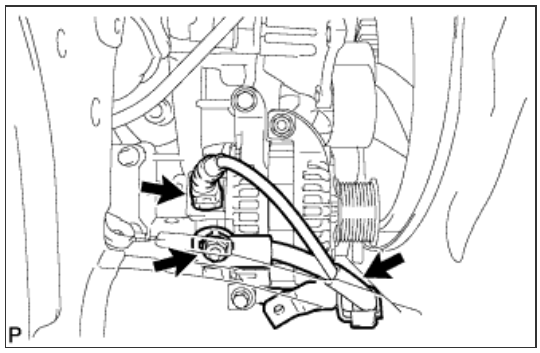
c. Connect the generator wire with the nut.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

d. Install the terminal cap.

e. Install the harness bracket to the generator with the bolt.

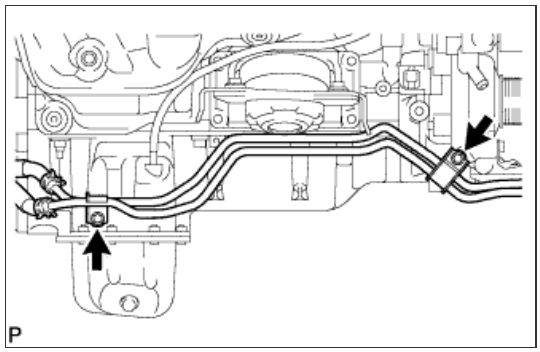
Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }



20. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

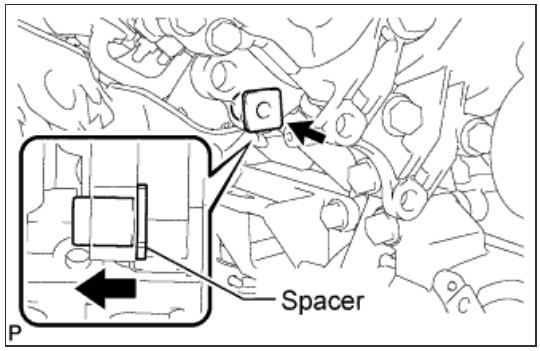
Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }



21. CONNECT VANE PUMP ASSEMBLY

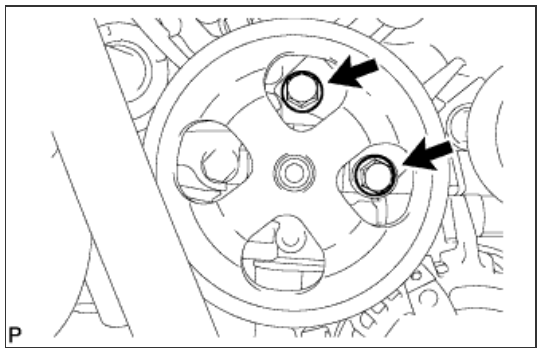
HINT:

Before performing the following procedures, move the spacer until the vane pump can be installed.

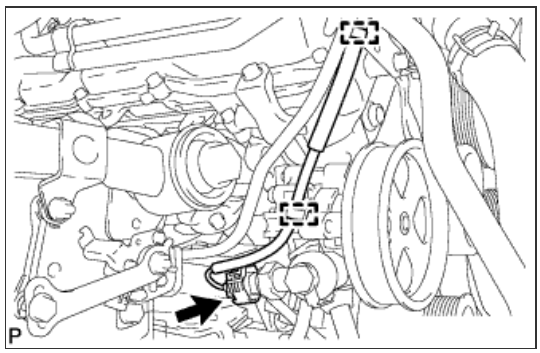


a. Connect the vane pump to the timing chain cover with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



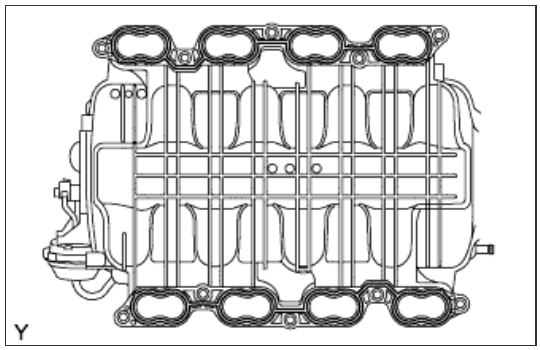
b. Connect the 2 clamps and power steering oil pressure switch connector.



22. INSTALL INTAKE MANIFOLD

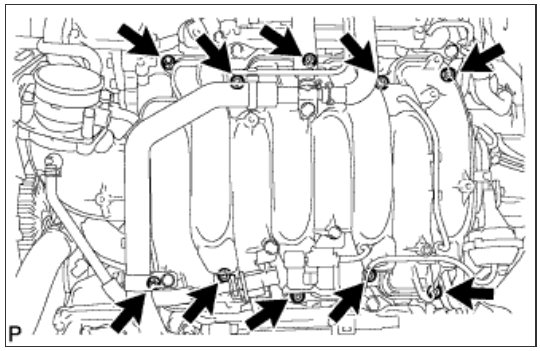
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



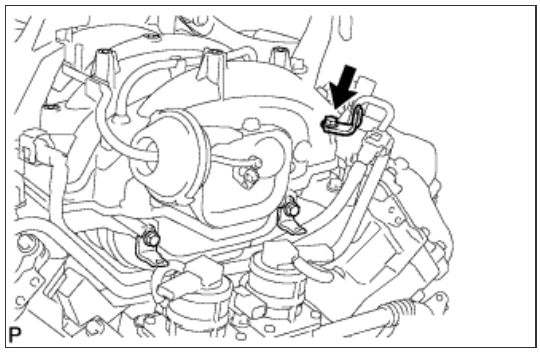
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

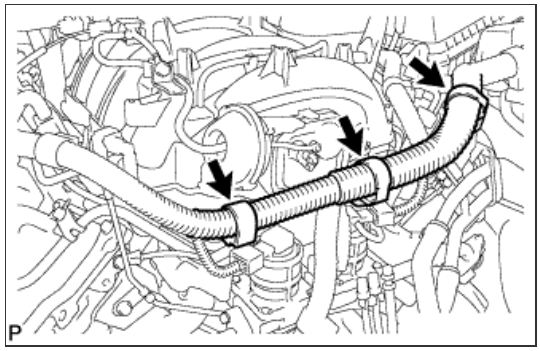


d. Install the wire bracket to the intake manifold with the bolt.

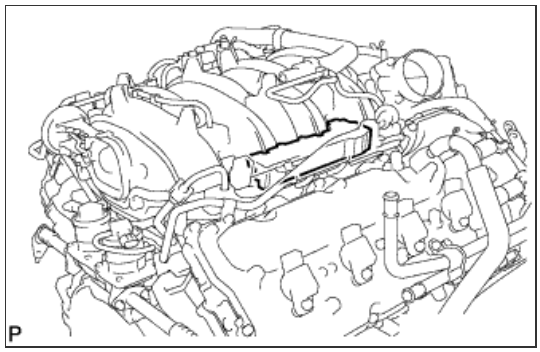
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



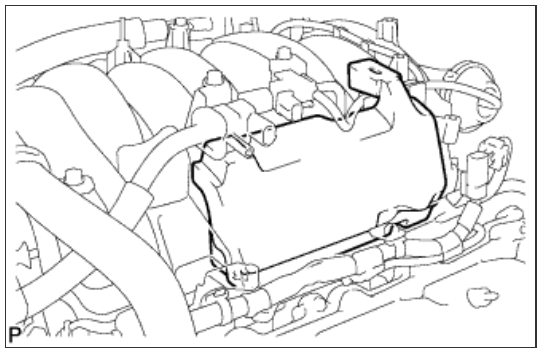
e. Connect the 3 wire clamps to the 3 wire brackets.



f. Install the No. 3 engine cover.



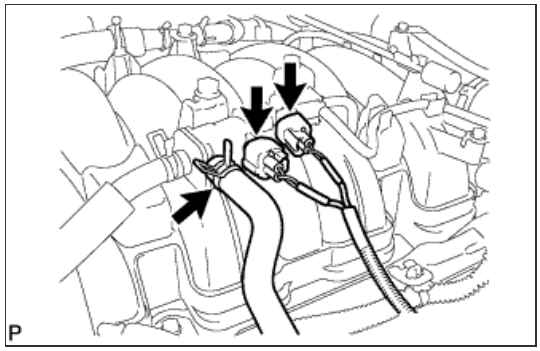
g. Install the No. 1 engine cover sub-assembly.



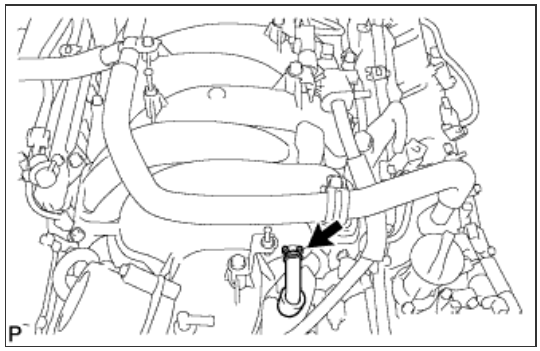
h. Connect the purge VSV connector.

i. Connect the purge line hose to the purge VSV.

j. Connect the vacuum switching valve connector (for ACIS).

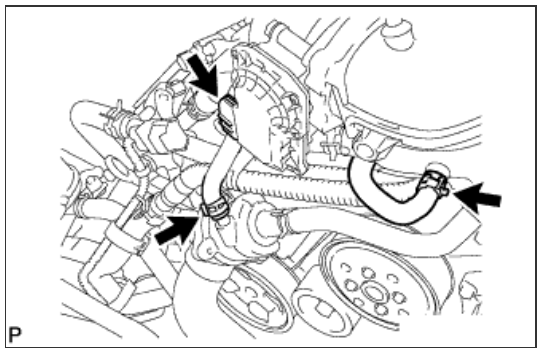


k. Connect the No. 1 ventilation hose.

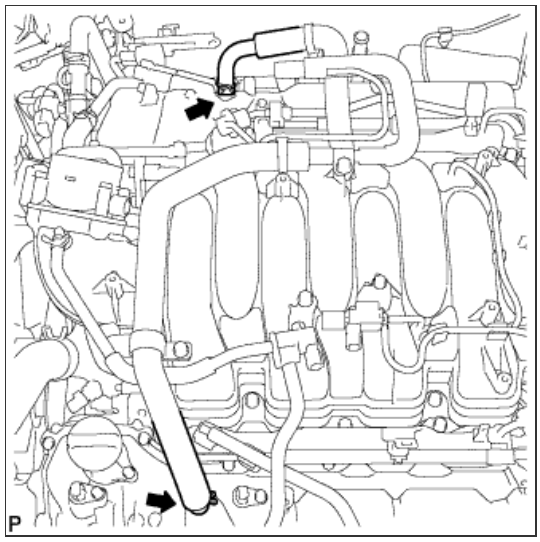


l. Connect the 2 water by-pass hoses.

m. Connect the throttle body connector.



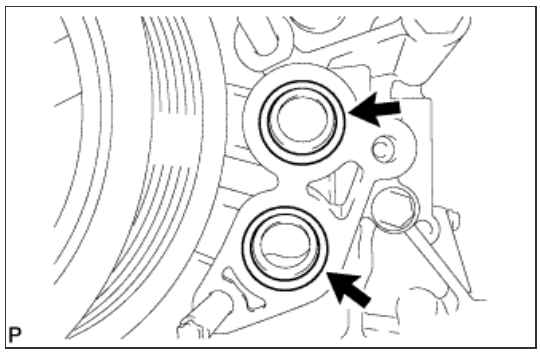
n. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.



23. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

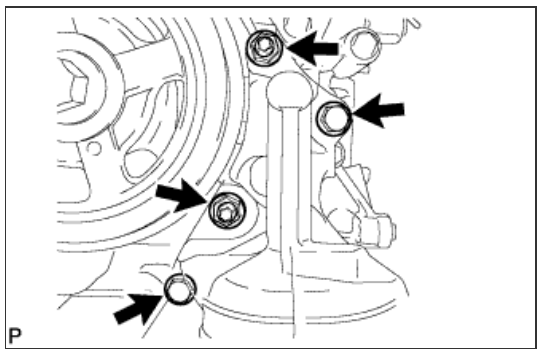
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

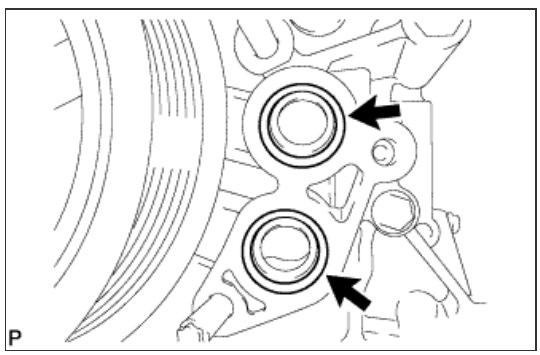
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



24. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

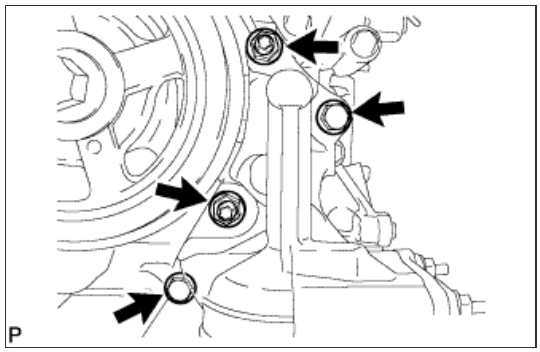
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

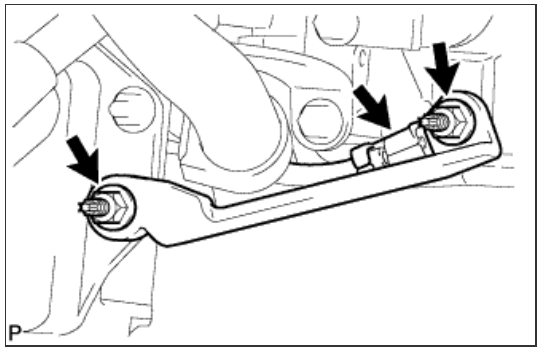


25. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

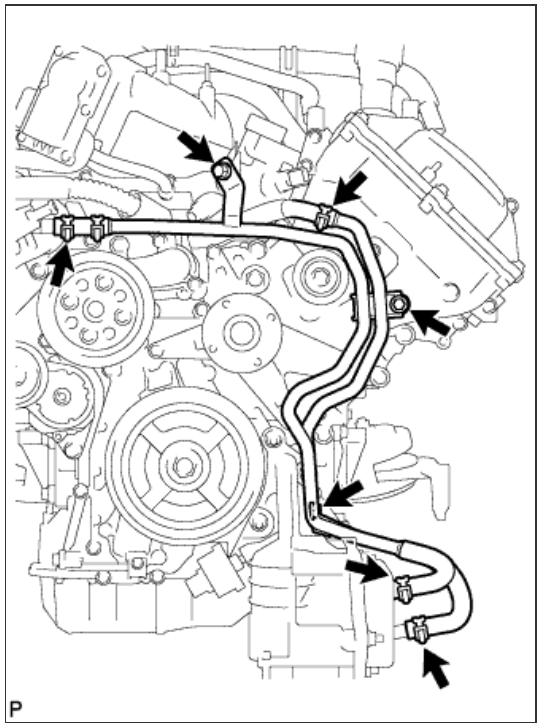


26. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

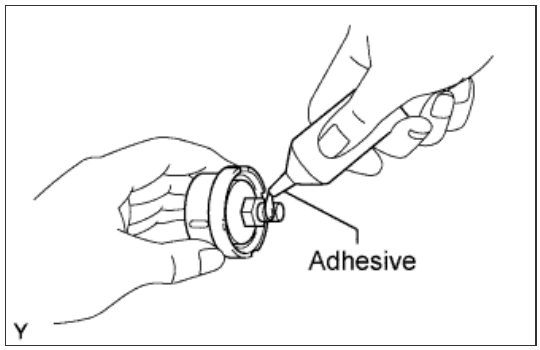
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



27. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

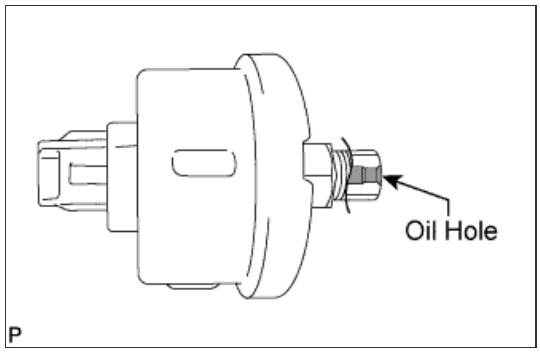
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

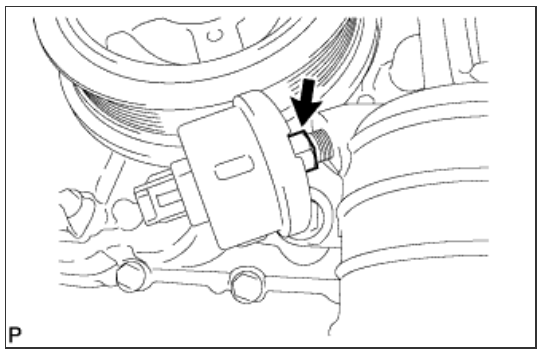


b. Install the oil pressure sender gauge.

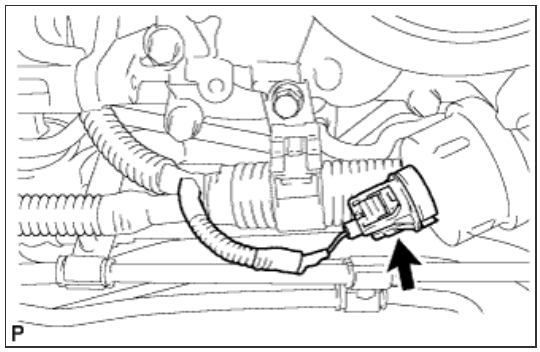
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



28. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

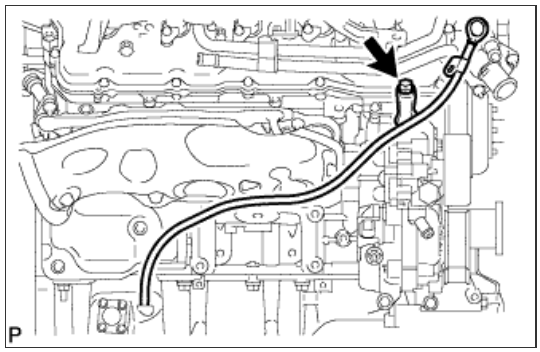
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Install the dipstick.



29. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

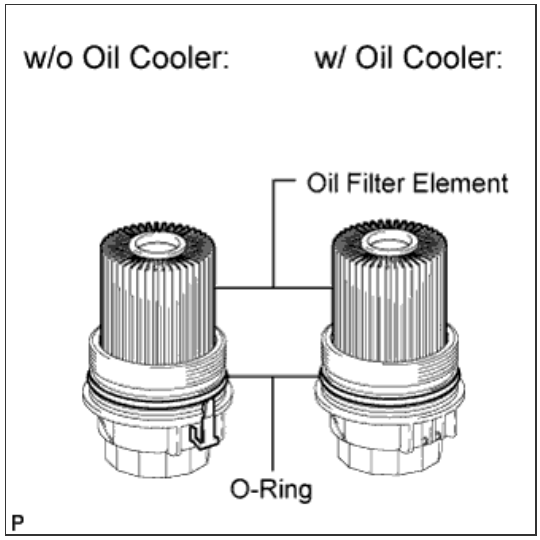
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



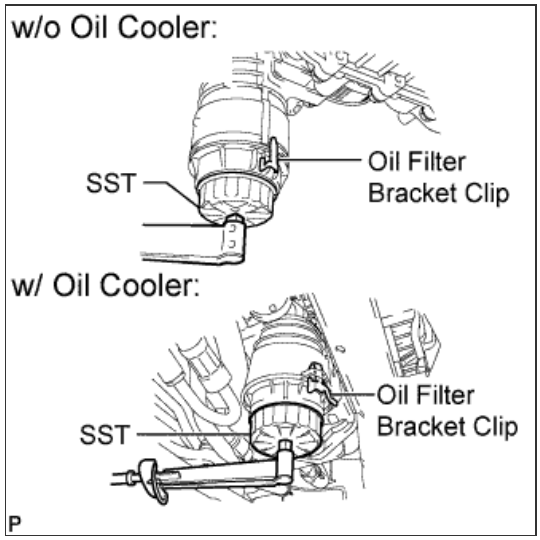
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

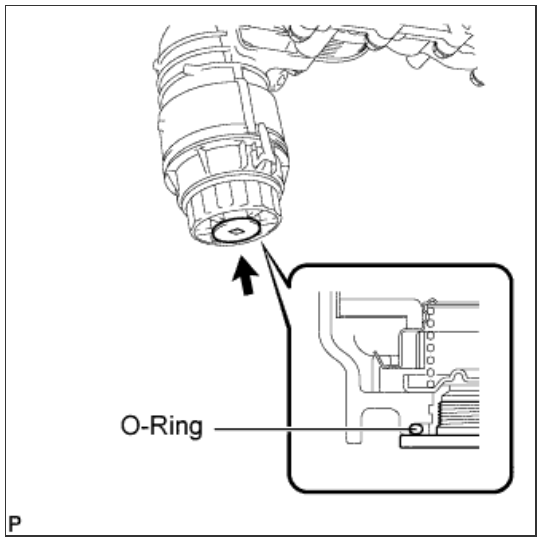
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

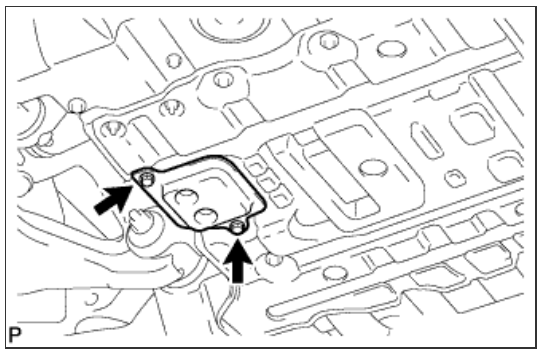
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

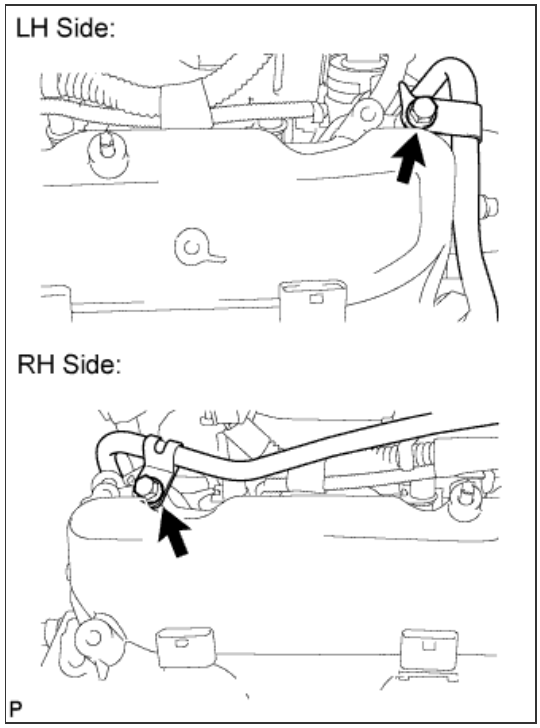
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



30. CONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Connect the fuel tube with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



31. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

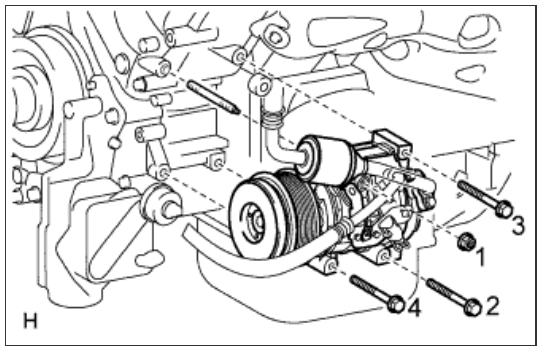
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

NOTICE:

Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.

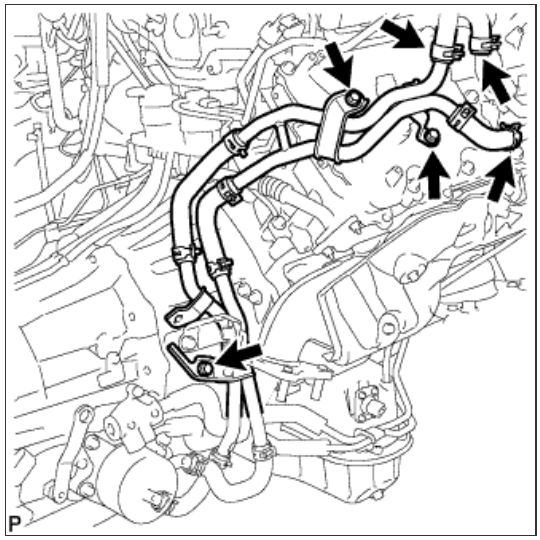


32. CONNECT NO. 2 WATER BY-PASS PIPE

a. Connect the No. 2 water by-pass pipe to the cylinder head cover with the 3 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }

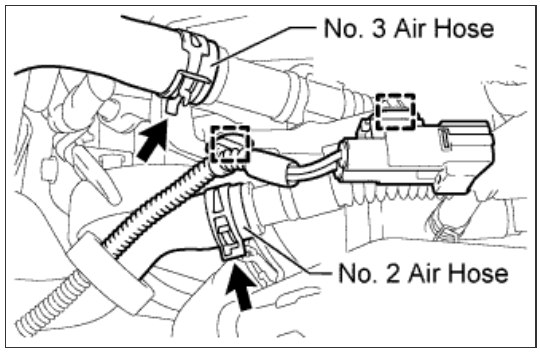
b. Connect the 3 hoses.



33. CONNECT AIR PUMP HOSE AND WIRE HARNESS

a. Connect the No. 2 and No. 3 air hoses.

b. Connect the 2 clamps and air pump wire harness.



34. CONNECT ENGINE WIRE

a. Engine Room RH Side:

i. Connect the 5 clamps.

ii. Connect the throttle position sensor and throttle control motor connector.

iii. Connect the 2 air pump connectors.

iv. Install the ground wire with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

v. Connect the noise filter connector.

vi. Connect the 2 VVT sensor connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

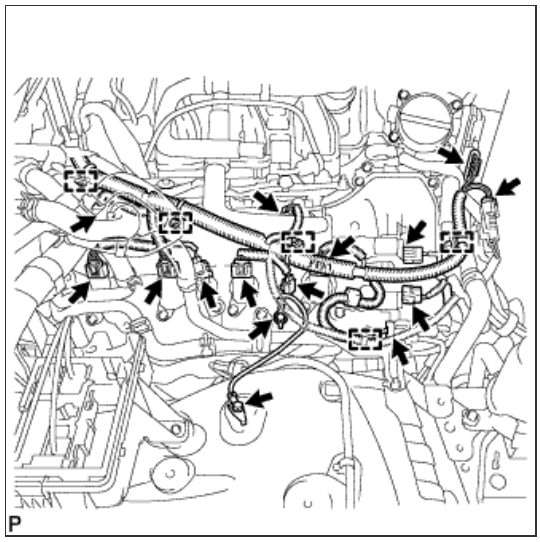
vii. Connect the injector connector.

viii. Connect the 4 ignition coil connectors.

ix. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



b. Engine Room LH Side:

i. Connect the cooler compressor connector.

ii. Connect the 3 clamps.

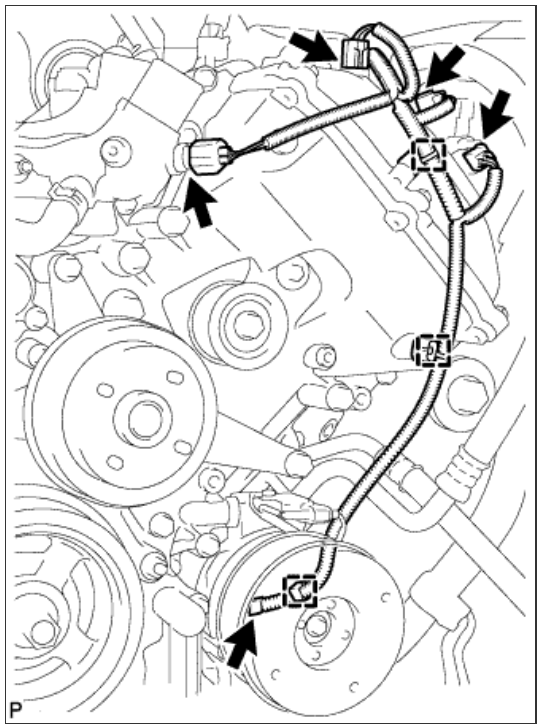
iii. Connect the camshaft position sensor connector.

iv. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

v. Connect the engine coolant temperature sensor connector.



vi. Connect the 4 clamps.

vii. Install the ground wire with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

viii. Connect the noise filter connector.

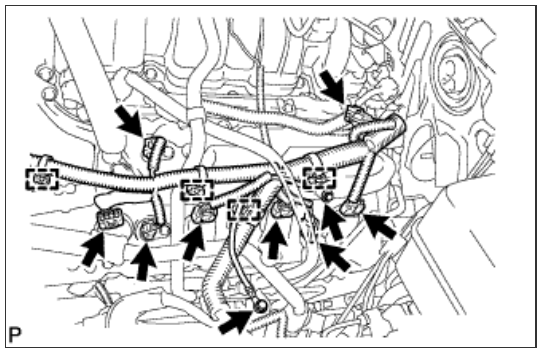
ix. Connect the 2 VVT sensor connectors.

HINT:

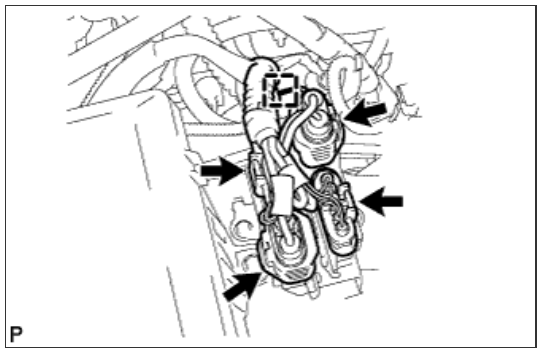
The wire harnesses on the exhaust side are wrapped with white tape.

x. Connect the 4 ignition coil connectors.

xi. Connect the injector connector.

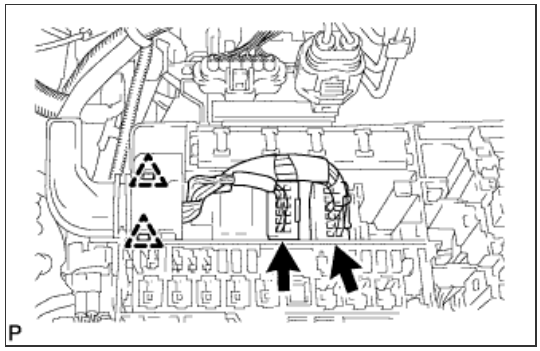


xii. Connect the wire harness clamp and 4 air injection control driver connectors.



xiii. Connect the 2 connectors and 2 clips to the engine room junction block.

xiv. Install the engine room relay block cover.



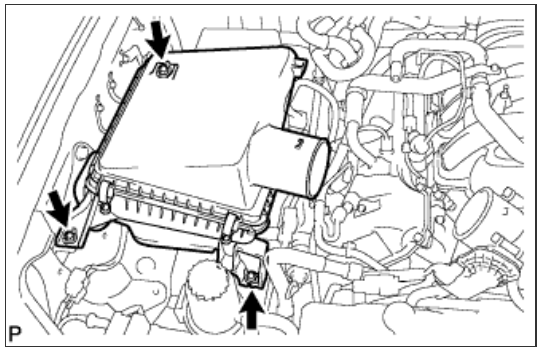
35. INSTALL RADIATOR ASSEMBLY

a. Install the radiator (Click here).

36. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



37. INSTALL AIR CLEANER HOSE ASSEMBLY

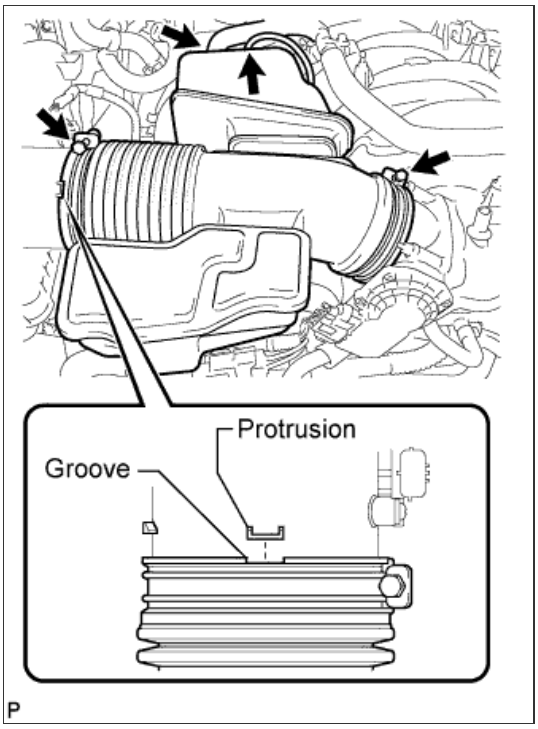
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

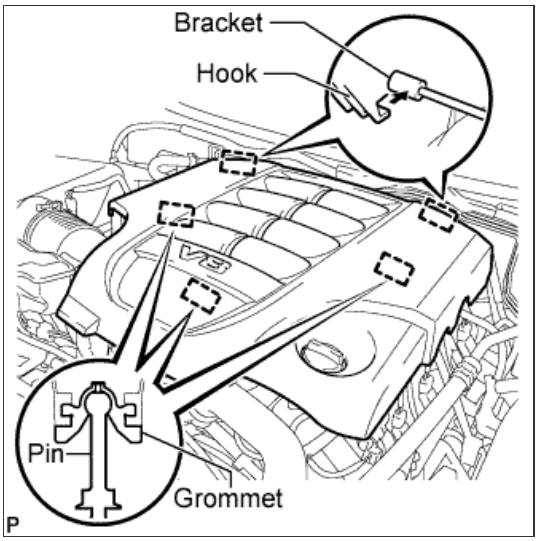
c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



38. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



39. ADD ENGINE OIL

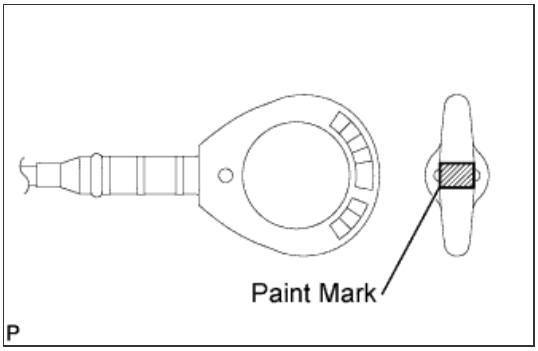
a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
	Drain and refill	7.0 liters (7.4 US



Blue	with oil filter change	qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

40. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

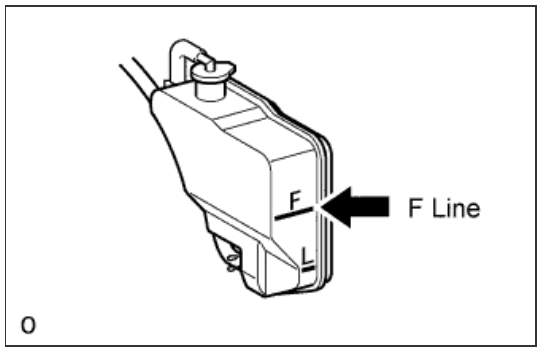
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

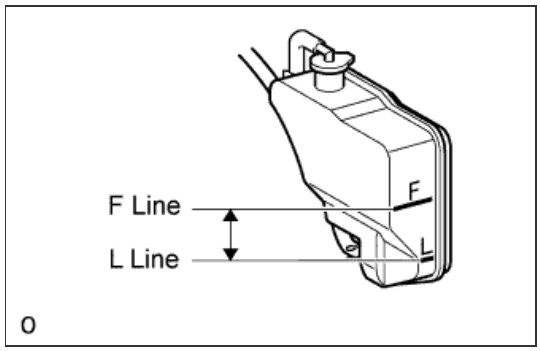
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



41. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

42. INSPECT FOR OIL LEAK

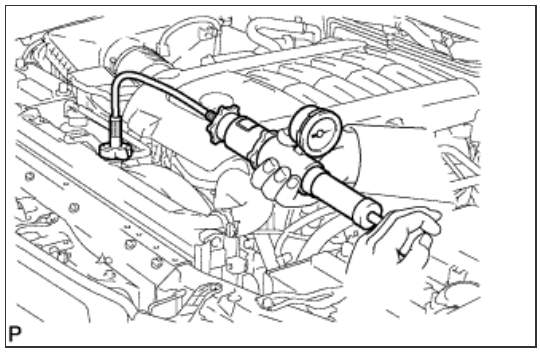
a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

43. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



44. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

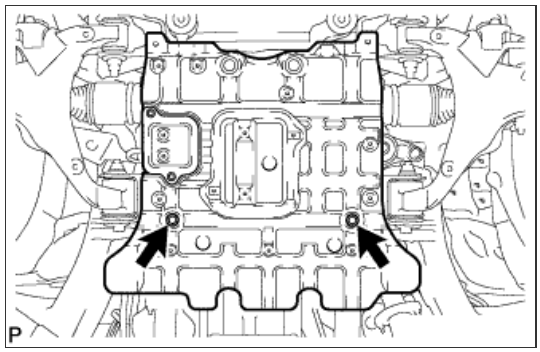
NOTICE:

Do not fill engine oil above the full level mark.

45. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

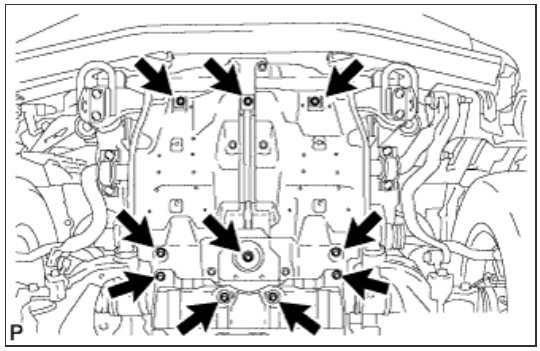
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



46. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

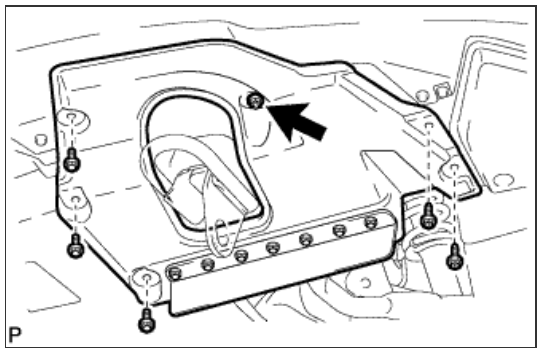
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



47. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



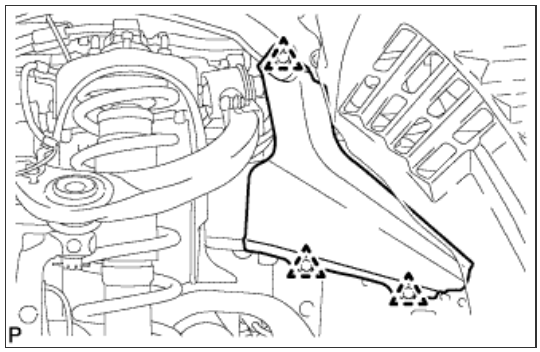
48. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

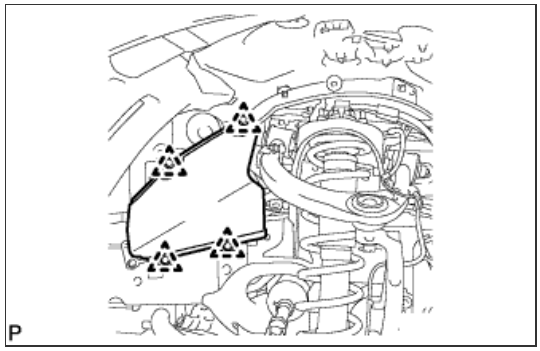
49. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



50. INSTALL FRONT FENDER APRON SEAL LH

a. Install the fender apron seal with the 4 clips.

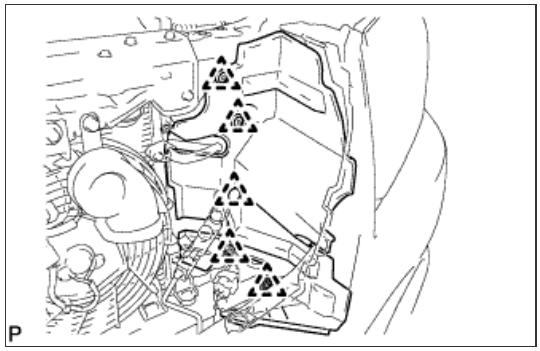


51. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

a. Install the cowl top ventilator louver (Click here).

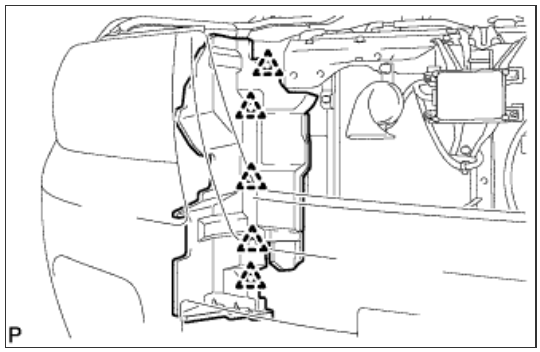
52. CONNECT RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



53. CONNECT RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



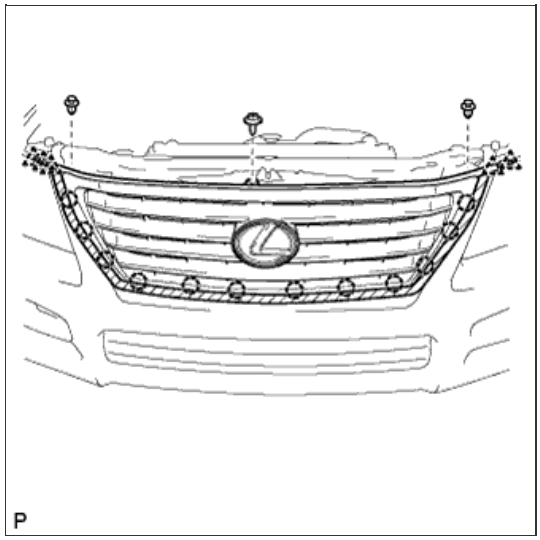
54. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

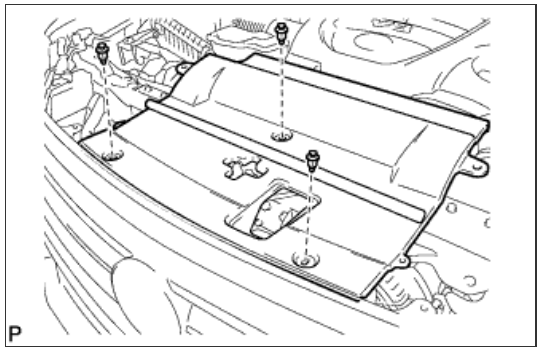
c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



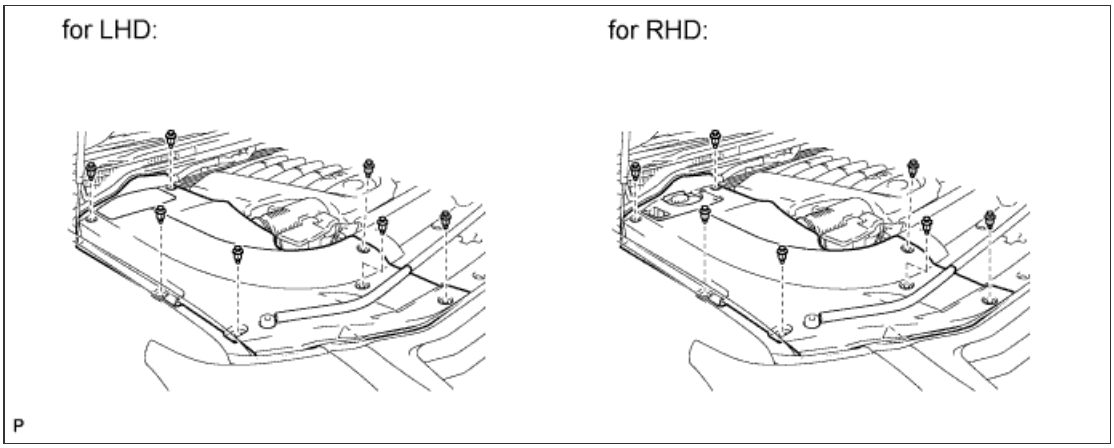
55. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



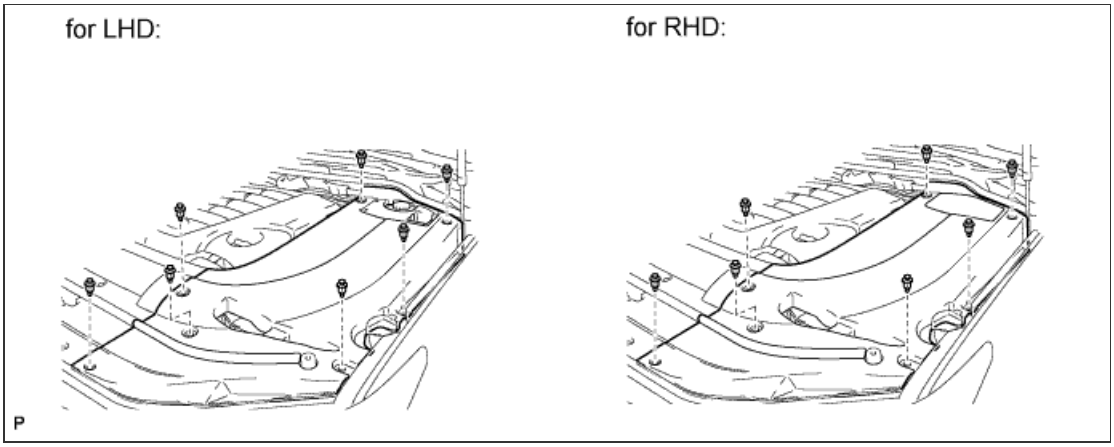
56. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



57. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.

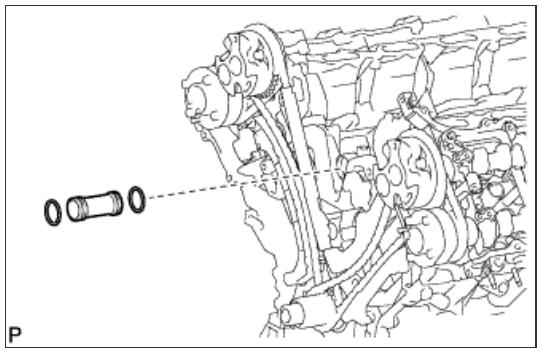


for Preparation Click here

1. INSTALL WATER INLET PIPE

a. Apply soapy water to 2 new O-rings and install them to the inlet pipe.

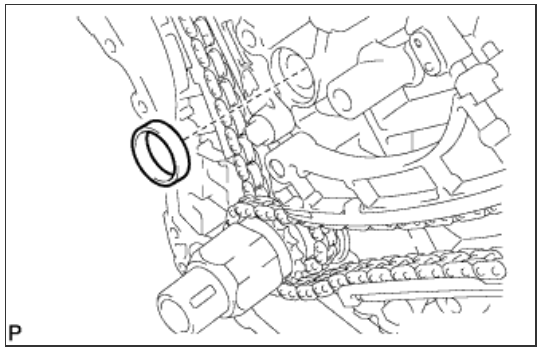
b. Install the inlet pipe to the No. 1 heat exchanger cover.



2. INSTALL TIMING CHAIN COVER SUB-ASSEMBLY

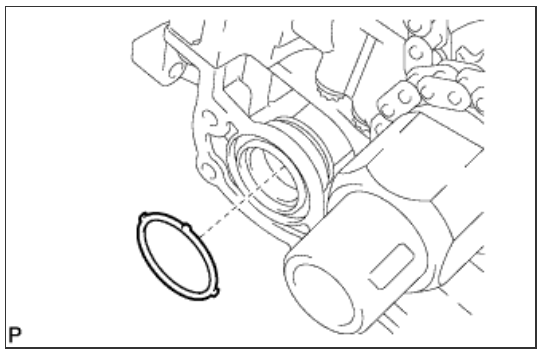
a. Apply a light coat of engine oil to a new oil pump gasket.

b. Install the oil pump gasket.

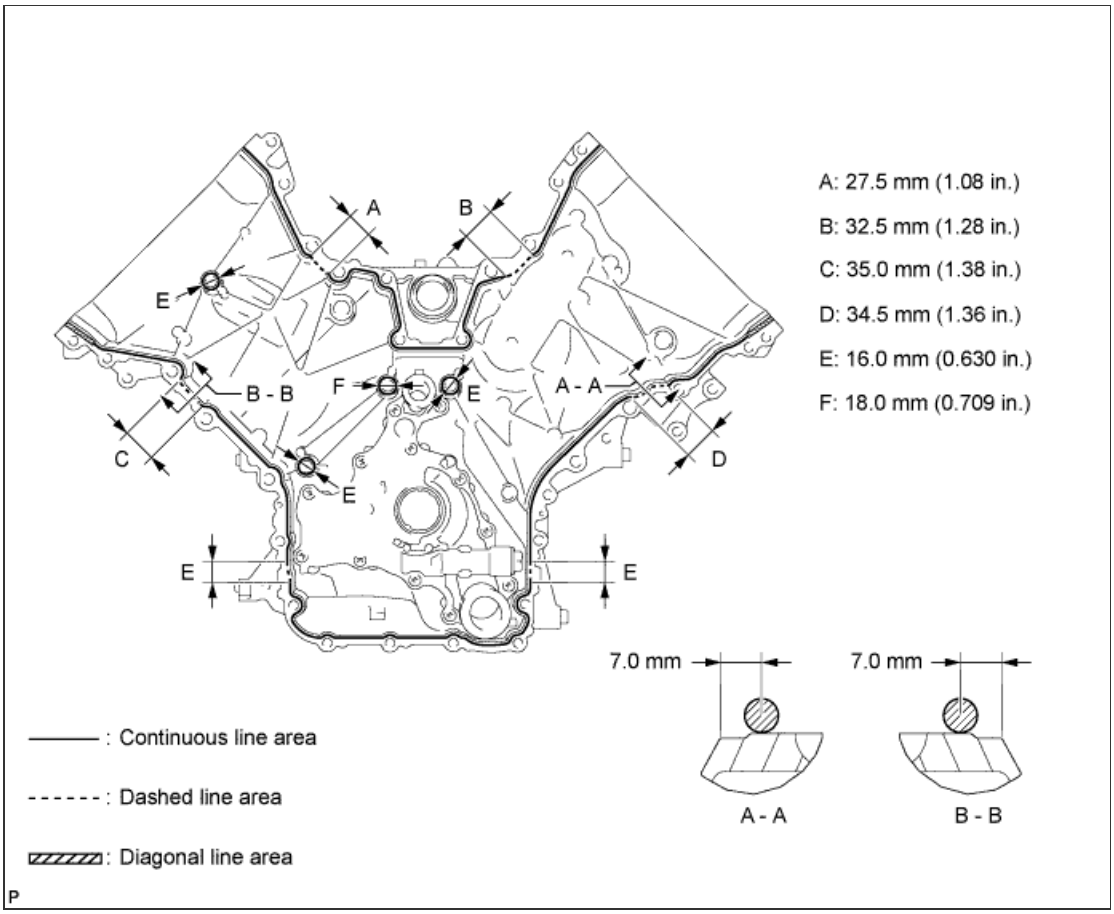


c. Apply a light coat of engine oil to a new O-ring.

d. Install the O-ring.



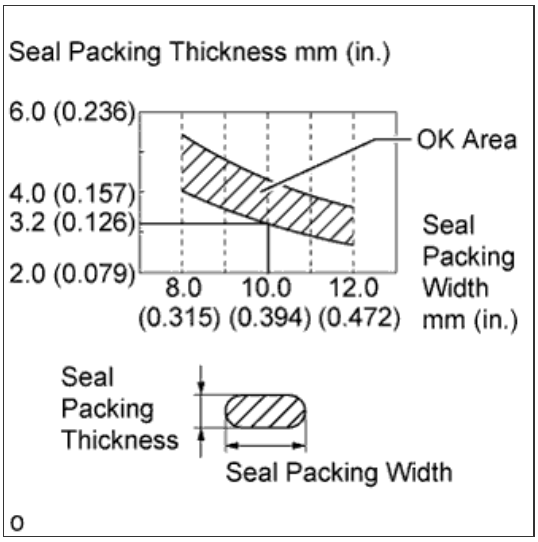
e. Apply seal packing in a continuous line to the timing chain cover as shown in the following illustration.



Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

Apply Seal Packing as Follows:

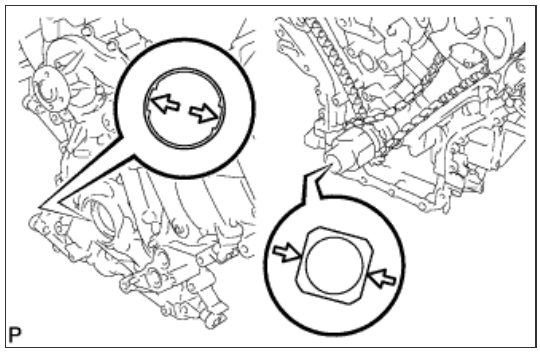
Area	Seal Packing Diameter	Application Position from Inside Edge of Cover
Continuous Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	2.5 mm (0.0984 in.)
Dashed Line Area	6.4 mm (0.252 in.) or more, or within OK area shown in illustration	7.0 mm (0.276 in.)
Diagonal Line Area	3.0 to 4.0 mm (0.118 to 0.157 in.)	5.5 mm (0.217 in.)



NOTICE:

- **When the contact surfaces are wet, wipe them with an oil-free cloth before applying seal packing.**
- **Install the chain cover within 3 minutes and tighten the bolts within 10 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after installing.**

f. Align the oil pump drive rotor spline and crankshaft as shown in the illustration.
Install the spline and chain cover to the crankshaft.



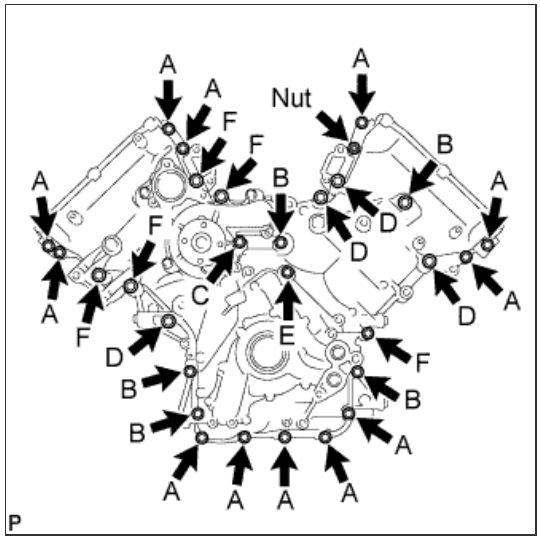
g. Temporarily install the timing chain cover with the 28 bolts and nut.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	25 mm (0.984 in.)	8 mm (0.315 in.)
Bolt B	55 mm (2.17 in.)	8 mm (0.315 in.)
Bolt C	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt D	35 mm (1.38 in.)	10 mm (0.394 in.)
Bolt E	55 mm (2.17 in.)	10 mm (0.394 in.)
Bolt F	80 mm (3.15 in.)	10 mm (0.394 in.)

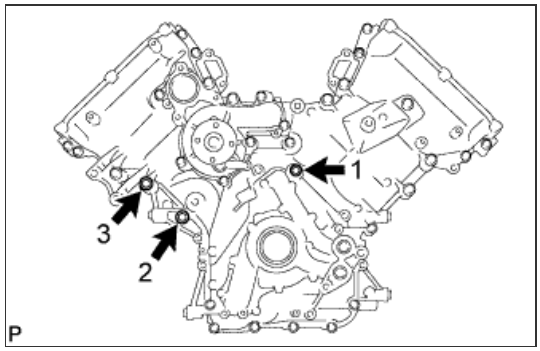
NOTICE:

Make sure that there is no oil on the bolt threads.



h. Tighten the 3 bolts in several steps in the sequence shown in the illustration.

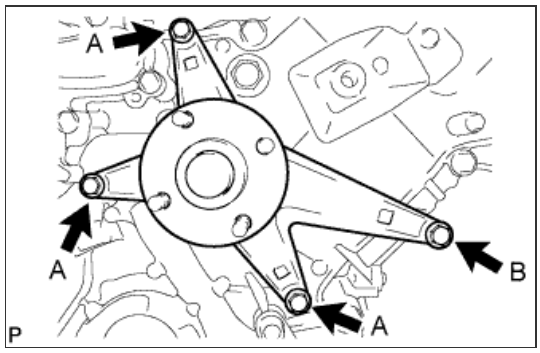
Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



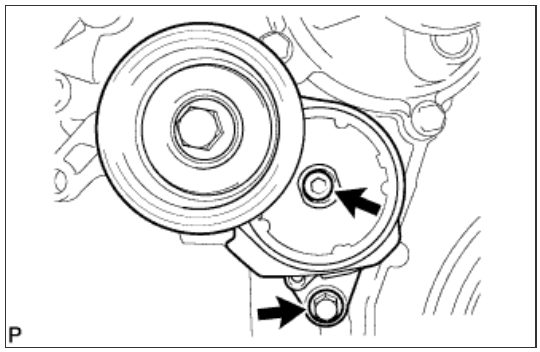
i. Temporarily install the fluid coupling bracket with the 4 bolts.

Standard Bolt:

Item	Length	Thread Diameter
Bolt A	70 mm (2.76 in.)	8 mm (0.315 in.)
Bolt B	80 mm (3.15 in.)	10 mm (0.394 in.)

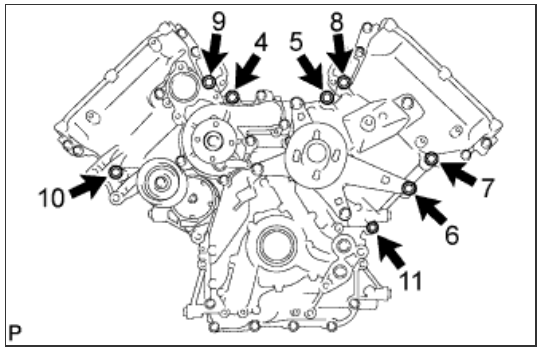


j. Temporarily install the belt tensioner with the standard bolt and 6 mm hexagon wrench bolt.



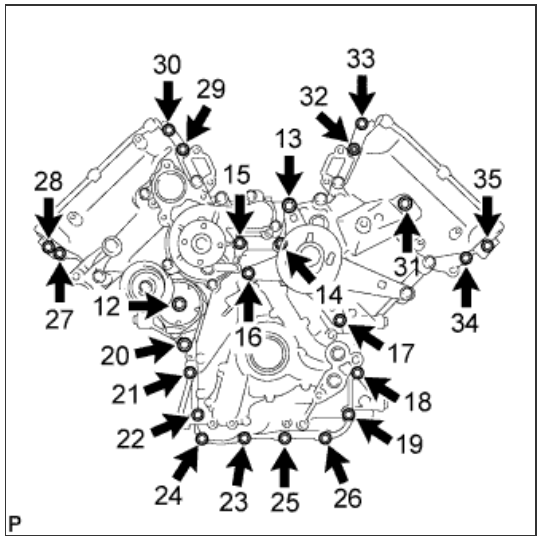
k. Tighten the 8 bolts labeled 4 to 11 in several steps in the sequence shown in the illustration.

Torque:
47 N*m{ 479 kgf*cm , 35 ft.*lbf }



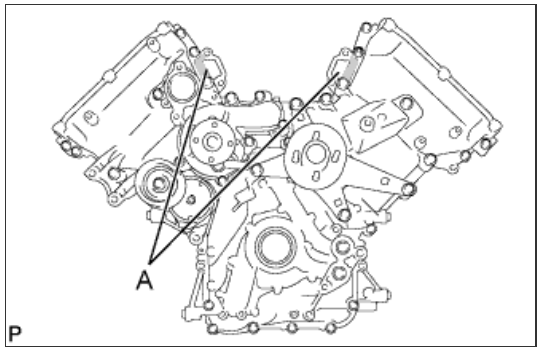
l. Tighten the 23 bolts and nut labeled 12 to 35 in several steps in the sequence shown in the illustration.

Torque:
23 N*m{ 235 kgf*cm , 17 ft.*lbf }



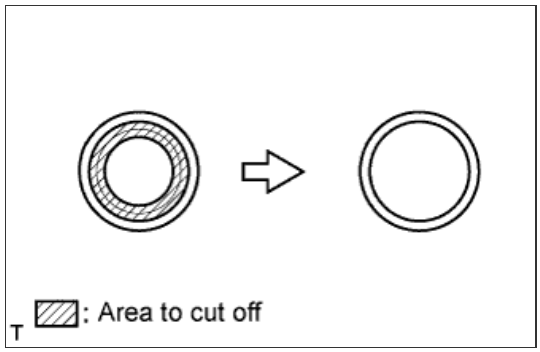
NOTICE:

After the installation, if the seal packing has seeped out at the areas labeled A shown in the illustration, wipe it off.



3. INSTALL SPARK PLUG TUBE GASKET

a. Using a cutter knife, cut off the seal part of the removed gasket.



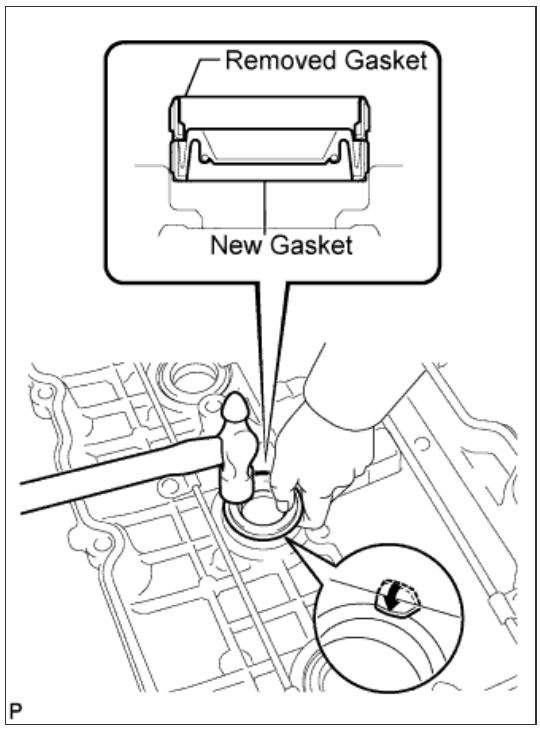
b. Using the removed gasket and a hammer, tap in a new gasket until it stops.

HINT:

If the removed gasket does not fit on the new one, correct the removed one with pliers.

c. Apply a light coat of MP grease to the lip of the gasket.

d. Return the 4 ventilation baffle plate claws to the original positions.



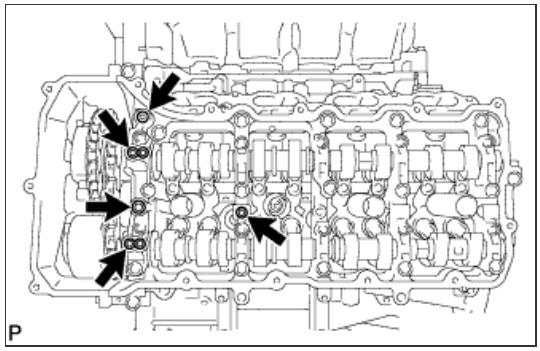
4. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY LH

a. Install 5 new gaskets to the camshaft bearing caps (No. 2, No. 3).

b. Install a new gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

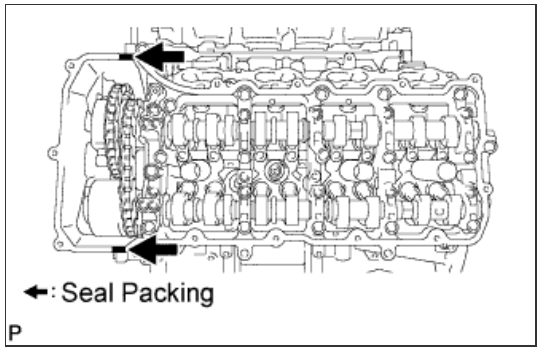


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

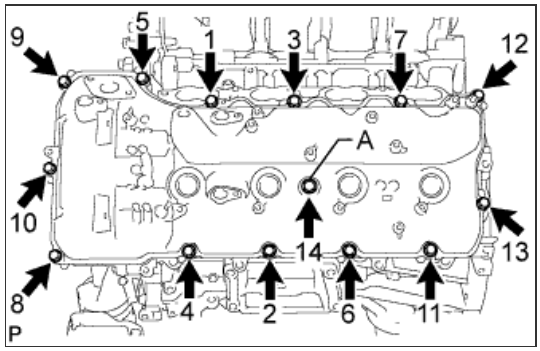
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



d. Install the cylinder head cover and a new seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



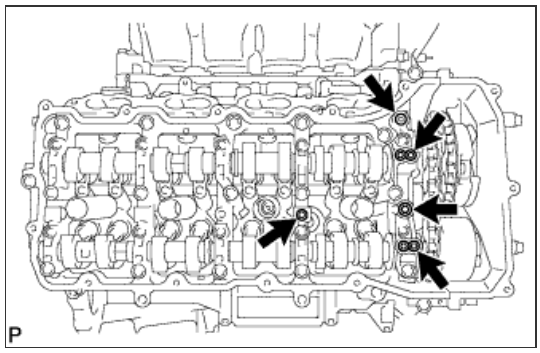
5. INSTALL CYLINDER HEAD COVER SUB-ASSEMBLY RH

a. Install 5 new gaskets to the camshaft bearing caps. (No. 1, No. 3).

b. Install a new gasket to the cylinder head cover.

NOTICE:

Remove any oil from the contact surface.

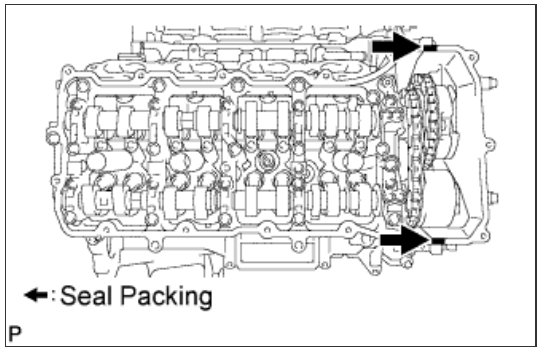


c. Apply seal packing as shown in the illustration.

Seal packing:
Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent

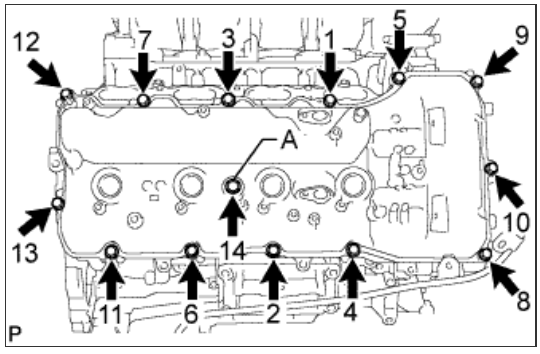
NOTICE:

- **Remove any oil from the contact surface.**
- **Install the cylinder head cover within 3 minutes and tighten the bolts within 15 minutes after applying seal packing.**
- **Do not start the engine for at least 2 hours after the installation.**



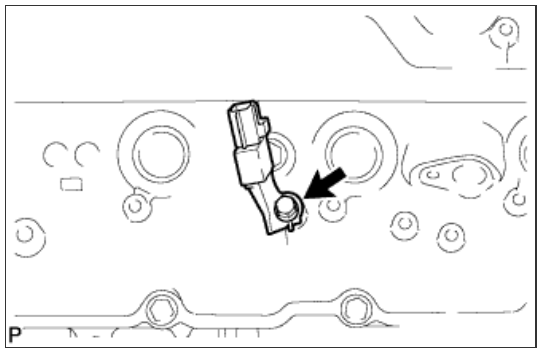
d. Install the cylinder head cover and a new seal washer with the 14 bolts in the order shown in the illustration.

Torque:
for bolt A:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }
except bolt A:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



e. Install the noise filter to the cylinder head cover with the bolt.

Torque:
7.0 N*m{ 71 kgf*cm , 62 in.*lbf }



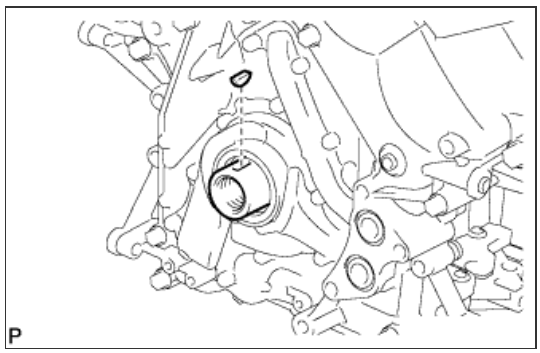
6. INSTALL IGNITION COIL ASSEMBLY

a. Install the 8 ignition coils with the 8 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

7. INSTALL CRANKSHAFT TIMING GEAR KEY

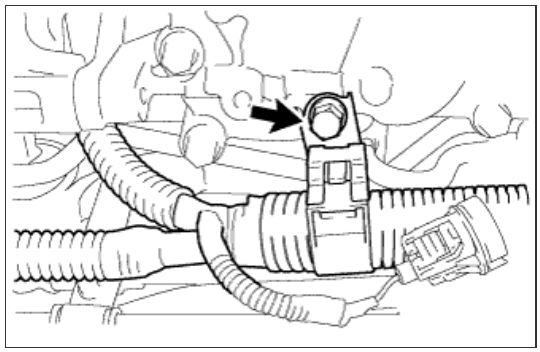
a. Install the crankshaft timing gear key to the crankshaft.



8. CONNECT WIRE HARNESS CLAMP BRACKET

a. Connect the bracket to the timing chain cover with the bolt.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



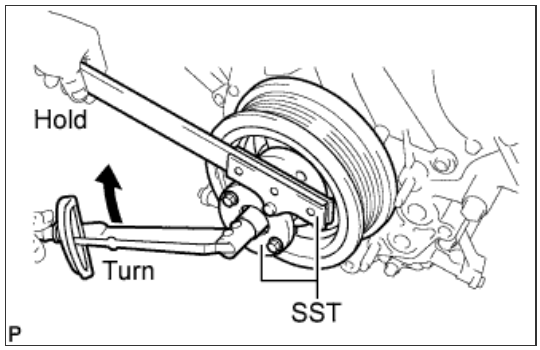
9. INSTALL CRANKSHAFT PULLEY

a. Align the pulley set key with the key groove of the pulley, and slide on the pulley.

b. Using SST, install the pulley set bolt.

SST
09213-70011 (09213-70020)
09330-00021

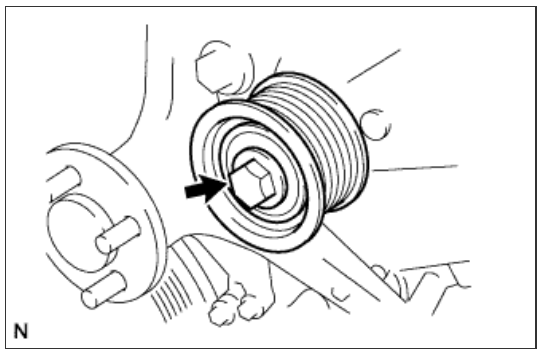
Torque:
300 N*m{ 3059 kgf*cm , 221 ft.*lbf }



10. INSTALL NO. 1 IDLER PULLEY SUB-ASSEMBLY

a. Install the idler pulley with the bolt.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



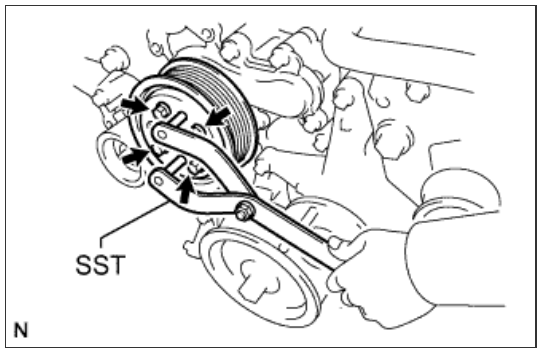
11. INSTALL WATER PUMP PULLEY

a. Temporarily install the pulley with the 4 bolts.

b. Using SST, hold the pulley and tighten the 4 bolts.

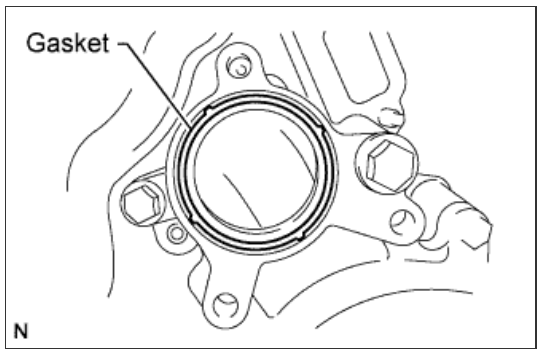
SST
09960-10010 (09962-01000, 09963-01000)

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



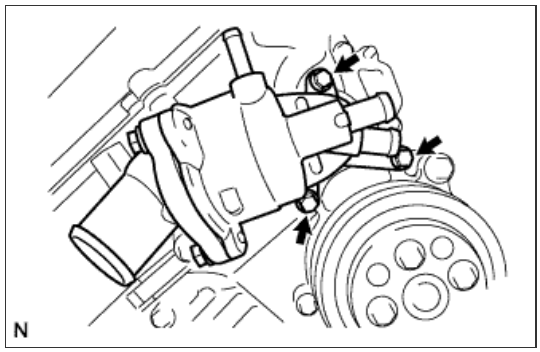
12. INSTALL WATER INLET HOUSING

a. Install a new gasket to the timing chain cover.



b. Install the water inlet with the 3 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

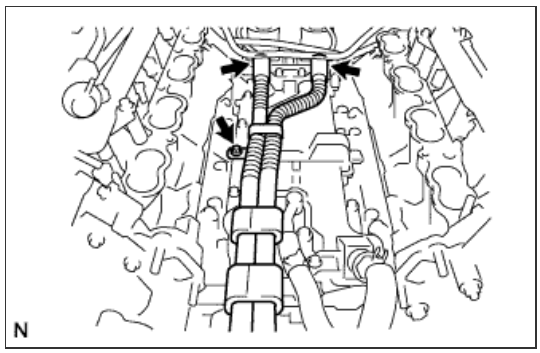


13. INSTALL AIR PIPE SUB-ASSEMBLY (w/ Secondary Air Injection System)

a. Connect the 2 hoses.

b. Install the air pipe with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



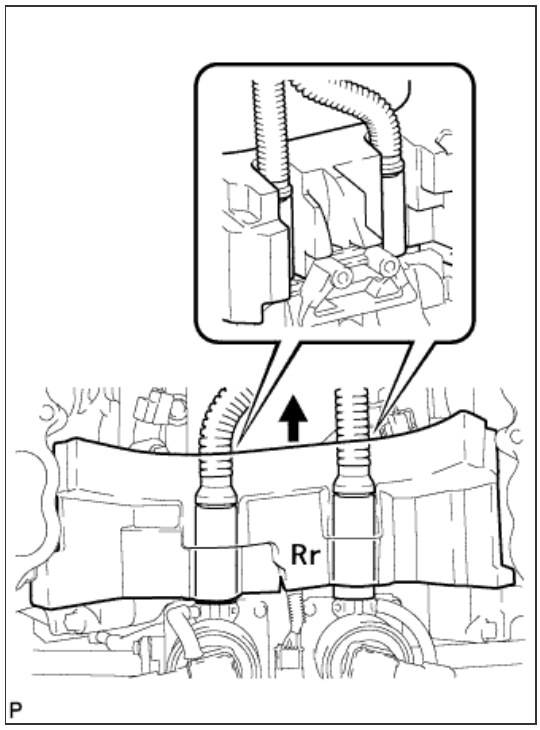
14. INSTALL NO. 1 ENGINE COVER

HINT:

- **Align the No. 1 engine cover cutouts with the air tube.**
- **Align the No. 1 engine cover with the air switching valve surface and cylinder head wall.**

NOTICE:

Make sure that the No. 1 engine cover is flush with the top surface of the intake port of the cylinder head for bank 1 and bank 2.



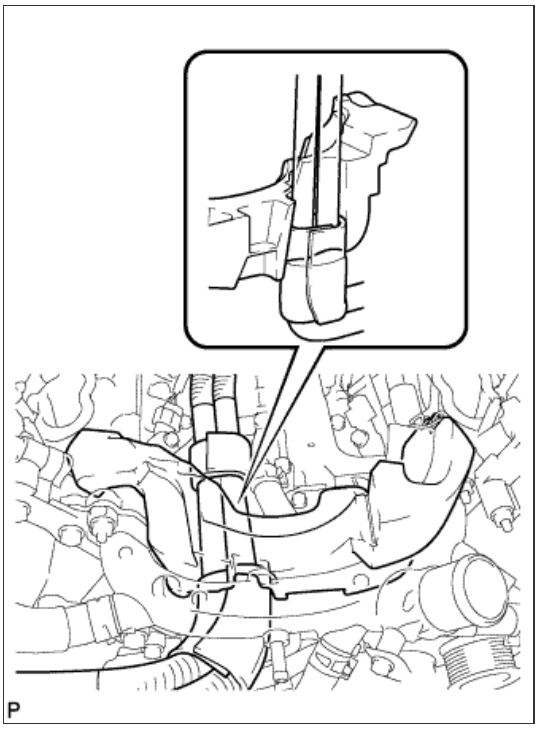
15. INSTALL NO. 2 ENGINE COVER

HINT:

- **Align the No. 2 engine cover cutout with the air tube.**
- **Align the No. 2 engine cover with the front water by-pass joint and cylinder head wall.**

NOTICE:

Make sure that the No. 2 engine cover is flush with the top surface of the intake port of the cylinder head.

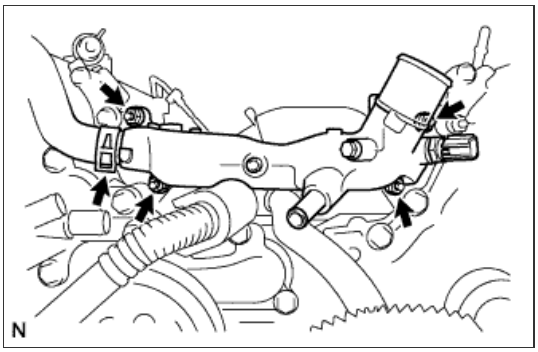


16. INSTALL FRONT WATER BY-PASS JOINT

a. Install 2 new gaskets and the water by-pass joint with the 4 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

b. Connect the No. 2 water by-pass hose to the water by-pass joint.

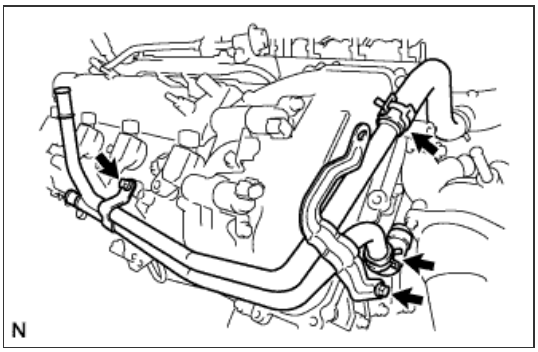


17. INSTALL WATER BY-PASS PIPE SUB-ASSEMBLY

a. Connect the 2 hoses.

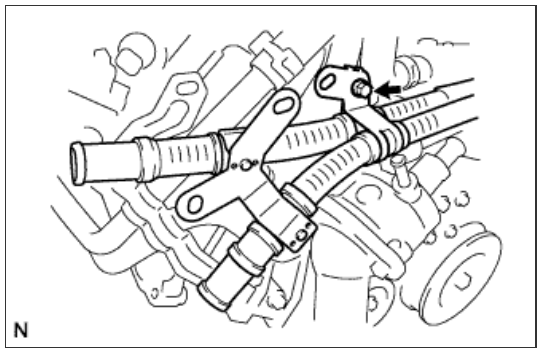
b. Install the water by-pass pipe with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



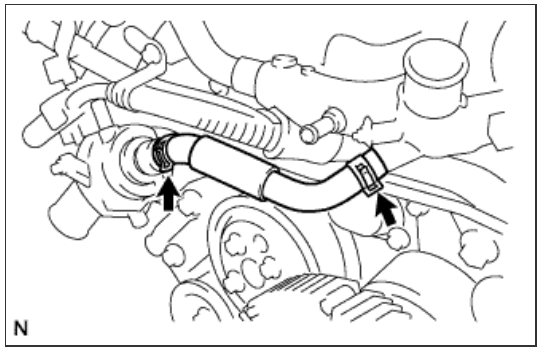
c. w/ Secondary Air Injection System:
Connect the air tube with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



18. INSTALL NO. 1 WATER BY-PASS HOSE

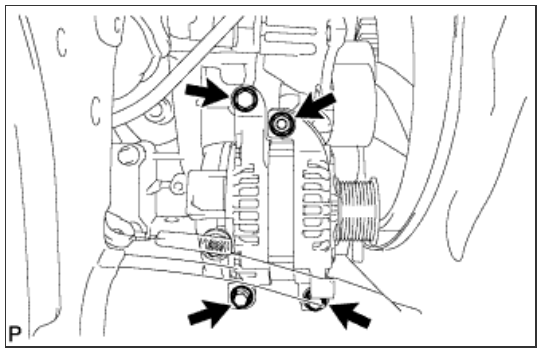
a. Install the No. 1 water by-pass hose by connecting the hose to the water inlet housing and front water by-pass joint.



19. INSTALL GENERATOR ASSEMBLY

a. Install the generator with the 3 bolts and nut.

Torque:
43 N*m{ 438 kgf*cm , 32 ft.*lbf }



b. Connect the generator connector.

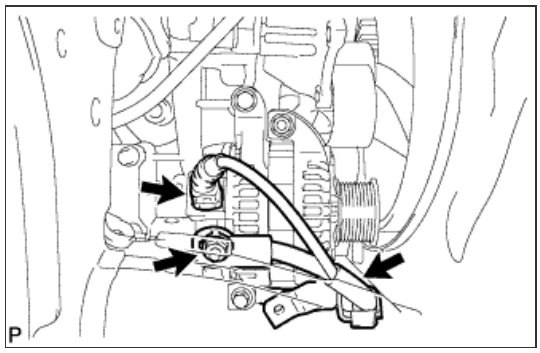
c. Connect the generator wire with the nut.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }

d. Install the terminal cap.

e. Install the harness bracket to the generator with the bolt.

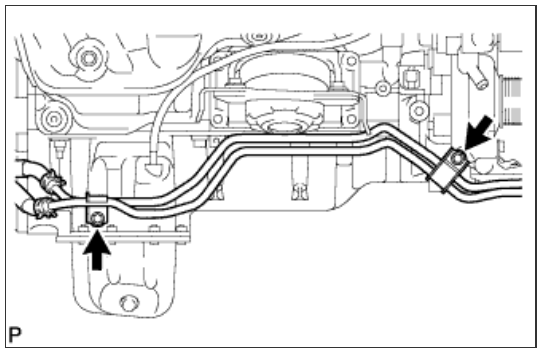
Torque:
31 N*m{ 316 kgf*cm , 23 ft.*lbf }



20. CONNECT OIL COOLER PIPE ASSEMBLY

a. Connect the oil cooler pipe with the 2 bolts.

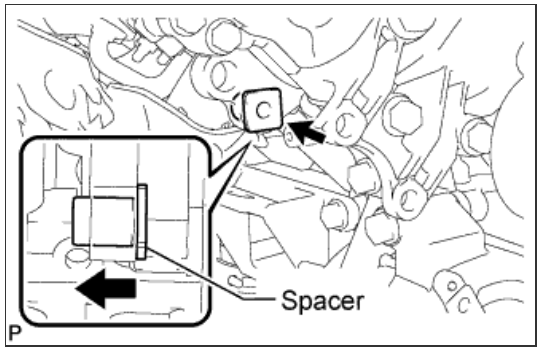
Torque:
14 N*m{ 143 kgf*cm , 10 ft.*lbf }



21. CONNECT VANE PUMP ASSEMBLY

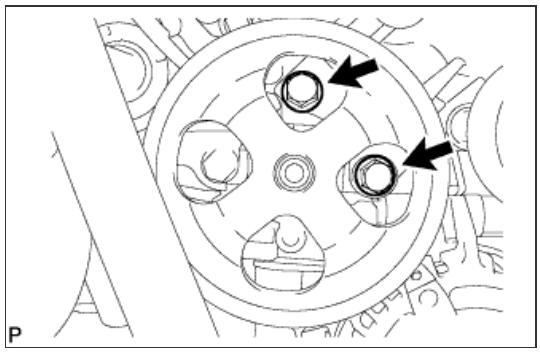
HINT:

Before performing the following procedures, move the spacer until the vane pump can be installed.

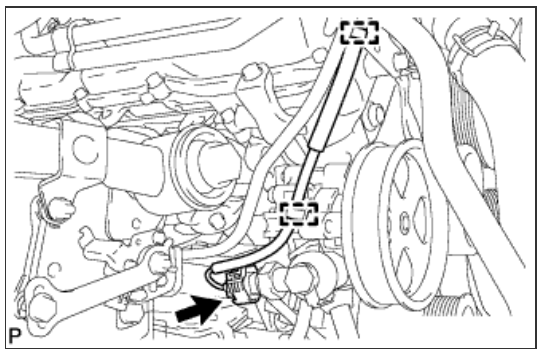


a. Connect the vane pump to the timing chain cover with the 2 bolts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



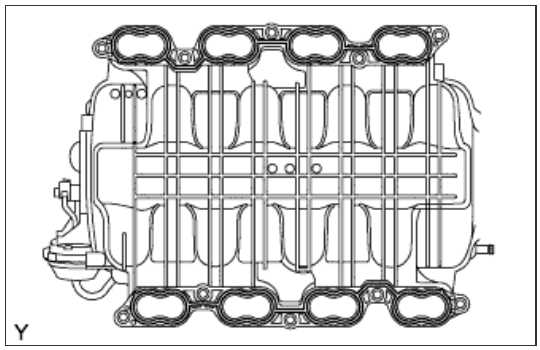
b. Connect the 2 clamps and power steering oil pressure switch connector.



22. INSTALL INTAKE MANIFOLD

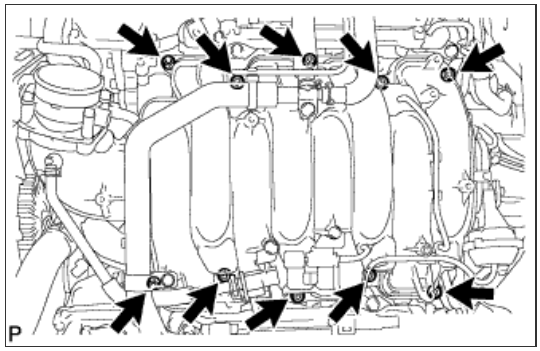
a. Place 2 new gaskets on the intake manifold.

b. Place the intake manifold on the cylinder head.



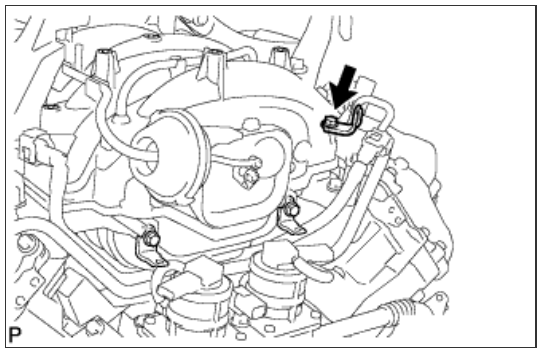
c. Install and uniformly tighten the 8 bolts and 2 nuts in several steps.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

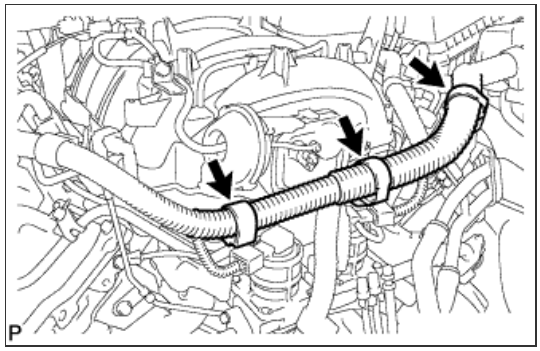


d. Install the wire bracket to the intake manifold with the bolt.

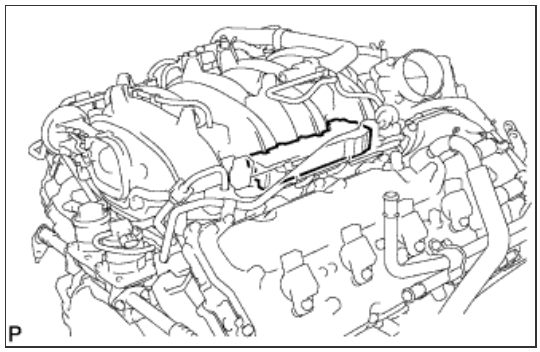
Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }



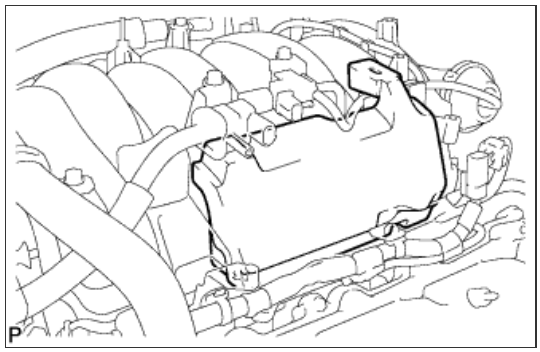
e. Connect the 3 wire clamps to the 3 wire brackets.



f. Install the No. 3 engine cover.



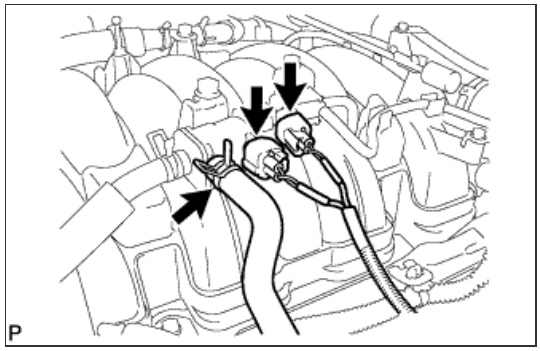
g. Install the No. 1 engine cover sub-assembly.



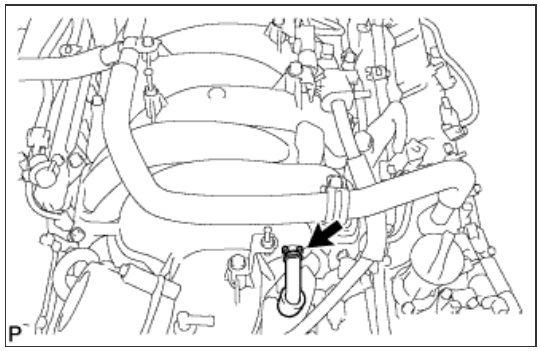
h. Connect the purge VSV connector.

i. Connect the purge line hose to the purge VSV.

j. Connect the vacuum switching valve connector (for ACIS).

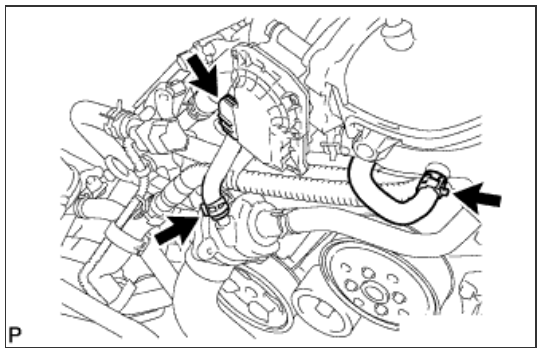


k. Connect the No. 1 ventilation hose.

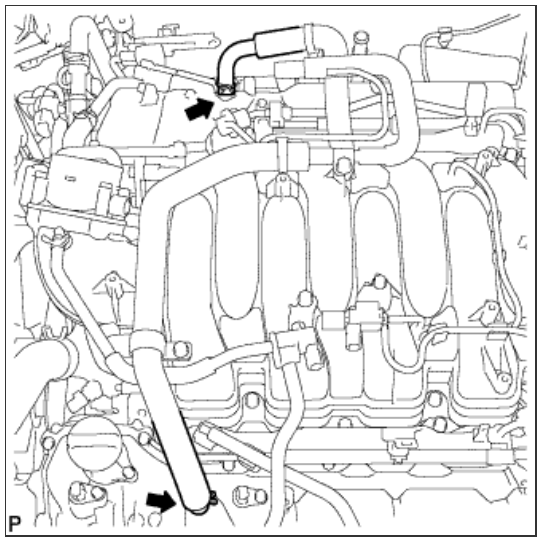


l. Connect the 2 water by-pass hoses.

m. Connect the throttle body connector.



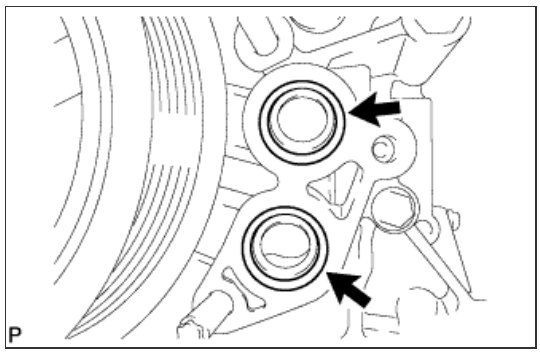
n. Connect the ventilation hose to the ventilation pipe of the cylinder head cover LH and RH.



23. INSTALL OIL FILTER BRACKET (w/o Oil Cooler)

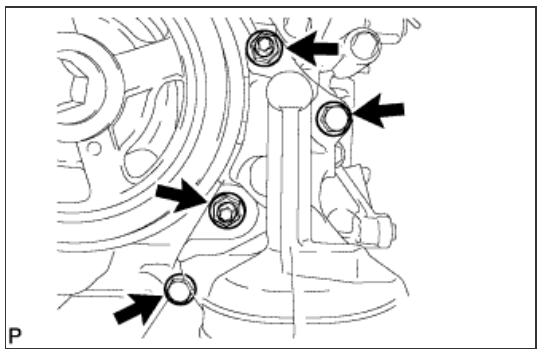
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 bolts and 2 nuts.

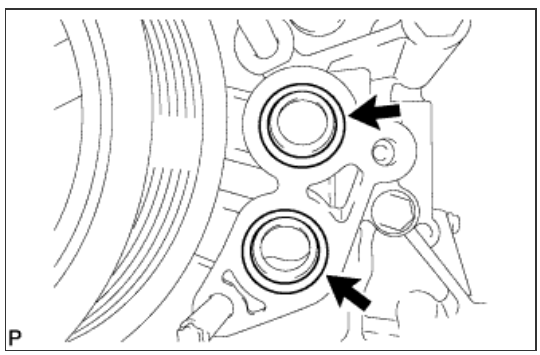
Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }



24. INSTALL OIL FILTER BRACKET (w/ Oil Cooler)

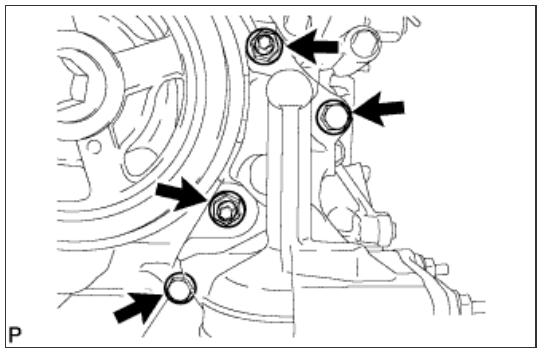
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

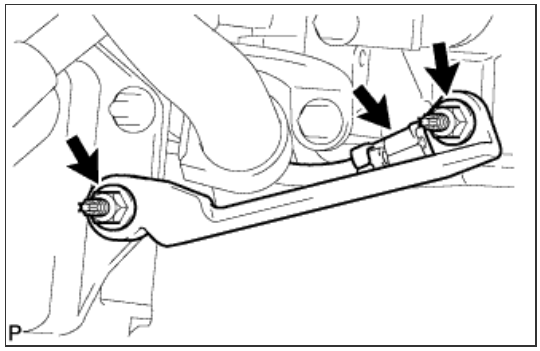


25. INSTALL NO. 1 OIL COOLER BRACKET (w/ Oil Cooler)

a. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

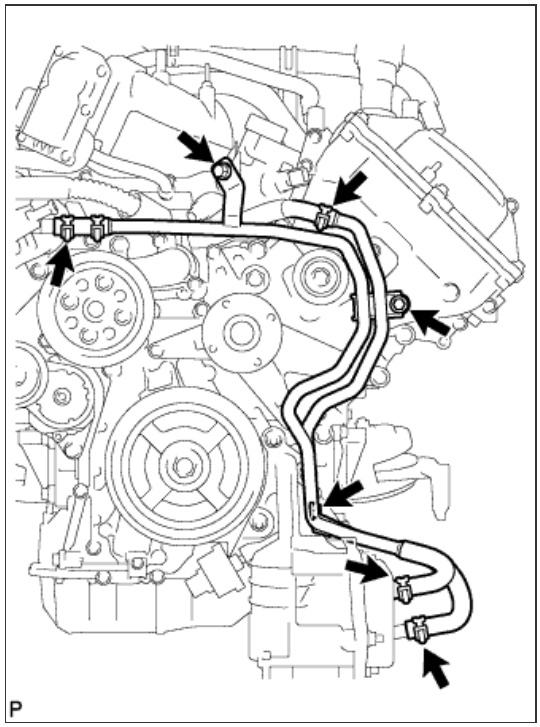


26. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY (w/ Oil Cooler)

a. Connect the 4 hoses.

b. Install the water by-pass pipe with the 3 bolts.

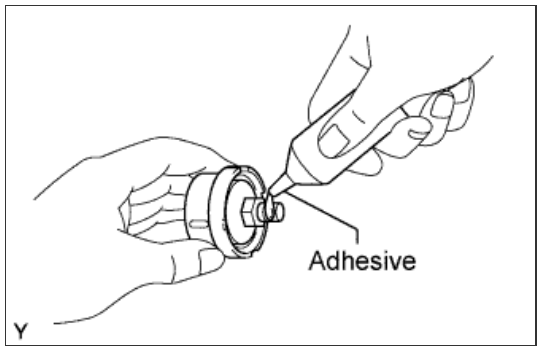
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



27. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

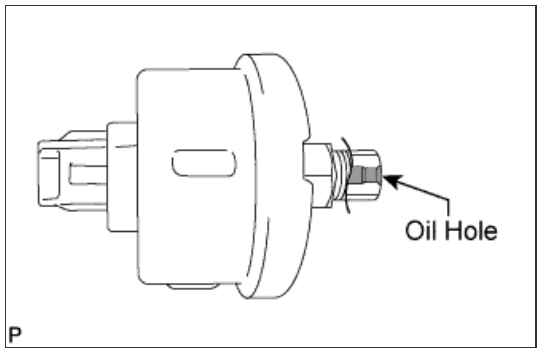
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

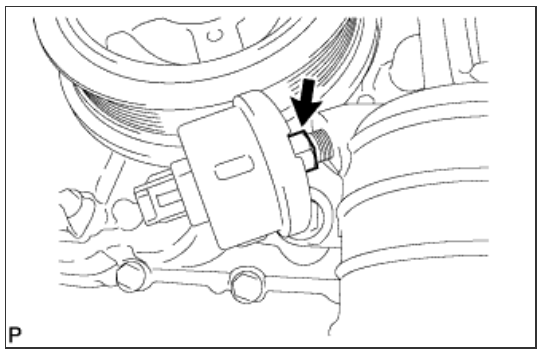


b. Install the oil pressure sender gauge.

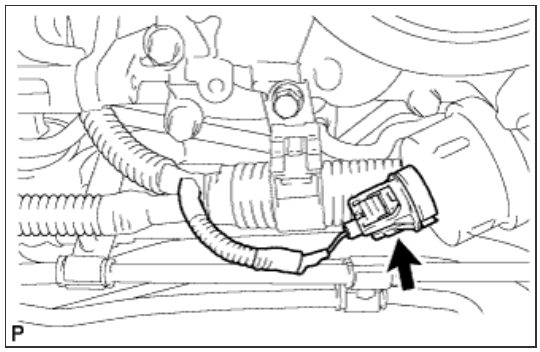
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



28. INSTALL ENGINE OIL LEVEL DIPSTICK GUIDE

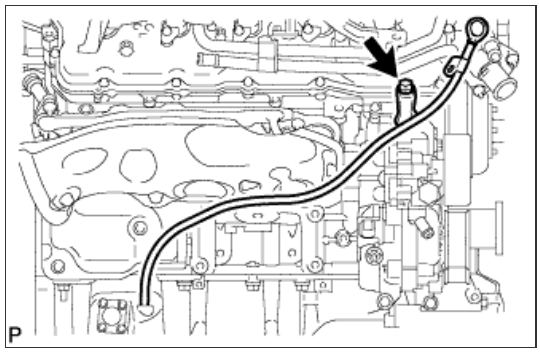
a. Apply a light coat of engine oil to a new O-ring.

b. Install the O-ring to the guide.

c. Install the dipstick guide with the bolt.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

d. Install the dipstick.



29. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

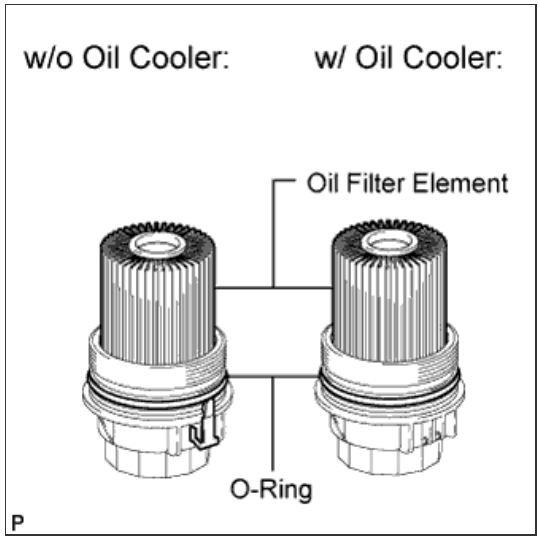
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



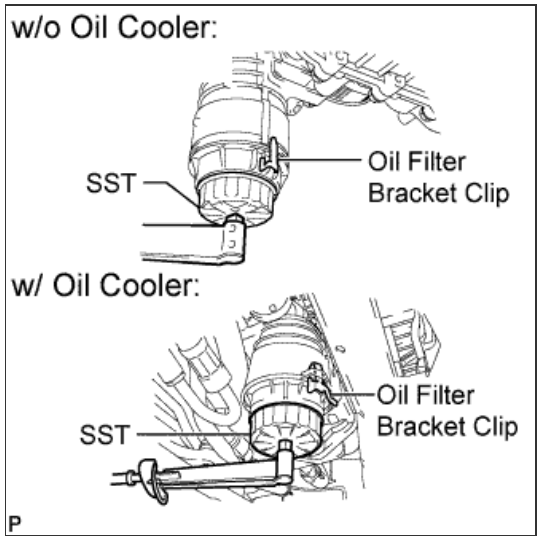
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

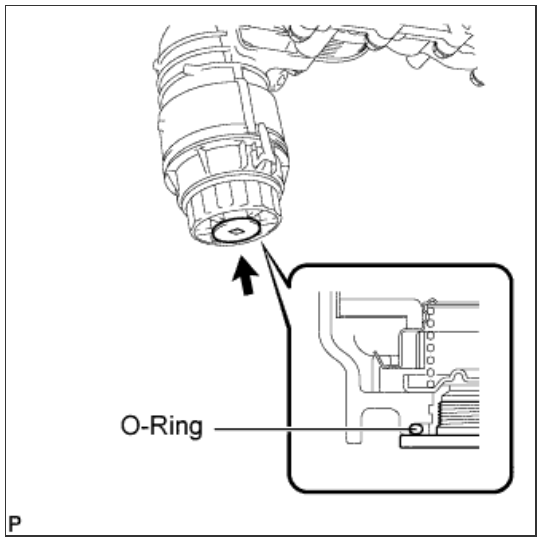
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

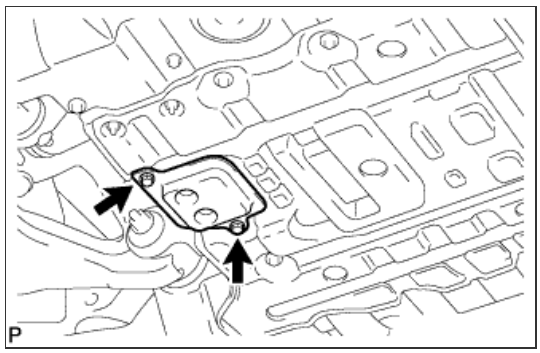
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

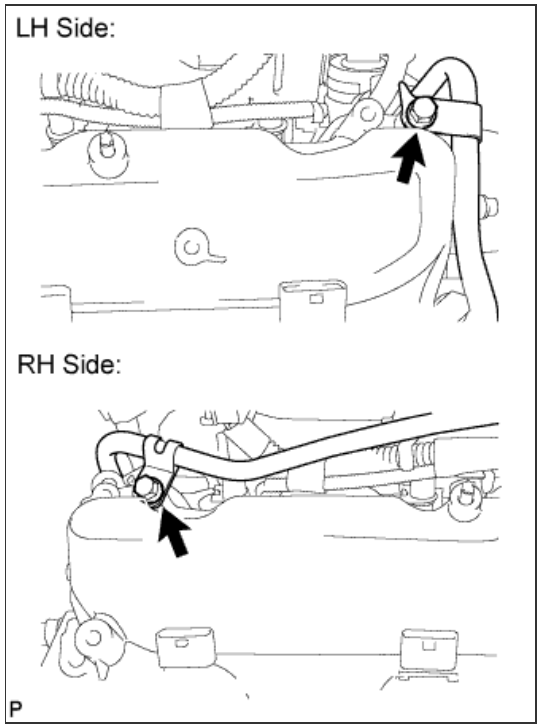
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



30. CONNECT NO. 2 FUEL TUBE SUB-ASSEMBLY

a. Connect the fuel tube with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



31. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

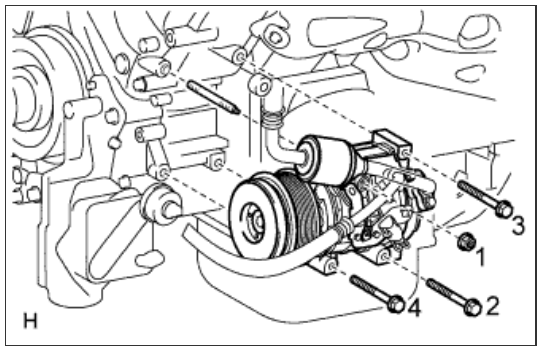
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

NOTICE:

Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.

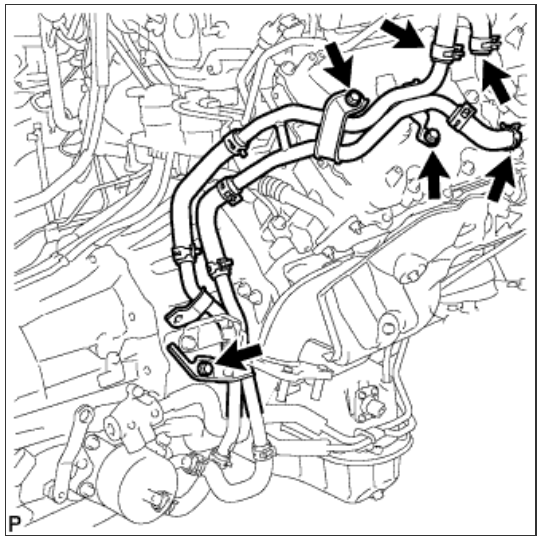


32. CONNECT NO. 2 WATER BY-PASS PIPE

a. Connect the No. 2 water by-pass pipe to the cylinder head cover with the 3 bolts.

Torque:
18 N*m{ 184 kgf*cm , 13 ft.*lbf }

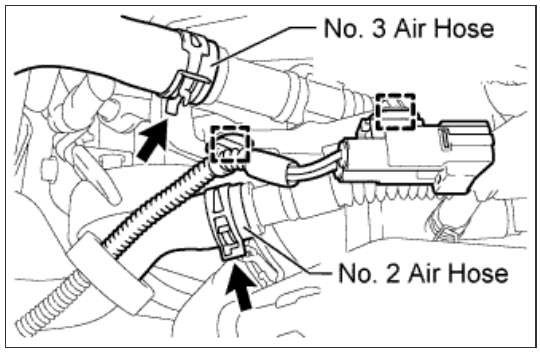
b. Connect the 3 hoses.



33. CONNECT AIR PUMP HOSE AND WIRE HARNESS (w/ Secondary Air Injection System)

a. Connect the No. 2 and No. 3 air hoses.

b. Connect the 2 clamps and air pump wire harness.



34. CONNECT ENGINE WIRE

a. Engine Room RH Side:

i. Connect the 5 clamps.

ii. Connect the throttle position sensor and throttle control motor connector.

iii. w/ Secondary Air Injection System:
Connect the 2 air pump connectors.

iv. Install the ground wire with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

v. Connect the noise filter connector.

vi. Connect the 2 VVT sensor connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

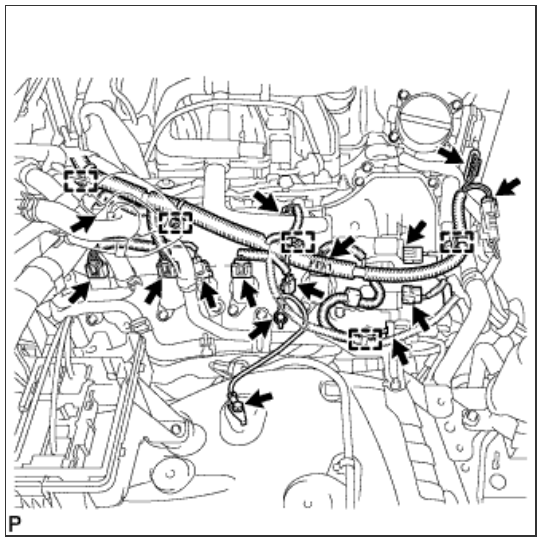
vii. Connect the injector connector.

viii. Connect the 4 ignition coil connectors.

ix. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.



b. Engine Room LH Side:

i. Connect the cooler compressor connector.

ii. Connect the 3 clamps.

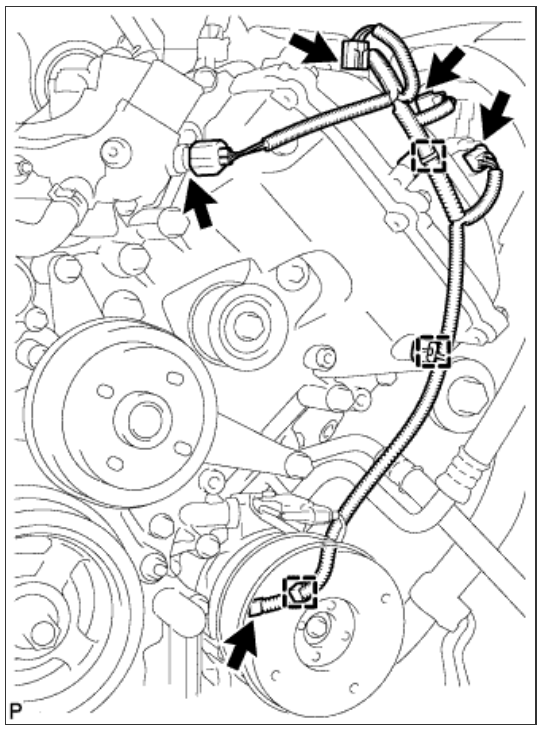
iii. Connect the camshaft position sensor connector.

iv. Connect the 2 camshaft timing oil control valve connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

v. Connect the engine coolant temperature sensor connector.



vi. Connect the 4 clamps.

vii. Install the ground wire with the 2 bolts.

Torque:
8.0 N*m{ 82 kgf*cm , 71 in.*lbf }

viii. Connect the noise filter connector.

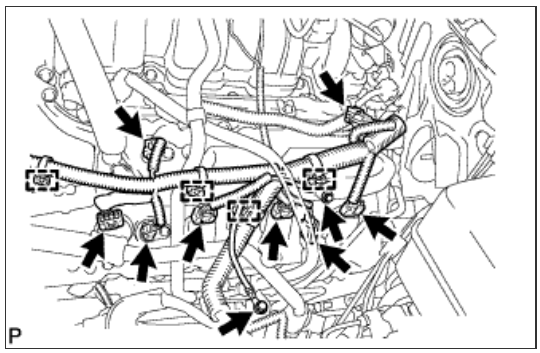
ix. Connect the 2 VVT sensor connectors.

HINT:

The wire harnesses on the exhaust side are wrapped with white tape.

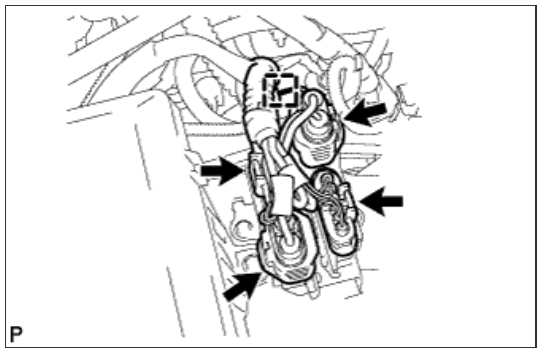
x. Connect the 4 ignition coil connectors.

xi. Connect the injector connector.



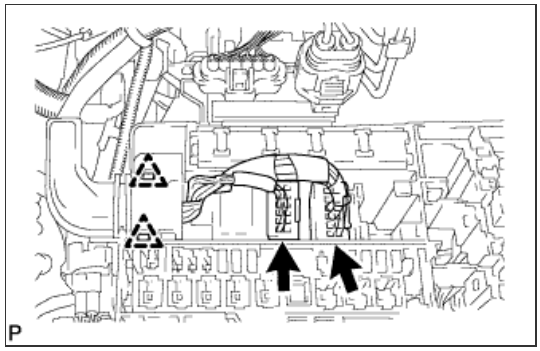
xii. w/ Secondary Air Injection System:

Connect the wire harness clamp and 4 air injection control driver connectors.



xiii. Connect the 2 connectors and 2 clips to the engine room junction block.

xiv. Install the engine room relay block cover.



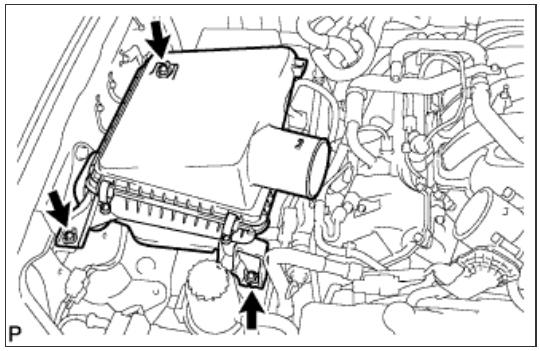
35. INSTALL RADIATOR ASSEMBLY

(Click here)

36. INSTALL AIR CLEANER ASSEMBLY

a. Install the air cleaner with the 3 bolts.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }



37. INSTALL AIR CLEANER HOSE ASSEMBLY

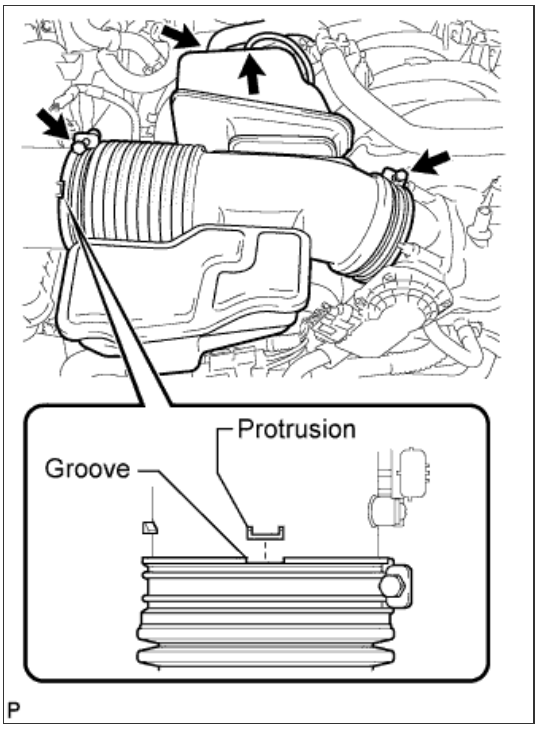
a. Install the air cleaner hose so that the protrusion of the air cleaner cap aligns with the groove of the hose as shown in the illustration.

b. Tighten the 2 clamps.

Torque:
5.0 N*m{ 51 kgf*cm , 44 in.*lbf }

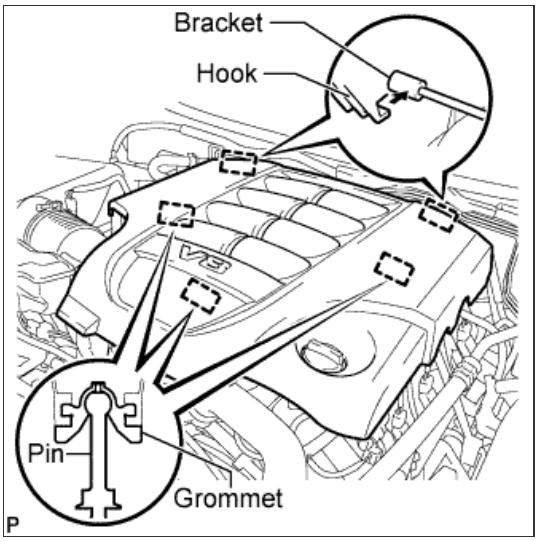
c. Connect the vacuum hose.

d. Connect the No. 2 ventilation hose.



38. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



39. ADD ENGINE OIL

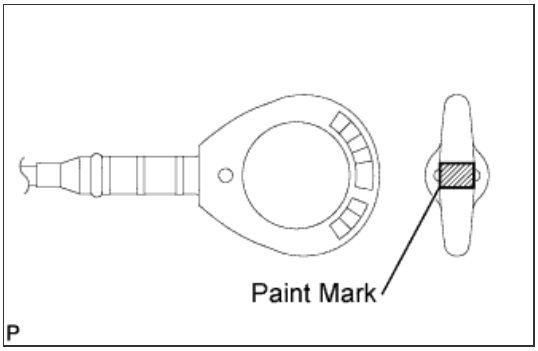
a. Add fresh oil and install the oil filler cap.

Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil API grade SL or SM multigrade engine oil	0W-20 5W-20 5W-30 10W-30 15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
	Drain and refill	7.0 liters (7.4 US



Blue	with oil filter change	qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)

40. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

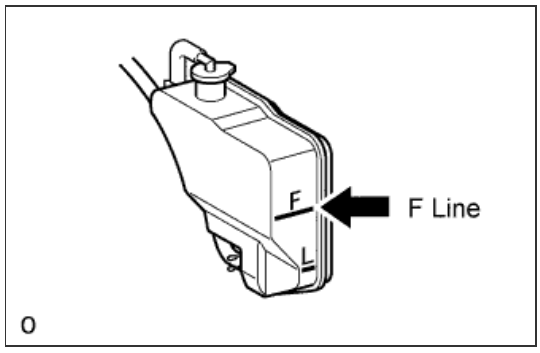
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.**
- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

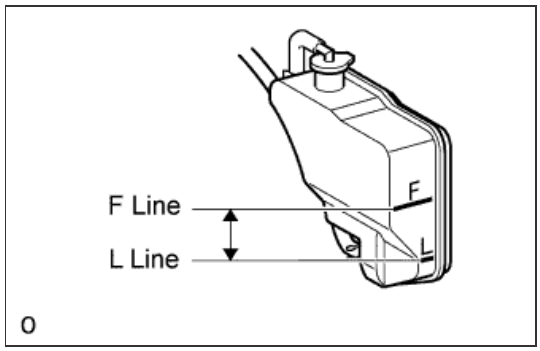
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



41. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

42. INSPECT FOR OIL LEAK

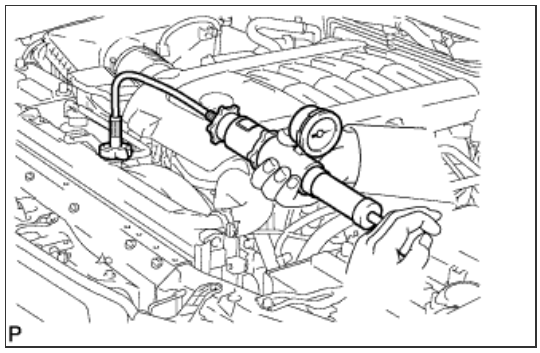
a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

43. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



44. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

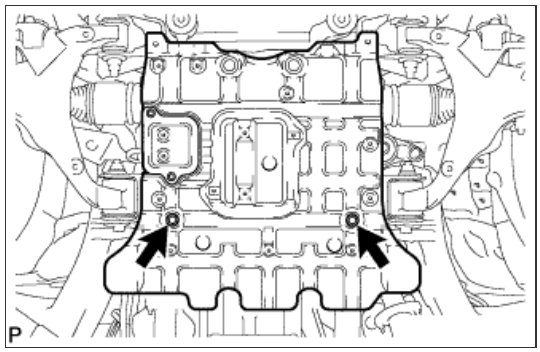
NOTICE:

Do not fill engine oil above the full level mark.

45. INSTALL NO. 2 ENGINE UNDER COVER

a. Install the No. 2 engine under cover with the 2 bolts.

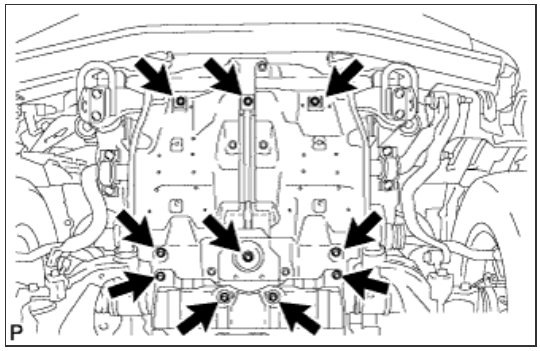
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



46. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

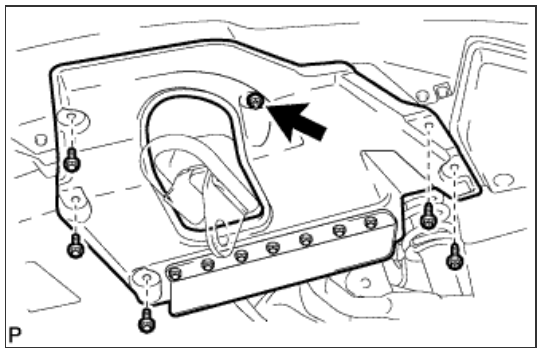
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



47. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



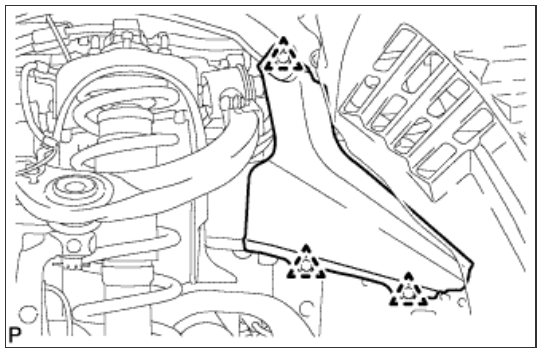
48. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

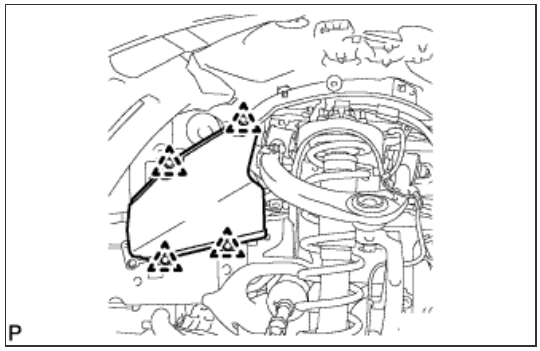
49. INSTALL FRONT FENDER APRON SEAL FRONT RH

a. Install the fender apron seal with the 3 clips.



50. INSTALL FRONT FENDER APRON SEAL FRONT LH

a. Install the fender apron seal with the 4 clips.

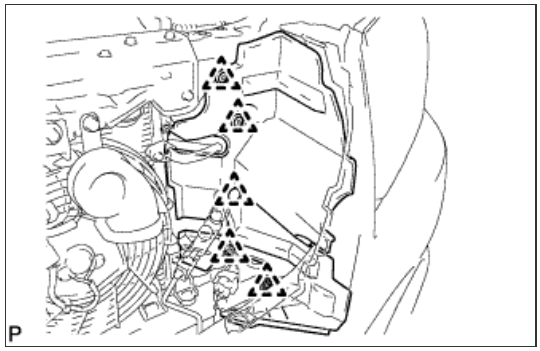


51. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY

(Click here)

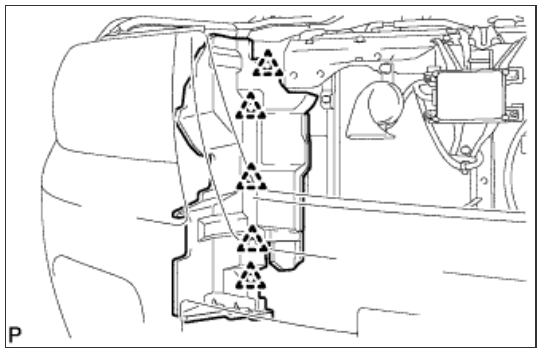
52. CONNECT RADIATOR SIDE DEFLECTOR LH

a. Install the side deflector with the 5 clips.



53. CONNECT RADIATOR SIDE DEFLECTOR RH (w/o Air Cooled Transmission Oil Cooler)

a. Install the side deflector with the 5 clips.



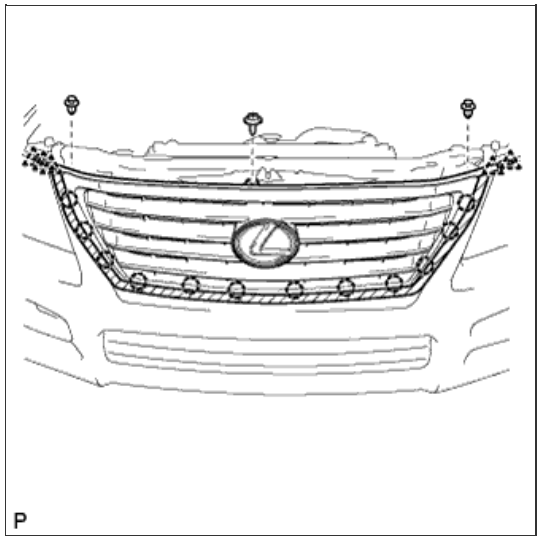
54. INSTALL RADIATOR GRILLE

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

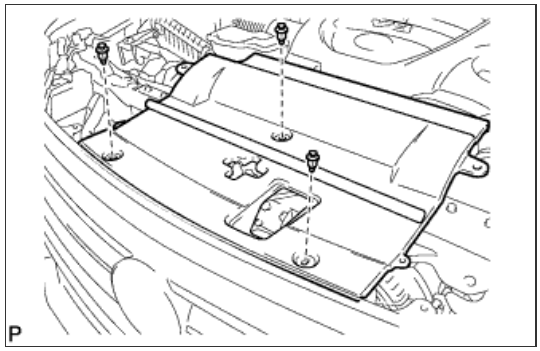
c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



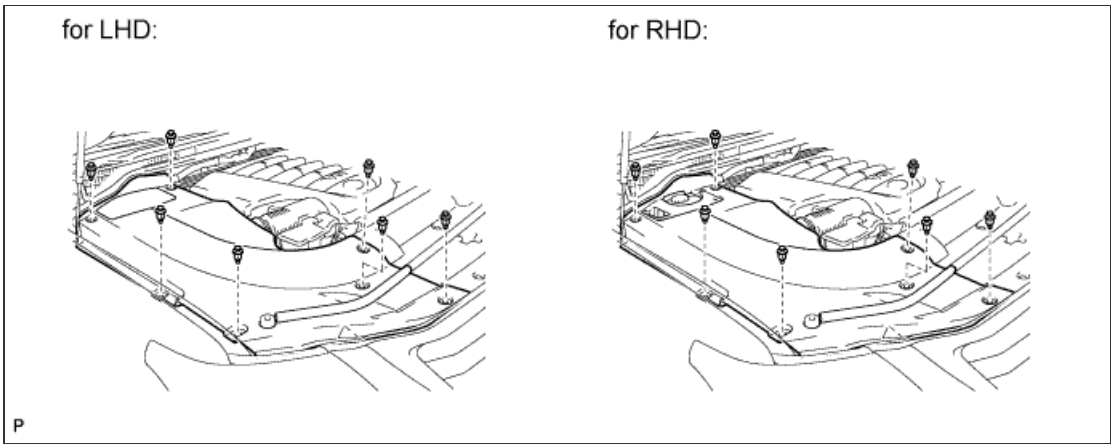
55. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



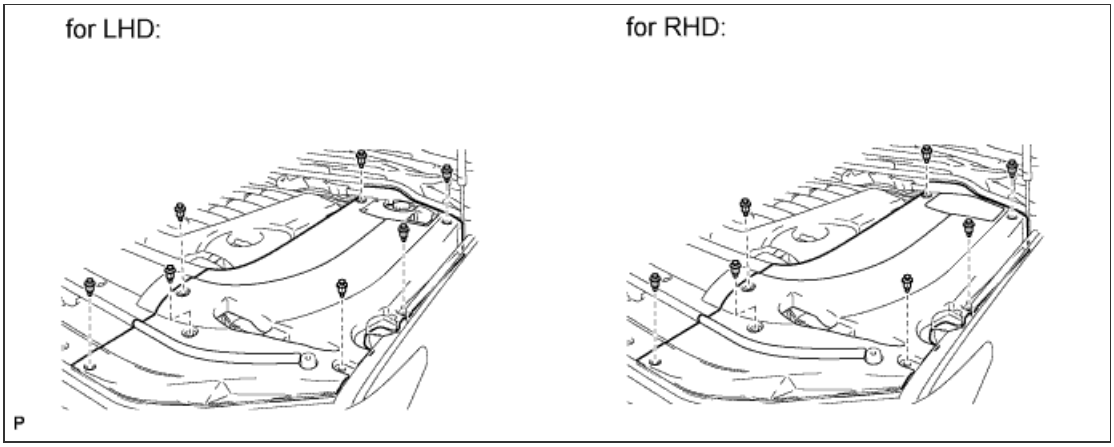
56. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

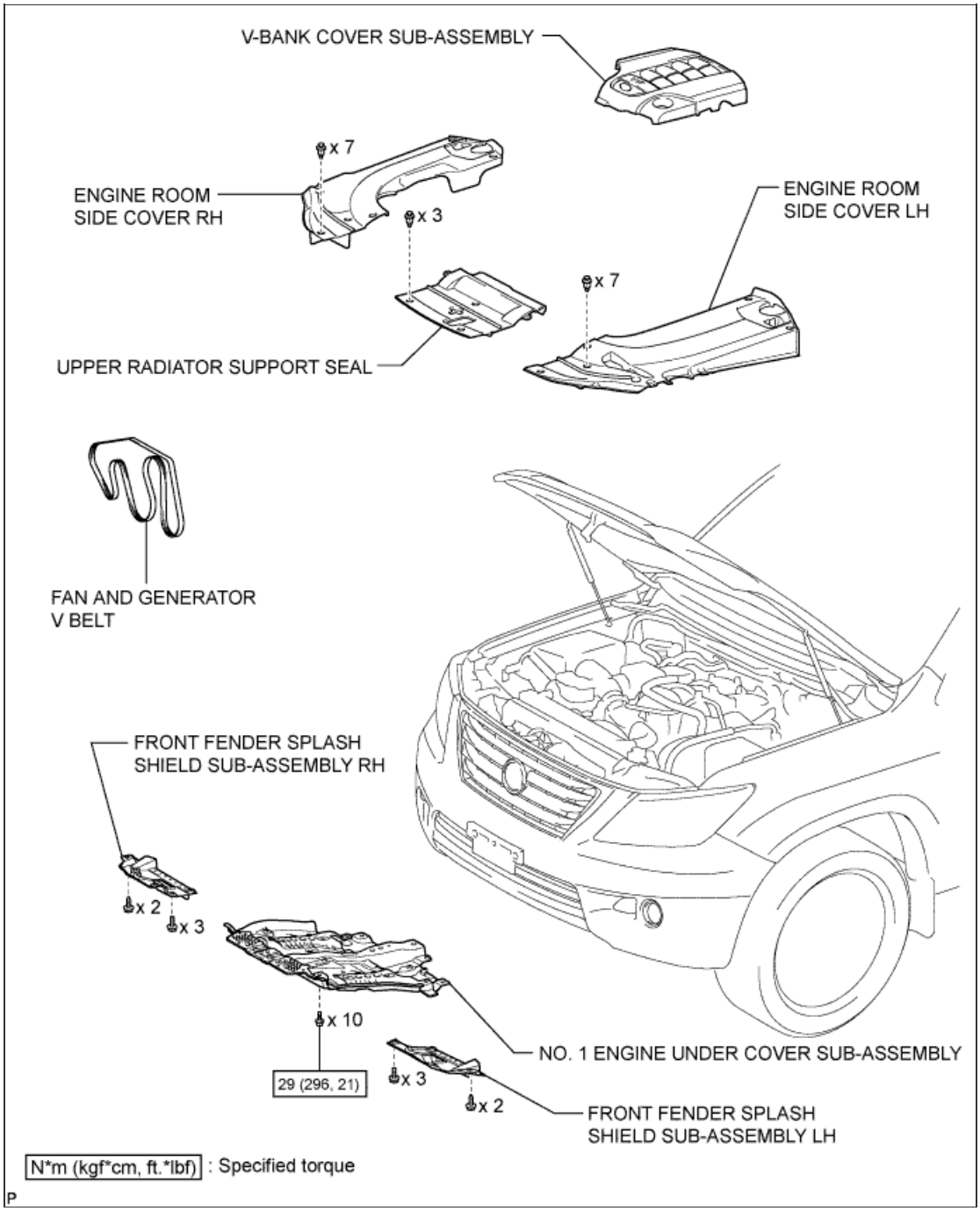


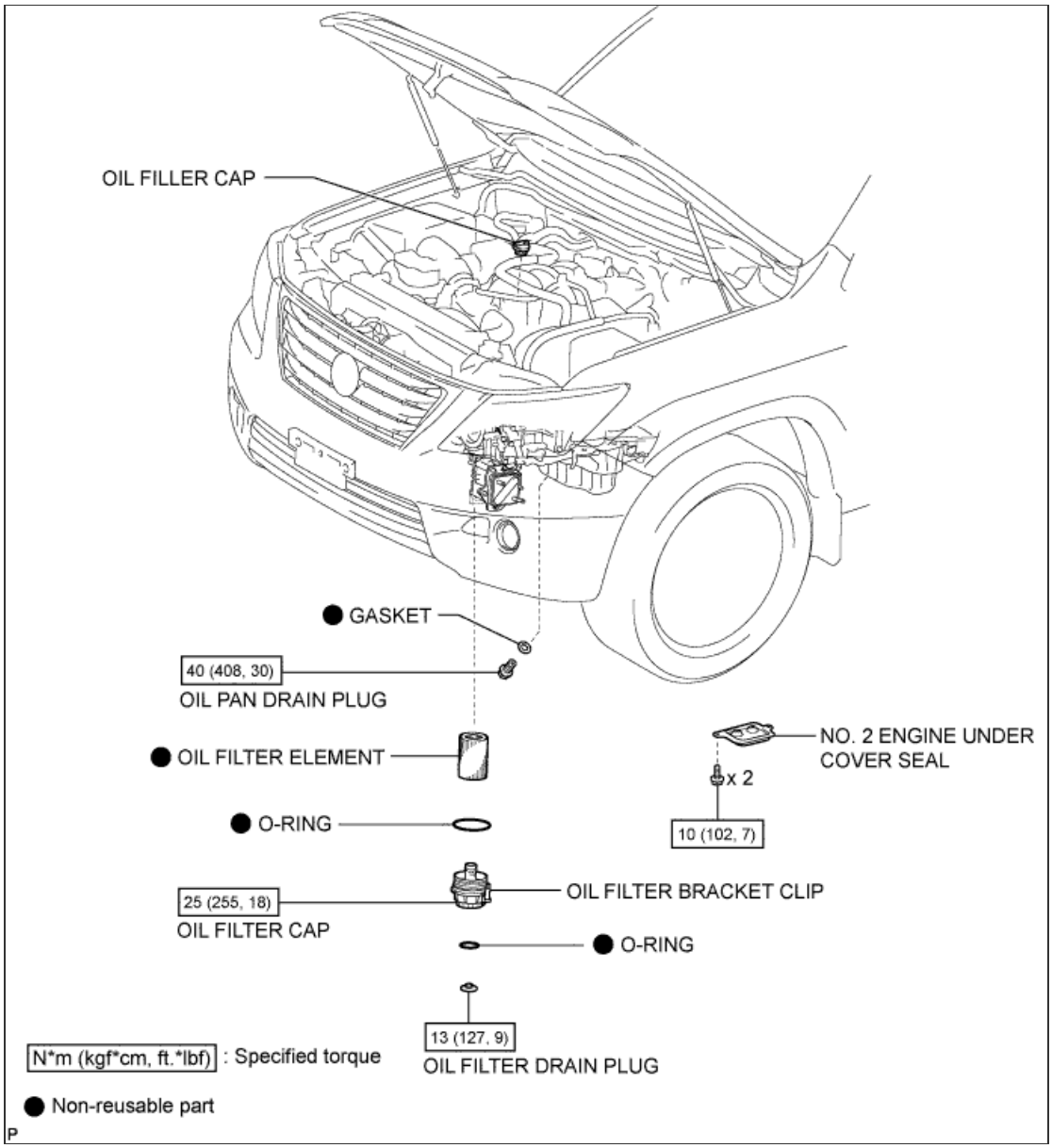
57. INSTALL ENGINE ROOM SIDE COVER LH

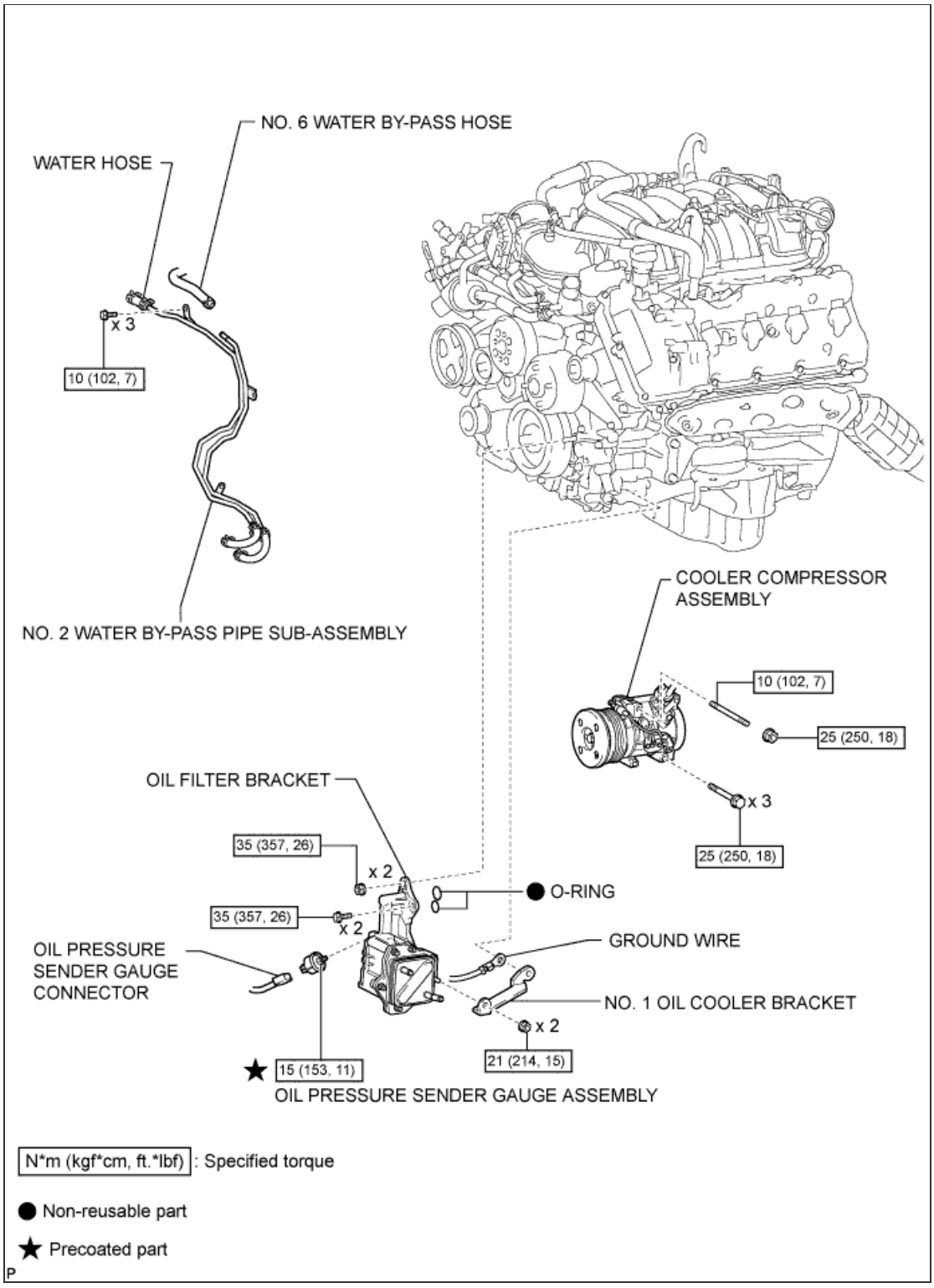
a. Install the engine room side cover with the 7 clips.

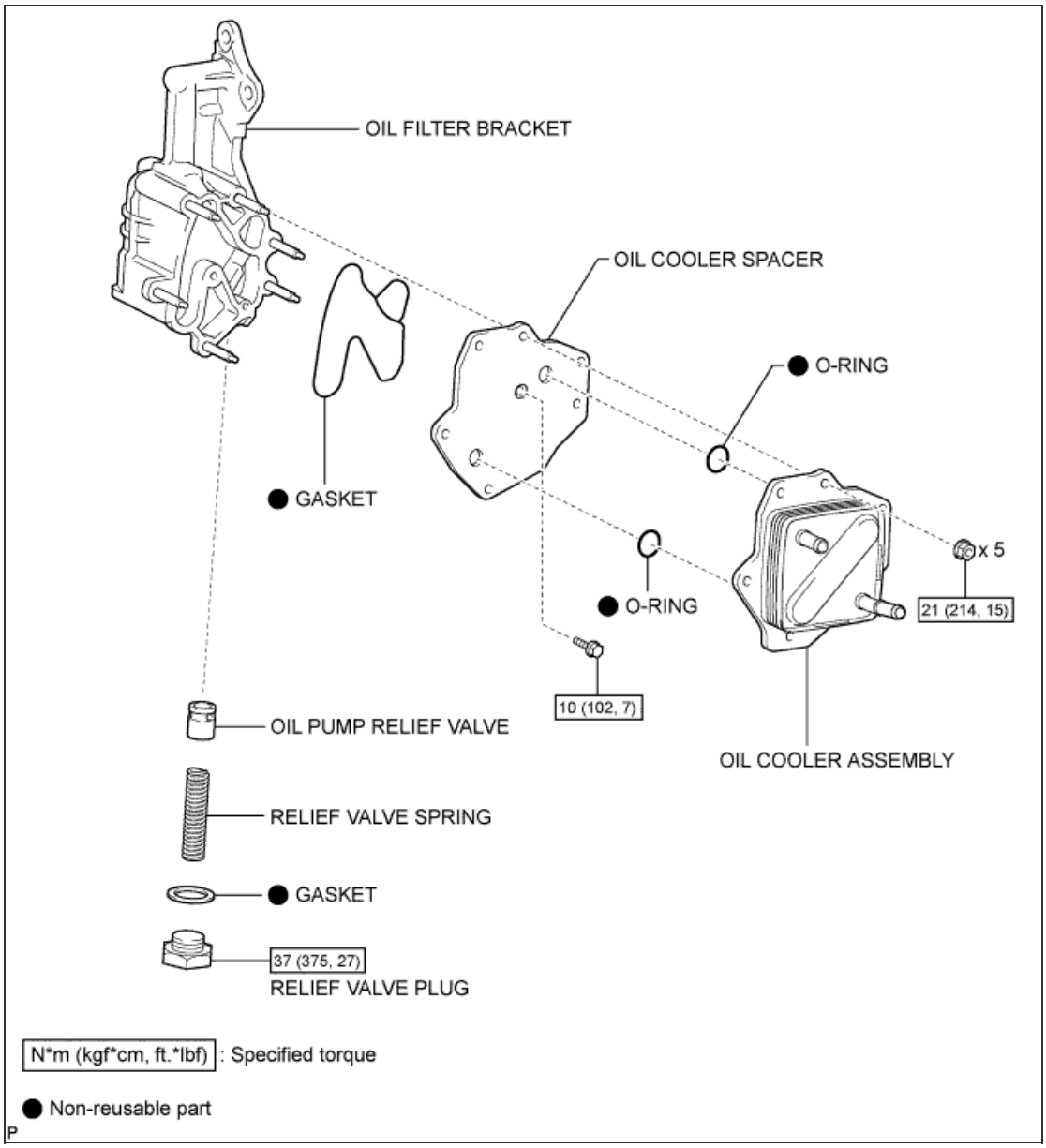


for Preparation [Click here]




OIL FILLER CAP
GASKET
40 (408, 30)
OIL PAN DRAIN PLUG
OIL FILTER ELEMENT
O-RING
25 (255, 18)
OIL FILTER CAP
NO. 2 ENGINE UNDER COVER SEAL
x 2
10 (102, 7)
OIL FILTER BRACKET CLIP
O-RING
13 (127, 9)
OIL FILTER DRAIN PLUG
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

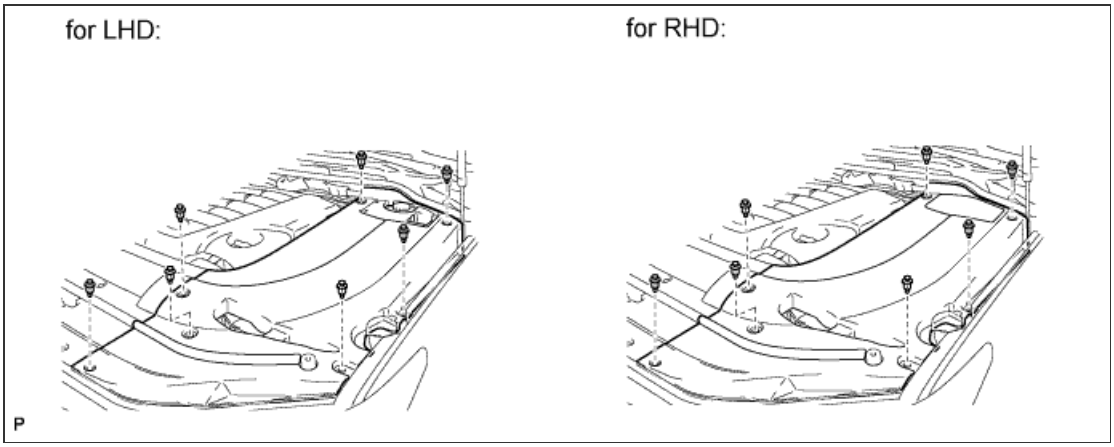

NO. 6 WATER BY-PASS HOSE
WATER HOSE
x 3
10 (102, 7)
NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY
COOLER COMPRESSOR ASSEMBLY
10 (102, 7)
25 (250, 18)
x 3
25 (250, 18)
OIL FILTER BRACKET
35 (357, 26)
x 2
O-RING
35 (357, 26)
x 2
GROUND WIRE
OIL PRESSURE SENDER GAUGE CONNECTOR
NO. 1 OIL COOLER BRACKET
x 2
21 (214, 15)
15 (153, 11)
OIL PRESSURE SENDER GAUGE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
Precoated part
P


OIL FILTER BRACKET
OIL COOLER SPACER
O-RING
GASKET
x 5
O-RING
21 (214, 15)
10 (102, 7)
OIL PUMP RELIEF VALVE
OIL COOLER ASSEMBLY
RELIEF VALVE SPRING
GASKET
37 (375, 27)
RELIEF VALVE PLUG
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
P

for Preparation Click here

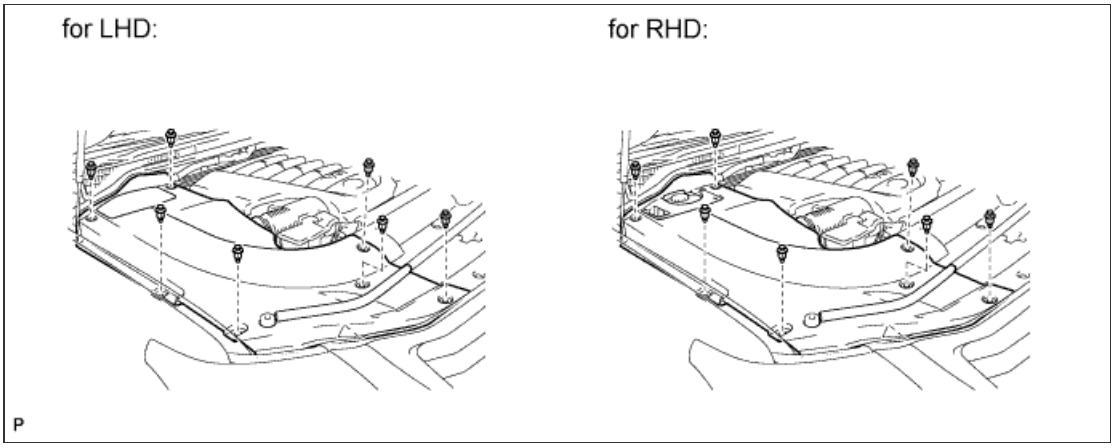
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



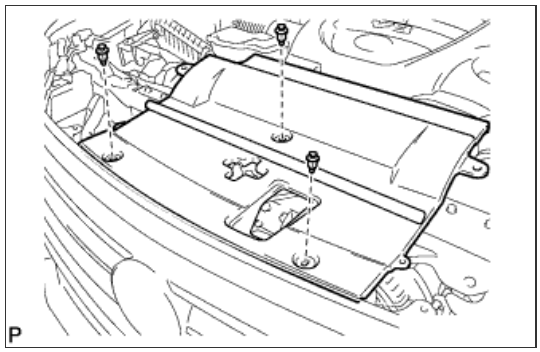
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

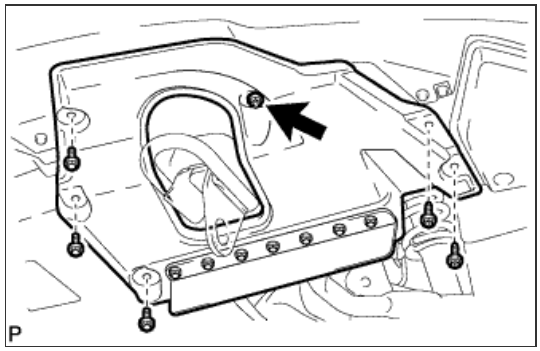
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

5. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Remove the 3 bolts and 2 screws.

b. Turn the clip indicated by the arrow in the illustration to remove the fender splash shield.



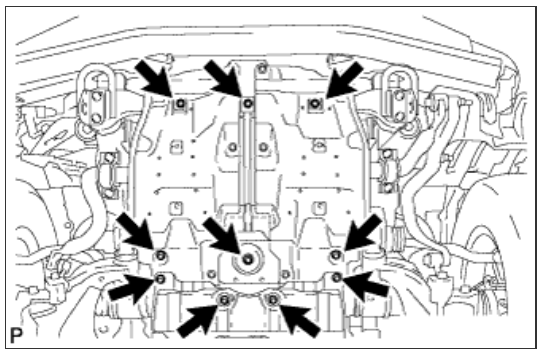
6. REMOVE FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

7. REMOVE NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Remove the 10 bolts and No. 1 engine under cover.



8. DRAIN ENGINE OIL

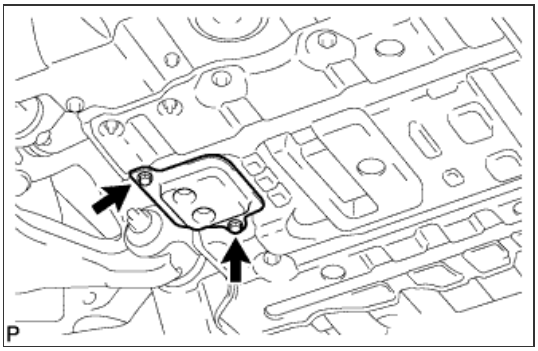
a. Remove the oil filler cap.

b. Remove the 2 bolts and No. 2 engine under cover seal.

c. Remove the oil pan drain plug and gasket, and drain the engine oil into a container.

d. Install a new gasket and the oil pan drain plug.

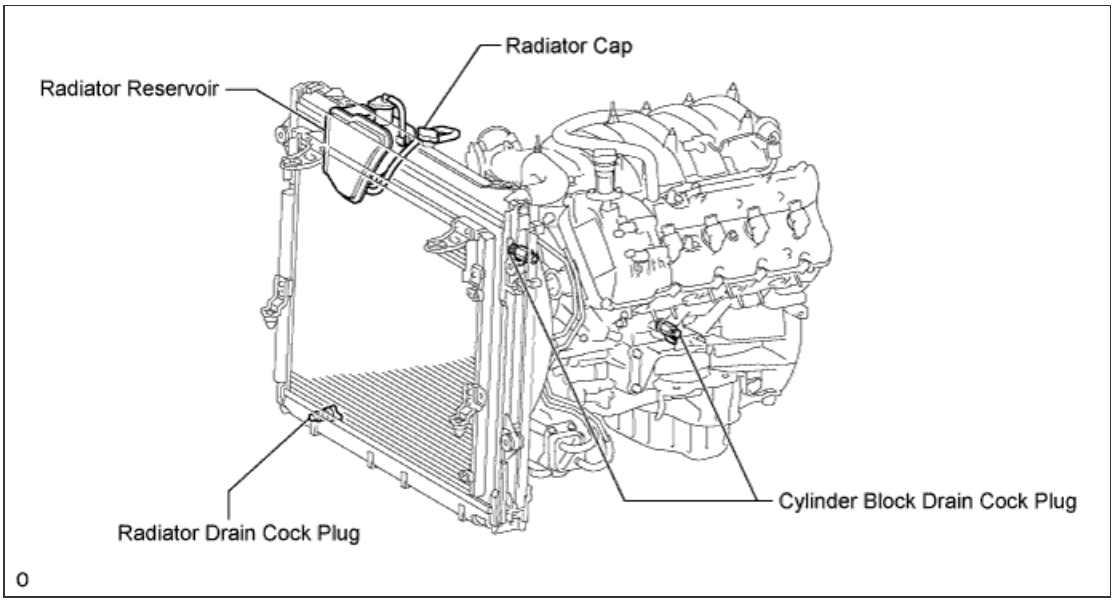
Torque:
40 N*m{ 408 kgf*cm , 30 ft.*lbf }



9. DRAIN ENGINE COOLANT

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.



a. Loosen the radiator drain cock plug.

HINT:

Collect the coolant in a container and dispose of it according to the regulations in your area.

b. Remove the radiator cap. Then drain the coolant from the radiator.

c. Loosen the 2 cylinder block drain cock plugs. Then drain the coolant from the engine.

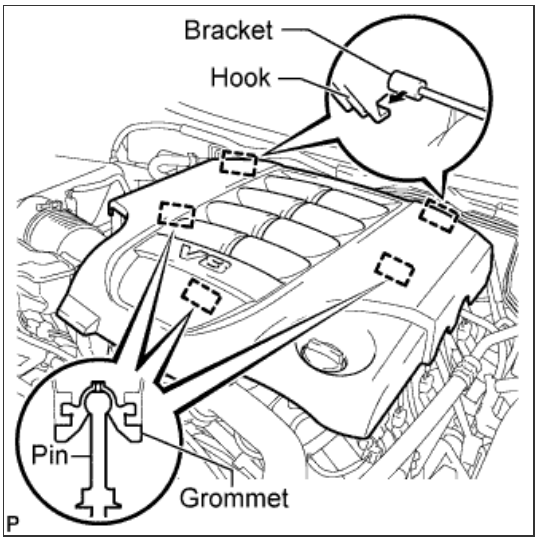
d. Tighten the 2 cylinder block drain cock plugs.

Torque:
13 N*m{ 130 kgf*cm , 10 ft.*lbf }

e. Tighten the radiator drain cock plug by hand.

10. REMOVE V-BANK COVER SUB-ASSEMBLY

a. Raise the front of the V-bank cover to detach the 3 pins. Then remove the 2 V-bank cover hooks from the bracket, and remove the V-bank cover.



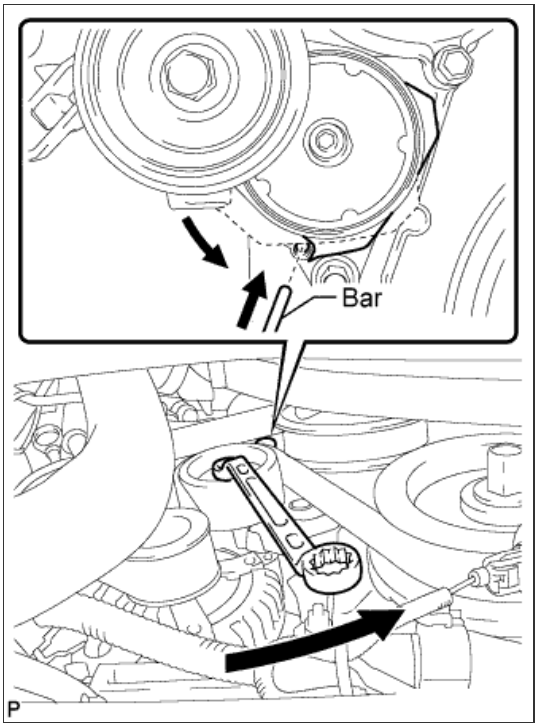
11. REMOVE FAN & GENERATOR V BELT

a. While turning the belt tensioner counterclockwise, align the service hole for the belt tensioner and the belt tensioner fixing position, and then insert a bar of φ5 mm (0.197 in.) into the service hole to fix the belt tensioner in place.

HINT:

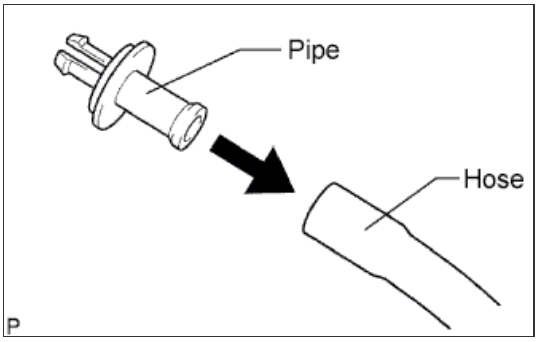
The pulley bolt for the belt tensioner has a left-hand thread.

b. Remove the V belt.

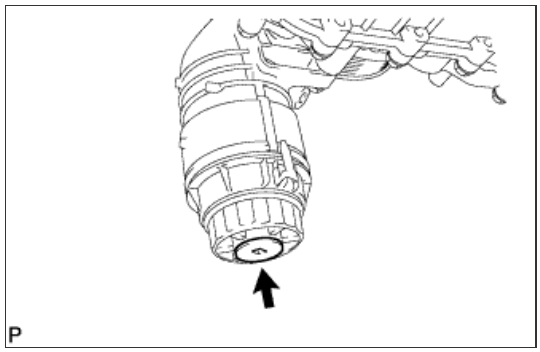


12. REMOVE OIL FILTER ELEMENT

a. Connect a hose with an inside diameter of 15 mm (0.591 in.) to the pipe.



b. Remove the oil filter drain plug.



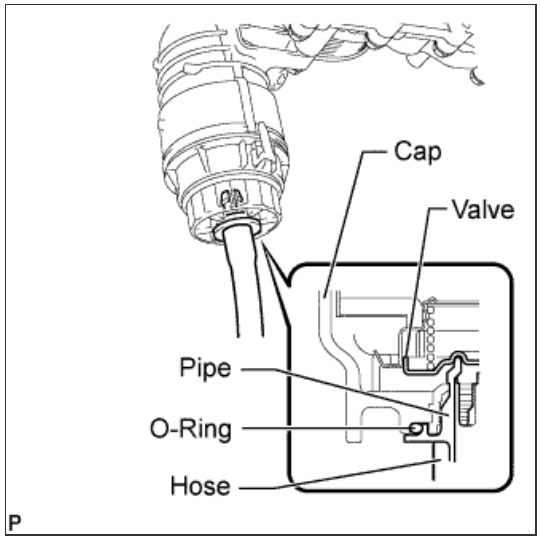
c. Install the pipe to the oil filter cap.

NOTICE:

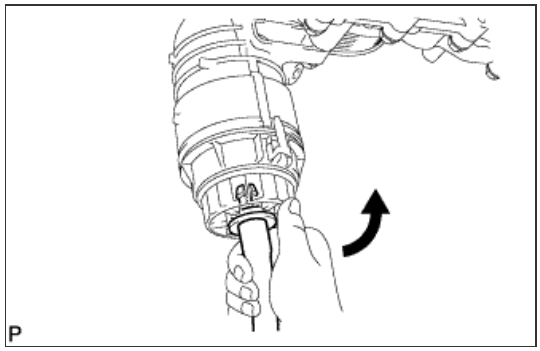
If the O-ring is removed with the drain plug, install the O-ring together with the pipe.

HINT:

Use a container to catch the draining oil.



d. Check that oil is drained from the oil filter. Then disconnect the pipe and remove the O-ring as shown in the illustration.

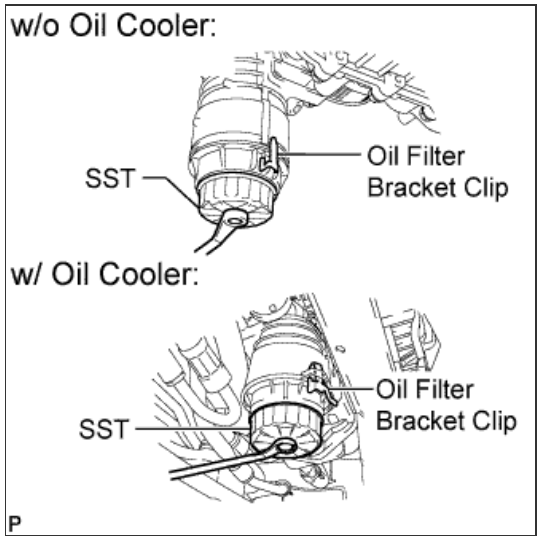


e. Using SST, remove the oil filter cap.

SST
09228-06501

NOTICE:

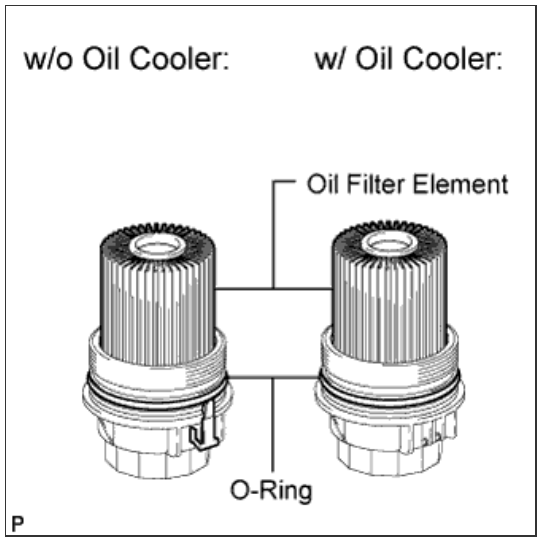
Do not remove the oil filter bracket clip.



f. Remove the oil filter element and O-ring from the oil filter cap.

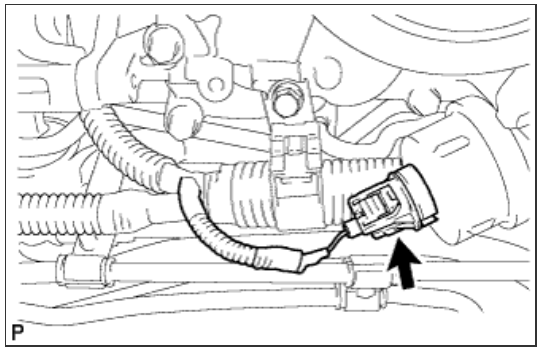
NOTICE:

Be sure to remove the cap O-ring by hand, without using any tools, to prevent damage to the cap O-ring groove.

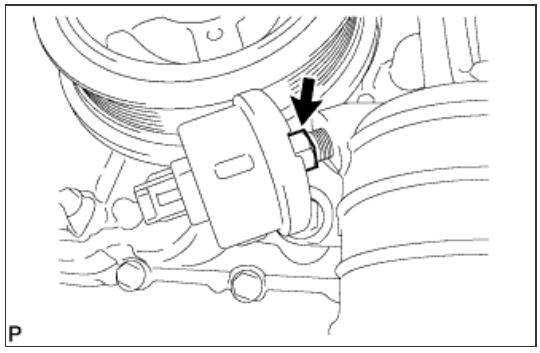


13. REMOVE OIL PRESSURE SENDER GAUGE ASSEMBLY

a. Disconnect the sender gauge connector.



b. Remove the oil pressure sender gauge.

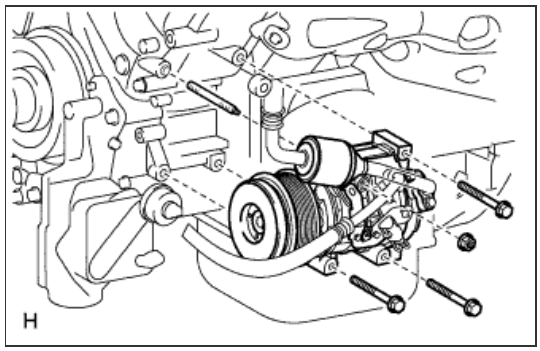


14. DISCONNECT COOLER COMPRESSOR ASSEMBLY

a. Remove the 3 bolts, nut and stud bolt, and disconnect the cooler compressor.

HINT:

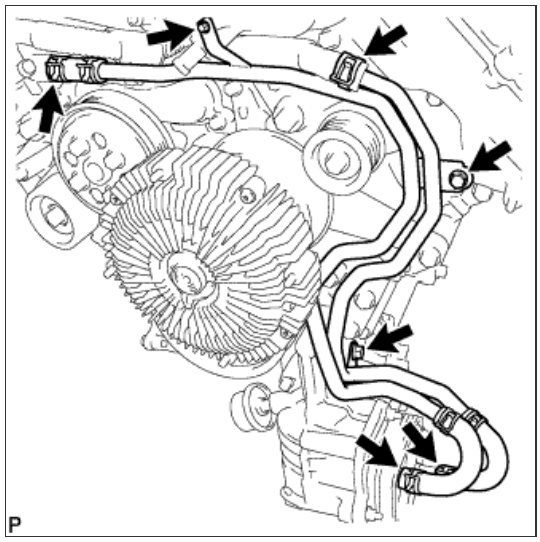
It is not necessary to completely remove the compressor. With the hoses connected to the compressor, hang the compressor on the vehicle body with a rope.



15. REMOVE NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY

a. Remove the 3 bolts.

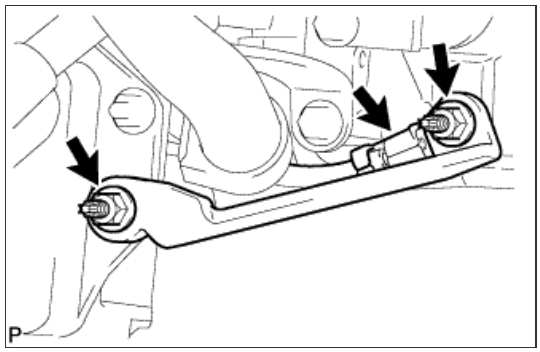
b. Disconnect the 4 hoses and remove the water by-pass pipe.



16. REMOVE NO. 1 OIL COOLER BRACKET

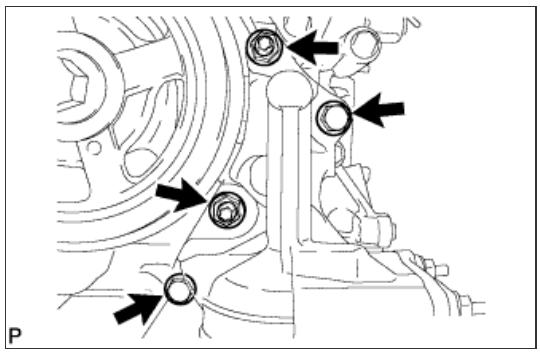
a. Remove the 2 nuts and bracket.

b. Disconnect the ground wire from the cylinder block.

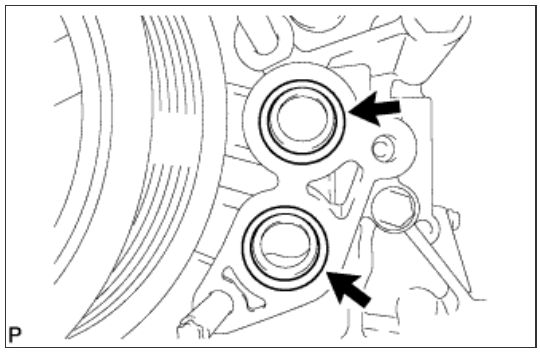


17. REMOVE OIL FILTER BRACKET

a. Remove the 2 bolts, 2 nuts and filter bracket.

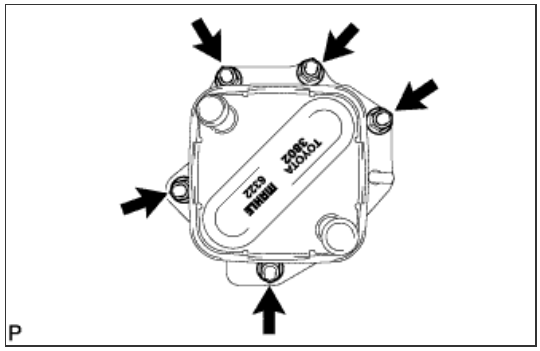


b. Remove the 2 O-rings.

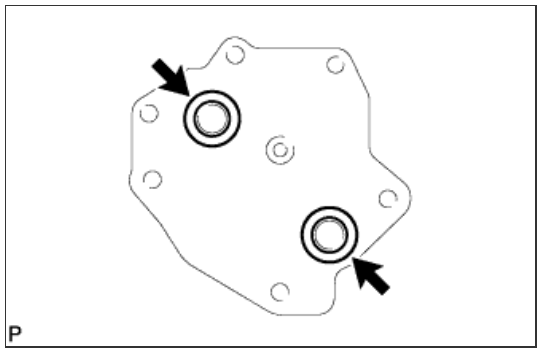


18. REMOVE OIL COOLER ASSEMBLY

a. Remove the 5 nuts and oil cooler from the oil filter bracket.

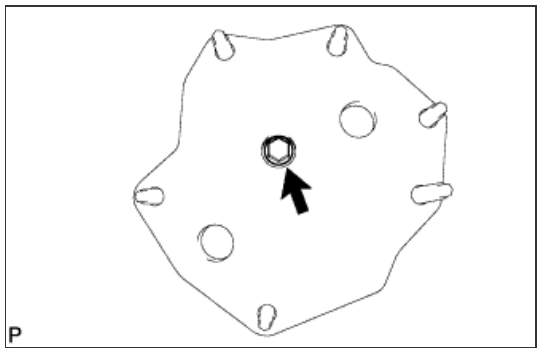


b. Remove the 2 O-rings.

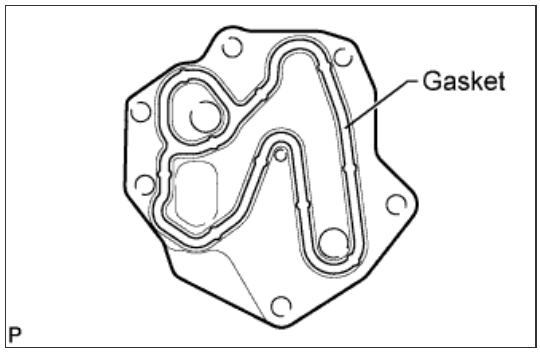


19. REMOVE OIL COOLER SPACER

a. Remove the bolt and oil cooler spacer from the oil filter bracket.



b. Remove the gasket.

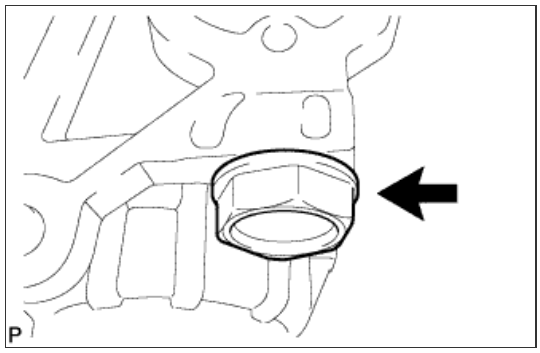

Gasket
P

for Preparation Click here

1. REMOVE OIL PUMP RELIEF VALVE

a. Remove the relief valve plug and gasket.

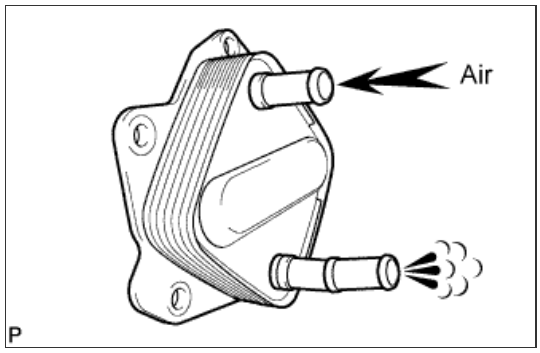
b. Remove the valve spring and oil pump relief valve.



for Preparation Click here

1. INSPECT OIL COOLER ASSEMBLY

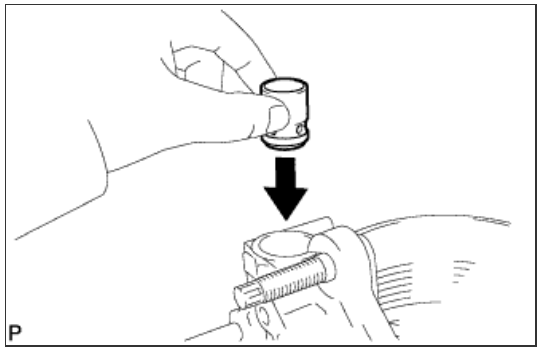
a. Check the oil cooler for damage or clogging.
If necessary, replace the oil cooler assembly.



2. INSPECT OIL PUMP RELIEF VALVE

a. Coat the relief valve with engine oil.

b. Check that the relief valve falls smoothly into the valve hole by its own weight.
If the relief valve does not fall smoothly, replace it. If necessary, replace the oil filter bracket.



for Preparation Click here

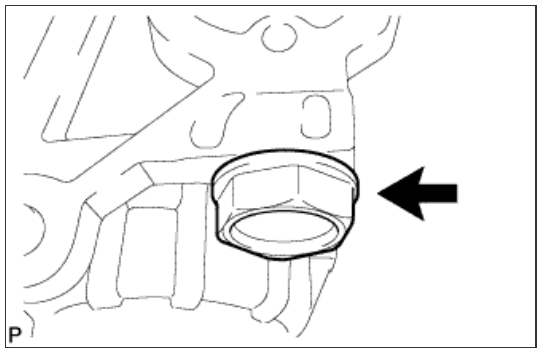
1. INSTALL OIL PUMP RELIEF VALVE

a. Coat the oil pump relief valve with engine oil.

b. Install the relief valve and valve spring into the oil pump cover hole.

c. Install a new gasket and the plug.

Torque:
37 N*m{ 375 kgf*cm , 27 ft.*lbf }

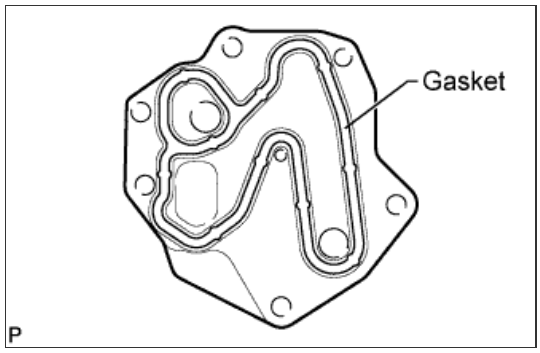


for Preparation Click here

1. INSTALL OIL COOLER SPACER

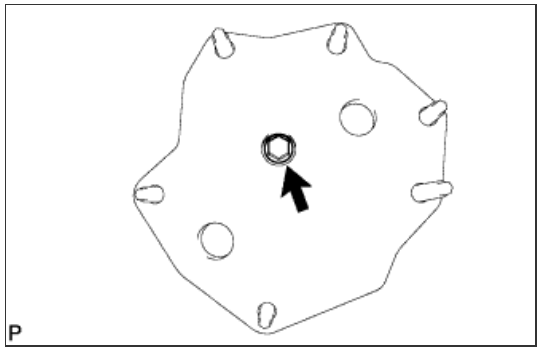
a. Apply a light coat of engine oil to a new gasket.

b. Install the gasket to the oil cooler spacer.



c. Install the oil cooler spacer to the oil filter bracket with the bolt.

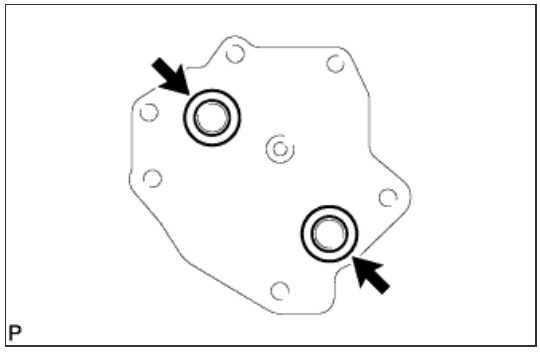
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



2. INSTALL OIL COOLER ASSEMBLY

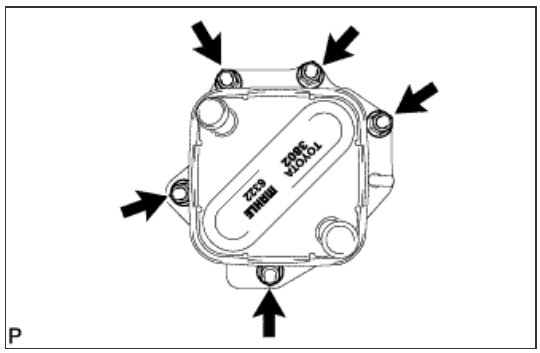
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the oil cooler.



c. Install the oil cooler with the 5 nuts.

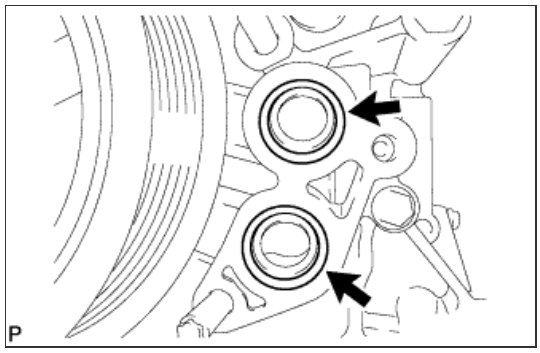
Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }



3. INSTALL OIL FILTER BRACKET

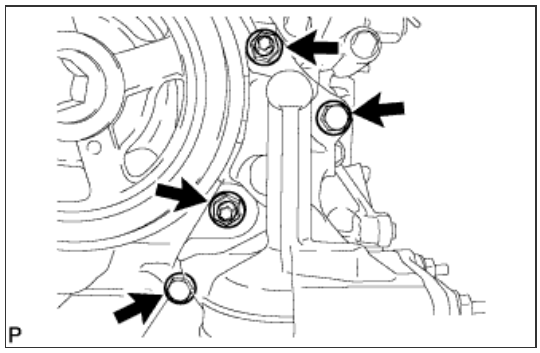
a. Apply a light coat of engine oil to 2 new O-rings.

b. Install the 2 O-rings to the timing chain cover.



c. Install the oil filter bracket with the 2 nuts and 2 bolts.

Torque:
35 N*m{ 357 kgf*cm , 26 ft.*lbf }

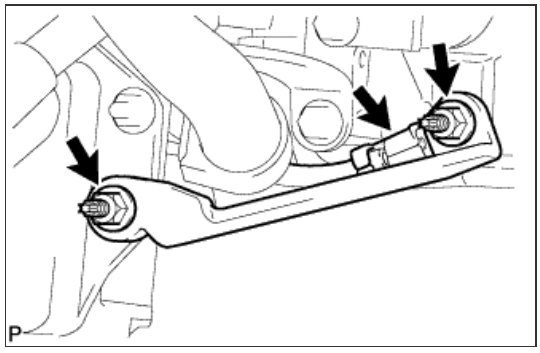


4. INSTALL NO. 1 OIL COOLER BRACKET

a. Connect the ground wire to the cylinder block.

b. Install the oil cooler bracket with the 2 nuts.

Torque:
21 N*m{ 214 kgf*cm , 15 ft.*lbf }

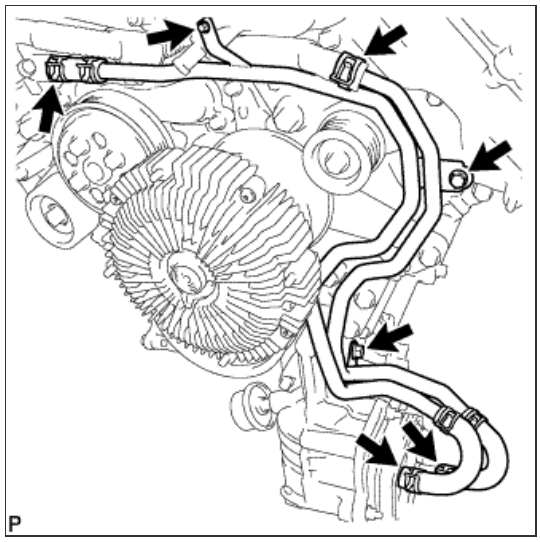


5. INSTALL NO. 2 WATER BY-PASS PIPE SUB-ASSEMBLY

a. Connect the 4 hoses.

b. Install the water by-pass hose with the 3 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



6. CONNECT COOLER COMPRESSOR ASSEMBLY

a. Install the cooler compressor with the stud bolt.

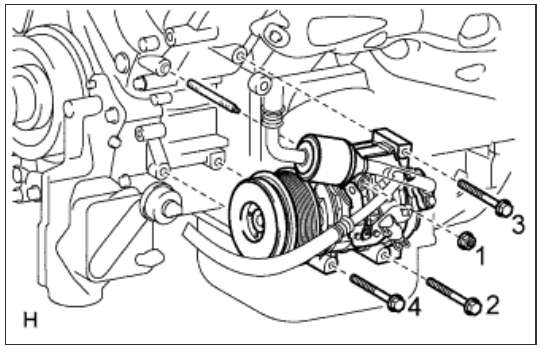
Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }

b. Install the 3 bolts and nut.

Torque:
25 N*m{ 250 kgf*cm , 18 ft.*lbf }

NOTICE:

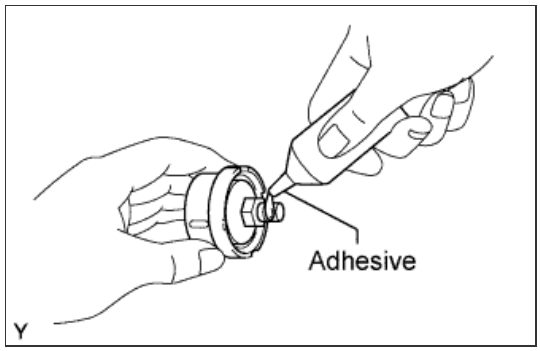
Tighten the bolts and nut in the order shown in the illustration to install the cooler compressor.



7. INSTALL OIL PRESSURE SENDER GAUGE ASSEMBLY

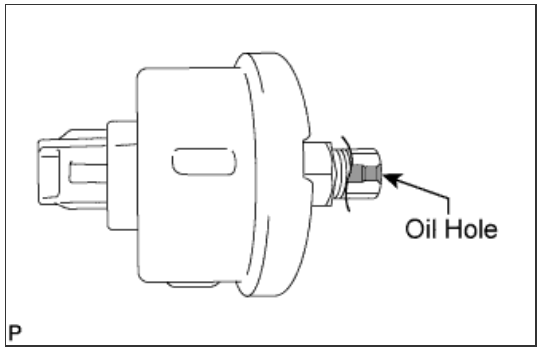
a. Apply adhesive to 2 or 3 threads of the oil pressure sender gauge.

Adhesive:
Toyota Genuine Adhesive 1344, Three Bond 1344 or equivalent



NOTICE:

Do not allow adhesive to contact the oil hole.

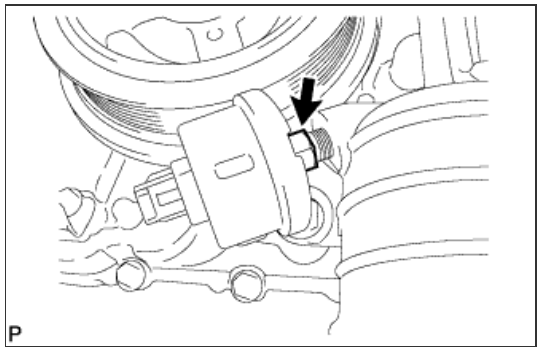


b. Install the oil pressure sender gauge.

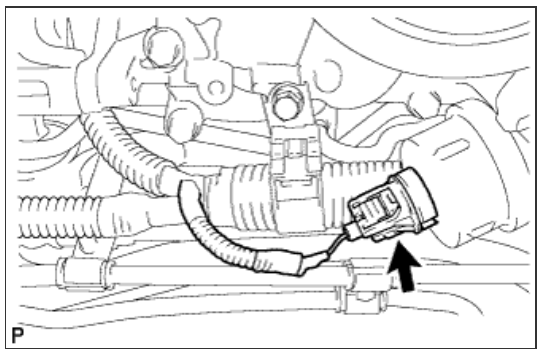
Torque:
15 N*m{ 153 kgf*cm , 11 ft.*lbf }

NOTICE:

Do not start the engine within 1 hour after installation.



c. Connect the sender gauge connector.



8. INSTALL OIL FILTER ELEMENT

a. Clean the inside of the oil filter cap, its threads and its O-ring groove.

b. Apply a small amount of engine oil to a new O-ring and install it to the oil filter cap.

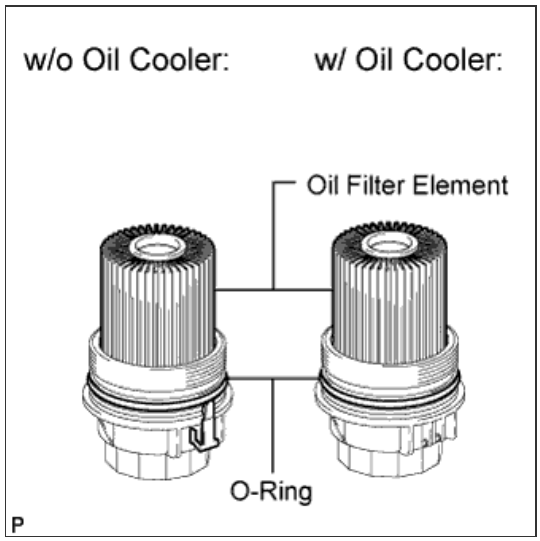
c. Set a new oil filter element to the oil filter cap.

d. Remove any dirt or foreign matter from the installation surface of the engine.

e. Apply a small amount of engine oil to the O-ring again and temporarily install the oil filter cap.

NOTICE:

Do not remove the oil filter bracket clip.



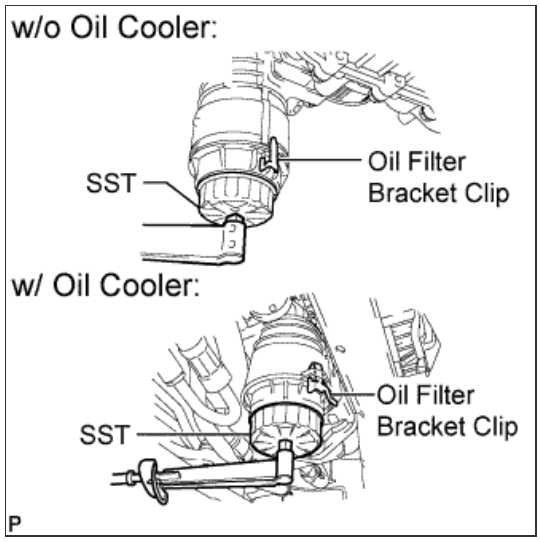
f. Using SST, tighten the oil filter cap.

SST
09228-06501

Torque:
25 N*m{ 255 kgf*cm , 18 ft.*lbf }

NOTICE:

- **When tightening the oil filter cap, do not remove the oil filter bracket clip.**
- **Make sure that the oil filter is installed securely as shown in the illustration.**
- **Be careful that the O-ring does not get caught between any surrounding parts.**



g. Apply a small amount of engine oil to a new drain plug O-ring, and install it to the oil filter cap.

NOTICE:

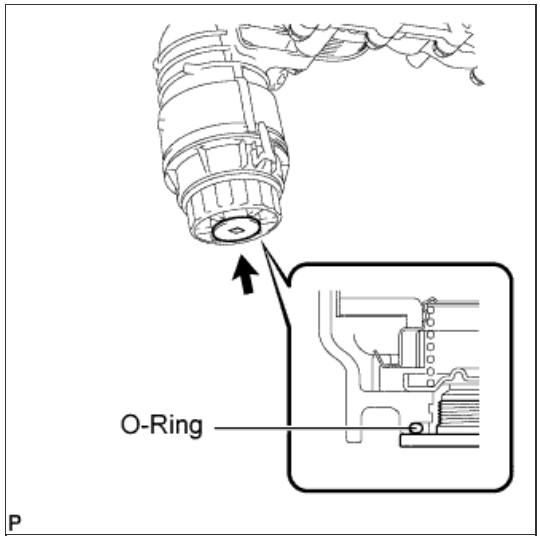
Before installing the O-ring, remove any dirt or foreign matter from the installation surface of the oil filter cap.

h. Install the oil filter drain plug.

Torque:
13 N*m{ 127 kgf*cm , 9 ft.*lbf }

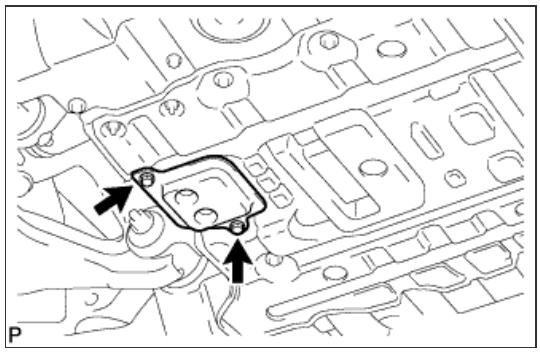
NOTICE:

Be careful that the O-ring does not get caught between any surrounding parts.



i. Install the No. 2 engine under cover seal with the 2 bolts.

Torque:
10 N*m{ 102 kgf*cm , 7 ft.*lbf }



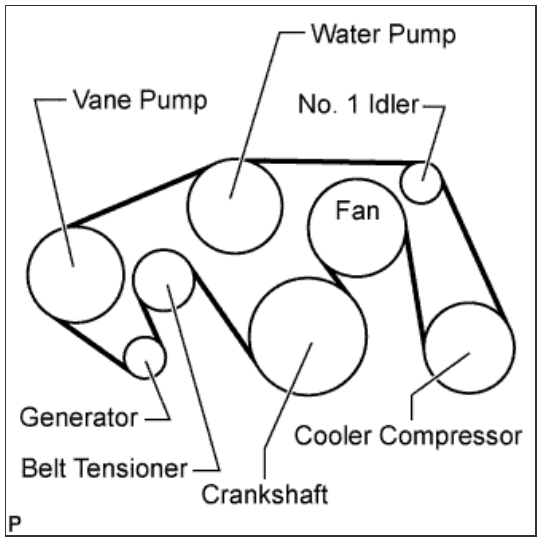
9. INSTALL FAN & GENERATOR V BELT

a. Set the V belt onto every part.

b. While turning the belt tensioner counterclockwise, remove the bar.

NOTICE:

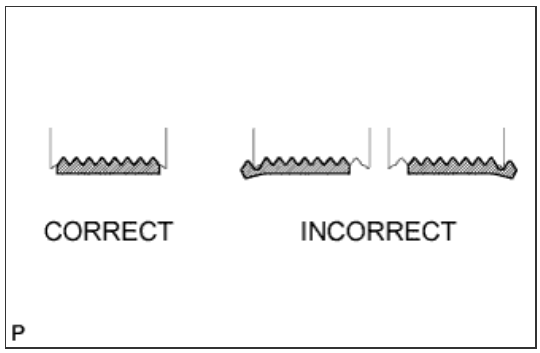
Make sure that the V belt is properly set to each pulley.



c. After installing the belt, check that it fits properly in the ribbed grooves.

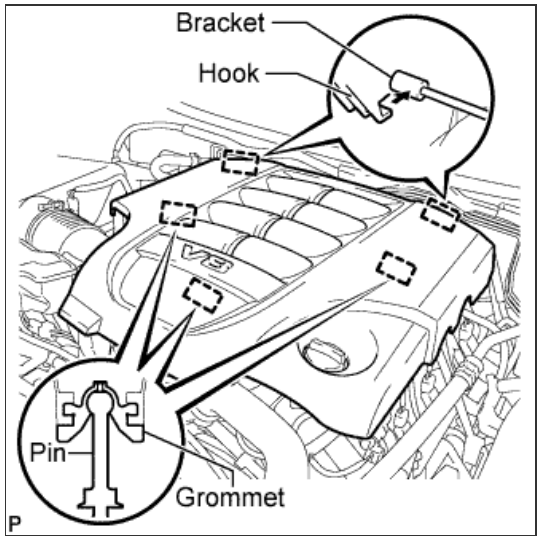
HINT:

Make sure to check by hand that the belt has not slipped out of the grooves on the bottom of the pulley.



10. INSTALL V-BANK COVER SUB-ASSEMBLY

a. Attach the 2 V-bank cover hooks to the bracket. Then align the 3 V-bank cover grommets with the 3 pins, and press down on the V-bank cover to attach the pins.



11. ADD ENGINE OIL

a. Add fresh oil and install the oil filler cap.

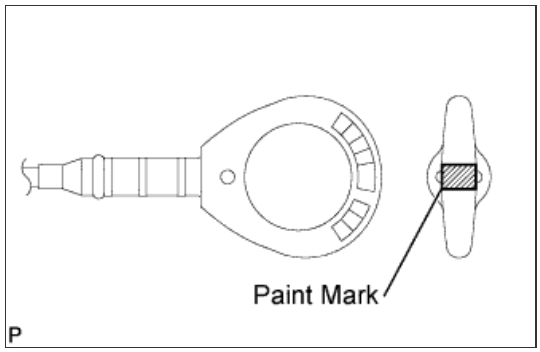
Standard Oil Grade:

Oil Grade	Oil Viscosity (SAE)
API grade SL "Energy-Conserving", SM "Energy-Conserving" or ILSAC multigrade engine oil	0W-20 5W-20 5W-30 10W-30

API grade SL or SM multigrade engine oil	15W-40 20W-50

Standard Oil Capacity:

Paint Mark	Item	Specified Condition
Blue	Drain and refill with oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)
	Drain and refill without oil filter change	6.6 liters (7.0 US qts, 5.8 Imp. qts)
	Dry fill	8.4 liters (8.9 US qts, 7.4 Imp. qts)
Green	Drain and refill with oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts)
	Drain and refill without oil filter change	7.1 liters (7.5 US qts, 6.2 Imp. qts)
	Dry fill	9.3 liters (9.8 US qts, 8.2 Imp. qts)



12. ADD ENGINE COOLANT

a. Add engine coolant.

Standard Capacity:

Item	Specified Condition
with transmission oil cooler	16.7 liters (17.6 US qts, 14.7 Imp. qts)
without transmission oil cooler	16.2 liters (17.1 US qts, 14.3 Imp. qts)

NOTICE:

Do not substitute plain water for engine coolant.

HINT:

TOYOTA vehicles are filled with TOYOTA SLLC at the factory. In order to avoid damage to the engine cooling system and other technical problems, only use TOYOTA SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite, non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology consists of a combination of low phosphates and organic acids).

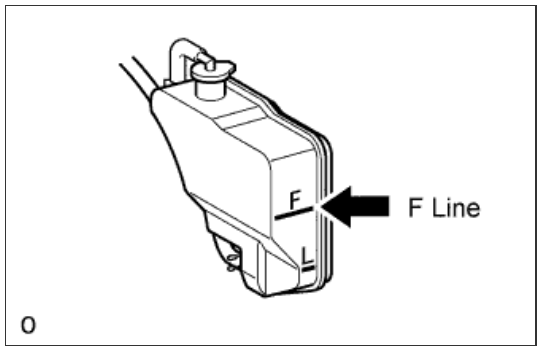
b. Slowly pour coolant into the radiator reservoir until it reaches the F line.

c. Install the reservoir cap.

d. Press the No. 1 and No. 2 radiator hoses several times by hand, and then check the coolant level. If the coolant level is low, add coolant.

e. Install the radiator cap.

f. Start the engine and warm it up until the thermostat opens.



NOTICE:

Switch off the A/C.

g. Maintain the engine speed at 2000 to 2500 rpm.

NOTICE:

- **Make sure that the radiator reservoir still has some coolant in it.**
- **Pay attention to the needle of the water temperature meter. Make sure that the needle does not show an abnormally high temperature.**
- **If there is not enough coolant, the engine may burn out or overheat.**
- **Immediately after starting the engine, if the radiator reservoir does not have any coolant, perform the following: 1) stop**

the engine, 2) wait until the coolant has cooled down, and 3) add coolant until the coolant is filled to the F line.

- **Run the engine at 2000 rpm until the coolant level has stabilized.**

h. Press the No. 1 and No. 2 radiator hoses several times by hand to bleed air.

CAUTION:

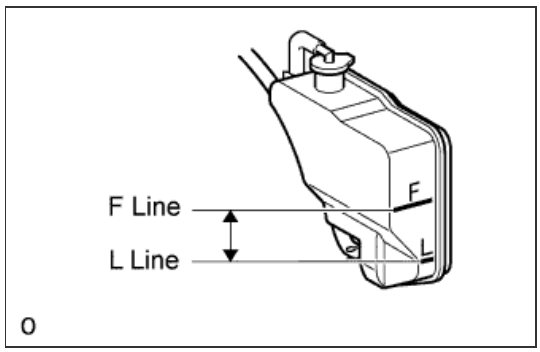
- **Wear protective gloves.**
- **Be careful as the radiator hoses are hot.**
- **Keep your hands away from the fan.**

i. Stop the engine, and wait until the engine coolant cools down to ambient temperature.

CAUTION:

Do not remove the radiator cap while the engine and radiator are still hot. Pressurized, hot engine coolant and steam may be released and cause serious burns.

j. Check that the coolant level is between the F and L lines.
If the coolant level is below the L line, repeat all of the procedures above.
If the coolant level is above the F line, drain coolant so that the coolant level is between the F and L lines.



13. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

14. INSPECT FOR OIL LEAK

a. Start the engine. Make sure that there are no oil leaks from the area that was worked on.

15. INSPECT ENGINE OIL LEVEL

a. Warm up the engine, stop the engine and wait 5 minutes. The oil level should be between the dipstick low level mark and full level mark.
If low, check for leakage and add oil up to the full level mark.

NOTICE:

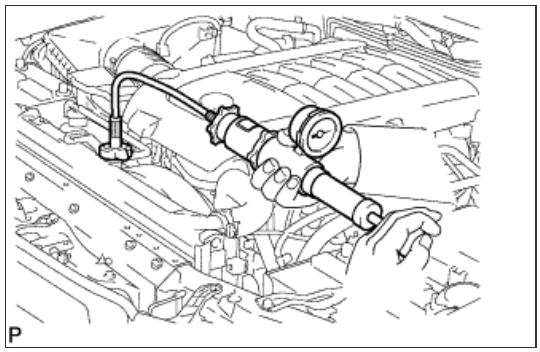
Do not fill engine oil above the full level mark.

16. INSPECT FOR COOLANT LEAK

a. Fill the radiator with coolant and attach a radiator cap tester.

b. Warm up the engine.

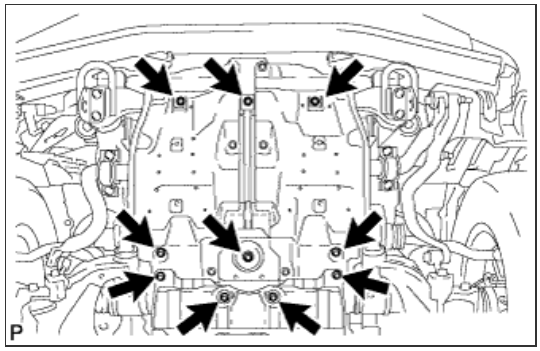
c. Using the radiator cap tester, increase the pressure inside the radiator to 123 kPa (1.3 kgf/cm^2, 18 psi), and check that the pressure does not drop.
If the pressure drops, check the hoses, radiator and water pump for leaks. If no external leaks are found, check the heater core, cylinder block and head.



17. INSTALL NO. 1 ENGINE UNDER COVER SUB-ASSEMBLY

a. Install the No. 1 engine under cover with the 10 bolts.

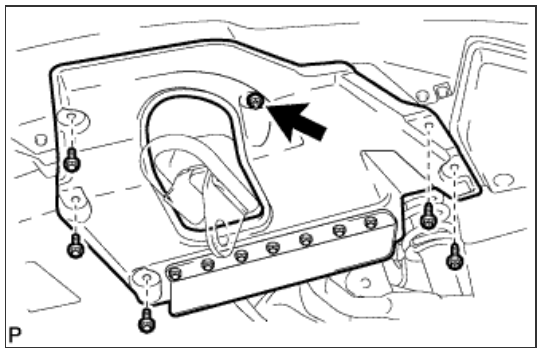
Torque:
29 N*m{ 296 kgf*cm , 21 ft.*lbf }



18. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY LH

a. Push in the clip indicated by the arrow in the illustration to install the fender splash shield.

b. Install the 3 bolts and 2 screws.



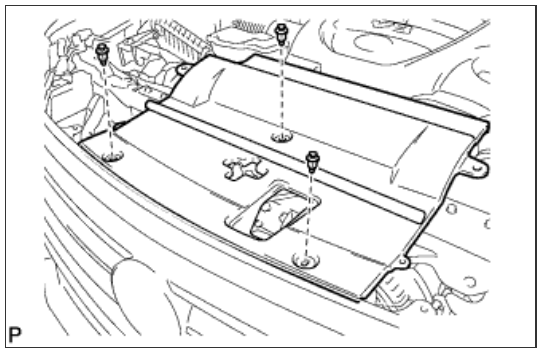
19. INSTALL FRONT FENDER SPLASH SHIELD SUB-ASSEMBLY RH

HINT:

Use the same procedures described for the LH side.

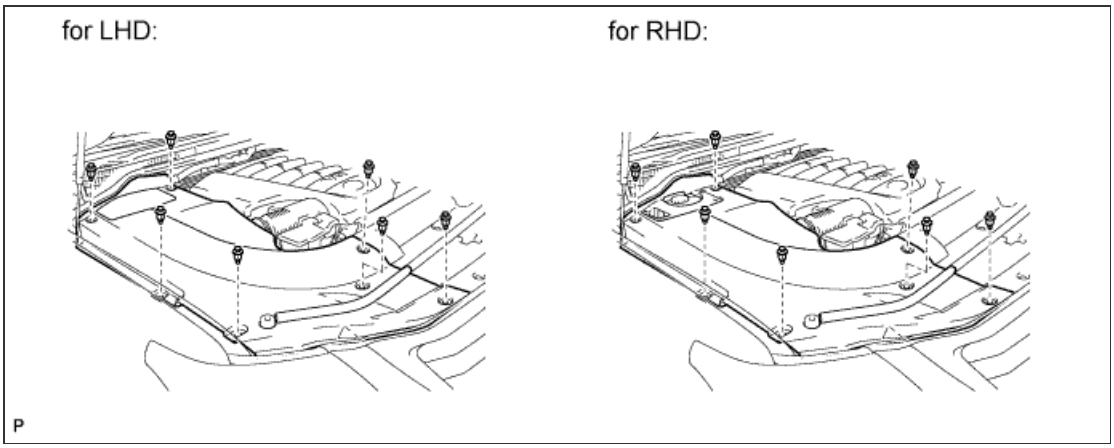
20. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



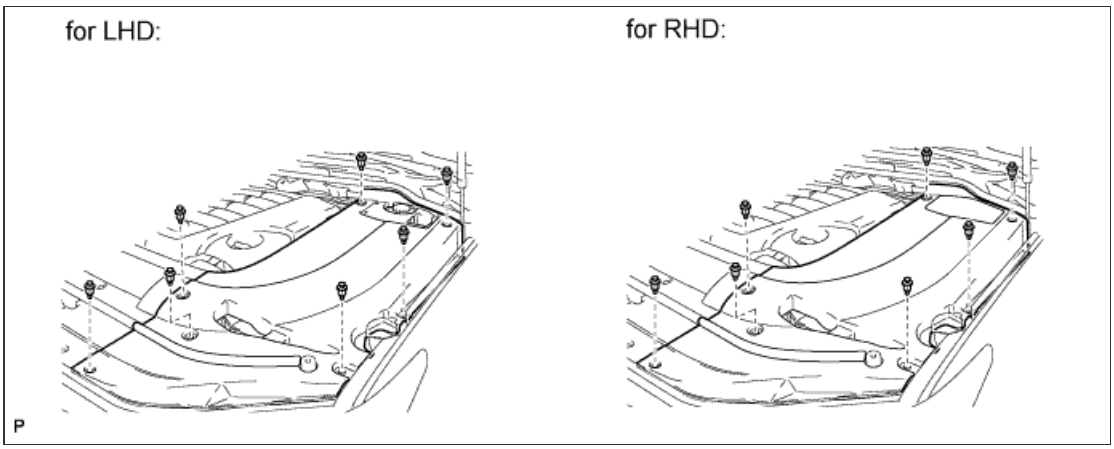
21. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.

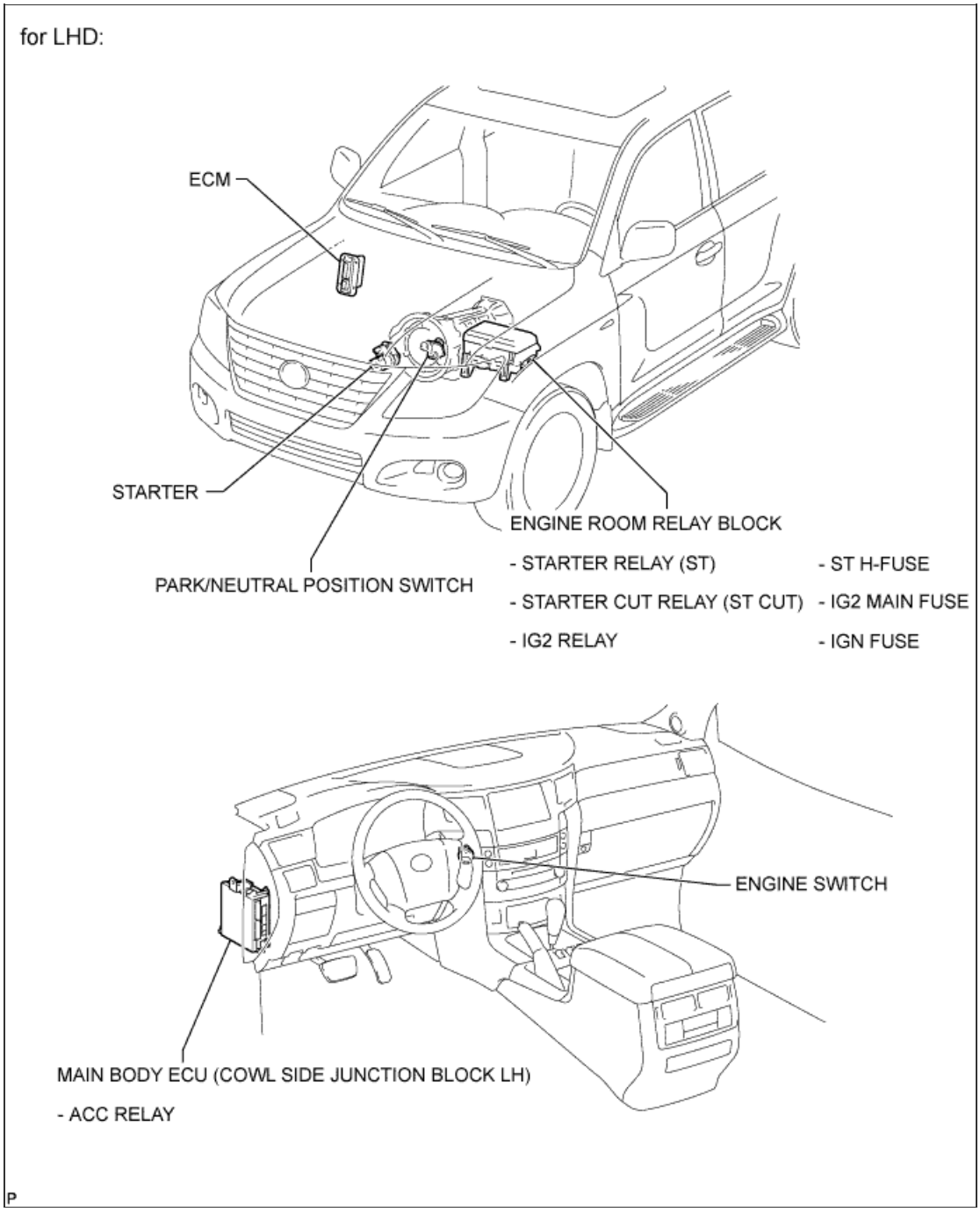


22. INSTALL ENGINE ROOM SIDE COVER LH

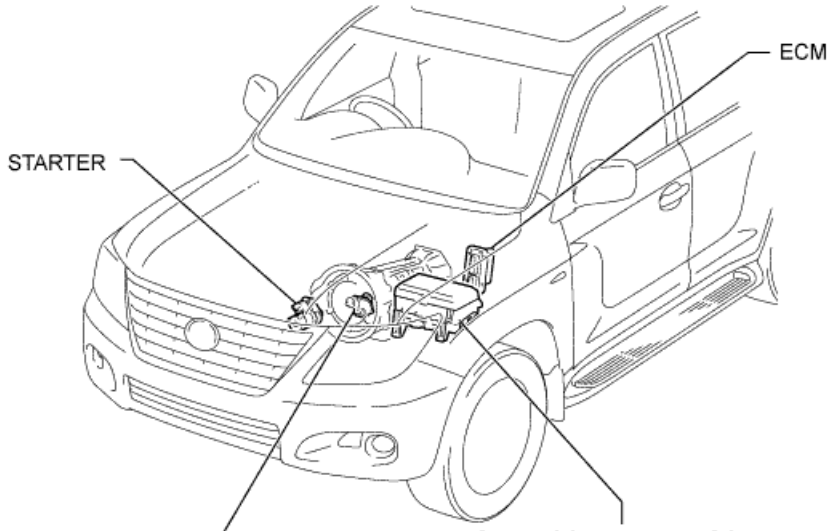
a. Install the engine room side cover with the 7 clips.



for Preparation Click here



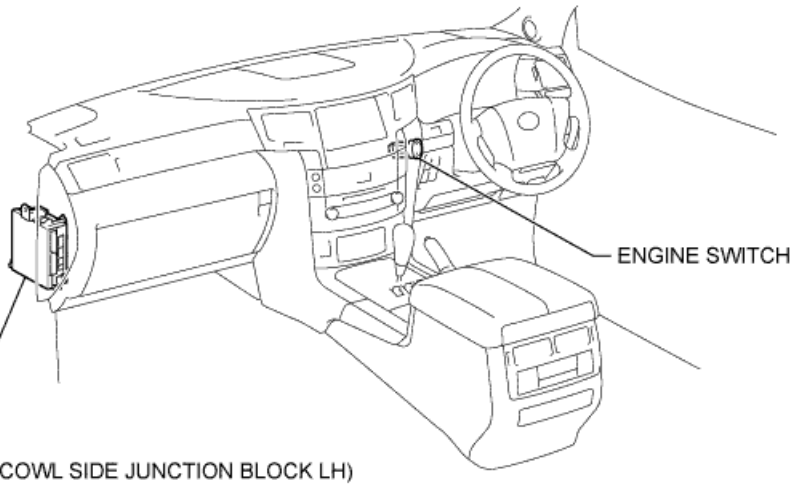
for RHD:



PARK/NEUTRAL POSITION SWITCH

ENGINE ROOM RELAY BLOCK

- STARTER RELAY (ST)
- STARTER CUT RELAY (ST CUT)
- IG2 RELAY
- ST H-FUSE
- IG2 MAIN FUSE
- IGN FUSE

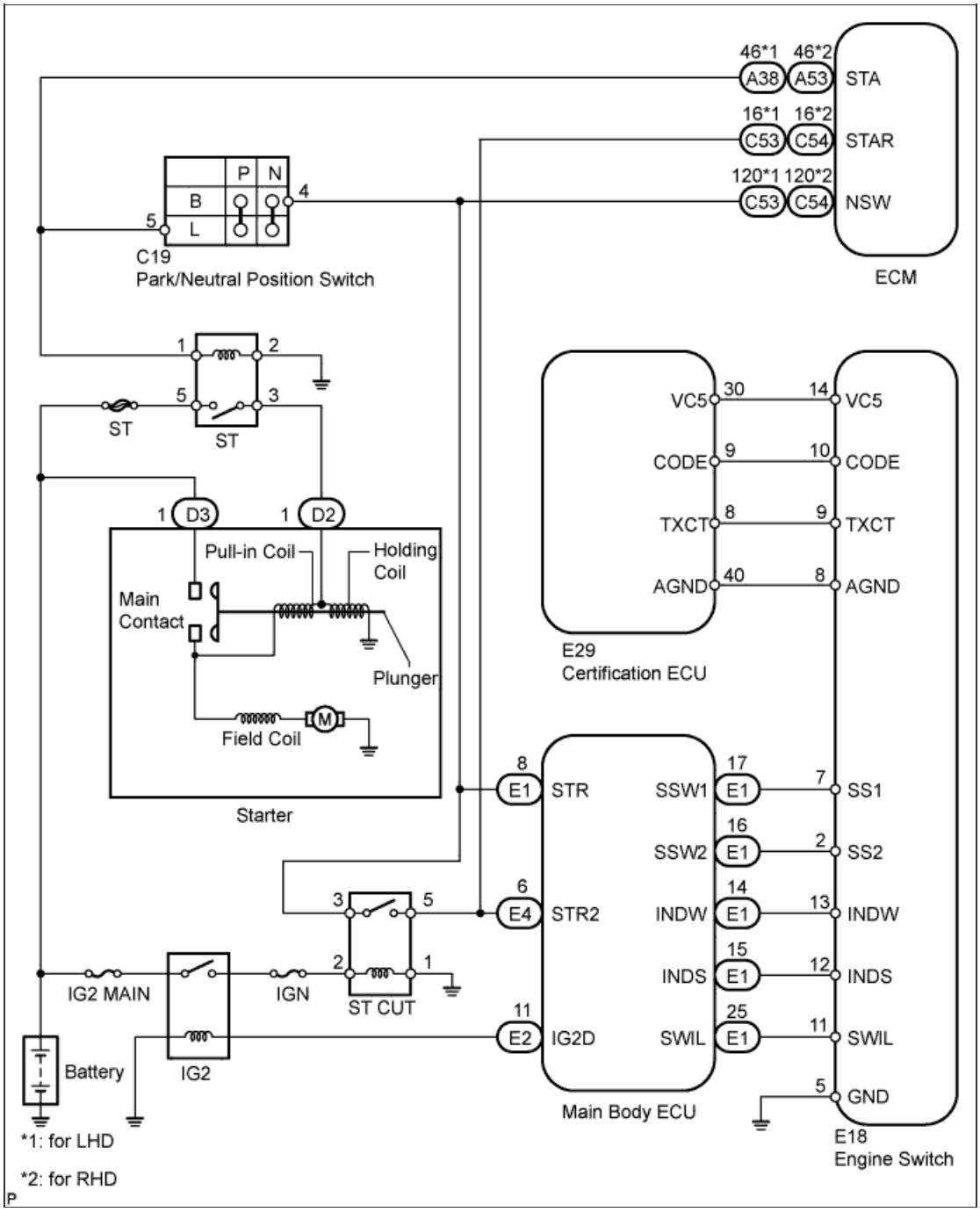


MAIN BODY ECU (COWL SIDE JUNCTION BLOCK LH)

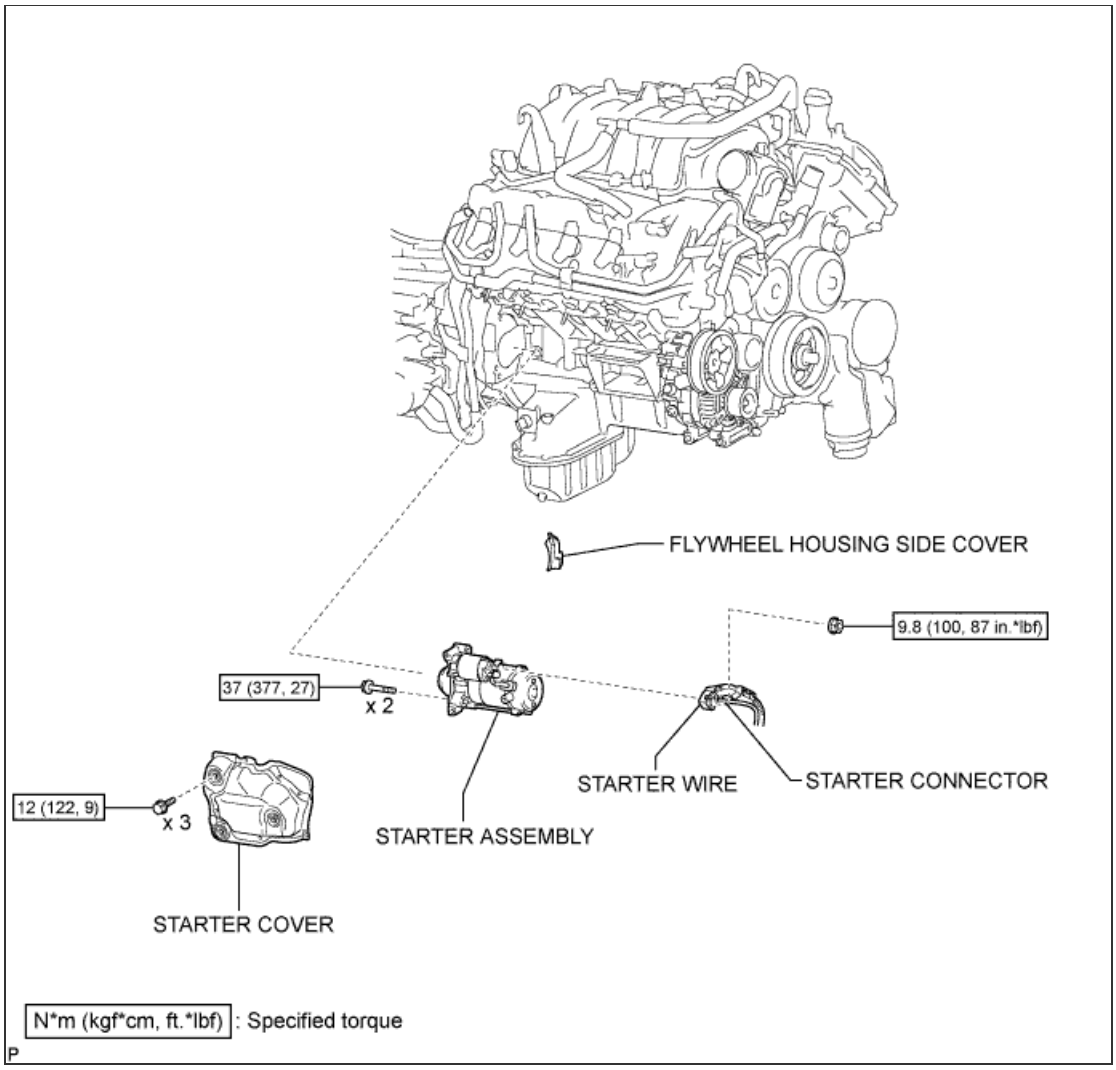
- ACC RELAY

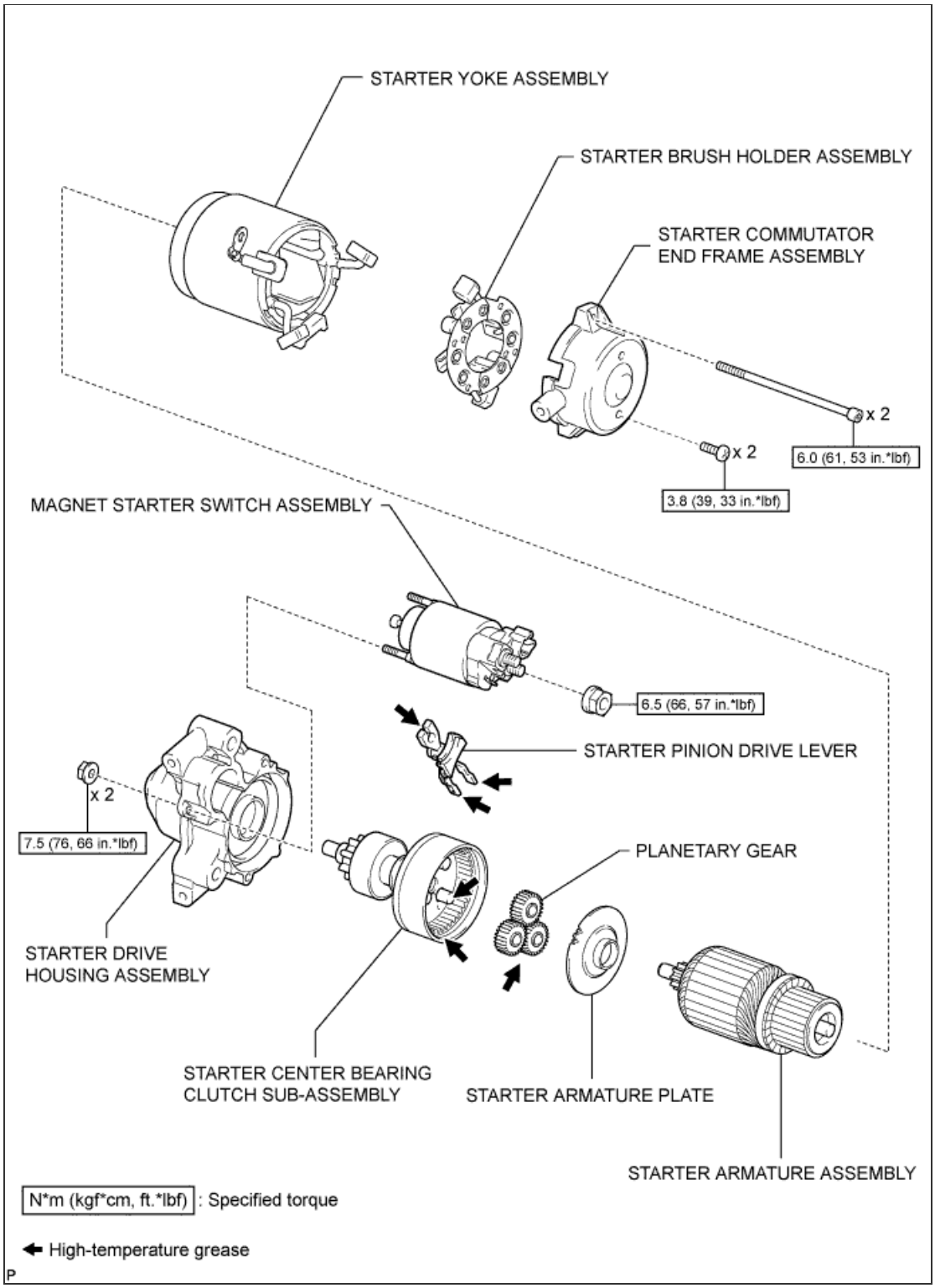
P

for Preparation Click here



for Preparation [Click here]




STARTER YOKE ASSEMBLY
STARTER BRUSH HOLDER ASSEMBLY
STARTER COMMUTATOR
END FRAME ASSEMBLY
x 2
6.0 (61, 53 in.*lbf)
x 2
3.8 (39, 33 in.*lbf)
MAGNET STARTER SWITCH ASSEMBLY
6.5 (66, 57 in.*lbf)
STARTER PINION DRIVE LEVER
x 2
7.5 (76, 66 in.*lbf)
PLANETARY GEAR
STARTER DRIVE
HOUSING ASSEMBLY
STARTER CENTER BEARING
CLUTCH SUB-ASSEMBLY
STARTER ARMATURE PLATE
STARTER ARMATURE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
High-temperature grease
P

for Preparation Click here

1. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Remove the exhaust manifold RH (Click here).

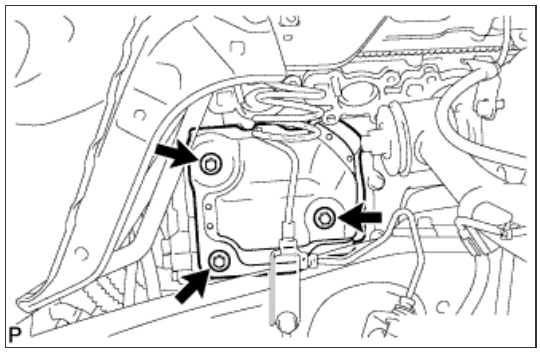
2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

3. REMOVE STARTER COVER

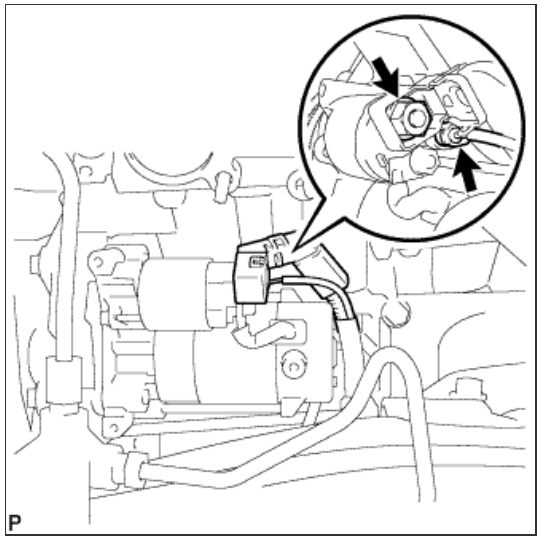
a. Remove the 3 bolts and starter cover.



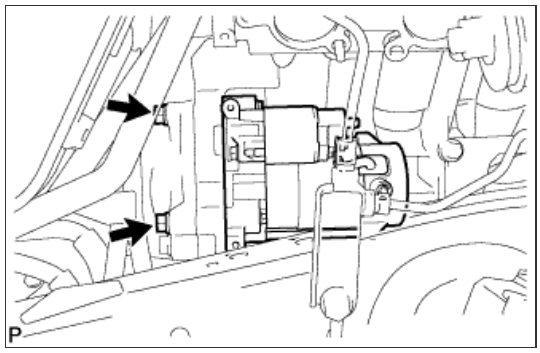
4. REMOVE STARTER ASSEMBLY

a. Disconnect the starter connector.

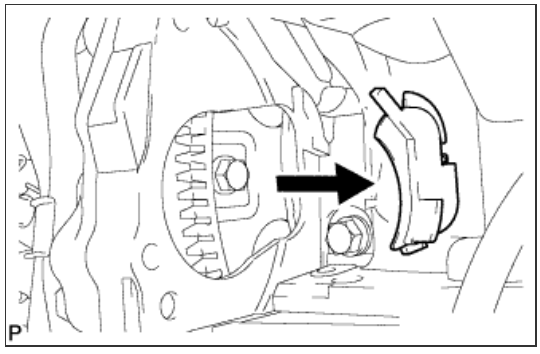
b. Remove the nut and disconnect the starter wire.



c. Remove the 2 bolts and starter.



d. Remove the flywheel housing side cover.



for Preparation Click here

1. REMOVE EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Remove the exhaust manifold RH (Click here).

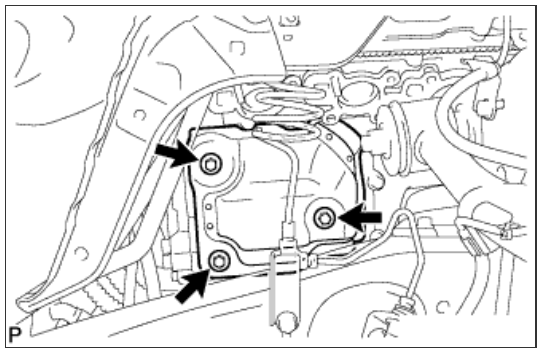
2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

3. REMOVE STARTER COVER

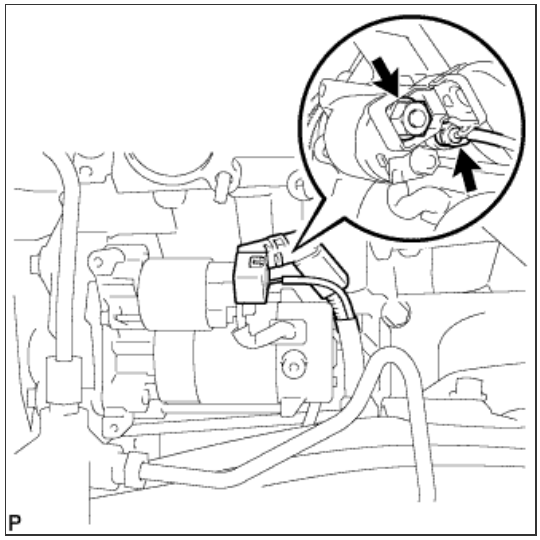
a. Remove the 3 bolts and starter cover.



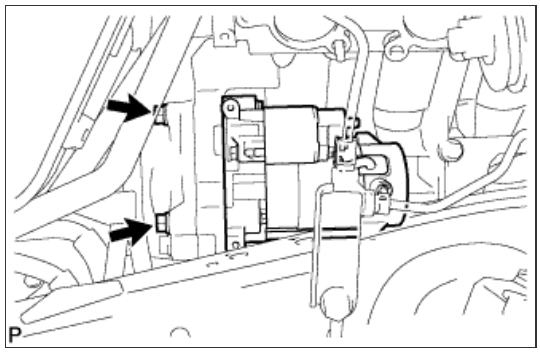
4. REMOVE STARTER ASSEMBLY

a. Disconnect the starter connector.

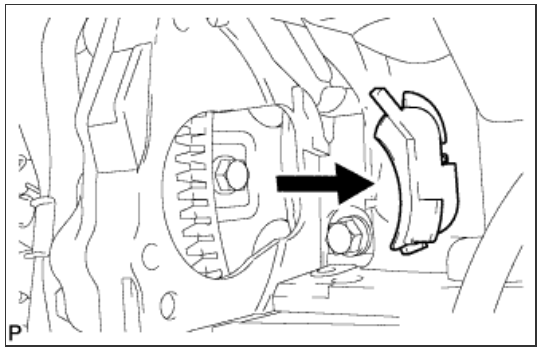
b. Remove the nut and disconnect the starter wire.



c. Remove the 2 bolts and starter.



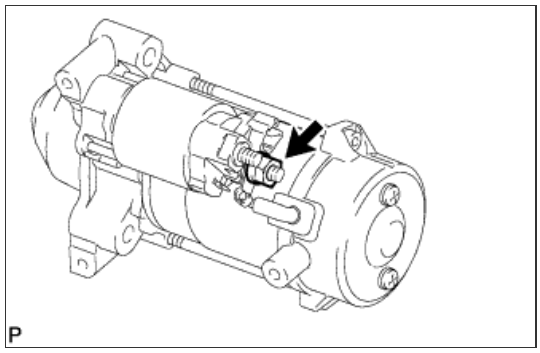
d. Remove the flywheel housing side cover.



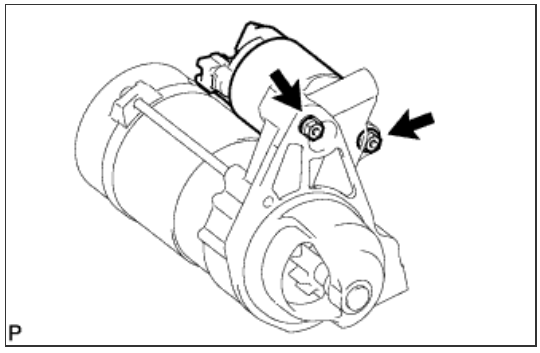
for Preparation Click here

1. REMOVE MAGNET STARTER SWITCH ASSEMBLY

a. Remove the nut, and disconnect the lead wire from the terminal C.



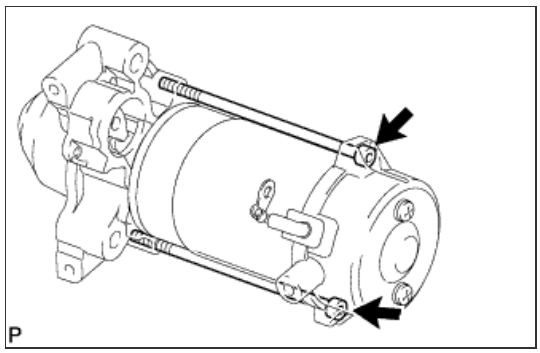
b. Remove the 2 nuts and magnet starter switch.



2. REMOVE STARTER DRIVE HOUSING ASSEMBLY

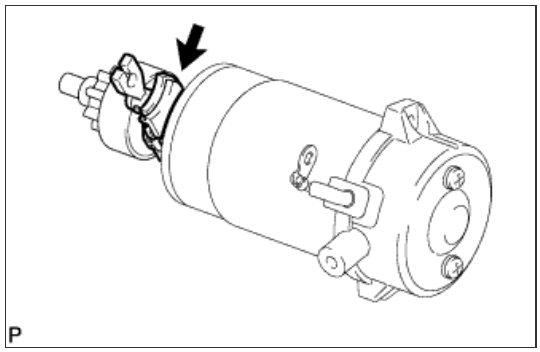
a. Using a T30 "TORX" socket wrench, remove the 2 bolts.

b. Pull out the starter yoke and the starter commutator end frame together with the starter armature.



3. REMOVE STARTER COMMUTATOR END FRAME ASSEMBLY

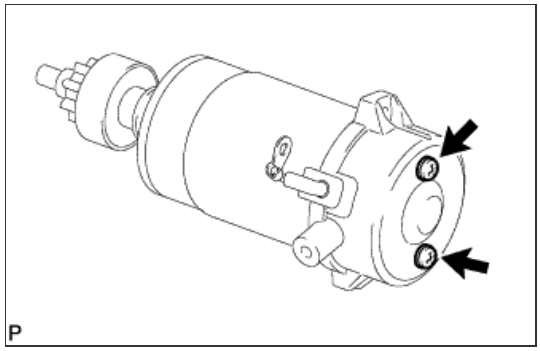
a. Remove the starter pinion drive lever.



b. Remove the 2 screws and end frame.

NOTICE:

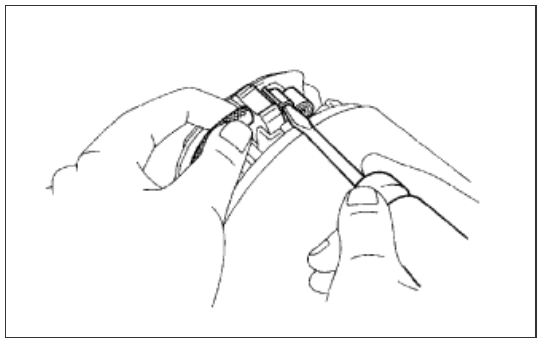
While holding down the lead wire, remove the starter commutator end frame.



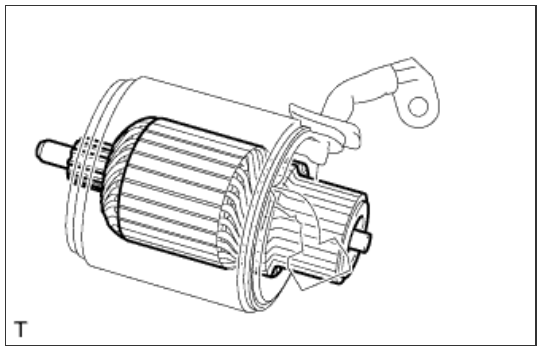
4. REMOVE STARTER ARMATURE ASSEMBLY

a. Using a screwdriver, hold the spring back and disconnect the brush from the starter brush holder.

b. Disconnect the 4 brushes and remove the starter brush holder.



c. Remove the starter armature from the starter yoke.

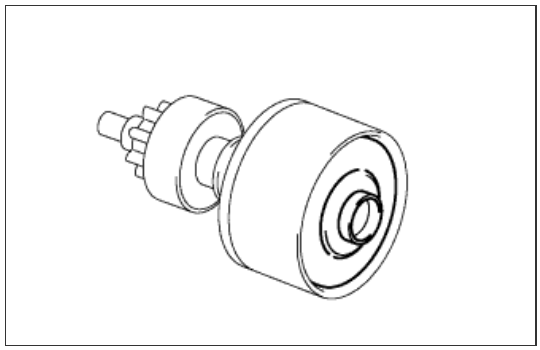


5. REMOVE STARTER YOKE ASSEMBLY

a. Remove the starter yoke from the starter center bearing clutch.

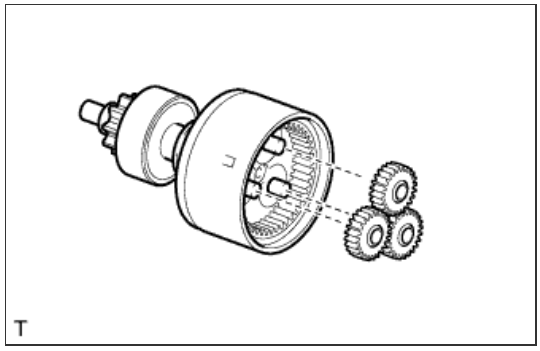
6. REMOVE STARTER ARMATURE PLATE

a. Remove the starter armature plate from the starter center bearing clutch.



7. REMOVE PLANETARY GEAR

a. Remove the 3 planetary gears.



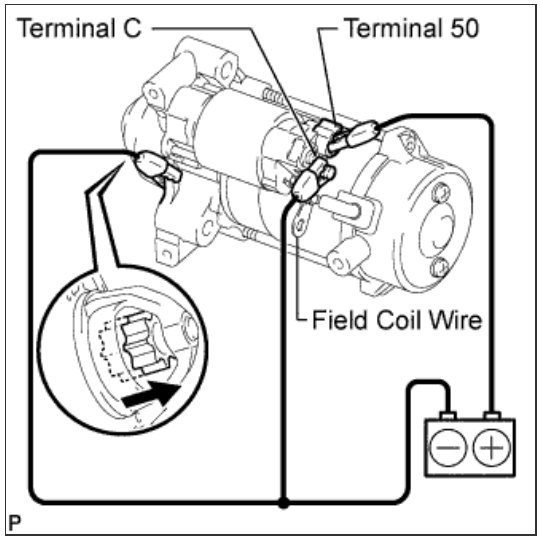
for Preparation Click here

1. INSPECT STARTER ASSEMBLY

NOTICE:

The following tests must be performed for no more than 5 seconds to prevent the coil from burning out.

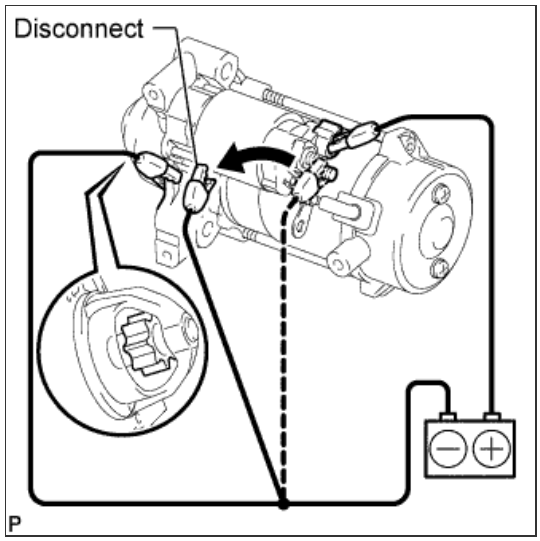
a. Perform pull-in test.



i. Disconnect the lead wire from terminal C.

ii. Connect the battery to the magnet starter switch as shown in the illustration. Check that the clutch pinion gear moves outward.
If the clutch pinion gear does not move outward, replace the magnet starter switch assembly.

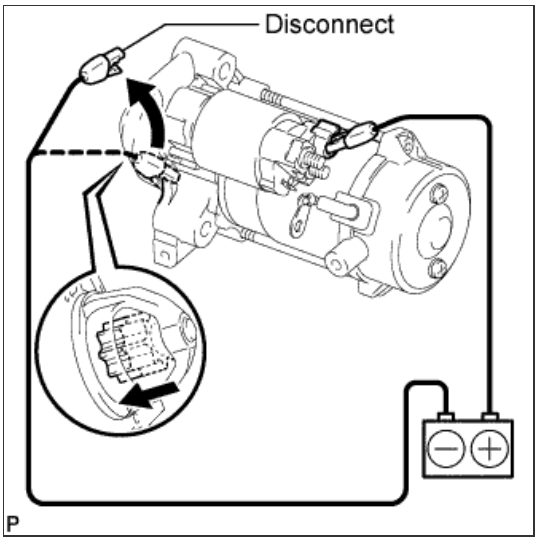
b. Perform holding test.



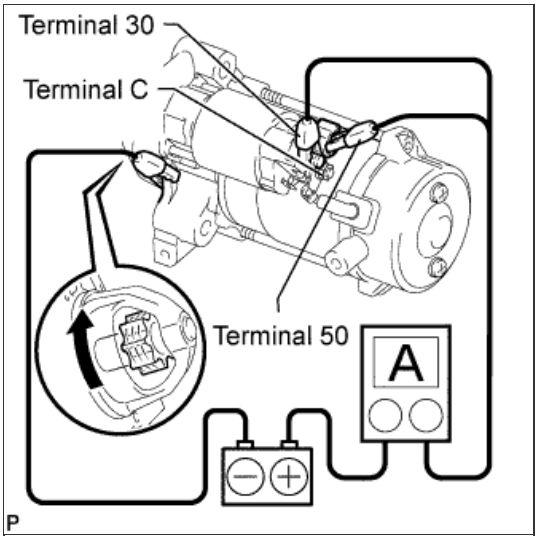
i. Disconnect the negative (-) terminal lead from terminal C with the condition specified in the pull-in test above being maintained. Check that the pinion gear remains out.
If the clutch pinion gear moves inward, replace the magnet starter switch assembly.

c. Inspect clutch pinion gear return.

i. Disconnect the negative (-) lead from the starter body. Check that the clutch pinion gear moves inward.
If the clutch pinion gear does not move inward, replace the magnet starter switch assembly.



d. Perform the operation test without load.



i. Connect the field coil wire to terminal C with the nut. Make sure that the lead is not grounded.

Torque:
6.5 N*m{ 66 kgf*cm , 57 in.*lbf }

ii. Clamp the starter in a vise.

iii. Connect the battery and an ammeter to the starter as shown in the illustration.

iv. Check that the starter rotates smoothly and steadily while the pinion gear is moving out.
Then measure the current.

Standard current:
190 A or less at 11.5 V

If the result is not as specified, replace the starter assembly.

2. INSPECT STARTER ARMATURE ASSEMBLY

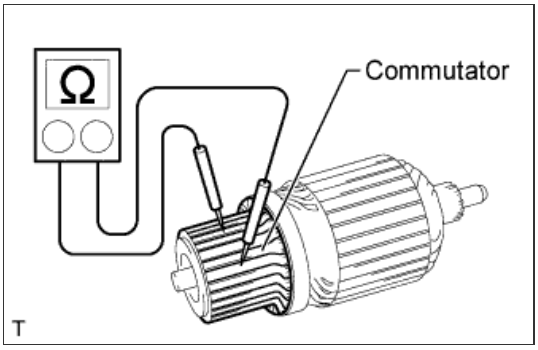
a. Inspect the commutator for an open circuit.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Commutator	Always	Below 1 Ω

If the result is not as specified, replace the starter armature assembly.



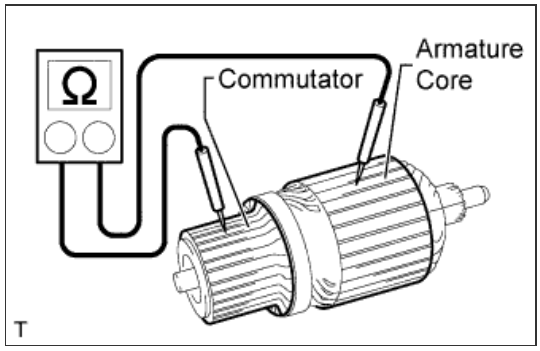
b. Inspect the commutator for a short circuit.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Commutator - Armature coil core	Always	10 kΩ or higher

If the result is not as specified, replace the starter armature assembly.



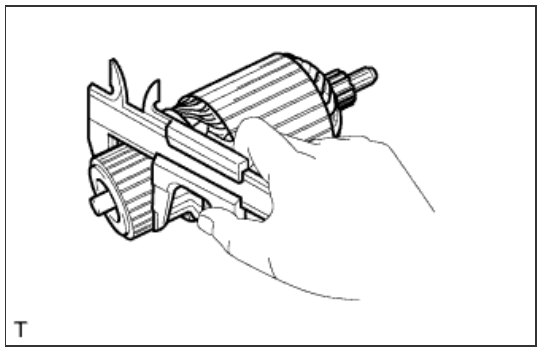
c. Check the surface of the commutator for dirt and burns.
If the surface is dirty or burnt, correct it with sandpaper (No. 400) or a lathe.

d. Using a vernier caliper, measure the commutator diameter.

Standard diameter:
35.0 mm (1.38 in.)

Minimum diameter:
34.0 mm (1.34 in.)

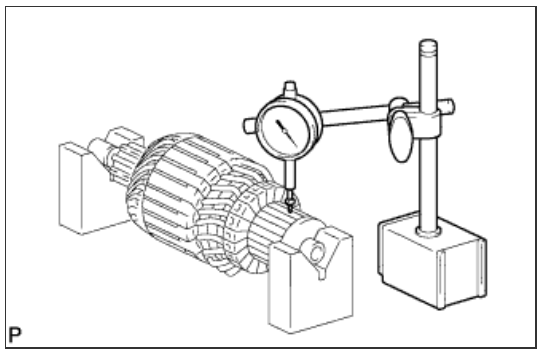
If the diameter is less than the minimum, replace the starter armature assembly.



e. Using a dial indicator, measure the commutator runout.

Maximum commutator runout:
0.05 mm (0.00197 in.)

If the commutator runout is more than the maximum, correct it using a lathe.

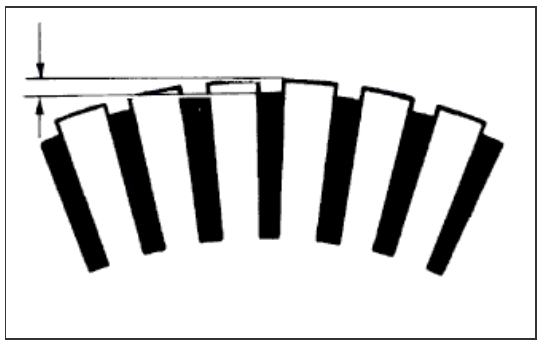


f. Measure the undercut depth of the commutator.

Standard undercut depth:
0.7 mm (0.0276 in.)

Minimum undercut depth:
0.2 mm (0.00787 in.)

If the undercut depth is less than the minimum, increase the depth using a hacksaw blade.



3. INSPECT BRUSH

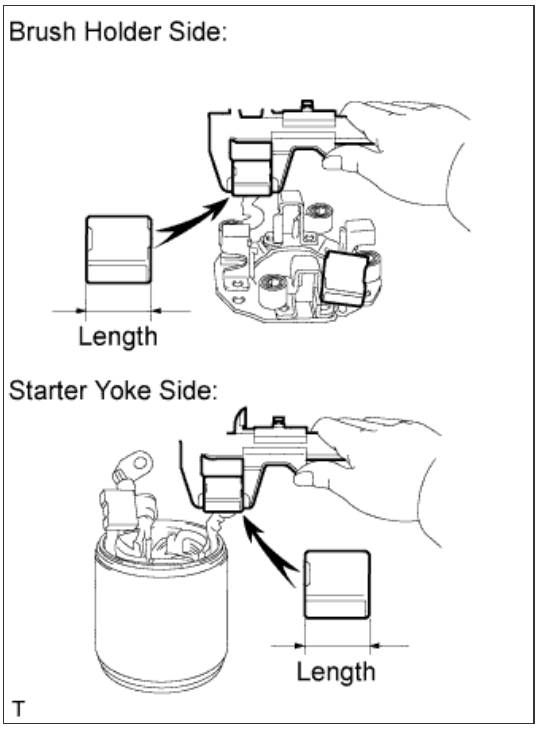
a. Using a vernier caliper, measure the brush length.

Standard length:
15.0 mm (0.591 in.)

Minimum length:
10.0 mm (0.394 in.)

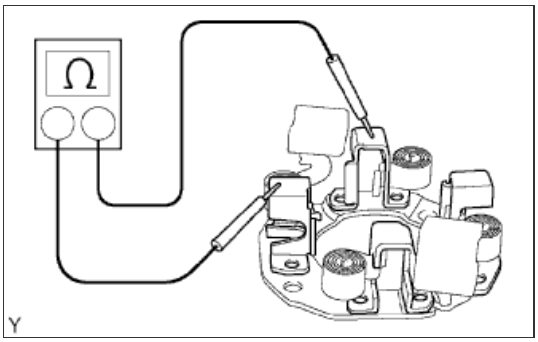
If the brush length is less than the minimum, replace the starter brush holder

assembly and yoke assembly.



4. INSPECT STARTER BRUSH HOLDER ASSEMBLY

a. Inspect the insulation.



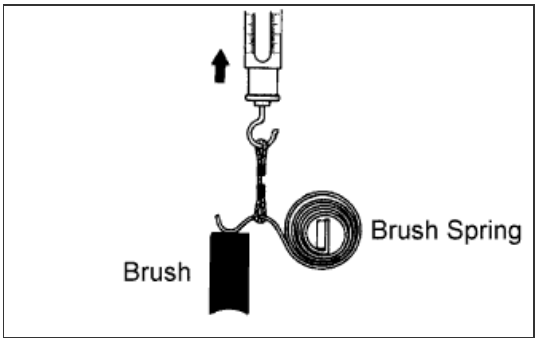
i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Positive (+) brush holder - Negative (-) brush holder	Always	10 kΩ or higher

If the result is not as specified, replace the starter brush holder assembly.

b. Inspect the load of the brush spring.



i. Take a pull scale reading immediately after the brush spring separates from the brush.

Standard spring installed load:
21.5 to 27.5 N (2.2 to 2.8 kgf, 4.8 to 6.2 lbf)

Minimum spring installed load:
12.3 N (1.3 kgf, 2.8 lbf)

If the installed load is less than the minimum, replace the starter brush holder assembly.

5. INSPECT STARTER YOKE ASSEMBLY

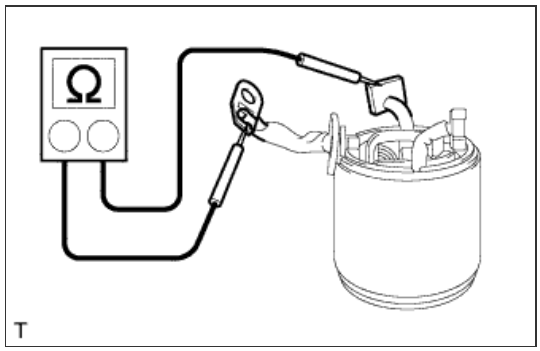
a. Inspect the resistance of the field coil.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Terminal C wire - Brushes	Always	Below 1 Ω

If the result is not as specified, repair or replace the starter yoke assembly.

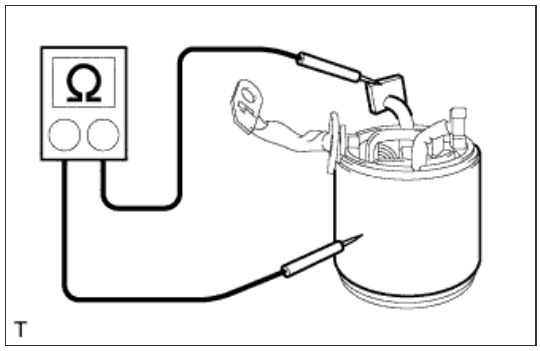


ii. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Brushes - Starter yoke body	Always	10 kΩ or higher

If the result is not as specified, repair or replace the starter yoke assembly.



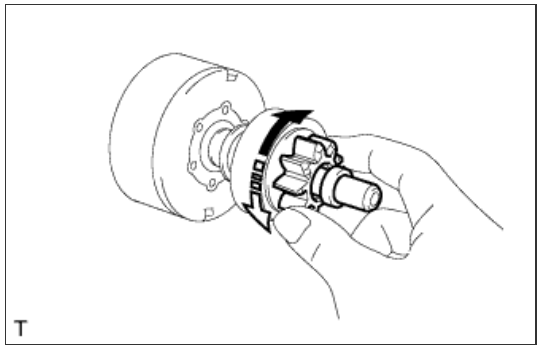
6. INSPECT STARTER CENTER BEARING CLUTCH SUB-ASSEMBLY

a. Check the gear teeth of the planetary gear and starter center bearing clutch for wear or damage.
If any planetary gear is damaged, replace the planetary gear assembly. If any gear of the starter center bearing clutch is damaged, replace the starter center bearing clutch sub-assembly.

b. Check the movement of the clutch pinion gear.

i. Rotate the clutch pinion gear clockwise, and check that it turns freely.

ii. Try to rotate the clutch pinion gear counterclockwise, and check that it locks.
If the clutch pinion gear cannot be turned clockwise smoothly, or does not lock in the counterclockwise direction, replace the starter center bearing clutch sub-assembly.



7. INSPECT MAGNET STARTER SWITCH ASSEMBLY

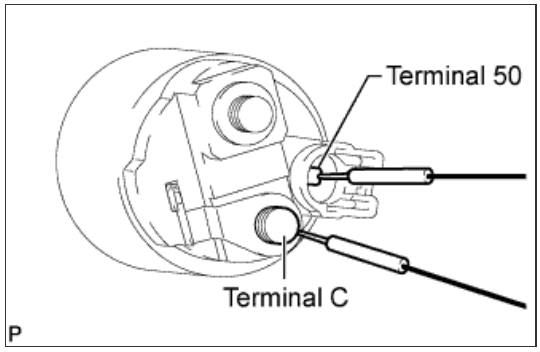
a. Inspect the pull-in coil.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Terminal 50 - Terminal C	Always	Below 1 Ω

If the result is not as specified, replace the magnet starter switch assembly.



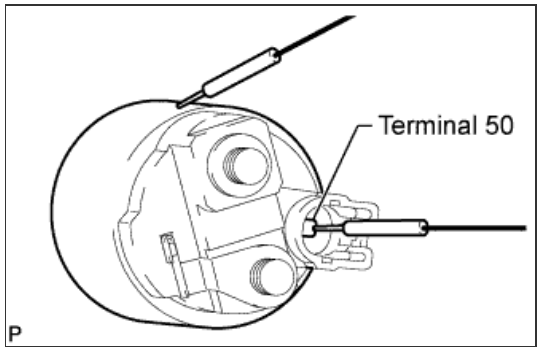
b. Inspect the holding coil.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
Terminal 50 - Switch body	Always	Below 2 Ω

If the result is not as specified, replace the magnet starter switch assembly.

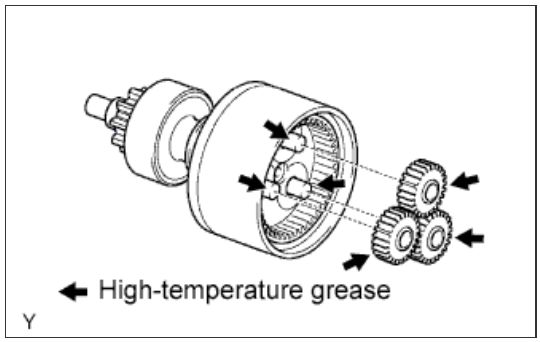


for Preparation Click here

1. INSTALL PLANETARY GEAR

a. Apply high-temperature grease to the planetary gears and pin parts of the planetary shaft, as shown in the illustration.

b. Install the 3 planetary gears.

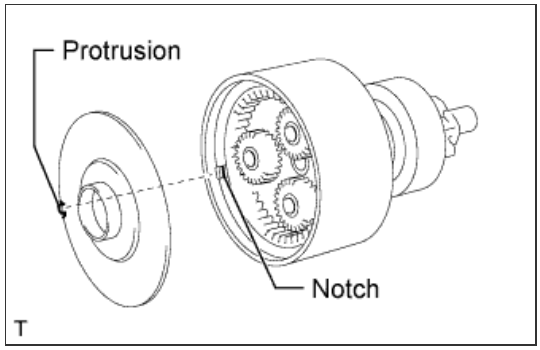


2. INSTALL STARTER ARMATURE PLATE

a. Insert the plate to the starter center bearing clutch.

NOTICE:

Check that the protrusion of the starter armature plate fits over the notch of the starter center bearing clutch.

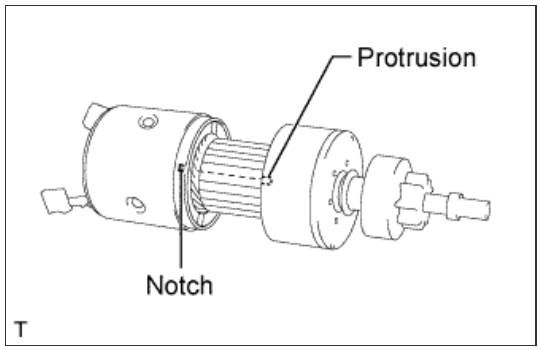


3. INSTALL STARTER ARMATURE ASSEMBLY

a. Install the starter armature to the starter center bearing clutch.

4. INSTALL STARTER YOKE ASSEMBLY

a. Align the protrusion of the starter center bearing clutch with the notch of the starter yoke, and install the starter yoke.

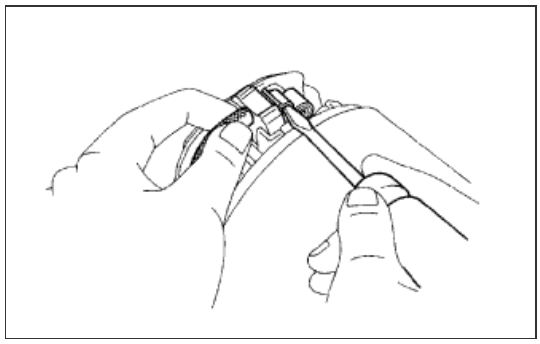


5. INSTALL STARTER COMMUTATOR END FRAME ASSEMBLY

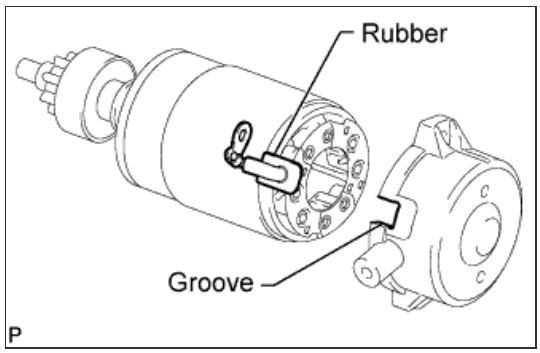
a. Install the starter brush holder.

b. Using a screwdriver, hold the brush spring back and connect the brush into the starter brush holder.

c. Connect the 4 brushes.

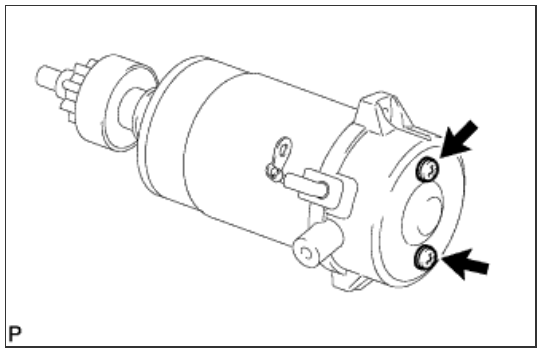


d. Align the starter commutator end frame groove with the rubber of the starter yoke.



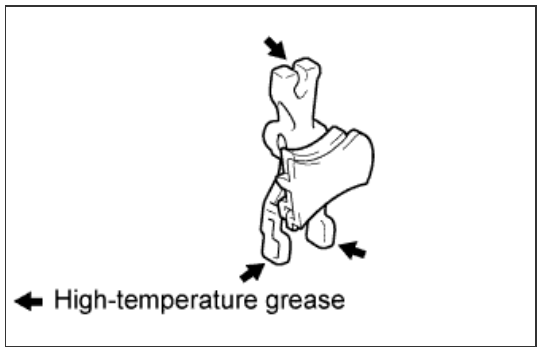
e. Install the starter commutator end frame with the 2 screws.

Torque:
3.8 N*m{ 39 kgf*cm , 33 in.*lbf }

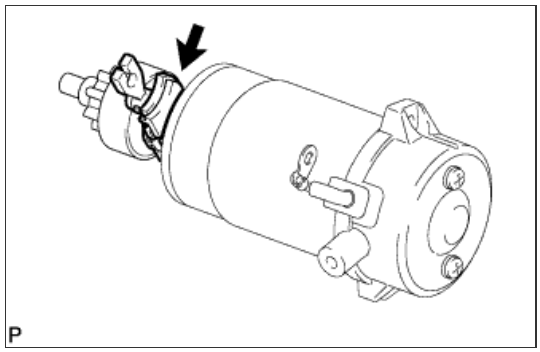


6. INSTALL STARTER DRIVE HOUSING ASSEMBLY

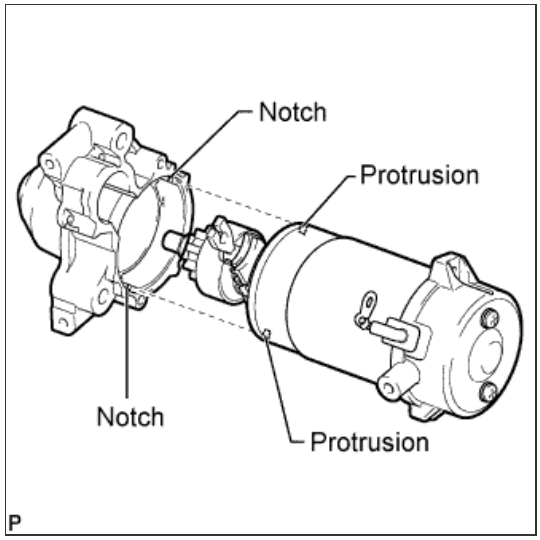
a. Apply high-temperature grease to the starter pinion drive lever, as shown in the illustration.



b. Install the starter pinion drive lever to the starter center bearing clutch.

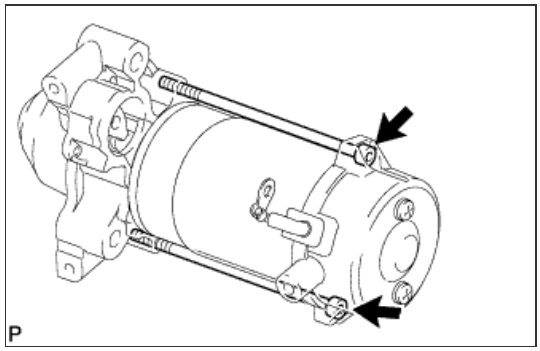


c. Align the protrusion of the starter center bearing clutch with the notch inside the starter drive housing.



d. Using a T30 "TORX" socket wrench, install the starter drive housing with the 2 bolts.

Torque:
6.0 N*m{ 61 kgf*cm , 53 in.*lbf }

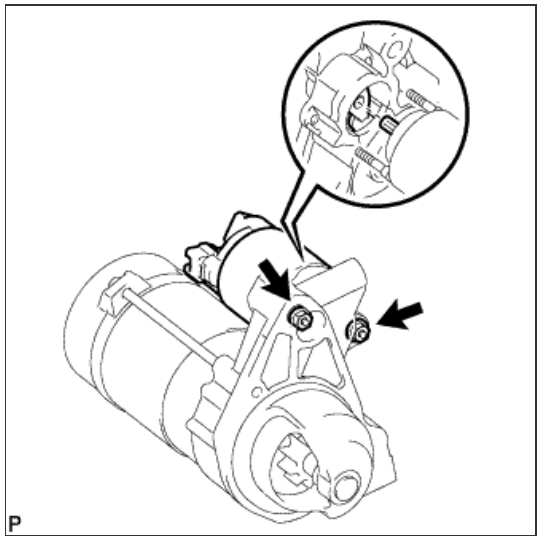


7. INSTALL MAGNET STARTER SWITCH ASSEMBLY

a. Temporarily install the magnet starter switch by hooking its tip to the upper side of the pinion drive lever.

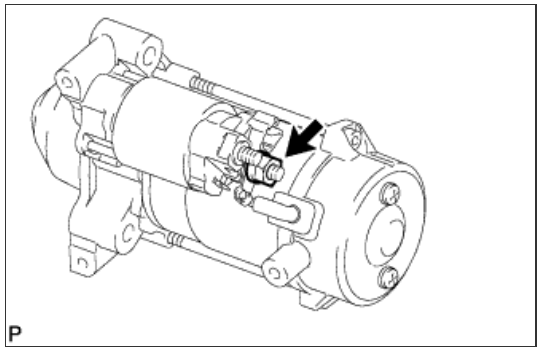
b. Install the 2 nuts.

Torque:
7.5 N*m{ 76 kgf*cm , 66 in.*lbf }



c. Connect the lead wire to the terminal with the nut.

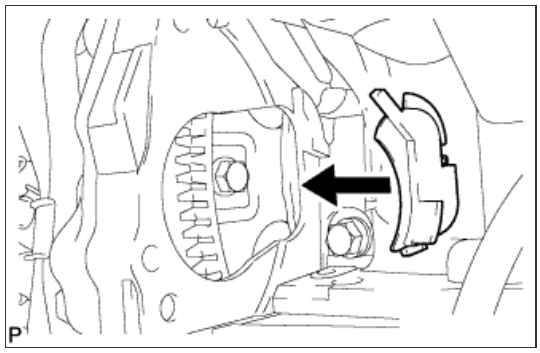
Torque:
6.5 N*m{ 66 kgf*cm , 57 in.*lbf }



for Preparation Click here

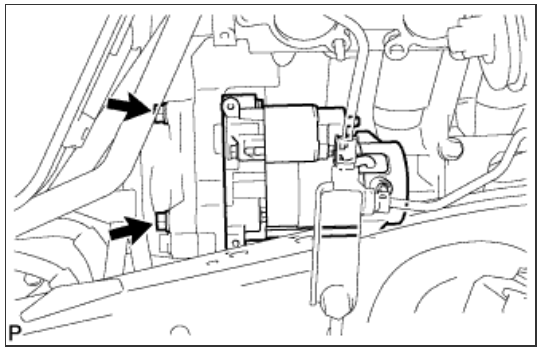
1. INSTALL STARTER ASSEMBLY

a. Install the flywheel housing side cover.



b. Install the starter with the 2 bolts.

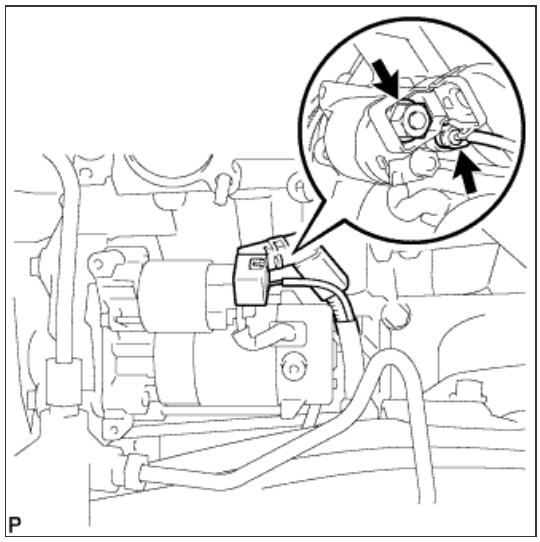
Torque:
37 N*m{ 377 kgf*cm , 27 ft.*lbf }



c. Install the starter wire with the nut.

Torque:
9.8 N*m{ 100 kgf*cm , 87 in.*lbf }

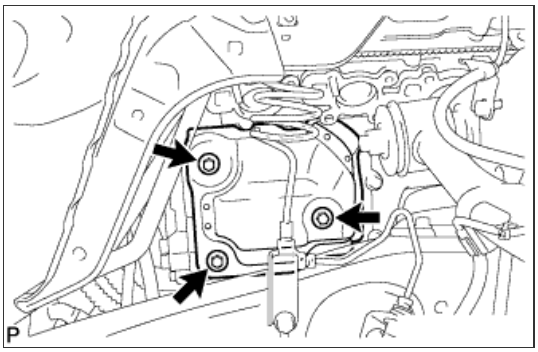
d. Connect the starter connector.



2. INSTALL STARTER COVER

a. Install the starter cover with the 3 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



3. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY RH

a. Install the exhaust manifold RH (Click here).

4. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

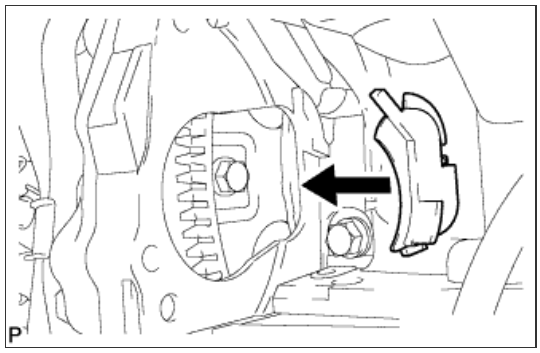
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

for Preparation Click here

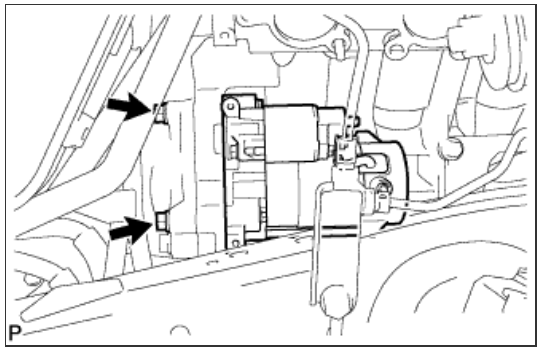
1. INSTALL STARTER ASSEMBLY

a. Install the flywheel housing side cover.



b. Install the starter with the 2 bolts.

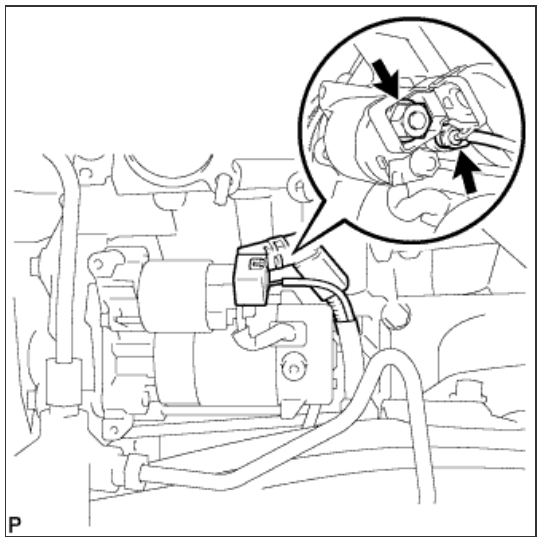
Torque:
37 N*m{ 377 kgf*cm , 27 ft.*lbf }



c. Install the starter wire with the nut.

Torque:
9.8 N*m{ 100 kgf*cm , 87 in.*lbf }

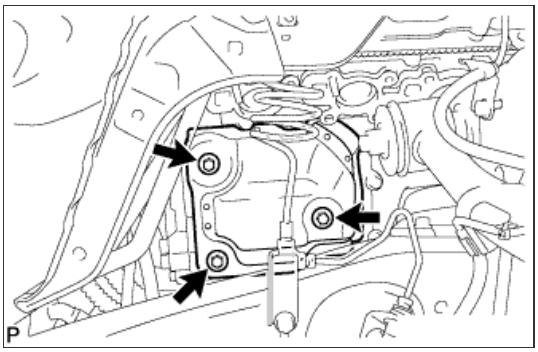
d. Connect the starter connector.



2. INSTALL STARTER COVER

a. Install the starter cover with the 3 bolts.

Torque:
12 N*m{ 122 kgf*cm , 9 ft.*lbf }



3. INSTALL EXHAUST MANIFOLD SUB-ASSEMBLY RH

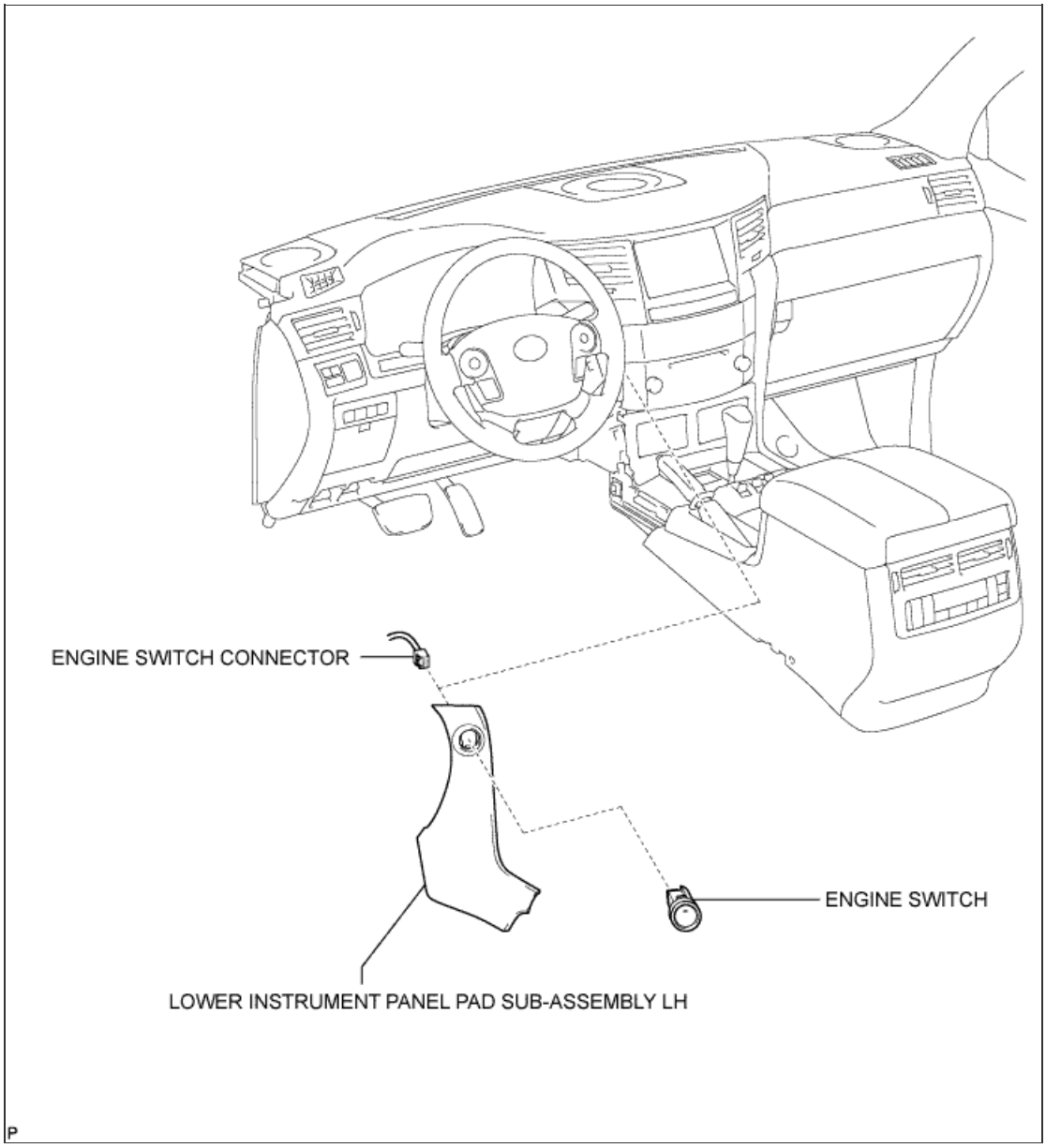
a. Install the exhaust manifold RH (Click here).

4. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

for Preparation Click here



for Preparation Click here

1. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

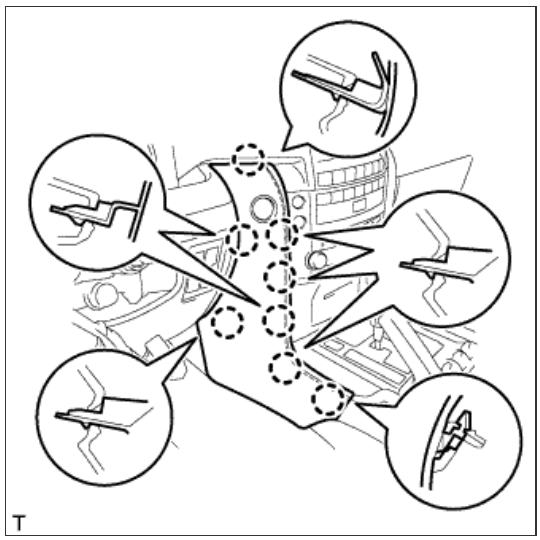
NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

2. REMOVE LOWER INSTRUMENT PANEL PAD SUB-ASSEMBLY LH

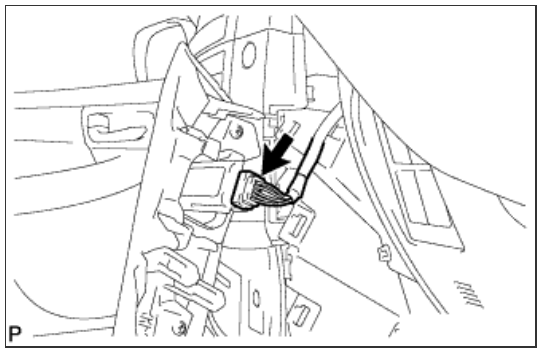
a. Detach the 8 claws.

b. Disconnect the connector and remove the panel pad.

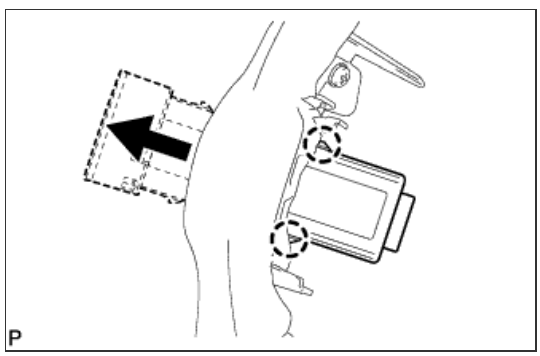


3. REMOVE ENGINE SWITCH

a. Disconnect the switch connector.



b. Detach the 2 claws and remove the switch.



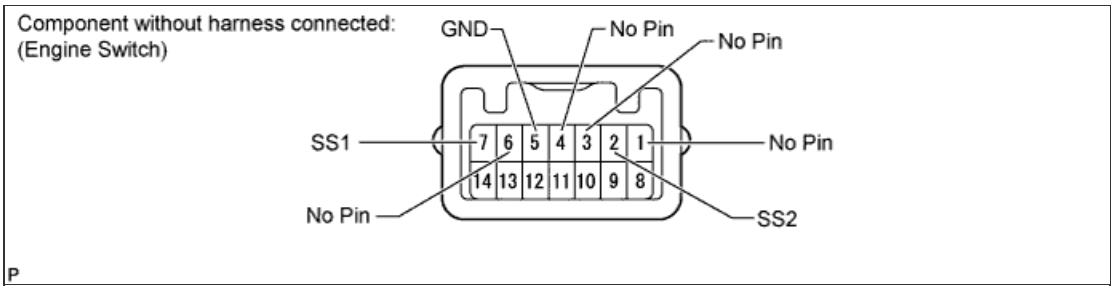
for Preparation [Click here]

1. INSPECT ENGINE SWITCH

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
7 (SS1) - 5 (GND)	Not pushed	10 kΩ or higher
2 (SS2) - 5 (GND)	Not pushed	10 kΩ or higher
7 (SS1) - 5 (GND)	Pushed	Below 1 Ω
2 (SS2) - 5 (GND)	Pushed	Below 1 Ω



If the result is not as specified, replace the engine switch.

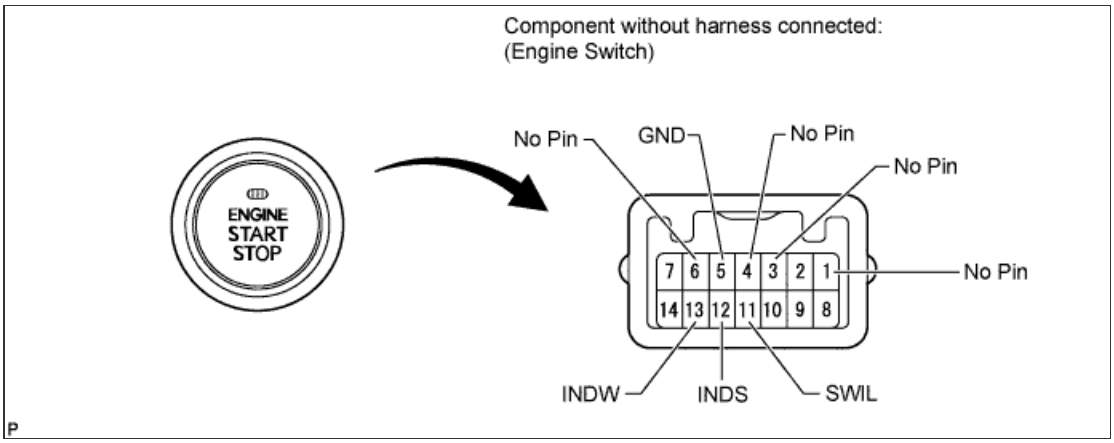
b. Apply battery voltage between the terminals of the switch, and check the illumination condition of the switch.

HINT:

- **If the positive (+) lead and the negative (-) lead are incorrectly connected, the engine switch indicator will not illuminate.**
- **If the voltage is too low, the indicator will not illuminate.**

OK:

Measurement Condition	Specified Condition
Battery positive (+) → Terminal 11 (SWIL) Battery negative (-) → Terminal 5 (GND)	Illuminates (illumination of lettering)
Battery positive (+) → Terminal 12 (INDS) Battery negative (-) → Terminal 5 (GND)	Illuminates (green)
Battery positive (+) → Terminal 13 (INDW) Battery negative (-) → Terminal 5 (GND)	Illuminates (amber)

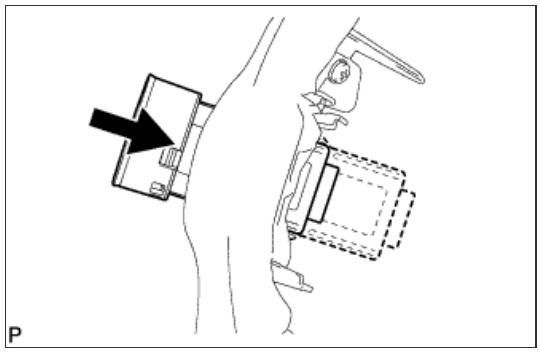


If the result is not as specified, replace the engine switch.

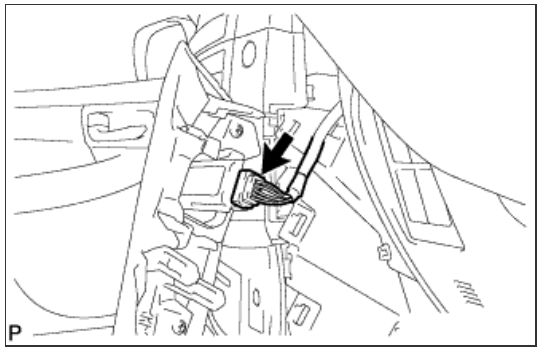
for Preparation Click here

1. INSTALL ENGINE SWITCH

a. Attach the 2 claws to install the switch.



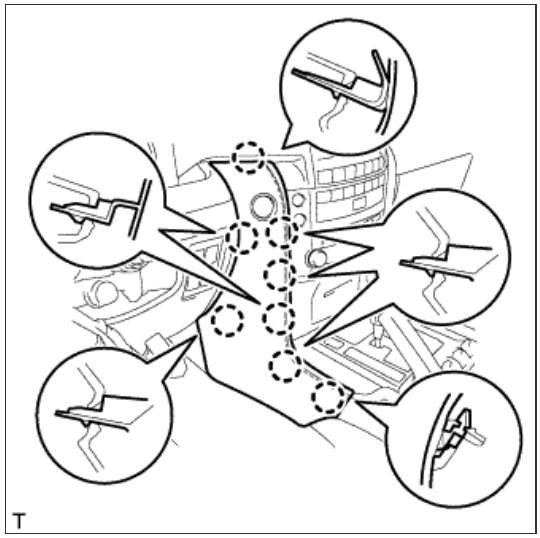
b. Connect the switch connector.



2. INSTALL LOWER INSTRUMENT PANEL PAD SUB-ASSEMBLY LH

a. Connect the connector.

b. Attach the 8 claws to install the panel pad.



3. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

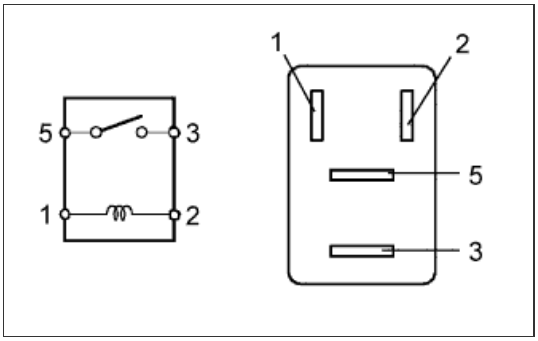
for Preparation Click here

1. INSPECT STARTER RELAY (ST)

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
3 - 5	Battery voltage not applied to terminals 1 and 2	10 kΩ or higher
	Battery voltage applied to terminals 1 and 2	Below 1 Ω



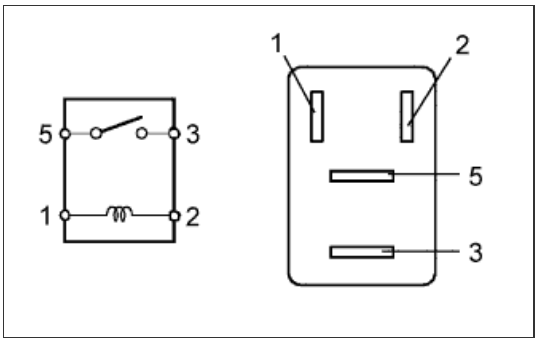
If the result is not as specified, replace the relay.

2. INSPECT STARTER CUT RELAY (ST CUT)

a. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

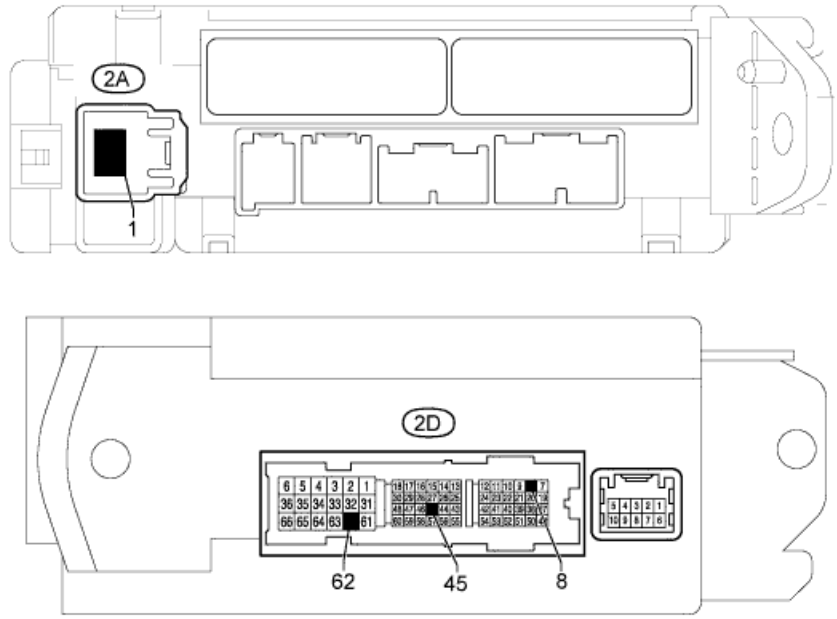
Tester Connection	Condition	Specified Condition
3 - 5	Battery voltage not applied to terminals 1 and 2	10 kΩ or higher
	Battery voltage applied to terminals 1 and 2	Below 1 Ω



If the result is not as specified, replace the relay.

3. INSPECT MAIN BODY ECU (ACC RELAY)

Component without harness connected: (Main Body ECU)



P

a. Measure the resistance of the ACC relay circuit.

i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
2A-1 - 2D-8	Battery voltage not applied between 2D-45 and 2D-62	10 kΩ or higher
	Battery voltage applied between 2D-45 and 2D-62	Below 1 Ω

If the result is not as specified, replace the main body ECU.

for Preparation Click here

1.HANDLING PRECAUTION FOR CRUISE CONTROL SYSTEM

a. Turn the cruise control main switch off when not using the cruise control system.

b. Be careful as the vehicle speed increases when driving downhill with the cruise control system on.

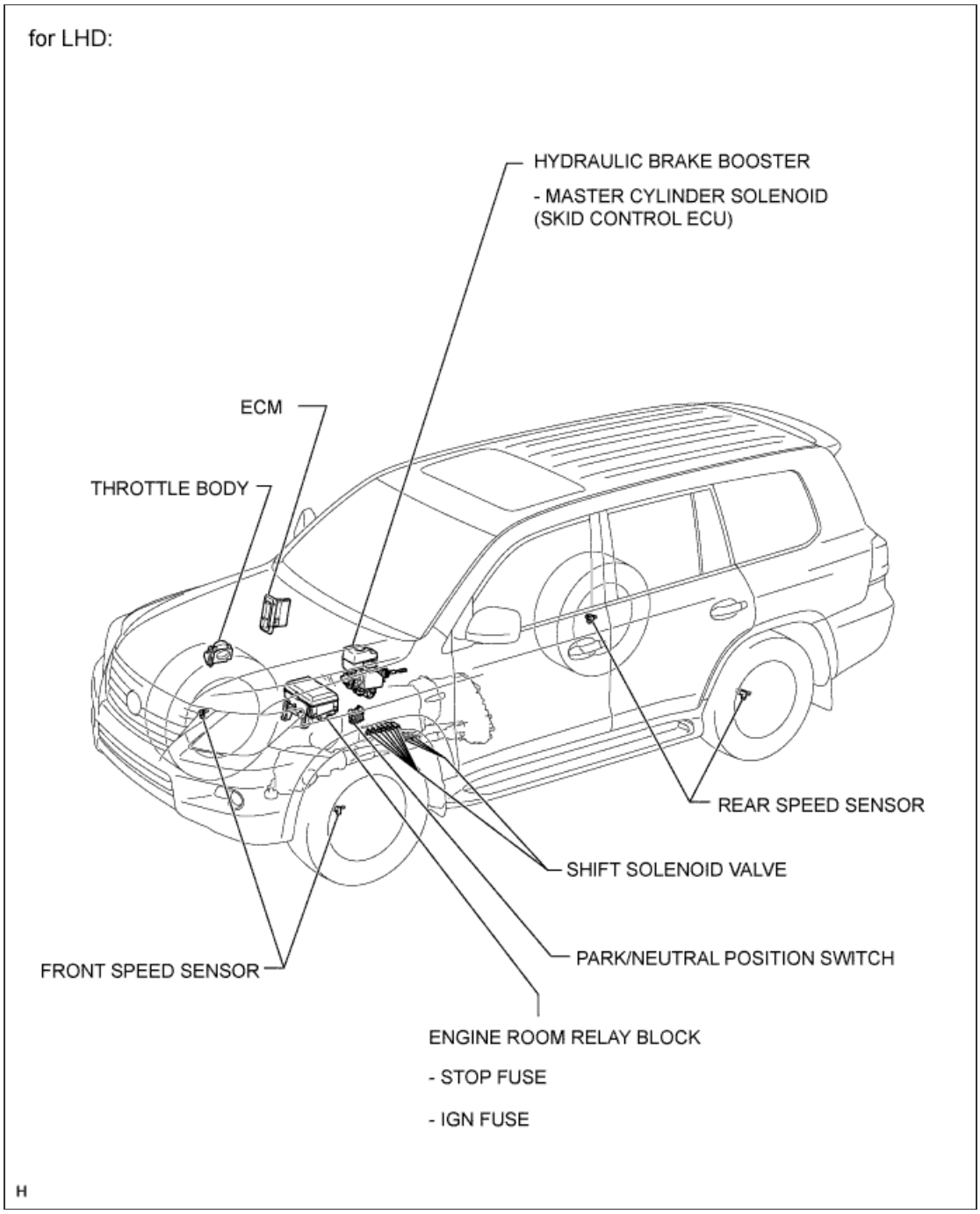
c. The +RES (ACCELERATION/RESUME) operation changes according to the cruise control system status. When the cruise control system is operating, + (ACCELERATION) operates. When the cruise control system is not operating, RES (RESUME) operates.

d. When the cruise control system is operating and the CRUISE main indicator light blinks, turn the cruise control main switch off to reset the cruise control system. After the reset, if the cruise control main switch cannot be turned on, or the cruise control system is canceled immediately after turning the cruise control main switch on, the system may have a malfunction.

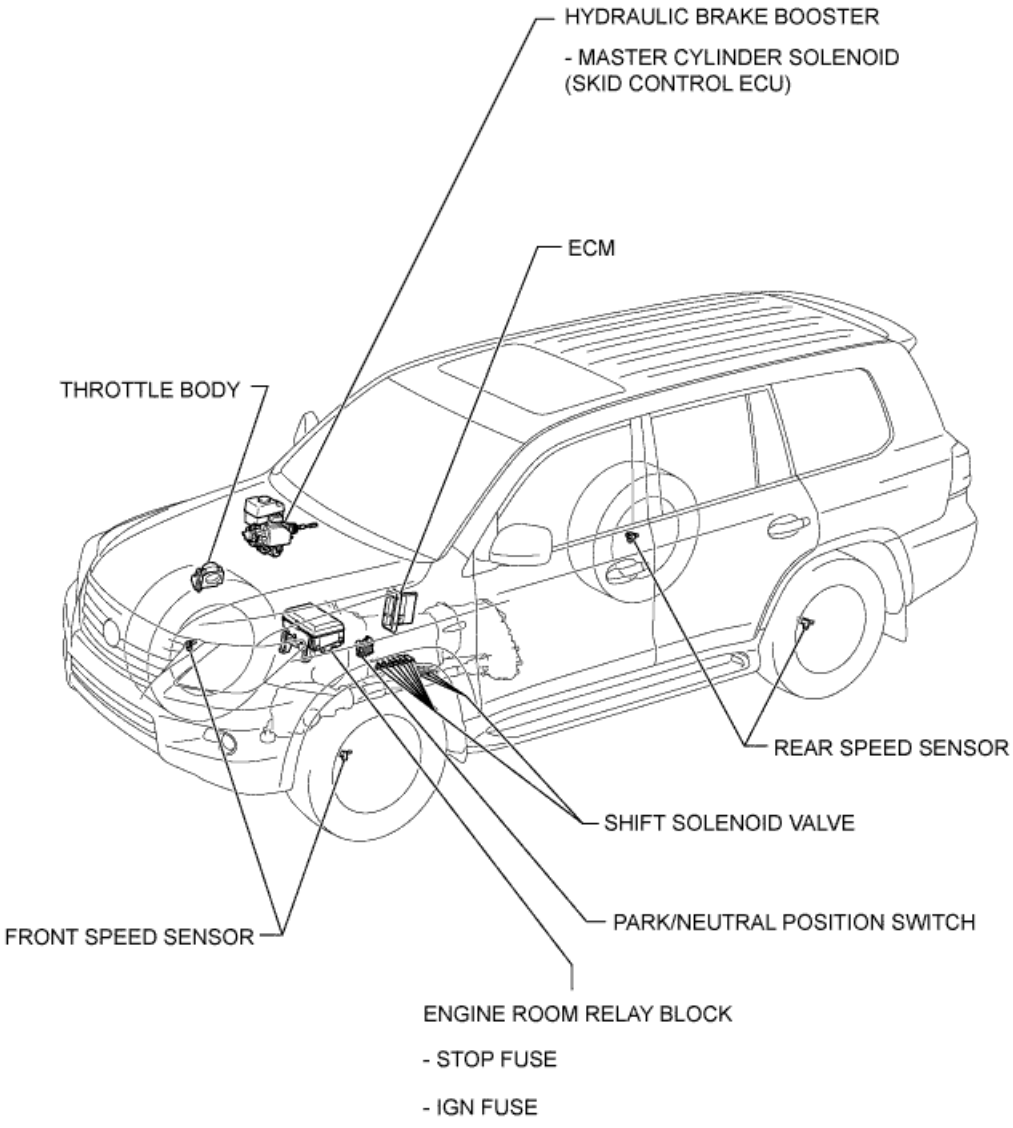
e. Do not use the cruise control system where the road conditions are as follows:

- Heavy traffic
- Steep decline
- Roads with sharp turns
- Icy or snowy roads
- Slippery roads

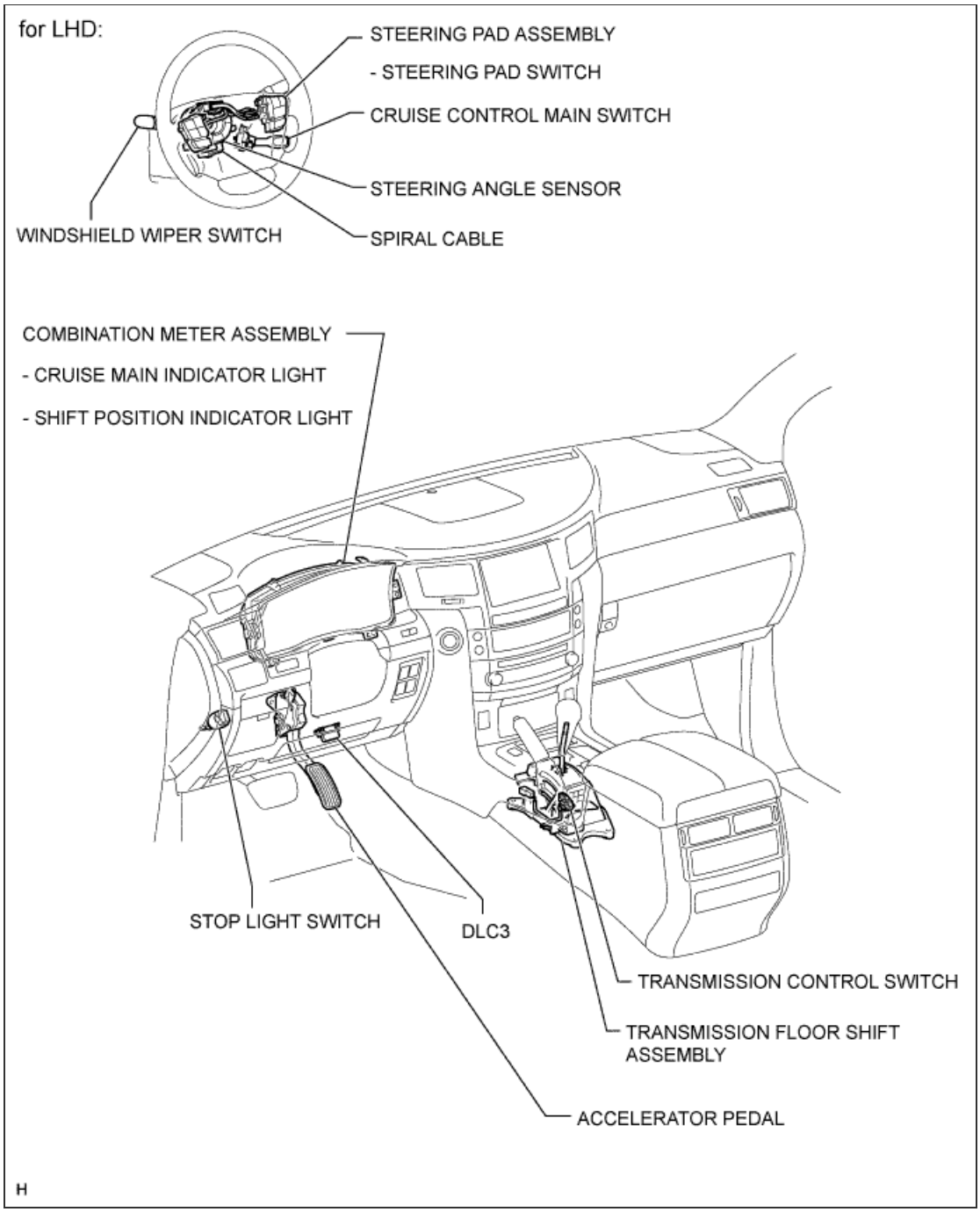
for Preparation Click here

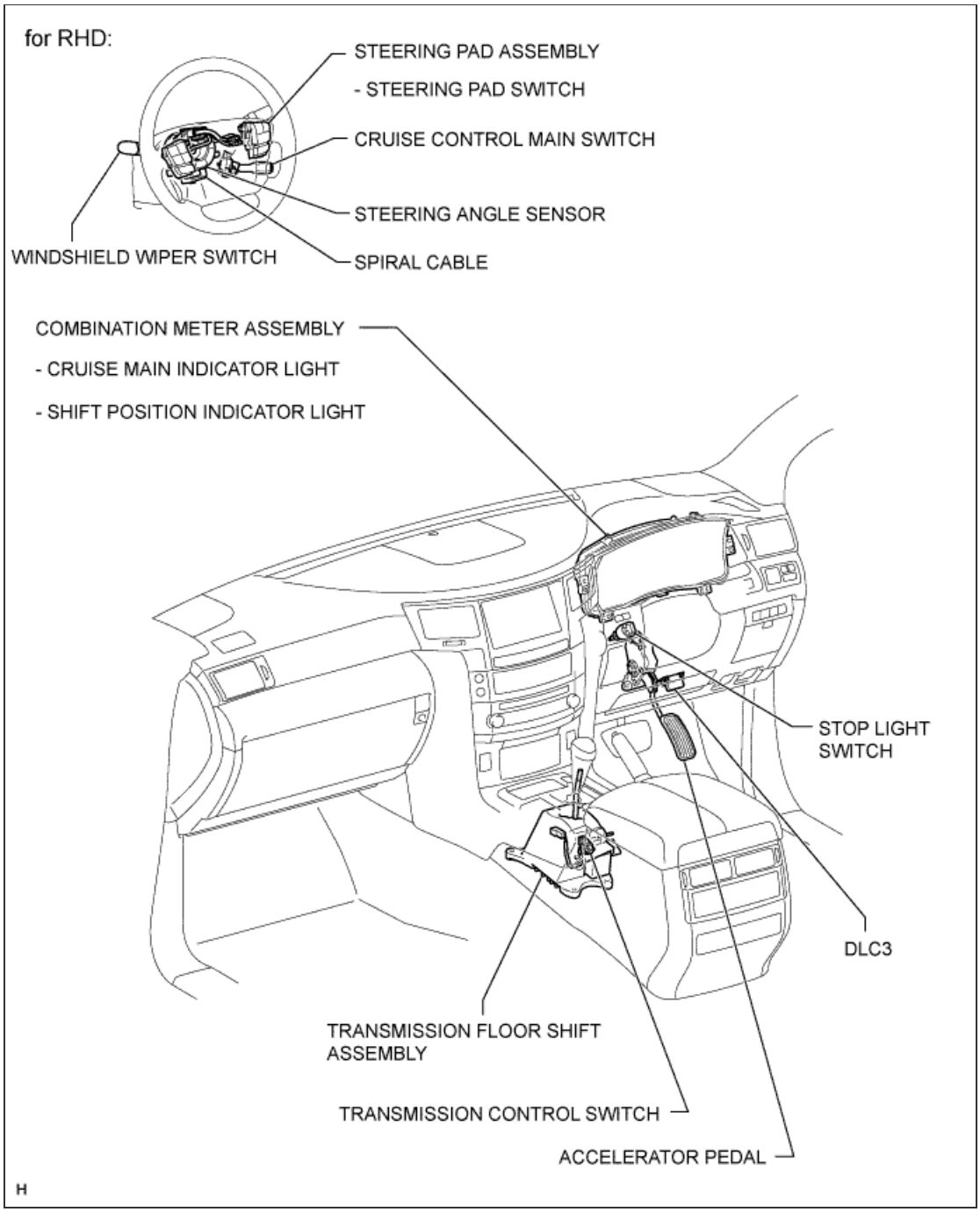


for RHD:

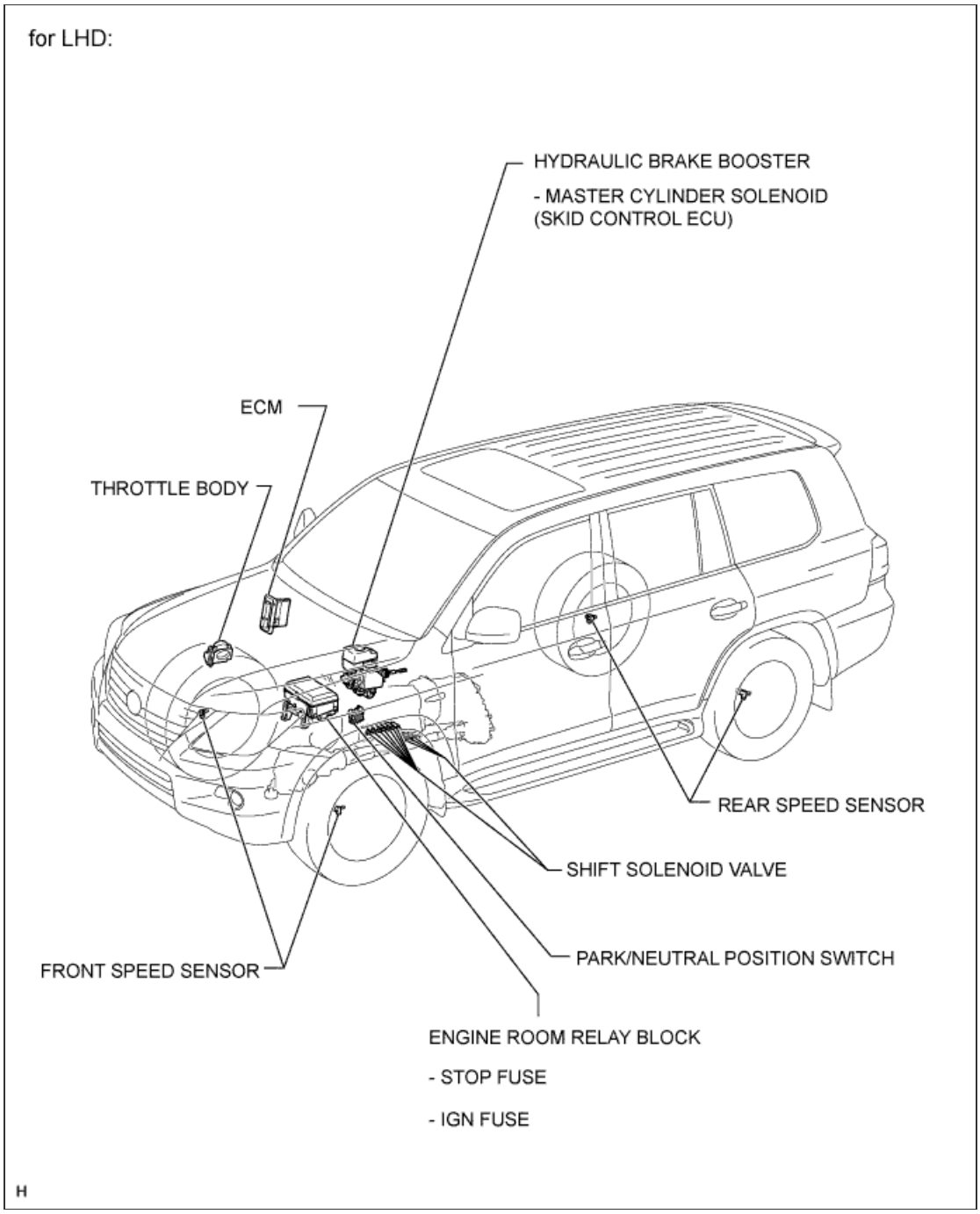

HYDRAULIC BRAKE BOOSTER
- MASTER CYLINDER SOLENOID
(SKID CONTROL ECU)
ECM
THROTTLE BODY
REAR SPEED SENSOR
SHIFT SOLENOID VALVE
PARK/NEUTRAL POSITION SWITCH
FRONT SPEED SENSOR
ENGINE ROOM RELAY BLOCK
- STOP FUSE
- IGN FUSE

H

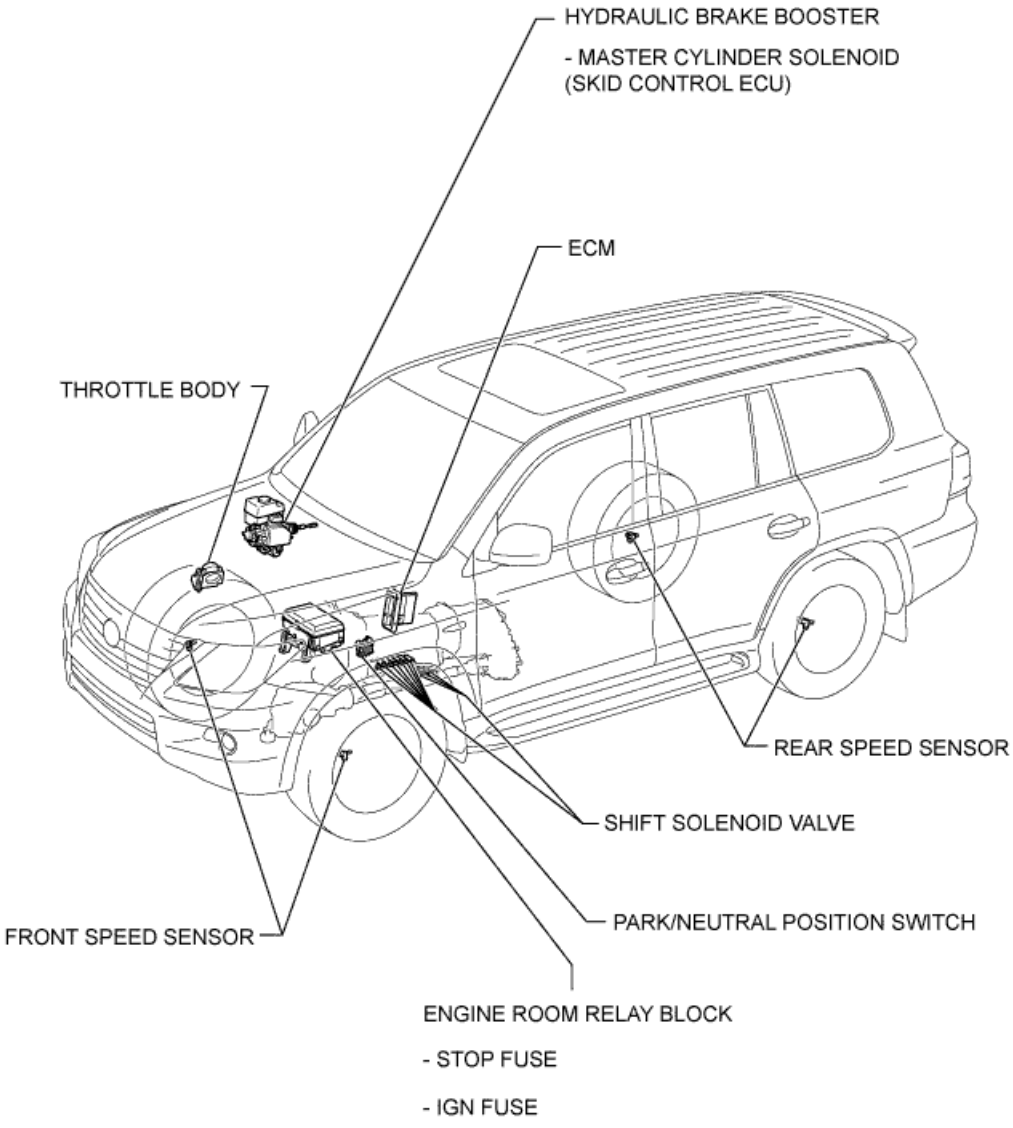

for LHD:
STEERING PAD ASSEMBLY
- STEERING PAD SWITCH
CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
- CRUISE MAIN INDICATOR LIGHT
- SHIFT POSITION INDICATOR LIGHT
STOP LIGHT SWITCH
DLC3
TRANSMISSION CONTROL SWITCH
TRANSMISSION FLOOR SHIFT ASSEMBLY
ACCELERATOR PEDAL
H


for RHD:
STEERING PAD ASSEMBLY
- STEERING PAD SWITCH
CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
- CRUISE MAIN INDICATOR LIGHT
- SHIFT POSITION INDICATOR LIGHT
STOP LIGHT SWITCH
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TRANSMISSION CONTROL SWITCH
ACCELERATOR PEDAL
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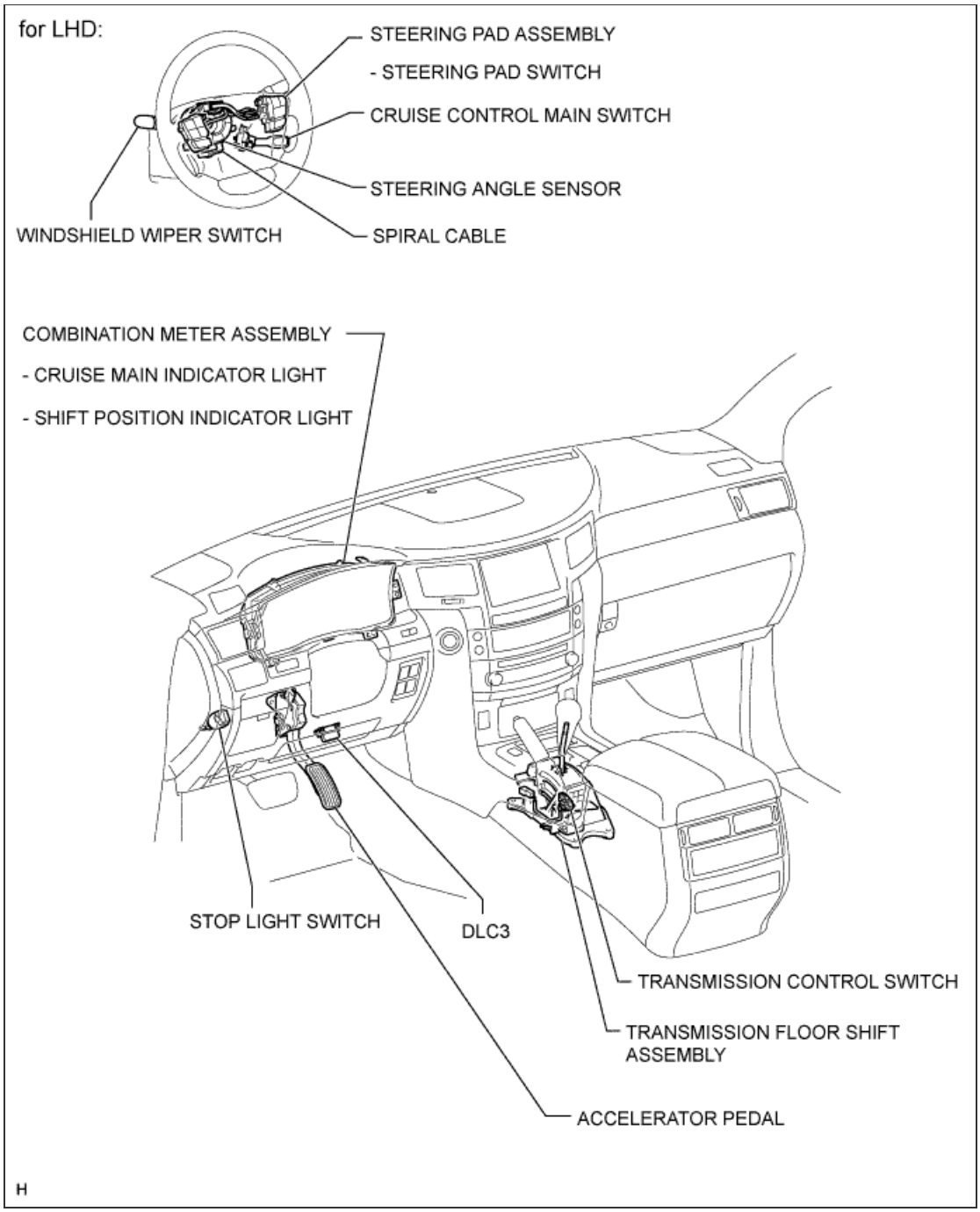
for Preparation Click here

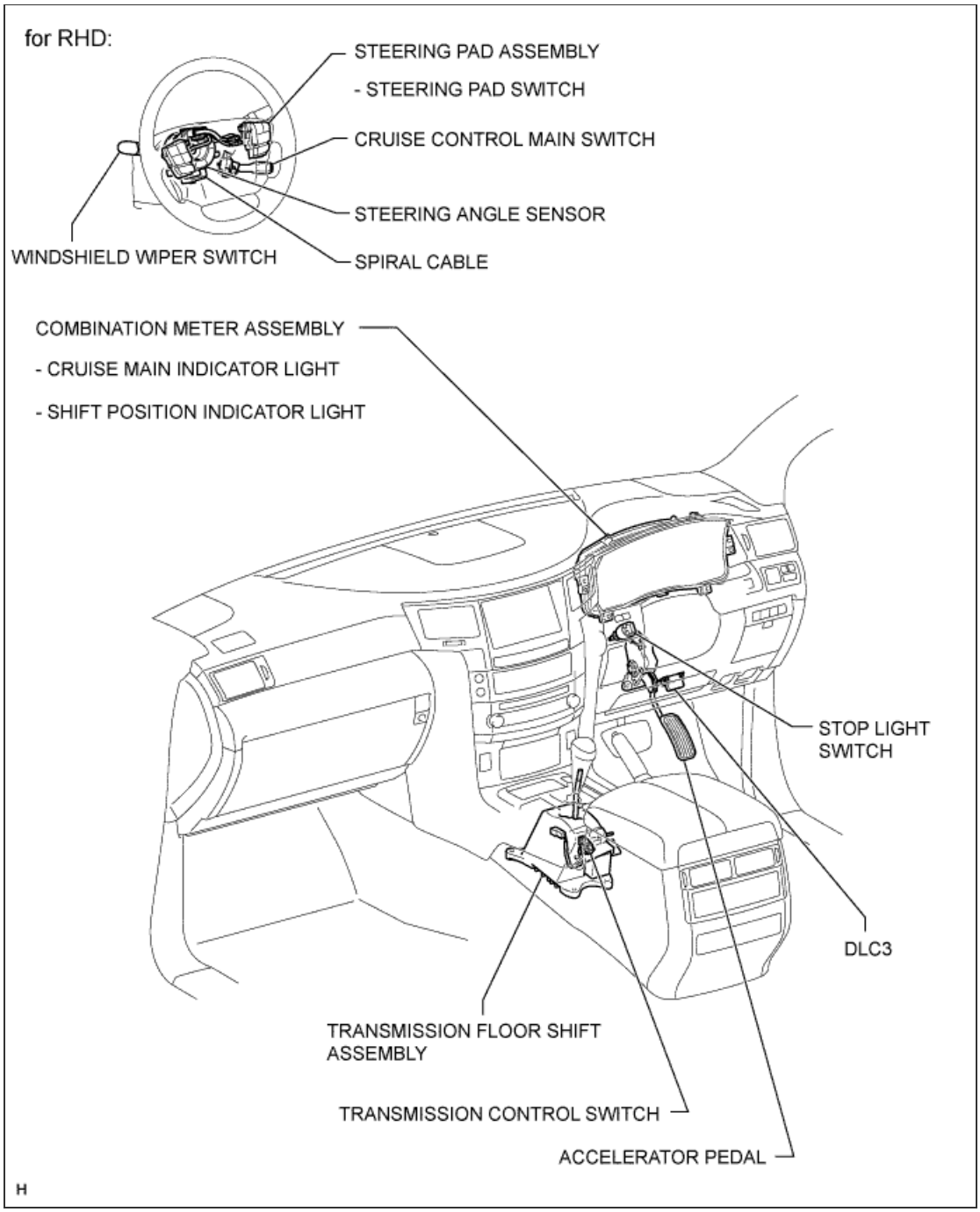


for RHD:

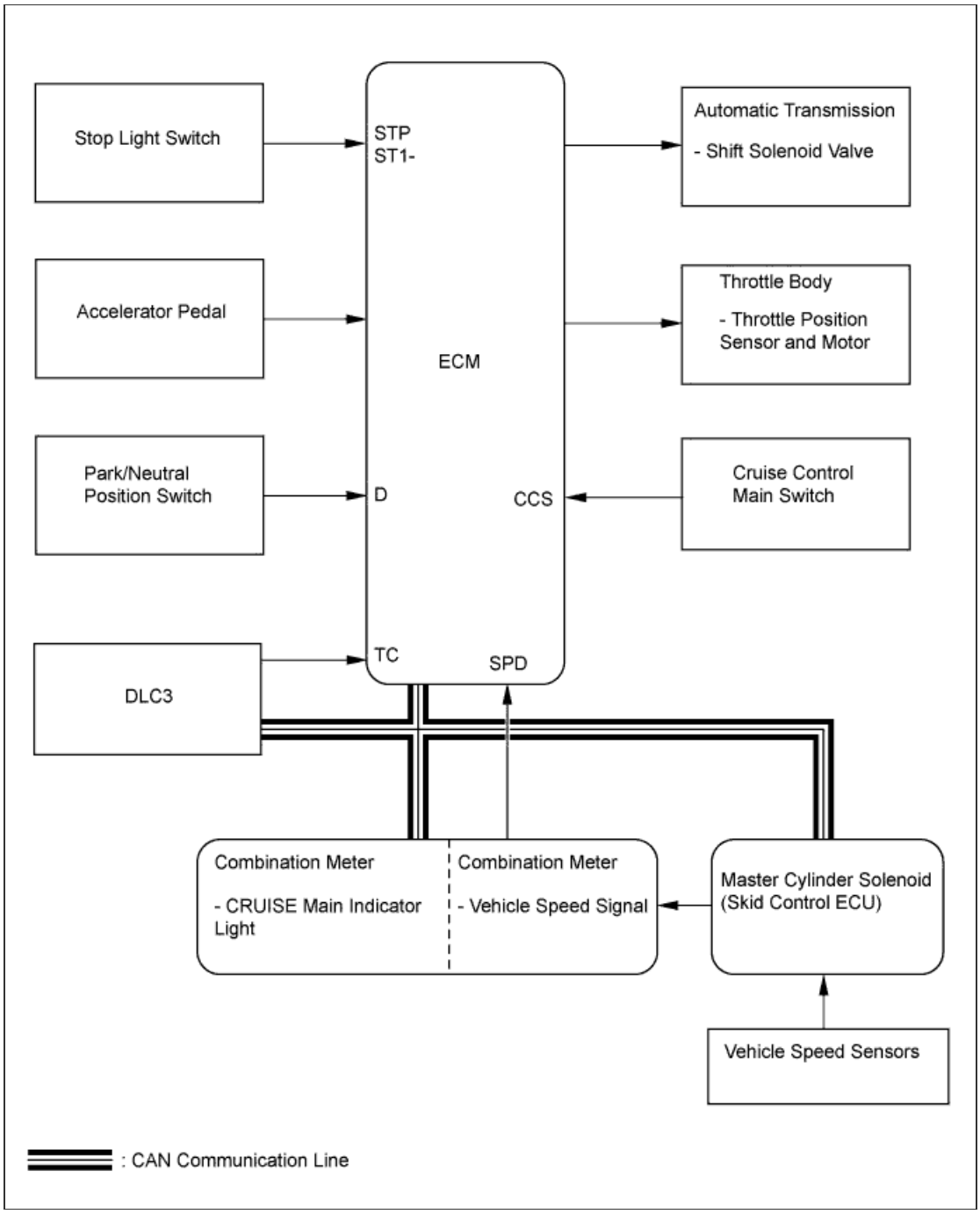

HYDRAULIC BRAKE BOOSTER
- MASTER CYLINDER SOLENOID
(SKID CONTROL ECU)
ECM
THROTTLE BODY
REAR SPEED SENSOR
SHIFT SOLENOID VALVE
PARK/NEUTRAL POSITION SWITCH
FRONT SPEED SENSOR
ENGINE ROOM RELAY BLOCK
- STOP FUSE
- IGN FUSE

H


for LHD:
STEERING PAD ASSEMBLY
- STEERING PAD SWITCH
CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
- CRUISE MAIN INDICATOR LIGHT
- SHIFT POSITION INDICATOR LIGHT
STOP LIGHT SWITCH
DLC3
TRANSMISSION CONTROL SWITCH
TRANSMISSION FLOOR SHIFT ASSEMBLY
ACCELERATOR PEDAL
H


for RHD:
STEERING PAD ASSEMBLY
- STEERING PAD SWITCH
CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
- CRUISE MAIN INDICATOR LIGHT
- SHIFT POSITION INDICATOR LIGHT
STOP LIGHT SWITCH
DLC3
TRANSMISSION FLOOR SHIFT ASSEMBLY
TRANSMISSION CONTROL SWITCH
ACCELERATOR PEDAL
H

for Preparation Click here



Communication Table

Transmitter	Receiver	Signal	Communication Line
ECM	Combination Meter	CRUISE main indicator operation signal	CAN

for Preparation Click here

CRUISE CONTROL SYSTEM

This system is controlled by the ECM, and is activated by the throttle position sensor and motor. The ECM controls the following functions: ON-OFF, -SET (COAST/SET), +RES (ACCELERATION/RESUME), CANCEL, vehicle speed operation, motor output control, and shift down control.

- The ECM compares the driving vehicle speed from the vehicle speed sensor with the stored vehicle speed set through the cruise control main switch. The ECM controls the throttle valve motor of the throttle position sensor and motor to open the valve when the driving speed is less than the stored speed.
- The ECM receives signals such as ON-OFF, -SET (COAST/SET), +RES (ACCELERATION/RESUME), and CANCEL from the cruise control main switch and executes the corresponding function.
- The ECM illuminates the CRUISE main indicator light on the combination meter when it receives the cruise control main switch on signal.
- The ECM cancels the cruise control system when the brake pedal is depressed and the ECM receives the stop light switch signal.
- The ECM cancels the cruise control system when the S3, S2, or S1 range is selected with the shift lever in S, or when the shift lever is moved from D to N, based on the PNP (Park/Neutral Position) switch signal.

LIMIT CONTROL

a. Low speed limit
The lowest possible limit of the speed setting range is set at approximately 40 km/h (25 mph). The cruise control system cannot be set when the driving vehicle speed is below the low speed limit. The cruise control operation will be automatically canceled but the stored vehicle speed will be retained when the vehicle speed decreases below the low speed limit of 40 km/h (25 mph) while cruise control is in operation.

b. High speed limit
The highest possible limit of the speed setting range is set at approximately 200 km/h (125 mph). The cruise control system cannot be set when the driving vehicle speed is over the high speed limit. Also, +RES (ACCELERATION/RESUME) cannot be used to increase speed beyond the high speed limit.

OPERATION OF CRUISE CONTROL

The cruise control main switch is used to operate 7 functions: SET, - (COAST), TAP-DOWN, RES (RESUME), + (ACCELERATION), TAP-UP, and CANCEL. The SET, TAP-DOWN and - (COAST) functions, and the RES (RESUME), TAP-UP and + (ACCELERATION) functions are operated with the same switch. The cruise control main switch is an automatic return type switch which turns on only while operating it in each arrow direction and turns off after releasing it.

a. SET CONTROL
Vehicle speed is stored and constant speed control is maintained when pushing the switch to -SET while driving with the cruise control main switch on (the CRUISE main indicator light is on), and the vehicle speed is within the set speed range (between the low and high speed limits).

b. - (COAST) CONTROL
When the cruise control main switch is pushed to -SET and held in that position while the cruise control system is operating, the ECM sends a "throttle valve opening angle 0°" demand signal to the throttle body. Then the vehicle speed is stored and maintained when the cruise control main switch is released.

HINT:

An actual throttle valve opening angle of 0° is not possible due to the idle speed control, etc.

c. TAP-DOWN CONTROL
When tapping down the cruise control main switch to -SET (for approximately 0.6 seconds) while the cruise control system is in operation, the stored vehicle speed decreases each time by approximately 1.6 km/h (1.0 mph). However, when the difference between the driving and stored vehicle speeds is more than approximately 5 km/h (3.1 mph), the stored vehicle speed is set to the actual vehicle speed at the moment the cruise control main switch is released from -SET and constant speed control is maintained.

d. + (ACCELERATION) CONTROL
The throttle valve motor of the throttle position sensor and motor is instructed by the ECM to open the throttle valve when +RES on the cruise control main switch is pressed and held while the cruise control system is in operation. When the cruise control main switch is released from +RES, the vehicle speed is stored and the vehicle is controlled at a constant speed.

e. TAP-UP CONTROL
When tapping up the cruise control main switch to +RES (for approximately 0.6 seconds) while the cruise control system is in operation, the stored vehicle speed increases each time by approximately 1.6 km/h (1.0 mph). However, when the difference between the driving and the stored vehicle speed is more than approximately 5 km/h (3.1 mph), the stored vehicle speed will not be changed.

f. RES (RESUME) CONTROL
If cruise control operation was canceled with the stop light switch or the CANCEL switch, and if the driving speed is within the limit range, pushing the cruise control main switch to +RES restores the vehicle speed memorized at the time of cancellation, and maintains constant speed control.

g. MANUAL CANCEL CONTROL

Performing any of the following cancels the cruise control system while in operation (the stored vehicle speed in the ECM is maintained).

- Depressing the brake pedal.
- Moving the shift lever from D to N.
- With the shift lever in S, selecting the S1, S2 or S3 range.
- Pulling the cruise control main switch to CANCEL.
- Turning the cruise control main switch off (the stored vehicle speed in the ECM is not maintained).
- Driving the vehicle while the VSC system is operating.

AUTO CANCEL (FAIL-SAFE)

This system has an automatic cancellation function (fail-safe) (Click here).

for Preparation Click here

HINT:

- **Use these procedures to troubleshoot the cruise control system.**
- ***: Use the intelligent tester.**

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.INSPECT BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If the voltage is below 11 V, recharge or replace the battery before proceeding.

NEXT

3.CHECK COMMUNICATION FUNCTION OF CAN COMMUNICATION SYSTEM*

a. Use the intelligent tester to check if the CAN communication system is functioning normally.

Result

Result	Proceed to
CAN DTC is not output	A
CAN DTC is output (for LHD)	B
CAN DTC is output (for RHD)	C

B. → GO TO CAN COMMUNICATION SYSTEM (Click here)

C. → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

4.CHECK INDICATOR

a. Check the indicator (Click here).

NEXT

5.CHECK FOR DTC*

a. Check for DTCs (Click here).

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

Result

Result	Proceed to
DTC is not output	A
DTC is output	B

B. GO TO DTC CHART (Click here)

A

6.PROBLEM SYMPTOMS TABLE

a. Refer to the Problem Symptoms Table (Click here).

Result

Result	Proceed to
Fault is not listed in problem symptoms table	A
Fault is listed in problem symptoms table	B

B. Go to step 8

A

7.OVERALL ANALYSIS AND TROUBLESHOOTING*

a. Terminals of ECU (Click here).

b. Data List / Active Test (Click here).

NEXT

8.ADJUST, REPAIR OR REPLACE

NEXT

9.CONFIRMATION TEST

NEXT

END

for Preparation Click here

HINT:

- **Use these procedures to troubleshoot the cruise control system.**
- ***: Use the intelligent tester.**

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.INSPECT BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If the voltage is below 11 V, recharge or replace the battery before proceeding.

NEXT

3.CHECK COMMUNICATION FUNCTION OF CAN COMMUNICATION SYSTEM*

a. Use the intelligent tester to check if the CAN communication system is functioning normally.

Result

Result	Proceed to
CAN DTC is not output	A
CAN DTC is output (for LHD)	B
CAN DTC is output (for RHD)	C

B. → GO TO CAN COMMUNICATION SYSTEM (Click here)

C. → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

4.CHECK INDICATOR

a. Check the indicator (Click here).

NEXT

5.CHECK FOR DTC*

a. Check for DTCs (Click here).

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

Result

Result	Proceed to
DTC is not output	A
DTC is output	B

B. GO TO DTC CHART (Click here)

A

6.PROBLEM SYMPTOMS TABLE

a. Refer to the Problem Symptoms Table (Click here).

Result

Result	Proceed to
Fault is not listed in problem symptoms table	A
Fault is listed in problem symptoms table	B

B. Go to step 8

A

7.OVERALL ANALYSIS AND TROUBLESHOOTING*

a. Terminals of ECU (Click here).

b. Data List / Active Test (Click here).

NEXT

8.ADJUST, REPAIR OR REPLACE

NEXT

9.CONFIRMATION TEST

NEXT

END

for Preparation Click here

HINT:

- **Use these procedures to troubleshoot the cruise control system.**
- ***: Use the intelligent tester.**

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.INSPECT BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If the voltage is below 11 V, recharge or replace the battery before proceeding.

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3.CHECK COMMUNICATION FUNCTION OF CAN COMMUNICATION SYSTEM*

a. Use the intelligent tester to check if the CAN communication system is functioning normally.

Result

Result	Proceed to
CAN DTC is not output	A
CAN DTC is output (for LHD)	B
CAN DTC is output (for RHD)	C

B. → GO TO CAN COMMUNICATION SYSTEM (Click here)

C. → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

4.CHECK INDICATOR

a. Check the indicator (Click here).

NEXT

5.CHECK FOR DTC*

a. Check for DTCs (Click here).

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

Result

Result	Proceed to
DTC is not output	A
DTC is output	B

B. GO TO DTC CHART (Click here)

A

6.PROBLEM SYMPTOMS TABLE

a. Refer to the Problem Symptoms Table (Click here).

Result

Result	Proceed to
Fault is not listed in problem symptoms table	A
Fault is listed in problem symptoms table	B

B. Go to step 8

A

7.OVERALL ANALYSIS AND TROUBLESHOOTING*

a. Terminals of ECU (Click here).

b. Data List / Active Test (Click here).

NEXT

8.ADJUST, REPAIR OR REPLACE

NEXT

9.CONFIRMATION TEST

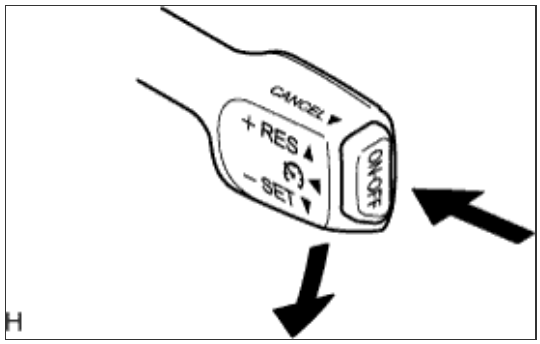
NEXT

END

for Preparation Click here

PROBLEM SYMPTOM CONFIRMATION

a. Inspect the SET function.



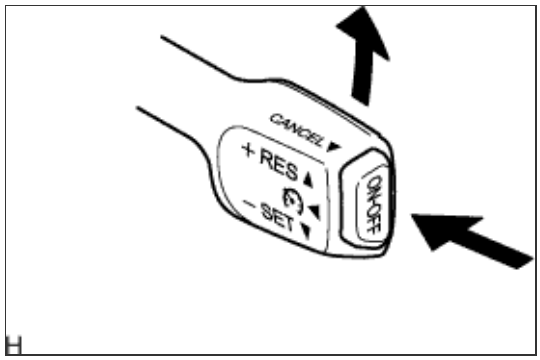
i. Turn the cruise control main switch on.

ii. Drive at the required speed (40 km/h (25 mph) or more).

iii. Push the cruise control main switch to -SET.

iv. After releasing the switch, check that the vehicle cruises at the set speed.

b. Inspect the + (ACCELERATION) function.



i. Turn the cruise control main switch on.

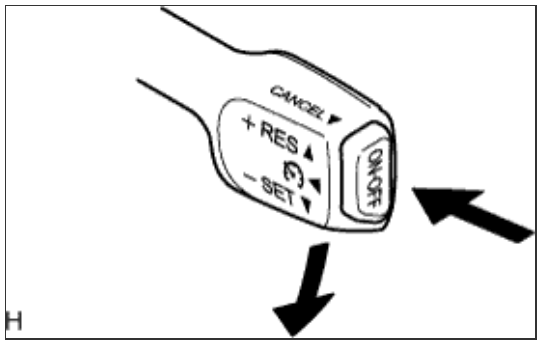
ii. Drive at the required speed (40 km/h (25 mph) or more).

iii. Push the cruise control main switch to -SET.

iv. Check that the vehicle speed increases while the cruise control main switch is pushed to +RES, and that the vehicle cruises at the newly set speed when the switch is released.

v. Momentarily push the cruise control main switch to +RES and then immediately release it. Check that the vehicle speed increases by approximately 1.6 km/h (1.0 mph) (tap-up control).

c. Inspect the - (COAST) function.



i. Turn the cruise control main switch on.

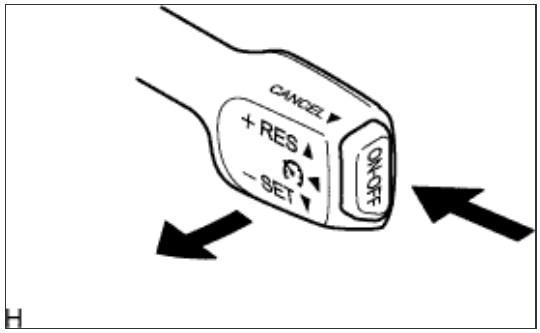
ii. Drive at the required speed (40 km/h (25 mph) or more).

iii. Push the cruise control main switch to -SET.

iv. Check that the vehicle speed decreases while the cruise control main switch is pushed to -SET, and that the vehicle cruises at the newly set speed when the switch is released.

v. Momentarily push the cruise control main switch to -SET, and then immediately release it. Check that vehicle speed decreases by approximately 1.6 km/h (1.0 mph) (tap-down control).

d. Inspect the CANCEL function.



i. Turn the cruise control main switch on.

ii. Drive at the required speed (40 km/h (25 mph) or more).

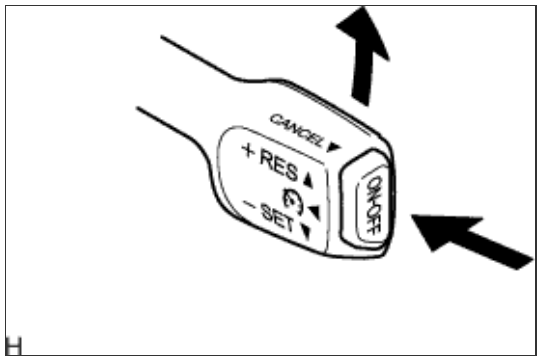
iii. Push the cruise control main switch to -SET.

iv. When performing one of the following, check that the cruise control system is canceled and that the normal driving mode is reset.

- Depressing the brake pedal.
- Moving the shift lever from D to N.

- With the shift lever in S, selecting the S1, S2 or S3 range.
- Turning the main switch off.
- Pulling the cruise control main switch to CANCEL.
- Driving the vehicle while the VSC system is operating.

e. Inspect the RES (RESUME) function.



H

i. Turn the cruise control main switch on.

ii. Drive at the required speed (40 km/h (25 mph) or more).

iii. Push the cruise control main switch to -SET.

iv. Cancel the cruise control system according to any of the above operations (other than turning the cruise control main switch off).

v. After pushing the cruise control main switch to +RES at a driving speed of more than 40 km/h (25 mph), check that the vehicle drives at the set speed.

for Preparation Click here

HINT:

- **Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.**
- **Inspect the fuses and relays related to this system before inspecting the suspected areas below.**

Cruise Control System

Symptom	Suspected Area	See page
Main switch cannot be turned on (CRUISE main indicator light on combination meter does not illuminate)	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, but turns off when operating SET function)	Cruise control switch circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, and remains illuminated when operating SET function)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
While the vehicle is driving with cruise control, the SET control is canceled (CRUISE main indicator light remains illuminated)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Stop light switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Park/neutral position switch circuit	Click here
	ECM	Click here
Hunting (speed is not constant)	Vehicle speed sensor circuit	Click here
	ECM	Click here
Vehicle speed setting cannot be canceled (CANCEL function failure)	Cruise control switch circuit	Click here
	ECM	Click

		here
DTC is not output, or is output when it should not be	TC and CG terminal circuit	Click here
	ECM	Click here
CRUISE main indicator light does not come on	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here

for Preparation Click here

HINT:

- **Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.**
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Cruise Control System

Symptom	Suspected Area	See page
Main switch cannot be turned on (CRUISE main indicator light on combination meter does not illuminate)	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, but turns off when operating SET function)	Cruise control switch circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, and remains illuminated when operating SET function)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
While the vehicle is driving with cruise control, the SET control is canceled (CRUISE main indicator light remains illuminated)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Stop light switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Park/neutral position switch circuit	Click here
	ECM	Click here
Hunting (speed is not constant)	Vehicle speed sensor circuit	Click here
	ECM	Click here
Vehicle speed setting cannot be canceled (CANCEL function failure)	Cruise control switch circuit	Click here
	ECM	Click

		here
DTC is not output, or is output when it should not be	TC and CG terminal circuit	Click here
	ECM	Click here
CRUISE main indicator light does not come on	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here

for Preparation Click here

HINT:

- **Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.**
- **Inspect the fuses and relays related to this system before inspecting the suspected areas below.**

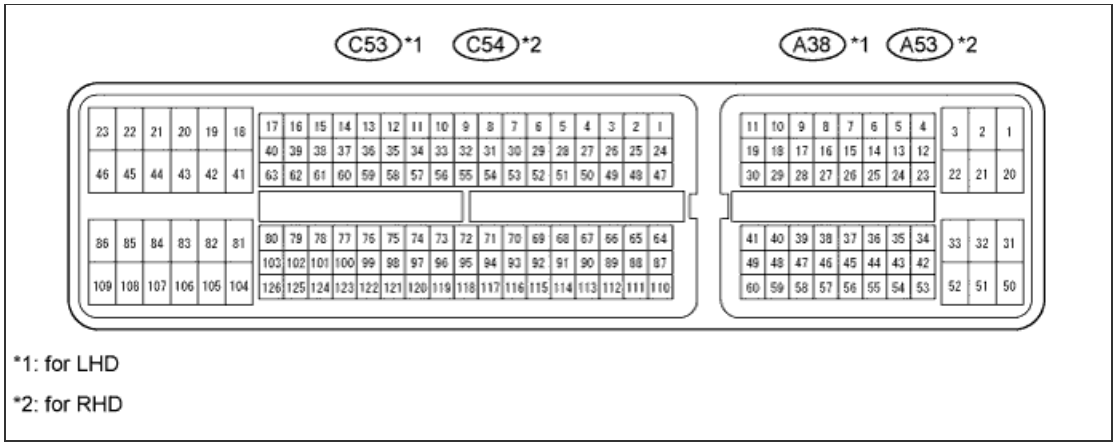
Cruise Control System

Symptom	Suspected Area	See page
Main switch cannot be turned on (CRUISE main indicator light on combination meter does not illuminate)	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, but turns off when operating SET function)	Cruise control switch circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, and remains illuminated when operating SET function)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
While the vehicle is driving with cruise control, the SET control is canceled (CRUISE main indicator light remains illuminated)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Stop light switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Park/neutral position switch circuit	Click here
	ECM	Click here
Hunting (speed is not constant)	Vehicle speed sensor circuit	Click here
	ECM	Click here
Vehicle speed setting cannot be canceled (CANCEL function failure)	Cruise control switch circuit	Click here
	ECM	Click

		here
DTC is not output, or is output when it should not be	TC and CG terminal circuit	Click here
	ECM	Click here
CRUISE main indicator light does not come on	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here

for Preparation Click here

CHECK ECM



HINT:

As the ECM connector is a waterproof connector, it is not possible to check the voltage of each terminal or check the waveform with an oscilloscope while the ECM is installed in the vehicle.

a. Disconnect the A38*1 and C53*1 or A53*2 and C54*2 ECM connectors.

*1: for LHD
*2: for RHD

b. Measure the voltage and resistance according to the value(s) in the table below.

Terminal No. (Symbol)	Wiring Color	Terminal Description	Condition	Specified Condition
A38*1-16 (TC) - Body ground A53*2-16 (TC) - Body ground	V-W - Body ground	Terminal TC of DLC3	Engine switch on (IG)	11 to 14 V
			Engine switch off	Below 1 V
C53*1-81 (E1) - Body ground C54*2-81 (E1) - Body ground	W-B - Body ground	ECM ground	Always	Below 1 Ω
C53*1-27 (D) - Body ground C54*2-27 (D) - Body ground	G - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in D	11 to 14 V
			Engine switch on (IG) Shift lever not in D	Below 1 V
A38*1-38 (SFTU) - Body ground A53*2-38 (SFTU) - Body ground	Y - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in S	Below 1 Ω
			Engine switch on (IG) Shift lever in +	10 kΩ or higher
A38*1-25 (S) - Body ground A53*2-25 (S) - Body ground	W - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in S	11 to 14 V
			Engine switch on (IG) Shift lever not in S	Below 1 V
A38*1-27 (SFTD) - Body ground A53*2-27 (SFTD) - Body ground	L - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in S	10 kΩ or higher
			Engine switch on (IG) Shift lever in -	Below 1 Ω
A38*1-36 (STP) - Body ground A53*2-36 (STP) - Body ground	R - Body ground	Stop light signal	Engine switch on (IG) Brake pedal depressed	11 to 14 V
			Engine switch on (IG) Brake pedal released	Below 1 V
A38*1-35 (ST1-) - Body ground A53*2-35 (ST1-) - Body	R-W - Body ground	Stop light signal (opposite to STP	Engine switch on (IG) Brake pedal depressed	Below 1 V
			Engine switch on (IG)	

ground		terminal)	Brake pedal released	11 to 14 V
A38*1-45 (CCS) - Body ground A53*2-45 (CCS) - Body ground	L - Body ground	Cruise control main switch signal	Engine switch on (IG) Main switch off	1 MΩ or higher
			Engine switch on (IG) CANCEL switch held on	1510 to 1570 Ω
			Engine switch on (IG) -SET switch held on	620 to 640 Ω
			Engine switch on (IG) +RES switch held on	235 to 245 Ω
			Engine switch on (IG) Main switch on	Below 2.5 Ω

*1: for LHD
*2: for RHD

If the result is not as specified, there may be a malfunction on the wire harness side.

for Preparation Click here

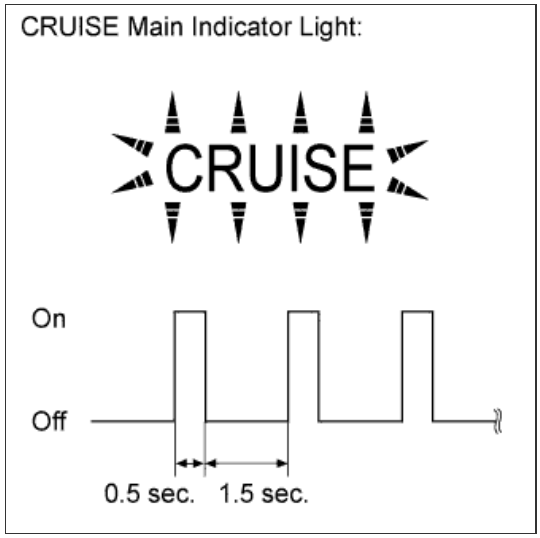
CHECK INDICATOR

a. Turn the engine switch on (IG).

b. Check that the CRUISE main indicator light illuminates when the cruise control main switch is turned on, and that the indicator light turns off when the main switch is turned off. If the results are not as specified, inspect the CRUISE main indicator light circuit (Click here).

HINT:

While driving with cruise control, the ECM activates AUTO CANCEL of the cruise control system when a malfunction in one of the following occurs: the vehicle speed sensors, stop light switch or other related parts. When AUTO CANCEL is activated, the CRUISE main indicator light outputs the blinking pattern shown in the illustration. At the same time, data of the malfunction is stored as a DTC.



for Preparation Click here

CHECK DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: Powertrain / Cruise Control / Trouble Codes.

e. Read the DTCs.

CLEAR DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: Powertrain / Cruise Control / Trouble Codes.

e. Clear the DTCs.

for Preparation Click here

HINT:

If the following conditions are detected while the cruise control is in operation, the system clears the stored vehicle speed in the ECM and cancels the cruise control operation.

Vehicle Condition	Auto Cancel Condition	Fail-safe Deactivation Condition
CRUISE main indicator light blinks	• There is an open or short in the stop light switch circuit • There is a problem with the vehicle speed signal	Turn the cruise control main switch on again
CRUISE main indicator light blinks	• There is a problem with the input circuit of the stop light switch circuit • There is a problem with the cancel circuit	• Turn the cruise control main switch on again • Turn the engine switch off then on again
CRUISE main indicator light remains on (Cruise control is canceled)	Under the following conditions, the stored vehicle speed is maintained: • The vehicle speed is less than the low speed limit (approx. 40 km/h (25 mph)) while running with the cruise control on • The VSC system is operated	Push the cruise control main switch to +RES
	• The vehicle speed is less than the stored speed by approx. 16 km/h (10 mph) or more	Push the cruise control main switch to -SET
CRUISE main indicator light goes off	There is a problem with the throttle position sensor and the motor	Turn the cruise control main switch on again

for Preparation Click here

READ DATA LIST

HINT:

Using the intelligent tester to read the Data List allows the values or states of switches, sensors, actuators and other items to be read without removing any parts. This non-intrusive inspection can be very useful because intermittent conditions or signals may be discovered before parts or wiring is disturbed. Reading the Data List information early in troubleshooting is one way to save diagnostic time.

NOTICE:

In the table below, the values listed under "Normal Condition" are reference values. Do not depend solely on these reference values when deciding whether a part is faulty or not.

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: Powertrain / Cruise Control / Data List.

e. According to the display on the intelligent tester, read the "Data List".

Cruise Control

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Vehicle Spd	Vehicle speed / min.: 0 km/h (0 mph), max.: 255 km/h (159 mph)	Actual vehicle speed displayed	-
CCS Mem Vehicle Spd	Vehicle speed / min.: 0 km/h (0 mph), max.: 200 km/h (125 mph)	Actual vehicle speed stored in memory	-
Cruise Operation Status	Transmission range sensor signal / ON or OFF	ON: Shift lever in D (6th, 5th or 4th gear) OFF: Shift lever not in D (6th, 5th or 4th gear)	-
Cruise Control	Cruise control / ON or OFF	ON: Cruise control operating OFF: Cruise control not operating	-
CCS Indicator M-CPU	CRUISE main indicator light (Main CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-
CCS Indicator S-CPU	CRUISE main indicator light (Sub CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-
CCS Ready S-CPU	Cruise control system standby condition (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-
CCS Ready M-CPU	Cruise control system standby condition (Main CPU) / ON or OFF	ON: Cruise control main switch (Main CPU) on OFF: Cruise control main switch (Main CPU) off	-
Main SW M-CPU	Cruise control main switch (Main CPU) / ON or OFF	ON: Cruise control main switch (Main CPU) on OFF: Cruise control main switch (Main CPU) off	-
Main SW S-CPU	Cruise control main switch (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-
Cancel Switch	CANCEL switch / ON or OFF	ON: CANCEL switch on OFF: CANCEL switch off	-
SET/COAST Switch	-SET switch / ON or OFF	ON: -SET switch on OFF: -SET switch off	-
RES/ACC Switch	+RES switch / ON or OFF	ON: +RES switch on OFF: +RES switch off	-
Stop Light SW M-CPU	Stop light switch signal (Main CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-

Stop Light SW S2-CPU	Stop light switch signal (Sub2 CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Stop Light SW S1-CPU	Stop light switch signal (Sub1 CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Throttle Opening Angle	Cruise throttle opening angle / min.: 0 deg, max.: 125 deg	Actual demanded throttle angle	-
# Codes	Number of trouble codes / Min.: 0, Max.: 255	-	-

PERFORM ACTIVE TEST

HINT:

Using the intelligent tester to perform Active Tests allows relays, VSVs, actuators and other items to be operated without removing any parts. This non-intrusive functional inspection can be very useful because intermittent operation may be discovered before parts or wiring is disturbed. Performing Active Tests early in troubleshooting is one way to save diagnostic time. Data List information can be displayed while performing Active Tests.

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: Body / Combination Meter / Active Test.

e. According to the display on the intelligent tester, perform the "Active Test".

Combination Meter

Tester Display	Test Part	Control Range	Diagnostic Note
Indicat. Lamp Cruise	CRUISE main indicator light operation	OFF or ON	-

for Preparation Click here

HINT:

If a trouble code is output during the DTC check, inspect the trouble areas listed for that code. For details of the code, refer to the "See page" below.

Cruise Control System

DTC Code	Detection Item	Trouble Area	See page
P0500	Vehicle Speed Sensor Malfunction	- Vehicle speed sensor signal circuit - Vehicle speed sensor - Combination meter - ECM	Click here
P0503	Vehicle Speed Sensor "A" Intermittent / Erratic / High	- Vehicle speed sensor - Vehicle speed sensor signal circuit - ECM - Combination meter	Click here
P0571	Brake Switch "A" Circuit	- Stop light switch - Stop light switch circuit - ECM	Click here
P0575	Cruise Control Input Circuit	ECM	Click here

for Preparation Click here

HINT:

If a trouble code is output during the DTC check, inspect the trouble areas listed for that code. For details of the code, refer to the "See page" below.

Cruise Control System

DTC Code	Detection Item	Trouble Area	See page
P0500	Vehicle Speed Sensor Malfunction	- Vehicle speed sensor signal circuit - Vehicle speed sensor - Combination meter - ECM	Click here
P0503	Vehicle Speed Sensor "A" Intermittent / Erratic / High	- Vehicle speed sensor - Vehicle speed sensor signal circuit - ECM - Combination meter	Click here
P0571	Brake Switch "A" Circuit	- Stop light switch - Stop light switch circuit - ECM	Click here
P0575	Cruise Control Input Circuit	ECM	Click here

DTC P0500 Vehicle Speed Sensor Malfunction

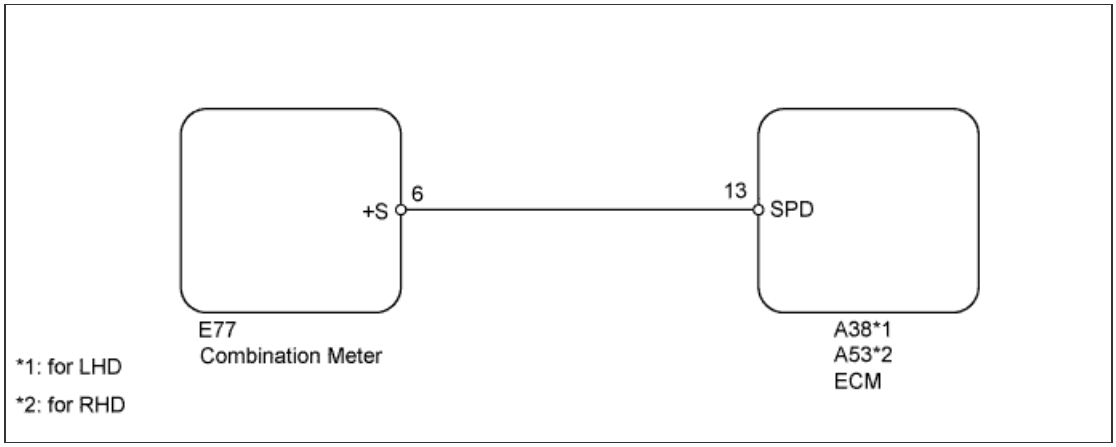
for Preparation Click here

DESCRIPTION

The speed sensor detects the wheel speed and sends the appropriate signals to the master cylinder solenoid (skid control ECU). The master cylinder solenoid (skid control ECU) converts these wheel speed signals into a 4-pulse signal and outputs it to the ECM via the combination meter. The ECM determines the vehicle speed based on the frequency of these pulse signals.

DTC Code	DTC Detection Condition	Trouble Area
P0500	The vehicle speed signal from the vehicle speed sensor is cut for 0.14 sec. or more while cruise control is in operation.	• Vehicle speed sensor signal circuit • Vehicle speed sensor • Combination meter • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

This DTC code may be output under the SFI system at the same time. In that case, perform troubleshooting for the SFI system first.

1.CHECK DTC (CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Cruise Control / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. With the shift lever in D, drive the vehicle for more than 10 seconds when the engine coolant temperature is more than 20°C (68°F).

d. Check for DTCs (Click here).

OK:

DTC P0500 is not output.

NG → **GO TO SFI SYSTEM (Click here)**

OK

USE SIMULATION METHOD TO CHECK (Click here)

DTC P0571 Brake Switch "A" Circuit

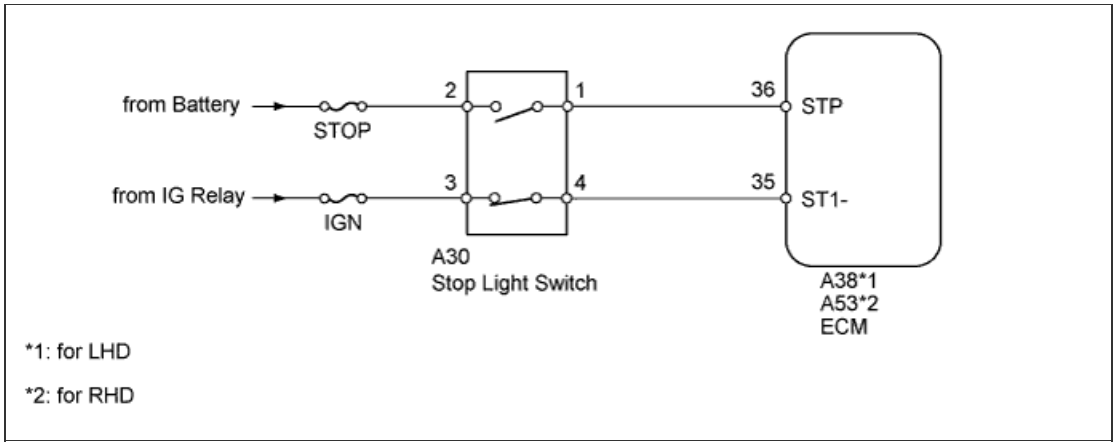
for Preparation Click here

DESCRIPTION

When the brake pedal is depressed, the stop light switch sends a signal to the ECM. When the ECM receives this signal, it cancels the cruise control. The fail-safe function operates to enable normal driving even if there is a malfunction in the stop light signal circuit. The cancellation condition occurs when voltage is applied to terminal STP. When the brake is applied, voltage is applied to terminal STP of the ECM through the STOP fuse and the stop light switch, and the ECM turns the cruise control off.

DTC Code	DTC Detection Condition	Trouble Area
P0571	When the voltage of the STP terminal and the ST1- terminal of the ECM is below 1 V for 0.5 sec. or more.	• Stop light switch • Stop light switch circuit • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

1.READ VALUE USING INTELLIGENT TESTER (STOP LIGHT SWITCH)

a. Using the intelligent tester, read the Data List.

Cruise Control

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
Stop Light SW M-CPU	Stop light switch signal (Main CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-

OK:

Normal conditions listed above are displayed.

NG → Go to step 2

OK

REPLACE ECM (Click here)

2.INSPECT STOP LIGHT SWITCH

a. Remove the stop light switch (Click here for LHD, Click here for RHD).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

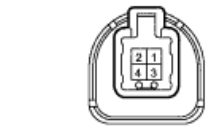
Tester Connection	Switch Condition	Specified Condition
1 - 2	Pin pushed	10 kΩ or higher
	Pin not pushed	Below 1 Ω
3 - 4	Pin pushed	Below 1 Ω

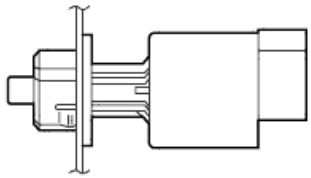
	Pin not pushed	10 kΩ or higher

Result

Result	Proceed to
OK	A
NG (for LHD)	B
NG (for RHD)	C

Component without harness connected: (Stop Light Switch)





Pin pushed

Pin released

B → REPLACE STOP LIGHT SWITCH (Click here)

C → REPLACE STOP LIGHT SWITCH (Click here)

A

3.CHECK HARNESS AND CONNECTOR (BATTERY - STOP LIGHT SWITCH)

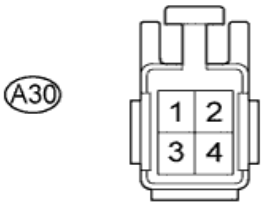
a. Disconnect the A30 stop light switch connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A30-2 - Body ground	Always	11 to 14 V
A30-3 - Body ground	Engine switch on (IG)	

Front view of wire harness connector: (to Stop Light Switch)



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

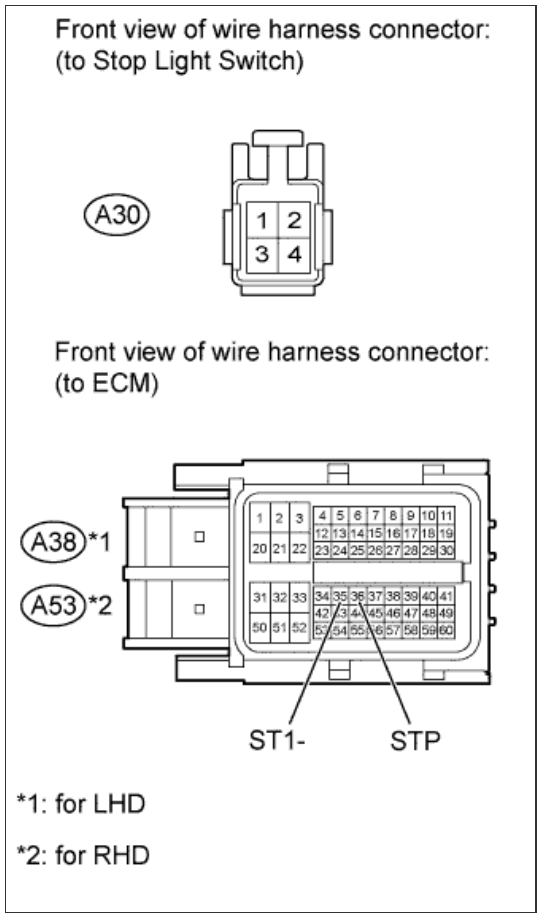
4.CHECK HARNESS AND CONNECTOR (STOP LIGHT SWITCH - ECM)

a. Disconnect the A30 stop light switch connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A30-1 - A38-36 (STP)	Always	Below 1 Ω
A30-1 - Body ground	Always	10 kΩ or higher
A30-4 - A38-35 (ST1-)	Always	Below 1 Ω
A30-4 - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A30-1 - A53-36 (STP)	Always	Below 1 Ω
A30-1 - Body ground	Always	10 kΩ or higher
A30-4 - A53-35 (ST1-)	Always	Below 1 Ω
A30-4 - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC P0503 Vehicle Speed Sensor "A" Intermittent / Erratic / High

for Preparation Click here

DESCRIPTION

If a malfunction (a rapid change in vehicle speed) in the vehicle speed signal being output from the master cylinder solenoid (skid control ECU) is detected while the cruise control is in operation, the ECM determines there to be a momentary interruption and noise, and outputs a DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0503	A momentary interruption and noise are detected when a rapid change of the vehicle speed occurs while cruise control is in operation.	• Vehicle speed sensor • Vehicle speed sensor signal circuit • ECM • Combination meter

INSPECTION PROCEDURE

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.CHECK DTC (VEHICLE STABILITY CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Chassis / ABS/VSC/TRAC / Trouble Code.

b. Check for DTCs (Click here).

OK:
DTC is not output.

NG → **GO TO VEHICLE STABILITY CONTROL SYSTEM (Click here)**

OK ↓

2.CHECK DTC (CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Cruise Control / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the cruise control.

d. Check for DTCs (Click here).

OK:
DTC P0503 is not output.

NG → **REPLACE ECM (Click here)**

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC P0575 Cruise Control Input Circuit

for Preparation Click here

DESCRIPTION

This DTC indicates internal abnormalities of the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0575	When either of the following conditions is met: • STP signals input to the ECM supervisory CPU and control ECU are different for 0.15 seconds or more. • 0.4 seconds have passed after the cruise cancel input signal (STP input) is input to the ECM.	ECM

HINT:

If DTC P0575 is stored while the cruise control is in operation, the master cylinder solenoid (skid control ECU) clears the stored vehicle speed in the ECM and cancels the cruise control operation. At the same time, the CRUISE main indicator light blinks to inform the driver of the malfunction. When this trouble code is stored, fail-safe remains on until the engine switch is turned off.

INSPECTION PROCEDURE

1.CHECK DTC (CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Cruise Control / Trouble Code.

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

OK:
DTC P0575 is not output.

NG → **REPLACE ECM (Click here)**

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC P0503 Vehicle Speed Sensor "A" Intermittent / Erratic / High

for Preparation Click here

DESCRIPTION

If a malfunction (a rapid change in vehicle speed) in the vehicle speed signal being output from the master cylinder solenoid (skid control ECU) is detected while the cruise control is in operation, the ECM determines there to be a momentary interruption and noise, and outputs a DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0503	A momentary interruption and noise are detected when a rapid change of the vehicle speed occurs while cruise control is in operation.	• Vehicle speed sensor • Vehicle speed sensor signal circuit • ECM • Combination meter

INSPECTION PROCEDURE

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.CHECK DTC (VEHICLE STABILITY CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Chassis / ABS/VSC/TRAC / Trouble Code.

b. Check for DTCs (Click here).

OK:
DTC is not output.

NG → **GO TO VEHICLE STABILITY CONTROL SYSTEM (Click here)**

OK ↓

2.CHECK DTC (CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Cruise Control / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the cruise control.

d. Check for DTCs (Click here).

OK:
DTC P0503 is not output.

NG → **REPLACE ECM (Click here)**

OK ↓

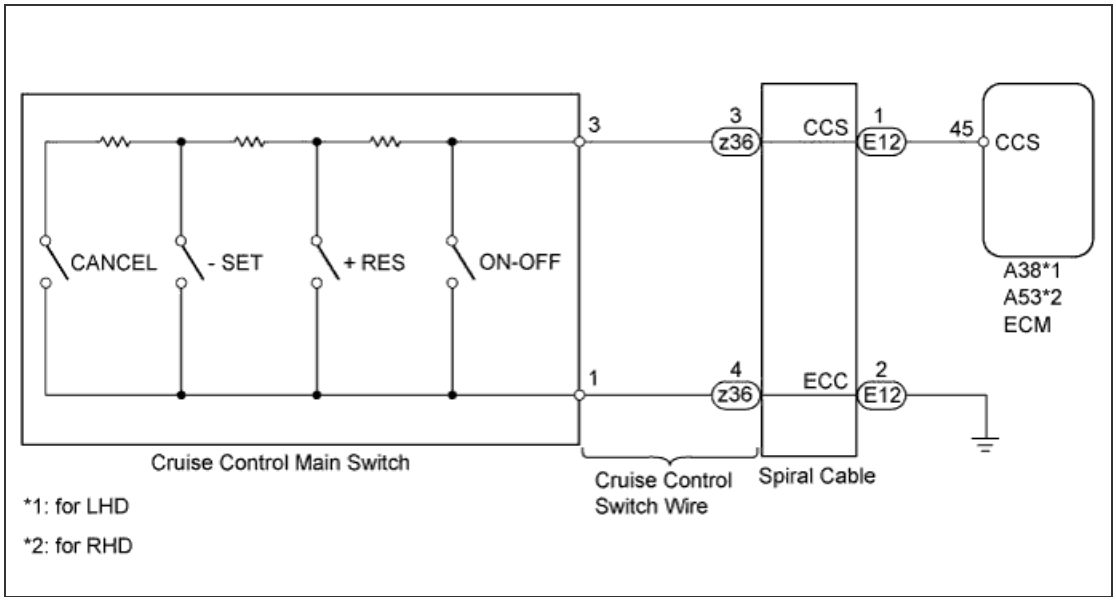
USE SIMULATION METHOD TO CHECK (Click here)

for Preparation Click here

DESCRIPTION

The cruise control main switch is used to operate 7 functions: SET, - (COAST), TAP-DOWN, RES (RESUME), + (ACCELERATION), TAP-UP, and CANCEL. The SET, TAP-DOWN and - (COAST) functions, and the RES (RESUME), TAP-UP and + (ACCELERATION) functions are operated with the same switch. The cruise control main switch is an automatic return type switch which turns on only while operating it in each arrow direction and turns off after releasing it. The internal contact point of the cruise control main switch is turned on with the switch operation. Then the ECM reads the resistance value that has been changed by the switch operation to control SET, - (COAST), RES (RESUME), + (ACCELERATION) and CANCEL.

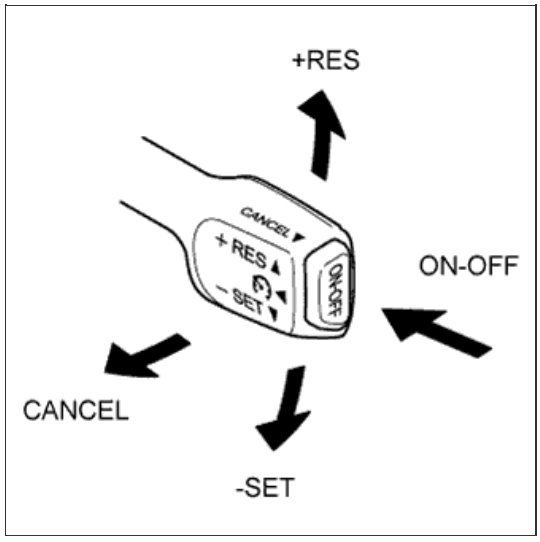
WIRING DIAGRAM



INSPECTION PROCEDURE

1.READ VALUE USING INTELLIGENT TESTER (CRUISE CONTROL MAIN SWITCH)

a. Using the intelligent tester, read the Data List.



Cruise Control

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Main SW M-CPU	Cruise control main switch (Main CPU) / ON or OFF	ON: Cruise control main switch (Main CPU) on OFF: Cruise control main switch (Main CPU) off	-
Cancel Switch	CANCEL switch signal / ON or OFF	ON: CANCEL switch on OFF: CANCEL switch off	-
SET/COAST Switch	-SET switch signal / ON or OFF	ON: -SET switch on OFF: -SET switch off	-

RES/ACC Switch	+RES switch signal / ON or OFF	ON: +RES switch on OFF: +RES switch off	-
CCS Main SW S-CPU	Cruise control main switch (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-

OK:

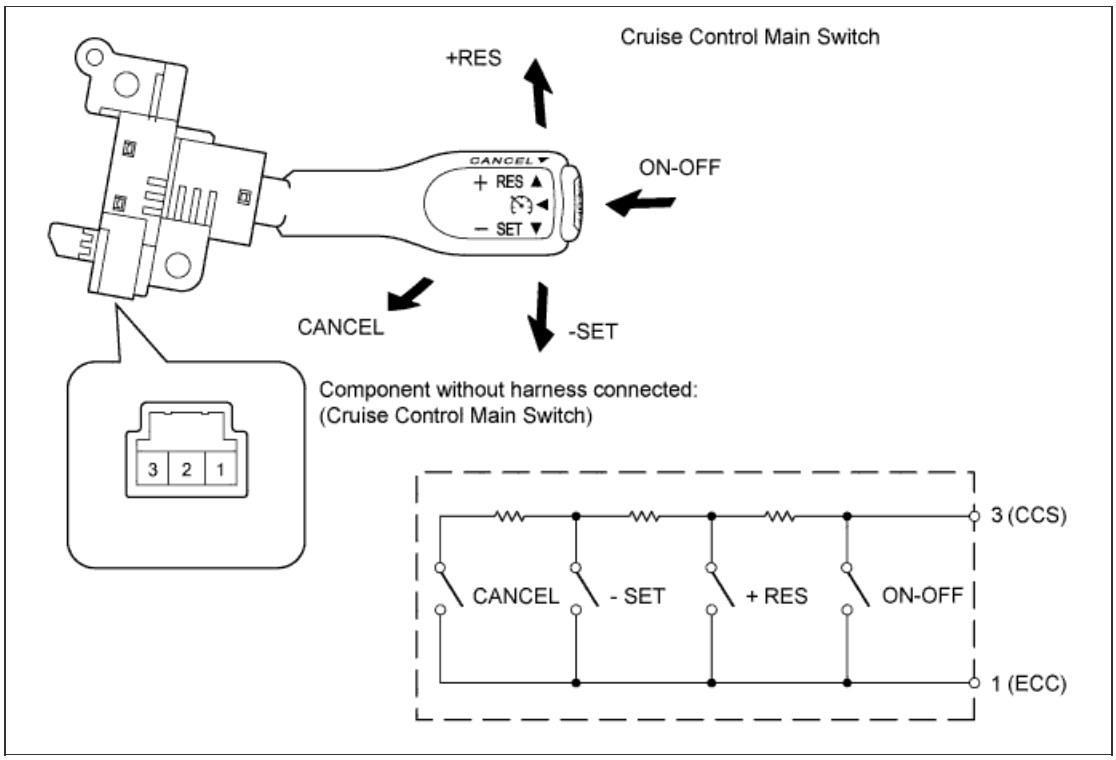
The intelligent tester display changes according to operation of cruise control main switch.

NG → Go to step 2

OK →

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

2.INSPECT CRUISE CONTROL MAIN SWITCH



a. Remove the cruise control main switch (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 - 3	Neutral	1 MΩ or higher
	Pushed to +RES	235 to 245 Ω
	Pushed to -SET	620 to 640 Ω
	Pushed to CANCEL	1510 to 1570 Ω
	Main switch pushed off	1 MΩ or higher
	Main switch pushed on	Below 2.5 Ω

NG → REPLACE CRUISE CONTROL MAIN SWITCH (Click here)

OK →

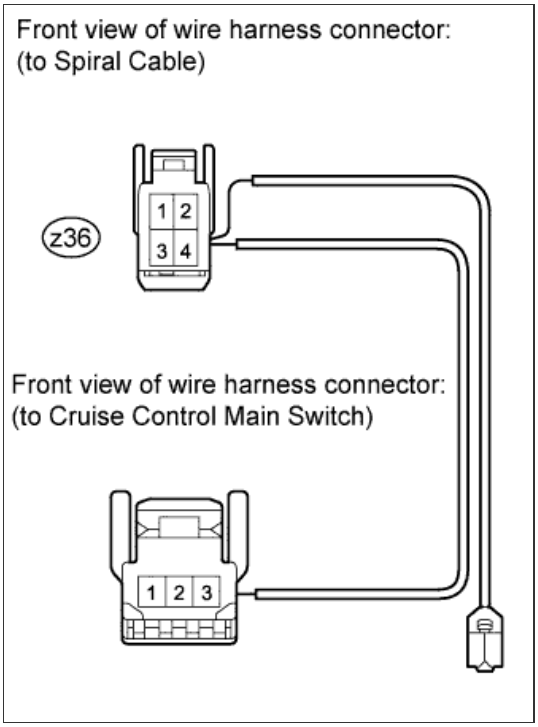
3.INSPECT CRUISE CONTROL SWITCH WIRE

a. Remove the cruise control switch wire.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - 3	Always	Below 1 Ω
z36-4 - 1		



NG → REPLACE CRUISE CONTROL SWITCH WIRE

OK

4.INSPECT SPIRAL CABLE

a. Check the spiral cable and connector for scratches, cracks, dents and chips. If any defects are found, replace the spiral cable with a new one.

b. Check the spiral cable.

i. Set the spiral cable to the center position (Click here).

ii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise, and measure the resistance according to the value(s) in the table below. Then rotate the spiral cable 5 times counterclockwise, and measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-4 - E12-2 (ECC)		

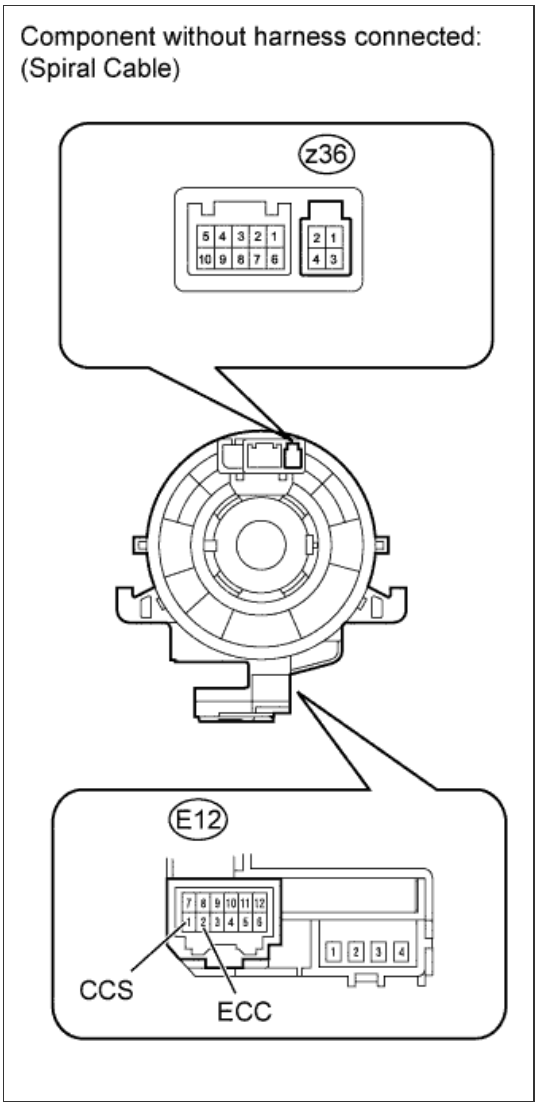
iii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise. Then while rotating the spiral cable 5 times counterclockwise, measure the resistance according to the value(s) in the table below.

NOTICE:

As the spiral cable may break, do not rotate the spiral cable more than the specified amount.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-4 - E12-2 (ECC)		



NG → REPLACE SPIRAL CABLE (Click here)

OK

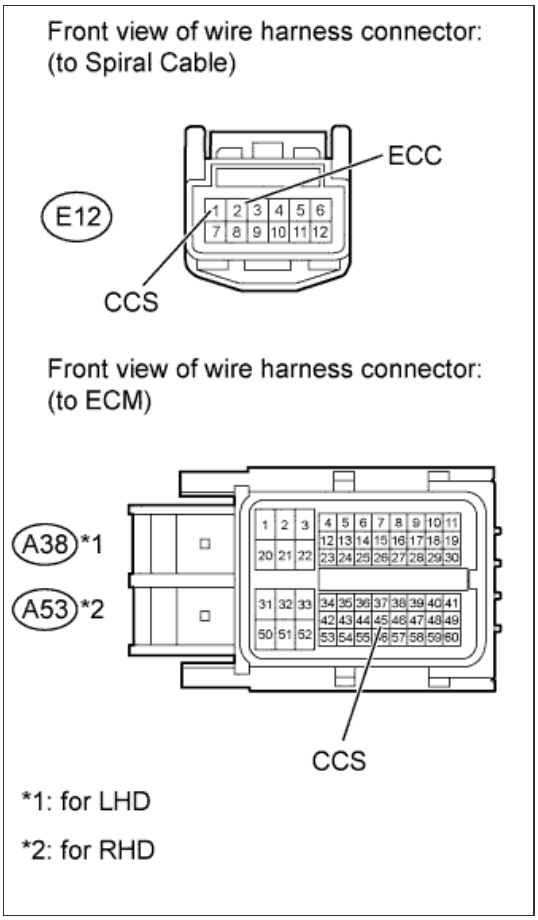
5.CHECK HARNESS AND CONNECTOR (SPIRAL CABLE - ECM AND BODY GROUND)

a. Disconnect the E12 spiral cable connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A38-45 (CCS)	Always	Below 1 Ω
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-2 (ECC) - Body ground	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A53-45 (CCS)	Always	Below 1 Ω
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-2 (ECC) - Body ground	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

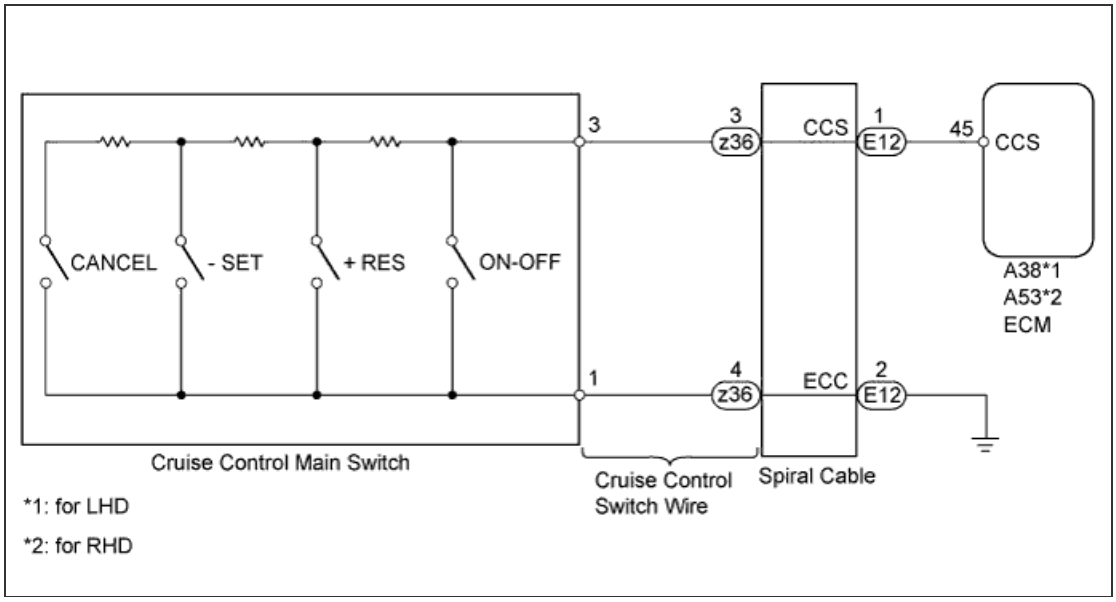
REPLACE ECM (Click here)

for Preparation Click here

DESCRIPTION

The cruise control main switch is used to operate 7 functions: SET, - (COAST), TAP-DOWN, RES (RESUME), + (ACCELERATION), TAP-UP, and CANCEL. The SET, TAP-DOWN and - (COAST) functions, and the RES (RESUME), TAP-UP and + (ACCELERATION) functions are operated with the same switch. The cruise control main switch is an automatic return type switch which turns on only while operating it in each arrow direction and turns off after releasing it. The internal contact point of the cruise control main switch is turned on with the switch operation. Then the ECM reads the resistance value that has been changed by the switch operation to control SET, - (COAST), RES (RESUME), + (ACCELERATION) and CANCEL.

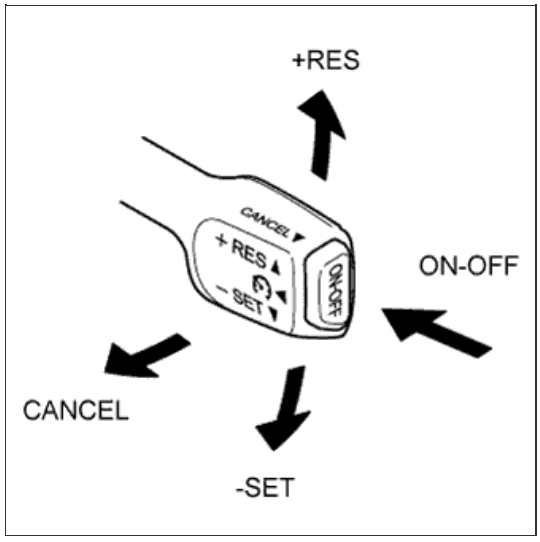
WIRING DIAGRAM



INSPECTION PROCEDURE

1.READ VALUE USING INTELLIGENT TESTER (CRUISE CONTROL MAIN SWITCH)

a. Using the intelligent tester, read the Data List.



Cruise Control

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Main SW M-CPU	Cruise control main switch (Main CPU) / ON or OFF	ON: Cruise control main switch (Main CPU) on OFF: Cruise control main switch (Main CPU) off	-
Cancel Switch	CANCEL switch signal / ON or OFF	ON: CANCEL switch on OFF: CANCEL switch off	-
SET/COAST Switch	-SET switch signal / ON or OFF	ON: -SET switch on OFF: -SET switch off	-

RES/ACC Switch	+RES switch signal / ON or OFF	ON: +RES switch on OFF: +RES switch off	-
CCS Main SW S-CPU	Cruise control main switch (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-

OK:

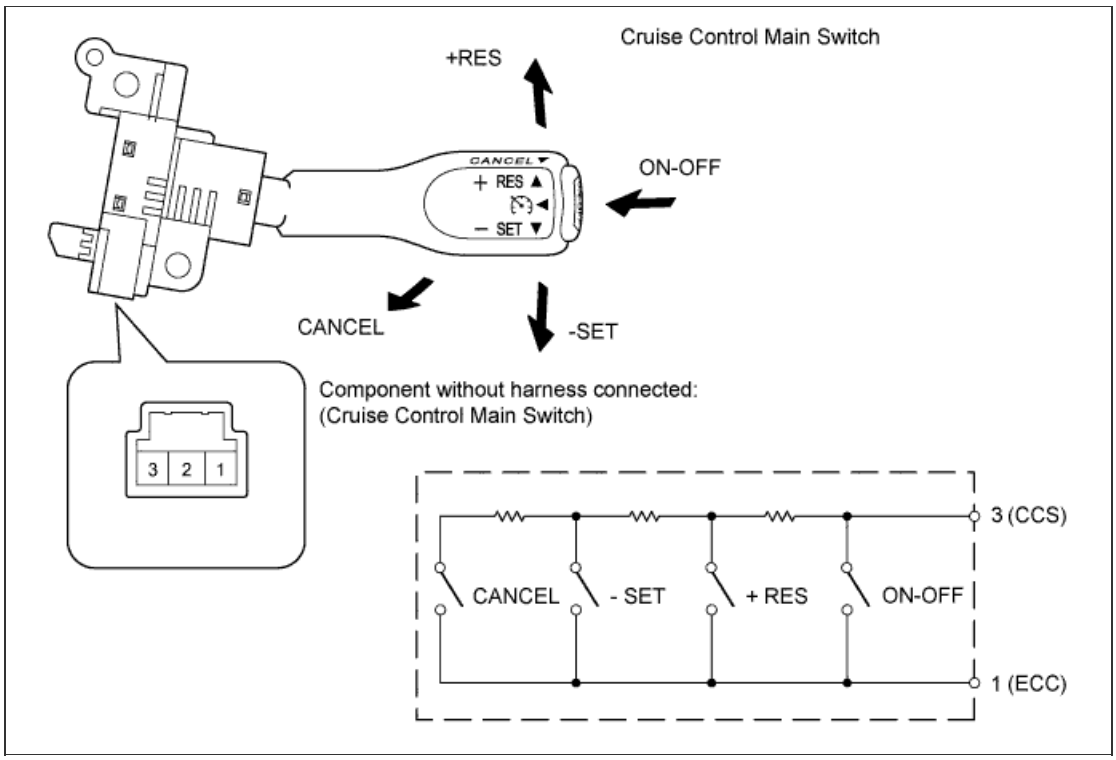
The intelligent tester display changes according to operation of cruise control main switch.

NG → Go to step 2

OK →

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

2.INSPECT CRUISE CONTROL MAIN SWITCH



a. Remove the cruise control main switch (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 - 3	Neutral	1 MΩ or higher
	Pushed to +RES	235 to 245 Ω
	Pushed to -SET	620 to 640 Ω
	Pushed to CANCEL	1510 to 1570 Ω
	Main switch pushed off	1 MΩ or higher
	Main switch pushed on	Below 2.5 Ω

NG → REPLACE CRUISE CONTROL MAIN SWITCH (Click here)

OK →

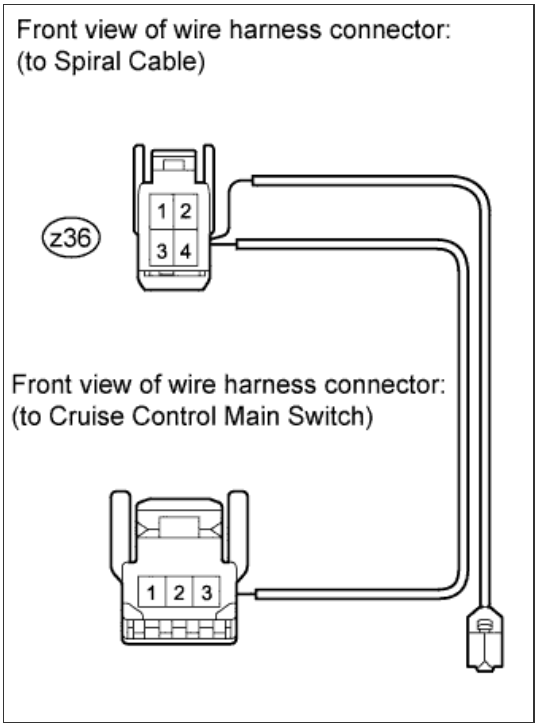
3.INSPECT CRUISE CONTROL SWITCH WIRE

a. Remove the cruise control switch wire.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - 3	Always	Below 1 Ω
z36-4 - 1		



NG → REPLACE CRUISE CONTROL SWITCH WIRE

OK

4.INSPECT SPIRAL CABLE

a. Check the spiral cable and connector for scratches, cracks, dents and chips. If any defects are found, replace the spiral cable with a new one.

b. Check the spiral cable.

i. Set the spiral cable to the center position (Click here).

ii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise, and measure the resistance according to the value(s) in the table below. Then rotate the spiral cable 5 times counterclockwise, and measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-4 - E12-2 (ECC)		

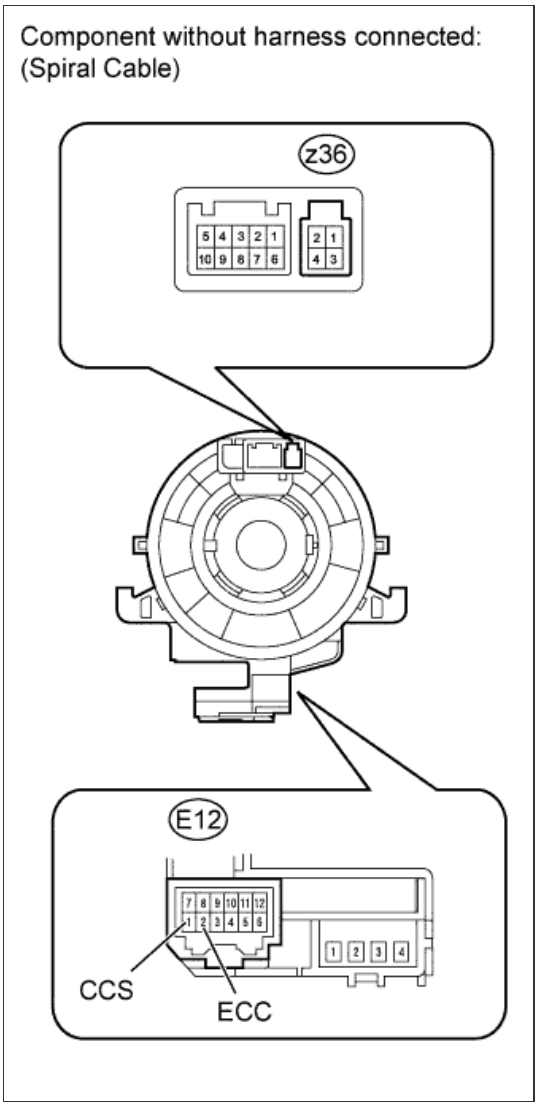
iii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise. Then while rotating the spiral cable 5 times counterclockwise, measure the resistance according to the value(s) in the table below.

NOTICE:

As the spiral cable may break, do not rotate the spiral cable more than the specified amount.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-4 - E12-2 (ECC)		



NG → REPLACE SPIRAL CABLE (Click here)

OK

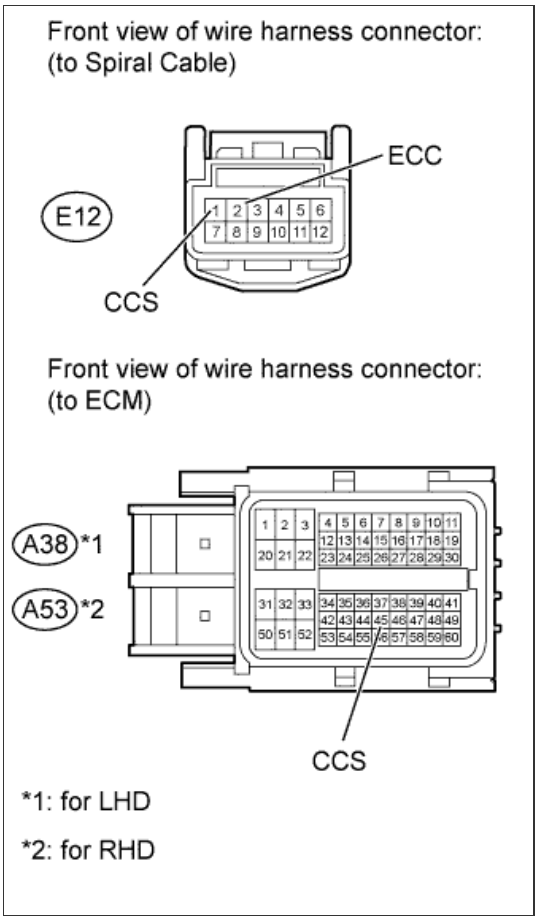
5.CHECK HARNESS AND CONNECTOR (SPIRAL CABLE - ECM AND BODY GROUND)

a. Disconnect the E12 spiral cable connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A38-45 (CCS)	Always	Below 1 Ω
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-2 (ECC) - Body ground	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A53-45 (CCS)	Always	Below 1 Ω
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-2 (ECC) - Body ground	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

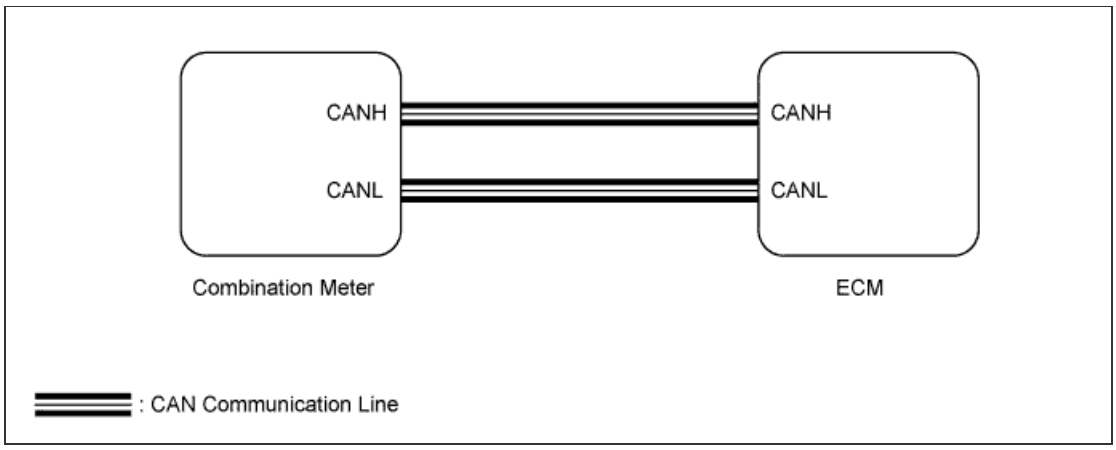
REPLACE ECM (Click here)

for Preparation Click here

DESCRIPTION

- The ECM detects a cruise control switch signal and sends it to the combination meter via the CAN communication line. Then the CRUISE main indicator light comes on.
- The CRUISE main indicator light circuit uses the CAN for communication. If there is a malfunction in this circuit, check for DTCs in the CAN communication system before troubleshooting this circuit.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, perform the Active Test.

Combination Meter

Tester Display	Test Part	Control Range	Diagnostic Note
Indicat. Lamp Cruise	CRUISE main indicator light operation	OFF or ON	-

OK:
Indicator light comes on/goes off.

NG → REPLACE COMBINATION METER ASSEMBLY (Click here)

OK ↓

2.READ VALUE USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, read the Data List.

Cruise Control

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Indicator M-CPU	CRUISE main indicator light (Main CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-

OK:
The intelligent tester display changes according to condition of CRUISE main indicator light.

NG → REPLACE ECM (Click here)

OK ↓

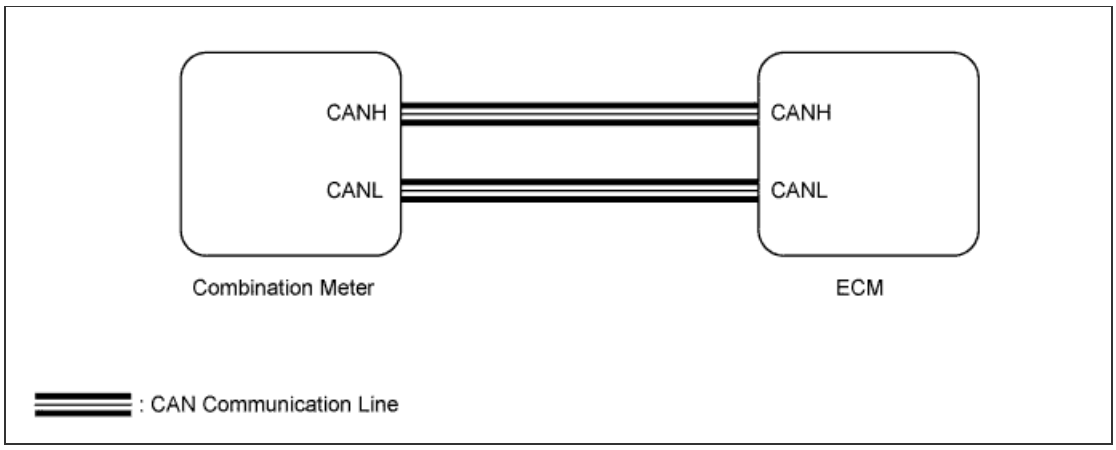
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

- The ECM detects a cruise control switch signal and sends it to the combination meter via the CAN communication line. Then the CRUISE main indicator light comes on.
- The CRUISE main indicator light circuit uses the CAN for communication. If there is a malfunction in this circuit, check for DTCs in the CAN communication system before troubleshooting this circuit.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, perform the Active Test.

Combination Meter

Tester Display	Test Part	Control Range	Diagnostic Note
Indicat. Lamp Cruise	CRUISE main indicator light operation	OFF or ON	-

OK:
Indicator light comes on/goes off.

NG → REPLACE COMBINATION METER ASSEMBLY (Click here)

OK ↓

2.READ VALUE USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, read the Data List.

Cruise Control

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Indicator M-CPU	CRUISE main indicator light (Main CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-

OK:
The intelligent tester display changes according to condition of CRUISE main indicator light.

NG → REPLACE ECM (Click here)

OK ↓

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

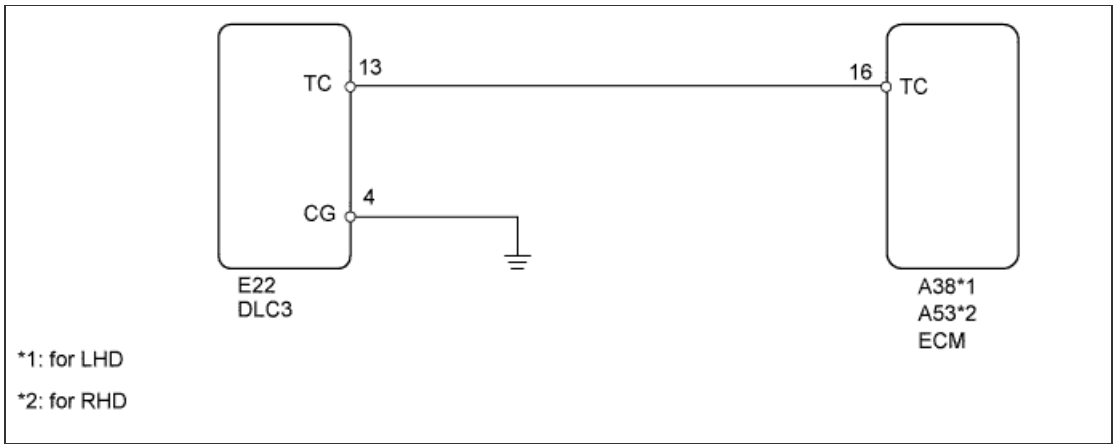
DESCRIPTION

Connecting terminals TC and CG of the DLC3 causes the system to enter self-diagnostic mode. If a malfunction is present, DTCs will be output.

HINT:

When a particular warning light remains blinking, a ground short in the wiring of terminal TC of the DLC3 or an internal ground short in the relevant ECU is suspected.

WIRING DIAGRAM



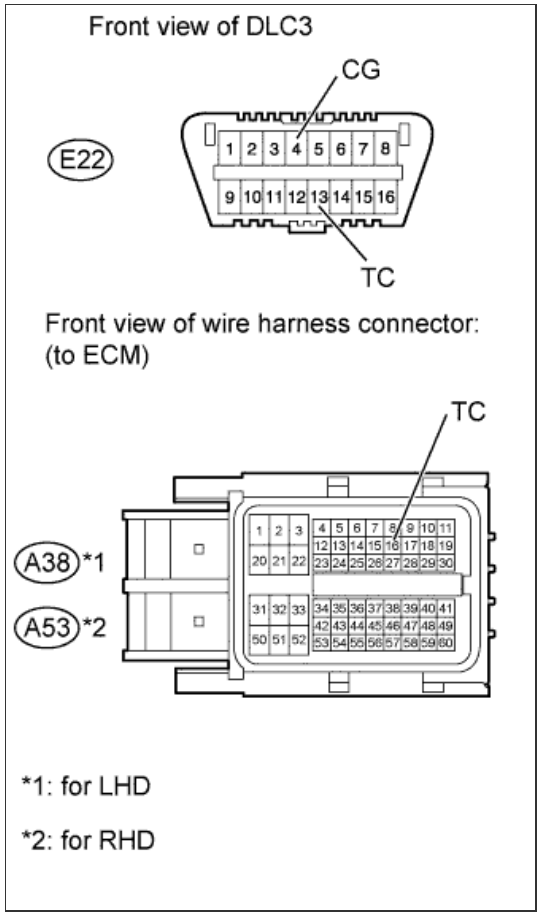
INSPECTION PROCEDURE

1.CHECK HARNESS AND CONNECTOR (DLC3 - ECM AND BODY GROUND)

a. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E22-13 (TC) - A38-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
E22-13 (TC) - A53-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

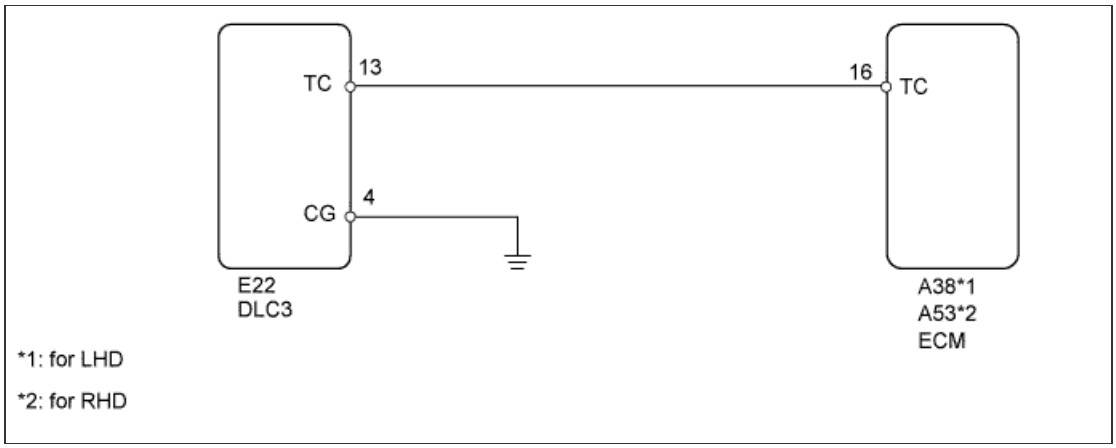
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WIRING DIAGRAM



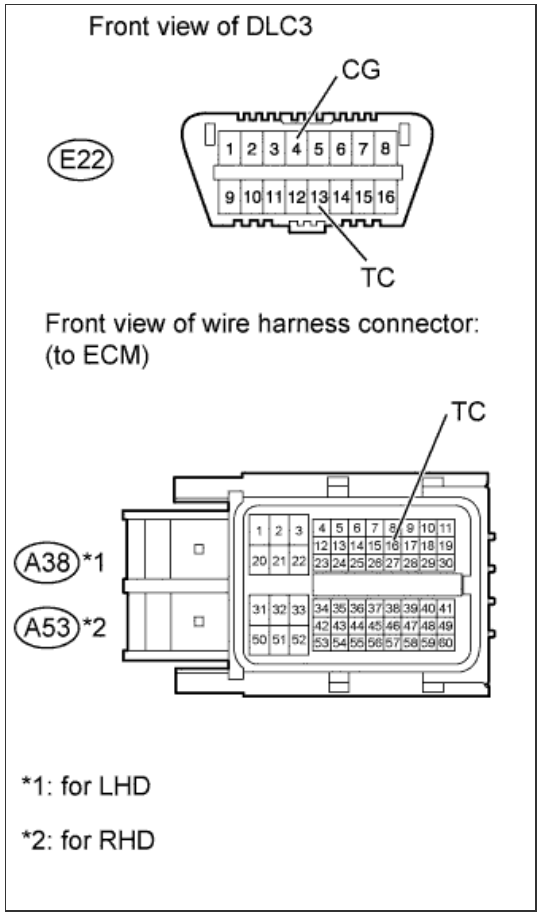
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Standard Resistance:

for LHD

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for RHD

Tester Connection	Condition	Specified Condition
E22-13 (TC) - A53-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

1.HANDLING PRECAUTION FOR DYNAMIC RADAR CRUISE CONTROL SYSTEM

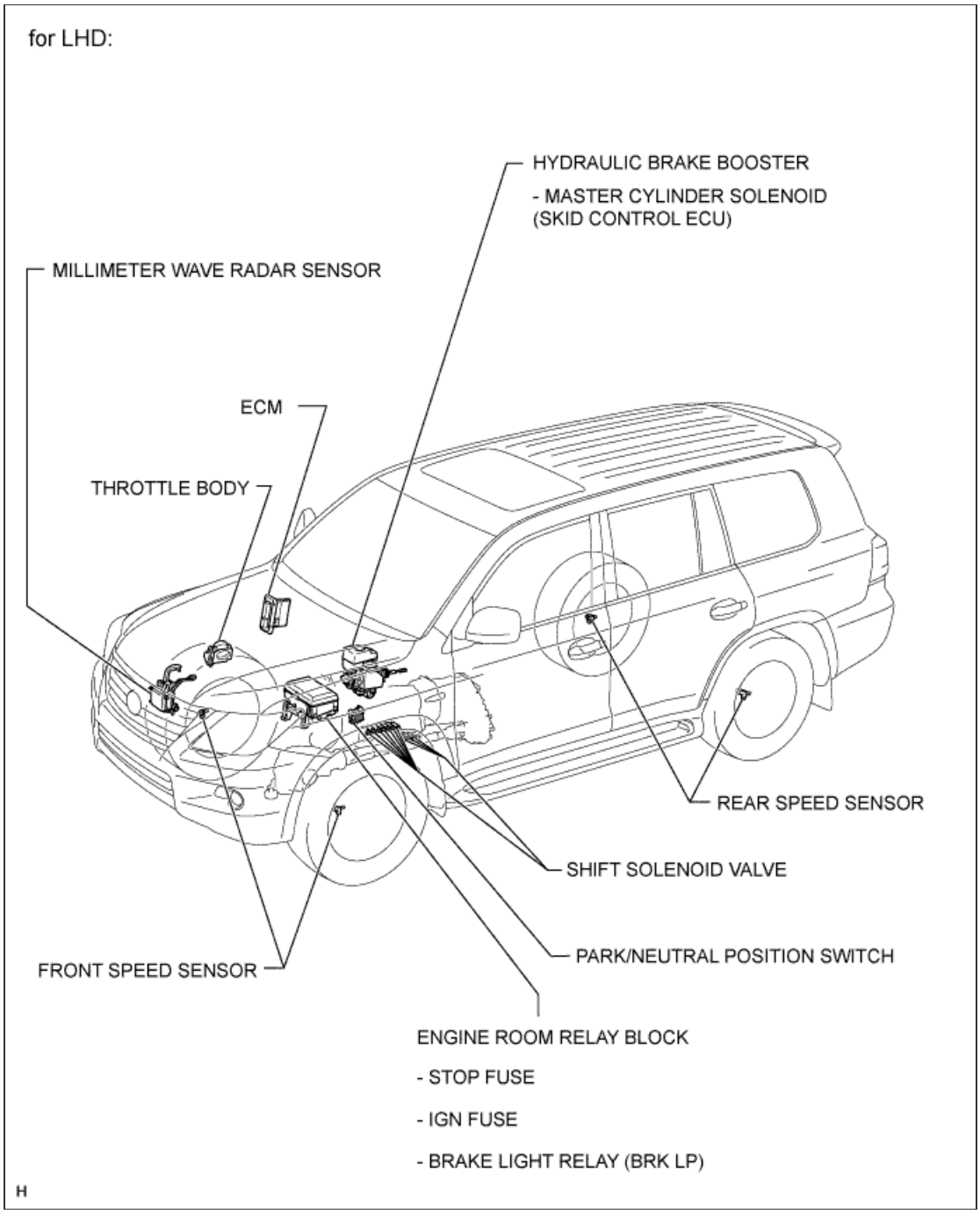
Keep in mind the following points when inspecting the dynamic radar cruise control system.

- As there is a limitation on the vehicle-to-vehicle distance controlling capability, do not overly rely on the dynamic radar cruise control system.
- Pay constant attention to the vehicle-to-vehicle distance and the traffic conditions when using the dynamic radar cruise control system. Decelerate with the brake pedal and accelerate with the accelerator pedal to keep an appropriate distance with the vehicle in front.
- When the vehicle in front decelerates rapidly or another vehicle moves in front of your vehicle, decelerating in time to avoid a collision may not be possible without additional braking.
- The dynamic radar cruise control system is designed to assist in maintaining an appropriate distance with the vehicle in front. However, the system alone is not sufficient. It is imperative that the driver pay attention at all times.
- The millimeter wave radar sensor has functions that automatically detect dirt on the sensor face and inform the driver. However, these functions are not perfect. Keep the sensor face clean.
- The dynamic radar cruise control system does not work, or give a vehicle-approaching warning, for vehicles which are stopped or driving at significantly slower speeds. Always pay attention to these vehicles.
- The millimeter wave radar sensor detection area is narrow at close range, so detection of a vehicle moving just in front may be delayed, or a motorcycle running on the side of the same lane may not be detected. The distance to the vehicle in front may not be maintained properly due to these reasons.
- Even if + (ACCELERATION) control is operated to increase the stored vehicle speed, the vehicle does not accelerate because the speed is controlled in accordance with the speed of the vehicle in front while driving with the vehicle-to-vehicle distance control mode on (follow-up cruising). However, as the stored vehicle speed has been increased by + (ACCELERATION) operation, the vehicle accelerates to the stored vehicle speed when there is no vehicle in front. Check the set speed with the stored vehicle speed indication on the display.
- The controlled vehicle distance may be shorter than the set vehicle distance when cruising on a long, downhill road.
- The cruise control switch must be turned off and then on if all of the following occur: 1) the CRUISE main indicator light blinks, 2) the master warning light illuminates at the same time a "pong" sound is heard, and 3) the fail message is shown on the display.
- The warning buzzer does not sound during constant speed control mode because the presence of the vehicle in front and the distance to it are not judged as during vehicle-to-vehicle distance control mode. Pay attention to the distance to the vehicle in front.
- The dynamic radar cruise control system has 2 cruise control modes: the constant speed control mode and vehicle-to-vehicle distance control mode. Confirm which mode is selected when using the dynamic radar cruise control system.

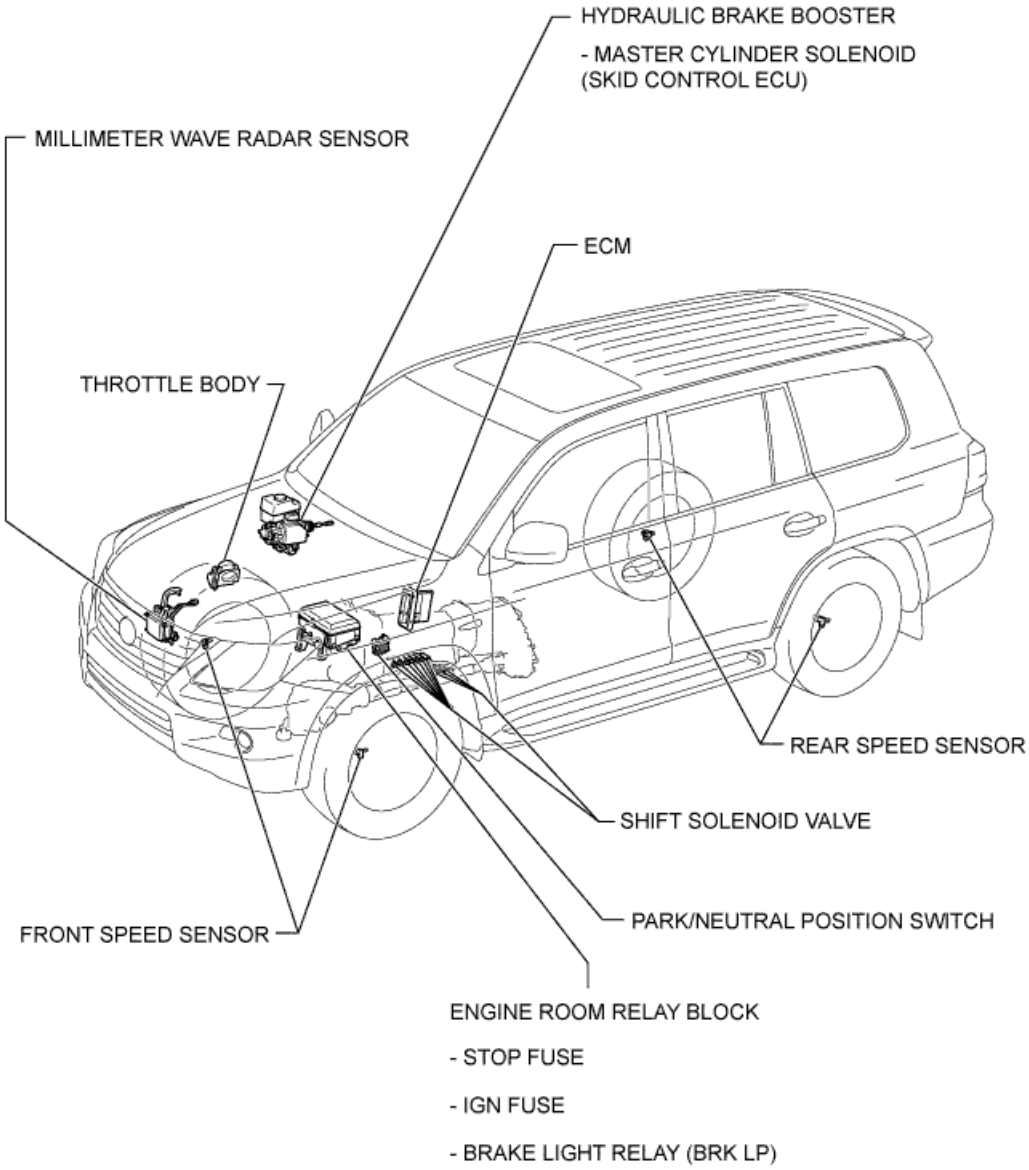
2.PRECAUTIONS WHEN REPLACING DISTANCE CONTROL ECU

a. When the distance control ECU is replaced with a new one, initialization must be performed (Click here). If initialization is not performed, the system will not operate normally.

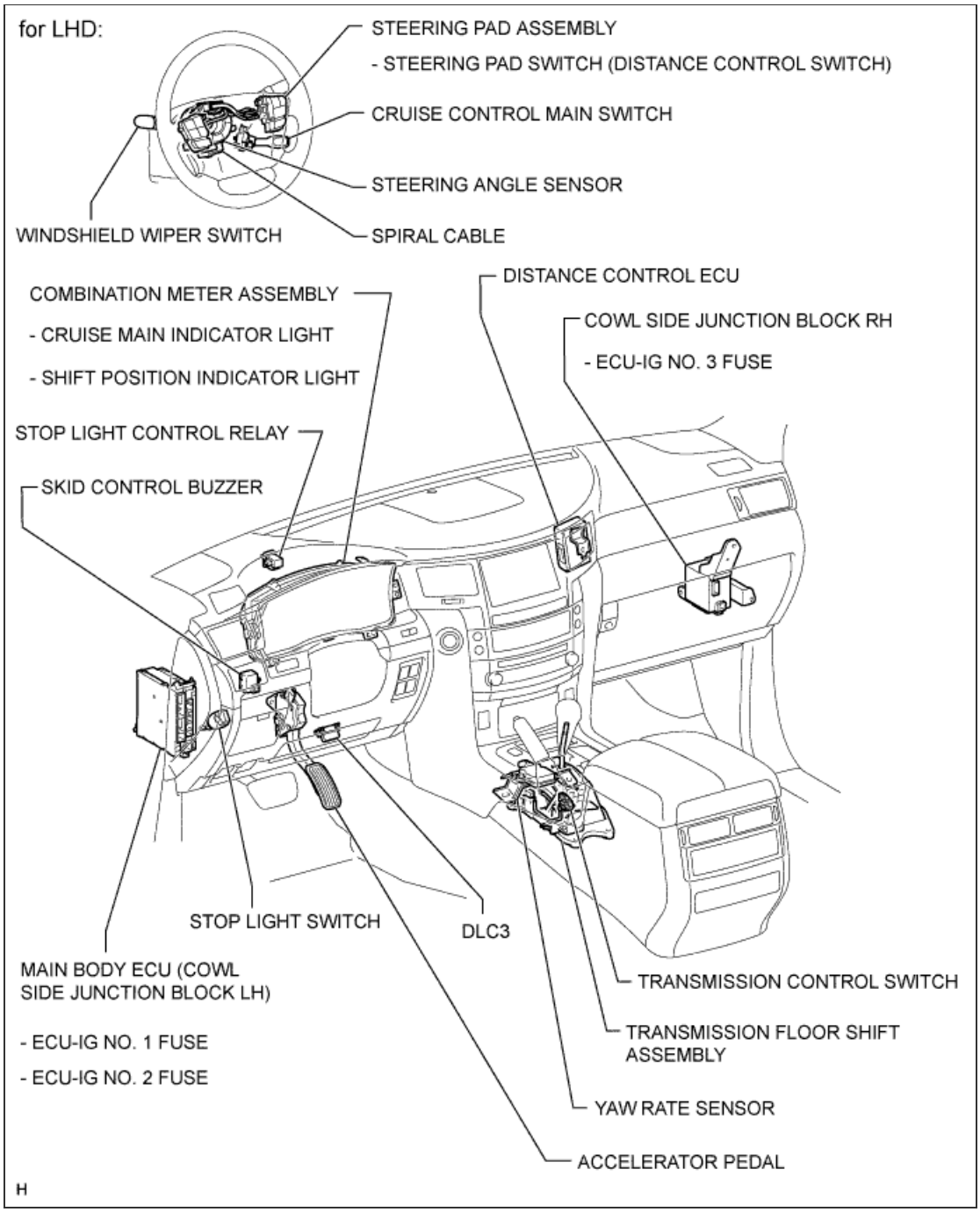
for Preparation Click here

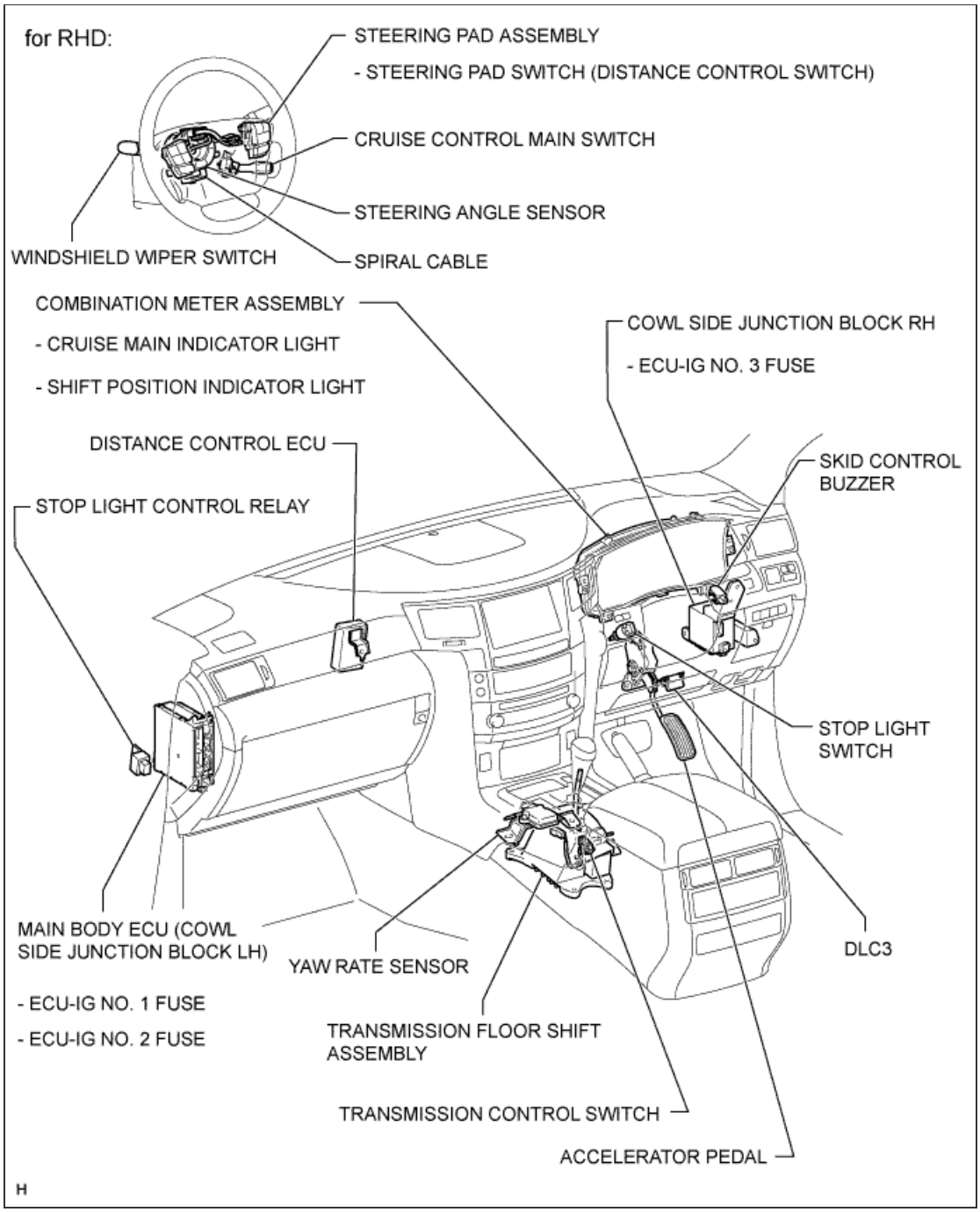


for RHD:

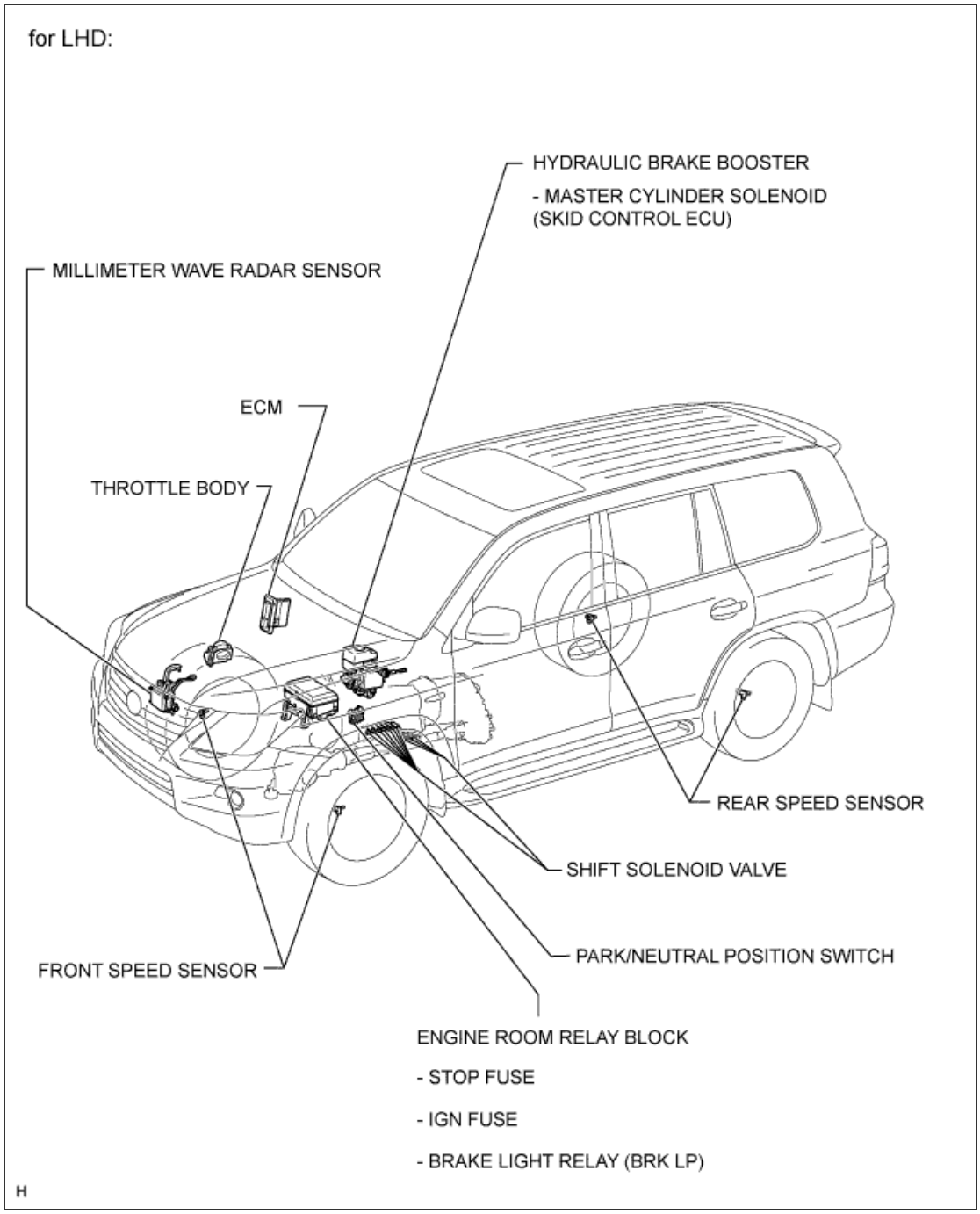

HYDRAULIC BRAKE BOOSTER
- MASTER CYLINDER SOLENOID
(SKID CONTROL ECU)
MILLIMETER WAVE RADAR SENSOR
ECM
THROTTLE BODY
REAR SPEED SENSOR
SHIFT SOLENOID VALVE
PARK/NEUTRAL POSITION SWITCH
FRONT SPEED SENSOR
ENGINE ROOM RELAY BLOCK
- STOP FUSE
- IGN FUSE
- BRAKE LIGHT RELAY (BRK LP)

H

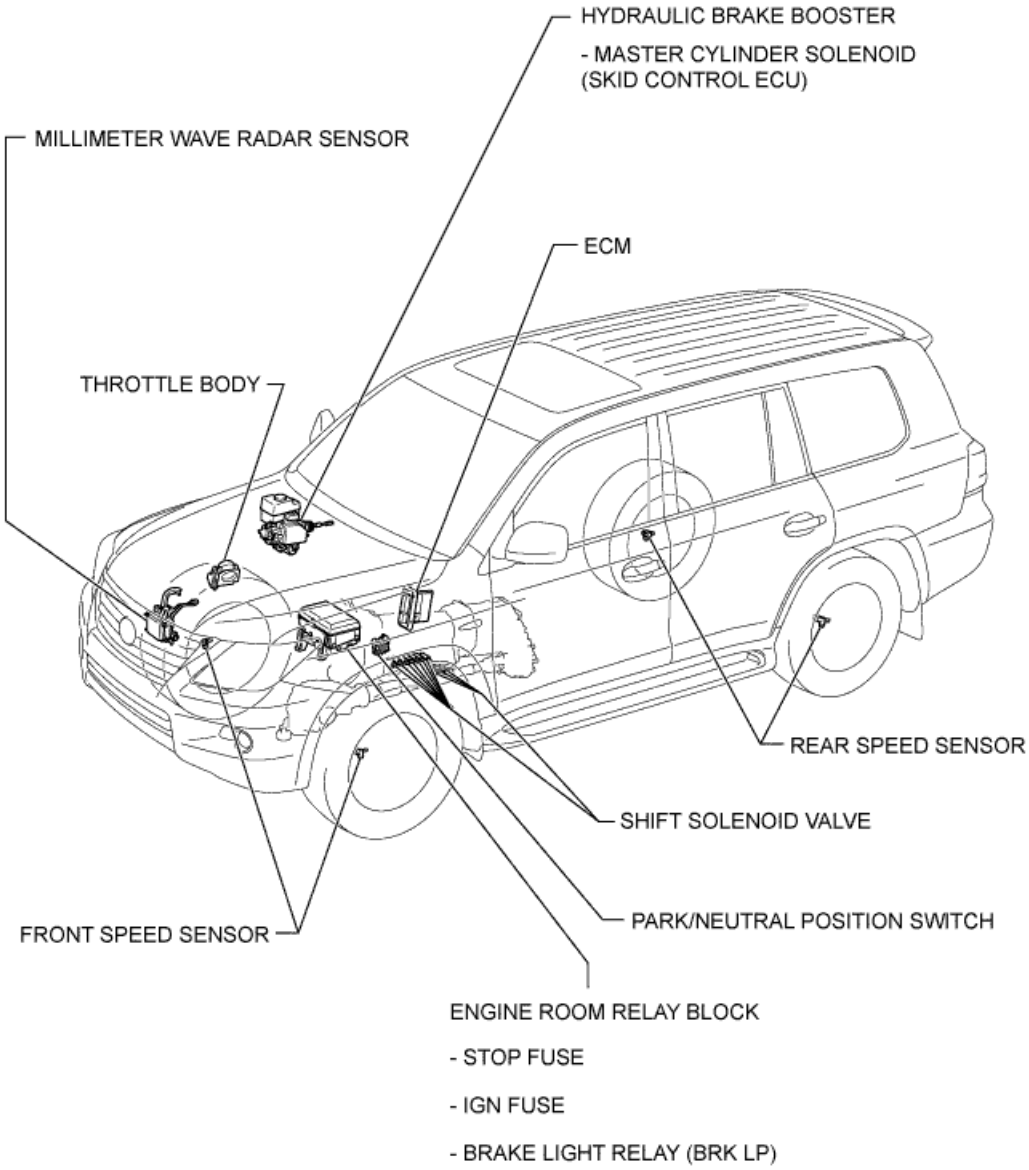

for LHD:
STEERING PAD ASSEMBLY
- STEERING PAD SWITCH (DISTANCE CONTROL SWITCH)
CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
- CRUISE MAIN INDICATOR LIGHT
- SHIFT POSITION INDICATOR LIGHT
STOP LIGHT CONTROL RELAY
SKID CONTROL BUZZER
DISTANCE CONTROL ECU
COWL SIDE JUNCTION BLOCK RH
- ECU-IG NO. 3 FUSE
STOP LIGHT SWITCH
DLC3
MAIN BODY ECU (COWL SIDE JUNCTION BLOCK LH)
- ECU-IG NO. 1 FUSE
- ECU-IG NO. 2 FUSE
TRANSMISSION CONTROL SWITCH
TRANSMISSION FLOOR SHIFT ASSEMBLY
YAW RATE SENSOR
ACCELERATOR PEDAL
H


for RHD:
STEERING PAD ASSEMBLY
- STEERING PAD SWITCH (DISTANCE CONTROL SWITCH)
CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
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MAIN BODY ECU (COWL SIDE JUNCTION BLOCK LH)
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TRANSMISSION FLOOR SHIFT ASSEMBLY
TRANSMISSION CONTROL SWITCH
ACCELERATOR PEDAL
H

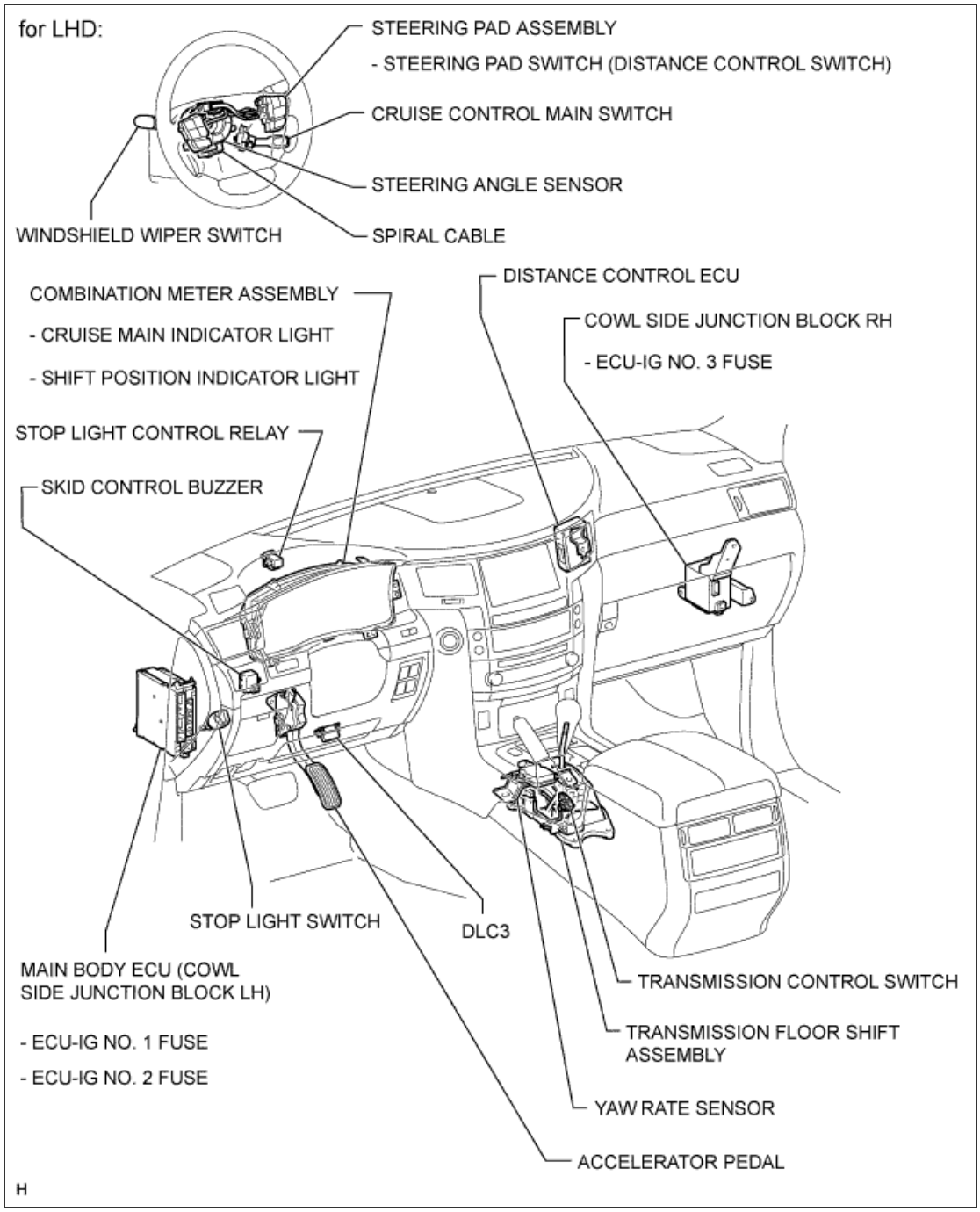
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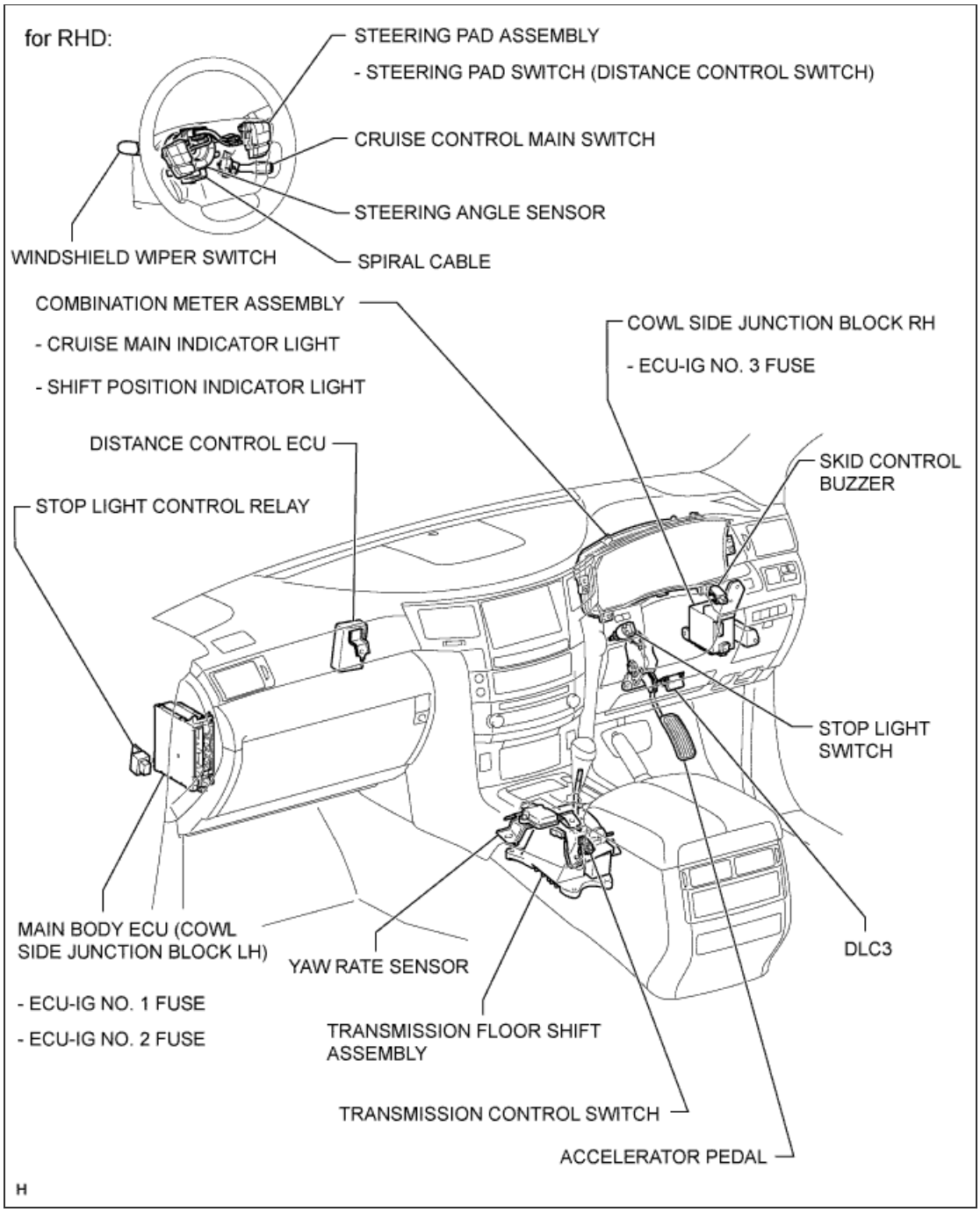


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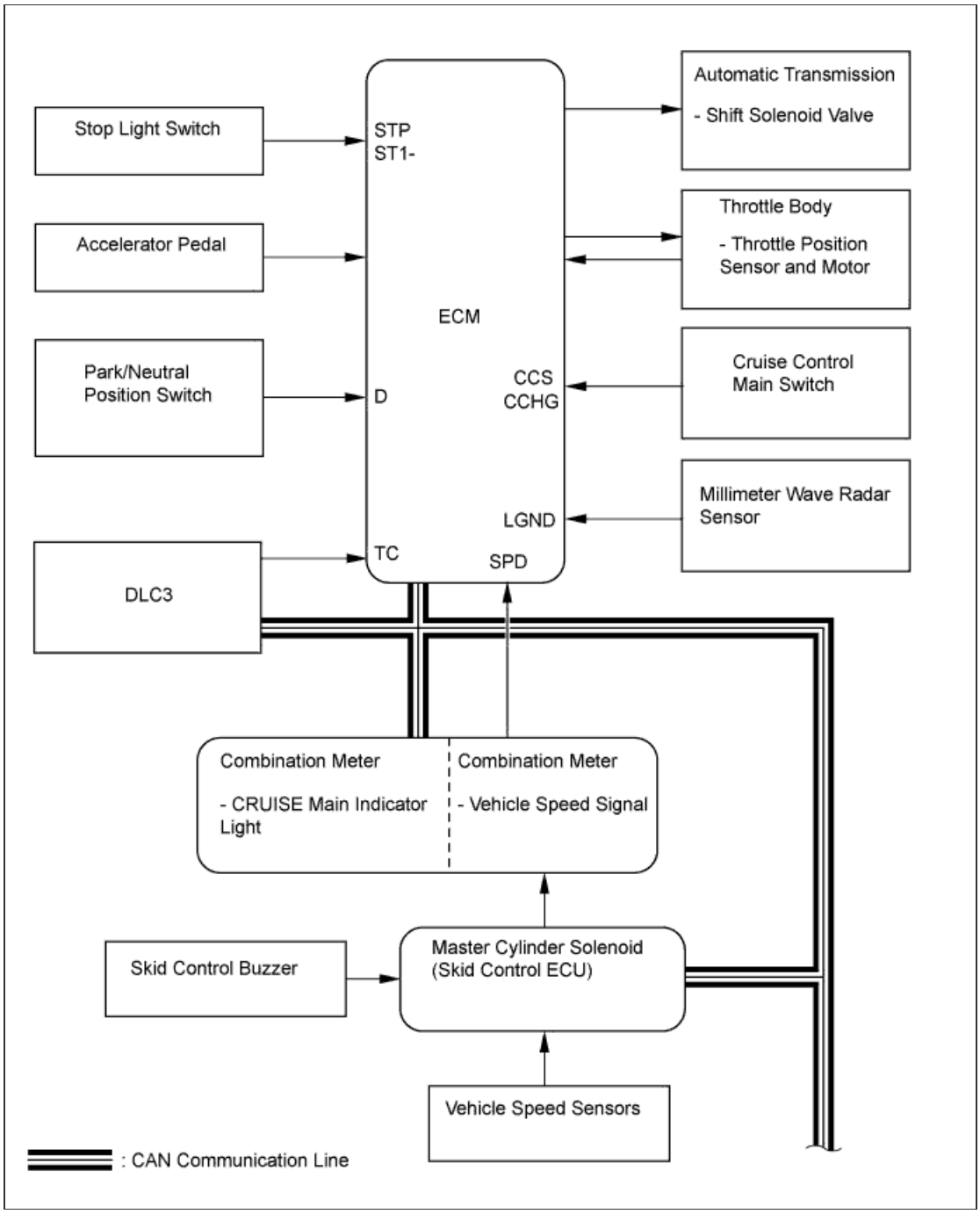

HYDRAULIC BRAKE BOOSTER
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MILLIMETER WAVE RADAR SENSOR
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SHIFT SOLENOID VALVE
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- IGN FUSE
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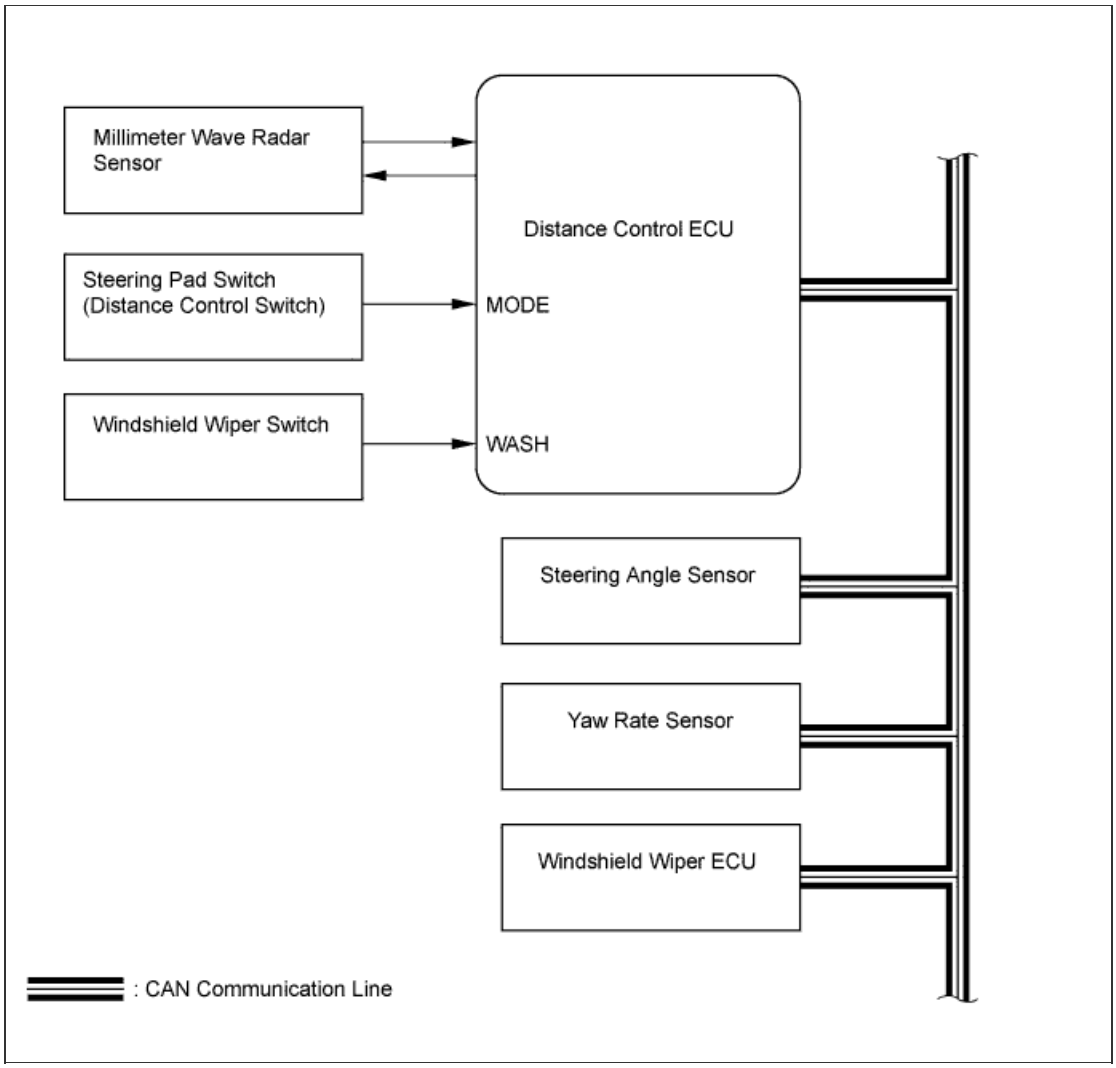
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for LHD:
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CRUISE CONTROL MAIN SWITCH
STEERING ANGLE SENSOR
SPIRAL CABLE
WINDSHIELD WIPER SWITCH
COMBINATION METER ASSEMBLY
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TRANSMISSION FLOOR SHIFT ASSEMBLY
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ACCELERATOR PEDAL
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YAW RATE SENSOR
TRANSMISSION FLOOR SHIFT ASSEMBLY
TRANSMISSION CONTROL SWITCH
ACCELERATOR PEDAL
H

for Preparation Click here





Communication Table

Transmitter	Receiver	Signal	Communication Line
ECM	Distance Control ECU	• A/T transmission signal • Cruise control operation signal • Cruise control low speed operation signal • Accelerator pedal idle signal • Set vehicle time signal • Brake demand response signal • Stored vehicle speed signal • Current vehicle speed signal • Cruise control switch signal • Brake control operation signal • Cruise control demand throttle opening angle signal • Radar light emission prohibiting signal • Dynamic radar cruise designation signal • Brake control interrupting signal • Steering wheel signal • Cruise control demand opening angle signal	CAN
Distance Control ECU	ECM	• Millimeter wave radar sensor beam axis deviation signal • Millimeter wave radar sensor malfunction signal • Millimeter wave radar sensor grime signal • Bad weather detection signal • Communication error signal (from distance control ECU to millimeter wave radar sensor) • Communication error signal (from ECM to distance control ECU) • Communication error signal (from master cylinder solenoid to distance control ECU) • Yaw rate communication error signal • Steering angle sensor communication error signal • Distance control ECU voltage signal • Dynamic radar cruise designation response signal	CAN

		• Estimated vehicle speed signal • Vehicle-to-vehicle distance signal • Vehicle-to-vehicle distance control signal • Brake control demand signal • Throttle fully closed demand signal • Approach warning signal (skid control buzzer demand signal) • Cruise target deceleration gradient signal • Vehicle-to-vehicle distance control acceleration signal	
ECM	Master Cylinder Solenoid (Skid Control ECU)	• Cruise target deceleration gradient signal • Cruise target deceleration signal • Throttle fully closed demand signal • Brake control demand signal • Dynamic radar cruise control designation signal • Cruise control operation signal	CAN
Master Cylinder Solenoid (Skid Control ECU)	Distance Control ECU	• Wheel speed signal • Speed sensor power drop signal • Speed sensor condition signal • Yaw rate sensor signal • Yaw rate sensor zero point error signal	CAN
Master Cylinder Solenoid (Skid Control ECU)	ECM	• Brake component malfunction signal • Brake control malfunction signal • Drive wheel slip signal • Cruise control cancel signal • Skid control buzzer malfunction signal • Communication logic error signal (from ECM to master cylinder solenoid) • Brake demand response signal • Brake control interrupting signal • Brake control operation signal	CAN
Steering Angle Sensor	Distance Control ECU	• Steering angle sensor malfunction signal • Steering angle sensor signal • Steering angle sensor zero point signal	CAN
Yaw Rate Sensor	Distance Control ECU	• Yaw rate sensor signal • Yaw rate sensor voltage signal	CAN
ECM	Combination Meter	• Cruise control diagnosis signal (DTC) • Preceding vehicle detection signal • Approach warning signal • Vehicle-to-vehicle distance signal • Millimeter wave radar sensor grime signal • Bad weather detection signal • Vehicle-to-vehicle distance control signal • Vehicle-to-vehicle distance control check mode signal • Vehicle-to-vehicle distance control standby condition signal • Constant speed cruise signal • CRUISE indicator operation signal • Cruise control warning signal • Dynamic radar cruise warning signal • Cruise control vehicle speed signal	CAN
Windshield Wiper ECU	Distance Control ECU	Wiper and washer switch signal	CAN
Distance Control ECU	Combination Meter	• Millimeter wave radar sensor beam axis deviation signal • Vehicle-to-vehicle distance signal • Preceding vehicle detection signal	CAN

for Preparation Click here

GENERAL

a. The dynamic radar cruise control system has 2 cruise control modes: the constant speed control mode and vehicle-to-vehicle distance control mode.

- The vehicle-to-vehicle distance control mode is always selected when starting the dynamic radar cruise control system.
- Operation of the constant speed control mode is the same as the cruise control system.

b. This system maintains the vehicle speed that the driver has set, as long as there are no vehicles ahead in the same lane. Then, the system maintains the vehicle distance that has been set by the driver. If the system detects a vehicle driving at a slower speed ahead while the driver is driving at a constant speed, it closes the throttle valve to decelerate. If further deceleration is required, the system controls the brake actuator in order to apply the brakes. Thereafter, if there are no vehicles ahead within the set vehicle-to-vehicle distance because either the vehicle ahead or the driver has changed lanes, the system accelerates slowly to reach the stored vehicle speed and resumes driving at the constant speed.

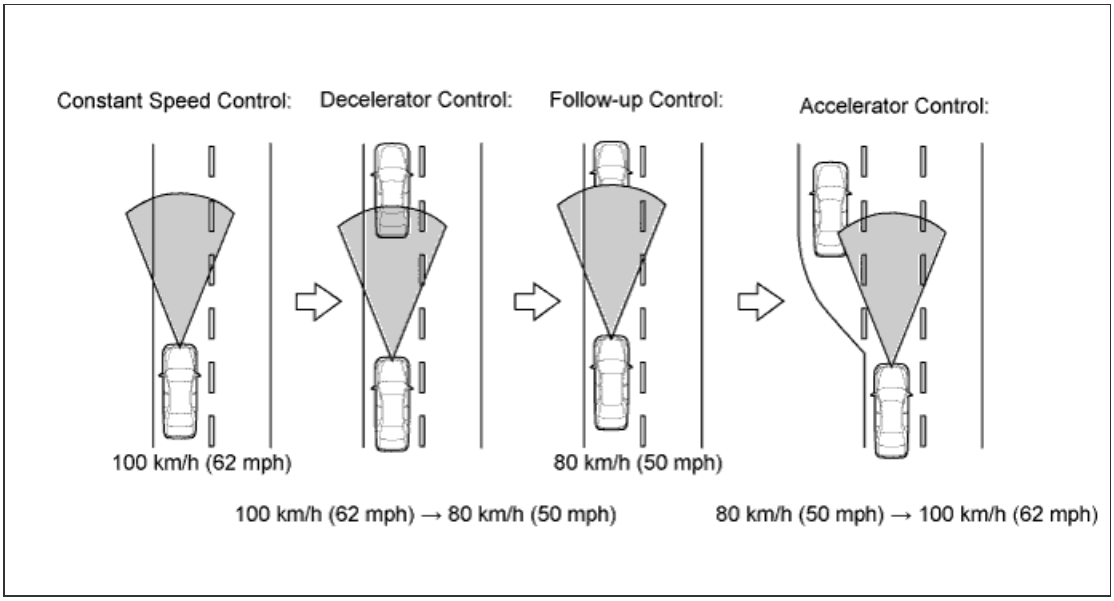
c. The constant speed control mode is designed to maintain a constant cruising speed. The vehicle-to-vehicle distance control mode is designed to control cruising using a constant speed function, deceleration cruising function, follow-up cruising function and acceleration cruising function.

d. The millimeter wave radar sensor and the distance control ECU control the system while the vehicle-to-vehicle distance control mode is in operation, and send signals to each actuator and ECU.

e. In vehicle-to-vehicle distance control mode, the dynamic radar cruise control system receives signals from the yaw rate (deceleration) sensor and the steering angle sensor. Based on these signals, it then estimates curve radius and corrects the information on the preceding vehicle while turning. It can also adjust the brake control when approaching another vehicle.

f. This system judges the presence of a vehicle in front and the distance to it based on the signals from the radar sensor while the vehicle-to-vehicle distance control mode is in operation. Using this information, the system informs the driver of any danger with the warning buzzer, performs brake control, and turns on the stop light when approaching the vehicle in front.

g. The following illustration shows an example under the following conditions: your vehicle speed is 100 km/h (62 mph) and the speed of the vehicle in front is 80 km/h (50 mph). Setting of the vehicle distance can be changed to 3 distances by operating the steering pad switch (distance control switch): long (approximately 50 m (164 ft.)), middle (approximately 40 m (131 ft.)), and short (approximately 30 m (98 ft.)) when the vehicle speed is approximately 80 km/h (50 mph).



HINT:

- **Vehicle distance increases and decreases in accordance with vehicle speed.**
- **Controlling condition is indicated on the multi-information display in the combination meter.**

FUNCTION OF MAIN COMPONENTS

Item	Outline
Combination meter (CRUISE main indicator light)	• Turns on when the cruise control main switch is on. • If the distance control ECU detects a malfunction, this light flashes to warn the driver.
Combination meter (Master warning light)	If the ECM or the distance control ECU detects an automatic cancel signal while the vehicle is operating under cruise control, this light turns on to inform the driver.
Combination meter (Buzzer)	If the ECM or the distance control ECU detects an automatic cancel signal while the vehicle is operating under cruise control, this buzzer sounds only once to inform the driver.
Combination meter (Multi-information display)	• While the system is in vehicle-to-vehicle distance control mode, the multi-information display receives signals from the distance control ECU in order to display system conditions in the graphic area. • If the ECM or the distance control ECU detects a malfunction signal while the vehicle is operating under cruise control, a warning message will be displayed in the warning area to inform the driver. • While the system is in radar sensor adjustment mode, the adjustment angle detected by the distance control ECU will be displayed in the warning area to inform the driver.
Cruise control main switch	Turns the cruise control system on/off.
Cruise control main switch (Control switch)	• Vehicle speed setting, deceleration setting, preset speed resumption, acceleration setting, and canceling signals are output to the ECM through operation of this switch. • Switch control modes: constant speed control mode and vehicle-to-vehicle distance control mode.
Steering pad switch (Distance control switch)	While the system is in vehicle-to-vehicle distance control mode, the driver can operate the steering pad switch (distance control switch) to select the vehicle-to-vehicle distance in three stages: long, middle, and short.
Stop light switch	Detects depressing of the brake pedal and transmits its signal to the ECM.
Combination switch (Windshield wiper switch)	Transmits windshield wiper switch information to the distance control ECU.
Millimeter wave radar sensor	Emits radar waves forward, uses reflected waves for detecting the presence of the vehicle in front, vehicle-to-vehicle distance, and relative speed, and transmits this information to the distance control ECU.
Vehicle speed sensor	The vehicle speed signal which is output from the master cylinder solenoid (skid control ECU) is sent to the ECM.
Steering angle sensor	Detects the angle and direction of the steering wheel and transmits a signal to the distance control ECU.
Yaw rate sensor	Detects the yaw rate of the vehicle and transmits its signal to the distance control ECU.
Master cylinder solenoid (Skid control ECU)	• Actuates the brakes in accordance with signals from the master cylinder solenoid (skid control ECU). • While the system is in vehicle-to-vehicle distance control mode, the master cylinder solenoid (skid control ECU) actuates the brake actuator in accordance with the brake request signal received from the distance control ECU. • Upon receiving the signal from the distance control ECU, the master cylinder solenoid (skid control ECU) sounds the skid control buzzer.
Skid control buzzer	This buzzer sounds upon receiving the signal from the master cylinder solenoid (skid control ECU).
ECM	• Controls the dynamic radar cruise control system in accordance with signals from switches, sensors, and the distance control ECU. • If the ECM detects a malfunction in the dynamic radar cruise control system, it will store DTCs (Diagnostic Trouble Codes).
Throttle position sensor and motor	Upon receiving a signal from the ECM, the throttle control motor actuates the throttle valve.
Distance control ECU	While the system is in vehicle-to-vehicle distance control mode, the distance control ECU detects the vehicle in front based on a signal from the millimeter wave radar sensor. Then, the distance control ECU calculates the acceleration or deceleration rate in order to attain target

	vehicle-to-vehicle distance, and outputs a request signal to the ECM and the master cylinder solenoid (skid control ECU).

LIMIT CONTROL

a. Low speed limit
The lowest possible limit of the speed setting range is set at approximately 40 km/h (25 mph). The cruise control system cannot be set when the driving vehicle speed is below the low speed limit. Cruise control operation will be automatically canceled when the vehicle speed decreases below the low speed limit (40 km/h (25 mph)) while cruise control is in operation. When the vehicle speed is increased above the low speed limit after the cruise control operation is canceled, pressing the RES (RESUME) switch increases the vehicle speed to the stored speed.

b. High speed limit (Constant speed control mode)
The highest possible limit of the speed setting range is approximately 100 km/h (62.5 mph). The cruise control system cannot be set when the driving vehicle speed is over the high speed limit. Also, +RES (ACCELERATION/RESUME) cannot be used to increase speed beyond the high speed limit.

CRUISE CONTROL OPERATION

The cruise control main switch operates 8 functions: SET, - (COAST), TAP-DOWN, RES (RESUME), + (ACCELERATION), TAP-UP, CANCEL and MODE. The SET, TAP-DOWN and - (COAST) functions, and the RES (RESUME), TAP-UP and + (ACCELERATION) functions are operated with the same switch. The cruise control main switch is an automatic return type switch which turns on only while operating it in each arrow direction and turns off after releasing it. The dynamic radar cruise control system has two cruise control modes: the constant speed control mode and vehicle-to-vehicle distance control mode.

- The vehicle-to-vehicle distance control mode is always selected when starting up the dynamic radar cruise control system.
- Operation of the constant speed control mode is the same as the cruise control system.

a. MODE CONTROL
Pushing the switch to MODE for more than 1 second while driving with the cruise control main switch ON-OFF button on (RADAR READY is on) switches the mode to the constant speed control mode.

b. SET CONTROL (Constant speed control mode)
Vehicle speed is stored and constant speed control is maintained when pushing the switch to -SET while driving with the vehicle speed within the set speed range (between the low and high speed limits) after pushing the cruise control main switch on (RADAR READY is on), and entering the constant speed control mode.

c. SET CONTROL (Vehicle-to-vehicle distance control mode)
Vehicle speed is stored and vehicle-to-vehicle distance control is maintained when pushing the switch to -SET while driving with the cruise control main switch on (RADAR READY is on), and vehicle speed is within the set speed range (between the low and high speed limits).

d. - (COAST) CONTROL (Constant speed control mode)
When the cruise control main switch is pushed to -SET and held in that position while the cruise control system is operating, the ECM sends a "throttle valve opening angle 0°" demand signal to the cruise control system. Then the vehicle speed, when the cruise control main switch is released, is stored and maintained.

HINT:

An actual throttle valve opening angle of 0° is not possible due to the idle speed control, etc.

e. - (COAST) CONTROL (Vehicle-to-vehicle distance control mode)
When the cruise control main switch is pushed to -SET and held in that position while the vehicle-to-vehicle distance control mode is in operation, the stored vehicle speed decreases by approximately 5 km/h or 5 mph.

f. TAP-DOWN CONTROL (Vehicle-to-vehicle distance control mode)
When tapping down the cruise control main switch to -SET (for approximately 0.6 seconds) while the vehicle-to-vehicle distance control mode is in operation, the stored vehicle speed decreases each time by approximately 5 km/h or 5 mph.

g. TAP-DOWN CONTROL (Constant speed control mode)
When tapping down the cruise control main switch to -SET (for approximately 0.6 seconds) while the constant speed control mode is in operation, the stored vehicle speed decreases each time by approximately 1.6 km/h (1 mph). When the cruise control main switch is released from -SET and the difference between the driving and stored vehicle speed is more than 5 km/h (3 mph), the vehicle speed is stored and constant speed control is maintained.

h. + (ACCELERATION) CONTROL (Constant speed control mode)
The throttle valve motor of the throttle position sensor and motor is instructed by the ECM to open the throttle valve when the cruise control main switch is pushed to +RES and held in that position while the constant speed control mode is in operation. When the cruise control main switch is released from +RES, the vehicle speed is stored and constant speed control is maintained.

i. + (ACCELERATION) CONTROL (Vehicle-to-vehicle distance control mode)
When the cruise control main switch is pushed to +RES and held in that position while the vehicle-to-vehicle distance control mode is in operation, the stored vehicle speed increases by approximately 5 km/h or 5 mph per second. Pushing the cruise control main switch to +RES while following a vehicle in front with the vehicle-to-vehicle distance control mode on does not increase the actual vehicle speed, but changes only the stored vehicle speed.

j. TAP-UP CONTROL (Vehicle-to-vehicle distance control mode)
When tapping up the cruise control main switch to +RES (approximately 0.6 seconds) while the vehicle-to-vehicle distance control mode is in operation, the stored vehicle speed increases each time by approximately 5 km/h or 5 mph.

k. TAP-UP CONTROL (Constant speed control mode)
When tapping up the cruise control main switch to +RES (approximately 0.6 seconds) while the constant speed control mode is in operation, the stored vehicle speed increases each time by approximately 1.6 km/h (1 mph). However, when the difference between the driving and the stored vehicle speeds is more than 5 km/h (3 mph), the stored vehicle speed will not be changed.

l. MANUAL CANCEL CONTROL
Performing any of the following cancels the cruise control system while it is in operation (the stored vehicle speed in the ECM is maintained).

- Depressing the brake pedal.
- Moving the shift lever from D to N.
- With the shift lever in S, selecting the S1, S2 or S3 range.
- Pulling the cruise control main switch to CANCEL.
- Turning the cruise control main switch off (the stored vehicle speed in the ECM is not maintained).
- Driving the vehicle while the VSC system is operating.

m. RES (RESUME) CONTROL
If the cruise control operation was canceled with the stop light switch or the CANCEL switch, and if the driving speed is within the set speed range, pushing the cruise control main switch to +RES restores the vehicle speed memorized at the time of cancellation, and maintains constant speed control.

BRAKE CONTROL

The distance control ECU determines the distance to the vehicle in front, relative speed, target decreasing speed and deceleration rate. Based on the data, the ECU may transmit a brake demand signal to the master cylinder solenoid (skid control ECU) via the ECM.

DOWN SHIFT CONTROL

When the dynamic radar cruise control system is in operation, the gear may down-shift on an uphill road. After the gear is shifted down, if the system determines that the uphill inclination has become smaller based on the throttle valve opening angle, the gear automatically returns.

AUTO CANCEL (FAIL-SAFE)

This system has an automatic cancellation function (fail-safe) (Click here).

for Preparation Click here

HINT:

- **Use these procedures to troubleshoot the cruise control system.**
- ***: Use the intelligent tester.**

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.INSPECT BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If the voltage is below 11 V, recharge or replace the battery before proceeding.

NEXT

3.CHECK COMMUNICATION FUNCTION OF CAN COMMUNICATION SYSTEM*

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
CAN DTC is not output	A
CAN DTC is output (for LHD)	B
CAN DTC is output (for RHD)	C

B. → GO TO CAN COMMUNICATION SYSTEM (**Click here**)

C. → GO TO CAN COMMUNICATION SYSTEM (**Click here**)

A

4.CHECK INDICATOR

a. Check the indicator (Click here).

NEXT

5.CHECK FOR DTC*

a. Check for DTCs (Click here).

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

Result

Result	Proceed to
DTC is not output	A
DTC is output	B

B. GO TO DTC CHART (Click here)

A

6.PROBLEM SYMPTOMS TABLE

a. Refer to the Problem Symptoms Table (Click here).

Result

Result	Proceed to
Fault is not listed in problem symptoms table	A
Fault is listed in problem symptoms table	B

B. Go to step 8

A

7.OVERALL ANALYSIS AND TROUBLESHOOTING*

a. Terminals of ECU (Click here).

b. Data List / Active Test (Click here).

NEXT

8.ADJUST, REPAIR OR REPLACE

NEXT

9.CONFIRMATION TEST

NEXT

END

for Preparation Click here

HINT:

- **Use these procedures to troubleshoot the cruise control system.**
- ***: Use the intelligent tester.**

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.INSPECT BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If the voltage is below 11 V, recharge or replace the battery before proceeding.

NEXT

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a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
CAN DTC is not output	A
CAN DTC is output (for LHD)	B
CAN DTC is output (for RHD)	C

B. → GO TO CAN COMMUNICATION SYSTEM (**Click here**)

C. → GO TO CAN COMMUNICATION SYSTEM (**Click here**)

A

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a. Check the indicator (Click here).

NEXT

5.CHECK FOR DTC*

a. Check for DTCs (Click here).

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

Result

Result	Proceed to
DTC is not output	A
DTC is output	B

B. GO TO DTC CHART (Click here)

A

6.PROBLEM SYMPTOMS TABLE

a. Refer to the Problem Symptoms Table (Click here).

Result

Result	Proceed to
Fault is not listed in problem symptoms table	A
Fault is listed in problem symptoms table	B

B. Go to step 8

A

7.OVERALL ANALYSIS AND TROUBLESHOOTING*

a. Terminals of ECU (Click here).

b. Data List / Active Test (Click here).

NEXT

8.ADJUST, REPAIR OR REPLACE

NEXT

9.CONFIRMATION TEST

NEXT

END

for Preparation Click here

HINT:

- **Use these procedures to troubleshoot the cruise control system.**
- ***: Use the intelligent tester.**

1.VEHICLE BROUGHT TO WORKSHOP

NEXT

2.INSPECT BATTERY VOLTAGE

Standard voltage:
11 to 14 V

If the voltage is below 11 V, recharge or replace the battery before proceeding.

NEXT

3.CHECK COMMUNICATION FUNCTION OF CAN COMMUNICATION SYSTEM*

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
CAN DTC is not output	A
CAN DTC is output (for LHD)	B
CAN DTC is output (for RHD)	C

B. → GO TO CAN COMMUNICATION SYSTEM (**Click here**)

C. → GO TO CAN COMMUNICATION SYSTEM (**Click here**)

A

4.CHECK INDICATOR

a. Check the indicator (Click here).

NEXT

5.CHECK FOR DTC*

a. Check for DTCs (Click here).

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

Result

Result	Proceed to
DTC is not output	A
DTC is output	B

B. GO TO DTC CHART (Click here)

A

6.PROBLEM SYMPTOMS TABLE

a. Refer to the Problem Symptoms Table (Click here).

Result

Result	Proceed to
Fault is not listed in problem symptoms table	A
Fault is listed in problem symptoms table	B

B. Go to step 8

A

7.OVERALL ANALYSIS AND TROUBLESHOOTING*

a. Terminals of ECU (Click here).

b. Data List / Active Test (Click here).

NEXT

8.ADJUST, REPAIR OR REPLACE

NEXT

9.CONFIRMATION TEST

NEXT

END

for Preparation Click here

HINT:

The dynamic radar cruise control system has 2 cruise control modes: the constant speed control mode and vehicle-to-vehicle distance control mode.

- **The vehicle-to-vehicle distance control mode is always selected when starting up the dynamic radar cruise control system.**
- **Operation of the constant speed control mode is the same as the cruise control system.**

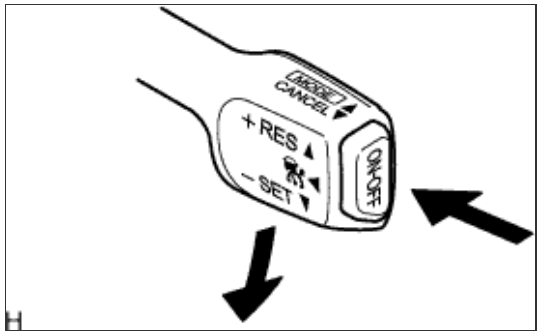
INSPECT SET SWITCH

a. Turn the cruise control main switch on.

b. Drive at the desired speed (40 km/h (25 mph) or higher).

c. Push the cruise control main switch to -SET (COAST/SET).

d. Check that the vehicle cruises at the desired speed.



INSPECT "+" SWITCH

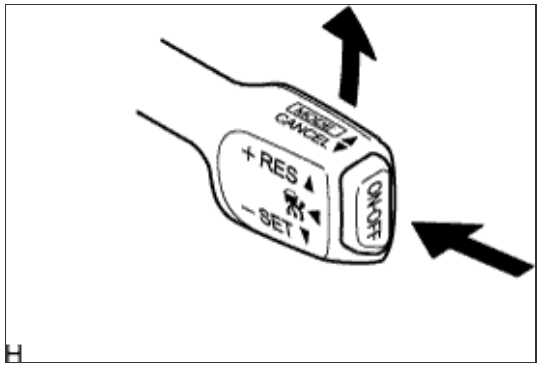
a. Turn the cruise control main switch on.

b. Drive at the desired speed (40 km/h (25 mph) or higher).

c. Push the cruise control main switch to -SET (COAST/SET).

d. Check that vehicle speed increases while the cruise control main switch is pushed to +RES (ACCELERATION/RESUME), and that the vehicle cruises at the set speed when released.

e. Vehicle-to-vehicle distance control mode:
Momentarily push the cruise control main switch to +RES (ACCELERATION/RESUME), and then immediately release it. Check that the driving and the stored vehicle speed increase by 5 km/h or 5 mph (Tap-up function).



HINT:

Pushing the cruise control main switch to +RES while following a vehicle in front with the vehicle-to-vehicle distance control mode on does not increase the actual vehicle speed, but changes only the stored vehicle speed.

f. Constant speed control mode:
Momentarily push the control main switch to +RES (ACCELERATION/RESUME), and then immediately release it. Check that the vehicle speed increases by approximately 1.6 km/h (1.0 mph) (Tap-up function).

INSPECT "-" SWITCH

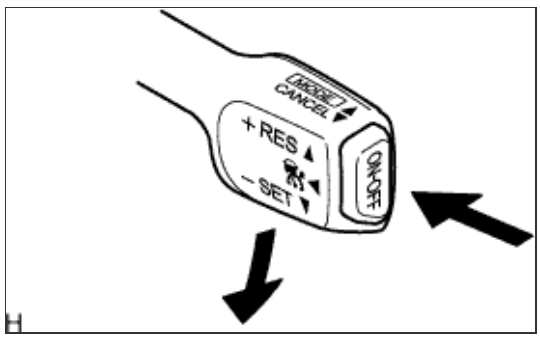
a. Turn the cruise control main switch on.

b. Drive at the desired speed (40 km/h (25 mph) or higher).

c. Push the cruise control main switch to -SET (COAST/SET).

d. Check that vehicle speed decreases while the cruise control main switch is pushed to -SET (COAST/SET), and the vehicle cruises at the set speed when released.

e. Vehicle-to-vehicle distance control mode:
Momentarily push the cruise control main switch to -SET (COAST/SET), and then immediately release it. Check that the driving and the stored vehicle speed decrease by 5 km/h or 5 mph (Tap-down function).



f. Constant speed control mode:
Momentarily push the cruise control main switch to -SET (COAST/SET), and then immediately release it. Check that the vehicle speed decreases by approximately 1.6 km/h (1.0 mph) (Tap-down function).

INSPECT CANCEL SWITCH

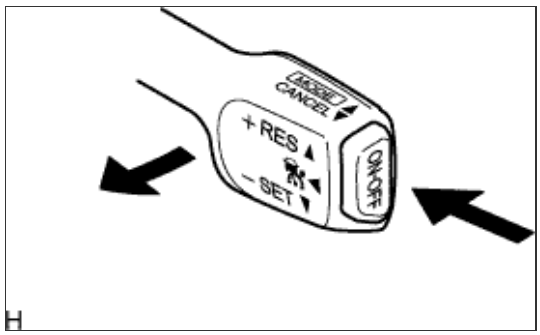
a. Turn the cruise control main switch on.

b. Drive at the desired speed (40 km/h (25 mph) or higher).

c. Push the cruise control main switch to -SET (COAST/SET).

d. When performing one of the following, check that the cruise control system is canceled.

- Depressing the brake pedal.
- Moving the shift lever from D to N.
- With the shift lever in S, selecting the S1, S2 or S3 range.
- Turning the cruise control main switch off (the stored vehicle speed in the ECM is not maintained).
- Pulling the cruise control main switch to CANCEL.
- Driving the vehicle while the VSC system is operating.



INSPECT RES (RESUME) SWITCH

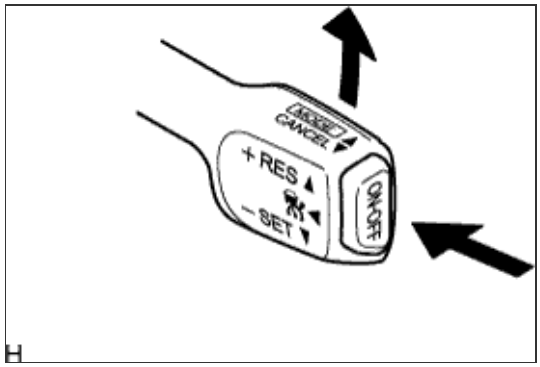
a. Turn the cruise control main switch on.

b. Drive at the desired speed (40 km/h (25 mph) or higher).

c. Push the cruise control main switch to -SET (COAST/SET).

d. Cancel the cruise control system by performing any of the operations below.

- Depressing the brake pedal.
- Moving the shift lever from D to N.
- With the shift lever in S, selecting the S1, S2 or S3 range.
- Pulling the cruise control switch to CANCEL.
- Driving the vehicle while the VSC system is operating.



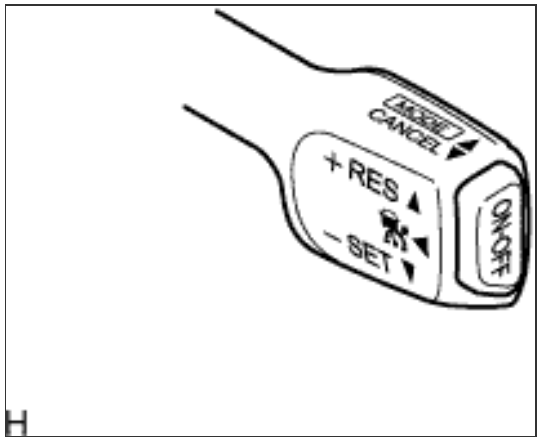
e. After the cruise control main switch is pushed to +RES (ACCELERATION/RESUME) at a driving speed of more than 40 km/h (25 mph), check that the vehicle restores the speed before the cancellation.

for Preparation Click here

INPUT SIGNAL CHECK

a. Connect the intelligent tester to the DLC3.

b. Check the cruise control main switch (ON-OFF, CANCEL, -SET, +RES, and MODE) using the Data List function in the intelligent tester.



INSPECT MODE SWITCH

a. Turn the engine switch on (IG).

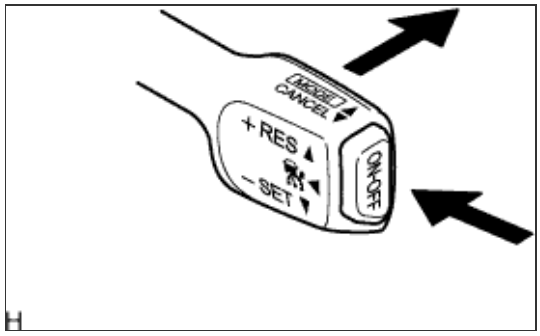
b. Turn the cruise control main switch on. Then push the cruise control main switch to MODE for 1 second or more to change to constant speed control mode. Check that "NORMAL" is indicated on the multi-information display.

NOTICE:

Do not push any other switches before pushing the cruise control main switch to MODE. If another switch is pushed, turn the control switch off and repeat the procedure above.

HINT:

If a malfunction is detected, turn the engine switch off and repeat the procedure above.

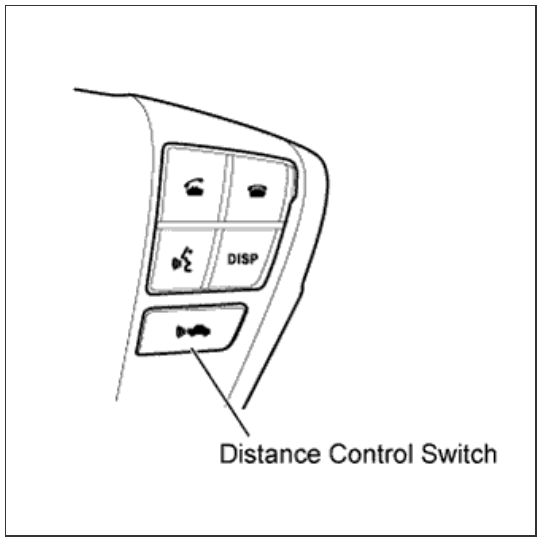


INSPECT STEERING PAD SWITCH

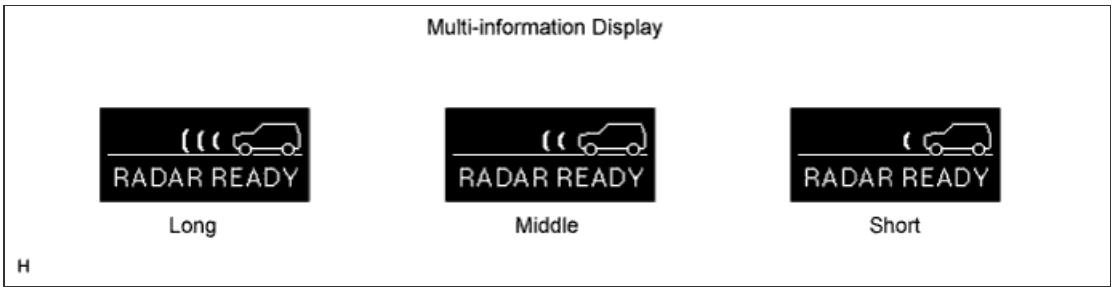
a. Turn the engine switch on (IG).

b. Turn the cruise control main switch on. Then push the cruise control main switch to MODE for 1 second or more to change to vehicle-to-vehicle distance control mode. Check that "RADAR READY" is indicated on the multi-information display.

c. Turn on the distance control switch of the steering pad switch.



d. Check that the indication of the vehicle-to-vehicle distance, which is shown in the multi-information display on the combination meter, changes from long to middle to short in that order.



HINT:

The indication is automatically set to long each time the engine is started.

for Preparation Click here

HINT:

- **Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.**
- **Inspect the fuses and relays related to this system before inspecting the suspected areas below.**

Dynamic Radar Cruise Control System

Symptom	Suspected Area	See page
Main switch cannot be turned on (CRUISE main indicator light on combination meter does not illuminate)	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, but turns off when operating SET function)	Cruise control switch circuit	Click here
	ECM	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, and remains illuminated when operating SET function)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
While the vehicle is driving with cruise control, the SET control is canceled (CRUISE main indicator light remains illuminated)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Stop light switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Park/neutral position switch circuit	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
	Vehicle speed sensor circuit	Click here
	Speedometer malfunction	Click here
	Millimeter wave radar	Click

Hunting (speed is not constant)	sensor power source circuit	here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
Vehicle speed setting cannot be canceled (CANCEL function failure)	Cruise control switch circuit	Click here
	ECM	Click here
DTC is not output, or is output when it should not be	TC and CG terminal circuit	Click here
	ECM	Click here
Erroneous detection or lost sight of vehicle in front	Clean radar sensor with soft cloth, etc.	-
	Improper aiming of sensor beam axis	-
Warning buzzer does not sound	Warning buzzer circuit	-
	Vehicle stability control system	Click here
	Millimeter wave radar sensor power source circuit	Click here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	ECM	Click here
Set distance cannot be changed	Meter/gauge system	Click here
	Cruise control switch circuit	Click here
	Distance control switch circuit	Click here
	ECM	Click here
No display	Meter/gauge system	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
No brake control (when decelerating)	Vehicle stability control system	Click here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
	Cruise control switch circuit	Click here
		Click

Constant speed control mode cannot be turned on	Meter/gauge system	here
	ECM	Click here
Vehicle speed cannot be canceled with wiper HI (including automatic wiper)	Wiper switch (HI speed) circuit	Click here
	Distance control ECU	Click here
	ECM	Click here
Unable to adjust beam axis of front millimeter wave radar sensor	Check for DTC P1570	-
	Check position, distance and angle of reflector	-
	Check installation of millimeter wave radar sensor	-
	Millimeter wave radar sensor	-
	Distance control ECU	Click here
	ECM	Click here
System cannot change between constant speed control mode and vehicle-to-vehicle distance control mode	Cruise control switch circuit	Click here
	ECM	Click here

for Preparation Click here

HINT:

- **Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.**
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Dynamic Radar Cruise Control System

Symptom	Suspected Area	See page
Main switch cannot be turned on (CRUISE main indicator light on combination meter does not illuminate)	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, but turns off when operating SET function)	Cruise control switch circuit	Click here
	ECM	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, and remains illuminated when operating SET function)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
While the vehicle is driving with cruise control, the SET control is canceled (CRUISE main indicator light remains illuminated)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Stop light switch circuit	Click here
	CRUISE main indicator light circuit	Click here
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	Vehicle speed sensor circuit	Click here
	Speedometer malfunction	Click here
	Millimeter wave radar	Click

Hunting (speed is not constant)	sensor power source circuit	here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
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	CAN communication line (for RHD)	Click here
	ECM	Click here
Vehicle speed setting cannot be canceled (CANCEL function failure)	Cruise control switch circuit	Click here
	ECM	Click here
DTC is not output, or is output when it should not be	TC and CG terminal circuit	Click here
	ECM	Click here
Erroneous detection or lost sight of vehicle in front	Clean radar sensor with soft cloth, etc.	-
	Improper aiming of sensor beam axis	-
Warning buzzer does not sound	Warning buzzer circuit	-
	Vehicle stability control system	Click here
	Millimeter wave radar sensor power source circuit	Click here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	ECM	Click here
Set distance cannot be changed	Meter/gauge system	Click here
	Cruise control switch circuit	Click here
	Distance control switch circuit	Click here
	ECM	Click here
No display	Meter/gauge system	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
No brake control (when decelerating)	Vehicle stability control system	Click here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
	Cruise control switch circuit	Click here
		Click

Constant speed control mode cannot be turned on	Meter/gauge system	here
	ECM	Click here
Vehicle speed cannot be canceled with wiper HI (including automatic wiper)	Wiper switch (HI speed) circuit	Click here
	Distance control ECU	Click here
	ECM	Click here
Unable to adjust beam axis of front millimeter wave radar sensor	Check for DTC P1570	-
	Check position, distance and angle of reflector	-
	Check installation of millimeter wave radar sensor	-
	Millimeter wave radar sensor	-
	Distance control ECU	Click here
	ECM	Click here
System cannot change between constant speed control mode and vehicle-to-vehicle distance control mode	Cruise control switch circuit	Click here
	ECM	Click here

for Preparation Click here

HINT:

- **Use the table below to help determine the cause of problem symptoms. If multiple suspected areas are listed, the potential causes of the symptoms are listed in order of probability in the "Suspected Area" column of the table. Check each symptom by checking the suspected areas in the order they are listed. Replace parts as necessary.**
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Dynamic Radar Cruise Control System

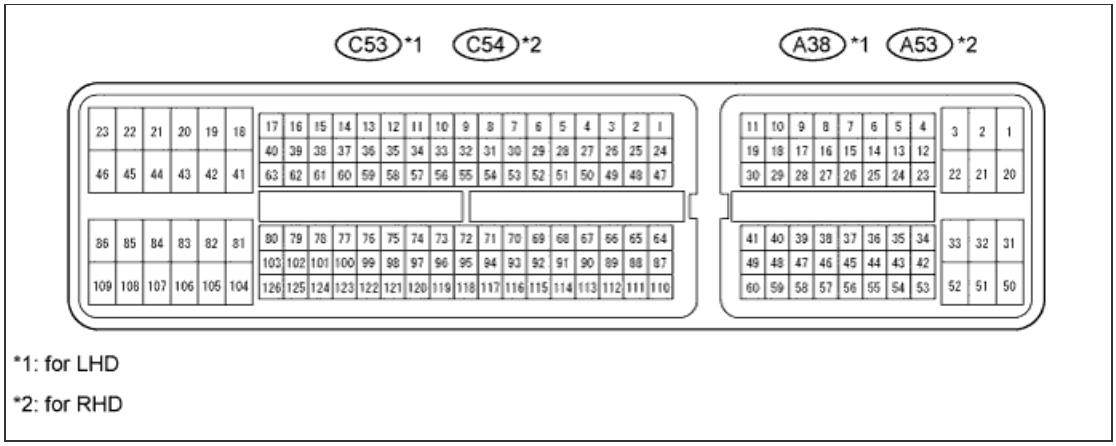
Symptom	Suspected Area	See page
Main switch cannot be turned on (CRUISE main indicator light on combination meter does not illuminate)	Cruise control switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Meter/gauge system	Click here
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	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, but turns off when operating SET function)	Cruise control switch circuit	Click here
	ECM	Click here
Vehicle speed setting cannot be performed (CRUISE main indicator light on combination meter illuminates when main switch is turned on, and remains illuminated when operating SET function)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Meter/gauge system	Click here
	ECM	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
While the vehicle is driving with cruise control, the SET control is canceled (CRUISE main indicator light remains illuminated)	Cruise control switch circuit	Click here
	Vehicle speed sensor circuit	Click here
	Stop light switch circuit	Click here
	CRUISE main indicator light circuit	Click here
	Park/neutral position switch circuit	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
	Vehicle speed sensor circuit	Click here
	Speedometer malfunction	Click here
	Millimeter wave radar	Click

Hunting (speed is not constant)	sensor power source circuit	here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
Vehicle speed setting cannot be canceled (CANCEL function failure)	Cruise control switch circuit	Click here
	ECM	Click here
DTC is not output, or is output when it should not be	TC and CG terminal circuit	Click here
	ECM	Click here
Erroneous detection or lost sight of vehicle in front	Clean radar sensor with soft cloth, etc.	-
	Improper aiming of sensor beam axis	-
Warning buzzer does not sound	Warning buzzer circuit	-
	Vehicle stability control system	Click here
	Millimeter wave radar sensor power source circuit	Click here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	ECM	Click here
Set distance cannot be changed	Meter/gauge system	Click here
	Cruise control switch circuit	Click here
	Distance control switch circuit	Click here
	ECM	Click here
No display	Meter/gauge system	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
No brake control (when decelerating)	Vehicle stability control system	Click here
	Distance control ECU power source circuit	Click here
	Distance control ECU	Click here
	CAN communication line (for LHD)	Click here
	CAN communication line (for RHD)	Click here
	ECM	Click here
	Cruise control switch circuit	Click here
		Click

Constant speed control mode cannot be turned on	Meter/gauge system	here
	ECM	Click here
Vehicle speed cannot be canceled with wiper HI (including automatic wiper)	Wiper switch (HI speed) circuit	Click here
	Distance control ECU	Click here
	ECM	Click here
Unable to adjust beam axis of front millimeter wave radar sensor	Check for DTC P1570	-
	Check position, distance and angle of reflector	-
	Check installation of millimeter wave radar sensor	-
	Millimeter wave radar sensor	-
	Distance control ECU	Click here
	ECM	Click here
System cannot change between constant speed control mode and vehicle-to-vehicle distance control mode	Cruise control switch circuit	Click here
	ECM	Click here

for Preparation Click here

CHECK ECM



HINT:

As the ECM connector is a waterproof connector, it is not possible to check the voltage of each terminal or check the waveform with an oscilloscope while the ECM is installed in the vehicle.

a. Disconnect the A38*1 and C53*1 or A53*2 and C54*2 ECM connectors.

*1: for LHD
*2: for RHD

b. Measure the voltage and resistance according to the value(s) in the table below.

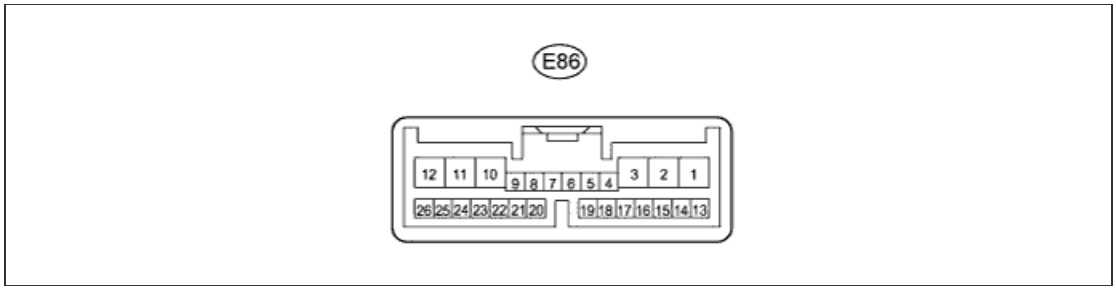
Terminal No. (Symbol)	Wiring Color	Terminal Description	Condition	Specified Condition
A38*1-16 (TC) - Body ground A53*2-16 (TC) - Body ground	V-W - Body ground	Terminal TC of DLC3	Engine switch on (IG)	11 to 14 V
			Engine switch off	Below 1 V
C53*1-81 (E1) - Body ground C54*2-81 (E1) - Body ground	W-B - Body ground	ECM ground	Always	Below 1 Ω
C53*1-27 (D) - Body ground C54*2-27 (D) - Body ground	G - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in D	11 to 14 V
			Engine switch on (IG) Shift lever not in D	Below 1 V
A38*1-38 (SFTU) - Body ground A53*2-38 (SFTU) - Body ground	Y - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in S	Below 1 Ω
			Engine switch on (IG) Shift lever in +	10 kΩ or higher
A38*1-25 (S) - Body ground A53*2-25 (S) - Body ground	W - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in S	11 to 14 V
			Engine switch on (IG) Shift lever not in S	Below 1 V
A38*1-27 (SFTD) - Body ground A53*2-27 (SFTD) - Body ground	L - Body ground	Park/neutral position switch signal	Engine switch on (IG) Shift lever in S	10 kΩ or higher
			Engine switch on (IG) Shift lever in -	Below 1 Ω
A38*1-36 (STP) - Body ground A53*2-36 (STP) - Body ground	R - Body ground	Stop light signal	Engine switch on (IG) Brake pedal depressed	11 to 14 V
			Engine switch on (IG) Brake pedal released	Below 1 V
A38*1-35 (ST1-) - Body ground A53*2-35 (ST1-) - Body	R-W - Body ground	Stop light signal (opposite to STP	Engine switch on (IG) Brake pedal depressed	Below 1 V
			Engine switch on (IG)	

ground		terminal)	Brake pedal released	11 to 14 V
A38*1-45 (CCS) - Body ground A53*2-45 (CCS) - Body ground	L - Body ground	Cruise control main switch signal	Engine switch on (IG) Main switch off	1 MΩ or higher
			Engine switch on (IG) CANCEL switch held on	1510 to 1570 Ω
			Engine switch on (IG) -SET switch held on	620 to 640 Ω
			Engine switch on (IG) +RES switch held on	235 to 245 Ω
			Engine switch on (IG) Main switch on	Below 2.5 Ω
A38*1-37 (CCHG) - Body ground A53*2-37 (CCHG) - Body ground	P-B - Body ground	Distance control switch signal	Engine switch on (IG) Main switch on MODE switch held on	Below 1 V
			Engine switch on (IG) Main switch on MODE switch off	11 to 14 V

*1: for LHD
*2: for RHD

If the result is not as specified, there may be a malfunction on the wire harness side.

CHECK DISTANCE CONTROL ECU



a. Disconnect the E86 distance control ECU connector.

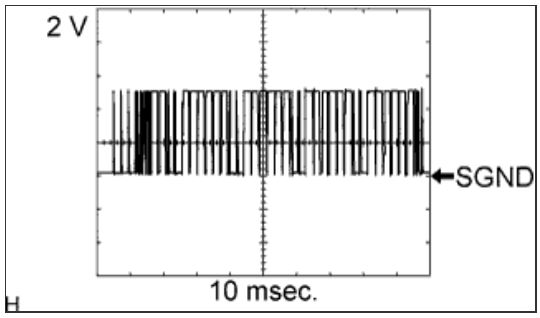
b. Measure the voltage and resistance according to the value(s) in the table below.

Terminal No. (Symbol)	Wiring Color	Terminal Description	Condition	Specified Condition
E86-1 (B) - Body ground	R - Body ground	Distance control ECU power source line	Engine switch on (IG)	11 to 14 V
E86-3 (WASH) - Body ground	L - Body ground	Windshield wiper switch signal	Engine switch on (IG) Windshield wiper switch on	11 to 14 V
			Engine switch on (IG) Windshield wiper switch off	Below 1 V
E86-12 (GND) - Body ground	BR - Body ground	Ground	Always	Below 1 Ω
E86-13 (IGB) - Body ground	R - Body ground	Engine switch on signal	Engine switch on (IG)	11 to 14 V
			Engine switch off	Below 1 V
E86-16 (MODE) - Body ground	W - Body ground	Distance control switch signal	Engine switch on (IG) Distance control switch on	Below 1 V
			Engine switch on (IG) Distance control switch off	11 to 14 V
E86-22 (LRDD) - E86-10 (SGND)	B - R	Millimeter wave radar sensor input signal	Engine switch on (IG)	Pulse generation (See waveform 1)
E86-23 (LRRD) - E86-10 (SGND)	W - R	Millimeter wave radar sensor output signal	Engine switch on (IG)	Pulse generation (See waveform 2)

If the result is not as specified, there may be a malfunction on the wire harness side.

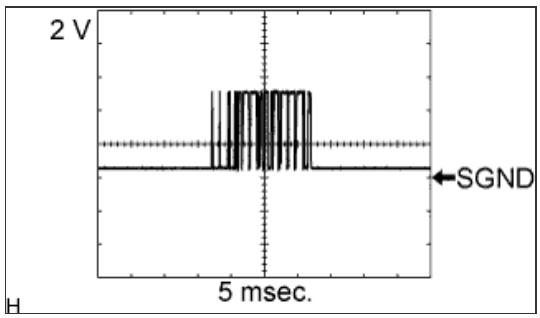
c. Using an oscilloscope, check waveform 1.

Item	Content
Terminal No. (Symbol)	E86-22 (LRDD) - E86-10 (SGND)
Tool Setting	2 V/DIV., 10 msec./DIV.
Condition	Engine switch on (IG)

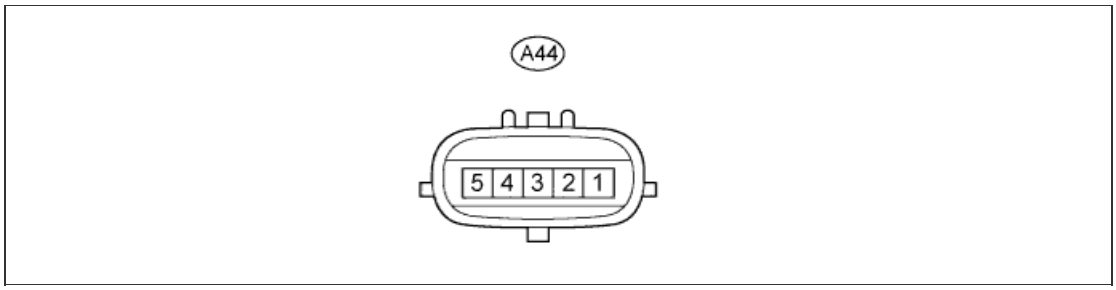


d. Using an oscilloscope, check waveform 2.

Item	Content
Terminal No. (Symbol)	E86-23 (LRRD) - E86-10 (SGND)
Tool Setting	2 V/DIV., 5 msec./DIV.
Condition	Engine switch on (IG)



CHECK MILLIMETER WAVE RADAR SENSOR



a. Disconnect the A44 millimeter wave radar sensor connector.

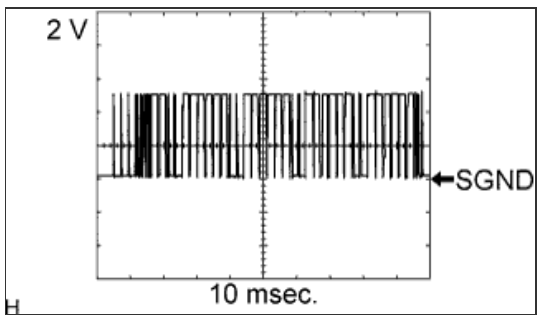
b. Measure the voltage according to the value(s) in the table below.

Terminal No. (Symbol)	Wiring Color	Terminal Description	Condition	Specified Condition
A44-3 (LRDD) - A44-2 (SGND)	B - R-W	Millimeter wave radar sensor output signal	Engine switch on (IG)	Pulse generation (See waveform 3)
A44-4 (LRRD) - A44-2 (SGND)	W - R-W	Millimeter wave radar sensor input signal	Engine switch on (IG)	Pulse generation (See waveform 4)
A44-5 (IGB) - A44-2 (SGND)	R-B - R-W	Engine switch on signal	Engine switch on (IG)	11 to 14 V
			Engine switch off	Below 1 V

If the result is not as specified, there may be a malfunction on the wire harness side.

c. Using an oscilloscope, check waveform 3.

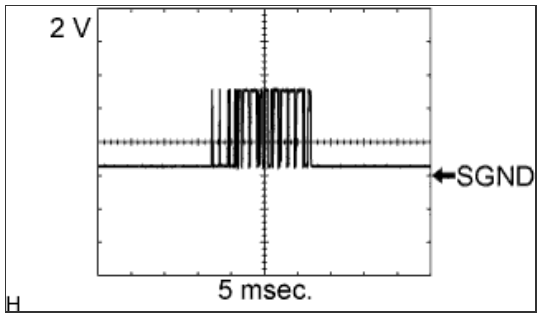
Item	Content
Terminal No. (Symbol)	A44-3 (LRDD) - A44-2 (SGND)
Tool Setting	2 V/DIV., 10 msec./DIV.
Condition	Engine switch on (IG)



d. Using an oscilloscope, check waveform 4.

Item	Content
Terminal No. (Symbol)	A44-4 (LRRD) - A44-2 (SGND)

Tool Setting	2 V/DIV., 5 msec./DIV.
Condition	Engine switch on (IG)



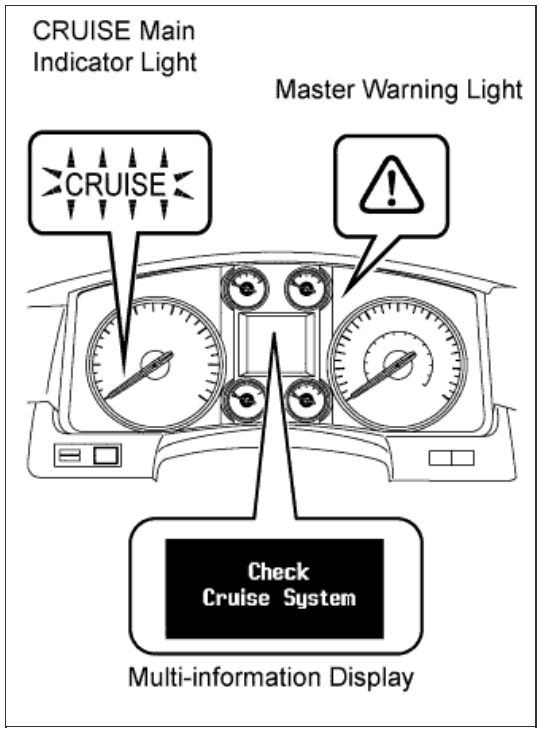
for Preparation Click here

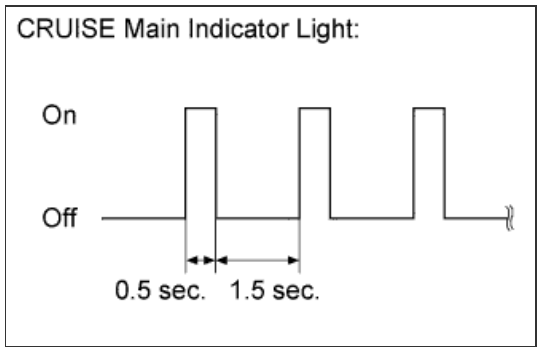
DIAGNOSIS FUNCTION

a. The diagnosis function makes the master warning light and the multi-information display come on, and the CRUISE main indicator light blinks as shown in the illustration. When a malfunction occurs in the dynamic radar cruise control system, DTCs are stored in the ECM.

NOTICE:

- **The master warning light goes off if the system returns to normal.**
- **Since the stored data in the ECM is cleared by disconnecting the EFI and ETCS fuses or the cable from the negative (-) battery terminal, do not disconnect them until the inspection has been completed.**





CHECK INDICATOR

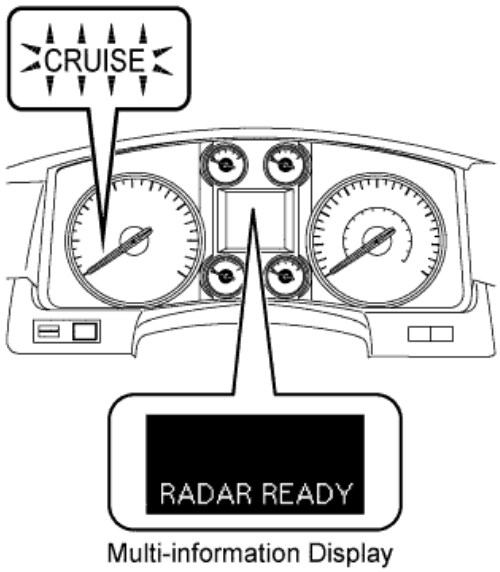
a. Turn the engine switch on (IG).

b. Check that the CRUISE main indicator light and RADAR READY indicator come on when the cruise control main switch ON-OFF button is pushed on, and that the indicator light goes off when the ON-OFF button is pushed off.

HINT:

- **If the indicator check result shows a problem, proceed to troubleshooting for the combination meter section.**

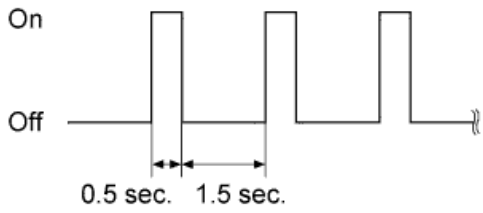
CRUISE Main Indicator Light



Multi-information Display

- **If a malfunction occurs in the vehicle speed sensors, the stop light switch, or other related parts during cruise control driving, the ECU activates AUTO CANCEL of cruise control and blinks the CRUISE main indicator light. This indicator light informs the driver of the malfunction. At the same time, the malfunction is stored as a diagnostic trouble code.**

CRUISE Main Indicator Light:



for Preparation Click here

CHECK DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: Powertrain / Radar Cruise / Trouble Codes.

e. Read the DTCs.

CLEAR DTC

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

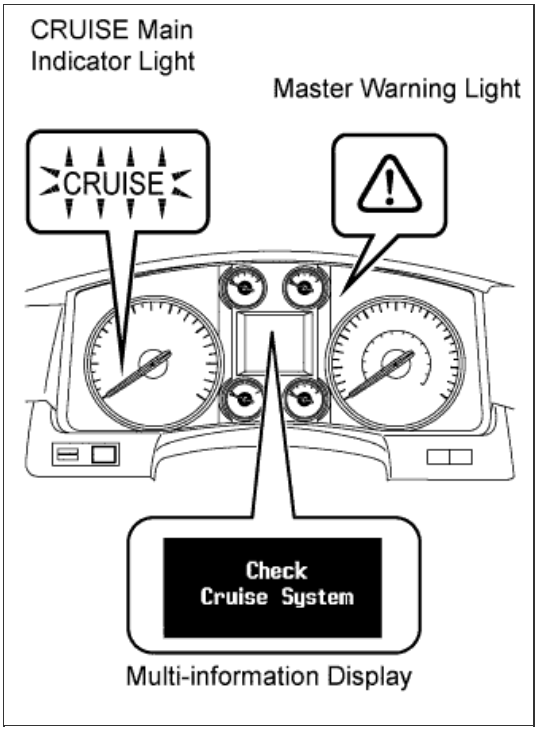
d. Enter the following menus: Powertrain / Radar Cruise / Trouble Codes.

e. Clear the DTCs.

for Preparation Click here

Constant speed control mode and vehicle-to-vehicle distance control mode:

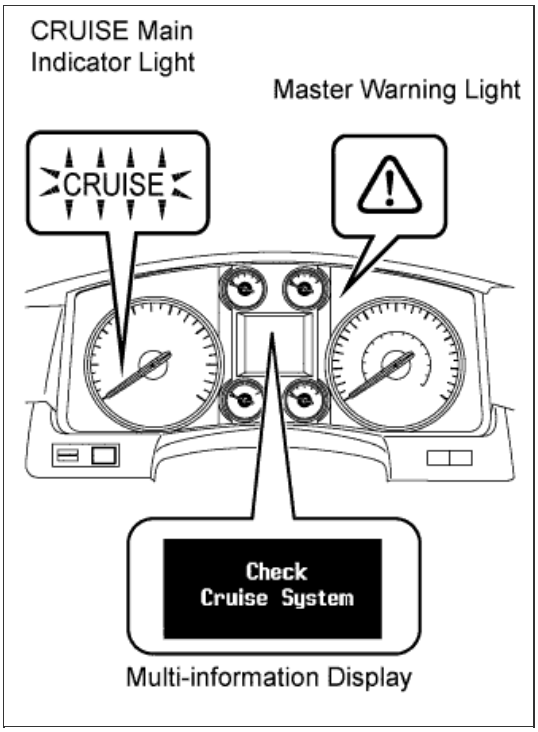
If the following conditions are detected while the dynamic radar cruise control system is in operation, the system clears the stored vehicle speed in the ECM and cancels the dynamic radar cruise control operation.



Vehicle Condition	Auto Cancel Condition	Fail-safe Deactivation Condition
• CRUISE main indicator light blinks • Master warning light comes on • "Check Cruise System" is displayed • "Pong" warning sound is heard	• There is an open or short in the stop light switch circuit • There is a problem with the vehicle speed signal • There is a problem with the throttle position sensor and the motor	Turn the cruise control main switch on again

Vehicle-to-vehicle distance control mode:

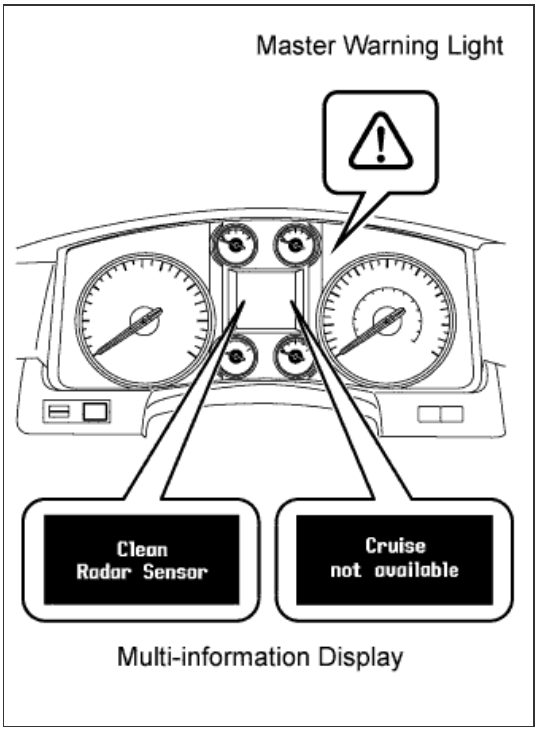
If the following conditions are detected while the dynamic radar cruise control system is in operation, the system clears the stored vehicle speed in the ECM and cancels the dynamic radar cruise control operation.



Vehicle Condition	Auto Cancel Condition	Fail-safe Deactivation Condition
• CRUISE main indicator light blinks • Master warning light comes on • "Check Cruise System" is displayed • "Pong" warning sound is heard	• There is a problem with the millimeter wave radar sensor • The beam axis of the millimeter wave radar sensor deviates	Turn the cruise control main switch on again

Vehicle-to-vehicle distance control mode:

If the following conditions are detected while the dynamic radar cruise control system is in operation, the system maintains the stored vehicle speed in the ECM and cancels the dynamic radar cruise control operation.



Vehicle Condition	Auto Cancel Condition	Fail-safe Deactivation Condition
• Master warning light comes on • "Clean Radar Sensor" is displayed • "Pong" warning sound is heard	There is dirt on the millimeter wave radar sensor.	Recover from the condition on left (RESUME operation is possible after recovery)
• Master warning light comes on • "Cruise not available" is displayed • "Pong" warning sound is heard	• The wiper switch is in HI position • The ECT-SNOW switch is on • The millimeter wave radar sensor is least sensitive because of bad	• Recover from the condition on left (RESUME operation is possible after recovery) • Turn the cruise control main switch

	weather such as rain, fog, snow and sandstorms	on again

Constant speed control mode and vehicle-to-vehicle distance control mode:

If the following conditions are detected while the dynamic radar cruise control system is in operation, the system clears the stored vehicle speed and cancels the dynamic radar cruise control operation.

HINT:

In the vehicle-to-vehicle distance control mode, the stored vehicle speed in the ECM is maintained.

Vehicle Condition	Auto Cancel Condition	Fail-safe Deactivation Condition
CRUISE main indicator light goes off	• The vehicle speed is less than the low speed limit (approx. 40 km/h (25 mph)) while the vehicle is running with the cruise control system in operation • The vehicle speed is less than the stored vehicle speed by 16 km/h (9.9 mph) or more while the vehicle is running with the cruise control system in operation	• Turn the cruise control main switch on again*1 • Push the cruise control main switch to +RES*2

HINT:

- ***1: During constant speed control mode**
- ***2: During vehicle-to-vehicle distance control mode**

for Preparation Click here

READ DATA LIST

HINT:

Using the intelligent tester to read the Data List allows the values or states of switches, sensors, actuators and other items to be read without removing any parts. This non-intrusive inspection can be very useful because intermittent conditions or signals may be discovered before parts or wiring is disturbed. Reading the Data List information early in troubleshooting is one way to save diagnostic time.

NOTICE:

In the table below, the values listed under "Normal Condition" are reference values. Do not depend solely on these reference values when deciding whether a part is faulty or not.

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: Powertrain / Radar Cruise / Data List.

e. According to the display on the intelligent tester, read the "Data List".

Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
Accel Request	Accelerator request signal / min.: -2621.44 km/h/s, max.: 2621.36 km/h/s	Actual demanded acceleration request	-
Vehicle Distance	Millimeter wave radar sensor / min.: 0 m (0 ft.), max.: 255 m (836.65 ft.)	Distance to the vehicle in front	-
L/C Option Flag	Dynamic radar cruise option flag / NO or YES	YES: Vehicle-to-vehicle distance control mode is selectable NO: Vehicle-to-vehicle distance control mode is not selectable	-
Car Dist Time Setting	Vehicle distance time setting condition / SHORT, MID, LONG or NO	Vehicle distance selected by steering pad switch (distance control switch)	-
O/D Cut Request	O/D cut request / Not Request or Request	Not Request: Idling Request: Performed	-
Shift Down Rqst to 3rd	Shift down request to 3rd gear / Not Request or Request	Not Request: Idling Request: Performed	-
Shift Down Rqst to 4th	Shift down request to 4th gear / Not Request or Request	Not Request: Idling Request: Performed	-
Shift Down Rqst to 5th	Shift down request to 5th gear / Not Request or Request	Not Request: Idling Request: Performed	-
Shift Down Rqst to 6th	Shift down request to 6th gear / Not Request or Request	Not Request: Idling Request: Performed	-
Alarm Request	Alarm request signal / Not Request or Request	Request: When beeping Not Request: When not beeping	-
All Throttle Close Rqst	All throttle close request / Not Request or Request	Request: Requested Not Request: Not requested	-
Brake Control Request	Brake control request / Not Request or Request	Request: Requested Not Request: Not requested	-
Targ Decl Slope	Cruise target deceleration slope / 0, 1, 2 or 3	0, 1, 2 or 3	-
CCS Vehicle Spd	Vehicle speed / min.: 0 km/h (0 mph), max.: 255 km/h (159 mph)	Actual vehicle speed displayed	-
CCS Mem Vehicle Spd	Vehicle speed / min.: 0 km/h (0 mph), max.: 200 km/h (125 mph)	Actual vehicle speed stored in memory	-
Cruise Operation Status	Transmission range sensor signal / ON or OFF	ON: Shift lever in D (6th, 5th or 4th gear) OFF: Shift lever not in D (6th, 5th or 4th gear)	-
Cruise Control	Cruise control / ON or OFF	ON: Cruise control operating OFF: Cruise control not operating	-

CCS Indicator M-CPU	CRUISE main indicator light (Main CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-
CCS Indicator S-CPU	CRUISE main indicator light (Sub CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-
CCS Ready S-CPU	Cruise control system standby condition (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-
CCS Ready M-CPU	Cruise control system standby condition (Main CPU) / ON or OFF	ON: Cruise control main switch (Main CPU) on OFF: Cruise control main switch (Main CPU) off	-
Main SW M-CPU	Cruise control main switch (Main CPU) / ON or OFF	ON: Cruise control main switch (Main CPU) on OFF: Cruise control main switch (Main CPU) off	-
Main SW S-CPU	Cruise control main switch (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-
Cancel Switch	CANCEL switch / ON or OFF	ON: CANCEL switch on OFF: CANCEL switch off	-
SET/COAST Switch	-SET switch / ON or OFF	ON: -SET switch on OFF: -SET switch off	-
RES/ACC Switch	+RES switch / ON or OFF	ON: +RES switch on OFF: +RES switch off	-
Stop Light SW M-CPU	Stop light switch signal (Main CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Stop Light SW S2-CPU	Stop light switch signal (Sub2 CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Stop Light SW S1-CPU	Stop light switch signal (Sub1 CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Throttle Opening Angle	Cruise throttle opening angle / min.: 0 deg, max.: 125 deg	Actual demanded throttle angle	-
# Codes	Number of trouble codes / Min.: 0, Max.: 255	-	-

PERFORM ACTIVE TEST

HINT:

Using the intelligent tester to perform Active Tests allows relays, VSVs, actuators and other items to be operated without removing any parts. This non-intrusive functional inspection can be very useful because intermittent operation may be discovered before parts or wiring is disturbed. Performing Active Tests early in troubleshooting is one way to save diagnostic time. Data List information can be displayed while performing Active Tests.

a. Connect the intelligent tester to the DLC3.

b. Turn the engine switch on (IG).

c. Turn the intelligent tester on.

d. Enter the following menus: All ECUs / (desired system) / Active Test.

e. According to the display on the intelligent tester, perform the "Active Test".

Combination Meter

Tester Display	Test Part	Control Range	Diagnostic Note
Indicat. Lamp Cruise	CRUISE main indicator light operation	OFF or ON	-

ABS/VSC/TRAC

Tester Display	Test Part	Control Range	Diagnostic Note
Buzzer	Skid control buzzer sounds	OFF or ON	-

for Preparation Click here

HINT:

If a trouble code is output during the DTC check, inspect the trouble areas listed for that code. For details of the code, refer to the "See page" below.

Dynamic Radar Cruise Control System

DTC Code	Detection Item	Trouble Area	See page
P0500	Vehicle Speed Sensor Malfunction	- Vehicle speed sensor signal circuit - Vehicle speed sensor - Combination meter - ECM	Click here
P0503	Vehicle Speed Sensor "A" Intermittent / Erratic / High	- Vehicle speed sensor - Vehicle speed sensor signal circuit - ECM - Combination meter	Click here
P0571	Stop Light Switch Circuit Malfunction	- Fuse (STOP, IGN, ECU-IG No. 2) - Stop light switch - Brake light relay - Stop light control relay - Master cylinder solenoid (skid control ECU) - Harness or connector - ECM	Click here
P0575	Cruise Control Input Circuit	ECM	Click here
P1570	Radar Sensor Malfunction	Millimeter wave radar sensor	Click here
P1572	Improper Aiming of Radar Sensor Beam Axis	Millimeter wave radar sensor	Click here
P1575	Warning Buzzer Malfunction	- Vehicle stability control system - ECM	Click here
P1578	Brake System Malfunction	- Vehicle stability control system - ECM	Click here
P1615	Communication Error from Distance Control ECU to ECM	- Distance control ECU - CAN communication system - ECM	Click here
P1616	Communication Error from ECM to Distance Control ECU	- Distance control ECU - CAN communication system - ECM	Click here
P1617	Distance Control ECU Malfunction	Distance control ECU	Click here
P1630	Communication Error from VSC to ECM	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
P1631	Communication Error from ECM to VSC	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
U0100	Communication Stop from ECM to Distance Control ECU, VSC	- Distance control ECU - CAN communication system - ECM	Click here
U0122	Lost Communication with Vehicle Dynamics Control Module	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
U0123	Lost Communication with Yaw Rate Sensor Module	- Distance control ECU - Yaw rate sensor - CAN communication system - ECM	Click here
U0126	Lost Communication with Steering Angle Sensor Module	- Distance control ECU - Steering angle sensor - CAN communication system - ECM	Click here
U0235	Lost Communication with Cruise Control Front Distance Range Sensor	- Millimeter wave radar sensor - Distance control ECU - Harness or connector - CAN communication system	Click here
U1101	Lost Communication with Distance Control ECU	- Distance control ECU - CAN communication system	Click here

		- ECM	
U1102	Lost Communication with Radar Sensor	- Millimeter wave radar sensor - Harness or connector - Distance control ECU	Click here

for Preparation Click here

HINT:

If a trouble code is output during the DTC check, inspect the trouble areas listed for that code. For details of the code, refer to the "See page" below.

Dynamic Radar Cruise Control System

DTC Code	Detection Item	Trouble Area	See page
P0500	Vehicle Speed Sensor Malfunction	- Vehicle speed sensor signal circuit - Vehicle speed sensor - Combination meter - ECM	Click here
P0503	Vehicle Speed Sensor "A" Intermittent / Erratic / High	- Vehicle speed sensor - Vehicle speed sensor signal circuit - ECM - Combination meter	Click here
P0571	Stop Light Switch Circuit Malfunction	- Fuse (STOP, IGN, ECU-IG No. 2) - Stop light switch - Brake light relay - Stop light control relay - Master cylinder solenoid (skid control ECU) - Harness or connector - ECM	Click here
P0575	Cruise Control Input Circuit	ECM	Click here
P1570	Radar Sensor Malfunction	Millimeter wave radar sensor	Click here
P1572	Improper Aiming of Radar Sensor Beam Axis	Millimeter wave radar sensor	Click here
P1575	Warning Buzzer Malfunction	- Vehicle stability control system - ECM	Click here
P1578	Brake System Malfunction	- Vehicle stability control system - ECM	Click here
P1615	Communication Error from Distance Control ECU to ECM	- Distance control ECU - CAN communication system - ECM	Click here
P1616	Communication Error from ECM to Distance Control ECU	- Distance control ECU - CAN communication system - ECM	Click here
P1617	Distance Control ECU Malfunction	Distance control ECU	Click here
P1630	Communication Error from VSC to ECM	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
P1631	Communication Error from ECM to VSC	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
U0100	Communication Stop from ECM to Distance Control ECU, VSC	- Distance control ECU - CAN communication system - ECM	Click here
U0122	Lost Communication with Vehicle Dynamics Control Module	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
U0123	Lost Communication with Yaw Rate Sensor Module	- Distance control ECU - Yaw rate sensor - CAN communication system - ECM	Click here
U0126	Lost Communication with Steering Angle Sensor Module	- Distance control ECU - Steering angle sensor - CAN communication system - ECM	Click here
U0235	Lost Communication with Cruise Control Front Distance Range Sensor	- Millimeter wave radar sensor - Distance control ECU - Harness or connector - CAN communication system	Click here
U1101	Lost Communication with Distance Control ECU	- Distance control ECU - CAN communication system	Click here

		- ECM	
U1102	Lost Communication with Radar Sensor	- Millimeter wave radar sensor - Harness or connector - Distance control ECU	Click here

for Preparation Click here

HINT:

If a trouble code is output during the DTC check, inspect the trouble areas listed for that code. For details of the code, refer to the "See page" below.

Dynamic Radar Cruise Control System

DTC Code	Detection Item	Trouble Area	See page
P0500	Vehicle Speed Sensor Malfunction	- Vehicle speed sensor signal circuit - Vehicle speed sensor - Combination meter - ECM	Click here
P0503	Vehicle Speed Sensor "A" Intermittent / Erratic / High	- Vehicle speed sensor - Vehicle speed sensor signal circuit - ECM - Combination meter	Click here
P0571	Stop Light Switch Circuit Malfunction	- Fuse (STOP, IGN, ECU-IG No. 2) - Stop light switch - Brake light relay - Stop light control relay - Master cylinder solenoid (skid control ECU) - Harness or connector - ECM	Click here
P0575	Cruise Control Input Circuit	ECM	Click here
P1570	Radar Sensor Malfunction	Millimeter wave radar sensor	Click here
P1572	Improper Aiming of Radar Sensor Beam Axis	Millimeter wave radar sensor	Click here
P1575	Warning Buzzer Malfunction	- Vehicle stability control system - ECM	Click here
P1578	Brake System Malfunction	- Vehicle stability control system - ECM	Click here
P1615	Communication Error from Distance Control ECU to ECM	- Distance control ECU - CAN communication system - ECM	Click here
P1616	Communication Error from ECM to Distance Control ECU	- Distance control ECU - CAN communication system - ECM	Click here
P1617	Distance Control ECU Malfunction	Distance control ECU	Click here
P1630	Communication Error from VSC to ECM	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
P1631	Communication Error from ECM to VSC	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
U0100	Communication Stop from ECM to Distance Control ECU, VSC	- Distance control ECU - CAN communication system - ECM	Click here
U0122	Lost Communication with Vehicle Dynamics Control Module	- Master cylinder solenoid (skid control ECU) - CAN communication system - ECM	Click here
U0123	Lost Communication with Yaw Rate Sensor Module	- Distance control ECU - Yaw rate sensor - CAN communication system - ECM	Click here
U0126	Lost Communication with Steering Angle Sensor Module	- Distance control ECU - Steering angle sensor - CAN communication system - ECM	Click here
U0235	Lost Communication with Cruise Control Front Distance Range Sensor	- Millimeter wave radar sensor - Distance control ECU - Harness or connector - CAN communication system	Click here
U1101	Lost Communication with Distance Control ECU	- Distance control ECU - CAN communication system	Click here

		- ECM	
U1102	Lost Communication with Radar Sensor	- Millimeter wave radar sensor - Harness or connector - Distance control ECU	Click here

DTC P0500 Vehicle Speed Sensor Malfunction

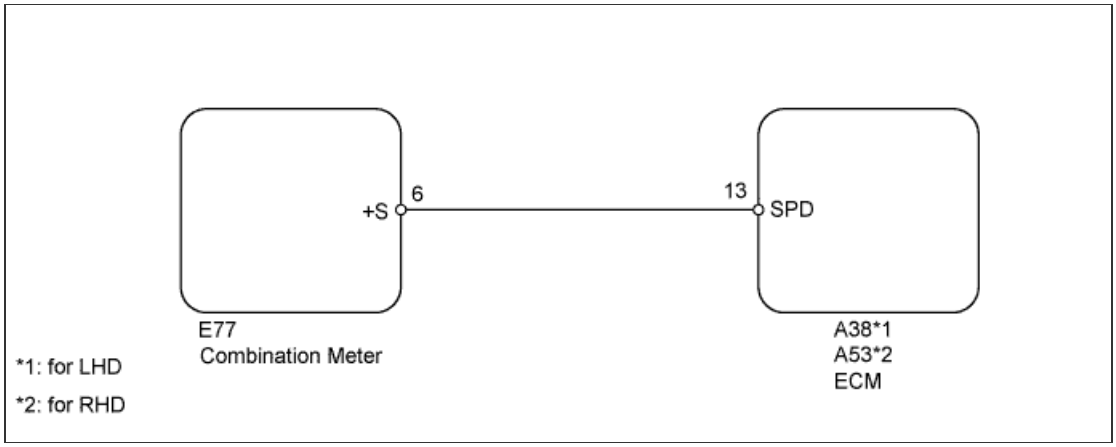
for Preparation Click here

DESCRIPTION

The speed sensor detects the wheel speed and sends the appropriate signals to the master cylinder solenoid (skid control ECU). The master cylinder solenoid (skid control ECU) converts these wheel speed signals into a 4-pulse signal and outputs it to the ECM via the combination meter. The ECM determines the vehicle speed based on the frequency of these pulse signals.

DTC Code	DTC Detection Condition	Trouble Area
P0500	The vehicle speed signal from the vehicle speed sensor is cut for 0.14 sec. or more while cruise control is in operation.	• Vehicle speed sensor signal circuit • Vehicle speed sensor • Combination meter • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

This DTC code may be output under the SFI system at the same time. In that case, perform troubleshooting for the SFI system first.

1.CHECK DTC (CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. With the shift lever in D, drive the vehicle for more than 10 seconds when the engine coolant temperature is more than 20°C (68°F).

d. Check for DTCs (Click here).

OK:

DTC P0500 is not output.

NG → **GO TO SFI SYSTEM (Click here)**

OK

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1631 Communication Error from ECM to VSC

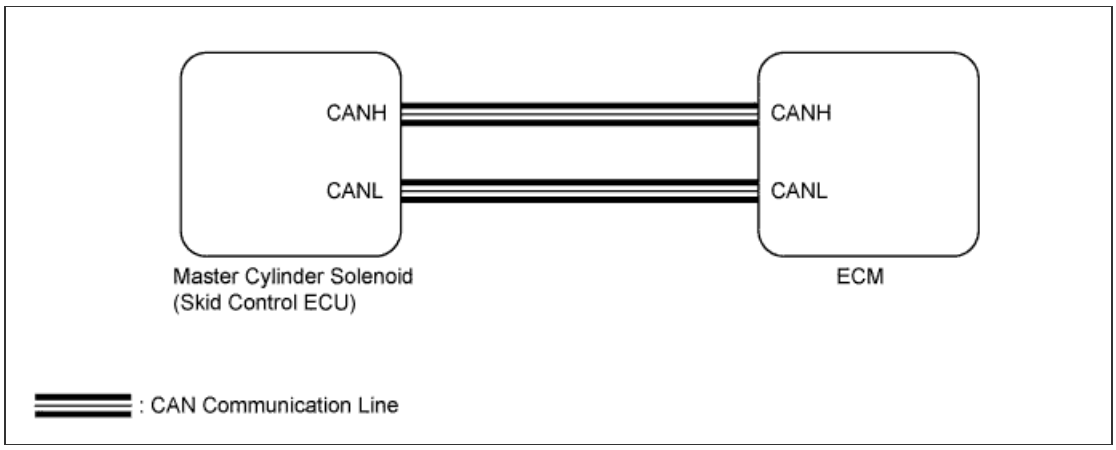
for Preparation Click here

DESCRIPTION

The distance control ECU sends brake control request signals, warning request signals, etc. to the master cylinder solenoid (skid control ECU) through the ECM. Based on these signals, the brake actuator operates and the warning buzzer sounds. The master cylinder solenoid (skid control ECU) sends brake system malfunction signals, etc. to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P1631	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the data sent from the ECM to the master cylinder solenoid (skid control ECU) is abnormal.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

1.REPLACE ECM

a. Replace the ECM with a new one (Click here).

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

Result

Result	Proceed to
OK (DTC P1631 is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B

REPLACE MASTER CYLINDER SOLENOID (SKID CONTROL ECU) (Click here)

C

REPLACE MASTER CYLINDER SOLENOID (SKID CONTROL ECU) (Click here)

A

END

DTC P0503 Vehicle Speed Sensor "A" Intermittent / Erratic / High

for Preparation Click here

DESCRIPTION

If a malfunction (a rapid change in vehicle speed) in the vehicle speed signal being output from the master cylinder solenoid (skid control ECU) is detected while the dynamic radar cruise control is in operation, the ECM determines there to be a momentary interruption and noise, and outputs a DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0503	A momentary interruption and noise are detected when a rapid change of the vehicle speed occurs while the dynamic radar cruise control is in operation.	• Vehicle speed sensor • Vehicle speed sensor signal circuit • ECM • Combination meter

INSPECTION PROCEDURE

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.CHECK DTC (VEHICLE STABILITY CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Chassis / ABS/VSC/TRAC / Trouble Code.

b. Check for DTCs (Click here).

OK:
DTC is not output.

NG → **GO TO VEHICLE STABILITY CONTROL SYSTEM (Click here)**

OK ↓

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the dynamic radar cruise control.

d. Check for DTCs (Click here).

OK:
DTC P0503 is not output.

NG → **REPLACE ECM (Click here)**

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P0503 Vehicle Speed Sensor "A" Intermittent / Erratic / High

for Preparation Click here

DESCRIPTION

If a malfunction (a rapid change in vehicle speed) in the vehicle speed signal being output from the master cylinder solenoid (skid control ECU) is detected while the dynamic radar cruise control is in operation, the ECM determines there to be a momentary interruption and noise, and outputs a DTC.

DTC Code	DTC Detection Condition	Trouble Area
P0503	A momentary interruption and noise are detected when a rapid change of the vehicle speed occurs while the dynamic radar cruise control is in operation.	• Vehicle speed sensor • Vehicle speed sensor signal circuit • ECM • Combination meter

INSPECTION PROCEDURE

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.CHECK DTC (VEHICLE STABILITY CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Chassis / ABS/VSC/TRAC / Trouble Code.

b. Check for DTCs (Click here).

OK:
DTC is not output.

NG → **GO TO VEHICLE STABILITY CONTROL SYSTEM (Click here)**

OK ↓

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the dynamic radar cruise control.

d. Check for DTCs (Click here).

OK:
DTC P0503 is not output.

NG → **REPLACE ECM (Click here)**

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P0571 Stop Light Switch Circuit Malfunction

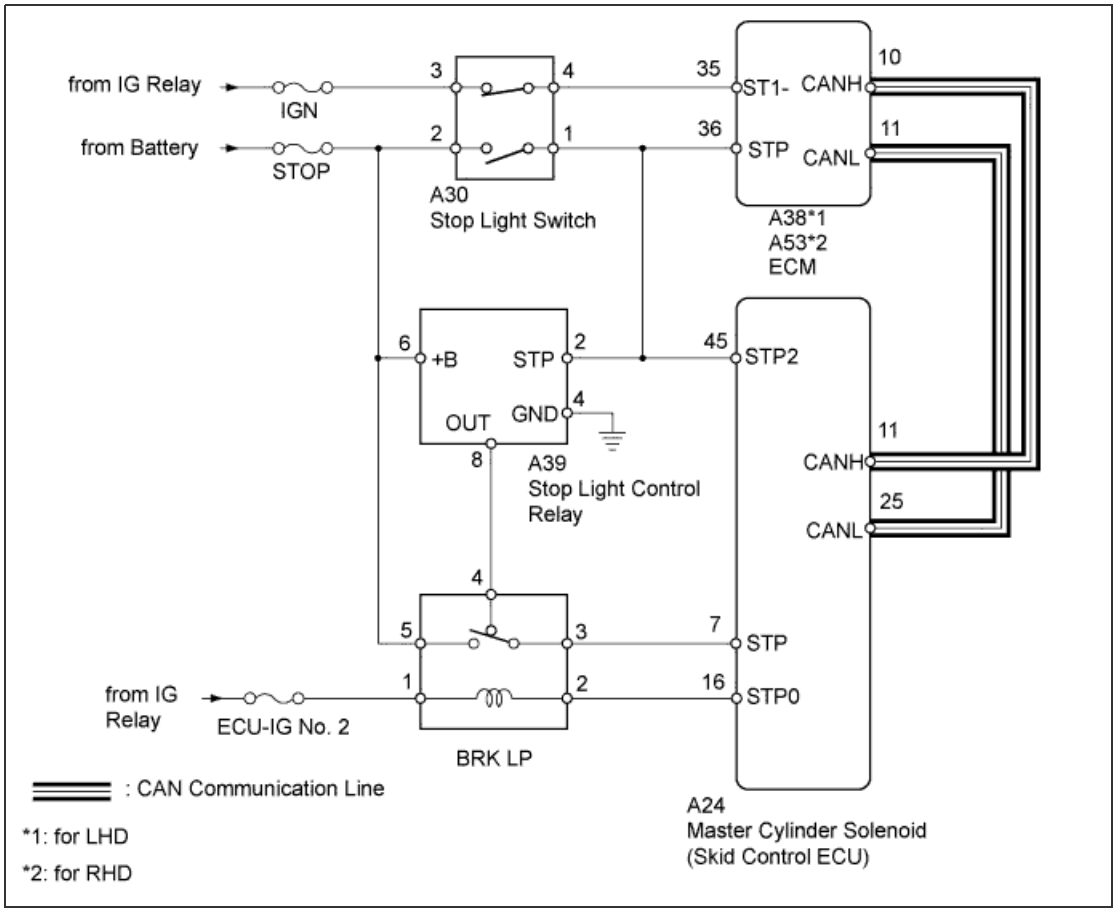
for Preparation Click here

DESCRIPTION

The ECM receives the brake demand signal from the stop light switch and transmits it to the master cylinder solenoid (skid control ECU). The master cylinder solenoid (skid control ECU) receives the signal from the ECM and operates the brake actuator.

DTC Code	DTC Detection Condition	Trouble Area
P0571	This trouble code is output when the ECM detects the brake light relay error signal from the master cylinder solenoid (skid control ECU) for 0.2 sec. or more while the dynamic radar cruise control is in operation.	• Fuse (STOP, IGN, ECU-IG No. 2) • Stop light switch • Brake light relay • Stop light control relay • Master cylinder solenoid (skid control ECU) • Harness or connector • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

1.INSPECT FUSE (STOP, IGN, ECU-IG No. 2)

a. Remove the STOP and IGN fuses from the engine room relay block.

b. Remove the ECU-IG No. 2 fuse from the cowl side junction block LH.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
STOP fuse	Always	Below 1 Ω
IGN fuse		
ECU-IG No. 2 fuse		

NG → REPLACE FUSE

OK

2.READ VALUE USING INTELLIGENT TESTER (STOP LIGHT SWITCH)

a. Using the intelligent tester, read the Data List.

Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
Stop Light SW M-CPU	Stop light switch signal (Main CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Stop Light SW-1 S-CPU	Stop light switch signal (Sub CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-
Stp Light SW S2-CPU	Stop light switch signal (Sub CPU) / ON or OFF	ON: Brake pedal depressed OFF: Brake pedal released	-

OK:
Normal conditions listed above are displayed.

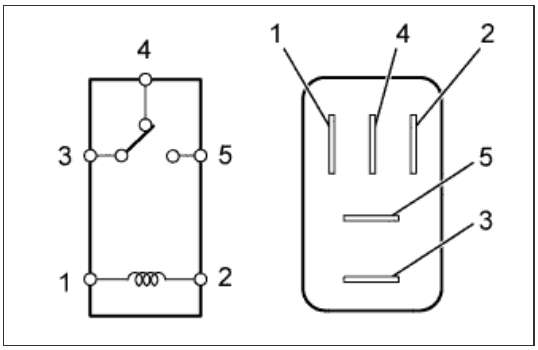
NG → Go to step 10

OK

3.INSPECT BRAKE LIGHT RELAY (BRK LP)

a. Remove the brake light relay from the engine room relay block.

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

Tester Connection	Condition	Specified Condition
3 - 4	Battery voltage is applied to terminals 1 and 2	10 kΩ higher
	Battery voltage is not applied to terminals 1 and 2	Below 1 Ω
3 - 5	Battery voltage is not applied to terminals 1 and 2	10 kΩ higher
	Battery voltage is applied to terminals 1 and 2	Below 1 Ω

NG → REPLACE BRAKE LIGHT RELAY

OK

4.CHECK HARNESS AND CONNECTOR (STOP LIGHT CONTROL RELAY - BATTERY AND BODY GROUND)

a. Disconnect the A39 stop light control relay connector.

b. Measure the voltage according to the value(s) in the table below.

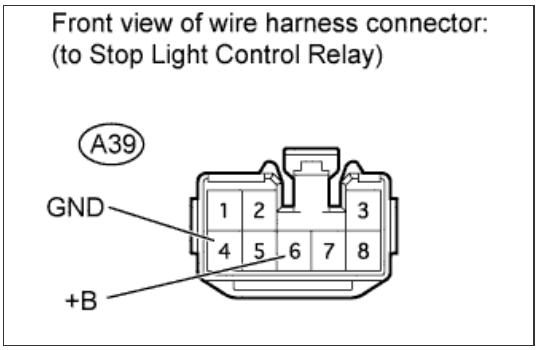
Standard Voltage:

Tester Connection	Condition	Specified Condition
A39-6 (+B) - Body ground	Always	11 to 14 V

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A39-4 (GND) - Body ground	Always	Below 1 Ω



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

5.CHECK HARNESS AND CONNECTOR (STOP LIGHT CONTROL RELAY - STOP LIGHT SWITCH)

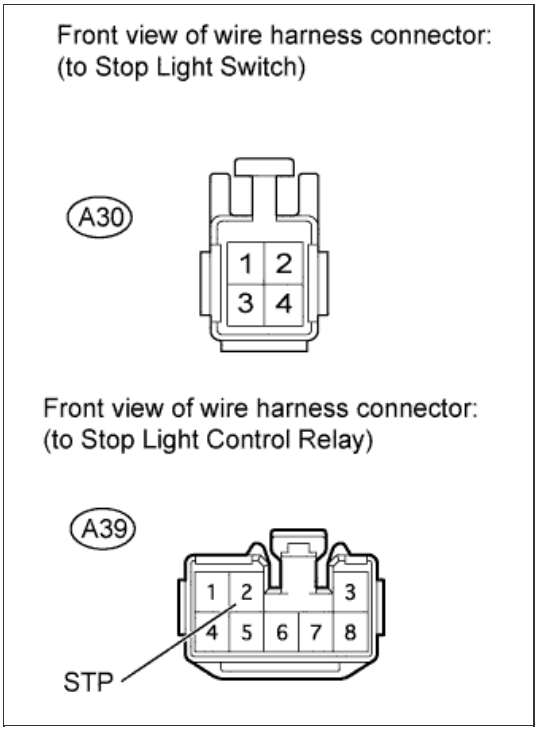
a. Disconnect the A39 stop light control relay connector.

b. Disconnect the A30 stop light switch connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A30-1 - A39-2 (STP)	Always	Below 1 Ω
A30-1 - Body ground	Always	10 kΩ higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6.CHECK HARNESS AND CONNECTOR (STOP LIGHT CONTROL RELAY - BRAKE LIGHT RELAY)

a. Disconnect the A39 stop light control relay connector.

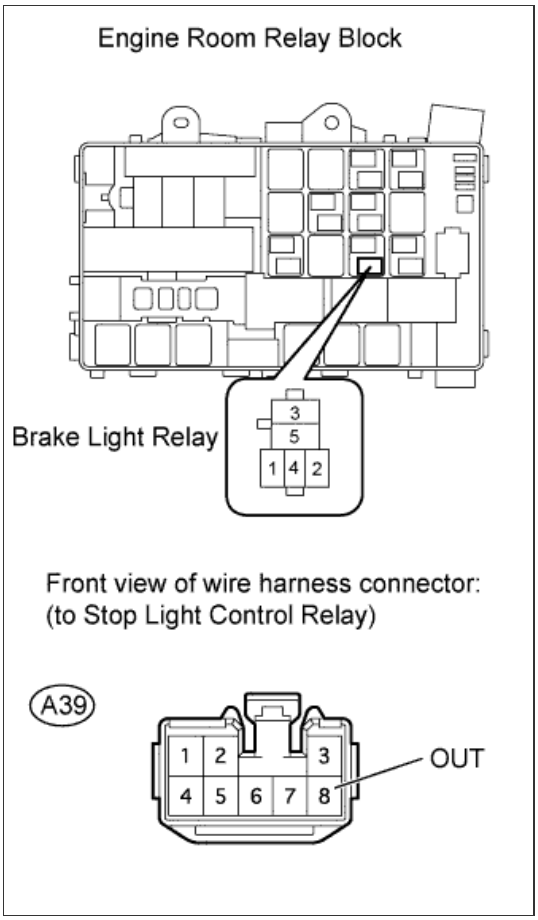
b. Remove the brake light relay from the engine room relay block.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A39-8 (OUT) - Brake light relay terminal 4	Always	Below 1 Ω

A39-8 (OUT) - Body ground	Always	10 kΩ higher



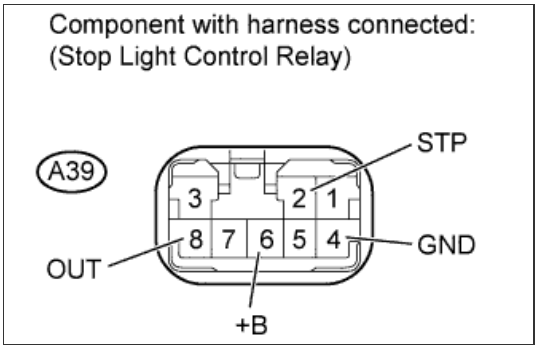
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7.CHECK STOP LIGHT CONTROL RELAY

a. Remove the stop light control relay with its connector still connected (Click here for LHD, Click here for RHD).

b. Measure the voltage according to the value(s) in the table below.



Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A39-6 (+B) - A39-4 (GND)	Always	11 to 14 V
A39-2 (STP) - Body ground	Stop light switch on (Brake pedal depressed)	11 to 14 V
	Stop light switch off (Brake pedal released)	Below 1 V
A39-8 (OUT) - Body ground	Stop light switch on (Brake pedal depressed)	11 to 14 V
	Stop light switch off (Brake pedal released)	Below 1 V

Result

Result	Proceed to

OK	A
NG (for LHD)	B
NG (for RHD)	C

B → REPLACE STOP LIGHT CONTROL RELAY (Click here)

C → REPLACE STOP LIGHT CONTROL RELAY (Click here)

A

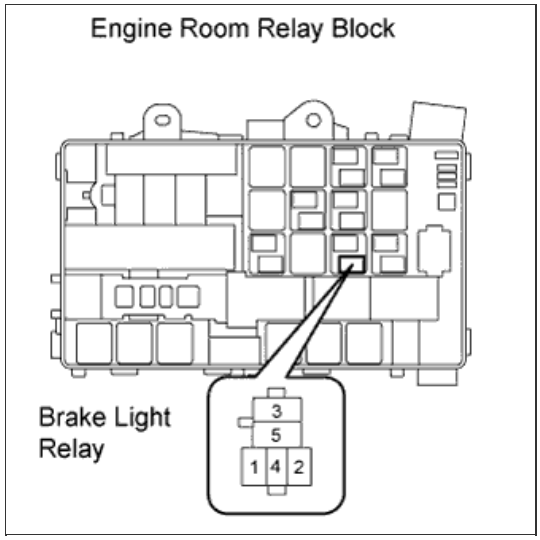
8.CHECK HARNESS AND CONNECTOR (BRAKE LIGHT RELAY - BATTERY)

a. Remove the brake light relay from the engine room relay block.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
Brake light relay terminal 1 - Body ground	Engine switch on (IG)	11 to 14 V
Brake light relay terminal 5 - Body ground		



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

9.CHECK HARNESS AND CONNECTOR (BRK LP, STOP LIGHT CONTROL RELAY - MASTER CYLINDER SOLENOID)

a. Disconnect the A24 master cylinder solenoid (skid control ECU) connector.

b. Remove the brake light relay from the engine room relay block.

c. Disconnect the A39 stop light control relay connector.

d. Measure the resistance according to the value(s) in the table below.

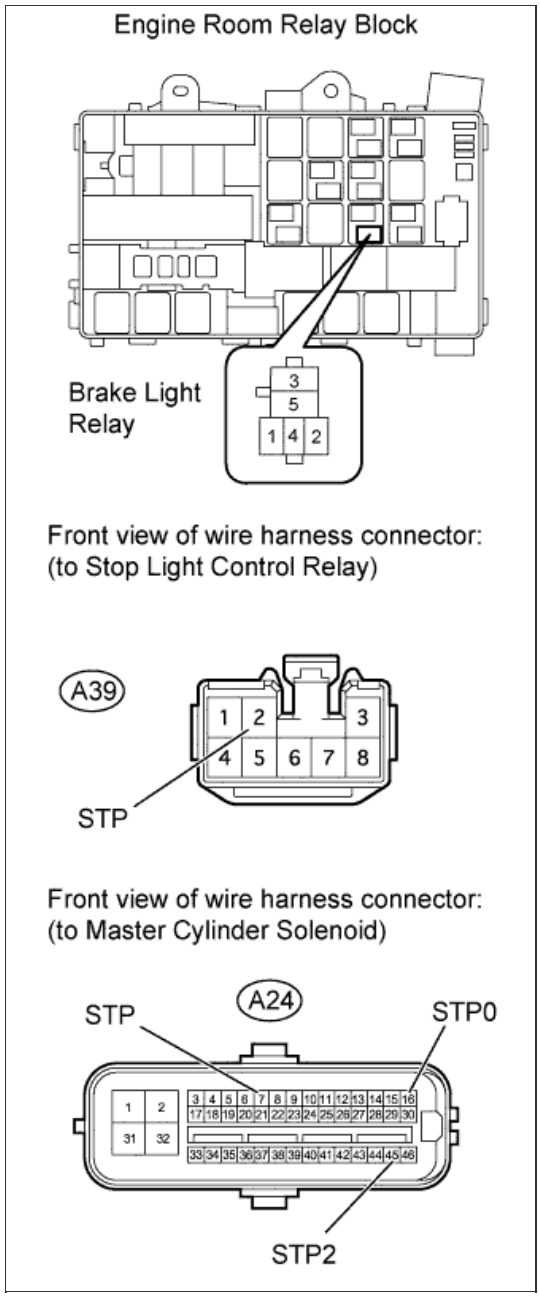
Standard Resistance:

Tester Connection	Condition	Specified Condition
Brake light relay terminal 2 - A24-16 (STP0)	Always	Below 1 Ω
A39-2 (STP) - A24-45 (STP2)		
Brake light relay terminal 3 - A24-7 (STP)		
Brake light relay terminal 2 - Body ground		
A39-2 (STP) -		

Body ground	Always	10 kΩ higher
Brake light relay terminal 3 - Body ground		

Result

Result	Proceed to
OK (for LHD)	A
OK (for RHD)	B
NG	C



B → REPLACE MASTER CYLINDER SOLENOID (SKID CONTROL ECU) (Click here)

C → REPAIR OR REPLACE HARNESS OR CONNECTOR

A → REPLACE MASTER CYLINDER SOLENOID (SKID CONTROL ECU) (Click here)

10.INSPECT STOP LIGHT SWITCH

a. Disconnect the A30 stop light switch connector.

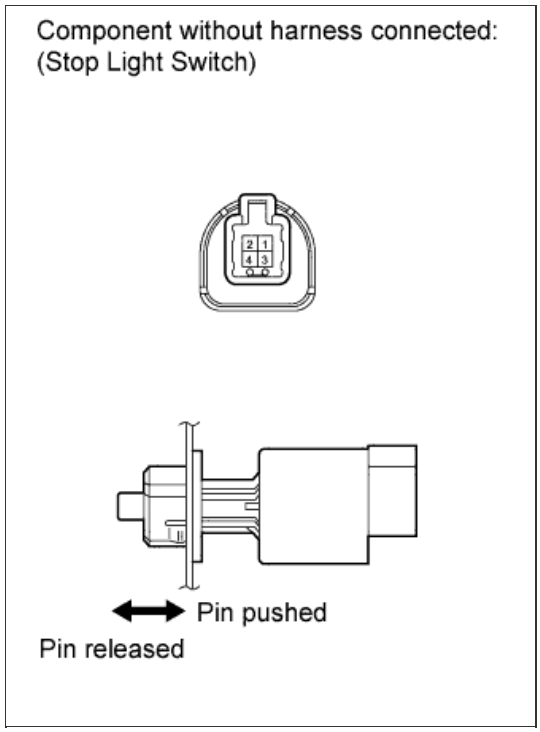
b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 - 2	Pin not pushed	Below 1 Ω
	Pin pushed	10 kΩ higher
3 - 4	Pin not pushed	10 kΩ higher
	Pin pushed	Below 1 Ω

Result

Result	Proceed to
OK	A
NG (for LHD)	B
NG (for RHD)	C



B → REPLACE STOP LIGHT SWITCH (Click here)

C → REPLACE STOP LIGHT SWITCH (Click here)

A

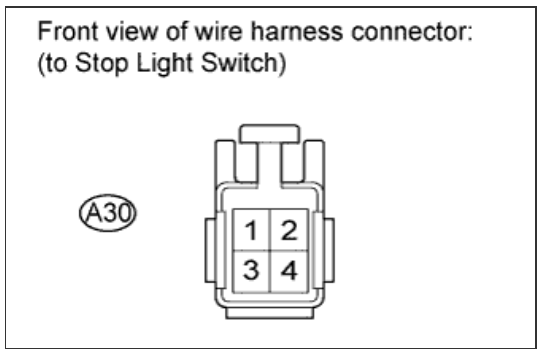
11.CHECK HARNESS AND CONNECTOR (STOP LIGHT SWITCH - BATTERY)

a. Disconnect the A30 stop light switch connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A30-2 - Body ground	Engine switch on (IG)	11 to 14 V
A30-3 - Body ground		



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

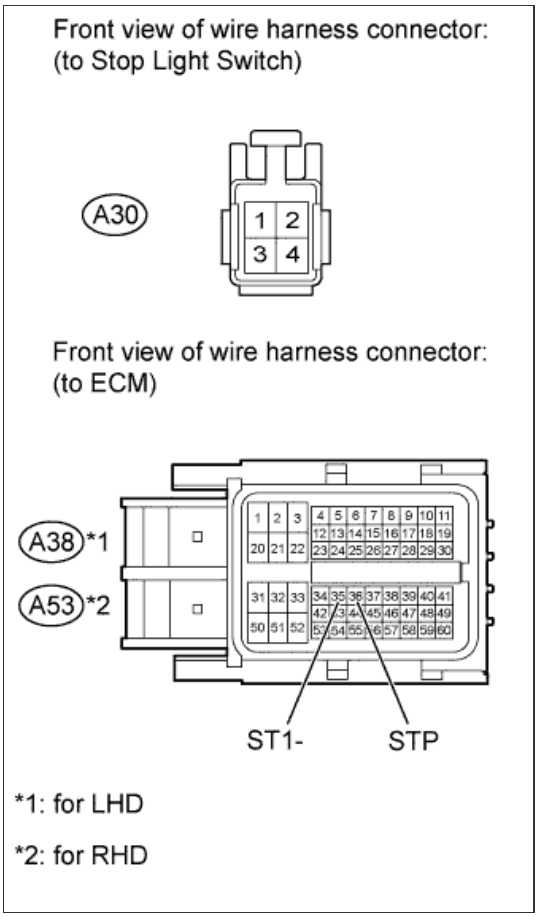
12.CHECK HARNESS AND CONNECTOR (STOP LIGHT SWITCH - ECM)

a. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

b. Disconnect the A30 stop light switch connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A30-4 - A38-35 (ST1-)	Always	Below 1 Ω
A30-1 - A38-36 (STP)		
A30-1 - Body ground	Always	10 kΩ higher
A30-4 - Body ground		

for RHD

Tester Connection	Condition	Specified Condition
A30-4 - A53-35 (ST1-)	Always	Below 1 Ω
A30-1 - A53-36 (STP)		
A30-1 - Body ground	Always	10 kΩ higher
A30-4 - Body ground		

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P0575 Cruise Control Input Circuit

for Preparation Click here

DESCRIPTION

This DTC indicates internal abnormalities of the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P0575	When either of the following conditions is met: • STP signals input to the ECM supervisory CPU and control ECU are different for 0.15 seconds or more. • 0.4 seconds have passed after the cruise cancel input signal (STP input) is input to the ECM.	ECM

HINT:

If DTC P0575 is stored while the dynamic radar cruise control is in operation, the master cylinder solenoid (skid control ECU) clears the stored vehicle speed in the ECM and cancels the dynamic radar cruise control operation. At the same time, the CRUISE main indicator light blinks to inform the driver of the malfunction. When this trouble code is stored, fail-safe remains on until the engine switch is turned off.

INSPECTION PROCEDURE

1.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Recheck for DTCs (Click here).

OK:
DTC P0575 is not output.

NG → **REPLACE ECM (Click here)**

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1570 Radar Sensor Malfunction

for Preparation Click here

DESCRIPTION

The millimeter wave radar sensor emits radar waves towards an object in front and measures the distance and direction of the object by receiving the wave reflections. Based on the reflections, the sensor calculates the difference in speed between your own vehicle and an object in front. This data is transmitted to the distance control ECU.

DTC Code	DTC Detection Condition	Trouble Area
P1570	The ECM detects a radar sensor malfunction signal for 0.15 sec. or more while the dynamic radar cruise control is in operation.	Millimeter wave radar sensor

HINT:

The millimeter wave radar sensor monitors the millimeter wave circuit activation by itself. This DTC is output when one of the following occurs: 1) the monitor is malfunctioning, 2) an EEPROM error is detected, 3) a voltage error is detected, or 4) the radar sensor is not adjusted. When raindrops or snowflakes strike the millimeter wave radar sensor face, the distance between the vehicle in front and your own vehicle cannot be measured correctly. The dynamic radar cruise control system functions by detecting the wave reflections from the vehicle directly in front. In the following cases, the system may not be able to detect the vehicle in front and may not properly maintain the correct vehicle-to-vehicle distance.

- **The vehicle in front is a tall trailer.**
- **Emissions from the vehicle in front or from other lanes are heavy.**

INSPECTION PROCEDURE

NOTICE:

When the millimeter wave radar sensor is replaced with a new one, adjustment of the radar sensor beam axis must be performed (Click here).

1.ADJUST MILLIMETER WAVE RADAR SENSOR

a. Refer to the adjustment (Click here).

HINT:

It is necessary to make the ECM recognize specification information (whether the vehicle is equipped with the dynamic radar or not). When this procedure has not been carried out, this DTC may be output.

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:
DTC P1570 is not output.

NG → **REPLACE MILLIMETER WAVE RADAR SENSOR (Click here)**

OK

END

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1572 Improper Aiming of Radar Sensor Beam Axis

for Preparation Click here

DESCRIPTION

This DTC is stored when there is a problem with the millimeter wave radar sensor beam axis adjustment.

DTC Code	DTC Detection Condition	Trouble Area
P1572	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the millimeter wave radar sensor beam axis is misaligned (0.15 sec. or more).	Millimeter wave radar sensor

HINT:

If the beam axis deviates vertically by +/-2° or more and/or horizontally by +/-4° or more at a distance of 4.0 to 6.0 m (13 to 20 ft), this DTC is stored.

INSPECTION PROCEDURE

NOTICE:

When the millimeter wave radar sensor is replaced with a new one, adjustment of the radar sensor beam axis must be performed (Click here).

1.ADJUST MILLIMETER WAVE RADAR SENSOR

a. Refer to the adjustment (Click here).

HINT:

It is necessary to make the ECM recognize specification information (whether the vehicle is equipped with the dynamic radar or not). If this procedure has not been carried out, this DTC may be output.

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:
DTC P1572 is not output.

NG → REPLACE MILLIMETER WAVE RADAR SENSOR (Click here)

OK

END

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1575 Warning Buzzer Malfunction

for Preparation Click here

DESCRIPTION

DTC Code	DTC Detection Condition	Trouble Area
P1575	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the approach warning buzzer malfunctions.	• Vehicle stability control system • ECM

INSPECTION PROCEDURE

NOTICE:

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (BUZZER)

a. Using the intelligent tester, perform the Active Test.

ABS/VSC/TRAC

Tester Display	Test Part	Control Range	Diagnostic Note
Buzzer	Skid control buzzer sounds	OFF or ON	-

OK:
Skid control buzzer sounds.

NG → GO TO VEHICLE STABILITY CONTROL SYSTEM (Skid Control Buzzer Circuit) (Click here)

OK ↓

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:
DTC P1575 is not output.

NG → REPLACE ECM (Click here)

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1578 Brake System Malfunction

for Preparation Click here

DESCRIPTION

This DTC may also be stored when there is a vehicle stability control system malfunction.

DTC Code	DTC Detection Condition	Trouble Area
P1578	During cruise control operation (vehicle-to-vehicle distance control mode), the brake system malfunctions.	• Vehicle stability control system • ECM

INSPECTION PROCEDURE

NOTICE:

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.CHECK DTC (VEHICLE STABILITY CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Chassis / ABS/VSC/TRAC / Trouble Code.

b. Check for DTCs (Click here).

OK:
DTC is not output.

NG → GO TO VEHICLE STABILITY CONTROL SYSTEM (Click here)

OK ↓

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the dynamic radar cruise control.

d. Check for DTCs (Click here).

OK:
DTC P1578 is not output.

NG → REPLACE ECM (Click here)

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1578 Brake System Malfunction

for Preparation Click here

DESCRIPTION

This DTC may also be stored when there is a vehicle stability control system malfunction.

DTC Code	DTC Detection Condition	Trouble Area
P1578	During cruise control operation (vehicle-to-vehicle distance control mode), the brake system malfunctions.	• Vehicle stability control system • ECM

INSPECTION PROCEDURE

NOTICE:

This DTC code may be output under the vehicle stability control system at the same time. In that case, perform troubleshooting for the vehicle stability control system first.

1.CHECK DTC (VEHICLE STABILITY CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Chassis / ABS/VSC/TRAC / Trouble Code.

b. Check for DTCs (Click here).

OK:
DTC is not output.

NG → GO TO VEHICLE STABILITY CONTROL SYSTEM (Click here)

OK ↓

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the dynamic radar cruise control.

d. Check for DTCs (Click here).

OK:
DTC P1578 is not output.

NG → REPLACE ECM (Click here)

OK ↓

USE SIMULATION METHOD TO CHECK (Click here)

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1615 Communication Error from Distance Control ECU to ECM

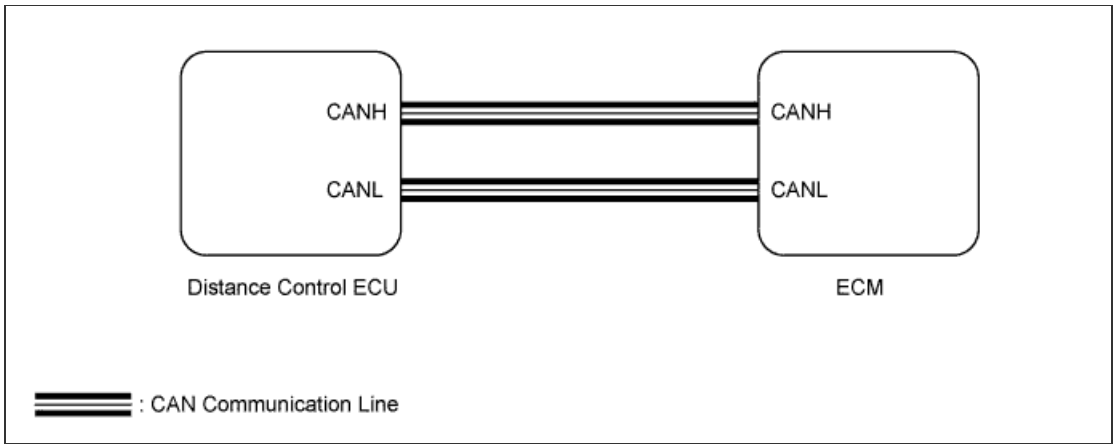
for Preparation Click here

DESCRIPTION

The ECM sends the cruise control main switch signal, vehicle speed signal, etc. to the distance control ECU. The distance control ECU sends the acceleration signal, deceleration request signal, etc. to the ECM. The ECM controls cruise control according to these signals.

DTC Code	DTC Detection Condition	Trouble Area
P1615	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the data sent from the distance control ECU to the ECM is abnormal.	• Distance control ECU • CAN communication system • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.REPLACE DISTANCE CONTROL ECU

a. Replace the distance control ECU with a new one (Click here).

b. Perform initialization (Click here).

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:

DTC P1615 is not output.

NG → REPLACE ECM (Click here)

OK

END

DTC U0100 Communication Stop from ECM to Distance Control ECU, VSC

DTC U0122 Lost Communication with Vehicle Dynamics Control Module

DTC U0123 Lost Communication with Yaw Rate Sensor Module

DTC U0126 Lost Communication with Steering Angle Sensor Module

DTC U1101 Lost Communication with Distance Control ECU

for Preparation Click here

DESCRIPTION

This DTC is output when a communication malfunction occurs between the sensors and ECUs.

DTC Code	DTC Detection Condition	Trouble Area
U0100	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the ECM to the distance control ECU stops.	• Distance control ECU • CAN communication system • ECM
U0122	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the master cylinder solenoid (skid control ECU) to the ECM stops.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM
U0123	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the yaw rate sensor to the distance control ECU is abnormal.	• Distance control ECU • Yaw rate sensor • CAN communication system • ECM
U0126	While cruise control is in operation (vehicle-to-vehicle distance control mode), the data sent from the steering angle sensor to the distance control ECU is abnormal.	• Distance control ECU • Steering angle sensor • CAN communication system • ECM
U1101	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and communication from the distance control ECU to the ECM stops.	• Distance control ECU • CAN communication system • ECM

INSPECTION PROCEDURE

1.CHECK DTC (CAN COMMUNICATION SYSTEM)

a. Use the intelligent tester to check if the CAN communication system is functioning normally (Click here for LHD, Click here for RHD).

Result

Result	Proceed to
OK (CAN DTC is not output)	A
NG (for LHD)	B
NG (for RHD)	C

B → GO TO CAN COMMUNICATION SYSTEM (Click here)

C → GO TO CAN COMMUNICATION SYSTEM (Click here)

A

USE SIMULATION METHOD TO CHECK (Click here)

DTC P1616 Communication Error from ECM to Distance Control ECU

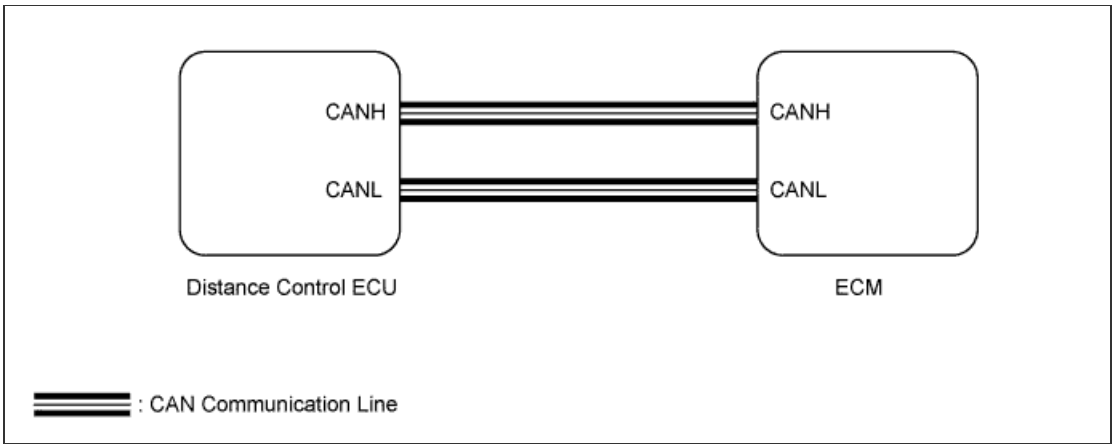
for Preparation Click here

DESCRIPTION

The ECM sends the cruise control main switch signal, vehicle speed signal, etc. to the distance control ECU. The distance control ECU sends the acceleration signal, deceleration request signal, etc. to the ECM. The ECM controls cruise control according to these signals.

DTC Code	DTC Detection Condition	Trouble Area
P1616	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the data sent from the ECM to the distance control ECU is abnormal.	• Distance control ECU • CAN communication system • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.REPLACE ECM

a. Replace the ECM with a new one (Click here).

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:
DTC P1616 is not output.

NG → REPLACE DISTANCE CONTROL ECU (**Click here**)


OK
END

DTC U0235 Lost Communication with Cruise Control Front Distance Range Sensor

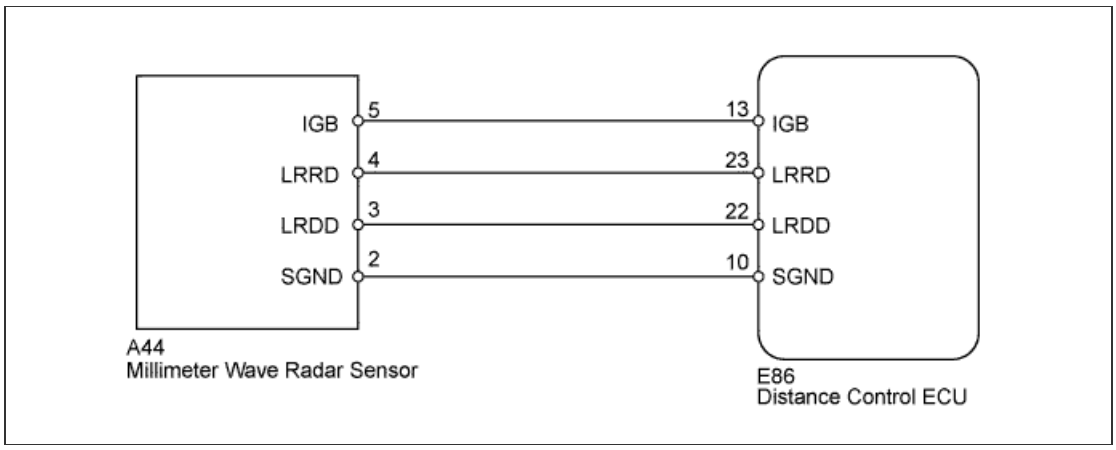
for Preparation Click here

DESCRIPTION

The distance control ECU sends general vehicle control information, such as vehicle speed, steering angle, etc., to the millimeter wave radar sensor. The millimeter wave radar sensor sends information about whether another vehicle is present in front of the vehicle, the distance between the vehicles, relative speed, etc. to the distance control ECU. The distance control ECU sends this information to the ECM and performs control of cruise control.

DTC Code	DTC Detection Condition	Trouble Area
U0235	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the data sent from the millimeter wave radar sensor to the distance control ECU is abnormal.	• Millimeter wave radar sensor • Distance control ECU • Harness or connector • CAN communication system

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

- **When the distance control ECU is replaced with a new one, initialization must be performed (Click here).**
- **When the millimeter wave radar sensor is replaced with a new one, adjustment of the radar sensor beam axis must be performed (Click here).**
- **As it is possible that this DTC was stored due to a bad connection of a connector, make sure to check that each connector is connected securely.**

1.CHECK HARNESS AND CONNECTOR (MILLIMETER WAVE RADAR SENSOR - DISTANCE CONTROL ECU)

a. Disconnect the A44 millimeter wave radar sensor connector.

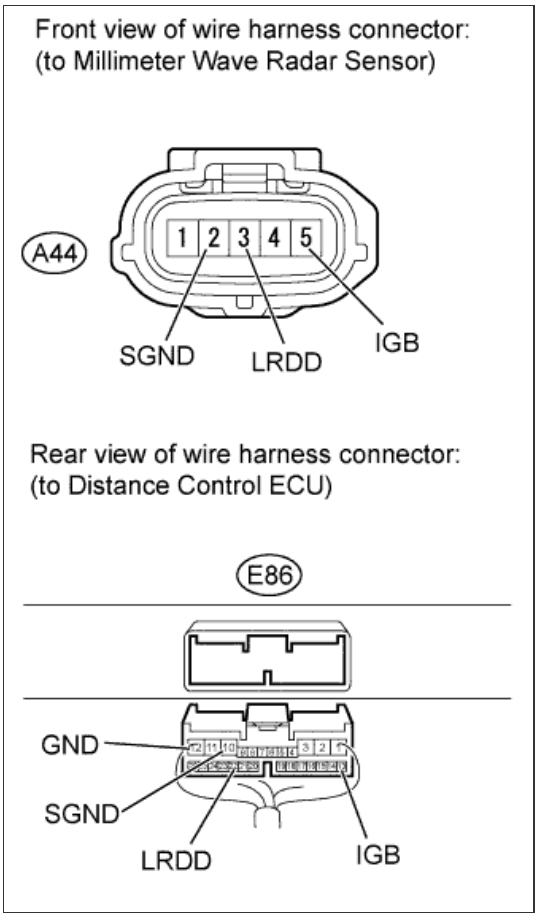
b. Disconnect the E86 distance control ECU connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A44-3 (LRDD) - E86-22 (LRDD)	Always	Below 1 Ω
A44-5 (IGB) - E86-13 (IGB)		
E86-12 (GND) - Body ground		
E86-22 (LRDD) - Body ground	Always	10 kΩ or higher
E86-13 (IGB) - Body ground		

A44-2 (SGND) - Body ground	Always	10 kΩ or higher
E86-10 (SGND) - Body ground		



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

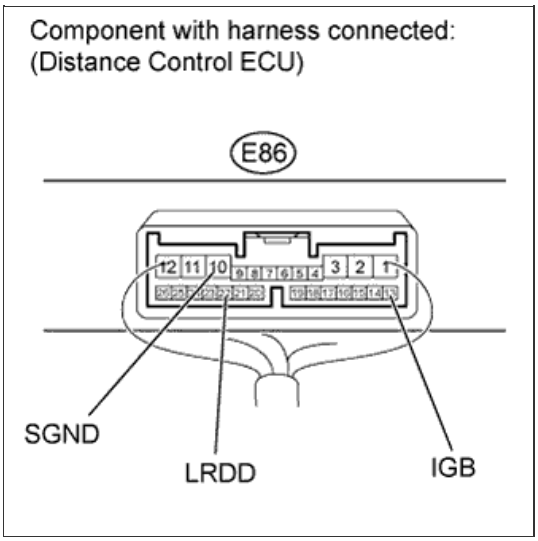
2.CHECK DISTANCE CONTROL ECU

a. Disconnect the A44 millimeter wave radar sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
E86-13 (IGB) - E86-10 (SGND)	Engine switch on (IG)	11 to 14 V
E86-22 (LRDD) - E86-10 (SGND)		4.5 to 5.5 V



NG → REPLACE DISTANCE CONTROL ECU (Click here)

OK

3.REPLACE MILLIMETER WAVE RADAR SENSOR

a. Replace the millimeter wave radar sensor with a new one (Click here).

b. Adjust the millimeter wave radar sensor (Click here).

NEXT

4.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the dynamic radar cruise control.

d. Check for DTCs (Click here).

OK:
DTC U0235 is not output.

NG → REPLACE DISTANCE CONTROL ECU (**Click here**)

OK

END

DTC P1617 Distance Control ECU Malfunction

for Preparation Click here

DESCRIPTION

In the dynamic radar cruise control system, the ECM and the distance control ECU communicate with one another to control the system based on designation information. If the designation information of the ECM and the distance control ECU is different or the distance control ECU is malfunctioning, this DTC is recorded.

DTC Code	DTC Detection Condition	Trouble Area
P1617	While the dynamic radar cruise control is either preparing for operation or operating, if designation signal from the ECM and designation return signal from the distance control ECU do not match, or the distance control ECU is malfunctioning for a certain amount of time or more.	Distance control ECU

INSPECTION PROCEDURE

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.CONFIRM DESIGNATION INFORMATION (DISTANCE CONTROL ECU)

a. Confirm the designation information.

i. Turn the engine switch on (IG).

ii. Turn the cruise control main switch on.

iii. Depress the brake pedal (brake switch on).

iv. With the brake pedal depressed, push the cruise control main switch to +RES 3 times within 3 seconds, and check that the buzzer sounds.

NOTICE:

At this time, do not turn the headlight dimmer switch on. Due to the activation of the beam axis automatic adjustment mode, turning the headlight dimmer switch on may result in an incorrect setting. If the headlight dimmer switch is turned on by mistake, perform the beam axis adjustment again (Click here).

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:
DTC P1617 is not output.

HINT:

If DTC P1617 is still output after replacing the distance control ECU, replace the ECM.

NG → REPLACE DISTANCE CONTROL ECU (Click here)


OK
END

DTC U1102 Lost Communication with Radar Sensor

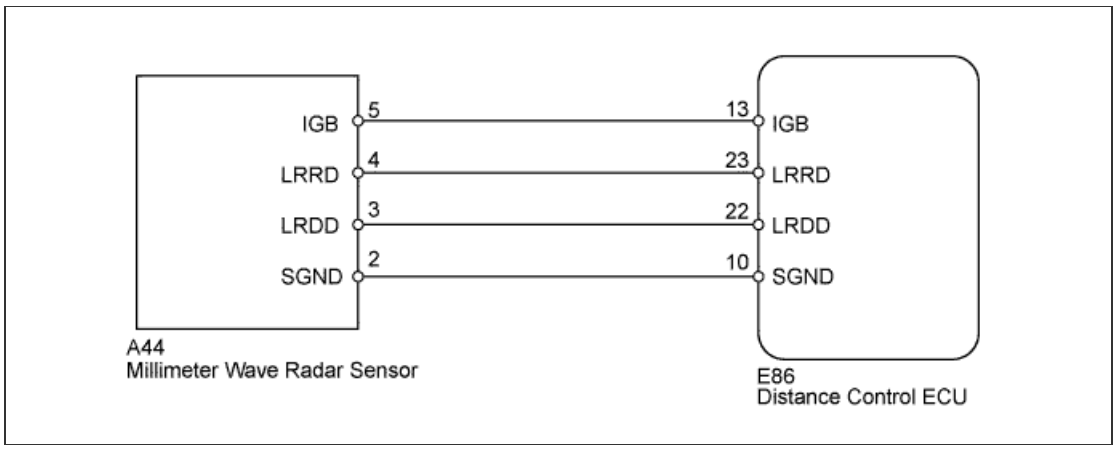
for Preparation Click here

DESCRIPTION

The distance control ECU sends the vehicle speed and estimated curve information to the millimeter wave radar sensor. The millimeter wave radar sensor sends information about whether another vehicle is present in front of the vehicle, the distance between the vehicles, relative speed, etc. to the distance control ECU. The distance control ECU sends this information to the ECM and performs control of cruise control.

DTC Code	DTC Detection Condition	Trouble Area
U1102	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the data sent from the distance control ECU to the millimeter wave radar sensor is abnormal.	• Distance control ECU • Harness or connector • Millimeter wave radar sensor

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

- **When the distance control ECU is replaced with a new one, initialization must be performed (Click here).**
- **When the millimeter wave radar sensor is replaced with a new one, adjustment of the radar sensor beam axis must be performed (Click here).**
- **As it is possible that this DTC was stored due to a bad connection of a connector, make sure to check that each connector is connected securely.**

1.CHECK HARNESS AND CONNECTOR (DISTANCE CONTROL ECU - MILLIMETER WAVE RADAR SENSOR)

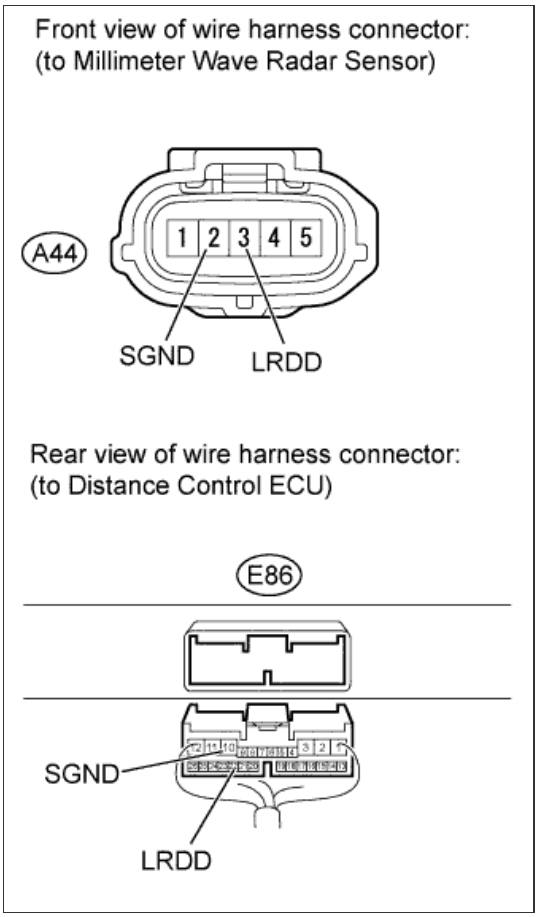
a. Disconnect the A44 millimeter wave radar sensor connector.

b. Disconnect the E86 distance control ECU connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A44-3 (LRDD) - E86-22 (LRDD)	Always	Below 1 Ω
E86-22 (LRDD) - Body ground	Always	10 kΩ or higher
A44-2 (SGND) - Body ground	Always	10 kΩ or higher
E86-10 (SGND) - Body ground		



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2.REPLACE DISTANCE CONTROL ECU

a. Replace the distance control ECU with a new one (Click here).

b. Perform initialization (Click here).

NEXT

3.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on.

iii. Push the -SET switch to activate the dynamic radar cruise control.

d. Check for DTCs (Click here).

OK:
DTC U1102 is not output.

NG → REPLACE MILLIMETER WAVE RADAR SENSOR (Click here)

OK

```
END
```

DTC P1630 Communication Error from VSC to ECM

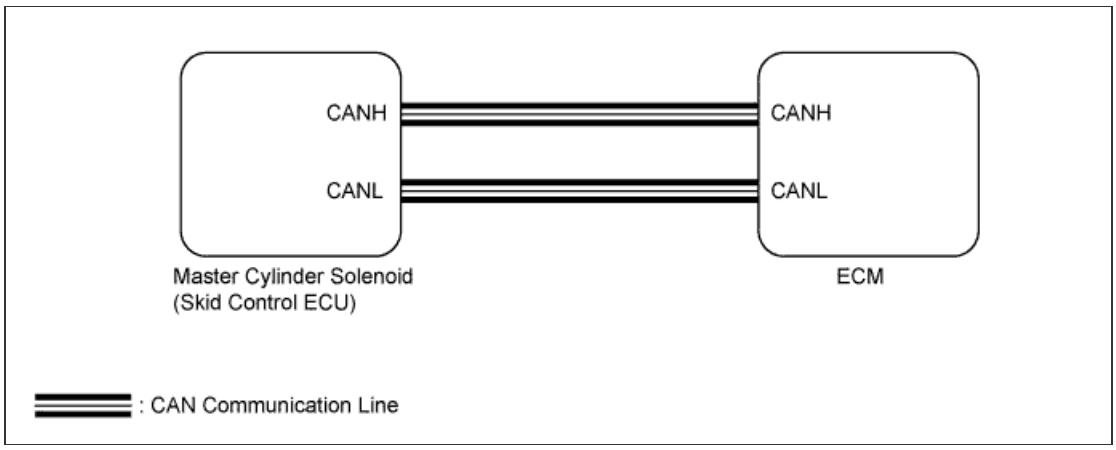
for Preparation Click here

DESCRIPTION

The distance control ECU sends brake control request signals, warning request signals, etc. to the master cylinder solenoid (skid control ECU) through the ECM. Based on these signals, the brake actuator operates and the warning buzzer sounds. The master cylinder solenoid (skid control ECU) sends brake system malfunction signals, etc. to the ECM.

DTC Code	DTC Detection Condition	Trouble Area
P1630	The vehicle speed is 40 km/h (25 mph) or more with the cruise control main switch on (vehicle-to-vehicle distance control mode) and the data sent from the master cylinder solenoid (skid control ECU) to the ECM is abnormal.	• Master cylinder solenoid (skid control ECU) • CAN communication system • ECM

WIRING DIAGRAM



INSPECTION PROCEDURE

1.REPLACE MASTER CYLINDER SOLENOID (SKID CONTROL ECU)

a. Replace the master cylinder solenoid (skid control ECU) with a new one (Click here for LHD, Click here for RHD).

NEXT

2.CHECK DTC (DYNAMIC RADAR CRUISE CONTROL SYSTEM)

a. Using the intelligent tester, enter the following menus: Powertrain / Radar Cruise / Trouble Code.

b. Clear the DTCs (Click here).

c. Perform the following to make sure the DTC detection conditions are met.

HINT:

If the detection conditions are not met, the system cannot detect the malfunction.

i. Drive the vehicle at a speed of 40 km/h (25 mph) or more.

ii. Turn the cruise control main switch on to set the vehicle-to-vehicle distance control mode to the standby state.

d. Check for DTCs (Click here).

OK:
DTC P1630 is not output.

NG → REPLACE ECM (Click here)

OK

```
END
```

for Preparation Click here

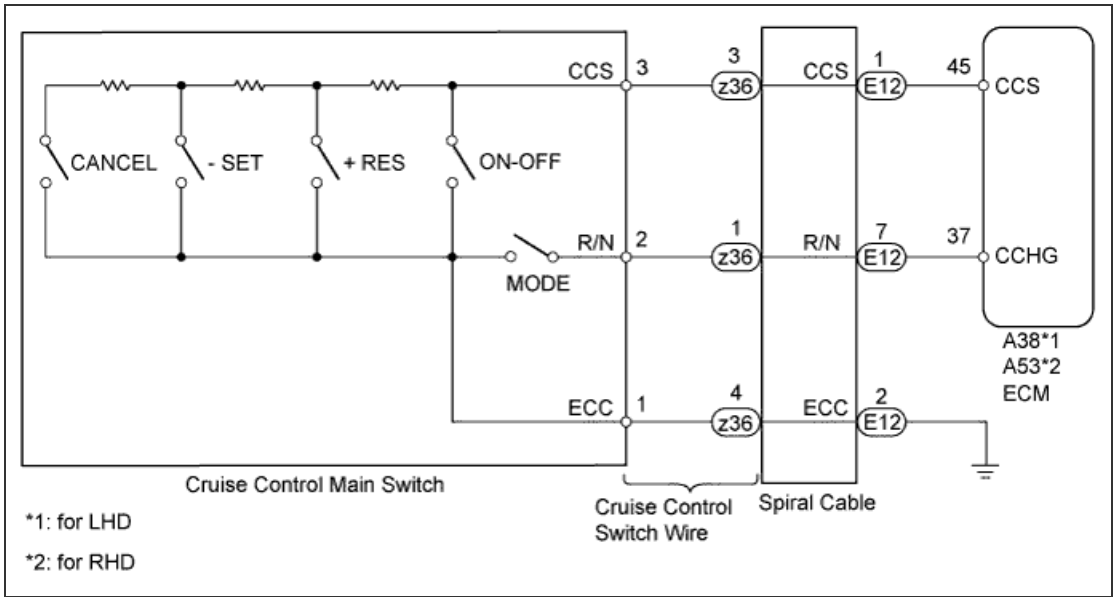
DESCRIPTION

The cruise control main switch is used to operate 8 functions: SET, - (COAST), TAP-DOWN, RES (RESUME), + (ACCELERATION), TAP-UP, CANCEL and MODE. The SET, TAP-DOWN and - (COAST) functions, and the RES (RESUME), TAP-UP and + (ACCELERATION) functions are operated with the same switch. The cruise control main switch is an automatic return type switch which turns on only while operating it in each arrow direction and turns off after releasing it. The internal contact point of the cruise control main switch is turned on with the switch operation. Then the ECM reads the resistance value that has been changed by the switch operation to control MODE, SET, - (COAST), RES (RESUME), + (ACCELERATION) and CANCEL. The dynamic radar cruise control system has two cruise control modes: the constant speed control mode and vehicle-to-vehicle distance control mode.

HINT:

- **The vehicle-to-vehicle distance control mode is always selected when starting up the dynamic radar cruise control system.**
- **The operation of the constant speed control mode is the same as the cruise control system.**

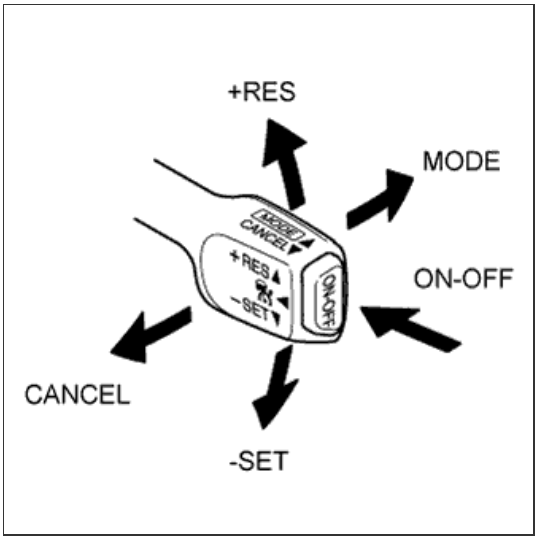
WIRING DIAGRAM



INSPECTION PROCEDURE

1.READ VALUE USING INTELLIGENT TESTER (CRUISE CONTROL MAIN SWITCH)

a. Using the intelligent tester, read the Data List.



Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
		ON: Cruise control main switch (Main CPU)	

CCS Main SW M-CPU	Cruise control main switch (Main CPU) / ON or OFF	on OFF: Cruise control main switch (Main CPU) off	-
Cancel Switch	CANCEL switch signal / ON or OFF	ON: CANCEL switch on OFF: CANCEL switch off	-
SET/COAST Switch	-SET switch signal / ON or OFF	ON: -SET switch on OFF: -SET switch off	-
RES/ACC Switch	+RES switch signal / ON or OFF	ON: +RES switch on OFF: +RES switch off	-
CCS Main SW S-CPU	Cruise control main switch (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-

OK:

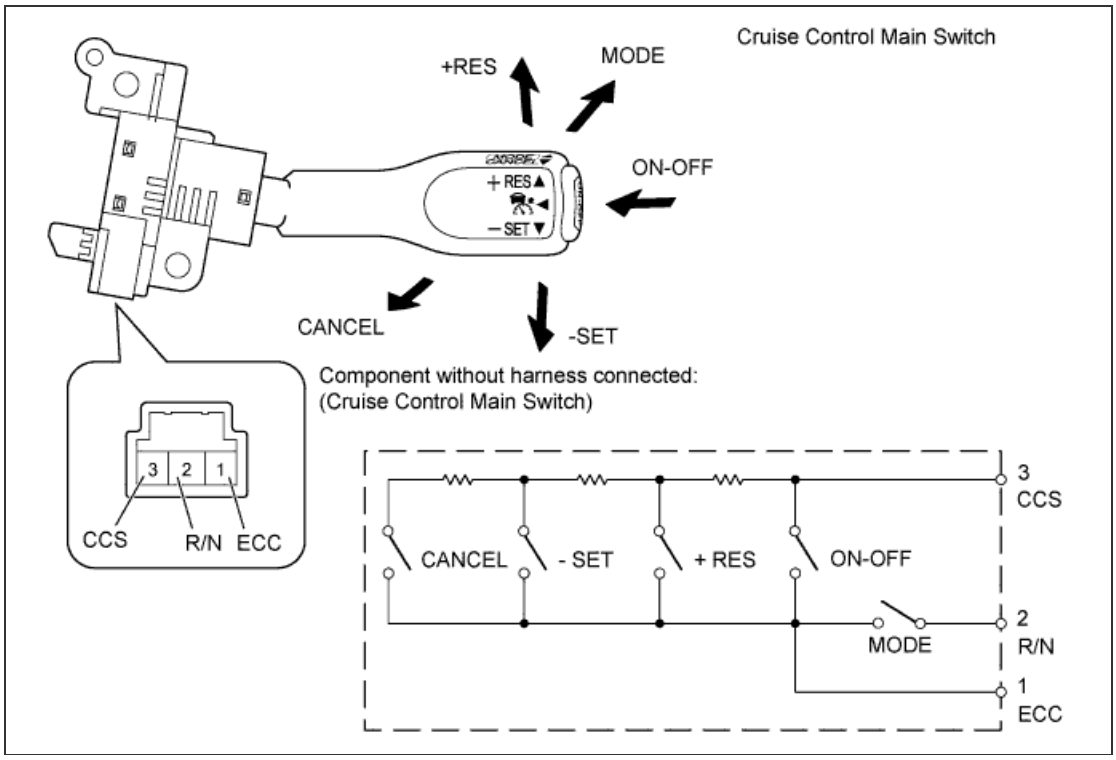
The intelligent tester display changes according to operation of cruise control main switch.

NG → Go to step 2

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

2.INSPECT CRUISE CONTROL MAIN SWITCH



a. Remove the cruise control main switch (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 (ECC) - 3 (CCS)	Neutral	1 MΩ or higher
	Pushed to +RES	235 to 245 Ω
	Pushed to -SET	620 to 640 Ω
	Pushed to CANCEL	1510 to 1570 Ω
	Main switch pushed off	1 MΩ or higher
	Main switch pushed on	Below 2.5 Ω

1 (ECC) - 2 (R/N)	MODE switch pushed on	Below 2.5 Ω
	MODE switch off	1 MΩ or higher

NG → REPLACE CRUISE CONTROL MAIN SWITCH (Click here)

OK

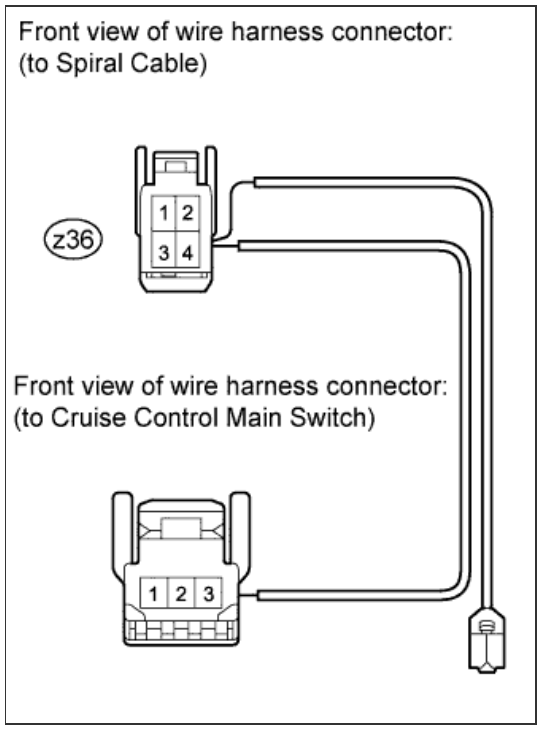
3.INSPECT CRUISE CONTROL SWITCH WIRE

a. Remove the cruise control switch wire.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - 3	Always	Below 1 Ω
z36-1 - 2		
z36-4 - 1		
z36-3 - Body ground	Always	10 kΩ or higher
z36-1 - Body ground		
z36-4 - Body ground		



NG → REPLACE CRUISE CONTROL SWITCH WIRE

OK

4.INSPECT SPIRAL CABLE

a. Check the spiral cable and connector for scratches, cracks, dents and chips. If any defects are found, replace the spiral cable with a new one.

b. Check the spiral cable.

i. Set the spiral cable to the center position (Click here).

ii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise, and measure the resistance according to the value(s) in the table below. Then rotate the spiral cable 5 times counterclockwise, and measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-1 - E12-7 (R/N)		
z36-4 - E12-2 (ECC)		

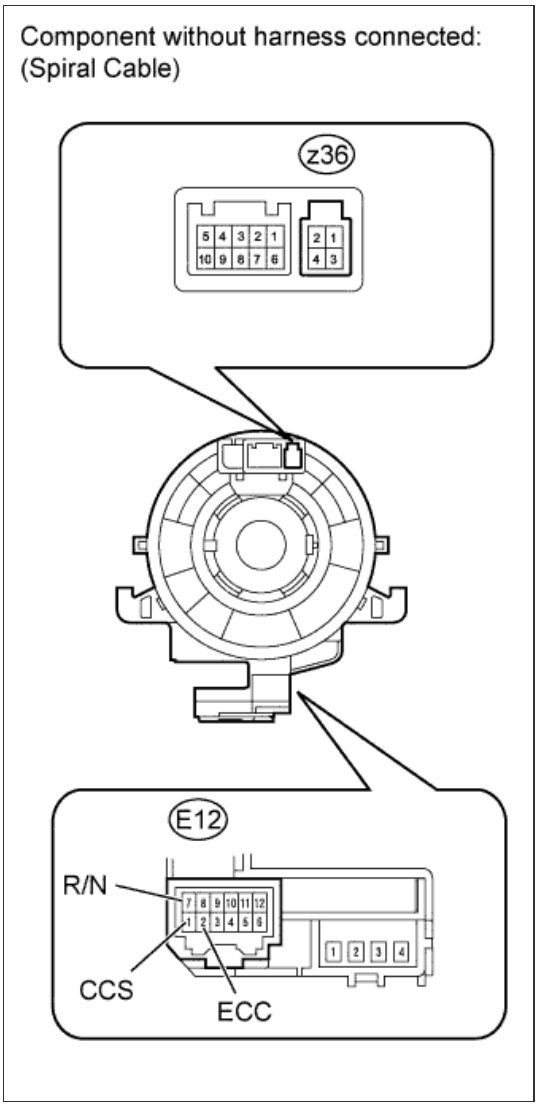
iii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise. Then while rotating the spiral cable 5 times counterclockwise, measure the resistance according to the value(s) in the table below.

NOTICE:

As the spiral cable may break, do not rotate the spiral cable more than the specified amount.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-1 - E12-7 (R/N)		
z36-4 - E12-2 (ECC)		



NG → REPLACE SPIRAL CABLE (Click here)

OK

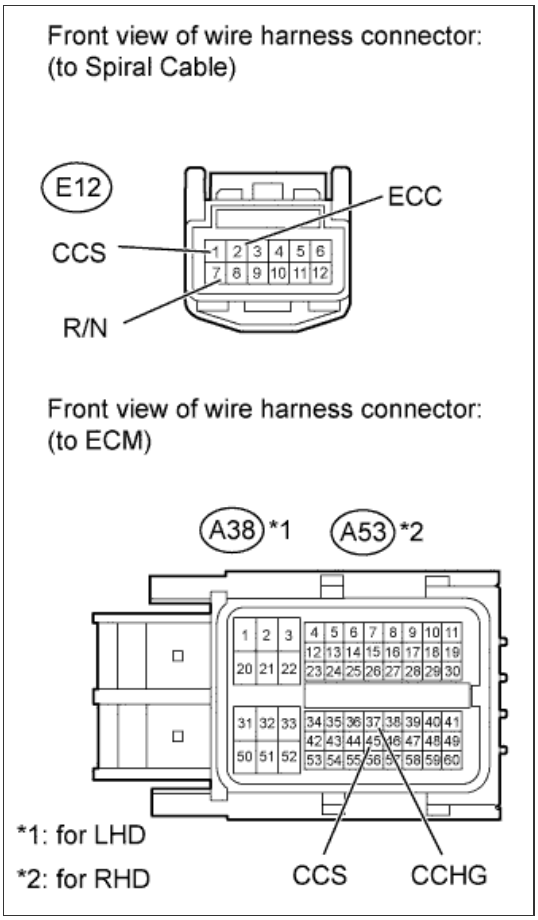
5.CHECK HARNESS AND CONNECTOR (SPIRAL CABLE - ECM AND BODY GROUND)

a. Disconnect the E12 spiral cable connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A38-45 (CCS)	Always	Below 1 Ω
E12-7 (R/N) - A38-37 (CCHG)		
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-7 (R/N) - Body ground		
E12-2 (ECC) - Body ground	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A53-45 (CCS)	Always	Below 1 Ω
E12-7 (R/N) - A53-37 (CCHG)		
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-7 (R/N) - Body ground		
E12-2 (ECC) - Body ground	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (Click here)

for Preparation Click here

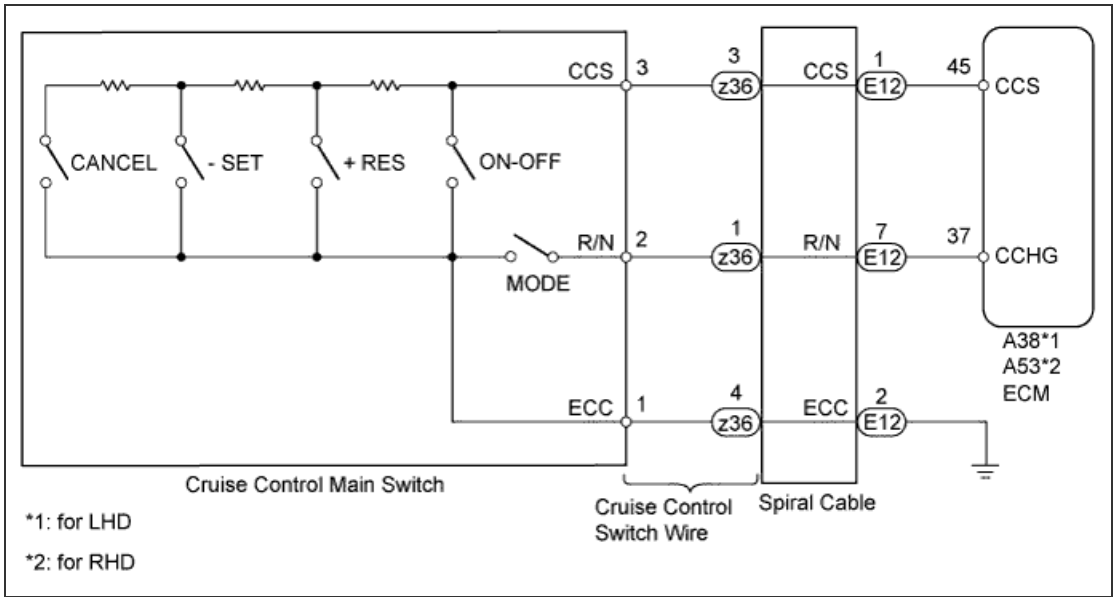
DESCRIPTION

The cruise control main switch is used to operate 8 functions: SET, - (COAST), TAP-DOWN, RES (RESUME), + (ACCELERATION), TAP-UP, CANCEL and MODE. The SET, TAP-DOWN and - (COAST) functions, and the RES (RESUME), TAP-UP and + (ACCELERATION) functions are operated with the same switch. The cruise control main switch is an automatic return type switch which turns on only while operating it in each arrow direction and turns off after releasing it. The internal contact point of the cruise control main switch is turned on with the switch operation. Then the ECM reads the resistance value that has been changed by the switch operation to control MODE, SET, - (COAST), RES (RESUME), + (ACCELERATION) and CANCEL. The dynamic radar cruise control system has two cruise control modes: the constant speed control mode and vehicle-to-vehicle distance control mode.

HINT:

- **The vehicle-to-vehicle distance control mode is always selected when starting up the dynamic radar cruise control system.**
- **The operation of the constant speed control mode is the same as the cruise control system.**

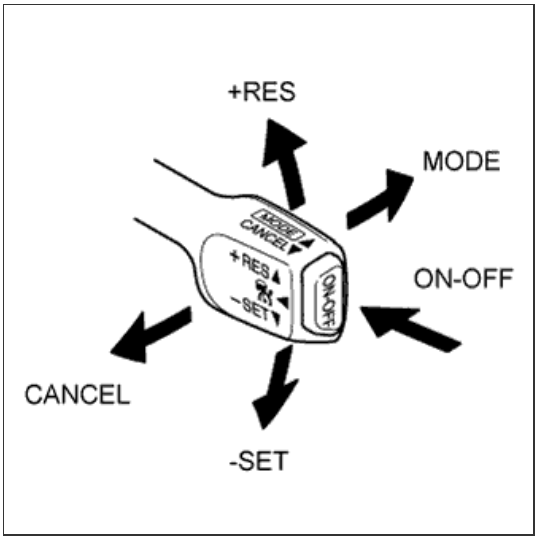
WIRING DIAGRAM



INSPECTION PROCEDURE

1.READ VALUE USING INTELLIGENT TESTER (CRUISE CONTROL MAIN SWITCH)

a. Using the intelligent tester, read the Data List.



Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
		ON: Cruise control main switch (Main CPU)	

CCS Main SW M-CPU	Cruise control main switch (Main CPU) / ON or OFF	on OFF: Cruise control main switch (Main CPU) off	-
Cancel Switch	CANCEL switch signal / ON or OFF	ON: CANCEL switch on OFF: CANCEL switch off	-
SET/COAST Switch	-SET switch signal / ON or OFF	ON: -SET switch on OFF: -SET switch off	-
RES/ACC Switch	+RES switch signal / ON or OFF	ON: +RES switch on OFF: +RES switch off	-
CCS Main SW S-CPU	Cruise control main switch (Sub CPU) / ON or OFF	ON: Cruise control main switch (Sub CPU) on OFF: Cruise control main switch (Sub CPU) off	-

OK:

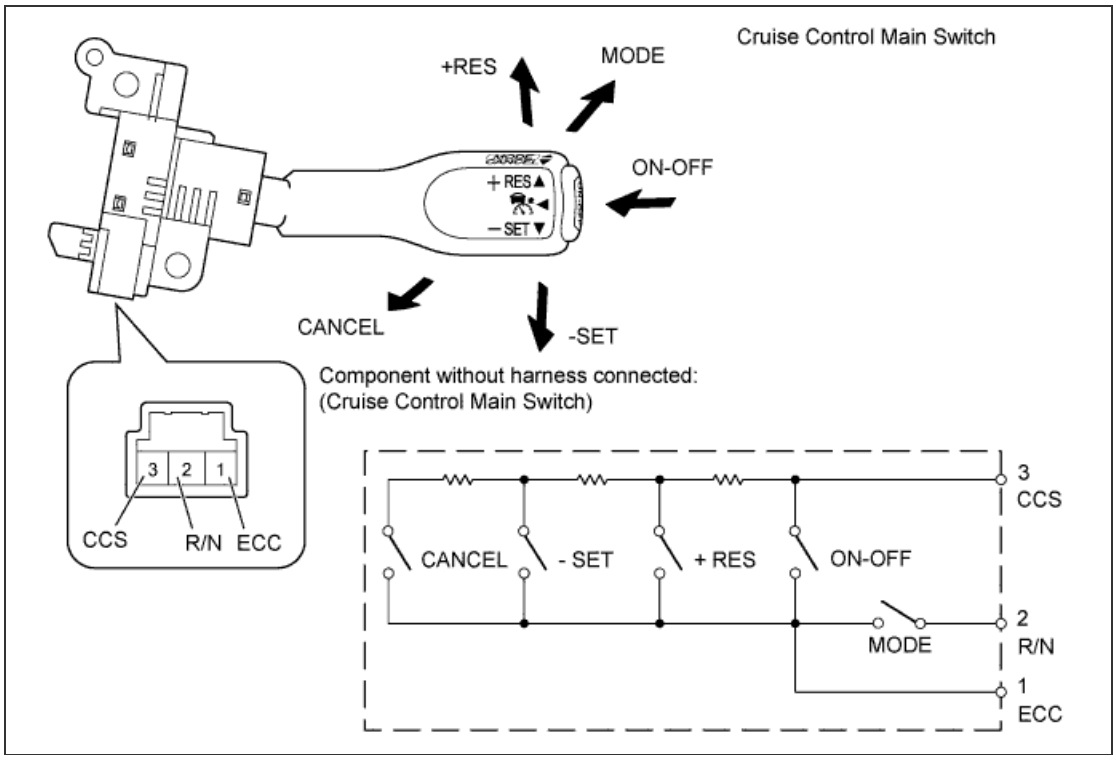
The intelligent tester display changes according to operation of cruise control main switch.

NG → Go to step 2

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

2.INSPECT CRUISE CONTROL MAIN SWITCH



a. Remove the cruise control main switch (Click here).

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 (ECC) - 3 (CCS)	Neutral	1 MΩ or higher
	Pushed to +RES	235 to 245 Ω
	Pushed to -SET	620 to 640 Ω
	Pushed to CANCEL	1510 to 1570 Ω
	Main switch pushed off	1 MΩ or higher
	Main switch pushed on	Below 2.5 Ω

1 (ECC) - 2 (R/N)	MODE switch pushed on	Below 2.5 Ω
	MODE switch off	1 MΩ or higher

NG → REPLACE CRUISE CONTROL MAIN SWITCH (Click here)

OK

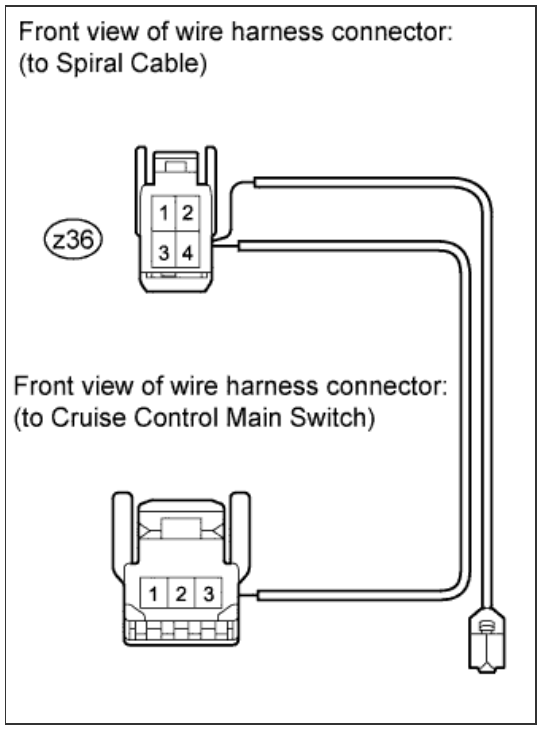
3.INSPECT CRUISE CONTROL SWITCH WIRE

a. Remove the cruise control switch wire.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - 3	Always	Below 1 Ω
z36-1 - 2		
z36-4 - 1		
z36-3 - Body ground	Always	10 kΩ or higher
z36-1 - Body ground		
z36-4 - Body ground		



NG → REPLACE CRUISE CONTROL SWITCH WIRE

OK

4.INSPECT SPIRAL CABLE

a. Check the spiral cable and connector for scratches, cracks, dents and chips. If any defects are found, replace the spiral cable with a new one.

b. Check the spiral cable.

i. Set the spiral cable to the center position (Click here).

ii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise, and measure the resistance according to the value(s) in the table below. Then rotate the spiral cable 5 times counterclockwise, and measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-1 - E12-7 (R/N)		
z36-4 - E12-2 (ECC)		

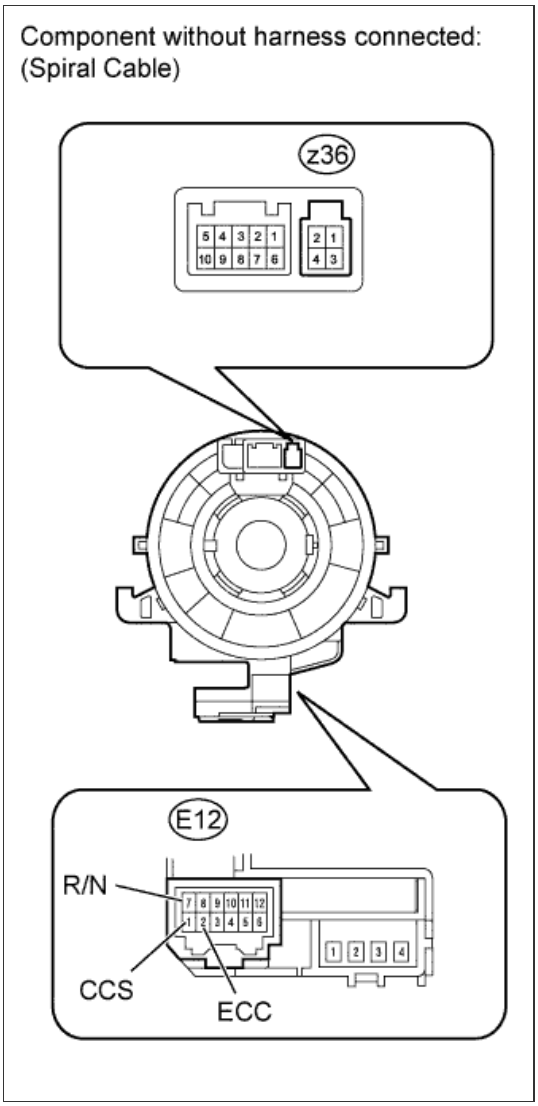
iii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise. Then while rotating the spiral cable 5 times counterclockwise, measure the resistance according to the value(s) in the table below.

NOTICE:

As the spiral cable may break, do not rotate the spiral cable more than the specified amount.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z36-3 - E12-1 (CCS)	Always	Below 1 Ω
z36-1 - E12-7 (R/N)		
z36-4 - E12-2 (ECC)		



NG → REPLACE SPIRAL CABLE (Click here)

OK

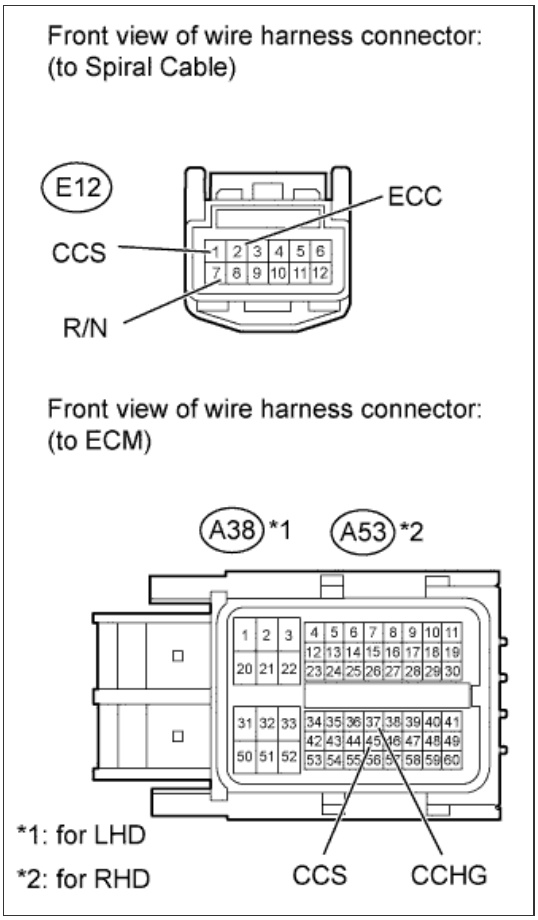
5.CHECK HARNESS AND CONNECTOR (SPIRAL CABLE - ECM AND BODY GROUND)

a. Disconnect the E12 spiral cable connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A38-45 (CCS)	Always	Below 1 Ω
E12-7 (R/N) - A38-37 (CCHG)		
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-7 (R/N) - Body ground		
E12-2 (ECC) - Body ground	Always	Below 1 Ω

for RHD

Tester Connection	Condition	Specified Condition
E12-1 (CCS) - A53-45 (CCS)	Always	Below 1 Ω
E12-7 (R/N) - A53-37 (CCHG)		
E12-1 (CCS) - Body ground	Always	10 kΩ or higher
E12-7 (R/N) - Body ground		
E12-2 (ECC) - Body ground	Always	Below 1 Ω

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

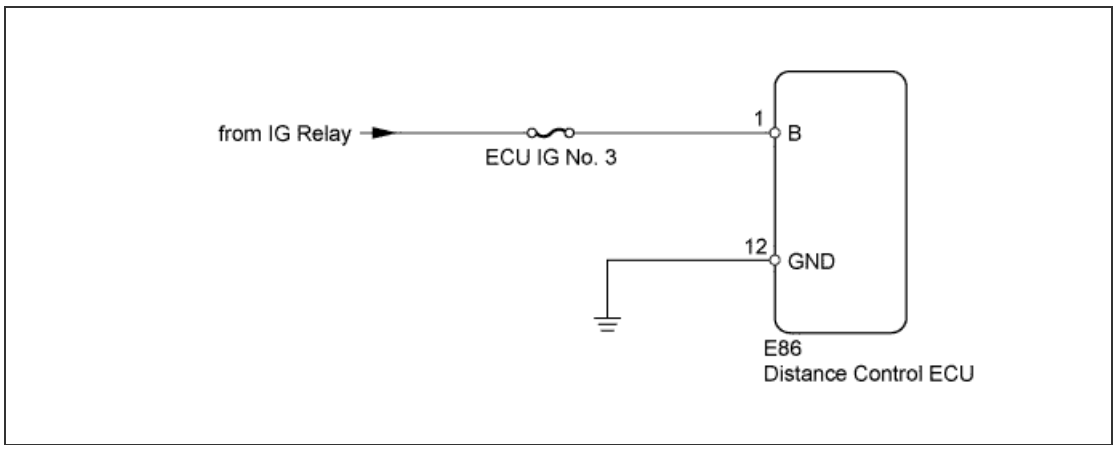
REPLACE ECM (Click here)

for Preparation Click here

DESCRIPTION

This circuit provides power to operate the distance control ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.INSPECT FUSE (ECU-IG No. 3)

a. Remove the ECU-IG No. 3 fuse from the cowl side junction block RH.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
ECU-IG No. 3 fuse	Always	Below 1 Ω

NG → REPLACE FUSE

OK

2.CHECK HARNESS AND CONNECTOR (DISTANCE CONTROL ECU - BATTERY AND BODY GROUND)

a. Disconnect the E86 distance control ECU connector.

b. Measure the voltage according to the value(s) in the table below.

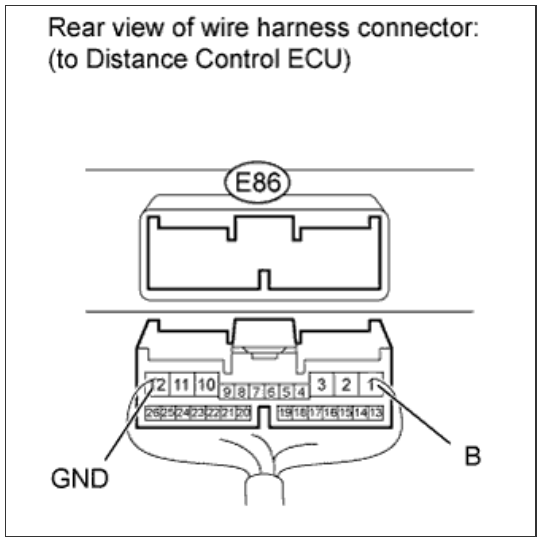
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
E86-1 (B) - Body ground	Engine switch on (IG)	11 to 14 V
	Engine switch off	Below 1 V

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
E86-12 (GND) - Body ground	Always	Below 1 Ω



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

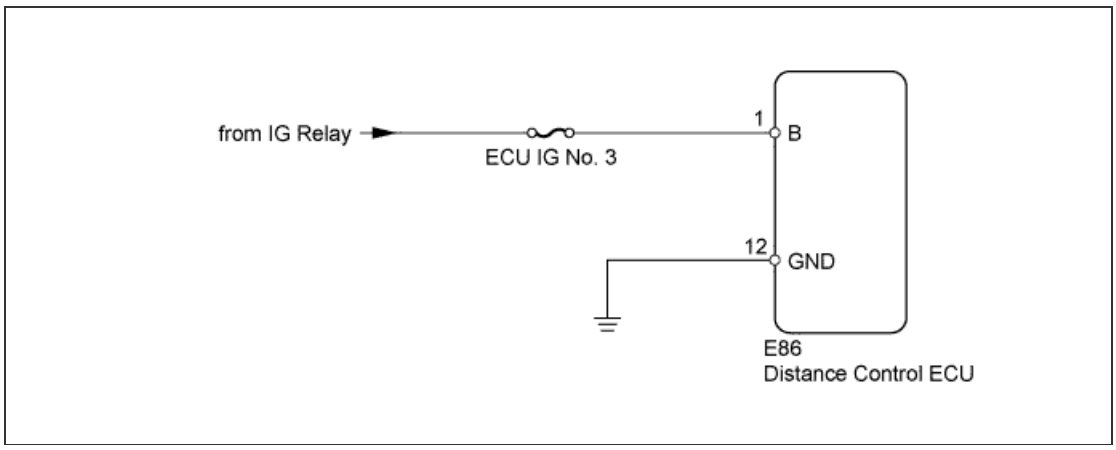
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

This circuit provides power to operate the distance control ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.INSPECT FUSE (ECU-IG No. 3)

a. Remove the ECU-IG No. 3 fuse from the cowl side junction block RH.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
ECU-IG No. 3 fuse	Always	Below 1 Ω

NG → REPLACE FUSE

OK

2.CHECK HARNESS AND CONNECTOR (DISTANCE CONTROL ECU - BATTERY AND BODY GROUND)

a. Disconnect the E86 distance control ECU connector.

b. Measure the voltage according to the value(s) in the table below.

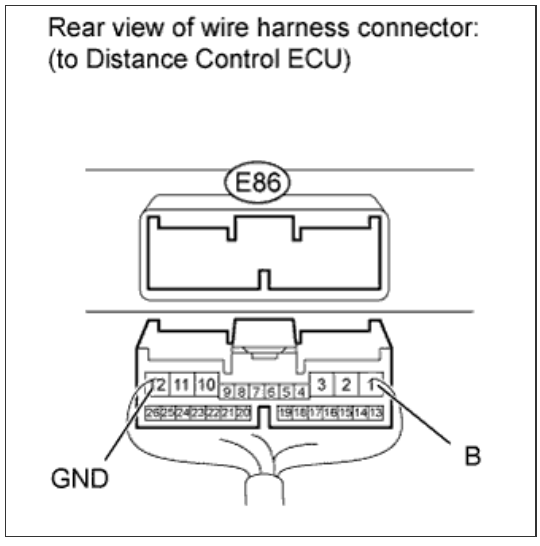
Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
E86-1 (B) - Body ground	Engine switch on (IG)	11 to 14 V
	Engine switch off	Below 1 V

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
E86-12 (GND) - Body ground	Always	Below 1 Ω



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

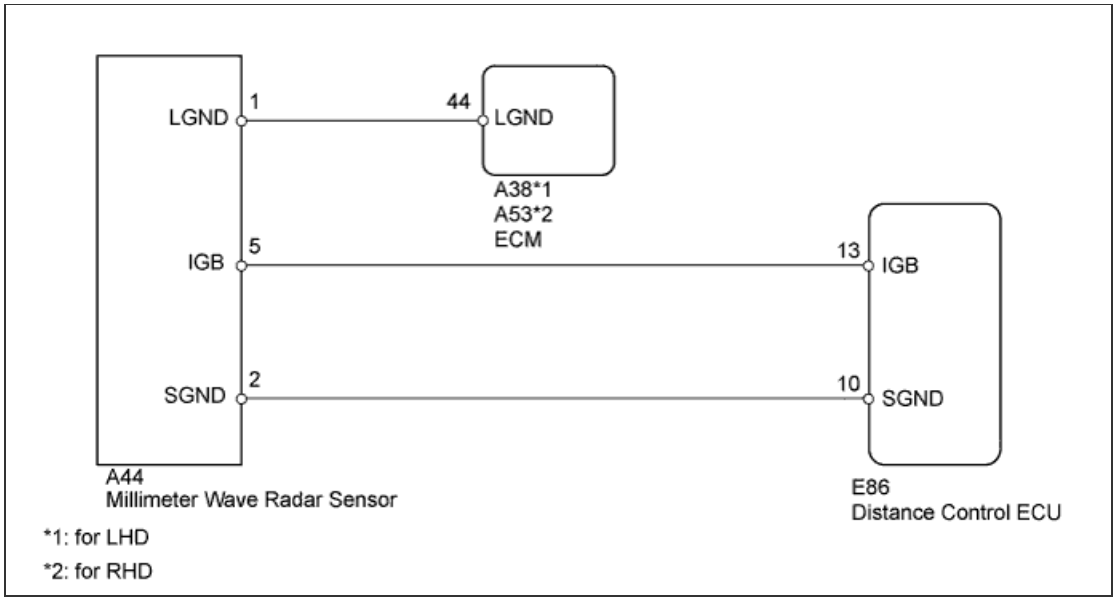
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

This circuit provides power to the millimeter wave radar sensor. The millimeter wave radar sensor emits radio waves towards an object in front and measures the distance and direction of the object by receiving the wave reflections. Based on the reflections, the sensor calculates the difference in speed between the vehicle and the object in front. This data is transmitted to the distance control ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.CHECK HARNESS AND CONNECTOR (MILLIMETER WAVE RADAR SENSOR - DISTANCE CONTROL ECU)

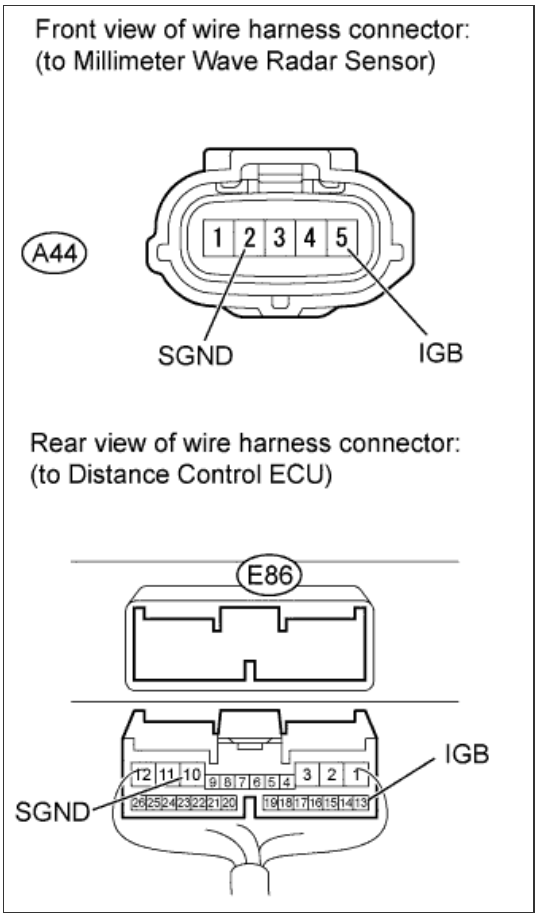
a. Disconnect the A44 millimeter wave radar sensor connector.

b. Disconnect the E86 distance control ECU connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A44-2 (SGND) - E86-10 (SGND)	Always	Below 1 Ω
A44-5 (IGB) - E86-13 (IGB)		
E86-13 (IGB) - Body ground	Always	10 kΩ or higher
A44-5 (IGB) - Body ground		



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

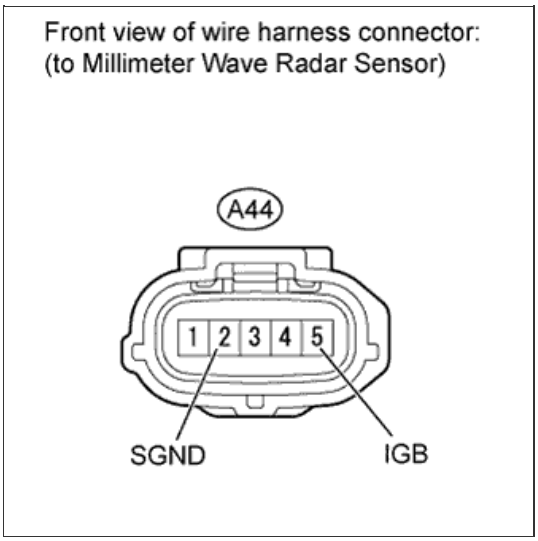
2.CHECK DISTANCE CONTROL ECU (IGB VOLTAGE)

a. Disconnect the A44 millimeter wave radar sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A44-5 (IGB) - A44-2 (SGND)	Engine switch on (IG)	11 to 14 V



NG → REPLACE DISTANCE CONTROL ECU (Click here)

OK

3.CHECK HARNESS AND CONNECTOR (MILLIMETER WAVE RADAR SENSOR - ECM AND BODY GROUND)

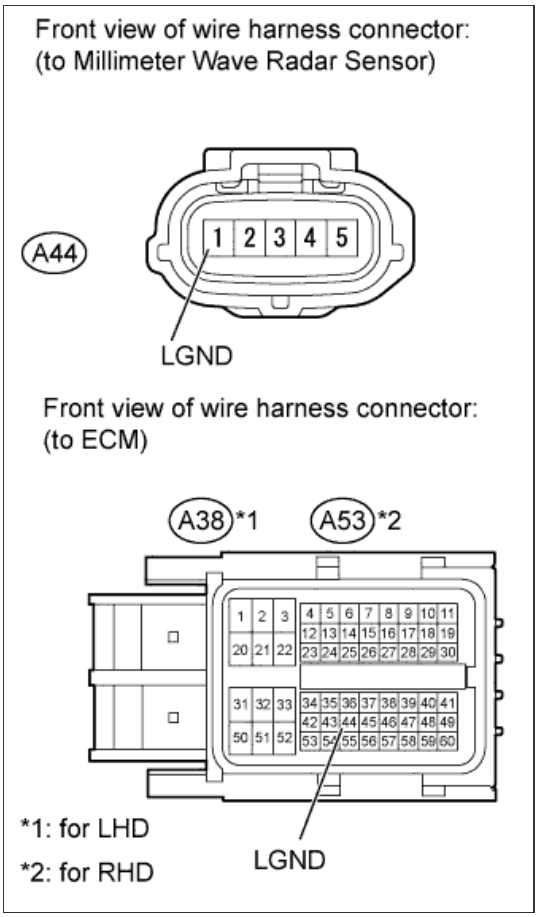
a. Disconnect the A44 millimeter wave radar sensor connector.

a. Disconnect the A44 millimeter wave radar sensor connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A44-1 (LGND) - A38-44 (LGND)	Always	Below 1 Ω
A44-1 (LGND) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A44-1 (LGND) - A53-44 (LGND)	Always	Below 1 Ω
A44-1 (LGND) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

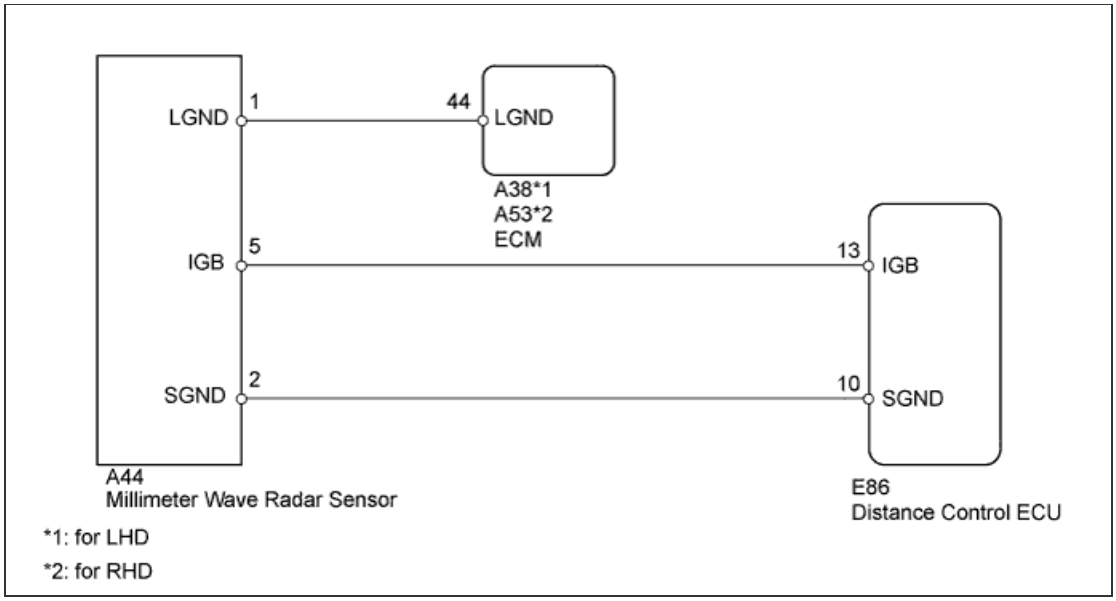
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

This circuit provides power to the millimeter wave radar sensor. The millimeter wave radar sensor emits radio waves towards an object in front and measures the distance and direction of the object by receiving the wave reflections. Based on the reflections, the sensor calculates the difference in speed between the vehicle and the object in front. This data is transmitted to the distance control ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.CHECK HARNESS AND CONNECTOR (MILLIMETER WAVE RADAR SENSOR - DISTANCE CONTROL ECU)

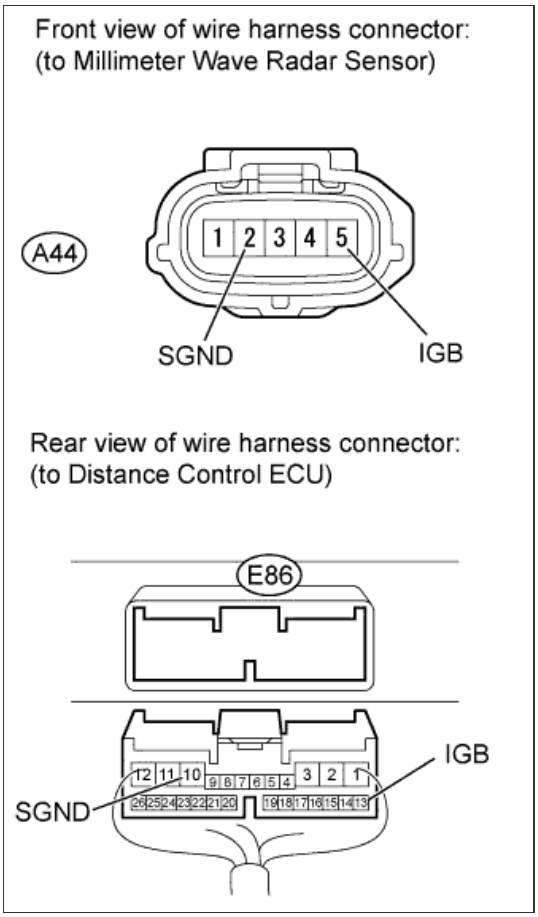
a. Disconnect the A44 millimeter wave radar sensor connector.

b. Disconnect the E86 distance control ECU connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
A44-2 (SGND) - E86-10 (SGND)	Always	Below 1 Ω
A44-5 (IGB) - E86-13 (IGB)		
E86-13 (IGB) - Body ground	Always	10 kΩ or higher
A44-5 (IGB) - Body ground		



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

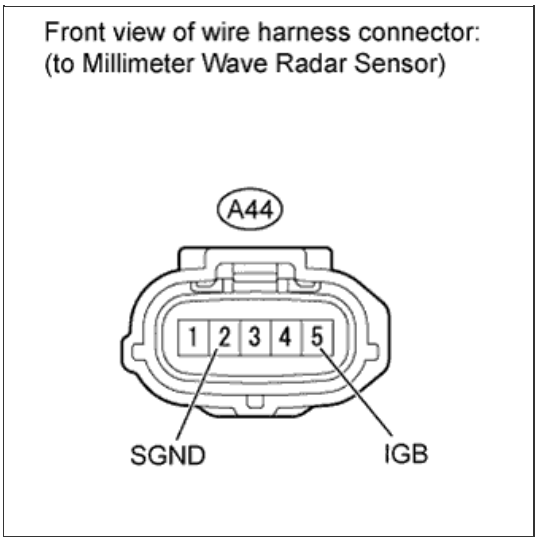
2.CHECK DISTANCE CONTROL ECU (IGB VOLTAGE)

a. Disconnect the A44 millimeter wave radar sensor connector.

b. Measure the voltage according to the value(s) in the table below.

Standard Voltage:

Tester Connection	Switch Condition	Specified Condition
A44-5 (IGB) - A44-2 (SGND)	Engine switch on (IG)	11 to 14 V



NG → REPLACE DISTANCE CONTROL ECU (Click here)

OK

3.CHECK HARNESS AND CONNECTOR (MILLIMETER WAVE RADAR SENSOR - ECM AND BODY GROUND)

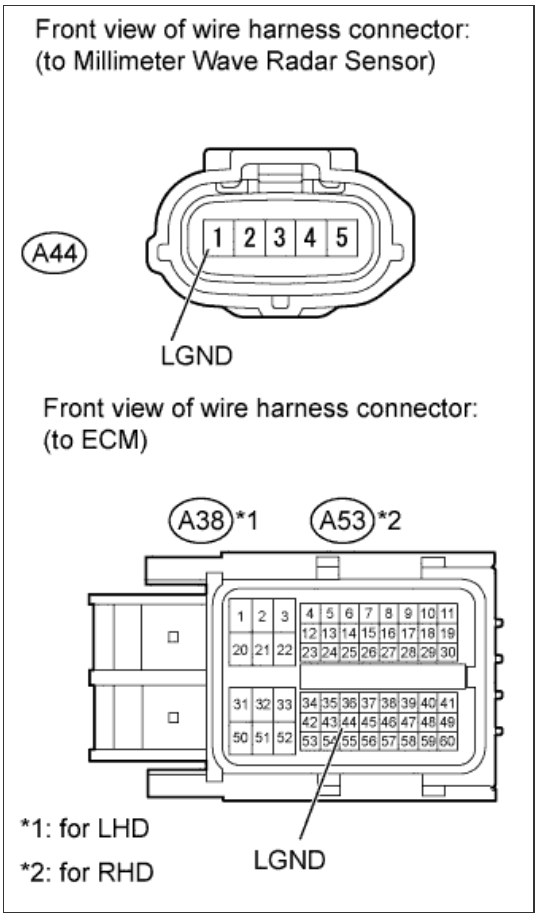
a. Disconnect the A44 millimeter wave radar sensor connector.

a. Disconnect the A44 millimeter wave radar sensor connector.

b. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
A44-1 (LGND) - A38-44 (LGND)	Always	Below 1 Ω
A44-1 (LGND) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
A44-1 (LGND) - A53-44 (LGND)	Always	Below 1 Ω
A44-1 (LGND) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

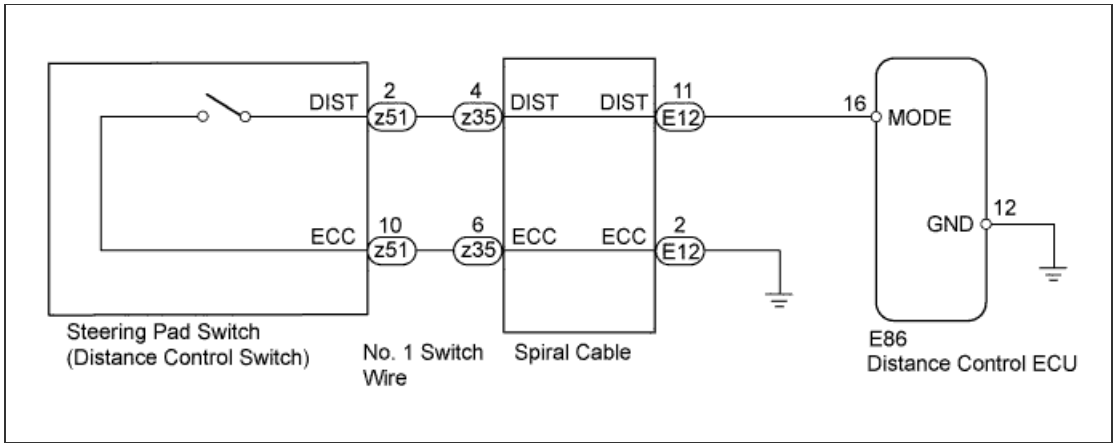
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

The distance control switch sets the vehicle-to-vehicle distance control mode. The distance control switch is installed in the steering pad switch. The vehicle-to-vehicle distance set value can be changed by operating the steering pad switch (distance control switch) while the dynamic radar cruise control system is in operation. The steering pad switch uses the CAN communication line to communicate with each ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

CAUTION:

The vehicle is equipped with an SRS (Supplemental Restraint System) which includes components such as airbags. Before servicing (including removal or installation of parts), be sure to read the Precaution for the SRS (Click here).

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.READ VALUE USING INTELLIGENT TESTER (VEHICLE DISTANCE)

a. Using the intelligent tester, read the Data List.

Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
Car Dist Time Setting	Vehicle distance time setting condition / SHORT, LONG, MID or NO	Vehicle distance selected by steering pad switch (distance control switch)	-

OK:

Normal conditions listed above are displayed.

NG → Go to step 2

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

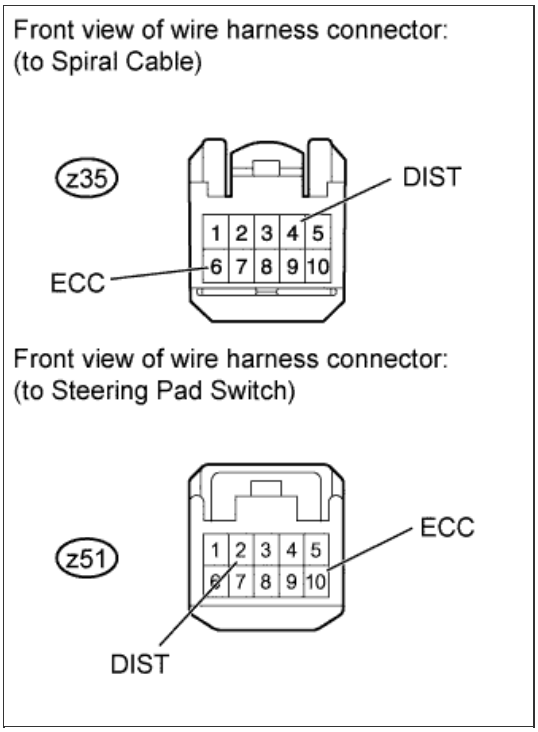
2.CHECK NO. 1 SWITCH WIRE

a. Disconnect the z35 and z51 No. 1 switch wire connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z35-4 (DIST) - z51-2 (DIST)	Always	Below 1 Ω
z35-6 (ECC) - z51-10 (ECC)	Always	Below 1 Ω

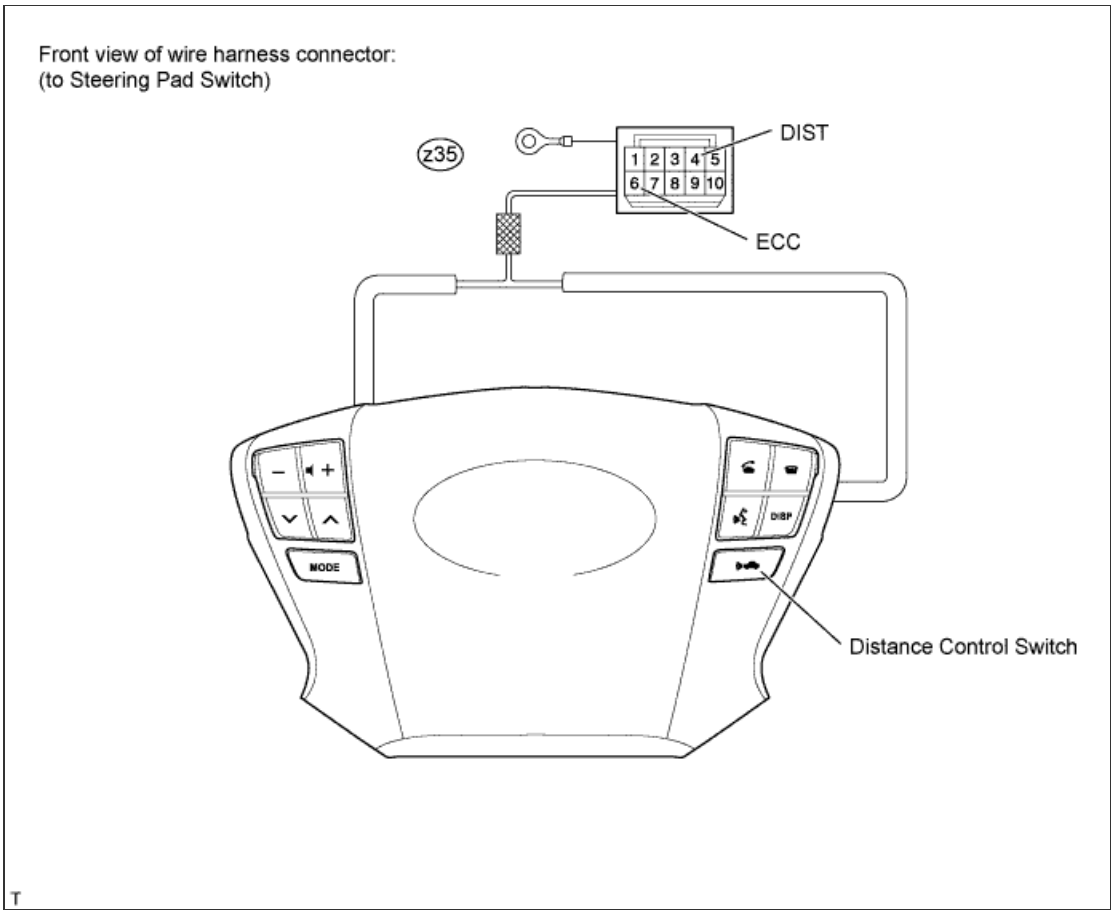


NG → REPLACE NO. 1 SWITCH WIRE

OK

3.INSPECT STEERING PAD SWITCH

a. Disconnect the z35 steering pad switch connector from the spiral cable.



b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
z35-4 (DIST) - z35-6 (ECC)	Distance control switch on (pushed)	Below 1 Ω
	Distance control switch off (pushed again)	1 MΩ or higher

NG → REPLACE STEERING PAD ASSEMBLY (Click here)

OK

4.INSPECT SPIRAL CABLE

a. Check the spiral cable and connector for scratches, cracks, dents and chips. If any defects are found, replace the spiral cable with a new one.

b. Check the spiral cable.

i. Set the spiral cable to the center position (Click here).

ii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise, and measure the resistance according to the value(s) in the table below. Then rotate the spiral cable 5 times counterclockwise, and measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z35-4 (DIST) - E12-11 (DIST)	Always	Below 1 Ω
z35-6 (ECC) - E12-2 (ECC)		

iii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise. Then while rotating the spiral cable 5 times counterclockwise, measure the resistance according to the value(s) in the table below.

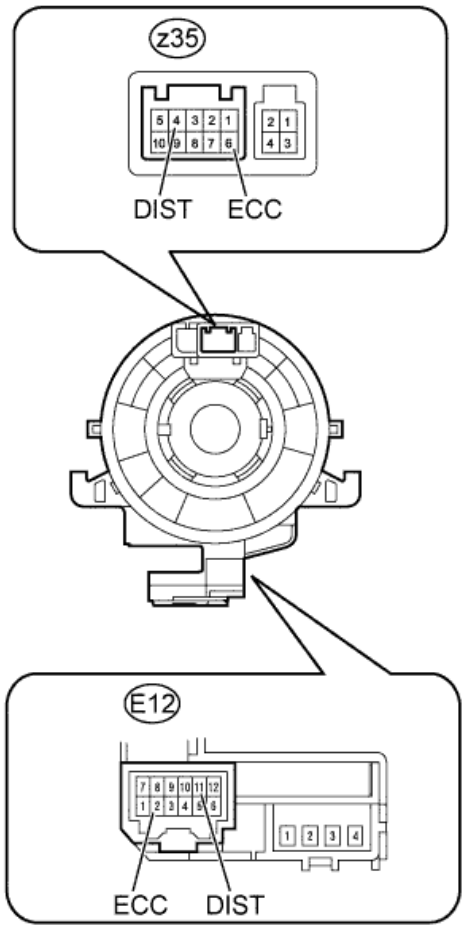
NOTICE:

As the spiral cable may break, do not rotate the spiral cable more than the specified amount.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z35-4 (DIST) - E12-11 (DIST)	Always	Below 1 Ω
z35-6 (ECC) - E12-2 (ECC)		

Component without harness connected: (Spiral Cable)



NG → REPLACE SPIRAL CABLE (Click here)

OK

5.CHECK HARNESS AND CONNECTOR (SPIRAL CABLE - DISTANCE CONTROL ECU AND BODY GROUND)

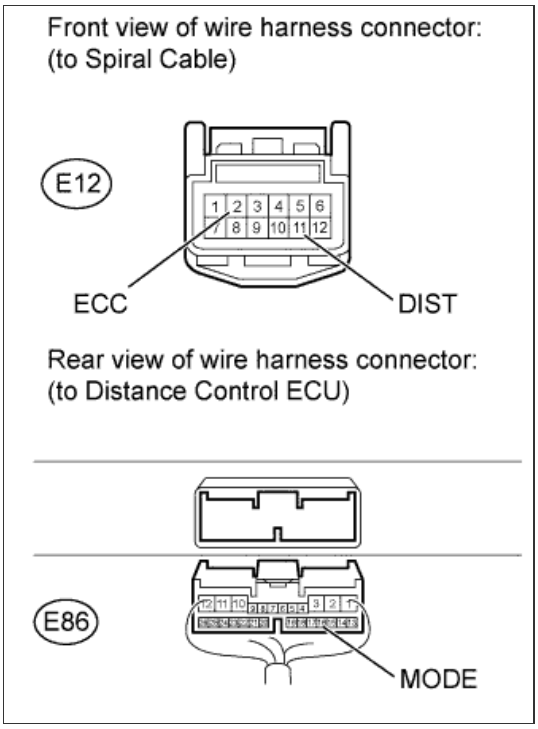
a. Disconnect the E86 distance control ECU connector.

b. Disconnect the E12 spiral cable connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
E12-2 (ECC) - Body ground	Always	Below 1 Ω
E12-11 (DIST) - E86-16 (MODE)	Always	Below 1 Ω
E12-11 (DIST) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

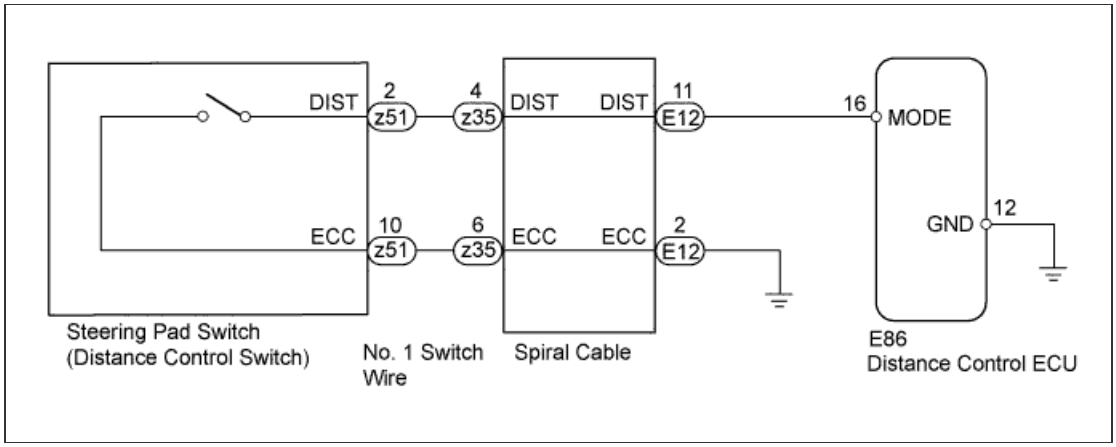
REPLACE DISTANCE CONTROL ECU (Click here)

for Preparation Click here

DESCRIPTION

The distance control switch sets the vehicle-to-vehicle distance control mode. The distance control switch is installed in the steering pad switch. The vehicle-to-vehicle distance set value can be changed by operating the steering pad switch (distance control switch) while the dynamic radar cruise control system is in operation. The steering pad switch uses the CAN communication line to communicate with each ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

CAUTION:

The vehicle is equipped with an SRS (Supplemental Restraint System) which includes components such as airbags. Before servicing (including removal or installation of parts), be sure to read the Precaution for the SRS (Click here).

NOTICE:

When the distance control ECU is replaced with a new one, initialization must be performed (Click here).

1.READ VALUE USING INTELLIGENT TESTER (VEHICLE DISTANCE)

a. Using the intelligent tester, read the Data List.

Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
Car Dist Time Setting	Vehicle distance time setting condition / SHORT, LONG, MID or NO	Vehicle distance selected by steering pad switch (distance control switch)	-

OK:

Normal conditions listed above are displayed.

NG → Go to step 2

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

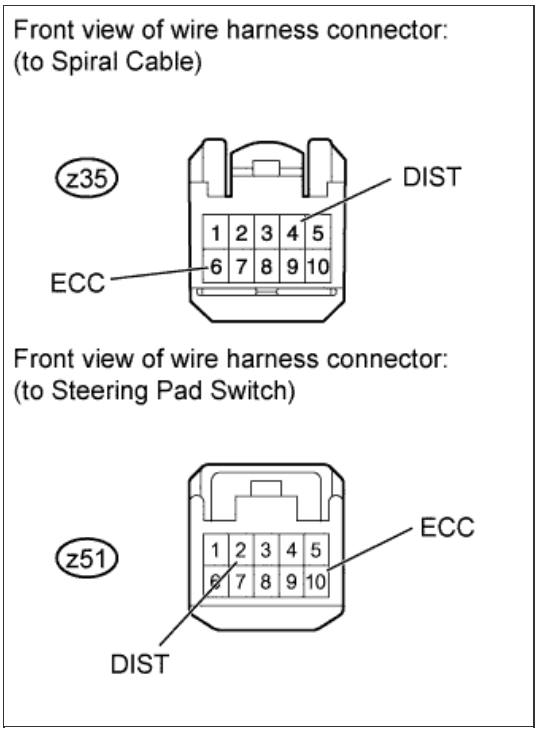
2.CHECK NO. 1 SWITCH WIRE

a. Disconnect the z35 and z51 No. 1 switch wire connectors.

b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z35-4 (DIST) - z51-2 (DIST)	Always	Below 1 Ω
z35-6 (ECC) - z51-10 (ECC)	Always	Below 1 Ω

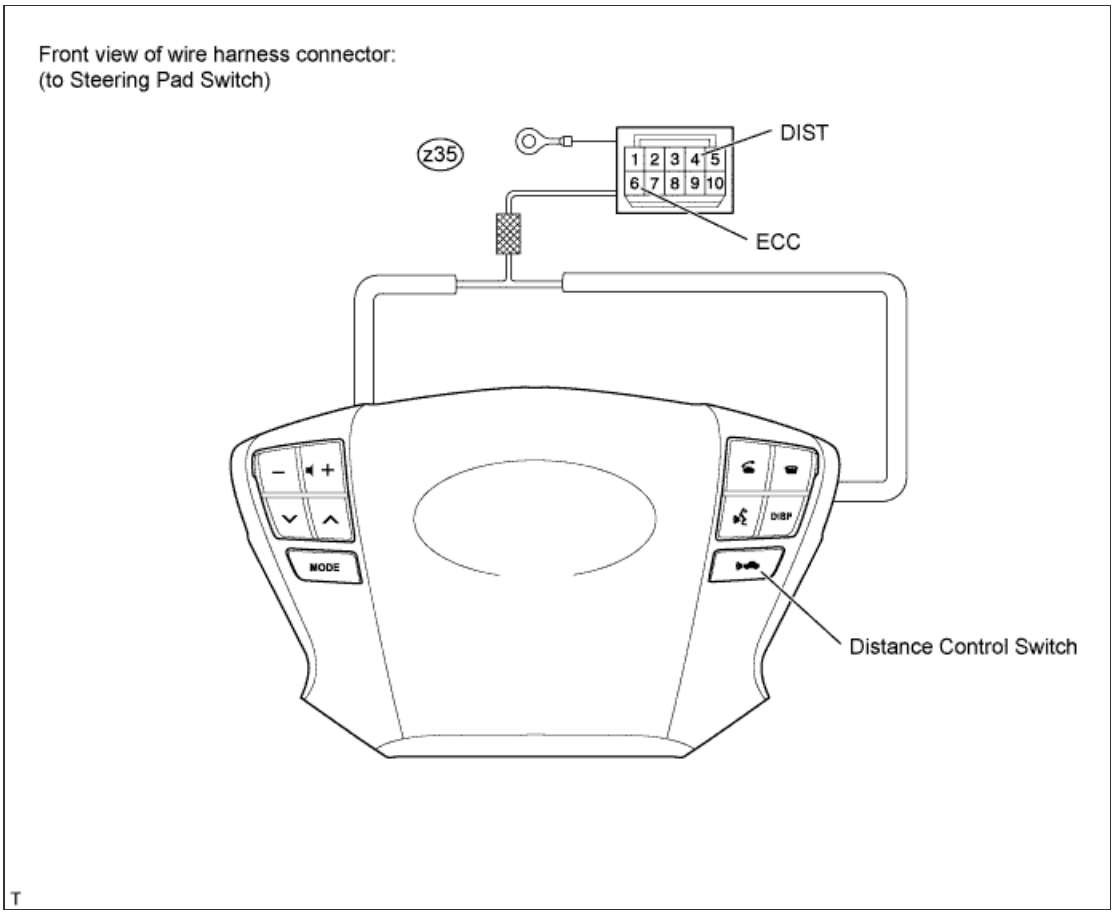


NG → REPLACE NO. 1 SWITCH WIRE

OK

3.INSPECT STEERING PAD SWITCH

a. Disconnect the z35 steering pad switch connector from the spiral cable.



b. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
z35-4 (DIST) - z35-6 (ECC)	Distance control switch on (pushed)	Below 1 Ω
	Distance control switch off (pushed again)	1 MΩ or higher

NG → REPLACE STEERING PAD ASSEMBLY (Click here)

OK

4.INSPECT SPIRAL CABLE

a. Check the spiral cable and connector for scratches, cracks, dents and chips. If any defects are found, replace the spiral cable with a new one.

b. Check the spiral cable.

i. Set the spiral cable to the center position (Click here).

ii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise, and measure the resistance according to the value(s) in the table below. Then rotate the spiral cable 5 times counterclockwise, and measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z35-4 (DIST) - E12-11 (DIST)	Always	Below 1 Ω
z35-6 (ECC) - E12-2 (ECC)		

iii. After setting the spiral cable to the center position, rotate the spiral cable 2.5 times clockwise. Then while rotating the spiral cable 5 times counterclockwise, measure the resistance according to the value(s) in the table below.

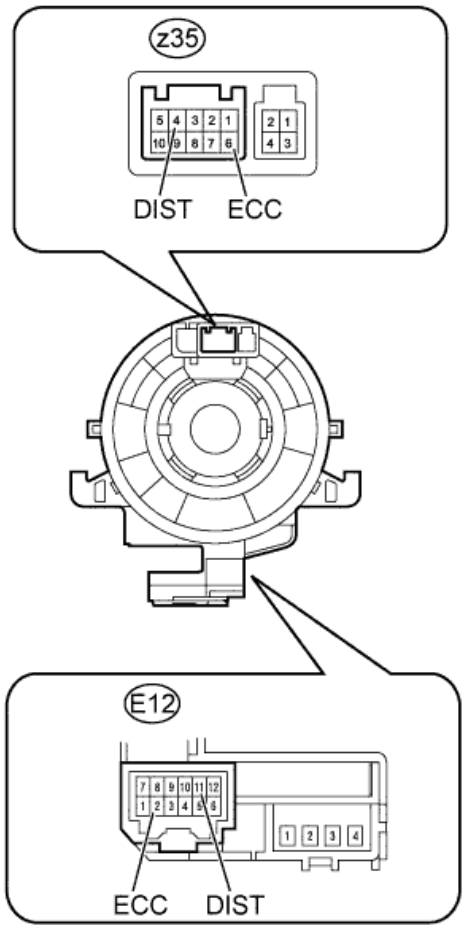
NOTICE:

As the spiral cable may break, do not rotate the spiral cable more than the specified amount.

Standard Resistance:

Tester Connection	Condition	Specified Condition
z35-4 (DIST) - E12-11 (DIST)	Always	Below 1 Ω
z35-6 (ECC) - E12-2 (ECC)		

Component without harness connected: (Spiral Cable)



NG → REPLACE SPIRAL CABLE (Click here)

OK

5.CHECK HARNESS AND CONNECTOR (SPIRAL CABLE - DISTANCE CONTROL ECU AND BODY GROUND)

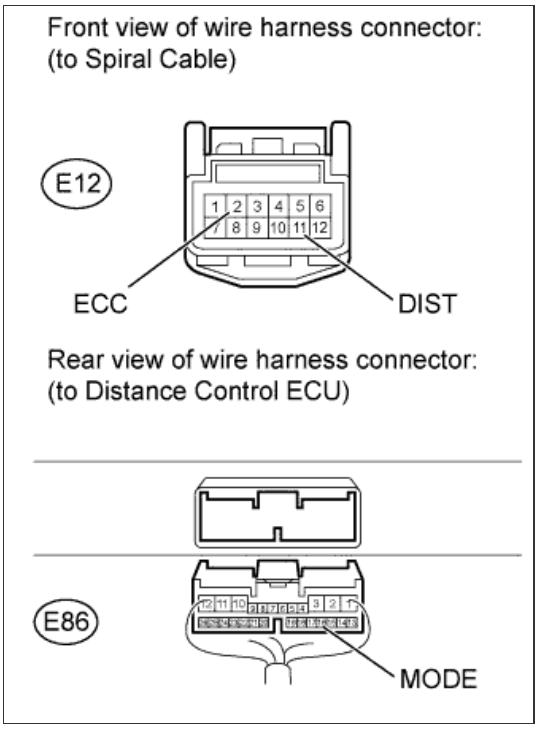
a. Disconnect the E86 distance control ECU connector.

b. Disconnect the E12 spiral cable connector.

c. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Condition	Specified Condition
E12-2 (ECC) - Body ground	Always	Below 1 Ω
E12-11 (DIST) - E86-16 (MODE)	Always	Below 1 Ω
E12-11 (DIST) - Body ground	Always	10 kΩ or higher



NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

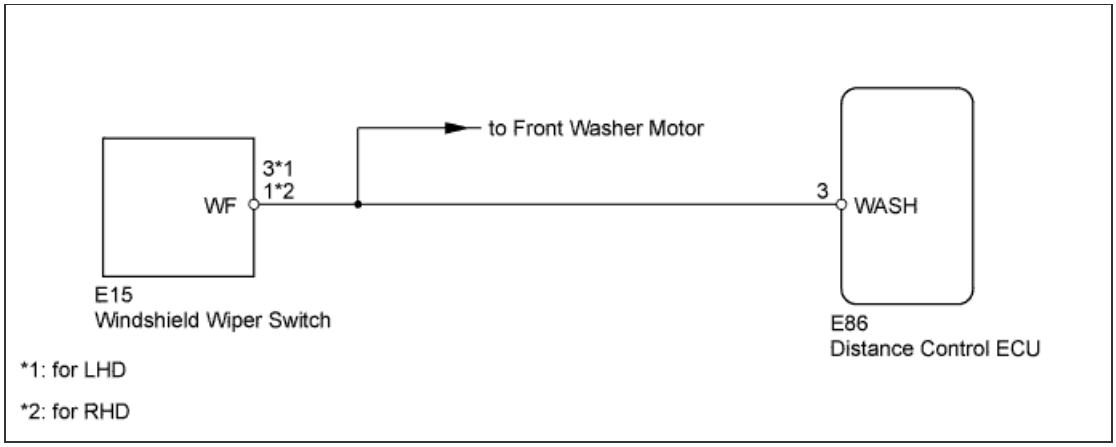
REPLACE DISTANCE CONTROL ECU (Click here)

for Preparation Click here

DESCRIPTION

The distance control ECU detects washer operation. Cruise control will be canceled by the distance control ECU if the windshield wipers operate in HI or LO mode.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.CHECK WASHER MOTOR (OPERATION)

a. Check that the front washer operates (Click here).

OK:
Washer function is normal.

NG → GO TO WIPER AND WASHER SYSTEM (**Click here**)

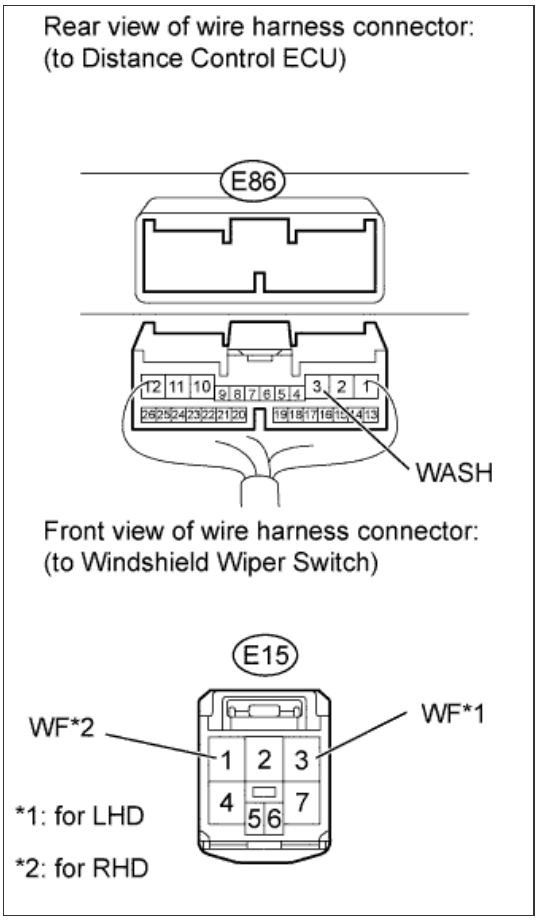
OK

2.CHECK HARNESS AND CONNECTOR (DISTANCE CONTROL ECU - WINDSHIELD WIPER SWITCH)

a. Disconnect the E86 distance control ECU connector.

b. Disconnect the E15 windshield wiper switch connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E86-3 (WASH) - E15-3 (WF)	Always	Below 1 Ω
E15-3 (WF) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
E86-3 (WASH) - E15-1 (WF)	Always	Below 1 Ω
E15-1 (WF) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

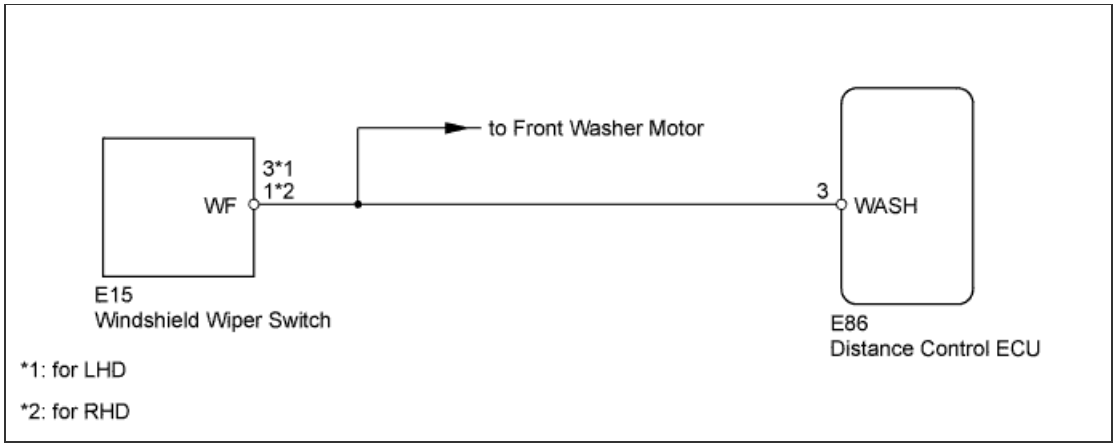
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

The distance control ECU detects washer operation. Cruise control will be canceled by the distance control ECU if the windshield wipers operate in HI or LO mode.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.CHECK WASHER MOTOR (OPERATION)

a. Check that the front washer operates (Click here).

OK:
Washer function is normal.

NG → GO TO WIPER AND WASHER SYSTEM (**Click here**)

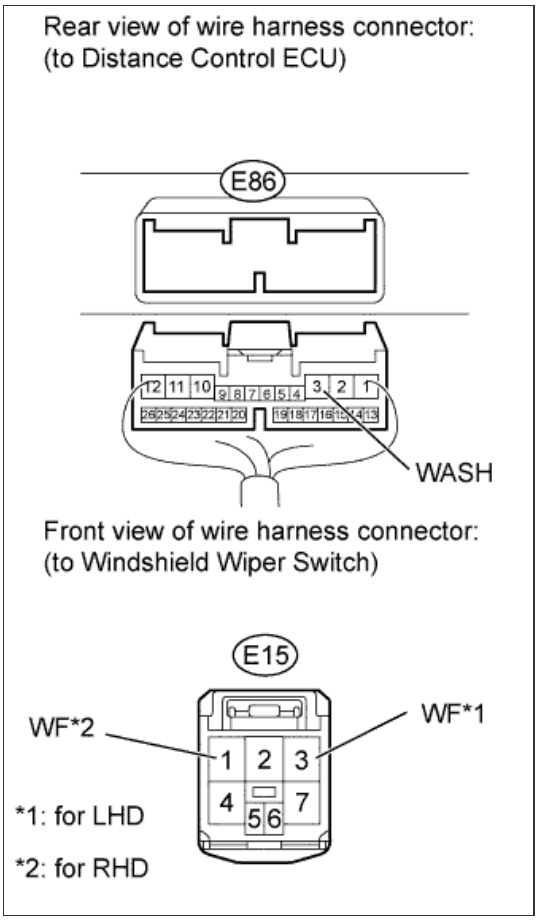
OK

2.CHECK HARNESS AND CONNECTOR (DISTANCE CONTROL ECU - WINDSHIELD WIPER SWITCH)

a. Disconnect the E86 distance control ECU connector.

b. Disconnect the E15 windshield wiper switch connector.

c. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E86-3 (WASH) - E15-3 (WF)	Always	Below 1 Ω
E15-3 (WF) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
E86-3 (WASH) - E15-1 (WF)	Always	Below 1 Ω
E15-1 (WF) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

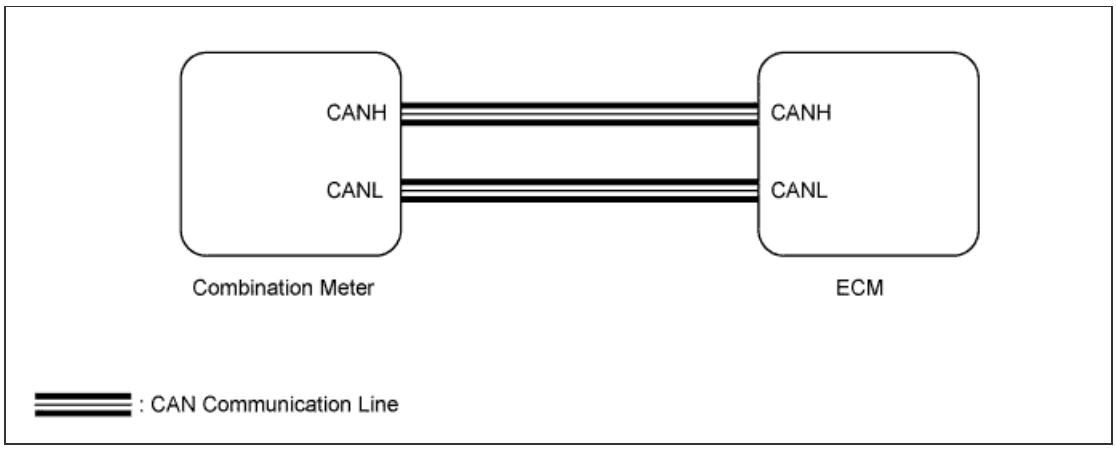
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

- The ECM detects a cruise control switch signal and sends it to the combination meter via the CAN communication line. Then the CRUISE main indicator light comes on.
- The CRUISE main indicator light circuit uses the CAN for communication. If there is a malfunction in this circuit, check for DTCs in the CAN communication system before troubleshooting this circuit.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, perform the Active Test.

Combination Meter

Tester Display	Test Part	Control Range	Diagnostic Note
Indicat. Lamp Cruise	CRUISE main indicator light operation	OFF or ON	-

OK:
Indicator light comes on/goes off.

NG → REPLACE COMBINATION METER ASSEMBLY (Click here)

OK ↓

2.READ VALUE USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, read the Data List.

Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Indicator M-CPU	CRUISE main indicator light (Main CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-

OK:
The intelligent tester display changes according to condition of CRUISE main indicator light.

NG → REPLACE ECM (Click here)

OK ↓

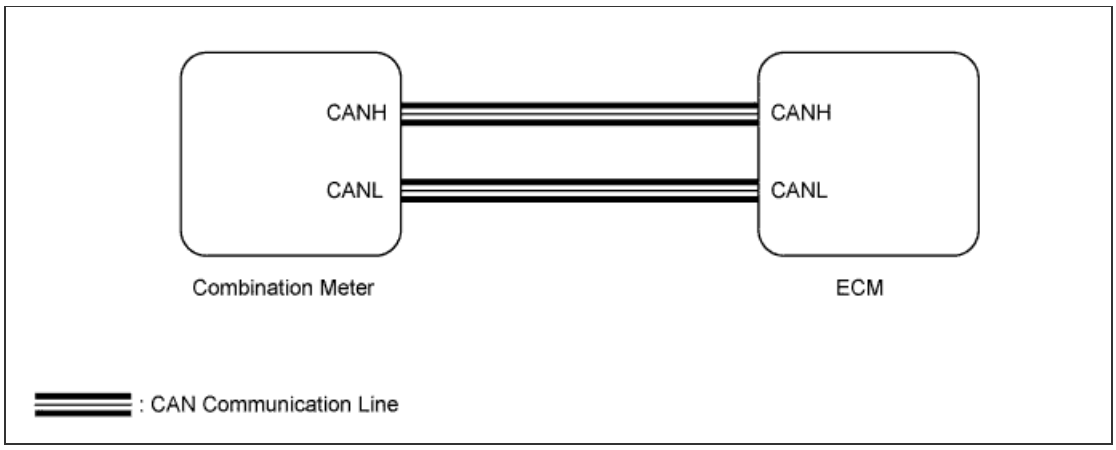
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

DESCRIPTION

- The ECM detects a cruise control switch signal and sends it to the combination meter via the CAN communication line. Then the CRUISE main indicator light comes on.
- The CRUISE main indicator light circuit uses the CAN for communication. If there is a malfunction in this circuit, check for DTCs in the CAN communication system before troubleshooting this circuit.

WIRING DIAGRAM



INSPECTION PROCEDURE

1.PERFORM ACTIVE TEST USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, perform the Active Test.

Combination Meter

Tester Display	Test Part	Control Range	Diagnostic Note
Indicat. Lamp Cruise	CRUISE main indicator light operation	OFF or ON	-

OK:
Indicator light comes on/goes off.

NG → REPLACE COMBINATION METER ASSEMBLY (Click here)

OK ↓

2.READ VALUE USING INTELLIGENT TESTER (CRUISE MAIN INDICATOR LIGHT)

a. Using the intelligent tester, read the Data List.

Radar Cruise

Tester Display	Measurement Item/Range	Normal Condition	Diagnostic Note
CCS Indicator M-CPU	CRUISE main indicator light (Main CPU) / ON or OFF	ON: CRUISE main indicator light on OFF: CRUISE main indicator light off	-

OK:
The intelligent tester display changes according to condition of CRUISE main indicator light.

NG → REPLACE ECM (Click here)

OK ↓

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

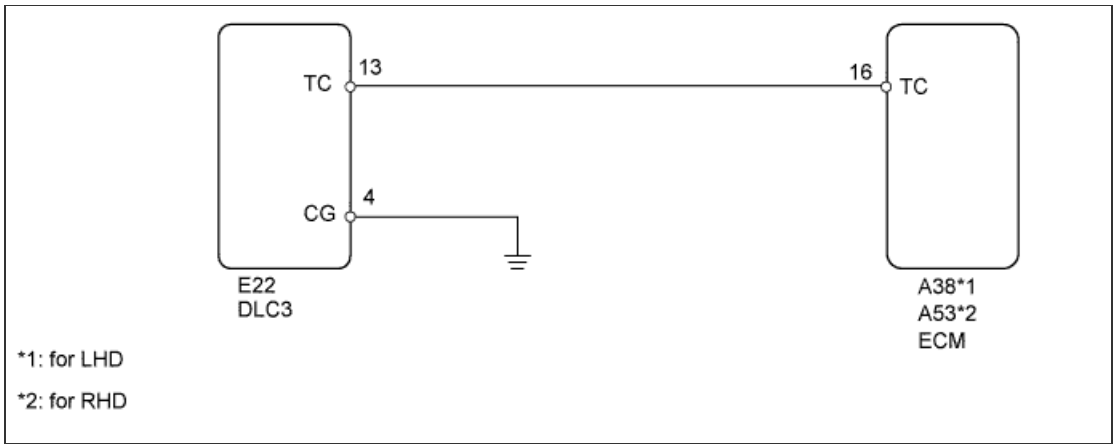
DESCRIPTION

Connecting terminals TC and CG of the DLC3 causes the system to enter self-diagnostic mode. If a malfunction is present, DTCs will be output.

HINT:

When a particular warning light remains blinking, a ground short in the wiring of terminal TC of the DLC3 or an internal ground short in the relevant ECU is suspected.

WIRING DIAGRAM



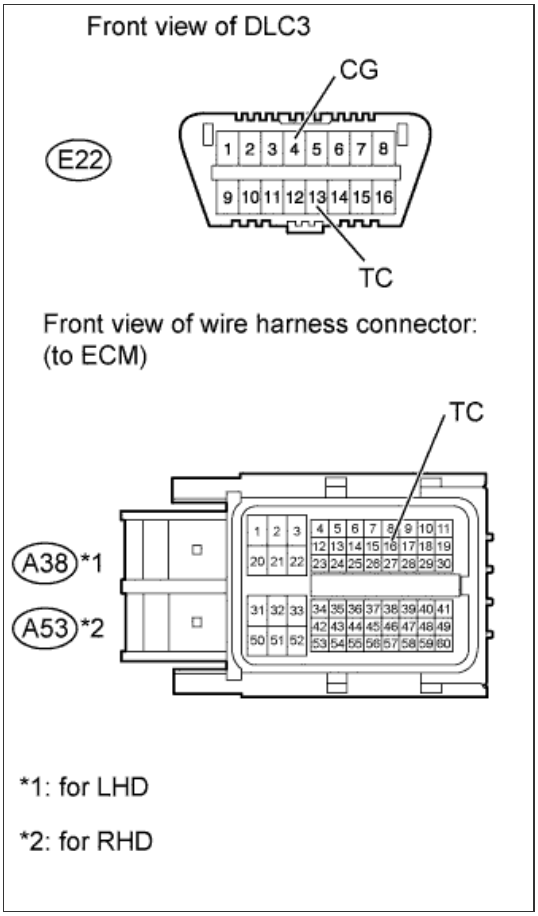
INSPECTION PROCEDURE

1.CHECK HARNESS AND CONNECTOR (DLC3 - ECM AND BODY GROUND)

a. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E22-13 (TC) - A38-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

for RHD

Tester Connection	Condition	Specified Condition
E22-13 (TC) - A53-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

for Preparation Click here

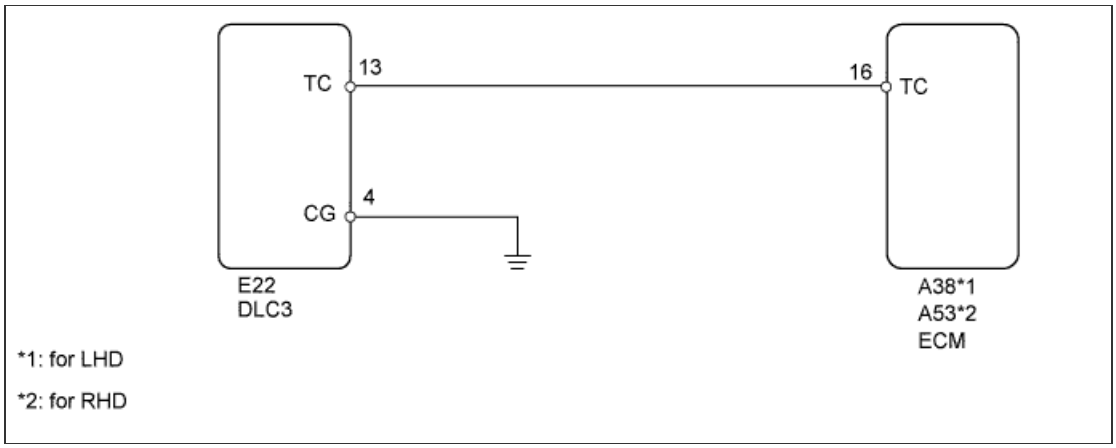
DESCRIPTION

Connecting terminals TC and CG of the DLC3 causes the system to enter self-diagnostic mode. If a malfunction is present, DTCs will be output.

HINT:

When a particular warning light remains blinking, a ground short in the wiring of terminal TC of the DLC3 or an internal ground short in the relevant ECU is suspected.

WIRING DIAGRAM



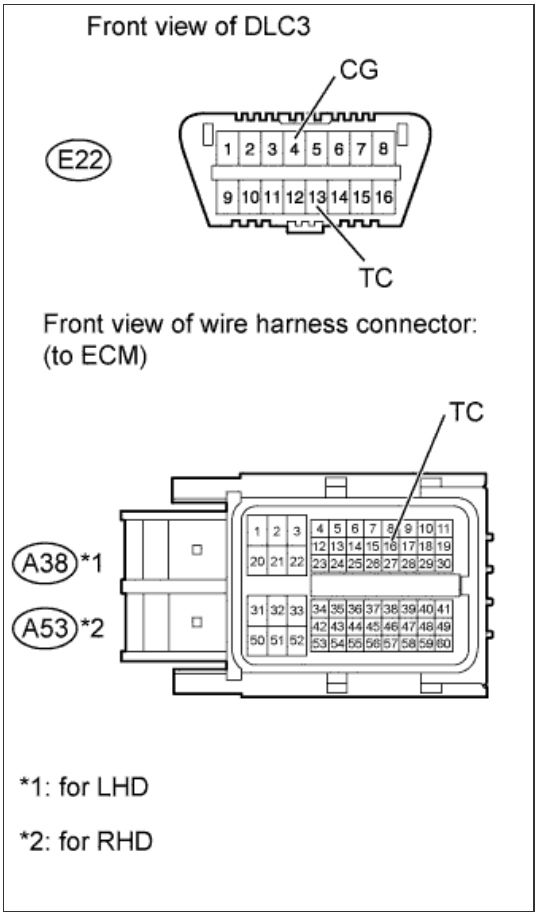
INSPECTION PROCEDURE

1.CHECK HARNESS AND CONNECTOR (DLC3 - ECM AND BODY GROUND)

a. Disconnect the A38*1 or A53*2 ECM connector.

*1: for LHD
*2: for RHD

b. Measure the resistance according to the value(s) in the table below.



Standard Resistance:

for LHD

Tester Connection	Condition	Specified Condition
E22-13 (TC) - A38-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

for RHD

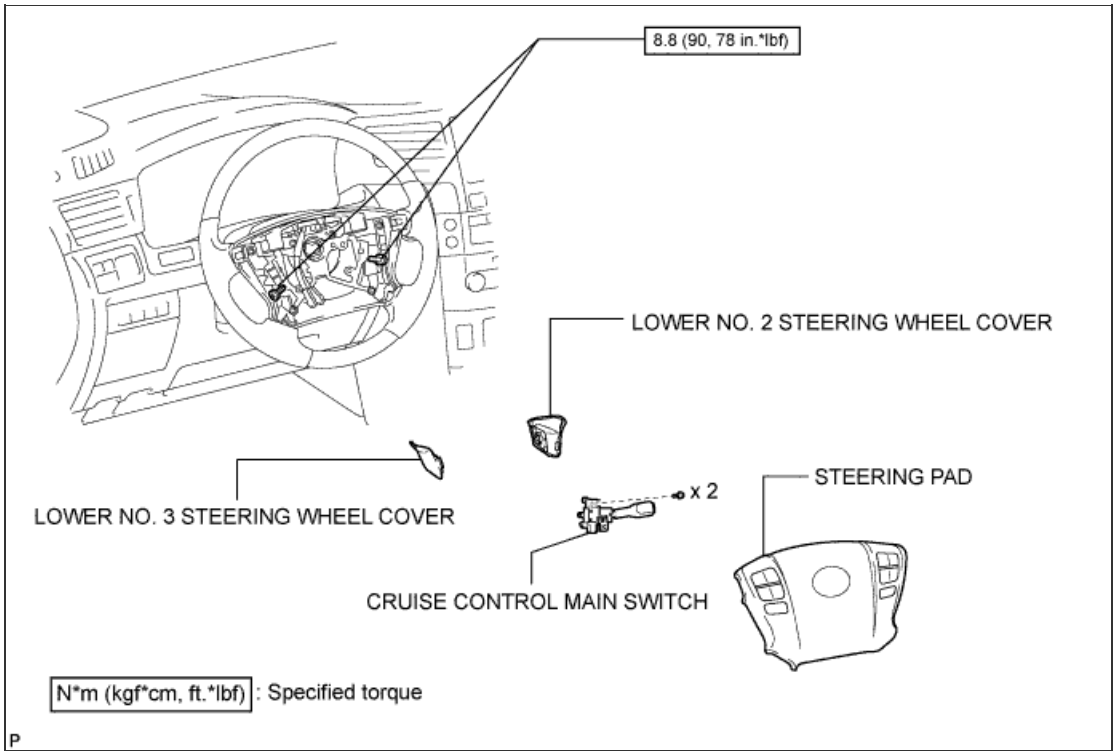
Tester Connection	Condition	Specified Condition
E22-13 (TC) - A53-16 (TC)	Always	Below 1 Ω
E22-4 (CG) - Body ground		
E22-13 (TC) - Body ground	Always	10 kΩ or higher

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE (Click here)

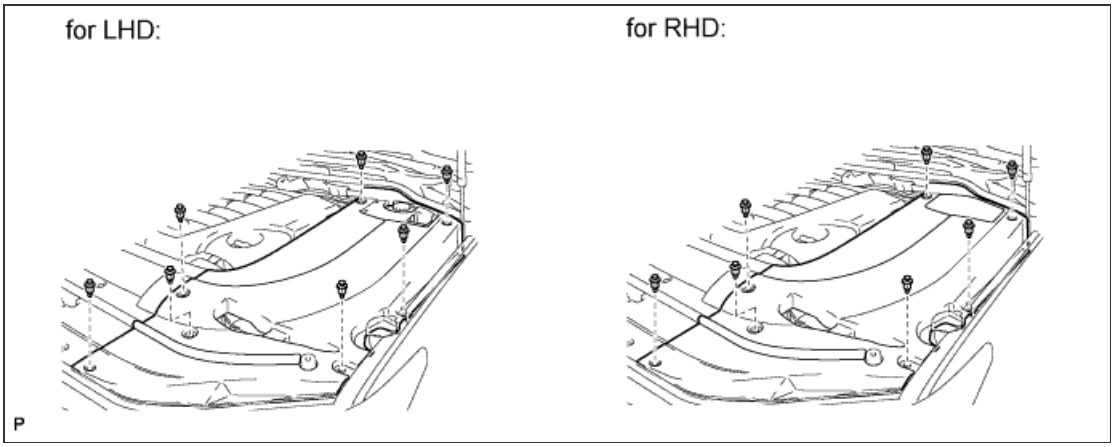
for Preparation Click here



for Preparation Click here

1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL

CAUTION:

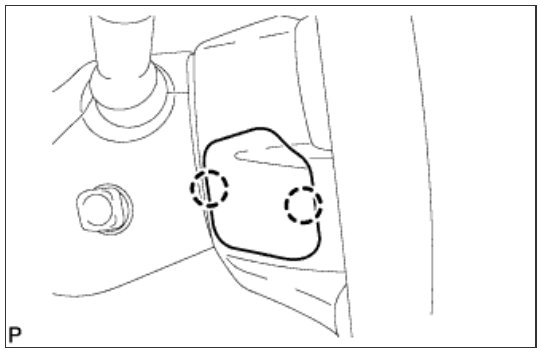
Wait at least 90 seconds after disconnecting the cable from the negative (-) battery terminal to disable the SRS system.

NOTICE:

- **When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).**
- **w/ Navigation system:**
  After the engine switch is turned off, the HDD navigation system requires approximately 6 minutes to record various types of memory and settings. As a result, after turning the engine switch off, wait 6 minutes or more before disconnecting the cable from the negative (-) battery terminal.

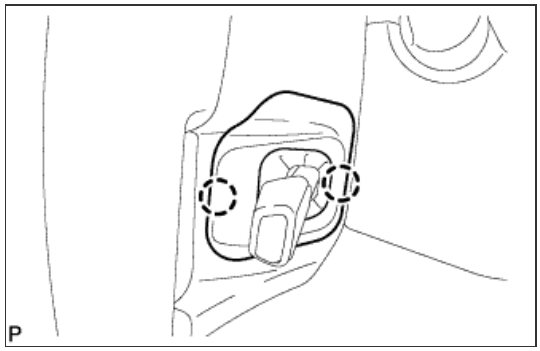
3. REMOVE LOWER NO. 3 STEERING WHEEL COVER

a. Detach the 2 claws and remove the steering wheel cover.



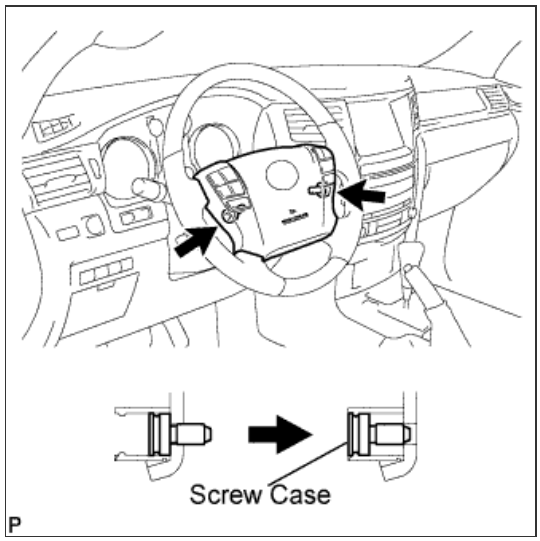
4. REMOVE LOWER NO. 2 STEERING WHEEL COVER

a. Detach the 2 claws and remove the steering wheel cover.



5. REMOVE STEERING PAD

a. Using a T30 "TORX" socket wrench, loosen the 2 screws until the groove along the screw circumference catches on the screw case.



b. Pull out the steering pad from the steering wheel, as shown in the illustration. Then support the steering pad with one hand.

NOTICE:

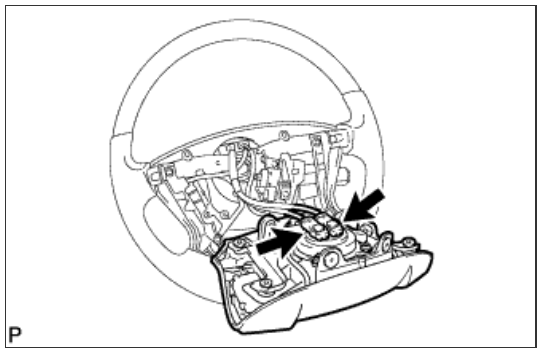
When removing the steering pad, do not pull the airbag wire harness.

c. Disconnect the horn connector.

d. Disconnect the 2 connectors and remove the steering pad.

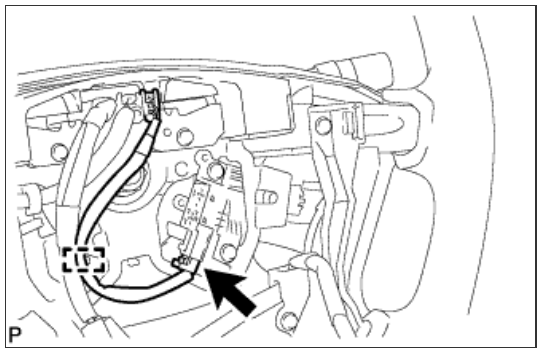
NOTICE:

When handling the airbag connector, take care not to damage the airbag wire harness.

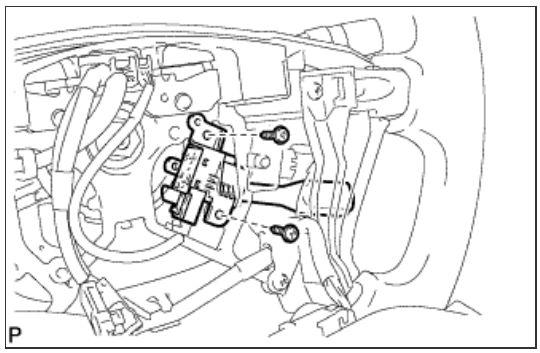


6. REMOVE CRUISE CONTROL MAIN SWITCH

a. Disconnect the connector and clamp.



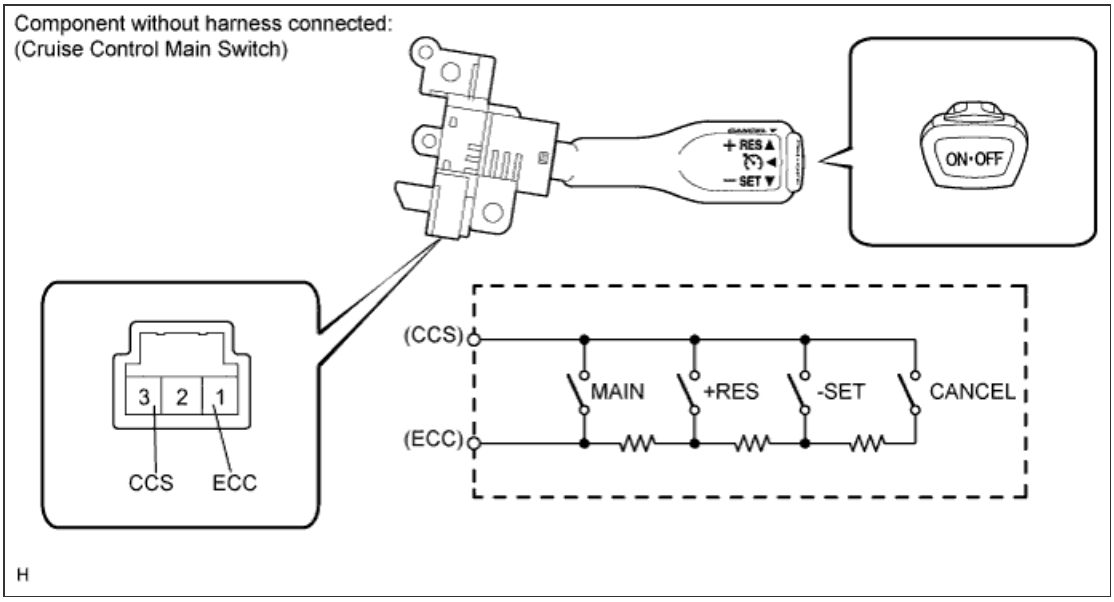
b. Remove the 2 screws and switch.



for Preparation Click here

1. INSPECT CRUISE CONTROL MAIN SWITCH ASSEMBLY

a. Measure the resistance (for vehicles without vehicle-to-vehicle distance control mode).



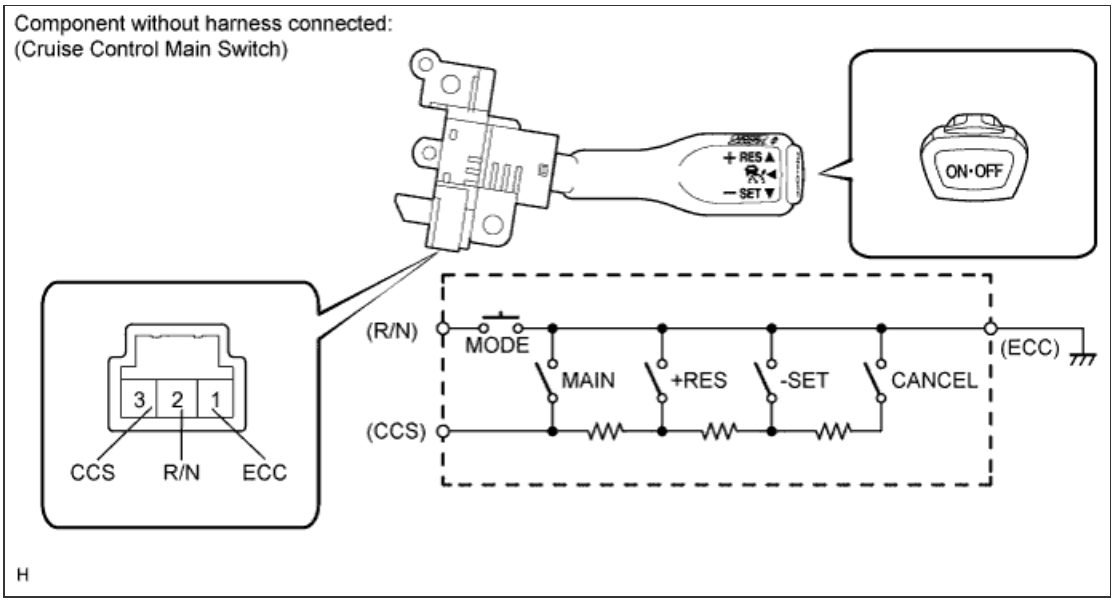
i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

Tester Connection	Switch Condition	Specified Condition
1 (ECC) - 3 (CCS)	Neutral	1 MΩ or higher
1 (ECC) - 3 (CCS)	+RES	235 to 245 Ω
1 (ECC) - 3 (CCS)	-SET	620 to 640 Ω
1 (ECC) - 3 (CCS)	CANCEL	1510 to 1570 Ω
1 (ECC) - 3 (CCS)	Main switch off	1 MΩ or higher
1 (ECC) - 3 (CCS)	Main switch on	Below 2.5 Ω

If the result is not as specified, replace the cruise control main switch assembly.

b. Measure the resistance (for vehicles with vehicle-to-vehicle distance control mode).



i. Measure the resistance according to the value(s) in the table below.

Standard Resistance:

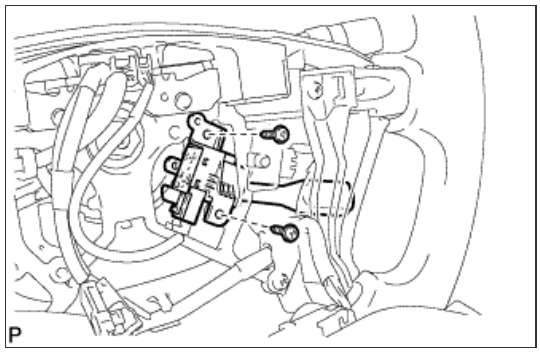
Tester Connection	Switch Condition	Specified Condition
1 (ECC) - 2 (R/N) 1 (ECC) - 3 (CCS)	Neutral	1 MΩ or higher
1 (ECC) - 3 (CCS)	+RES	235 to 245 Ω
1 (ECC) - 3 (CCS)	-SET	620 to 640 Ω
1 (ECC) - 3 (CCS)	CANCEL	1510 to 1570 Ω
1 (ECC) - 3 (CCS)	Main switch off	1 MΩ or higher
1 (ECC) - 3 (CCS)	Main switch on	Below 2.5 Ω
3 (CCS) - 2 (R/N)	Main switch on and mode switch on	Below 2.5 Ω

If the result is not as specified, replace the cruise control main switch assembly.

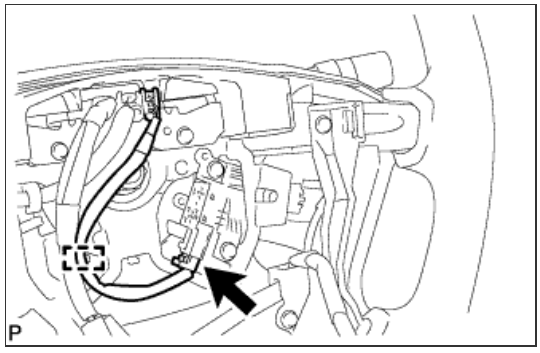
for Preparation Click here

1. INSTALL CRUISE CONTROL MAIN SWITCH

a. Install the switch with the 2 screws.



b. Connect the connector and clamp.



2. INSTALL STEERING PAD

a. With the steering pad installed on the vehicle, perform a visual check. If there are any defects as mentioned below, replace the steering pad with a new one:
Cuts, minute cracks or marked discoloration on the steering pad top surface or in the grooved portion.

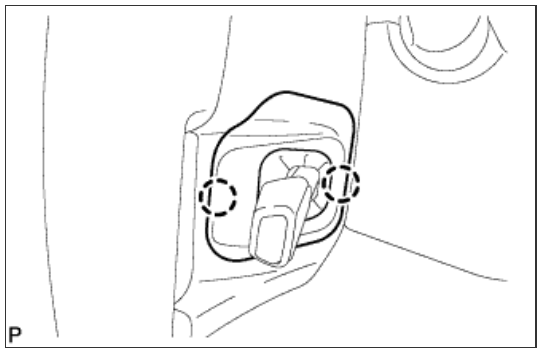
b. Make sure that the horn sounds.

HINT:

If the horn does not sound, inspect the horn system.

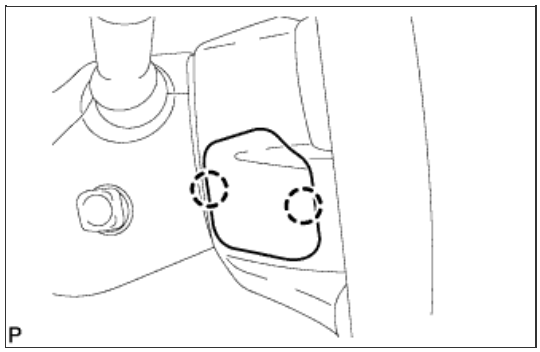
3. INSTALL LOWER NO. 2 STEERING WHEEL COVER

a. Attach the 2 claws to install the cover.



4. INSTALL LOWER NO. 3 STEERING WHEEL COVER

a. Attach the 2 claws to install the cover.



5. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

NOTICE:

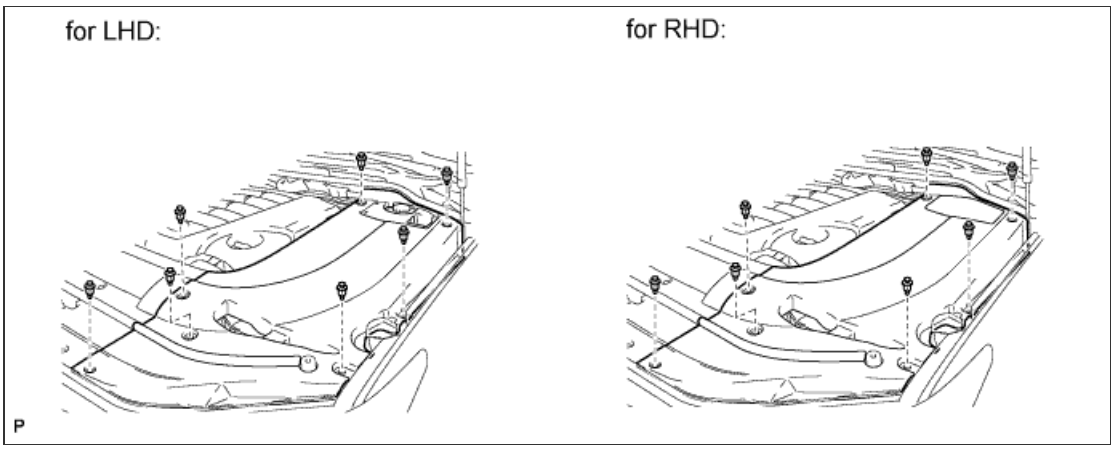
When disconnecting the cable, some systems need to be initialized after the cable is reconnected (Click here).

6. CHECK SRS WARNING LIGHT

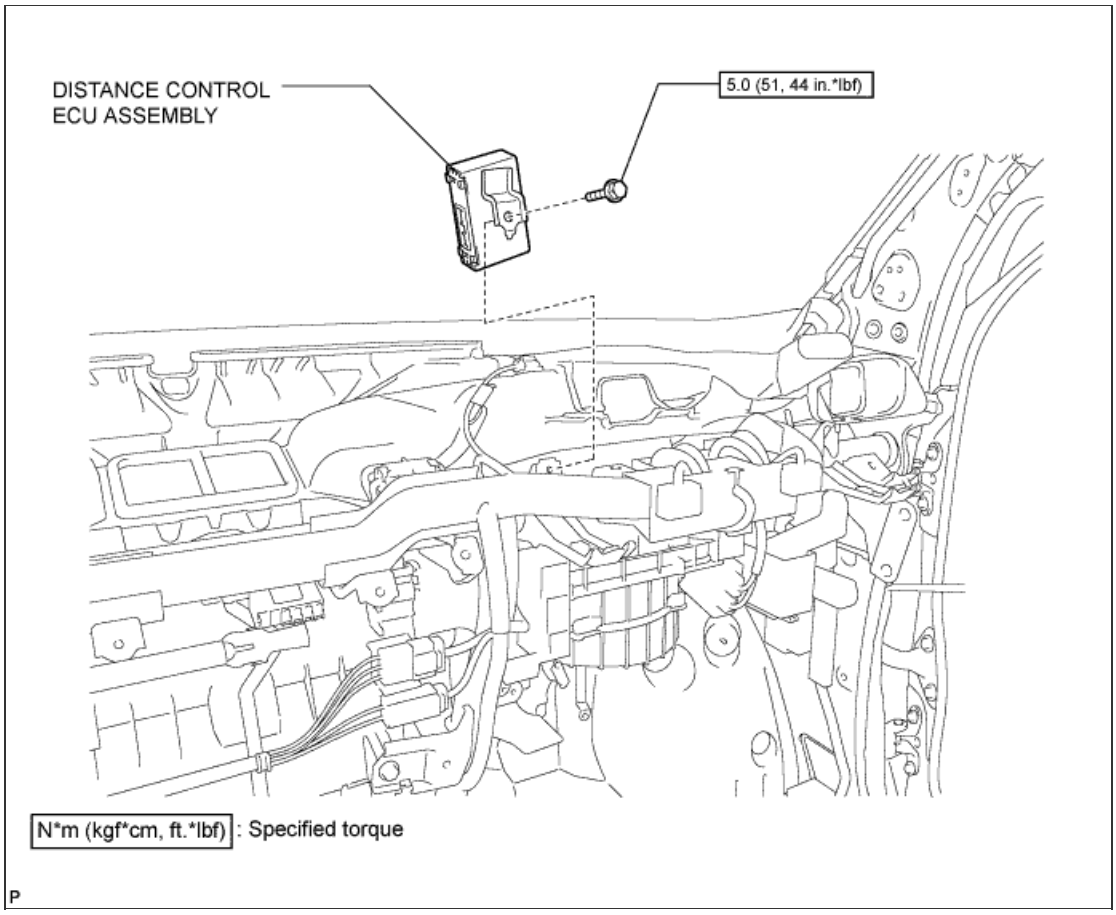
a. Check the SRS warning light (Click here).

7. INSTALL ENGINE ROOM SIDE COVER LH

a. Install the engine room side cover with the 7 clips.



for Preparation Click here



for Preparation Click here

NOTICE:

After removing and installing or replacing the distance control ECU assembly, be sure to perform the following procedures.

INITIALIZE DISTANCE CONTROL ECU

a. Turn the engine switch on (IG).

b. Turn the cruise control main switch on.

c. Depress the brake pedal (brake switch on).

d. With the brake pedal depressed, push the cruise control main switch to +RES 3 times within 3 seconds, and check that the buzzer sounds.

NOTICE:

At this time, do not turn the headlight dimmer switch on. Due to the activation of the beam axis automatic adjustment mode, turning the headlight dimmer switch on may result in an incorrect setting. If the headlight dimmer switch is turned on by mistake, perform the beam axis adjustment again.

for Preparation Click here

1. REMOVE INSTRUMENT PANEL SAFETY PAD

a. Remove the instrument panel safety pad (Click here).

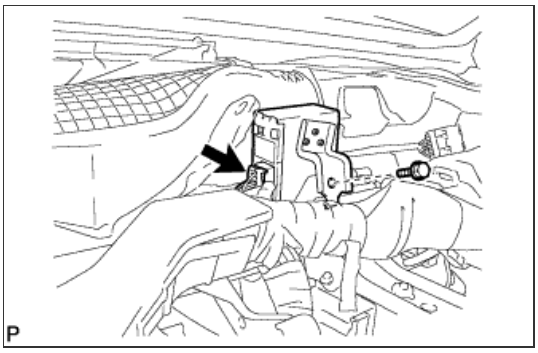
2. REMOVE DISTANCE CONTROL ECU ASSEMBLY

a. Disconnect the ECU connector.

b. Remove the bolt and ECU.

NOTICE:

Do not drop the ECU or subject it to strong shocks.



for Preparation Click here

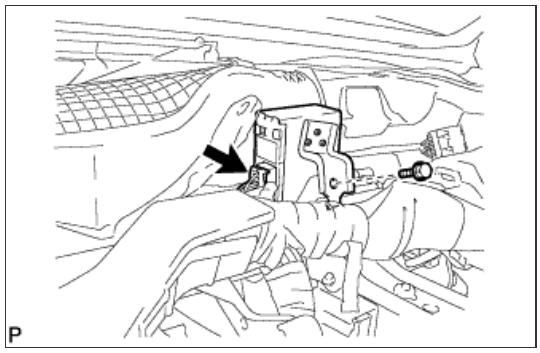
1. INSTALL DISTANCE CONTROL ECU ASSEMBLY

a. Install the ECU with the bolt.

NOTICE:

Do not use an ECU which has been dropped or subjected to any strong shocks.

b. Connect the ECU connector.



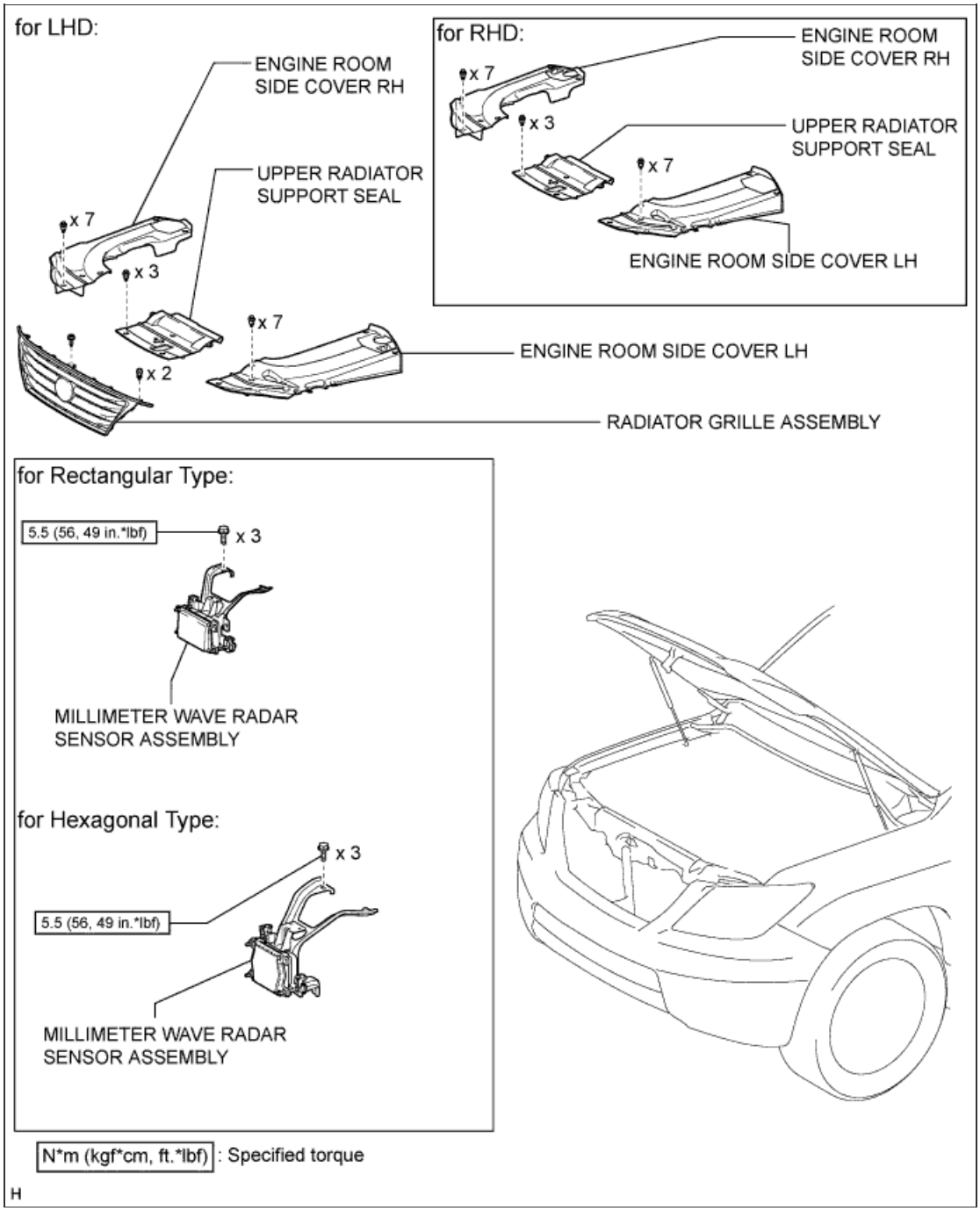
2. INSTALL INSTRUMENT PANEL SAFETY PAD

a. Install the instrument panel safety pad (Click here).

3. INITIALIZATION DISTANCE CONTROL ECU ASSEMBLY

a. Initialize the distance control ECU assembly (Click here).

for Preparation Click here



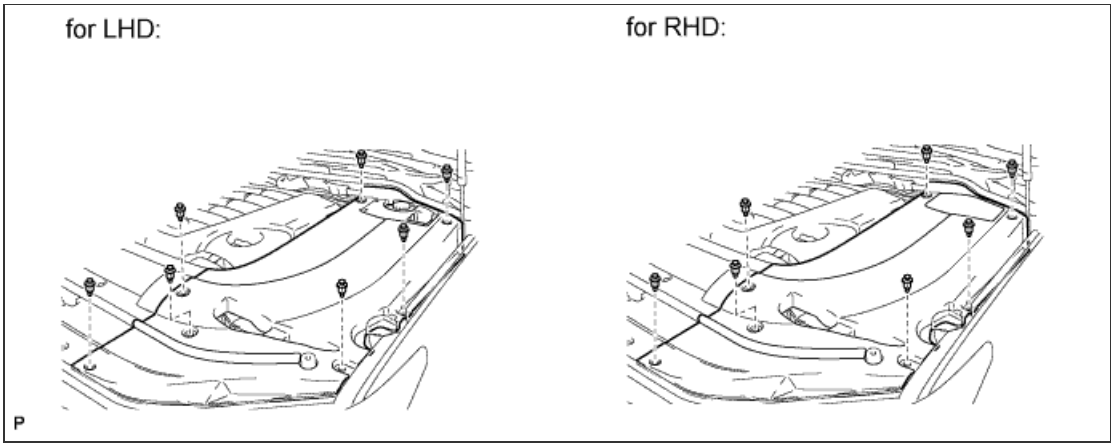
for Preparation Click here

HINT:

- **Use the same procedures for LHD and RHD vehicles.**
- **The procedures listed below are for LHD vehicles.**

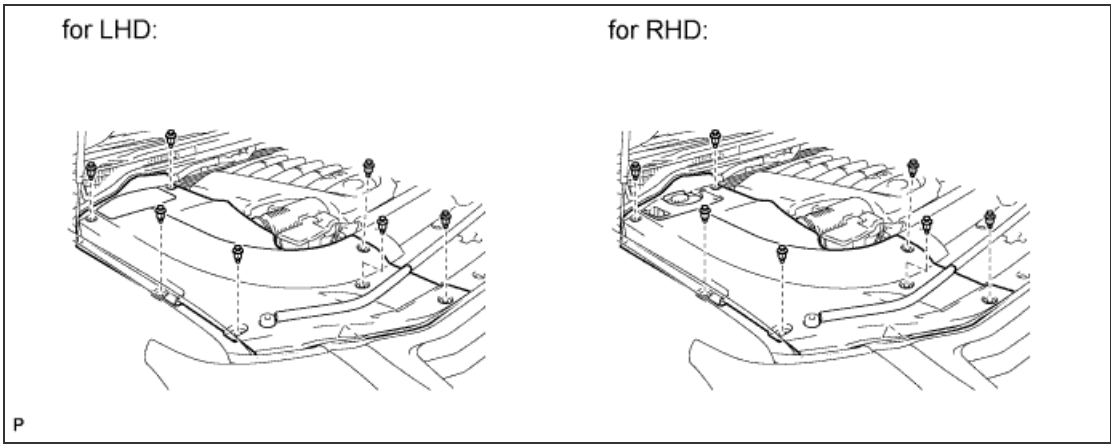
1. REMOVE ENGINE ROOM SIDE COVER LH

a. Remove the 7 clips and engine room side cover.



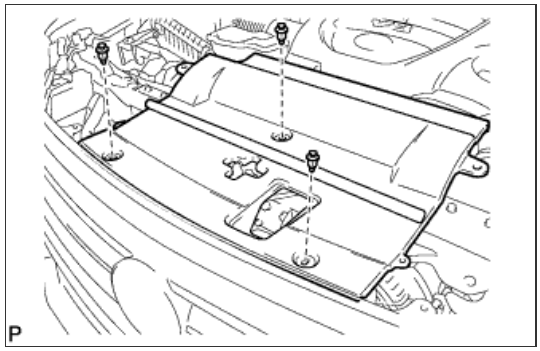
2. REMOVE ENGINE ROOM SIDE COVER RH

a. Remove the 7 clips and engine room side cover.



3. REMOVE UPPER RADIATOR SUPPORT SEAL

a. Remove the 3 clips and upper radiator support seal.



4. REMOVE RADIATOR GRILLE ASSEMBLY

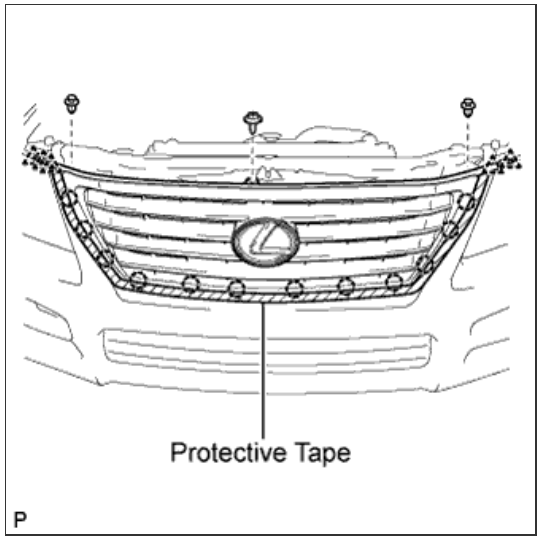
a. Put protective tape around the radiator grille.

b. Remove the screw and 2 clips.

c. Detach the 5 clips and partially remove the upper radiator seal.

d. w/o Wide View Front Monitor System:
Detach the 12 claws and remove the radiator grille.

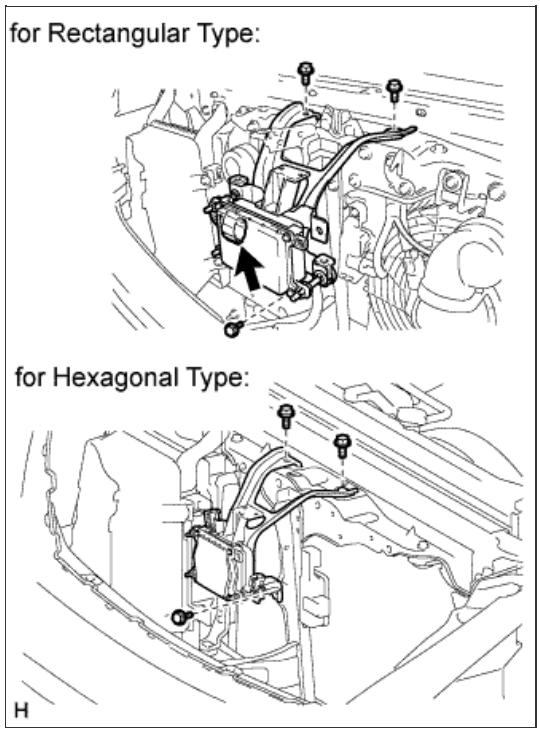
e. w/ Wide View Front Monitor System:
Detach the 12 claws, disconnect the connector and remove the radiator grille.



5. REMOVE MILLIMETER WAVE RADAR SENSOR ASSEMBLY

a. Disconnect the sensor connector.

b. Remove the 3 bolts and sensor.

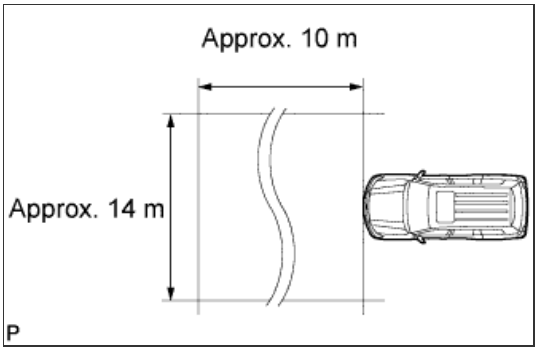


for Preparation Click here

1. ADJUST MILLIMETER WAVE RADAR SENSOR ASSEMBLY

NOTICE:

- **Perform measurements on a level surface.**
- **Make sure that there are no metal objects on the ground or within a 10 m (32.8 ft.) x 14 m (45.9 ft.) area in front of the vehicle. If possible, the surrounding area should also be free of large metal objects.**



a. Before adjusting, perform the following:

i. Remove all cargo from the inside of the vehicle.

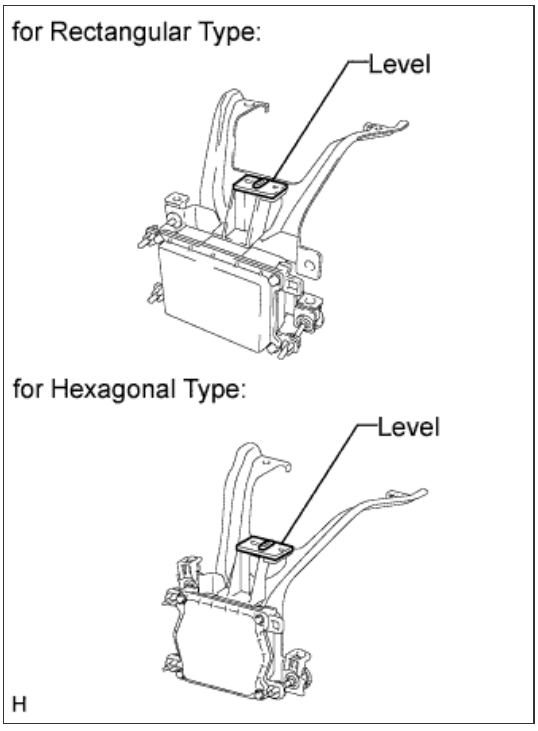
ii. Adjust the tire pressure to the specified value(s).

b. w/ Air suspension:
Adjust the vehicle's height to the standard height.

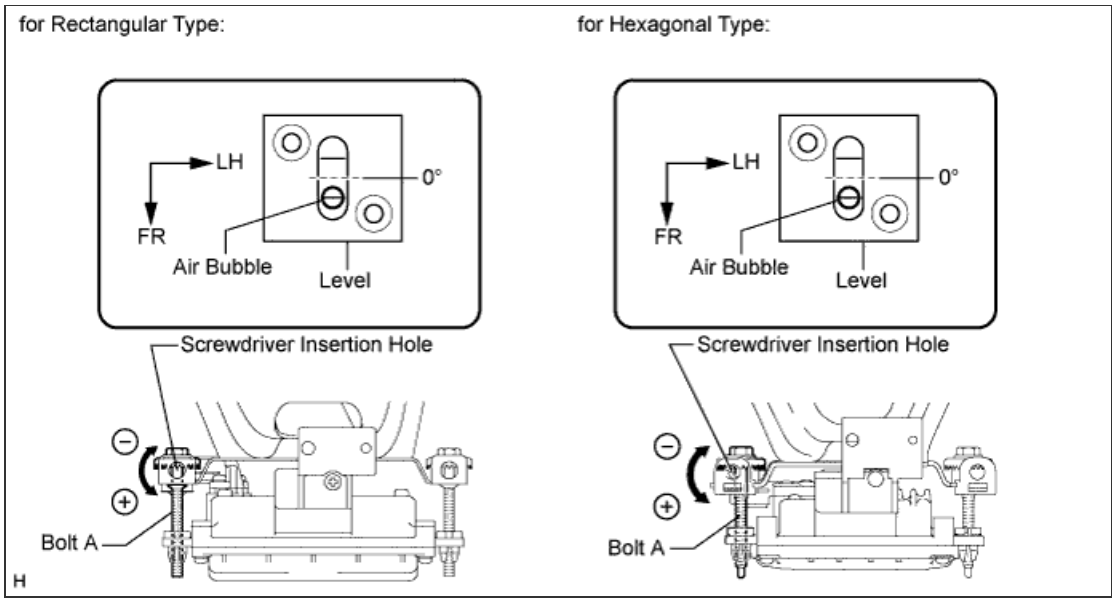
c. Adjust the vertical direction.

i. Remove any dust and oil from the level rack of the millimeter wave radar sensor assembly.

ii. Set a level for use with the sensor in the center of the level rack of the millimeter wave radar sensor assembly.



iii. Using a screwdriver, adjust the sensor by turning the vertical adjusting bolt of the millimeter wave radar sensor assembly (bolt A) until the air bubble is centered on the red line of the level as shown in the illustration.



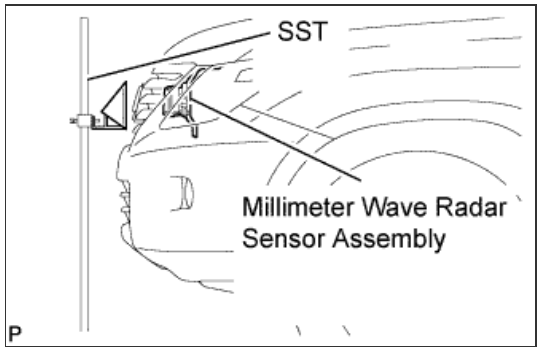
Standard:
0.2° upward

HINT:

The adjustable range within the red frame of the level is +/-0.2°.

Vertical adjustment	• Upward direction: Turn bolt A in minus direction • Downward direction: Turn bolt A in plus direction	For 1 complete turn of screwdriver, sensor moves about 0.12°

d. Adjust SST (reflector) height.



i. Adjust SST (reflector) so that the center of SST (reflector) is the same height as the millimeter wave radar sensor assembly.

SST
09870-60000 (09870-60010)
09870-60040

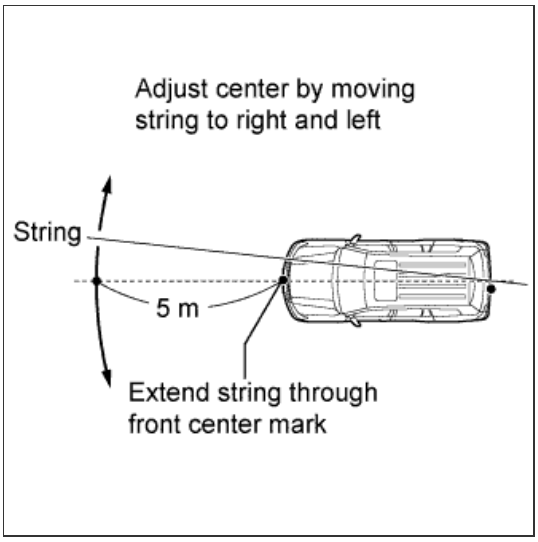
e. Place SST (reflector).

i. Hang a pointed weight from the center of the front and rear bumpers of the vehicle (center of the emblem) and accurately mark the center points on the ground.

ii. Mark a point 5 m (16.4 ft.) in front of the vehicle on the line that connects the front and rear center point marks.

HINT:

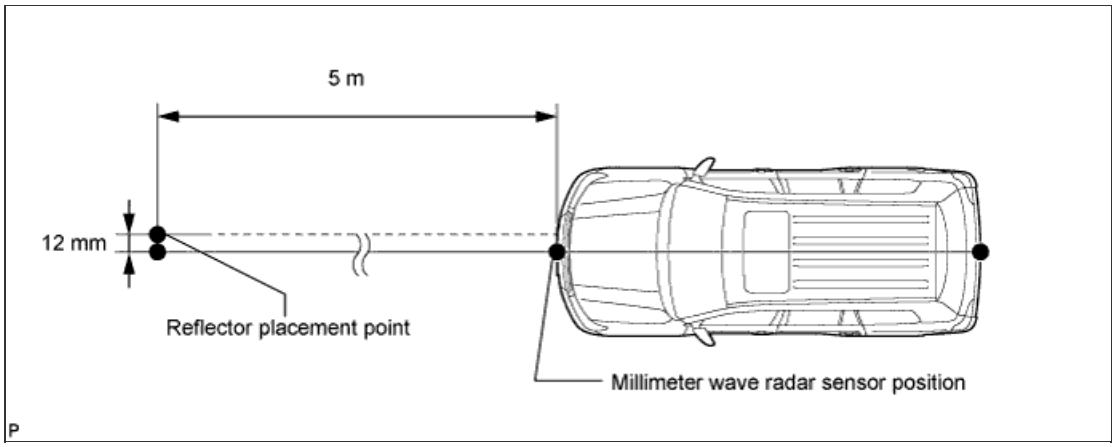
Affix one end of a string to the rear center point mark and extend the string 5 m (16.4 ft.) from the front of the vehicle. Move the other end of the string left and right to align the string with the front center point mark and make a straight line.



iii. Place SST at a position 12 mm (0.472 in.) from the marked position, to the right of the vehicle.

NOTICE:

Perform the operation as precisely as possible.



f. Adjust the beam axis.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch ON, and turn the cruise control main switch ON.

iv. Select "Radar Cruise" from the display screen.

HINT:

A buzzer will sound for 1 second.

v. Select "Utility" from the display screen.

vi. Select "Beam Axis Adjustment" from the display screen.

vii. Follow the tester display, and continue with the adjustment.

viii. Intelligent tester

NOTICE:

- **Turn the cruise control main switch ON before pressing Next.**
- **Make sure there is at least 20 cm (7.9 inches) between the radar sensor and any nearby individuals.**

CAUTION:

Do not come within 20 cm (7.9 inches) of the radar sensor.

ix. Check the following items on the laser cruise divergence data screen.

CAUTION:

While using the intelligent tester's beam axis adjustment mode, the actual direction and angle of the radar sensor may be different from the intelligent tester's data. In such a case, the deviation is displayed on the combination meter's multi-information display.

1. Confirm that the distance value is approximately 5 m (16.41 ft.).

   HINT:

   - **A value between 0.0 and 6.3 m (20.67 ft.) is indicated.**
   - **If the distance is 0 m (0 ft.), the sensor cannot detect the target. Reconfirm that there is no metal in the specified area in front of the vehicle (refer to the NOTICE at the beginning of this adjustment procedure).**

2. Confirm that the left/right side value is between 0.0 and 6.3.

   HINT:

   If the distance is 0 m (0 ft.), the sensor cannot detect the target. Reconfirm that there is no metal in the specified area in front of the vehicle (refer to the NOTICE at the beginning of this adjustment procedure).

g. Adjust the horizontal direction.

i. Read the current amount of angle deviation.

Standard:
0° (Both left and right)

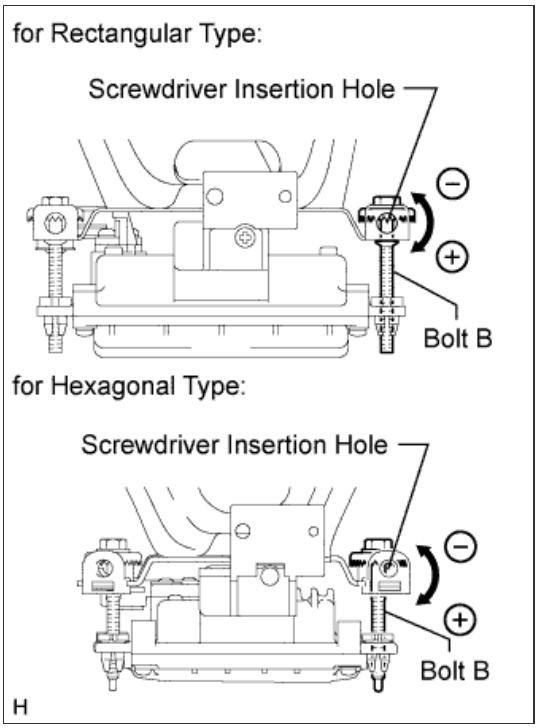
ii. Based on the results of the beam axis deviation measurement, using a screwdriver, adjust the sensor by turning the horizontal adjusting bolt of the millimeter wave radar sensor assembly (bolt B).

for Rectangular Type:

Horizontal adjustment	• Right direction: Turn bolt B in plus direction • Left direction: Turn bolt B in minus direction	For 1 complete turn of screwdriver, sensor moves about 0.05°

for Hexagonal Type:

Horizontal adjustment	• Right direction: Turn bolt B in plus direction • Left direction: Turn bolt B in minus direction	For 1 complete turn of screwdriver, sensor moves about 0.07°



NOTICE:

If it is difficult to reach a value of 0°, it is possible that the sensor is targeting an object other than SST. Reconfirm that there are no reflective objects in the surrounding area.

iii. Because the driving learned value will be reset, cover the left half of the sensor with aluminum foil or equivalent (a metal material that blocks electric waves) for a period of approximately 10 seconds.

NOTICE:

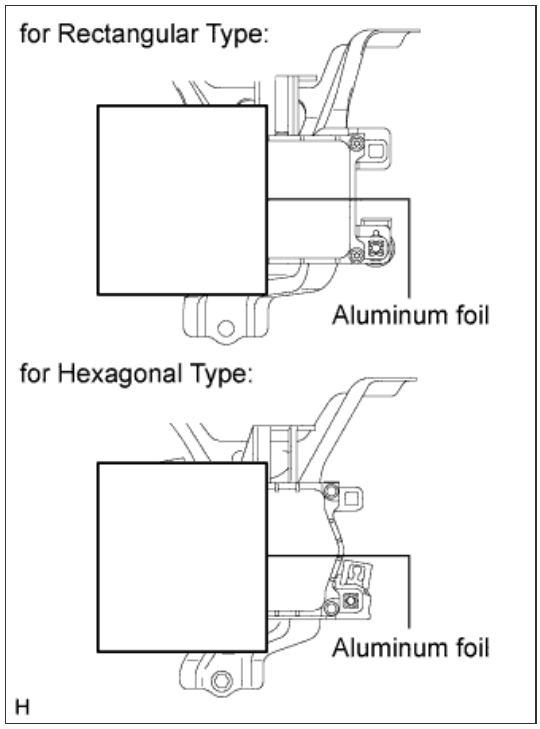
At this time, leave SST in place and make sure there are no objects between the right half of the sensor and the reflector.

HINT:

When the value is reset, the buzzer will sound for 10 seconds, a distance value between 0 and 6.3° and a right side value between 0 and 6.3 m (20.7 ft.) will be displayed on the screen.

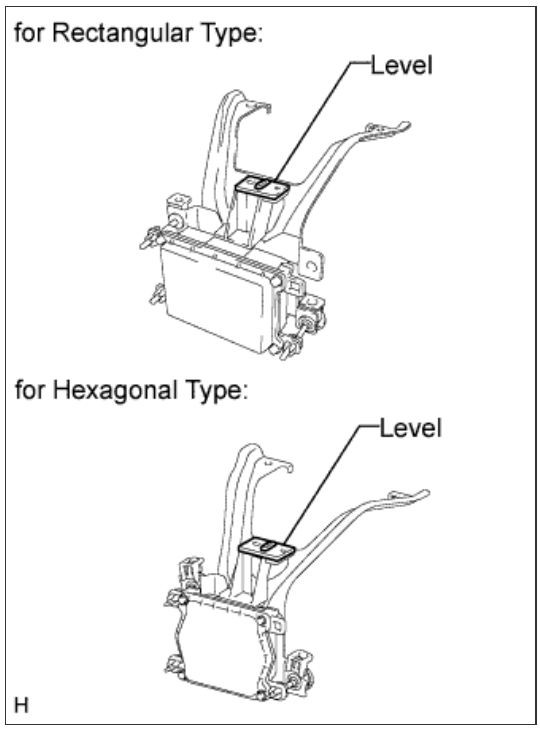
iv. Continue the procedure according to the display to complete the beam axis adjustment.

v. Disconnect the intelligent tester from the vehicle.

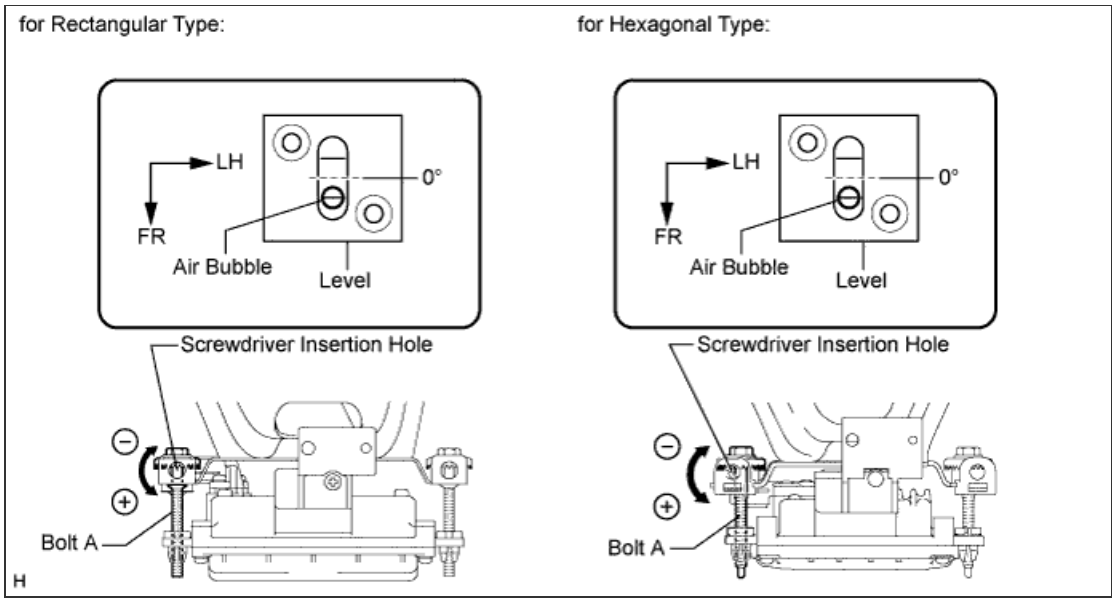


h. Reconfirm the vertical direction.

i. Set a level for use with the sensor in the center of the level rack of the millimeter wave radar sensor assembly.



ii. Using a screwdriver, adjust the sensor by turning the vertical adjusting bolt of the millimeter wave radar sensor assembly (bolt A) until the air bubble is centered on the red line of the level as shown in the illustration.



Standard:
0.2° upward

HINT:

The adjustable range within the red frame of the level is +/-0.2°.

Vertical adjustment	• Upward direction: Turn bolt A in minus direction • Downward direction: Turn bolt A in plus direction	For 1 complete turn of screwdriver, sensor moves about 0.12°

2. DRIVE TEST

a. Perform the drive test.

NOTICE:

- **Be sure to perform the driving test after adjusting the millimeter wave radar sensor assembly.**
- **Be careful when driving.**

i. Drive at 30 km/h (19 mph) on a straight road with good visibility while staying in the center of the lane.

NOTICE:

Because the pre-crash safety system may activate under the following conditions, avoid conditions like these when performing the test.

- **There are objects on the side of the road at the beginning of a curve.**
- **Passing an oncoming vehicle on a curve.**
- **Crossing a narrow metal bridge.**
- **There are metal objects on the road surface.**
- **There is an oncoming vehicle when turning right.**
- **Rapidly approaching a vehicle driving in front.**

ii. On a straight road, when passing an oncoming vehicle with no danger of collision, check that the master warning does not illuminate and that the buzzer does not sound. At the same time, check that "BRAKE!" is not displayed on the display in the combination meter.

iii. If "BRAKE!" is displayed, perform the millimeter wave radar sensor assembly adjustment again.

HINT:

- **Check the installation condition of the millimeter wave radar sensor assembly.**
- **Check that the pre-crash safety brake switch is not pushed in.**

for Preparation Click here

HINT:

- **Use the same procedures for LHD and RHD vehicles.**
- **The procedures listed below are for LHD vehicles.**

1. INSTALL MILLIMETER WAVE RADAR SENSOR ASSEMBLY

a. Temporarily install the millimeter wave radar sensor assembly with the 3 bolts.

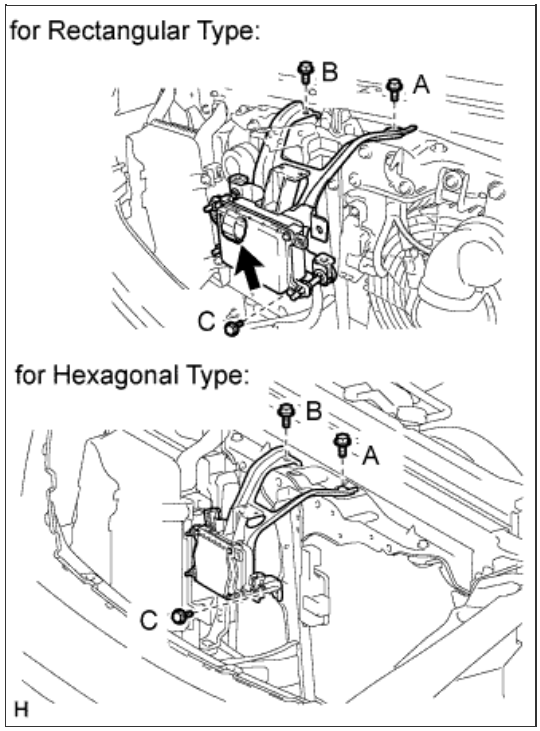
b. Tighten the 3 bolts in alphabetical order.

Torque:
5.5 N*m{ 56 kgf*cm , 49 in.*lbf }

c. Connect the sensor connector.

NOTICE:

Do not use a sensor which has been dropped or subjected to any strong shocks.



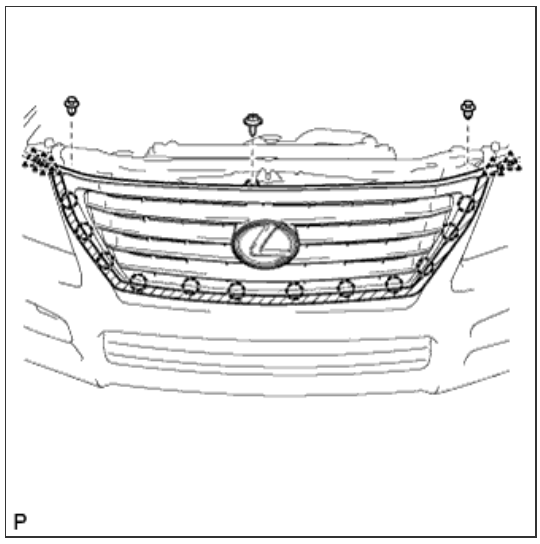
2. INSTALL RADIATOR GRILLE ASSEMBLY

a. w/ Wide View Front Monitor System:
Connect the connector.

b. Attach the 12 claws to install the radiator grille.

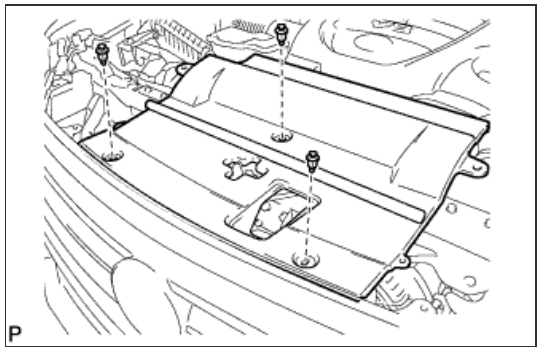
c. Attach the 5 clips to install the detached part of the upper radiator seal.

d. Install the screw and 2 clips.



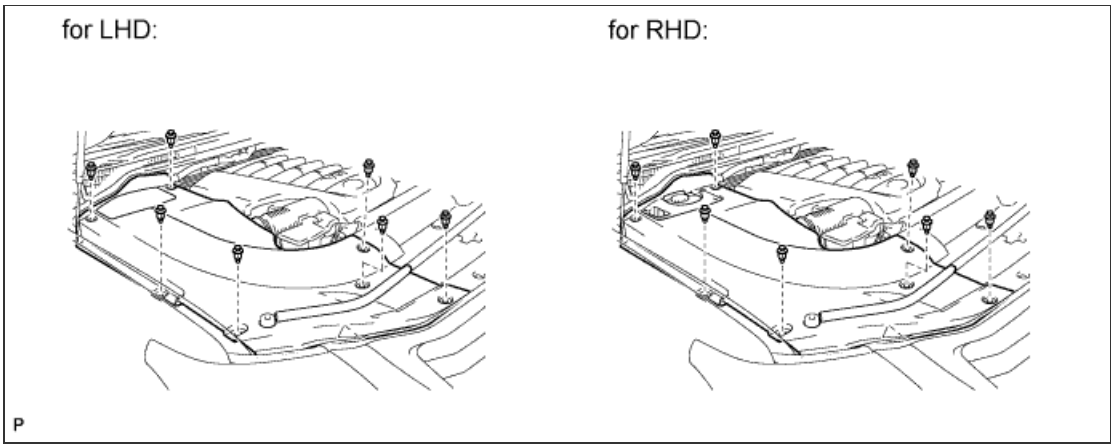
3. INSTALL UPPER RADIATOR SUPPORT SEAL

a. Install the upper radiator support seal with the 3 clips.



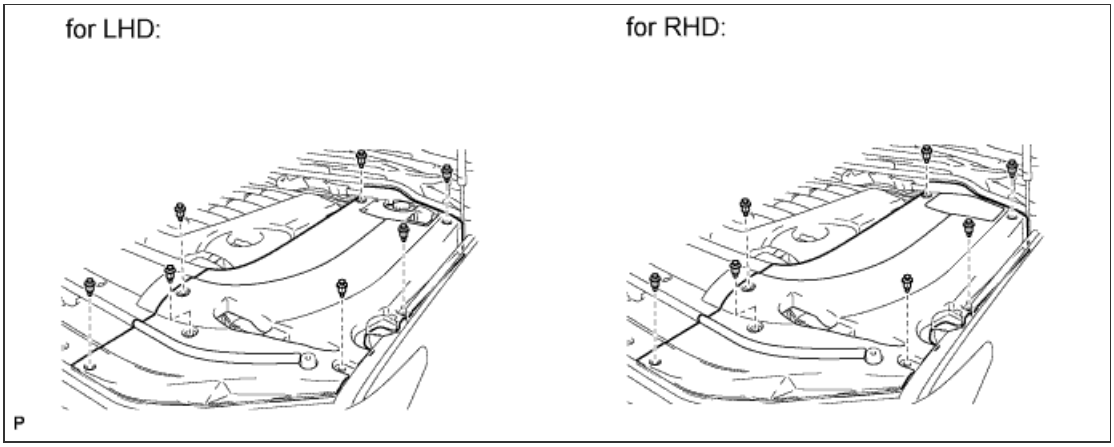
4. INSTALL ENGINE ROOM SIDE COVER RH

a. Install the engine room side cover with the 7 clips.



5. INSTALL ENGINE ROOM SIDE COVER LH

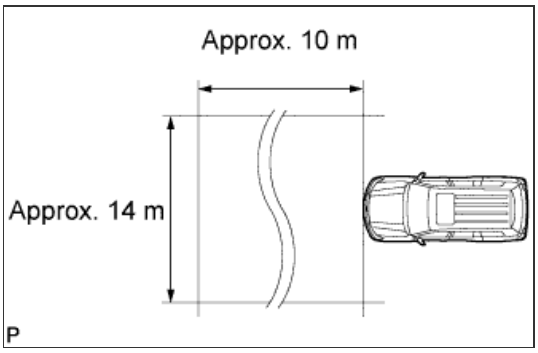
a. Install the engine room side cover with the 7 clips.



6. ADJUST MILLIMETER WAVE RADAR SENSOR ASSEMBLY

NOTICE:

- **Perform measurements on a level surface.**
- **Make sure that there are no metal objects on the ground or within a 10 m (32.8 ft.) x 14 m (45.9 ft.) area in front of the vehicle. If possible, the surrounding area should also be free of large metal objects.**



a. Before adjusting, perform the following:

i. Remove all cargo from the inside of the vehicle.

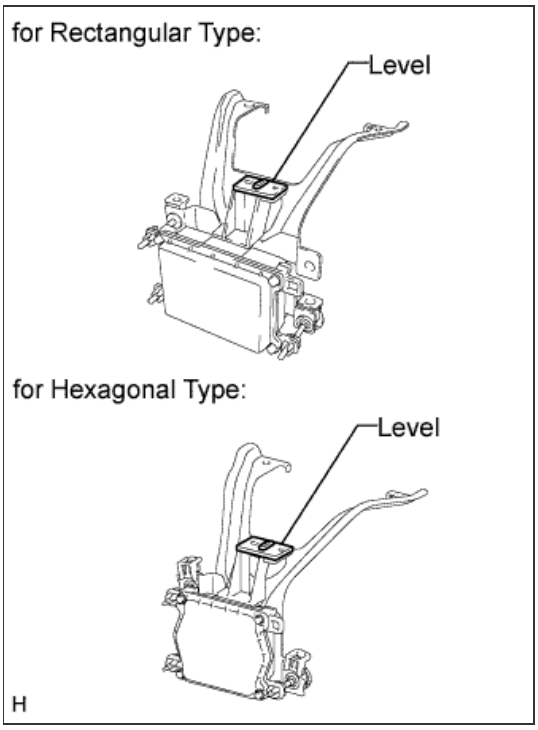
ii. Adjust the tire pressure to the specified value(s).

b. w/ Air suspension:
Adjust the vehicle's height to the standard height.

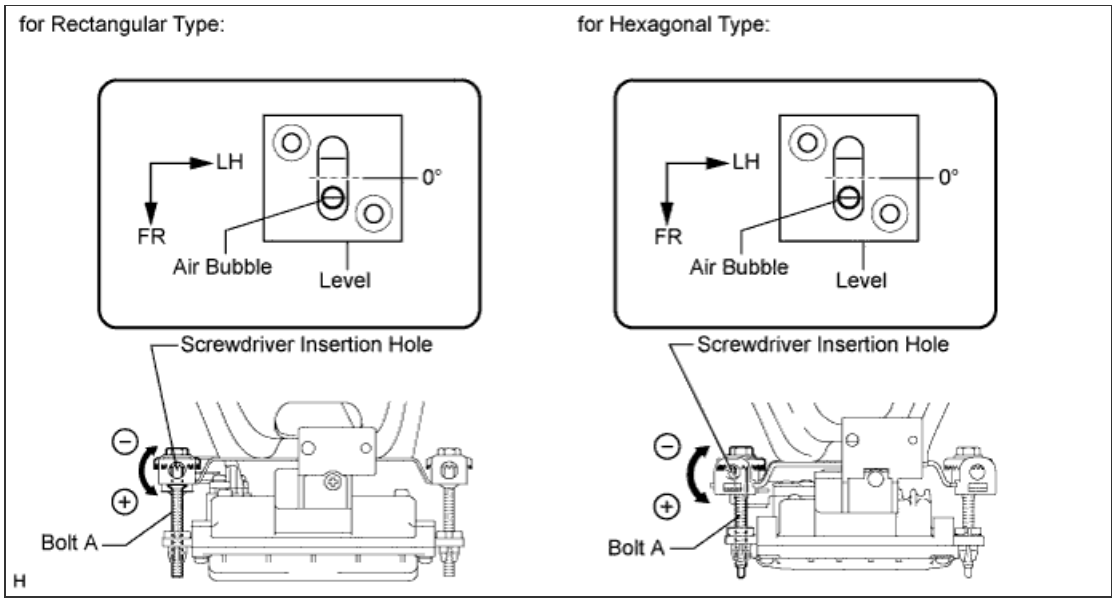
c. Adjust the vertical direction.

i. Remove any dust and oil from the level rack of the millimeter wave radar sensor assembly.

ii. Set a level for use with the sensor in the center of the level rack of the millimeter wave radar sensor assembly.



iii. Using a screwdriver, adjust the sensor by turning the vertical adjusting bolt of the millimeter wave radar sensor assembly (bolt A) until the air bubble is centered on the red line of the level as shown in the illustration.



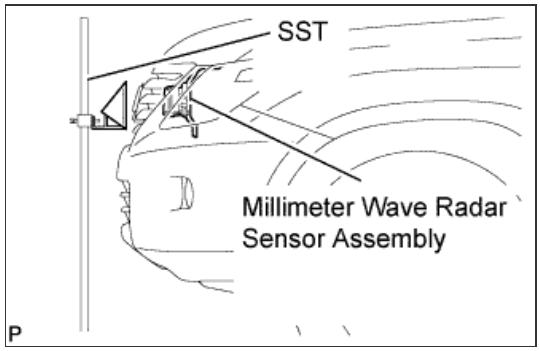
Standard:
0.2° upward

HINT:

The adjustable range within the red frame of the level is +/-0.2°.

Vertical adjustment	• Upward direction: Turn bolt A in minus direction • Downward direction: Turn bolt A in plus direction	For 1 complete turn of screwdriver, sensor moves about 0.12°

d. Adjust SST (reflector) height.



i. Adjust SST (reflector) so that the center of SST (reflector) is the same height as the millimeter wave radar sensor assembly.

SST
09870-60000 (09870-60010)
09870-60040

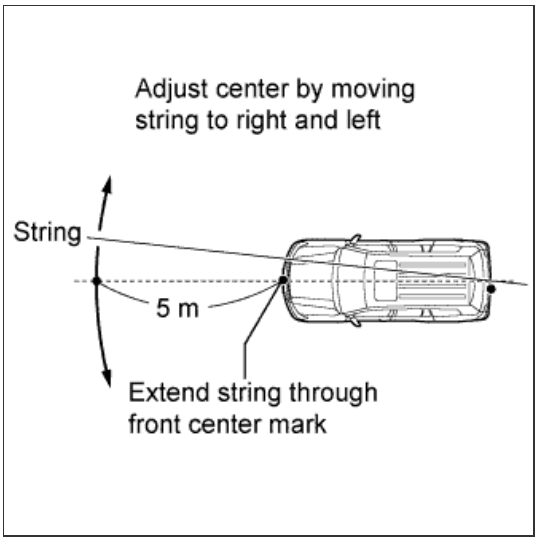
e. Place SST (reflector).

i. Hang a pointed weight from the center of the front and rear bumpers of the vehicle (center of the emblem) and accurately mark the center points on the ground.

ii. Mark a point 5 m (16.4 ft.) in front of the vehicle on the line that connects the front and rear center point marks.

HINT:

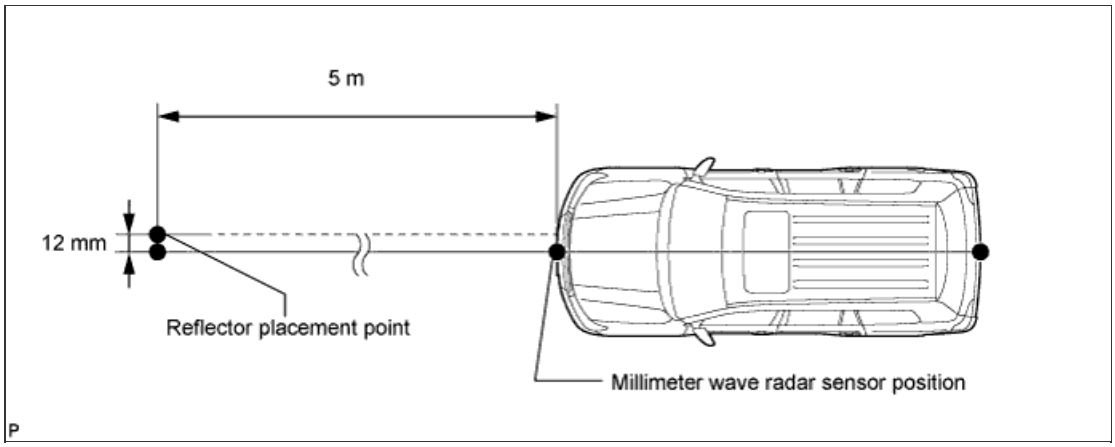
Affix one end of a string to the rear center point mark and extend the string 5 m (16.4 ft.) from the front of the vehicle. Move the other end of the string left and right to align the string with the front center point mark and make a straight line.



iii. Place SST at a position 12 mm (0.472 in.) from the marked position, to the right of the vehicle.

NOTICE:

Perform the operation as precisely as possible.



f. Adjust the beam axis.

i. Connect the intelligent tester to the DLC3.

ii. Turn the engine switch on (IG).

iii. Turn the intelligent tester main switch ON, and turn the cruise control main switch ON.

iv. Select "Radar Cruise" from the display screen.

HINT:

A buzzer will sound for 1 second.

v. Select "Utility" from the display screen.

vi. Select "Beam Axis Adjustment" from the display screen.

vii. Follow the tester display, and continue with the adjustment.

viii. Intelligent tester

NOTICE:

- **Turn the cruise control main switch ON before pressing Next.**
- **Make sure there is at least 20 cm (7.9 inches) between the radar sensor and any nearby individuals.**

CAUTION:

Do not come within 20 cm (7.9 inches) of the radar sensor.

ix. Check the following items on the laser cruise divergence data screen.

CAUTION:

While using the intelligent tester's beam axis adjustment mode, the actual direction and angle of the radar sensor may be different from the intelligent tester's data. In such a case, the deviation is displayed on the combination meter's multi-information display.

1. Confirm that the distance value is approximately 5 m (16.41 ft.).

   HINT:

   - **A value between 0.0 and 6.3 m (20.67 ft.) is indicated.**
   - **If the distance is 0 m (0 ft.), the sensor cannot detect the target. Reconfirm that there is no metal in the specified area in front of the vehicle (refer to the NOTICE at the beginning of this adjustment procedure).**

2. Confirm that the left/right side value is between 0.0 and 6.3.

   HINT:

   If the distance is 0 m (0 ft.), the sensor cannot detect the target. Reconfirm that there is no metal in the specified area in front of the vehicle (refer to the NOTICE at the beginning of this adjustment procedure).

g. Adjust the horizontal direction.

i. Read the current amount of angle deviation.

Standard:
0° (Both left and right)

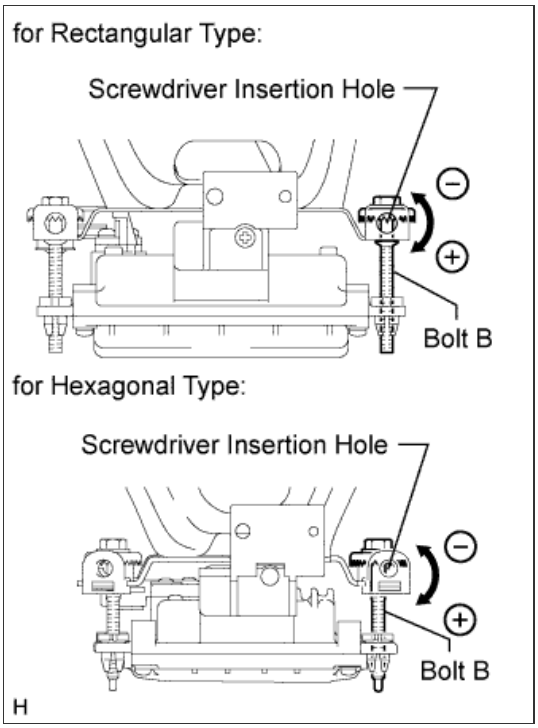
ii. Based on the results of the beam axis deviation measurement, using a screwdriver, adjust the sensor by turning the horizontal adjusting bolt of the millimeter wave radar sensor assembly (bolt B).

for Rectangular Type:

Horizontal adjustment	• Right direction: Turn bolt B in plus direction • Left direction: Turn bolt B in minus direction	For 1 complete turn of screwdriver, sensor moves about 0.05°

for Hexagonal Type:

Horizontal adjustment	• Right direction: Turn bolt B in plus direction • Left direction: Turn bolt B in minus direction	For 1 complete turn of screwdriver, sensor moves about 0.07°



NOTICE:

If it is difficult to reach a value of 0°, it is possible that the sensor is targeting an object other than SST. Reconfirm that there are no reflective objects in the surrounding area.

iii. Because the driving learned value will be reset, cover the left half of the sensor with aluminum foil or equivalent (a metal material that blocks electric waves) for a period of approximately 10 seconds.

NOTICE:

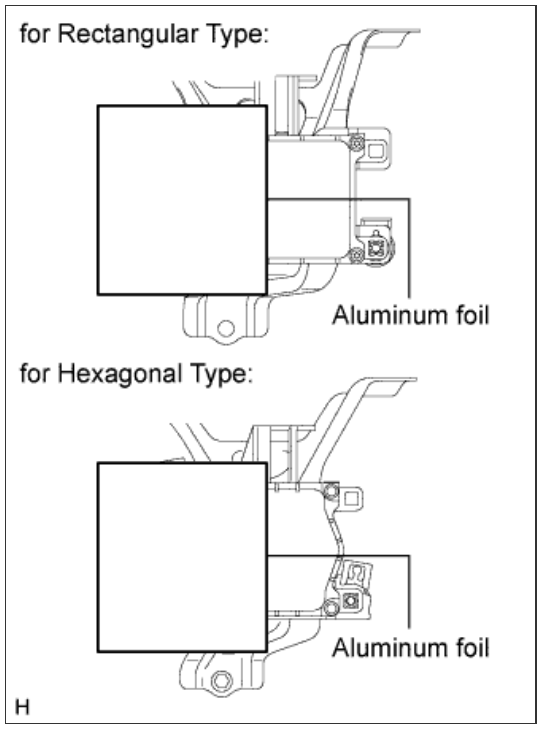
At this time, leave SST in place and make sure there are no objects between the right half of the sensor and the reflector.

HINT:

When the value is reset, the buzzer will sound for 10 seconds, a distance value between 0 and 6.3° and a right side value between 0 and 6.3 m (20.7 ft.) will be displayed on the screen.

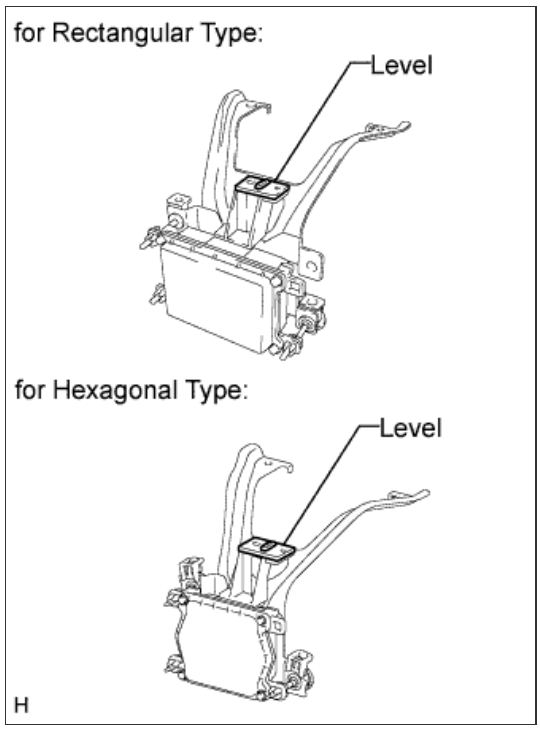
iv. Continue the procedure according to the display to complete the beam axis adjustment.

v. Disconnect the intelligent tester from the vehicle.

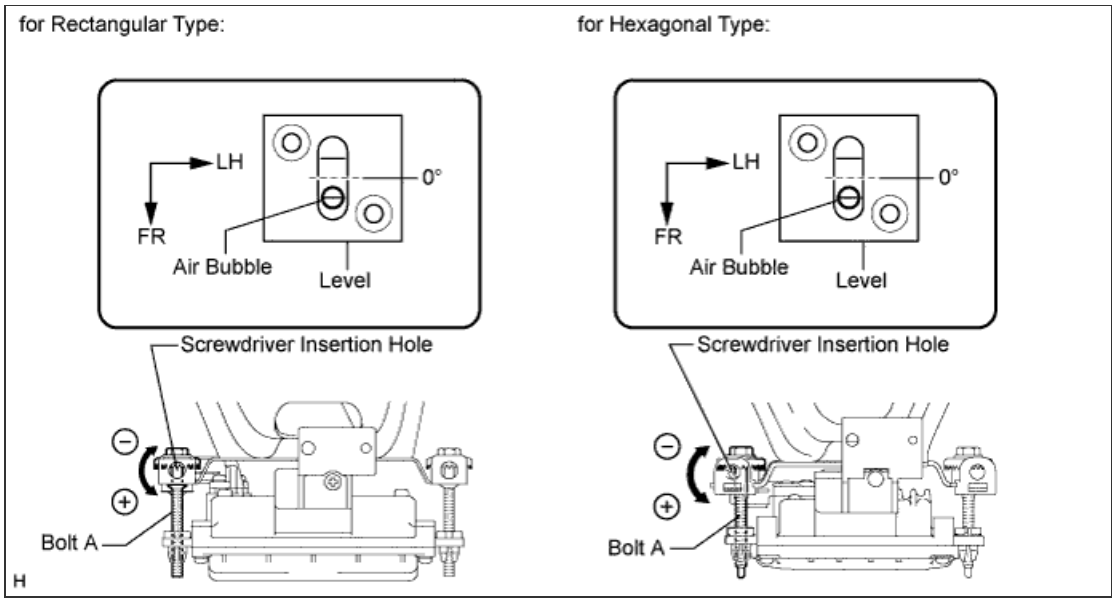


h. Reconfirm the vertical direction.

i. Set a level for use with the sensor in the center of the level rack of the millimeter wave radar sensor assembly.



ii. Using a screwdriver, adjust the sensor by turning the vertical adjusting bolt of the millimeter wave radar sensor assembly (bolt A) until the air bubble is centered on the red line of the level as shown in the illustration.



Standard:
0.2° upward

HINT:

The adjustable range within the red frame of the level is +/-0.2°.

Vertical adjustment	• Upward direction: Turn bolt A in minus direction • Downward direction: Turn bolt A in plus direction	For 1 complete turn of screwdriver, sensor moves about 0.12°

7. PERFORM DRIVE TEST

a. Perform the drive test.

NOTICE:

- **Be sure to perform the driving test after adjusting the millimeter wave radar sensor assembly.**
- **Be careful when driving.**

i. Drive at 30 km/h (19 mph) on a straight road with good visibility while staying in the center of the lane.

NOTICE:

Because the pre-crash safety system may activate under the following conditions, avoid conditions like these when performing the test.

- **There are objects on the side of the road at the beginning of a curve.**
- **Passing an oncoming vehicle on a curve.**
- **Crossing a narrow metal bridge.**
- **There are metal objects on the road surface.**
- **There is an oncoming vehicle when turning right.**
- **Rapidly approaching a vehicle driving in front.**

ii. On a straight road, when passing an oncoming vehicle with no danger of collision, check that the master warning does not illuminate and that the buzzer does not sound. At the same time, check that "BRAKE!" is not displayed on the display in the combination meter.

iii. If "BRAKE!" is displayed, perform the millimeter wave radar sensor assembly adjustment again.

HINT:

- **Check the installation condition of the millimeter wave radar sensor assembly.**
- **Check that the pre-crash safety brake switch is not pushed in.**