SFI SYSTEM

PRECAUTION

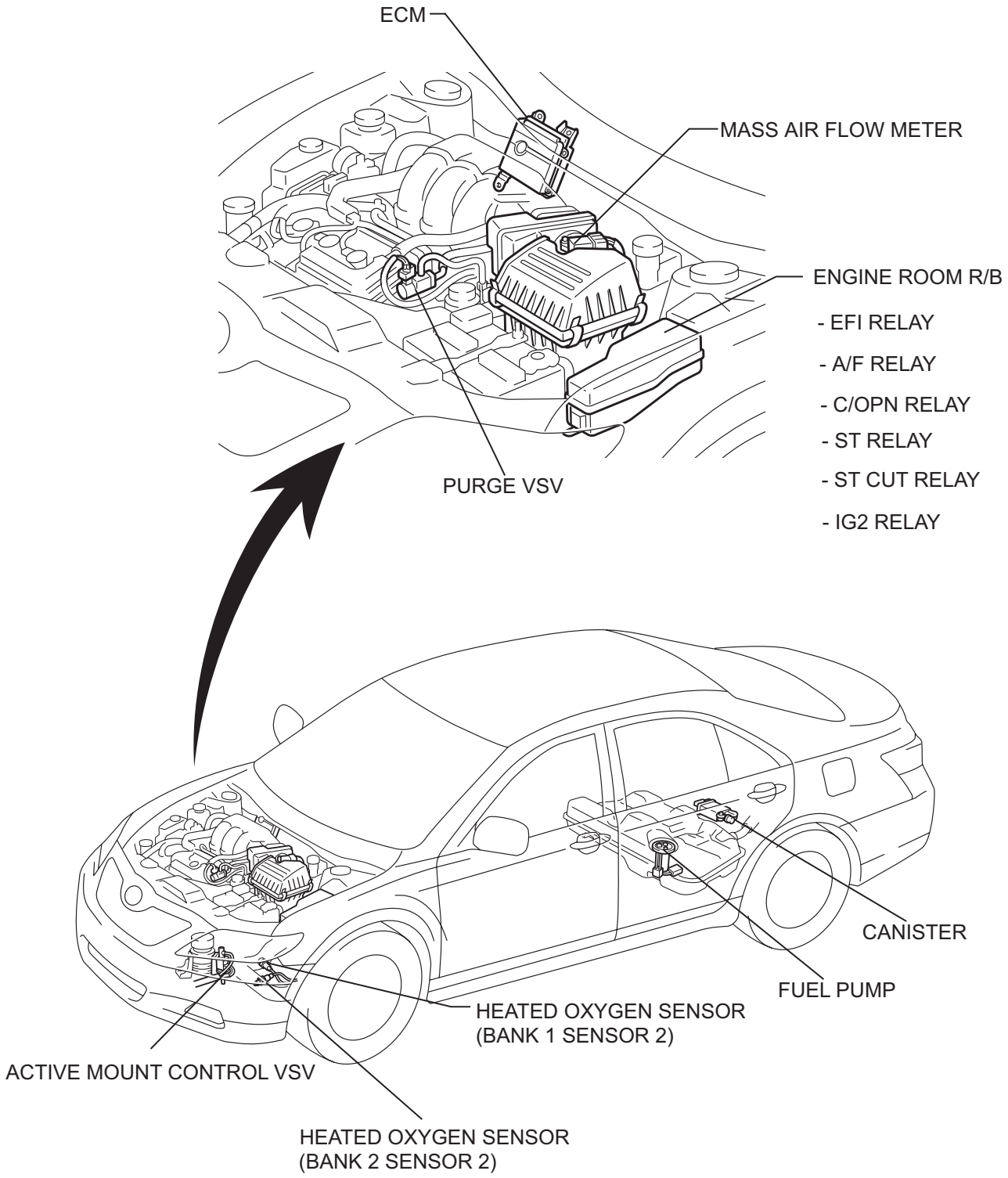
NOTICE:

- **Perform the RESET MEMORY (AT) initialization operation after replacing the automatic transmission assembly, engine assembly or ECM (See page AX-25).**
- **Perform REGISTRATION (VIN registration) when replacing the ECM (See page ES-20).**

DEFINITION OF TERMS

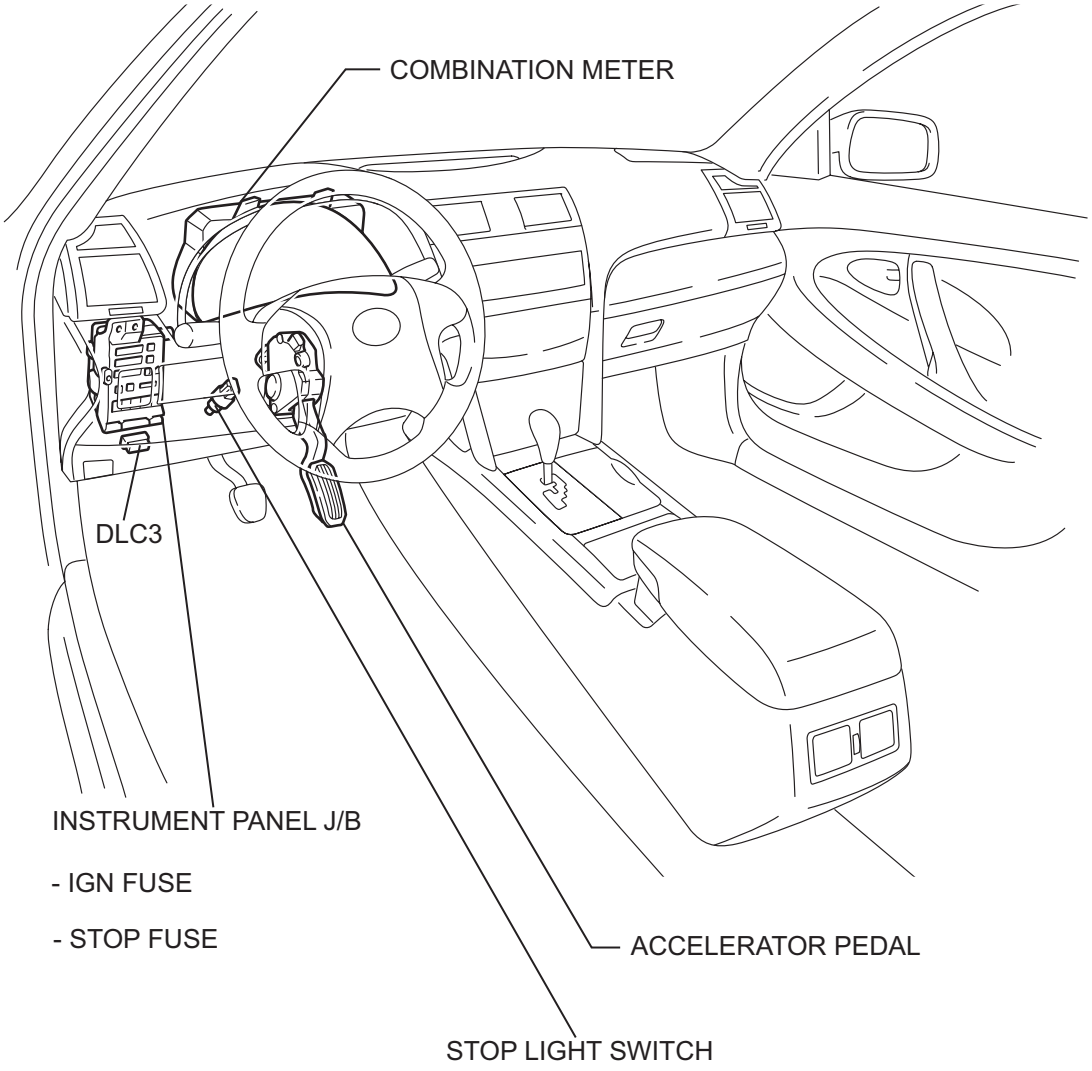
Terms	Definition
Monitor Description	Description of what ECM monitors and how to detect malfunctions (monitoring purpose and its details).
Related DTCs	A group of diagnostic trouble codes that are output by ECM based on the same malfunction detection logic.
Typical Enabling Condition	Preconditions that allow ECM to detect malfunctions. With all preconditions satisfied, ECM sets DTC when monitored value(s) exceeds malfunction threshold(s).
Sequence of Operation	Order of monitor priority, applied if multiple sensors and components are involved in single malfunction detection process. Each sensor and component monitored in turn and not monitored until previous detection operation is completed.
Required Sensor/Components	Sensors and components used by ECM to detect each malfunction.
Frequency of Operation	Number of times ECM checks for each malfunction during each driving cycle. "Once per driving cycle" means that ECM checks for malfunctions only once in single driving cycle. "Continuous" means that ECM checks for malfunctions whenever enabling conditions are met.
Duration	Minimum time for which ECM must detect continuous deviation in monitored value(s) in order to set DTC. Timing begins when Typical Enabling Conditions are met.
Malfunction Thresholds	Value, beyond which, ECM determines malfunctions exist and sets DTCs.
MIL Operation	Timing of MIL illumination after a malfunction is detected. "Immediate" means that ECM illuminates MIL as soon as a malfunction is detected. "2 driving cycle" means that ECM illuminates MIL if the same malfunction is detected twice during next sequential driving cycle.

PARTS LOCATION



ES

ES



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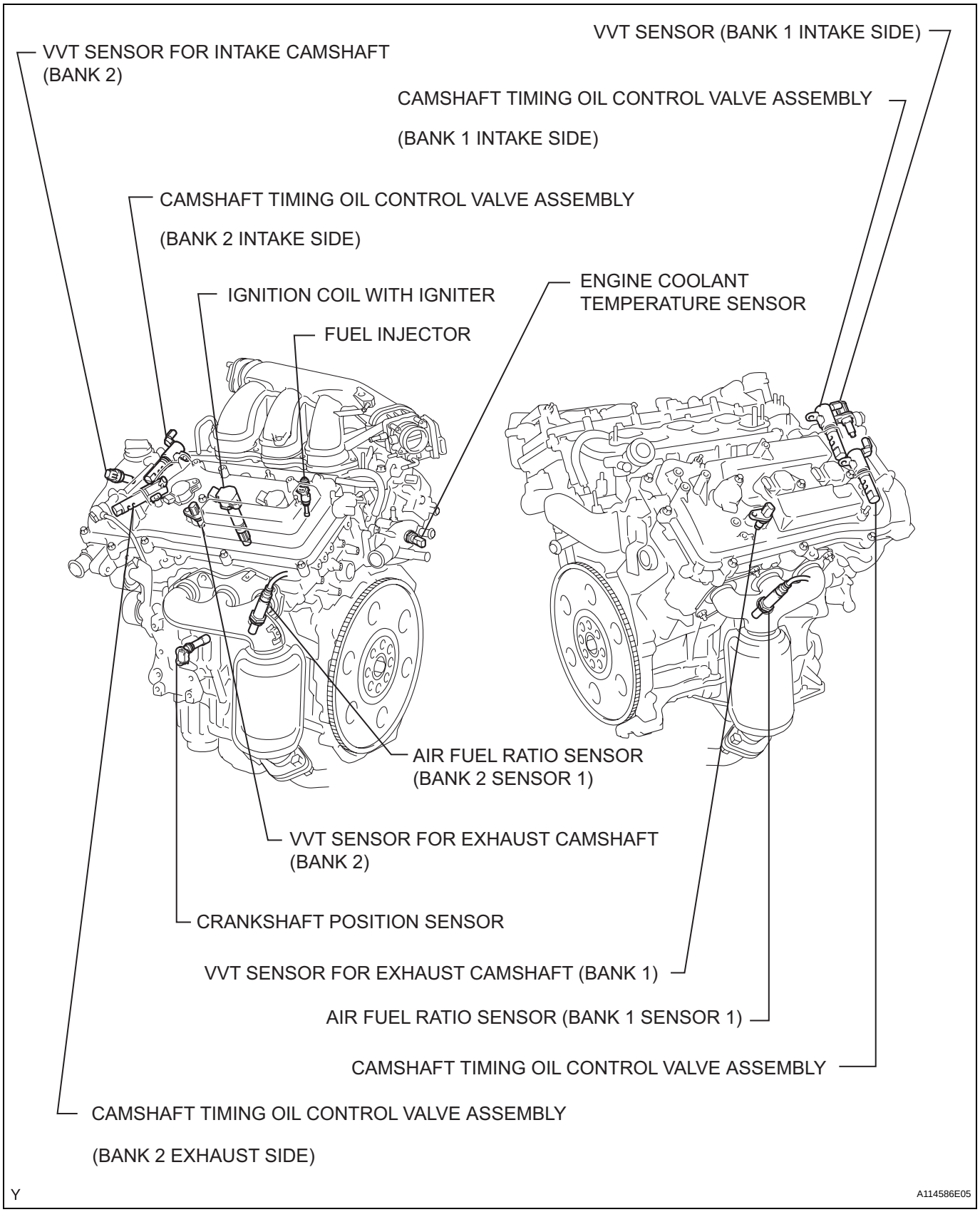
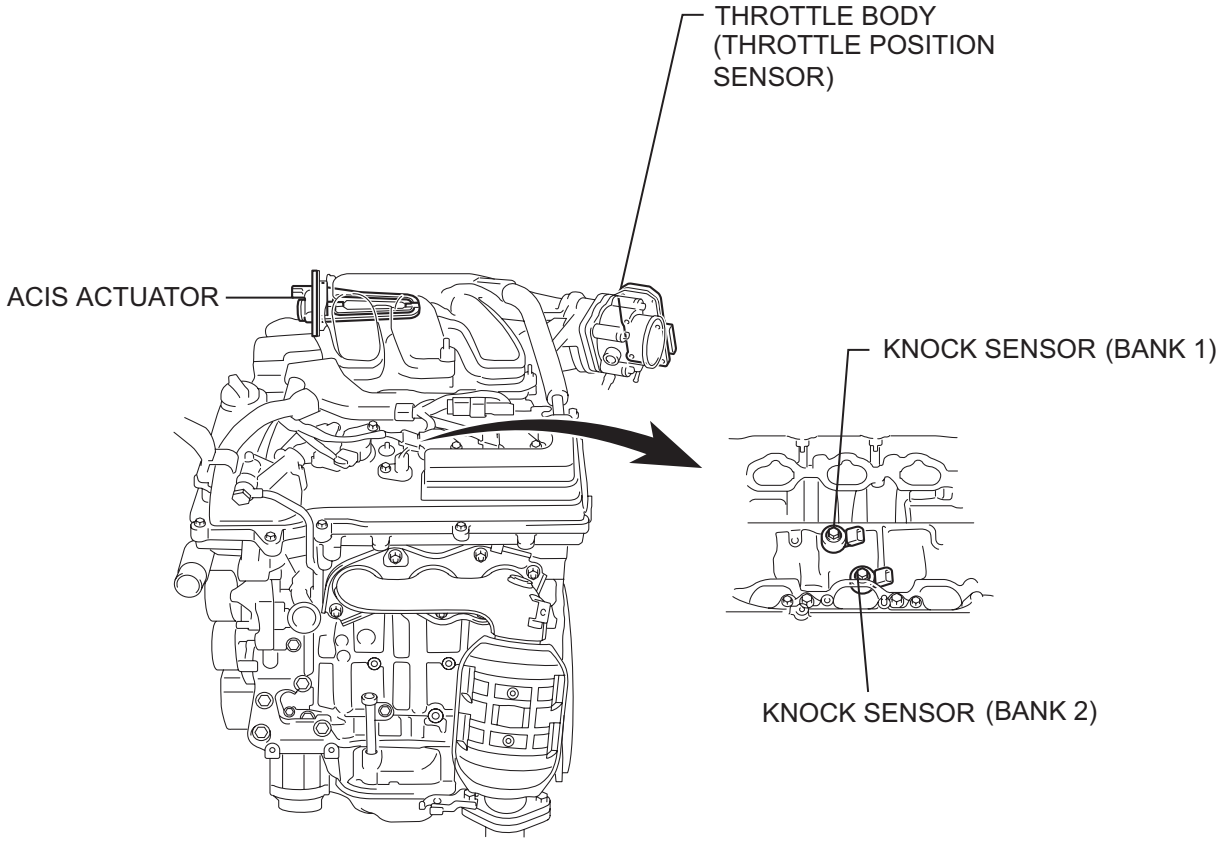

VVT SENSOR (BANK 1 INTAKE SIDE)
VVT SENSOR FOR INTAKE CAMSHAFT (BANK 2)
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (BANK 1 INTAKE SIDE)
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (BANK 2 INTAKE SIDE)
IGNITION COIL WITH IGNITER
ENGINE COOLANT TEMPERATURE SENSOR
FUEL INJECTOR
AIR FUEL RATIO SENSOR (BANK 2 SENSOR 1)
VVT SENSOR FOR EXHAUST CAMSHAFT (BANK 2)
CRANKSHAFT POSITION SENSOR
VVT SENSOR FOR EXHAUST CAMSHAFT (BANK 1)
AIR FUEL RATIO SENSOR (BANK 1 SENSOR 1)
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (BANK 2 EXHAUST SIDE)
Y
A114586E05

ES

ES

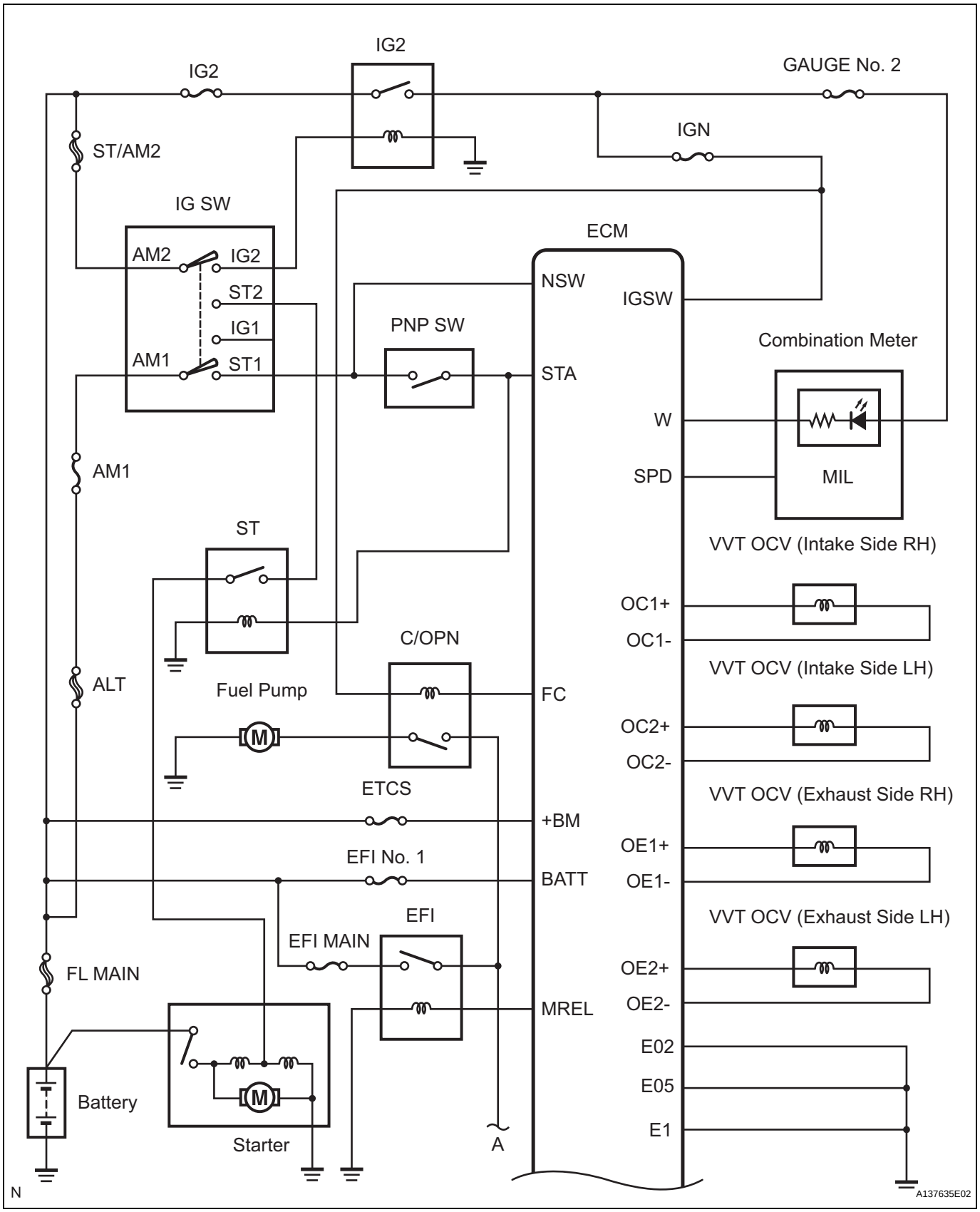


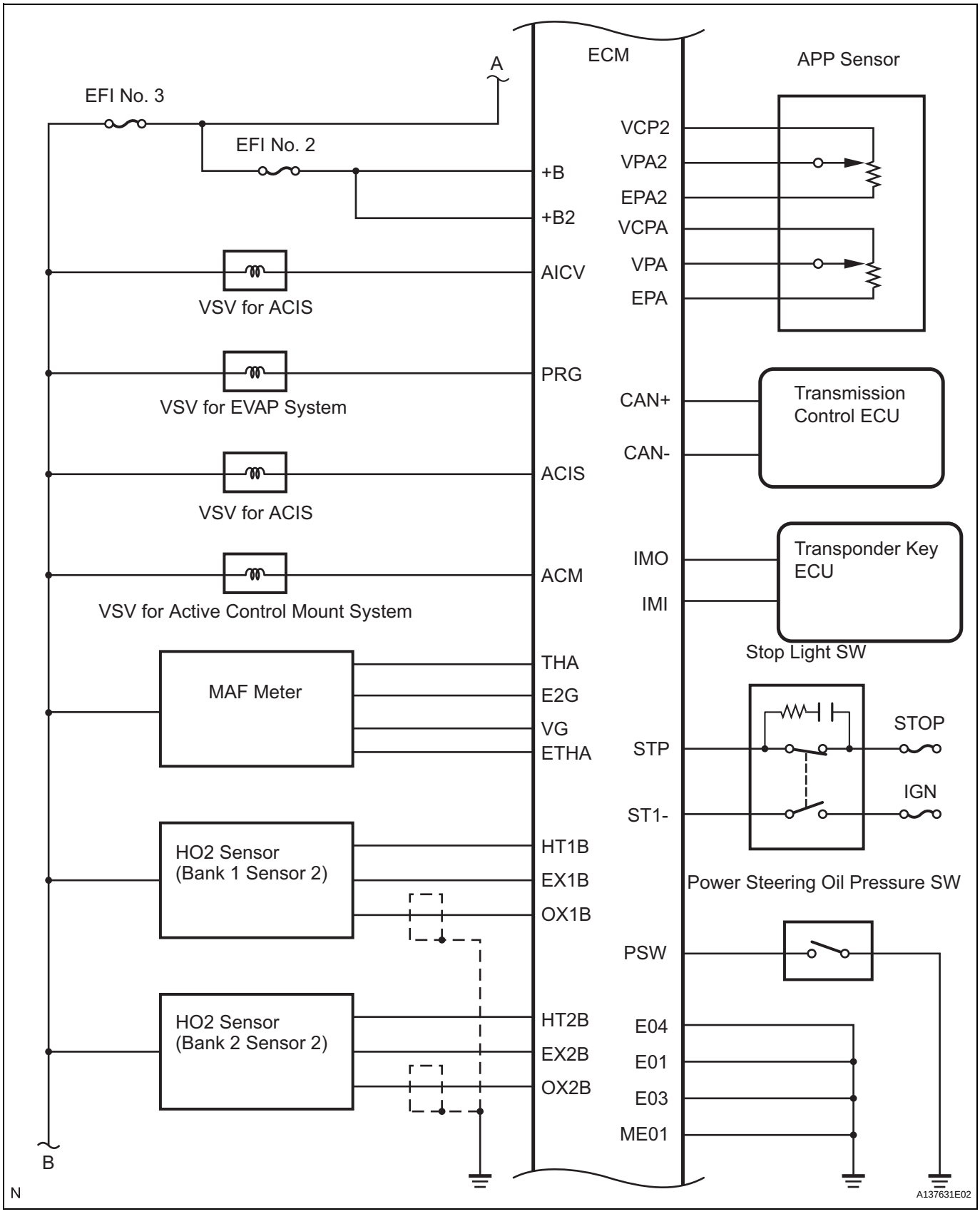
Y

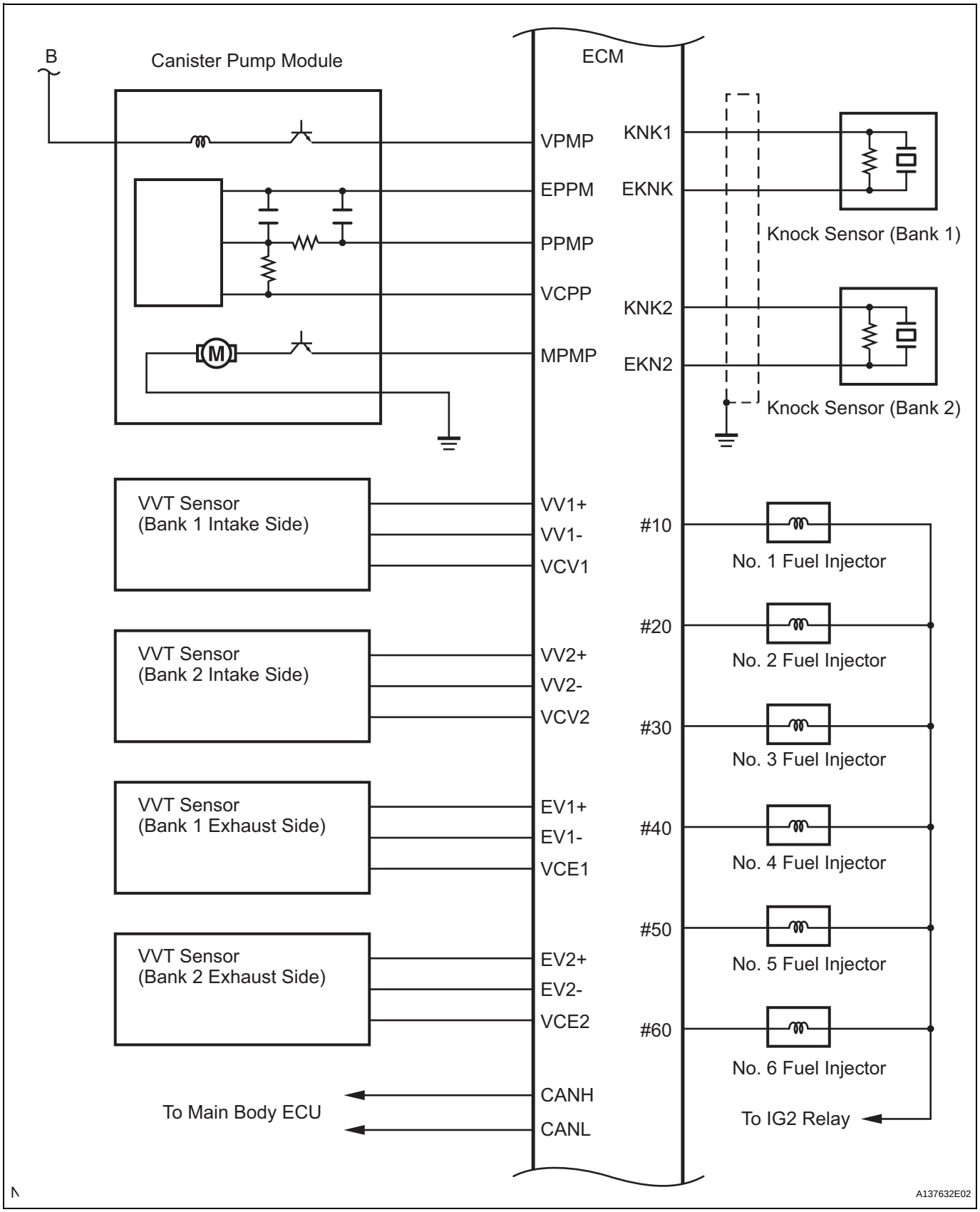
A114543E04

SYSTEM DIAGRAM

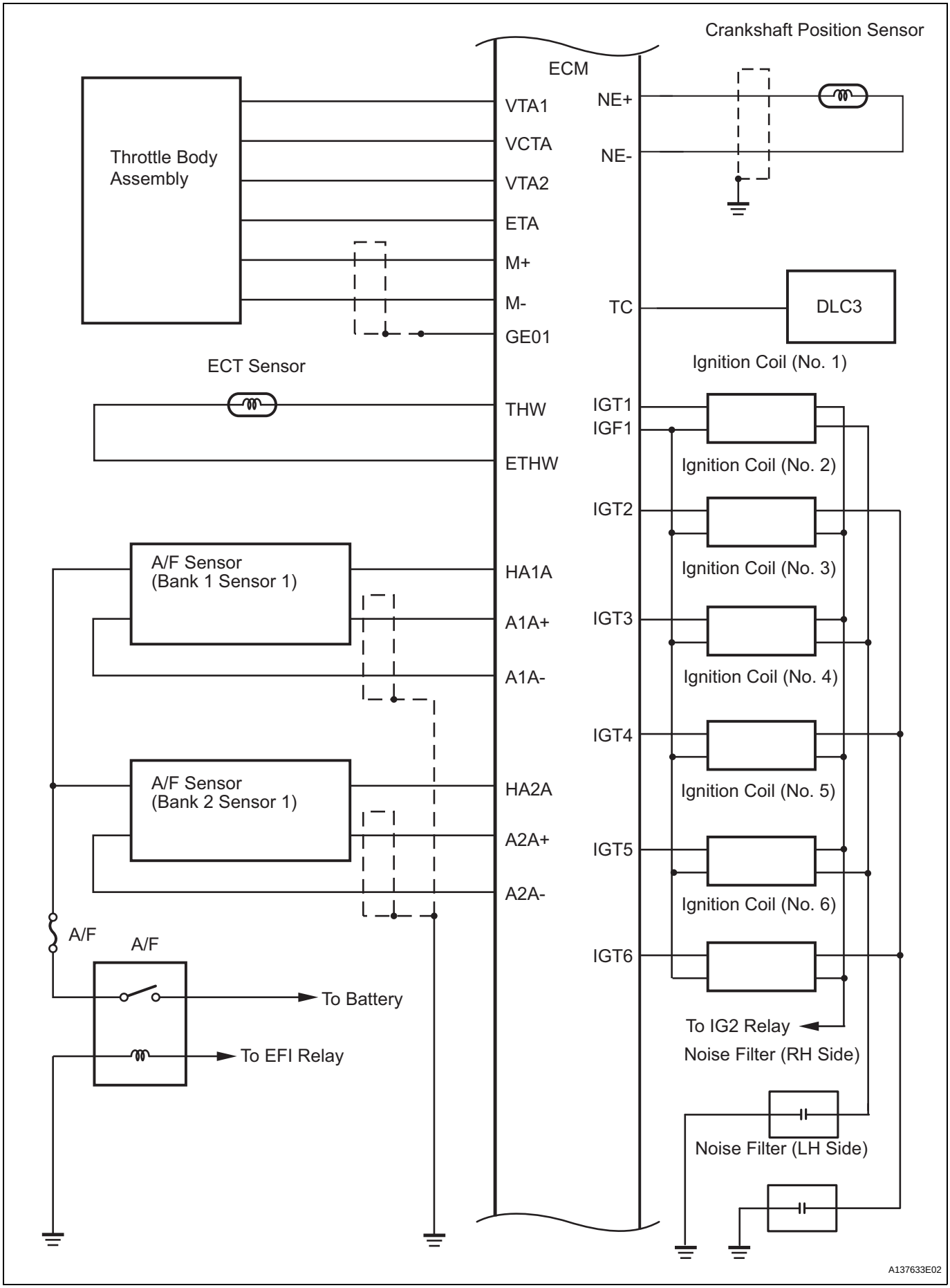
1. Without Smart Key System:

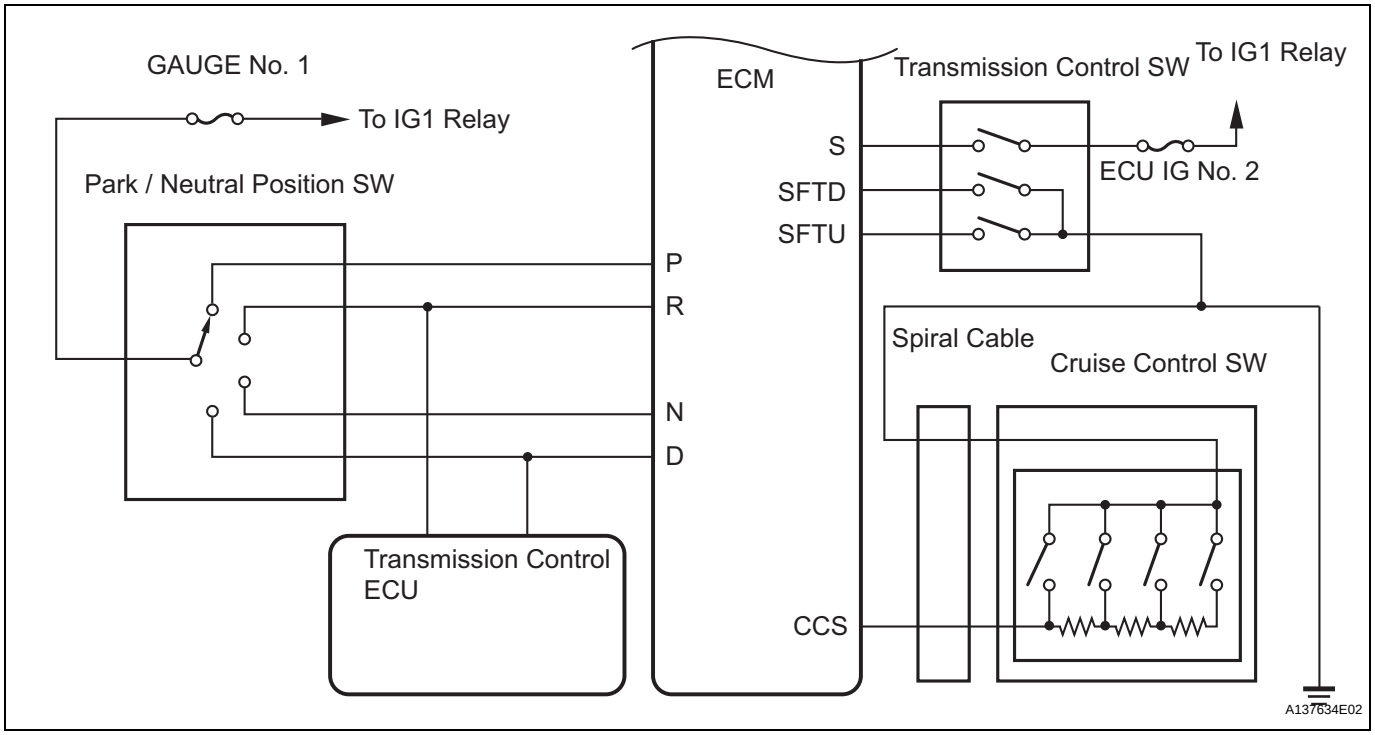



ECM
APP Sensor
A
EFI No. 3
EFI No. 2
+B
+B2
AICV
VSV for ACIS
PRG
VSV for EVAP System
ACIS
VSV for ACIS
ACM
VSV for Active Control Mount System
MAF Meter
THA
E2G
VG
ETHA
HO2 Sensor
(Bank 1 Sensor 2)
HT1B
EX1B
OX1B
HO2 Sensor
(Bank 2 Sensor 2)
HT2B
EX2B
OX2B
B
VCP2
VPA2
EPA2
VCPA
VPA
EPA
CAN+
CAN-
Transmission
Control ECU
IMO
IMI
Transponder Key
ECU
Stop Light SW
STP
ST1-
STOP
IGN
Power Steering Oil Pressure SW
PSW
E04
E01
E03
ME01
N
A137631E02


B
Canister Pump Module
ECM
VPMP
EPPM
PPMP
VCPP
MPMP
M
KNK1
EKNK
Knock Sensor (Bank 1)
KNK2
EKN2
Knock Sensor (Bank 2)
VVT Sensor
(Bank 1 Intake Side)
VV1+
VV1-
VCV1
VVT Sensor
(Bank 2 Intake Side)
VV2+
VV2-
VCV2
VVT Sensor
(Bank 1 Exhaust Side)
EV1+
EV1-
VCE1
VVT Sensor
(Bank 2 Exhaust Side)
EV2+
EV2-
VCE2
To Main Body ECU
CANH
CANL
#10
No. 1 Fuel Injector
#20
No. 2 Fuel Injector
#30
No. 3 Fuel Injector
#40
No. 4 Fuel Injector
#50
No. 5 Fuel Injector
#60
No. 6 Fuel Injector
To IG2 Relay
A137632E02

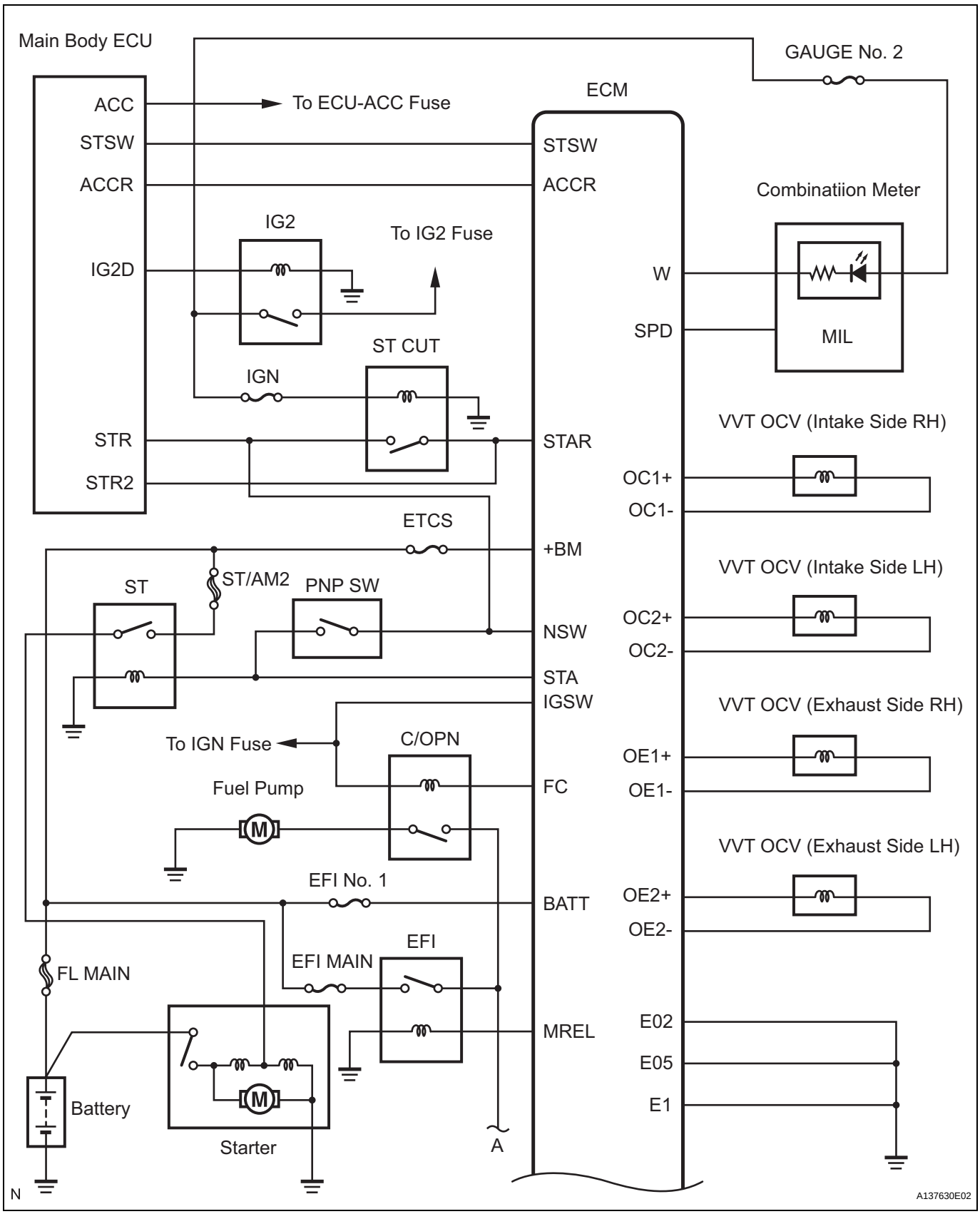
ES

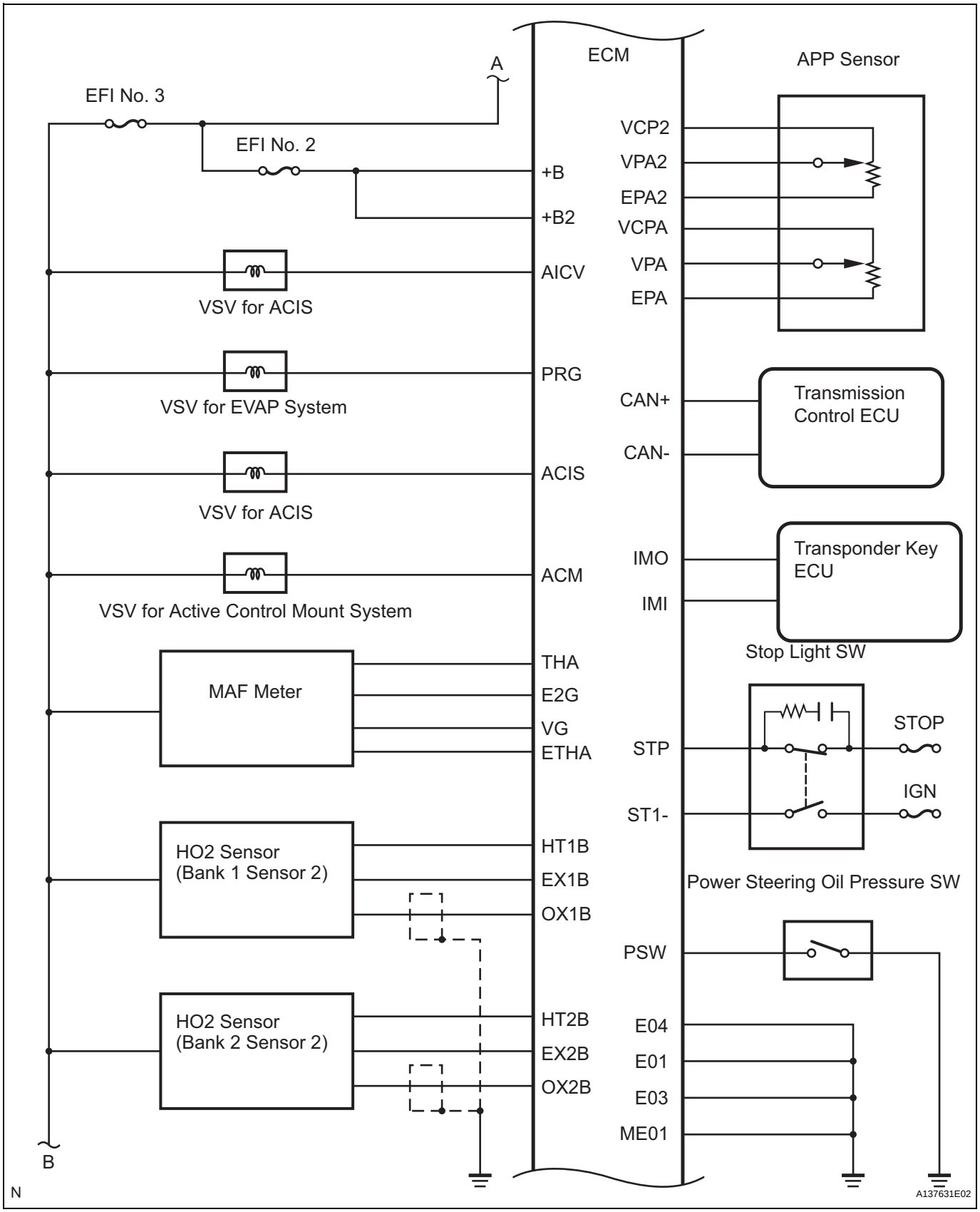

Crankshaft Position Sensor
ECM
Throttle Body Assembly
VTA1
VCTA
VTA2
ETA
M+
M-
GE01
NE+
NE-
TC
DLC3
Ignition Coil (No. 1)
ECT Sensor
THW
ETHW
IGT1
IGF1
Ignition Coil (No. 2)
IGT2
Ignition Coil (No. 3)
A/F Sensor (Bank 1 Sensor 1)
HA1A
A1A+
A1A-
IGT3
Ignition Coil (No. 4)
IGT4
Ignition Coil (No. 5)
A/F Sensor (Bank 2 Sensor 1)
HA2A
A2A+
A2A-
IGT5
Ignition Coil (No. 6)
IGT6
A/F
A/F
To Battery
To EFI Relay
To IG2 Relay
Noise Filter (RH Side)
Noise Filter (LH Side)
A137633E02


GAUGE No. 1
To IG1 Relay
Park / Neutral Position SW
Transmission Control ECU
ECM
P
R
N
D
S
SFTD
SFTU
CCS
Transmission Control SW
To IG1 Relay
ECU IG No. 2
Spiral Cable
Cruise Control SW
A137634E02

ES

2. With Smart Key System:




ECM
A
EFI No. 3
EFI No. 2
+B
+B2
AICV
VSV for ACIS
PRG
VSV for EVAP System
ACIS
VSV for ACIS
ACM
VSV for Active Control Mount System
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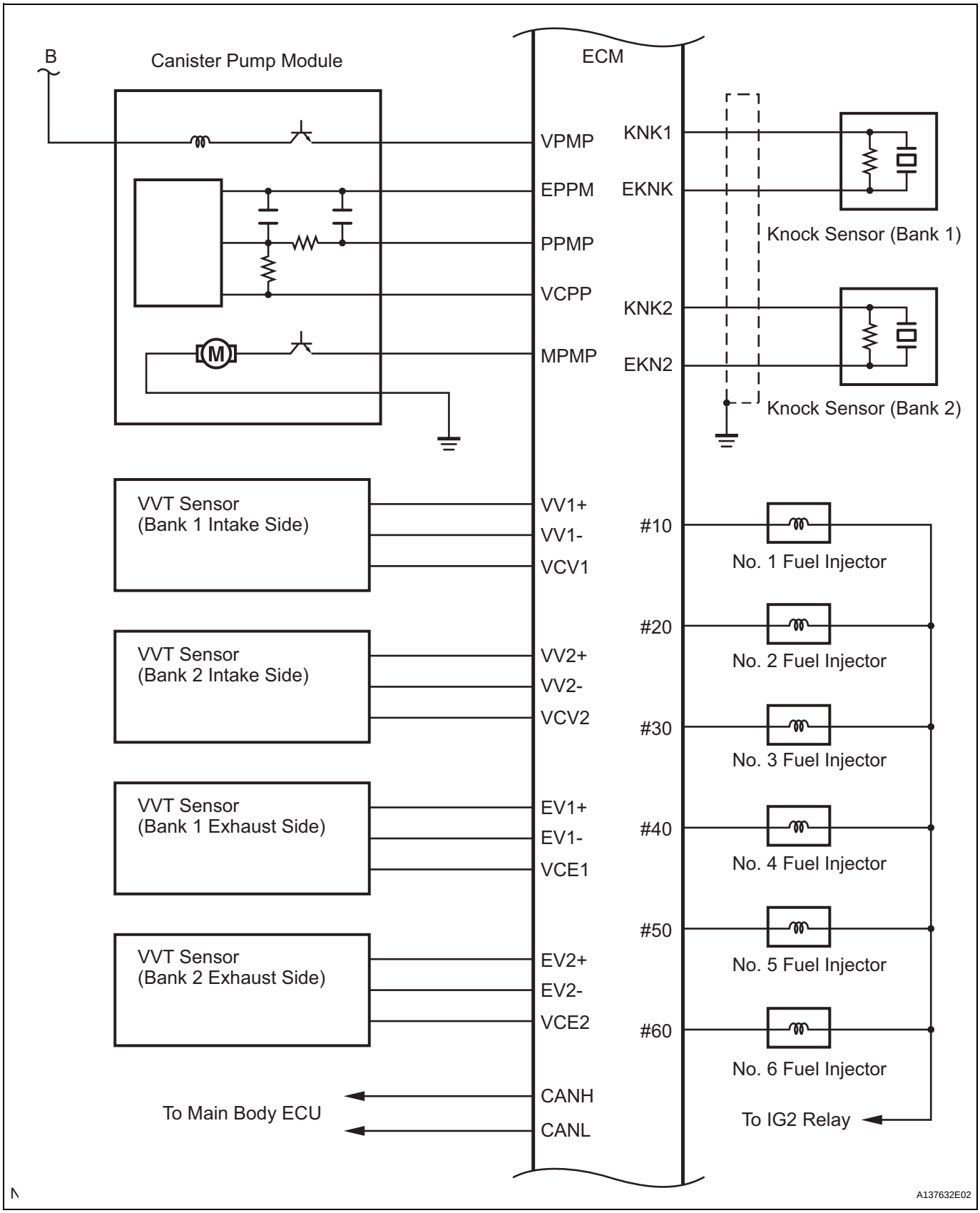
E2G
VG
ETHA
MAF Meter
HT1B
EX1B
OX1B
HO2 Sensor
(Bank 1 Sensor 2)
HT2B
EX2B
OX2B
HO2 Sensor
(Bank 2 Sensor 2)
B
N
APP Sensor
VCP2
VPA2
EPA2
VCPA
VPA
EPA
CAN+
CAN-
Transmission
Control ECU
IMO
IMI
Transponder Key
ECU
Stop Light SW
STP
ST1-
STOP
IGN
Power Steering Oil Pressure SW
PSW
E04
E01
E03
ME01
A137631E02


B
Canister Pump Module
ECM
VPMP
EPPM
PPMP
VCPP
MPMP
M
KNK1
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KNK2
EKN2
Knock Sensor (Bank 1)
Knock Sensor (Bank 2)
VVT Sensor
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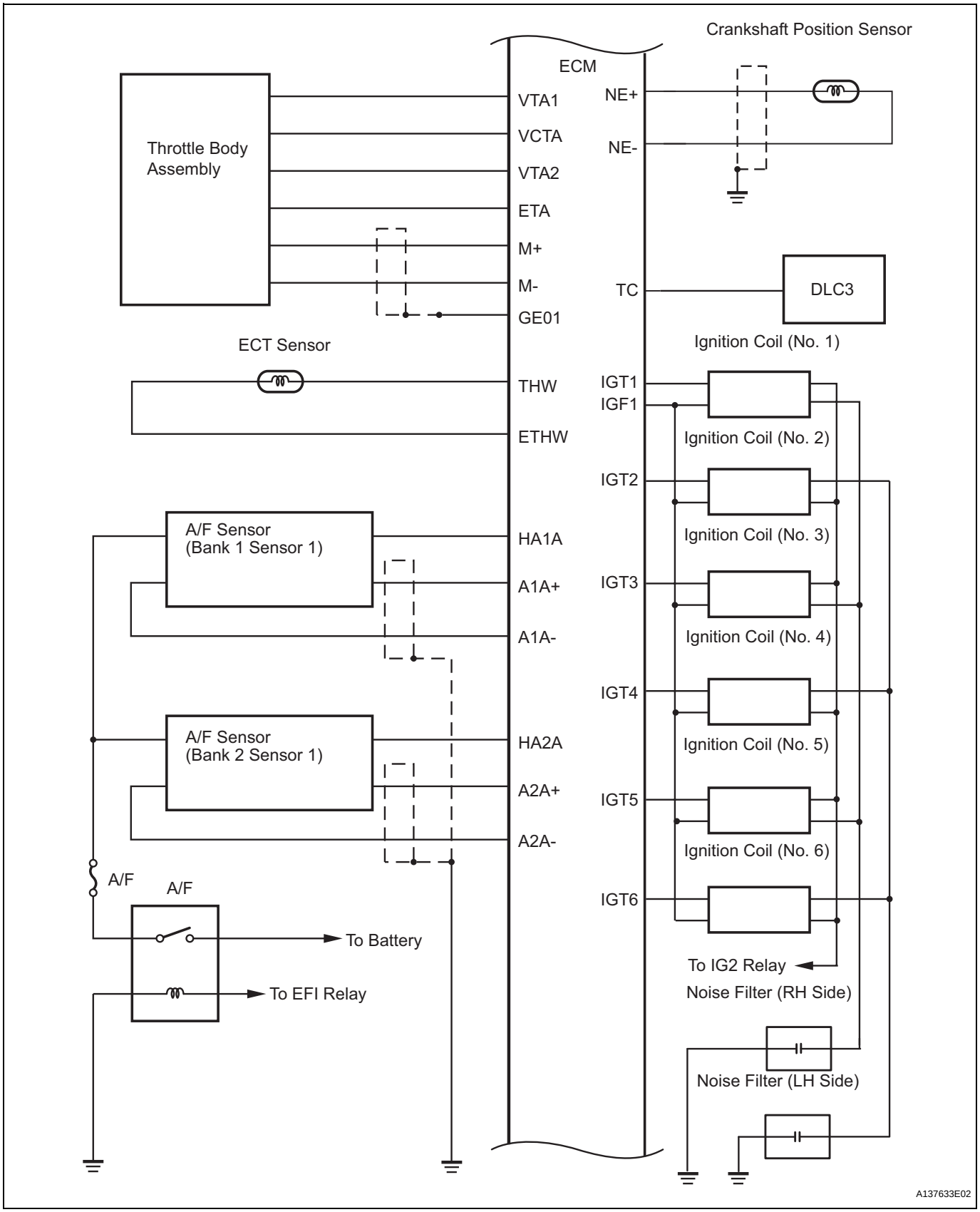
VCV1
VVT Sensor
(Bank 2 Intake Side)
VV2+
VV2-
VCV2
VVT Sensor
(Bank 1 Exhaust Side)
EV1+
EV1-
VCE1
VVT Sensor
(Bank 2 Exhaust Side)
EV2+
EV2-
VCE2
To Main Body ECU
CANH
CANL
#10
#20
#30
#40
#50
#60
No. 1 Fuel Injector
No. 2 Fuel Injector
No. 3 Fuel Injector
No. 4 Fuel Injector
No. 5 Fuel Injector
No. 6 Fuel Injector
To IG2 Relay
A137632E02


Crankshaft Position Sensor
ECM
Throttle Body Assembly
VTA1
VCTA
VTA2
ETA
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IGT4
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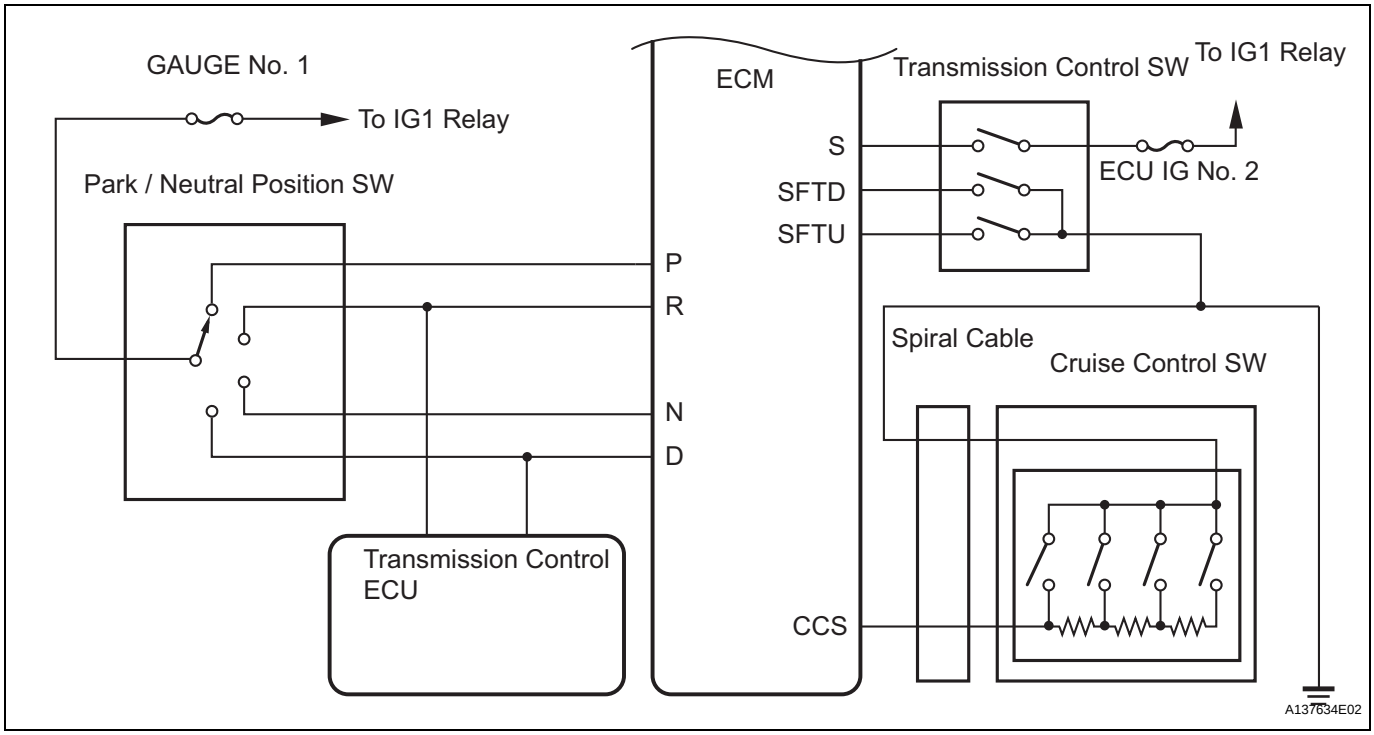
HA1A
A1A+
A1A-
A/F Sensor (Bank 2 Sensor 1)
HA2A
A2A+
A2A-
A/F
A/F
To Battery
To EFI Relay
To IG2 Relay
Noise Filter (RH Side)
Noise Filter (LH Side)
A137633E02


GAUGE No. 1
To IG1 Relay
Park / Neutral Position SW
ECM
Transmission Control SW
To IG1 Relay
S
SFTD
SFTU
ECU IG No. 2
P
R
N
D
Spiral Cable
Cruise Control SW
Transmission Control ECU
CCS
A137634E02

ES

HOW TO PROCEED WITH TROUBLESHOOTING

HINT:
*: Use the intelligent tester.

1	VEHICLE BROUGHT TO WORKSHOP

NEXT

2	CUSTOMER PROBLEM ANALYSIS

NEXT

3	CONNECT INTELLIGENT TESTER TO DLC3*

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

NEXT

4	CHECK DTC AND FREEZE FRAME DATA*

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

NEXT

5	CLEAR DTC AND FREEZE FRAME DATA*

NEXT

6	CONDUCT VISUAL INSPECTION

NEXT

7	SET CHECK MODE DIAGNOSIS*

NEXT

8	CONFIRM PROBLEM SYMPTOMS

HINT:
If the engine does not start, perform steps 10 and 12 first.

Result

Result	Proceed to
Malfunction does not occur	A
Malfunction occurs	B

B → GO TO STEP 10

A

9	SIMULATE SYMPTOMS

NEXT

ES

10	CHECK FOR DTCS*

Result

Result	Proceed to
Trouble code	A
No code	B

B → GO TO STEP 12

A

11	REFER TO DTC CHART

NEXT

GO TO STEP 14

12	CONDUCT BASIC INSPECTION

Result

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

B → GO TO STEP 17

A

13	REFER TO PROBLEM SYMPTOMS TABLE

Result

Result	Proceed to
Malfunctioning circuit confirmed	A

Result	Proceed to
Malfunctioning parts confirmed	B

B → GO TO STEP 17

A

14	CHECK ECM POWER SOURCE CIRCUIT

NEXT

15	CONDUCT CIRCUIT INSPECTION

ES

Result

Result	Proceed to
Malfunction not confirmed	A
Malfunction confirmed	B

B → GO TO STEP 18

A

16	CHECK FOR INTERMITTENT PROBLEMS

NEXT

GO TO STEP 18

17	CONDUCT PARTS INSPECTION

NEXT

18	IDENTIFY PROBLEM

NEXT

19	ADJUST AND/OR REPAIR

NEXT

20	CONDUCT CONFIRMATION TEST

NEXT

END

CHECK FOR INTERMITTENT PROBLEMS

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

1. Clear the DTCs.
2. Switch the ECM from normal mode to check mode using an intelligent tester (See page ES-49).
3. Perform a simulation test (See page IN-40).
4. Check and wiggle the harness(es), connector(s) and terminal(s) (See page IN-45).

BASIC INSPECTION

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

1 CHECK BATTERY VOLTAGE

NOTICE:
Carry out this check with the engine stopped and the engine switch off.
Result

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

NG → **CHARGE OR REPLACE BATTERY**

OK ↓

2 CHECK WHETHER ENGINE CRANKS

NG → **PROCEED TO PROBLEM SYMPTOMS TABLE**

OK ↓

3 CHECK WHETHER ENGINE STARTS

NG → **GO TO STEP 6**

OK ↓

4 CHECK AIR FILTER

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

NG → **REPLACE AIR FILTER**

OK ↓

5 CHECK IDLING SPEED

NG → **TROUBLESHOOT IDLING SPEED AND PROCEED TO NEXT STEP**

OK

6	CHECK FUEL PRESSURE

NG → TROUBLESHOOT FUEL PRESSURE AND PROCEED TO NEXT STEP

OK

7	CHECK FOR SPARKS

NG → TROUBLESHOOT SPARK AND PROCEED TO NEXT STEP

OK

PROCEED TO PROBLEM SYMPTOMS TABLE

REGISTRATION

NOTICE:
The Vehicle Identification Number (VIN) must be input into the replacement ECM.
HINT:
The VIN is in the form of a 17-digit alphanumeric vehicle identification number. An intelligent tester is required to register the VIN.

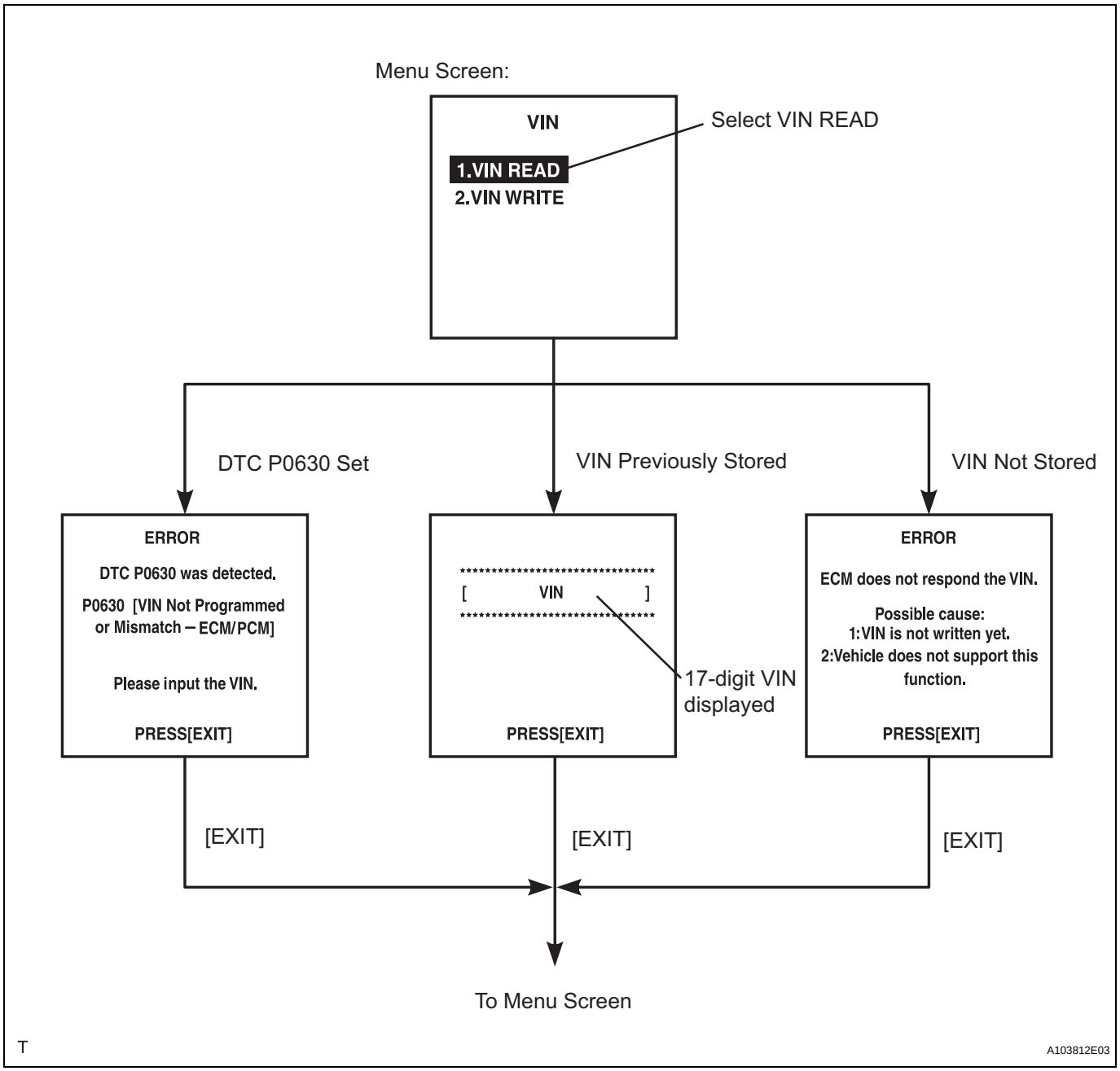
1. INPUT INSTRUCTIONS

(a) The general VIN input instructions using an intelligent tester are explained below:
(b) The arrow buttons (UP, DOWN, RIGHT and LEFT) and numerical buttons (0 to 9) are used, in order to input the VIN.
(c) Cursor Operation
To move the cursor around the tester screen, press the RIGHT and LEFT buttons.
(d) Alphabetical Character Input
(1) Press the UP and DOWN buttons to select the desired alphabetical character.
(e) Numeric Character Input
(1) Press the numerical button corresponding to the number that you want to input.
HINT:
Numerical characters can be selected by using the UP and DOWN buttons.
(f) Correction
(1) When correcting the input character(s), put the cursor onto the character using the RIGHT or LEFT button.
(2) Select or input the correct character using the UP and DOWN buttons, or the numerical buttons.
(g) Finishing Input Operation
(1) Make sure that the input VIN matches the vehicle VIN after input.
(2) Press the ENTER button on the tester.

2. READ VIN (Vehicle Identification Number)

(a) The flowchart of the VIN reading process is shown. This process allows the VIN stored in the ECM to be read, in order to confirm that the two VINs, provided with the vehicle and stored in the vehicle's ECM, are the same.
(b) Read VIN using an intelligent tester.
(c) Check the vehicle's VIN.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the ignition switch on (IG).
(f) Turn the tester on.

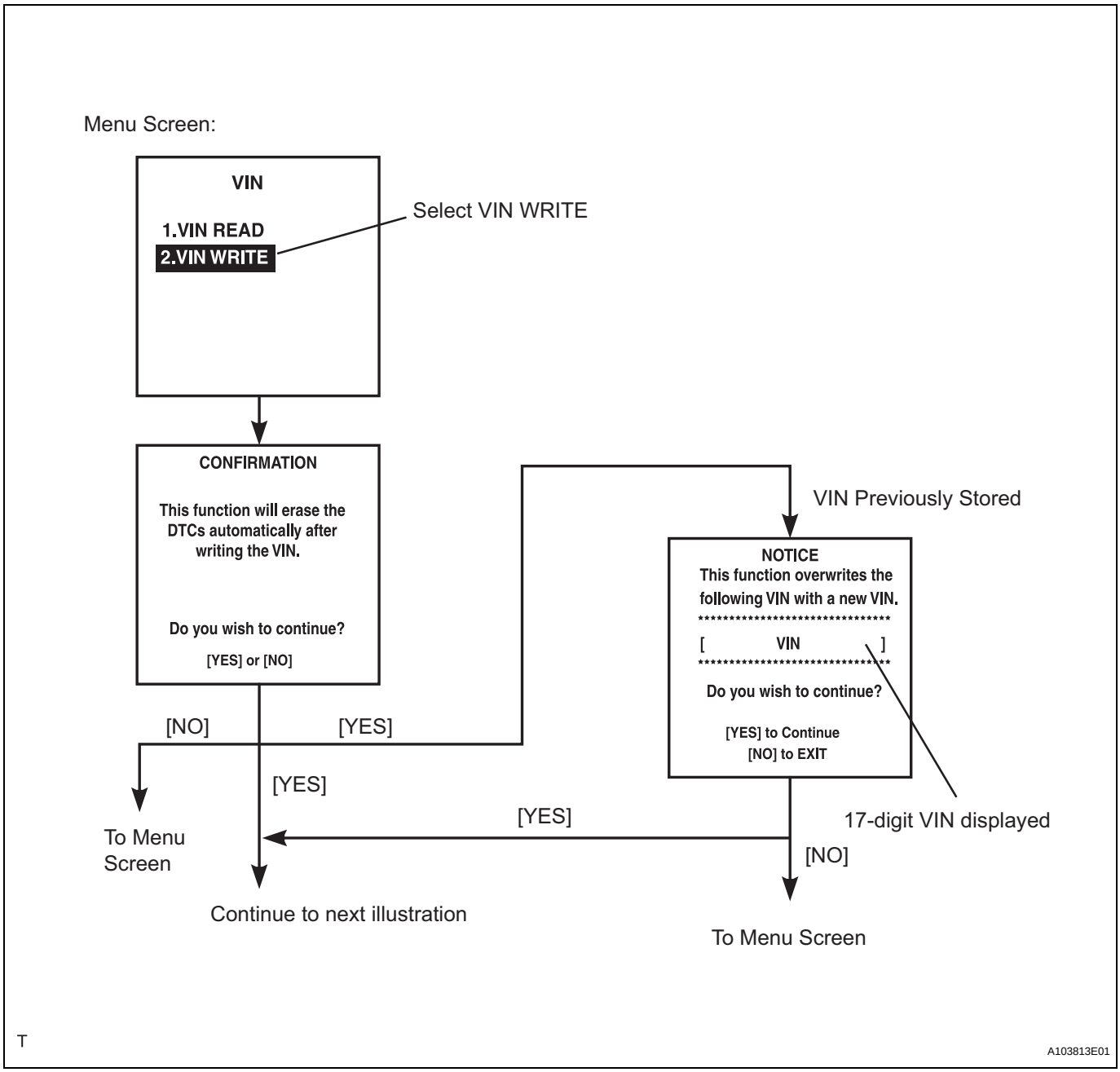
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / VIN.

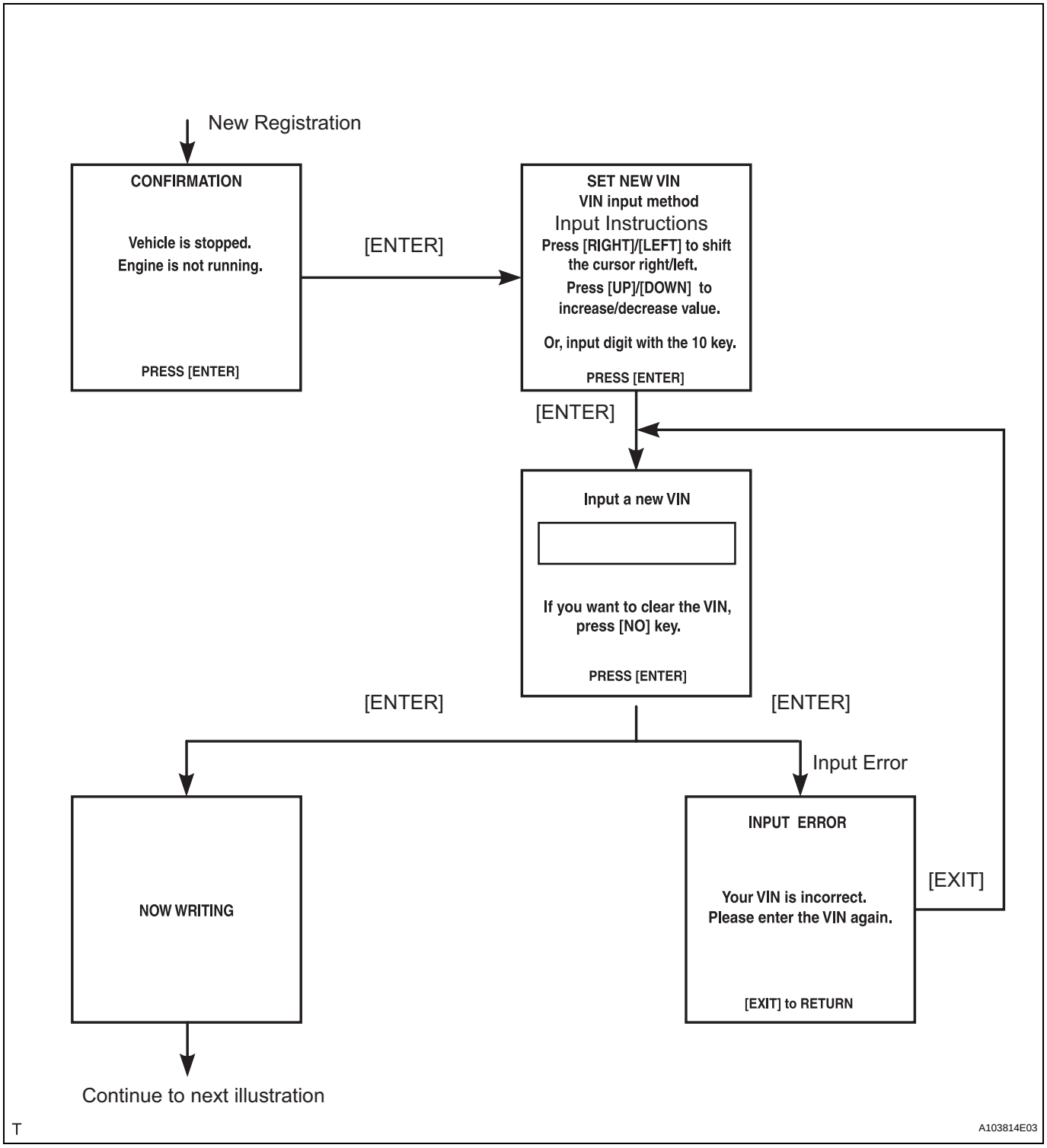


3. WRITE VIN

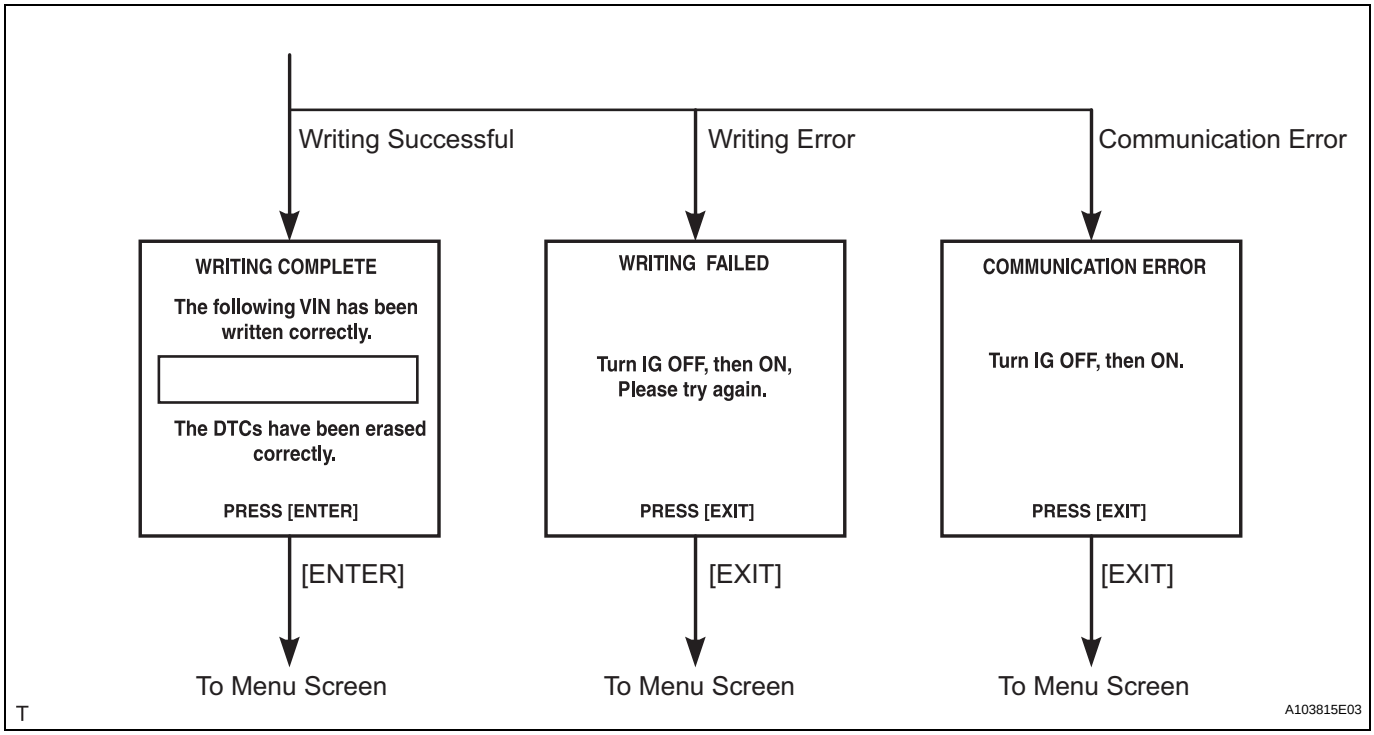
(a) The flowchart of the VIN writing process is shown. This process allows the VIN to be input into the ECM. If the ECM is changed, or the VINs do not match, the VIN can be registered, or overwritten in the ECM by following this procedure.
(b) Write VIN using the intelligent tester.
(c) Check the vehicle's VIN.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the ignition switch on (IG).
(f) Turn the tester on.

(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / VIN.




New Registration
CONFIRMATION
Vehicle is stopped.
Engine is not running.
PRESS [ENTER]
[ENTER]
SET NEW VIN
VIN input method
Input Instructions
Press [RIGHT]/[LEFT] to shift the cursor right/left.
Press [UP]/[DOWN] to increase/decrease value.
Or, input digit with the 10 key.
PRESS [ENTER]
[ENTER]
Input a new VIN
If you want to clear the VIN, press [NO] key.
PRESS [ENTER]
[ENTER]
[ENTER]
Input Error
NOW WRITING
INPUT ERROR
Your VIN is incorrect.
Please enter the VIN again.
[EXIT] to RETURN
[EXIT]
Continue to next illustration
T
A103814E03

ES


Writing Successful
Writing Error
Communication Error
WRITING COMPLETE
The following VIN has been written correctly.
The DTCs have been erased correctly.
PRESS [ENTER]
WRITING FAILED
Turn IG OFF, then ON, Please try again.
PRESS [EXIT]
COMMUNICATION ERROR
Turn IG OFF, then ON.
PRESS [EXIT]
[ENTER]
[EXIT]
[EXIT]
To Menu Screen
To Menu Screen
To Menu Screen
T
A103815E03

ES

CHECKING MONITOR STATUS

The purpose of the monitor result (mode 06) is to allow access to the results for on-board diagnostic monitoring tests of specific components/systems that are not continuously monitored. Examples are catalyst, evaporative emission (EVAP) and thermostat.

The monitor result allows the OBD II scan tool to display the monitor status, test value, minimum test limit and maximum test limit. These data are displayed after the vehicle has been driven to run the monitor.

When the test value is not between the minimum test limit and maximum test limit, the ECM (PCM) interprets this as a malfunction. When the component is not malfunctioning, if the difference of the test value and test limit is very small, the component will malfunction in the near future.

Perform the following instructions to view the monitor status. Although the Toyota diagnostic tester is used in the following instructions, it can be checked using a generic OBD II scan tool. Refer to your scan tool operator's manual for specific procedures.

1. PERFORM MONITOR DRIVE PATTERN

The monitor results and test values can be checked with the OBD II scan tool or the intelligent tester. The engine control module (ECM) monitors the emissions-related components such as the thermostat, catalyst converter and evaporative emissions (EVAP), and determines whether they are functioning normally or not. When monitoring is finished, the ECM stores the monitor results and the test values. The monitor result indicates whether the component is functioning normally or not. The test value is the value that was used to determine the monitor result. If the test value is outside of the test limit (malfunction criterion), the ECM determines the component is malfunctioning. Some emissions-related components have multiple test values to determine monitor result. If one of these test values is outside of the test limit, the ECM determines the component is malfunctioning.

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Clear the DTCs.
(d) Run the vehicle in accordance with the applicable drive pattern described in READINESS MONITOR DRIVE PATTERN (See page ES-28). DO NOT turn the engine switch off.

NOTICE:
The test results will be lost if the engine switch is turned off.

2. ACCESS MONITOR RESULT

(a) Select the following menus on the intelligent tester: DIAGNOSIS, ENHANCED OBDII, MONITOR INFO and MONITOR RESULT. The monitor status appears after the component name.
- INCMP: The component has not been monitored yet.
- PASS: The component is functioning normally.
- FAIL: The component is malfunctioning.

(b) Confirm that the component is either PASS or FAIL.

(c) Select the component and press ENTER. The accuracy test value appears if the monitor status is either PASS or FAIL.

HINT:

The monitor result might be PASS on rare occasions even if the Malfunction Indicator Lamp (MIL) is illuminated. This indicates that the system was malfunctioning in the previous driving cycle. This might be caused by an intermittent problem.

3. CHECK COMPONENT STATUS

(a) Compare the test value with the minimum test limit (MIN LIMIT) and maximum test limit (MAX LIMIT).

(b) If the test value is between the minimum test limit and maximum test limit, the component is functioning normally. If not, the component is malfunctioning. The test value is usually significantly higher or lower than the test limit. If the test value is on the borderline of the test limit, the component will malfunction in the near future.

HINT:

The monitor result might be PASS on rare occasions even if the Malfunction Indicator Lamp (MIL) is illuminated. This indicates that the system was malfunctioning in the previous driving cycle. This might be caused by an intermittent problem.

4. MONITOR RESULT INFORMATION

If you use a generic scan tool, multiply the test value by the scaling value listed below.

A/F Sensor Bank 1:

Monitor ID	Test ID	Scaling	Unit	Description
$01	$8E	Multiply by 0.0003	No dimension	A/F sensor deterioration level
$01	$91	Multiply by 0.004	mA	A/F sensor current

HO2S Bank 1 Sensor 2:

Monitor ID	Test ID	Scaling	Unit	Description
$02	$07	Multiply by 0.001	V	Minimum sensor voltage
$02	$08	Multiply by 0.001	V	Maximum sensor voltage
$02	$8F	Multiply by 0.003	g	Maximum oxygen storage capacity

A/F Sensor Bank 2:

Monitor ID	Test ID	Scaling	Unit	Description
$05	$8E	Multiply by 0.0003	No dimension	A/F sensor deterioration level
$05	$91	Multiply by 0.004	mA	A/F sensor current

HO2S Bank 2 Sensor 2:

Monitor ID	Test ID	Scaling	Unit	Description
$06	$07	Multiply by 0.001	V	Minimum sensor voltage
$06	$08	Multiply by 0.001	V	Maximum sensor voltage
$06	$8F	Multiply by 0.003	g	Maximum oxygen storage capacity

Catalyst-Bank 1:

Monitor ID	Test ID	Scaling	Unit	Description
$21	$A9	Multiply by 0.003	No dimension	Oxygen storage capacity of catalyst-bank 1

Catalyst-Bank 2:

Monitor ID	Test ID	Scaling	Unit	Description
$22	$A9	Multiply by 0.003	No dimension	Oxygen storage capacity of catalyst-bank 2

EVAP:

Monitor ID	Test ID	Scaling	Unit	Description
$3D	$C9	Multiply by 0.001	kPa	Test value for small leak (P0456)
$3D	$CA	Multiply by 0.001	kPa	Test value for gross leak (P0455)
$3D	$CB	Multiply by 0.001	kPa	Test value for leak detection pump OFF stuck (P2401)
$3D	$CD	Multiply by 0.001	kPa	Test value for leak detection pump ON stuck (P2402)
$3D	$CE	Multiply by 0.001	kPa	Test value for vent valve OFF stuck (P2420)
$3D	$CF	Multiply by 0.001	kPa	Test value for vent valve ON stuck (P2419)
$3D	$D0	Multiply by 0.001	kPa	Test value for reference orifice low flow (P043E)
$3D	$D1	Multiply by 0.001	kPa	Test value for reference orifice high flow (P043F)
$3D	$D4	Multiply by 0.001	kPa	Test value for purge VSV close stuck (P0441)
$3D	$D5	Multiply by 0.001	kPa	Test value for purge VSV open stuck (P0441)
$3D	$D7	Multiply by 0.001	kPa	Test value for purge flow insufficient (P0441)

Misfire:

Monitor ID	Test ID	Scaling	Unit	Description
$A1	$0B	Multiply by 1	Time	Exponential Weighted Moving Average (EWMA) misfire for all cylinders: Misfire counts for last ten driving cycles-Total
$A1	$0C	Multiply by 1	Time	Misfire rate for all cylinders: Misfire counts for last/current driving cycles-Total
$A2	$0B	Multiply by 1	Time	EWMA misfire for cylinder 1: Misfire counts for last ten driving cycles-Total
$A2	$0C	Multiply by 1	Time	Misfire rate for cylinder 1: Misfire counts for last/current driving cycle-Total
$A3	$0B	Multiply by 1	Time	EWMA misfire for cylinder 2: Misfire counts for last ten driving cycles-Total
$A3	$0C	Multiply by 1	Time	Misfire rate for cylinder 2: Misfire counts for last/current driving cycle-Total
$A4	$0B	Multiply by 1	Time	EWMA misfire for cylinder 3: Misfire counts for last ten driving cycles-Total
$A4	$0C	Multiply by 1	Time	Misfire rate for cylinder 3: Misfire counts for last/current driving cycle-Total
$A5	$0B	Multiply by 1	Time	EWMA misfire for cylinder 4: Misfire counts for last ten driving cycles-Total
$A5	$0C	Multiply by 1	Time	Misfire rate for cylinder 4: Misfire counts for last/current driving cycle-Total
$A6	$0B	Multiply by 1	Time	EWMA misfire for cylinder 5: Misfire counts for last ten driving cycles-Total
$A6	$0C	Multiply by 1	Time	Misfire rate for cylinder 5: Misfire counts for last/current driving cycle-Total
$A7	$0B	Multiply by 1	Time	EWMA misfire for cylinder 6: Misfire counts for last ten driving cycles-Total

Monitor ID	Test ID	Scaling	Unit	Description
$A7	$0C	Multiply by 1	Time	Misfire rate for cylinder 6: Misfire counts for last/current driving cycle-Total

Rear Oxygen Sensor Heater:

Monitor ID	Test ID	Scaling	Unit	Description
$42	$91	Multiply by 0.001	Ohm	Oxygen sensor heater resistance bank 1 sensor 2
$46	$91	Multiply by 0.004	Ohm	Oxygen sensor heater resistance bank 2 sensor 2

READINESS MONITOR DRIVE PATTERN

1. PURPOSE OF READINESS TESTS

- The On-Board Diagnostic (OBD II) system is designed to monitor the performance of emission-related components, and indicate any detected abnormalities with DTCs (Diagnostic Trouble Codes). Since various components need to be monitored in different driving conditions, the OBD II system is designed to run separate monitoring programs called Readiness Monitors.
- The intelligent tester's software must be version 9.0 or newer to view the Readiness Monitor status. To view the status, select the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / MONITOR STATUS.
- When the Readiness Monitor status reads COMPL (complete), the necessary conditions have been met for running the performance tests for that Readiness Monitor.
- A generic OBD II scan tool can also be used to view the Readiness Monitor status.

HINT:

Many Inspection and Maintenance (I/M) programs require a vehicle's Readiness Monitor status to show COMPL before beginning emission tests.

The Readiness Monitor will be reset to INCMPL (incomplete) if:

- The ECM has lost battery power or broken a fuse.
- DTCs have been cleared.
- The conditions for running the Readiness Monitor have not been met.

If the Readiness Monitor status shows INCMPL, follow the appropriate Readiness Monitor Drive Pattern to change the status to COMPL.

CAUTION:

Strictly observe posted speed limits, traffic laws, and road conditions when performing these drive patterns.

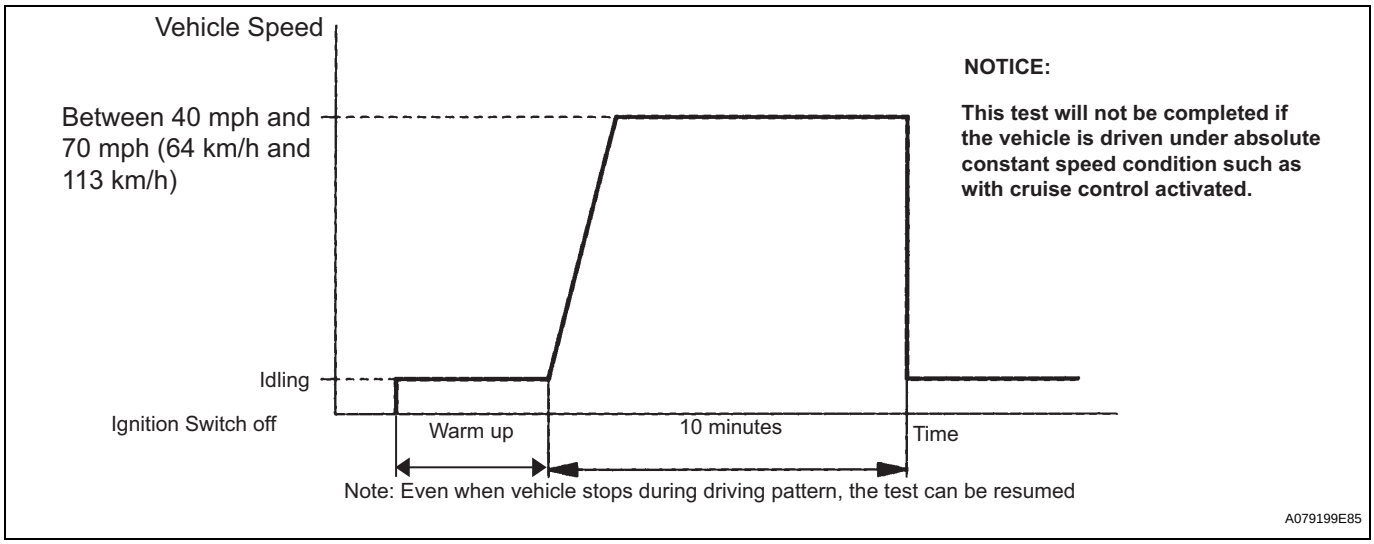
NOTICE:

These drive patterns represent the fastest method of satisfying all conditions necessary to achieve complete status for each specific Readiness Monitor.

In the event of a drive pattern being interrupted (possibly due to factors such as traffic conditions), the drive pattern can be resumed. In most cases, the Readiness Monitor will still achieve complete status upon completion of the drive pattern.

To ensure completion of the Readiness Monitors, avoid sudden changes in vehicle load and speed (driving up and down hills and/or sudden acceleration).

2. CATALYST MONITOR (ACTIVE AIR-FUEL RATIO CONTROL TYPE)



(a) Preconditions

The monitor will not run unless:

- The MIL is OFF.

(b) Drive Pattern

(1) Connect an intelligent tester.
(2) Turn the ignition switch on (IG).
(3) Turn the tester or scan tool ON.
(4) Clear the DTCs.
(5) Start the engine and warm it up.
(6) Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes.

(c) Monitor Status

(1) Check the Readiness Monitor status displayed on the tester.
(2) If the status does not switch to COMPL (complete), extend the driving time.

3. EVAP MONITOR (KEY-OFF TYPE)

(a) Preconditions

The monitor will not run unless:

- The fuel tank is less than 90% full.
- The altitude is less than 8,000 ft (2,450 m).
- The vehicle is stationary.
- The engine coolant temperature is between 4.4°C and 35°C (40°F to 95°F).
- The intake air temperature is between 4.4°C and 35°C (40°F to 95°F).
- Vehicle was driven in the city area (or on free-way) for 10 minutes or more.

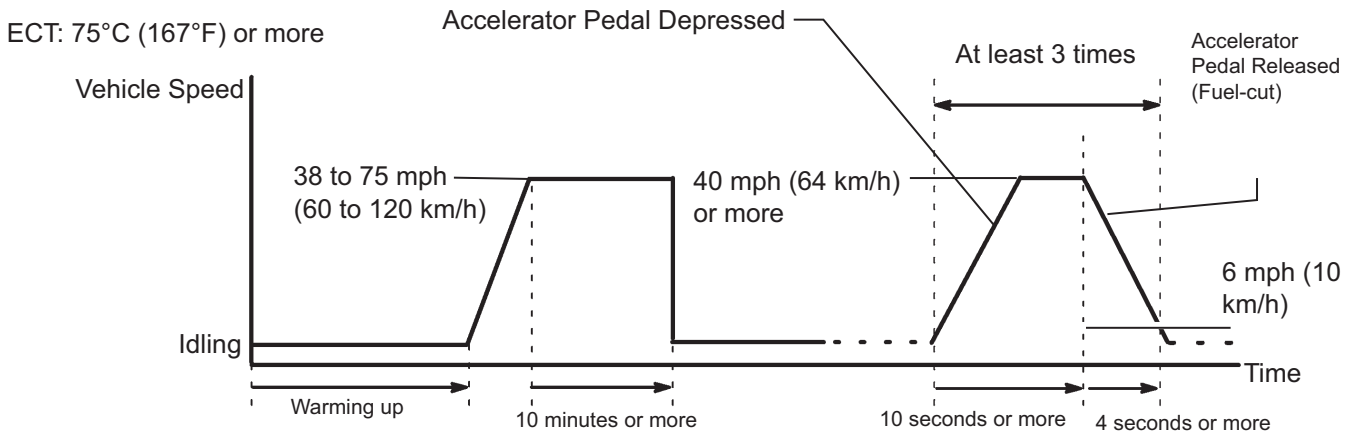
(b) Monitor Conditions

(1) Turn the ignition switch off and wait for 6 hours.
HINT:
Do not start the engine until checking Readiness Monitor status. If the engine is started, the step described above must be repeated.

(c) Monitor Status
(1) Connect an intelligent tester to the DLC3.
(2) Turn the ignition switch on (IG).
(3) Turn the tester or scan tool on.
(4) Check the Readiness Monitor status displayed on the tester or scan tool.
If the status does not switch to COMPL (complete), restart the engine, make sure that the preconditions have been met, and then perform the Monitor Conditions again.

4. A/F SENSOR AND HO2S MONITORS

Monitor Drive Pattern:



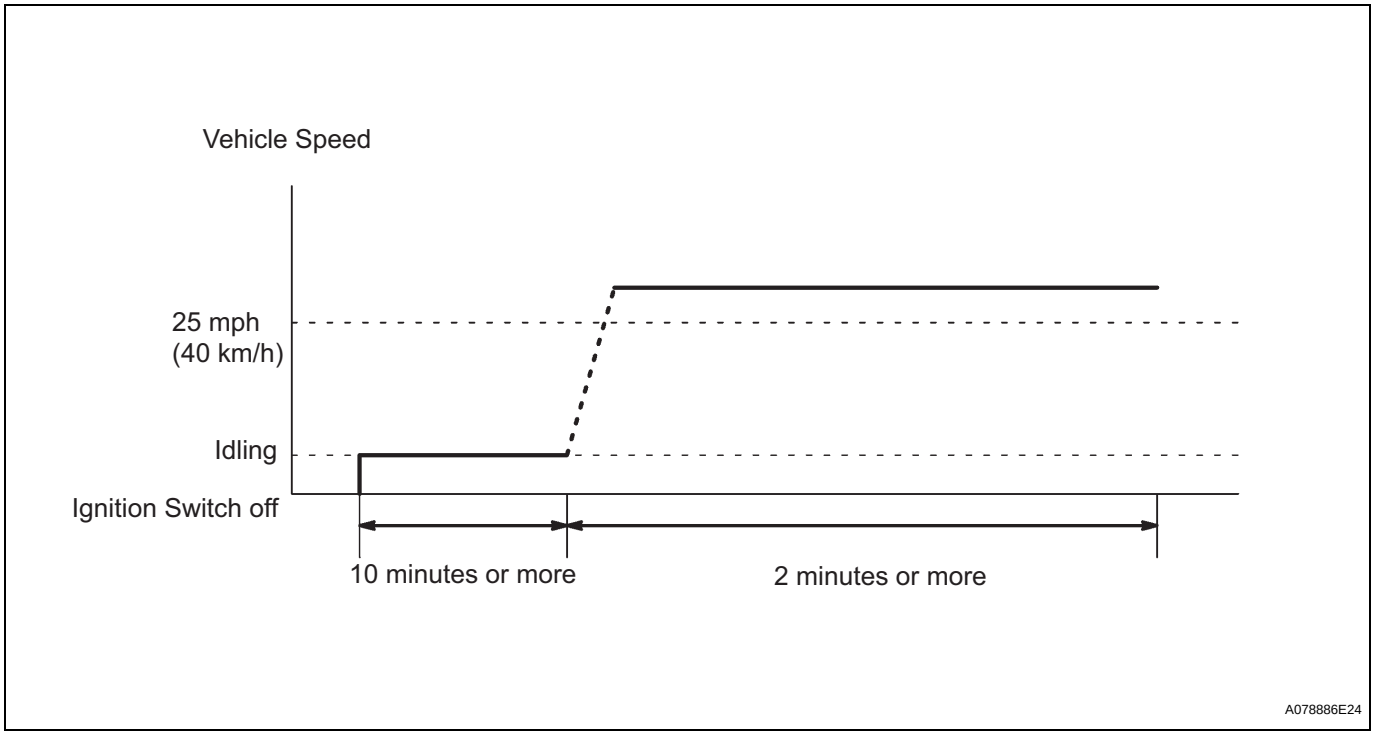
(a) Preconditions
The monitor will not run unless:
- 2 minutes or more have elapsed since the engine was started.
- The Engine Coolant Temperature (ECT) is 75°C (167°F) or more.
- Cumulative driving time at a vehicle speed of 30 mph (48 km/h) or more exceeds 6 minutes.
- Air-fuel ratio feedback control is performed.
- Fuel-cut control is performed for 8 seconds or more (for the Rear HO2 Sensor Monitor).

(b) Drive Pattern for front A/F sensor and HO2 sensor
(1) Connect an intelligent tester to the DLC3.
(2) Turn the ignition switch on (IG).
(3) Turn the tester on.
(4) Clear the DTCs.
(5) Start the engine, and warm it up until the ECT reaches 75°C (167°F) or higher.
(6) Drive the vehicle at 38 mph (60 km/h) or more for at least 10 minutes.
(7) Change the transmission to the 2nd gear.
(8) Accelerate the vehicle to 40 mph (64 km/h) or more by depressing the accelerator pedal for at least 10 seconds (Procedure "A").

(9) Soon after performing procedure "A" above, release the accelerator pedal for at least 4 seconds without depressing the brake pedal, in order to execute fuel-cut control (Procedure "B").
(10) Allow the vehicle to decelerate until the vehicle speed declines to less than 6 mph (10 km/h) (Procedure "C").
(11) Repeat procedures from "A" through "C" above at least 3 times in one driving cycle.

(c) Monitor Status
(1) Check the Readiness Monitor status displayed on the tester.
(2) If the status does not switch to COMPL (complete), make sure that the preconditions have been met and then perform the Drive Pattern again.

5. AIR-FUEL RATIO (A/F) AND HEATED OXYGEN (HO2) SENSOR HEATER MONITORS (FRONT A/F AND REAR HO2 SENSOR TYPE)



(a) Preconditions
The monitor will not run unless:
- The MIL is OFF.

(b) Drive Pattern
(1) Connect an intelligent tester to the DLC3.
(2) Turn the ignition switch on (IG).
(3) Clear the DTCs.
(4) Start the engine.
(5) Allow the engine to idle for 10 minutes or more.
(6) Drive the vehicle at 25 mph (40 km/h) or more for at least 2 minutes.

(c) Monitor Status

(1) Check the Readiness Monitor status displayed on the tester or scan tool.
If the status does not switch to COMPL (complete), make sure that the preconditions have been met, and repeat the Drive Pattern.

PROBLEM SYMPTOMS TABLE

HINT:
When a malfunction is not confirmed by a DTC (Diagnostic Trouble Code) check and the cause of problem cannot be identified through a basic inspection, troubleshoot according to the priority order indicated in the table below.

SFI SYSTEM

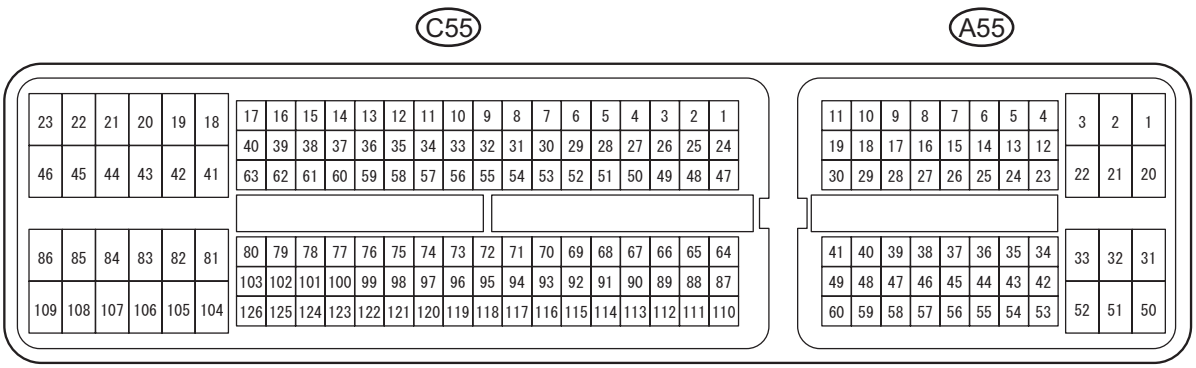
Symptom	Suspected area	See page
Without Smart Key System: Engine does not crank (Does not start)	1. Immobilizer system (with smart key system)	EI-7
	2. Immobilizer system (without smart key system)	EI-55
	3. Starter signal circuit	ES-304
	4. Starter	ST-143
	5. STARTER relay	ST-149
With Smart Key System: Engine does not crank (Does not start)	1. Immobilizer system (with smart key system)	EI-7
	2. Immobilizer system (without smart key system)	EI-55
	3. Cranking holding function circuit	ES-455
	4. Starter signal circuit	ES-304
	5. Starter	ST-143
	6. STARTER relay	ST-149
	7. ECM power source circuit	ES-432
	8. ECM	ES-518
No initial combustion (Does not start)	1. ECM power source circuit	ES-432
	2. Ignition system	IG-3
	3. Fuel pump control circuit	ES-449
	4. Injector	FU-15
	5. Crank angle sensor	ES-497
	6. ECM	ES-518
Engine cranks normally but difficult to start	1. Electronic Throttle Control System (ETCS)	ES-320
	2. Fuel pump control circuit	ES-449
	3. Ignition system	IG-3
	4. Spark plug	IG-5
	5. Compression	EM-3
	6. Injector	FU-15
	7. Crank angle sensor	ES-497
Difficult to start with cold engine	1. Starter signal circuit	ES-304
	2. Electronic Throttle Control System (ETCS)	ES-320
	3. Fuel pump control circuit	ES-449
	4. Spark plug	IG-5
	5. Ignition system	IG-3
	6. Injector	FU-15
	7. Engine coolant temperature sensor	ES-500
Difficult to start with warm engine	1. Starter signal circuit	ES-304
	2. Electronic Throttle Control System (ETCS)	ES-320
	3. Fuel pump control circuit	ES-449
	4. Spark plug	IG-5
	5. Ignition system	IG-3
	6. Injector	FU-15
	7. Engine coolant temperature sensor	ES-500

Symptom	Suspected area	See page
High engine idling speed (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-320
	2. ECM power source circuit	ES-432
	3. A/C signal circuit (Compressor circuit)	-
	4. Acoustic Control Induction System (ACIS)	ES-462
	5. PCV hose	EC-5
	6. ECM	ES-518
Low engine idling speed (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-320
	2. ECM power source circuit	ES-432
	3. A/C signal circuit (Compressor circuit)	-
	4. Acoustic Control Induction System (ACIS)	ES-462
	5. PCV hose	EC-5
	6. Injector	FU-15
	7. ECM	ES-518
Rough idling (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-320
	2. Injector	FU-15
	3. Ignition system	IG-3
	4. Compression	EM-3
	5. Fuel pump control circuit	ES-449
	6. Spark plug	IG-5
	7. Acoustic Control Induction System (ACIS)	ES-462
	8. PCV hose	EC-5
Hunting (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-320
	2. ECM power source circuit	ES-432
	3. Fuel pump control circuit	ES-449
	4. Spark plug	IG-5
	5. Ignition system	IG-3
	6. Injector	FU-15
	7. Acoustic Control Induction System (ACIS)	ES-462
	8. PCV hose	EC-5
Hesitation/Poor acceleration (Poor driveability)	1. Injector	FU-15
	2. Fuel pump control circuit	ES-449
	3. Ignition system	IG-3
	4. Spark plug	IG-5
	5. Air Intake Control System (AICS)	ES-462
	6. A/T faulty	AX-9
Surging (Poor driveability)	1. Fuel pump control circuit	ES-449
	2. Spark plug	IG-5
	3. Ignition system	IG-3
	4. Injector	FU-15
Engine stalls soon after starting	1. Fuel pump control circuit	ES-449
	2. Electronic Throttle Control System (ETCS)	ES-320
	3. Crank angle sensor	ES-497
	4. Spark plug	IG-5
	5. Ignition system	IG-3
	6. Injector	FU-15
Engine stalls during A/C operation	1. A/C signal circuit	-
	2. ECM	ES-518
Unable/difficult to refuel	Refueling valve (canister)	-
Engine vibrates frequently when idling (Active Control engine Mount (ACM) system does not operate)	Active control engine mount circuit	ES-393

ES

TERMINALS OF ECM

1. SFI SYSTEM



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HINT:
The standard normal voltage between each pair of the ECM terminals is shown in the table below. The appropriate conditions for checking each pair of the terminals are also indicated.
The check results should be compared with the standard normal voltage for that pair of terminals, listed in the "STD Voltages" column.
The illustration above can be used as a reference to identify the ECM terminal locations.

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
+B (A55-2) - E1 (C55-81)	R - W-B	Power source of ECM	Ignition switch on (IG)	9 to 14 V
+B2 (A55-1) - E1 (C55-81)	R - W-B	Power source of ECM	Ignition switch on (IG)	9 to 14 V
BATT (A55-20) - E1 (C55-81)	Y - W-B	Battery (for measuring the battery voltage and for the ECM memory)	Always	9 to 14 V
VPMP (A55-42) - E1 (C55-81)	W - W-B	Vent valve operation signal (built into pump module)	Ignition switch on (IG)	9 to 14 V
MPMP (A55-34) - E1 (C55-81)	G - W-B	Vacuum pump operation signal (built into pump module)	Vacuum pump OFF	0 to 3 V
MPMP (A55-34) - E1 (C55-81)	G - W-B	Vacuum pump operation signal (built into pump module)	Vacuum pump ON	9 to 14 V
+BM (A55-3) - E1 (C55-81)	LG - W-B	Power source of ETCS throttle motor	Always	9 to 14 V
MREL (A55-44) - E1 (C55-81)	O - W-B	EFI relay operation signal	Ignition switch on (IG)	9 to 14 V
IGSW (A55-28) - E1 (C55-81)	Y - W-B	Ignition switch signal	Ignition switch on (IG)	9 to 14 V
FC (A55-7) - E1 (C55-81)	FC (A55-7) - E1 (C55-81)	C/OPEN relay operation signal (fuel pump control)	Ignition switch on (IG), Engine stopped	9 to 14 V
FC (A55-7) - E1 (C55-81)	FC (A55-7) - E1 (C55-81)	C/OPEN relay operation signal (fuel pump control)	Ignition switch on (IG), Engine idling	0 to 1.5 V
STP (A55-36) - E1 (C55-81)	- W-B	Stop light switch signal	W-Brake pedal depressed	7.5 to 14 V
STP (A55-36) - E1 (C55-81)	- W-B	Stop light switch signal	W-Brake pedal released	Below 1.5 V
ST1- (A55-35) - E1 (C55-81)	GR - W-B	Stop light switch signal (opposite to STP terminal)	Ignition switch on (IG), W-Brake pedal depressed	Below 1.5 V

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
ST1- (A55-35) - E1 (C55-81)	GR - W-B	Stop light switch signal (opposite to STP terminal)	Ignition switch on (IG), W-Brake pedal released	7.5 to 14 V
ACCR*2 (A24-17) - E1 (C55-81)	B - W-B	ACC relay control signal	Cranking	Below 1.5 V
VPA (A55-55) - E1 (C55-81)	G - W-B	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully released	0.5 to 1.1 V
VPA (A55-55) - E1 (C55-81)	G - W-B	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully depressed	2.6 to 4.5 V
VPA2 (A55-58) - EPA2 (A55-60)	R - O	Accelerator pedal position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully released	1.2 to 2.0 V
VPA2 (A55-58) - EPA2 (A55-60)	R - O	Accelerator pedal position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully depressed	3.4 to 5.0 V
EPA (A5-59) - VPA (A55-55)	Y - G	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully released	0.5 to 1.1 V
EPA (A5-59) - VPA (A55-55)	Y - G	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully depressed	2.6 to 4.5 V
EPA2 (A55-60) - VPA2 (A55-58)	O - R	Accelerator pedal position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully released	1.2 to 2.0 V
EPA2 (A55-60) - VPA2 (A55-58)	O - R	Accelerator pedal position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully depressed	3.4 to 5.0 V
PPMP (C55-77) - E1 (C55-81)	L - W-B	Pressure sensor signal (built into pump module)	Ignition switch on (IG)	3 to 3.6 V
TC (A55-27) - E1 (C55-81)	P - W-B	Terminal TC of DLC3	Ignition switch on (IG)	9 to 14 V
VCPA (A55-57) - EPA (A55-59)	R - Y	Power source of accelerator pedal position sensor (for VPA)	Ignition switch on (IG)	4.5 to 5.0 V
VCP2 (A55-56) - EPA2 (A55-60)	L - O	Power source of accelerator pedal position sensor (for VPA2)	Ignition switch on (IG)	4.5 to 5.0 V
TACH (A55-15) - E1 (C55-81)	B - W-B	Engine speed signal (for combination meter)	Idling	Pulse generation (see waveform 11)
CCS (A55-40) - E1 (C55-81)	W - W-B	Cruise control main switch signal	Ignition switch on (IG) CANCEL switch ON SET/COAST switch ON RES/ACC switch ON Main switch ON	10 to 16 V 6.6 to 10.1 V 4.5 to 7.1 V 2.3 to 4.0 V Below 1 V
SPD (A55-24) - E1 (C55-81)	BR - W-B	Vehicle speed signal from combination meter	Ignition switch on (IG), driving wheel rotated slowly	Pulse generation (see waveform 8)
W (A55-24) - E1 (C55-81)	BR - W-B	Malfunction Indicator Lamp (MIL) operation signal	Ignition switch on (IG)	Below 3.0 V
W (A55-24) - E1 (C55-81)	BR - W-B	Malfunction Indicator Lamp (MIL) operation signal	Idling	9 to 14 V
CANH (A55-41) - CANL (A55-49)	B - W	CAN communication circuit	Ignition switch off	54 to 69 Ω
E1 (C55-81) - Body ground	W-B - -	Earth (ground) circuit of ECM	Always	Below 1 V

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
#10 (C55-45) - E01 (C55-22) #20 (C55-85) - E01 (C55-22) #30 (C55-44) - E01 (C55-22) #40 (C55-84) - E01 (C55-22) #50 (C55-43) - E01 (C55-22) #60 (C55-83) - E01 (C55-20)	B - W-B R - W-B Y - W-B L - W-B W-L - W-B BR - W-B	Fuel injector operation signal	Ignition switch on (IG)	9 to 14 V
#10 (C55-45) - E01 (C55-22) #20 (C55-85) - E01 (C55-22) #30 (C55-44) - E01 (C55-22) #40 (C55-84) - E01 (C55-22) #50 (C55-43) - E01 (C55-22) #60 (C55-83) - E01 (C55-20)	B - W-B R - W-B Y - W-B L - W-B W-L - W-B BR - W-B	Fuel injector operation signal	Idling	Pulse generation (see waveform 3)
PSW (C55-810) - E1 (C55-81)	B - W-B	P/S pressure switch signal	Ignition switch on (IG)	9 to 14 V
STA (A55-48) - E1 (C55-81)	V - W-B	Starter relay operation signal	Cranking	9 to 14 V
STSW*2 (A55-14) - E1 (C55-81)	R - W-B	Starter relay operation signal	Cranking	9 to 14 V
OC2- (C55-51) - OC2+ (C55-52)	R - BR	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OC2+ (C55-52) - OC2- (C55-51)	BR - R	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OC1- (C55-57) - OC1+ (C55-58)	B - W	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OC1+ (C55-58) - OC1- (C55-57)	W - B	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
VV2+ (C55-67) - VV2- (C55-90)	W - B	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
VV1+ (C55-69) - VV1- (C55-92)	L - LG	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
NE- (C55-111) - NE+ (C55-110)	R - G	Crankshaft position sensor signal	Idling	Pulse generation (see waveform 5)
NE+ (C55-110) - NE- (C55-111)	G - R	Crankshaft position sensor signal	Idling	Pulse generation (see waveform 5)
EV2- (C55-89) - EV2+ (C55-66)	L - G-R	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
EV2+ (C55-66) - EV2- (C55-89)	G-R - L	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
EV1- (C55-91) - EV1+ (C55-68)	B - Y	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
EV1+ (C55-68) - EV1- (C55-91)	Y - B	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
OE1+ (C55-16) - OE1- (C55-17)	L - LG	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
OE2+ (C55-14) - OE2- (C55-15)	W-L - Y	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
VV2- (C55-90) - VV2+ (C55-67)	B - W	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
VV1- (C55-92) - VV1+ (C55-69)	LG - L	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
OE1- (B47-31) - OE1+ (B47-26)	LG - L	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OE2- (C55-15) - OE2+ (C55-14)	Y - W-L	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
HT1B (C55-48) - E1 (C55-81) HT2B (C55-47) - E1 (C55-81)	LG - W-B Y - W-B	Heated oxygen sensor heater operation signal	Idling	Below 3.0 V
HT1B (C55-48) - E1 (C55-81) HT2B (C55-47) - E1 (C55-81)	LG - W-B Y - W-B	Heated oxygen sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
ACM (C55-42) - E1 (C55-81)	L-B - W-B	VSV for active control mount system operation signal	Ignition switch on (IG)	9 to 14 V
M- (C55-18) - ME01 (C55-20)	R - B	Throttle drive motor operation signal (negative terminal)	Idling with warm engine	Pulse generation (see waveform 10)
M+ (C55-19) - ME01 (C55-20)	G - B	Throttle drive motor operation signal (positive terminal)	Idling with warm engine	Pluse generation (see waveform 9)
E02 (C55-21) - Body ground	B-W - -	Earth (ground) circuit of ECM	Always	Below 1 V
E01 (C55-22) - Body ground	W-B - -	Earth (ground) circuit of ECM	Always	Below 1 V
IGT1 (C55-40) - E1 (C55-81) IGT2 (C55-39) - E1 (C55-81) IGT3 (C55-38) - E1 (C55-81) IGT4 (C55-37) - E1 (C55-81) IGT5 (C55-36) - E1 (C55-81) IGT6 (C55-35) - E1 (C55-81)	W - W-B GR - W-B G - W-B LG - W-B P - W-B G-R - W-B	Ignition coil with igniter (ignition signal)	Idling	Pulse generation (see waveform 6)
GE01(C55-41) - E1 (C55-81)	G-R - W-B	Shielded earth (ground) circuit of throttle drive motor	Always	Below 1 V
OX1B (C55-88) - EX1B (C55-65) OX2B (C55-87) - EX2B (C55-64)	W - BR B - W-B	Heated oxygen sensor signal	With engine speed at 2,500 rpm for 2 minutes after warming up	Pulse generation (see waveform 2)
VTA2 (C55-99) - ETA (C55-97)	W-L - P	Throttle position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully released	2.1 to 3.1 V
VTA2 (C55-99) - ETA (C55-97)	W-L - P	Throttle position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully depressed	4.5 to 5.0 V
VTA1 (C55-98) - ETA (C55-97)	Y - P	Throttle position sensor signal (for engine control)	Ignition switch on (IG), Throttle valve fully closed	0.5 to 1.2 V
VTA1 (C55-98) - ETA (C55-97)	Y - P	Throttle position sensor signal (for engine control)	Ignition switch on (IG), Throttle valve fully open	3.2 to 4.8 V
THW (C55-79) - ETHW (C55-78)	B - P	Engine coolant temperature sensor signal	Idling, Engine coolant temperature 80°C (176°F)	0.2 to 1.0 V
THA (C55-71) - ETHA (C55-74)	P - G-R	Intake air temperature sensor signal	Idling, Intake air temperature 20°C (68°F)	0.5 to 3.4 V

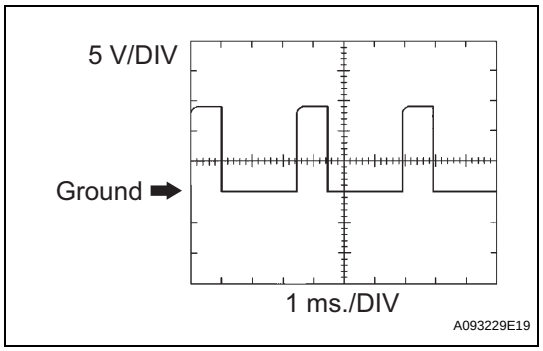
ES

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
IGF1 (C55-106) - E1 (C55-81)	BR - W-B	Ignition coil with igniter (ignition confirmation signal)	Ignition switch on (IG)	4.5 to 5.0 V
IGF1 (C55-106) - E1 (C55-81)	BR - W-B	Ignition coil with igniter (ignition confirmation signal)	Idling	Pulse generation (see waveform 6)
AICV (A55-4) - E1 (C55-81)	V - W-B	VSV for Air intake control system operation signal	Ignition switch on (IG)	9 to 14 V
E2G (C55-73) - E1 (C55-81)	LG - W-B	Earth (ground) circuit of sensor for mass air flow meter	Always	Below 1 V
VG (C55-72) - E2G (C55-73)	L-B - LG	Mass Air Flow (MAF) meter signal	Idling, Shift lever position P or N, A/C switch OFF	0.5 to 3.0 V
ACIS (C55-107) - E1 (C55-81)	R - W-B	VSV for ACIS (Acoustic Control Induction System) operation signal	Ignition switch on (IG)	9 to 14 V
PRG (C55-108) - E1 (C55-81)	G-R - W-B	Purge VSV for EVAP system operation signal	Ignition switch on (IG)	9 to 14 V
PRG (C55-108) - E1 (C55-81)	G-R - W-B	Purge VSV for EVAP system operation signal	Idling	Pulse generation (see waveform 7)
HA2A (C55-109) - E05 (C55-46)	B-W - W	A/F sensor heater operation signal	Idling	Below 3.0 V
HA2A (C55-109) - E05 (C55-46)	B-W - W	A/F sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
HA1A (C55-86) - E04 (C55-23)	G - W	A/F sensor heater operation signal	Idling	Below 3.0 V
HA1A (C55-86) - E04 (C55-23)	G - W	A/F sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
ME01 (C55-20) - E1 (C55-81)	B - W-R	Earth (ground) circuit of ECM	Always	Below 1 V
E03 (C55-104) - E1 (C55-81)	B - W-B	Earth (ground) circuit of ECM	Always	Below 1 V
HT2B (C55-47) - E1 (C55-81) HT1B (C55-48) - E1 (C55-81)	Y - W-B LG - W-B	Heated oxygen sensor heater operation signal	Idling	Below 3.0 V
HT2B (C55-47) - E1 (C55-81) HT1B (C55-48) - E1 (C55-81)	Y - W-B LG - W-B	Heated oxygen sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
E05 (C55-46) - E1 (C55-81)	W - W-B	Earth (ground) circuit of ECM	Always	Below 1 V
E04 (C55-23) - E1 (C55-81)	W - W-B	Earth (ground) circuit of ECM	Always	Below 1 V
NSW (C55-62) - E1 (C55-81)	R - W-B	Park/Neutral position switch signal	Ignition switch on (IG), Shift lever position P or N	Below 3.0 V
NSW (C55-62) - E1 (C55-81)	R - W-B	Park/Neutral position switch signal	Ignition switch on (IG), Shift lever position other than P or N	9 to 14 V
EKN2 (C55-117) - KNK2 (C55-118)	W - B	Earth (ground) circuit of knock sensor	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
KNK2 (C55-118) - EKN2 (C55-117)	B - W	Knock sensor signal	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
A1A+ (C55-93) - E1 (C55-81)	P - W-B	A/F sensor signal	Ignition switch on (IG)	3.3 V*1
A1A+ (C55-93) - E1 (C55-81)	P - W-B	A/F sensor signal	Ignition switch on (IG)	3.0 V*1
A2A+ (C55-120) - E1 (C55-81)	L - W-B	A/F sensor signal	Ignition switch on (IG)	3.3 V*1
A2A+ (C55-120) - E1 (C55-81)	L - W-B	A/F sensor signal	Ignition switch on (IG)	3.0 V*1
EKNK (C55-94) - KNK1 (C55-95)	G - R	Earth (ground) circuit of knock sensor	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
KNK1 (C55-95) - EKNK (C55-94)	R - G	Knock sensor signal	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
A1A- (C55-116) - E1 (C55-81)	P - W-B	A/F sensor	Ignition switch on (IG)	3.3 V*1

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
A1A- (B46-30) - E1 (C55-81)	P - W-B	A/F sensor	Ignition switch on (IG)	3.0 V*1
A2A- (C55-119) - E1 (C55-81)	Y - W-B	A/F sensor	Ignition switch on (IG)	3.3 V*1
A2A- (C55-119) - E1 (C55-81)	Y - W-B	A/F sensor	Ignition switch on (IG)	3.0 V*1
OX2B (C55-87) - EX2B (C55-64) OX1B (C55-88) - EX1B (C55-65)	B - W-R W - BR	Heated oxygen sensor signal	With engine speed at 2,500 rpm for 2 minutes after warming up	Pulse generation (see waveform 2)

*1: The ECM terminal voltage is constant regardless of the output voltage from the sensor.

*2: With Smart Key system

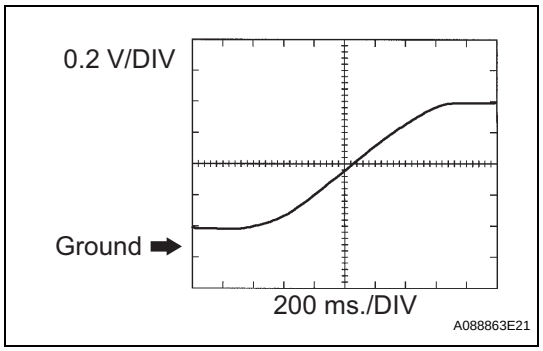


(a) WAVEFORM 1

(1) Camshaft timing Oil Control Valve (OCV) operation signal

ECM Terminal Names	Between OC1+ and OC1- , OC2+ and OC2- , OE1+ and OE1- , or OE2+ and OE2-
Tester Ranges	5 V/DIV, 1 ms./DIV
Conditions	Idling

HINT:
The wavelength becomes shorter as the engine rpm increases.

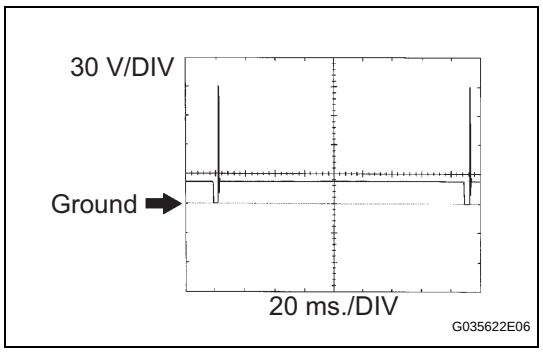


(b) WAVEFORM 2

(1) Heated oxygen sensor signal

ECM Terminal Names	Between OX1B and EX1B, or OX2B and EX2B
Tester Ranges	0.2 V/DIV, 200 ms./DIV
Conditions	Engine speed is maintained at 2,500 rpm for 2 minutes after sensor is warmed up

HINT:
In the DATA LIST, item O2S B1S2 shows the ECM input values from the heated oxygen sensor.



(c) WAVEFORM 3

(1) Fuel injector operation signal

ECM Terminal Names	Between #10 (to 60) and E01
Tester Ranges	30 V/DIV, 20 ms./DIV
Conditions	Idling

HINT:
The wavelength becomes shorter as the engine rpm increases.

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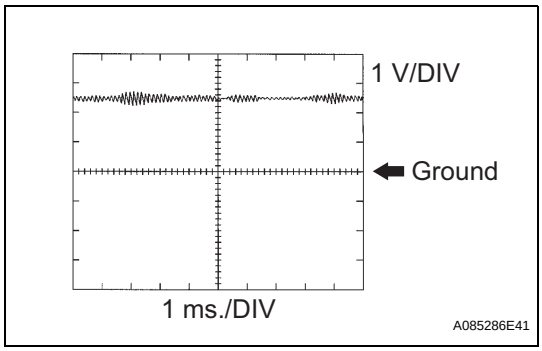
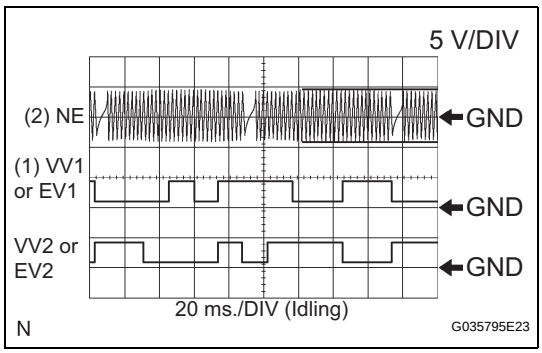


(d) WAVEFORM 4
(1) Knock sensor signal

ECM Terminal Names	Between KNK1 and EKNK, or KNK2 and EKN2
Tester Ranges	0.01 to 10 V/DIV, 0.01 to 10 ms./DIV
Conditions	Engine speed is maintained at 4,000 rpm after engine is warmed up

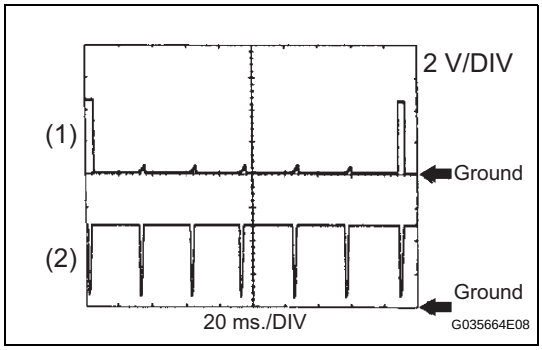
HINT:
- The wavelength becomes shorter as the engine rpm increases.
- The waveforms and amplitudes displayed differ slightly depending on the vehicle.



(e) WAVEFORM 5
(1) Variable Valve Timing (VVT) sensor signal (1)
(2) Crankshaft position sensor signal (2)

ECM Terminal Names	(1) Between VV1+ and VV1- , VV2+ and VV2-, EV1+ and EV1-, or EV2+ and EV2- (2) Between NE+ and NE-
Tester Ranges	5 V/DIV, 20 ms./DIV
Conditions	Idling

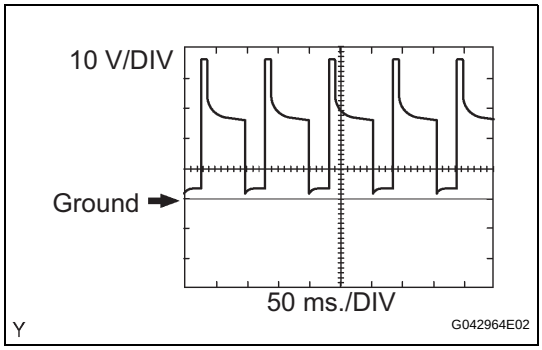
HINT:
The wavelength becomes shorter as the engine rpm increases.



(f) WAVEFORM 6
(1) Igniter IGT signal (from ECM to igniter) (1)
(2) Igniter IGF signal (from igniter to ECM) (2)

ECM Terminal Names	(1) Between IGT (1 to 6) and E1 (2) Between IGF1 and E1
Tester Ranges	2 V/DIV, 20 ms./DIV
Conditions	Idling

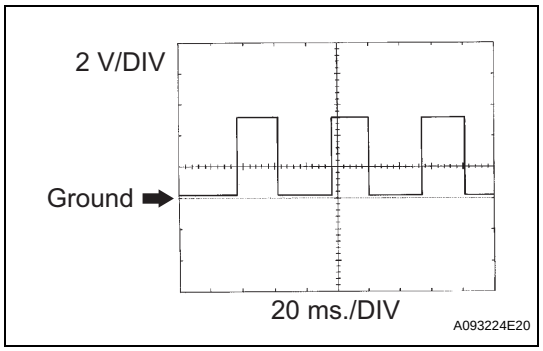
HINT:
The wavelength becomes shorter as the engine rpm increases.



(g) WAVEFORM 7
(1) Purge VSV for EVAP system operation signal

ECM Terminal Names	Between PRG and E1
Tester Ranges	10 V/DIV, 50 ms./DIV
Conditions	Idling

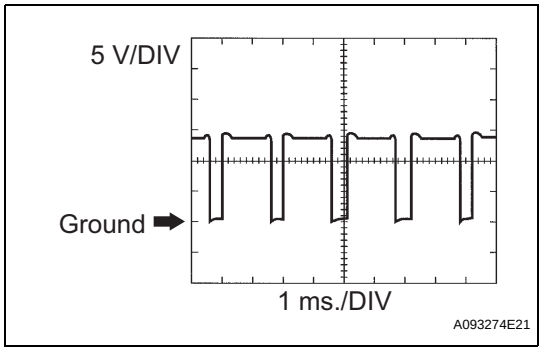
HINT:
If the waveform is not similar to that shown in the illustration, check the waveform again after idling for 10 minutes or more.



(h) WAVEFORM 8
(1) Vehicle speed signal

ECM Terminal Names	Between SPD and E1
Tester Ranges	2 V/DIV, 20 ms./DIV
Conditions	Driving at 12 mph (20 km/h)

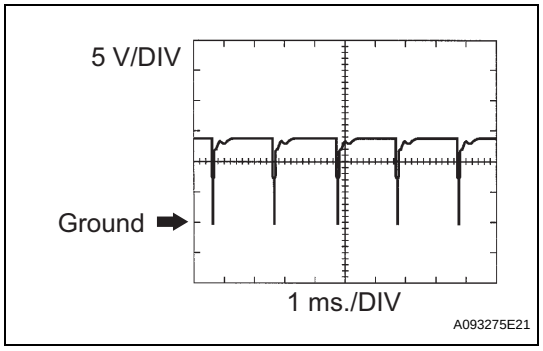
HINT:
- The wavelength becomes shorter as the vehicle speed increases.
- Depending on the vehicle, the output waveform voltage may rise to 12 V if influenced by optionally installed systems.



(i) WAVEFORM 9
(1) Throttle drive motor operation signal (positive terminal)

ECM Terminal Names	Between M+ and ME01
Tester Ranges	5 V/DIV, 1 ms./DIV
Conditions	Idling with warm engine

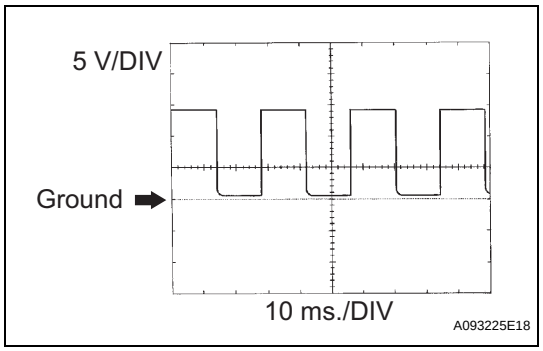
HINT:
The duty ratio varies depending on the throttle actuator operation.



(j) WAVEFORM 10
(1) Throttle drive motor operation signal (negative terminal)

ECM Terminal Names	Between M- and ME01
Tester Ranges	5 V/DIV, 1 ms./DIV
Conditions	Idling with warm engine

HINT:
The duty ratio varies depending on the throttle actuator operation.



(k) WAVEFORM 11
(1) Engine speed signal

ECM Terminal Names	Between TACH and E1
Tester Ranges	5 V/DIV, 10 ms./DIV
Conditions	Idling

HINT:
The wavelength becomes shorter as the engine rpm increases.

ES

DIAGNOSIS SYSTEM

1. DESCRIPTION

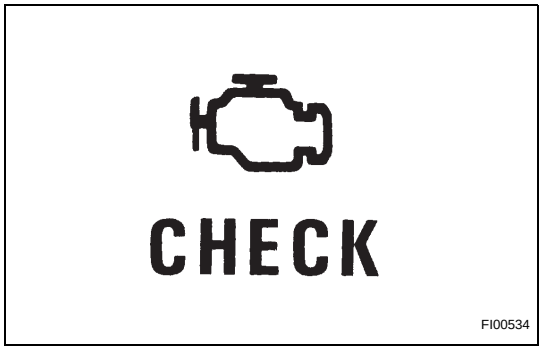
When troubleshooting OBD II (On-Board Diagnostics) vehicles, the intelligent tester (complying with SAE J1987) must be connected to the DLC3 (Data Link Connector 3) of the vehicle. Various data in the vehicle's ECM (Engine Control Module) can be then read.

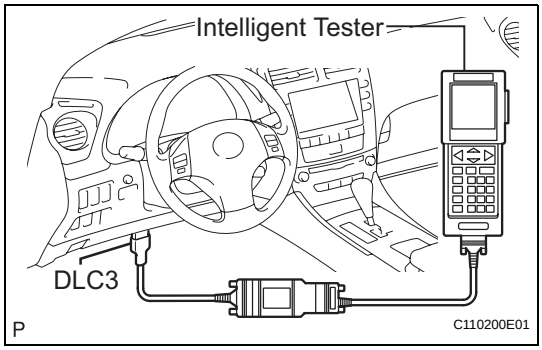
OBD ll regulations require that the vehicle's on-board computer illuminates the MIL (Malfunction Indicator Lamp) on the instrument panel when the computer detects a malfunction in:

(a) The emission control systems and components.
(b) The power train control components (which affect vehicle emissions).
(c) The computer itself.

In addition, the applicable DTCs (Diagnostic Trouble Codes) prescribed by SAE J2012 are recorded on 3 consecutive trips, the MIL turns off automatically but the DTCs remain recorded in the ECM memory.

To check for DTCs, connect the intelligent tester to the DLC3. The tester displays DTCs, freeze frame data, and a variety of the engine data. The DTCs and freeze frame data can be erased with the tester. In order to enhance OBD function on vehicles and develop the Off-Board diagnosis system, CAN communication is introduced in this system (CAN: Controller Area Network). It minimizes a gap between technician skills and vehicle technology. CAN is a network, which uses a pair of data transmission lines, spanning multiple computers and sensors. It allows a high speed communication between the systems and simplification of the wire harness connection. Since this system is equipped with the CAN communication, connecting the CAN VIM (VIM: Vehicle Interface Module) with the intelligent tester is necessary to display any information from the ECM. (Also the communication between the intelligent tester and the ECM uses CAN communication signal). When confirming the DTCs and any data of the ECM, connect the CAN VIM between the DLC3 and the intelligent tester.





2. NORMAL MODE AND CHECK MODE

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

3. 2 TRIP DETECTION LOGIC

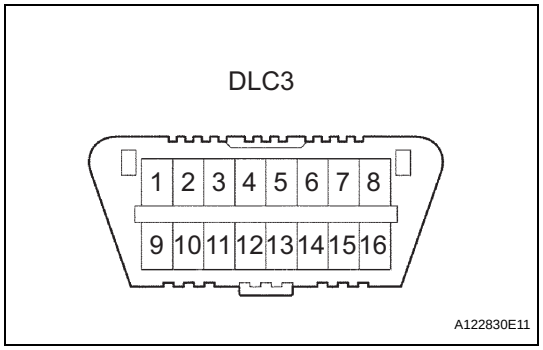
When a malfunction is first detected, the malfunction is temporarily stored in the ECM memory (1st trip). If the same malfunction is detected during the next subsequent drive cycle, the MIL is illuminated (2nd trip).

4. FREEZE FRAME DATA

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

5. DLC3 (Data link Connector 3)

The vehicle's ECM uses ISO 15765-4 for communication protocol. The terminal arrangement of the DLC3 complies with SAE J1962 and matches the ISO 15765-4 format.



Symbols	Terminal No.	Names	Reference terminal	Results	Condition
SIL	7	Bus "+" line	5 - Signal ground	Pulse generation	During transmission
CG	4	Chassis ground	Body ground	1 Ω or less	Always
SG	5	Signal ground	Body ground	1 Ω or less	Always
BAT	16	Battery ground	Body ground	9 to 14 V	Always
CANH	6	CAN "High" line	CANL	54 to 69 Ω	Engine switch off
CANH	6	CAN "High" line	Battery positive	1 MΩ or higher	Engine switch off
CANH	6	CAN "High" line	CG	1 kΩ or higher	Engine switch off
CANL	14	CAN "Low" line	Battery positive	1 MΩ or higher	Engine switch off
CANL	14	CAN "Low" line	CG	1 kΩ or higher	Engine switch off

HINT:

The DLC3 is the interface prepared for reading various data from the vehicle's ECM. After connecting the cable of an intelligent tester, turn the ignition switch on (IG) and turn the tester on. If a communication failure message is displayed on the tester screen (on the tester: UNABLE TO CONNECT TO VEHICLE), a problem exists in either the vehicle or tester. In order to identify the location of the problem, connect the tester to another vehicle.

If communication is normal: Inspect the DLC3 on the original vehicle.

If communication is still not possible: The problem is probably in the tester itself. Consult the Service Department listed in the instruction manual.

6. BATTERY VOLTAGE

Standard Voltage:

11 to 14 V

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

7. MIL (Malfunction Indicator Lamp)

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

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

HINT:
If the MIL is not illuminated when the engine switch is first turned on, check the MIL circuit (See page ES-471).

DTC CHECK / CLEAR

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

HINT:

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

1. CHECK DTC (Using an intelligent tester)

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Check the DTC(s) and freeze frame data, and then write them down.
(f) Check the details of the DTC(s) (See page ES-63).

2. CLEAR DTC (Using an intelligent tester)

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CLEAR CODES.
(e) Press the YES button.

3. CLEAR DTC (Without using an intelligent tester)

(a) Perform either one of the following operations:
(1) Disconnect the negative battery cable for more than 1 minute.
(2) Remove the EFI MAIN and ETCS fuses from the Engine Room relay block located inside the engine compartment for more than 1 minute.

FREEZE FRAME DATA

1. DESCRIPTION

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

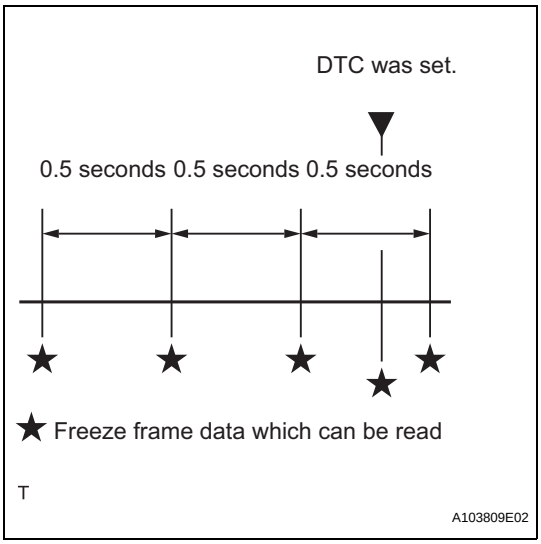
HINT:

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

The ECM records engine conditions as freeze frame data every 0.5 seconds. Using the intelligent tester, five separate sets of freeze frame data, including the data values at the time when the DTC was set, can be checked.

– 3 data set before the DTC was set.
– 1 data set when the DTC was set.
– 1 data set after the DTC was set.

These data sets can be used to simulate the condition of the vehicle around the time of the occurrence of the malfunction. The data may assist in identifying of the cause of the malfunction, and in judging whether it was temporary or not.



2. LIST OF FREEZE FRAME DATA

LABEL (Intelligent Tester Display)	Measurement Item/Range	Diagnostic Note
IGN ADVANCE	Ignition advance	-
CALC LOAD	Calculate load	Calculated load by ECM
VEHICLE LOAD	Vehicle load	-
MAF	Mass air flow volume	If value is approximately 0.0 g/s: • Mass air flow meter power source circuit open or shorted • VG circuit open or shorted If value is 160.0 g/s or more: • E2G circuit open
ENGINE SPD	Engine speed	-
VEHICLE SPD	Vehicle speed	Speed indicated on speedometer
COOLANT TEMP	Engine coolant temperature	If value is -40°C (-40°F), sensor circuit open If value is 140°C (284°F), sensor circuit shorted
INTAKE AIR	Intake air temperature	If value is -40°C (-40°F), sensor circuit open If value is 140°C (284°F), sensor circuit shorted
FUEL PRESS	Fuel pressure	-
AIR-FUEL PATIO	Air-fuel ratio	-
AMBIENT TEMP	Ambient temperature	-
PURGE DENSITY	Learning value of purge density	-
PURGE FLOW	Purge flow	-
EVAP PURGE VSV	EVAP purge VSV duty ratio	-
KNOCK CRRT VAL	Correction learning value of knocking	-

LABEL (Intelligent Tester Display)	Measurement Item/Range	Diagnostic Note
KNOCK FB VAL	Feedback value of knocking	-
ACCEL POS #1	Absolute Accelerator Pedal Position (APP) No. 1	-
ACCEL POS #2	Absolute APP No. 2	-
THROTTLE POS	Throttle position	Read value with ignition switch on (IG) (Do not start engine)
THROTTLE POS	Throttle sensor positioning	Read value with ignition switch on (IG) (Do not start engine)
THROTTLE POS #2	Throttle sensor positioning #2	-
THROTTLE MOT	Throttle motor	-
O2S B1 S2	Heated oxygen sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
O2S B2 S2	Heated oxygen sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
AFS B1 S1	A/F sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
AFS B2 S1	A/F sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
TOTAL FT #1	Total fuel trim	-
TOTAL FT #2	Total fuel trim	-
SHORT FT #1	Short-term fuel trim	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
LONG FT #1	Long-term fuel trim	Overall fuel compensation carried out in long-term to compensate for a continual deviation of short-term fuel trim from central valve
SHORT FT #2	Short-term fuel trim	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
LONG FT #2	Long-term fuel trim	Overall fuel compensation carried out in long-term to compensate for a continual deviation of short-term fuel trim from central valve
FUEL SYS #1	Fuel system status (Bank 1)	• OL (Open Loop): Has not yet satisfied conditions to go closed loop • CL (Closed Loop): Using heated oxygen sensor as feedback for fuel control • OL DRIVE: Open loop due to driving conditions (fuel enrichment) • OL FAULT: Open loop due to detected system fault • CL FAULT: Closed loop but heated oxygen sensor, which used for fuel control malfunctioning
FUEL SYS #2	Fuel system status (Bank 2)	• OL (Open Loop): Has not yet satisfied conditions to go closed loop • CL (Closed Loop): Using heated oxygen sensor as feedback for fuel control • OL DRIVE: Open loop due to driving conditions (fuel enrichment) • OL FAULT: Open loop due to detected system fault • CL FAULT: Closed loop but heated oxygen sensor, which used for fuel control malfunctioning
O2FT B1 S2	Fuel trim at heated oxygen sensor	Same as SHORT FT #1
O2FT B2 S2	Fuel trim at heated oxygen sensor	Same as SHORT FT #1

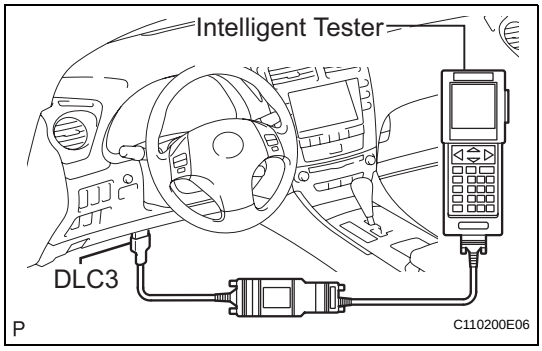
LABEL (Intelligent Tester Display)	Measurement Item/Range	Diagnostic Note
AF FT B1 S1	Fuel trim at A/F sensor	-
AF FT B2 S1	Fuel trim at A/F sensor	-
CAT TEMP B1 S1	Catalyst temperature	-
CAT TEMP B2 S1	Catalyst temperature	-
CAT TEMP B1 S2	Catalyst temperature	-
CAT TEMP B2 S2	Catalyst temperature	-
INI COOL TEMP	Initial engine coolant temperature	-
INI INTAKE TEMP	Initial intake air temperature	-
INJ VOL	Injection volume	-
ING TIMMING D4	Injection timing (D4)	-
FUEL PUMP D4	Fuel pump duty (D4)	-
COMBUSTION D4	Combustion status (D4)	-
ACC RELAY	ACC relay	-
STARTER RELAY	Starter relay	-
STARTER SIG	Starter signal	-
STARTER CONTROL	Starter control	-
CTP SW	Closed throttle position switch	-
A/C SIGNAL	A/C signal	-
PNP SW (NSW)	Neutral position switch signal	-
ELECT LOAD SIG	Electrical load signal	-
STOP LIGHT SW	Stop light switch	-
ENG OIL PRES SW	Engine oil pressure switch signal	Always ON while engine is running
BATTERY VOLTAGE	Battery voltage	-
ATM PRESSURE	Atmospheric pressure	-
FUEL PMP SP CTL	Fuel pump speed control status	-
VVT CTRL B2	VVT control status (bank 2)	-
EVAP (Purge) VSV	EVAP Purge VSV	-
A/C MAG CLUTCH	A/C magnetic clutch relay	-
FUEL PUMP/SPD	Fuel pump/speed status	-
VVT CTRL B1	VVT control status (bank 1)	-
TC/TE1	TC and TE1 terminals of DLC3	-
SCV DUTY RATIO	SCV duty ratio	-
VVTL AIM ANGL#1	VVT aim angle (bank 1)	-
VVT CHNG ANGL#1	VVT change angle (bank 1)	-
VVT OCV D B1	VVT OCV operation duty (bank 1)	-
VVT EX HOLD B1	VVT exhaust hold duty ratio learning value (bank 1)	-
VVT EX CHG ANG1	VVT exhaust change angle (bank 1)	-
VVT EX OCV D B1	VVT exhaust OCV duty (bank 1)	-
VVTL AIM ANGL#2	VVT aim angle (bank 2)	-
VVT CHNG ANGL#2	VVT change angle (bank 2)	-
VVT OCV DUTY B2	VVT OCV operation duty (bank 2)	-
VVT EX HOLD B2	VVT exhaust hold duty ratio learning value (bank 2)	-
VVT EX CHG ANG2	VVT exhaust change angle (bank 2)	-
VVT EX OCV D B2	VVT exhaust OCV duty (bank 2)	-
FC IDL	Idle fuel cut	ON: when throttle valve fully closed and engine speed over 1,500 rpm
FC TAU	FC TAU	Fuel cut being performed under very light load to prevent incomplete engine combustion

LABEL (Intelligent Tester Display)	Measurement Item/Range	Diagnostic Note
IGNITION	Ignition	-
CYL ALL	All cylinder misfire rate	Displayed only during idling
MISFIRE RPM	Misfire RPM	-
CYL ALL	All cylinder misfire rate	Displayed only during idling
MISFIRE RPM	Misfire RPM	-
MISFIRE LOAD	Misfired load	-
MISFIRE MARGIN	Misfire monitoring	-
ENG RUN TIME	Accumulated engine running time	-
TIME DTC CLEAR	Cumulative time after DTC cleared	-
DIST DTC CLEAR	Accumulated distance after DTC cleared	-
WU CYC DTC CLEAR	Warm-up cycle after DTC cleared	-

CHECK MODE PROCEDURE

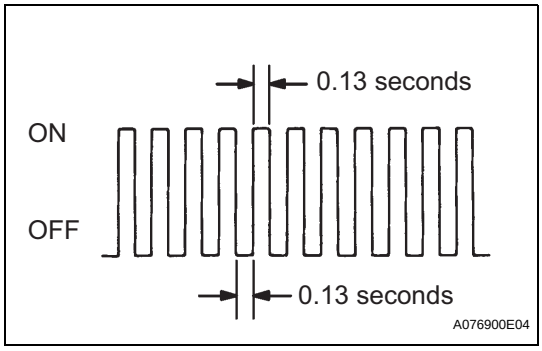
HINT:
Intelligent tester only:
Compared to the normal mode, check mode is more sensitive to malfunctions. Therefore, check mode can detect the malfunctions that cannot be detected in normal mode.
NOTICE:
All the stored DTCs and freeze frame data are erased if: 1) the ECM is changed from normal mode to check mode or vice versa; or 2) the engine switch is turned from on (IG) to ACC or off while in check mode. Before changing modes, always check and note any DTCs and freeze frame data.

ES



1. CHECK MODE PROCEDURE (Using an intelligent tester)

(a) Check and ensure the following conditions:
  (1) Battery positive voltage 11 V or more.
  (2) Throttle valve fully closed.
  (3) Transmission in the P or N position.
  (4) A/C switch OFF.
(b) Turn the engine switch off.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester on.
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / CHECK MODE.
(g) Switch the ECM from normal mode to check mode.



(h) Make sure that the MIL flashes as shown in the illustration.
(i) Start the engine.
(j) Make sure that the MIL turns OFF.
(k) Simulate the conditions of the malfunction described by the customer.
(l) Check for DTCs and freeze frame data using the tester.

FAIL-SAFE CHART

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

DTCs	Components	Fail-Safe Operations	Fail-Safe Deactivation Conditions
P0031, P0032, P0051 and P0052	Air-Fuel Ratio (A/F) Sensor Heater	ECM turns off A/F sensor heater	Ignition switch off
P0037, P0038, P0057 and P0058	Heated Oxygen (HO2) Sensor Heater	ECM turns off HO2 sensor heater	Ignition switch off
P0100, P0102 and P0103	Mass Air Flow (MAF) Meter	ECM calculates ignition timing according to engine speed and throttle valve position	Pass condition detected
P0110, P0112 and P0113	Intake Air Temperature (IAT) Sensor	ECM estimates IAT to be 20°C (68°F)	Pass condition detected
P0115, P0117 and P0118	Engine Coolant Temperature (ECT) Sensor	ECM estimates ECT to be 80°C (176°F)	Pass condition detected
P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0604, P0606, P0607, P0657, P2102, P2103, P2111, P2112, P2118, P2119 and P2135	Electronic Throttle Control System (ETCS)	ECM cuts off throttle actuator current and throttle valve returned to 6.5° throttle position by return spring ECM then adjusts engine output by controlling fuel injection (intermittent fuel-cut) and ignition timing in accordance with accelerator pedal opening angle, to allow vehicle to continue at minimal speed*	Pass condition detected and then ignition switch turned off
P0327, P0328, P0332 and P0333	Knock Sensor	ECM sets ignition timing to maximum retard	Ignition switch off
P0351 to P0356	Igniter	ECM cuts fuel	Pass condition detected
P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138	Accelerator Pedal Position (APP) Sensor	APP sensor has 2 sensor circuits: Main and Sub If either of circuits malfunctions, ECM controls engine using the other circuit If both of circuits malfunction, ECM regards accelerator pedal as being released. As a result, throttle valve is closed and engine idles	Pass condition detected and then ignition switch turned off

NOTE:

*: The vehicle can be driven slowly when the accelerator pedal is depressed slowly. If the accelerator pedal is depressed quickly, the vehicle may speed up and slow down erratically.

DATA LIST / ACTIVE TEST

1. DATA LIST

HINT:

By reading the DATA LIST displayed on an intelligent tester, you can check values, including those of the switches, sensors, and actuators, without removing any parts. Reading the DATA LIST as the first step in troubleshooting is one method of shortening diagnostic time.

NOTICE:

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

(a) Warm up the engine.
(b) Turn the ignition switch off.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester on.
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST.
(g) Check the values by referring to the table below.

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
INJECTOR	Injection period of No. 1 cylinder: Min.: 0 ms, Max.: 32.64 ms	1.2 to 2.4 ms: Idling	-
IGN ADVANCE	Ignition timing advance for No. 1 cylinder: Min.: -64 deg, Max.: 63.5 deg	BTDC 7 to 24 deg: Idling	-
CALC LOAD	Load calculated by ECM: Min.: 0%, Max.: 100%	• 10 to 20%: Idling • 10 to 20%: Running without load at 2,500 rpm	Load value
VEHICLE LOAD	Vehicle load: Min.: 0%, Max.: 25,700%	Actual vehicle load	Load percentage in terms of maximum intake air flow amount
MAF	Air flow rate from MAF meter: Min.: 0 g/sec., Max.: 655.35 g/sec.	2 to 5 g/sec.: Idling 8 to 19 g/sec.: Running without load at 2,500 rpm	If value is approximately 0.0 g/sec.: • Mass air flow meter power source circuit open • VG circuit open or shorted If value is 160.0 g/sec. or more: • E2G circuit open
ENGINE SPD	Engine speed: Min.: 0 rpm, Max.: 16,383.75 rpm	600 to 700 rpm: Idling	-
VEHICLE SPD	Vehicle speed: Min.: 0 km/h, Max.: 255 km/h	Actual vehicle speed	Speed indicated on speedometer
COOLANT TEMP	Engine coolant temperature: Min.: -40°C, Max.: 140°C	80 to 100°C (176 to 212°F): After warming up	• If value is -40°C (-40°F): sensor circuit open • If value is 140°C (284°F) or more: sensor circuit shorted
INTAKE AIR	Intake air temperature: Min.: -40°C, Max.: 140°C	Equivalent to ambient air temperature	• If value is -40°C (-40°F): sensor circuit open • If value is 140°C (284°F) or more: sensor circuit shorted
AIR-FUEL RATIO	Ratio compared to stoichiometric level: Min.: 0, Max.: 1.999	0.8 to 1.2: Idling	-
PURGE DENSITY	Learning value of purge density: Min.: -50, Max.: 350	-40 to 0: Idling	Service data

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
EVAP PURGE FLOW	Ratio of evaporative purge flow to intake air volume: Min.: 0%, Max.: 102.4%	0 to 8%: Idling	-
EVAP PURGE VSV	EVAP (PURGE) VSV control duty: Min.: 0%, Max.: 100%	0 to 100%: Idling	Command signal from ECM
VAPOR PRES PUMP	Vapor pressure: Min.: 33.853 kPa, Max.: 125.596 kPa	0 kPa: Fuel tank cap removed	EVAP system pressure monitored by canister pressure sensor
VAPOR PRES CALC	Vapor pressure (calculated): Min.: -5.632 kPa, Max.: 715.264 kPa	0 kPa: Fuel tank cap removed	EVAP system pressure monitored by canister pressure sensor
KNOCK CRRT VAL	Correction learning value of knocking: Min: -64°CA, Max.: 1,984°CA	0 to 22°CA: Driving at 70 km/h (44 mph)	Service data
KNOCK FB VAL	Feedback value of knocking: Min: -64°CA, Max.: 1,984°CA	-22 to 0°CA: Driving at 70 km/h (44 mph)	Service data
CLUTCH	Clutch current: Min.: 0 A, Max.: 2.49 A	-	-
EVAP VAPOR PRES	EVAP vapor pressure: Min.: 0 kPa, Max.: 327.675 kPa	0 kPa: Fuel tank cap removed	EVAP system pressure monitored by canister pressure sensor
ACCEL POS #1	Absolute Accelerator Pedal Position (APP) No. 1: Min.: 0%, Max.: 100%	10 to 22%: Accelerator pedal released 54 to 86%: Accelerator pedal fully depressed	Read value with ignition switch ON (Do not start engine)
ACCEL POS #2	Absolute APP No. 2: Min.: 0%, Max.: 100%	12 to 42%: Accelerator pedal released 66 to 98%: Accelerator pedal fully depressed	Read value with ignition switch ON (Do not start engine)
ACCEL POS #1	APP sensor No. 1 voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze frame data
ACCEL POS #2	APP sensor No. 2 voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze frame data
ACCEL POS #1	APP sensor No. 1 voltage: Min.: 0 V, Max.: 5 V	0.5 to 1.1 V: Accelerator pedal released 2.6 to 4.5 V: Accelerator pedal fully depressed	Read value with ignition switch ON (Do not start engine)
ACCEL POS #2	APP sensor No. 2 voltage: Min.: 0 V, Max.: 5 V	1.2 to 2.0 V: Accelerator pedal released 3.4 to 5.0 V: Accelerator pedal fully depressed	Read value with ignition switch ON (Do not start engine)
ACCEL IDL POS	Whether or not accelerator pedal position sensor detecting idle: ON or OFF	ON: Idling	-
THRTL LEARN VAL	Throttle valve fully closed (learned value): Min.: 0 V, Max.: 5 V	0.4 to 0.8 V	-
ACCEL SSR #1 AD	Accelerator fully closed value No. 1 (AD): Min.: 0 V, Max.: 4.98 V	-	ETCS service data
ACCEL LRN VAL#1	Accelerator fully closed learning value No. 1: Min.: 0 deg, Max.: 124.512 deg	-	ETCS service data
ACCEL LRN VAL#2	Accelerator fully closed learning value No. 2: Min.: 0 deg, Max.: 124.512 deg	-	ETCS service data
FAIL #1	Whether or not fail safe function executed: ON or OFF	ON: ETCS has failed	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
FAIL #2	Whether or not fail safe function executed: ON or OFF	ON: ETCS has failed	-
ST1	Starter signal: ON or OFF	ON: Cranking	-
SYS GUARD JUDGE	System guard: ON or OFF	-	ETCS service data
OPN MALFUNCTION	Open side malfunction: ON or OFF	-	ETCS service data
THROTTLE POS	Absolute throttle position sensor: Min.: 0%, Max.: 100%	• 10 to 24%: Throttle fully closed • 64 to 96%: Throttle fully open	• Calculated value based on VTA1 • Read value with ignition switch ON (Do not start engine)
THROTTL IDL POS	Whether or not throttle position sensor detecting idle: ON or OFF	ON: Idling	-
THRTL REQ POS	Throttle requirement position: Min.: 0 V, Max.: 5 V	0.5 to 1.0 V: Idling	-
THROTTLE POS	Throttle position: Min.: 0%, Max.: 100%	0 to 18%: Idling	Calculated value based on VTA1
THROTTLE POS #2	Absolute throttle position sensor No. 2: Min.: 0%, Max.: 100%	-	Calculated value based on VTA2
THROTTLE POS #1	Throttle position sensor No. 1 output voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze frame data
THROTTLE POS #2	Throttle position sensor No. 2 output voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze frame data
THROTTLE POS #1	Throttle position sensor No. 1 output voltage: Min.: 0 V, Max.: 5 V	• 0.5 to 1.2 V: Throttle fully closed • 3.2 to 4.8 V: Throttle fully open	-
THROTTLE POS #2	Throttle position sensor No. 2 output voltage: Min.: 0 V, Max.: 5 V	• 2.0 to 2.9 V: Throttle fully closed • 4.6 to 5.0 V: Throttle fully open	Read value with ignition switch ON (Do not start engine)
THRTL COMND VAL	Throttle position command value: Min.: 0 V, Max.: 4.9804 V	0.5 to 4.8 V	Read value with ignition switch ON (Do not start engine)
THROTTLE SSR #1	Throttle sensor opener position No. 1: Min.: 0 V, Max.: 4.9804 V	0.6 to 0.9 V	ETCS service data
THROTTLE SSR #2	Throttle sensor opener position No. 2: Min.: 0 V, Max.: 4.9804 V	2.2 to 2.6 V	ETCS service data
THRTL SSR #1 AD	Throttle position sensor No. 1 output voltage (AD): Min.: 0 V, Max.: 4.9804 V	0.6 to 0.9 V	ETCS service data
THROTTLE MOT	Whether or not throttle actuator control permitted: ON or OFF	ON: Idling	Read value with ignition switch ON (Do not start engine)
THROTTLE MOT	Throttle actuator current: Min.: 0 A, Max.: 80 A	0 to 3.0 A: Idling	-
THROTTLE MOT	Throttle actuator: Min.: 0%, Max.: 100%	0.5 to 40%: Idling	-
THROTTLE MOT	Throttle actuator current: Min.: 0 A, Max.: 19.92 A	0 to 3.0 A: Idling	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
THROTL OPN DUTY	Throttle actuator opening duty ratio: Min.: 0%, Max.: 100%	0 to 40%: Idling	• When accelerator pedal is depressed, duty ratio increaseds • Read value with ignition switch ON (Do not start engine)
THROTL CLS DUTY	Throttle actuator closed duty ratio: Min.: 0%, Max.: 100%	0 to 40%: Idling	• When accelerator pedal is increaseds quickly, duty ratio increaseds • Read value with ignition switch ON (Do not start engine)
THRTL MOT (OPN)	Throttle actuator duty ratio (open): Min.: 0%, Max.: 100%	-	ETCS service data
THRTL MOT (CLS)	Throttle actuator duty ratio (closed): Min.: 0%, Max.: 100%	-	ETCS service data
O2S B1 S2	Heated oxygen sensor output voltage for bank 1 sensor 2: Min.: 0 V Max.: 1.275 V	0.1 to 0.9 V: Driving at 70 km/h (44 mph)	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
O2S B2 S2	Heated oxygen sensor output voltage for bank 2 sensor 2: Min.: 0 V Max.: 1.275 V	0.1 to 0.9 V: Driving at 70 km/h (44 mph)	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
AF FT B1 S1	Short-term fuel trim associated with sensor 1: Min.: 0, Max.: 1.999	• Value less than 1 (0.000 to 0.999) =Lean • Stoichiometric air-fuel ratio=1 • Value greater than 1 (1.001 to 1.999) = Rich	-
AF FT B2 S1	Short-term fuel trim associated with sensor 1: Min.: 0, Max.: 1.999	• Value less than 1 (0.000 to 0.999) =Lean • Stoichiometric air-fuel ratio=1 • Value greater than 1 (1.001 to 1.999) = Rich	-
AFS B1 S1	A/F sensor output voltage for bank 1 sensor 1: Min.: 0 V Max.: 7.999 V	2.8 to 3.8 V: Idling	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
AFS B2 S1	A/F sensor output voltage for bank 2 sensor 1: Min.: 0 V Max.: 7.999 V	2.8 to 3.8 V: Idling	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
TOTAL FT #1	Total fuel trim of bank 1 Average value for fuel system of bank 1: Min.: -0.5, Max.: 0.496	-0.2 to 0.2: Idling	-
TOTAL FT #2	Total fuel trim of bank 2 Average value for fuel system of bank 2: Min.: -0.5, Max.: 0.496	-0.2 to 0.2: Idling	-
SHORT FT #1	Short-term fuel trim of bank 1: Min.: -100%, Max.: 99.2%	-20 to 20%	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
SHORT FT #2	Short-term fuel trim of bank 2: Min.: -100%, Max.: 99.2%	-20 to 20%	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
LONG FT #1	Long-term fuel trim of bank 1: Min.: -100%, Max.: 99.2%	-20 to 20%	Overall fuel compensation carried out in long-term to compensate for continual deviation of short-term fuel trim from central value

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
LONG FT #2	Long-term fuel trim of bank 2: Min.: -100%, Max.: 99.2%	-20 to 20%	Overall fuel compensation carried out in long-term to compensate for continual deviation of short-term fuel trim from central value
FUEL SYS #1	Fuel system status (Bank 1): OL or CL or OL DRIVE or OL FAULT or CL FAULT	CL: Idling after warming up	• OL (Open Loop): Has not yet satisfied conditions to go closed loop • CL (Closed Loop): Using A/F sensor as feedback for fuel control • OL DRIVE: Open loop due to driving conditions (fuel enrichment) • OL FAULT: Open loop due to detected system fault • CL FAULT: Closed loop but A/F sensor, which used for fuel control malfunctioning
FUEL SYS #2	Fuel system status (Bank 2): OL or CL or OL DRIVE or OL FAULT or CL FAULT	CL: Idling after warming up	• OL (Open Loop): Has not yet satisfied conditions to go closed loop • CL (Closed Loop): Using A/F sensor as feedback for fuel control • OL DRIVE: Open loop due to driving conditions (fuel enrichment) • OL FAULT: Open loop due to detected system fault • CL FAULT: Closed loop but A/F sensor, which used for fuel control, malfunctioning
O2FT B1 S2	Short-term fuel trim associated with bank 1 sensor 2: Min.: -100%, Max.: 99.2%	-20 to 20%	Same as SHORT FT #1
O2FT B2 S2	Short-term fuel trim associated with bank 2 sensor 2: Min.: -100%, Max.: 99.2%	-20 to 20%	Same as SHORT FT #2
AF FT B1 S1	Short-term fuel trim associated with bank 1 sensor 1: Min.: 0, Max.: 1.999	• Value less than 1 (0.000 to 0.999) = Lean • Stoichiometric air-fuel ratio = 1 • Value greater than 1 (1.001 to 1.999) = Rich	-
AF FT B2 S1	Short-term fuel trim associated with bank 2 sensor 1: Min.: 0, Max.: 1.999	• Value less than 1 (0.000 to 0.999) = Lean • Stoichiometric air-fuel ratio = 1 • Value greater than 1 (1.001 to 1.999) = Rich	-
AFS B1 S1	A/F sensor current: Min.: -128 mA, Max.: 127.99 mA	-	-
AFS B2 S1	A/F sensor current: Min.: -128 mA, Max.: 127.99 mA	-	-
CAT TEMP B1S1	Estimated catalyst temperature (bank 1 sensor 1): Min.: -40°C, Max.: 6,513.5°C	-	-
CAT TEMP B1S2	Estimated catalyst temperature (bank 1 sensor 2): Min.: -40°C, Max.: 6,513.5°C	-	-
CAT TEMP B2S1	Estimated catalyst temperature (bank 2 sensor 1): Min.: -40°C, Max.: 6,513.5°C	-	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
CAT TEMP B2S2	Estimated catalyst temperature (bank 2 sensor 2): Min.: -40°C, Max.: 6,513.5°C	-	-
S O2S B1S2	Sub heated oxygen sensor impedance (bank 1 sensor 2): Min.: 0 Ω, Max.: 21,247.68 Ω	-	-
S O2S B2S2	Sub heated oxygen sensor impedance (bank 2 sensor 2): Min.: 0 Ω, Max.: 21,247.68 Ω	-	-
INI COOL TEMP	Engine coolant temperature at engine start: Min.: -40°C, Max.: 120°C	Close to ambient air temperature	-
INI INTAKE TEMP	Intake air temperature at engine start: Min.: -40°C, Max.: 120°C	Close to ambient air temperature	-
INJ VOL	Injection volume (cylinder 1): Min.: 0 ml, Max.: 2.048 ml	Max.: 0.5 ml	Fuel volume injected over 10 injections
STARTER SIG	Starter signal: ON or OFF	ON: Cranking	-
PS SW	Power steering signal: ON or OFF	ON: Power steering operation	-
PS SIGNAL	Power steering signal (history): ON or OFF	ON: When steering wheel is first turned after battery terminals connected	Signal status usually ON until battery terminals disconnected
CTP SW	Closed throttle position switch: ON or OFF	• ON: Throttle fully closed • OFF: Throttle open	-
A/C SIGNAL	A/C signal: ON or OFF	ON: A/C ON	-
PNP SW [NSW]	PNP switch status: ON or OFF	ON: P or N position	-
ELECT LOAD SIG	Electrical load signal: ON or OFF	ON: Headlights or defogger turned ON	-
STOP LIGHT SW	Stop light switch: ON or OFF	ON: Brake pedal depressed	-
+BM	Whether or not electric throttle control system power input: ON or OFF	ON: Idling	-
+BM VOLTAGE	+BM voltage: Min.: 0, Max.: 19.922	10 to 15 V: Idling	ETCS service data
BATTERY VOLTAGE	Battery voltage: Min.: 0 V, Max.: 65.535 V	9 to 14 V: Idling	-
ACTUATOR POWER	Actuator power supply: ON or OFF	ON: Idling	ETCS service data
ATM PRESSURE	Atmospheric pressure: Min.: 0 kPa, Max.: 255 kPa	Equivalent to atmospheric pressure (absolute pressure)	-
BATTERY CURRENT	Battery current: Min.: -100 A, Max.: 100 A	-	-
BATTERY TEMP	Battery temperature: Min.: -45 °C, Max.: 156.4 °C	-	-
ALT OUTPUT DUTY	Generator output duty ratio: Min.: 0%, Max.: 100%	-	During charge control
ALT V NORMAL	Request output voltage: Min.: 0 V, Max.: 20 V	9 to 14 V	Not during alternator forced activation
ALT V ACT TST	Request output voltage: Min.: 0 V, Max.: 20 V	-	During alternator forced activation
FUEL PMP SP CTL	Fuel pump speed control status: ON or OFF	Idling: ON	Active Test support data

ES

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
ACIS VSV	VSV for Acoustic Control Induction System Status: ON or OFF	-	ON: Open OFF: Closed
EVAP (Purge) VSV	Purge VSV status: ON or OFF	-	Active Test support data
FUEL PUMP / SPD	Fuel pump status: ON or OFF	-	Active Test support data
VVT CTRL B1	VVT control (bank 1) status: ON or OFF	-	Active Test support data
VVT CTRL B2	VVT control (bank 2) status: ON or OFF	-	Active Test support data
VACUUM PUMP	Key-off EVAP system leak detection pump status: ON or OFF	-	Active Test support data
EVAP VENT VAL	Key-off EVAP system vent valve status: ON or OFF	-	Active Test support data
FAN MOTOR	Electric fan motor: ON or OFF	ON: Electric fan motor operating	Active Test support data
AICV VSV	VSV for Air Intake Control System Status: ON or OFF	-	-
TC/TE1	TC and CG (TE1) terminal of DLC3: ON or OFF	-	Active Test support data
VVTL AIM ANGL#1*2	VVT aim angle (bank 1 Intake side): Min.: 0%, Max.: 100%	-	-
VVT CHNG ANGL#1*2	VVT change angle (bank 1 Intake side): Min.: 0°FR, Max.: 60°FR	0 to 5°FR: Idling	Displacement angle during intrusive operation
VVT OCV DUTY B1*2	VVT OCV operation duty (bank 1 Intake side): Min.: 0%, Max.: 100%	0 to 100%	Requested duty value for intrusive operation
VVT EX HOLD B1*2	VVT exhaust hold duty ratio learning value (bank 1 Exhaust side): Min.: 0%, Max.: 100%	10 to 50%: Idling	Requested duty value for intrusive operation
VVT EX CHG ANG1*2	VVT change angle (bank 1 Exhaust side): Min.: 0° FR, Max.: 60° FR	0 to 5° FR: Idling	Displacement angle during intrusive operation
VVT EX OCV D B1*2	VVT OCV operation duty (bank 1 Exhaust side): Min.: 0%, Max.: 100%	0 to 100%	Requested duty value for intrusive operation
VVTL AIM ANGL #2*2	VVT aim angle (bank 2 Intake side): Min.: 0%, Max.: 100%	-	-
VVT CHNG ANGL #2*2	VVT change angle (bank 2 Intake side): Min.: 0° FR, Max.: 60° FR	0 to 5° FR: Idling	Displacement angle during intrusive operation
VVT OCV DUTY B2*2	VVT OCV operation duty (bank 2 Intake side): Min.: 0%, Max.: 100%	0 to 100%	Requested duty value for intrusive operation
VVT EX HOLD B2*2	VVT exhaust hold duty ratio learning value (bank 2 Exhaust side): Min.: 0%, Max.: 100%	10 to 50%: Idling	Requested duty value for intrusive operation
VVT EX CHG ANG2*2	VVT change angle (bank 2 Exhaust side): Min.: 0° FR, Max.: 60° FR	0 to 5° FR: Idling	Displacement angle during intrusive operation

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
VVT EX OCV D B2*2	VVT exhaust operation duty (bank 2 Exhaust side): Min.: 0%, Max.: 100%	0 to 100%	Requested duty value for intrusive operation
FC IDL	Fuel cut idle: ON or OFF	ON: Fuel cut operation	FC IDL = "ON" when throttle valve fully closed and engine speed over 2,800 rpm
FC TAU	Fuel cut TAU (Fuel cut with very light load): ON or OFF	ON: Fuel cut operating	Fuel cut being performed with very light load to prevent incomplete engine combustion
IGNITION	Ignition counter: Min.: 0, Max.: 800	0 to 800	-
CYL #1	Misfire ratio of cylinder 1: Min.: 0, Max.: 255	0	This item displayed only during idling
CYL #2	Misfire ratio of cylinder 2: Min.: 0, Max.: 255	0	This item displayed only during idling
CYL #3	Misfire ratio of cylinder 3: Min.: 0, Max.: 255	0	This item displayed only during idling
CYL #4	Misfire ratio of cylinder 4: Min.: 0, Max.: 255	0	This item displayed only during idling
CYL #5	Misfire ratio of cylinder 5: Min.: 0, Max.: 255	0	This item displayed only during idling
CYL #6	Misfire ratio of cylinder 6: Min.: 0, Max.: 255	0	This item displayed only during idling
CYL ALL	All cylinders misfire rate: Min.: 0, Max.: 255	0 to 35	-
MISFIRE RPM	Engine RPM for first misfire range: Min.: 0 rpm, Max.: 6,375 rpm	0 rpm: Misfire 0	-
MISFIRE LOAD	Engine load for first misfire range: Min.: 0 g/rev, Max.: 3.98 g/rev	0 g/rev: Misfire 0	-
MISFIRE MARGIN	Misfire monitoring: Min.: -100%, Max.: 99.22%	-100 to 99.22%	Misfire detecting margin
#CODES	#Codes: Min.: 0, Max.: 255	-	Number of detected DTCs
CHECK MODE	Check mode: ON or OFF	ON: Check mode ON	(see page ES-49)
SPD TEST	Check mode result for vehicle speed sensor: COMPL or INCMPL	-	-
MISFIRE TEST	Check mode result for misfire monitor: COMPL or INCMPL	-	-
OXS1 TEST	Check mode result for HO2 sensor (bank 1): COMPL or INCMPL	-	-
OXS2 TEST	Check mode result for HO2 sensor (bank 2): COMPL or INCMPL	-	-
A/F SSR TEST B1	Check mode result for air-fuel ratio sensor (bank 1): COMPL or INCMPL	-	-
A/F SSR TEST B2	Check mode result for air-fuel ratio sensor (bank 2): COMPL or INCMPL	-	-
MIL	MIL status: ON or OFF	ON: MIL ON	-
MIL ON RUN DIST	MIL ON run distance: Min.: 0 km, Max.: 65,535 km	Distance driven after DTC detected	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
MIL ON RUN TIME	Running time from MIL ON: Min.: 0 minutes, Max.: 65,535 minutes	Running time after MIL ON	-
ENG RUN TIME	Engine run time: Min.: 0 seconds, Max.: 65,535 seconds	Time after engine start	-
TIME DTC CLEAR	Time after DTC cleared: Min.: 0 minutes, Max.: 65,535 minutes	Time after DTCs erased	-
DIST DTC CLEAR	Distance after DTC cleared: Min.: 0 km, Max.: 65,535 km	Distance driven after DTCs erased	-
WU CYC DTC CLEAR	Warm-up cycle after DTC cleared: Min.: 0, Max.: 255	-	Number of warm-up cycles after DTC cleared
OBD CERT	OBD requirement	OBD2	-
#CARB CODES	Number of emission related DTCs	-	-
COMP MON	Comprehensive component monitor: NOT AVL or AVAIL	-	-
FUEL MON	Fuel system monitor: NOT AVL or AVAIL	-	-
MISFIRE MON	Misfire monitor: NOT AVL or AVAIL	-	-
O2S (A/FS) HTR	O2S (A/FS) heater monitor: NOT AVL or AVAIL	-	-
O2S (A/FS) HTR	O2S (A/FS) heater monitor: COMPL or INCMPL	-	-
O2S (A/FS) MON	O2S (A/FS) monitor: NOT AVL or AVAIL	-	-
O2S (A/FS) MON	O2S (A/FS) monitor: COMPL or INCMPL	-	-
EVAP MON	EVAP monitor: NOT AVL or AVAIL	-	-
EVAP MON	EVAP monitor: COMPL or INCMPL	-	-
CAT MON	Catalyst monitor: NOT AVL or AVAIL	-	-
CAT MON	Catalyst monitor: COMPL or INCMPL	-	-
CCM ENA	Comprehensive component monitor: UNABLE or ENABLE	-	-
CCM CMPL	Comprehensive component monitor: COMPL or INCMPL	-	-
FUEL ENA	Fuel system monitor: UNABLE or ENABLE	-	-
FUEL CMPL	Fuel system monitor: COMPL or INCMPL	-	-
MISFIRE ENA	Misfire monitor: UNABLE or ENABLE	-	-
MISFIRE CMPL	Misfire monitor: COMPL or INCMPL	-	-
EGR ENA	EGR monitor: UNABLE or ENABLE	-	-
EGR CMPL	EGR monitor: COMPL or INCMPL	-	-
HTR ENA	O2S (A/FS) heater monitor: UNABLE or ENABLE	-	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*1	Diagnostic Note
HTR CMPL	O2S (A/FS) heater monitor: COMPL or INCMPL	-	-
O2S (A/FS) ENA	O2S (A/FS) monitor: UNABLE or ENABLE	-	-
O2S (A/FS) CMPL	O2S (A/FS) monitor: COMPL or INCMPL	-	-
ACRF ENA	A/C monitor: UNABLE or ENABLE	-	-
ACRF CMPL	A/C monitor: COMPL or INCMPL	-	-
AIR ENA	2nd Air monitor: UNABLE or ENABLE	-	-
AIR CMPL	2nd Air monitor: COMPL or INCMPL	-	-
EVAP ENA	EVAP monitor: UNABLE or ENABLE	-	-
EVAP CMPL	EVAP monitor: COMPL or INCMPL	-	-
HCAT ENA	Heated catalyst monitor: UNABLE or ENABLE	-	-
HCAT CMPL	Heated catalyst monitor: COMPL or INCMPL	-	-
CAT ENA	Catalyst monitor: UNABLE or ENABLE	-	-
CAT CMPL	Catalyst monitor: COMPL or INCMPL	-	-
MODEL CODE	Model code information	-	Identifying model code: GSA3#
ENGINE TYPE	Engine type information	-	Identifying engine type: 2GRFE
CYLINDER NUMBER	Cylinder number: Min.: 0, Max.: 255	-	Identifying cylinder number: 6
TRANSMISSION	Transmission type information	-	Identifying transmission type: 5AT
DESTINATION	Destination information	-	Identifying destination: A (America)
MODEL YEAR	Model year: Min.: 1900, Max.: 2155	-	Identifying model year: 200#
SYSTEM	Engine system information	-	Identifying engine system: GASLIN (gasoline engine)

HINT:

- *1: If no idling conditions are specified, the transmission gear selector lever should be in the N or P position, and the A/C switch and all accessory switches should be OFF.
- *2: DATA LIST values are displayed only when performing the following ACTIVE TESTs: VVT B1, VVT B2, VVT EX B1 and VVT EX B2. For other ACTIVE TESTs, the DATA LIST value will be 0.

ES

2. ACTIVE TEST

HINT:

Performing an ACTIVE TEST enables components including the relays, VSV (Vacuum Switching Valve) and actuators, to be operated without removing any parts. The ACTIVE TEST can be performed with an intelligent tester. Performing an ACTIVE TEST as the first step in troubleshooting is one method of shortening diagnostic time.

DATA LIST can be displayed during ACTIVE TEST.

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST.
(e) Perform the ACTIVE TEST by referring to the table below.

Intelligent Tester Displays	Test Details	Control Ranges	Diagnostic Note
INJ VOL	Change injection volume	Between -12.5 and 24.8 %	• All injectors tested at the same time • Perform test at less than 3,000 rpm • Injection volume can be changed in 1 % graduations within control range
A/F CONTROL	Change injection volume	Lower by 12.5 % or increase by 24.8 %	• Perform test at less than 3,000 rpm • A/F CONTROL enables to check and to graph A/F (Air Fuel Ratio) sensor and Heated Oxygen (HO2) sensor voltage outputs • To conduct test, select following menu items: ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2, and press YES and ENTER followed by F4
FUEL PMP SP CTL	Fuel pump speed control	ON (low speed)/OFF (high speed)	Test is possible when following conditions are met: • Ignition switch is on (IG) • Engine is stopped
EVAP (PURGE) VSV	Activate VSV for EVAP (Purge)	ON/OFF	-
EVAP VSV (ALONE)	Activate EVAP VSV control	ON/OFF	-
VVT CTRL B1	Turn on and off OCV (Oil Control Valve)	ON/OFF	• Engine stalls or idles roughly when OCV turned ON • Normal engine running or idling when OCV OFF
VVT CTRL B2	Turn on and off OCV (Oil Control Valve)	ON/OFF	• Engine stalls or idles roughly when OCV turned ON • Normal engine running or idling when OCV OFF
A/C MAG CLUTCH	Control the A/C magnet clutch	ON/OFF	-
FUEL PUMP / SPD	Activate fuel pump (C/OPN Relay)	ON/OFF	-
TC/TE1	Turn on and off TC and TE1 connection	ON/OFF	• ON: TC and TE1 connected • OFF: TC and TE1 disconnected
FC IDL PROHBT	Prohibit idling fuel cut control	ON/OFF	-

Intelligent Tester Displays	Test Details	Control Ranges	Diagnostic Note
COOLING FAN	Control Electric Cooling Fan	ON/OFF	Test is possible when following conditions are met: • Ignition switch is on (IG) • Ignition is stopped
ACC CUT	Active ACC cut relay	ON/OFF	Test is possible when following conditions are met: • Ignition switch is on (IG) • Ignition is stopped
STARTER	Starter	ON/OFF	-
ETCS OPEN SLOW	Throttle actuator	ON: Throttle valve opens slowly	Test is possible when following conditions are met: • Ignition switch is on (IG) • Ignition is stopped • Accelerator pedal is fully depressed (APP: 58 degrees or more)
ETCS CLOSE SLOW	Throttle actuator	ON: Throttle valve closes slowly	Same as above
ETCS OPEN FAST	Throttle actuator	ON: Throttle valve opens fast	Same as above
ETCS CLOSE FAST	Throttle actuator	ON: Throttle valve closes fast	Same as above
FUEL CUT #1	Cylinder #1 injector fuel cut	ON/OFF	Test is possible during vehicle stopping and engine idling.
FUEL CUT #2	Cylinder #2 injector fuel cut	ON/OFF	Same as above
FUEL CUT #3	Cylinder #3 injector fuel cut	ON/OFF	Same as above
FUEL CUT #4	Cylinder #4 injector fuel cut	ON/OFF	Same as above
FUEL CUT #5	Cylinder #5 injector fuel cut	ON/OFF	Same as above
FUEL CUT #6	Cylinder #6 injector fuel cut	ON/OFF	Same as above
COMPRESS CHECK	Check the cylinder compression pressure	ON/OFF	Fuel injection and ignition stop in all cylinders.
VVT B1	Control VVT (bank 1)	-128 to 127 % This valve added to present OCV control duty 100 %: Maximum advance -100 %: Maximum retard	Engine stalls or roughly idles when VVT actuator is operated by 100 %. Test is possible during idling.
VVT B2	Control VVT (bank 2)	Between -128 and 127%	Same as above
VVT EX B1	Control VVT (bank 1)	-128 to 127 % This valve added to present OCV control duty 100 %: Maximum advance -100 %: Maximum retard	-
VVT EX B2	Control VVT (bank 2)	Between -128 and 127 %	Same as above
TARGET FUEL PRS	Control the target fuel pressure	Between -12.5 and 24.8 %	Test is possible during vehicle stopping and engine idling.
INJ TIMING #1	Control injection timing #1	Between -16 CA and 16 CA	Test is possible during vehicle stopping and engine idling.
INJ TIMING #2	Control injection timing #2	Between -16 CA and 16 CA	Same as above
INJ TIMING #3	Control injection timing #3	Between -16 CA and 16 CA	Same as above
INJ TIMING #4	Control injection timing #4	Between -16 CA and 16 CA	Same as above
INJ TIMING #5	Control injection timing #5	Between -16 CA and 16 CA	Same as above
INJ TIMING #6	Control injection timing #6	Between -16 CA and 16 CA	Same as above
VACUUM PUMP	Vacuum pump	ON/OFF	-
VENT VALVE	Vent valve	ON/OFF	-

3. SYSTEM CHECK

HINT:

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK.
(e) Perform the SYSTEM CHECK by referring to the table below.

ES

Intelligent Tester Display	Test Detail	Recommended Fuel Temperature	Diagnostic Note
EVAP SYS CHECK (AUTO OPERATION)	Perform 4 steps in order to operate EVAP key-off monitor automatically	35°C (95°F) or less	• If no DTCs are in PENDING CODE after performing this test, system is functioning normally • Refer to EVAP system
EVAP SYS CHECK (MANUAL OPERATION)	Perform 4 steps in order to operate EVAP key-off monitor automatically	35°C (95°F) or less	• Used to detect malfunctioning parts • Refer to EVAP system

DIAGNOSTIC TROUBLE CODE CHART

HINT:
The parameters listed in the chart may not conform exactly to those read during the DTC check due to the type of instrument or other factors.
If a trouble code is displayed during the DTC check in the check mode, check the circuit for the code listed in the table below. For details of each code, refer to the "See page" column in the DTC chart.

SFI SYSTEM:

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0010	Camshaft Position "A" Actuator Circuit (Bank 1)	1. Open or short in Oil Control Valve (OCV) for intake camshaft circuit 2. OCV for intake camshaft (bank 1) 3. ECM	Comes on	DTC stored	ES-79
P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)	1. Valve timing 2. OCV for intake camshaft 3. OCV filter 4. Intake camshaft timing gear assembly 5. ECM	Comes on	DTC stored	ES-84
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	Same as DTC P0011	Comes on	DTC stored	ES-84
P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)	1. Open or short in Oil Control Valve (OCV) for exhaust camshaft circuit 2. OCV for exhaust camshaft (bank 1) 3. ECM	Comes on	DTC stored	ES-91
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	1. Valve timing 2. OCV for exhaust camshaft 3. OCV filter 4. Exhaust camshaft 5. ECM	Comes on	DTC stored	ES-96
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	Same as DTC P0014	Comes on	DTC stored	ES-96
P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)	1. Mechanical system (Timing chain has jumped teeth or chain is stretched) 2. ECM	Comes on	DTC stored	ES-104
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	Same as DTC P0016	Comes on	DTC stored	ES-104
P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)	Same as DTC P0016	Comes on	DTC stored	ES-104
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	Same as DTC P0016	Comes on	DTC stored	ES-104

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0020	Camshaft Position "A" Actuator Circuit (Bank 2)	1. Open or short in Oil Control Valve (OCV) for intake camshaft circuit 2. OCV for intake camshaft (bank 2) 3. ECM	Comes on	DTC stored	ES-79
P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)	Same as DTC P0011	Comes on	DTC stored	ES-84
P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)	Same as DTC P0011	Comes on	DTC stored	ES-84
P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)	1. Open or short in Oil Control Valve (OCV) for exhaust camshaft circuit 2. OCV for exhaust camshaft (bank 2) 3. ECM	Comes on	DTC stored	ES-91
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	Same as DTC P0014	Comes on	DTC stored	ES-96
P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)	Same as DTC P0014	Comes on	DTC stored	ES-96
P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)	1. Open in Air-Fuel Ratio (A/F) sensor heater circuit 2. A/F sensor heater (bank 1 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-107
P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)	1. Short in A/F sensor heater circuit 2. A/F sensor heater (bank 1 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-107
P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)	1. Open in Heated Oxygen (HO2) sensor heater circuit 2. HO2 sensor heater (bank 1 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-115
P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)	1. Short in HO2 sensor heater circuit 2. HO2 sensor heater (bank 1 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-115

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)	1. Open in A/F sensor heater circuit 2. A/F sensor heater (bank 2 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-107
P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)	1. Short in A/F sensor heater circuit 2. A/F sensor heater (bank 2 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-107
P0057	Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)	1. Open in HO2 sensor heater circuit 2. HO2 sensor heater (bank 2 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-115
P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)	1. Short in HO2 sensor heater circuit 2. HO2 sensor heater (bank 2 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-115
P0100	Mass or Volume Air Flow Circuit	1. Open or short in Mass Air Flow (MAF) meter circuit 2. MAF meter 3. ECM	Comes on	DTC stored	ES-125
P0101	Mass Air Flow Circuit Range / Performance Problem	MAF meter	Comes on	DTC stored	ES-133
P0102	Mass or Volume Air Flow Circuit Low Input	1. Open in MAF meter circuit 2. Short in MAF meter circuit 3. MAF meter 4. ECM	Comes on	DTC stored	ES-125
P0103	Mass or Volume Air Flow Circuit High Input	1. Short in MAF meter circuit (+B circuit) 2. MAF meter 3. ECM	Comes on	DTC stored	ES-125
P0110	Intake Air Temperature Circuit Malfunction	1. Open or short in Intake Air Temperature (IAT) sensor circuit 2. IAT sensor (built into Mass Air Flow [MAF] meter) 3. ECM	Comes on	DTC stored	ES-136
P0111	Intake Air Temperature Sensor Gradient Too High	MAF meter	Comes on	DTC stored	ES-142

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0112	Intake Air Temperature Circuit Low Input	1. Short in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. ECM	Comes on	DTC stored	ES-136
P0113	Intake Air Temperature Circuit High Input	1. Open in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. ECM	Comes on	DTC stored	ES-136
P0115	Engine Coolant Temperature Circuit Malfunction	1. Open or short in Engine Coolant Temperature (ECT) sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-145
P0116	Engine Coolant Temperature Circuit Range / Performance Problem	1. Thermostat 2. ECT sensor	Comes on	DTC stored	ES-151
P0117	Engine Coolant Temperature Circuit Low Input	1. Short in ECT sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-145
P0118	Engine Coolant Temperature Circuit High Input	1. Open in ECT sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-145
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction	1. Throttle Position (TP) sensor (built into throttle body) 2. ECM	Comes on	DTC stored	ES-154
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	ES-161
P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input	1. TP sensor (built into throttle body) 2. Short in VTA1 circuit 3. Open in VC circuit 4. ECM	Comes on	DTC stored	ES-154
P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input	1. TP sensor (built into throttle body) 2. Open in VTA1 circuit 3. Open in E2 circuit 4. Short between VC and VTA1 circuits 5. ECM	Comes on	DTC stored	ES-154
P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control	1. Cooling system 2. ECT sensor 3. Thermostat	Comes on	DTC stored	ES-165
P0128	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)	1. Thermostat 2. Cooling system 3. ECT sensor 4. ECM	Comes on	DTC stored	ES-168

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)	1. Open or short in HO2 sensor (bank 1 sensor 2) circuit 2. HO2 sensor (bank 1 sensor 2) 3. HO2 sensor heater (bank 1 sensor 2) 4. A/F sensor (bank 1 sensor 1) 5. Engine room junction block (EFI relay) 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-171
P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)	1. Open in HO2 sensor (bank 1 sensor 2) circuit 2. HO2 sensor (bank 1 sensor 2) 3. HO2 sensor heater (bank 1 sensor 2) 4. Engine room junction block (EFI relay) 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-171
P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)	1. Short in HO2 sensor (bank 1 sensor 2) circuit 2. HO2 sensor (bank 1 sensor 2) 3. ECM internal circuit malfunction	Comes on	DTC stored	ES-171
P0141	Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)	1. HO2 sensor 2. ECM	Comes on	DTC stored	ES-115
P0156	Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)	1. Open or short in HO2 sensor (bank 2 sensor 2) circuit 2. HO2 sensor (bank 2 sensor 2) 3. HO2 sensor heater (bank 2 sensor 2) 4. A/F sensor (bank 2 sensor 1) 5. Engine room junction block (EFI relay) 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-171
P0157	Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)	1. Open in HO2 sensor (bank 2 sensor 2) circuit 2. HO2 sensor (bank 2 sensor 2) 3. HO2 sensor heater (bank 2 sensor 2) 4. Engine room junction block (EFI relay) 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-171

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0158	Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)	1. Short in HO2 sensor (bank 2 sensor 2) circuit 2. HO2 sensor (bank 2 sensor 2) 3. ECM internal circuit malfunction	Comes on	DTC stored	ES-171
P0161	Oxygen Sensor Heater Circuit Malfunction (Bank 2 Sensor 2)	1. HO2 sensor 2. ECM	Comes on	DTC stored	ES-115
P0171	System Too Lean (Bank 1)	1. Air induction system 2. Injector blockage 3. MAF meter 4. ECT sensor 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 1 sensor 1) circuit 8. A/F sensor (bank 1 sensor 1) 9. A/F sensor heater (bank 1 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. PCV hose connections 13. PCV valve and hose 14. ECM	Comes on	DTC stored	ES-191
P0172	System Too Rich (Bank 1)	1. Injector leakage or blockage 2. MAF meter 3. ECT sensor 4. Ignition system 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 1 sensor 1) circuit 8. A/F sensor (bank 1 sensor 1) 9. A/F sensor heater (bank 1 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. ECM	Comes on	DTC stored	ES-191

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0174	System Too Lean (Bank 2)	1. Air induction system 2. Injector blockage 3. MAF meter 4. ECT sensor 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 2 sensor 1) circuit 8. A/F sensor (bank 2 sensor 1) 9. A/F sensor heater (bank 2 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. PCV hose connections 13. PCV valve and hose 14. ECM	Comes on	DTC stored	ES-191
P0175	System Too Rich (Bank 2)	1. Injector leakage or blockage 2. MAF meter 3. ECT sensor 4. Ignition system 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 2 sensor 1) circuit 8. A/F sensor (bank 2 sensor 1) 9. A/F sensor heater (bank 2 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. ECM	Comes on	DTC stored	ES-191
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	1. TP sensor (built into throttle body) 2. ECM	Comes on	DTC stored	ES-154
P0222	Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input	1. TP sensor (built into throttle body) 2. Short in VTA2 circuit 3. Open in VC circuit 4. ECM	Comes on	DTC stored	ES-154
P0223	Throttle / Pedal Position Sensor / Switch "B" Circuit High Input	1. TP sensor (built into throttle body) 2. Open in VTA2 circuit 3. Open in E2 circuit 4. Short between VC and VTA2 circuits 5. ECM	Comes on	DTC stored	ES-154

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0300	Random / Multiple Cylinder Misfire Detected	1. Open or short in engine wire harness 2. Connector connections 3. Vacuum hose connection 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. ECM	Comes on or flashes	DTC stored	ES-204
P0301	Cylinder 1 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-204
P0302	Cylinder 2 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-204
P0303	Cylinder 3 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-204
P0304	Cylinder 4 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-204
P0305	Cylinder 5 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-204
P0306	Cylinder 6 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-204
P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)	1. Short in knock sensor 1 circuit 2. Knock sensor 1 3. ECM	Comes on	DTC stored	ES-216
P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)	1. Open in knock sensor 1 circuit 2. Knock sensor 1 3. ECM	Comes on	DTC stored	ES-216
P0332	Knock Sensor 2 Circuit Low Input (Bank 2)	1. Short in knock sensor 2 circuit 2. Knock sensor 2 3. ECM	Comes on	DTC stored	ES-216
P0333	Knock Sensor 2 Circuit High Input (Bank 2)	1. Open in knock sensor 2 circuit 2. Knock sensor 2 3. ECM	Comes on	DTC stored	ES-216
P0335	Crankshaft Position Sensor "A" Circuit	1. Open or short in Crankshaft Position Sensor (CKP) circuit 2. CKP sensor 3. Sensor plate (CKP sensor plate) 4. ECM	Comes on	DTC stored	ES-222
P0339	Crankshaft Position Sensor "A" Circuit Intermittent	Same as DTC P0335	Does not come on	DTC stored	ES-222

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0340	Camshaft Position Sensor Circuit Malfunction	1. Open or short in VVT sensor for intake camshaft circuit 2. VVT sensor for intake camshaft 3. Camshaft timing gear for intake camshaft 4. Jumped tooth of timing chain for intake camshaft 5. ECM	Comes on	DTC stored	ES-228
P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)	Same as DTC P0340	Comes on	DTC stored	ES-228
P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)	Same as DTC P0340	Comes on	DTC stored	ES-228
P0345	Camshaft Position Sensor "A" Circuit (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-228
P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-228
P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-228
P0351	Ignition Coil "A" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 6) between ignition coil and ECM 3. No. 1 to No. 6 ignition coils 4. ECM	Comes on	DTC stored	ES-234
P0352	Ignition Coil "B" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-234
P0353	Ignition Coil "C" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-234
P0354	Ignition Coil "D" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-234
P0355	Ignition Coil "E" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-234
P0356	Ignition Coil "F" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-234
P0365	Camshaft Position Sensor "B" Circuit (Bank 1)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-243

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-243
P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-243
P0390	Camshaft Position Sensor "B" Circuit (Bank 2)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-243
P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-243
P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-243
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	1. Gas leakage from exhaust system 2. A/F sensor (bank 1 sensor 1) 3. HO2 sensor (bank 1 sensor 2) 4. Exhaust manifold (Three-Way Catalytic Converter [TWC])	Comes on	DTC stored	ES-249

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0430	Catalyst System Efficiency Below Threshold (Bank 2)	1. Gas leakage from exhaust system 2. A/F sensor (bank 2 sensor 1) 3. HO2 sensor (bank 2 sensor 2) 4. Exhaust manifold (Three-Way Catalytic Converter [TWC])	Comes on	DTC stored	ES-249
P043E	Evaporative Emission System Reference Orifice Clog Up	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-255
P043F	Evaporative Emission System Reference Orifice High Flow	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-255
P0441	Evaporative Emission Control System Incorrect Purge Flow	1. EVAP VSV 2. Connector / wire harness (EVAP VSV - ECM) 3. ECM 4. Pump module 5. Leakage from EVAP system 6. Leakage from EVAP line (EVAP VSV - Intake manifold)	Comes on	DTC stored	ES-260
P0450	Evaporative Emission Control System Pressure Sensor / Switch	1. Pump module (including pressure sensor) 2. ECM	Comes on	DTC stored	ES-267
P0451	Evaporative Emission Control System Pressure Sensor Range / Performance	1. Pump module (including pressure sensor) 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-267
P0452	Evaporative Emission Control System Pressure Sensor / Switch Low Input	1. Pump module (including pressure sensor) 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-267
P0453	Evaporative Emission Control System Pressure Sensor / Switch High Input	1. Pump module (include pressure sensor) 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-267

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0455	Evaporative Emission Control System Leak Detected (Gross Leak)	1. Fuel tank cap (loose) 2. Leakage from EVAP line (Canister - Fuel tank) 3. Leakage from EVAP line (EVAP VSV - Canister) 4. Pump module 5. Leakage from fuel tank 6. Leakage from canister	Comes on	DTC stored	ES-274
P0456	Evaporative Emission Control System Leak Detected (Very Small Leak)	Same as DTC P0455	Comes on	DTC stored	ES-274
P0500	Vehicle Speed Sensor "A"	1. Vehicle speed sensor 2. Vehicle speed sensor signal circuit 3. Combination meter 4. ECM 5. Skid control ECU	Comes on	DTC stored	ES-279
P0504	Brake Switch "A" / "B" Correlation	1. Short in stop light switch signal circuit 2. Stop light switch 3. ECM	Does not come on	DTC stored	ES-284
P0505	Idle Control System Malfunction	1. ETCS (Electronic Throttle Control System) 2. Air induction system 3. PCV hose connection 4. ECM	Comes on	DTC stored	ES-288
P050A	Cold Start Idle Air Control System Performance	1. Throttle body assembly 2. MAF meter 3. Air induction system 4. PCV hose connections 5. VVT system 6. Air cleaner filter element 7. ECM	Comes on	DTC stored	ES-291
P050B	Cold Start Ignition Timing Performance	Same as DTC P050A	Comes on	DTC stored	ES-291
P0560	System Voltage	1. Open in back-up power source circuit 2. ECM	Comes on	DTC stored	ES-297
P0604	Internal Control Module Random Access Memory (RAM) Error	ECM	Comes on	DTC stored	ES-302
P0606	ECM / PCM Processor	ECM	Comes on (except when there is a malfunction in the ECM internal circuit)	DTC stored	ES-302

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0607	Control Module Performance	ECM	Comes on (except when there is a malfunction in the cruise control switch circuit)	DTC stored	ES-302
P0617	Starter Relay Circuit High	1. Park / Neutral Position (PNP) switch 2. Starter relay circuit 3. Cranking holding function circuit 4. Ignition switch 5. ECM	Comes on	DTC stored	ES-304
P0630	VIN not Programmed or Mismatch - ECM / PCM	ECM	Comes on	DTC stored	ES-309
P0657	Actuator Supply Voltage Circuit / Open	ECM	Comes on	DTC stored	ES-302
P0705	Transmission Range Sensor Circuit Malfunction (PRNDL Input)	1. Short in park / neutral position switch circuit 2. Park / neutral position switch 3. ECM	Comes on	DTC stored	ES-311
P0724	Brake Switch "B" Circuit High	1. Short in stop light switch signal circuit 2. Stop light switch 3. ECM	Comes on	DTC stored	ES-284
P2102	Throttle Actuator Control Motor Circuit Low	1. Open in throttle actuator circuit 2. Throttle actuator 3. ECM	Comes on	DTC stored	ES-320
P2103	Throttle Actuator Control Motor Circuit High	1. Short in throttle actuator circuit 2. Throttle actuator 3. Throttle valve 4. Throttle body assembly 5. ECM	Comes on	DTC stored	ES-320
P2111	Throttle Actuator Control System - Stuck Open	1. Throttle actuator 2. Throttle body 3. Throttle valve	Comes on	DTC stored	ES-324
P2112	Throttle Actuator Control System - Stuck Closed	Same as DTC P2111	Comes on	DTC stored	ES-324
P2118	Throttle Actuator Control Motor Current Range / Performance	1. Open in ETCS power source circuit 2. ETCS fuse 3. ECM	Comes on	DTC stored	ES-327
P2119	Throttle Actuator Control Throttle Body Range / Performance	1. ETCS 2. ECM	Comes on	DTC stored	ES-331
P2120	Throttle / Pedal Position Sensor / Switch "D" Circuit	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-334
P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-341

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2122	Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input	1. Accelerator Pedal Position (APP) sensor 2. Open in VCP1 circuit 3. Open or ground short in VPA circuit 4. ECM	Comes on	DTC stored	ES-334
P2123	Throttle / Pedal Position Sensor / Switch "D" Circuit High Input	1. Accelerator Pedal Position (APP) sensor 2. Open in EPA circuit 3. ECM	Comes on	DTC stored	ES-334
P2125	Throttle / Pedal Position Sensor / Switch "E" Circuit	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-334
P2127	Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input	1. Accelerator Pedal Position (APP) sensor 2. Open in VCP2 circuit 3. Open or ground short in VPA2 circuit 4. ECM	Comes on	DTC stored	ES-334
P2128	Throttle / Pedal Position Sensor / Switch "E" Circuit High Input	1. Accelerator Pedal Position (APP) sensor 2. Open in EPA2 circuit 3. ECM	Comes on	DTC stored	ES-334
P2135	Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation	1. Short between VTA1 and VTA2 circuits 2. TP sensor (built into throttle body) 3. ECM	Comes on	DTC stored	ES-154
P2138	Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation	1. Short between VPA and VPA2 circuits 2. APP sensor 3. ECM	Comes on	DTC stored	ES-334
P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)	1. Open or short in A/F sensor (bank 1 sensor 1) circuit 2. A/F sensor (bank 1 sensor 1) 3. A/F sensor heater (bank 1 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. Air induction system 7. Fuel pressure 8. Injector 9. ECM	Comes on	DTC stored	ES-345
P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	Same as DTC P2195	Comes on	DTC stored	ES-345

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)	1. Open or short in A/F sensor (bank 2 sensor 1) circuit 2. A/F sensor (bank 2 sensor 1) 3. A/F sensor heater (bank 2 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. Air induction system 7. Fuel pressure 8. Injector 9. ECM	Comes on	DTC stored	ES-345
P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)	Same as DTC P2197	Comes on	DTC stored	ES-345
P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)	1. Open or short in A/F sensor (bank 1 sensor 1) circuit 2. A/F sensor (bank 1 sensor 1) 3. A/F sensor heater (bank 1 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. ECM	Comes on	DTC stored	ES-364
P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-364
P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)	1. Open or short in A/F sensor (bank 2 sensor 1) circuit 2. A/F sensor (bank 2 sensor 1) 3. A/F sensor heater (bank 2 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. ECM	Comes on	DTC stored	ES-364
P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-364
P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-364
P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-364
P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-364

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-364
P2401	Evaporative Emission System Leak Detection Pump Control Circuit Low	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-255
P2402	Evaporative Emission System Leak Detection Pump Control Circuit High	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-255
P2419	Evaporative Emission System Switching Valve Control Circuit Low	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-255
P2420	Evaporative Emission System Switching Valve Control Circuit High	1. Pump module (0.02 inch orifice, vacuum pump, vent valve) EVAP system monitor 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-373
P2610	ECM / PCM Internal Engine Off Timer Performance	ECM	Comes on	DTC stored	ES-377
P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)	1. Open or short in A/F sensor (bank 1 sensor 1) circuit 2. A/F sensor (bank1 sensor 1) 3. ECM	Comes on	DTC stored	ES-380
P2A03	A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)	1. Open or short in A/F sensor (bank 2 sensor 1) circuit 2. A/F sensor (bank 2 sensor 1) 3. ECM	Comes on	DTC stored	ES-380
U0101	Lost Communication with TCM	1. Open or short in TCM and ECM circuit 2. TCM 3. ECM	Comes on	DTC stored	ES-389

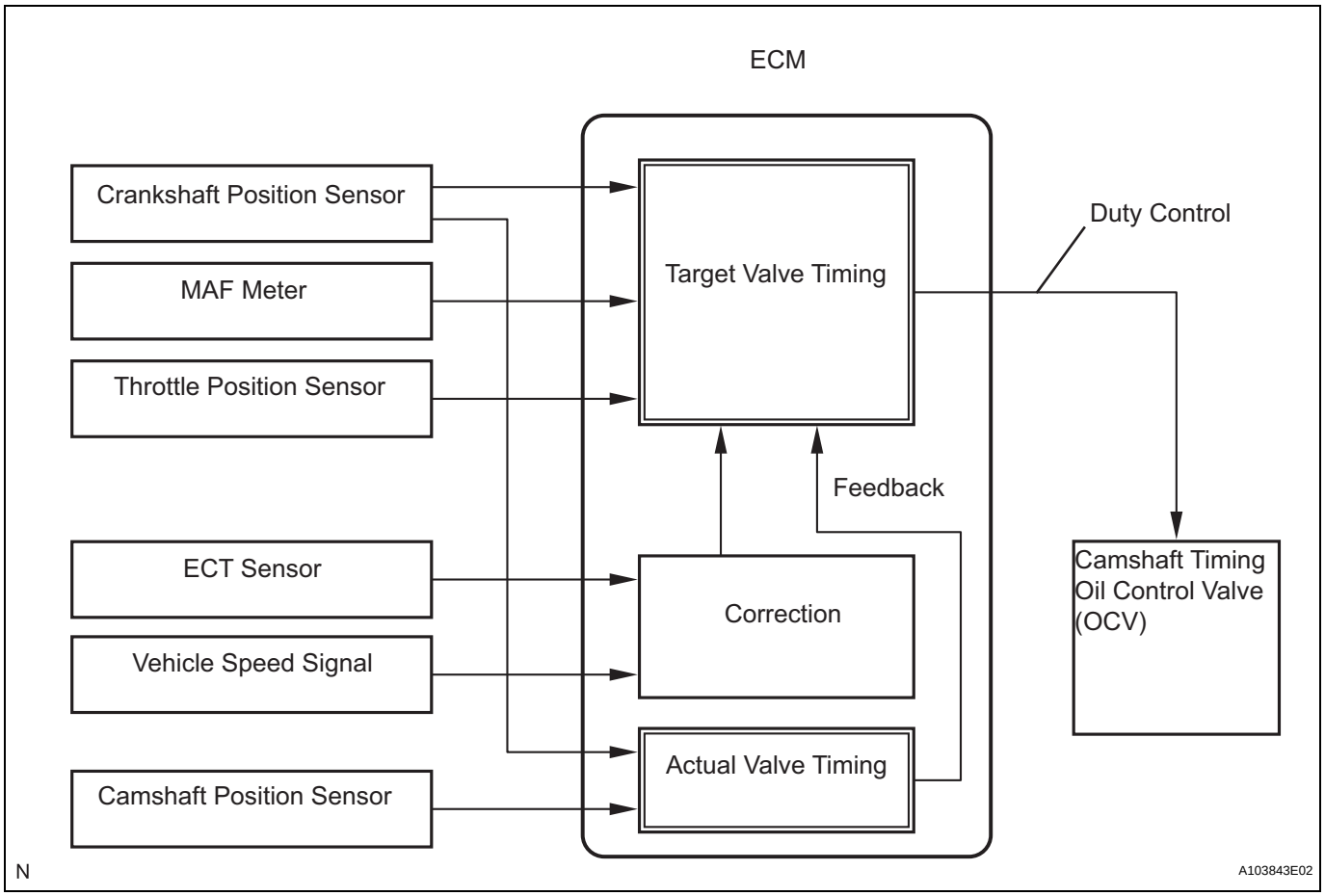
*1: This DTC is related to the A/F sensor, although the caption in the "Detection Item" column refers to the heated oxygen sensor.
*2: This DTC indicates a malfunction related to the primary circuit.

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

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

DESCRIPTION

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



DTC No.	DTC Detection Condition	Trouble Area
P0010	Open or short in OCV for intake camshaft (bank 1) circuit (1 trip detection logic)	• Open or short in OCV for intake camshaft (bank 1) circuit • OCV for intake camshaft (bank 1) • ECM
P0020	Open or short in OCV for intake camshaft (bank 2) circuit (1 trip detection logic)	• Open or short in OCV for intake camshaft (bank 2) circuit • OCV for intake camshaft (bank 2) • ECM

MONITOR DESCRIPTION

After the ECM sends the "target" duty-cycle signal to the OCV, the ECM monitors the OCV current to establish an "actual" duty-cycle. The ECM detects a malfunction and sets a DTC when the actual duty-cycle ratio varies from the target duty-cycle ratio.

MONITOR STRATEGY

Related DTCs	P0010: VVT OCV (bank 1) open/short P0020: VVT OCV (bank 2) open/short
Required sensors / components (Main)	VVT OCV (Variable Valve Timing oil control valve)
Required sensors / components (Sub)	-
Frequency of operation	Continuous
Duration	1 second
MIL operation	Immediately
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever these DTCs are not present	None
All of the following conditions are met:	-
Starter	OFF
Engine switch	ON
Time after turning ignition switch off to on (IG)	0.5 seconds or more

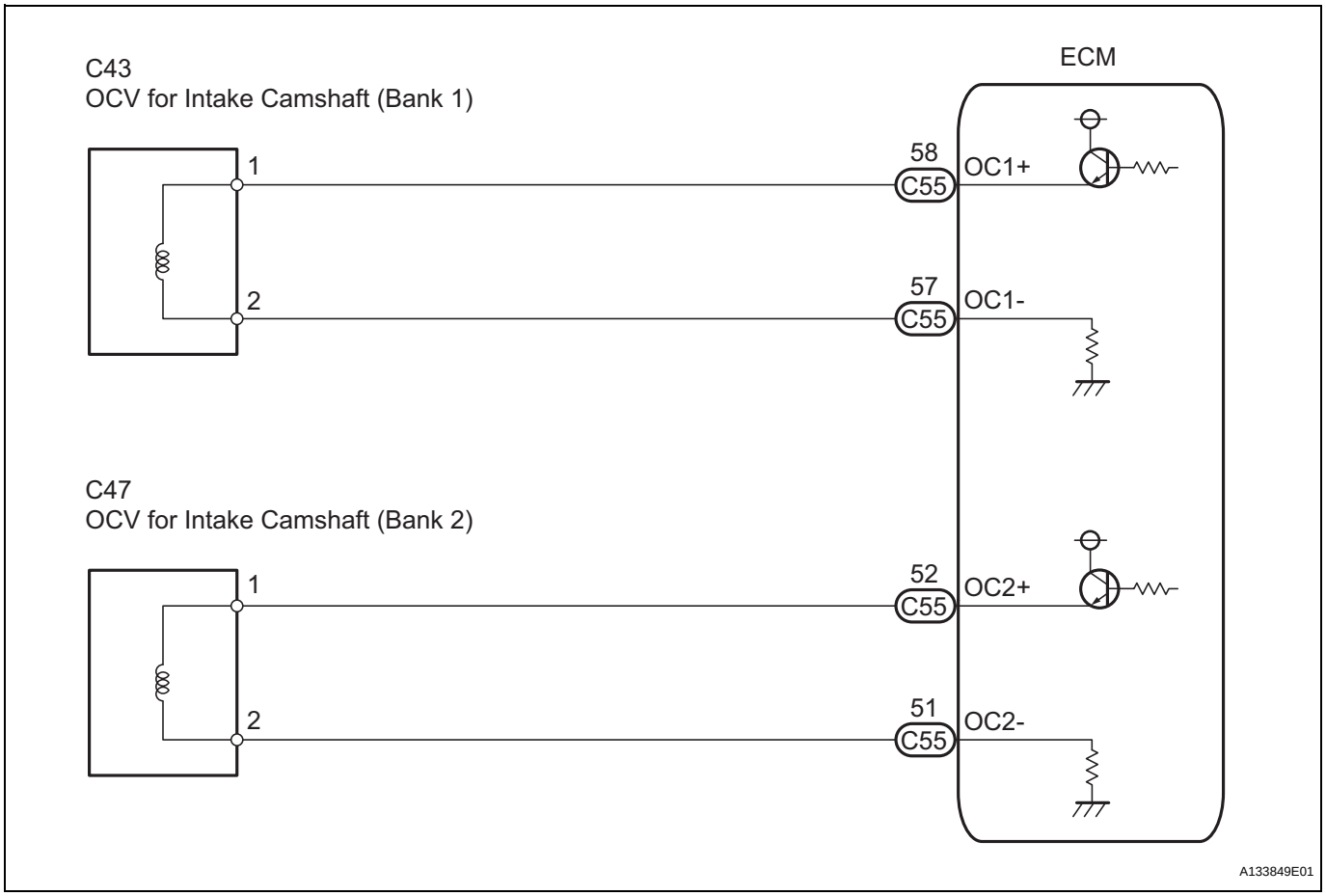
TYPICAL MALFUNCTION THRESHOLDS

One of the following conditions is met:	Condition A, B or C
A. All of the following conditions are met:	-
Battery voltage	11 to 13 V
Target duty ratio	Less than 70 %
Output signal duty ratio	100 %
B. All of the following conditions are met:	-
Battery voltage	13 V or more
Target duty ratio	Less than 80 %
Output signal duty ratio	100 %
C. All of the following conditions are met:	-
Current cut status	Not cut
Output signal duty ratio	3 % or less

COMPONENT OPERATING RANGE

VVT OCV duty ratio	More than 3 %, and Less than 100 %

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:

- If DTC P0010 is displayed, check the intake camshaft circuit for the right bank VVT system.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0020 is displayed, check the intake camshaft circuit for the left bank VVT system.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	**PERFORM ACTIVE TEST BY CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV)**

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine.
(d) On the tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1 or VVT CTRL B2.
(e) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

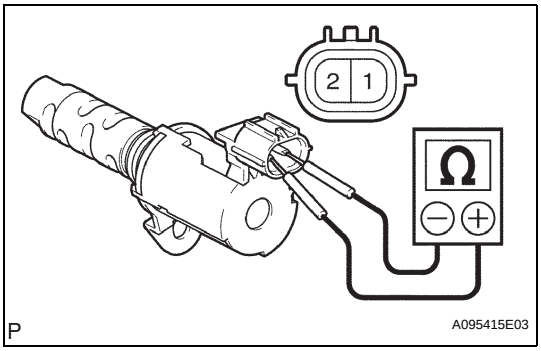
OK

Tester Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

OK → **CHECK FOR INTERMITTENT PROBLEMS (See page ES-33)**

NG

2 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY



(a) Disconnect the C43 or C47 OCV connector.
(b) Measure the resistance between the terminals of the OCV.

Standard resistance

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

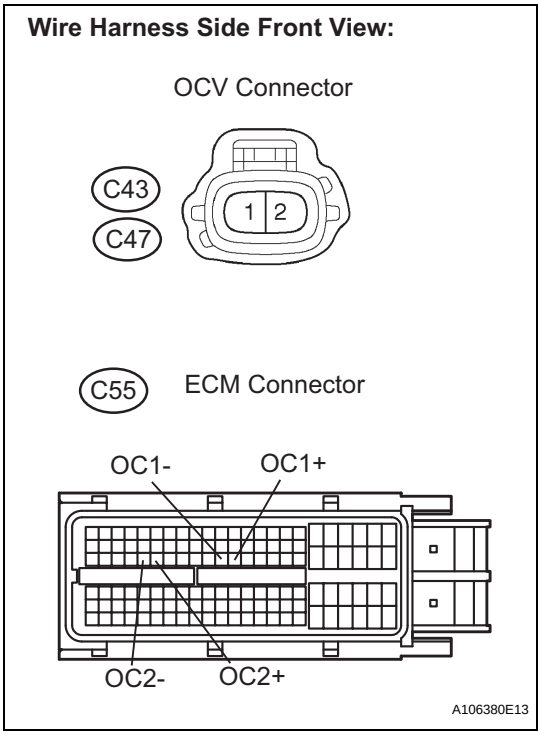
(c) Reconnect the OCV connector.

OK → **REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (See page ES-481)**

NG

3 CHECK HARNESS AND CONNECTOR (OCV - ECM)

Wire Harness Side Front View:



(a) Disconnect the C43 or C47 OCV connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
OC1+ (C55-58) - C43-1	Below 1 Ω
OC1- (C55-57) - C43-2	Below 1 Ω
OC2+ (C55-52) - C47-1	Below 1 Ω
OC2- (C55-51) - C47-2	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
OC1+ (C55-58) or C43-1 - Body ground	10 kΩ or higher
OC1- (C55-57) or C43-2 - Body ground	10 kΩ or higher
OC2+ (C55-52) or C47-1 - Body ground	10 kΩ or higher
OC2- (C55-51) or C47-2 - Body ground	10 kΩ or higher

(d) Reconnect the OCV connector.
(e) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM (See page ES-518)

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

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

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

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

ES

DESCRIPTION

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

DTC No.	DTC Detection Condition	Trouble Area
P0011 P0021	Advanced cam timing: With warm engine and engine speed of between 500 rpm and 4,000 rpm, all conditions (1), (2) and (3) are met (1 trip detection logic): 1. Difference between target and actual intake valve timing is more than 5°CA (Crankshaft Angle) for 4.5 seconds 2. Current intake valve timing is fixed (timing changes less than 5°CA in 5 seconds) 3. Variations in VVT controller timing is more than 19°CA of maximum delayed timing (advance)	• Valve timing • Oil Control valve (OCV) for intake camshaft (bank 1) • OCV filter (bank 1) • Intake camshaft (bank 1) timing gear assembly • ECM
P0012 P0022	Retarded cam timing: With warm engine and engine speed of between 500 rpm and 4,000 rpm, all conditions (1), (2) and (3) are met (2 trip detection logic): 1. Difference between target and actual intake valve timing is more than 5°CA (Crankshaft Angle) for 4.5 seconds 2. Current intake valve timing is fixed (timing changes less than 5°CA in 5 seconds) 3. Variations in VVT controller timing is 19°CA or less of maximum delayed timing (retarded)	• Valve timing • OCV for intake camshaft (bank 2) • OCV filter (bank 2) • Intake camshaft (bank 2) timing gear assembly • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the intake valve timing using the VVT (Variable Valve Timing) system to control the intake camshaft. The VVT system includes the ECM, the Oil Control Valve (OCV) and the VVT controller.

2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft. If the difference between the target and actual intake valve timing is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and sets a DTC.
   Example:
   A DTC will be set when the following conditions 1), 2) and 3) are met:
   1) The difference between the target and actual intake valve timings is more than 5° CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
   2) It takes 5 seconds or more to change the valve timing by 5° CA.
   3) After above conditions 1) and 2) are met, the OCV is forcibly activated 63 times or more.
3. DTCs P0011 and P0021 (Advanced Cam Timing) are detected with 1 trip detection logic.
4. DTCs P0012 and P0022 (Retarded Cam Timing) are detected with 2 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   (a) The engine is warm (the engine coolant temperature is 75°C (167°F) or more).
   (b) The vehicle has been driven at more than 40 mph (64 km/h) for 3 minutes.
   (c) The engine has idled for 3 minutes.

ES

MONITOR STRATEGY

Related DTCs	P0011: Advanced camshaft timing (bank 1) P0012: Retard camshaft timing (bank 1) P0021: Advanced camshaft timing (bank 2) P0022: Retard camshaft timing (bank 2)
Required sensors / components (Main)	VVT OCV and VVT Actuator
Required sensors / components (Sub)	Crankshaft position sensor, camshaft position sensor and Engine coolant temperature sensor
Frequency of operation	Once per drive cycle
Duration	Within 10 seconds
MIL operation	Advanced camshaft timing (bank 1): Immediately Advanced camshaft timing (bank 2): Immediately Retard camshaft timing (bank 1): 2 driving cycles Retard camshaft timing (bank 2): 2 driving cycles
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	P0100 - P0103 (MAF sensor) P0115 - P0118 (ECT sensor) P0125 (Insufficient ECT for closed loop) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0351 - P0358 (ignitor)
Battery voltage	11 V or more
Engine	500 to 4,000 rpm
ECT	75 to 100°C (167 to 212°F)

TYPICAL MALFUNCTION THRESHOLDS

Advanced camshaft timing:

Difference between actual valve timing and target valve timing	More than 5°CA
Valve timing	No change in advanced valve timing

Retard camshaft timing:

Difference between actual valve timing and target valve timing	More than 5°CA

Valve timing	No change in retarded valve timing

WIRING DIAGRAM

Refer to DTC P0010 (See page ES-81).

INSPECTION PROCEDURE

HINT:

Abnormal bank	Advanced timing over (Valve timing is out of specified range)	Retarded timing over (Valve timing is out of specified range)
Bank 1	P0011	P0012
Bank 2	P0021	P0022

- If DTC P0011 or P0012 is displayed, check the right bank VVT system for intake camshaft circuit (bank 1).
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0021 or P0022 is displayed, check the intake camshaft circuit for the left bank VVT system (bank 2).
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using an intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0011, P0012, P0021 or P0022	A
P0011, P0012, P0021 or P0022 and other DTCs	B

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

B → **GO TO DTC CHART (See page ES-63)**

A

2	**PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATE OCV)**

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1 or VVT CTRL B2.

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

OK

Tester Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

NG → **Go to step 4**

OK

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Clear the DTCs.
(d) Start the engine and warm it up.
(e) Switch the ECM from normal mode to check mode using the tester.
(f) Drive the vehicle for more than 10 minutes.
(g) Read the DTCs using the tester.
OK:
No DTC output.

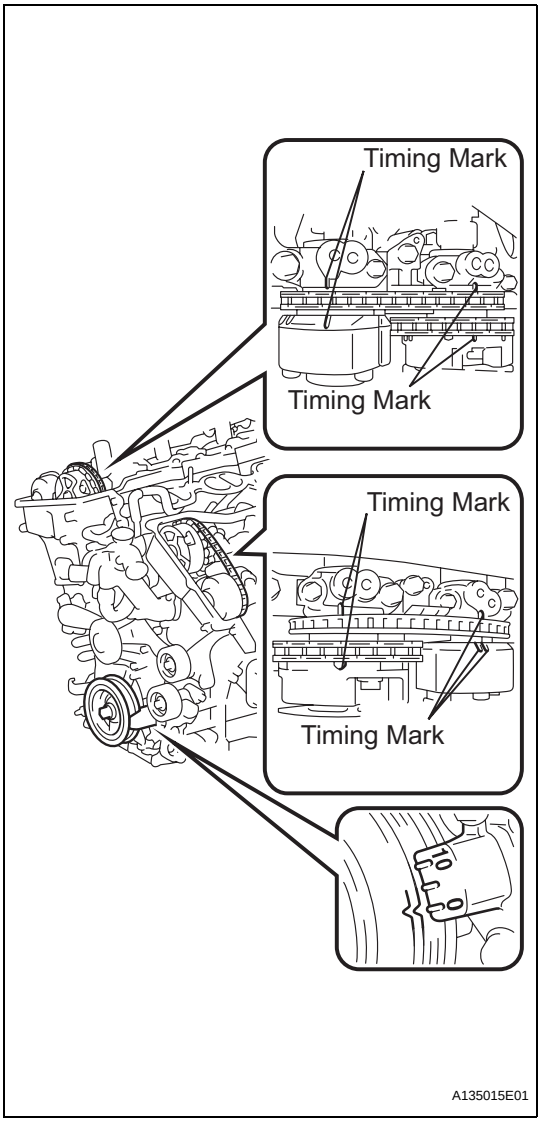
NG → **Go to step 4**

OK

END

ES

4	CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)

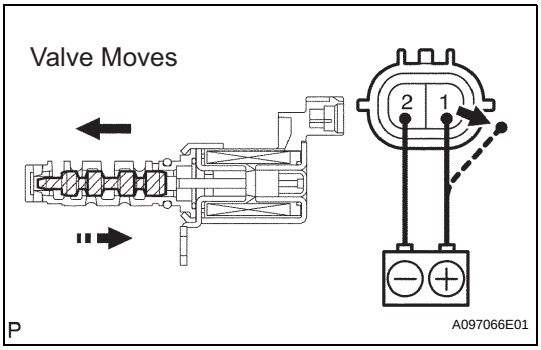


(a) Remove the cylinder head covers RH and LH.
(b) Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.
(c) Check that the timing marks of the camshaft timing gears are aligned with the timing marks of the bearing cap as shown in the illustration.
If not, turn the crankshaft 1 revolution (360°), then align the marks as above.
OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.
(d) Reinstall the cylinder head cover.

NG → **ADJUST VALVE TIMING**

OK

5	INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV)



(a) Remove the OCV.
(b) Measure the resistance between the terminals of the OCV.
Standard resistance

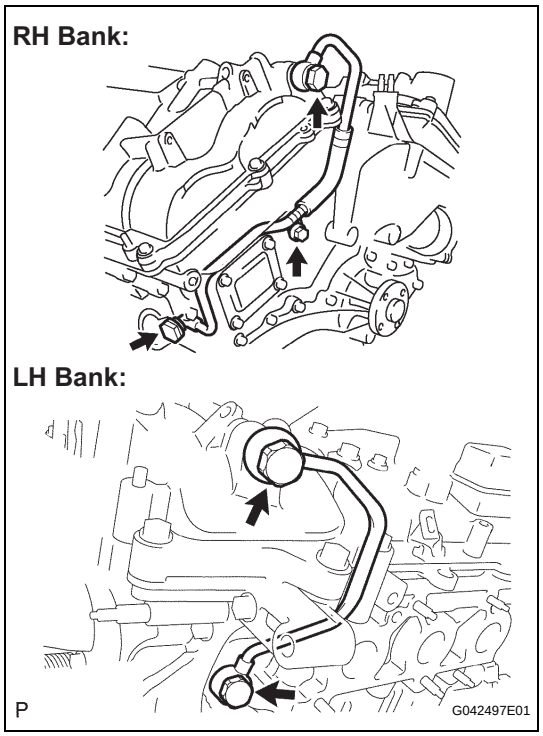
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

(c) Apply positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.
OK:
Valve moves quickly.
(d) Reinstall the OCV.

NG → REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (See page ES-481)

OK

6 INSPECT OIL CONTROL VALVE FILTER AND PIPE



(a) Remove the oil pipe No. 1 or No. 2.
(b) Remove the oil control valve filter.
(c) Check that the filter and pipe are not clogged.
OK:
The filter and pipe are not clogged.

NG → CLEAN OIL CONTROL VALVE FILTER AND PIPE

OK

7 REPLACE CAMSHAFT TIMING GEAR ASSEMBLY

NEXT

8 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Clear the DTCs.
(d) Start the engine and warm it up.
(e) Switch the ECM from normal mode to check mode using the tester.
(f) Driver the vehicle for more than 10 minutes.
(g) Read the output DTCs using the intelligent tester.
OK:
No DTC output.

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

OK → **SYSTEM IS OK**

NG

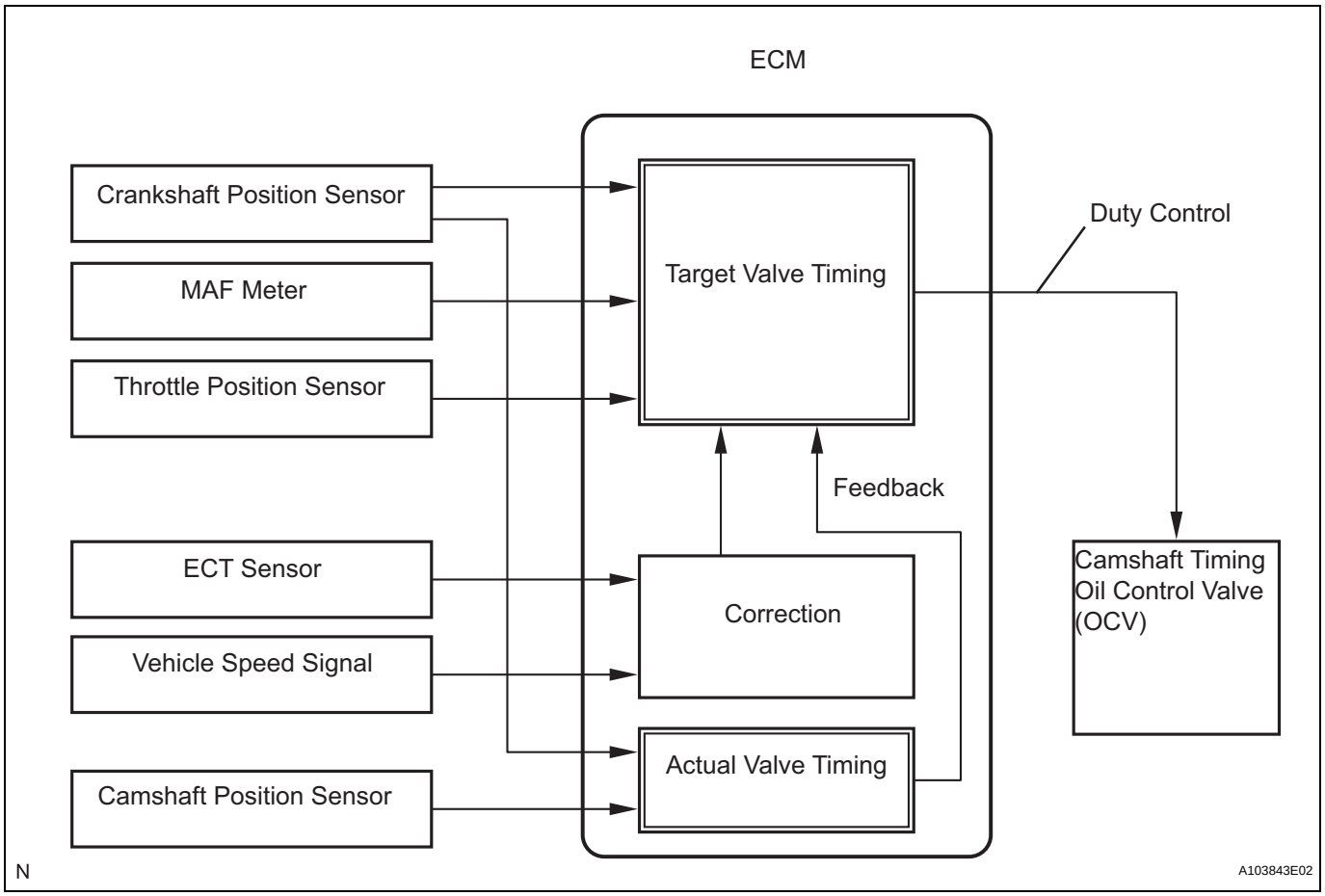
REPLACE ECM (See page ES-518)

DTC	P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)

DTC	P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)

DESCRIPTION

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



DTC No.	DTC Detection Condition	Trouble Area
P0013	Open or short in OCV for exhaust camshaft (bank 1) circuit (1 trip detection logic)	• Open or short in OCV for exhaust camshaft (bank 1) circuit • OCV for exhaust camshaft (bank 1) • ECM
P0023	Open or short in OCV for exhaust camshaft (bank 2) circuit (1 trip detection logic)	• Open or short in OCV for exhaust camshaft (bank 2) circuit • OCV for exhaust camshaft (bank 2) • ECM

MONITOR DESCRIPTION

The ECM optimizes the valve timing using the VVT system to control the exhaust camshaft. The VVT system includes the ECM, the OCV and the VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
After the ECM sends the target duty-cycle signal to the OCV, the ECM monitors the OCV current to establish an actual duty-cycle. The ECM determines the existence of a malfunction and sets the DTC when the actual duty-cycle ratio varies from the target duty-cycle ratio.

MONITOR STRATEGY

Related DTCs	P0013: VVT OCV (bank 1) open/short P0023: VVT OCV (bank 2) open/short
Required sensors / components (Main)	VVT OCV (Variable Valve Timing oil control valve)
Required sensors / components (Sub)	-
Frequency of operation	Continuous
Duration	1 second
MIL operation	Immediate
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None
All of the following conditions are met:	-
Starter	OFF
Engine switch	ON
Time after engine switch off to on	0.5 seconds or more

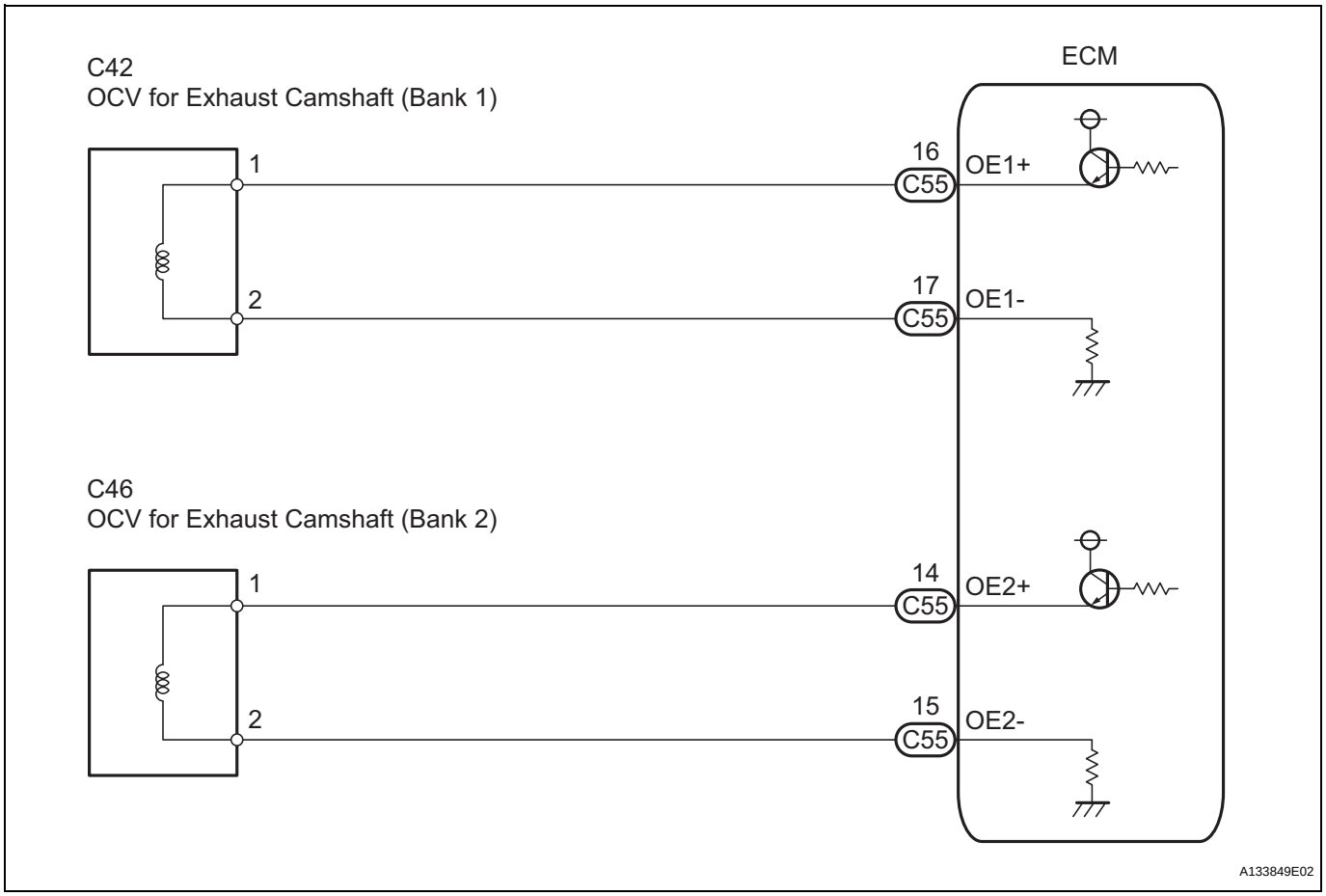
TYPICAL MALFUNCTION THRESHOLDS

One of the following conditions is met:	Condition A, B or C
A. All of the following conditions are met:	-
Battery voltage	11 to 13 V
Target duty ratio	Less than 70%
Output signal duty ratio	100 %
B. All of the following conditions are met:	-
Battery voltage	13 V or more
Target duty ratio	Less than 80%
Output duty ratio	100 %
C. All of the following conditions are met:	-
Current cut status	Not cut
Output signal duty ratio	3% or less

COMPONENT OPERATING RANGE

VVT duty ratio	More than 3, and less than 100 %

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:

- If DTC P0013 is displayed, check the exhaust camshaft circuit for the bank 1 VVT system.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0023 is displayed, check the exhaust camshaft circuit for the bank 2 VVT system.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using an intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATE OCV)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1 or VVT CTRL B2.
(e) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK

Tester Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

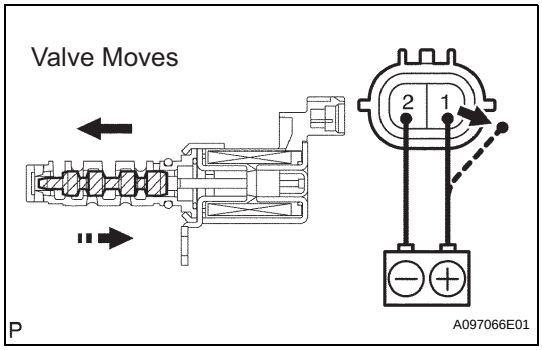
NG → **Go to step 2**

OK →

CHECK FOR INTERMITTENT PROBLEMS

ES

2 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY



(a) Disconnect the C42 or C46 OCV connector.
(b) Measure the resistance between the terminals of the OCV.

Standard resistance

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

(c) Reconnect the OCV connector.

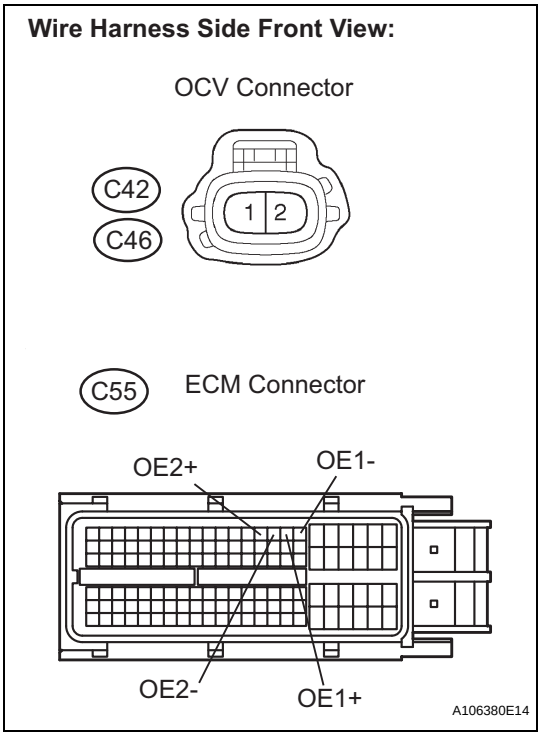
NG → **Go to step 3**

OK →

REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (See page ES-481)

3	CHECK HARNESS AND CONNECTOR (OCV - ECM)

Wire Harness Side Front View:



(a) Disconnect the C42 or C46 OCV connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
OE1+ (C55-16) - C42-1	Below 1 Ω
OE1- (C55-17) - C42-2	Below 1 Ω
OE2+ (C55-14) - C46-1	Below 1 Ω
OE2- (C55-15) - C46-2	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
OE1+ (C55-16) or C42-1 - Body ground	10 kΩ or higher
OE1- (C55-17) or C42-2 - Body ground	10 kΩ or higher
OE2+ (C55-14) or C46-1 - Body ground	10 kΩ or higher
OE2- (C55-15) or C46-2 - Body ground	10 kΩ or higher

(d) Reconnect the ECM connector.
(e) Reconnect the OCV connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM (See page ES-481)

ES

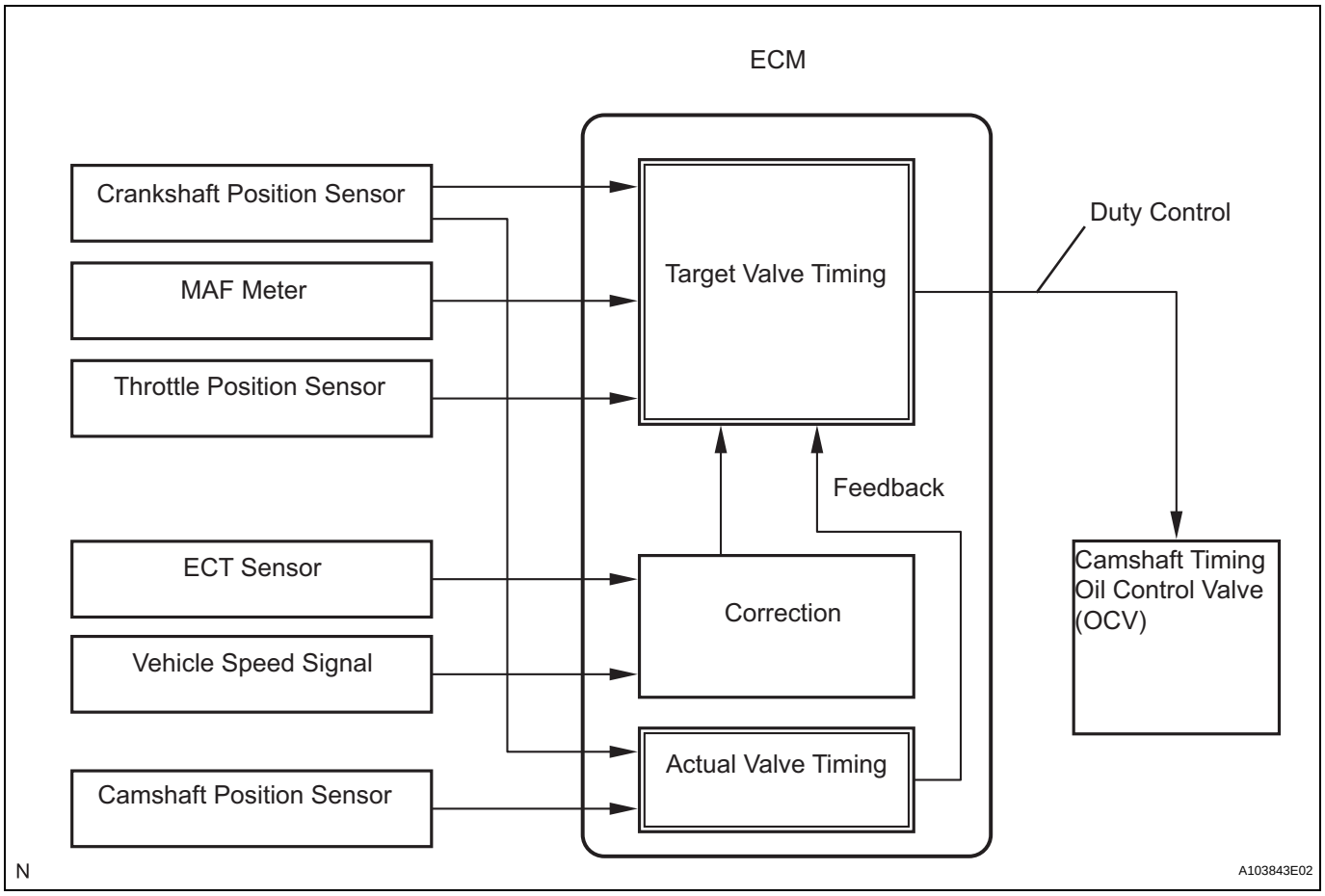
DTC	P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)
DTC	P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)
DTC	P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)
DTC	P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)

DESCRIPTION

HINT:

If DTC P0014, P0015, P0024 or P0025 is present, check the VVT (Variable Valve Timing) system.

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



DTC No.	DTC Detection Condition	Trouble Area
P0014 P0024	Advanced cam timing: With warm engine and engine speed of between 500 rpm and 4,000 rpm, all conditions (a), (b) and (c) are met (2 trip detection logic): (a) Difference between target and actual exhaust valve timing is more than 5°CA (Crankshaft Angle) for 4.5 seconds (b) Current exhaust valve timing is fixed (timing changes less than 5°CA in 5 seconds) (c) Variations in VVT controller timing are more than 19°CA of maximum delayed timing (advanced)	• Valve timing • Oil control valve (OCV) for exhaust camshaft (bank 1) • OCV filter (bank 1) • Exhaust camshaft • ECM
P0015 P0025	Retarded cam timing: With warm engine and engine speed of between 500 rpm and 4,000 rpm, all conditions (a), (b) and (c) are met (1 trip detection logic): (a) Difference between target and actual exhaust valve timing is more than 5°CA (Crankshaft Angle) for 4.5 seconds (b) Current exhaust valve timing is fixed (timing changes less than 5°CA in 5 seconds) (c) Variations in VVT controller timing are more than 19°CA or less of maximum delayed timing (retarded)	• Valve timing • OCV for exhaust camshaft (bank 2) • OCV filter (bank 2) • Exhaust camshaft • ECM

MONITOR DESCRIPTION

1. The ECM optimizes the exhaust valve timing using the VVT (Variable Valve Timing) system to control the exhaust camshaft. The VVT system includes the ECM, the Oil Control Valve (OCV) and the VVT controller.

2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.
   If the difference between the target and actual exhaust valve timings is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and sets a DTC.
   Example:
   A DTC is set when the following conditions A, B and C are met:
   (1) The difference between the target and actual exhaust valve timings is more than 5°CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
   (2) It takes 5 seconds or more to change the valve timing by 5°CA (Procedure "B").
   (3) After above procedures "A" and "B" are met, the OCV is forcibly activated 63 times or more (Procedure "C").
3. DTCs P0014 and P0024 (Advanced Cam Timing) are detected with 1 trip detection logic.
4. DTCs P0015 and P0025 (Retarded Cam Timing) are detected with 2 trip detection logic.
   These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
   (a) The engine is warm (the engine coolant temperature is 75°C [167°F] or more).
   (b) The vehicle has been driven at more than 40 mph (64 km/h) for 3 minutes.
   (c) The engine has idled for 3 minutes.

ES

MONITOR STRATEGY

Related DTCs	P0014: Advanced camshaft timing (bank 1) P0015: Retarded camshaft timing (bank 1) P0024: Advanced camshaft timing (bank 2) P0025: Retarded camshaft timing (bank 2)
Required sensors / components (Main)	VVT OCV and VVT Actuator
Required sensors / components (Related)	Crankshaft position sensor, Camshaft position sensor and Engine coolant temperature sensor
Frequency of operation	Once per driving cycle
Duration	Within 10 seconds
MIL operation	Advanced camshaft timing (bank 1): Immediate Advanced camshaft timing (bank 2): Immediate Retarded camshaft timing (bank 1): 2 driving cycles Retarded camshaft timing (bank 2): 2 driving cycles
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	P0100 - P0103 (MAF sensor) P0115 - P0118 (ECT sensor) P0125 (insufficient ECT for closed loop) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0351 - P0358 (ignitor)
Battery voltage	11 V or more
Engine RPM	500 to 4,000 rpm
Engine coolant temperature	75 to 100°C (167 to 212°F)

TYPICAL MALFUNCTION THRESHOLDS

Advanced camshaft timing:

Valve timing	No change
Valve timing	Advanced position

Retarded camshaft timing:

Valve timing	No change
Valve timing	Retard position

WIRING DIAGRAM

Refer to DTC P0013 (See page ES-93).

INSPECTION PROCEDURE

HINT:

Abnormal bank	Advanced timing over (Valve timing is out of specified range)	Retarded timing over (Valve timing is out of specified range)
Bank 1	P0014	P0015
Bank 2	P0024	P0025

- If DTC P0014 or P0015 is displayed, check the exhaust camshaft circuit for the bank 1 VVT system.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0024 or P0025 is displayed, check for exhaust camshaft circuit for the bank 2 VVT system.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0014, P0015, P0024 OR P0025)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read the DTCs.

Result

Display (DTC output)	Proceed to
P0014, P0015, P0024 or P0025	A
P0014, P0015, P0024 or P0025 and other DTCs	B

HINT:
If any DTCs other than P0014, P0015, P0024 or P0025 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (See page ES-63)

A

2	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATE OCV)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1.

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

OK

Tester Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

NG → **Go to step 4**

OK

3 CHECK WHETHER DTC OUTPUT RECURS (DTC P0014, P0015, P0024 OR P0025)

ES

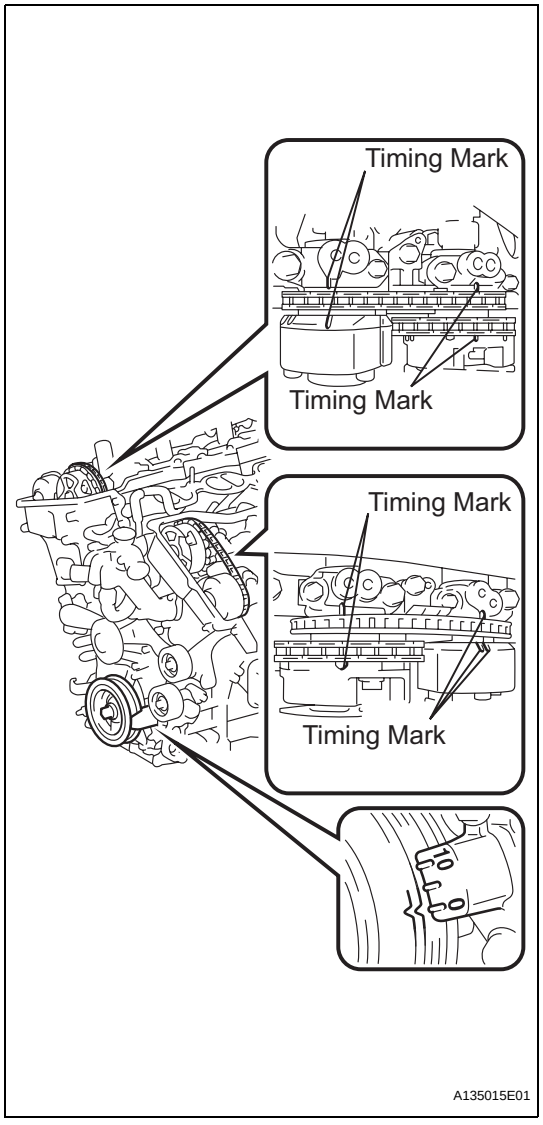
(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-45).
(d) Start the engine and warm it up.
(e) Switch the ECM from normal mode to check mode using the tester (See page ES-49).
(f) Drive the vehicle for more than 10 minutes.
(g) Read the DTCs using the tester.
OK:
No DTC output.

NG → **Go to step 4**

OK

END

4 CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)

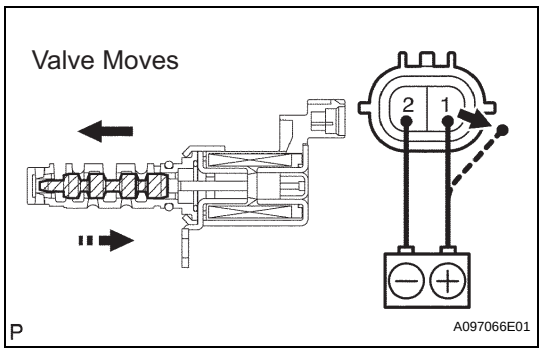


(a) Remove the cylinder head covers RH and LH.
(b) Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.
(c) Check that the timing marks of the camshaft timing gears are aligned with the timing marks of the bearing cap as shown in the illustration.
If not, turn the crankshaft 1 revolution (360°), then align the marks as above.
OK:
Timing marks on crankshaft timing gears are aligned as shown in the illustration.
(d) Reinstall the cylinder head covers.

NG → **ADJUST VALVE TIMING**

OK

5 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV FOR EXHAUST CAMSHAFT)



(a) Remove the OCV.
(b) Measure the resistance between the terminals of the OCV.
Standard resistance

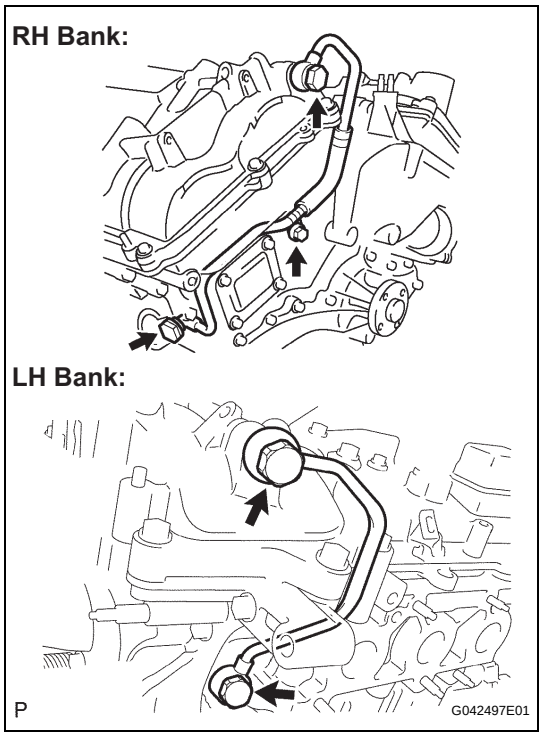
Tester Connection	Condition	Specified Condition
1 - 2	20°C (68°F)	6.9 to 7.9 Ω

(c) Apply positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.
OK:
Valve moves quickly.
(d) Reinstall the OCV.

NG → **REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (See page ES-481)**

OK

6	INSPECT OIL CONTROL VALVE FILTER AND PIPE



(a) Remove the oil pipe No. 1 or No. 2.
(b) Remove the oil control valve filter.
(c) Check that the filter and pipe are not clogged.
OK:
Filter is not clogged.

NG → **CLEAN OIL CONTROL VALVE FILTER AND PIPE**

OK

7	REPLACE EXHAUST CAMSHAFT

NEXT

8	CHECK WHETHER DTC OUTPUT RECURS

(a) Clear the DTCs.
(1) Operate the intelligent tester, or disconnect the EFI and ETCS fuses more than 60 seconds to erase the codes.
(b) Start the engine and warm up the engine.
(c) Switch the ECM from normal mode to check mode using the intelligent tester (See page ES-49).
(d) Drive the vehicle for more than 10 minutes or more.
(e) Read the output DTCs using the intelligent tester.
OK:
No DTC output.

HINT:
DTC P0014, P0015, P0024 or P0025 is output when foreign objects in engine oil are caught in some parts of the system. These codes will stay output even if the system returns to normal after a short time. These foreign objects are then captured by the oil, thus eliminating the source of the problem.

OK → **SYSTEM IS OK**

NG

REPLACE ECM (See page ES-518)

DTC	P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)

DTC	P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)

DTC	P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)

DTC	P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

ES

DESCRIPTION

In the VVT system, the appropriate intake and exhaust valve open and close timings are controlled by the ECM. The ECM performs intake and exhaust valve control by performing the following: 1) controlling the camshaft and camshaft oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the gaps between the camshaft and crankshaft.

DTC No.	DTC Detection Condition	Trouble Area
P0016	Deviation in crankshaft position sensor signal and VVT sensor 1 (for intake camshaft (bank 1)) signal (2 trip detection logic)	• Mechanical system (Timing chain has jumped teeth or chain stretched) • ECM
P0017	Deviation in crankshaft position sensor signal and VVT sensor 1 (for exhaust camshaft (bank 1)) signal (2 trip detection logic)	• Mechanical system (Timing chain has jumped teeth or chain stretched) • ECM
P0018	Deviation in crankshaft position sensor signal and VVT sensor 2 (for intake camshaft (bank 2)) signal (2 trip detection logic)	• Mechanical system (Timing chain has jumped teeth or chain stretched) • ECM
P0019	Deviation in crankshaft position sensor signal and VVT sensor 2 (for exhaust camshaft (bank 2)) signal (2 trip detection logic)	• Mechanical system (Timing chain has jumped teeth or chain stretched) • ECM

MONITOR DESCRIPTION

To monitor the correlation of the intake camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The intake valve timing is set to the most retarded angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and sets the DTC P0016 (Bank 1) or P0018 (Bank 2).

To monitor the correlation of the exhaust camshaft position and crankshaft position, the ECM checks the VVT learning value while the engine is idling. The VVT learning value is calibrated based on the camshaft position and crankshaft position. The exhaust valve timing is set to the most advanced angle while the engine is idling. If the VVT learning value is out of the specified range in consecutive driving cycles, the ECM illuminates the MIL and sets the DTC P0017 (Bank 1) or P0019 (Bank 2).

MONITOR STRATEGY

Related DTCs	P0016: Camshaft timing misalignment at idle (intake camshaft bank 1) P0017: Camshaft timing misalignment at idle (exhaust camshaft bank 1) P0018: Camshaft timing misalignment at idle (intake camshaft bank 2) P0019: Camshaft timing misalignment at idle (exhaust camshaft bank 2)
Required sensors/components (Main)	VVT actuator

Required sensors/components (Sub)	Camshaft position sensor, Crankshaft position sensor
Frequency of operation	Once per drive cycle
Duration	Within 1 minute
MIL operation	2 driving cycles
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	P0011 (VVT system 1 - advance) P0012 (VVT system 1 - retard) P0021 (VVT system 2 - advance) P0115 - P0118 (ECT sensor)

Intake side:

Engine speed	500 to 1,000 rpm

Exhaust side:

VVT feedback mode	Executing
VVT	Maximum advanced position
Engine speed	500 to 1,000 rpm

TYPICAL MALFUNCTION THRESHOLDS

Intake side:

One of the following conditions is met:	Condition 1 or 2
1. VVT leaning value at maximum retarded valve timing	Less than 18.5°CA
2. VVT leaning valve at maximum retarded valve timing	More than 43.5°CA

Exhaust side:

One of the following conditions is met:	Condition 1 or 2
1. VVT leaning value	Less than 77°CA
2. VVT leaning value	More than 102°CA

WIRING DIAGRAM

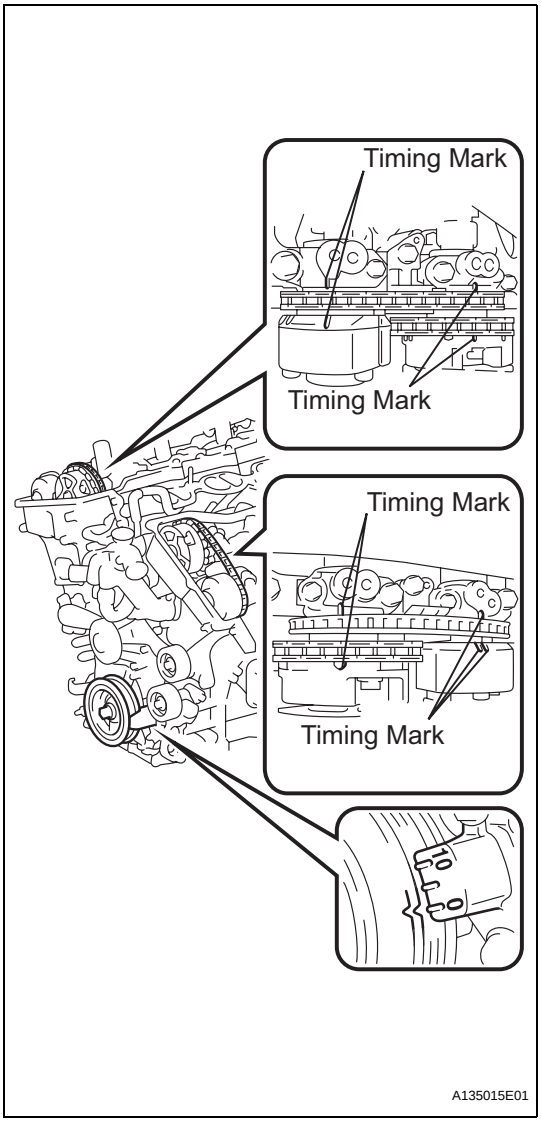
Refer to DTC P0335 (See page ES-224).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	CHECK VALVE TIMING (CHECK FOR LOOSE AND A JUMPED TOOTH OF TIMING CHAIN)



(a) Remove the cylinder head covers RH and LH.
(b) Turn the crankshaft pulley, and align its groove with the timing mark "0" of the timing chain cover.
(c) Check that the timing marks of the camshaft timing gears are aligned with the timing marks of the bearing cap as shown in the illustration.
If not, turn the crankshaft 1 revolution (360°), then align the marks as above.
OK:
Timing marks on camshaft timing gears are aligned as shown in the illustration.
(d) Reinstall the cylinder head covers.

NG → **ADJUST VALVE TIMING (REPAIR OR REPLACE TIMING CHAIN)**

OK

REPLACE ECM (See page ES-518)

DTC	P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)

DTC	P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)

DTC	P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)

DTC	P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

DESCRIPTION

HINT:

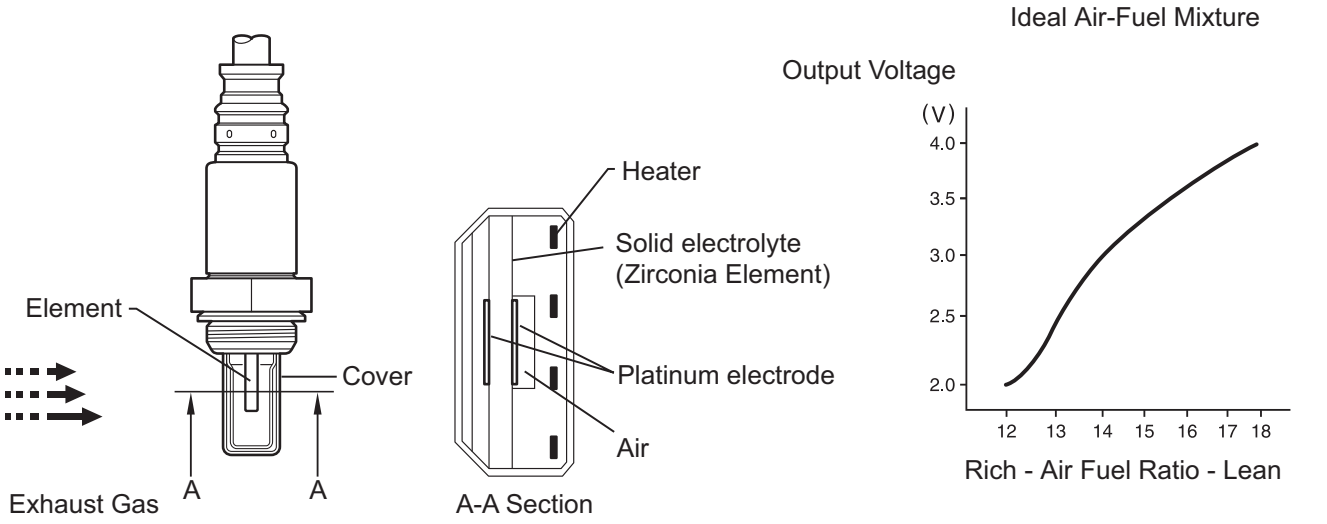
- Although the DTC titles include oxygen sensor, these DTCs relate to the Air-Fuel Ratio (A/F) sensor.
- Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.

The A/F sensor generates voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air-fuel ratio. The ECM determines the deviation from the stoichiometric air-fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air-fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor, in order to facilitate accurate oxygen concentration detection. In addition, the sensor and heater portions are narrower than the conventional type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

A three-way catalytic converter (TWC) is used in order to convert the carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxide (NOx) into less harmful substances. To allow the TWC to function effectively, it is necessary to keep the air-fuel ratio of the engine near the stoichiometric air-fuel ratio.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted to a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



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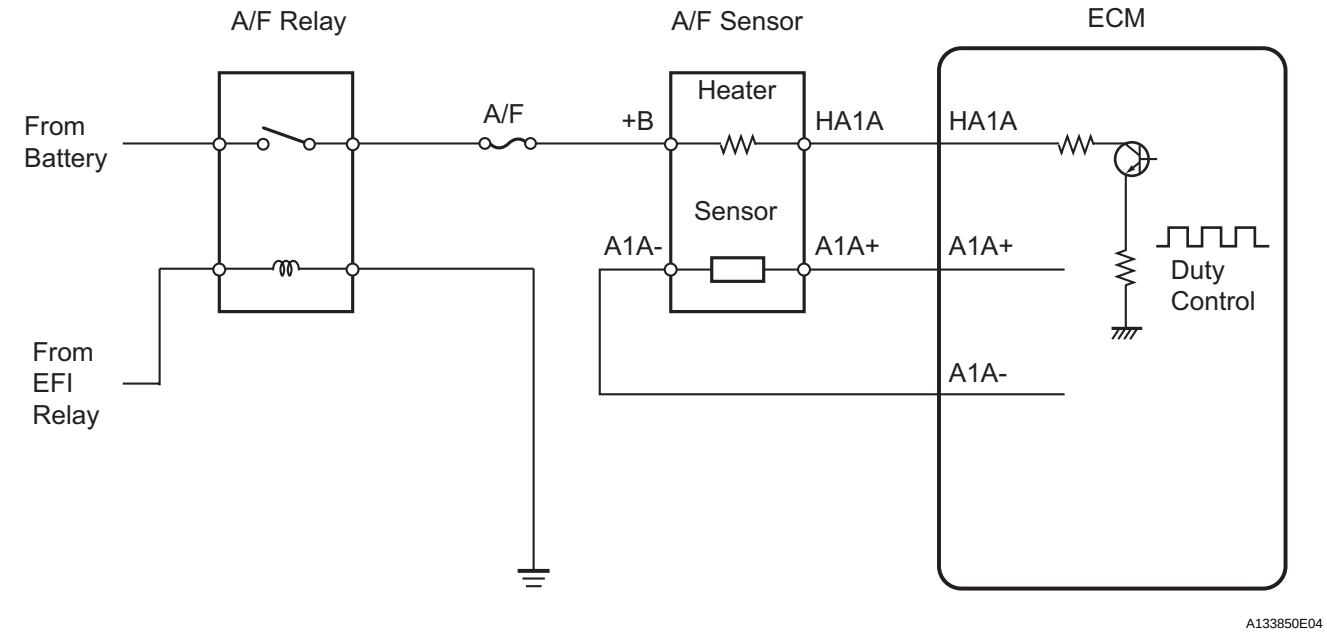
HINT:

- When any of these DTCs are set, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.
- The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the B+ side of the circuit.

Reference (System Diagram of Bank 1 Sensor 1):



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DTC No.	DTC Detection Condition	Trouble Area
P0031 P0051	Air-Fuel Ratio (A/F) sensor heater (bank 1, 2, sensor 1) current is less than 0.8 A (1 trip detection logic)	• Open in A/F sensor heater (bank 1, 2, sensor 1) circuit • A/F sensor heater (bank 1, 2, sensor 1) • A/F HTR relay • ECM

DTC No.	DTC Detection Condition	Trouble Area
P0032 P0052	Air-Fuel Ratio (A/F) sensor heater (bank 1, 2, sensor 1) current is more than 10 A (1 trip detection logic)	• Short in A/F sensor heater (bank 1, 2, sensor 1) circuit • A/F sensor heater (sensor 1) • A/F HTR relay • ECM

HINT:
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Sensor 1 refers to the sensor closest to the engine assembly.
- Sensor 2 refers to the sensor farthest away from the engine assembly.

MONITOR DESCRIPTION

1. The ECM uses information from the Air-Fuel Ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.
2. The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.
3. The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.
4. The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor will be inaccurate, as a result, the ECM will be unable to regulate air-fuel ratio properly.
5. When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and sets a DTC.

   Example:

   The ECM sets DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A. Conversely, when the heater current is less than 0.8 A, DTC P0031 or P0051 is set.

MONITOR STRATEGY

Related DTCs	P0031: A/F sensor heater (bank 1) open/short (Low electrical current) P0032: A/F sensor heater (bank 1) open/short (High electrical current) P0051: A/F sensor heater (bank 2) open/short (Low electrical current) P0052: A/F sensor heater (bank 2) open/short (High electrical current)
Required sensors / components (Main)	A/F sensor heater (bank 1 and 2)
Required sensors / components (Sub)	-
Frequency of operation	Continuous
Duration	10 seconds
MIL operation	Immediate
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	P0300 - P0306 (misfire)

P0031 and P0051:

Battery voltage	10.5 V or more
Heater output duty	50 % or more

Time after engine start	10 seconds or more

P0032 and P0052:

Battery voltage	Less than 20 V
Engine	Running
Heater output duty	More than 0 %

TYPICAL MALFUNCTION THRESHOLDS

P0031 and P0051:

A/F sensor heater current	Less than 0.8 A

P0032 and P0052:

Hybrid IC high current limiter port	Fail

ES

COMPONENT OPERATING RANGE

P0031 and P0051:

A/F sensor heater current	1.8 to 3.4 A at 20°C (68°F)

WIRING DIAGRAM

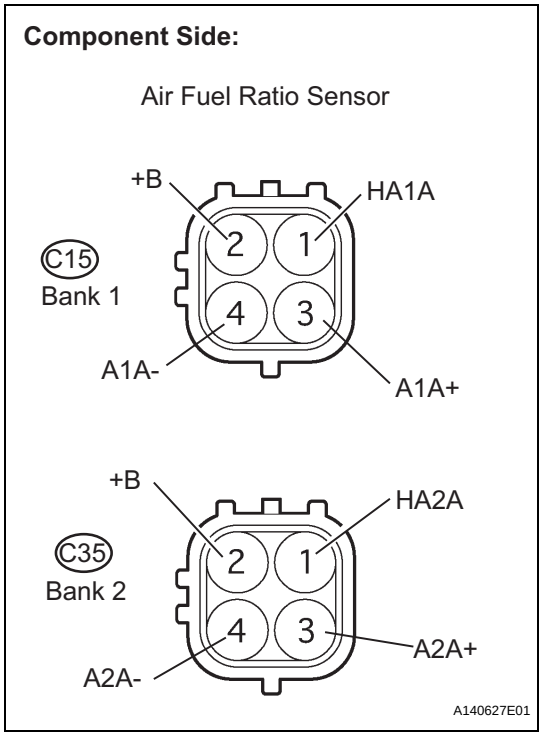
Refer to DTC P2195 (See page ES-350)

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the C15 or C35 A/F sensor connector.
(b) Measure the resistance according to the value(s) in the table below.

Standard resistance (Bank 1 sensor 1)

Tester Connection	Condition	Specified Condition
HA1A (1) - +B (2)	20°C (68°F)	1.8 to 3.4 Ω
HA1A (1) - A1A- (4)	-	10 kΩ or higher

Standard resistance (Bank 2 sensor 1)

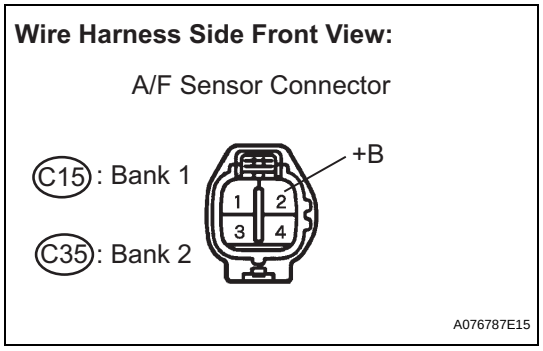
Tester Connection	Condition	Specified Condition
HA2A (1) - +B (2)	20°C (68°F)	1.8 to 3.4 Ω
HA2A (1) - A2A- (4)	-	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR (See page EC-19)**

OK

2 CHECK TERMINAL VOLTAGE (+B OF A/F SENSOR)



(a) Disconnect the C15 or C35 A/F sensor Connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the terminals of the A/F sensor connector and body ground.

Standard voltage

Tester Connection	Specified Condition
+B (C15-2) - Body ground	9 to 14 V
+B (C35-2) - Body ground	9 to 14 V

OK → **Go to step 7**

NG

3 INSPECT FUSE (A/F)

(a) Remove the A/F sensor fuse from the No. 1 integration relay.
(b) Measure the A/F sensor fuse resistance.

Standard resistance:
Below 1 Ω

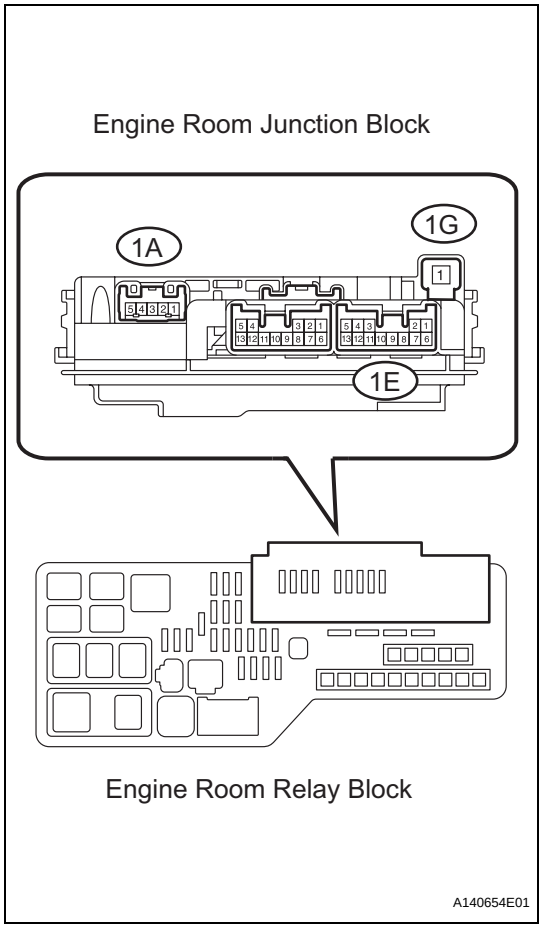
(c) Reinstall the A/F fuse.

NG → **REPLACE A/F FUSE**

ES

OK

4	INSPECT ENGINE ROOM JUNCTION BLOCK (EFI RELAY, A/F RELAY)



(a) Remove the engine room junction block from the engine room R/B.
(b) Inspect the EFI relay.
  (1) Measure the EFI relay resistance.
  Standard resistance

Tester Connection	Specified Condition
1E-12 - 1E-6	10 kΩ or higher
1E-12 - 1E-6	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

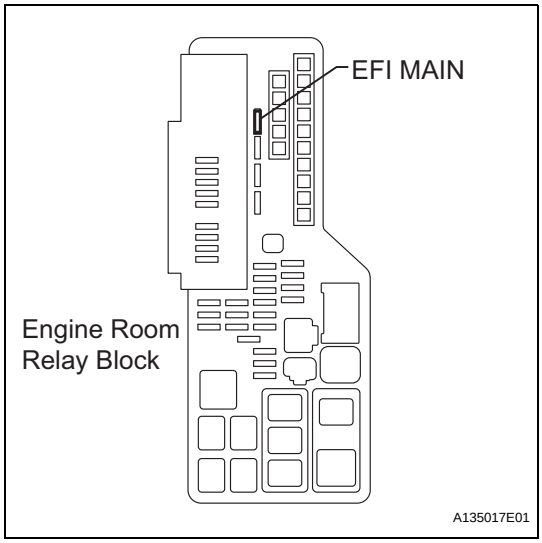
(c) Inspect the A/F relay.
  (1) Measure the A/F relay resistance.
  Standard resistance

Tester Connection	Specified Condition
1G-1 - 1A-4	10 kΩ or higher
1G-1 - 1A-4	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

NG → REPLACE ENGINE ROOM JUNCTION BLOCK

OK

5	INSPECT FUSE (EFI MAIN)

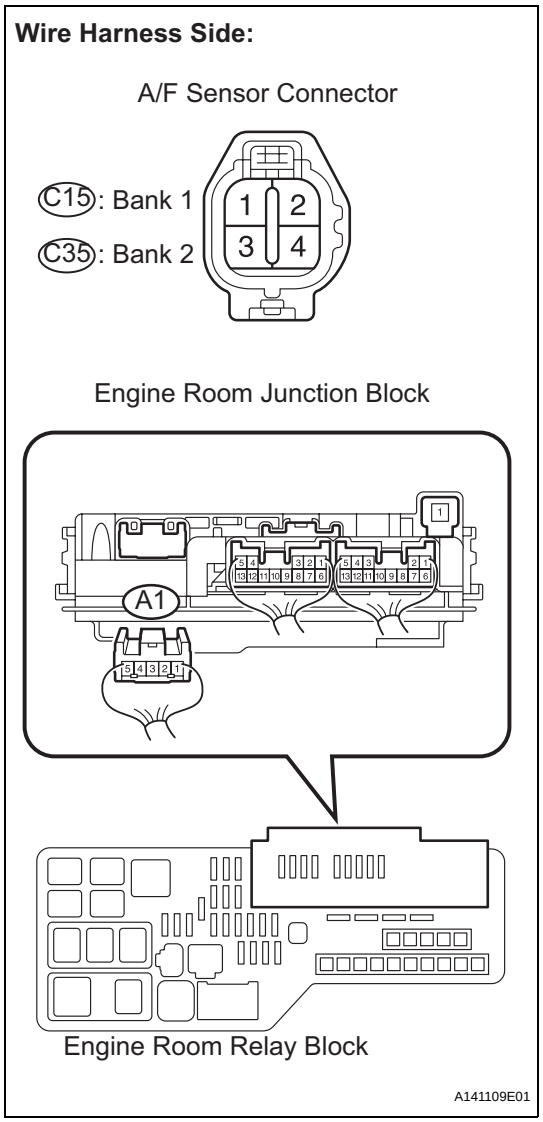


(a) Remove the EFI MAIN fuse from the engine room R/B.
(b) Measure the EFI MAIN fuse resistance.
  Standard resistance:
  Below 1 Ω
(c) Reinstall the EFI MAIN fuse.

NG → REPLACE EFI MAIN FUSE

OK

6	CHECK HARNESS AND CONNECTOR (A/F SENSOR - A/F RELAY)



(a) Disconnect the C15 or C35 A/F sensor connector.
(b) Remove the engine room junction block from the engine room R/B.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
+B (C15-2) - 1A-4 (Engine room R/B)	Below 1 Ω
+B (C35-2) - 1A-4 (Engine room R/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
+B (C15-2) or 1A-4 (Engine room R/B) - Body ground	10 kΩ or higher
+B (C35-2) or 1A-4 (Engine room R/B) - Body ground	10 kΩ or higher

(d) Reinstall the engine room junction block.
(e) Reconnect the A/F sensor connector.

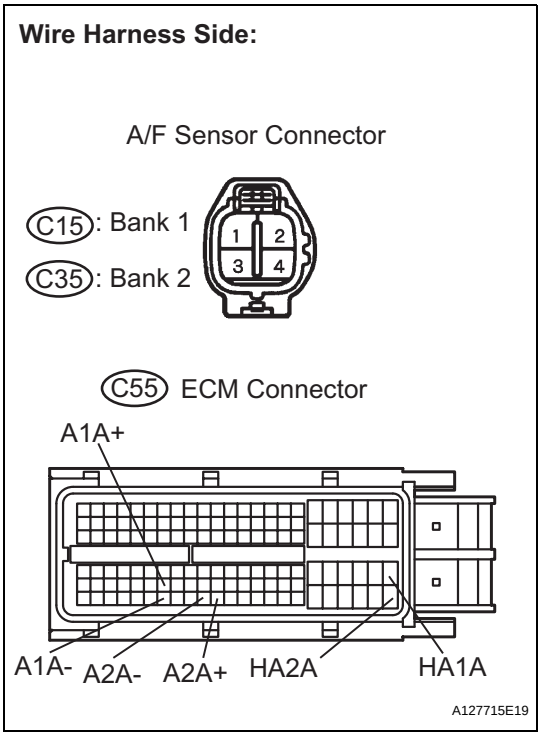
NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT (See page ES-432)

ES

7 CHECK HARNESS AND CONNECTOR



(a) Disconnect the C15 or C35 A/F sensor connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
HA1A (C55-86) - HA1A (C15-1)	Below 1 Ω
HA2A (C55-109) - HA2A (C35-1)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
HA1A (C55-86) or HA1A (C15-1) - Body ground	10 kΩ or higher
HA2A (C55-109) or HA2A (C35-1) - Body ground	10 kΩ or higher

(d) Reconnect the ECM connector.
(e) Reconnect the A/F sensor connectors.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

8 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the intelligent tester on.
(d) Clear the DTCs (See page ES-45).
(e) Start the engine.
(f) Allow the engine to idle for 1 minute or more.
(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(h) Read the DTCs.

Result

Display (DTC Output)	Proceed to
No output	A
P0031, P0032, P0051 and/or P0052	B

B → **REPLACE ECM (See page ES-518)**

A

CHECK FOR INTERMITTENT PROBLEMS

DTC	P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)
DTC	P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)
DTC	P0057	Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)
DTC	P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)
DTC	P0141	Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)
DTC	P0161	Oxygen Sensor Heater Circuit Malfunction (Bank 2 Sensor 2)

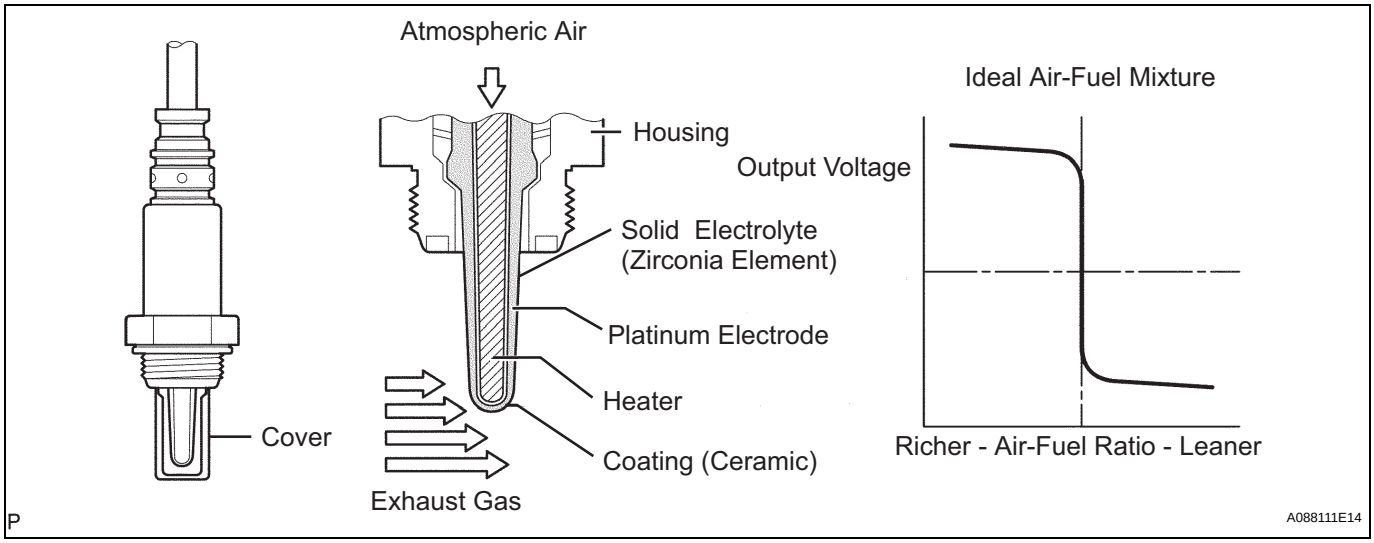
DESCRIPTION

A three-way catalytic converter (TWC) is used in order to convert the carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxide (NOx) into less harmful substances. To allow the TWC to function effectively, it is necessary to keep the air-fuel ratio of the engine near the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas becomes rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. less than 0.45 V). Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel level, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. more than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.

The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.

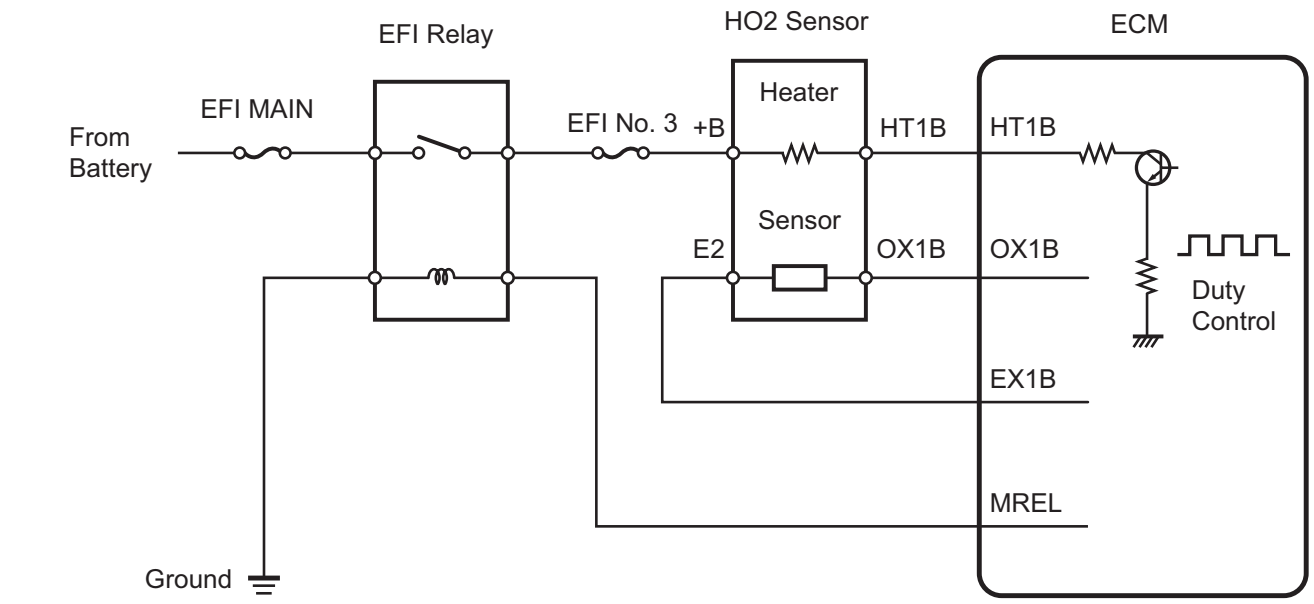


ES

HINT:

- Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.
- When any of these DTCs are set, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.
- The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the B+ side of the circuit.

Reference (System Diagram of Bank 1 Sensor 2):



DTC No.	DTC Detection Condition	Trouble Area
P0037 P0057	Heated Oxygen (HO2) sensor heater current is less than 0.3 A (1 trip detection logic)	• Open in HO2 sensor heater circuit • HO2 sensor heater • Engine room junction block (EFI relay) • ECM
P0038 P0058	Heated Oxygen (HO2) sensor heater current is more than 2 A (1 trip detection logic)	• Short in HO2 sensor heater circuit • HO2 sensor heater • Engine room junction block (EFI relay) • ECM

DTC No.	DTC Detection Condition	Trouble Area
P0141 P0161	Cumulative heater resistance correction value exceeds the acceptable threshold. (2 trip detection logic)	• HO2 sensor heater • ECM

HINT:
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Sensor 1 refers to the sensor closest to the engine assembly.
- Sensor 2 refers to the sensor farthest away from the engine assembly.

MONITOR DESCRIPTION

The sensing position of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037,P0038, P0057 and P0058):

The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM will determine that there is an open circuit in the heater. If the current is above the threshold value, the ECM will determine that there is a short circuit in the heater.

Example:

The ECM sets DTC P0038 or P0058 when the current in the HO2 sensor heater is more than 2 A. Conversely, when the heater current is less than 0.3 A, DTC P0037 or P0057 is set.

Heated oxygen sensor heater performance (P0141 and P0161):

After the accumulated heater ON time exceeds 100 seconds, the ECM calculates the heater resistance using the battery voltage and the current applied to the heater. If the resistance is above the threshold value, the ECM will determine that there is a malfunction in the HO2S heater and set DTC P0141 and P0161.

MONITOR STRATEGY

Related DTCs	P0037: Heated oxygen sensor heater (bank 1 sensor 2) open/short (Low electrical current) P0038: Heated oxygen sensor heater (bank 1 sensor 2) open/short (High electrical current) P0057: Heated oxygen sensor heater (bank 2 sensor 2) open/short (Low electrical current) P0058: Heated oxygen sensor heater (bank 2 sensor 2) open/short (High electrical current) P0141: Heated oxygen sensor heater performance (bank 1 sensor 2) P0161: Heated oxygen sensor heater performance (bank 2 sensor 2)
Required sensors / components (Main)	Heated oxygen sensor heater (bank 1 sensor 2) Heated oxygen sensor heater (bank 2 sensor 2)
Required sensors / components (Sub)	Vehicle speed sensor
Frequency of operation	Continuous
Duration	1 second: P0037, P0038, P0057 and P0058 10 seconds: P0141 and P0161
MIL operation	Immediate: P0037, P0038, P0057 and P0058 2 driving cycles: P0141 and P0161
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	None

P0037 and P0057:

Battery voltage	10.5 to 20 V

P0038 and P0058 (Case 1):

Battery voltage	10.5 V or more
Engine	Running
Starter	OFF

P0038 and P0058 (Case 2):

Battery voltage	10.5 to 20 V

P0141 and P0161:

One of the following conditions is met:	Condition A or B
A. All of the following conditions are met:	Conditions 1, 2, 3, 4 and 5
1. Battery voltage	10.5 V or more
2. Fuel cut	OFF
3. Time after fuel cut ON to OFF	30 seconds or more
4. Accumulated heater ON time	100 seconds or more
5. Learned heater OFF current operation	Completed
B. Duration that rear heated oxygen sensor impedance is less than 15 kΩ	2 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P0037 and P0057:

Heater current	Less than 0.3 A

P0038 and P0058:

One of the following conditions is met:	Condition A or B
A. Learned heater OFF current	More than 2 A
B. Heater current	2 A or more

P0141 and P0161 (Heater performance monitor check):

Accumulated heater resistance	Varies with sensor element temperature (Example: More than 23 ohm)

COMPONENT OPERATING RANGE

Heated Oxygen (HO2) sensor heater current	0.4 to 1 A (when engine idles, HO2 sensor warmed up and battery voltage 11 to 14 V)

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-25).

WIRING DIAGRAM

Refer to DTC P0136 (See page ES-178).

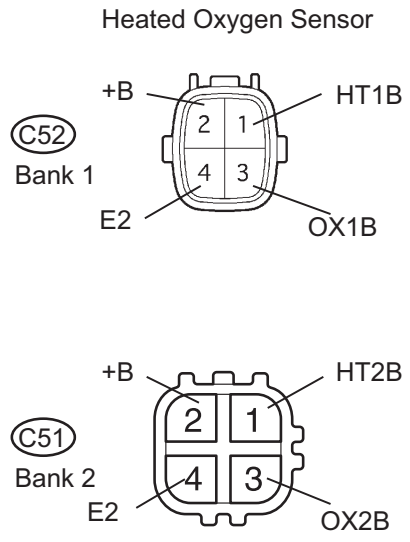
INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

Component Side:



A137614E06

(a) Disconnect the C52 heated oxygen sensor connector (Bank 1 Sensor 2) or C51 heated oxygen sensor connector (Bank 2 Sensor 2).

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

Standard resistance (Bank 1 sensor 2)

Tester Connection	Condition	Specified Condition
HT1B (1) - +B (2)	20°C (68°F)	11 to 16 Ω
HT1B (1) - E2 (4)	Always	10 kΩ or higher

Standard resistance (Bank 2 sensor 2)

Tester Connection	Condition	Specified Condition
HT2B (1) - +B (2)	20°C (68°F)	11 to 16 Ω
HT2B (1) - E2 (4)	Always	10 kΩ or higher

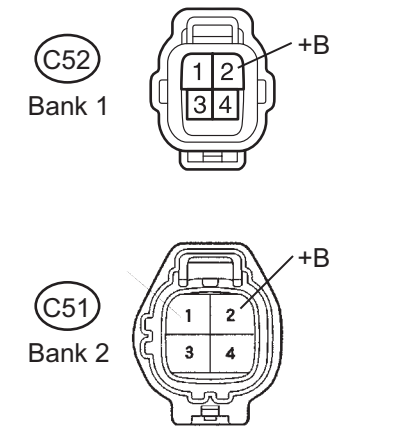
(c) Reconnect the HO2 sensor connector.

NG → **REPLACE HEATED OXYGEN SENSOR (See page EC-20)**

OK

2 CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

Wire Harness Side:



A137619E01

(a) Disconnect the C52 heated oxygen sensor connector (Bank 1 Sensor 2) or C51 heated oxygen sensor connector (Bank 2 Sensor 2).

(b) Turn the ignition switch on (IG).

(c) Measure the voltage between the terminals.

Standard voltage

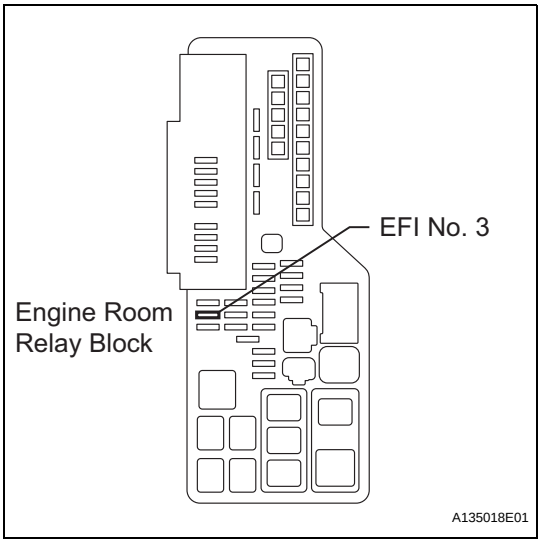
Tester Connection	Specified Condition
+B (C52-2) - Body ground	9 to 11 V
+B (C51-2) - Body ground	9 to 11 V

(d) Reconnect the HO2 sensor connector.

OK → **Go to step 7**

NG

3	INSPECT FUSE (EFI NO. 3)

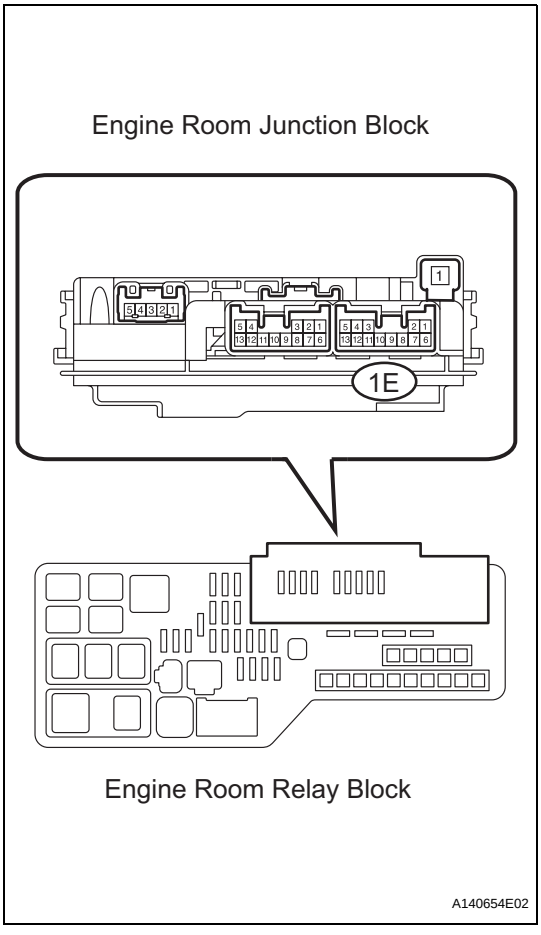


(a) Remove the EFI No. 3 fuse from the engine room R/B.
(b) Measure the EFI No. 3 fuse resistance.
Standard resistance:
Below 1 Ω
(c) Reinstall the EFI No. 3 fuse.

NG → **REPLACE EFI NO. 3 FUSE**

OK

4	INSPECT ENGINE ROOM JUNCTION BLOCK



(a) Remove the engine room junction block from the engine room R/B.
(b) Inspect the EFI relay.
(1) Measure the EFI relay resistance.
Standard resistance

Tester Connection	Specified Condition
1E-12 - 1E-6	10 kΩ or higher
1E-12 - 1E-6	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

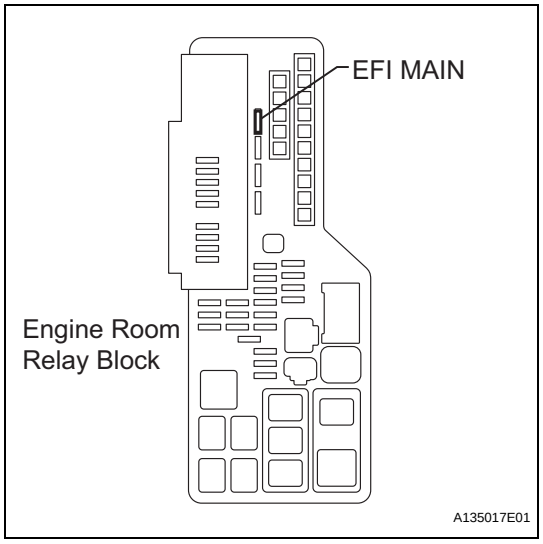
(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK**

OK

ES

5	INSPECT FUSE (EFI MAIN)



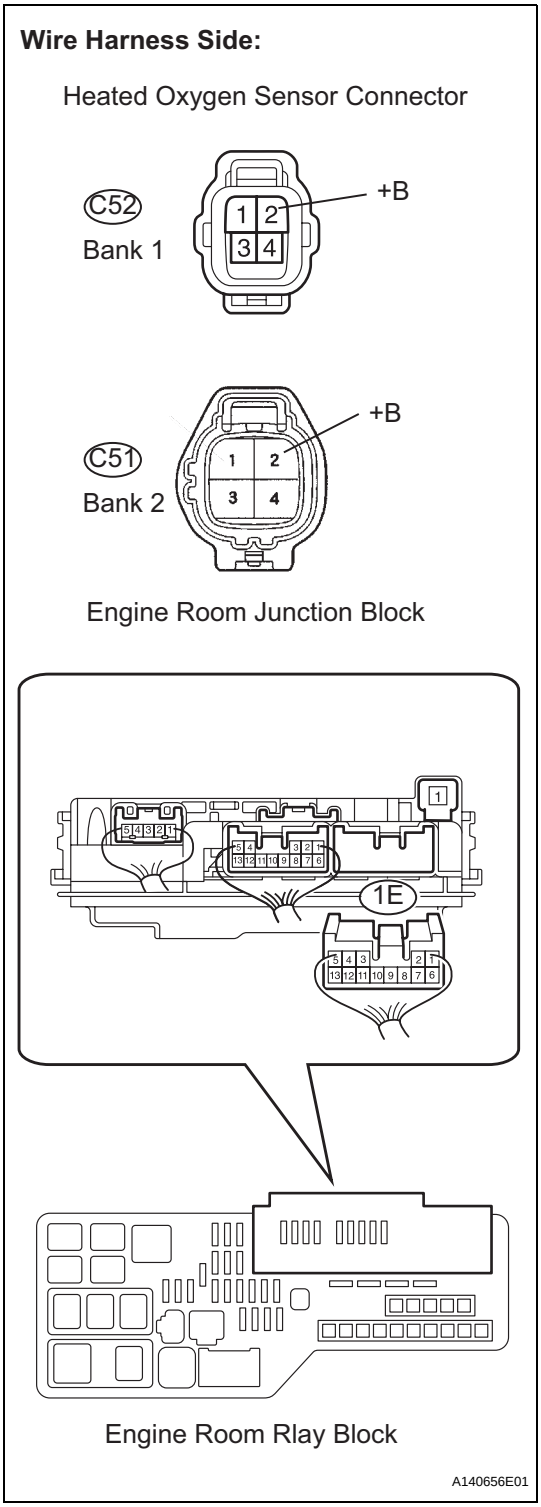
(a) Remove the EFI MAIN fuse from the engine room R/B.
(b) Measure the EFI MAIN fuse.
Standard resistance:
Below 1 Ω
(c) Reinstall the EFI MAIN fuse.

NG → **REPLACE EFI MAIN FUSE**

OK

ES

6	CHECK HARNESS AND CONNECTOR (HO2 SENSOR - EFI RELAY)



(a) Disconnect the C52 or C51 HO2 sensor connector.
(b) Remove the engine room junction block from the engine room R/B.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
+B (C52-2) - 1E-6 (Engine room R/B)	Below 1 Ω
+B (C51-2) - 1E-6 (Engine room R/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
+B (C52-2) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher
+B (C51-2) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher

(d) Reinstall the engine room junction block.
(e) Reconnect the HO2 sensor connector.

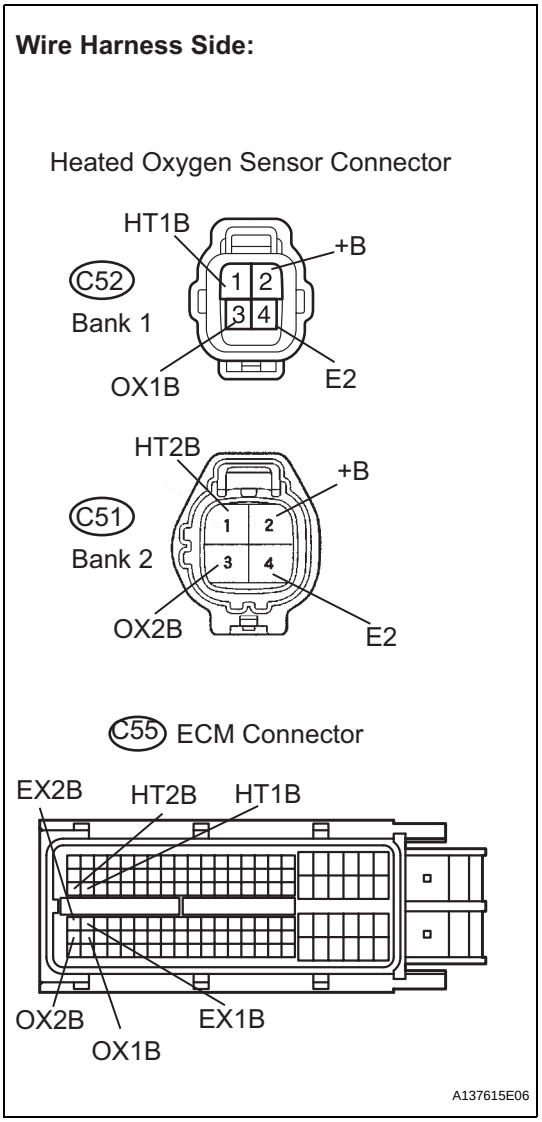
NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

CHECK ECM POWER SOURCE CIRCUIT

7 CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

Wire Harness Side:



(a) Disconnect the C52 heated oxygen sensor connector (Bank 1 Sensor 2) or C51 heated oxygen sensor connector (Bank 2 Sensor 2).
(b) Turn the ignition switch on (IG).
(c) Measure the voltage according to the value(s) in the table below.

Standard voltage

Terminal Connection	Specified Condition
+B (C52-2) - Body ground	9 to 14 V
+B (C51-2) - Body ground	9 to 14 V

(d) Turn the engine switch off.
(e) Disconnect the C55 ECM connector.
(f) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Terminal Connection	Specified Condition
HT1B (C52-1) - HT1B (C55-48)	Below 1 Ω
OX1B (C52-3) - OX1B (C55-88)	Below 1 Ω
E2 (C52-4) - EX1B (C55-65)	Below 1 Ω
HT2B (C51-1) - HT2B (C55-47)	Below 1 Ω
OX2B (C51-3) - OX2B (C55-87)	Below 1 Ω
E2 (C51-4) - EX2B (C55-64)	Below 1 Ω

Standard resistance (Check for short)

Terminal Connection	Specified Condition
HT1B (C52-1) or HT1B (C55-48) - Body ground	10 kΩ or higher
OX1B (C52-3) - OX1B (C55-88) - Body ground	10 kΩ or higher
E2 (C52-4) or EX1B (C55-65) - Body ground	10 kΩ or higher
HT2B (C51-1) or HT2B (C55-47) - Body ground	10 kΩ or higher
OX2B (C51-3) or OX2B (C55-87) - Body ground	10 kΩ or higher
E2 (C51-4) or EX2B (C55-64) - Body ground	10 kΩ or higher

(g) Reconnect the HO2 sensor connector.
(h) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

8 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the intelligent tester on.
(d) Clear the DTCs (See page ES-45).
(e) Start the engine.
(f) Allow the engine to idle for 2 minutes.

(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(h) Read the DTCs.

Result

Display (DTC Output)	Proceed to
No output	A
P0037, P0038, P0057 and/or P0058	B

B → **REPLACE ECM (See page ES-518)**

A

CHECK FOR INTERMITTENT PROBLEMS (See page ES-33)

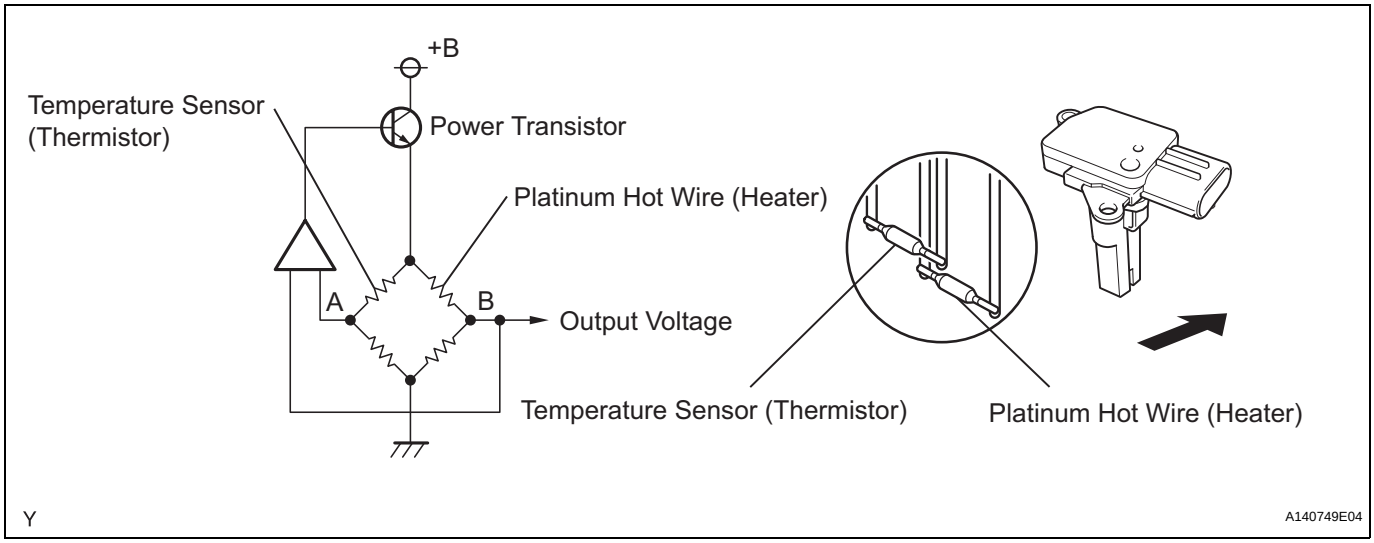
DTC	P0100	Mass or Volume Air Flow Circuit

DTC	P0102	Mass or Volume Air Flow Circuit Low Input

DTC	P0103	Mass or Volume Air Flow Circuit High Input

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the valve. The ECM uses this information to determine the fuel injection time and to prove appropriate air-fuel ratio. Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.
By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter. The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.
The circuit is constructed so that the platinum hot wire and the temperature sensor provide a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.
HINT:
When any of these DTCs are set, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine RPM and throttle valve position. Fail-safe mode continues until a pass condition is detected.



DTC No.	DTC Detection Condition	Trouble Area
P0100	Open or short in Mass Air Flow (MAF) meter circuit for 3 seconds	• Open or short in MAF meter circuit • MAF meter • ECM
P0102	Open in Mass Air Flow (MAF) meter circuit for 3 seconds	• Open in MAF meter circuit • Short in MAF meter circuit • MAF meter • ECM
P0103	Short in Mass Air Flow (MAF) meter circuit for 3 seconds	• Short in MAF meter circuit (+B circuit) • MAF meter • ECM

HINT:
When any of these DTCs are set, check the air-flow rate by entering the following menus on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF.

Mass Air Flow Rate (gm/s)	Malfunctions
Approximately 0.0	• Open in Mass Air Flow (MAF) meter power source circuit • Open or short in VG circuit
271.0 or more	Open in EVG circuit

MONITOR DESCRIPTION

If there is a defect in the MAF meter or an open or short circuit, the voltage level deviates from the normal operating range. The ECM interprets this deviation as a malfunction in the MAF meter and sets a DTC.
Example:
When the sensor output voltage remains less than 0.2 V, or more than 4.9 V, for more than 3 seconds, the ECM sets a DTC.
If the malfunction is not repaired successfully, a DTC is set 3 seconds after the engine is next started.

ES

MONITOR STRATEGY

Related DTCs	P0100: Mass air flow meter range check (Fluctuating) P0102: Mass air flow meter range check (Low voltage) P0103: Mass air flow meter range check (High voltage)
Required Sensors/Components (Main)	MAF meter
Required Sensors/Components (Sub)	Crankshaft position sensor
Frequency of Operation	Continuous
Duration	3 seconds
MIL Operation	Immediate: Engine RPM less than 4,000 rpm 2 driving cycles: Engine RPM 4,000 rpm or more
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0100:

Mass air flow meter voltage	Less than 0.2 V, or more than 4.9 V

P0102:

Mass air flow meter voltage	Less than 0.2 V

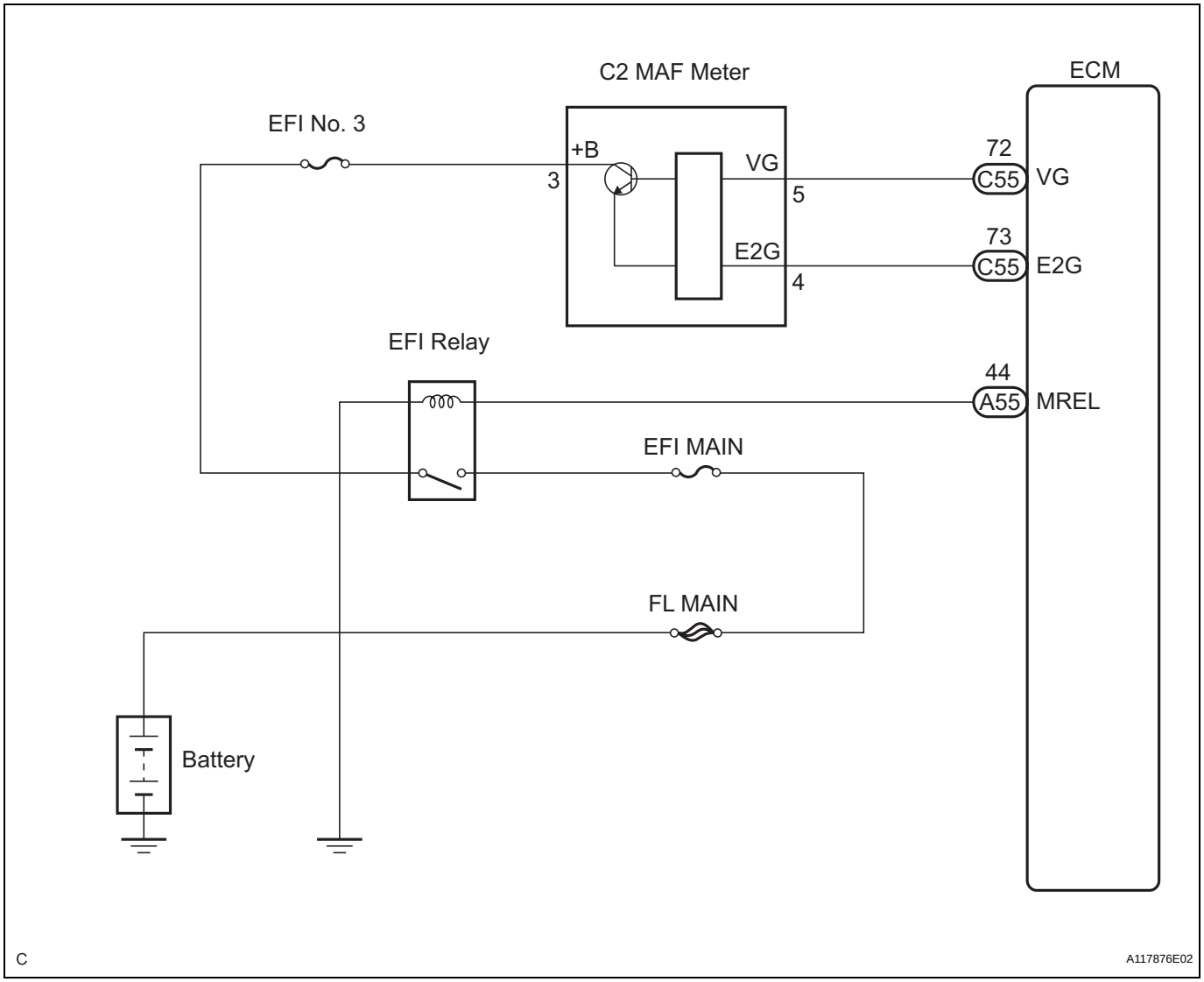
P0103:

Mass air flow meter voltage	More than 4.9 V

COMPONENT OPERATING RANGE

Mass air flow meter voltage	Between 0.4 V and 2.2 V

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	**READ VALUE OF MASS AIR FLOW METER (MAF)**

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine.
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF.
(e) Read the values displayed on the tester.

Result

Mass Air Flow Rate (gm/s)	Proceed to
0.0	A
271.0 or more	B
Between 1.0 and 270.0 (*1)	C

*1: The value must be changed when the throttle valve is open or closed.

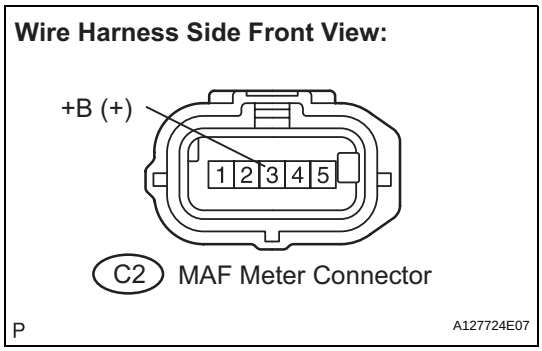
B → Go to step 8

C → CHECK FOR INTERMITTENT PROBLEMS (See page ES-33)

A

ES

2 INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)



(a) Disconnect the C2 mass air flow (MAF) meter connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage according to the value(s) in the table below.

Standard voltage

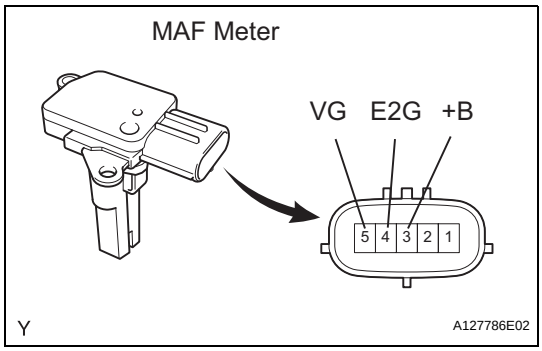
Tester Connection	Specified Condition
+B (C2-3) - Body ground	9 to 14 V

(d) Reconnect the MAF meter connector.

NG → Go to step 5

OK

3 INSPECT MASS AIR FLOW METER (VG VOLTAGE)



(a) Inspect the output voltage.
(1) Apply battery voltage across terminals +B and E2G.
(2) Connect the positive (+) tester probe to terminal VG, and negative (-) tester probe to terminal E2G.
(3) Measure the voltage between the terminals.

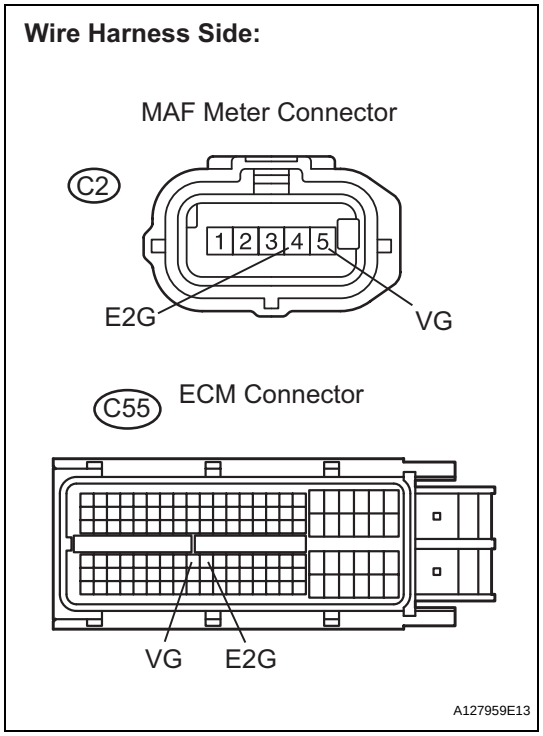
Standard voltage

Tester Connection	Specified Condition
5 (VG) - 4 (E2G)	0.2 to 4.9 V

NG → REPLACE MASS AIR FLOW METER

OK

4 CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
VG (C55-72) - VG (C2-5)	Below 1 Ω
E2G (C55-73) - E2G (C2-4)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VG (C55-72) or VG (C2-5) - Body ground	10 kΩ or higher
E2G (C55-73) or E2G (C2-4) - Body ground	10 kΩ or higher

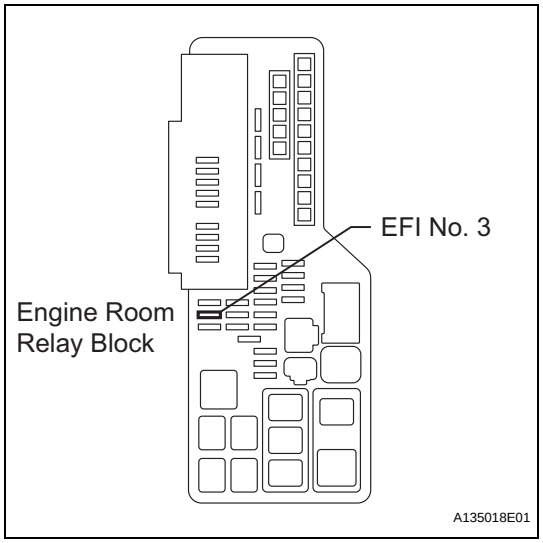
(d) Reconnect the MAF meter connector.
(e) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM

5 INSPECT FUSE (EFI NO. 3)



(a) Remove the EFI No. 3 fuse from the engine room R/B.
(b) Measure the EFI No. 3 fuse resistance.

Standard resistance:
Below 1 Ω

(c) Reinstall the EFI No. 3 fuse.

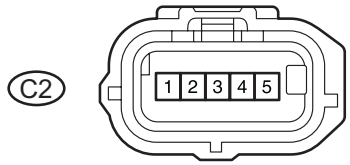
NG → **REPLACE EFI NO. 3 FUSE**

OK

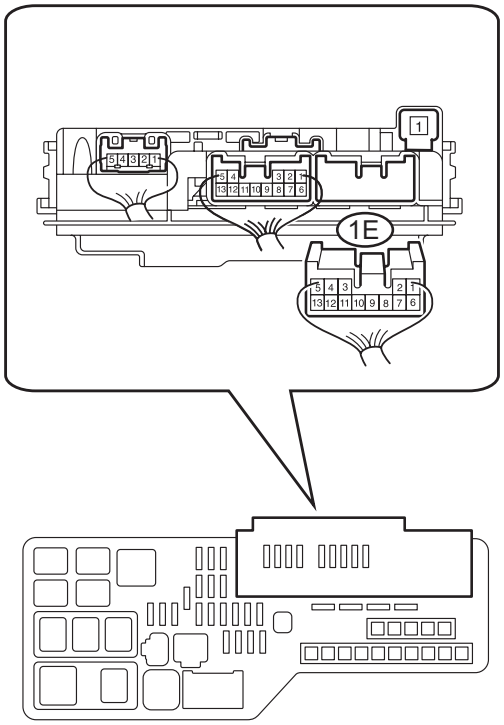
6	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ENGINE ROOM JUNCTION BLOCK)

Wire Harness Side:

MAF Meter Connector



Engine Room Junction Block



Engine Room Relay Block

A140657E01

OK

(a) Disconnect the C2 MAF meter connector.
(b) Remove the engine room junction block from the engine room R/B.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
+B (C2-3) - 1E-6 (Engine room R/B)	Below 1 Ω

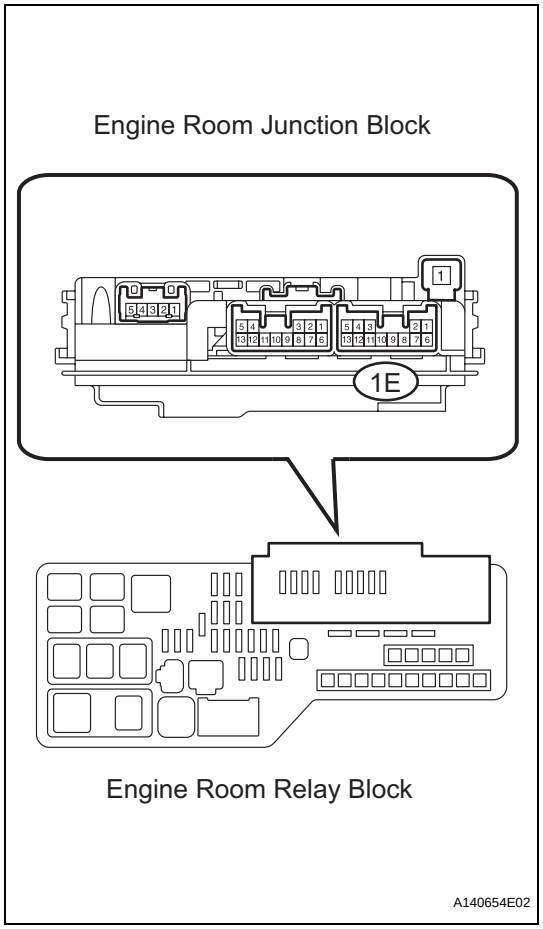
Standard resistance (Check for short)

Tester Connection	Specified Condition
+B (C2-3) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher

(d) Reinstall the engine room junction block.
(e) Reconnect the C2 MAF meter connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

7 INSPECT ENGINE ROOM JUNCTION BLOCK (EFI RELAY)



(a) Remove the engine room junction block from the engine room R/B.
(b) Inspect the EFI relay.
(1) Measure the EFI relay resistance.
Standard resistance

Tester Connection	Specified Condition
1E-12 - 1E-6	10 kΩ or higher
1E-12 - 1E-6	Bellow 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

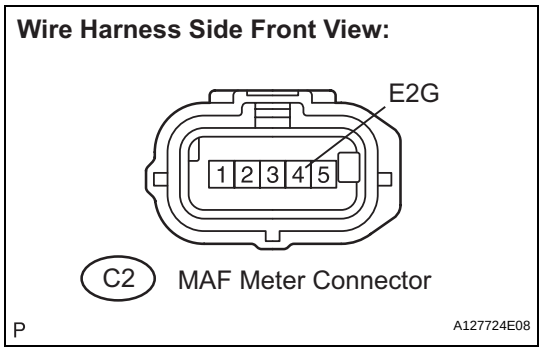
(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK**

OK

CHECK ECM POWER SOURCE CIRCUIT (See page ES-432)

8 CHECK HARNESS AND CONNECTOR (SENSOR GROUND)



(a) Disconnect the C2 MAF meter connector.
(b) Measure the resistance between the terminals.
Standard resistance

Tester Connection	Specified Condition
E2G (C2-4) - Body ground	Below 1 Ω

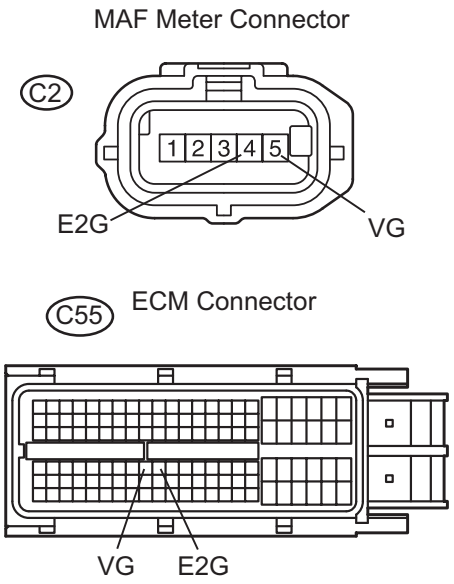
(c) Reconnect the MAF meter connector.

OK → **REPLACE MASS AIR FLOW METER (See page ES-477)**

NG

9	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)

Wire Harness Side:



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
VG (C55-72) - VG (C2-5)	Below 1 Ω
E2G (C55-73) - E2G (C2-4)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VG (C55-72) or VG (C2-5) - Body ground	10 kΩ or higher
E2G (C55-73) or E2G (C2-4) - Body ground	10 kΩ or higher

(d) Reconnect the MAF meter connector.
(e) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

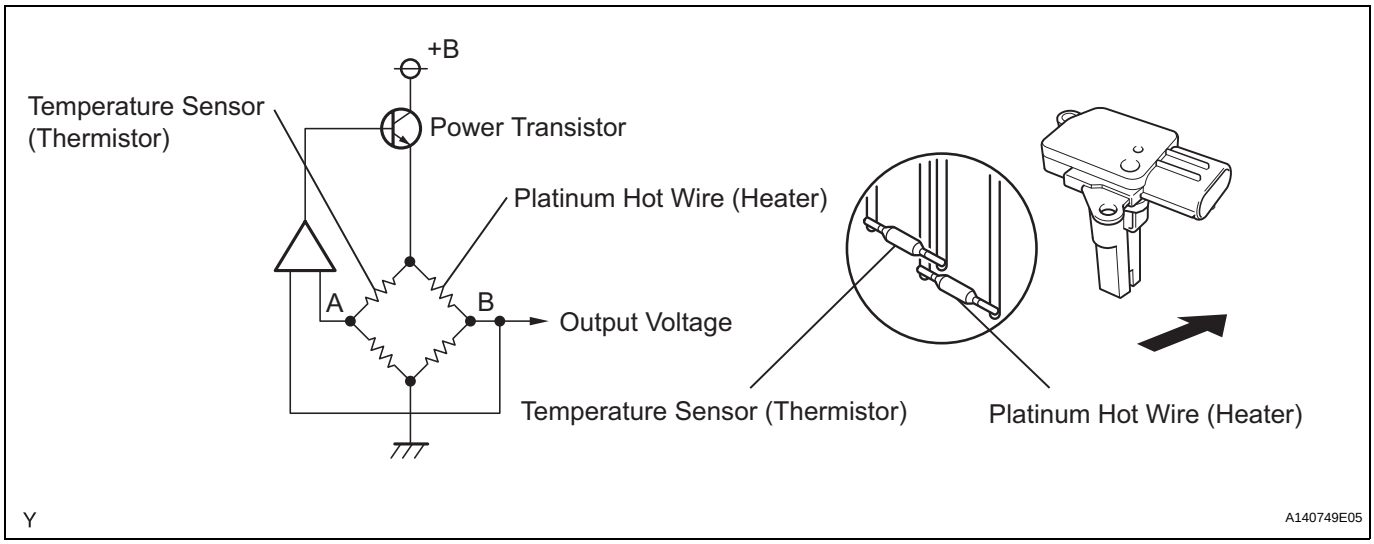
OK

REPLACE ECM (See page ES-518)

DTC	P0101	Mass Air Flow Circuit Range / Performance Problem

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the valve. The ECM uses this information to determine the fuel injection time and to prove appropriate air-fuel ratio. Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.
By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter. The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.
The circuit is constructed so that the platinum hot wire and the temperature sensor provide a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.
HINT:
When any of these DTCs are set, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine RPM and throttle valve position. Fail-safe mode continues until a pass condition is detected.



DTC No.	DTC Detection Condition	Trouble Area
P0101	Test value calculated with engine load and fuel trim are out of specified threshold under the following conditions (2 trip detection logic): – Engine load is 30 % or more and constant – Engine coolant temperature is 70°C (158°F) or higher	MAF meter

MONITOR DESCRIPTION

The MAF meter is a sensor that measures the amount of air flowing through the throttle valve. The ECM uses this information to determine the fuel injection time and to provide an appropriate air-fuel ratio. Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air. By applying a specific electrical current to the wire, the ECM heats it to a specific temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components of the MAF meter. The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume. If there is a defect in the sensor, or an open or short in the circuit, the voltage level deviates from the normal operating range. The ECM interprets this deviation as a malfunction in the MAF meter and sets the DTC.

Example:

If the voltage is more than 2.2 V, or less than 1.48 V while idling, the ECM determines that there is a malfunction in the MAF meter and sets the DTC.

ES

MONITOR STRATEGY

Related DTCs	P0101: Mass air flow meter rationality
Required Sensors/Components (Main)	Mass air flow meter
Required Sensors/Components (Sub)	Crankshaft position sensor, engine coolant temperature sensor and throttle position sensor
Frequency of Operation	Continuos
Duration	10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for closed loop) P0335 (CKP sensor) P0340, P0341 (CMP sensor)
TP (Throttle position) sensor voltage	0.24 V or more
Engine	Running
Battery voltage	10.5 V or more
ECT	70°C (158°F) or more
IAT sensor circuit	OK
ECT sensor circuit	OK
CKP sensor circuit	OK
TP sensor circuit	OK
FTP sensor circuit	OK
EVAP leak detection pump	OK
EVAP vent valve	OK

TYPICAL MALFUNCTION THRESHOLDS

Average engine load	Less than 0.838 %, or more than 1.287 %

WIRING DIAGRAM

Refer to DTC P0100 (See page ES-127).

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0101)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

ES

Result

Display (DTC Output)	Proceed to
P0101 and other DTCs	A
P0101	B

(e) Read the DTCs.
HINT:
If any DTCs other than P0101 are output, troubleshoot those DTCs first.

B → **REPLACE MASS AIR FLOW METER (See page ES-477)**

A →

GO TO DTC CHART (See page ES-63)

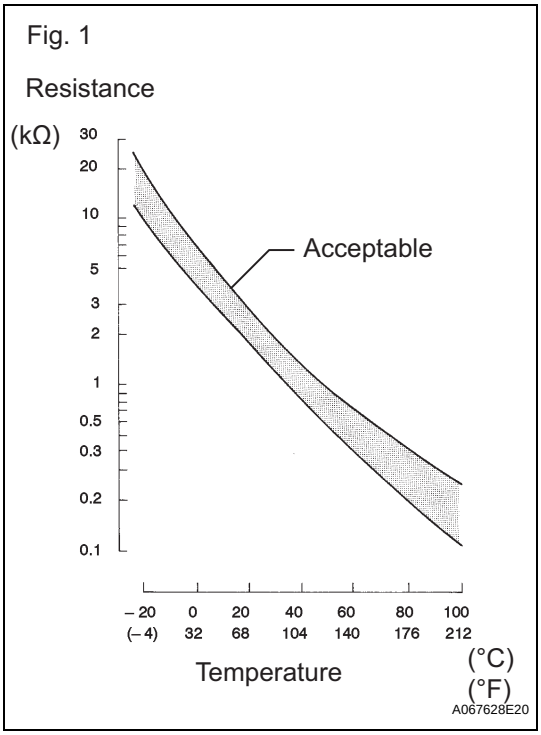
DTC	P0110	Intake Air Temperature Circuit Malfunction

DTC	P0112	Intake Air Temperature Circuit Low Input

DTC	P0113	Intake Air Temperature Circuit High Input

DESCRIPTION

Fig. 1



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT drops, the resistance of the thermistor increases. When the temperature rises, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).

The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.

Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

When any of DTCs P0110, P0112 and P0113 are set, the ECM enters fail-safe mode. During fail-safe mode, the IAT is estimated to be 20°C (68°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

DTC No.	Proceed to	DTC Detection Condition	Trouble Area
P0110	Step 1	Open or short in Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic)	• Open or short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0112	Step 4	Short in Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic)	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM
P0113	Step 2	Open in Intake Air Temperature (IAT) sensor circuit for 0.5 seconds (1 trip detection logic)	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • ECM

HINT:
When any of these DTCs are set, check the IAT by entering the following menus on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The ECM monitors the sensor voltage and uses this value to calculate the Intake Air Temperature (IAT). When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a malfunction in the IAT sensor and sets a DTC.
Example:

If the sensor output voltage is -40°C (-40°F) for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and sets DTC P0113. Conversely, if the output voltage is more than 140°C (284°F) for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and sets DTC P0112.

If the malfunction is not repaired successfully, a DTC is set 0.5 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0110: Intake air temperature sensor open/short (Fluctuating) P0112: Intake air temperature sensor short (Low electrical resistance) P0113: Intake air temperature sensor open (High electrical resistance)
Required Sensors/Components (Main)	Intake Air Temperature (IAT) sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0110:

Intake air temperature sensor voltage	Less than 0.18 V, or more than 4.91 V

P0112:

Intake air temperature sensor voltage	Less than 0.18 V

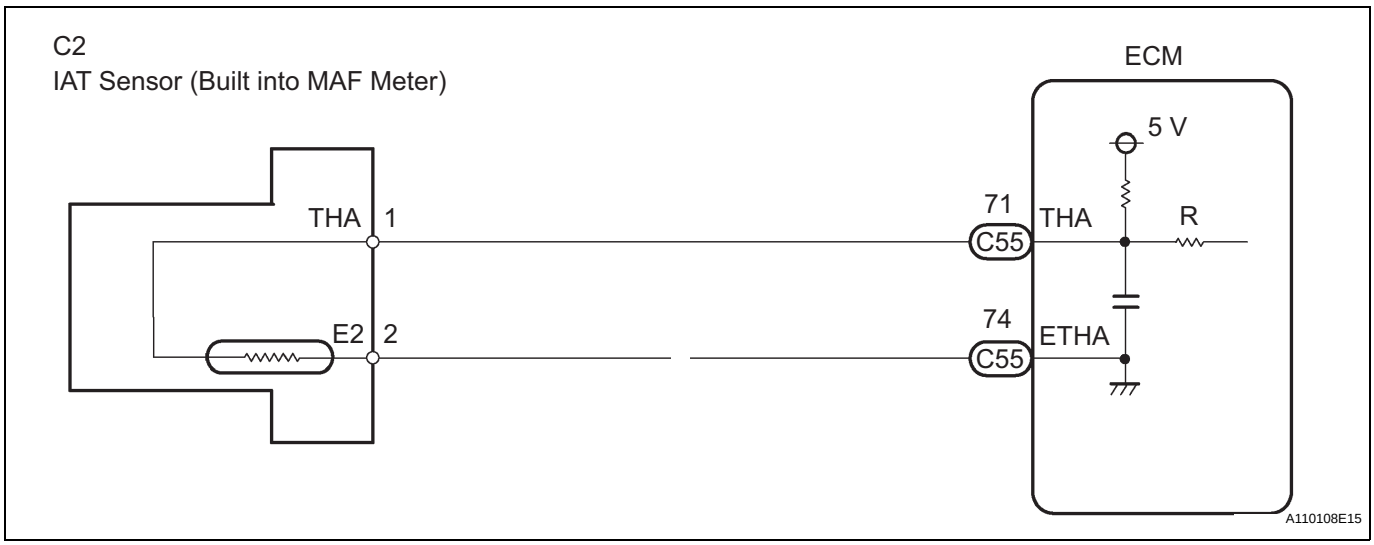
P0113:

Intake air temperature sensor voltage	More than 4.91 V

COMPONENT OPERATING RANGE

Intake air temperature sensor resistance	98.5 Ω to 156 kΩ [-40 to 140°C (-40 to 284°F)]

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	CHECK DTC OUTPUT

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the intelligent tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read the DTCs.

Result

Display (DTC output)	Proceed to
P0110	A
P0112	B
P0113	C

B → Go to step 6

C → Go to step 4

A

2	READ VALUE OF INTAKE AIR TEMPERATURE SENSOR (INTAKE AIR)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.

(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(e) Read the value displayed on the tester.

Standard:
Same as actual Intake Air Temperature (IAT).

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Same as actual IAT	C

HINT:
- If there is an open circuit, the intelligent tester indicates -40°C (-40°F).
- If there is a short circuit, the intelligent tester indicates 140°C (284°F) or higher.

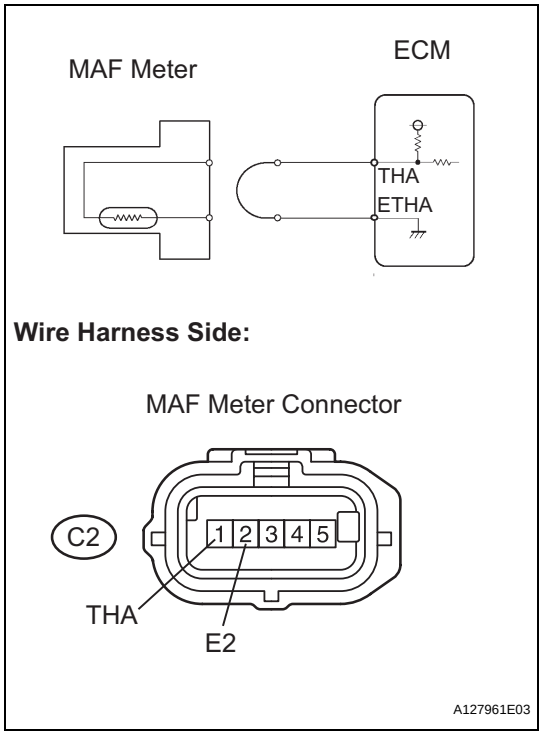
ES

B → **Go to step 5**

C → **CHECK FOR INTERMITTENT PROBLEMS (See page ES-33)**

A

3 CHECK MASS AIR FLOW METER (CHECK FOR OPEN IN SENSOR)



(a) Confirm good connection of the Mass Air Flow (MAF) meter.
(b) Disconnect the C2 MAF meter connector.
(c) Connect terminals THA and E2 of the MAF meter wire harness side connector.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the ignition switch on (IG).
(f) Turn the tester on.
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(h) Read the value displayed on the tester.

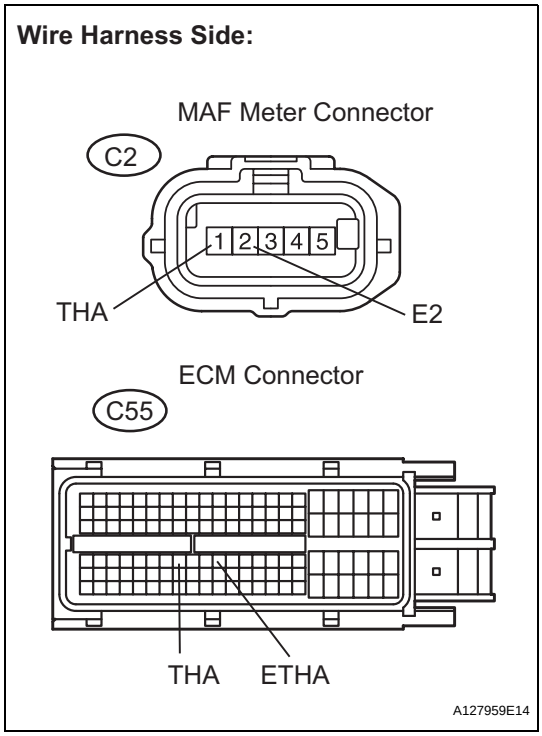
Standard:
140°C (284°F) or higher

(i) Reconnect the MAF meter connector.

OK → **REPLACE MASS AIR FLOW METER (See page ES-477)**

NG

4 CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ECM)



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
THA (C55-71) - THA (C2-1)	Below 1 Ω
ETHA (C55-74) - E2 (C2-2)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
THA (C55-71) or THA (C2-1) - Body ground	10 kΩ or higher
ETHA (C55-74) or E2 (C2-2) - Body ground	10 kΩ or higher

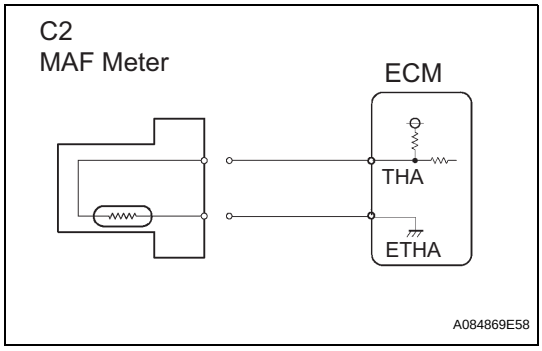
(d) Reconnect the MAF meter connector.
(e) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM (See page ES-518)

5 CHECK MASS AIR FLOW METER (CHECK FOR SHORT IN SENSOR)



(a) Disconnect the C2 MAF meter connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG).
(d) Turn the tester on.
(e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(f) Read the value displayed on the tester.

Standard:

-40°C (-40°F) or higher

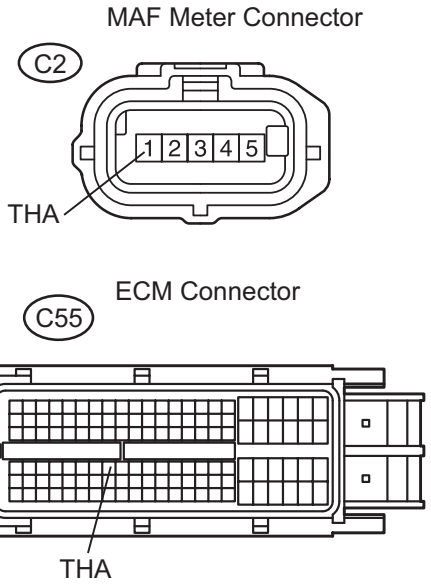
(g) Reconnect the MAF meter connector.

OK → **REPLACE MASS AIR FLOW METER (See page ES-477)**

NG

6	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER- ECM)

Wire Harness Side:



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.
Standard resistance

Tester Connection	Specified Condition
THA (C55-71) or THA (C2-1) - Body ground	10 kΩ or higher

(d) Reconnect the MAF meter connector.
(e) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

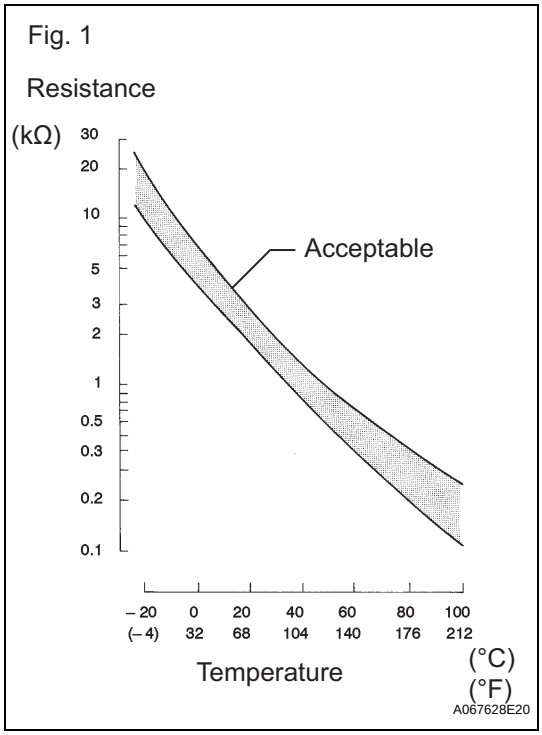
OK

REPLACE ECM (See page ES-518)

ES

DTC	P0111	Intake Air Temperature Sensor Gradient Too High

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT drops, the resistance of the thermistor increases. When the temperature rises, the resistance drops. These variations in resistance are transmitted to the ECM as voltage changes (See Fig. 1).
The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R.
Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

DTC No.	DTC Detection Condition	Trouble Area
P0111	1. The intake air temperature rise is large, from the previous trip warm-up to the following trip. (2 trip detection logic) 2. When the change in the intake air temperature after engine start is less than the threshold value.	Mass air flow meter assembly

MONITOR DESCRIPTION

The ECM performs OBD II monitoring based on the values from the intake air temperature sensor. If there is no change of the sensor value within the normal range, the ECM will not be able to perform OBD II monitoring or will misdiagnose that there is a malfunction in the sensor. The ECM detects the stuck intake air temperature sensor value by performing monitoring after the engine switch is turned off or the engine is started (short soak or long soak).

MONITOR STRATEGY

Related DTCs	P0111: Intake air temperature sensor rationality (After engine stop) P0111: Intake air temperature sensor rationality (After cold engine start)

Required Sensors/Components (Main)	Intake Air Temperature (IAT) sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Once per driving cycle
Duration	5 hours
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	None

After engine stop:

Time after engine start	10 seconds or more
Battery voltage	10.5 V or more
ECT sensor circuit	OK
ECT change since engine stopped	Less than 180°C (356°F)
ECT before engine stop	70°C (158°F) or more
Time that MAF is low before engine stop	70 minutes
Accumulated MAF amount before engine stop	3,800 g or more
Key-off duration	30 minutes

After cold engine start:

Key-off duration	5 hours
Time after engine start	10 seconds or more
ECT sensor circuit	OK
ECT	70°C (158°F) or more
Accumulated MAF amount	6,300 g or more
One of the following conditions 1 or 2 is met:	-
1. Duration while engine load is low	129 seconds or more
2. Duration while engine load is high	10 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

After engine stop:

IAT change	Less than 1°C (2°F)

After cold engine start:

IAT change	Less than 1°C (2°F)

WIRING DIAGRAM

Refer to DTC P0110 (See page ES-138).

INSPECTION PROCEDURE

1	**CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0111)**

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

(e) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0111 and other DTCs	A
P0111	B

HINT:
If any DTCs other than P0111 are output, troubleshoot those DTCs first.

B → **REPLACE MASS AIR FLOW METER (See page ES-477)**

A →

ES

GO TO DTC CHART (See page ES-63)

DTC	P0115	Engine Coolant Temperature Circuit Malfunction

DTC	P0117	Engine Coolant Temperature Circuit Low Input

DTC	P0118	Engine Coolant Temperature Circuit High Input

DESCRIPTION

A thermistor is built into the Engine Coolant Temperature (ECT) sensor, of which the resistance value varies according to the ECT.

The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

HINT:

When any of DTCs P0115, P0117 and P0118 are set, the ECM enters fail-safe mode. During fail-safe mode, the ECT is estimated to be 80°C (176°F) by the ECM. Fail-safe mode continues until a pass condition is detected.

ES

DTC No.	Proceed to	DTC Detection Condition	Trouble Area
P0115	Step 1	Open or short in Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic)	• Open or short in ECT sensor circuit • ECT sensor • ECM
P0117	Step 4	Short in Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic)	• Short in ECT sensor circuit • ECT sensor • ECM
P0118	Step 2	Open in Engine Coolant Temperature (ECT) sensor circuit for 0.5 seconds (1 trip detection logic)	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

When any of these DTCs are set, check the ECT by entering the following menus on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.

Temperature Displayed	Malfunction
-40°C (-40°F)	Open circuit
140°C (284°F) or higher	Short circuit

MONITOR DESCRIPTION

The Engine Coolant Temperature (ECT) sensor is used to monitor the ECT. The ECT sensor has a thermistor with a resistance that varies according to the temperature of the engine coolant. When the coolant temperature drops, the resistance in the thermistor increases. When the temperature rises, the resistance drops. These variations in resistance are reflected in the output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and sets a DTC.

Example:

If the sensor output voltage is -40°C (-40°F) for 0.5 seconds or more, the ECM determines that there is an open in the ECT sensor circuit, and sets DTC P0118. Conversely, if the voltage output is more than 140°C (284°F) for 0.5 seconds or more, the ECM determines that there is a short in the sensor circuit, and sets DTC P0117.

If the malfunction is not repaired successfully, a DTC is set 0.5 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0115: Engine coolant temperature sensor open/short (Fluctuating) P0117: Engine coolant temperature sensor short (Low electrical resistance) P0118: Engine coolant temperature sensor open (High electrical resistance)
Required Sensors/Components (Main)	Engine coolant temperature sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0115:

Engine coolant temperature sensor voltage	Less than 0.14 V, or more than 4.91 V

P0117:

Engine coolant temperature sensor voltage	Less than 0.14 V

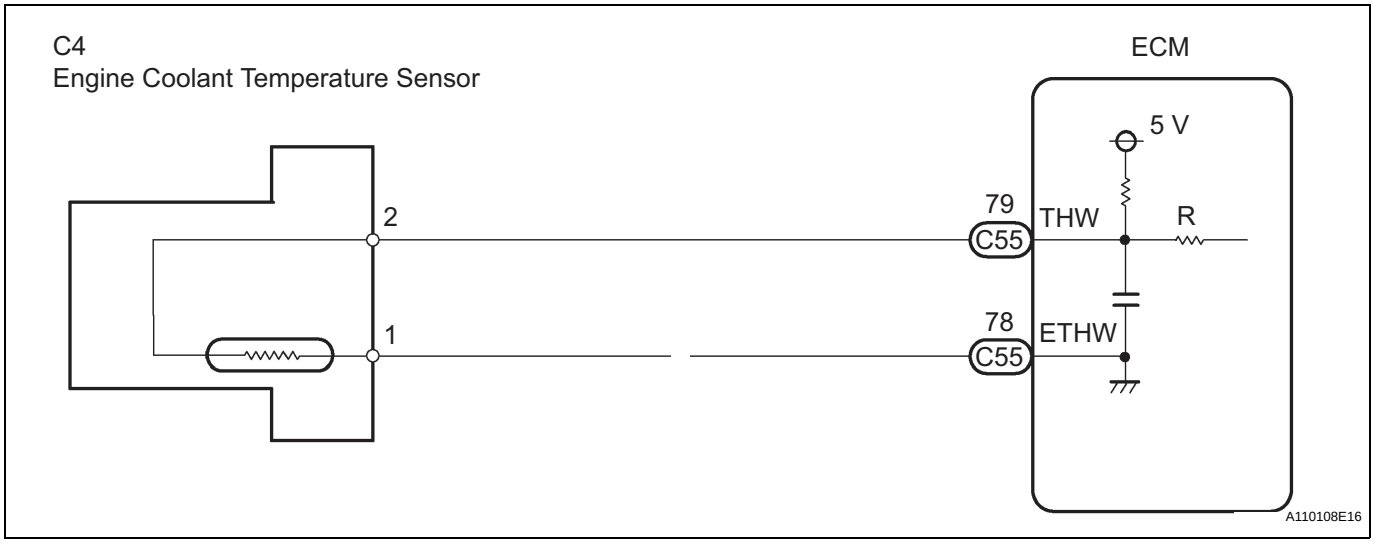
P0118:

Engine coolant temperature sensor voltage	More than 4.91 V

COMPONENT OPERATING RANGE

Engine coolant temperature sensor resistance	79 Ω to 156 kΩ [-40 to 140°C (-40 to 284°F)]

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	CHECK DTC OUTPUT

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0115	A
P0117	B
P0118	C

B → **Go to step 6**

C → **Go to step 4**

A

2	READ VALUE OF ENGINE COOLANT TEMPERATURE SENSOR (COOLANT TEMP)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(e) Read the value displayed on the tester.

Standard:

Between 80°C and 97°C (176°F and 207°F) with warm engine.

Result

Temperature Displayed	Proceed to
-40°C (-40°F)	A
140°C (284°F) or higher	B
Between 80°C and 97°C (176°F and 207°F)	C

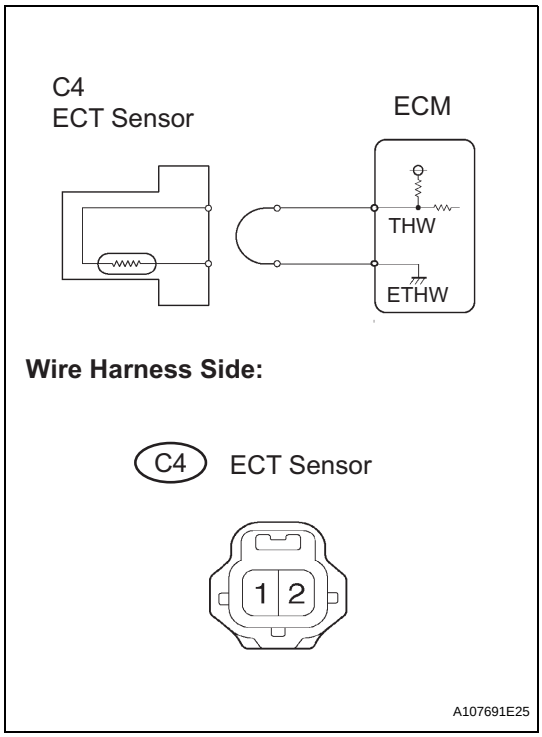
HINT:
- If there is an open circuit, the intelligent tester indicates -40°C (-40°F).
- If there is a short circuit, the intelligent tester indicates 140°C (284°F) or higher.

B → **Go to step 5**

C → CHECK FOR INTERMITTENT PROBLEMS

A

3 CHECK ENGINE COOLANT TEMPERATURE SENSOR (CHECK FOR OPEN IN SENSOR)

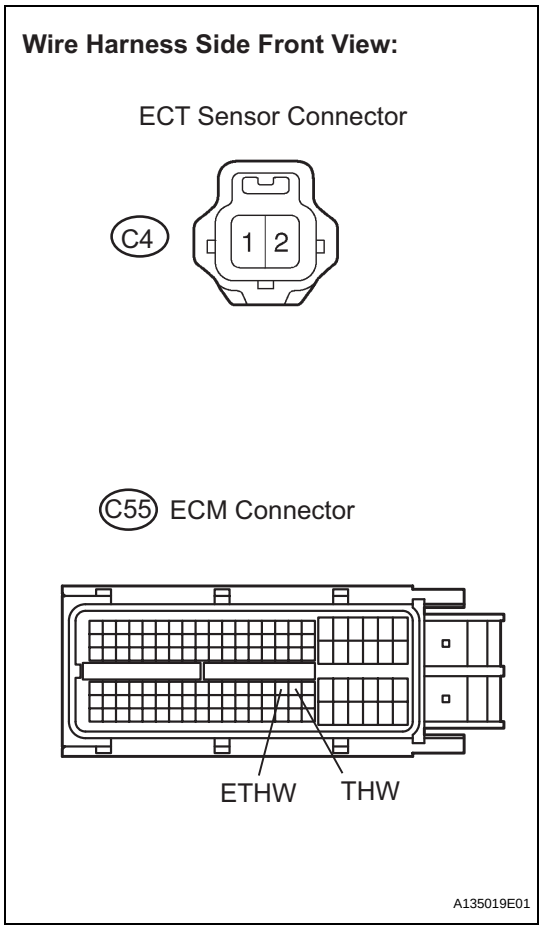


(a) Confirm good connection of the sensor.
(b) Disconnect the C4 engine coolant temperature (ECT) sensor connector.
(c) Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the ignition switch on (IG).
(f) Turn the tester on.
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(h) Read the value displayed on the tester.
Standard:
140°C (284°F) or higher.
(i) Reconnect the ECT sensor connector.

OK → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page ES-499)**

NG

4	CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)



(a) Disconnect the C4 ECT sensor connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.
Standard resistance

Tester Connection	Specified Condition
THW (C55-79) - C4-2	Below 1 Ω
ETHW (C55-78) - C4-1	Below 1 Ω

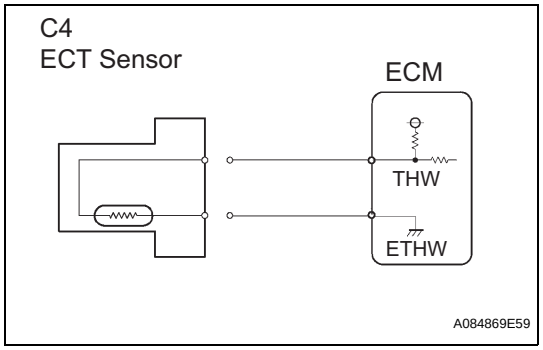
(d) Reconnect the ECM connector.
(e) Reconnect the ECT connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM (See page ES-518)

5	CHECK ENGINE COOLANT TEMPERATURE SENSOR (CHECK FOR SHORT IN SENSOR)



(a) Disconnect the C4 ECT sensor connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG).
(d) Turn the tester on.
(e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(f) Read the value displayed on the tester.
Standard:
-40°C (-40°F)
(g) Reconnect the ECT sensor connector.

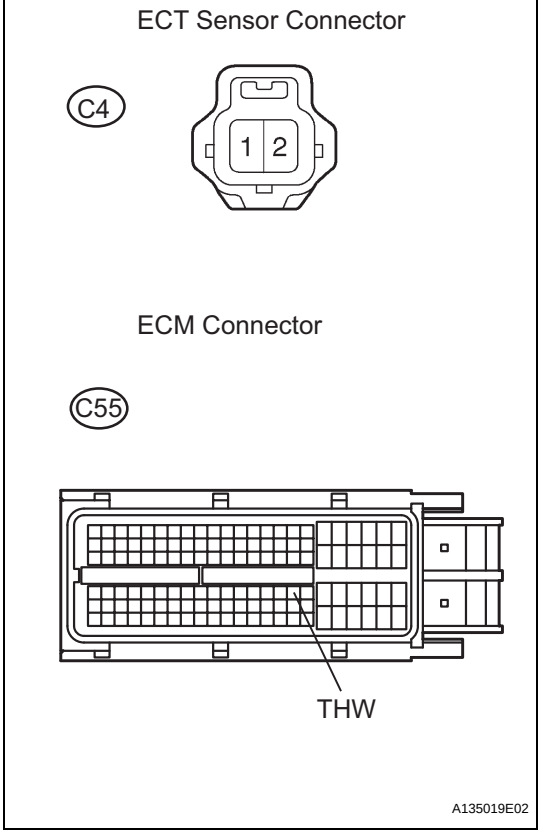
OK → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page ES-499)**

ES

NG

6	CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

Wire Harness Side Front View:



(a) Disconnect the C4 ECT sensor connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance

Tester Connection	Specified Condition
THW (C55-79) or C4-2 - Body ground	10 kΩ or higher

(d) Reconnect the ECT sensor connector.
(e) Reconnect the ECM connector.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM (See page ES-518)

DTC	P0116	Engine Coolant Temperature Circuit Range / Performance Problem

DESCRIPTION

A thermistor is built into the Engine Coolant Temperature (ECT) sensor, of which the resistance value varies according to the ECT.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

DTC No.	DTC Detection Condition	Trouble Area
P0116	ECTs as listed below are nearly same (2 trip detection logic): – ECT when engine is started at lower than 60°C (140°F) of ECT – ECT when engine is warmed up	• Thermostat • ECT sensor
	ECTs as listed below are nearly same when engine is started at higher than 60°C (140°F) of ECT (2 trip detection logic) – ECT when engine is stopped after driving – ECT when engine is started at lower than 60°C (140°F) of ECT	

ES

MONITOR DESCRIPTION

The ECT sensor is used to monitor the ECT. The ECT sensor has a built-in thermistor with a resistance that varies according to the temperature of the engine coolant. When the ECT drops, the resistance of the thermistor increases. When the temperature rises, the resistance drops. These variations in the resistance are reflected in the output voltage from the ECT sensor.
The ECM monitors the sensor voltage and uses this value to calculate the ECT. If the sensor output voltage deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the ECT sensor and sets the DTC.

Examples:

(1) Upon starting the engine, the ECT is between 35°C and 60°C (95°F and 140°F). If, after driving for 250 seconds, the ECT remains within 3°C (5.4°F) of the starting temperature, the DTC is set (2 trip detection logic).

(2) Upon starting the engine, the ECT is over 60°C (140°F). If, after driving for 250 seconds, the ECM remains within 1°C (1.8°F) of the starting temperature, the DTC is set (6 trip detection logic).

MONITOR STRATEGY

Related DTCs	P0116: Engine coolant temperature sensor rationality (ECT sensor cold start monitor) P0116: Engine coolant temperature sensor rationality (ECT sensor soak monitor)
Required Sensors/Components (Main)	Engine coolant temperature (ECT) sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Once per driving cycle
Duration	10
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	P0100 - P0103 (MAF sensor)

ECT sensor cold start monitor:

Battery voltage	10.5 V or more
Time after engine start	1 second or more
ECT at engine start	Less than 60°C (140°F)
IAT sensor circuit	OK
Soak time	5 hours
Accumulated MAF	1,056.06 g or more
Engine	Running
Fuel cut	OFF
Difference between ECT at engine start and IAT	Less than 40°C (104°F)

ECT sensor soak monitor:

Battery voltage	10.5 V or more
Engine	Running
Soak time	5 hours or more
ECT at engine start	60°C (140°F) or more
Accumulated MAF	2,101.98 times or more

ES

TYPICAL MALFUNCTION THRESHOLDS

ECT sensor cold start monitor:

ECT sensor value change	Less than 5°C (9°F)

ECT sensor soak monitor:

Difference between current ECT sensor value and previous ECT sensor value when engine stopped	Less than 5°C (9°F)

COMPONENT OPERATING RANGE

Engine coolant temperature	Varies with actual engine coolant temperature

INSPECTION PROCEDURE

HINT:

- If any of DTCs P0115, P0117, P0118 or P0125 are set simultaneously with DTC P0116, the ECT sensor may have an open or a short circuit. Troubleshoot those DTCs first.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0116)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(e) Read the DTC.

Result

Display (DTC output)	Proceed to
P0116	A

Display (DTC output)	Proceed to
P0116 and other DTCs	B

B → **GO TO DTC CHART (See page ES-63)**

A

2 INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-13).
(b) Check the valve opening temperature of the thermostat.
Standard:
80 to 84°C (176 to 183°F)
HINT:
In addition to the above check, confirm that the valve is completely closed when the temperature is below the standard.
(c) Reinstall the thermostat (See page CO-14).

NG → **REPLACE THERMOSTAT (See page CO-13)**

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page ES-499)

DTC	P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction
DTC	P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input
DTC	P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input
DTC	P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit
DTC	P0222	Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input
DTC	P0223	Throttle / Pedal Position Sensor / Switch "B" Circuit High Input
DTC	P2135	Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation

ES

DESCRIPTION

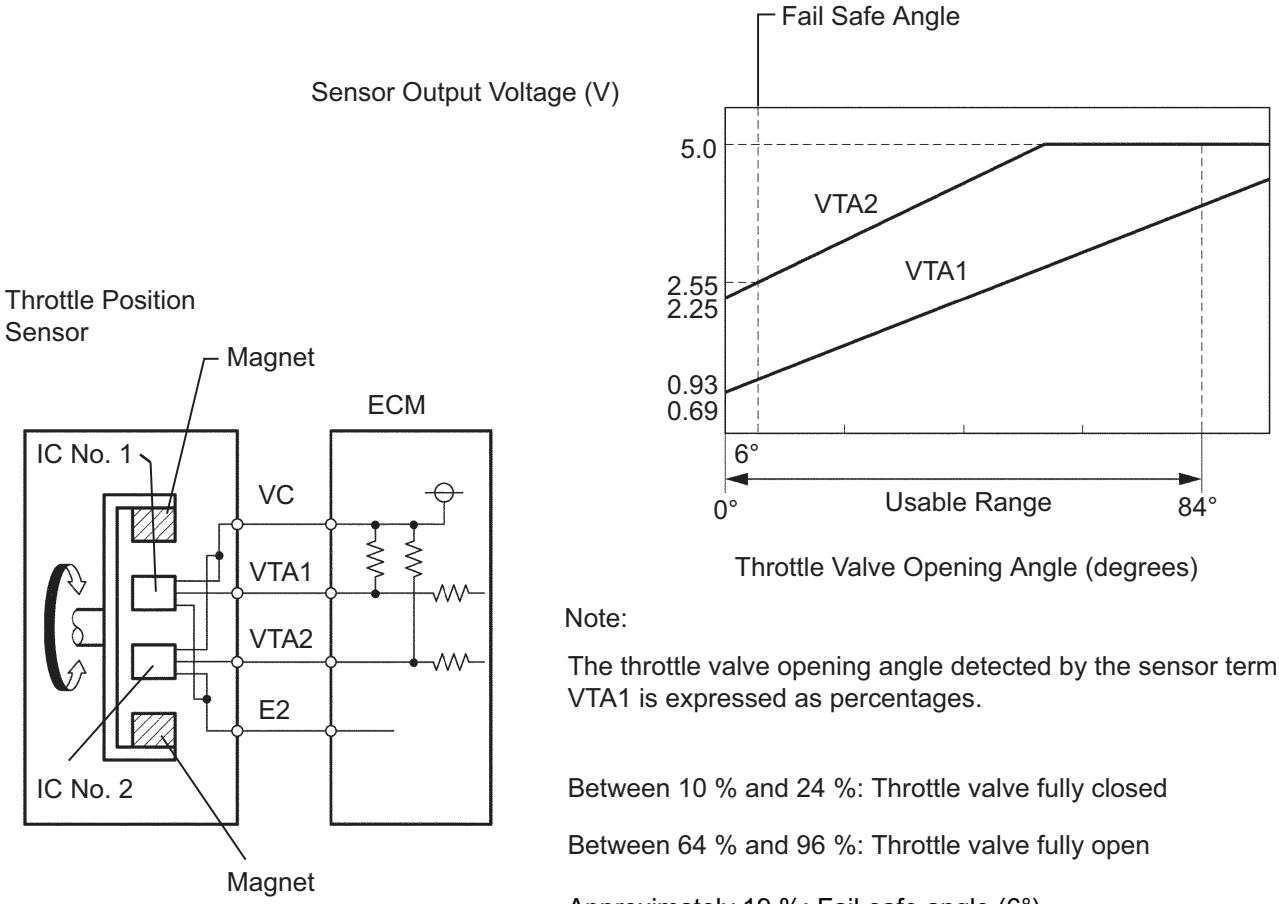
HINT:

This ETC (Electrical Throttle Control System) does not use a throttle cable.

The Throttle Position (TP) sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type, and uses Hall-effect elements, in order to yield accurate signals, even in extreme driving conditions, such as at high speeds as well as very low speeds.

The TP sensor has two sensor circuits which each transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.

As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel-cut control.



Note:

The throttle valve opening angle detected by the sensor terminal VTA1 is expressed as percentages.

Between 10 % and 24 %: Throttle valve fully closed

Between 64 % and 96 %: Throttle valve fully open

Approximately 19 %: Fail-safe angle (6°)

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DTC No.	DTC Detection Condition	Trouble Area
P0120	Output voltage of VTA1 quickly fluctuates beyond lower and upper malfunction thresholds for 2 seconds (1 trip detection logic)	• Throttle Position (TP) sensor (built into throttle body) • ECM
P0122	Output voltage of VTA1 is 0.2 V or less for 2 seconds (1 trip detection logic)	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • ECM
P0123	Output voltage of VTA1 is 4.535 V or more for 2 seconds (1 trip detection logic)	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • ECM
P0220	Output voltage of VTA2 quickly fluctuates beyond lower and upper malfunction thresholds for 2 seconds (1 trip detection logic)	• TP sensor (built into throttle body) • ECM

DTC No.	DTC Detection Condition	Trouble Area
P0222	Output voltage of VTA2 is 1.75 V or less for 2 seconds (1 trip detection logic)	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • ECM
P0223	Output voltage of VTA2 is 4.8 V or more, and VTA1 is between 0.2 V and 2.02 V, for 2 seconds (1 trip detection logic)	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • ECM
P2135	Either condition (a) or (b) is met (1 trip detection logic): (a) Difference between output voltages of VTA1 and VTA2 is 0.02 V or less for 0.5 seconds or more (b) Output voltage of VTA1 is 0.2 V or less, and VTA2 is 1.75 V or less, for 0.4 seconds or more	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • ECM

HINT:

- When any of these DTCs are set, check the throttle valve opening angle by entering the following menus on an intelligent tester: DIAGNOSIS / ENHANCED OBD ll / DATA LIST / ETCS / THROTTLE POS AND THROTTLE POS #2.
- THROTTLE POS denotes the VTA1 signal (expressed in percentages), and THROTTLE POS #2 denotes the VTA2 signal (expressed in voltages).

Reference (Normal Condition):

Tester Display	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
THROTTLE POS	10 to 24 %	64 to 96 %
THROTTLE POS #2	2.1 to 3.1 V	4.5 to 5.0 V

MONITOR DESCRIPTION

The ECM uses the Throttle Position (TP) sensor to monitor the throttle valve opening angle. There are several checks that the ECM performs to confirm the proper operation of the TP sensor.

- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and sets a DTC.
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and sets a DTC.
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and sets a DTC.

MONITOR STRATEGY

Related DTCs	P0120: Throttle position sensor 1 range check (Fluctuating) P0122: Throttle position sensor 1 range check (Low voltage) P0123: Throttle position sensor 1 range check (High voltage) P0220: Throttle position sensor 2 range check (Fluctuating) P0222: Throttle position sensor 2 range check (Low voltage) P0223: Throttle position sensor 2 range check (High voltage) P2135: Throttle position sensor range check (Correlation)
Required Sensors/Components (Main)	Throttle position sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Continuous

Duration	Throttle position sensor 1 range check (Fluctuating): 2 seconds (Accelerator pedal ON) Throttle position sensor 1 range check (Low voltage): 2 seconds (Accelerator pedal ON) Throttle position sensor 1 range check (High voltage): 2 seconds (Accelerator pedal ON) Throttle position sensor 2 range check (Fluctuating): 2 seconds (Accelerator pedal ON) Throttle position sensor 2 range check (Low voltage): 2 seconds (Accelerator pedal ON) Throttle position sensor 2 range check (High voltage): 2 seconds (Accelerator pedal ON) Throttle position sensor 1 range check (Fluctuating): 10 seconds (Accelerator pedal OFF) Throttle position sensor 1 range check (Low voltage): 10 seconds (Accelerator pedal OFF) Throttle position sensor 1 range check (High voltage): 10 seconds (Accelerator pedal OFF) Throttle position sensor 2 range check (Fluctuating): 10 seconds (Accelerator pedal OFF) Throttle position sensor 2 range check (Low voltage): 10 seconds (Accelerator pedal OFF) Throttle position sensor 2 range check (High voltage): 10 seconds (Accelerator pedal OFF) Throttle position sensor range check (Correlation): Within 0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0120:

VTA1 voltage	0.2 V or less, or 4.535 V or more

P0122:

VTA1 voltage	0.2 V or less

P0123:

VTA1 voltage	4.535 V or more

P0220:

VTA2 voltage	1.75 V or less, or 4.8 V or more

P0222:

VTA2 voltage	1.75 V or less

P0223:

VTA2 voltage when VTA1 is 0.2 to 2.02 V	4.8 V or more

P2135:

Either of following conditions A or B is met:	-
Condition A	-
Difference between VTA1 and VTA2 voltages	0.02 V or less
Condition B	-
VTA1 voltage	0.2 V or less
VTA2 voltage	1.75 V or less

COMPONENT OPERATING RANGE

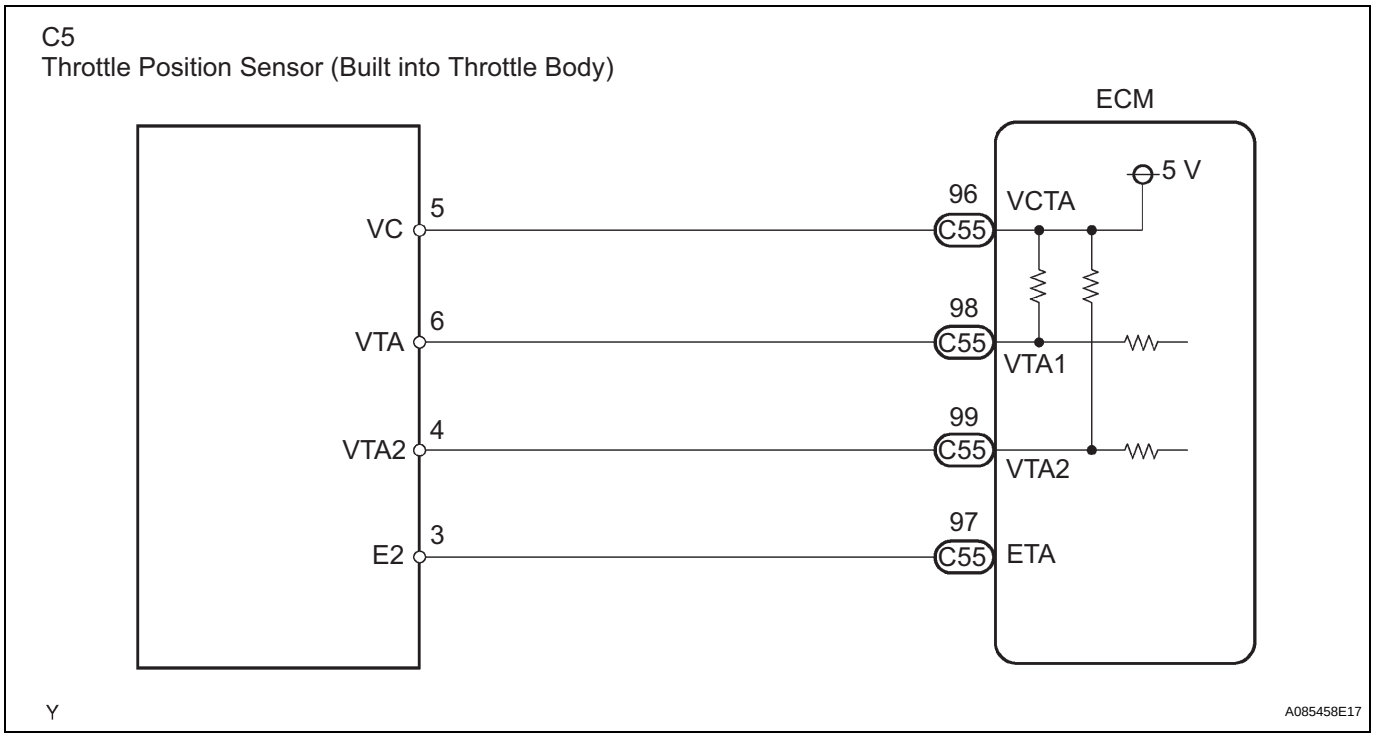
VTA1 voltage	0.69 to 4.05 V
VTA2 voltage	2.25 to 4.8 V

FAIL-SAFE

When any of these DTCs, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions, are set, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator off, and the throttle valve is returned to a 6° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel-cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed gently, the vehicle can be driven slowly.

WIRING DIAGRAM

ES



INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	**READ VALUE OF THROTTLE POSITION SENSOR (THROTTLE POS AND THROTTLE POS #2)**

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the intelligent tester on.

(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ETCS / THROTTLE POS and THROTTLE POS #2.
(d) Check the values displayed on the tester.

Result

TP#1 (VTA1) When AP Released	TP#2 (VTA2) When AP Released	TP#1 (VTA1) When AP Depressed	TP#2 (VTA2) When AP Depressed	Trouble Area	Proceed to
0 %	Between 0 V and 0.2 V	0 %	Between 0 V and 0.2 V	VC circuit open	A
100 %	Between 4.5 V and 5.0 V	100 %	Between 4.5 V and 5.0 V	E2 circuit open	A
0 % or 100 %	Between 2.1 V and 3.1 V (Fail-safe)	0 % or 100 %	Between 2.1 V and 3.1 V (Fail-safe)	VTA1 circuit open or ground short	A
Approx. 19 % (Fail-safe)	Between 0 V and 0.2 V, or 4.5 V and 5.0 V	Between 10 % and 24 % (Fail-safe)	Between 0 V and 0.2 V, or 4.5 V and 5.0 V	VTA2 circuit open or ground short	A
Between 10 % and 24 %	Between 2.1 V and 3.1 V	Between 64 % and 96 % (Not fail-safe)	Between 4.5 V and 5.0 V (Not fail-safe)	TP sensor circuit normal	B

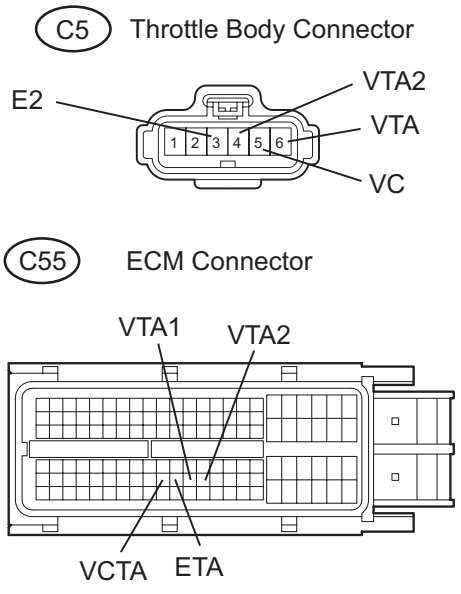
HINT:
- TP#1 denotes THROTTLE POS, and TP#2 denotes THROTTLE POS#2.
- AP denotes Accelerator Pedal.
- VTA1 is expressed as percentages, and VTA2 is expressed as voltages.

B → **Go to step 5**

A

2 CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)

Wire Harness Side Front View:



(a) Disconnect the C5 throttle body connector.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
VC (C5-5) - VCTA (C55-96)	Below 1 Ω
VTA (C5-6) - VTA1 (C55-98)	Below 1 Ω
VTA2 (C5-4) - VTA2 (C55-99)	Below 1 Ω
E2 (C5-3) - ETA (C55-97)	Below 1 Ω

Standard resistance (Check for short)

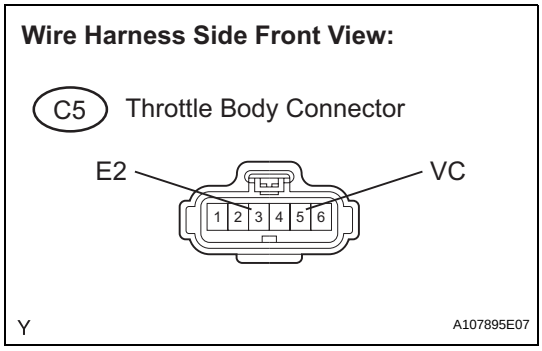
Tester Connection	Specified Condition
VC (C5-5) or VCTA (C55-96) - Body ground	10 kΩ or higher
VTA (C5-6) or VTA1 (C55-98) - Body ground	10 kΩ or higher
VTA2 (C5-4) or VTA2 (C55-99) - Body ground	10 kΩ or higher

(d) Reconnect the throttle body connector.
(e) Reconnect the ECM connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3 INSPECT ECM (VC VOLTAGE)



(a) Disconnect the C5 throttle body connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage according to the value(s) in the table below.

Standard voltage

Tester Connection	Specified Condition
VC (C5-5) - E2 (C5-3)	4.5 to 5.0 V

(d) Reconnect the throttle body connector.

NG → REPLACE ECM (See page ES-518)

OK

4 REPLACE THROTTLE BODY

(a) Replace the throttle body assembly (See page ES-503).

NEXT

5 CHECK WHETHER DTC OUTPUT RECURS (THROTTLE POSITION SENSOR DTCS)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-45).
(d) Start the engine.
(e) Allow the engine to idle for 15 seconds or more.
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0120, P0122, P0123, P0220, P0223, and/or P2135	A
No output	B

B → SYSTEM IS OK

A

REPLACE ECM (See page ES-518)

DTC	P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem

DESCRIPTION

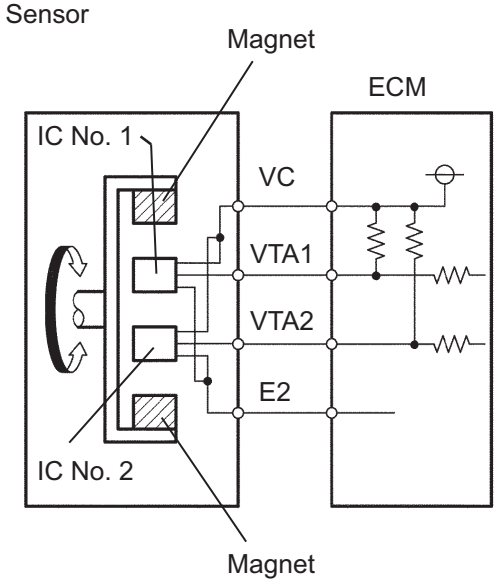
HINT:

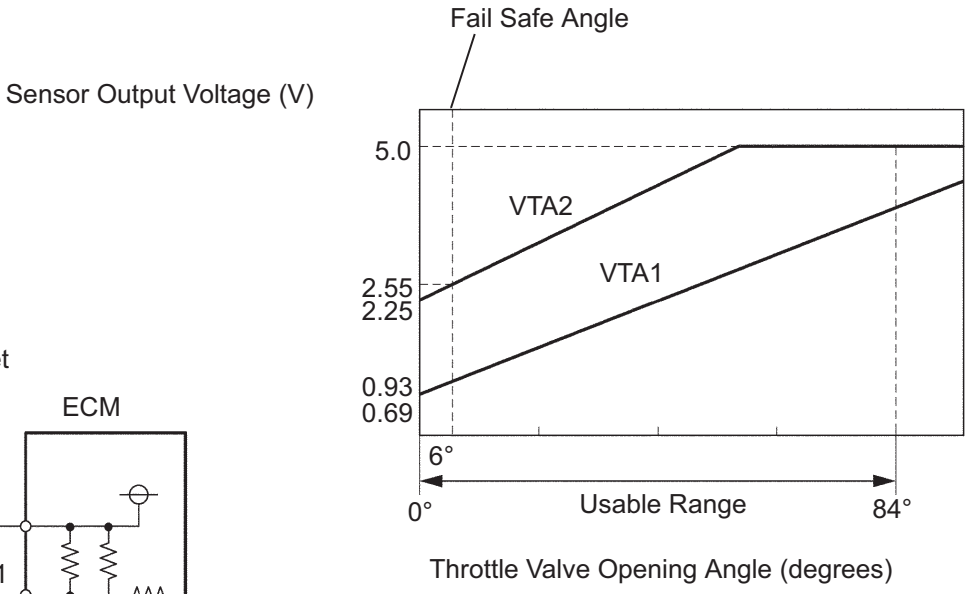
This ETC (Electrical Throttle Control System) does not use a throttle cable.

The Throttle Position (TP) sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type, and uses Hall-effect elements, in order to yield accurate signals, even in extreme driving conditions, such as at high speeds as well as very low speeds.

The TP sensor has two sensor circuits which each transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM.

As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel-cut control.





Note:

The throttle valve opening angle detected by the sensor terminal VTA1 is expressed as percentages.

Between 10 % and 24 %: Throttle valve fully closed

Between 64 % and 96 %: Throttle valve fully open

Approximately 19 %: Fail-safe angle (6°)

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HINT:
This DTC relates to the Throttle Position (TP) sensor.

DTC No.	DTC Detection Condition	Trouble Area
P0121	Difference between VTA1 and VTA2 voltages less than 0.8 V, or more than 1.6 V for 2 seconds (1 trip detection logic)	TP sensor (built into throttle body)

MONITOR DESCRIPTION

The ECM uses the TP sensor to monitor the throttle valve opening angle.
This sensor transmits two signals: VTA1 and VTA2. VTA1 is used to detect the throttle opening angle and VTA2 is used to detect malfunctions in VTA1. The ECM performs several checks to confirm the proper operation of the TP sensor and VTA1.

For each throttle opening angle, a specific voltage difference is expected between the outputs of VTA1 and VTA2. If the output voltage difference between the two signals deviates from the normal operating range, the ECM interprets this as a malfunction of the TP sensor. The ECM illuminates the MIL and sets the DTC.
If the malfunction is not repaired successfully, the DTC is set 2 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0121: TP sensor rationality
Required Sensors/Components (Main)	TP sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Continuous
Duration	Within 2 seconds
MIL Operation	Immediate
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	P0120, P0122, P0123, P0220, P0222, P0223, P2135 (TP sensor)
Either of following conditions A or B is met:	-
A. Engine switch	ON
B. Electric throttle motor power	ON
TP sensor malfunction (P0120, P0122, P0123, P0220, P0222, P0223, P2135)	Not detected

TYPICAL MALFUNCTION THRESHOLDS

Difference in voltage between VAT1 and VTA2 TP sensor 1 - [TP sensor 2 x 0.8 (corrected by learning value)]	Less than 0.8 V or more than 1.6 V

FAIL-SAFE

When this DTC, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions, is set, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator off, and the throttle valve is returned to a 6° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel-cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed firmly and gently, the vehicle can be driven slowly. Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air/fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	**CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0121)**

(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.

(d) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(e) Read the DTC.

Result

Display (DTC output)	Proceed to
P0121	A
P0121 and other DTCs	B

B → **GO TO DTC CHART (See page ES-63)**

A

REPLACE THROTTLE BODY (See page ES-503)

DTC	P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control

DESCRIPTION

A thermistor is built into the Engine Coolant Temperature (ECT) sensor, and its resistance value varies according to the ECT.
The structure of the sensor and its connection to the ECM are the same as those of the Intake Air Temperature (IAT) sensor.

DTC No.	DTC Detection Condition	Trouble Area
P0125	Engine coolant temperature (ECT) does not reach closed-loop enabling temperature for 20 minutes (this period varies with ECT when engine start)	• Engine coolant temperature sensor • Cooling system • Thermostat

MONITOR DESCRIPTION

The resistance of the ECT varies in proportion to the actual ECT. The ECT supplies a constant voltage to the sensor and monitors the signal output voltage of the sensor. The signal voltage output varies according to the changing resistance of the sensor. After the engine is started, the ECT is monitored through this signal. If the ECT sensor indicates that the engine is not yet warm enough for closed-loop fuel control, despite a specified period of time having elapsed since the engine was started, the ECM interprets this as a malfunction in the sensor or cooling system and sets the DTC.
Example:

The ECT is 0°C (32°F) at engine start. After 5 minutes running time, the ECT sensor still indicates that the engine is not warm enough to begin closed-loop fuel (air-fuel ratio feedback) control. The ECM interprets this as a malfunction in the sensor or cooling system and sets the DTC.

MONITOR STRATEGY

Related DTCs	P0125: Insufficient engine coolant temperature for closed-loop fuel control
Required Sensors/Components (Main)	Thermostat, cooling system
Required Sensors/Components (Related)	Engine coolant temperature sensor and mass air flow meter
Frequency of Operation	Once per driving cycle
Duration	64 seconds: Closed-loop enabling temperature - 8.34°C (15°F) or more 111.2 seconds: Closed-loop enabling temperature - 19.45 to 8.34°C (35 to 15°F) 1,200 seconds: Less than closed-loop enabling temperature - 19.45°C (35°F)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	P0100 - P0103 (MAF sensor) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor)
MAF sensor circuit fail	Not detected
IAT sensor circuit fail	Not detected
ECT sensor circuit fail	Not detected
Thermostat fail	Not detected

TYPICAL MALFUNCTION THRESHOLDS

Time until actual engine coolant temperature reaches closed-loop fuel control enabling temperature	64 seconds or more: Engine coolant temperature at engine start is - 8.34°C (15°F) or more 111.2 seconds or more: Engine coolant temperature at engine start is - 19.45 to 8.35°C (15 to 35°F) 1,200 seconds or more: Engine coolant temperature at engine start is less than - 19.4°C (35°F)

WIRING DIAGRAM

Refer to DTC P0115 (See page ES-146).

INSPECTION PROCEDURE

HINT:

- If any of DTCs P0115, P0116, P0117 or P0118 are set simultaneously with DTC P0125, the Engine Coolant Temperature (ECT) sensor may have an open or a short circuit. Troubleshoot those DTCs first.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

ES

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0125)

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0125	A
P0125 and other DTCs	B

HINT:
If any DTCs other than P0125 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART (See page ES-63)

A

2	INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-13).
(b) Check the valve opening temperature of the thermostat.
Standard:
80 to 84°C (176 to 183°F)
HINT:
In addition to the above check, confirm that the valve is completely closed when the temperature is below the standard.
(c) Reinstall the thermostat (See page CO-14).

NG → REPLACE THERMOSTAT (See page CO-13)

OK

3	CHECK COOLING SYSTEM

(a) Check for defects in the cooling system that might cause the system to be too cold, such as abnormal radiator fan operation or any modifications.

NG → REPAIR OR REPLACE COOLING SYSTEM

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page ES-499)

DTC	P0128	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)

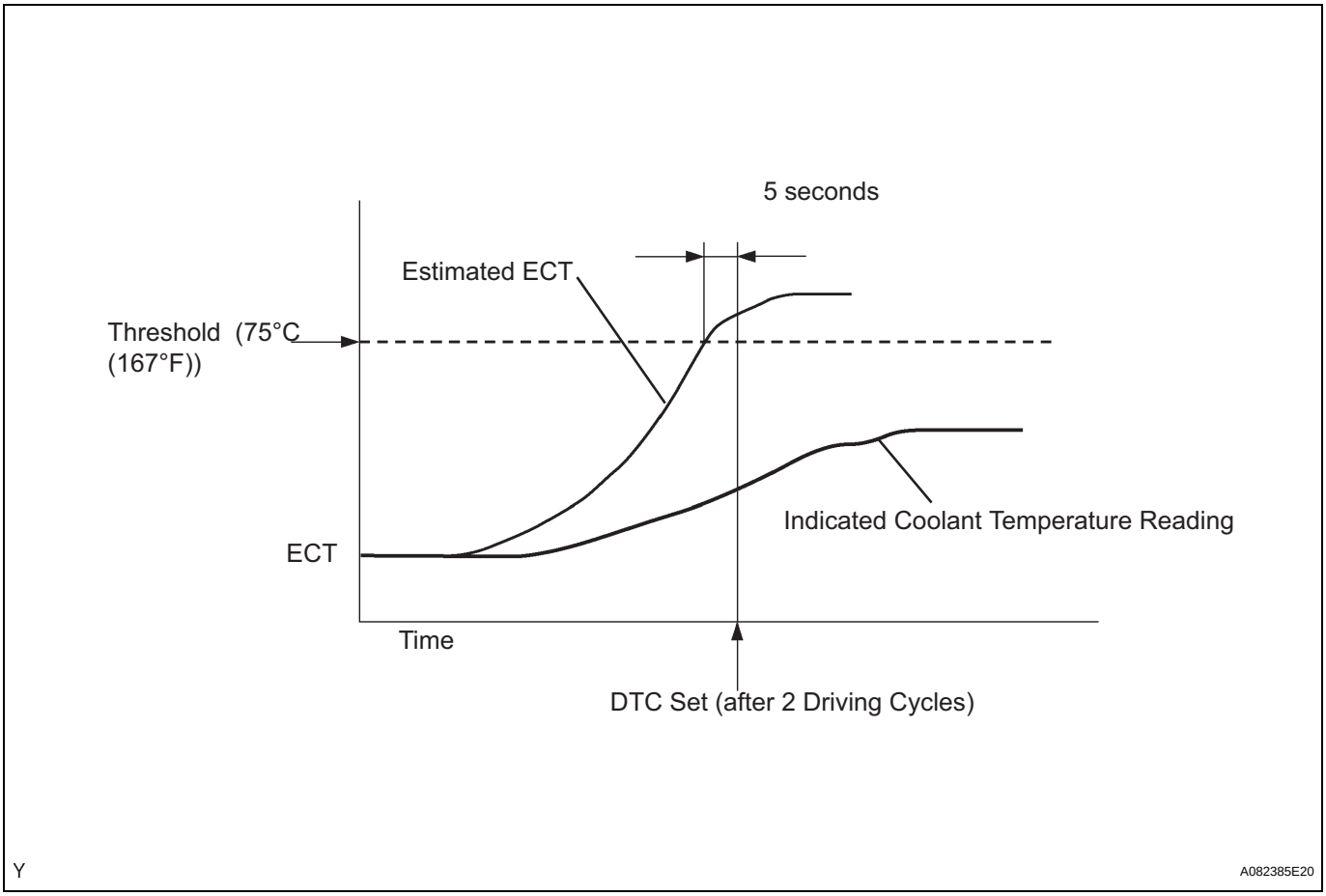
DESCRIPTION

This DTC is set when the Engine Coolant Temperature (ECT) does not reach 75°C (167°F) despite sufficient engine warm-up time.

DTC No.	DTC Detection Condition	Trouble Area
P0128	Conditions (a), (b) and (c) are met for 5 seconds (2 rip detection logic): (a) Cold start (b) Engine warmed up (c) ECT less than 75°C (167°F)	• Thermostat • Cooling system • ECT sensor • ECM

ES

MONITOR DESCRIPTION



The ECM estimates the ECT based on the starting temperature, engine loads, and engine speeds. The ECM then compares the estimated temperature with the actual ECT. When the estimated ECT reaches 75°C (167°F), the ECM checks the actual ECT. If the actual ECT is less than 75°C (167°F), the ECM interprets this as a malfunction in the thermostat or the engine cooling system and sets the DTC.

MONITOR STRATEGY

Related DTCs	P0128: Coolant Thermostat
Required Sensors/Components (Main)	Thermostat
Required Sensors/Components (Sub)	Engine Coolant Temperature (ECT) sensor, Intake Air Temperature (IAT) sensor, Vehicle speed sensor
Frequency of Operation	Once per driving cycle

Duration	900 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever this DTC is not present	P0010, P0020 (VVT OCV Bank 1, 2) P0011 (VVT System 1 - Advance) P0012 (VVT System 1 - Retard) P0021 (VVT System 2 - Advance) P0022 (VVT System 2 - Retard) P0031, P0032, P0051, P0052 (A/F sensor heater - Sensor 1) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0308 (Misfire) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0351 - P0356 (Ignitor) P0500 (VSS) P2196, P2198 (A/F sensor - rationality) P2A00, P2A03 (A/F sensor - slow response)
Battery voltage	11 V or more
Either of following conditions 1 or 2 is met:	-
1. All of following conditions are met:	-
• ECT at engine start - IAT at engine start	-15 to 7°C (-27 to 12.6°F)
• ECT at engine start	-10 to 56°C (14 to 133°F)
• IAT at engine start	-10 to 56°C (14 to 133°F)
2. All of following conditions are met:	-
• ECT at engine start - IAT at engine start	More than 7°C (12.6°F)
• ECT at engine start	56°C (132.8°F) or less
• IAT at engine start	-10°C (14°F) or more
Accumulated time with 80 mph (128 km/h) or more of vehicle speed	Less than 20 seconds

TYPICAL MALFUNCTION THRESHOLDS

Duration that both of the following conditions 1 and 2 are met:	5 seconds or more
1. Estimated ECT	75°C (167°F) or more
2. ECT sensor output	Less than 75°C (167°F)

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).

1	**CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0128)**

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.

(d) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(e) Read the DTC.

Result

Display (DTC Output)	Proceed to
P0128	A
P0128 and other DTCs	B

HINT:
If any DTC other than P0128 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART (See page ES-63)**

A

ES

2 CHECK COOLING SYSTEM

(a) Check for defects in the cooling system that might cause the system to be too cold, such as abnormal radiator fan operation or any modifications.

NG → **REPAIR OR REPLACE COOLING SYSTEM**

OK

3 INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-13).
(b) Check the valve opening temperature of the thermostat.
Standard:
80 to 84°C (176 to 183°F)
HINT:
In addition to the above check, confirm that the valve is completely closed when the temperature is below the standard.
(c) Reinstall the thermostat (See page CO-14).

NG → **REPLACE THERMOSTAT (See page CO-13)**

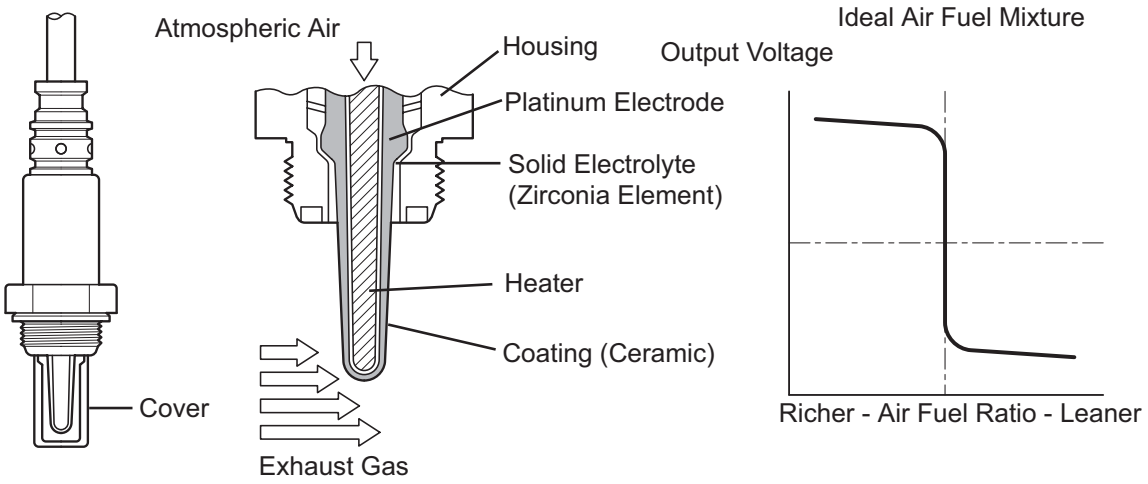
OK

REPLACE ECM (See page ES-518)

DTC	P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)
DTC	P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)
DTC	P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)
DTC	P0156	Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)
DTC	P0157	Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)
DTC	P0158	Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)

DESCRIPTION

A three-way catalytic converter (TWC) is used in order to convert the carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxide (NOx) into less harmful substances. To allow the TWC to function effectively, it is necessary to keep the air-fuel ratio of the engine near the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, the Heated Oxygen (HO2) sensor is used.
The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).
When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas becomes rich. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is lean (low voltage, i.e. less than 0.45 V). Conversely, when the air-fuel ratio is richer than the stoichiometric air-fuel level, the oxygen concentration in the exhaust gas becomes lean. The HO2 sensor informs the ECM that the post-TWC air-fuel ratio is rich (high voltage, i.e. more than 0.45 V). The HO2 sensor has the property of changing its output voltage drastically when the air-fuel ratio is close to the stoichiometric level.
The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



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DTC No.	DTC Detection Condition	Trouble Area
P0136 P0156	• Abnormal voltage output: During active air-fuel ratio control, following conditions (a) and (b) are met for a certain period of time (2 trip detection logic) (a) Heated Oxygen (HO2) sensor voltage does not decrease to less than 0.2 V (b) HO2 sensor voltage does not increase to more than 0.6 V • Low impedance: Sensor impedance is less than 5 Ω for more than 30 seconds when ECM presumes sensor to being warmed up and operating normally (2 trip detection logic)	• Open or short in HO2 sensor (bank 1, 2 sensor 2) circuit • HO2 sensor (bank 1, 2 sensor 2) • HO2 sensor heater (bank 1, 2 sensor 2) • Air-Fuel Ratio (A/F) sensor (bank 1, 2 sensor 1) • Engine room junction block (EFI relay) • Gas leakage from exhaust system
P0137 P0157	• Low voltage (open): During active air-fuel ratio control, following conditions (a) and (b) are met for a certain period of time (2 trip detection logic) (a) HO2 sensor voltage output less than 0.21 V (b) Target air-fuel ratio rich • High impedance: Sensor impedance is 15 kΩ or more for more than 90 seconds when ECM presumes sensor to being warmed up and operating normally (2 trip detection logic)	• Open in HO2 sensor (bank 1, 2 sensor 2) circuit • HO2 sensor (bank 1, 2 sensor 2) • HO2 sensor heater (bank 1, 2 sensor 2) • Engine room junction block (EFI relay) • Gas leakage from exhaust system
P0138 P0158	• High voltage (short): During active air-fuel ratio control, following conditions (a) and (b) are met for a certain period of time (2 trip detection logic) (a) HO2 sensor voltage output 0.59 V or more (b) Target air-fuel ratio lean • Extremely high voltage (short): HO2 sensor voltage output exceeds 1.2 V for more than 30 seconds (2 trip detection logic)	• Short in HO2 sensor (bank 1, 2 sensor 2) circuit • HO2 sensor (bank 1, 2 sensor 2) • ECM internal circuit malfunction

MONITOR DESCRIPTION

1. Active Air-Fuel Ratio Control

The ECM usually performs air-fuel ratio feedback control so that the Air-Fuel Ratio (A/F) sensor output indicates a near stoichiometric air-fuel level. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to detect any deterioration in the Three-Way Catalytic Converter (TWC) and Heated Oxygen (HO2) sensor malfunctions (refer to the diagram below).

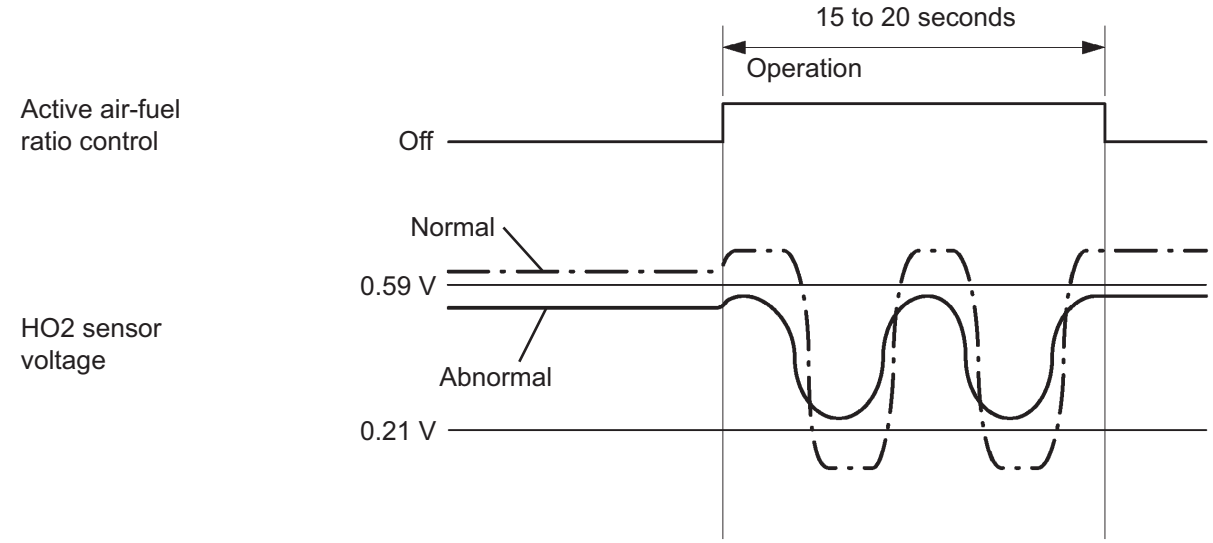
Active air-fuel ratio control is performed for approximately 15 to 20 seconds while driving with a warm engine. During active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become lean or rich by the ECM. If the ECM detects a malfunction, one of the following DTCs is set: DTC P0136 or P0156 (abnormal voltage output), P0137 or P0157 (open circuit) or P0138 or P0158 (short circuit).

2. Abnormal Voltage Output of HO2 Sensor (DTCs P0136 and P0156)

While the ECM is performing active air-fuel ratio control, the air-fuel ratio is forcibly regulated to become rich or lean. If the sensor is not functioning properly, the voltage output variation is small. For example, when the HO2 sensor voltage does not decrease to less than 0.21 V and does not increase to more than 0.59 V during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormal and sets DTCs P0136 and P0156.

ES

HO2 SENSOR CIRCUIT MALFUNCTION (P0136 and P0156: ABNORMAL VOLTAGE):



3. Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTCs P0137 and P0157 or P0138 and P0158)

During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three- Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean. If the HO2 sensor has an open or short circuit, or the voltage output of the sensor noticeably decreases, the OSC indicates an extraordinarily high value. Even if the ECM attempts to continue regulating the air-fuel ratio to become rich or lean, the HO2 sensor output does not change.

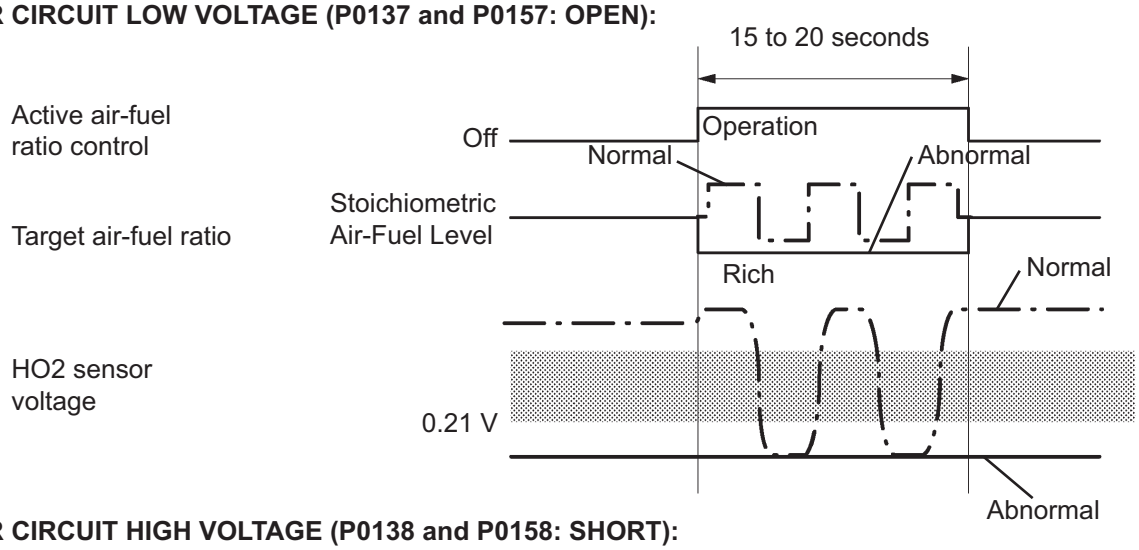
While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and sets DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output is 0.59 V or more (rich) during active air-fuel ratio control, the ECM determines that the sensor voltage output is abnormally high, and sets DTC P0138 or P0158.

HINT:

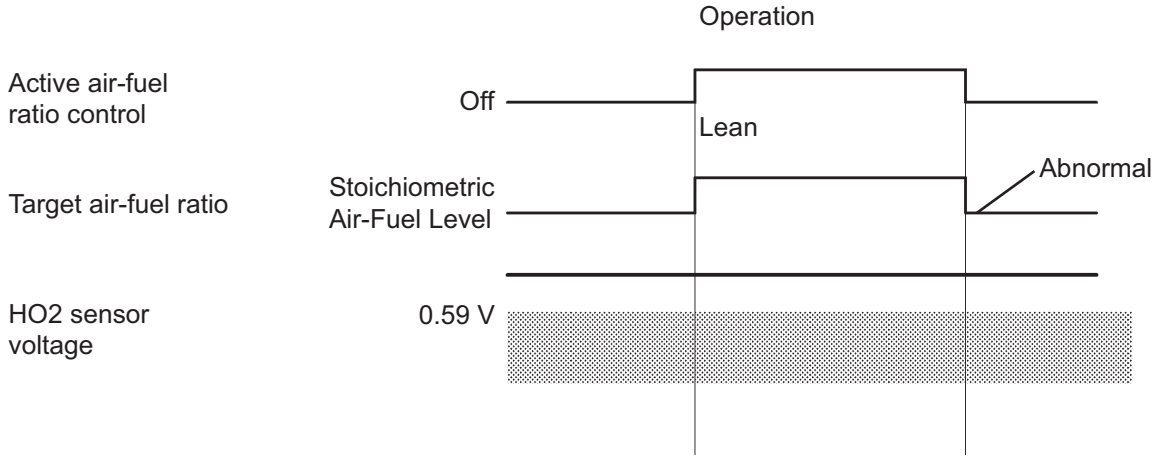
DTC P0138 or P0158 is also set if the HO2 sensor voltage output is more than 1.2 V for 30 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated, based on the calculated OSC value (See page ES-249).

HO2 SENSOR CIRCUIT LOW VOLTAGE (P0137 and P0157: OPEN):



HO2 SENSOR CIRCUIT HIGH VOLTAGE (P0138 and P0158: SHORT):



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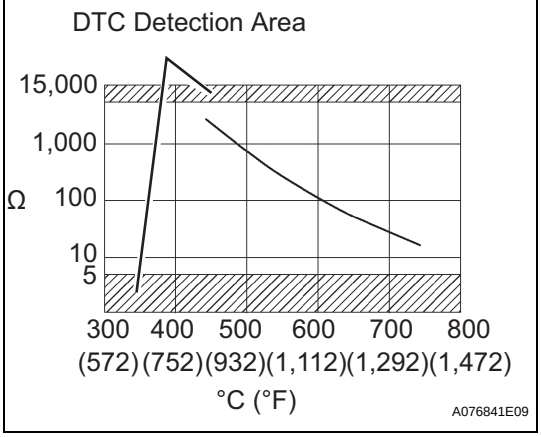
Interrelation between temperature of element and impedance:



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4. High or Low Impedance of Heated Oxygen (HO2) Sensor (DTCs P0136 and P0156 or P0137 and P0157)

During normal air-fuel ratio feedback control, there are small variations in the exhaust gas oxygen concentration. In order to continuously monitor the slight variation of the HO2 sensor signal while the engine is running, the impedance* of the sensor is measured by the ECM. The ECM determines that there is a malfunction in the sensor when the measured impedance deviates from the standard range.

*: The effective resistance in an alternating current electrical circuit.

HINT:

- The impedance cannot be measured using an ohmmeter.

- DTCs P0136 and P0156 indicate the deterioration of the HO2 sensor. The ECM sets the DTCs by calculating the impedance of the sensor when the typical enabling conditions are satisfied (1 driving cycle).
- DTCs P0137 and P0157 indicate an open or short circuit in the HO2 sensor (1 driving cycle). The ECM sets the DTCs when the impedance of the sensor exceeds the threshold of 15 kΩ.

MONITOR STRATEGY

Related DTCs	P0136: HO2S voltage (Bank 1) P0136: HO2S low impedance (Bank 1) P0137: HO2S high impedance (Bank 1) P0137: HO2S low voltage (Bank 1) P0138: HO2S high voltage (Bank 1) P0138: HO2S high voltage (Extremely high) (Bank 1) P0156: HO2S voltage (Bank 2) P0156: HO2S low impedance (Bank 2) P0157: HO2S high impedance (Bank 2) P0157: HO2S low voltage (Bank 2) P0158: HO2S high voltage (Bank 2) P0158: HO2S high voltage (Extremely high) (Bank 2)
Required Sensors/Components (Main)	HO2S
Required Sensors/Components (Sub)	Crankshaft position sensor, Engine coolant temperature sensor, Mass air flow meter, Throttle position sensor
Frequency of Operation	Once per driving cycle
Duration	20 seconds: HO2S voltage (P0136, P0156), HO2S low voltage (P0137, P0157), HO2S high voltage (P0138, P0158) 30 seconds: HO2S low impedance (P0136, P0156) 90 seconds: HO2S high impedance (P0137, P0157) 10 seconds: HO2S high voltage (P0138, P0158)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	P0031, P0032, P0051, P0052 (A/F sensor heater - Sensor 1) P0037, P0038, P0057, P0058 (O2 Sensor Heater - Sensor 2) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0308 (Misfire) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0442 - P0456 (EVAP system) P0500 (VSS) P2196, P2198 (A/F sensor - rationality) P2A00, P2A03 (A/F sensor - slow response)

HO2S voltage (P0136, P0156), HO2S low voltage (P0137, P0157), HO2S high voltage (P0138, P0158):

Active A/F control	Performing
Battery voltage	11 V or more
ECT	75 °C (167°F) or more
Idle	OFF

Engine rpm	Less than 3,200 rpm
A/F sensor status	Activated
Fuel system status	Closed loop
Fuel-cut	OFF
Engine load	10 to 70%
Shift position	4th or more

HO2S low impedance (P0136, P0156):

Battery voltage	11 V or more
Estimated rear HO2S temperature	Less than 700°C (1,292°F)
ECM monitor	Completed
P0606	Not set

HO2S high impedance (P0137, P0157):

Battery voltage	11 V or more
Estimated rear HO2S temperature	450°C (842°F) or more
P0606	Not preset

HO2S high voltage (Extremely high) (P0138, P0158):

Battery voltage	11 V or more
Time after engine start	2 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

HO2S voltage (P0136, P0156):

Either of the following conditions 1 or 2 is met:	-
1. All of the following conditions (a), (b) and (c) are met:	-
(a) Commanded air-fuel ratio	14.3 or less
(b) Rear HO2S voltage	0.21 to 0.59 V
(c) OSC (Oxygen capacity of catalyst)	2 g or more
2. All of the following conditions (d), (e) and (f) are met:	-
(d) Commanded air-fuel ratio	14.9 or more
(e) Rear HO2S voltage	0.21 to 0.59 V
(f) OSC (Oxygen capacity of catalyst)	2 g or more

HO2S low impedance (P0136, P0156):

Duration that following condition is met:	30 seconds or more
Rear HO2S impedance	Less than 5 Ω

HO2S high impedance (P0137, P0157):

Duration that following condition is met:	90 seconds or more
Rear HO2S impedance	15 kΩ or more

HO2S low voltage (P0137, P0157):

All of the following conditions 1, 2 and 3 are met:	-
1. Commanded air-fuel ratio	14.3 or less
2. Rear HO2S voltage	Less than 0.21 V
3. OSC (Oxygen capacity of catalyst)	2 g or more

HO2S high voltage (P0138, P0158):

All of the following conditions 1, 2 and 3 are met:	-
1. Commanded air-fuel ratio	14.9 or more
2. Rear HO2S voltage	More than 0.59 V
3. OSC (Oxygen capacity of catalyst)	2 g or more

HO2S high voltage (Extremely high) (P0138, P0158):

Duration that following condition is met:	10 seconds or more
Rear HO2S voltage	1.2 V or more

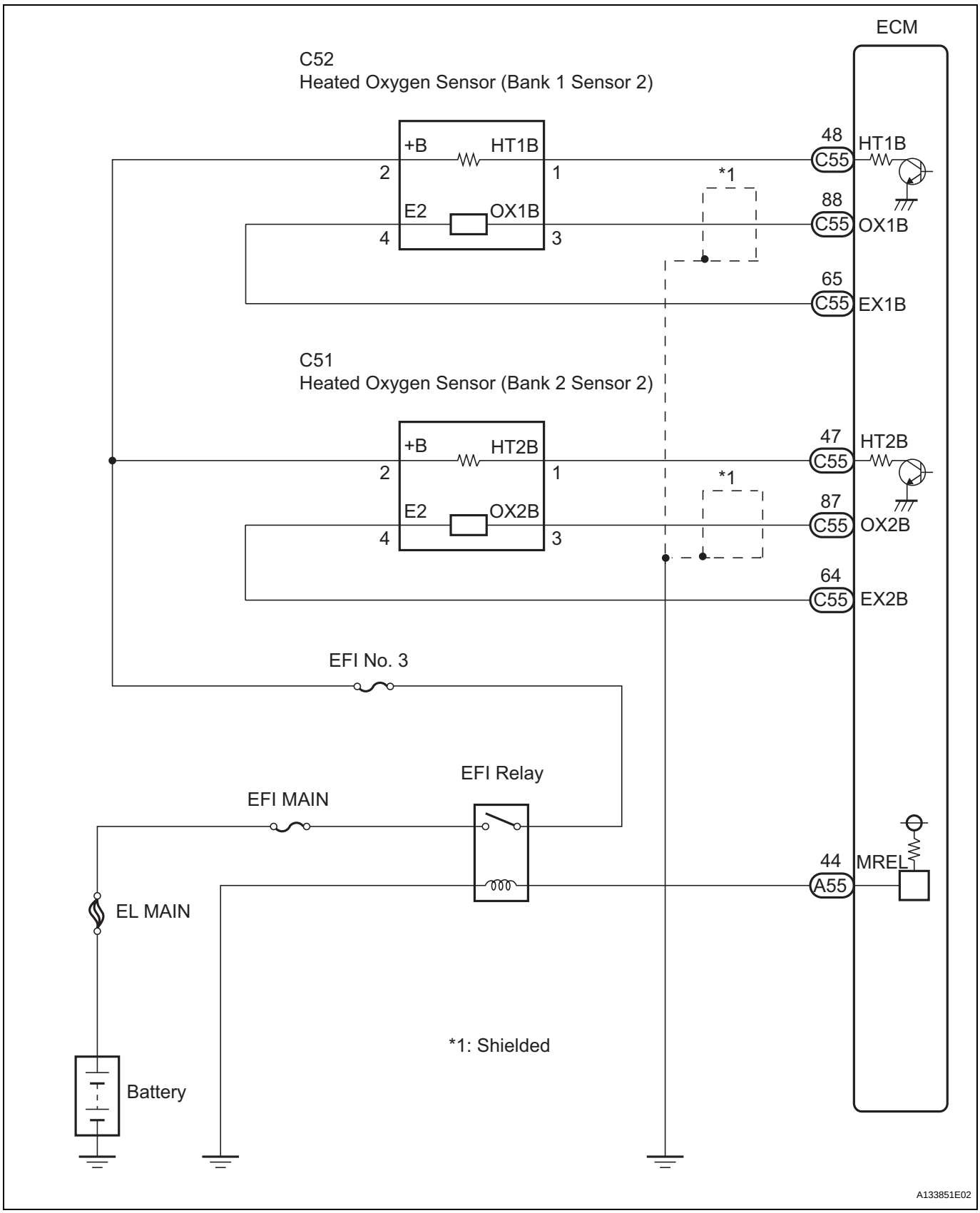
COMPONENT OPERATING RANGE

Duration that following condition is met:	30 seconds or more
Heated oxygen sensor voltage	Varies between 0.1 and 0.9 V

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-25).

WIRING DIAGRAM



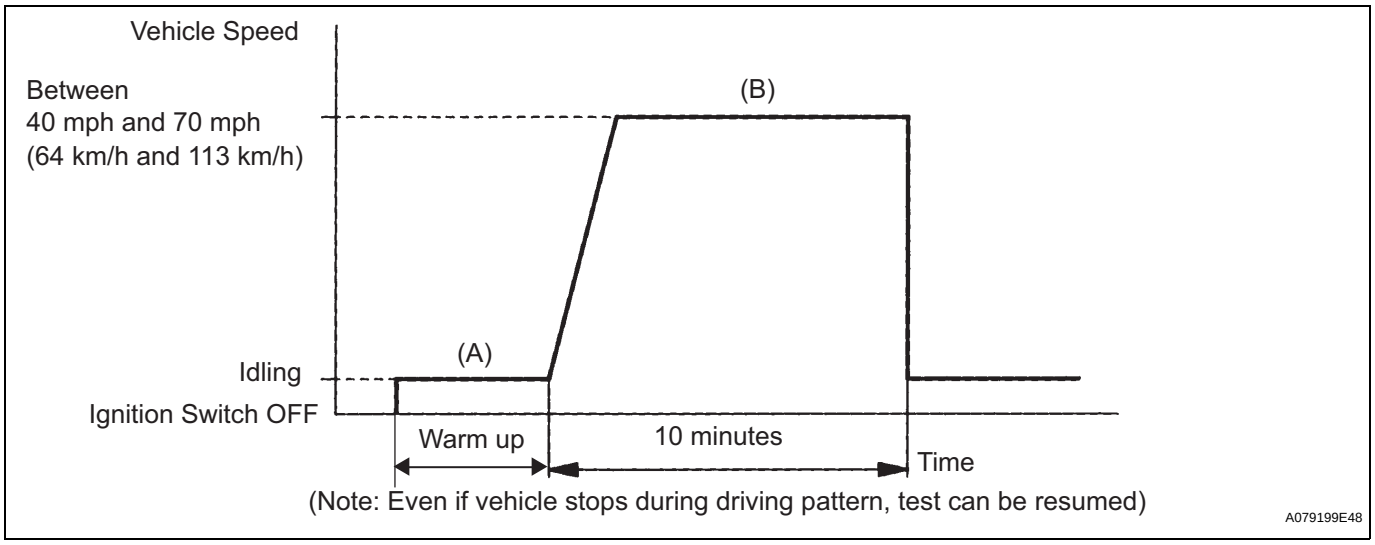
CONFIRMATION DRIVING PATTERN

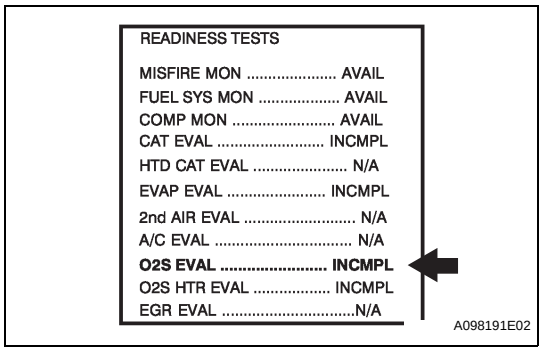
HINT:

- This confirmation driving pattern is used in steps 5, 8 and 11 of the following diagnostic troubleshooting procedure when using an intelligent tester.
- Performing this confirmation driving pattern will activate the Heated Oxygen (HO2) sensor monitor. (The catalyst monitor is performed simultaneously.) This is very useful for verifying the completion of a repair.

NOTICE:

This test will not be completed if the vehicle is driven under absolutely constant speed conditions such as with cruise control activated.





1. Connect an intelligent tester to the DLC3.
2. Turn the ignition switch on (IG).
3. Turn the tester on.
4. Clear the DTCs (where set) (See page ES-45).
5. Select the following menu items: DIAGNOSIS / CARB OBD II / READINESS TESTS.
6. Check that O2S EVAL is INCMPL (incomplete).
7. Start the engine and warm it up (Procedure "A").
8. Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes (Procedure "B").
9. Note the state of the Readiness Tests items. Those items will change to COMPL (complete) as O2S EVAL monitor operates.
10. On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES and check if any DTCs (any pending DTCs) are set.

HINT:

If O2S EVAL does not change to COMPL, and any pending DTCs fail to set, extend the driving time.

INSPECTION PROCEDURE

HINT:

Intelligent tester only:

Malfunctioning areas can be identified by performing the A/F CONTROL function provided in the ACTIVE TEST. The A/F CONTROL function can help to determine whether the Air-Fuel Ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the A/F CONTROL operation using an intelligent tester.

1. Connect the intelligent tester to the DLC3.
2. Start the engine and turn the tester on.
3. Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
4. On the tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
5. Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
6. Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2) displayed on the tester.

ES

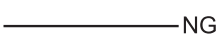
HINT:

- The A/F CONTROL operation lowers the fuel injection volume by 12.5 % or increases the injection volume by 25 %.
- Each sensor reacts in accordance with increases in the fuel injection volume.

Tester Display (Sensor)	Injection Volume	Status	Voltage
AFS B1S1 or AFS B2S1 (A/F)	+25 %	Rich	Less than 3.0 V
AFS B1S1 or AFS B2S1 (A/F)	-12.5 %	Lean	More than 3.35 V
O2S B1S2 or O2S B2S2 (HO2)	+25 %	Rich	More than 0.55 V
O2S B1S2 or O2S B2S2 (HO2)	-12.5 %	Lean	Less than 0.4 V

NOTICE:

The Air-Fuel Ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
1	Injection Volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.55 V Less than 0.4 V		
2	Injection Volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.55 V Less than 0.4 V		

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
3	Injection Volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage Almost no reaction		
4	Injection volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		• Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

ES

- Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
- To display the graph, enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2, and press the YES button and then the ENTER button followed by the F4 button.

HINT:

- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page ES-45).
- If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be set.
- If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be set.

1	READ DTC OUTPUT

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0138 or P0158	A
P0137 or P0157	B
P0136 or P0156	C

B → Go to step 14

C → Go to step 7

A

2	READ VALUE OF OXYGEN SENSOR (OUTPUT VOLTAGE)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.

(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / O2S B1S2 or O2S B2S2.
(d) Allow the engine to idle.
(e) Read the Heated Oxygen (HO2) sensor output voltage while idling.

Result

HO2 Sensor Output Voltage	Proceed to
More than 1.2 V	A
Less than 1.0 V	B

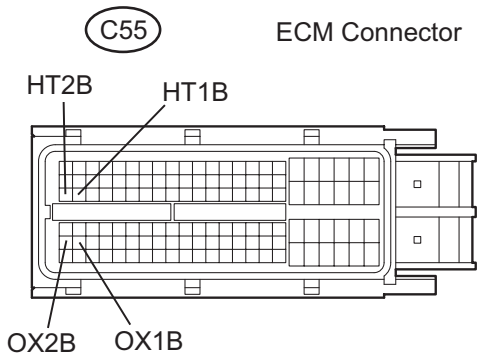
B → **Go to step 5**

A

ES

3 CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT)

Wire Harness Side Front View:



(a) Turn the engine switch off and wait for 5 minutes.
(b) Disconnect the C55 ECM connector.
(c) Measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Specified Condition
HT1B (C55-48) - OX1B (C55-88)	10 kΩ or higher
HT2B (C55-47) - OX2B (C55-87)	10 kΩ or higher

(d) Reconnect the ECM connector.

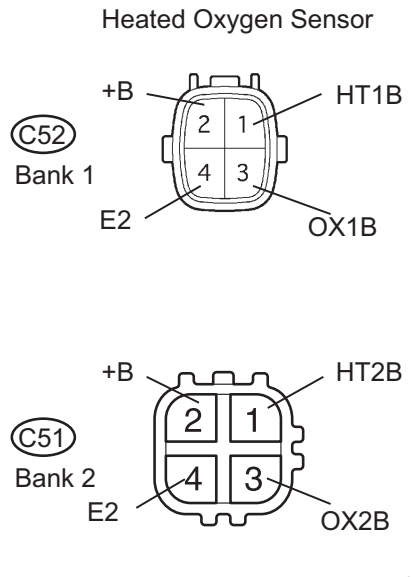
NG → **Go to step 4**

OK

REPLACE ECM (See page ES-518)

4	INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)

Component Side:



(a) Disconnect the C52 oxygen sensor connector (Bank 1 Sensor 2) or C51 oxygen sensor connector (Bank 2 sensor 2).

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

Standard resistance (Bank 1 sensor 2)

Tester Connection	Specified Condition
+B (2) - E2 (4)	10 kΩ or higher
+B (2) - OX1B (3)	10 kΩ or higher

Standard resistance (Bank 2 sensor 2)

Tester Connection	Specified Condition
+B (2) - E2 (4)	10 kΩ or higher
+B (2) - OX2B (3)	10 kΩ or higher

ES

NG → **REPLACE HEATED OXYGEN SENSOR (See page EC-20)**

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR

5	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

6	CHECK WHETHER DTC OUTPUT RECURS (DTC P0138 or P0158)

(a) On the intelligent tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

(b) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0138 or P0158	A
No output	B

B → **CHECK FOR INTERMITTENT PROBLEMS**

A

REPLACE HEATED OXYGEN SENSOR (See page EC-20)

7	READ VALUE OF OXYGEN SENSOR (OUTPUT VOLTAGE)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Start the engine.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / O2S B1S2 or O2S B1S2.
(e) After warming up the engine, run the engine at an engine speed of 2,500 rpm for 3 minutes.
(f) Read the output voltage of the HO2 sensor when the engine rpm is suddenly increased.
HINT:
Quickly accelerate the engine to 4,000 rpm 3 times using the accelerator pedal.
Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or more.

NG → **Go to step 14**

OK

8	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

9	CHECK WHETHER DTC OUTPUT RECURS (DTC P0136 or P0156)

(a) On the intelligent tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(b) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0136 or P0156	A
No output	B

B → **CHECK FOR INTERMITTENT PROBLEMS**

A

10	REPLACE HEATED OXYGEN SENSOR

(a) Replace the hated oxygen sensor (See page EC-20).

NEXT

11	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

12	CHECK WHETHER DTC OUTPUT RECURS (DTC P0136 or P0156)

(a) On the intelligent tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(b) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0136 or P0156	A
No output	B

B → END

A

13	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (INJECTION VOLUME)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II /ACTIVE TEST / INJ VOL.
(e) Change the fuel injection volume using the tester, while monitoring the output voltage of Air-Fuel Ratio (A/F) and HO2 sensor displayed on the tester.

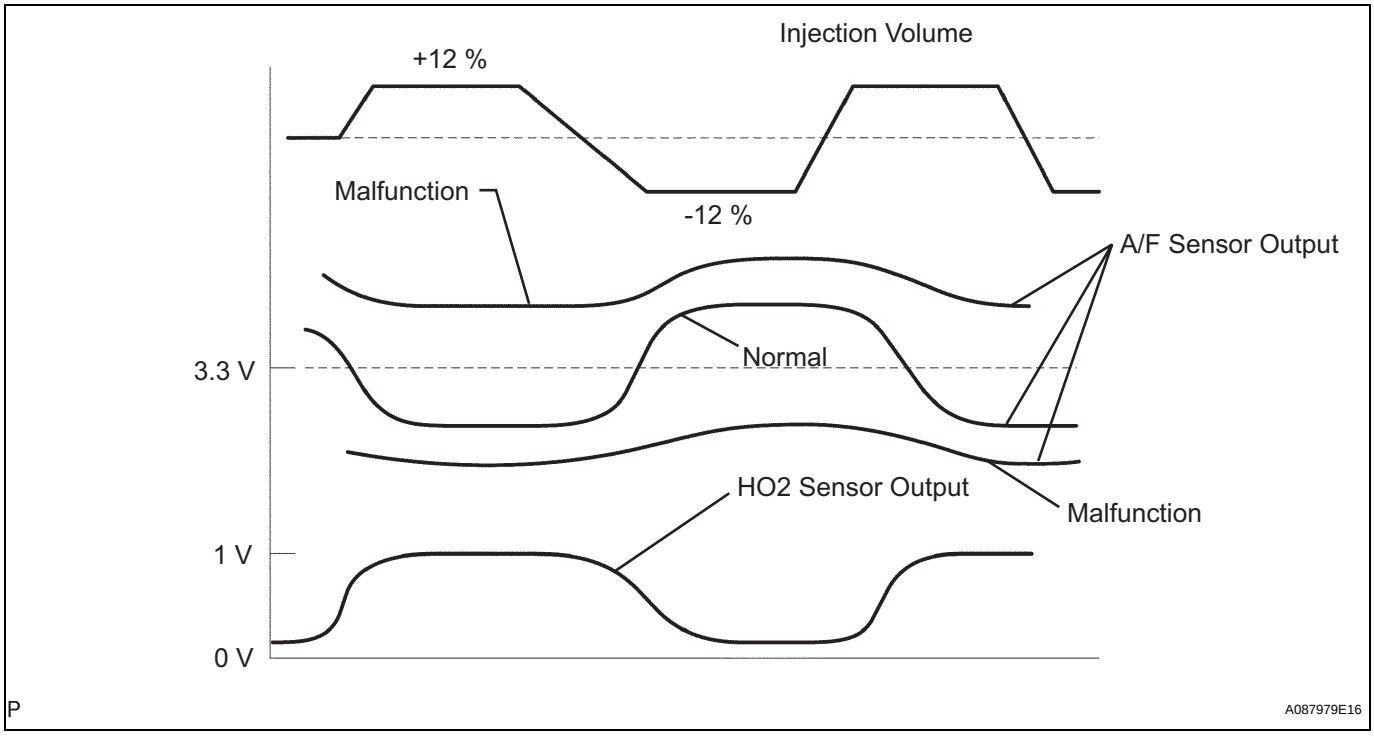
HINT:

- Change the fuel injection volume within the range of -12 % and +12 %. The injection volume can be changed in 1 % graduations within the range.
- The A/F sensor is displayed as AFS B1S1 or AFS B2S1, and the HO2 sensor is displayed as O2S B1S2 or O2S B2S2, on the intelligent tester.

Result

Tester Display (Sensor)	Voltage Variation	Proceed to
AFS B1S1 (A/F) AFS B2S1 (A/F)	Alternates between more and less than 3.3 V	OK
AFS B1S1 (A/F) AFS B2S1 (A/F)	Remains more than 3.3 V	NG
AFS B1S1 (A/F) AFS B2S1 (A/F)	Remains less than 3.3 V	NG

HINT:
A normal HO2 sensor voltage (O2S B1S2 or O2S B2S2) reacts in accordance with increases and decreases in fuel injection volumes. When the A/F sensor voltage remains either less or more than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



NG → **REPLACE AIR FUEL RATIO SENSOR (See page EC-19)**

OK →

CHECK AND REPAIR EXTREMELY RICH OR LEAN ACTUAL AIR FUEL RATIO (INJECTOR, FUEL PRESSURE, GAS LEAKAGE FROM EXHAUST SYSTEM)

14	CHECK FOR EXHAUST GAS LEAKS

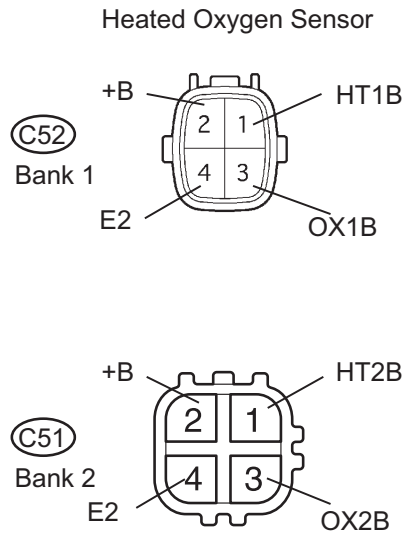
OK:
No gas leakage.

NG → **REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT**

OK →

15	INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

Component Side:



A137614E04

(a) Disconnect the C52 oxygen sensor connector (Bank 1 Sensor 2) or C51 oxygen sensor connector (Bank 2 sensor 2).

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

Standard resistance (Bank 1 sensor 2)

Tester Connection	Condition	Specified Condition
HT1B (1) - +B (2)	20°C (68°F)	11 to 16 Ω
HT1B (1) - E2 (4)	Always	10 kΩ or higher

Standard resistance (Bank 2 sensor 2)

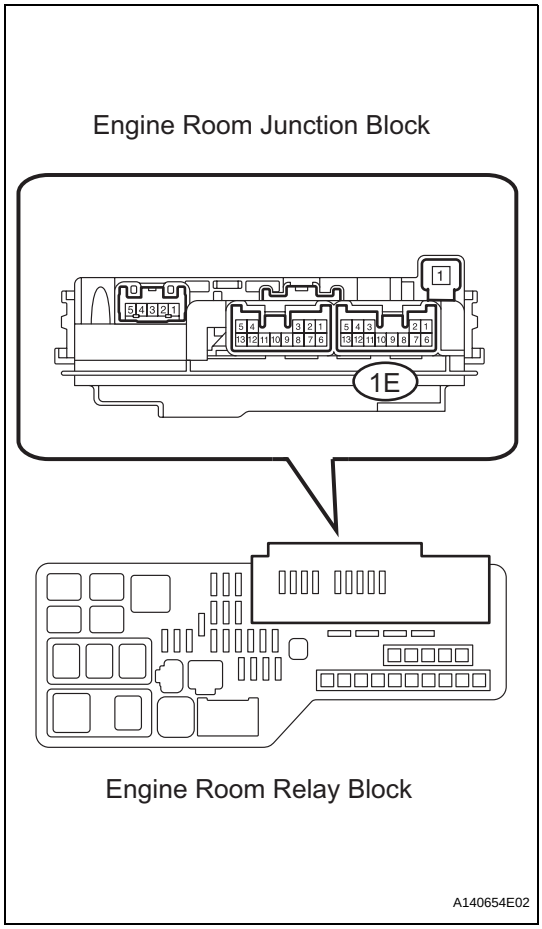
Tester Connection	Condition	Specified Condition
HT2B (1) - +B (2)	20°C (68°F)	11 to 16 Ω
HT2B (1) - E2 (4)	Always	10 kΩ or higher

ES

NG → **REPLACE HEATED OXYGEN SENSOR (See page EC-20)**

OK

16	INSPECT ENGINE ROOM JUNCTION BLOCK (EFI MAIN RELAY)



(a) Remove the engine room junction block from the engine room R/B.
(b) Measure the resistance according to the value(s) in the table below.

Standard resistance

Terminal Connection	Specified Condition
1E-12 - 1E-6	10 kΩ or higher
1E-12 - 1E-6	Below 1 Ω (when battery voltage applied to terminals 1E-9 and 1E-10)

(c) Reinstall the engine room junction block.

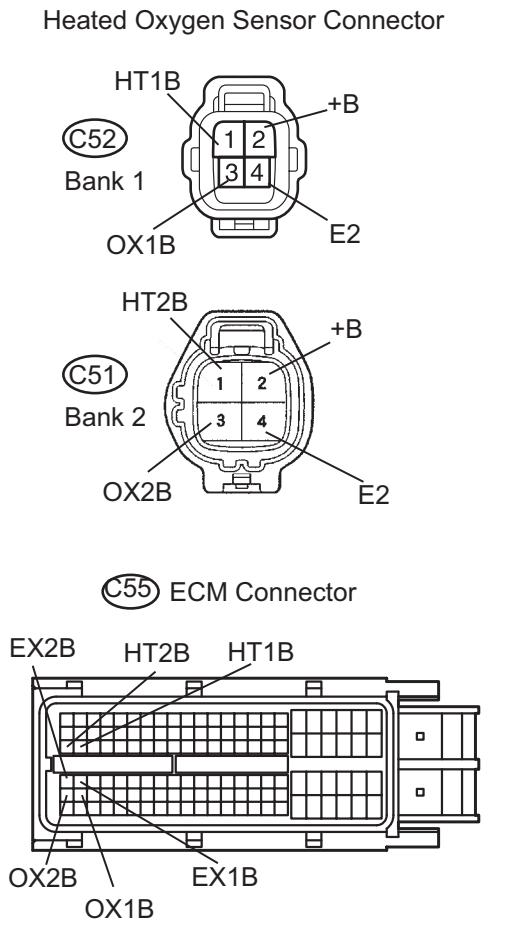
NG → **REPLACE ENGINE ROOM JUNCTION BLOCK**

OK

ES

17	CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

Wire Harness Side:



(a) Disconnect the C52 oxygen sensor connector (Bank 1 Sensor 2) or C51 oxygen sensor connector (Bank 2 sensor 2).
(b) Turn the ignition switch on (IG).
(c) Measure the voltage according to the value(s) in the table below.

Standard voltage

Terminal Connection	Specified Condition
+B (C52-2) - Body ground	9 to 14 V
+B (C51-2) - Body ground	9 to 14 V

(d) Turn the engine switch off.
(e) Disconnect the C55 ECM connector.
(f) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Terminal Connection	Specified Condition
HT1B (C52-1) - HT1B (C55-48)	Below 1 Ω
OX1B (C52-3) - OX1B (C55-88)	Below 1 Ω
E2 (C52-4) - EX1B (C55-65)	Below 1 Ω
HT2B (C51-1) - HT2B (C55-47)	Below 1 Ω
OX2B (C51-3) - OX2B (C55-87)	Below 1 Ω
E2 (C51-4) - EX2B (C55-64)	Below 1 Ω

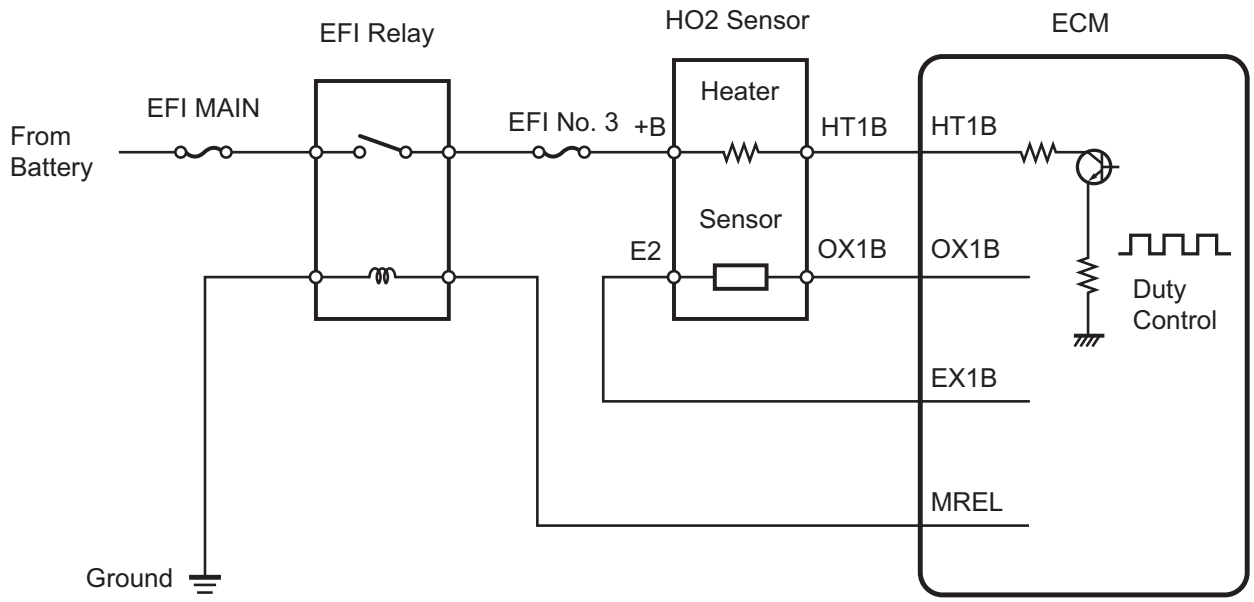
Standard resistance (Check for short)

Terminal Connection	Specified Condition
HT1B (C52-1) or HT1B (C55-48) - Body ground	10 kΩ or higher
OX1B (C52-3) or OX1B (C55-88) - Body ground	10 kΩ or higher
E2 (C52-4) or EX1B (C55-65) - Body ground	10 kΩ or higher
HT2B (C51-1) or HT2B (C55-47) - Body ground	10 kΩ or higher
OX2B (C51-3) or OX2B (C55-87) - Body ground	10 kΩ or higher
E2 (C51-4) or EX2B (C55-64) - Body ground	10 kΩ or higher

(g) Reconnect the HO2 sensor connector.
(h) Reconnect the ECM connector.

ES

Reference (System Diagram of Bank 1 Sensor 2):



ES

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE HEATED OXYGEN SENSOR (See page EC-20)

DTC	P0171	System Too Lean (Bank 1)

DTC	P0172	System Too Rich (Bank 1)

DTC	P0174	System Too Lean (Bank 2)

DTC	P0175	System Too Rich (Bank 2)

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and long-term fuel trims.

The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the Air-Fuel Ratio (A/F) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.

Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

If both the short-term and long-term fuel trims are lean or rich beyond predetermined values, it is interpreted as a malfunction, and the ECM illuminates the MIL and sets a DTC.

ES

DTC No.	DTC Detection Conditions	Trouble Areas
P0171 P0174	With warm engine and stable air-fuel ratio feedback, fuel trim considerably in error to lean side (2 trip detection logic)	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (bank 1, 2 sensor 1) circuit • A/F sensor (bank 1, 2 sensor 1) • A/F sensor heater (bank 1, 2 sensor 1) • A/F sensor heater relay • A/F sensor heater and A/F sensor heater relay circuits • PCV valve and hose • PCV hose connections • ECM
P0172 P0175	With warm engine and stable air-fuel ratio feedback, fuel trim considerably in error to rich side (2 trip detection logic)	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in A/F sensor (bank 1, 2 sensor 1) circuit • A/F sensor (bank 1, 2 sensor 1) • A/F sensor heater (bank 1, 2 sensor 1) • A/F sensor heater relay • A/F sensor heater and A/F sensor heater relay circuits • ECM

HINT:

- When DTC P0171 or P0174 is set, the actual air-fuel ratio is on the lean side. When DTC P0172 or P0175 is set, the actual air-fuel ratio is on the rich side.
- If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 or P0174 may be set. The MIL is then illuminated.

- When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is more than 75°C [167°F]), the system is functioning normally.

MONITOR DESCRIPTION

Under closed-loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM's estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction thresholds, the ECM interprets this as a fault in the fuel system and sets a DTC.

Example:

The average fuel trim learning value is more than +35% or less than -35%, the ECM interprets this as a fuel system malfunction.

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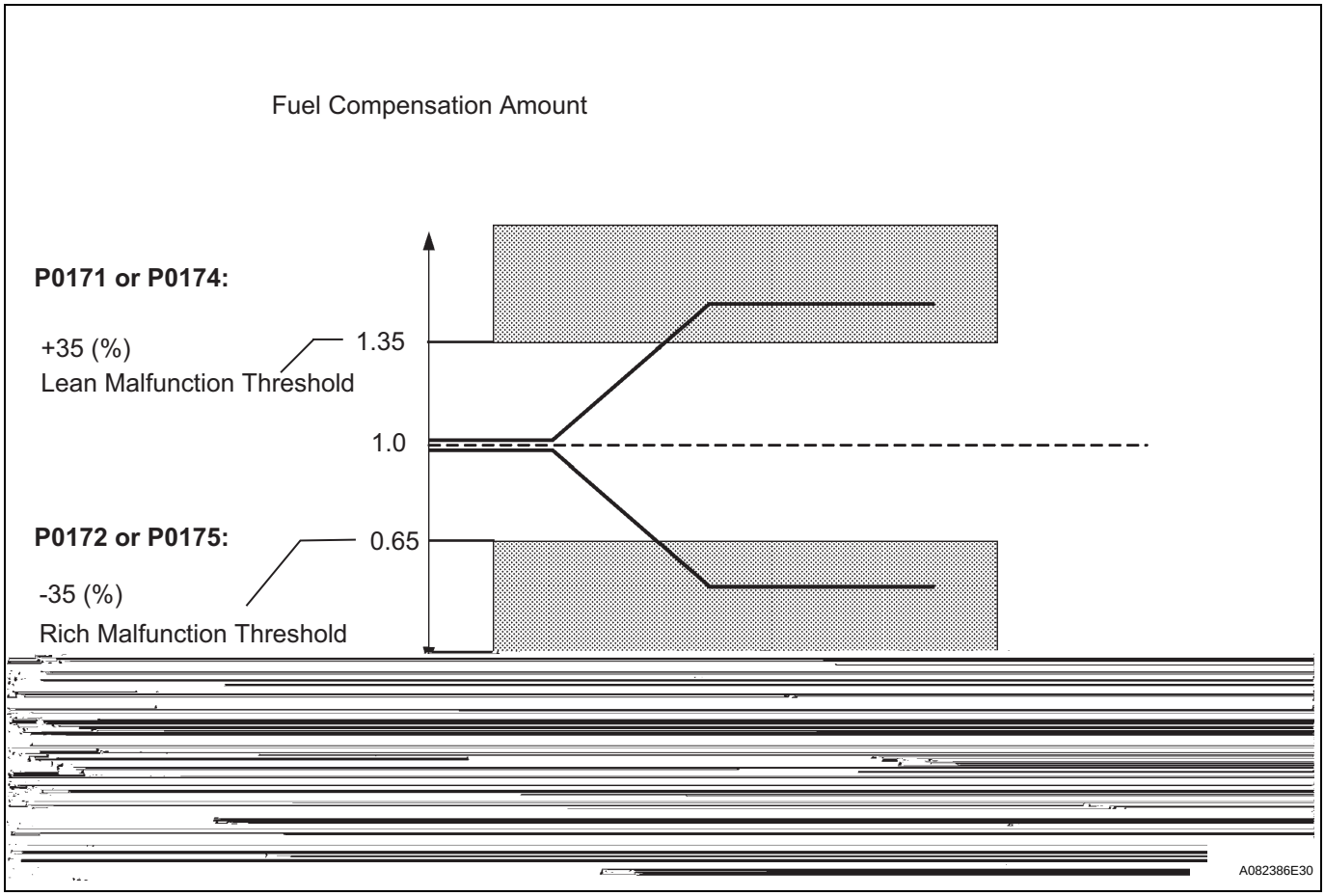


MONITOR STRATEGY

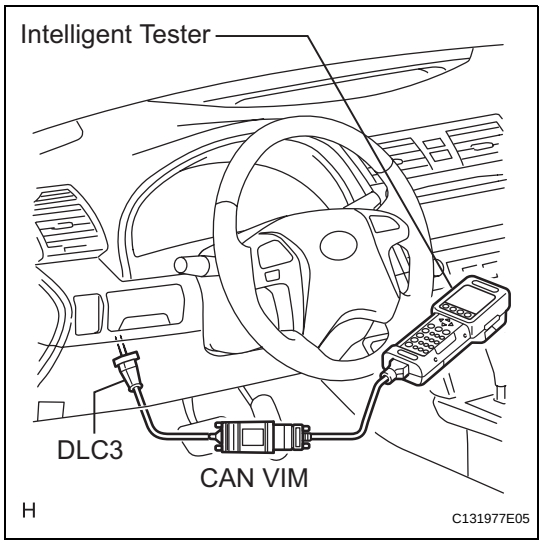
Related DTCs	P0171: Fuel trim Lean (Bank 1) P0172: Fuel trim Rich (Bank 1) P0174: Fuel trim Lean (Bank 2) P0175: Fuel trim Rich (Bank 2)
Required Sensors / Components (Main)	Fuel system
Required Sensors / Components (Related)	A/F sensor, Mass air flow meter, Crankshaft position sensor
Frequency of Operation	Continuous
Duration	Less than 10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

ON-VEHICLE INSPECTION

1. CHECK MASS AIR FLOW METER

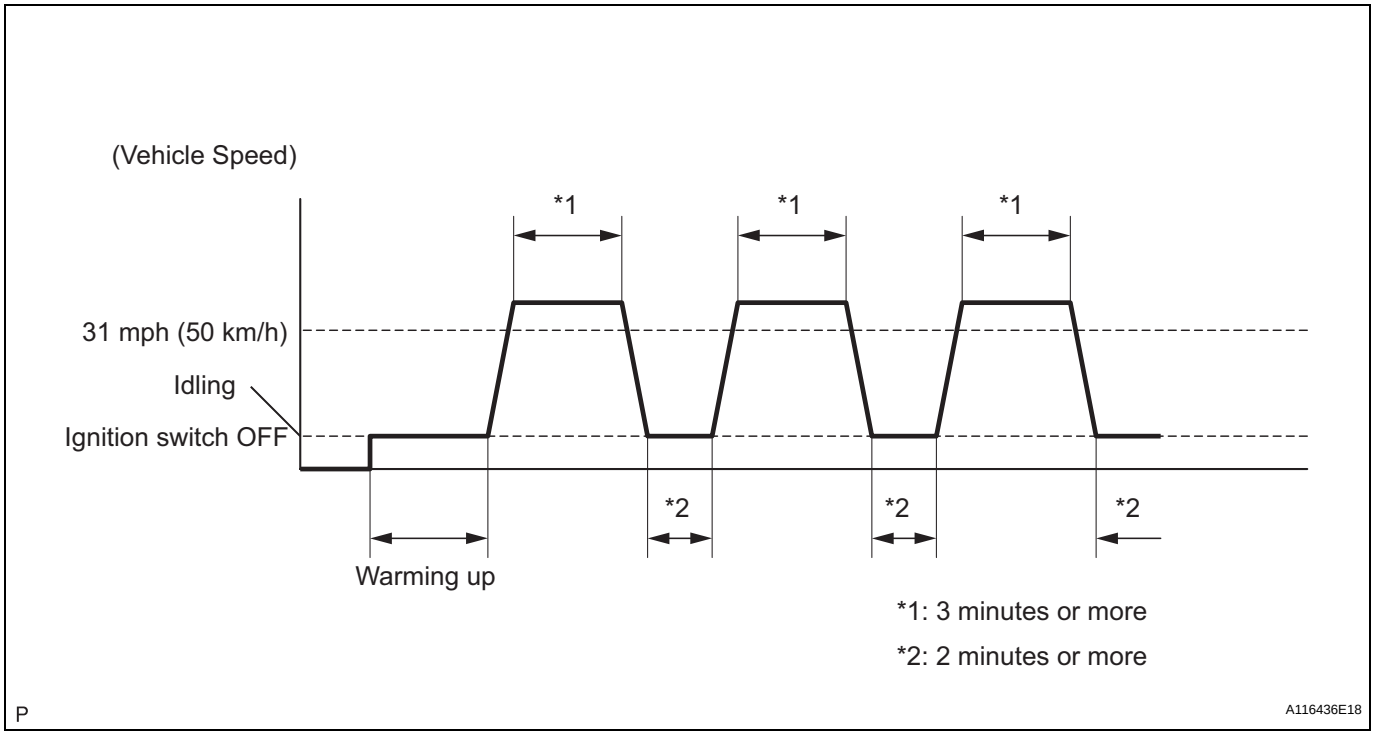
NOTICE:

- **Perform the MAF meter inspection by following the procedures below.**
- **Only replace the MAF meter when both the LONG FT#1 value and MAF value in the DATA LIST (with the engine stopped) are not within the normal operating range.**



(a) Perform confirmation driving pattern.

(1) Connect the intelligent tester to the DLC3.
(2) Turn the ignition switch on (IG).
(3) Turn the tester on.
(4) Clear the DTCs (See page ES-45).
(5) Start the engine and warm it up with all accessory switches off (until the engine coolant temperature is 75 °C(167°F) or more).
(6) Drive the vehicle at 31 mph (50 km/h) or more for 3 minutes or more (*1).
(7) Allow the engine to idle (accelerator pedal fulley released) for 2 minutes or more (*2).
(8) Perform steps (*1) and (*2) at least 3 times or more.



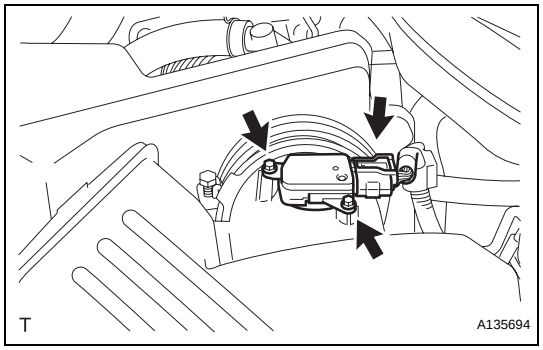
(b) Read values using the intelligent tester (LONG FT#1).

(1) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / LONG FT#1.

(2) Read the values displayed on the tester.
Standard value:
Within -15 to +15 %
If the result is not within the specified range, perform the inspection below.

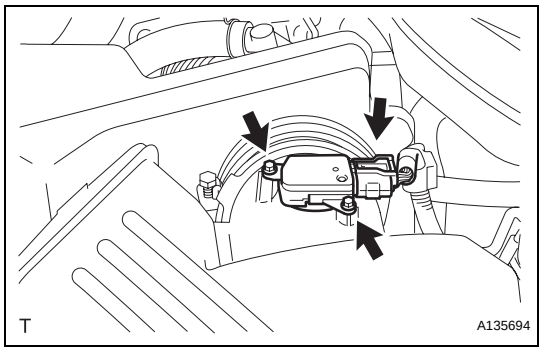
(c) Read values using the intelligent tester (MAF).
NOTICE:
- **Turn off the engine.**
- **Perform the inspection with the vehicle indoors and on a level surface.**
- **Perform the inspection of the MAF meter while it is installed to the air cleaner case (installed to the vehicle).**
- **During the test, do not use the exhaust air duct to perform suction on the exhaust pipe.**

(1) Turn off the engine (do not run the engine).
(2) Turn the ignition switch on (IG).
(3) Turn the tester on.
(4) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / PRIMARY / MAF.
(5) Wait 30 seconds, and read the values on the intelligent tester.
Standard condition:
Less than 0.56 g/sec
- If the result is not as specified, replace the MAF meter.
- If the result is within the specified range, inspect the cause of the extremely rich or lean air fuel ratio (See page EC-19).



REMOVAL

1. REMOVE MASS AIR FLOW METER
(a) Disconnect the mass air flow meter connector.
(b) Remove the 2 screws and mass air flow meter.

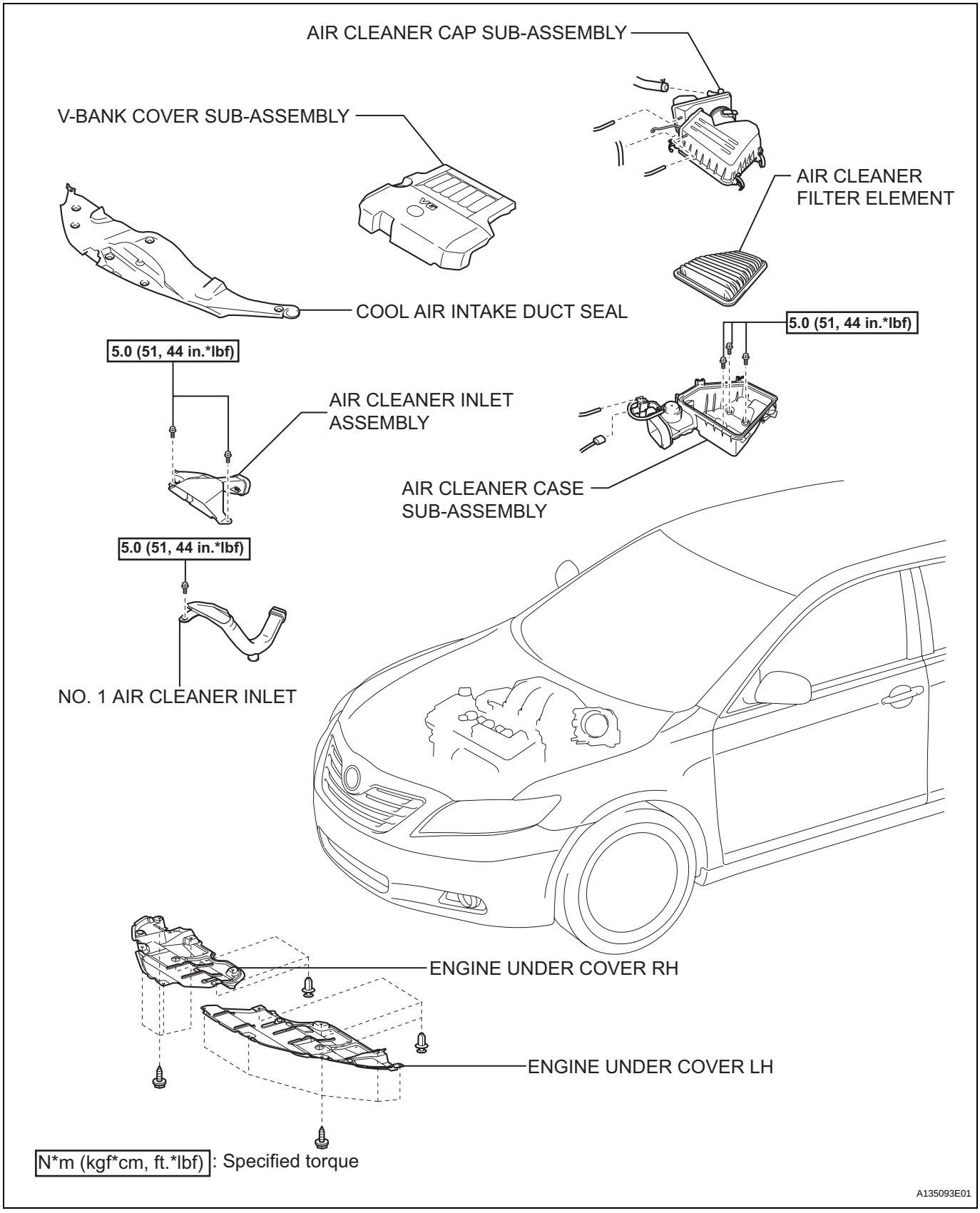


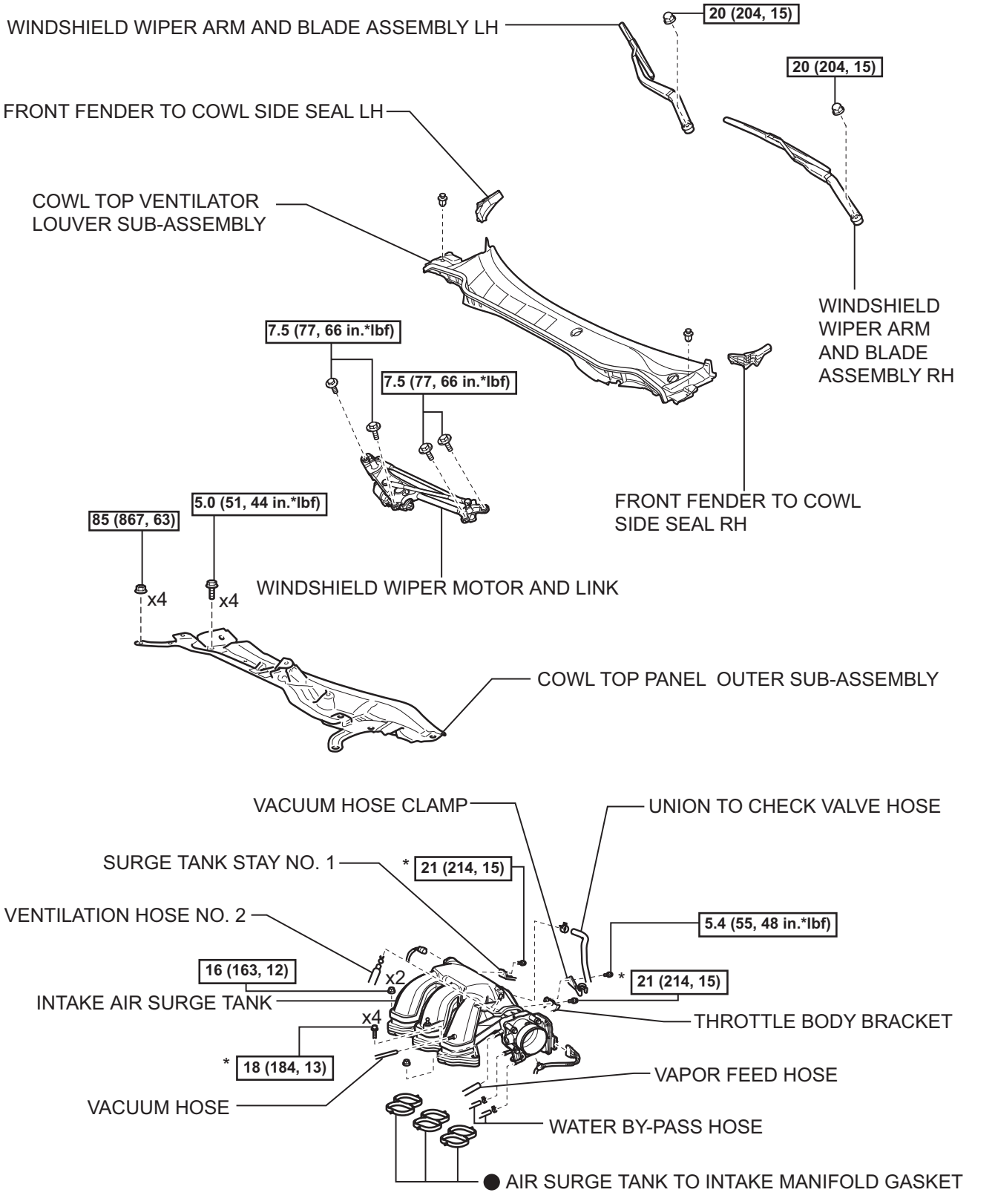
INSTALLATION

1. INSTALL MASS AIR FLOW METER
(a) Install the mass air flow meter with the 2 screws.
(b) Connect the mass air flow meter connector.

CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

COMPONENTS





N*m (kgf*cm, ft.*lbf) : Specified torque ● Non-reusable part * DO NOT apply oil

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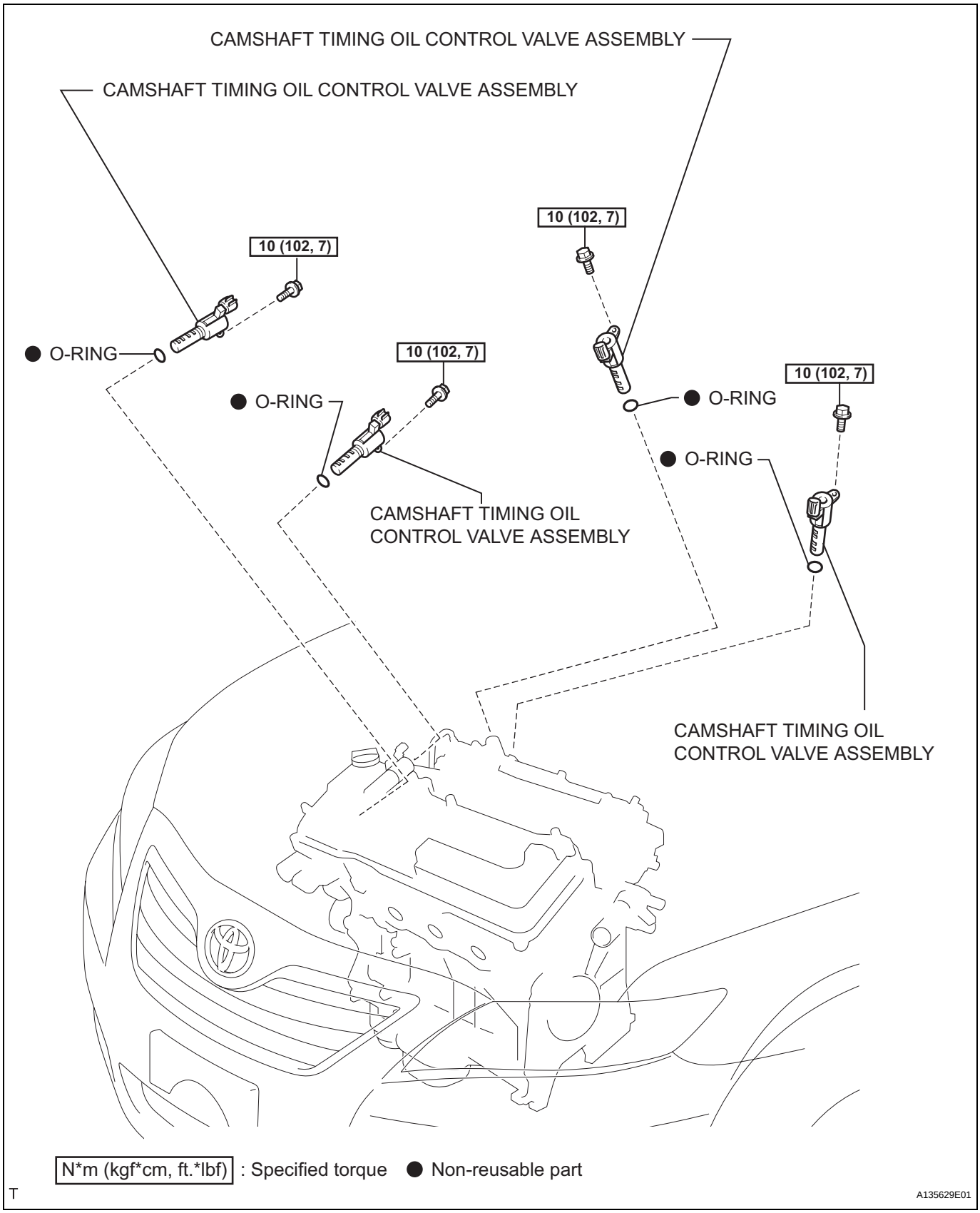
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
10 (102, 7)
10 (102, 7)
O-RING
10 (102, 7)
O-RING
10 (102, 7)
O-RING
O-RING
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
A135629E01

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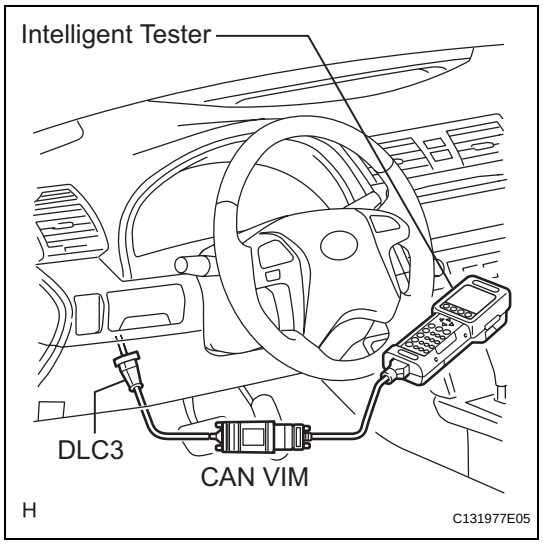


ON-VEHICLE INSPECTION

1. INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

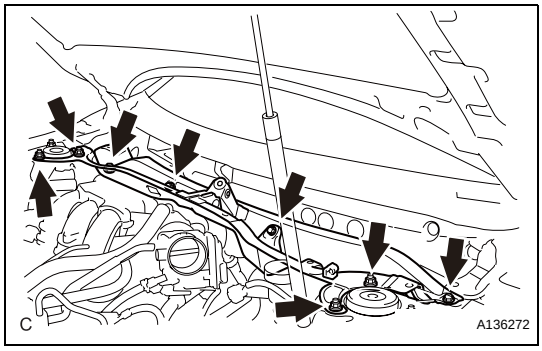
(a) Connect the intelligent tester (with CAN VIM) to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Start and warm up the engine.
(d) Connect the intelligent tester and select VVT from the ACTIVE TEST menu.
(e) Check the engine speed when the OCV is operated with the intelligent tester.
OK

Condition	Specified Condition
VVT system is OFF (OCV is OFF)	Normal engine speed
VVT system is ON (OCV is ON)	Rough idle or engine stalled

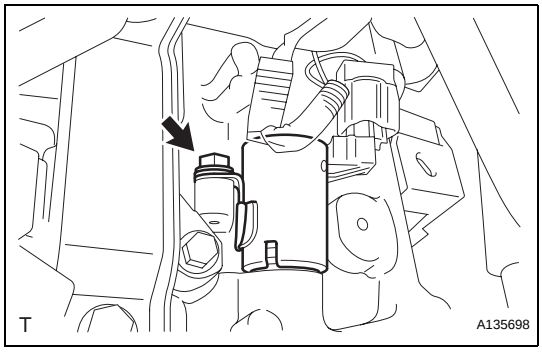
ES

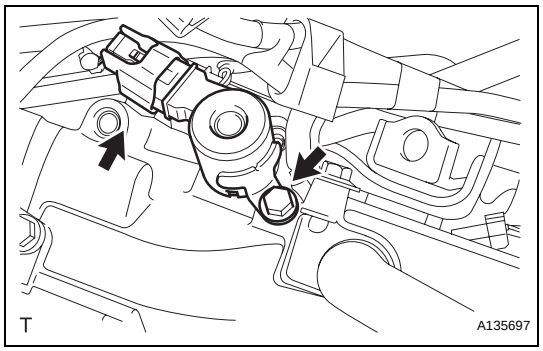
REMOVAL

1. **REMOVE ENGINE UNDER COVER LH**
2. **REMOVE ENGINE UNDER COVER RH**
3. **DRAIN ENGINE COOLANT (See page CO-5)**
4. **REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-9)**
5. **REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-9)**
6. **REMOVE FRONT FENDER TO COWL SIDE SEAL LH (See page WW-9)**
7. **REMOVE FRONT FENDER TO COWL SIDE SEAL RH (See page WW-9)**
8. **REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-10)**
9. **REMOVE WINDSHIELD WIPER MOTOR AND LINK (See page WW-10)**
10. **REMOVE COWL TOP PANEL OUTER SUB-ASSEMBLY**
    (a) Remove the 4 bolts, 4 nuts and cowl top panel outer sub-assembly.



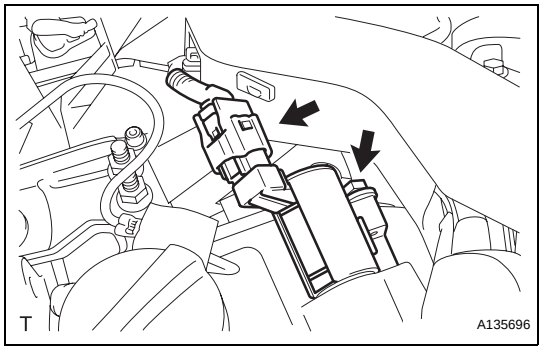
11. **REMOVE COOL AIR INTAKE DUCT SEAL (See page EM-23)**
12. **REMOVE V-BANK COVER SUB-ASSEMBLY (See page EM-23)**
13. **REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-24)**
14. **REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-503)**
15. **REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-24)**
16. **REMOVE NO. 1 AIR CLEANER INLET (See page EM-24)**
17. **REMOVE INTAKE AIR SURGE TANK (See page FU-13)**
18. **REMOVE CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 1 Exhaust Side)**
    (a) Disconnect the camshaft timing oil control valve connector.
    (b) Remove the bolt and camshaft timing oil control valve.
    (c) Remove the O-ring from the camshaft timing oil control valve.





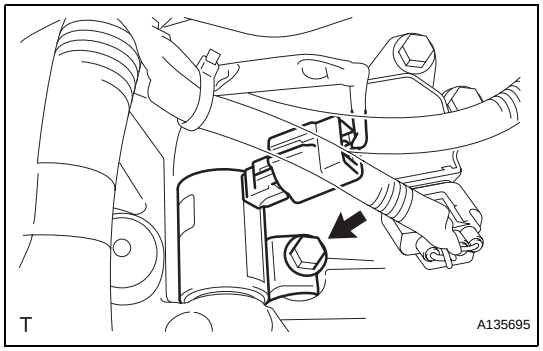
19. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 1 Intake Side)

(a) Disconnect the camshaft timing oil control valve connector.
(b) Remove the bolt and camshaft timing oil control valve.
(c) Remove the O-ring from the camshaft timing oil control valve.



20. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 2 Exhaust Side)

(a) Disconnect the camshaft timing oil control valve connector.
(b) Remove the bolt and camshaft timing oil control valve.
(c) Remove the O-ring from the camshaft timing oil control valve.



21. REMOVE CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 2 Intake Side)

(a) Disconnect the camshaft timing oil control valve connector.
(b) Remove the bolt and camshaft timing oil control valve.
(c) Remove the O-ring from the camshaft timing oil control valve.

INSPECTION

1. INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

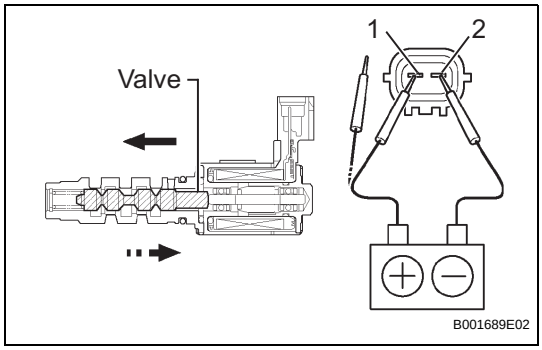
(a) Resistance inspection.

(1) Using an ohmmeter, measure the resistance between the terminals.

Standard resistance:

6.9 to 7.9 Ω at 20°C (68°F)

If necessary, replace the camshaft timing oil control valve assembly.



(b) Movement inspection.

(1) Connect the positive (+) lead from the battery to terminal 1 and the negative (-) lead to terminal 2, and check the movement of the valve.

NOTICE:

Confirm that the valve moves freely and does not stick in any position.

If necessary, replace the camshaft timing oil control valve assembly.

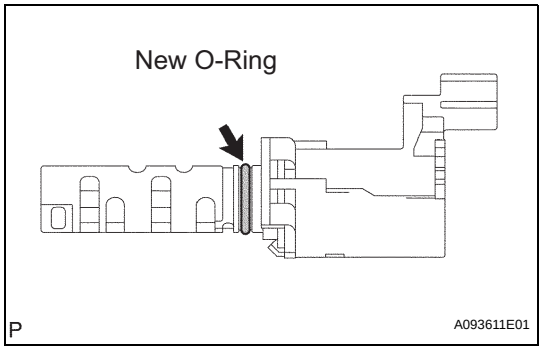
HINT:

Accumulation of foreign objects causes subtle pressure leaks. The subtle pressure leaks will cause the camshaft to advance, and this will cause a DTC to be set.

INSTALLATION

1. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 2 Intake Side)

(a) Apply a light coat of engine oil to a new O-ring and install it to the camshaft timing oil control valve.

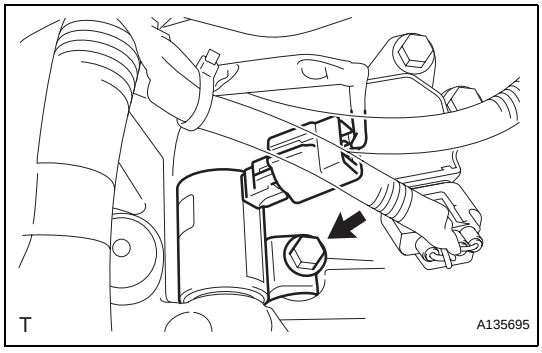


(b) Install the camshaft timing oil control valve with the bolt.

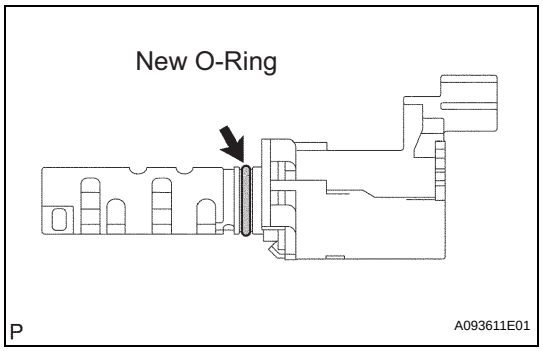
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)

NOTICE:

Make sure that the O-ring is not cracked or jammed when installing the oil control valve.

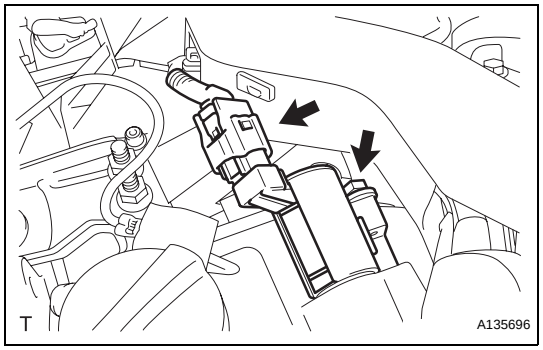


(c) Connect the camshaft timing oil control valve connector.



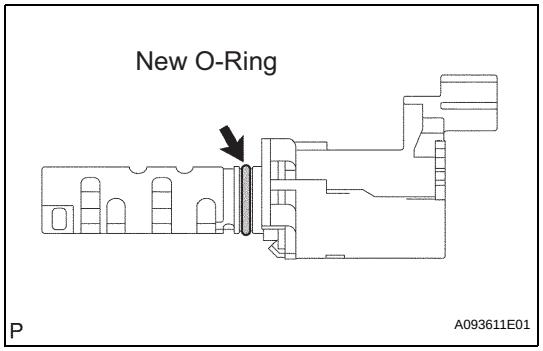
2. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 2 Exhaust Side)

(a) Apply a light coat of engine oil to a new O-ring and install it to the camshaft timing oil control valve.



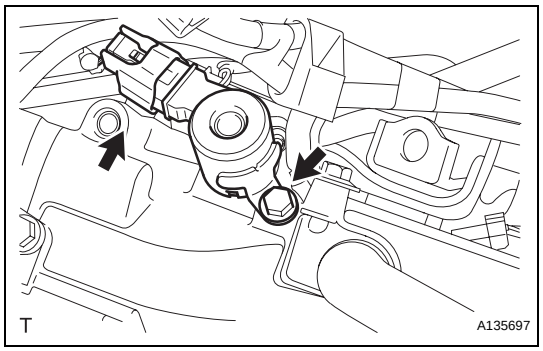
(b) Install the camshaft timing oil control valve with the bolt.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
NOTICE:
Make sure that the O-ring is not cracked or jammed when installing the oil control valve.

(c) Connect the camshaft timing oil control valve connector.



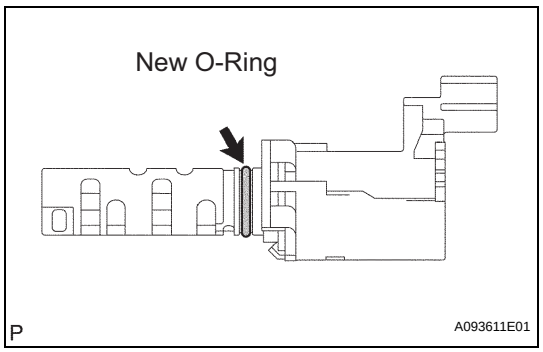
3. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 1 Intake Side)

(a) Apply a light coat of engine oil to a new O-ring and install it to the camshaft timing oil control valve.



(b) Install the camshaft timing oil control valve with the bolt.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
NOTICE:
Make sure that the O-ring is not cracked or jammed when installing the oil control valve.

(c) Connect the camshaft timing oil control valve connector.



4. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE (for Bank 1 Exhaust Side)

(a) Apply a light coat of engine oil to a new O-ring and install it to the camshaft timing oil control valve.

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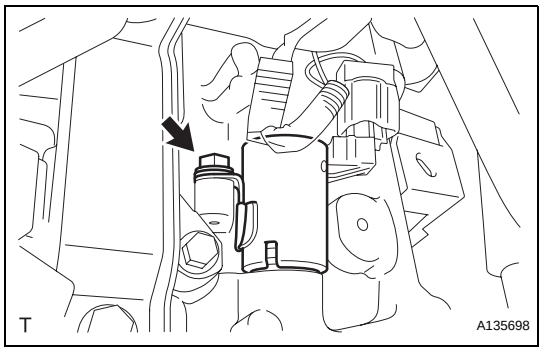
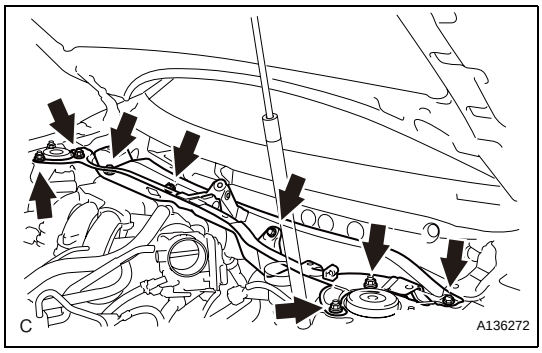


(b) Install the camshaft timing oil control valve with the bolt.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
NOTICE:
Make sure that the O-ring is not cracked or jammed when installing the oil control valve.
(c) Connect the camshaft timing oil control valve connector.

5. **INSTALL INTAKE AIR SURGE TANK (See page FU-18)**
6. **INSTALL NO. 1 AIR CLEANER INLET (See page EM-49)**
7. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-50)**
8. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-506)**
9. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-50)**
10. **INSTALL V-BANK COVER SUB-ASSEMBLY (See page EM-52)**
11. **INSTALL COOL AIR INTAKE DUCT SEAL (See page EM-52)**



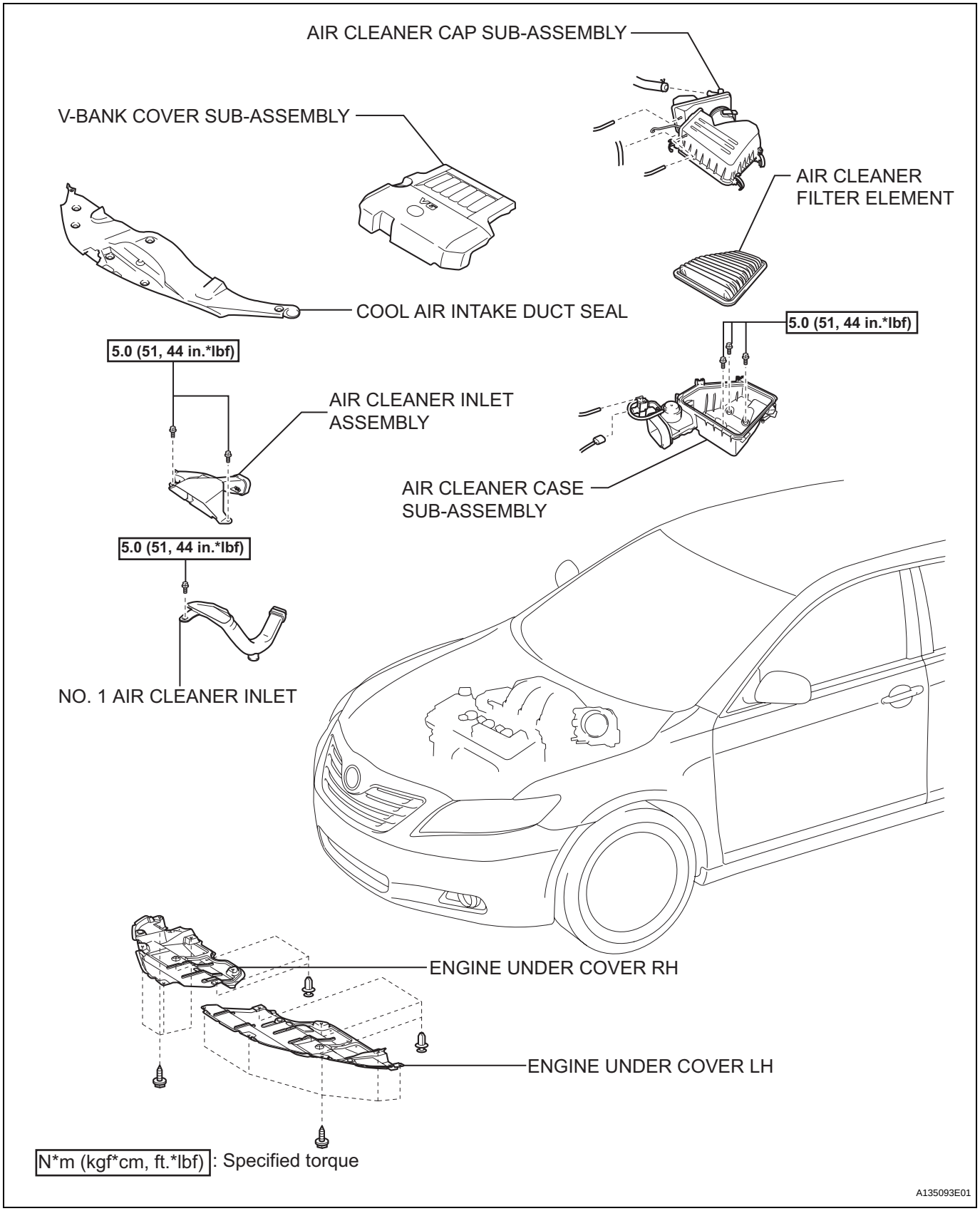
12. **INSTALL COWL TOP PANEL OUTER SUB-ASSEMBLY**
(a) Install the cowl top panel outer sub-assembly with the 4 bolts and 4 nuts.
Torque: Bolt
5.0 N*m (51 kgf*cm, 44 in.*lbf)
Nut
85 N*m (867 kgf*cm, 63 ft.*lbf)
13. **INSTALL WINDSHIELD WIPER MOTOR AND LINK (See page WW-14)**
14. **INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-15)**
15. **INSTALL FRONT FENDER TO COWL SIDE SEAL RH (See page WW-15)**
16. **INSTALL FRONT FENDER TO COWL SIDE SEAL LH (See page WW-15)**
17. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-15)**
18. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-16)**
19. **ADD ENGINE COOLANT (See page CO-6)**
20. **CHECK FOR ENGINE COOLANT LEAKS (See page CO-1)**
21. **INSTALL ENGINE UNDER COVER RH**

ES

22. INSTALL ENGINE UNDER COVER LH

VVT SENSOR

COMPONENTS



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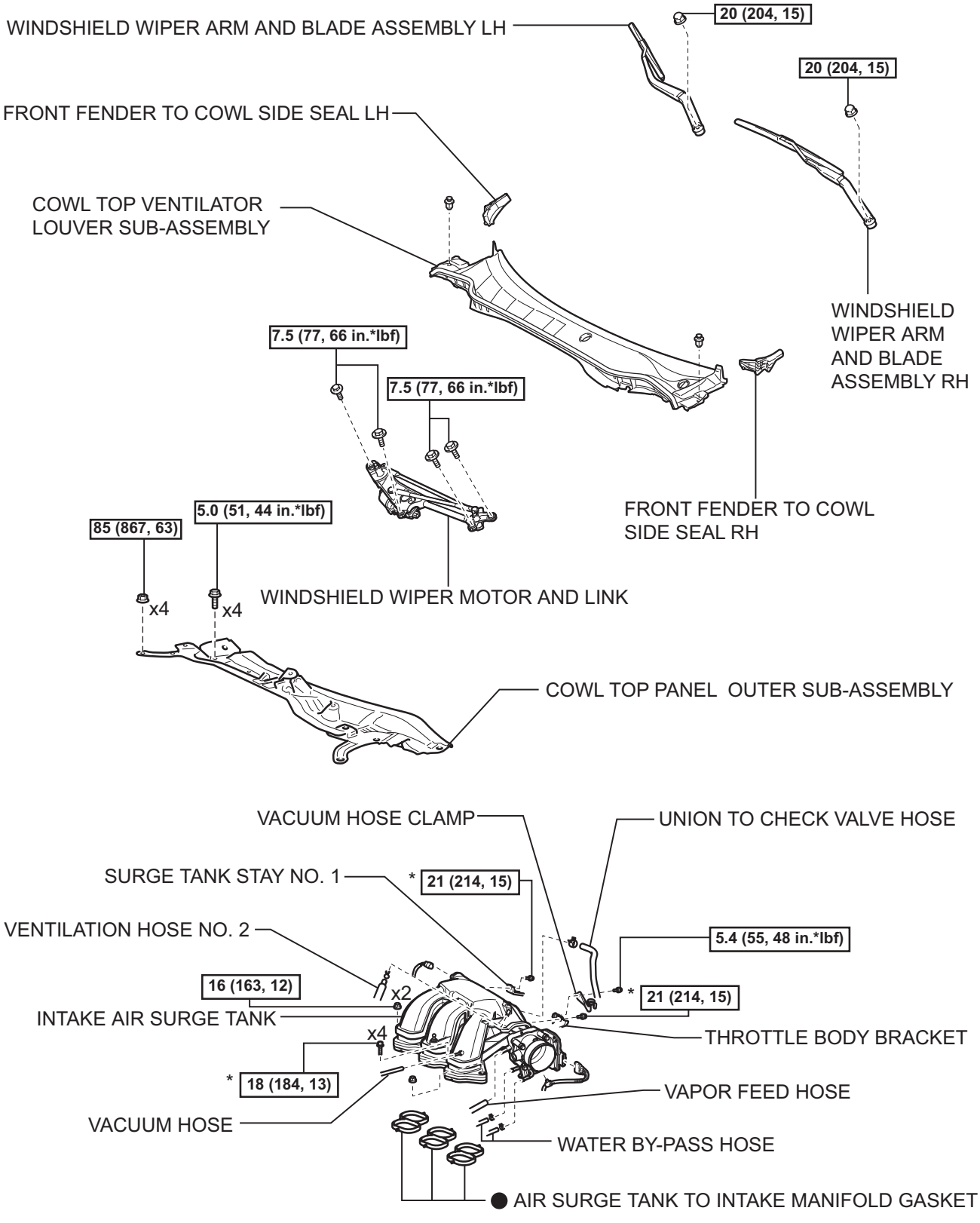

N*m (kgf*cm, ft.*lbf) : Specified torque ● Non-reusable part * DO NOT apply oil

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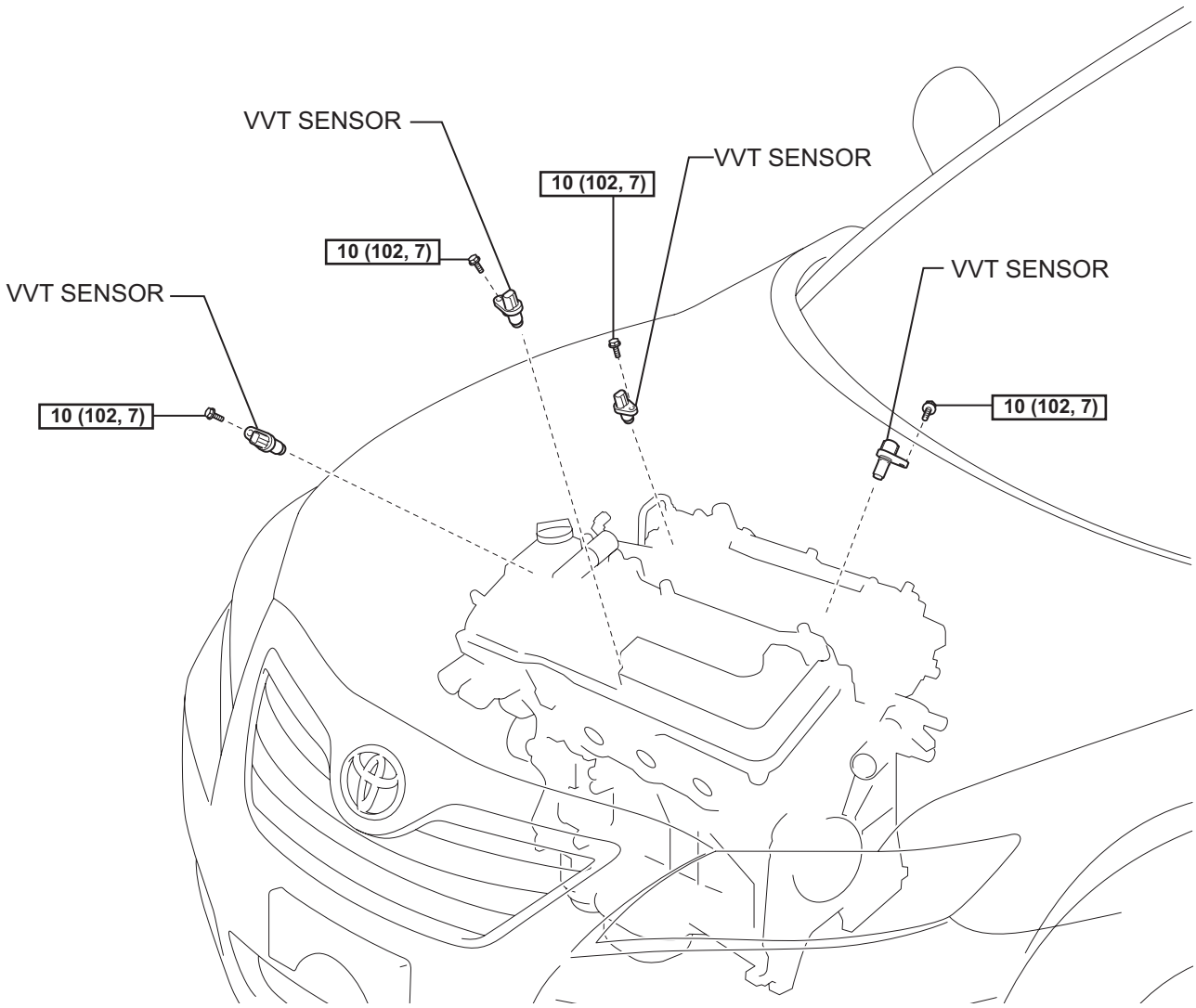
VVT SENSOR
VVT SENSOR
10 (102, 7)
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VVT SENSOR
VVT SENSOR
10 (102, 7)
10 (102, 7)
N*m (kgf*cm, ft.*lbf): Specified torque
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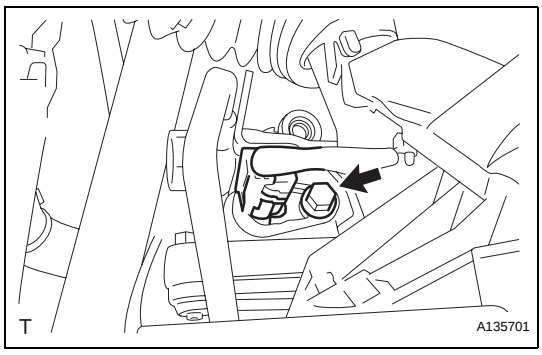
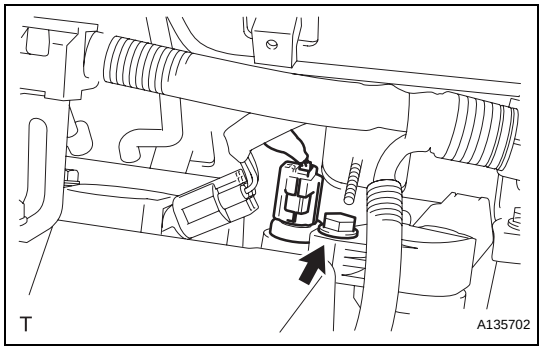
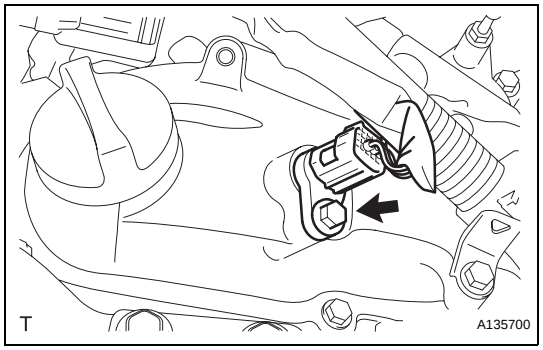
REMOVAL

1. **REMOVE ENGINE UNDER COVER LH**
2. **REMOVE ENGINE UNDER COVER RH**
3. **DRAIN ENGINE COOLANT (See page CO-5)**
4. **REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-9)**
5. **REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-9)**
6. **REMOVE FRONT FENDER TO COWL SIDE SEAL LH (See page WW-9)**
7. **REMOVE FRONT FENDER TO COWL SIDE SEAL RH (See page WW-9)**
8. **REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-10)**
9. **REMOVE WINDSHIELD WIPER MOTOR AND LINK (See page WW-10)**
10. **REMOVE COWL TOP PANEL OUTER SUB-ASSEMBLY (See page ES-481)**
11. **REMOVE COOL AIR INTAKE DUCT SEAL (See page EM-23)**
12. **REMOVE V-BANK COVER SUB-ASSEMBLY (See page EM-23)**
13. **REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-24)**
14. **REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-503)**
15. **REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-24)**
16. **REMOVE NO. 1 AIR CLEANER INLET (See page EM-24)**
17. **REMOVE INTAKE AIR SURGE TANK ASSEMBLY (See page FU-13)**
18. **REMOVE VVT SENSOR (for Bank 1 Intake Side)**
    (a) Disconnect the VVT sensor connector.
    (b) Remove the bolt and VVT sensor.

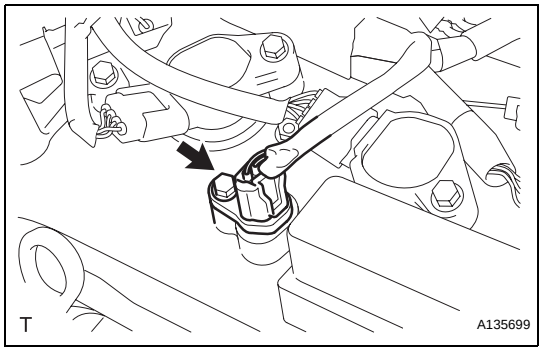




19. REMOVE VVT SENSOR (for Bank 1 Exhaust Side)
(a) Disconnect the VVT sensor connector.
(b) Remove the bolt and VVT sensor.

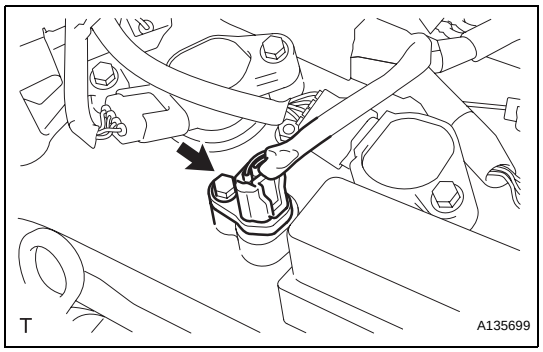


20. REMOVE VVT SENSOR (for Bank 2 Intake Side)
(a) Disconnect the VVT sensor connector.
(b) Remove the bolt and VVT sensor.

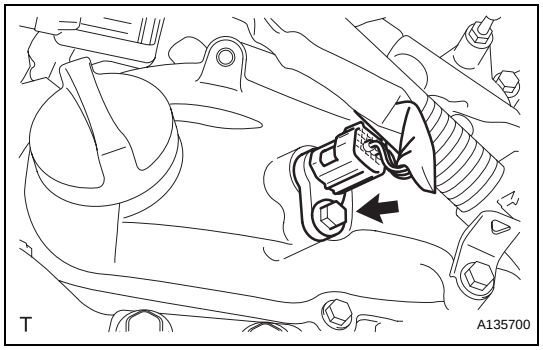


21. REMOVE VVT SENSOR (for Bank 2 Exhaust Side)
(a) Disconnect the VVT sensor connector.
(b) Remove the bolt and VVT sensor.

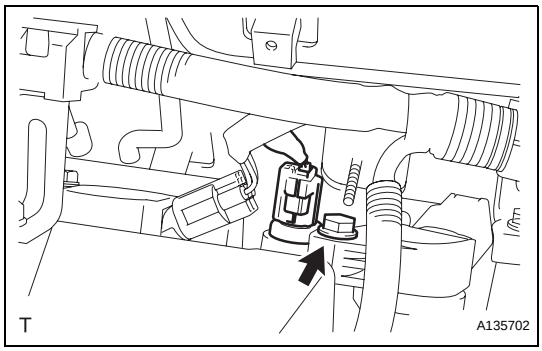
INSTALLATION



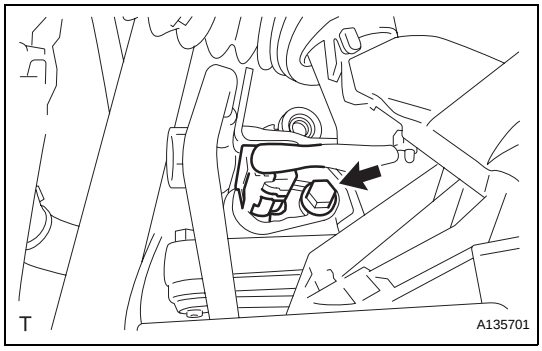
1. INSTALL VVT SENSOR (for Bank 2 Exhaust Side)
(a) Install the VVT sensor with the bolt.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
(b) Connect the VVT sensor connector.



2. INSTALL VVT SENSOR (for Bank 2 Intake Side)
(a) Install the VVT sensor with the bolt.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
(b) Connect the VVT sensor connector.



3. **INSTALL VVT SENSOR (for Bank 1 Exhaust Side)**
   (a) Install the VVT sensor with the bolt.
   Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
   (b) Connect the VVT sensor connector.



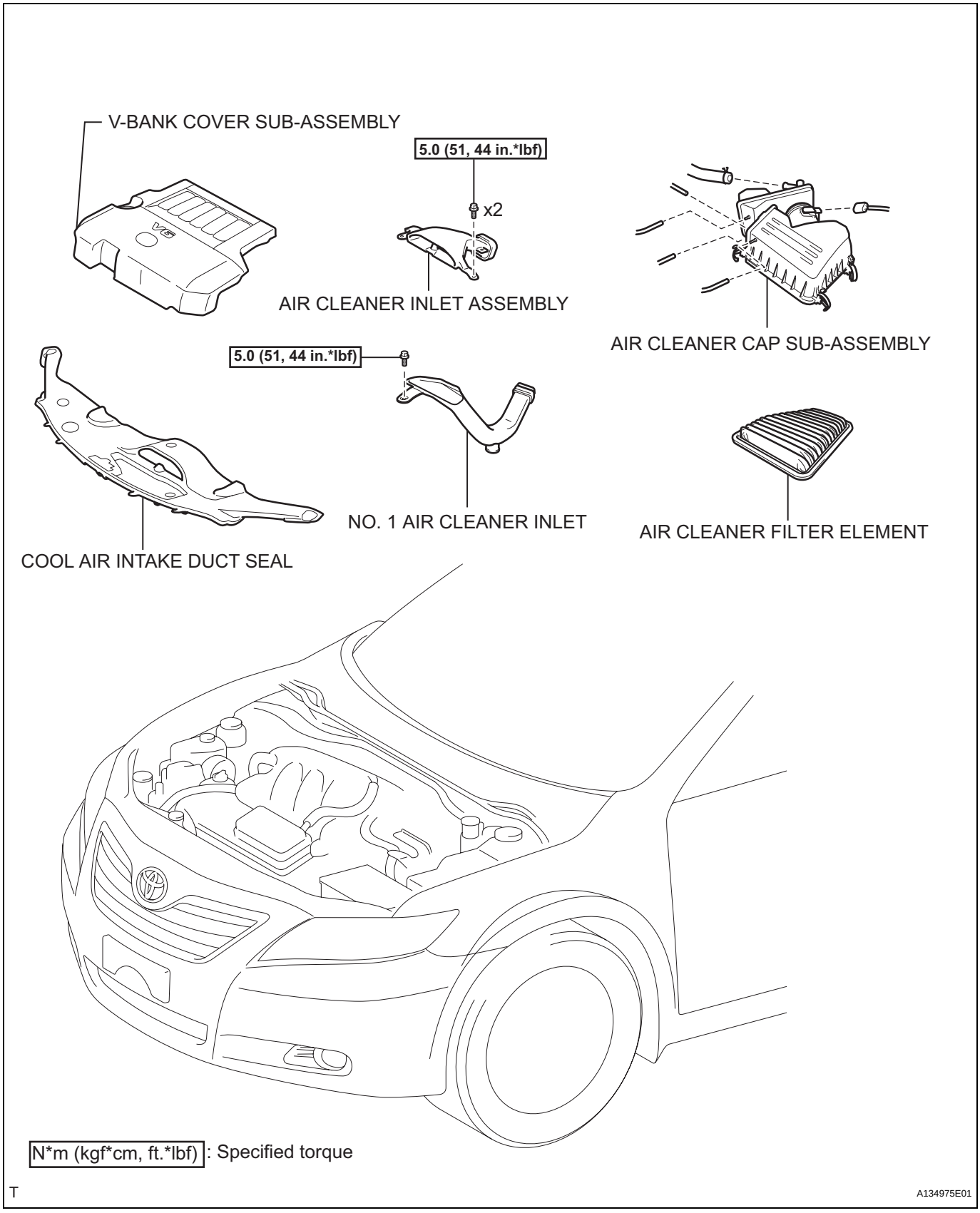
4. **INSTALL VVT SENSOR (for Bank 1 Intake Side)**
   (a) Install the VVT sensor with the bolt.
   Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)
   (b) Connect the VVT sensor connector.
5. **INSTALL INTAKE AIR SURGE TANK ASSEMBLY (See page FU-18)**
6. **INSTALL NO. 1 AIR CLEANER INLET (See page EM-49)**
7. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-50)**
8. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-506)**
9. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-50)**
10. **INSTALL V-BANK COVER SUB-ASSEMBLY (See page EM-52)**
11. **INSTALL COOL AIR INTAKE DUCT SEAL (See page EM-52)**
12. **INSTALL COWL TOP PANEL OUTER SUB-ASSEMBLY (See page ES-485)**
13. **INSTALL WINDSHIELD WIPER MOTOR AND LINK (See page WW-14)**
14. **INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-15)**
15. **INSTALL FRONT FENDER TO COWL SIDE SEAL RH (See page WW-15)**
16. **INSTALL FRONT FENDER TO COWL SIDE SEAL LH (See page WW-15)**
17. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-15)**
18. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-16)**
19. **ADD ENGINE COOLANT (See page CO-6)**
20. **CHECK FOR ENGINE COOLANT LEAKS (See page CO-1)**
21. **INSTALL ENGINE UNDER COVER RH**

ES

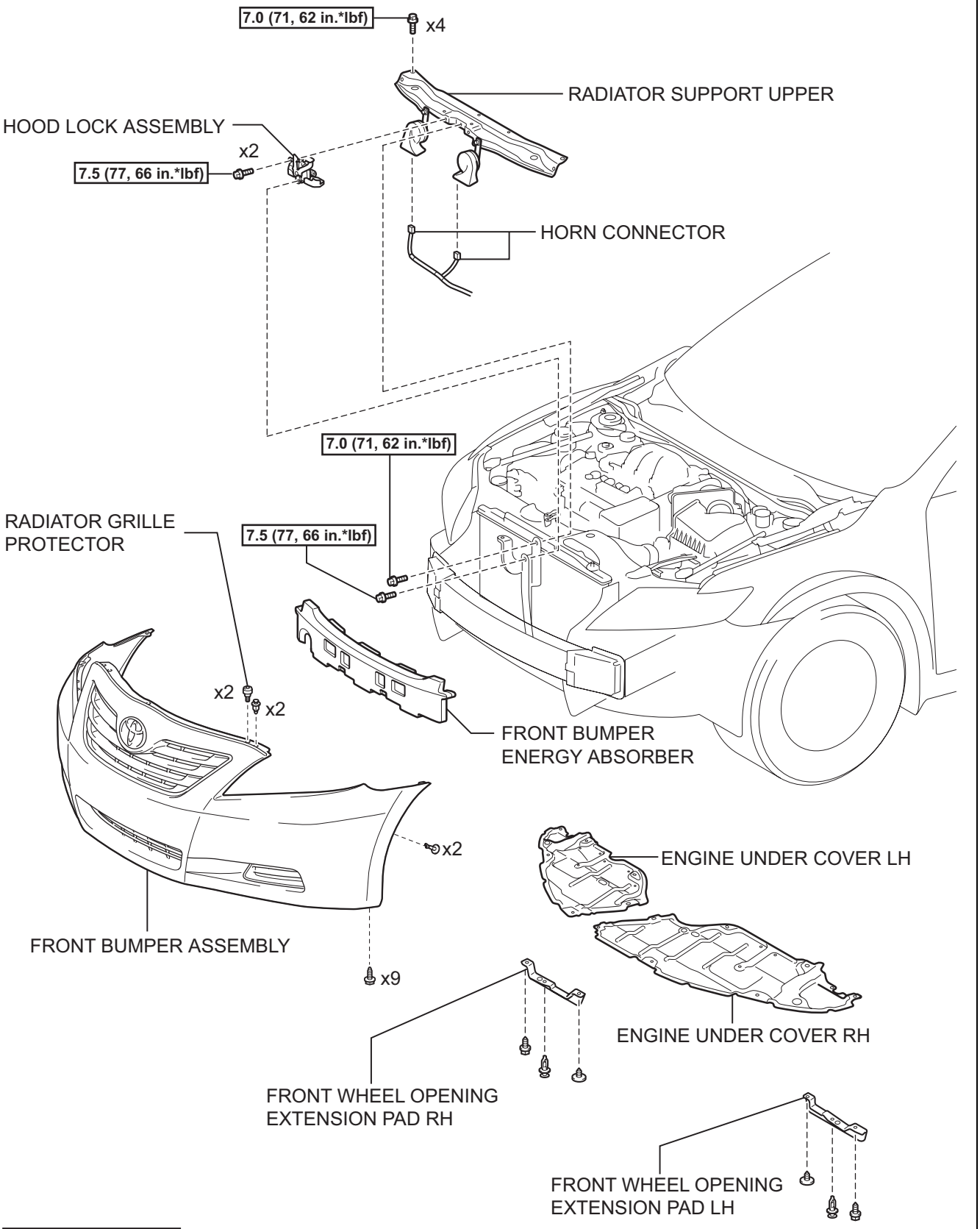
22. INSTALL ENGINE UNDER COVER LH

CRANKSHAFT POSITION SENSOR

COMPONENTS



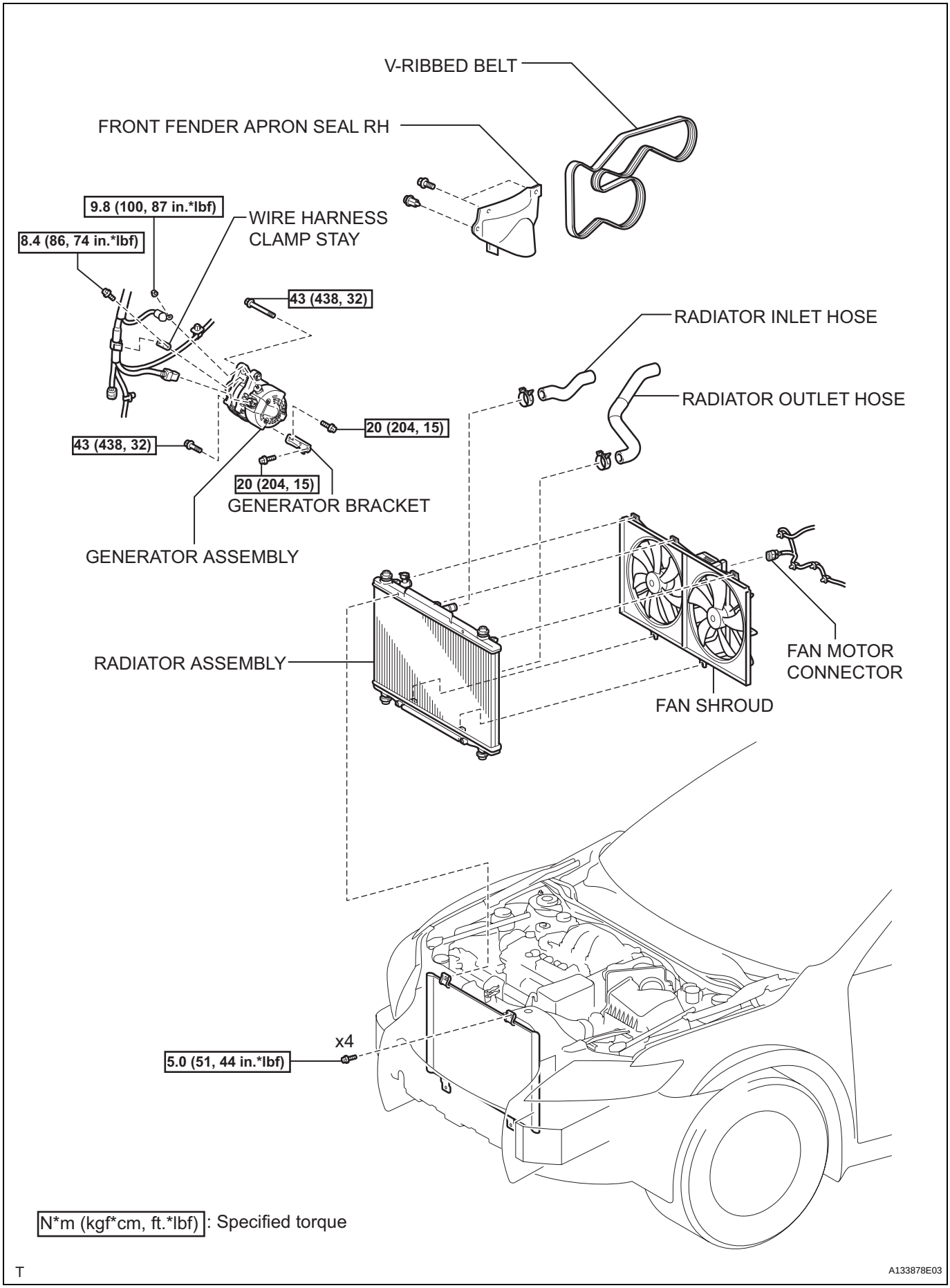
ES

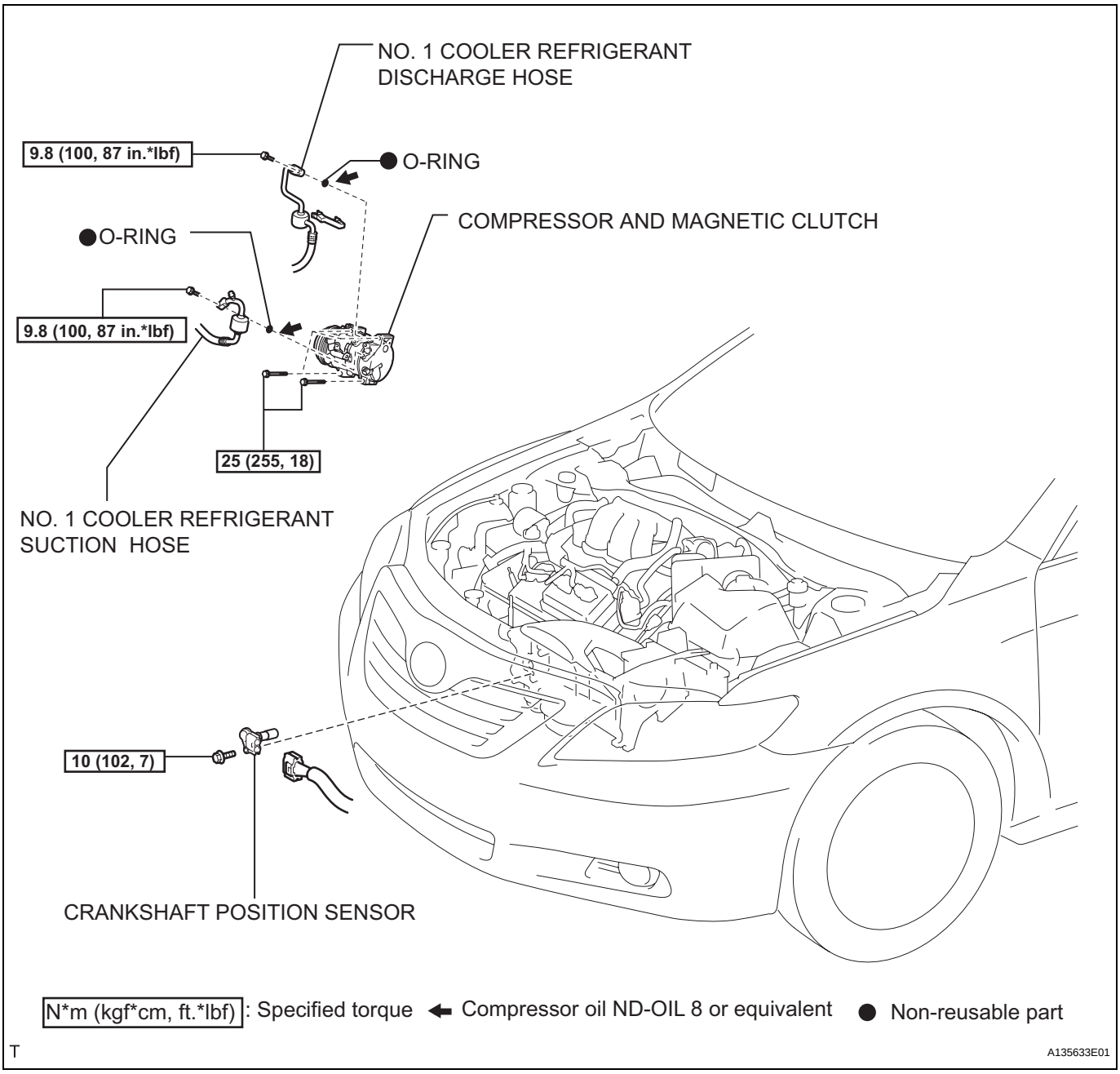


N*m (kgf*cm, ft.*lbf) : Specified torque

T

A133359E05

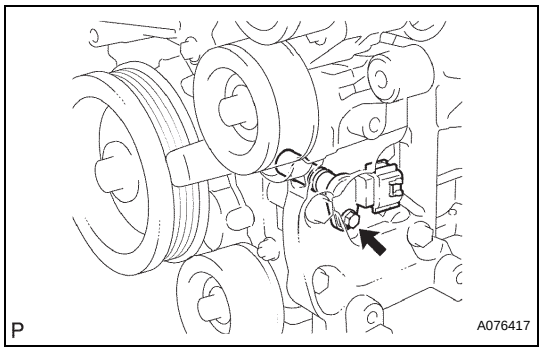

V-RIBBED BELT
FRONT FENDER APRON SEAL RH
9.8 (100, 87 in.*lbf)
WIRE HARNESS CLAMP STAY
8.4 (86, 74 in.*lbf)
43 (438, 32)
RADIATOR INLET HOSE
RADIATOR OUTLET HOSE
20 (204, 15)
43 (438, 32)
20 (204, 15)
GENERATOR BRACKET
GENERATOR ASSEMBLY
RADIATOR ASSEMBLY
FAN MOTOR CONNECTOR
FAN SHROUD
x4
5.0 (51, 44 in.*lbf)
N*m (kgf*cm, ft.*lbf): Specified torque
T
A133878E03

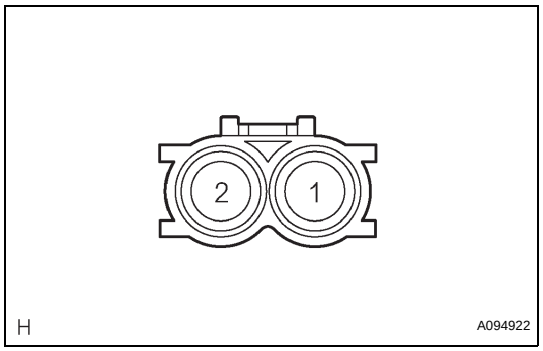

NO. 1 COOLER REFRIGERANT DISCHARGE HOSE
9.8 (100, 87 in.*lbf)
O-RING
O-RING
COMPRESSOR AND MAGNETIC CLUTCH
9.8 (100, 87 in.*lbf)
25 (255, 18)
NO. 1 COOLER REFRIGERANT SUCTION HOSE
10 (102, 7)
CRANKSHAFT POSITION SENSOR
N*m (kgf*cm, ft.*lbf): Specified torque
Compressor oil ND-OIL 8 or equivalent
Non-reusable part
T
A135633E01

ES

REMOVAL

1. **REMOVE GENERATOR ASSEMBLY**
   HINT:
   (See page CH-13)
2. **DISCONNECT COOLER COMPRESSOR ASSEMBLY**
   HINT:
   (See page AC-219)
3. **REMOVE CRANKSHAFT POSITION SENSOR**
   (a) Disconnect the crankshaft position sensor connector.
   (b) Remove the bolt and crankshaft position sensor.



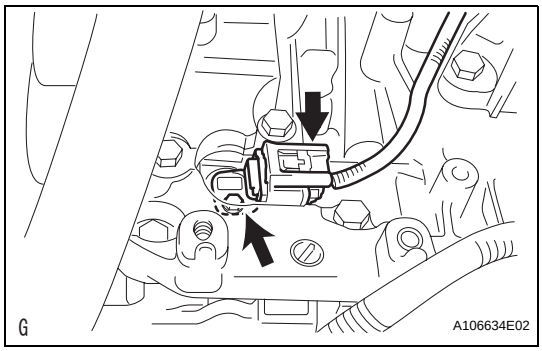


INSPECTION

1. **INSPECT CRANKSHAFT POSITION SENSOR**
   (a) Using an ohmmeter, measure the resistance between the terminals.
   Resistance:
   1,630 to 2,740 Ω at cold
   2,065 to 3,225 Ω at hot
   NOTICE:
   The terms "cold" and "hot" refer to the temperature of the coils. "Cold" means approximately -10 to 50°C (14 to 122°F). "Hot" means approximately 50 to 100°C (122 to 212°F).
   If the resistance is not as specified, replace the sensor.

ES

INSTALLATION



1. INSTALL CRANKSHAFT POSITION SENSOR

(a) Apply a light coat of engine oil to the O-ring of the crankshaft position sensor.

(b) Install the crankshaft position sensor with the bolt.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)

(c) Connect the crankshaft position sensor connector.

2. INSTALL COOLER COMPRESSOR ASSEMBLY

HINT:
(See page AC-225)

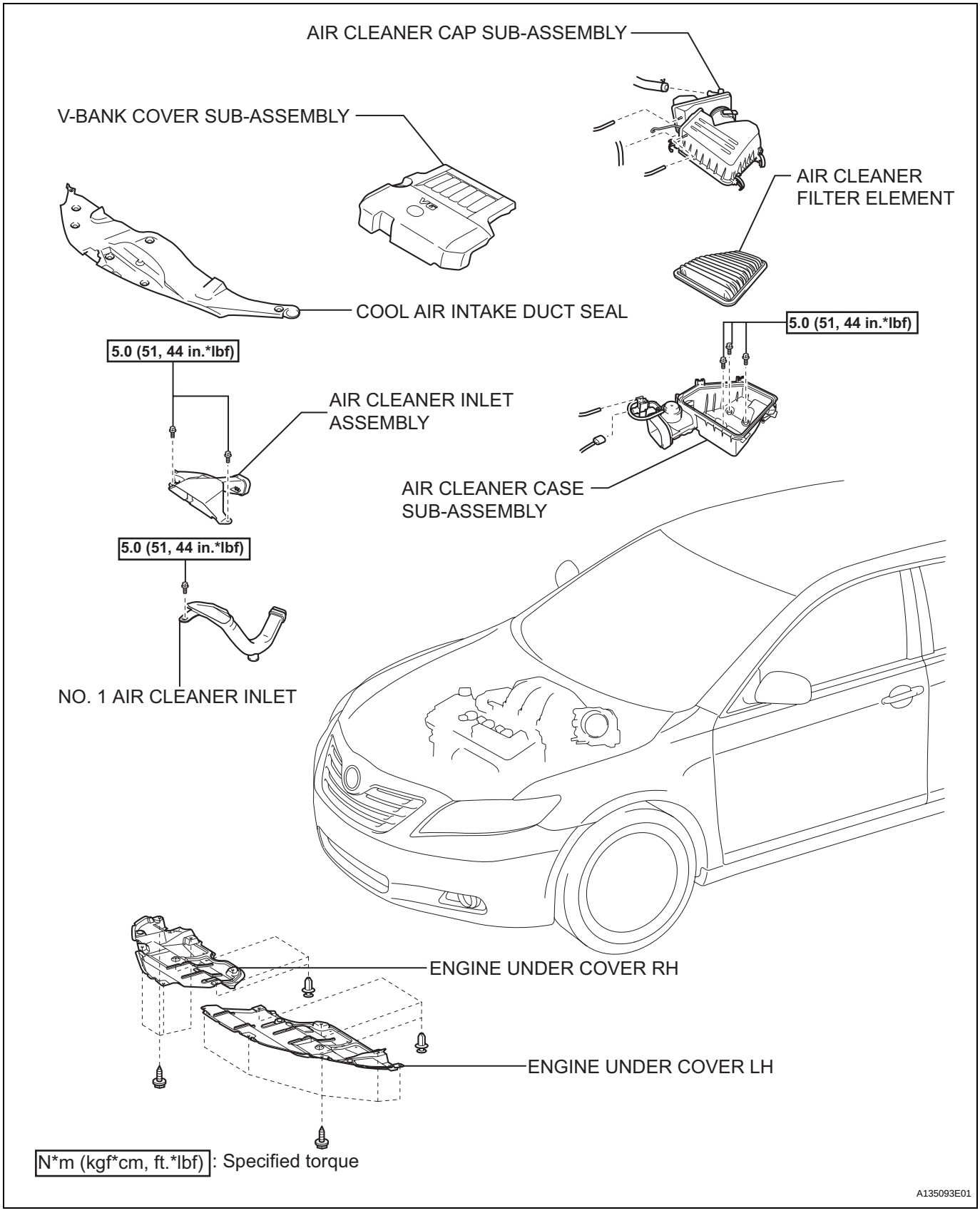
3. INSTALL GENERATOR ASSEMBLY

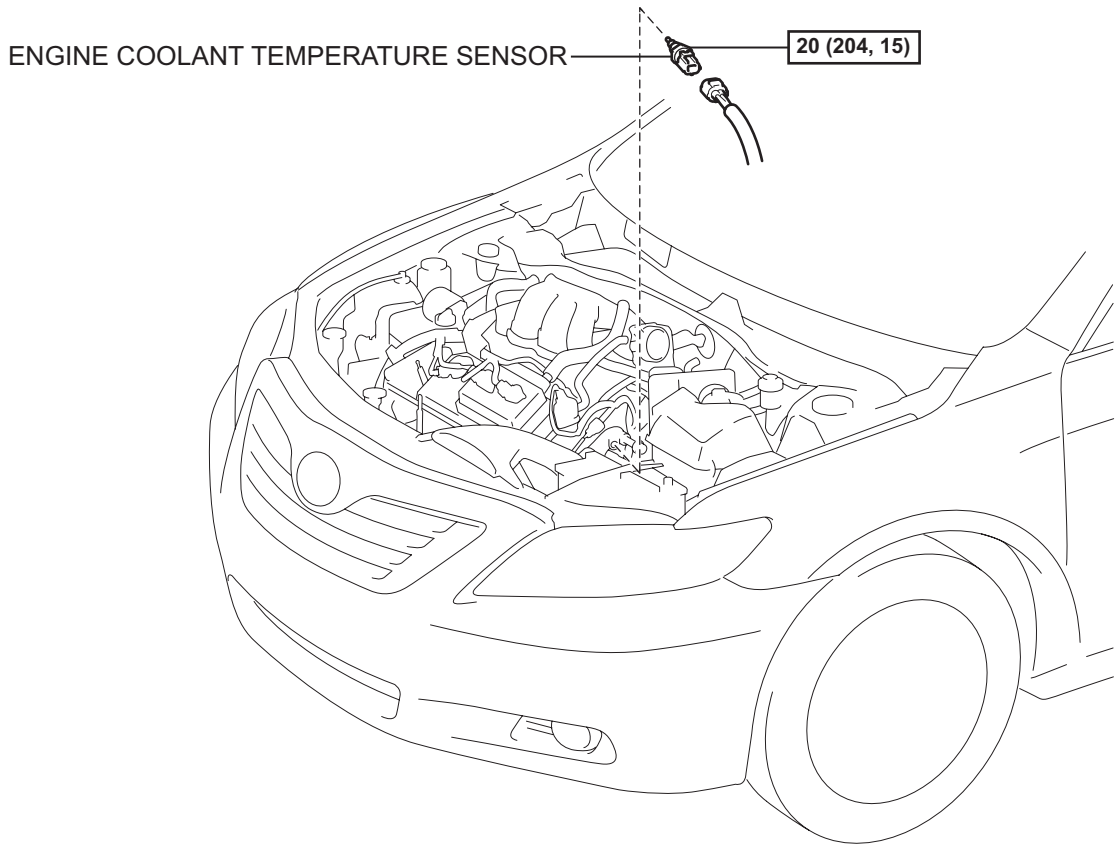
HINT:
(See page CH-22)

ES

ENGINE COOLANT TEMPERATURE SENSOR

COMPONENTS





N*m (kgf*cm, ft.*lbf): Specified torque

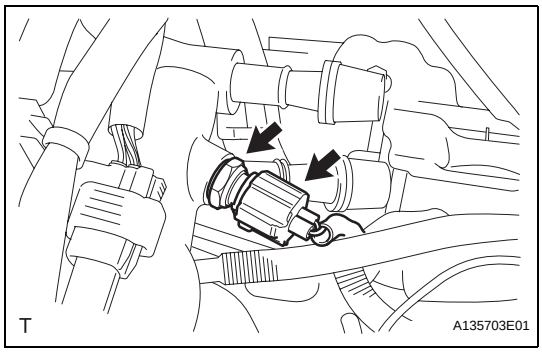
T

A135635E01

ES

REMOVAL

1. **REMOVE ENGINE UNDER COVER LH**
2. **REMOVE ENGINE UNDER COVER RH**
3. **DRAIN ENGINE COOLANT (See page CO-5)**
4. **REMOVE V-BANK COVER SUB-ASSEMBLY (See page EM-23)**
5. **REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-24)**
6. **REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-503)**
7. **REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-24)**
8. **REMOVE NO. 1 AIR CLEANER INLET (See page EM-24)**
9. **REMOVE ENGINE COOLANT TEMPERATURE SENSOR**
   (a) Remove the engine coolant temperature sensor connector.
   (b) Remove the engine coolant temperature sensor.



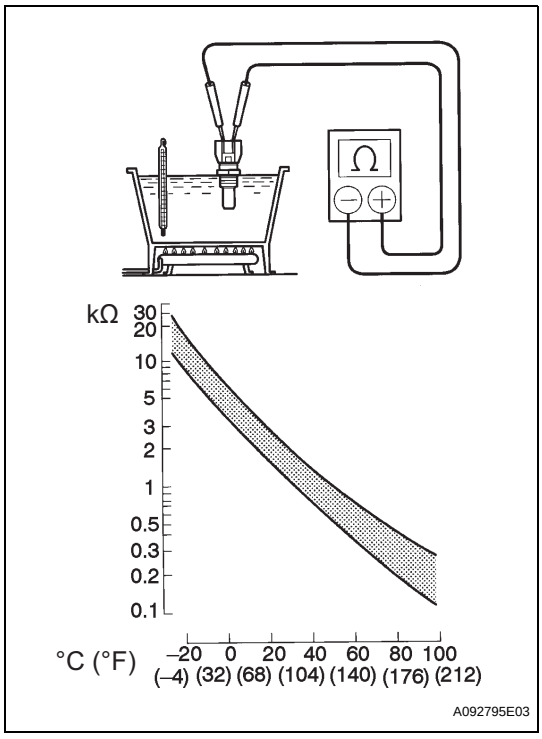
INSPECTION

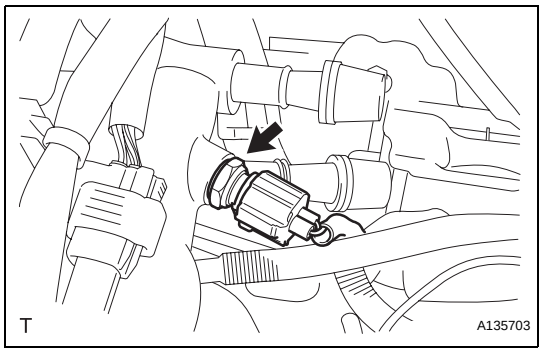
1. **INSPECT ENGINE COOLANT TEMPERATURE SENSOR**
   (a) Measure the resistance between the terminals.
   Standard resistance

Condition	Specified Condition
Approx. 20°C (68°F)	2.32 to 2.59 kΩ
Approx. 80°C (176°F)	0.31 to 0.326 kΩ

If the result is not as specified, replace the sensor.

NOTICE:
If checking the ECT sensor in the water, keep the terminals dry. After checking, dry the sensor.



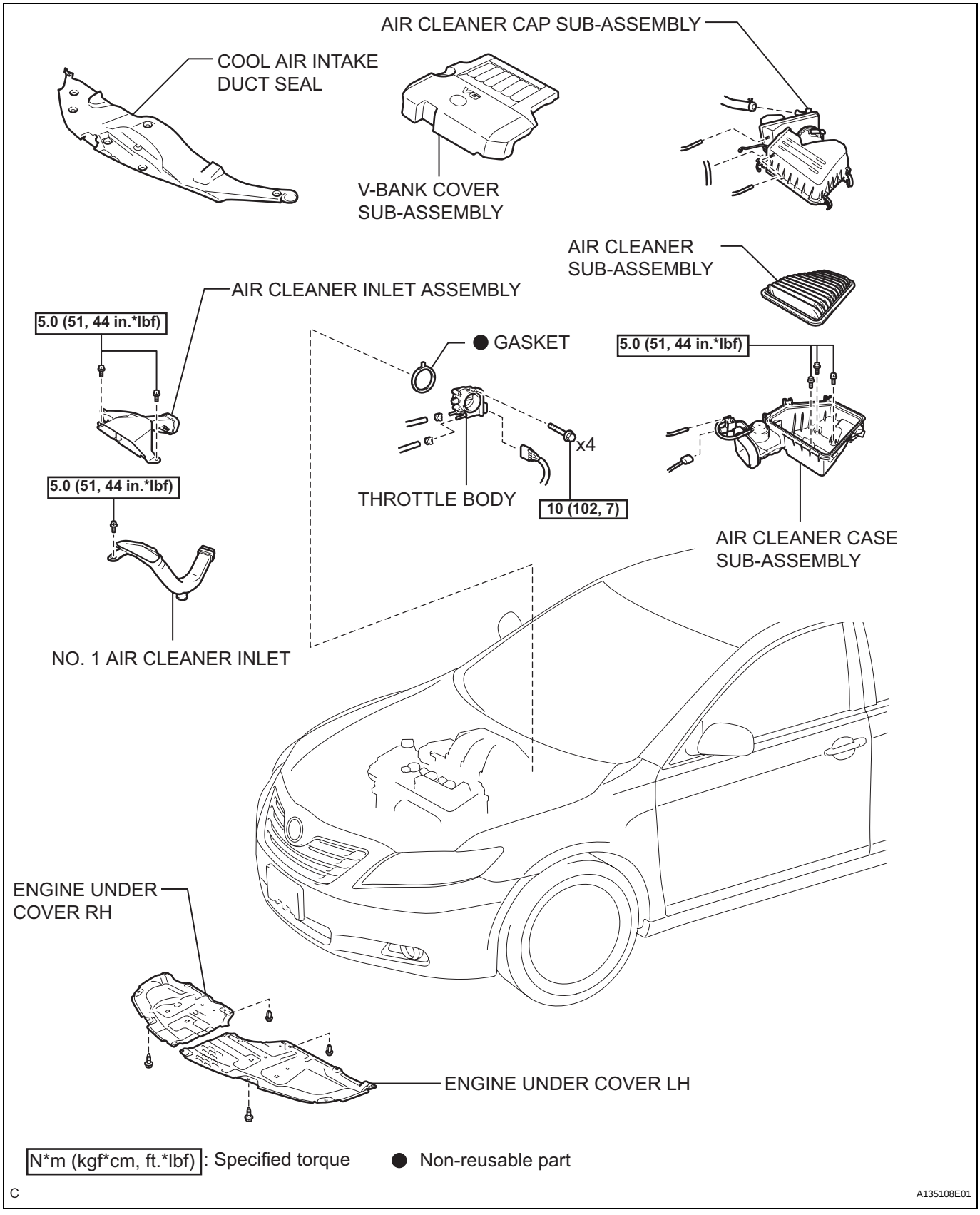


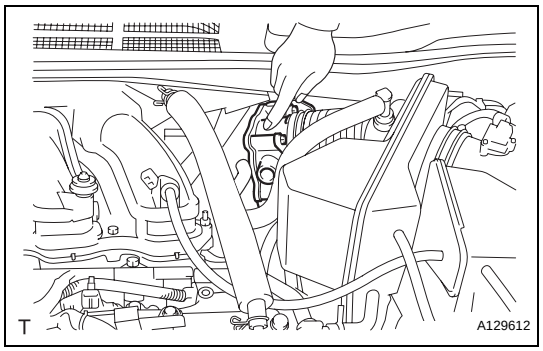
INSTALLATION

1. **INSTALL ENGINE COOLANT TEMPERATURE SENSOR**
   (a) Install a new gasket to the engine coolant temperature sensor.
   (b) Install the engine coolant temperature sensor.
   Torque: 20 N*m (204 kgf*cm, 15 ft.*lbf)
   (c) Connect the engine coolant temperature sensor connector.
2. **INSTALL NO. 1 AIR CLEANER INLET (See page EM-49)**
3. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-50)**
4. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-506)**
5. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-50)**
6. **INSTALL V-BANK COVER SUB-ASSEMBLY (See page EM-52)**
7. **ADD ENGINE COOLANT (See page CO-6)**
8. **CHECK FOR ENGINE COOLANT LEAKS (See page CO-1)**
9. **INSTALL ENGINE UNDER COVER RH**
10. **INSTALL ENGINE UNDER COVER LH**

THROTTLE BODY

COMPONENTS





ON-VEHICLE INSPECTION

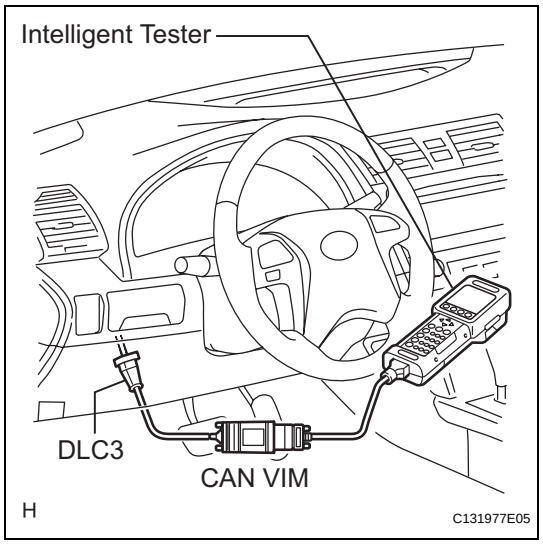
1. INSPECTION THROTTLE BODY

(a) Inspect the throttle control motor for operating sounds.

(1) Turn the ignition switch on (IG).

(2) When turning the accelerator pedal position sensor lever, check for running sounds of the motor. The motor should be running smoothly without friction sounds.

If operation is not as specified, check the throttle control motor, wiring and ECM (See page ES-505).



(b) Inspect the throttle position sensor.

(1) Connect the intelligent tester (with CAN VIM) to the DLC3.

(2) Turn the ignition switch on (IG).

(3) Check that the MIL is off.

(4) Check that, under the CURRENT DATA, THROTTLE POS (throttle valve opening percentage) is within the standard range below.

Standard throttle valve opening percentage:
60 % or more

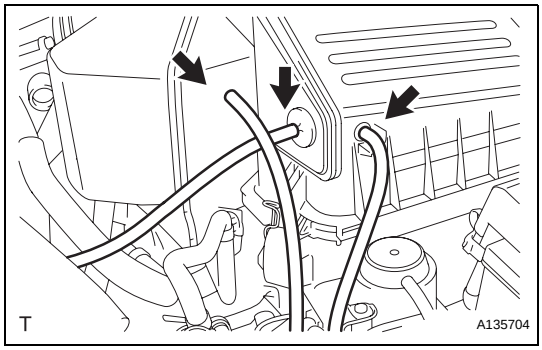
If operation is not as specified, check the throttle position sensor, wiring and ECM (See page ES-505).

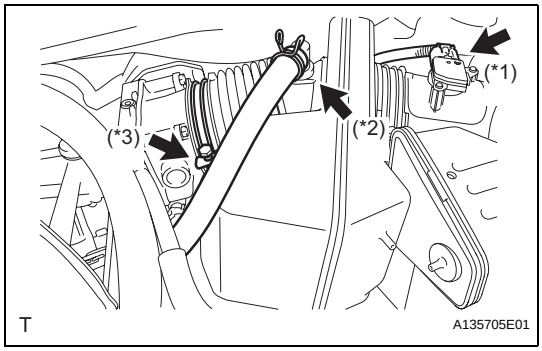
ES

ES

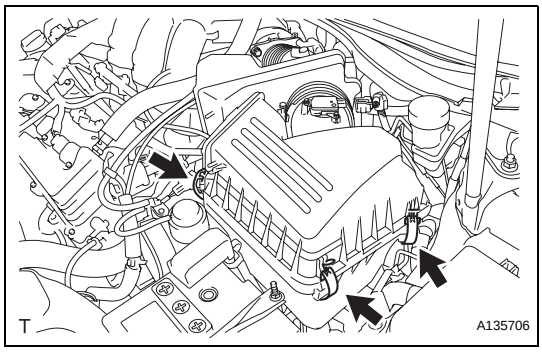
REMOVAL

1. **REMOVE ENGINE UNDER COVER LH**
2. **REMOVE ENGINE UNDER COVER RH**
3. **DRAIN ENGINE COOLANT (See page CO-5)**
4. **REMOVE COOL AIR INTAKE DUCT SEAL (See page EM-23)**
5. **REMOVE V-BANK COVER SUB-ASSEMBLY (See page EM-23)**
6. **REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-24)**
7. **REMOVE AIR CLEANER CAP SUB-ASSEMBLY**
   (a) Disconnect the 3 vacuum hoses.

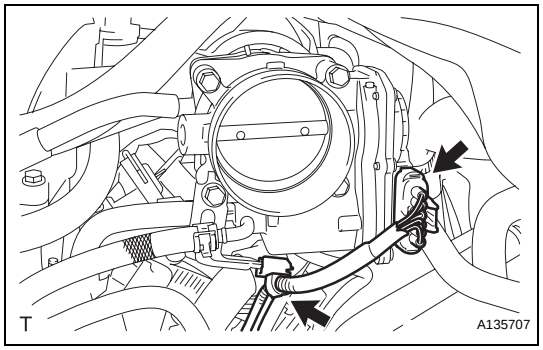




   (b) Disconnect the mass air flow meter connector (*1).
   (c) Disconnect the No. 2 ventilation hose (*2).
   (d) Disconnect the hose band (*3).

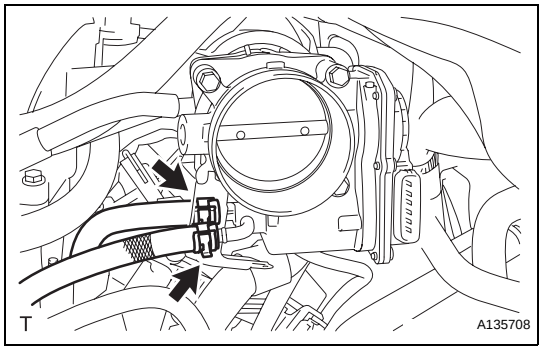


   (e) Disconnect the 3 bands, and remove the air cleaner cap sub-assembly.
8. **REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-24)**
9. **REMOVE NO. 1 AIR CLEANER INLET (See page EM-24)**

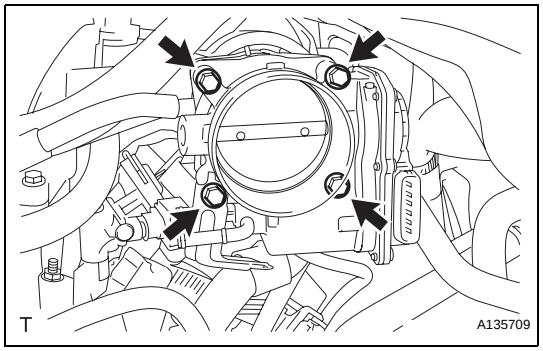


10. REMOVE THROTTLE BODY

(a) Disconnect the throttle body connector and clamp.

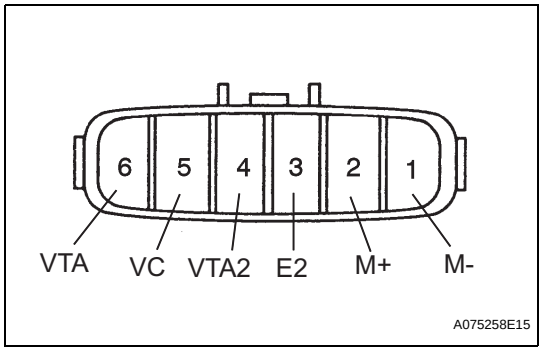


(b) Disconnect the 2 water by-pass hoses from the throttle body.



(c) Remove the 4 bolts and throttle body.

(d) Remove the throttle body gasket from the intake air surge tank.



INSPECTION

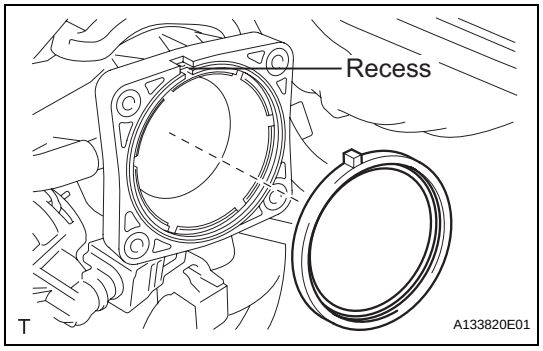
1. INSPECT THROTTLE BODY

(a) Measure the resistance between the terminals.

Standard resistance

Tester Connection	Condition	Specified Condition
2 (M+) - 1 (M-)	20°C (68°F)	0.3 to 100 Ω
5 (VC) - 3 (E2)	20°C (68°F)	1.2 to 3.2 kΩ

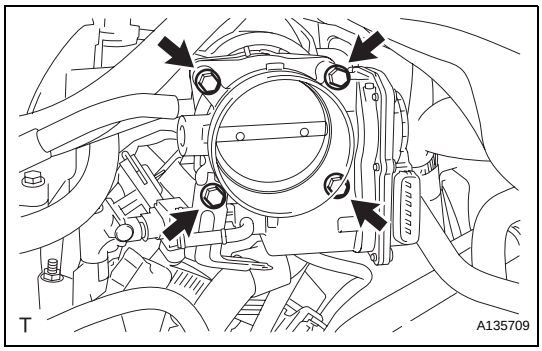
If the result is not as specified, replace the throttle body assembly.



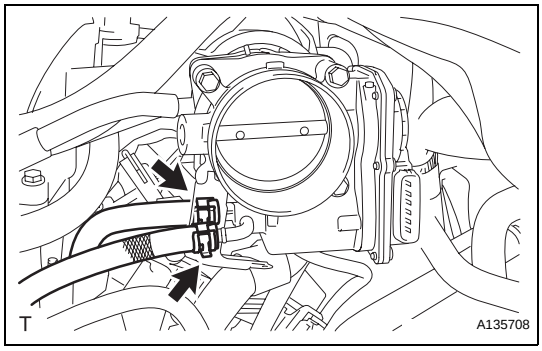
INSTALLATION

1. INSTALL THROTTLE BODY

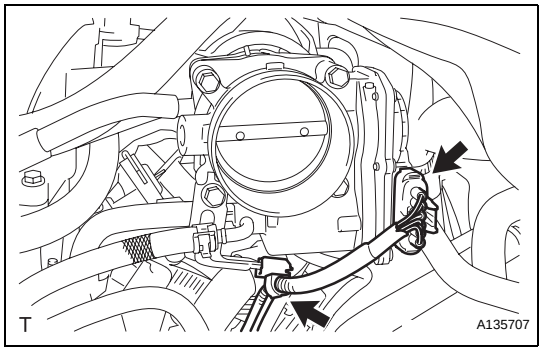
(a) Install a new throttle body gasket to the intake air surge tank.



(b) Install the throttle body with the 4 bolts.
Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)



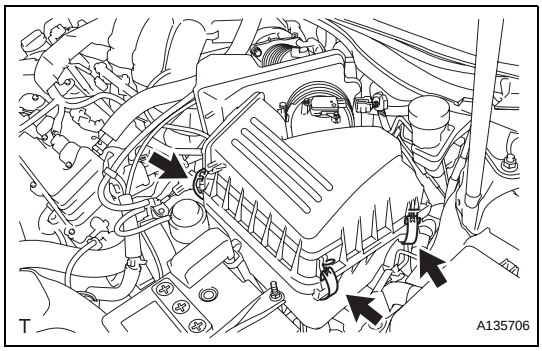
(c) Connect the 2 water by-pass hoses.



(d) Connect the throttle body connector and clamp.

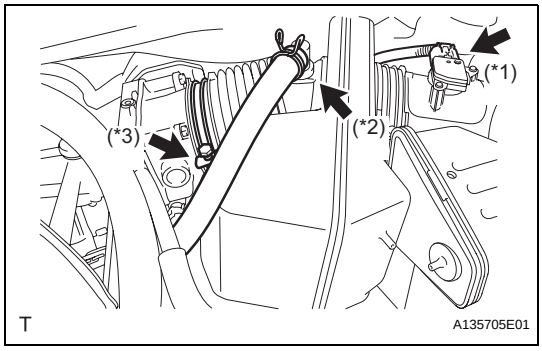
2. INSTALL NO. 1 AIR CLEANER INLET (See page EM-49)

3. INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-50)



4. INSTALL AIR CLEANER CAP SUB-ASSEMBLY

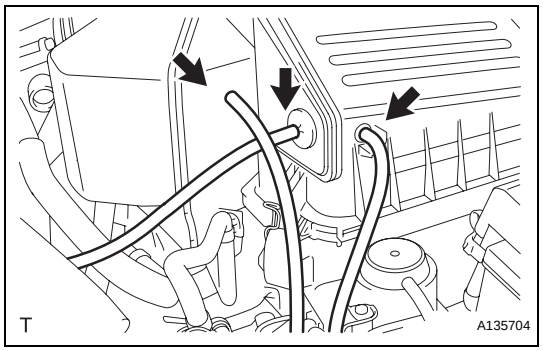
(a) Install the air cleaner cap sub-assembly, and connect the 3 bands.



(b) Connect the mass air flow meter connector (*1).

(c) Connect the No. 2 ventilation hose (*2).

(d) Connect the hose band (*3).

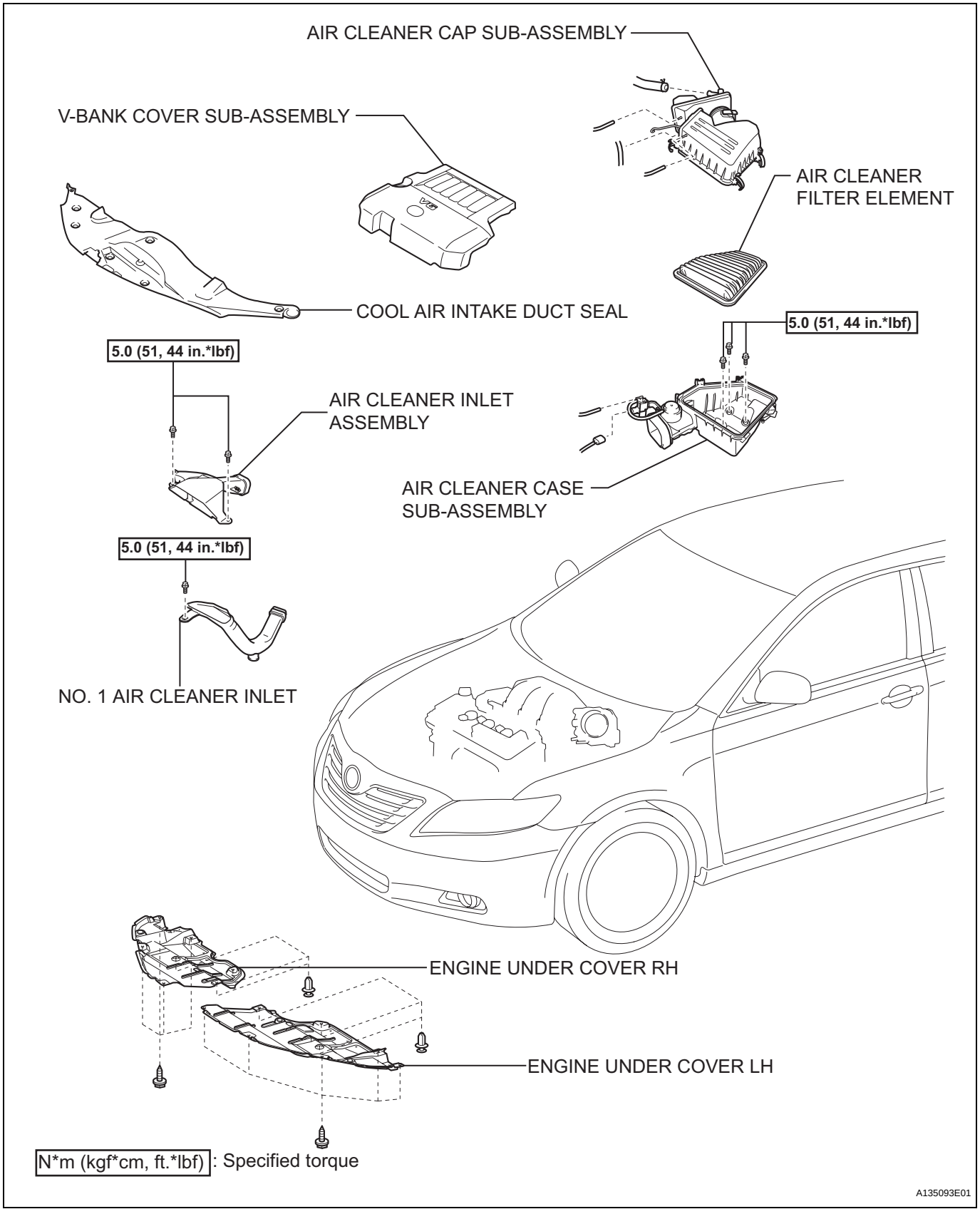


(e) Connect the 3 vacuum hoses.

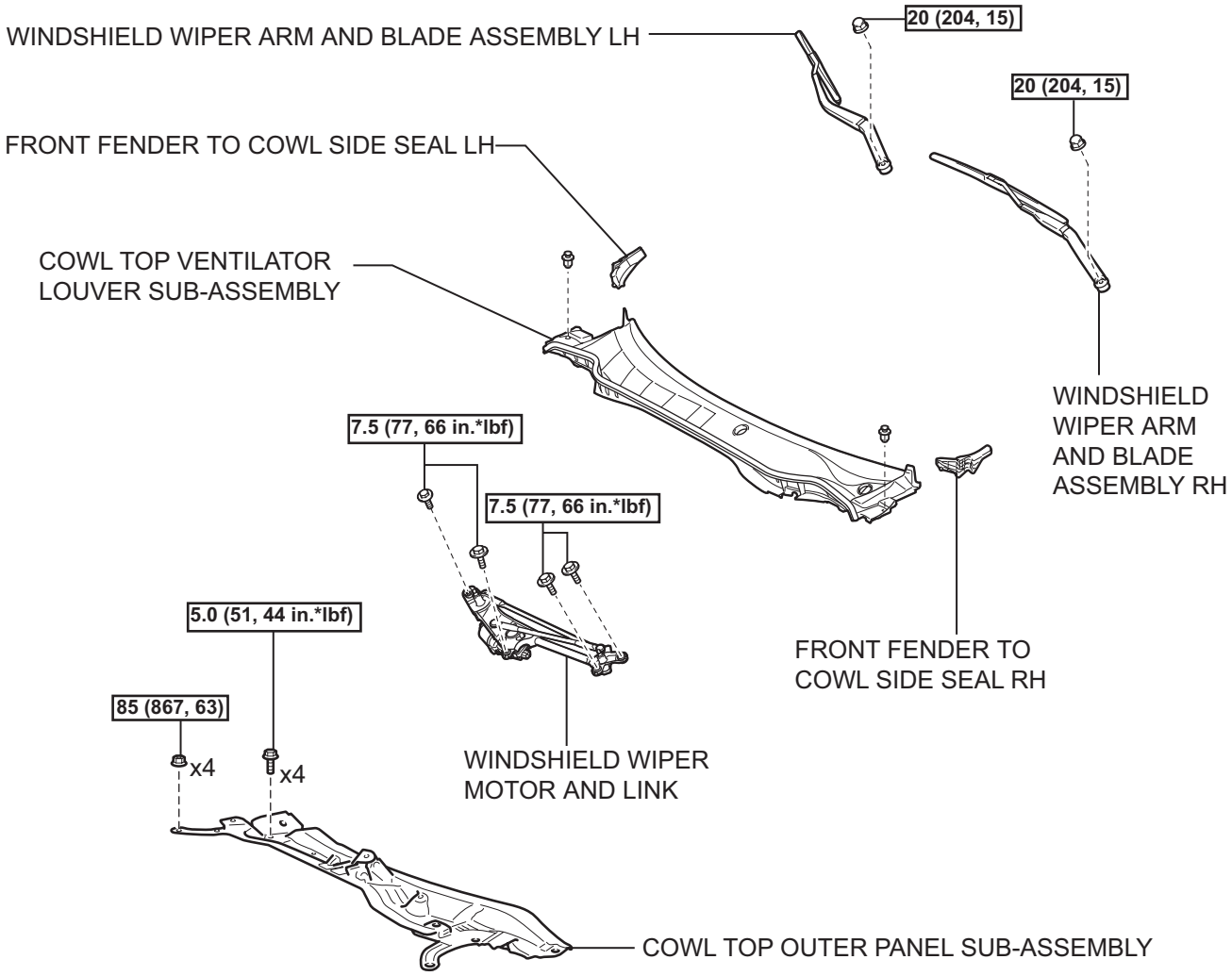
5. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-50)**
6. **INSTALL COOL AIR INTAKE DUCT SEAL (See page EM-52)**
7. **ADD ENGINE COOLANT (See page CO-6)**
8. **CHECK FOR ENGINE COOLANT LEAKS (See page CO-1)**
9. **CHECK FUNCTION OF THROTTLE BODY (See page ES-503)**
10. **INSTALL V-BANK COVER SUB-ASSEMBLY (See page EM-52)**

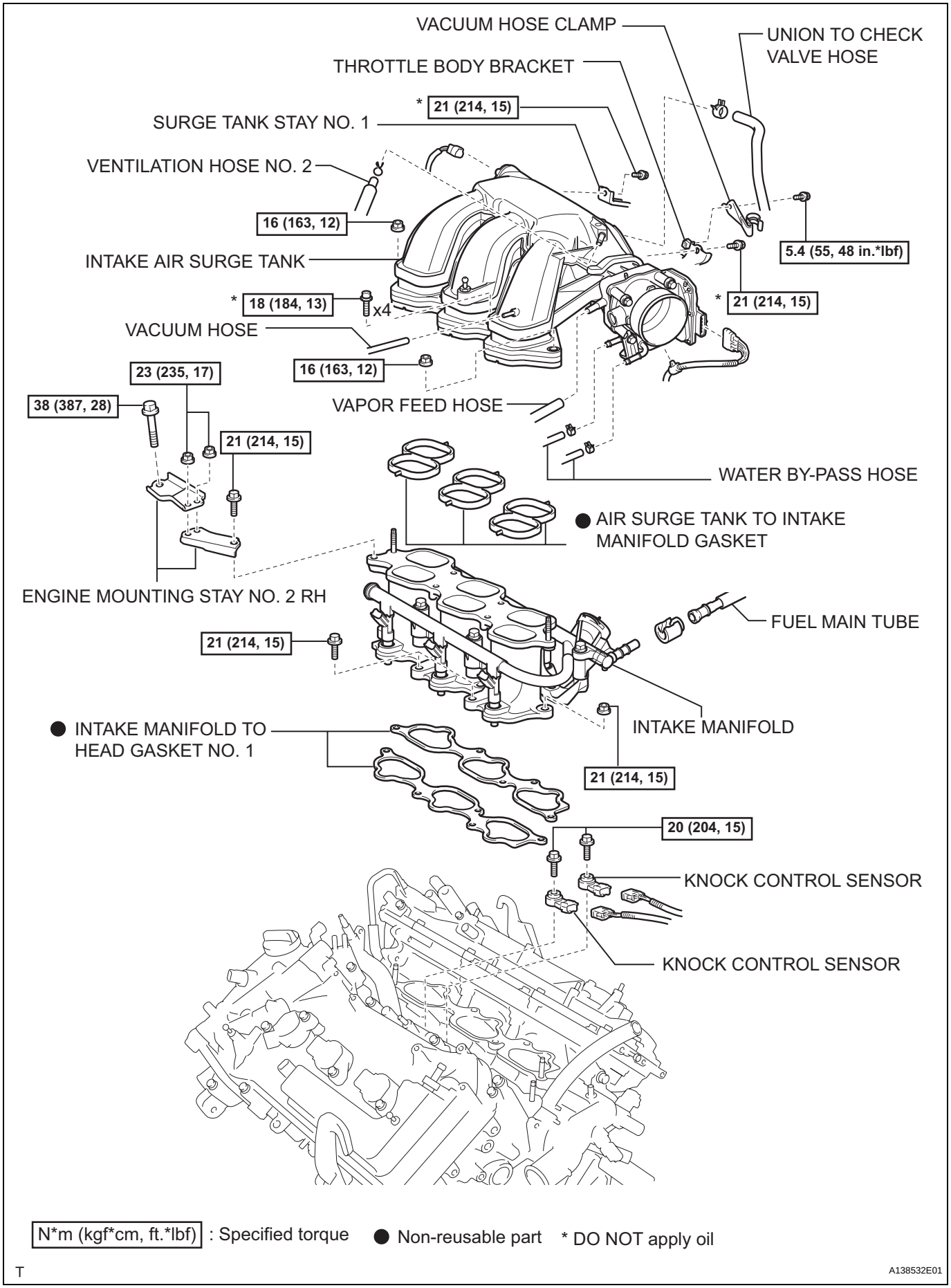
KNOCK SENSOR

COMPONENTS



ES


WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH
20 (204, 15)
20 (204, 15)
FRONT FENDER TO COWL SIDE SEAL LH
COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY
WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH
7.5 (77, 66 in.*lbf)
7.5 (77, 66 in.*lbf)
5.0 (51, 44 in.*lbf)
85 (867, 63)
x4
x4
FRONT FENDER TO COWL SIDE SEAL RH
WINDSHIELD WIPER MOTOR AND LINK
COWL TOP OUTER PANEL SUB-ASSEMBLY
N*m (kgf*cm, ft.*lbf) : Specified torque
A135105E01



N*m (kgf*cm, ft.*lbf) : Specified torque ● Non-reusable part * DO NOT apply oil

T

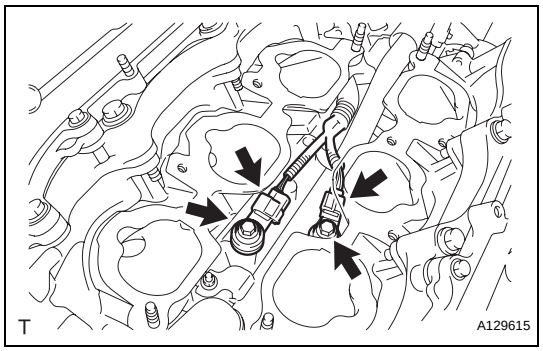
A138532E01

ES

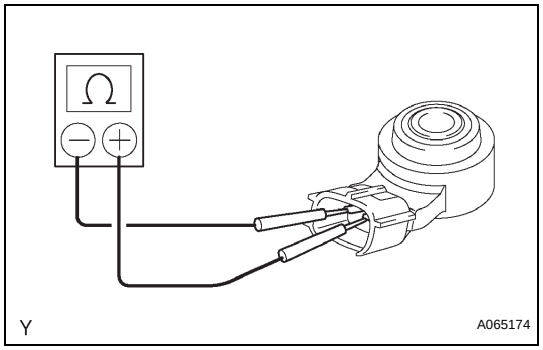
ES

REMOVAL

1. DISCHARGE FUEL SYSTEM PRESSURE (See page FU-13)
2. REMOVE ENGINE UNDER COVER LH
3. REMOVE ENGINE UNDER COVER RH
4. DRAIN ENGINE COOLANT (See page CO-5)
5. REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-9)
6. REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-9)
7. REMOVE FRONT FENDER TO COWL SIDE SEAL LH (See page WW-9)
8. REMOVE FRONT FENDER TO COWL SIDE SEAL RH (See page WW-9)
9. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-10)
10. REMOVE WINDSHIELD WIPER MOTOR AND LINK (See page WW-10)
11. REMOVE COWL TOP PANEL OUTER SUB-ASSEMBLY (See page ES-481)
12. REMOVE COOL AIR INTAKE DUCT SEAL (See page ES-481)
13. REMOVE V-BANK COVER SUB-ASSEMBLY (See page EM-23)
14. REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-24)
15. REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-503)
16. REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-24)
17. REMOVE NO. 1 AIR CLEANER INLET (See page EM-24)
18. REMOVE INTAKE AIR SURGE TANK (See page FU-13)
19. SEPARATE FUEL TUBE SUB-ASSEMBLY (See page EM-28)
20. REMOVE INTAKE MANIFOLD (See page EM-32)

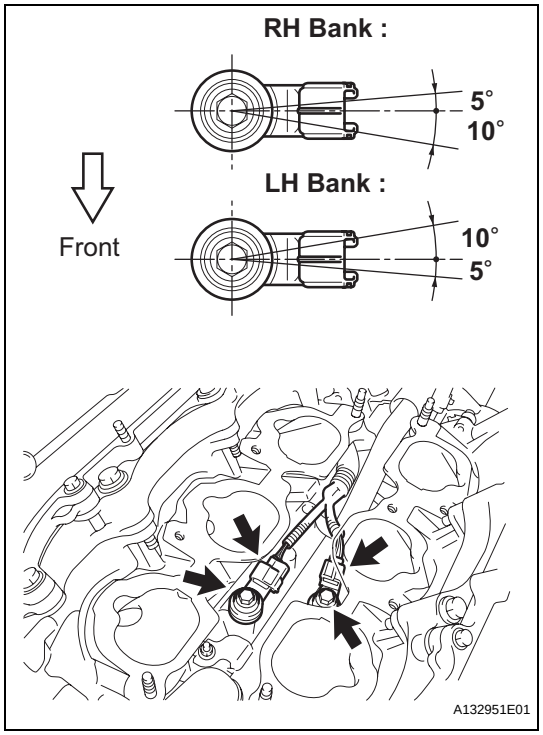


21. **REMOVE KNOCK CONTROL SENSOR**
    (a) Disconnect the 2 knock control sensor connectors.
    (b) Remove the 2 bolts and 2 knock control sensors.



INSPECTION

1. **INSPECT KNOCK CONTROL SENSOR**
    (a) Using an ohmmeter, measure the resistance between the terminals.
    Standard resistance:
    120 to 280 kΩ at 20°C (68°F)
    If the result is not as specified, replace the sensor.

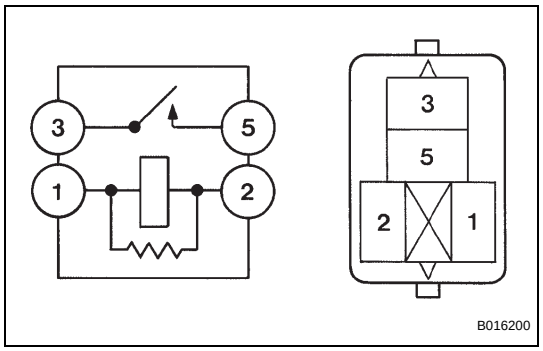


INSTALLATION

1. **INSTALL KNOCK CONTROL SENSOR**
    (a) Install the 2 knock control sensors with the 2 bolts as shown in the illustration.
    Torque: 20 N*m (204 kgf*cm, 15 ft.*lbf)
    (b) Connect the 2 knock control sensor connectors.
2. **INSTALL INTAKE MANIFOLD (See page EM-41)**
3. **CONNECT FUEL TUBE SUB-ASSEMBLY (See page EM-46)**
4. **INSTALL INTAKE AIR SURGE TANK (See page FU-18)**
5. **INSTALL NO. 1 AIR CLEANER INLET (See page EM-49)**
6. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-50)**
7. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-506)**
8. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-50)**
9. **INSTALL V-BANK COVER SUB-ASSEMBLY (See page EM-52)**
10. **INSTALL COOL AIR INTAKE DUCT SEAL (See page EM-52)**
11. **INSTALL COWL TOP PANEL OUTER SUB-ASSEMBLY (See page ES-485)**
12. **INSTALL WINDSHIELD WIPER MOTOR AND LINK (See page WW-14)**

ES

13. **INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-15)**
14. **INSTALL FRONT FENDER TO COWL SIDE SEAL RH (See page WW-15)**
15. **INSTALL FRONT FENDER TO COWL SIDE SEAL LH (See page WW-15)**
16. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-15)**
17. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-16)**
18. **ADD ENGINE COOLANT (See page CO-6)**
19. **CHECK FOR ENGINE COOLANT LEAKS (See page CO-1)**
20. **CHECK FOR FUEL LEAKS (See page FU-8)**
21. **INSTALL ENGINE UNDER COVER RH**
22. **INSTALL ENGINE UNDER COVER LH**



IG2 RELAY

INSPECTION

1. INSPECT IG2 RELAY

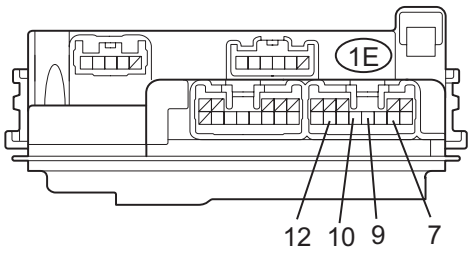
(a) Using an ohmmeter, measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Specified Condition
3 - 5	10 kΩ or higher
3 - 5	Below 1 Ω (Battery voltage applied between terminals 1 and 2)

If the result is not as specified, replace the relay.

Engine Room R/B Unit D:



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EFI RELAY

INSPECTION

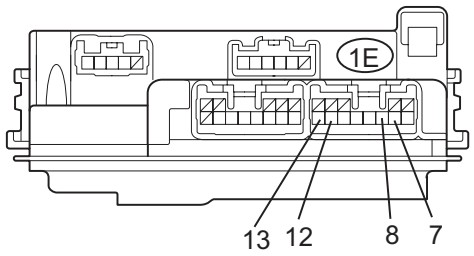
1. INSPECT EFI RELAY

(a) Using an ohmmeter, measure the resistance according to the value(s) in the table below.

Standard resistance

Tester connection	Specified Condition
1E-9 - 1E-10	Below 1 Ω
1E-7 - 1E-12	10 kΩ or higher
1E-7 - 1E-12	Below 1 Ω (Battery voltage applied between terminals 1E-9 and 1E-10)

Engine Room R/B Unit D:



A137364E02

CIRCUIT OPENING RELAY

INSPECTION

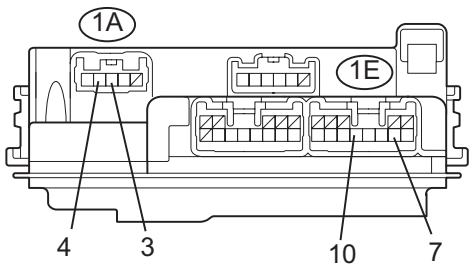
1. INSPECT CIRCUIT OPENING RELAY

(a) Using an ohmmeter, measure the resistance according to the value(s) in the table below.

Standard resistance

Tester connection	Specified Condition
1E-8 - 1E-12	Below 1 Ω
1E-7 - 1E-13	10 kΩ or higher
1E-7 - 1E-13	Below 1 Ω (Battery voltage applied between terminals 1E-8 and 1E-12)

Engine Room R/B Unit D:



A137364E03

AIR FUEL RATIO SENSOR RELAY

INSPECTION

1. INSPECT AIR FUEL RATIO SENSOR RELAY

(a) Using an ohmmeter, measure the resistance according to the value(s) in the table below.

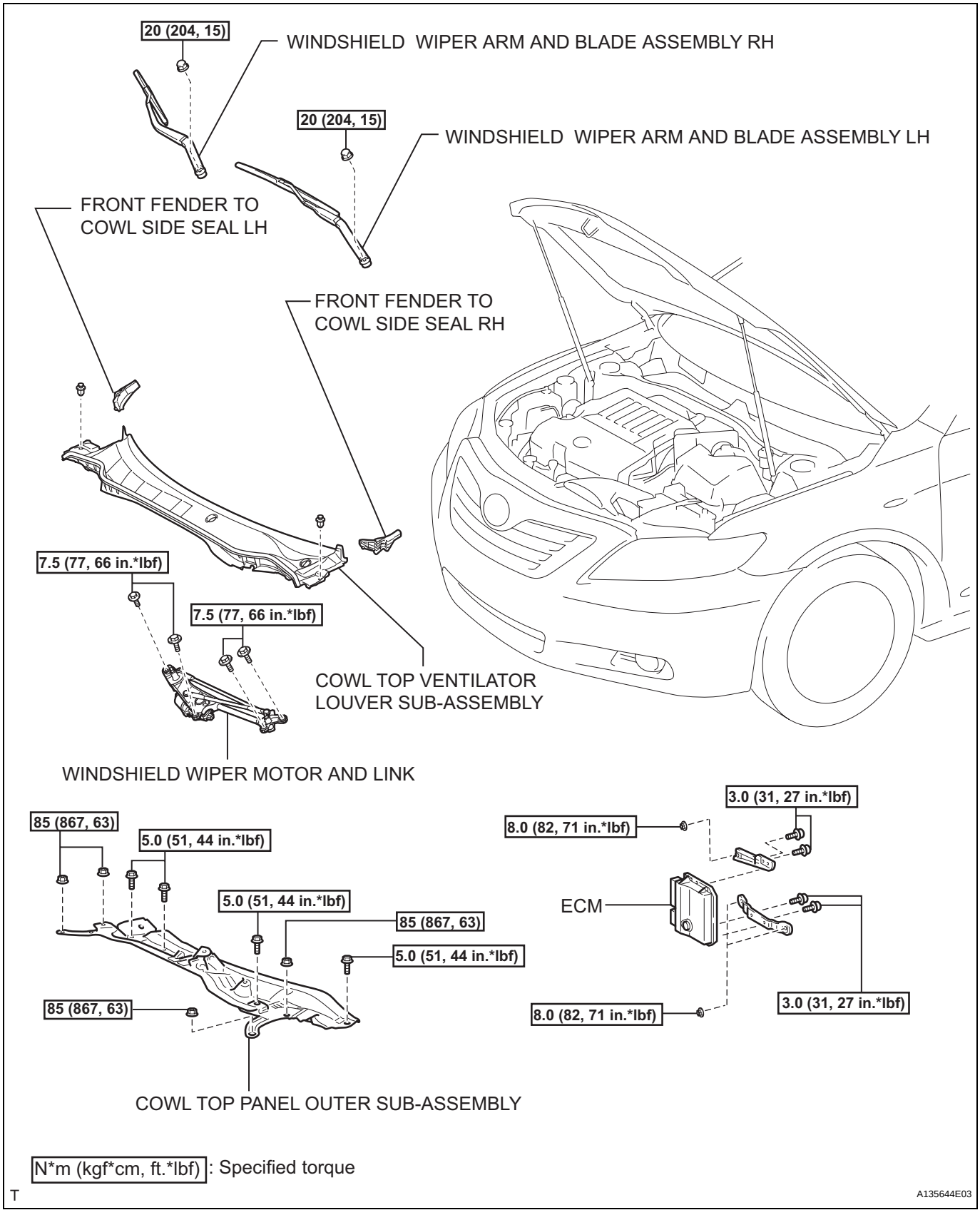
Standard resistance

Tester connection	Specified Condition
1E-7 - 1E-10	Below 1 Ω
1A-3 - 1A-4	10 kΩ or higher
1A-3 - 1A-4	Below 1 Ω (Battery voltage applied between terminals 1E-7 and 1E-10)

ES

ECM

COMPONENTS

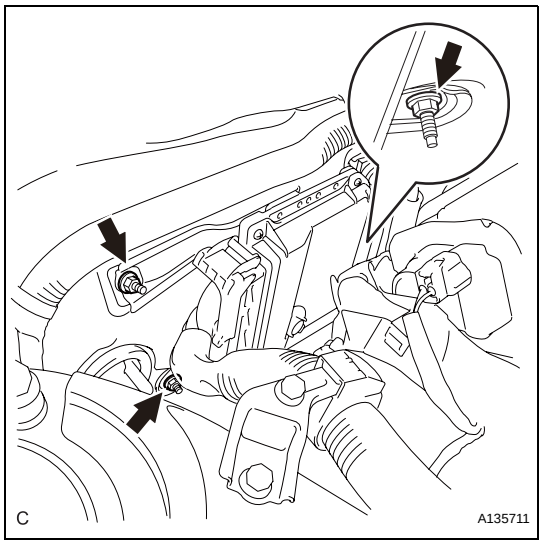


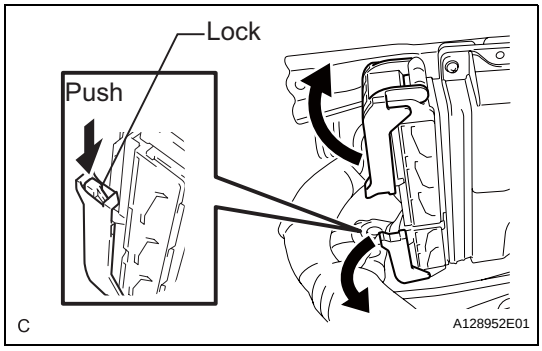
ES

REMOVAL

1. **REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-9)**
2. **REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-9)**
3. **REMOVE FRONT FENDER TO COWL SIDE SEAL LH (See page WW-9)**
4. **REMOVE FRONT FENDER TO COWL SIDE SEAL RH (See page WW-9)**
5. **REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-10)**
6. **REMOVE WINDSHIELD WIPER MOTOR AND LINK (See page WW-10)**
7. **REMOVE COWL TOP OUTER PANEL SUB-ASSEMBLY (See page ES-481)**
8. **REMOVE ECM**

(a) Remove the 3 nuts.



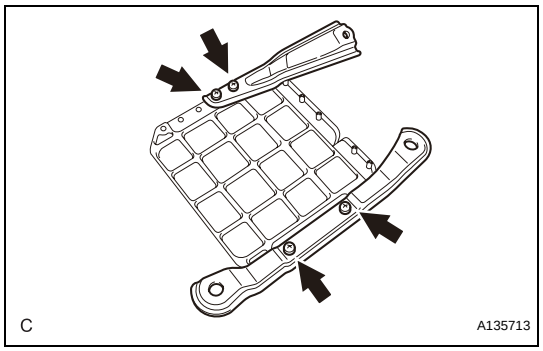


(b) Disconnect the 2 ECM connectors and remove the ECM.

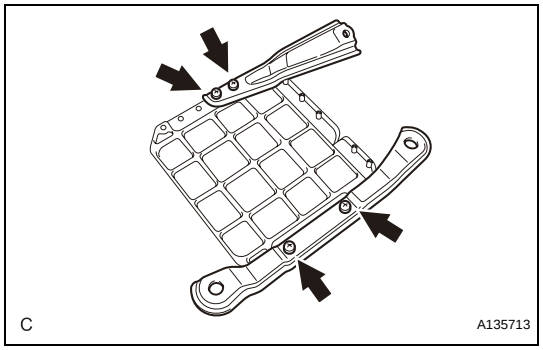
(1) Raise the 2 levers while pushing the locks on the 2 levers, and disconnect the 2 ECM connectors.

NOTICE:
After disconnecting the connector, make sure that dirt, water and other foreign matter do not contact the connecting part of the connector.

(2) Remove the ECM.



(c) Remove the 4 screws and 2 ECM brackets.



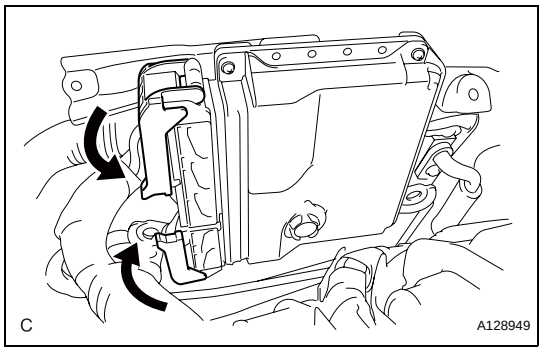
INSTALLATION

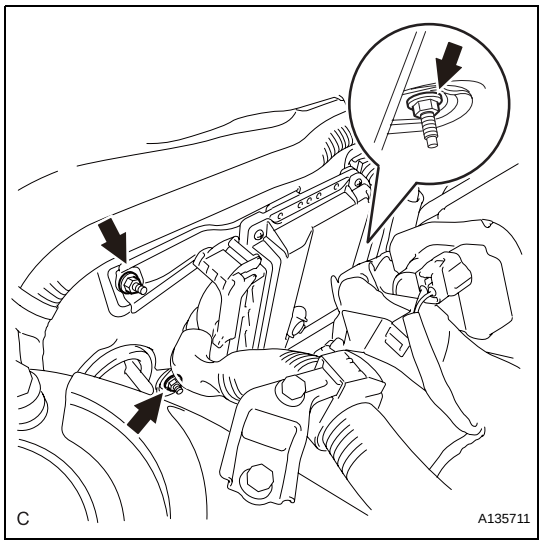
1. INSTALL ECM

(a) Install the ECM bracket with the 4 screws.
Torque: 3.0 N*m (31 kgf*cm, 27 in.*lbf)

(b) Connect the 2 ECM connectors.
NOTICE:
When connecting the connector, make sure that dirt, water and other foreign matter do not become stuck between the connector and other parts.

(1) Connect the 2 ECM connectors and lower the 2 levers.
NOTICE:
Make sure that the 2 levers are securely lowered.





(c) Install the ECM with the 3 nuts.
Torque: 8.0 N*m (82 kgf*cm, 71 in.*lbf)

2. INSTALL COWL TOP PANEL OUTER SUB-ASSEMBLY (See page ES-485)

3. INSTALL WINDSHIELD WIPER MOTOR AND LINK (See page WW-14)

4. INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-15)

5. INSTALL FRONT FENDER TO COWL SIDE SEAL RH (See page WW-15)

6. INSTALL FRONT FENDER TO COWL SIDE SEAL LH (See page WW-15)

7. INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-15)

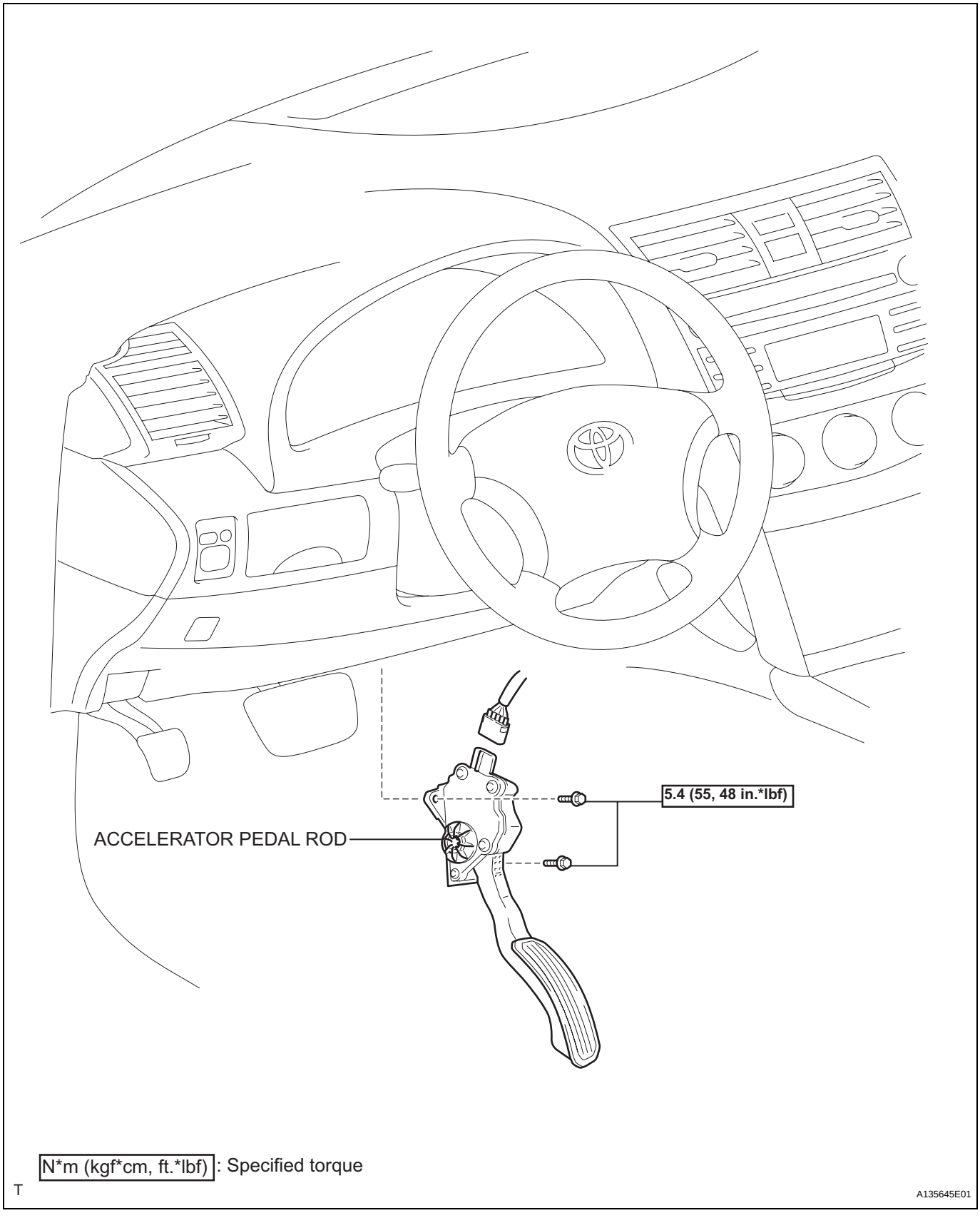
8. INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-16)

9. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL (See page EM-51)

ACCELERATOR PEDAL

COMPONENTS

ES



N*m (kgf*cm, ft.*lbf): Specified torque

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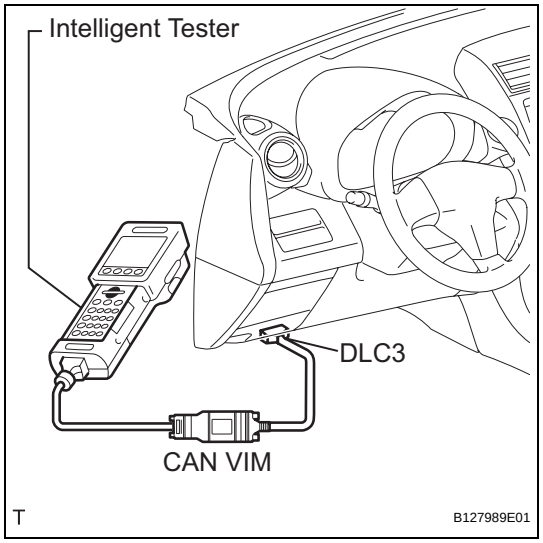


ON-VEHICLE INSPECTION

1. CHECK ACCELERATOR PEDAL ROD

(a) Measure the voltage.

(1) Connect the intelligent tester to the DLC3.

(2) Turn the ignition switch on (IG).

(3) Turn the intelligent tester ON.

(4) Select the menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / ACCEL POS #1, ACCEL POS #2.

(5) Operate the accelerator pedal, and then check that the ACCEL POS #1 and ACCEL POS #2 values are within the specifications.

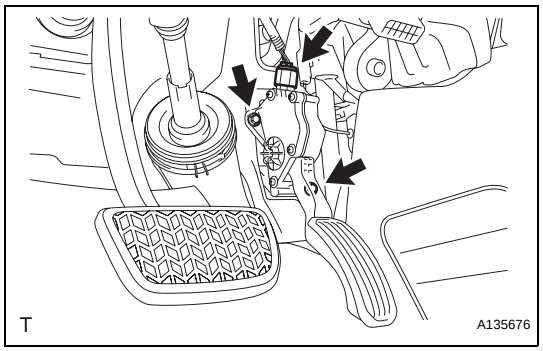
Standard voltage (ACCEL POS #1)

Accelerator Pedal Condition	Specified Condition
Released	0.5 to 1.1 V
Depressed	2.5 to 4.5 V

Standard voltage (ACCEL POS #2)

Accelerator Pedal Condition	Specified Condition
Released	1.2 to 2.0 V
Depressed	3.4 to 5.0 V

If the result is not as specified, check the accelerator pedal rod, wire harness or ECM.



REMOVAL

1. REMOVE ACCELERATOR PEDAL

(a) Disconnect the accelerator pedal connector.

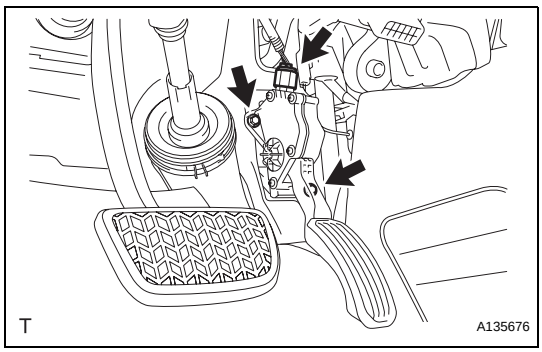
(b) Remove the 2 bolts and the accelerator pedal assembly.

INSTALLATION

1. INSTALL ACCELERATOR PEDAL

NOTICE:

- **Avoid physical shock to the accelerator pedal assembly.**
- **Do not disassemble the accelerator pedal assembly.**



(a) Install the accelerator pedal assembly with the 2 bolts.

Torque: 5.4 N*m (55 kgf*cm, 48 in.*lbf)

(b) Connect the accelerator pedal connector.