SFI SYSTEM

PRECAUTION

1. **INITIALIZATION**
   NOTICE:
   - **When disconnecting the negative (-) battery cable, initialize the following system after the cable is reconnected.**

System Name	See procedure
Power Window Control	IN-29
Sliding Roof System	IN-29

   - **Perform the RESET MEMORY (AT initialization) when replacing the automatic transaxle assembly, engine assembly or ECM (See page AX-15).**
   - **Perform the REGISTRATION (VIN registration) when replacing the ECM (See page ES-19).**

   HINT:
   Initialization can not be completed by only removing the battery.

2. **FOR USING INTELLIGENT TESTER**
   CAUTION:
   Observe the following items for safety reasons:
   - **Read its instruction books before using the tester.**
   - **Prevent the tester cable from being caught on the pedals, shift lever and steering wheel when driving with the tester connected to the vehicle.**
   - **When driving the vehicle for testing purposes using the tester, two persons are required. One is for driving the vehicle, and the other operates the tester.**

3. **EXPRESSIONS OF IGNITION SWITCH**
   (a) The type of ignition switch used on this model differs according to the specifications of the vehicle. The expressions listed in the table below are used in this section.

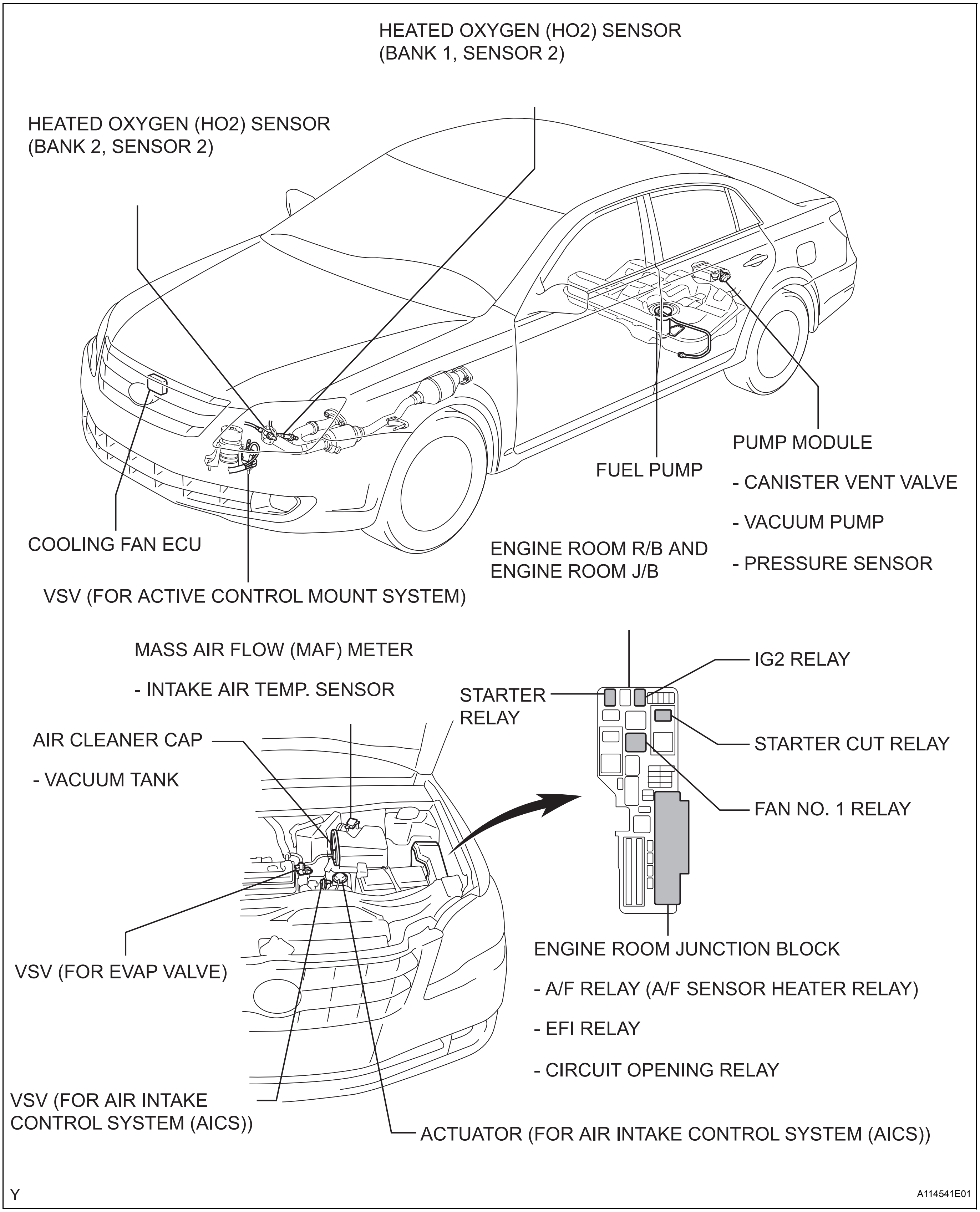
Switch Type		Ignition Switch (position)	Engine Switch (condition)
Expression	Ignition Switch off	LOCK	Off
	Ignition Switch on (IG)	ON	On (IG)
	Ignition Switch on (ACC)	ACC	On (ACC)
	Engine Start	START	Start

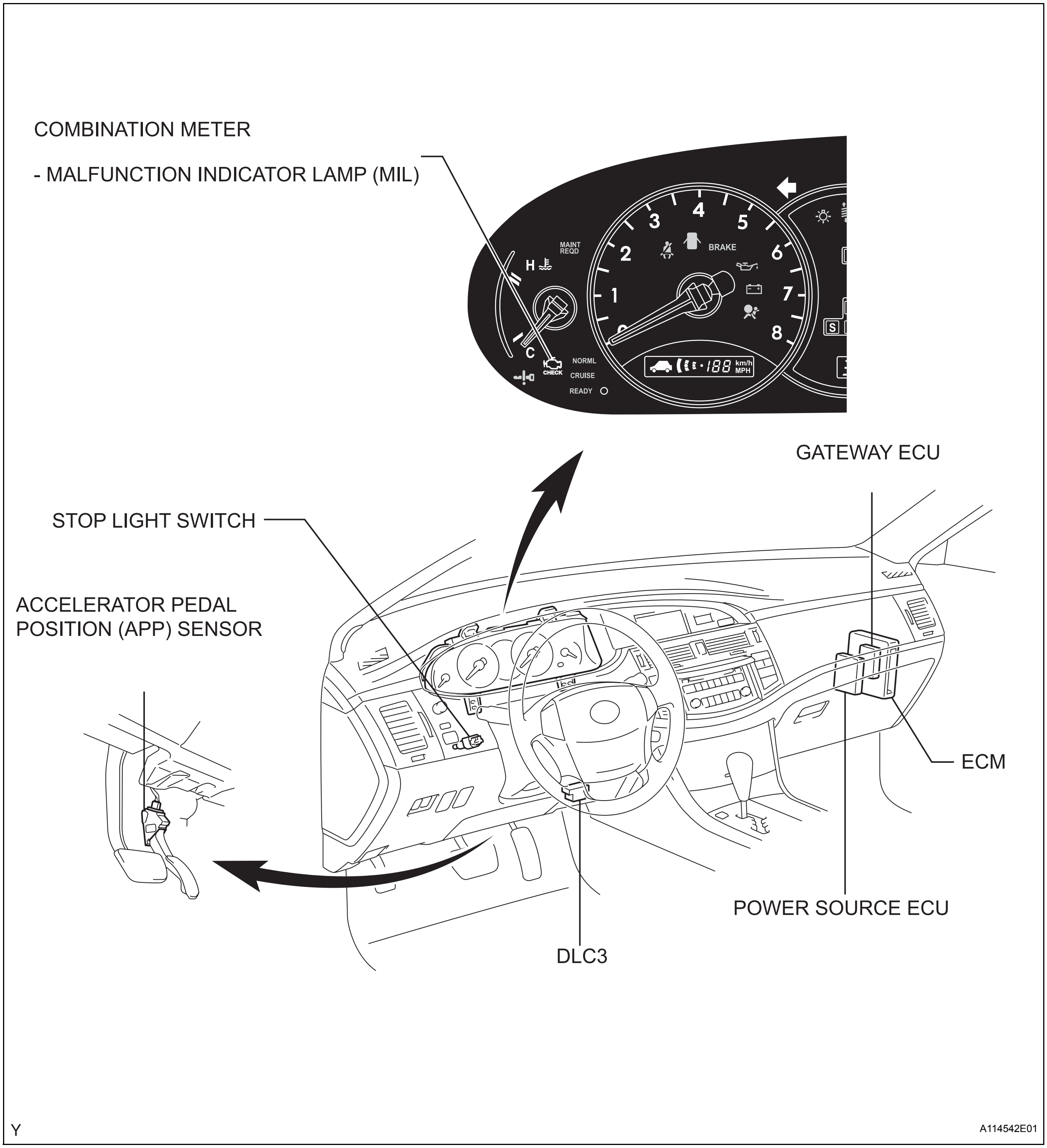
4. **FOR USING BATTERY DURING INSPECTION**
   (a) While using the battery during inspection, do not bring the positive and negative tester probes too close to each other as a short circuit may occur.

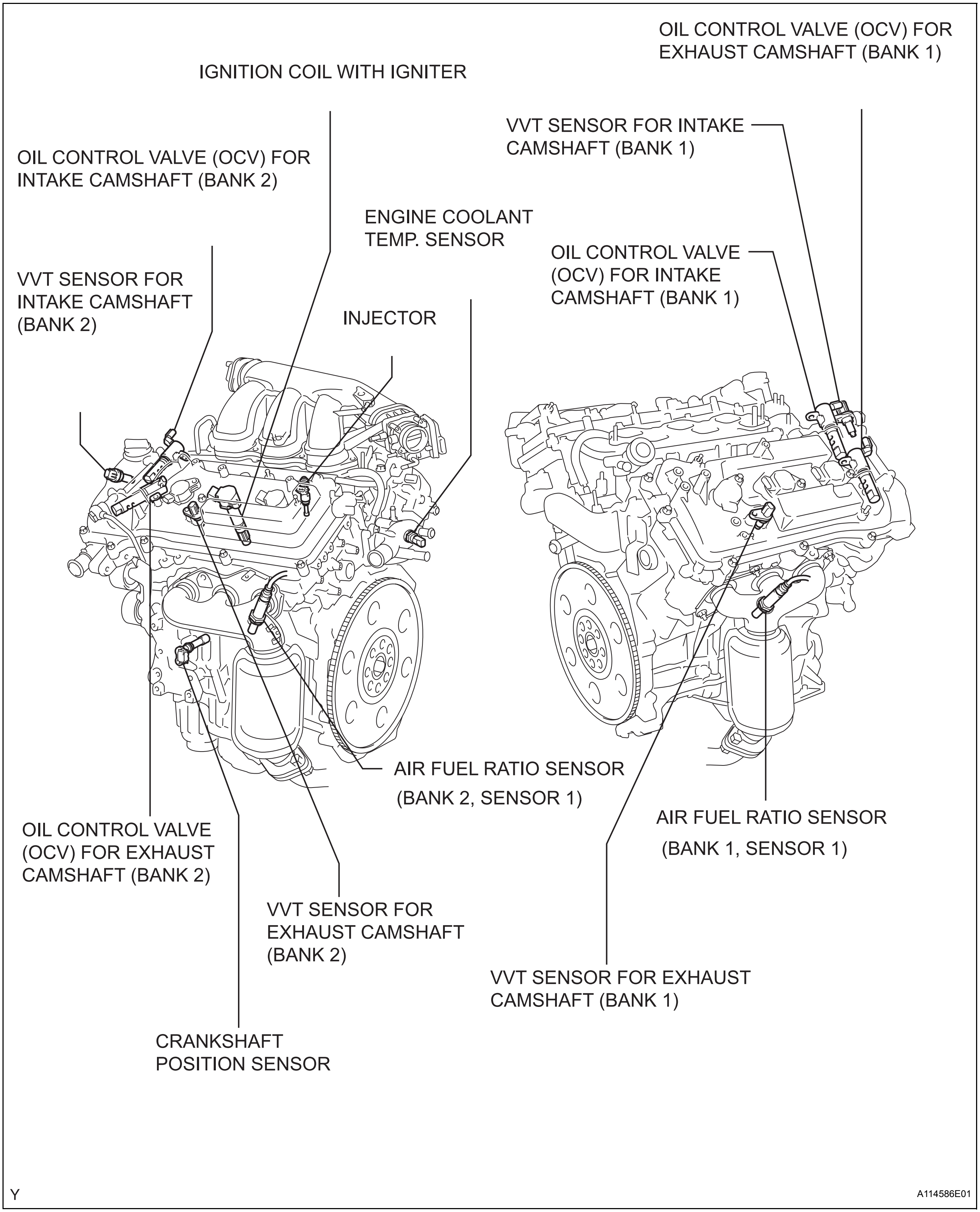
DEFINITION OF TERMS

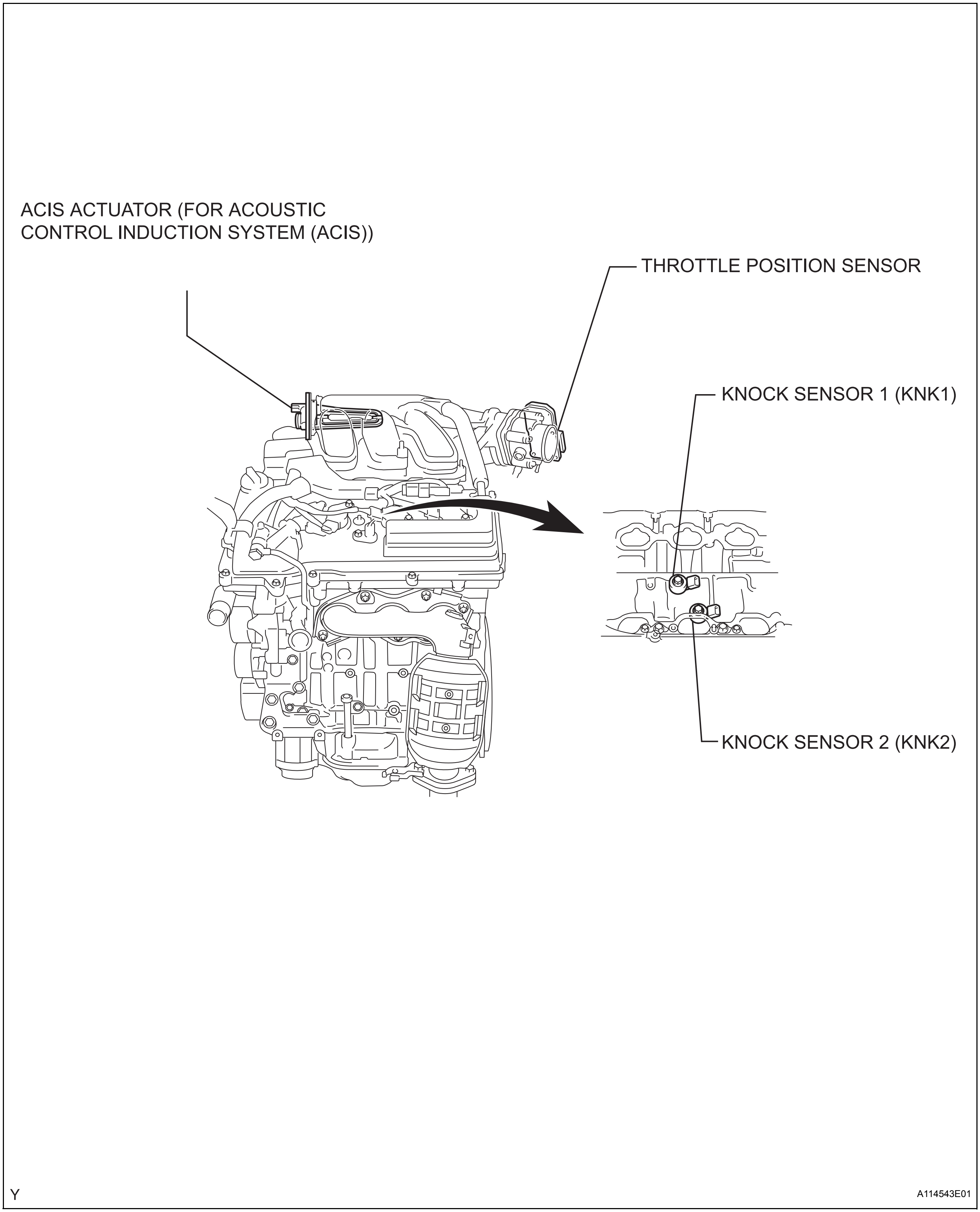
Terms	Definitions
Monitor Description	Description of what ECM monitors and how to detect malfunctions (monitoring purpose and details).
Related DTCs	A group of diagnostic trouble codes that are output by ECM based on the same malfunction detection logic.
Typical Enabling Conditions	Preconditions that allow ECM to detect malfunction. 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 involved in single malfunction detection process. Each sensor and component monitored in turn and not monitored until previous detection operation is completed.
Required Sensors / 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 ECM only performs checks for that malfunction once during single driving cycle. "Continuous" means ECM performs checks for that malfunction 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	Values, beyond which, ECM determines malfunctions exist and sets DTCs.
MIL Operation	Timing of MIL illumination after defect is detected. "Immediate" means ECM illuminates MIL as soon as malfunction is detected. "2 driving cycles" means ECM illuminates MIL if the same malfunction is detected twice during the next sequential driving cycle.

PARTS LOCATION



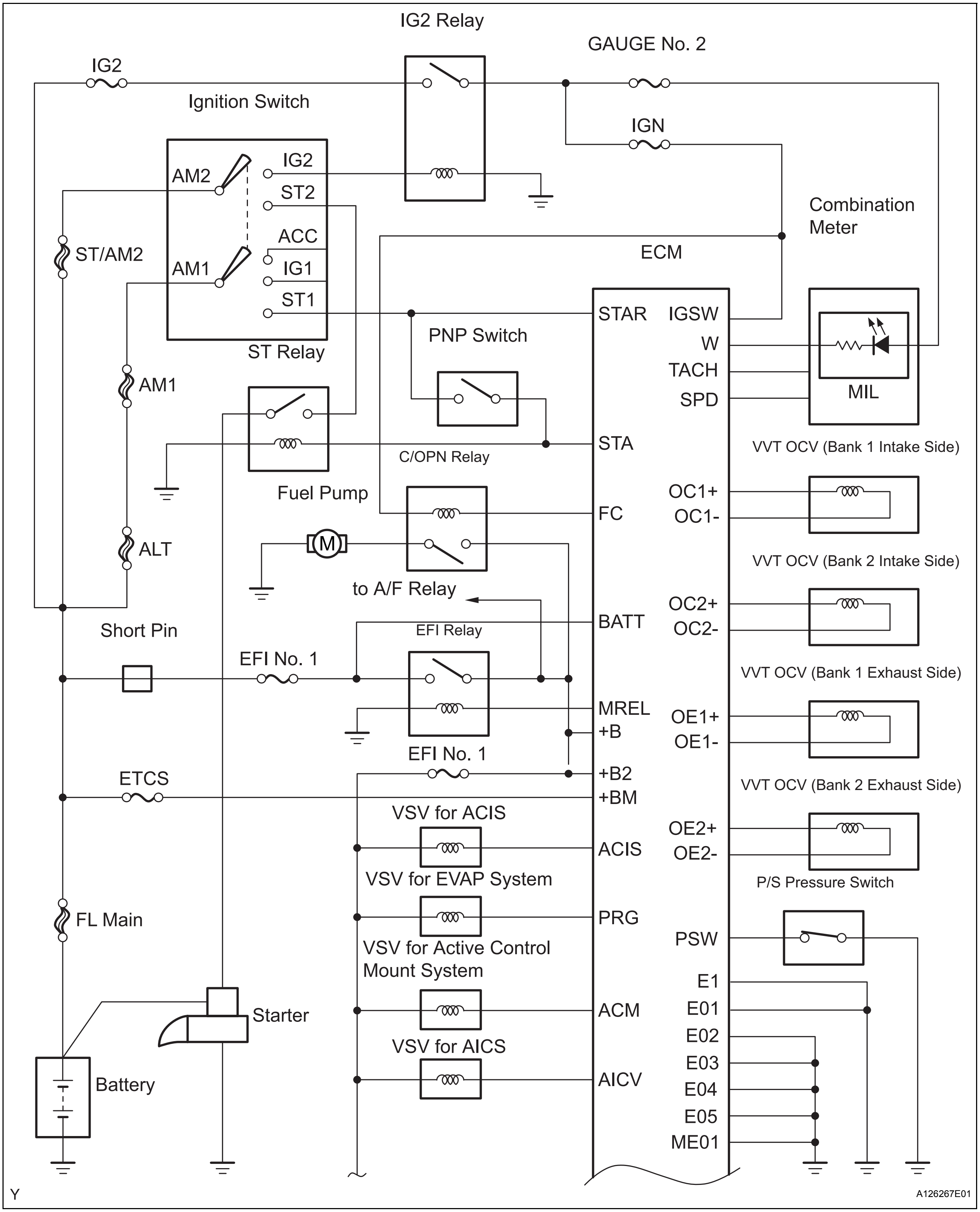

COMBINATION METER
- MALFUNCTION INDICATOR LAMP (MIL)
GATEWAY ECU
STOP LIGHT SWITCH
ACCELERATOR PEDAL POSITION (APP) SENSOR
ECM
POWER SOURCE ECU
DLC3
Y
A114542E01


OIL CONTROL VALVE (OCV) FOR EXHAUST CAMSHAFT (BANK 1)
IGNITION COIL WITH IGNITER
VVT SENSOR FOR INTAKE CAMSHAFT (BANK 1)
OIL CONTROL VALVE (OCV) FOR INTAKE CAMSHAFT (BANK 2)
ENGINE COOLANT TEMP. SENSOR
OIL CONTROL VALVE (OCV) FOR INTAKE CAMSHAFT (BANK 1)
VVT SENSOR FOR INTAKE CAMSHAFT (BANK 2)
INJECTOR
AIR FUEL RATIO SENSOR (BANK 2, SENSOR 1)
AIR FUEL RATIO SENSOR (BANK 1, SENSOR 1)
OIL CONTROL VALVE (OCV) FOR EXHAUST CAMSHAFT (BANK 2)
VVT SENSOR FOR EXHAUST CAMSHAFT (BANK 2)
VVT SENSOR FOR EXHAUST CAMSHAFT (BANK 1)
CRANKSHAFT POSITION SENSOR
Y
A114586E01

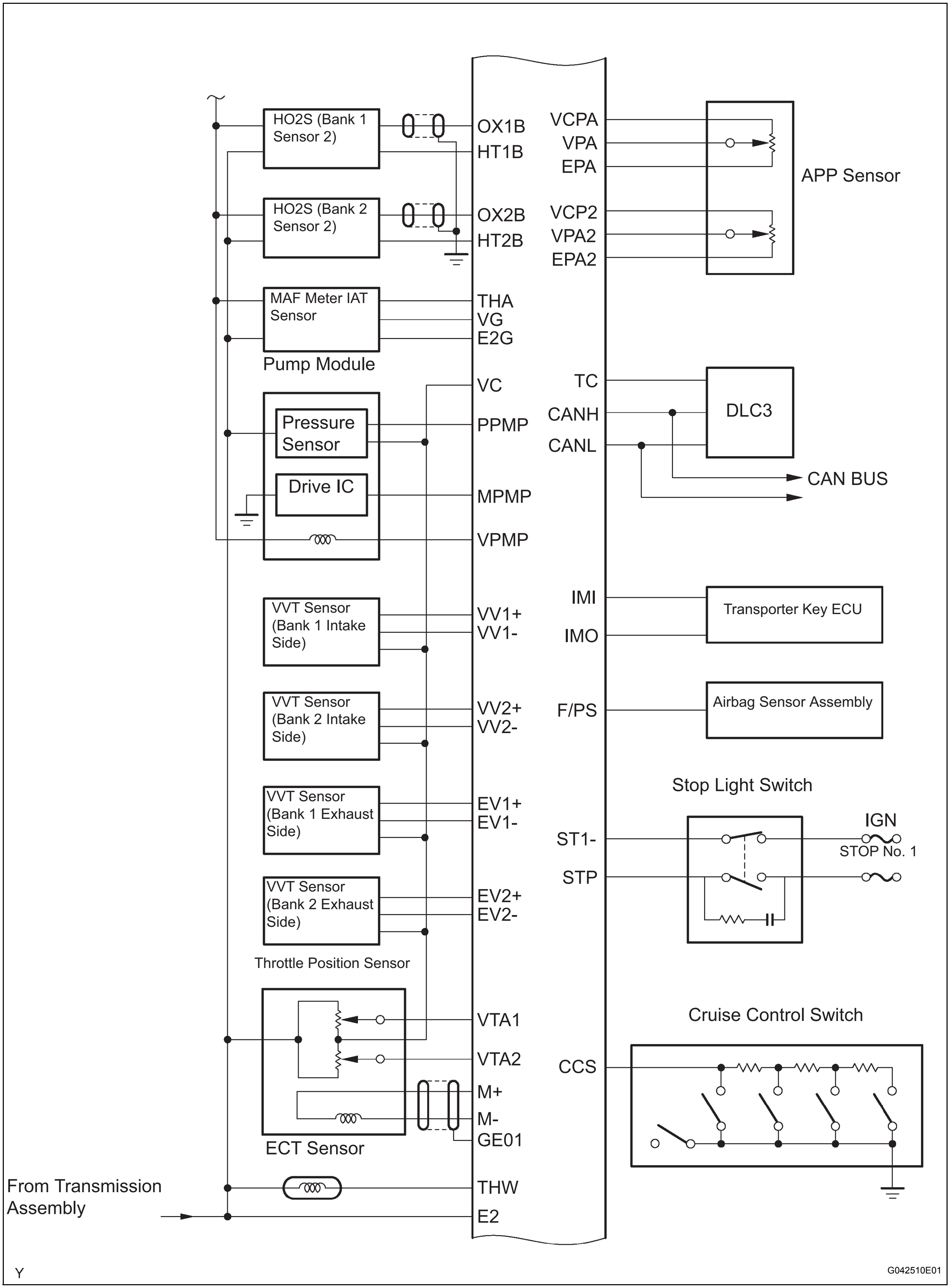

ACIS ACTUATOR (FOR ACOUSTIC
CONTROL INDUCTION SYSTEM (ACIS))
THROTTLE POSITION SENSOR
KNOCK SENSOR 1 (KNK1)
KNOCK SENSOR 2 (KNK2)
Y
A114543E01

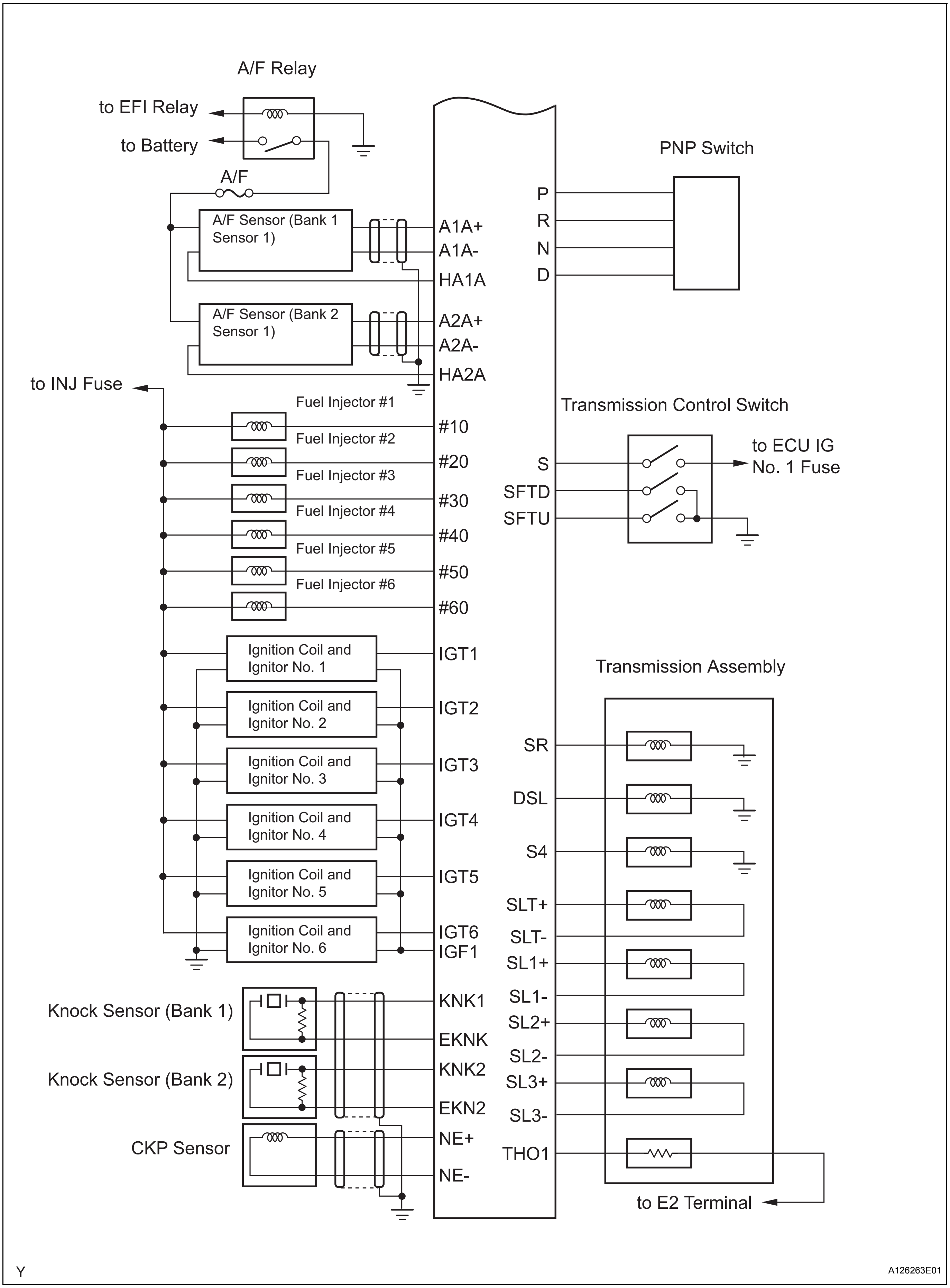
SYSTEM DIAGRAM

1. Without Smart Key System:



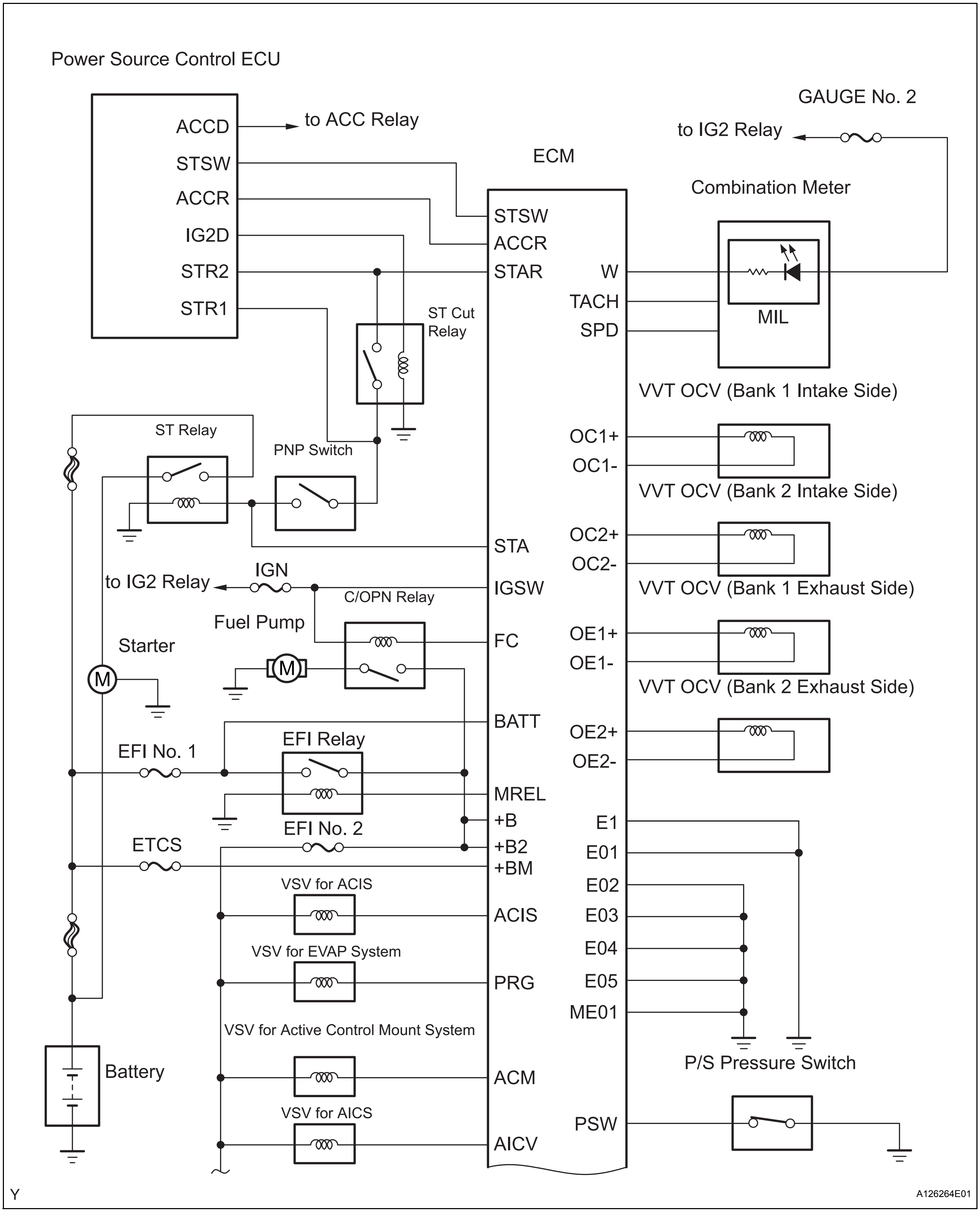
ES

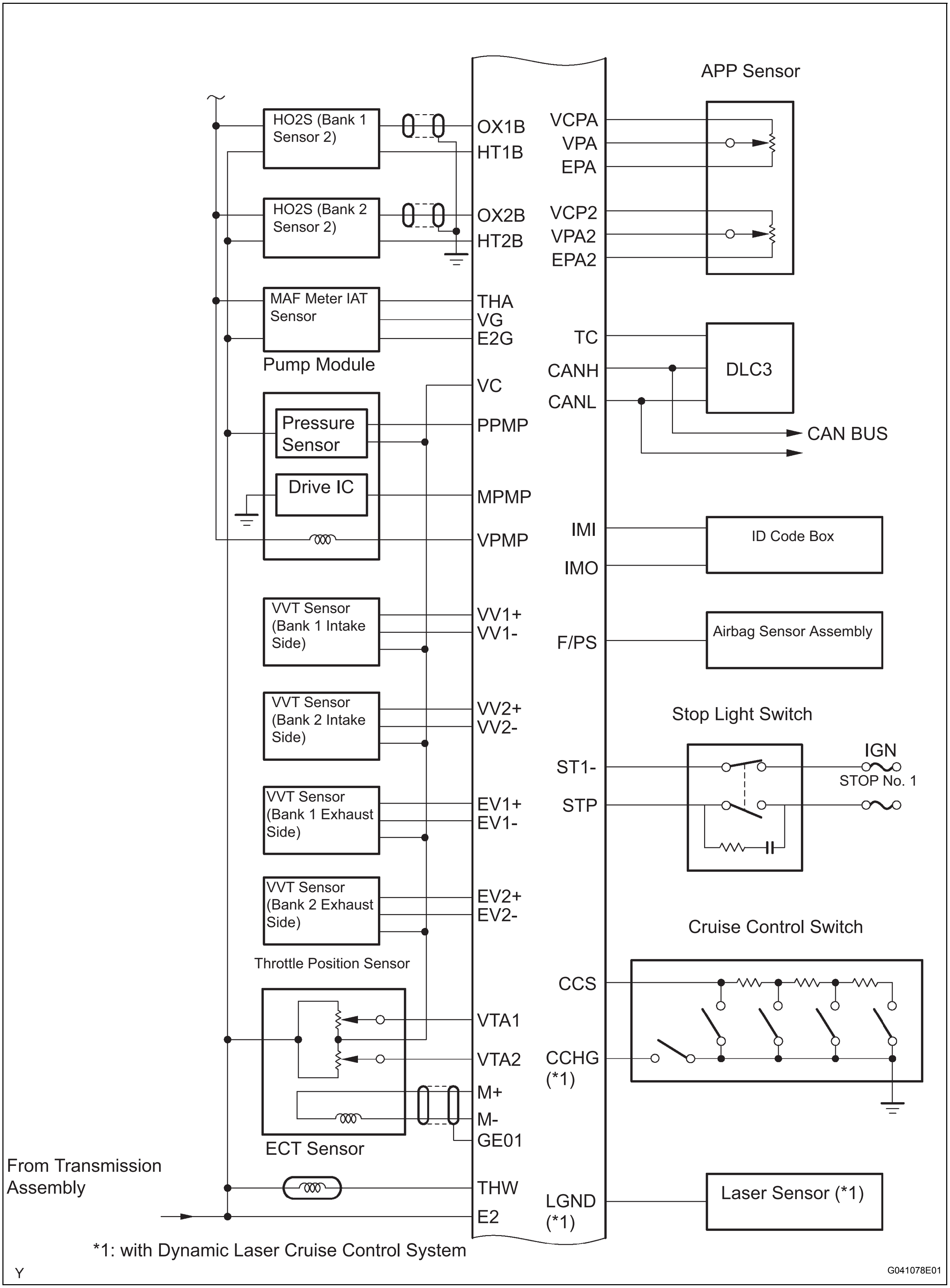

HO2S (Bank 1 Sensor 2)
HO2S (Bank 2 Sensor 2)
MAF Meter IAT Sensor
Pump Module
Pressure Sensor
Drive IC
VVT Sensor (Bank 1 Intake Side)
VVT Sensor (Bank 2 Intake Side)
VVT Sensor (Bank 1 Exhaust Side)
VVT Sensor (Bank 2 Exhaust Side)
Throttle Position Sensor
ECT Sensor
From Transmission Assembly
OX1B
HT1B
OX2B
HT2B
THA
VG
E2G
VC
PPMP
MPMP
VPMP
VV1+
VV1-
VV2+
VV2-
EV1+
EV1-
EV2+
EV2-
VTA1
VTA2
M+
M-
GE01
THW
E2
VCPA
VPA
EPA
VCP2
VPA2
EPA2
APP Sensor
TC
CANH
CANL
DLC3
CAN BUS
IMI
IMO
Transporter Key ECU
F/PS
Airbag Sensor Assembly
Stop Light Switch
IGN
STOP No. 1
ST1-
STP
Cruise Control Switch
CCS
Y
G042510E01

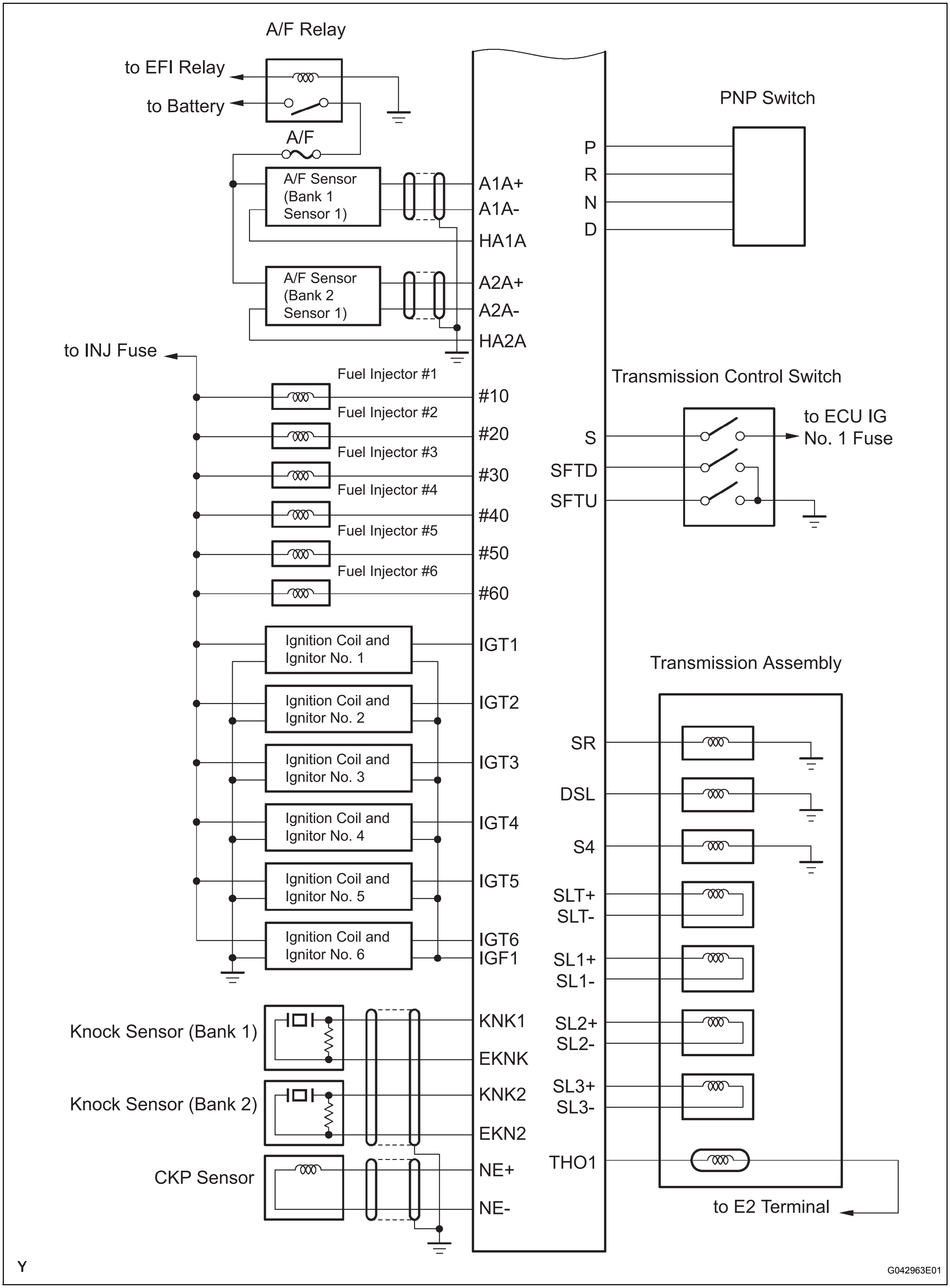

A/F Relay
to EFI Relay
to Battery
A/F
A/F Sensor (Bank 1 Sensor 1)
A/F Sensor (Bank 2 Sensor 1)
to INJ Fuse
Fuel Injector #1
Fuel Injector #2
Fuel Injector #3
Fuel Injector #4
Fuel Injector #5
Fuel Injector #6
Ignition Coil and Ignitor No. 1
Ignition Coil and Ignitor No. 2
Ignition Coil and Ignitor No. 3
Ignition Coil and Ignitor No. 4
Ignition Coil and Ignitor No. 5
Ignition Coil and Ignitor No. 6
Knock Sensor (Bank 1)
Knock Sensor (Bank 2)
CKP Sensor
A1A+
A1A-
HA1A
A2A+
A2A-
HA2A
#10
#20
#30
#40
#50
#60
IGT1
IGT2
IGT3
IGT4
IGT5
IGT6
IGF1
KNK1
EKNK
KNK2
EKN2
NE+
NE-
P
R
N
D
PNP Switch
Transmission Control Switch
S
SFTD
SFTU
to ECU IG No. 1 Fuse
Transmission Assembly
SR
DSL
S4
SLT+
SLT-
SL1+
SL1-
SL2+
SL2-
SL3+
SL3-
THO1
to E2 Terminal
Y
A126263E01

ES

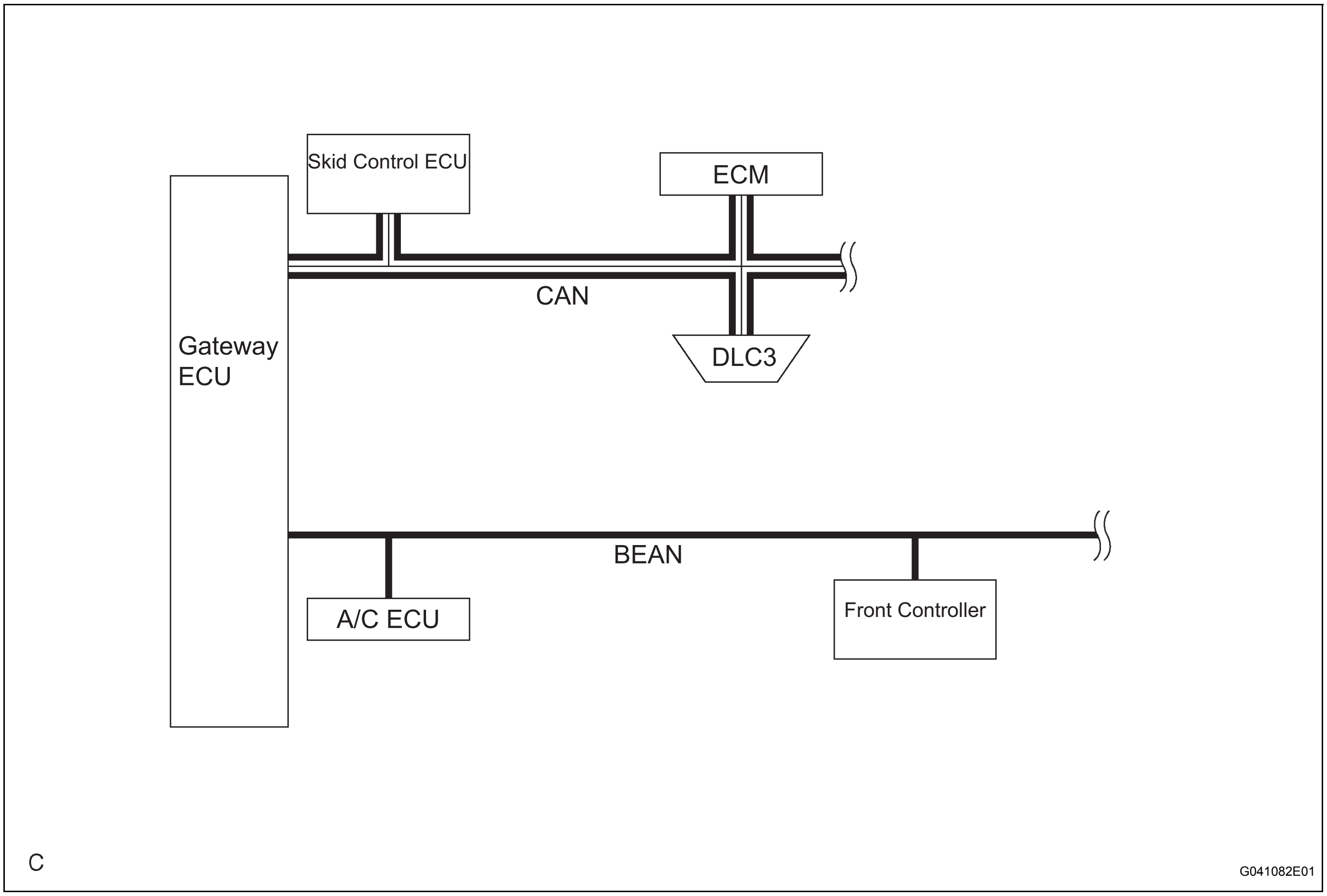
2. With Smart Key System:




HO2S (Bank 1 Sensor 2)
HO2S (Bank 2 Sensor 2)
MAF Meter IAT Sensor
Pump Module
Pressure Sensor
Drive IC
VVT Sensor (Bank 1 Intake Side)
VVT Sensor (Bank 2 Intake Side)
VVT Sensor (Bank 1 Exhaust Side)
VVT Sensor (Bank 2 Exhaust Side)
Throttle Position Sensor
ECT Sensor
From Transmission Assembly
OX1B
HT1B
OX2B
HT2B
THA
VG
E2G
VC
PPMP
MPMP
VPMP
VV1+
VV1-
VV2+
VV2-
EV1+
EV1-
EV2+
EV2-
VTA1
VTA2
M+
M-
GE01
THW
E2
VCPA
VPA
EPA
VCP2
VPA2
EPA2
TC
CANH
CANL
IMI
IMO
F/PS
ST1-
STP
CCS
CCHG (*1)
LGND (*1)
APP Sensor
DLC3
CAN BUS
ID Code Box
Airbag Sensor Assembly
Stop Light Switch
IGN
STOP No. 1
Cruise Control Switch
Laser Sensor (*1)
*1: with Dynamic Laser Cruise Control System
Y
G041078E01


A/F Relay
to EFI Relay
to Battery
A/F
A/F Sensor (Bank 1 Sensor 1)
A/F Sensor (Bank 2 Sensor 1)
A1A+
A1A-
HA1A
A2A+
A2A-
HA2A
PNP Switch
P
R
N
D
to INJ Fuse
Fuel Injector #1
Fuel Injector #2
Fuel Injector #3
Fuel Injector #4
Fuel Injector #5
Fuel Injector #6
#10
#20
#30
#40
#50
#60
Transmission Control Switch
to ECU IG No. 1 Fuse
S
SFTD
SFTU
Ignition Coil and Ignitor No. 1
Ignition Coil and Ignitor No. 2
Ignition Coil and Ignitor No. 3
Ignition Coil and Ignitor No. 4
Ignition Coil and Ignitor No. 5
Ignition Coil and Ignitor No. 6
IGT1
IGT2
IGT3
IGT4
IGT5
IGT6
IGF1
Transmission Assembly
SR
DSL
S4
SLT+
SLT-
SL1+
SL1-
SL2+
SL2-
SL3+
SL3-
THO1
to E2 Terminal
Knock Sensor (Bank 1)
Knock Sensor (Bank 2)
CKP Sensor
KNK1
EKNK
KNK2
EKN2
NE+
NE-
Y
G042963E01

3. COMMUNICATION WITH OTHER COMPUTERS



4. COMMUNICATIONS

(a) The ECM communicates with the following ECU using the signals listed below. The following table explains receiving and sending signals by the ECM or ECU.

Transmitter	Receiver	Signal	Communication Line
ECM	Front Controller	Radiator cooling fan control signal	CAN → BEAN
ECM	A/C ECU	A/C control signal (compressor control for turning off) A/C and engine co-operation control signal (compressor control for deceleration)	CAN → BEAN
A/C ECU	ECM	Idle up request signal	BEAN → CAN
Skid control ECU	ECM	Throttle closing request signal Ignition retard angle request signal Engine torque reduction request signal	CAN

HOW TO PROCEED WITH TROUBLESHOOTING

HINT:
The intelligent tester can be used in steps 2, 3, 4, 6 and 9.

1	VEHICLE BROUGHT TO WORKSHOP

NEXT

2	CONNECT INTELLIGENT TESTER TO DLC3

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

NEXT

3	CHECK DTC AND FREEZE FRAME DATA

(a) Check the DTC(s) and freeze frame data (See page ES-45).
HINT:
Record or print DTCs and freeze frame data, if necessary.

NEXT

4	CLEAR DTC AND FREEZE FRAME DATA

(a) Clear the DTC(s) and freeze frame data (See page ES-45).

NEXT

5	CONDUCT VISUAL INSPECTION

NEXT

6	SET CHECK MODE DIAGNOSIS

(a) Set the check mode (See page ES-48).

NEXT

7	CONFIRM PROBLEM SYMPTOMS

HINT:
If the engine does not start, perform steps 9 and 11 first.

Result

Result	Proceed to
Malfunction does not occur	A
Malfunction occurs	B

B → **GO TO STEP 9**

A

8 SIMULATE SYMPTOMS

NEXT

9 CHECK DTC

(a) Check the DTC (See page ES-44).

Result

Result	Proceed to
Trouble code	A
No code	B

B → **GO TO STEP 11**

A

10 REFER TO DTC CHART

HINT:

Refer to the DTC chart (See page ES-60).

NEXT

GO TO STEP 13

11 CONDUCT BASIC INSPECTION

HINT:

Refer to "BASIC INSPECTION" (See page ES-17).

Result

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

B → **GO TO STEP 16**

A

12 REFER TO PROBLEM SYMPTOMS TABLE

HINT:
Refer to "PROBLEM SYMPTOMS TABLE" (See page ES-30).

Result

Result	Proceed to
Malfunctioning circuit confirmed	A
Malfunctioning parts confirmed	B

B → GO TO STEP 16

ES

A

13 CHECK ECM POWER SOURCE CIRCUIT

HINT:
Refer to "ECM POWER SOURCE CIRCUIT" (See page ES-395).

NEXT

14 CONDUCT CIRCUIT INSPECTION

Result

Result	Proceed to
Malfunction not confirmed	A
Malfunction confirmed	B

B → GO TO STEP 17

A

15 CHECK FOR INTERMITTENT PROBLEMS

HINT:
Refer to "CHECK FOR INTERMITTENT PROBLEMS" (See page ES-17).

NEXT

GO TO STEP 17

16 CONDUCT PARTS INSPECTION

NEXT

17	IDENTIFY PROBLEM

NEXT

18	ADJUST AND/OR REPAIR

NEXT

19	CONDUCT CONFIRMATION TEST

NEXT

END

CHECK FOR INTERMITTENT PROBLEMS

1. CHECK FOR INTERMITTENT PROBLEMS

HINT:

For use of the intelligent tester only:

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.

(a) Clear DTCs (See page ES-44).

(b) Switch the ECM from normal mode to check mode using an intelligent tester (See page ES-48).

(c) Perform a simulation test (See page IN-31).

(d) Check and wiggle the harness(es), connector(s) and terminal(s) (See page IN-36).

BASIC INSPECTION

When a 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 engine troubleshooting.

1	CHECK BATTERY VOLTAGE

NOTICE:
Carry out this check with the engine stopped and ignition 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

(a) Check the idling speed (See page EM-2).

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

OK

6 CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-7).

NG → **TROUBLESHOOT FUEL PRESSURE AND PROCEED TO NEXT STEP**

OK

7 CHECK FOR SPARK

(a) Check for spark (See page IG-6).

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.

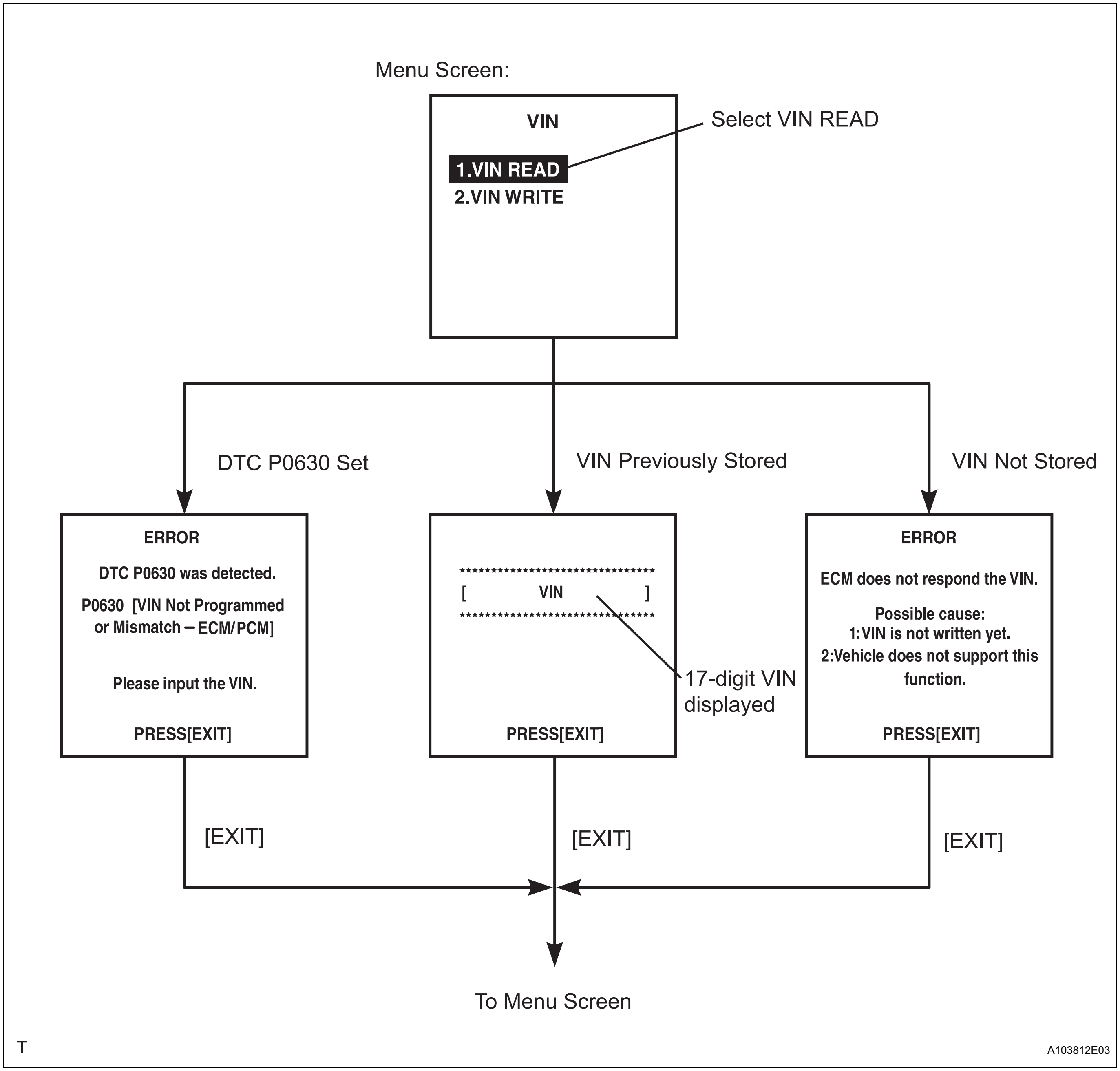
HINT:
The VIN is a 17-digit alphanumeric vehicle identification number. The intelligent tester is required to register the VIN.

1. **INPUT INSTRUCTIONS**
   (a) Explains the general VIN input instructions using the intelligent tester.
   (b) Intelligent tester
   The arrow buttons (UP, DOWN, RIGHT and LEFT) and numerical buttons (0 to 9) are used 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.
      (2) After selection, the cursor should move.
   (e) Numeric Character Input
      (1) Press the numerical button corresponding to the number that you want to input.
      (2) After input, the cursor should move.
      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 buttons.
      (2) Select or input the correct character using the UP/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) Explains the VIN reading process in a flowchart. Reading the VIN stored in the ECM is necessary when comparing it to the VIN provided with the vehicle.
   (b) Read VIN using the intelligent tester.
   (c) Check the vehicle's VIN.
   (d) Connect the intelligent tester to the DLC3.
   (e) Turn the ignition switch to ON.
   (f) Turn the tester ON.

ES

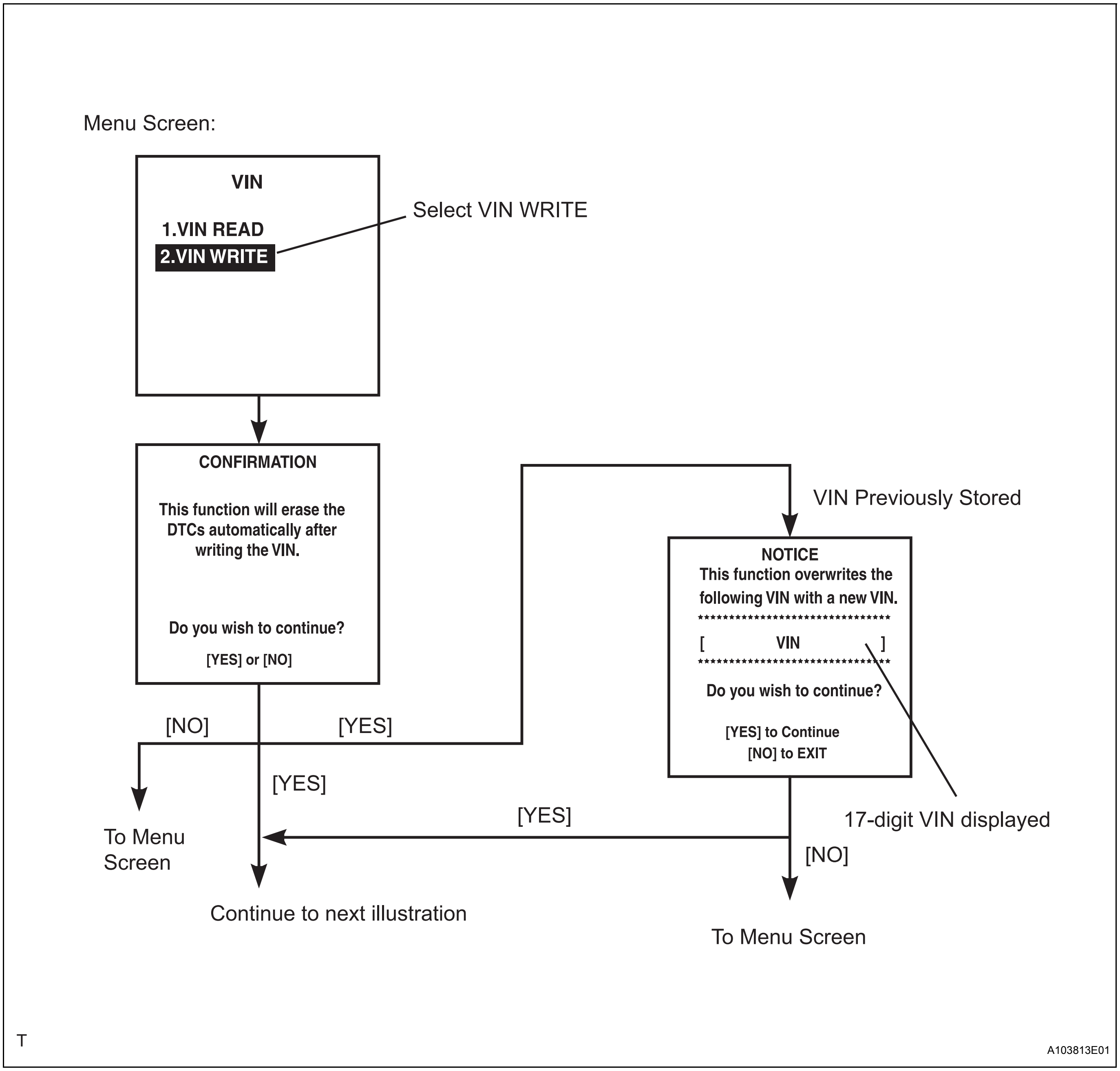
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / VIN.

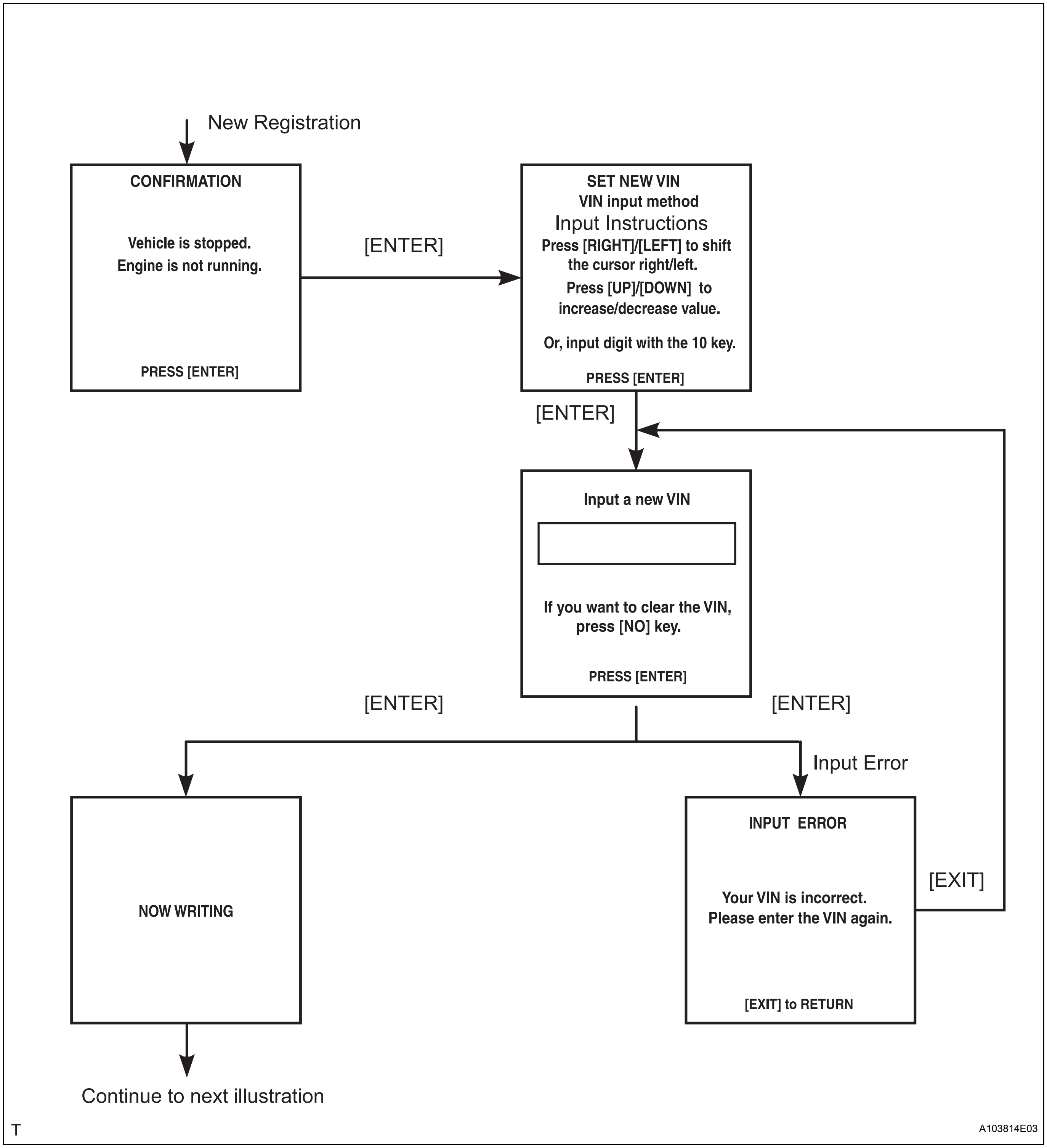


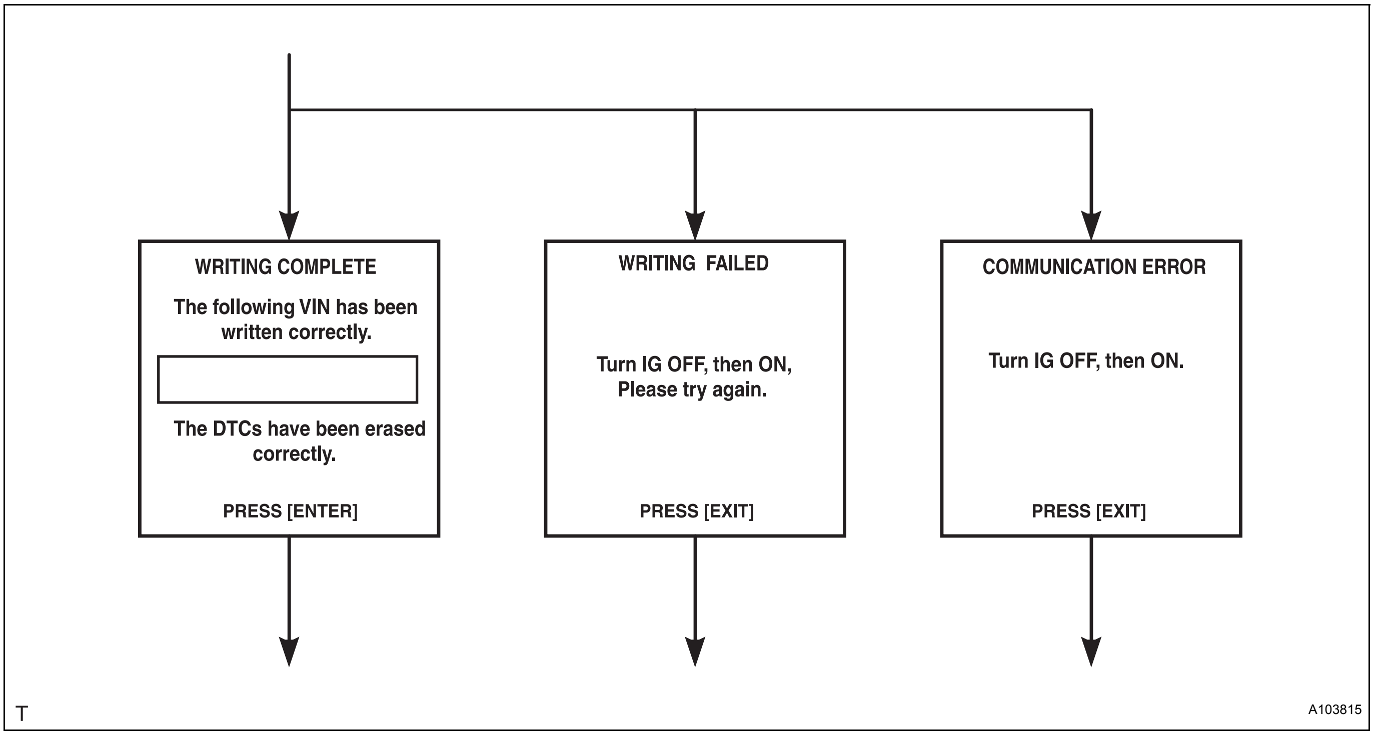
3. WRITE VIN

(a) Explains the VIN writing process in a flowchart. This process allows the VIN to be input into the ECM. If the ECM is changed, or the ECM VIN and Vehicle VIN 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) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch to ON.
(e) Turn the tester ON.

(f) 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


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]
T
A103815

O2S TEST RESULT

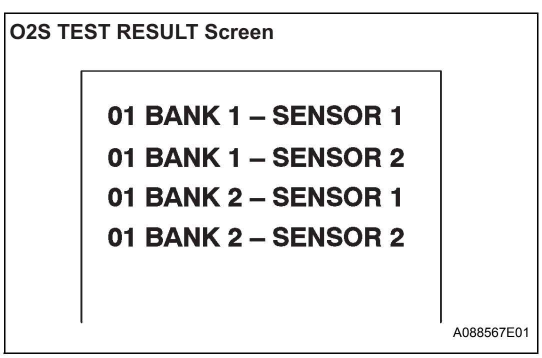
1. INTRODUCTION

(a) The O2S TEST RESULT refers to the results of the engine control module (ECM) when it monitors the oxygen sensor (O2S), and it can be read using the intelligent tester or the generic OBD II scan tool. Based on this, you can find the O2S's conditions. The ECM monitors the O2S in the various items. You can read the monitor result (TEST DATA) of each monitor item using the O2S TEST RESULT. However, the output value of the TEST DATA is the latest "snapshot" value that is taken after monitoring and therefore it is not dynamic.
In this repair manual, the description of the O2S TEST RESULT (for O2S related DTCs) are written in a table.
This table consists of 5 items:
1. TEST ID (a code applied to each TEST DATA)
2. Description of TEST DATA
3. Conversion Factor (When Conversion Factor has a value written in the table, multiply the TEST DATA value appearing on the scan tool by the Conversion Factor value. The result will be the required value.)
4. Unit
5. Standard Value

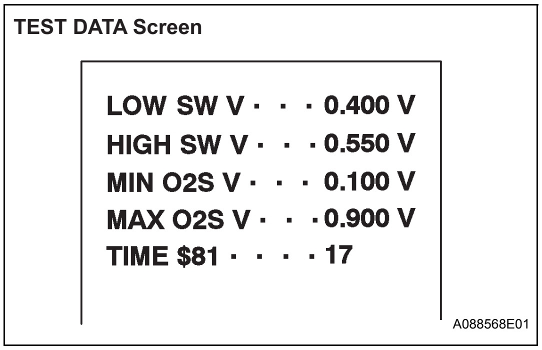
If the TEST DATA value appearing on the scan tool is out of the standard value, the O2S is malfunctioning. If it is within the standard value, the O2S is functioning normally. However, if the value is on the borderline of the standard value, the O2S may malfunction very soon.

2. HOW TO READ O2S TEST RESULT USING INTELLIGENT TESTER

(a) Connect the intelligent tester to the DLC3.



(b) On the tester screen, enter the following menus: DIAGNOSIS / CARB OBDII / O2S TEST RESULT. A list of the O2S equipped on the vehicle will be displayed.



(c) Select the desired O2S and press ENTER. The TEST DATA screen will appear.

(d) Press HELP and * simultaneously. More information will appear.

(e) Example:
   (1) The intelligent tester displays "17" as a value of the "TIME $81" (see the illustration) (step (1)).
   (2) Find the Conversion Factor value of "TIME $81" in the O2S TEST RESULT chart below. 0.3906 is specified for $81 in this chart (step (2)).
   (3) Multiply "17" in step (1) by 0.3906 (Conversion Factor) in the step (2).
   17 x 0.3906 = 6.6 %
   (4) If the answer is within the standard value, the "TIME $81" can be confirmed to be normal.

O2S TEST RESULT Chart

TEST ID	Description of TEST DATA	Conversion Factor	Unit	Standard Value
$81	Percentage of monitoring time when the O2S voltage is less than 0.05 V	Multiply 0.3906	%	Within 60%

CHECKING MONITOR STATUS

1. **Outline**
   (a) 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 finished monitoring, 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 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 test limit, the ECM determines the component is malfunctioning.
2. **Description**
   (a) The test value and test limit information are described as shown in the following table. This information is included under "MONITOR RESULT" in the emissions-related DTC sections:

Thermostat

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$E1	$E8	Multiply by 0.1 [°C]	ECT sensor output when estimated ECT reached to malfunction criteria	Malfunction criteria	Maximum test limit

   - MID (Monitor Identification Data) is assigned to each emissions-related component.
   - TID (Test Identification Data) is assigned to each test value.
   - Scaling is used to calculate the test value indicated on generic OBD II scan tools.
3. **Procedure (using intelligent tester)**
   (a) Connect the intelligent tester to the DLC3.
   (b) Turn the ignition switch on (IG).
   (c) Turn the tester or scan tool ON.
   (d) Clear DTCs.
   (e) Allow the vehicle to drive in accordance with the applicable drive pattern described in the READINESS MONITOR DRIVE PATTERN (See page ES-26).
   (f) Check the monitor result. Select the intelligent tester menus: DIAGNOSIS, ENHANCED OBD II, MONITOR INFO and MONITOR STATUS. The monitor result appears after the component name.
   - AVAIL indicates the component has not been monitored yet.

- COMPL indicates the component is functioning normally.
- INCMPL indicates the component is malfunctioning.

(g) Check the test value(s). Select the intelligent tester menus: DIAGNOSIS, ENHANCED OBD II, MONITOR INFO and TEST RESULT.

(h) Select the component and press ENTER. If the monitor result has been COMPL or INCMPL, the accuracy test value appears.

(i) Compare the test value with the test limits, MIN and MAX.

- If the test value is outside of the test limit, the component is malfunctioning.
- If the test value is on the borderline of the test limit, a malfunction is concealed in the component.

HINT:

The monitor result might on rare occasions be COMPL even if the Malfunction Indicator Lamp (MIL) is illuminated. This indicates the system malfunctioned on a previous driving cycle. This might be caused by an intermittent problem.

ES

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 during 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.

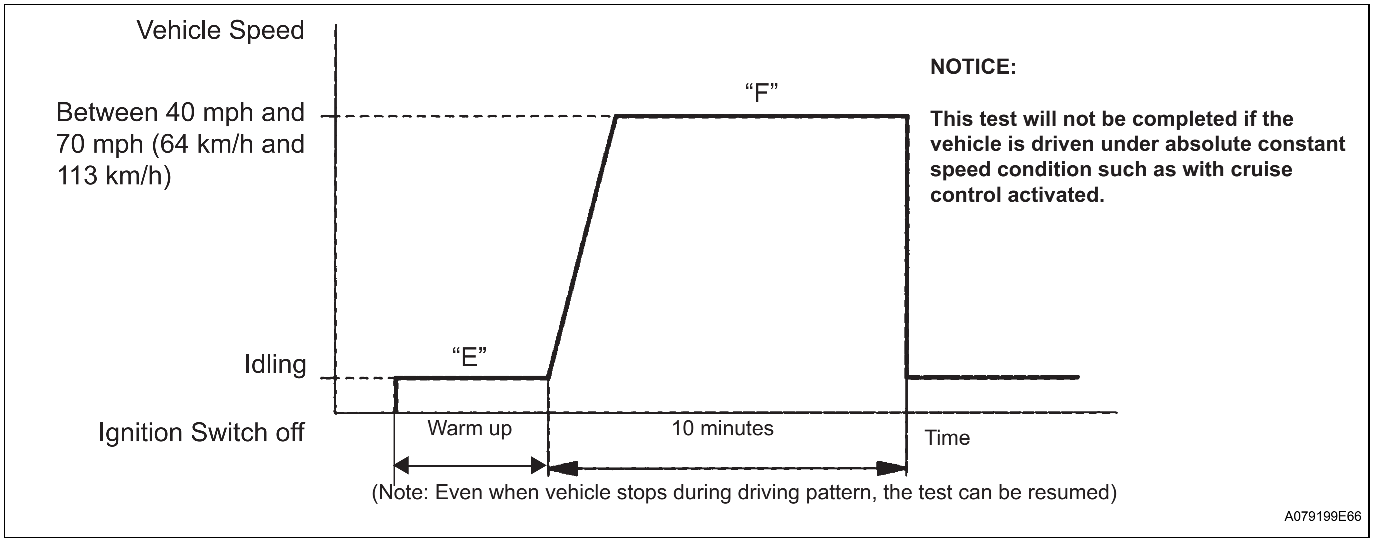
CAUTION:
Strictly observe posted speed limits, traffic laws, and road conditions when performing these drive patterns.

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).

Contents:

Steps	Section Titles
1	Catalyst Monitor (Active Air-Fuel Ratio Control Type)
2	EVAP System Monitor (Key-Off Type)
3	Air-Fuel Ratio (A/F) and Heated Oxygen (HO2) Sensor Monitors (Active Air-Fuel Ratio Control Type)
4	Air-Fuel Ratio (A/F) and Heated Oxygen (HO2) Sensor Heater Monitors (Front A/F and Rear HO2 Sensor Type)

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 or OBDII scan tool to the DLC3 (Procedure "A").
(2) Turn the ignition switch on (IG) (Procedure "B").
(3) Turn the tester or scan tool ON (Procedure "C").
(4) Clear DTCs (where set) (See page ES-44) (Procedure "D").
(5) Start the engine and warm it up (Procedure "E").
(6) Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes (Procedure "F").

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

3. EVAP SYSTEM 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 freeway) 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. AIR-FUEL RATIO (A/F) AND HEATED OXYGEN (HO2) SENSOR MONITORS (ACTIVE AIR-FUEL RATIO CONTROL TYPE)

(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 (Procedure "A").
  (2) Turn the ignition switch on (IG) (Procedure "B").
  (3) Turn the tester ON (Procedure "C").
  (4) Clear DTCs (See page ES-44) (Procedure "D").
  (5) Start the engine, and warm it up until the ECT reaches 75°C (167°F) or higher (Procedure "E").
  (6) Drive the vehicle at 38 mph (60 km/h) or more for at least 10 minutes (Procedure "F").
  (7) Change the transmission to 2nd gear (Procedure "G").
  (8) Accelerate the vehicle to 40 mph (64 km/h) or more by depressing the accelerator pedal for at least 10 seconds (Procedure "H").
  (9) Soon after performing procedure "H" above, release the accelerator pedal for at least 4 seconds without depressing the brake pedal, in order to execute fuel-cut control (Procedure "I").

ES

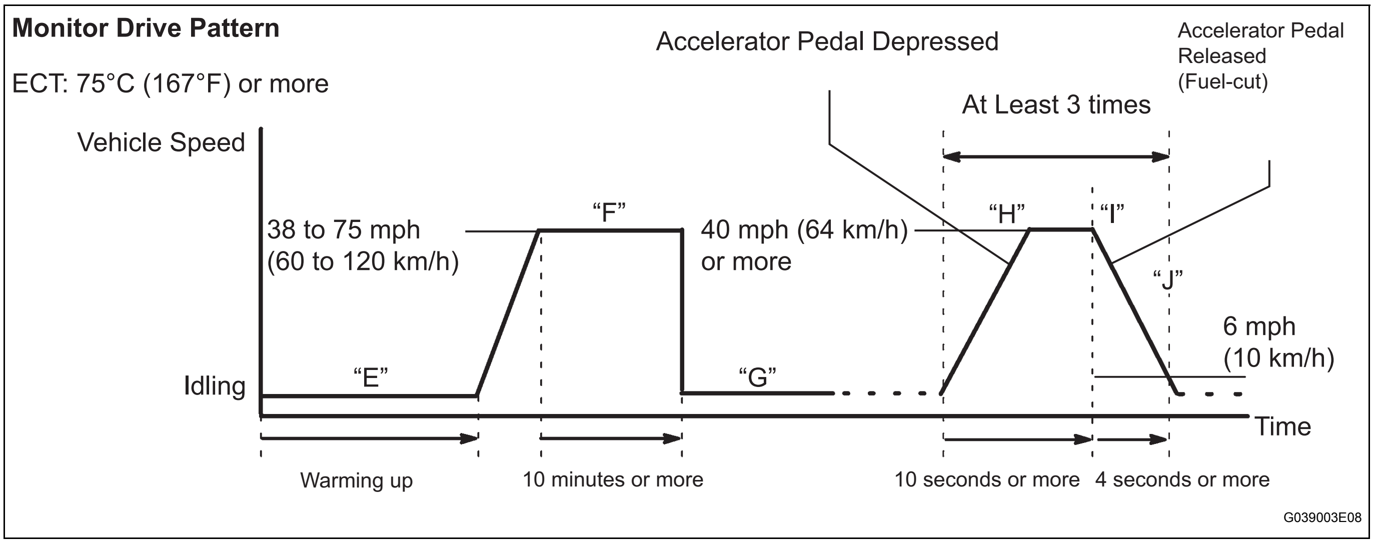
(10)Allow the vehicle to decelerate until the vehicle speed declines to less than 6 mph (10 km/h) (Procedure "J").

(11)Repeat procedures from "H" through "J" above at least 3 times in one driving cycle (Procedure "K").

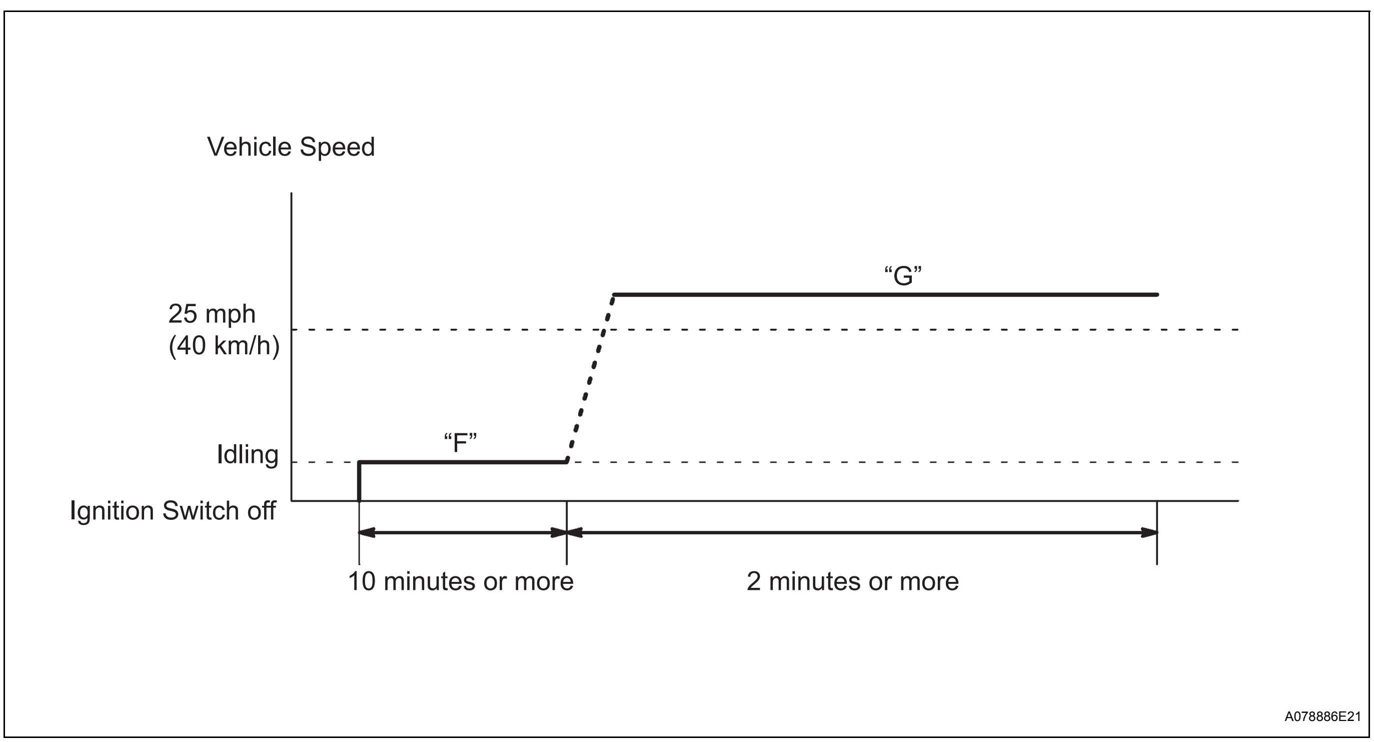
(c) Monitor Status

(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 procedures from "E" through "K" in Drive Pattern above.



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 (Procedure "A").

(2) Turn the ignition switch on (IG) (Procedure "B").

(3) Turn the tester or scan tool ON (Procedure "C").

(4) Clear DTCs (where set) (See page ES-44) (Procedure "D").

(5) Start the engine (Procedure "E").

(6) Allow the engine to idle for 10 minutes or more (Procedure "F").

(7) Drive the vehicle at 25 mph (40 km/h) or more for at least 2 minutes (Procedure "G").

(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 procedures through "E" to "G" described in the Drive Pattern above.

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.

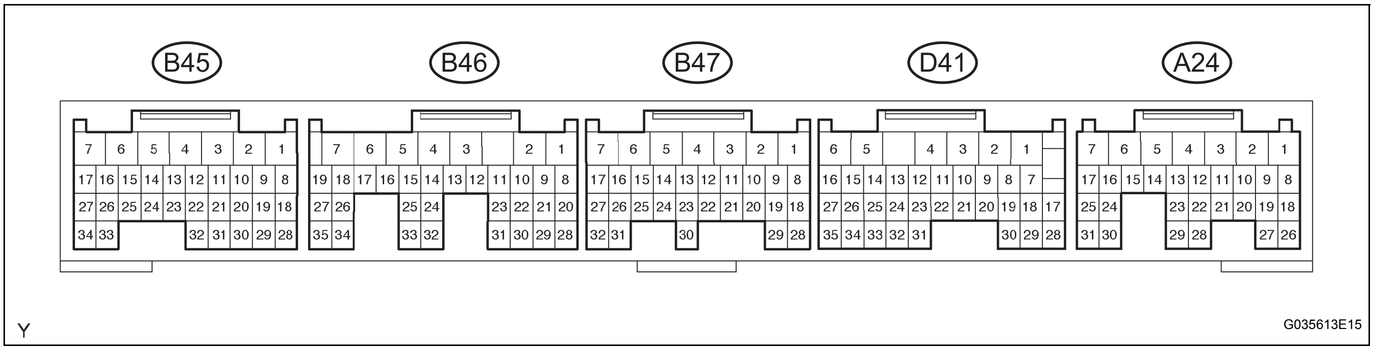
SFI SYSTEM

Symptom	Suspected area	See page
Without Smart Key System: Engine does not crank (Does not start)	1. Immobilizer system	EI-4
	2. Starter signal circuit	ES-281
	3. Starter	ST-74
	4. STARTER relay	ST-80
With Smart Key System: Engine does not crank (Does not start)	1. Immobilizer system	EI-4
	2. Cranking holding function circuit	ES-406
	3. Starter signal circuit	ES-281
	4. Starter	ST-74
	5. STARTER relay	ST-80
	6. ECM power source circuit	ES-395
	7. ECM	ES-445
No initial combustion (Does not start)	1. ECM power source circuit	ES-395
	2. Ignition system	ES-215
	3. Fuel pump control circuit	ES-401
	4. Injector	ES-183
	5. Crank angle sensor	-
	6. ECM	ES-445
Engine cranks normally but difficult to start	1. Electronic Throttle Control System (ETCS)	ES-136
	2. Fuel pump control circuit	ES-401
	3. Ignition system	ES-215
	4. Spark plug	IG-6
	5. Compression	EM-2
	6. Injector	ES-183
	7. Crank angle sensor	-
Difficult to start with cold engine	1. Starter signal circuit	ES-281
	2. Electronic Throttle Control System (ETCS)	ES-136
	3. Fuel pump control circuit	ES-401
	4. Spark plug	IG-6
	5. Ignition system	ES-215
	6. Injector	ES-183
	7. Engine coolant temperature sensor	-
Difficult to start with warm engine	1. Starter signal circuit	ES-281
	2. Electronic Throttle Control System (ETCS)	ES-136
	3. Fuel pump control circuit	ES-401
	4. Spark plug	IG-6
	5. Ignition system	ES-215
	6. Injector	ES-183
	7. Engine coolant temperature sensor	-

Symptom	Suspected area	See page
High engine idling speed (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-136
	2. ECM power source circuit	ES-395
	3. A/C signal circuit (Compressor circuit)	AC-100
	4. Acoustic Control Induction System (ACIS)	ES-413
	5. PCV hose	-
	6. ECM	ES-445
Low engine idling speed (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-136
	2. ECM power source circuit	ES-395
	3. A/C signal circuit (Compressor circuit)	AC-100
	4. Acoustic Control Induction System (ACIS)	ES-413
	5. PCV hose	-
	6. Injector	ES-183
	7. ECM	ES-445
Rough idling (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-136
	2. Injector	ES-183
	3. Ignition system	ES-215
	4. Compression	EM-2
	5. Fuel pump control circuit	ES-401
	6. Spark plug	IG-6
	7. Acoustic Control Induction System (ACIS)	ES-413
	8. PCV hose	-
Hunting (Poor idling)	1. Electronic Throttle Control System (ETCS)	ES-136
	2. ECM power source circuit	ES-395
	3. Fuel pump control circuit	ES-401
	4. Spark plug	IG-6
	5. Ignition system	ES-215
	6. Injector	ES-183
	7. Acoustic Control Induction System (ACIS)	ES-413
	8. PCV hose	-
Hesitation/Poor acceleration (Poor driveability)	1. Injector	ES-183
	2. Fuel pump control circuit	ES-401
	3. Ignition system	ES-215
	4. Spark plug	IG-6
	5. Air Intake Control System (AICS)	ES-417
	6. A/T faulty	AX-6
Surging (Poor driveability)	1. Fuel pump control circuit	ES-401
	2. Spark plug	IG-6
	3. Ignition system	ES-215
	4. Injector	ES-183
Engine stalls soon after starting	1. Fuel pump control circuit	ES-401
	2. Electronic Throttle Control System (ETCS)	ES-136
	3. Crank angle sensor	-
	4. Spark plug	IG-6
	5. Ignition system	ES-215
	6. Injector	ES-183
Engine stalls during A/C operation	1. Air conditioning system (Compressor Air)	AC-26
	2. ECM	ES-445
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-359

TERMINALS OF ECM

1. SFI SYSTEM



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 (A24-1) - E1 (B47-1)	L - BR	Power source of ECM	Ignition switch on (IG)	9 to 14 V
+B2 (A24-2) - E1 (B47-1)	R - BR	Power source of ECM	Ignition switch on (IG)	9 to 14 V
BATT (A24-3) - E1 (B47-1)	B - BR	Battery (for measuring the battery voltage and for the ECM memory)	Always	9 to 14 V
VPMP (A24-5) - E1 (B47-1)	W - BR	Vent valve operation signal (built into pump module)	Ignition switch on (IG)	9 to 14 V
MPMP (A24-6) - E1 (B47-1)	G - BR	Vacuum pump operation signal (built into pump module)	Vacuum pump OFF	0 to 3 V
MPMP (A24-6) - E1 (B47-1)	G - BR	Vacuum pump operation signal (built into pump module)	Vacuum pump ON	9 to 14 V
+BM (A24-7) - E1 (B47-1)	V - BR	Power source of ETCS throttle motor	Always	9 to 14 V
MREL (A24-8) - E1 (B47-1)	V - BR	EFI relay operation signal	Ignition switch on (IG)	9 to 14 V
IGSW (A24-9) - E1 (B47-1)	Y - BR	Ignition switch signal	Ignition switch on (IG)	9 to 14 V
FC (A24-10) - E1 (B47-1)	O - BR	C/OPEN relay operation signal (fuel pump control)	Ignition switch on (IG)	9 to 14 V
STP (A24-15) - E1 (B47-1)	W - BR	Stop light switch signal	Brake pedal depressed	7.5 to 14 V
STP (A24-15) - E1 (B47-1)	W - BR	Stop light switch signal	Brake pedal released	Below 1.5 V
ST1- (A24-16) - E1 (B47-1)	GR - BR	Stop light switch signal (opposite to STP terminal)	Ignition switch on (IG), Brake pedal depressed	Below 1.5 V
ST1- (A24-16) - E1 (B47-1)	GR - BR	Stop light switch signal (opposite to STP terminal)	Ignition switch on (IG), Brake pedal released	7.5 to 14 V
ACCR*2 (A24-17) - E1 (B47-1)	B - BR	ACC relay control signal	Cranking	Below 1.5 V
VPA (A24-18) - EPA (A24-20)	W - LG	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully released	0.5 to 1.1 V

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
VPA (A24-18) - EPA (A24-20)	W - LG	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully depressed	2.6 to 4.5 V
VPA2 (A24-19) - EPA2 (A24-21)	R - L-B	Accelerator pedal position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully released	1.2 to 2.0 V
VPA2 (A24-19) - EPA2 (A24-21)	R - L-B	Accelerator pedal position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully depressed	3.4 to 5.0 V
EPA (A24-20) - VPA (A24-18)	LG - W	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully released	0.5 to 1.1 V
EPA (A24-20) - VPA (A24-18)	LG - W	Accelerator pedal position sensor signal (for engine control)	Ignition switch on (IG), Accelerator pedal fully depressed	2.6 to 4.5 V
EPA2 (A24-21) - VPA2 (A24-19)	L-B - 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 (A24-21) - VPA2 (A24-19)	L-B - 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 (A24-22) - E2 (B45-28)	V - W	Pressure sensor signal (built into pump module)	Ignition switch on (IG)	3 to 3.6 V
TC (A24-23) - E1 (B47-1)	P - BR	Terminal TC of DLC3	Ignition switch on (IG)	9 to 14 V
VCPA (A24-26) - EPA (A24-20)	B - LG	Power source of accelerator pedal position sensor (for VPA)	Ignition switch on (IG)	4.5 to 5.0 V
VCP2 (A24-27) - EPA2 (A24-21)	L - L-B	Power source of accelerator pedal position sensor (for VPA2)	Ignition switch on (IG)	4.5 to 5.0 V
LGND*3 (A24-31) - E1 (B47-1)	BR - BR	Laser sensor ground (for dynamic laser cruise control system)	Always	Below 1 Ω
TACH (D41-1) - E1 (B47-1)	W - BR	Engine speed signal (for combination meter)	Idling	Pulse generation (see waveform 11)
CCS (D41-2) - E1 (B47-1)	B - BR	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
CCHG*3 (D41-4) - E1 (B47-1)	Y - BR	Distance control switch signal	Ignition switch on (IG) Cruise control main switch ON MODE switch ON → MODE switch OFF	Below 1 V → 10 to 14 V
SPD (D41-8) - E1 (B47-1)	GR - BR	Vehicle speed signal from combination meter	Ignition switch on (IG), Rotate driving wheel slowly	Pulse generation (see waveform 8)
W (D41-30) - E1 (B47-1)	R - BR	Malfunction Indicator Lamp (MIL) operation signal	Ignition switch on (IG)	Below 3.0 V
W (D41-30) - E1 (B47-1)	R - BR	Malfunction Indicator Lamp (MIL) operation signal	Idling	9 to 14 V
F/PS (D41-32) - E1 (B47-1)	R - BR	Airbag sensor assembly	Idling with warm engine	Pulse generation (see waveform 12)
CANH (D41-33) - CANL (D41-34)	G - W	CAN communication circuit	Ignition switch off	54 to 69 Ω
CANL (D41-34) - CANH (D41-33)	W - G	CAN communication circuit	Ignition switch off	54 to 69 Ω
E1 (B47-1) - Body ground	BR - -	Earth (ground) circuit of ECM	Always	Below 1 V

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
#10 (B47-2) - E01 (B45-7) #20 (B47-3) - E01 (B45-7) #30 (B47-4) - E01 (B45-7) #40 (B47-5) - E01 (B45-7) #50 (B47-6) - E01 (B45-7) #60 (B47-7) - E01 (B45-7)	L - W-B Y - W-B B - W-B W - W-B W-L - W-B G - W-B	Fuel injector operation signal	Ignition switch on (IG)	9 to 14 V
#10 (B47-2) - E01 (B45-7) #20 (B47-3) - E01 (B45-7) #30 (B47-4) - E01 (B45-7) #40 (B47-5) - E01 (B45-7) #50 (B47-6) - E01 (B45-7) #60 (B47-7) - E01 (B45-7)	L - W-B Y - W-B B - W-B W - W-B W-L - W-B G - W-B	Fuel injector operation signal	Idling	Pulse generation (see waveform 3)
PSW (B47-10) - E1 (B47-1)	W-R - BR	P/S pressure switch signal	Ignition switch on (IG)	9 to 14 V
STA (B47-11) - E1 (B47-1)	B - BR	Starter relay operation signal	Cranking	9 to 14 V
STSW*2 (B47-12) - E1 (B47-1)	B-W - BR	Starter relay operation signal	Cranking	9 to 14 V
OC2- (B47-14) - OC2+ (B47-15)	L-B - BR	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OC2+ (B47-15) - OC2- (B47-14)	BR - L-B	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OC1- (B47-16) - OC1+ (B47-17)	L - Y	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OC1+ (B47-17) - OC1- (B47-16)	Y - L	Camshaft timing Oil Control Valve (OCV) operation signal (Intake side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
VV2+ (B47-18) - VV2- (B47-28)	P - L	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
VV1+ (B47-19) - VV1- (B47-29)	G - R	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
NE- (B47-20) - NE+ (B47-21)	B - W	Crankshaft position sensor signal	Idling	Pulse generation (see waveform 5)
NE+ (B47-21) - NE- (B47-20)	W - B	Crankshaft position sensor signal	Idling	Pulse generation (see waveform 5)
EV2- (B47-22) - EV2+ (B47-23)	R - L	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
EV2+ (B47-23) - EV2- (B47-22)	L - R	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
EV1- (B47-24) - EV1+ (B47-25)	W - B	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
EV1+ (B47-25) - EV1- (B47-24)	B - W	Variable Valve Timing (VVT) sensor signal (Exhaust side)	Idling	Pulse generation (see waveform 5)
OE1+ (B47-26) - OE1- (B47-31)	W-R - B-W	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)

ES

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
OE2+ (B47-27) - OE2- (B47-32)	G-R - W-L	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
VV2- (B47-28) - VV2+ (B47-18)	L - P	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
VV1- (B47-29) - VV1+ (B47-19)	R - G	Variable Valve Timing (VVT) sensor signal (Intake side)	Idling	Pulse generation (see waveform 5)
OE1- (B47-31) - OE1+ (B47-26)	B-W - W-R	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
OE2- (B47-32) - OE2+ (B47-27)	W-L - G-R	Camshaft timing Oil Control Valve (OCV) operation signal (Exhaust side)	Ignition switch on (IG)	Pulse generation (see waveform 1)
HT1B (B45-1) - E1 (B47-1) HT2B (B46-5) - E1 (B47-1)	R - BR R - BR	Heated oxygen sensor heater operation signal	Idling	Below 3.0 V
HT1B (B45-1) - E1 (B47-1) HT2B (B46-5) - E1 (B47-1)	R - BR R - BR	Heated oxygen sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
ACM (B45-3) - E1 (B47-1)	G - BR	VSV for active control mount system operation signal	Ignition switch on (IG)	9 to 14 V
M- (B45-4) - ME01 (B46-3)	W - W-B	Throttle drive motor operation signal (negative terminal)	Idling with warm engine	Pulse generation (see waveform 10)
M+ (B45-5) - ME01 (B46-3)	B - W-B	Throttle drive motor operation signal (positive terminal)	Idling with warm engine	Pluse generation (see waveform 9)
E02 (B45-6) - Body ground	W-B - -	Earth (ground) circuit of ECM	Always	Below 1 V
E01 (B45-7) - Body ground	W-B - -	Earth (ground) circuit of ECM	Always	Below 1 V
IGT1 (B45-8) - E1 (B47-1) IGT2 (B45-9) - E1 (B47-1) IGT3 (B45-10) - E1 (B47-1) IGT4 (B45-11) - E1 (B47-1) IGT5 (B45-12) - E1 (B47-1) IGT6 (B45-13) - E1 (B47-1)	Y - BR P - BR G - BR L - BR B - BR BR - BR	Ignition coil with igniter (ignition signal)	Idling	Pulse generation (see waveform 6)
GE01 (B45-17) - E1 (B47-1)	- - BR	Shielded earth (ground) circuit of throttle drive motor	Always	Below 1 V
OX1B (B45-18) - E2 (B45-28) OX2B (B46-33) - E2 (B45-28)	B - W B - W	Heated oxygen sensor signal	With engine speed at 2,500 rpm for 2 minutes after warming up	Pulse generation (see waveform 2)
VTA2 (B45-19) - E2 (B45-28)	L-B - W	Throttle position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully released	2.1 to 3.1 V
VTA2 (B45-19) - E2 (B45-28)	L-B - W	Throttle position sensor signal (for sensor malfunction detection)	Ignition switch on (IG), Accelerator pedal fully depressed	4.5 to 5.0 V
VTA1 (B45-20) - E2 (B45-28)	G-R - W	Throttle position sensor signal (for engine control)	Ignition switch on (IG), Throttle valve fully closed	0.5 to 1.2 V
VTA1 (B45-20) - E2 (B45-28)	G-R - W	Throttle position sensor signal (for engine control)	Ignition switch on (IG), Throttle valve fully open	3.2 to 4.8 V
THW (B45-21) - E2 (B45-28)	B-W - W	Engine coolant temperature sensor signal	Idling, Engine coolant temperature 80°C (176°F)	0.2 to 1.0 V
THA (B45-22) - E2 (B45-28)	W-L - W	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
VC (B45-23) - E2 (B45-28)	R - W	Power source of sensors (specific voltage)	Ignition switch on (IG)	4.5 to 5.0 V
IGF1 (B45-24) - E1 (B47-1)	W - BR	Ignition coil with igniter (ignition confirmation signal)	Ignition switch on (IG)	4.5 to 5.0 V
IGF1 (B45-24) - E1 (B47-1)	W - BR	Ignition coil with igniter (ignition confirmation signal)	Idling	Pulse generation (see waveform 6)
AICV (B45-27) - E1 (B47-1)	P - BR	VSV for Air intake control system operation signal	Ignition switch on (IG)	9 to 14 V
E2 (B45-28) - E1 (B47-1)	W - BR	Earth (ground) circuit of sensors for ETCS	Always	Below 1 V
E2G (B45-29) - E1 (B47-1)	W-R - BR	Earth (ground) circuit of sensor for mass air flow meter	Always	Below 1 V
VG (B45-30) - E2G (B45-29)	R - W-R	Mass Air Flow (MAF) meter signal	Idling, Shift lever position P or N, A/C switch OFF	0.5 to 3.0 V
ACIS (B45-33) - E1 (B47-1)	L - BR	VSV for ACIS (Acoustic Control Induction System) operation signal	Ignition switch on (IG)	9 to 14 V
PRG (B45-34) - E1 (B47-1)	G - BR	Purge VSV for EVAP system operation signal	Ignition switch on (IG)	9 to 14 V
PRG (B45-34) - E1 (B47-1)	G - BR	Purge VSV for EVAP system operation signal	Idling	Pulse generation (see waveform 7)
HA2A (B46-1) - E05 (B46-6)	B - W-B	A/F sensor heater operation signal	Idling	Below 3.0 V
HA2A (B46-1) - E05 (B46-6)	B - W-B	A/F sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
HA1A (B46-2) - E04 (B46-7)	L - W-B	A/F sensor heater operation signal	Idling	Below 3.0 V
HA1A (B46-2) - E04 (B46-7)	L - W-B	A/F sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
ME01 (B46-3) - E1 (B47-1)	W-B - BR	Earth (ground) circuit of ECM	Always	Below 1 V
E03 (B46-4) - E1 (B47-1)	W-B - BR	Earth (ground) circuit of ECM	Always	Below 1 V
HT2B (B46-5) - E1 (B47-1) HT1B (B45-1) - E1 (B47-1)	R - BR R - BR	Heated oxygen sensor heater operation signal	Idling	Below 3.0 V
HT2B (B46-5) - E1 (B47-1) HT1B (B45-1) - E1 (B47-1)	R - BR R - BR	Heated oxygen sensor heater operation signal	Ignition switch on (IG)	9 to 14 V
E05 (B46-6) - E1 (B47-1)	W-B - BR	Earth (ground) circuit of ECM	Always	Below 1 V
E04 (B46-7) - E1 (B47-1)	W-B - BR	Earth (ground) circuit of ECM	Always	Below 1 V
STAR (B46-8) - E1 (B47-1)	W-R - BR	Park/Neutral position switch signal	Ignition switch on (IG), Shift lever position P or N	Below 3.0 V
STAR (B46-8) - E1 (B47-1)	W-R - BR	Park/Neutral position switch signal	Ignition switch on (IG), Shift lever position other than P or N	9 to 14 V
EKN2 (B46-20) - KNK2 (B46-21)	G - R	Earth (ground) circuit of knock sensor	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
KNK2 (B46-21) - EKN2 (B46-20)	R - G	Knock sensor signal	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
A1A+ (B46-22) - E1 (B47-1)	BR - BR	A/F sensor signal	Ignition switch on (IG)	3.3 V[*1]
A1A+ (B46-22) - E1 (B47-1)	BR - BR	A/F sensor signal	Ignition switch on (IG)	3.0 V[*1]
A2A+ (B46-23) - E1 (B47-1)	P - BR	A/F sensor signal	Ignition switch on (IG)	3.3 V[*1]
A2A+ (B46-23) - E1 (B47-1)	P - BR	A/F sensor signal	Ignition switch on (IG)	3.0 V[*1]

Symbols (Terminal No.)	Wiring Colors	Terminal Descriptions	Conditions	STD Voltages
EKNK (B46-28) - KNK1 (B46-29)	W - B	Earth (ground) circuit of knock sensor	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
KNK1 (B46-29) - EKNK (B46-28)	B - W	Knock sensor signal	With engine speed at 4,000 rpm after warming up	Pulse generation (see waveform 4)
A1A- (B46-30) - E1 (B47-1)	Y - BR	A/F sensor	Ignition switch on (IG)	3.3 V*1
A1A- (B46-30) - E1 (B47-1)	Y - BR	A/F sensor	Ignition switch on (IG)	3.0 V*1
A2A- (B46-31) - E1 (B47-1)	L - BR	A/F sensor	Ignition switch on (IG)	3.3 V*1
A2A- (B46-31) - E1 (B47-1)	L - BR	A/F sensor	Ignition switch on (IG)	3.0 V*1
OX2B (B46-33) - E2 (B45-28) OX1B (B45-18) - E2 (B45-28)	B - W B - W	Heated oxygen sensor signal	With engine speed at 2,500 rpm for 2 minutes after warming up	Pulse generation (see waveform 2)

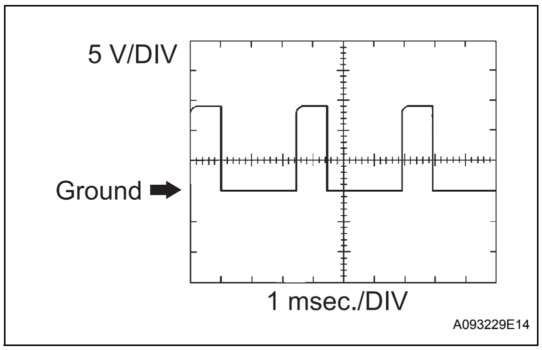
*1: The ECM terminal voltage is constant regardless of the output voltage from the sensor.

*2: With Smart Key system

*3: With Dynamic Radar Cruise Control system

(a) WAVEFORM 1

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

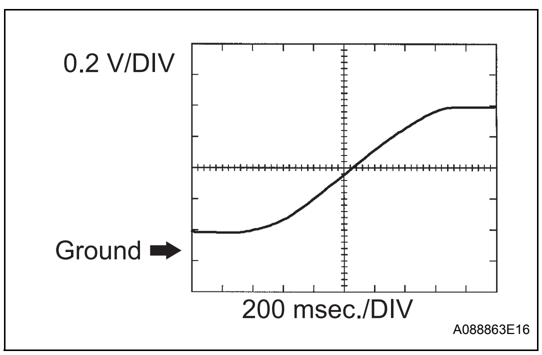


ECM Terminal Names	Between OC1+ and OC1- , OC2+ and OC2- , OE1+ and OE1- , or OE2+ and OE2-
Tester Ranges	5 V/DIV, 1 msec./DIV
Conditions	Idling

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

(b) WAVEFORM 2

(1) Heated oxygen sensor signal

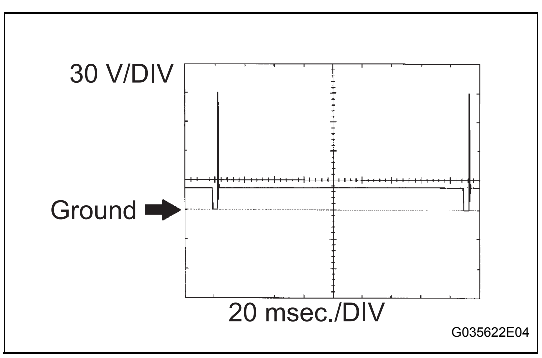


ECM Terminal Names	Between OX1B and E2, or OX2B and E2
Tester Ranges	0.2 V/DIV, 200 msec./DIV
Conditions	Engine speed is maintained at 2,500 rpm for 2 minutes after sensor is warmed up

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

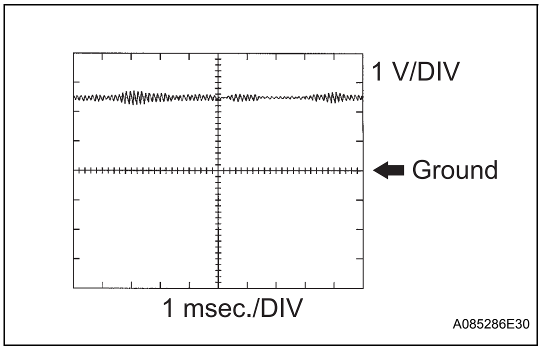
(c) WAVEFORM 3

(1) Fuel injector operation signal



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

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



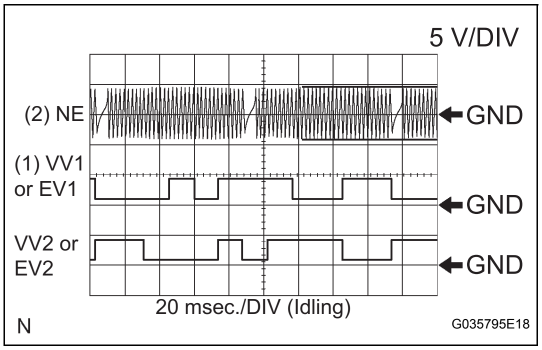
(d) WAVEFORM 4

(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 msec./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

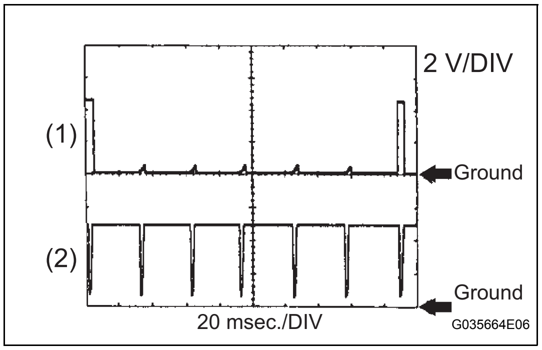
(1) Variable Valve Timing (VVT) sensor signal (1)

(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 msec./DIV
Conditions	Idling

HINT:

The wavelength becomes shorter as the engine rpm increases.



(f) WAVEFORM 6

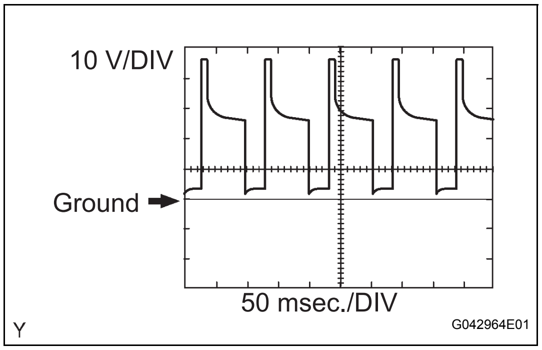
(1) Igniter IGT signal (from ECM to igniter) (1)

(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 msec./DIV
Conditions	Idling

HINT:

The wavelength becomes shorter as the engine rpm increases.



(g) WAVEFORM 7

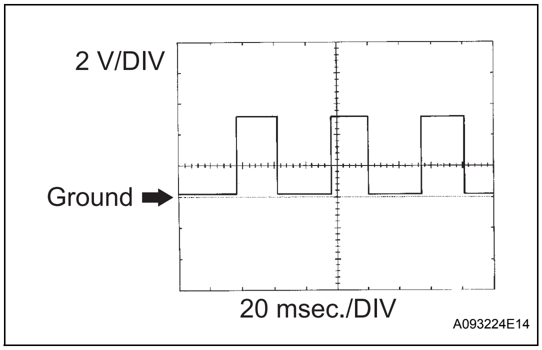
(1) Purge VSV for EVAP system operation signal

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

ES



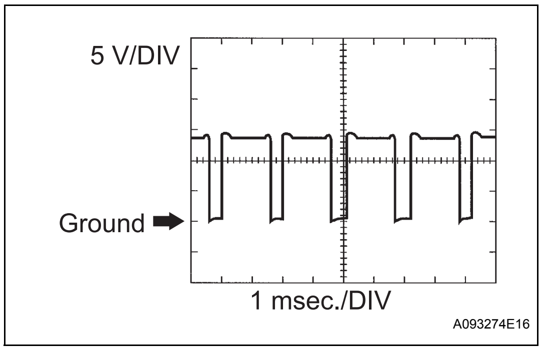
(h) WAVEFORM 8

(1) Vehicle speed signal

ECM Terminal Names	Between SPD and E1
Tester Ranges	2 V/DIV, 20 msec./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.



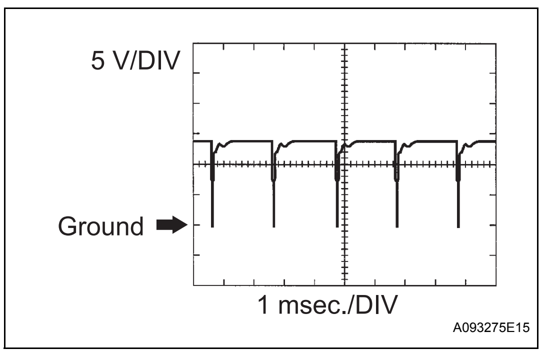
(i) WAVEFORM 9

(1) Throttle drive motor operation signal (positive terminal)

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

HINT:

The duty ratio varies depending on the throttle actuator operation.



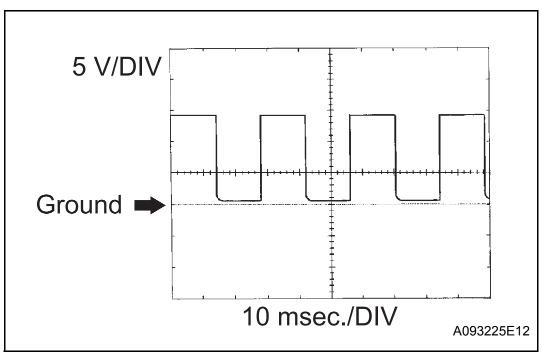
(j) WAVEFORM 10

(1) Throttle drive motor operation signal (negative terminal)

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

HINT:

The duty ratio varies depending on the throttle actuator operation.



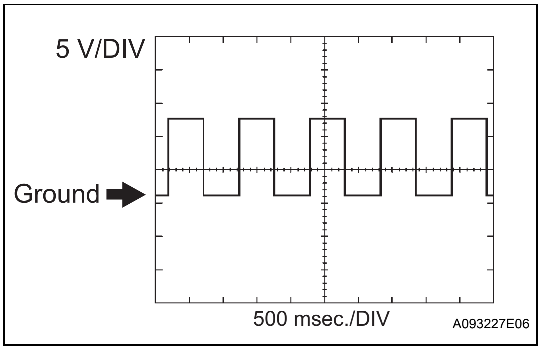
(k) WAVEFORM 11

(1) Engine speed signal

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

HINT:

The wavelength becomes shorter as the engine rpm increases.



(l) WAVEFORM 12

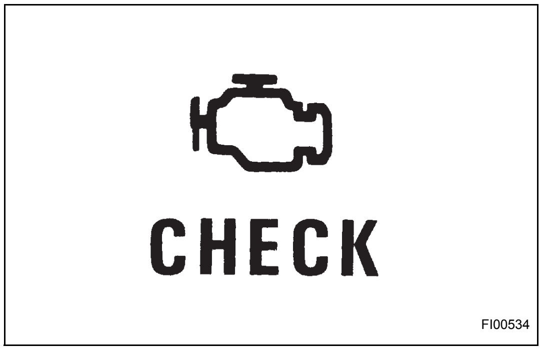
(1) Airbag sensor assembly

ECM Terminal Names	Between F/PS and E1
Tester Ranges	5 V/DIV, 500 msec./DIV
Conditions	Idling with warm engine

DIAGNOSIS SYSTEM

1. DESCRIPTION

(a) When troubleshooting OBD II (On-Board Diagnostics) vehicles, a 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.

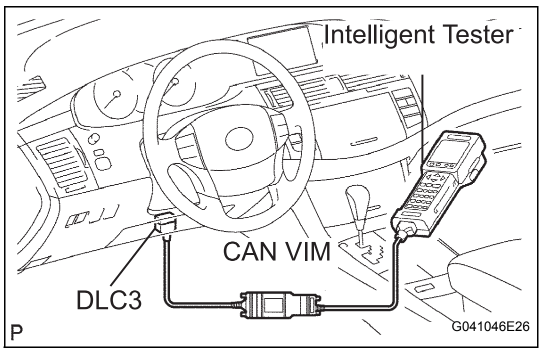


FI00534

(b) OBD II 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:

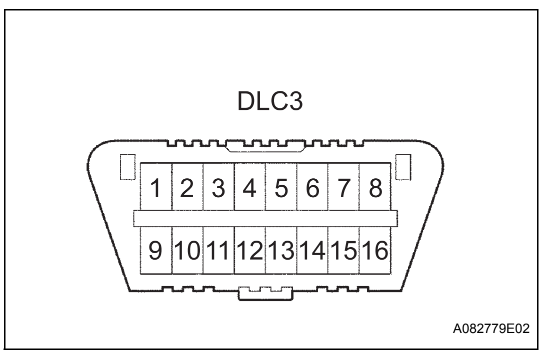
(1) The emission control systems and components
(2) The power train control components (which affect vehicle emissions)
(3) The computer itself

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.



G041046E26

(c) To check DTCs, connect an intelligent tester to the DLC3. The tester displays DTCs, freeze frame data, and a variety of engine data. The DTCs and freeze frame data can be erased with the tester (See page ES-44).

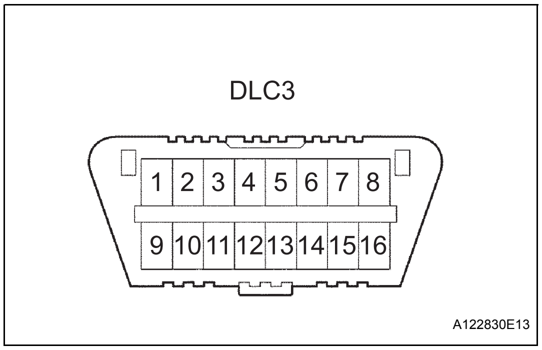


A082779E02

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 to simplify the wire harness connection.
Since this system is equipped with the CAN communication, connecting the CAN VIM (VIM: Vehicle Interface Module) with an 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**
   (a) 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) (See page ES-48).
3. **2 TRIP DETECTION LOGIC**
   (a) 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**
   (a) 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)**
   (a) The vehicle's ECM uses the 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 terminals	Results	Conditions
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 positive	Body ground	9 to 14 V	Always
CANH	6	CAN "High" line	14 - CANL	54 to 69 Ω	Ignition switch off
CANH	6	CAN "High" line	Battery positive	1 MΩ or higher	Ignition switch off
CANH	6	CAN "High" line	4 - CG	1 kΩ or higher	Ignition switch off
CANL	14	CAN "Low" line	Battery positive	1 MΩ or higher	Ignition switch off
CANL	14	CAN "Low" line	4 - CG	1 kΩ or higher	Ignition 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 impossible: The problem is probably with the tester itself. Consult the Service Department listed in the instruction manual.

6. BATTERY VOLTAGE

Battery Voltage:

11 to 14 V

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

7. MIL (Malfunction Indicator Lamp)

(a) The MIL is illuminated when the ignition switch is first turned on (IG) (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:

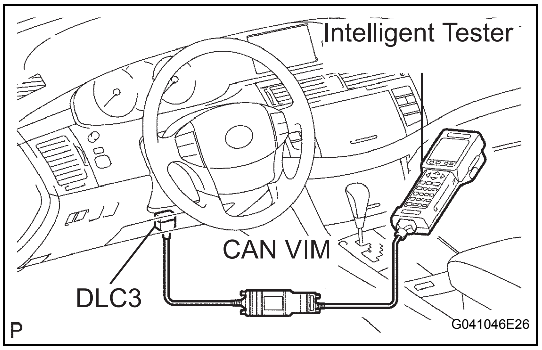
If the MIL is not illuminated when the ignition switch is first turned on (IG), check the MIL circuit (See page ES-421).

DTC CHECK / CLEAR

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 ignition switch is turned from on (IG) to on (ACC) or off while in check mode.
Before changing modes, always check and make a note of any 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 current and pending DTCs.
- Some DTCs are not set if the ECM does not detect the same malfunction again during the 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 the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester ON.
(d) Select 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-60).

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

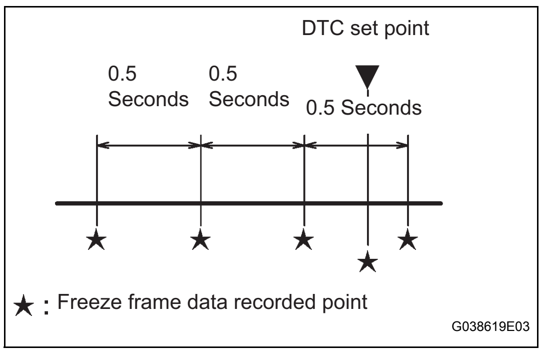
3. CLEAR DTC (Without using an intelligent tester)
(a) Perform either one of the following operations:
(1) Disconnect the negative battery cable for more than 1 minute.
(2) Remove the EFI No. 1 and ETCS fuses from the Relay Block (R/B) located inside the engine compartment for more than 1 minute.

ES

FREEZE FRAME DATA

1. DESCRIPTION

(a) 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 replicate the problem even though a DTC is detected, confirm the freeze frame data.



(b) The ECM records engine conditions in the form of 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 sets 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	Diagnostic Note
Freeze DTC	Freeze DTC	-
INJECTOR	Injector	-
IGN ADVANCE	Ignition advance	-
CALC LOAD	Calculate load	Calculated load by ECM
VEHICLE LOAD	Vehicle load	-
MAF	Mass air flow volume	If value approximately 0.0 g/s: • Mass air flow meter power source circuit open or short • VG circuit open or short If value 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 -40°C (-40°F), sensor circuit open If value 140°C (284°F), sensor circuit shorted
INTAKE AIR	Intake air temperature	If value -40°C (-40°F), sensor circuit open If value 140°C (284°F), sensor circuit shorted
AIR-FUEL RATIO	Air-fuel ratio	-
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	-
KNOCK FB VAL	Feedback value of knocking	-

LABEL (Intelligent Tester Display)	Measurement Item	Diagnostic Note
EVAP VAPOR PRES	EVAP vapor pressure	-
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 (Do not start engine)
THROTTLE POS	Throttle sensor positioning	Read value with ignition switch on (Do not start engine)
THROTTLE POS#2	Throttle sensor positioning#2	Read value with ignition switch on (Do not start engine)
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 voltage output of sensor
O2S B2 S2	Heated oxygen sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check voltage output of sensor
AFS B1 S1	A/F sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check voltage output of sensor
AFS B2 S1	A/F sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check voltage output of sensor
TOTAL FT #1	Total fuel trim of bank 1	-
TOTAL FT #2	Total fuel trim of bank 2	-
SHORT FT #1	Short-term fuel trim of bank 1	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	Overall fuel compensation carried out in long-term to compensate a continual deviation of short-term fuel trim from central valve
SHORT FT #2	Short-term fuel trim of bank 2	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
LONG FT #2	Long-term fuel trim of bank 2	Overall fuel compensation carried out in long-term to compensate 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

LABEL (Intelligent Tester Display)	Measurement Item	Diagnostic Note
O2FT B2 S2	Fuel trim at heated oxygen sensor	Same as SHORT FT #2
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	-
ACC RELAY	ACC relay signal	-
STARTER RELAY	Starter relay signal	-
STARTER SIG	Starter signal	-
STARTER CONTROL	Starter control	-
PS SW	Power steering signal	-
PS SIGNAL	Power steering signal (history)	This signal status usually ON until ignition switch turned off
CTP SW	Closed throttle position switch	-
A/C SIG	A/C signal	-
ELECT LOAD SIG	Electrical load signal	-
STOP LIGHT SW	Stop light switch	-
BATTERY VOLTAGE	Battery voltage	-
ATM PRESSURE	Atmospheric pressure	-
ACIS VSV	VSV for Air Intake Control Induction System (AICS)	-
VVT CTRL B2	VVT control (bank 2 Intake side) status	-
EVAP (Purge) VSV	EVAP purge VSV	-
FUEL PUMP/SPD	Fuel pump speed status	VSV for EVAP controlled by ECM (ground side duty control)
VVT CTRL B1	VVT control (bank 1 Intake side) status	-
VACUUM PUMP	Key-off EVAP system pump status	-
EVAP VENT VAL	Key-off EVAP system vent valve status	-
FAN MOTOR	Electric fan motor	-
AICV VSV	VSV for Air Intake Control System (AICS)	-
TC/TE1	TC and TE1 terminals of DLC3	-
VVTL AIM ANGL #1	VVT aim angle	-
VVT CHNG ANGL #1	VVT change angle	-
VVT OCV DUTY B1	VVT OCV operation duty	-
VVT EX HOLD B1	VVT exhaust hold duty ratio learning value (bank 1 Exhaust side)	-
VVT EX CHG ANG1	VVT change angle (bank 1 Exhaust side)	-
VVT EX OCV D B1	VVT OCV (bank 1 Exhaust side) operation duty	-
VVTL AIM ANGL#2	VVT aim angle (bank 2 Intake side)	-
VVT CHNG ANGL#2	VVT change angle (bank 2 Intake side)	-
VVT OCV DUTY B2	VVT OCV (bank 2 Intake side) operation duty	-
VVT EX HOLD B2	VVT exhaust hold duty ratio learning value (bank 2 Exhaust side)	-
VVT EX CHG ANG2	VVT change angle (bank 2 Exhaust side)	-
VVT EX OCV D B2	VVT OCV (bank 2 Exhaust side) operation duty	-

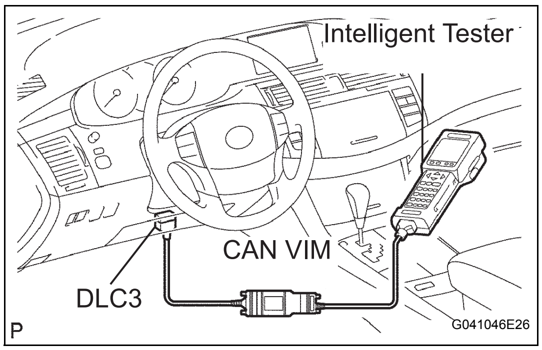
LABEL (Intelligent Tester Display)	Measurement Item	Diagnostic Note
FC IDL	Idle fuel cut	ON: when throttle valve fully closed and engine speed over 1,500 rpm
FC TAU	FC TAU	Fuel cut initiated under light load to prevent incomplete combustion
IGNITION	Ignition	-
CYL #1	Cylinder #1 misfire rate	Displayed only during idling
CYL #2	Cylinder #2 misfire rate	Displayed only during idling
CYL #3	Cylinder #3 misfire rate	Displayed only during idling
CYL #4	Cylinder #4 misfire rate	Displayed only during idling
CYL #5	Cylinder #5 misfire rate	Displayed only during idling
CYL #6	Cylinder #6 misfire rate	Displayed only during idling
CYL ALL	All cylinder misfire rate	Displayed only during idling
MISFIRE RPM	Misfire RPM	-
MISFIRE LOAD	Misfire 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	-

ES

CHECK MODE PROCEDURE

HINT:
Intelligent tester only:
Compared to normal mode, check mode is more sensitive to malfunctions. Therefore, check mode can detect the malfunctions that cannot be detected by normal mode.

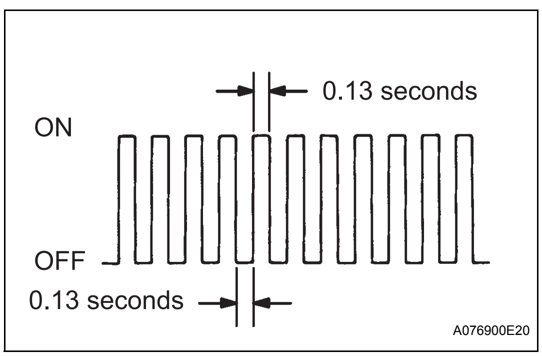
NOTICE:
All the stored DTCs and freeze frame data are erased if: 1) the ECM is changed from normal mode to check mode or vice versa; or 2) the ignition switch is turned from on (IG) to on (ACC) or off while in check mode.
Before changing modes, always check and make a note of any DTCs and freeze frame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



1. CHECK MODE PROCEDURE (Using an intelligent tester)

(a) Check and ensure the following conditions:
(1) Battery voltage 12 V or more
(2) Throttle valve fully closed
(3) The shift lever is in the P or N position
(4) A/C switched OFF

(b) Turn the ignition switch off.
(c) Connect an intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester ON.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / CHECK MODE.
(g) Switch the ECM from normal mode to check mode.



(h) Make sure the MIL flashes as shown in the illustration.
(i) Start the engine.
(j) Make sure the MIL goes off.
(k) Simulate the conditions of the malfunction described by the customer.
(l) Check 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 firmly and slowly. If the accelerator pedal is depressed quickly, the vehicle may speed up and slow down erratically.

ES

DATA LIST / ACTIVE TEST

1. DATA LIST

HINT:
Reading the DATA LIST displayed on an intelligent tester enables values, including those of the switches, sensors, and actuators, to be checked without removing any parts. Reading the DATA LIST as the first step of troubleshooting is one method to shorten diagnostic time.

NOTICE:
In the table below, the values listed under Normal Condition are for 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 an intelligent tester to the DLC3.
(d) Start the engine.
(e) Turn the tester ON.
(f) Select the following menu items: 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*	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°: Idling	-
CALC LOAD	Load calculated by ECM: Min.: 0%, Max.: 100%	• 11.4 to 16.4%: Idling • 13.1 to 18.9%: Running without load (2,500 rpm)	-
VEHICLE LOAD	Vehicle load: Min.: 0%, Max.: 25,700%	Actual vehicle load	-
MAF	Air flow rate from MAF meter: Min.: 0 g/sec., Max.: 655.35 g/sec.	3.2 to 4.7 g/sec.: Idling 13.1 to 18.9 g/sec.: 2,500 rpm	If value is approximately 0.0 g/sec.: • Mass air flow meter power source circuit open • VG circuit open or short 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 (0 mph), Max.: 255 km/h (158 mph)	Actual vehicle speed	Speed indicated on speedometer
COOLANT TEMP	Engine coolant temperature: Min.: -40°C (-40°F), Max.: 140°C (284°F)	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): sensor circuit shorted
INTAKE AIR	Intake air temperature: Min.: -40°C (-40°F), Max.: 140°C (284°F)	Equivalent to ambient air temperature	• If value is -40°C (-40°F): sensor circuit open • If value is 140°C (284°F): sensor circuit shorted
AIR-FUEL RATIO	Air-fuel ratio: 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
PURGE FLOW	Purge flow: Min.: 0%, Max.: 102.4%	0 to 8%: Idling	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
EVAP PURGE VSV	EVAP (Purge) VSV control duty: Min.: 0%, Max.: 100%	0 to 100%: Idling	Order signal from ECM
VAPOR PRESSURE	Vapor pressure: Min.: 33.853 kPa, Max.: 125.596 kPa	0 kPa: Fuel tank cap removed	Pressure inside fuel tank monitored by vapor pressure sensor
VAPOR PRESS CALC	Vapor pressure: (calculated) Min.: -5.632 kPa, Max.: 715.264 kPa	0 kPa: Fuel tank cap removed	Pressure inside fuel tank monitored by vapor pressure sensor
KNOCK CRRT VAL	Correction learning value of knocking: Min.: -64 CA, Max.: 1,984 CA	0 to 22° CA: Driving, 44 mph (70 km/h)	Service data
KNOCK FB VAL	Feedback value of knocking: Min.: -64 CA, Max.: 1,984 CA	-22 to 0° CA Driving, 44 mph (70 km/h)	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	-
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	-
ACCEL POS #2	Absolute APP No. 2: Min.: 0 %, Max.: 100 %	12 to 42%: accelerator pedal released 66 to 98%: accelerator pedal fully depressed	-
ACCEL POS #1	APP sensor No. 1 voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze data
ACCEL POS #2	APP sensor No. 2 voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze 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.	-
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.	-
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, Max.: 4.9804 V	-	ETCS service data
ACCEL LRN VAL#1	Accelerator fully closed learning value No. 1: Min.: 0, Max.: 124.512	-	ETCS service data
ACCEL LRN VAL#2	Accelerator fully closed learning value No. 2: Min.: 0, Max.: 124.512	-	ETCS service data
FAIL #1	Whether or not fail safe function executed: ON or OFF	ON: ETCS has failed	-
FAIL #2	Whether or not fail safe function executed (Main CPU): 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

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
THROTTLE POS	Absolute throttle position sensor: Min.: 0%, Max.: 100%	• 10 to 24%: Throttle fully closed • 64 to 96%: Throttle fully open	Read value with intrusive operation (active test)
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 sensor positioning: Min.: 0%, Max.: 100%	10 to 18%: Idling	Calculated value based on VTA1
THROTTLE POS #2	Throttle sensor positioning #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 data
THROTTLE POS #2	Throttle position sensor No. 2 output voltage: Min.: 0 V, Max.: 4.98 V	-	ETCS freeze data
THROTTLE POS #1	Throttle position No. 1: Min.: 0 V, Max.: 5 V	• 0.5 to 1.2 V: Throttle fully closed • 3.2 to 4.8 V: Throttle fully opened	-
THROTTLE POS #2	Throttle position No. 2: 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 intrusive operation (active test)
THRTL COMND VAL	Throttle position command value: Min.: 0 V, Max.: 4.9804 V	0.5 to 4.8 V	ETCS service data
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 sensor opener position No. 1 (AD): Min.: 0 V, Max.: 4.9804 V	0.6 to 0.9 V	ETCS service data
THROTTLE MOT	Whether or not throttle motor control permitted: ON or OFF	ON: Idling	Read value with ignition switch on (IG) (Do not start engine)
THROTTLE MOT	Throttle motor current: Min.: 0 A, Max.: 80 A	0 to 3.0 A: Idling	-
THROTTLE MOT	Throttle motor: Min.: 0%, Max.: 100%	0.5 to 40%: Idling	-
THROTTLE MOT	Throttle motor current: Min.: 0 A, Max.: 19.92 A	0 to 3.0 A: Idling	-
THROTL OPN DUTY	Throttle motor opening duty ratio: Min.: 0%, Max.: 100%	0 to 40%: Idling	When accelerator pedal is depressed, duty ratio increases
THROTL CLS DUTY	Throttle motor closed duty ratio: Min.: 0%, Max.: 100%	0 to 40%: Idling	When accelerator pedal is released quickly, duty ratio increases
THRTL MOT (OPN)	Throttle motor duty ratio (open): Min.: 0%, Max.: 100%	-	ETCS service data
THRTL MOT (CLS)	Throttle motor duty ratio (close): 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 44 mph (70 km/h)	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check voltage output 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 44 mph (70 km/h)	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check voltage output of sensor

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
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 voltage output 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 voltage output of sensor
TOTAL FT #1	Total fuel trim of bank 1 Average value for fuel trim 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 trim 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%	0 +/- 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%	0 +/- 20%	Overall fuel compensation carried out in long-term to compensate for continual deviation of short-term fuel trim from central value
SHORT FT #2	Short-term fuel trim of bank 2: Min.: -100%, Max.: 99.2%	0 +/- 20%	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
LONG FT #2	Long-term fuel trim of bank 2: Min.: -100%, Max.: 99.2%	0 +/- 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 become a 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, used for fuel control, malfunctions
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 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, used for fuel control, malfunctions
O2FT B1 S2	Short-term fuel trim associated with bank 1 sensor 2: Min.: -100%, Max.: 99.2%	0 +/- 20%	Same as SHORT FT #1
O2FT B2 S2	Short-term fuel trim associated with bank 2 sensor 2: Min.: -100%, Max.: 99.2%	0 +/- 20%	Same as SHORT FT #2

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
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	-
CAT TEMP B1S1	Catalyst temperature (Bank 1, Sensor 1): Min.: -40°C (-40°F), Max.: 6,513.5°C (11,756.3°F)	-	-
CAT TEMP B2S1	Catalyst temperature (Bank 2, Sensor 1): Min.: -40°C (-40°F), Max.: 6,513.5°C (11,756.3°F)	-	-
CAT TEMP B1S2	Catalyst temperature (Bank 1, Sensor 2): Min.: -40°C (-40°F), Max.: 6,513.5°C (11,756.3°F)	-	-
CAT TEMP B2S2	Catalyst temperature (Bank 2, Sensor 2): Min.: -40°C (-40°F), Max.: 6,513.5°C (11,756.3°F)	-	-
INI COOL TEMP	Initial engine coolant temperature: Min.: -40°C (-40°F), Max.: 120°C (248°F)	Close to ambient air temperature	Service data
INI INTAKE TEMP	Initial intake air temperature: Min.: -40°C (-40°F), Max.: 120°C (248°F)	Close to ambient air temperature	Service data
INJ VOL	Injection volume (cylinder 1): Min.: 0 ml, Max.: 2.048 ml	Max.: 0.5 ml	Quantity of fuel injected over 10 injections
ACC RELAY	ACC relay signal: ON or OFF	ON: ACC relay ON	-
STARTER RELAY	Starter relay signal: ON or OFF	ON: Starter relay ON	-
STARTER SIG	Starter signal: ON or OFF	ON: Cranking	-
STARTER CONTROL	Starter Control: ON or OFF	ON: Cranking	-
PS SW	Power steering signal: ON or OFF	ON: Power steering operation	-
PS SIGNAL	Power steering signal: ON or OFF	ON: Steering wheel is first turned after ignition switch is turned on (IG)	This signal status is usually ON until ignition switch is turned off
CTP SW	Closed throttle position switch: ON or OFF	• ON: Throttle fully closed • OFF: Throttle open	-
A/C SIG	A/C signal: ON or OFF	ON: A/C ON	-
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.: 19.92182 [V]	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.: 125 kPa	Equivalent to atmospheric pressure (absolute pressure)	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
ACIS VSV	VSV for Acoustic Control Induction System Status: ON or OFF	-	ON: Open OFF: Closed
VVT CTRL B2	VVT control (bank 2) status: ON or OFF	-	Active Test support data
EVAP (Purge) VSV	VSV status for EVAP control: 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
VACUUM PUMP	Key-off EVAP system 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	-	Active Test support data
AICV VSV	VSV for Air Intake Control System Status: ON or OFF	-	-
TC/TE1	TC and TE1 terminals of DLC3: ON or OFF	-	-
VVTL AIM ANGL #1	VVT aim angle (bank 1 Intake side): Min.: 0%, Max.: 100%	0%: Idling	VVT duty signal value during intrusive operation
VVT CHNG ANGL #1	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	VVT OCV (bank 1 Intake side) operation duty: Min.: 0%, Max.: 100%	10 to 50%: Idling	Requested duty value for intrusive operation
VVT EX HOLD B1	VVT exhaust hold duty ratio learning value (bank 1 Exhaust side): Min.: 0%, Max.: 100%	30 to 70%: Idling	Requested duty value for intrusive operation
VVT EX CHG ANG1	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	VVT OCV (bank 1 Exhaust side) operation duty: Min.: 0%, Max.: 100%	10 to 50%: Idling	Requested duty value for intrusive operation
VVTL AIM ANGL #2	VVT aim angle (bank 2 Intake side): Min.: 0%, Max.: 100%	0%: Idling	VVT duty signal value during intrusive operation
VVT CHNG ANGL #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	VVT OCV (bank 2 Intake side) operation duty: Min.: 0%, Max.: 100%	30 to 70%: Idling	Requested duty value for intrusive operation
VVT EX HOLD D B2	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	VVT change angle (bank 2 Exhaust side): Min.: 0° FR, Max.: 60° FR	0 to 5° FR: Idling	Displacement angle during intrusive operation
VVT EX OCV D B2	VVT exhaust (bank 2 Exhaust side) operation duty: Min.: 0%, Max.: 100%	0%: Idling	Requested duty value for intrusive operation
FC IDL	Fuel cut idle: ON or OFF	ON: Fuel cut operation	FC IDL = ON when throttle valve is fully closed and engine speed is over 2,800 rpm
FC TAU	Fuel cut TAU: Fuel cut during very light load: ON or OFF	ON: Fuel cut operation	Fuel cut being performed under very light load to prevent engine combustion from becoming incomplete

ES

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
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 99.2%	Misfire detecting margin
#CODES	#Codes: Min.: 0, Max.: 255	-	Number of detected DTCs
CHECK MODE	Check mode: 0: OFF, 1: ON	ON: Check mode ON	See page ES-48
SPD TEST	Check mode result for vehicle speed sensor: 0: COMPL, 1: INCMPL	-	-
MISFIRE TEST	Check mode result for misfire monitor: 0: COMPL, 1: INCMPL	-	-
OXS2 TEST	Check mode result for HO2 sensor (bank 2): 0: COMPL, 1: INCMPL	-	-
OXS1 TEST	Check mode result for HO2 sensor (bank 1): 0: COMPL, 1: INCMPL	-	-
A/F SSR TEST B2	Check mode result for air-fuel ratio sensor (bank 2): 0: COMPL, 1: INCMPL	-	-
A/F SSR TEST B1	Check mode result for air-fuel ratio sensor (bank 1): 0: COMPL, 1: INCMPL	-	-
MIL ON RUN DIST	MIL ON Run Distance: Min.: 0 km (0 mile), Max.: 65,535 km (40,723 mile)	Distance driven after DTC detected	-
MIL ON RUN TIME	Running time from MIL ON: Min.: 0 minute, Max.: 65,535 minutes	Running time after MIL ON	-
ENG RUN TIME	Engine run time: Min.: 0 second, Max.: 65,535 seconds	Time after engine start	Service data
TIME DTC CLEAR	Time after DTC cleared: Min.: 0 minute, Max.: 65,535 minutes	Time after DTCs erased	-
DIST DTC CLEAR	Distance after DTC cleared: Min.: 0 km (0 mile), Max.: 65,535 km/h (40,723 mile)	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)	-
#CARB CODES	Number of Emission related DTC	-	-

Intelligent Tester Display	Measurement Item: Range (Display)	Normal Condition*	Diagnostic Note
COMP MON	Comprehensive Component Monitor: NOT AVL / AVAIL	-	-
FUEL MON	Fuel System Monitor: NOT AVL / AVAIL	-	-
MISFIRE MON	Misfire Monitor: NOT AVL / AVAIL	-	-
O2S (A/FS) MON	O2S (A/FS) Monitor: NOT AVL / AVAIL	-	-
O2S (A/FS) MON	O2S (A/FS) Monitor: Complete / Incomplete	-	-
EVAP MON	EVAP Monitor: NOT AVL: AVAIL	-	-
EVAP MON	EVAP Monitor: Complete: Incomplete	-	-
CAT MON	Catalyst Monitor: NOT AVL / AVAIL	-	-
CAT MON	Catalyst Monitor: Complete / Incomplete	-	-
EGR MON	EGR Monitor ENA: NOT AVL / AVAIL	-	-
EGR MON	EGR Monitor CMPL: Complete / Incomplete	-	-
MODEL CODE	Model code information	-	Identifying model code: GSX3#
ENGINE TYPE	Engine type information	-	Identifying engine type: 2GRFE
CYLINDER NUMBER	Cylinder number: Min.: 0, Max.: 255	-	Identifying cylinder number: 6
DESTINATION	Destination	-	Identifying destination: A (America)
MODEL YEAR	Model year: Min.: 1900 MY, Max.: 2155 MY	-	Identifying model year: 200#

*: 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. 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 of troubleshooting is one method to shorten diagnostic time.

DATA LIST can be displayed during ACTIVE TESTs.

(a) Connect an intelligent tester to the DLC3.
(b) Start the engine.
(c) Turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST.

ES

ES

(e) Perform the ACTIVE TEST by referring to the table below.

Intelligent Tester Display	Test Detail	Control Range	Diagnostic Note
INJ VOL	Change the 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 by 1% within control range
A/F CONTROL	Change the injection volume	Lower by 12.5% or increase by 24.8%	• Perform test at less than 3,000 rpm • A/F CONTROL enables checking and graphing of 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, or AFS B2S1 and O2S B2S2, and press YES and ENTER. Then press F4.
INTAKE CTL VSV1	Activate the VSV for Acoustic Control Induction System (ACIS)	ON / OFF	-
EVAP VSV (ALONE)	Activate EVAP VSV control	ON / OFF	-
VVT CTRL B1	Turn on and off OCV (Oil Control Valve) for VVT (Bank 1)	ON: Exhaust side camshaft moves to retard side OFF: Exhaust side camshaft moves to advance side	• Engine stalls or idles roughly when OCV on • Engine running or idling normally when OCV off
VVT CTRL B2	Turn on and off OCV (Oil Control Valve) for VVT (Bank 2)	ON: Exhaust side camshaft moves to retard side OFF: Exhaust side camshaft moves to advance side	• Engine stalls or idles roughly when OCV on • Engine running or idling normally when OCV off
FUEL PUMP/SPD	Activate fuel pump (C/OPN Relay)	ON / OFF	-
ACM INHIBIT	Control the ACM inhibit	ON / OFF	Test is possible while engine idling
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	-
COOLING FAN	Control the electric cooling fan	ON / OFF	-
STARTER	Activate the Starter Relay	ON / OFF	Confirm that the engine is stopped
ACC CUT	Activate the ACC Cut Relay	ON / OFF	Confirm that the engine is stopped
ETCS OPEN SLOW	Control the ETCS (throttle motor) opening slow speed	ON: throttle valve opens slowly	Test is possible when the following conditions are met: • Ignition switch on (IG) • Engine does not start • Accelerator pedal fully depressed (APP: 58 degrees or more)
ETCS CLOSE SLOW	Control the ETCS (throttle motor) closing slow speed	ON: throttle valve closes slowly	Same as above
ETCS OPEN FAST	Control the ETCS (throttle motor) opening fast speed	ON: throttle valve opens fast	Same as above
ETCS CLOSE FAST	Control the ETCS (throttle motor) closing fast speed	ON: throttle valve closes fast	Same as above

Intelligent Tester Display	Test Detail	Control Range	Diagnostic Note
FUEL CUT #1	Cylinder #1 injector fuel cut	ON / OFF	Test is possible while vehicle is stopped with 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
VVT B1	Control the VVT (bank 1 Intake Side)	Between -128 and 127% This valve added to present OCV control duty 100%: Maximum advance -100% : Maximum retard	Engine stalls or idles roughly when VVT actuator operated by 100%. Test is possible while idling.
VVT B2	Control the VVT (bank 2 Intake Side)	Between -128% and 127%	Same as above
VVT EX B1	Control the VVT (bank 1 Exhaust Side)	This valve added to present OCV control duty 100%: Maximum retard -100%: Maximum advance	Same as above
VVT EX B2	Control the VVT (bank 2 Exhaust Side)	Same as above	Same as above
VACUUM PUMP	Activate the Vacuum Pump built into pump module	ON / OFF	-
VENT VALVE	Activate the VSV for Vent Valve built into pump module	ON / OFF	-
AICV VSV	Activate the VSV for Air Intake Control System (AICS)	ON / OFF	-

ES

3. SYSTEM CHECK

HINT:

Performing a SYSTEM CHECK enables the system, which consists of the 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 an intelligent tester to the DLC3.
(b) Start the engine.
(c) Turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK.
(e) Perform the SYSTEM CHECK by referring to the table below.

Intelligent Tester Displays	Test Details	Recommended Fuel Temperatures	Diagnostic Notes
EVAP SYS CHECK (AUTO OPERATION)	Perform 5 steps in order to operate EVAP key-off monitor automatically	35°C (95°F) or less	• If no DTCs in PENDING CODE after performing this test, system functioning normally • Refer to EVAP System (See page ES-365)
EVAP SYS CHECK (MANUAL OPERATION)	Perform 5 steps in order to operate EVAP key-off monitor manually	35°C (95°F) or less	• Used to detect malfunctioning parts • Refer to EVAP System (See page ES-365)

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" 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) circuit for intake camshaft 2. OCV for intake camshaft (bank 1) 3. ECM	Comes on	DTC stored	ES-76
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-81
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	Same as DTC P0011	Comes on	DTC stored	ES-81
P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)	1. Open or short in Oil Control Valve (OCV) circuit for exhaust camshaft 2. OCV for exhaust camshaft (bank 1) 3. ECM	Comes on	DTC stored	ES-87
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 timing gear assembly 5. ECM	Comes on	DTC stored	ES-92
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	Same as DTC P0014	Comes on	DTC stored	ES-92
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-98
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	Same as DTC P0016	Comes on	DTC stored	ES-98
P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)	Same as DTC P0016	Comes on	DTC stored	ES-98
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	Same as DTC P0016	Comes on	DTC stored	ES-98

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) circuit for intake camshaft 2. OCV for intake camshaft (bank 2) 3. ECM	Comes on	DTC stored	ES-76
P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)	Same as DTC P0011	Comes on	DTC stored	ES-81
P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)	Same as DTC P0011	Comes on	DTC stored	ES-81
P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)	1. Open or short in Oil Control Valve circuit (OCV) for exhaust camshaft 2. OCV for exhaust camshaft (bank 2) 3. ECM	Comes on	DTC stored	ES-87
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	Same as DTC P0014	Comes on	DTC stored	ES-92
P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)	Same as DTC P0014	Comes on	DTC stored	ES-92
P0031 *1	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-101
P0032 *1	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-101
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. EFI relay 4. ECM	Comes on	DTC stored	ES-107
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. EFI relay 4. ECM	Comes on	DTC stored	ES-107

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0051 *1	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-101
P0052 *1	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-101
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. EFI relay 4. ECM	Comes on	DTC stored	ES-107
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. EFI relay 4. ECM	Comes on	DTC stored	ES-107
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-113
P0101	Mass or Volume Air Flow Circuit Range / Performance Problem	MAF meter	Comes on	DTC stored	ES-120
P0102	Mass or Volume Air Flow Circuit Low Input	1. Open in MAF meter circuit 2. Short in ground circuit 3. MAF meter 4. ECM	Comes on	DTC stored	ES-113
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-113
P0110	Intake Air Temperature Circuit	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-122
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-122
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-122

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0115	Engine Coolant Temperature Circuit	1. Open or short in Engine Coolant Temperature (ECT) sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-128
P0116	Engine Coolant Temperature Circuit Range / Performance Problem	ECT sensor	Comes on	DTC stored	ES-133
P0117	Engine Coolant Temperature Circuit Low Input	1. Short in ECT sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-128
P0118	Engine Coolant Temperature Circuit High Input	1. Open in ECT sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-128
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit	1. Throttle Position (TP) sensor (built into throttle body) 2. ECM	Comes on	DTC stored	ES-136
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	ES-144
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-136
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-136
P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control	1. Cooling system 2. ECT sensor 3. Thermostat	Comes on	DTC stored	ES-146
P0128	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)	1. Thermostat 2. Cooling system 3. ECT sensor 4. ECM	Comes on	DTC stored	ES-149
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. EFI relay 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-152

ES

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
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. EFI relay 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-152
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-152
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. EFI relay 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-152
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. EFI relay 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-152
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-152

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
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-171
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-171

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-171
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-171
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	1. TP sensor (built into throttle body) 2. ECM	Comes on	DTC stored	ES-136
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-136
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-136

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. Cylinder compression 10. Valve clearance 11. Valve timing 12. PCV hose connection 13. PCV hose 14. ECM 15. Air induction system	Comes on or flashes	DTC stored	ES-183
P0301	Cylinder 1 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-183
P0302	Cylinder 2 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-183
P0303	Cylinder 3 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-183
P0304	Cylinder 4 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-183
P0305	Cylinder 5 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-183
P0306	Cylinder 6 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-183
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-197
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-197
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-197
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-197
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-203
P0339	Crankshaft Position Sensor "A" Circuit Intermittent	Same as DTC P0335	Does not come on	DTC stored	ES-203

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0340	Camshaft Position Sensor "A" Circuit (Bank 1 or Single Sensor)	1. Open or short in VVT sensor circuit for intake camshaft 2. VVT sensor for intake camshaft 3. Camshaft timing pulley 4. Jumped teeth of timing chain 5. ECM	Comes on	DTC stored	ES-209
P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)	Same as DTC P0340	Comes on	DTC stored	ES-209
P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)	Same as DTC P0340	Comes on	DTC stored	ES-209
P0345	Camshaft Position Sensor "A" Circuit (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-209
P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-209
P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-209
P0351 *2	Ignition Coil "A" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 6) between ignition coil with igniter and ECM 3. No. 1 to No. 6 ignition coils with igniters 4. ECM	Comes on	DTC stored	ES-215
P0352 *2	Ignition Coil "B" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-215
P0353 *2	Ignition Coil "C" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-215
P0354 *2	Ignition Coil "D" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-215
P0355 *2	Ignition Coil "E" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-215
P0356 *2	Ignition Coil "F" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-215
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. ECM	Comes on	DTC stored	ES-225

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 teeth of timing chain 5. ECM	Comes on	DTC stored	ES-225
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 teeth of timing chain 5. ECM	Comes on	DTC stored	ES-225
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. ECM	Comes on	DTC stored	ES-225
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 teeth of timing belt 5. ECM	Comes on	DTC stored	ES-225
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 teeth of timing belt 5. ECM	Comes on	DTC stored	ES-225
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-229
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-229

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P043E	Evaporative Emission System Reference Orifice Clog Up	1. Pump module 2. Connector / wire harness (between pump module and ECM) 3. Leakage from EVAP system 4. ECM	Comes on	DTC stored	ES-236
P043F	Evaporative Emission System Reference Orifice High Flow	1. Pump module 2. Connector / wire harness (between pump module and ECM) 3. Leakage from EVAP system 4. ECM	Comes on	DTC stored	ES-236
P0441	Evaporative Emission Control System Incorrect Purge Flow	1. Purge VSV 2. Purge VSV circuit (between purge VSV and ECM) 3. Leakage from EVAP line (between purge VSV and intake manifold) 4. EVAP line clogged (between purge VSV and canister) 5. ECM	Comes on	DTC stored	ES-242
P0450	Evaporative Emission Control System Pressure Sensor / Switch	1. Pump module (including pressure sensor) 2. ECM	Comes on	DTC stored	ES-249
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-249
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-249
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-249

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 (between canister and fuel tank) 3. Leakage from EVAP line (between purge VSV and canister) 4. Leakage from pump module 5. Leakage from fuel tank 6. Leakage from canister	Comes on	DTC stored	ES-257
P0456	Evaporative Emission Control System Leak Detected (Very Small Leak)	Same as DTC P0455	Comes on	DTC stored	ES-257
P0500	Vehicle Speed Sensor "A"	1. Open or short in speed sensor circuit 2. Speed sensor 3. Combination meter 4. ECM 5. Skid control ECU	Comes on	DTC stored	ES-262
P0504	Brake Switch "A" / "B" Correlation	1. Short in stop light switch signal circuit 2. STOP fuse 3. Stop light switch 4. ECM	Does not come on	DTC stored	ES-265
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-271
P0560	System Voltage	1. Open in back up power source circuit 2. EFI No. 1 fuse 3. ECM	Comes on	DTC stored	ES-275
P0604	Internal Control Module Random Access Memory (RAM) Error	ECM	Comes on	DTC stored	ES-279
P0606	ECM / PCM Processor	ECM	Comes on	DTC stored	ES-279
P0607	Control Module Performance	ECM	Comes on	DTC stored	ES-279
P0617	Starter Relay Circuit High	1. Park / Neutral Position (PNP) switch 2. Starter relay circuit 3. Ignition switch 4. ECM	Comes on	DTC stored	ES-281
P0630	VIN not Programmed or Mismatch - ECM / PCM	ECM	Comes on	DTC stored	ES-285
P0657	Actuator Supply Voltage Circuit / Open	ECM	Comes on	DTC stored	ES-279

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2102	Throttle Actuator Control Motor Circuit Low	1. Open in throttle actuator circuit 2. Throttle actuator 3. ECM	Comes on	DTC stored	ES-287
P2103	Throttle Actuator Control Motor Circuit High	1. Short in throttle actuator circuit 2. Throttle actuator 3. Throttle valve 4. Throttle body 5. ECM	Comes on	DTC stored	ES-287
P2111	Throttle Actuator Control System - Stuck Open	1. Throttle actuator 2. Throttle body 3. Throttle valve	Comes on	DTC stored	ES-291
P2112	Throttle Actuator Control System - Stuck Closed	Same as DTC P2111	Comes on	DTC stored	ES-291
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-294
P2119	Throttle Actuator Control Throttle Body Range / Performance	1. ETCS 2. ECM	Comes on	DTC stored	ES-298
P2120	Throttle / Pedal Position Sensor / Switch "D" Circuit	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-301
P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-309
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-301
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-301
P2125	Throttle / Pedal Position Sensor / Switch "E" Circuit	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-301
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-301
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-301

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
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-136
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-301
P2195 *1	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-313
P2196 *1	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	Same as DTC P2195	Comes on	DTC stored	ES-313
P2197 *1	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-313
P2198 *1	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)	Same as DTC P2197	Comes on	DTC stored	ES-313
P2238 *1	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-329
P2239 *1	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-329

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2241 *1	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-329
P2242 *1	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-329
P2252 *1	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-329
P2253 *1	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-329
P2255 *1	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-329
P2256 *1	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-329
P2401	Evaporative Emission System Leak Detection Pump Control Circuit Low	1. Pump module 2. Connector / wire harness (between pump module and ECM) 3. ECM 4. Leakage from EVAP system	Comes on	DTC stored	ES-336
P2402	Evaporative Emission System Leak Detection Pump Control Circuit High	1. Pump module 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-336
P2419	Evaporative Emission System Switching Valve Control Circuit Low	1. Pump module 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-342
P2420	Evaporative Emission System Switching Valve Control Circuit High	1. Pump module 2. Connector / wire harness (between pump module and ECM) 3. ECM 4. Leakage from EVAP system	Comes on	DTC stored	ES-342
P2610	ECM / PCM Internal Engine Off Timer Performance	ECM	Comes on	DTC stored	ES-348

DTC No.	Detection Item	Suspected Trouble Area	MIL	Memory	See page
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-350
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-350

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

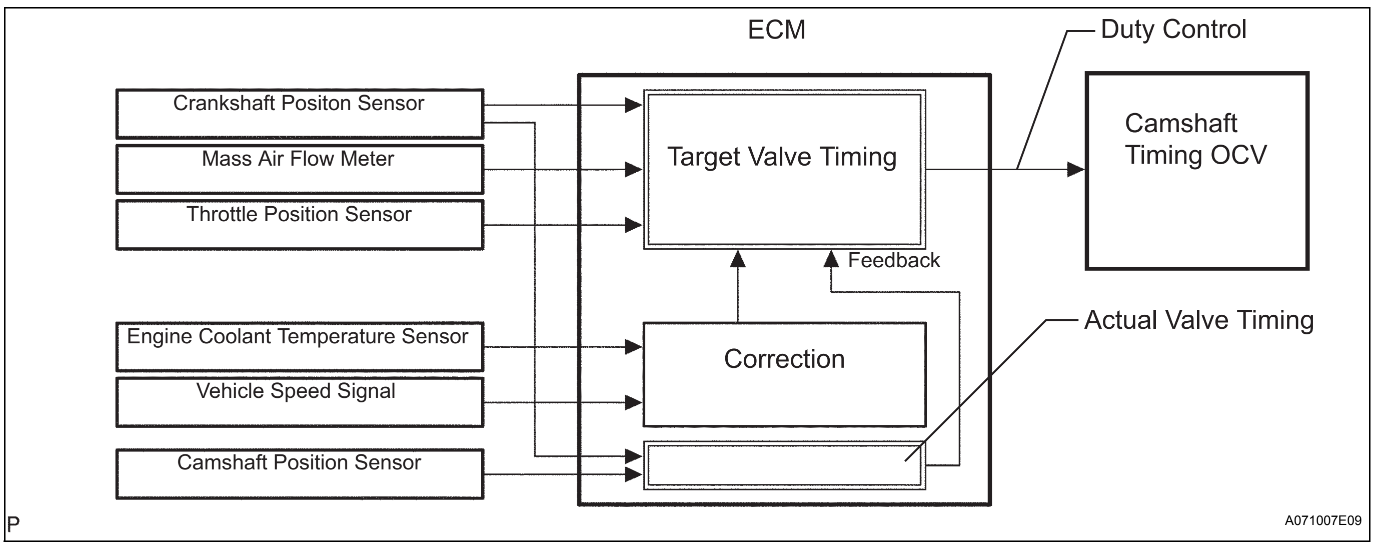
DTC	P0010	Camshaft Position "A" Actuator Circuit (Bank 1)

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

HINT:
These DTCs relate to the Oil Control Valve (OCV) for intake camshaft.

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 applied 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 Conditions	Trouble Areas
P0010	Open or short in OCV circuit (1 trip detection logic)	• Open or short in Oil Control Valve (OCV) circuit for intake camshaft • OCV for intake camshaft (bank 1) • ECM
P0020	Open or short in OCV circuit (1 trip detection logic)	• Open or short in Oil Control Valve (OCV) circuit for intake camshaft • OCV for intake camshaft (bank 2) • ECM

MONITOR DESCRIPTION

The ECM optimizes the valve timing using the VVT system to control the intake 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 applied to the VVT controller. The VVT controller can advance or retard the intake 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 a DTC when the actual duty-cycle ratio varies from the target duty-cycle ratio.

MONITOR STRATEGY

Related DTCs	P0010: VVT OCV (Bank 1) range check P0020: VVT OCV (Bank 2) range check
Required sensors / components (Main)	VVT OCV
Required sensors / components (Related)	-
Frequency of operation	Continuous
Duration	1 second
MIL operation	Immediate
Sequence operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Battery voltage	11 to 13 V
Target duty ratio for the OCV	Less than 70%
Starter	OFF
Current cut status for the OCV	Not cut
Ignition switch	ON

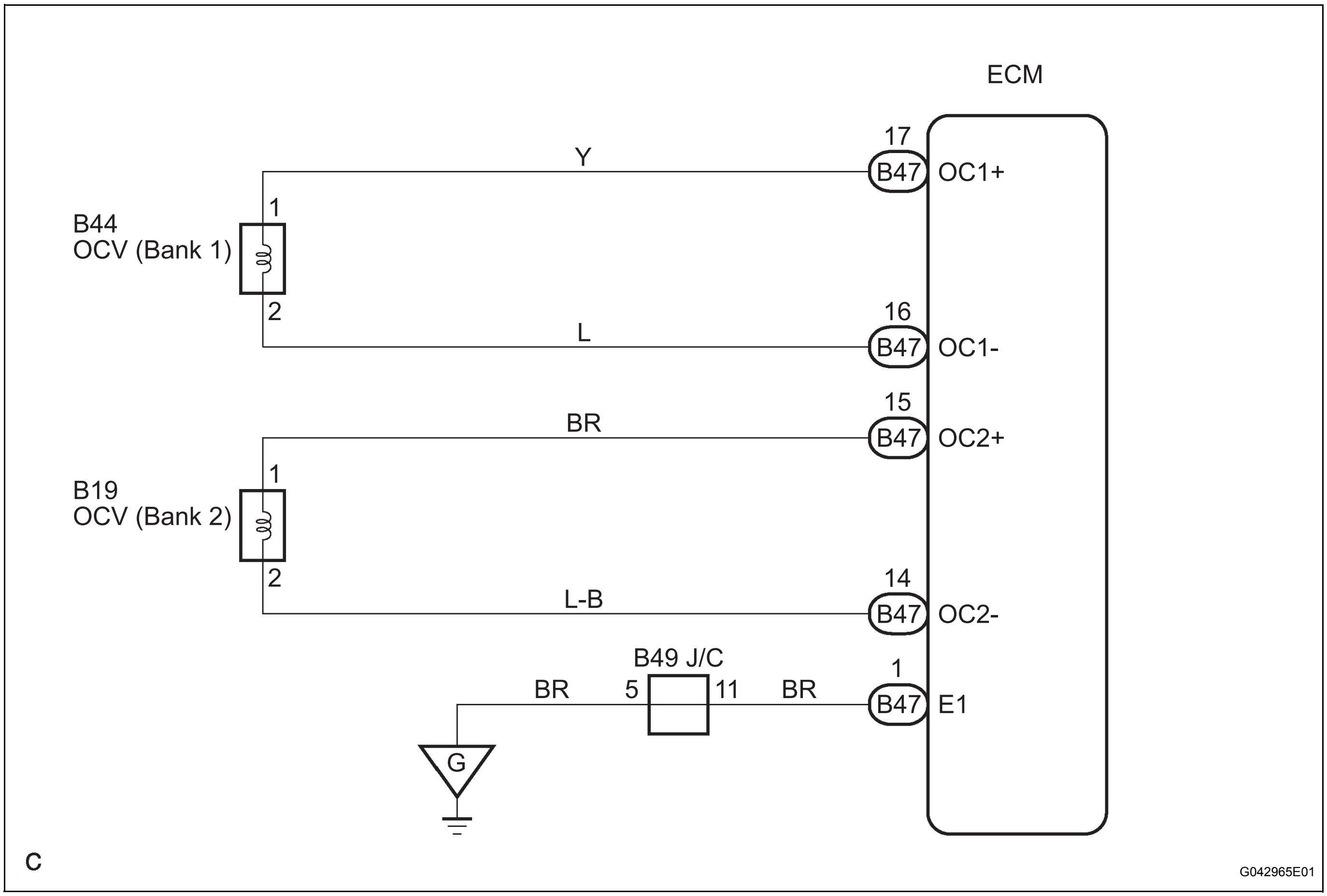
TYPICAL MALFUNCTION THRESHOLDS

Either of the following conditions is met:	Condition 1 or 2
1. Output signal duty for OCV	Output duty ratio is 100% (always ON) but target duty ratio is less than 70%
2. Output signal duty for OCV	Output duty is ratio 3% or less despite the ECM supplying current to the OCV

COMPONENT OPERATING RANGE

Output signal duty for OCV	"More than 3%" and " less than 100%"

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P0010 is displayed, check the bank 1 VVT system circuit.
- Bank 1 refers to the bank that include cylinder No. 1.
- If DTC P0020 is displayed, check the bank 2 VVT system circuit.
- Bank 2 refers to the bank that does not includes 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.

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 and idle it.
(d) Select the following menu items on the tester: 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.

Standard

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

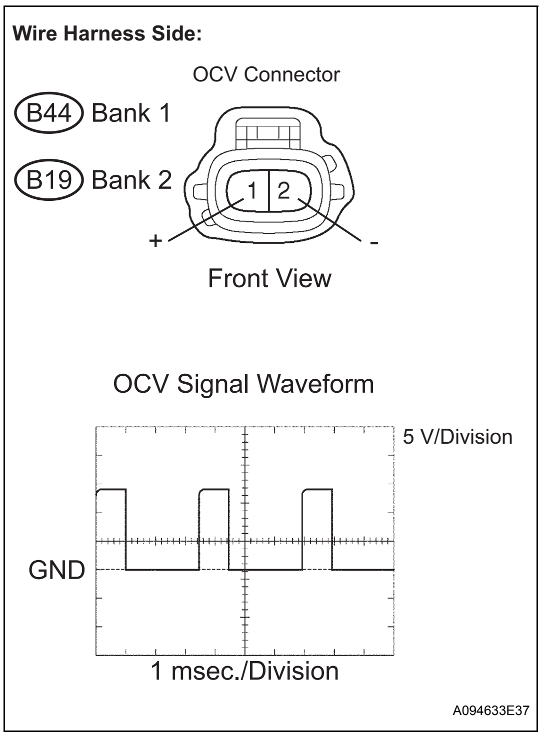
NG → **Go to step 2**

OK

CHECK FOR INTERMITTENT PROBLEMS

ES

2 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV SIGNAL)



(a) Disconnect the B44 or B19 OCV connector.

(b) While idling, check the waveform between the terminals of the B44 or B19 OCV connector using an oscilloscope.

OK

Tester Connections	Specified Conditions
+ (B44-1) - - (B44-2)	Correct waveform appears
+ (B19-1) - - (B19-2)	Correct waveform appears

(c) Reconnect the OCV connector.

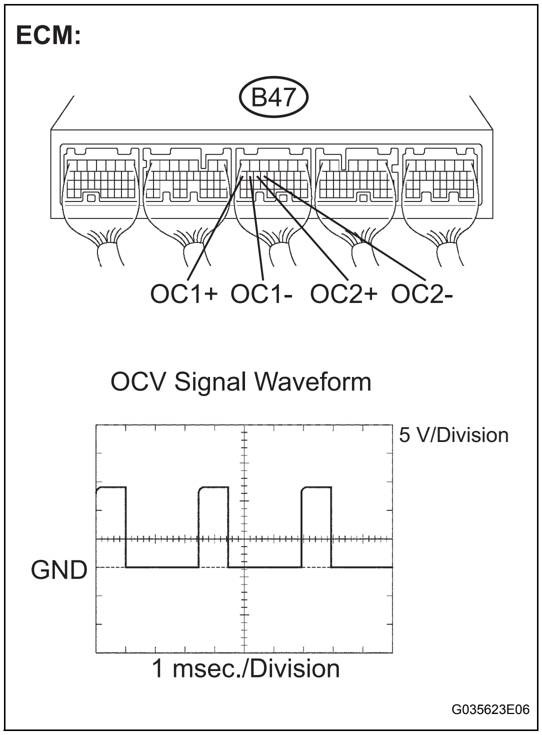
NG → **Go to step 3**

OK

REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

ES

3	INSPECT ECM (OCV SIGNAL)



(a) Inspect the ECM using an oscilloscope.
(b) While idling, check the waveform between the terminals of the B47 ECM connector.
OK

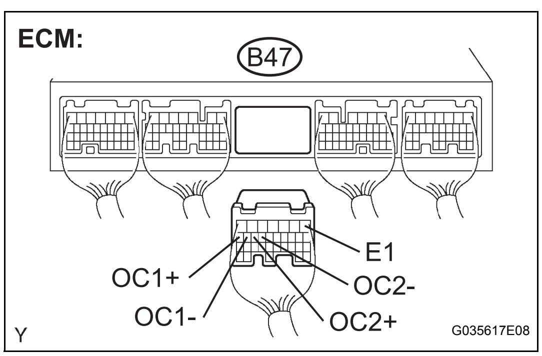
Tester Connections	Specified Conditions
OC1+ (B47-17) - OC1- (B47-16)	Correct waveform appears
OC2+ (B47-15) - OC2- (B47-14)	Correct waveform appears

NG → **Go to step 4**

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR (OCV SIGNAL OPEN CIRCUIT)

4	CHECK HARNESS AND CONNECTOR (OCV SIGNAL SHORT CIRCUIT)



(a) Disconnect the B44 or B19 OCV connector.
(b) Disconnect the B47 ECM connector.
(c) Measure the resistance between the wire harness side connectors.
Standard resistance (Check for short)

Symbols (Terminal No.)	Specified condition
OC1+ (B47-17) - E1 (B47-1)	10 kΩ or higher
OC1- (B47-16) - E1 (B47-1)	10 kΩ or higher
OC2+ (B47-15) - E1 (B47-1)	10 kΩ or higher
OC2- (B47-14) - E1 (B47-1)	10 kΩ or higher

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

OK

REPLACE ECM

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)

HINT:
If DTC P0011, P0012, P0021 or P0022 is present, check the VVT (Variable Valve Timing) system.

DESCRIPTION

Refer to DTC P0010 (See page ES-76).

DTC No.	DTC Detection Conditions	Trouble Areas
P0011 P0021	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 (1 trip detection logic): (a) Difference between target and actual intake valve timings is more than 5° CA (Crankshaft Angle) for 4.5 seconds (b) Current intake 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 • OCV for intake camshaft • OCV filter • Intake camshaft 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 (a), (b) and (c) are met (2 trip detection logic): (a) Difference between target and actual intake valve is timings more than 5° CA (Crankshaft Angle) for 4.5 seconds (b) Current intake valve timing is fixed (timing changes less than 5° CA in 5 seconds) (c) Variations in VVT controller timing is 19° CA or less of maximum delayed timing (retarded)	• Valve timing • OCV for intake camshaft • OCV filter • Intake camshaft timing gear assembly • ECM

MONITOR DESCRIPTION

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. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure applied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
If the difference between the target and actual intake valve timings is large, and changes in 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.
DTCs P0011 and P0021 (Advanced Cam Timing) are subject to 1 trip detection logic.
DTCs P0012 and P0022 (Retarded Cam Timing) are subject to 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.
The monitor will not run unless the following conditions are met:
- The engine is warm (the engine coolant temperature is 75°C [167°F] or more).
- The vehicle has been driven at more than 40 mph (64 km/h) for 3 minutes.
- The engine has idled for 3 minutes.

MONITOR STRATEGY

Related DTCs	P0011: Advanced intake camshaft timing (bank 1) P0012: Retarded intake camshaft timing (bank 1) P0021: Advanced intake camshaft timing (bank 2) P0022: Retarded intake camshaft timing (bank 2)
Required sensors / components (Main)	VVT OCV, VVT Actuator
Required sensors / components (Related)	Crankshaft position sensor, Camshaft position sensor, ECT sensor
Frequency of operation	Once per driving cycles
Duration	Less than 10 seconds
MIL operation	P0011 and P0021: Immediate P0012 and P0022: 2 driving cycles
Sequence operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	P0100, P0101, P0102, P0103 (MAF Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0125 (Insufficient ECT for Closed Loop), P0335 (CKP Sensor), P0340 (VVT Sensor 1, 2), P0351, P0352, P0353, P0354, P0355, P0356 (Ignitor)
Battery voltage	11 V or more
Engine RPM	500 to 4,000 rpm
ECT	75 to 100°C (167 to 212°F)

TYPICAL MALFUNCTION THRESHOLDS

P0011, P0021:

Duration of valve timing	More than 5° CA (Crankshaft angle)
Valve timing	No change at advanced valve timing

P0012, P0022:

Duration of valve timing	More than 5° CA (Crankshaft angle)
Valve timing	No change at retarded valve timing

If the difference between the target and actual camshaft timings is greater than the specified value, the ECM operates the VVT actuator.
Then, the ECM monitors the camshaft timing change for 5 seconds.

WIRING DIAGRAM

Refer to DTC P0010 (See page ES-78).

INSPECTION PROCEDURE

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

HINT:

- If DTC P0011 or P0012 is displayed, check the bank 1 VVT system circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0021 or P0022 is displayed, check the bank 2 VVT system circuit.
- 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.

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) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read 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**

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) Select the following menu items on the tester: 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 Operations	Specified Conditions
OCV OFF	Normal engine idle 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 DTCs (See page ES-44).
(d) Start the engine and warm it up.
(e) Select check mode using the tester (See page ES-48).
(f) Drive the vehicle for more than 10 minutes.
(g) Read DTCs using the tester.

OK:

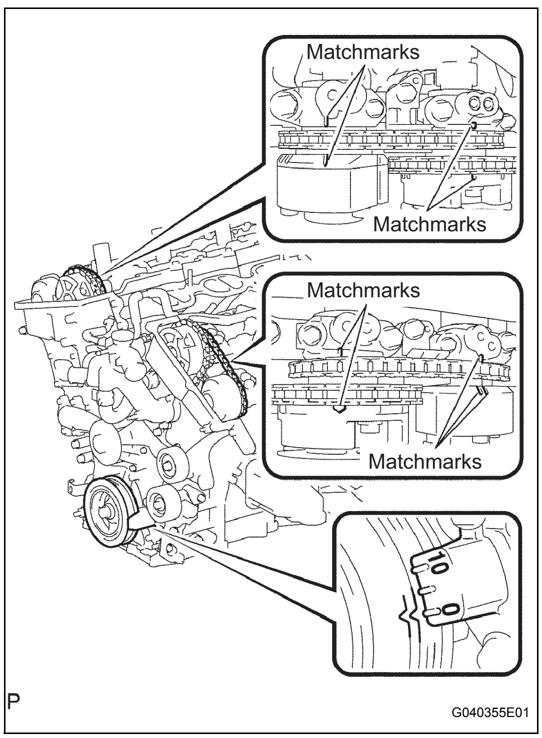
No DTC output.

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 to align the matchmarks of the crankshaft.
(c) Align the notch of the crankshaft pulley to the "0" position.
(d) Check if the matchmarks of the camshaft pulley and camshaft bearing cap align.
(e) Turn the crankshaft clockwise by 360° if the matchmarks do not align. Check if they align once again.

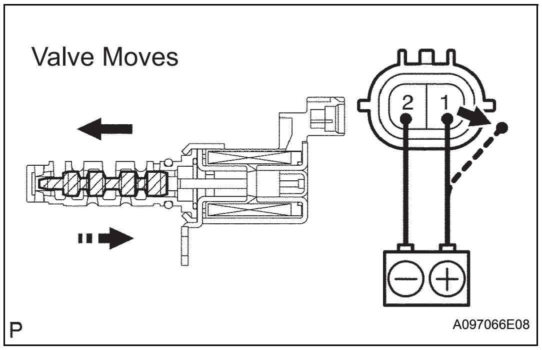
OK:

The matchmarks of the camshaft pulley and the camshaft bearing cap align when the notch of the crankshaft pulley is in the "0" position.

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.

Resistance:

6.9 to 7.9 Ω at 20°C (68°F)

(c) Apply the positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.

OK:

Valve moves quickly.

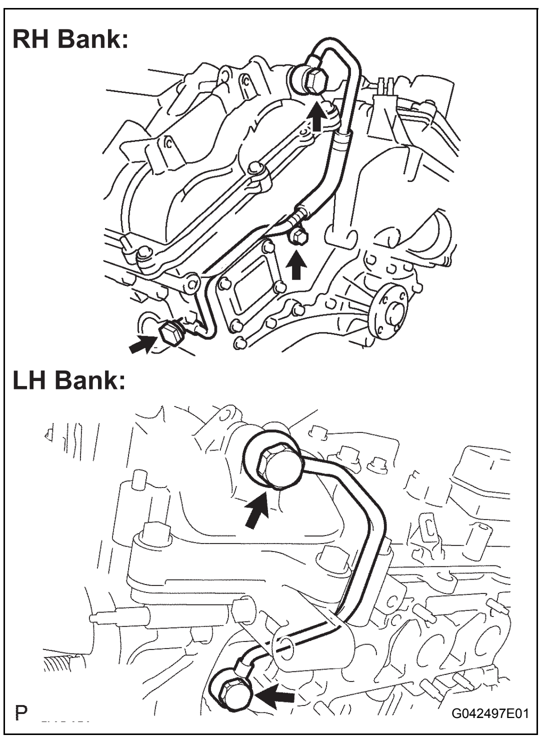
(d) Reinstall the OCV.

NG → **REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY**

ES

OK

6	CHECK OIL PIPE AND OIL CONTROL VALVE FILTER



(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 → **REPLACE OIL PIPE OR OIL CONTROL VALVE FILTER**

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 DTCs (See page ES-44).
(d) Start the engine and warm it up.
(e) Select the check mode using the tester (See page ES-48).
(f) Drive the vehicle for more than 10 minutes.
(g) Confirm that no DTC is set using the 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 registered 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.

NG → **REPLACE ECM**

ES

OK

END

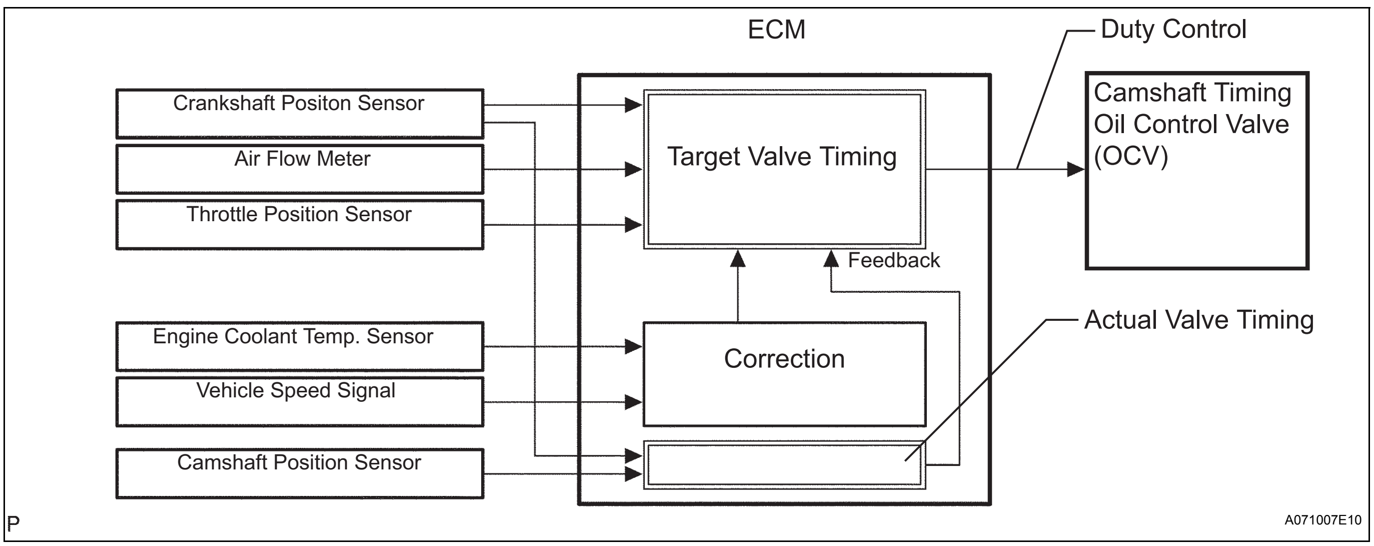
DTC	P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)

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

HINT:
These DTCs relate to the Oil Control Valve (OCV) for exhaust camshaft.

DESCRIPTION

The Variable Valve Timing (VVT) system controls the exhaust camshaft to provide the optimal valve timing for every driving condition. This control is performed based on the signals, such as intake air volume, throttle position and engine coolant temperature.
The ECM controls the Oil Control Valve (OCV), based on the signals output from the sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative position between the camshaft and the crankshaft becomes optimal, and the engine torque and fuel economy improve, and exhaust emissions decrease under overall driving conditions. Also, the ECM detects the actual valve timing using the signals from the camshaft position sensor and the crankshaft position sensor, and performs feedback control. This is how target valve timing is achieved by the ECM.



DTC No.	DTC Detection Conditions	Trouble Areas
P0013	Open or short in OCV exhaust camshaft circuit	• Open or short in OCV for exhaust camshaft circuit • OCV for exhaust camshaft (bank1) • ECM
P0023	Open or short in OCV exhaust camshaft circuit	• Open or short in OCV for exhaust camshaft 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 (for exhaust camshaft) and the VVT controller. The ECM sends a target duty-cycle control signal to the OCV (for exhaust camshaft). 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 (for exhaust camshaft), the ECM monitors the OCV (for exhaust camshaft) 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: Exhaust VVT OCV (bank 1) open/short P0023: Exhaust VVT OCV (bank 2) open/short
Required Sensors / Components (Main)	VVT OCV (Variable Valve Timing Oil Control Valve)
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

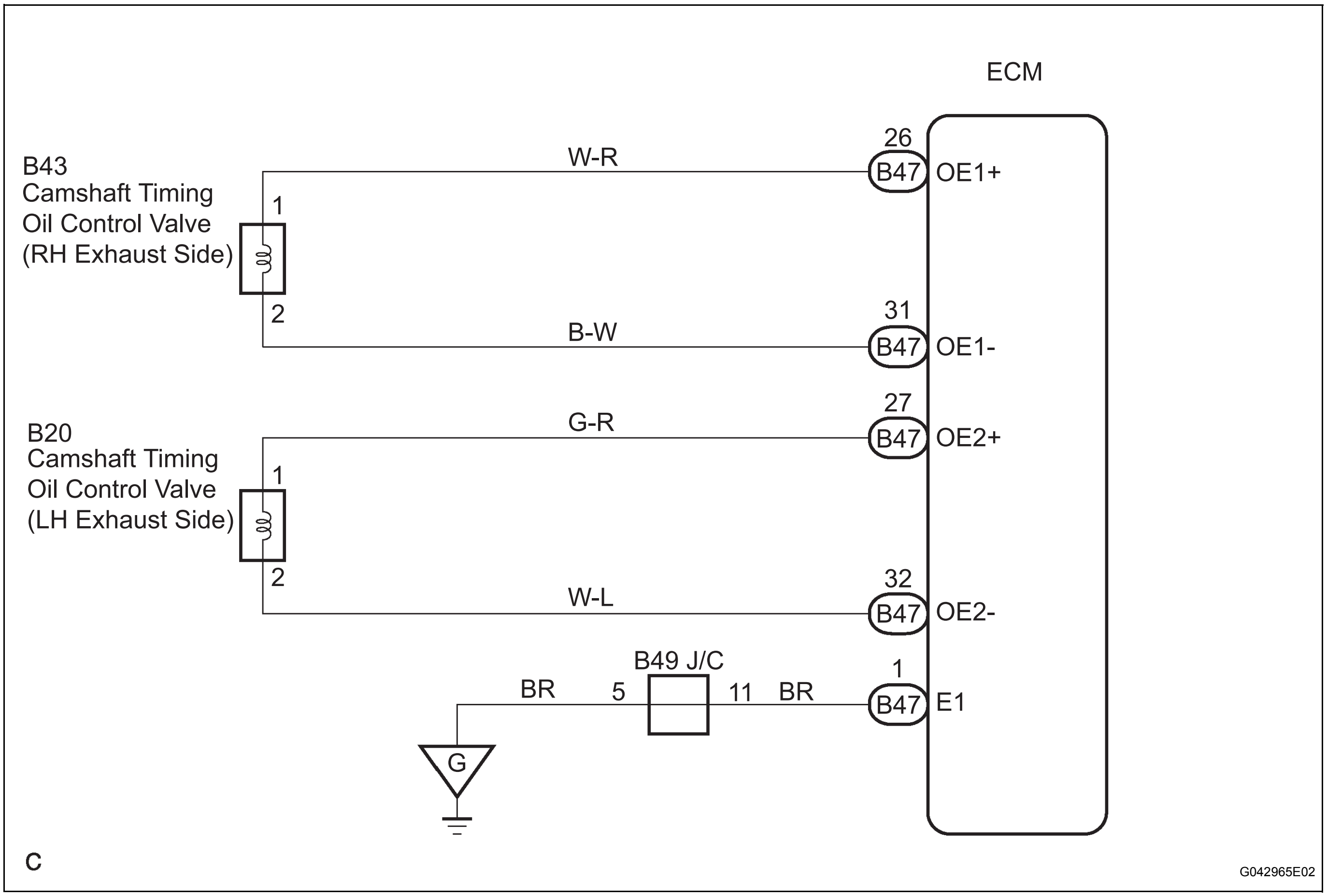
The monitor will run whenever these DTCs are not present	None
Battery voltage	11 to 13 V
Target duty ratio for exhaust VVT OCV	Less than 70%
Starter	OFF
Ignition switch	ON
Current cut status for exhaust VVT OCV	Not cut

TYPICAL MALFUNCTION THRESHOLDS

Exhaust VVT OCV condition	No operation record

ES

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P0013 is displayed, check the right bank VVT system for exhaust camshaft circuit.
- If DTC P0023 is displayed, check the left bank VVT system for exhaust camshaft circuit.
- 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.

1	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATE OCV)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and warm it up.
(c) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT EX B1 or VVT EX B2.
(d) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

Standard

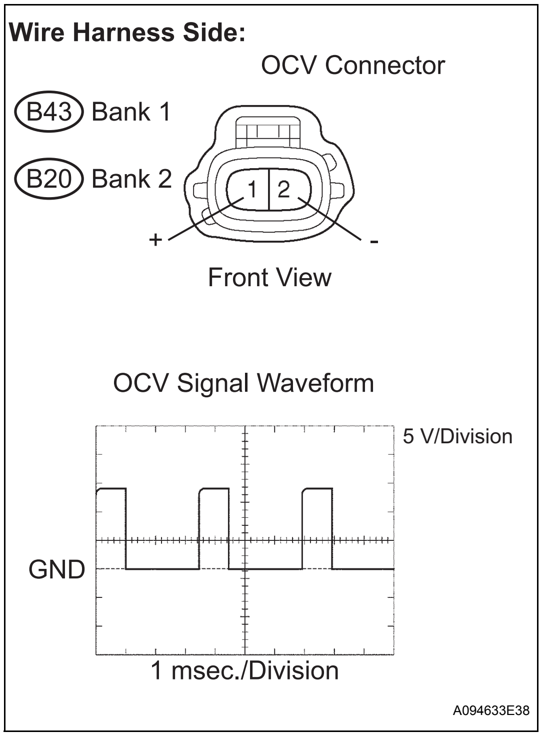
Tester Operations	Specified Conditions
OCV OFF	Normal engine idle speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

NG → Go to step 2

OK

CHECK FOR INTERMITTENT PROBLEMS

2 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV SIGNAL)



(a) Disconnect the B43 or B20 OCV connector.
(b) While idling, check the waveform between the terminals of the B43 or B20 OCV connector using an oscilloscope.
OK

Tester Connections	Specified Conditions
+ (B43-1) - - (B43-2)	Correct waveform appears
+ (B20-1) - - (B20-2)	Correct waveform appears

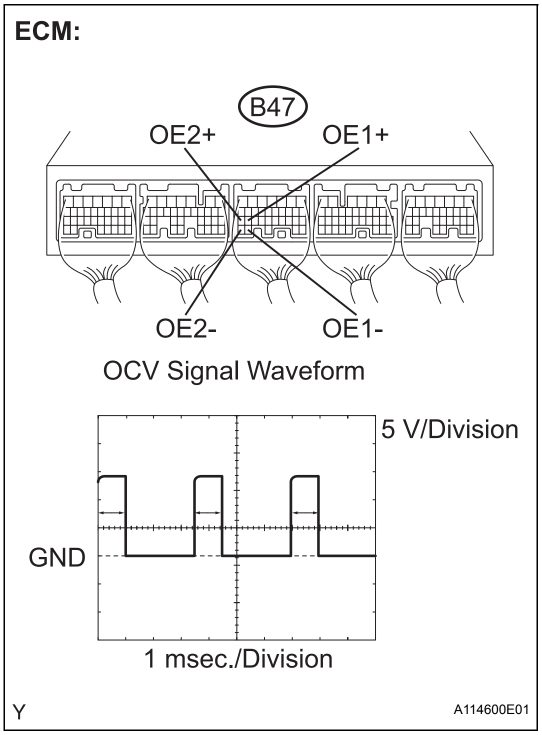
(c) Reconnect the OCV connector.

NG → Go to step 3

OK

REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

3	CHECK ECM (OCV SIGNAL)



(a) Inspect the ECM using an oscilloscope.
(b) While idling, check the waveform between the terminals of the B47 ECM connector.
OK

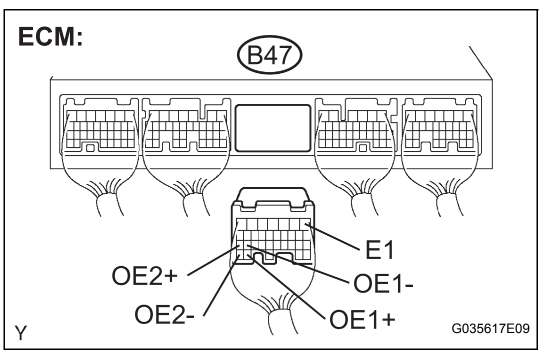
Tester Connections	Specified Conditions
OE1+ (B47-26) - OE1- (B47-31)	Correct waveform appears
OE2+ (B47-27) - OE2- (B47-32)	Correct waveform appears

NG → **Go to step 4**

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR

4	CHECK HARNESS AND CONNECTOR (OCV SIGNAL SHORT CIRCUIT)



(a) Disconnect the B43 or B20 OCV connector.
(b) Disconnect the B47 ECM connector.
(c) Measure the resistance between the wire harness side connectors.
Standard resistance (Check for short)

Tester Connections	Specified Conditions
OE1+ (B47-26) - E1 (B47-1)	10 kΩ or higher
OE1- (B47-31) - E1 (B47-1)	10 kΩ or higher
OE2+ (B47-27) - E1 (B47-1)	10 kΩ or higher
OE2- (B47-32) - E1 (B47-1)	10 kΩ or higher

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

OK

REPLACE ECM

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)

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

DESCRIPTION

Refer to DTC P0013 (See page ES-87).

DTC No.	DTC Detection Condition	Trouble Area
P0014 P0024	Condition (a) or (b) continues after engine is warmed up and engine speed is at 500 to 4,000 rpm (Problem of the advanced OCV for exhaust camshaft.): (a) Valve timing does not change from current valve timing (b) Current valve timing is fixed	• Valve timing • OCV for exhaust camshaft • OCV filter • Exhaust camshaft timing gear assembly • ECM
P0015 P0025	Condition (a) or (b) continues after engine is warmed up and engine speed is at 500 to 4,000 rpm (Problem of the retarded OCV.): (a) Valve timing does not change from current valve timing (b) Current valve timing is fixed	• Valve timing • OCV for exhaust camshaft • OCV filter • Exhaust camshaft timing gear assembly • ECM

MONITOR DESCRIPTION

DTC P0014 and P0024
The ECM compares current valve timing with target valve timing, while the engine is running and after being warmed up, in order to monitor the VVT system on the exhaust side. Valve timing is calculated from the positions of the camshaft and crankshaft. The ECM controls the engine so that current valve timing meets target valve timing. If these timings are not met, the ECM determines this as a malfunction.
DTC P0015 and P0025
The ECM compares current valve timing with target valve timing, while the engine is running and after being warmed up, in order to monitor the VVT system on the exhaust side. Valve timing is calculated from the positions of the camshaft and crankshaft. The ECM controls the engine so that current valve timing meets target valve timing. If these timings are not met, the ECM determines this as a malfunction.

MONITOR STRATEGY

Related DTCs	P0014: Advanced exhaust camshaft timing (bank 1) P0015: Retarded exhaust camshaft timing (bank 1) P0024: Advanced exhaust camshaft timing (bank 2) P0025: Retarded exhaust camshaft timing (bank 2)
Required Sensors / Components (Main)	VVT OCV and VVT Actuator

Required Sensors / Components (Related)	P0014 and P0015: Exhaust camshaft control actuator bank 1 Exhaust OCV bank 1 P0024 and P0025: Exhaust camshaft control actuator bank 2 Exhaust OCV bank 2
Frequency of Operation	Continuously
Duration	Less than 10 seconds
MIL Operation	P0014 and P0024: Immediate P0015 and P0025: 2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
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

One of the following conditions met	Conditions 1, 2 or 3
1. Deviation from target valve timing	More than 5° CA (Crankshaft angle)
2. Actual valve timing	No change
3. Camshaft position	Advanced

If the difference between the target and actual camshaft timings is greater than the specified value, the ECM operates the VVT actuator.
Then, the ECM monitors the camshaft timing change for 5 seconds.

WIRING DIAGRAM

Refer to DTC P0013 (See page ES-89).

INSPECTION PROCEDURE

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

HINT:
- If DTC P0014 or P0015 is displayed, check the bank 1 VVT system circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0024 or P0025 is displayed, check the bank 2 VVT system circuit.
- 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.

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) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read 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**

ES

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) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT EX B1 or VVT EX B2.
(e) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK

Tester Operations	Specified Conditions
OCV OFF	Normal engine idle 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)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Clear DTCs (See page ES-44).
(d) Start the engine and warm it up.
(e) Select check mode using the tester (See page ES-48).
(f) Drive the vehicle for more than 10 minutes.
(g) Read DTCs using the tester.

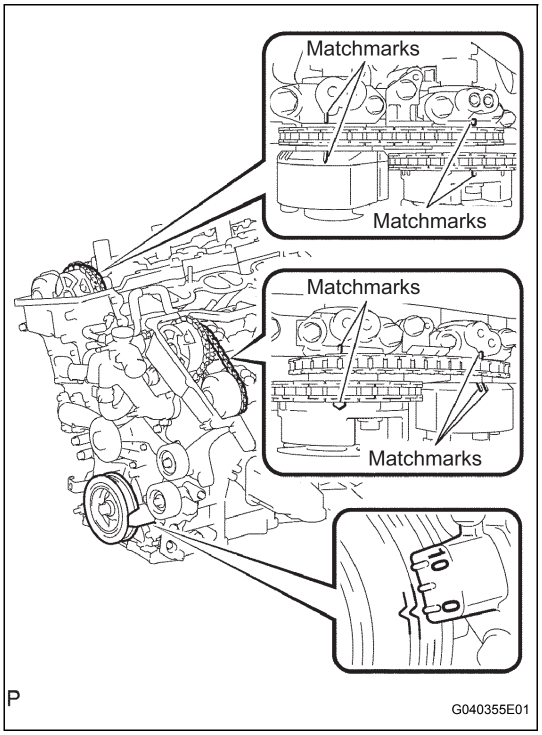
OK:
No DTC output.

NG → **Go to step 4**

OK

END

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



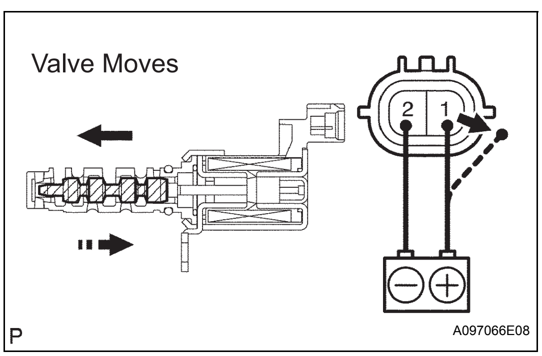
(a) Remove the cylinder head covers RH and LH.
(b) Turn the crankshaft to align the matchmarks of the crankshaft.
(c) Align the notch of the crankshaft pulley to the "0" position.
(d) Check if the matchmarks of the camshaft pulley and camshaft bearing cap align.
(e) Turn the crankshaft clockwise by 360° if the matchmarks do not align. Check if they align once again.
OK:
The matchmarks of the camshaft pulley and the camshaft bearing cap align when the notch of the crankshaft pulley is in the "0" position.

NG → **ADJUST VALVE TIMING**

OK

ES

5	INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV)



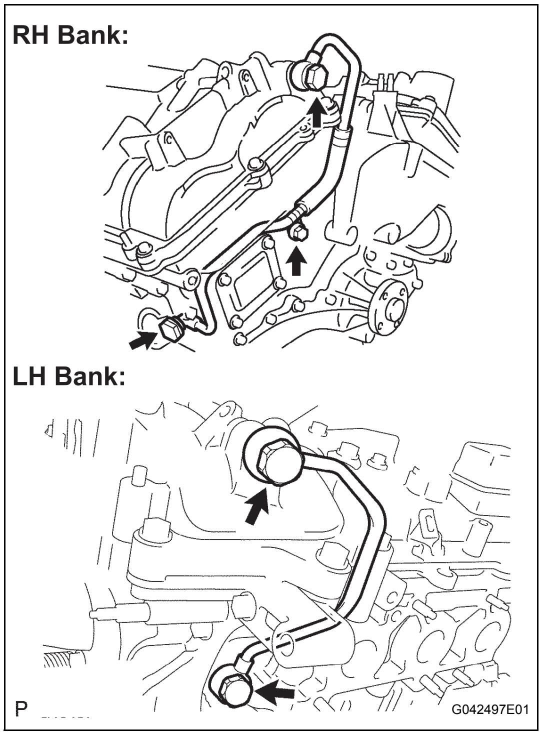
(a) Remove the OCV.
(b) Measure the resistance between the terminals of the OCV.
Standard resistance:
6.9 to 7.9 Ω at 20°C (68°F)
(c) Apply the positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.
OK:
Valve moves quickly.
(d) Reinstall the OCV.

NG → **REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY**

OK

ES

6	CHECK OIL PIPE AND OIL CONTROL VALVE FILTER



(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 → **REPLACE OIL PIPE OR OIL CONTROL VALVE FILTER**

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 DTCs (See page ES-44).
(d) Start the engine and warm it up.
(e) Select the check mode using the tester (See page ES-48).
(f) Drive the vehicle for more than 10 minutes.
(g) Confirm that no DTC is set using the 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 registered 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.

NG → **REPLACE ECM**

OK

END

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)

DESCRIPTION

Refer to DTC P0335 (See page ES-203).

DTC No.	DTC Detection Conditions	Trouble Areas
P0016	Deviations in crankshaft and camshaft position sensor (for intake camshaft) 1 signals (2 trip detection logic)	• Mechanical system (Timing chain has jumped tooth or chain stretched) • ECM
P0017	Deviations in crankshaft and camshaft position sensor (for exhaust camshaft) 1 signals (2 trip detection logic)	• Mechanical system (Timing chain has jumped tooth or chain stretched) • ECM
P0018	Deviations in crankshaft and camshaft position sensor (for intake camshaft) 2 signals (2 trip detection logic)	• Mechanical system (Timing chain has jumped tooth or chain stretched) • ECM
P0019	Deviations in crankshaft and camshaft position sensor (for exhaust camshaft) 2 signals (2 trip detection logic)	• Mechanical system (Timing chain has jumped tooth or chain stretched) • ECM

MONITOR DESCRIPTION

DTC P0016 and P0018

The ECM optimizes the valve timing by 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.

The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure applied to the VVT controller. The VVT controller can advance or retard the intake camshaft. The ECM calibrates the intake valve timing by setting the intake camshaft to the most retarded angle while the engine is idling. The ECM closes the OCV to retard the cam. The ECM stores this value as the VVT learning value. When the difference between the target and actual intake valve timings is 5° CA (Crankshaft Angle) or less, the ECM stores it.

If the VVT learning value matches the following conditions, the ECM determines the existence of a malfunction in the VVT system, and sets the DTC.

- The VVT learning value: Less than 18.5° CA, or more than 43.5° CA.
- The above condition continues for 18 seconds or more.

This DTC indicates that the intake camshaft has been installed toward the crankshaft at an incorrect angle, caused by factors such as the timing chain having jumped a tooth.

This monitor begins to run after the engine has idled for 5 minutes.

DTC P0017 and P0019

The ECM checks valve timing (VVT learning value) on the exhaust side while the engine is running at a low speed, in order to monitor the gap between current and target valve timings on the exhaust side. The VVT learning value is calculated from the positions of the camshaft and crankshaft. The camshaft will come to the most retarded position when the engine is running at a low speed. If the camshaft position is normal, the VVT learning value should be within the specified range. If the VVT learning value is not within the specified range, the ECM determines this as a malfunction.

MONITOR STRATEGY

Related DTCs	P0016: Deviation in crankshaft position sensor signal and camshaft position sensor signal (Bank 1) P0017: Deviation in crankshaft position sensor signal and camshaft position sensor signal (Bank 1 Sensor 2) P0018: Deviation in crankshaft position sensor signal and camshaft position sensor signal (Bank 2) P0019: Deviation in crankshaft position sensor signal and camshaft position sensor signal (Bank 2 Sensor 2)
Required Sensors / Components (Main)	P0016 and P0018: VVT actuator P0017 and P0019: Timing chain/belt
Required Sensors / Components (Related)	P0016 and P0018: Camshaft position sensor, Crankshaft position sensor P0017 and P0019 None
Frequency of Operation	Once per driving cycle
Duration	Less than 60 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	P0011, P0012 (VVT System1-Advance, Retard), P0021, P0022 (VVT System2-Adavance, Retard), P0115, P0116, P0117, P0118 (ECT Sensor),

P0016 and P0018:

Engine RPM	500 to 1,400 rpm

P0017 and P0019:

VVT feed back mode	Executing
VVT	Maximum advanced position
Engine RPM	500 to 1,000 rpm

TYPICAL MALFUNCTION THRESHOLDS

P0016 and P0018:

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

P0017 and P0019:

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

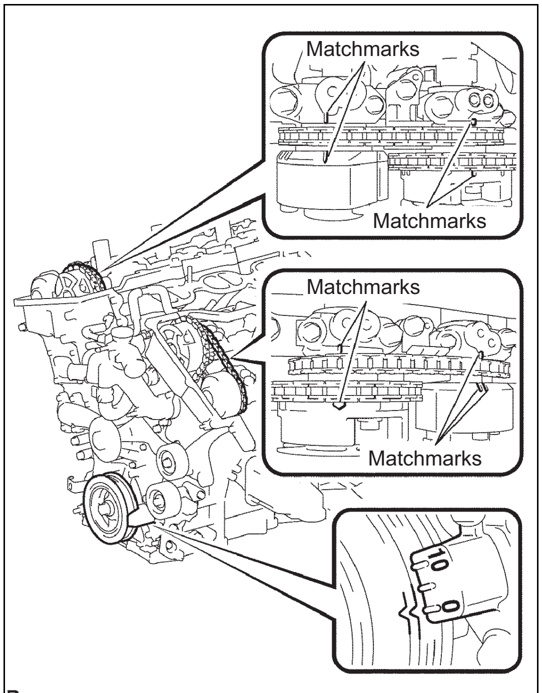
WIRING DIAGRAM

Refer to DTC P0335 (See page ES-205).

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.

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



G040355E01

(a) Remove the cylinder head covers RH and LH.
(b) Turn the crankshaft to align the matchmarks of the crankshaft.
(c) Align the notch of the crankshaft pulley to the "0" position.
(d) Check if the matchmarks of the camshaft pulley and camshaft bearing cap align.
(e) Turn the crankshaft clockwise by 360° if the matchmarks do not align. Check if they align once again.

OK:

The matchmarks of the camshaft pulley and the camshaft bearing cap align when the notch of the crankshaft pulley is in the "0" position.

NOTICE:

After replacing the ECM or adjusting intake valve timing, confirm that the DTC output does not recur.

(f) Confirm that the DTC output does not recur.
  (1) Connect the intelligent tester to the DLC3.
  (2) Turn the ignition switch on (IG).
  (3) Turn the tester on.
  (4) Clear DTCs (See page ES-44).
  (5) Select the check mode using the tester (See page ES-48).
  (6) Start the engine and warm it up.
  (7) Allow the engine to idle for 1 minute or more, and then drive the vehicle for 1 minute or more.
  (8) Confirm that no DTC is set, using the tester.

NG → **ADJUST VALVE TIMING**

OK ↓

REPLACE ECM

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)**

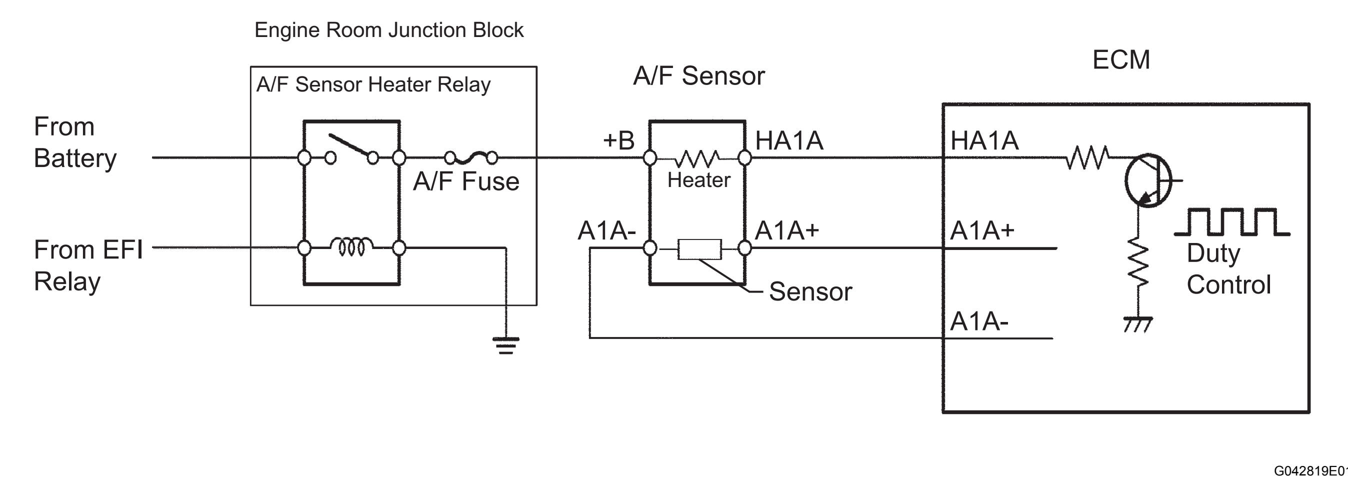
DTC	**P0052**	**Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)**

HINT:
- Although the DTC titles say the 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.

DESCRIPTION

Refer to DTC P2195 (See page ES-313).
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 ignition 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):



DTC No.	DTC Detection Conditions	Trouble Areas
P0031 P0051	Air-Fuel Ratio (A/F) sensor heater current less than 0.8 A (1 trip detection logic)	• Open in A/F sensor heater circuit • A/F sensor heater • A/F sensor heater relay • ECM
P0032 P0052	Air-Fuel Ratio (A/F) sensor heater current more than 10 A (1 trip detection logic)	• Short in A/F sensor heater circuit • A/F sensor heater • A/F sensor heater 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 closest sensor to the engine assembly.
- Sensor 2 refers to the furthest sensor away from the engine assembly.

MONITOR DESCRIPTION

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 gas.
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.
The zirconia element generates 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.
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.
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) range check (Low current) P0032: A/F sensor heater (Bank 1) range check (High current) P0051: A/F sensor heater (Bank 2) range check (Low current) P0052: A/F sensor heater (Bank 2) range check (High current)
Required sensors / components (Main)	A/F sensor heater
Required sensors / components (Related)	-
Frequency of operation	Continuous
Duration	10 seconds
MIL operation	Immediate
Sequence operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

P0031 and P0051:

Battery voltage	10.5 V or more
A/F sensor heater duty ratio	50% or more
Time after engine start	10 seconds or more

P0032 and P0052:

Time after engine start	10 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P0031 and P0051:

A/F sensor heater current	Less than 0.8 A

P0032 and P0052:

Hybrid IC high current limit port	Fail

COMPONENT OPERATING RANGE

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

MONITOR RESULT

Refer to Checking Monitor Status for detailed information (See page ES-25).
The test value and test limit information are described as shown in the following table. Check the monitor result and test values after performing the monitor drive pattern (See page ES-26).

- TID (Test Identification Data) is assigned to each emissions-related component.
- TLT (Test Limit Type):
  If TLT is 0, the component is malfunctioning when the test value is higher than the test limit.
  If TLT is 1, the component is malfunctioning when the test value is lower than the test limit.
- CID (Component Identification Data) is assigned to each test value.
- Unit Conversion is used to calculate the test value indicated on generic OBD II scan tools.

TID $07: A/F sensor heater

TLT	CID	Unit Conversion	Description of Test Data	Description of Test Limit
1	$01	Multiply by 0.00017 (A)	Maximum heater current (Bank 1)	Malfunction criterion for A/F sensor heater
1	$10	Multiply by 0.00017 (A)	Maximum heater current (Bank 2)	Malfunction criterion for A/F sensor heater

WIRING DIAGRAM

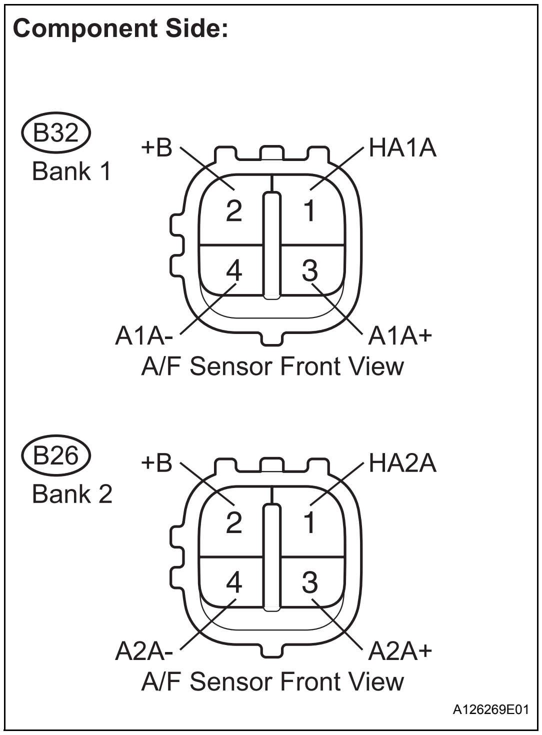
Refer to DTC P2195 (See page ES-317).

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.

ES

1 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the B26 or B32 A/F sensor connector.

(b) Measure the resistance between the terminals of the A/F sensor connector.

Standard resistance:

Bank 1

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

Bank 2

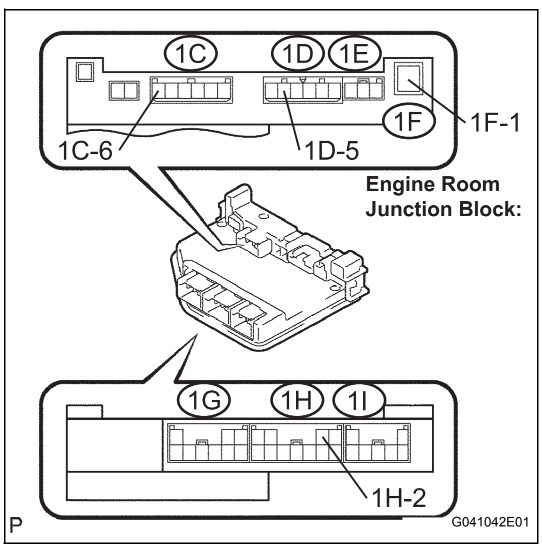
Tester Connections	Specified Conditions
HA2A (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HA2A (1) - A2A- (4)	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

2 INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (A/F SENSOR HEATER RELAY)



(a) Remove the engine room junction block.

(b) Measure the A/F sensor heater relay resistance.

Standard resistance

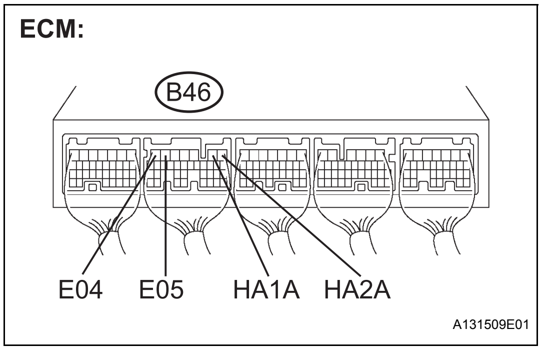
Tester Connections	Specified Conditions
1F-1 - 1C-6	10 kΩ or higher
1F-1 - 1C-6	Below 1 Ω (when battery voltage applied to terminals 1D-5 and 1H-2)

(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

OK

3	INSPECT ECM (HA1A OR HA2A VOLTAGE)



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

(b) Measure the voltage between the terminals of the B46 ECM connector.

Standard voltage

Tester Connections	Specified Conditions
HA1A (B46-2) - E04 (B46-7)	9 to 14 V
HA2A (B46-1) - E05 (B46-6)	9 to 14 V

HINT:

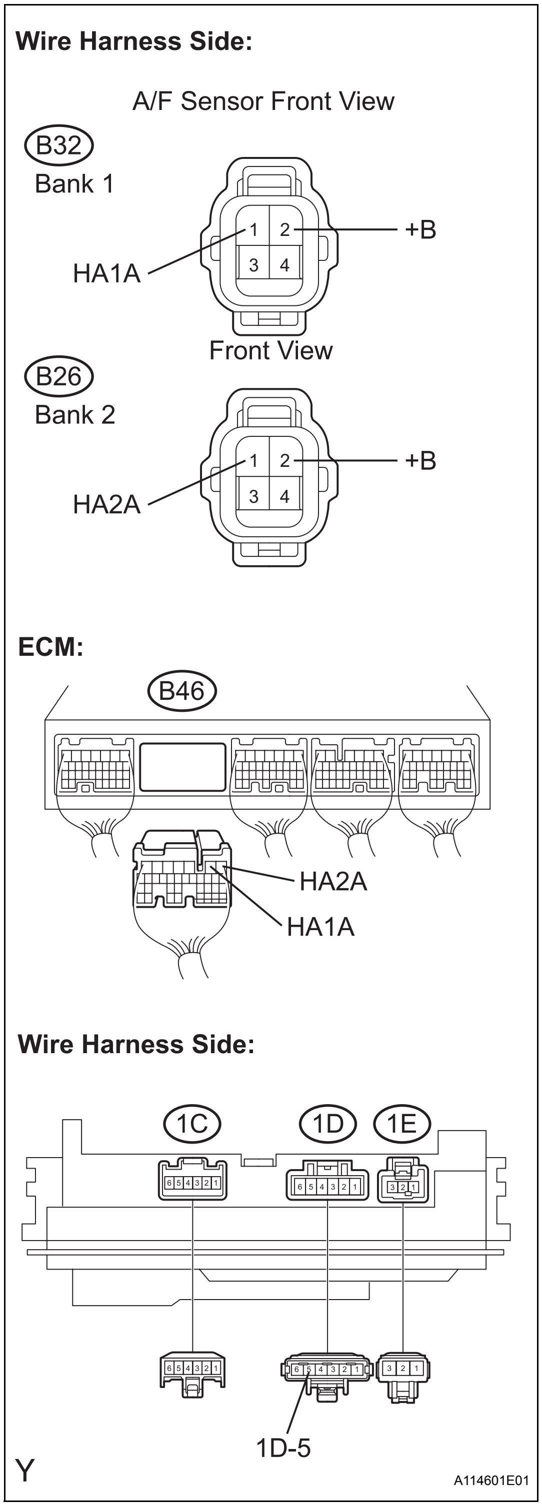
- The HA1A means the A/F sensor bank 1 sensor 1.
- The HA2A means the A/F sensor bank 2 sensor 1.

ES

OK → **REPLACE ECM**

NG

4	CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM, A/F SENSOR - A/F SENSOR HEATER RELAY)



(a) Check the harness and the connector between the ECM and the A/F sensor.
   (1) Disconnect the B26 or B32 A/F sensor connector.
   (2) Disconnect the B46 ECM connector.
   (3) Measure the resistance.
   Standard resistance (Check for open)

Tester Connections	Specified Conditions
HA1A (B32-1) - HA1A (B46-2)	Below 1 Ω
HA2A (B26-1) - HA2A (B46-1)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1A (B32-1) or HA1A (B46-2) - Body ground	10 kΩ or higher
HA2A (B26-1) or HA2A (B46-1) - Body ground	10 kΩ or higher

(b) Check the harness and the connector between the A/F sensor and engine room junction block (A/F sensor heater relay).
   (1) Remove the engine room junction block.
   (2) Measure the resistance.
   Standard resistance (Check for open)

Tester Connections	Specified Conditions
+B (B32-2) - Engine room junction block (A/F sensor heater relay) (1D-5)	Below 1 Ω
+B (B26-2) - Engine room junction block (A/F sensor heater relay) (1D-5)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
+B (B32-2) or Engine room junction block (A/F sensor heater relay) (1D-5) - Body ground	10 kΩ or higher
+B (B26-2) or Engine room junction block (A/F sensor heater relay) (1D-5) - Body ground	10 kΩ or higher

   (3) Reconnect the A/F sensor connector.
   (4) Reconnect the ECM connector.
   (5) Reinstall the engine room junction block.

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

OK

REPLACE ECM

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)

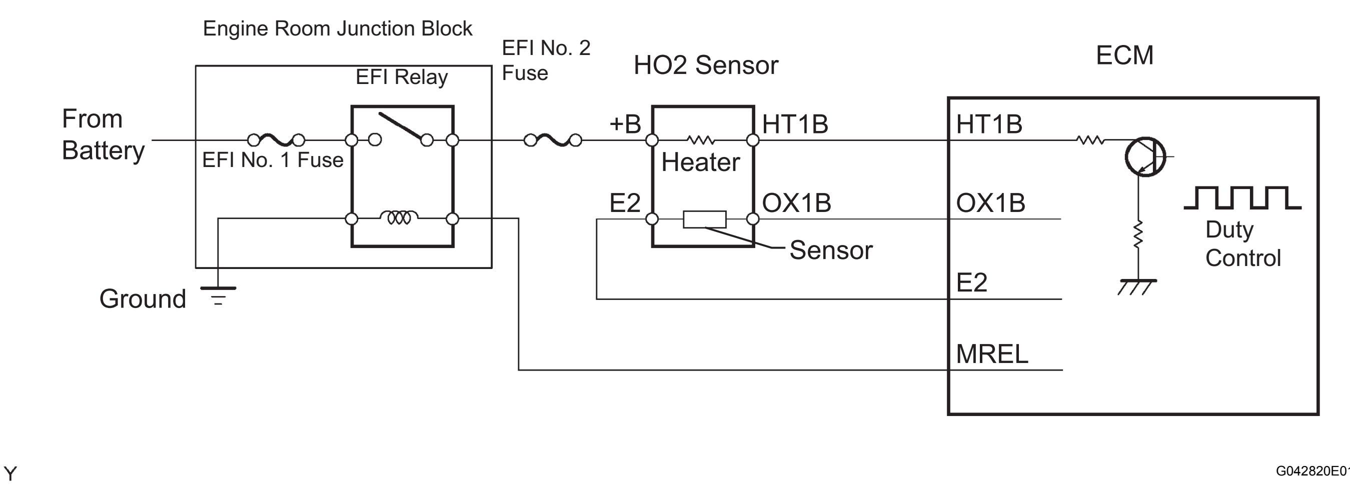
DTC	P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)

HINT:
Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located furthest from the engine assembly.

DESCRIPTION

Refer to DTC P0136 (See page ES-152).
HINT:
- 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 ignition 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 Conditions	Trouble Areas
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 • EFI relay • ECM
P0038 P0058	Heated Oxygen (HO2) sensor heater current is more than 2 A (1 trip detection logic)	• Open in HO2 sensor heater circuit • HO2 sensor heater • EFI 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 furthest away from the engine assembly.

MONITOR DESCRIPTION

The sensing portion 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. When the current in the sensor heater is outside the standard operating range, the ECM interprets this as a malfunction in the sensor heater and sets a DTC.

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.

MONITOR STRATEGY

Related DTCs	P0037: Heated oxygen sensor heater (bank 1) open/short (Low electrical current) P0038: Heated oxygen sensor heater (bank 1) open/short (High electrical current) P0057: Heated oxygen sensor heater (bank 2) open/short (Low electrical current) P0058: Heated oxygen sensor heater (bank 2) open/short (High electrical current)
Required Sensors / Components (Main)	Heated oxygen sensor heater (bank 1 and 2)
Required Sensors / Components (Related)	Vehicle speed sensor
Frequency of Operation	Continuous
Duration	P0037 and P0057: 0.5 seconds P0038 and P0058: 0.3 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	None

P0037 and P0057:

Battery voltage	10.5 V or more
Engine	Running
Starter	OFF
All heater is turned OFF and intrusive heating is operated when the following conditions are met	(a) and (b)
(a) Heater	ON
(b) Heater current	Less than 0.3 A

P0038 and P0058 Case 1:

Battery voltage	10.5 V or more
Engine	Running
Starter	OFF
Intrusive heating	Not operating

P0038 and P0058 Case 2:

Battery voltage	10.5 V or more
All heater is turned OFF and intrusive heating is operated when the following conditions are met	(a) and (b)

(a) Heater	ON
(b) Heater current	More than 2 A

TYPICAL MALFUNCTION THRESHOLDS

P0037 and P0057:

Heated oxygen sensor heater current during intrusive heating	Less than 0.3 A

P0038 and P0058 Case 1:

Heated oxygen sensor heater current	More than 2 A

P0038 and P0058 Case 2:

Heated oxygen sensor heater current during intrusive heating	2 A or more

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 for detailed information (See page ES-25).

Heated oxygen sensor heater:

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$42	$90	Multiply by 0.001 [A]	Maximum sensor heater current	Minimum test limit	Maximum test limit

WIRING DIAGRAM

Refer to DTC P0136 (See page ES-159).

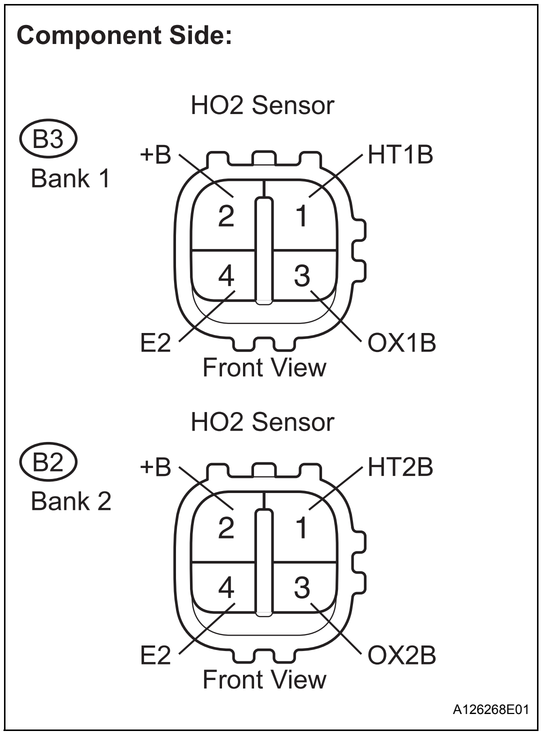
INSPECTION PROCEDURE

HINT:

- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.
- 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.

ES

1 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



(a) Disconnect the B3 or B2 Heated Oxygen (HO2) sensor connector.

(b) Measure the resistance between the terminals of the HO2 sensor connector.

Standard resistance:

Bank 1

Tester Connections	Specified Conditions
HA1B (1) - +B (2)	11 to 16 Ω at 20°C (68°F)
HA1B (1) - E2 (4)	10 kΩ or higher

Bank 2

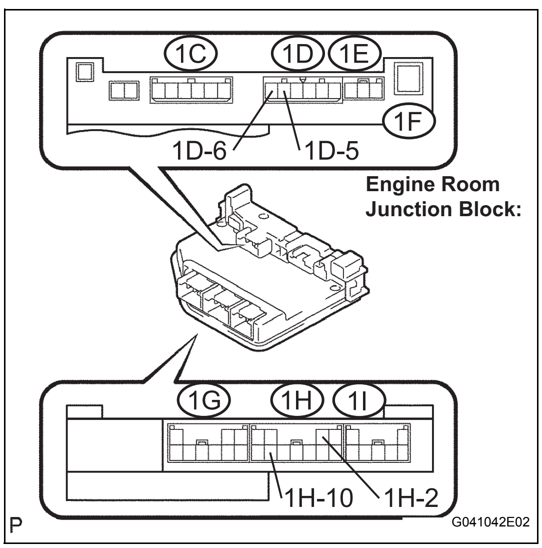
Tester Connections	Specified Conditions
HA2B (1) - +B (2)	11 to 16 Ω at 20°C (68°F)
HA2B (1) - E2 (4)	10 kΩ or higher

(c) Reconnect the HO2 sensor connector.

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

2 INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (EFI RELAY)



(a) Remove the engine room junction block.

(b) Measure the EFI relay heater relay resistance.

Standard resistance

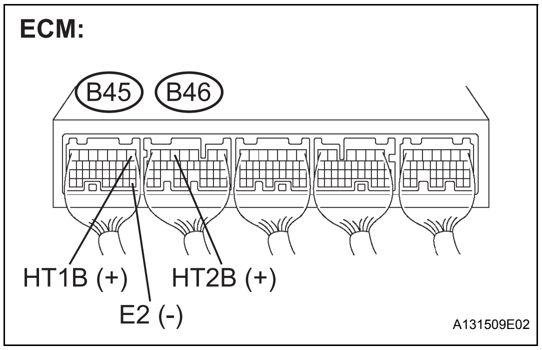
Tester Connections	Specified Conditions
1D-5 - 1D-6	10 kΩ or higher
1D-5 - 1D-6	Below 1 Ω (when battery voltage applied to terminals 1H-10 and 1H-2)

(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

OK

3	INSPECT ECM (HT1B OR HT2B VOLTAGE)



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

(b) Measure the voltage between the terminals of the B45 and B46 ECM connector.

Standard voltage

Tester Connections	Specified Conditions
HA1B (B45-1) - E2 (B45-28)	9 to 14 V
HA2B (B46-5) - E2 (B45-28)	9 to 14 V

HINT:

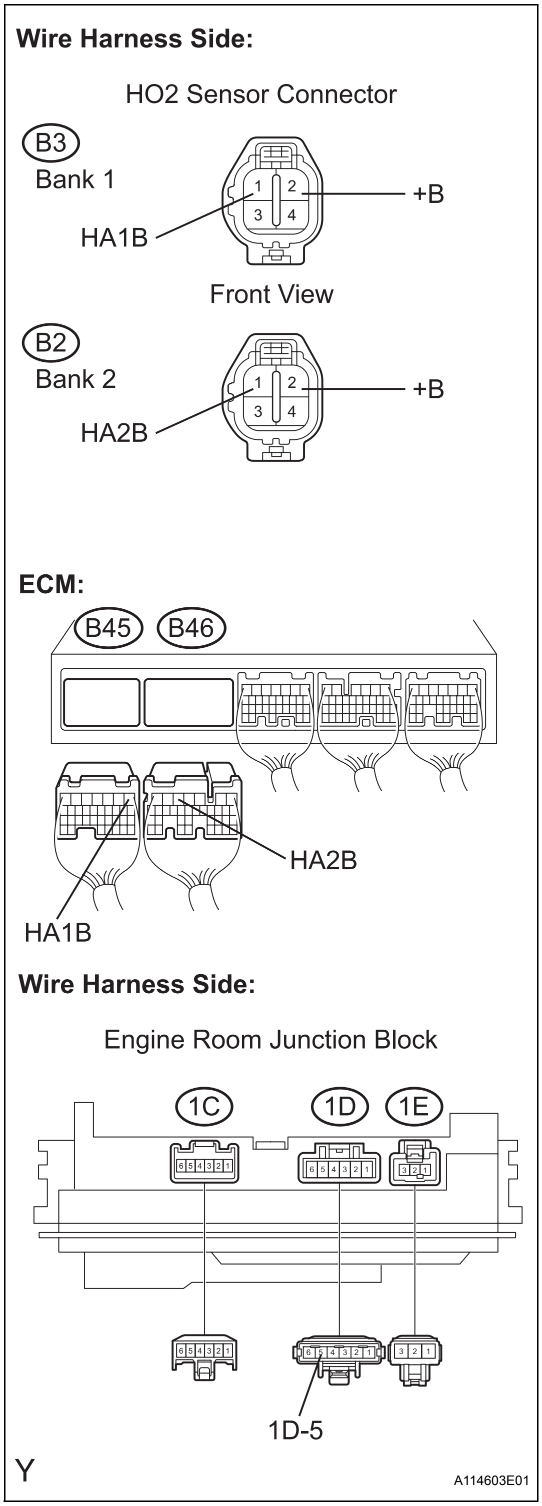
- The HT1B means the heated oxygen sensor bank 1 sensor 2.
- The HT2B means the heated oxygen sensor bank 2 sensor 2.

OK → **REPLACE ECM**

NG

ES

4	CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM, HEATED OXYGEN SENSOR - EFI RELAY)



(a) Check the harness and the connector between the ECM and the HO2 sensor.
(1) Disconnect the B2 or B3 HO2 sensor connector.
(2) Disconnect the B45 or B46 ECM connector.
(3) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
HA1B (B3-1) - HA1B (B45-1)	Below 1 Ω
HA2B (B2-1) - HA2B (B46-5)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1B (B3-1) or HA1B (B45-1) - Body ground	10 kΩ or higher
HA2B (B2-1) or HA2B (B46-5) - Body ground	10 kΩ or higher

(b) Check the harness and the connector between the HO2 sensor and engine room junction block (EFI relay).
(1) Inspect the EFI No. 2 fuse
- Remove the EFI No. 2 fuse from engine room junction block.
- Check the EFI No. 2 fuse resistance.
Standard resistance:
Below 1 Ω

(2) Measure the resistance.
- Remove the engine room junction block.
Standard resistance (Check for open):

Tester Connections	Specified Conditions
+B (B3-2) - engine room junction block (EFI relay) (1D-5)	Below 1 Ω
+B (B2-2) - engine room junction block (EFI relay) (1D-5)	Below 1 Ω

Standard resistance (Check for short):

Tester Connections	Specified Conditions
+B (B3-2) or engine room junction block (EFI relay) (1D-5) - Body ground	10 kΩ or higher
+B (B2-2) or engine room junction block (EFI relay) (1D-5) - Body ground	10 kΩ or higher

(3) Reconnect the HO2 sensor connector.
(4) Reconnect the ECM connector.
(5) Reinstall the engine room junction block.

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

OK

REPLACE ECM

DTC	P0100	Mass or Volume Air Flow Circuit

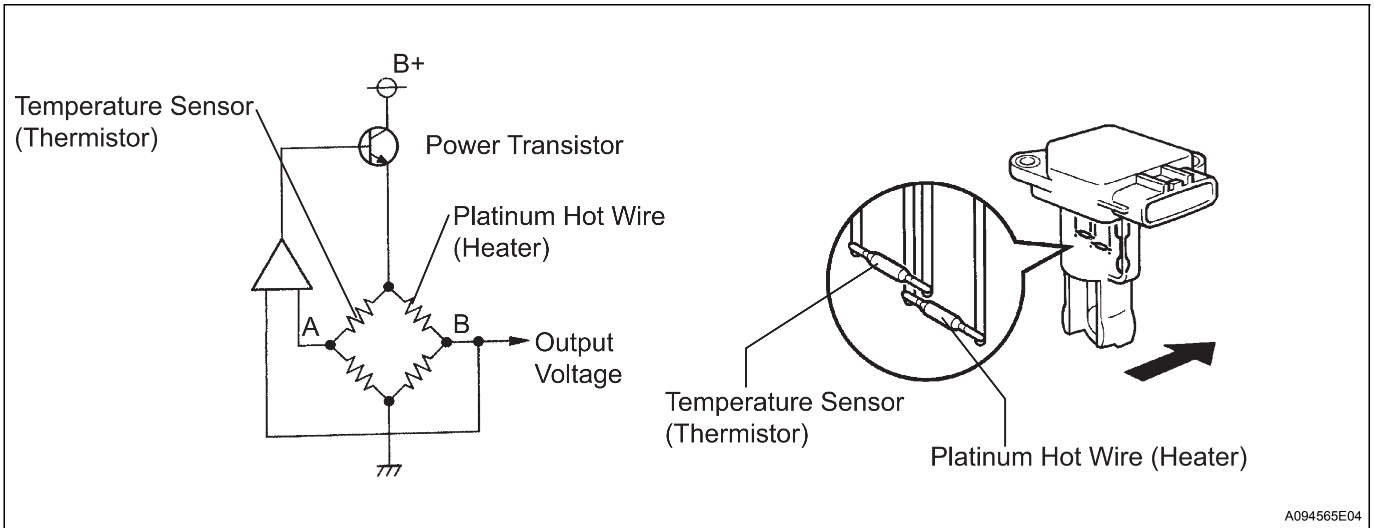
DTC	P0102	Mass or Volume Air Flow Circuit Low Input

DTC	P0103	Mass or Volume Air Flow Circuit High Input

ES

DESCRIPTION

The Mass Air Flow (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 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, changing 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 air flow 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 Conditions	Trouble Areas
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 ground 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 selecting the following menu items on an 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 voltage output 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 (Related)	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

The monitor will run whenever these 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

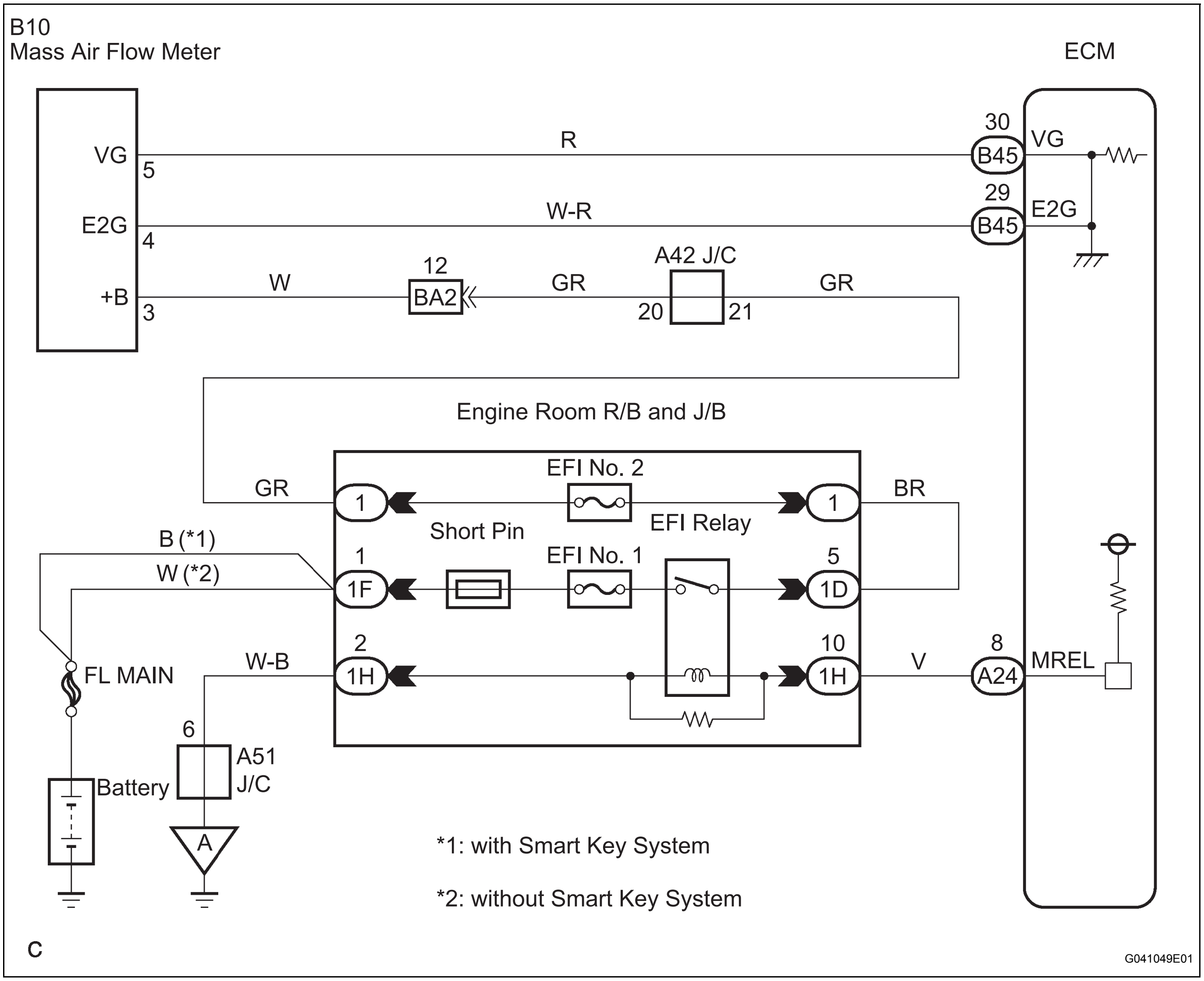
P0103:

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



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.

1	READ VALUE OF INTELLIGENT TESTER (MASS AIR FLOW RATE)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine.
(c) Turn the tester on.
(d) Select the following menu items: 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

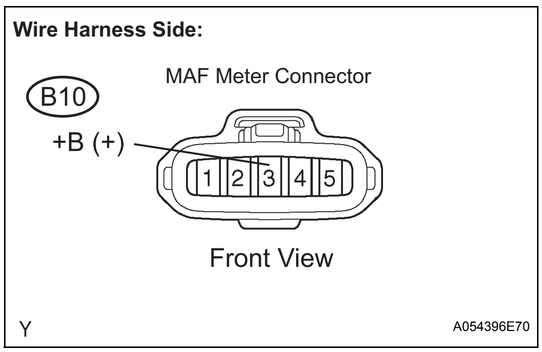
*1: The value must be changed when the throttle valve is open or closed.

B → Go to step 6

C → CHECK FOR INTERMITTENT PROBLEMS

A

2 INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)



(a) Disconnect the B10 Mass Air Flow (MAF) meter connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the terminal of the wire harness side connector and body ground.
Standard voltage

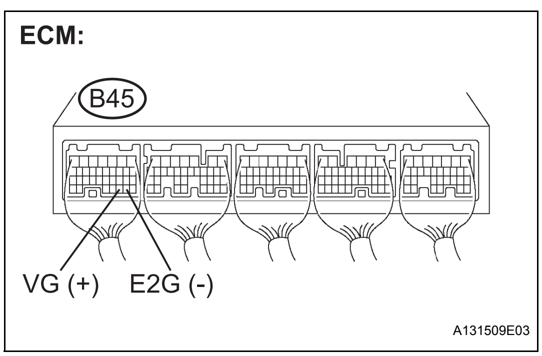
Tester Connections	Specified Conditions
+B (B10-3) - Body ground	9 to 14 V

(d) Reconnect the MAF meter connector.

NG → Go to step 5

OK

3 INSPECT ECM (VG VOLTAGE)



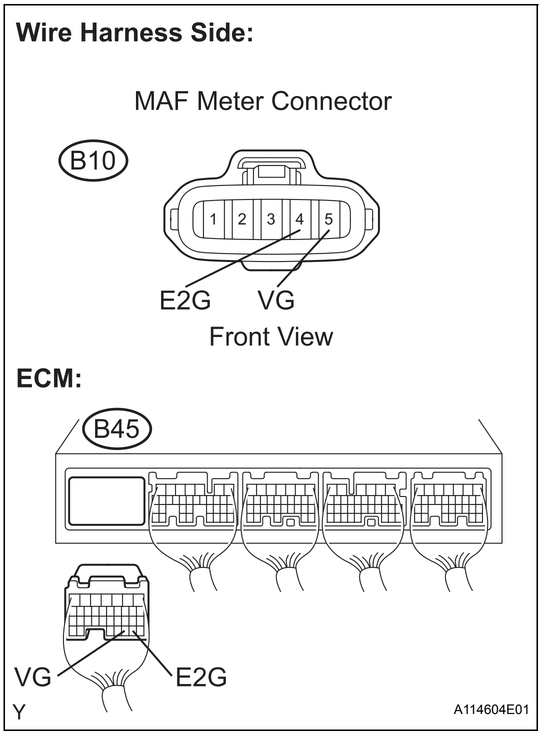
(a) Start the engine.
(b) Measure the voltage between the terminals of the B45 ECM connector.
HINT:
The transmission gear selector lever should be in the P or N position and the A/C switch should be turned off.
Standard voltage

Tester Connections	Conditions	Specified Conditions
VG (B45-30) - E2G (B45-29)	Engine idling	0.5 to 3.0 V

OK → REPLACE ECM

NG

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



(a) Disconnect the B10 MAF meter connector.
(b) Disconnect the B45 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
VG (B10-5) - VG (B45-30)	Below 1 Ω
E2G (B10-4) - E2G (B45-29)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
VG (B10-5) or VG (B45-30) - Body ground	10 kΩ or higher

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

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

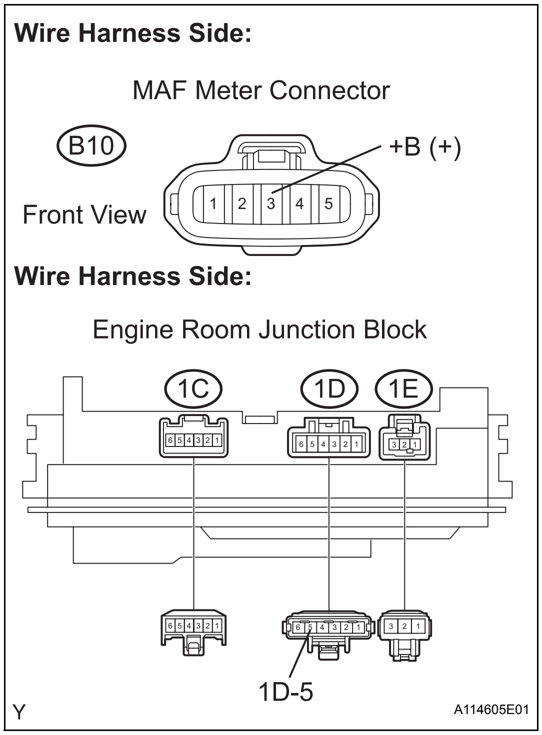
ES

OK

REPLACE MASS AIR FLOW METER

ES

5 CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - EFI RELAY)



(a) Inspect the EFI No. 2 fuse.
(1) Remove the EFI No. 2 fuse from the engine room junction block.
(2) Measure the EFI No. 2 fuse resistance.
Standard::
Below 1 Ω
(3) Reinstall the EFI No. 2 fuse.
(b) Disconnect the B10 MAF meter connector.
(c) Remove the engine room junction block (EFI relay).
(d) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
+B (B10-3) - Engine room junction block (EFI relay) (1D-5)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
+B (B10-3) or Engine room junction block (EFI relay) (1D-5) - Body ground	10 kΩ or higher

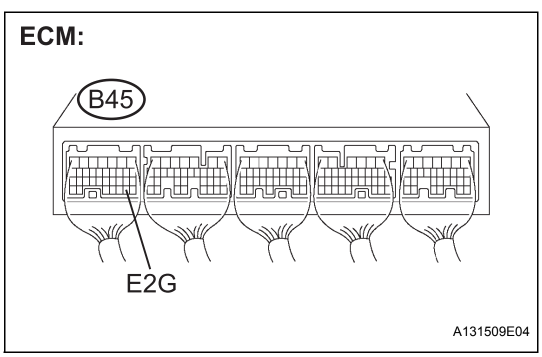
(e) Reconnect the MAF meter connector.
(f) Reinstall the EFI relay.

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

OK

CHECK ECM POWER SOURCE CIRCUIT

6 INSPECT ECM (SENSOR GROUND)



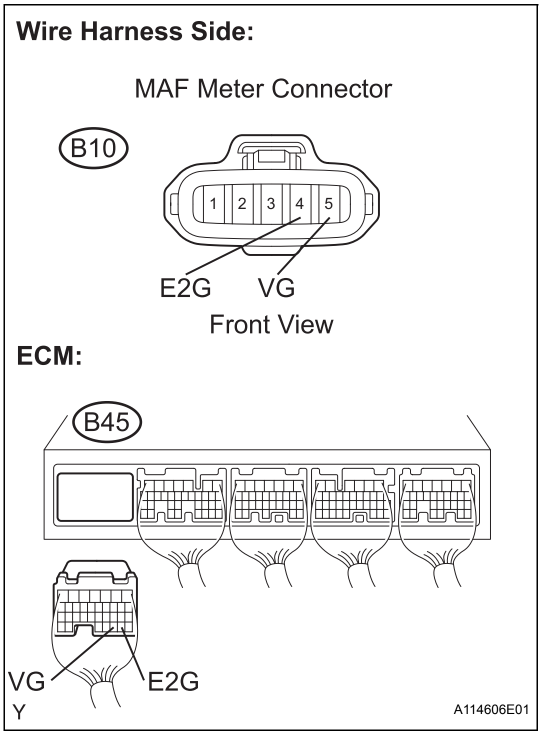
(a) Check the resistance.
Standard resistance

Tester Connections	Specified Conditions
E2G (B45-29) - Body ground	Below 1 Ω

NG → **REPLACE ECM**

OK

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



(a) Disconnect the B10 MAF meter connector.
(b) Disconnect the B45 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
VG (B10-5) - VG (B45-30)	Below 1 Ω
E2G (B10-4) - E2G (B45-29)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
VG (B10-5) or VG (B45-30) - 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 MASS AIR FLOW METER

ES

DTC	P0101	Mass or Volume Air Flow Circuit Range / Performance Problem

DESCRIPTION

Refer to DTC P0100 (See page ES-113).

DTC No.	DTC Detection Conditions	Trouble Areas
P0101	1. High voltage: Conditions (a), (b) and (c) continue for more than 10 seconds (2 trip detection logic): (a) Engine speed is less than 2,000 rpm (b) Engine coolant temperature is 70°C (158°F) or higher (c) Voltage output of Mass Air Flow (MAF) meter is more than 2.2 V (varies with Throttle Position [TP] sensor voltage) 2. Low voltage: Conditions (a) and (b) continue for more than 10 seconds (2 trip detection logic): (a) Engine speed is more than 300 rpm (b) Voltage output of MAF meter is less than 0.73 V (varies with TP sensor voltage)	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, changing 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 air flow 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 0.73 V while idling, the ECM determines that there is a malfunction in the MAF meter and sets the DTC.

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0335 (CKP Sensor), P0340 (VVT Sensor 1, 2)

Mass Air Flow Meter Rationality (High Voltage):

Engine speed	Less than 2,000 rpm
Engine coolant temperature	70°C (158°F) or more

Mass Air Flow Meter Rationality (Low Voltage):

Engine speed	More than 300 rpm
Engine coolant temperature	OFF

TYPICAL MALFUNCTION THRESHOLDS

Mass Air Flow Meter Rationality (High Voltage):

Mass air flow meter voltage	More than 2.2 V (varies with throttle position sensor voltage)

Mass Air Flow Meter Rationality (Low Voltage):

Mass air flow meter voltage	Less than 0.73 V (varies with throttle position sensor voltage)

WIRING DIAGRAM

Refer to DTC P0100 (See page ES-115).

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.

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

Result

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

HINT:
If any DTCs other than P0101 are output, troubleshoot those DTCs first.

B → **REPLACE MASS AIR FLOW METER**

A

GO TO DTC CHART

DTC	P0110	Intake Air Temperature Circuit

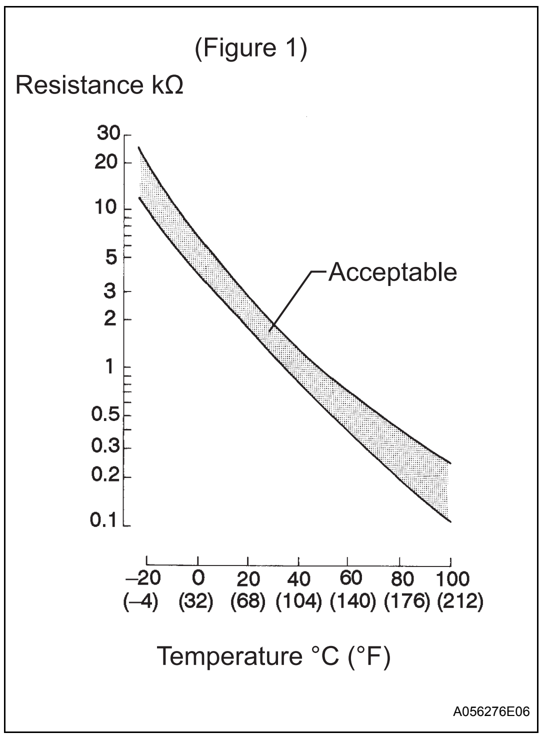
DTC	P0112	Intake Air Temperature Circuit Low Input

DTC	P0113	Intake Air Temperature Circuit High Input

DESCRIPTION

ES

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 is low, the resistance of the thermistor increases. When the temperature is high, 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 applied 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 drivability.



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 Conditions	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

DTC No.	Proceed to	DTC Detection Conditions	Trouble Area
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 selecting the following menu items on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.

Temperature Displayed	Malfunctions
-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 voltage output 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 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 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 voltage) P0113: Intake air temperature sensor open (High electrical voltage)
Required Sensors / Components (Main)	Intake Air Temperature (IAT) sensor
Required sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these 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 [More than 140°C (284°F)]

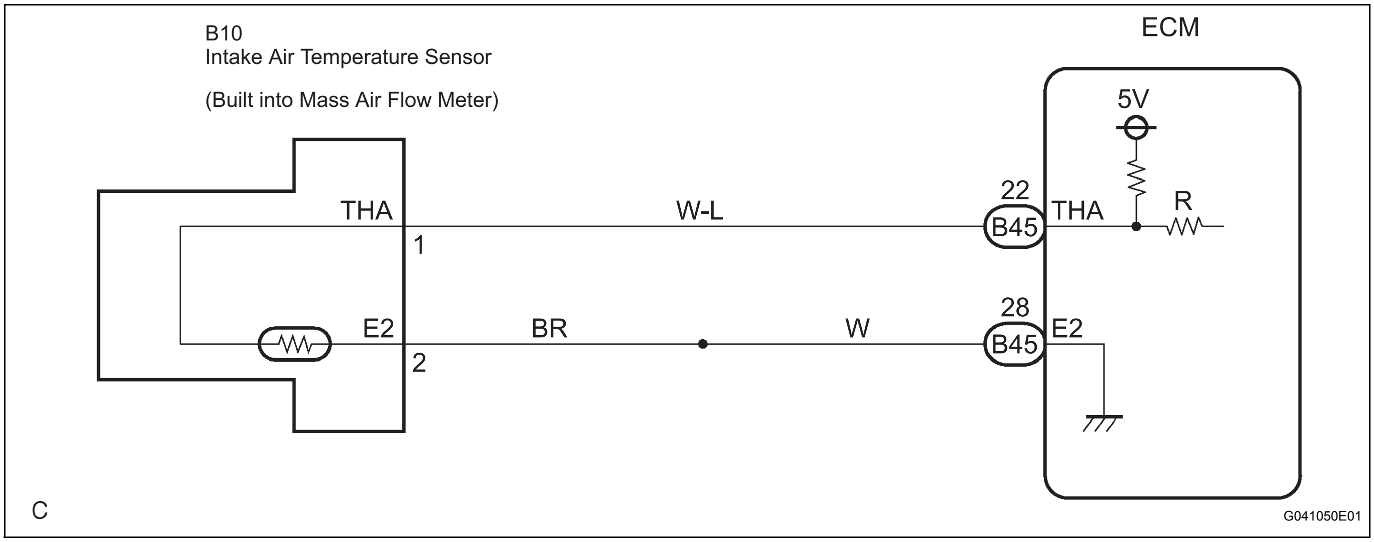
P0113:

Intake air temperature sensor voltage	More than 4.91 V [Less than -40°C (-40°F)]

COMPONENT OPERATING RANGE

Intake air temperature sensor voltage	0.18 V to 4.91 V [-40 to 140°C (-40 to 284°F)]

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.
- 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.

1	READ VALUE OF INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCEDOBD 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).

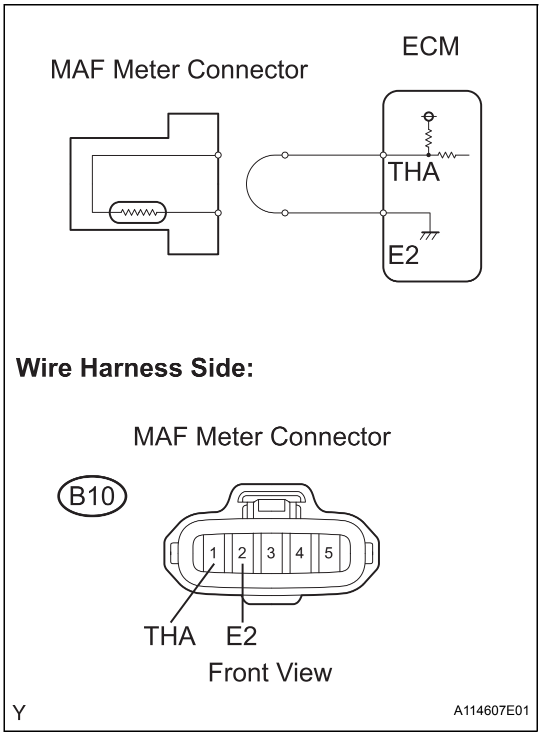
- If there is a short circuit, the intelligent tester indicates140°C (284°F) or higher.

B → **Go to step 4**

C → **CHECK FOR INTERMITTENT PROBLEMS**

A

2 READ VALUE OF INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

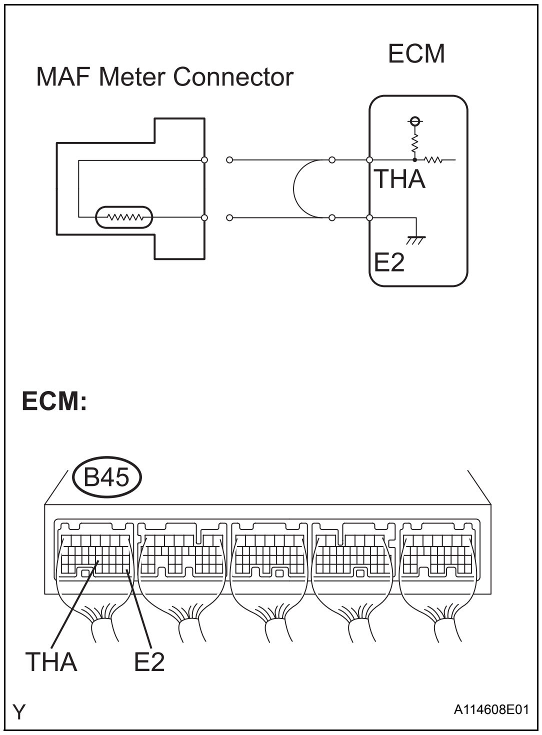


(a) Disconnect the B10 Mass Air Flow (MAF) meter connector.
(b) Connect terminals THA and E2 of the MAF meter wire harness side connector.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester on.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(g) Read the value displayed on the tester.
Standard:
140°C (284°F) or higher
(h) Reconnect the MAF meter connector.

OK → **CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER**

NG

3	READ VALUE OF INTELLIGENT TESTER (CHECK FOR OPEN IN ECM)



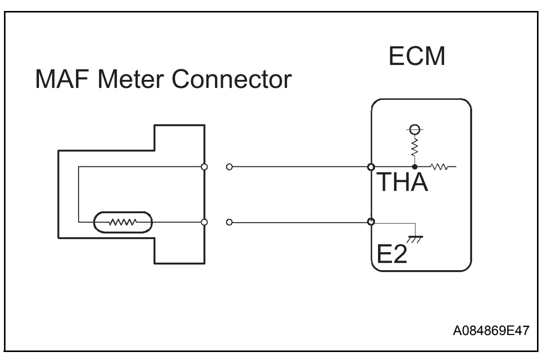
(a) Disconnect the B10 MAF meter connector.
(b) Connect terminals THA and E2 of the B45 ECM connector.
HINT:
Before checking, do visual and contact pressure checks on the ECM connector.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester on.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(g) Read the value displayed on the tester.
Standard:
140°C (284°F) or higher
(h) Reconnect the MAF meter connector.

OK → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

NG

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM

4	READ VALUE OF INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

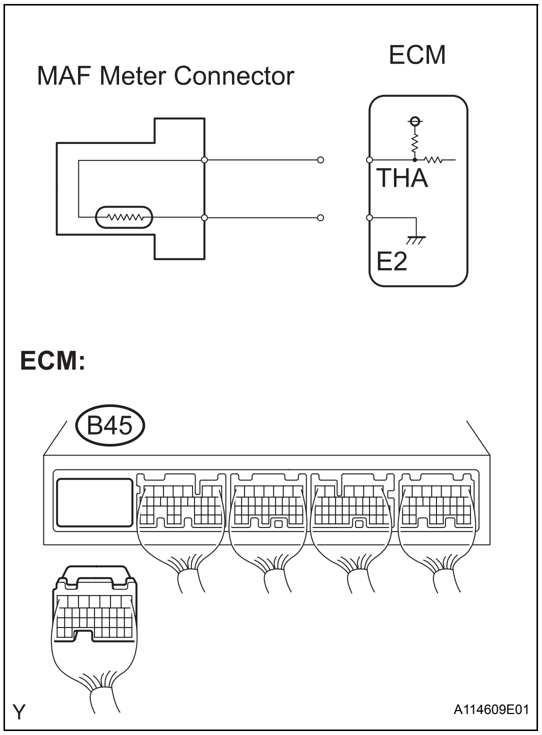


(a) Disconnect the B10 MAF meter connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG).
(d) Turn the tester on.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(f) Read the value displayed on the tester.
Standard:
-40°C (-40°F)
(g) Reconnect the MAF meter connector.

OK → **CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE MASS AIR FLOW METER**

NG

5	READ VALUE OF INTELLIGENT TESTER (CHECK FOR SHORT IN ECM)



(a) Disconnect the B45 ECM connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG).
(d) Turn the tester on.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(f) Read the value displayed on the tester.
Standard:
-40°C (-40°F)
(g) Reconnect the ECM connector.

OK → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

NG

REPLACE ECM

ES

DTC	P0115	Engine Coolant Temperature Circuit

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.

DTC No.	Proceed to	DTC Detection Conditions	Trouble Areas
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 selecting the following menu items on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.

Temperature Displayed	Malfunctions
-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 is low, the resistance in the thermistor increases. When the temperature is high, the resistance drops.
These variations in resistance are reflected in the voltage output 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 voltage output 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 voltage) P0118: Engine coolant temperature sensor open (High electrical voltage)
Required Sensors / Components (Main)	Engine coolant temperature sensor
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these 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 [More than 140°C (284°F)]

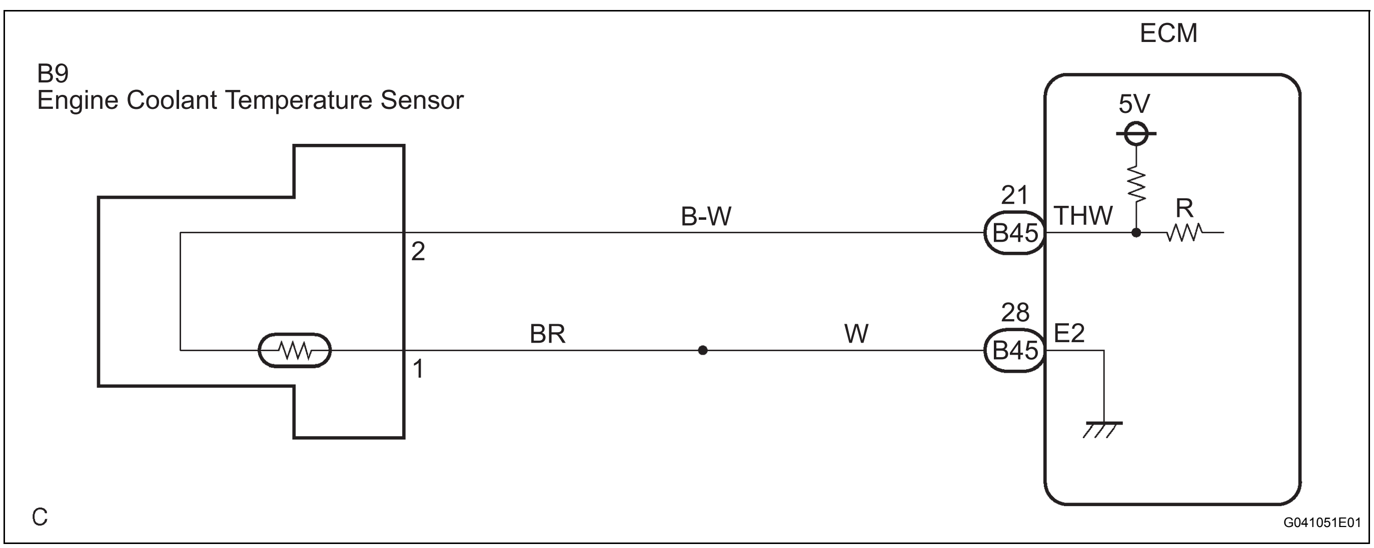
P0118:

Engine coolant temperature sensor voltage	More than 4.91 V [Less than -40°C (-40°F)]

COMPONENT OPERATING RANGE

Engine coolant temperature sensor voltage	0.14 V to 4.91 V [-40 to 140°C (-40 to 284°F)]

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.

- 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.

1	READ VALUE OF INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Select the following menu items: 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

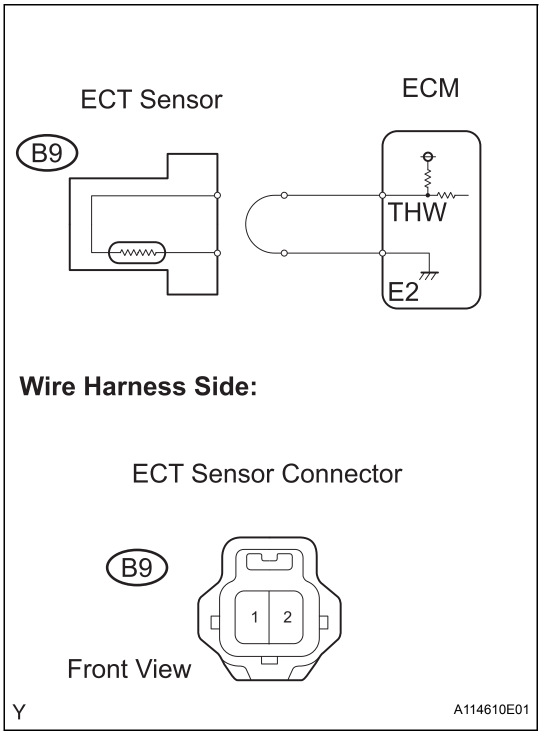
HINT:
- If there is an open circuit, the intelligent tester indicates -40°C (-40°F).
- If there is a short circuit, the intelligent tester indicates 140°C (284°F) or higher.

B → **Go to step 4**

C → **CHECK FOR INTERMITTENT PROBLEMS**

A

2	READ VALUE OF INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

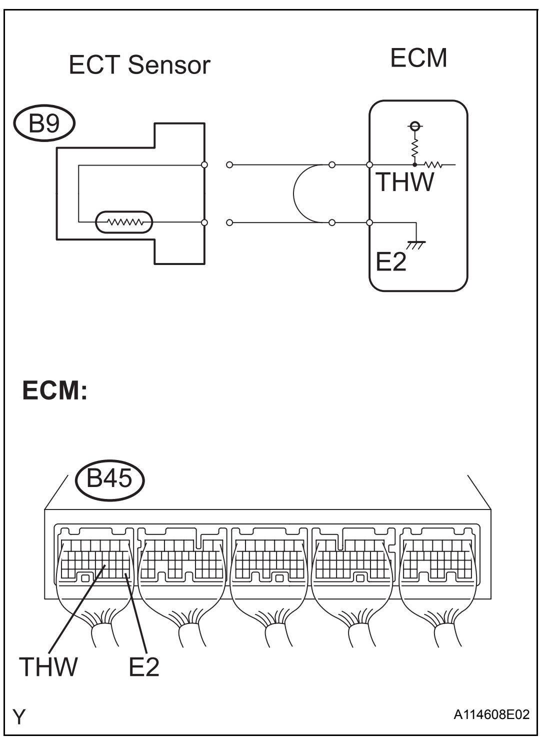


(a) Disconnect the B9 Engine Coolant Temperature (ECT) sensor connector.
(b) Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester on.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(g) Read the value displayed on the tester.
Standard:
140°C (284°F) or higher
(h) Reconnect the ECT sensor connector.

OK → **CONFIRM GOOD CONNECTION TO SENSOR. IF OK, REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

NG

3	READ VALUE OF INTELLIGENT TESTER (CHECK FOR OPEN IN ECM)



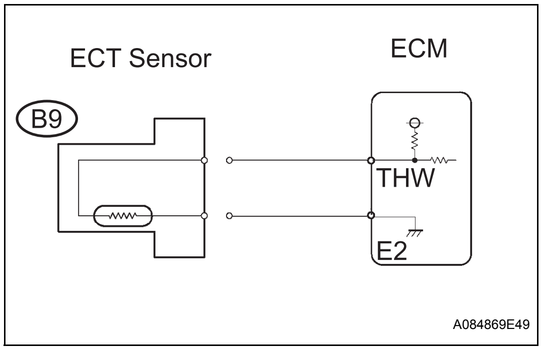
(a) Disconnect the B9 ECT sensor connector.
(b) Connect terminals THW and E2 of the E4 ECM connector.
HINT:
Before checking, do visual and contact pressure checks on the ECM connector.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch on (IG).
(e) Turn the tester on.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(g) Read the value displayed on the tester.
Standard:
140°C (284°F) or higher
(h) Reconnect the ECT sensor connector.

OK → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

NG

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM

4 READ VALUE OF INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

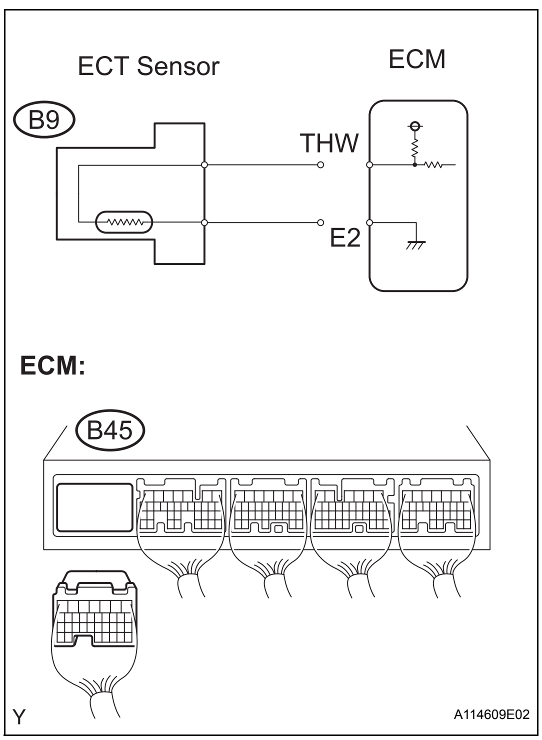


(a) Disconnect the B9 ECT sensor connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG).
(d) Turn the tester on.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(f) Read the value displayed on the tester.
Standard:
-40°C (-40°F)
(g) Reconnect the ECT sensor connector.

OK → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

NG

5 READ VALUE OF INTELLIGENT TESTER (CHECK FOR SHORT IN ECM)



(a) Disconnect the B45 ECM connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG).
(d) Turn the tester on.
(e) Select the following menu items: 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 ECM connector.

OK → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

NG

REPLACE ECM

DTC	P0116	Engine Coolant Temperature Circuit Range / Performance Problem

DESCRIPTION

Refer to DTC P0115 (See page ES-128).

DTC No.	DTC Detection Conditions	Trouble Areas
P0116	Case 1: Engine Coolant Temperature (ECT) is between 35°C and 60°C (95°F and 140°F) when engine is started, and conditions (a) and (b) are met (2 trip detection logic): (a) Vehicle driven at varying speeds (accelerated and decelerated) (b) ECT remains within 3°C (5.4°F) of initial ECT Case 2: ECT is more than 60°C (140°F) when engine is started, and conditions (a) and (b) are met (6 trip detection logic): (a) Vehicle driven at varying speeds (accelerated and decelerated) (b) ECT measurements remain within 1°C (1.8°F) of initial ECT on 6 successive occasions	ECT sensor

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 is low, the resistance of the thermistor increases. When the temperature is high, the resistance drops. These variations in the resistance are reflected in the voltage output from the ECT sensor.
The ECM monitors the sensor voltage and uses this value to calculate the ECT. If the sensor voltage output deviates from the normal operating range, the ECM interprets this deviation as a malfunction in the ECT sensor and sets the DTC.

Examples:

- 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 staring temperature, the DTC is set (2 trip detection logic).
- Upon starting the engine, the ECT is over 60°C (140°F). If after driving for 250 seconds, the ECT 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 output stuck at low engine coolant temperature P0116: Engine coolant temperature sensor output stuck at high engine coolant temperature
Required Sensors / Components (Main)	Engine Coolant Temperature (ECT) sensor
Required Sensors / Components (Related)	Crankshaft position sensor, intake air temperature sensor and mass air flow meter
Frequency of Operation	Continuous
Duration	250 seconds or more
MIL Operation	2 driving cycles: ECT sensor output stuck at low engine coolant temperature 6 driving cycles: ECT sensor output stuck at high engine coolant temperature
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Engine Coolant Temperature Sensor Output Stuck at Low Engine Coolant Temperature:

The monitor will run whenever these DTCs are not present	P0100, P0101, P0102, P0103 (MAF Sensor)
Cumulative idle off period	250 seconds or more
Speed increase by 18.6 mph (30 km/h) or more	10 times or more
Engine coolant temperature at engine start	35° to 60°C (95° to 140°F)
Intake air temperature at engine start	-6.7°C (20°F) or more

Engine Coolant Temperature Sensor Output Stuck at High Engine Coolant Temperature:

The monitor will run whenever these DTCs are not present	P0100, P0101, P0102, P0103 (MAF Sensor)
Engine coolant temperature at engine start	60°C (140°F) or more
Intake air temperature at engine start	-6.7°C (20°F) or more
Stop and go*1	Once or more
Steady driving and stop*2	Once or more
Engine running time after engine start	0.3 seconds or more

*1: The vehicle is stopped for 20 seconds or more and accelerated to more than 43.5 mph (70 km/h) within 40 seconds.

*2: Following these steps: 1) the vehicle is driven at 40.4 mph (65 km/h) or more for 30 seconds or more and the vehicle speed reaches 43.5 mph (70 km/h); 2) the vehicle is decelerated from 40.4 mph (65 km/h) to 1.86 mph (3 km/h) or less within 35 seconds; and 3) the vehicle is stopped for 10 seconds.

TYPICAL MALFUNCTION THRESHOLDS

Engine Coolant Temperature Sensor Output Stuck at Low Engine Coolant Temperature:

Variation of engine coolant temperature	Less than 3°C (5.4°F)

Engine Coolant Temperature Sensor Output Stuck at High Engine Coolant Temperature:

Variation of engine coolant temperature	1°C (1.8°F) or less

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.

1	REPLACE ENGINE COOLANT TEMPERATURE SENSOR

(a) Replace the engine coolant temperature sensor.

NEXT

END

ES

DTC	**P0120**	**Throttle / Pedal Position Sensor / Switch "A" Circuit**

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**

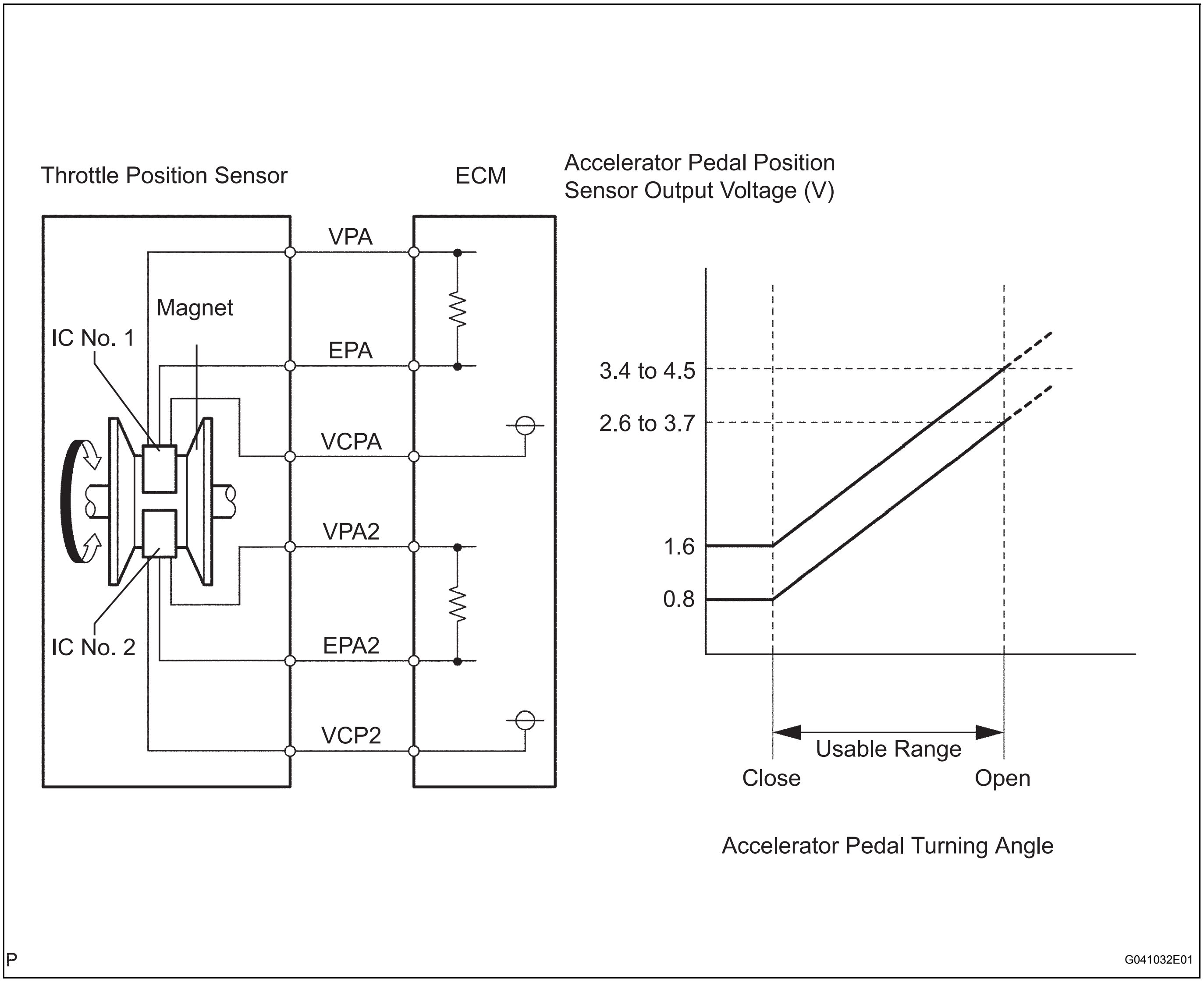
DTC	**P0223**	**Throttle / Pedal Position Sensor / Switch "B" Circuit High Input**

DTC	**P2135**	**Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation**

HINT:
These DTCs relate to the Throttle Position (TP) sensor.

DESCRIPTION

HINT:
This ETCS (Electronic Throttle Control System) does not use a throttle cable.
The Accelerator Pedal Position (APP) sensor is integrated with the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). 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 voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0 V and 5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.
The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.



DTC No.	DTC Detection Conditions	Trouble Areas
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
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

DTC No.	DTC Detection Conditions	Trouble Areas
P2135	Either condition (a) or (b) 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 0.5 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 selecting the following menu items on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / 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.

If the malfunction is not repaired successfully, a DTC is set 2 seconds after the engine is next started.

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 (Related)	-
Frequency of Operation	Continuous
Duration	2 seconds: P0120, P0122, P0123, P0220, P0222 and P0223 (Accelerator pedal ON) 10 seconds: P0120, P0122, P0123, P0220, P0222 and P0223 (Accelerator pedal OFF) Within 0.5 seconds: P2135
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these 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 0.2 V to 2.02 V	4.8 V or more

P2135:

Either of following conditions A or B met:	-
Condition A	-
Difference between VTA1 and VTA2 voltages	0.02 V or less
Condition B	-
Both of the following conditions are met	(a) or (b)
(a) VTA1 voltage	0.2 V or less
(b) VTA2 voltage	1.75 V or less

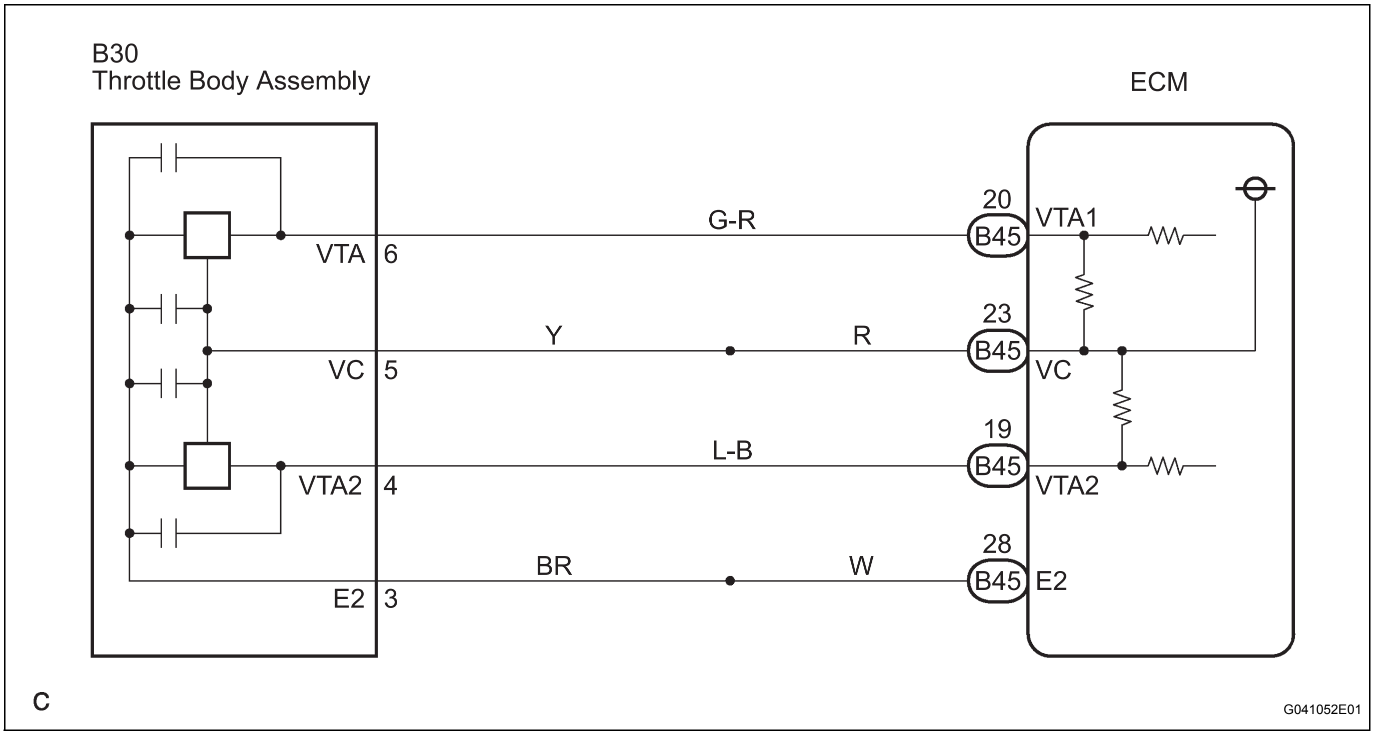
COMPONENT OPERATING RANGE

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 fully depressed slowly, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the ignition switch is turned to OFF.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.
- 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.

1	READ VALUE OF INTELLIGENT TESTER (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) Select the following menu items: 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 Areas	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

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 Areas	Proceed to
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

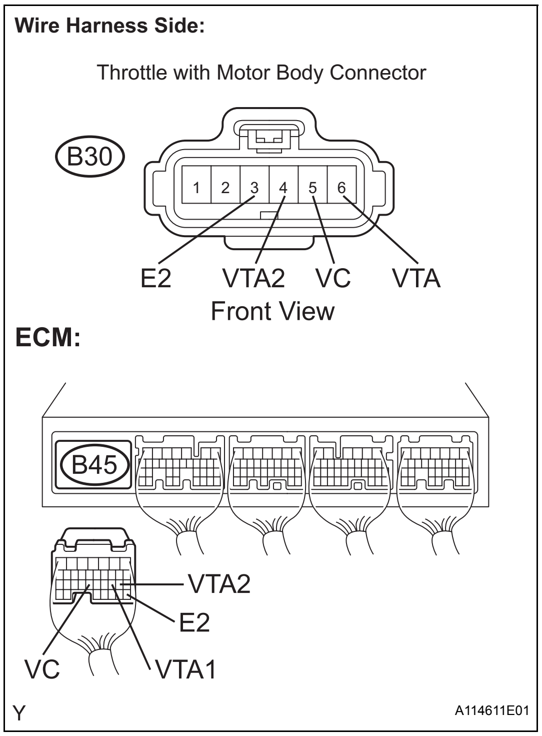
HINT:
- TP#1 denotes THROTTLE POS, and TP#2 denotes THROTTLE POS#2.
- AP denotes Accelerator Pedal.
- VTA1 is expressed as percentage, and VTA2 is expressed as voltage.

ES

B → **Go to step 5**

A

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



(a) Disconnect the B30 throttle with motor body connector.
(b) Disconnect the B45 ECM connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VC (B30-5) - VC (B45-23)	Below 1 Ω
VTA (B30-6) - VTA1 (B45-20)	Below 1 Ω
VTA2 (B30-4) - VTA2 (B45-19)	Below 1 Ω
E2 (B30-3) - E2 (B45-28)	Below 1 Ω

Standard resistance (Check for short)

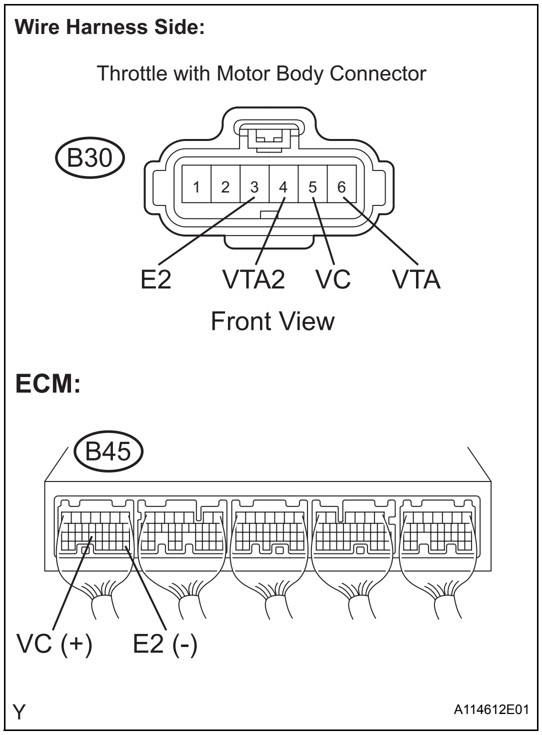
Tester Connections	Specified Conditions
VC (B30-5) or VC (B45-23) - Body ground	10 kΩ or higher
VTA (B30-6) or VTA1 (B45-20) - Body ground	10 kΩ or higher
VTA2 (B30-4) or VTA2 (B45-19) - Body ground	10 kΩ or higher

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

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

OK

3	INSPECT ECM (VC VOLTAGE)



(a) Disconnect the B30 throttle with motor body connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the terminals of the B45 ECM connector.
Standard voltage

Tester Connections	Specified Conditions
VC (B45-23) - E2 (B45-28)	4.5 to 5.0 V

(d) Reconnect the throttle with motor body connector.

NG → **REPLACE ECM**

OK

4	REPLACE THROTTLE WITH MOTOR BODY ASSEMBLY

(a) Replace the throttle with motor body assembly (See page ES-434).

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 DTCs (See page ES-44).
(d) Start the engine.
(e) Allow the engine to idle for 15 seconds or more.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read DTCs.

Result

Display (DTC Output)	Proceed to
P0120, P0122, P0123, P0220, P0222, P0223 and/or P2135	A
No output	B

B → **SYSTEM OK**

A

REPLACE ECM

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

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

DESCRIPTION

Refer to DTC P0120 (See page ES-136).

DTC No.	DTC Detection Conditions	Trouble Areas
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 voltage output 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 (Related)	-
Frequency of Operation	Continuous
Duration	Within 2 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

This monitor will not run whenever these DTCs are not present	None
Either of the following conditions 1 or 2	-
1. Ignition switch	ON
2. Electric throttle motor power	ON
TP sensor malfunction (P0120, P0122, P0123, P0220, P0222, P0223, P02135)	Not detected

TYPICAL MALFUNCTION THRESHOLDS

Difference in voltage between VTA1 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 fully depressed slowly, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the ignition 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.

1	REPLACE THROTTLE BODY ASSEMBLY

(a) Replace the throttle body assembly (See page ES-433).

NEXT

END

DTC	P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control

DESCRIPTION

Refer to DTC P0115 (See page ES-128).

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

ES

MONITOR DESCRIPTION

The resistance of the ECT sensor varies in proportion to the actual ECT. The ECM 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	Continuous
Duration	61 seconds: Engine coolant temperature at engine start -8.34°C (17°F) or more 106 seconds: Engine coolant temperature at engine start -19.45 to -8.34°C (-3 to 17°F) 20 minutes: Engine coolant temperature at engine start less than -19.45°C (-3°F)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Fuel cut	OFF
Engine	Running

TYPICAL MALFUNCTION THRESHOLDS

Time until actual engine coolant temperature reaches closed-loop fuel control enabling temperature	61 seconds or more: Engine coolant temperature at engine start -8.34°C (17°F) or more 106 seconds or more: Engine coolant temperature at engine start -19.45 to -8.34°C (-3 to 17°F) 20 minutes or more: Engine coolant temperature at engine start less than -19.45°C (-3°F)

WIRING DIAGRAM

Refer to DTC P0115 (See page ES-129).

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.

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

ES

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

A

2 INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-26).
(b) Check the valve opening temperature of the thermostat (See page CO-26).
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-27).

NG → **REPLACE THERMOSTAT**

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

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

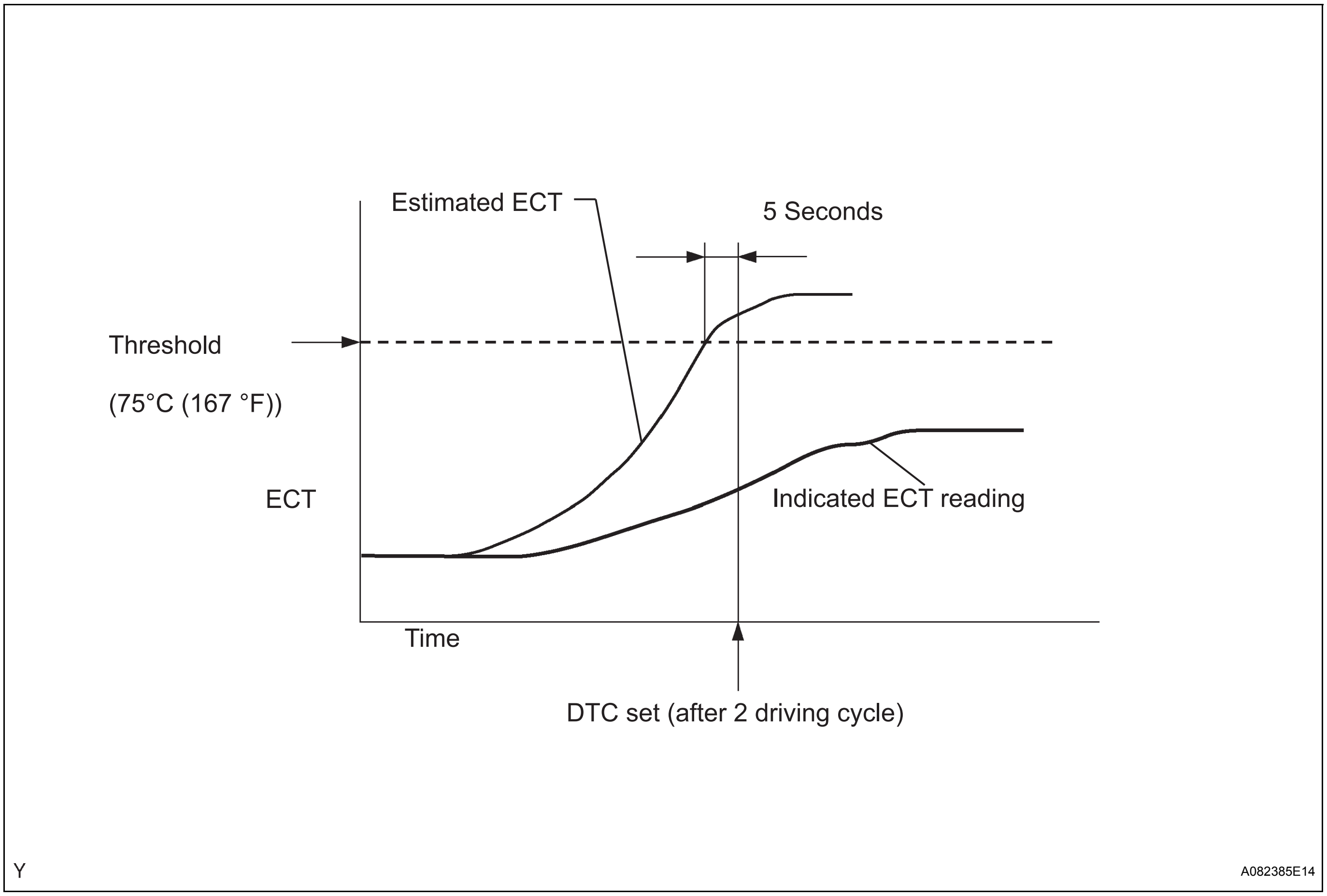
HINT:
This DTC relates to the thermostat.

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 Conditions	Trouble Areas
P0128	Conditions (a), (b) and (c) are met for 5 seconds (2 trip detection logic): (a) Cold start (b) Engine warmed up (c) ECT less than 75°C (167°F)	• Thermostat • Cooling system • ECT sensor • ECM

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 (Related)	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

The monitor will run whenever these DTCs are not present	P0010, P0020 (VVT VSV 1, 2), P0011, P0012 (VVT System1-Advance, Retard), P0021, P0022 (VVT System2-Adavance, Retard), P0031, P0032, P0051, P0052 (A/F Sensor heater Sensor 1), P0100, P0101, P0102, P0103 (MAF Sensor), P0110, P0112, P0113 (IAT Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0125 (Insufficient ECT for Closed Loop), P0137, P0138 (O2 Sensor 1), P0171,P0172 (Fuel System), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor1, 2), P0351, P0352, P0353, P0354, P0355, 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 met:	Condition 1 or 2
1. All of following conditions met:	Condition (a), (b) and (c)
(a) ECT at engine start - IAT at engine starts	-15° to 7°C (5° to 45°F)
(b) ECT at engine start	-10° to 56°C (14° to 133°F)
(c) IAT at engine start	-10° to 56°C (14° to 133°F)
2. All of following conditions met:	Condition (a), (b) and (c)
(a) ECT at engine start - IAT at engine start	More than 7°C (45°F)
(b) ECT at engine start	56°C (133°F) or less
(c) IAT at engine start	-10°C (14°F) or more
Accumulated time that vehicle speed is 80 mph (128km/h) or more	Less than 20 seconds

TYPICAL MALFUNCTION THRESHOLDS

Duration that all of following conditions 1 and 2 met	5 seconds or more
1. Estimated ECT	75°C (167°F) or more
2. ECT sensor output	Below 75°C (167°F)

MONITOR RESULT

Refer to Checking monitor Status for detailed information (See page ES-25).

Thermostat:

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$E1	$E8	Multiply by 0.1 [°C]	ECT sensor output when estimated ECT reached to malfunction criteria	Malfunction criteria	Maximum test limit

If the Test Value is less than Test Limit when the engine is warmed up, the ECM interprets this as a malfunction.

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.

1 CHECK ANY OTHER DTCS 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) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read DTCs.

Result

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

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

B → **GO TO DTC CHART**

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-26).
(b) Check the valve opening temperature of the thermostat (See page CO-26).
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-27).

NG → **REPLACE THERMOSTAT**

OK

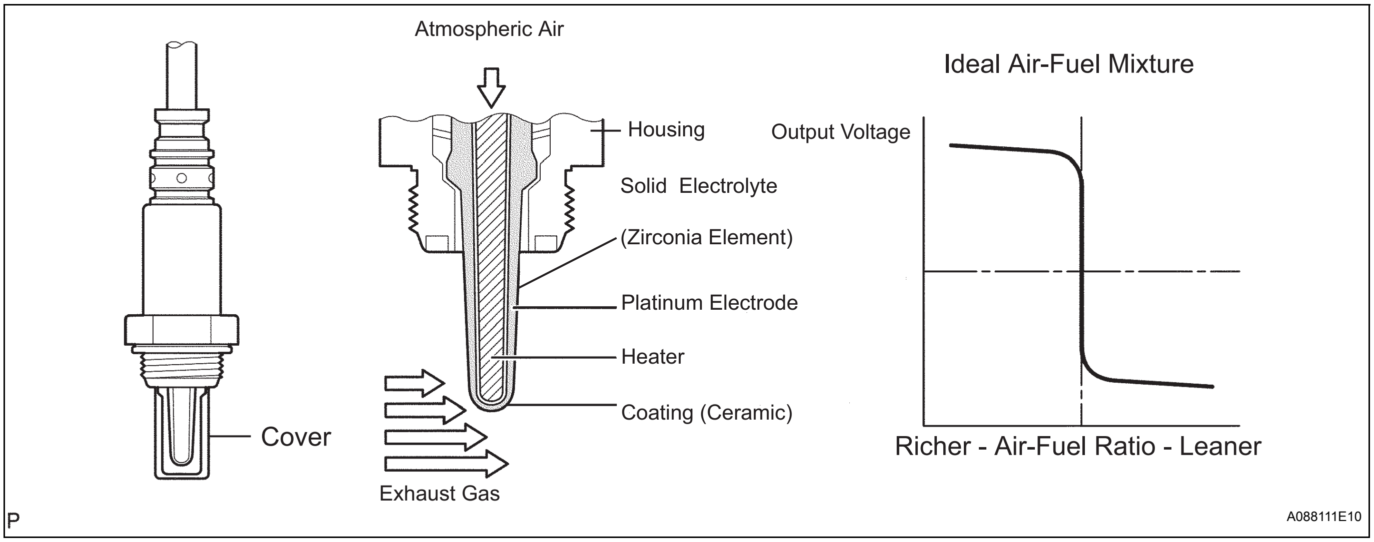
REPLACE ECM

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)**

HINT:
Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.

DESCRIPTION

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC (Three-Way Catalytic Converter) is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel level. For 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 is 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.



DTC No.	DTC Detection Conditions	Trouble Areas
P0136 P0156	• Abnormal voltage output: During active air-fuel ratio control, following conditions (a) and (b) are met for 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 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) • 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 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 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) • 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 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

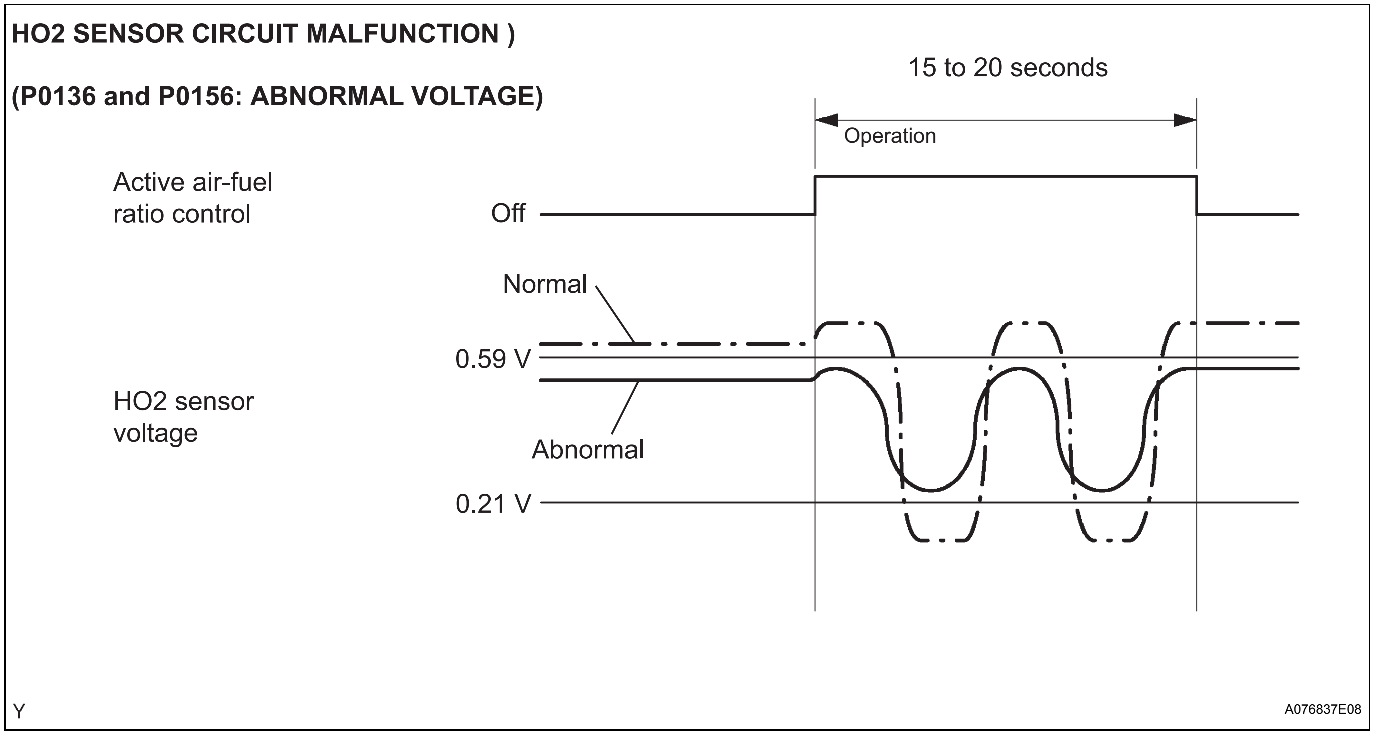
Active Air-Fuel Ratio Control

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).

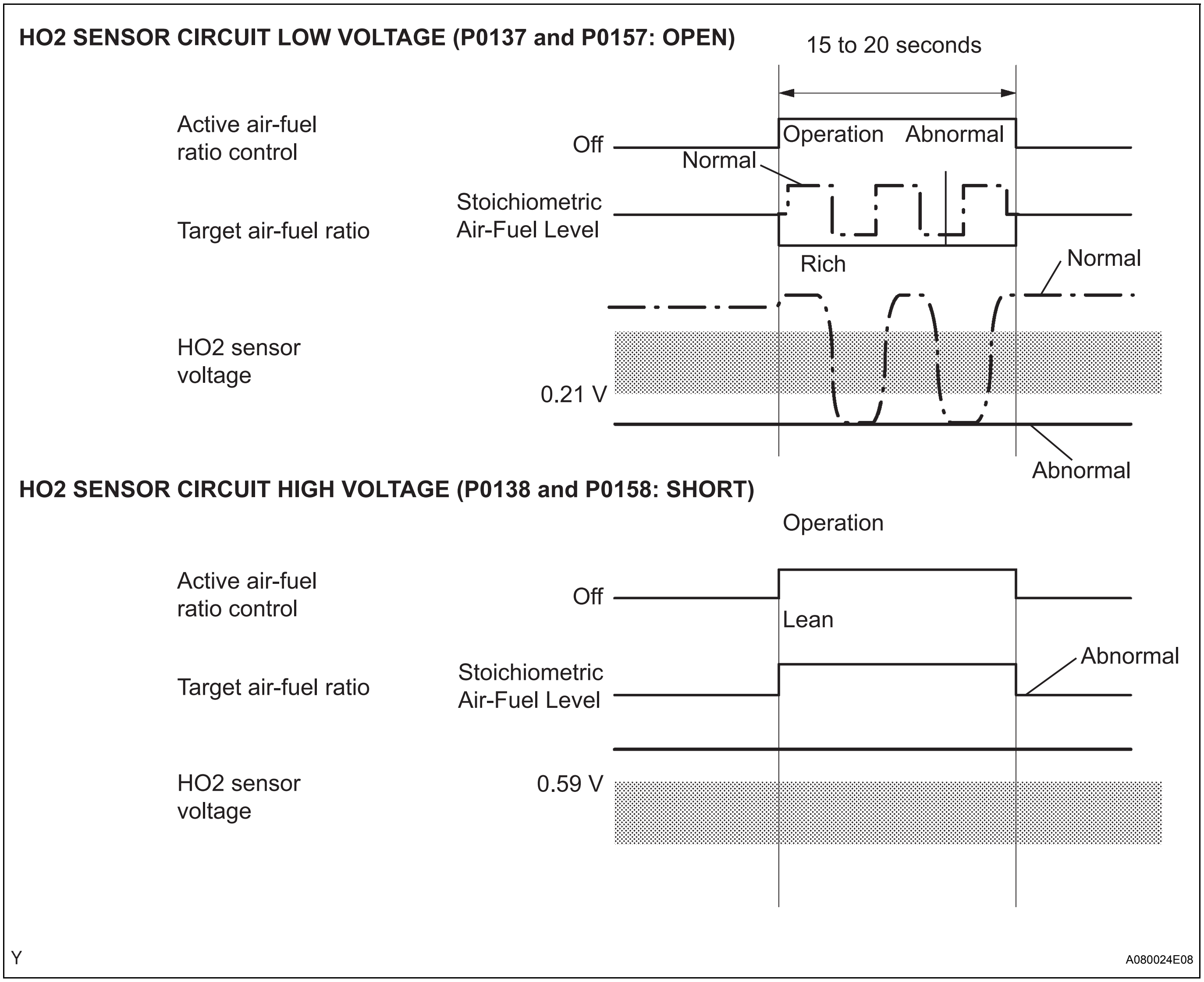
Abnormal Voltage Output of HO2 Sensor (DTCs P0136 and P0156)

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 or 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.



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

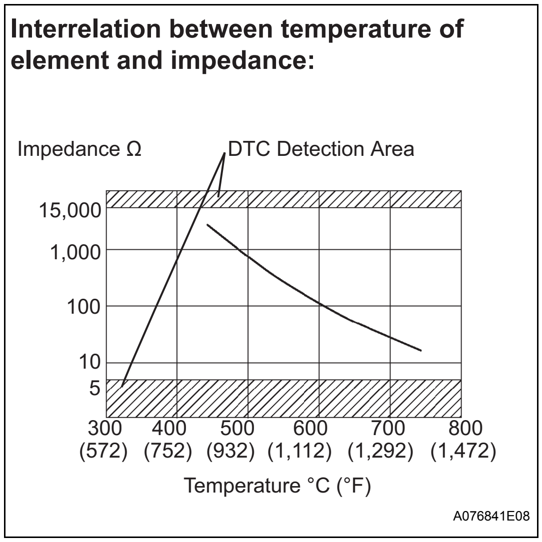
During active air-fuel ratio control, the ECM calculates the Oxygen Storage Capacity (OSC)* of the Three-Way Catalytic Converter (TWC) by forcibly regulating the air-fuel ratio to become rich or lean.
If the HO2 sensor has an open or short, or the voltage output of the sensor noticeably decreases, the 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-229).


HO2 SENSOR CIRCUIT LOW VOLTAGE (P0137 and P0157: OPEN)
15 to 20 seconds
Active air-fuel ratio control
Off
Operation
Abnormal
Normal
Target air-fuel ratio
Stoichiometric Air-Fuel Level
Rich
Normal
HO2 sensor voltage
0.21 V
Abnormal
HO2 SENSOR CIRCUIT HIGH VOLTAGE (P0138 and P0158: SHORT)
Operation
Active air-fuel ratio control
Off
Lean
Abnormal
Target air-fuel ratio
Stoichiometric Air-Fuel Level
HO2 sensor voltage
0.59 V
Y
A080024E08

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 15 kΩ.

MONITOR STRATEGY

Related DTCs	P0136: Heated oxygen sensor output voltage (Output voltage) (bank 1) P0136: Heated oxygen sensor impedance (Low) (bank 1) P0137: Heated oxygen sensor output voltage (Low voltage) (bank 1) P0137: Heated oxygen sensor impedance (High) (bank 1) P0138: Heated oxygen sensor output voltage (High voltage) (bank 1) P0138: Heated oxygen sensor output voltage (Extremely high) (bank 1) P0156: Heated oxygen sensor output voltage (Output voltage) (bank 2) P0156: Heated oxygen sensor impedance (Low) (bank 2) P0157: Heated oxygen sensor output voltage (Low voltage) (bank 2) P0157: Heated oxygen sensor impedance (High) (bank 2) P0158: Heated oxygen sensor output voltage (High voltage) (bank 2) P0158: Heated oxygen sensor impedance (Extremely high) (bank 2)
Required Sensors / Components (Main)	Heated oxygen sensor
Required Sensors / Components (Related)	Crankshaft position sensor, engine coolant temperature sensor, mass air flow meter and throttle position sensor
Frequency of Operation	Once per driving cycle: Active air-fuel ratio control detection Continuous: Others
Duration	20 seconds.: Heated oxygen sensor output (Output voltage, High voltage, Low voltage) 30 seconds.: Heated oxygen sensor impedance (Low) 90 seconds.: Heated oxygen sensor impedance (High) 10 seconds.: Heated oxygen sensor impedance (Extremely high)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	P0031, P0032, P0051, P0052 (A/F Sensor Heater Sensor 1), P0100, P0101, P0102, P0103 (MAF Sensor), P0110, P0112, P0113 (IAT Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0137, P0138 (O2 Sensor 1), P0171,P0172 (Fuel System), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1,2), P0500 (VSS), P2196, P2198 (A/F Sensor (Rationality)), P2A00, P2A03 (A/F Sensor (Slow Response))

Heated Oxygen Sensor Output Voltage (Output Voltage, High Voltage and Low Voltage):

Active air-fuel ratio control	Performing
Active air-fuel ratio control begins when all of following conditions met:	-
Battery voltage	11 V or more
Engine coolant temperature	75°C (167°F) or more
Idle	OFF
Engine RPM	Less than 3,200 rpm
A/F sensor status	Activated
Fuel-cut	OFF
Engine load	10 to 70%
Shift position	4th or more

Heated Oxygen Sensor Impedance (Low):

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

Heated Oxygen Sensor Impedance (High):

Battery voltage	11 V or more
Estimated HO2S temperature	More than 450°C (842°F)
DTC P0606	Not set

Heated Oxygen Sensor Output Voltage (Extremely High):

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

TYPICAL MALFUNCTION THRESHOLDS

Heated Oxygen Sensor Output Voltage (Output voltage):

Either of the following conditions is met:	1 or 2
1. All of the following conditions (a), (b) and (c) are met	-
(a) Commanded air-fuel ratio	14.3 or less
(b) Rear HO2 sensor voltage	0.21 to 0.59 V
(c) OSC (Oxygen Storage Capacity of Catalyst)	1.8 g or more
2. All of the following conditions (d), (f) and (g) are met.	-
(d) Commanded air-fuel ratio	14.9 or more
(f) Rear HO2 sensor voltage	0.21 to 0.59 V
(g) OSC	1.8 g or more

Heated Oxygen Sensor Output Voltage (Low output voltage):

All of the following conditions (a), (b) and (c) are met.	-
(a) Commanded air-fuel ratio	14.3 or less
(b) Rear HO2 sensor voltage	Less than 0.21 V

(c) OSC (Oxygen Storage Capacity of Catalyst)	1.8 g or more

Heated Oxygen Sensor Output Voltage (High output voltage):

All of the following conditions (a), (b) and (c) are met.	-
(a) Commanded air-fuel ratio	14.9 or more
(b) Rear HO2 sensor voltage	More than 0.59 V
(c) OSC (Oxygen Storage Capacity of Catalyst)	1.8 g or more

Heated Oxygen Sensor Impedance (Low):

Duration of following condition	30 seconds or more
Rear heated oxygen sensor impedance	Less than 5 Ω

Heated Oxygen Sensor Impedance (High):

Duration of following condition	90 seconds or more
Rear heated oxygen sensor impedance	15 kΩ or more

Heated Oxygen Sensor Impedance (Extremely High):

Duration of following condition	10 seconds or more
Rear heated oxygen sensor voltage	1.2 V or more

COMPONENT OPERATING RANGE

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

MONITOR RESULT

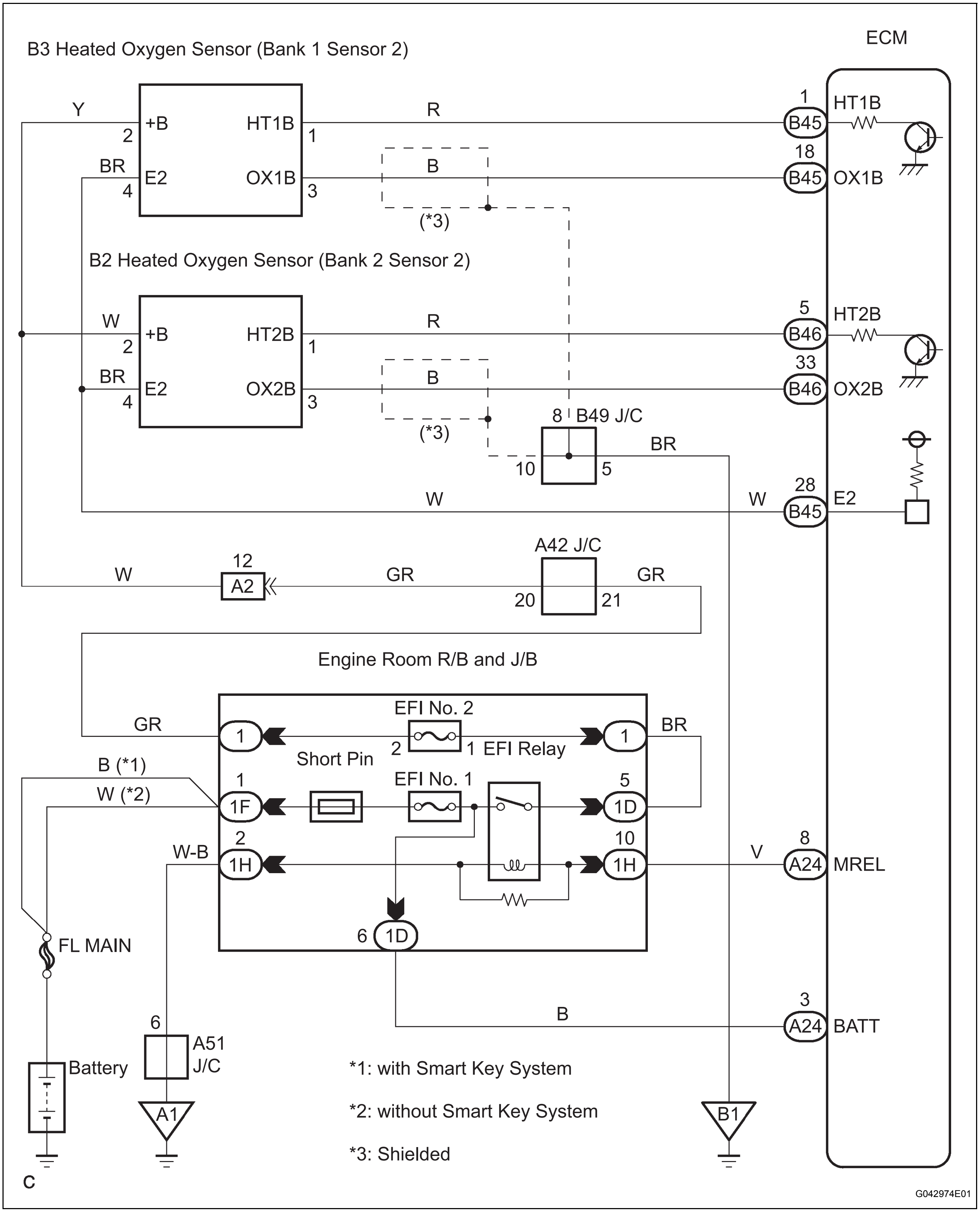
Refer to Checking Monitor Status for detailed information (See page ES-25).

HO2S bank 1 sensor 2

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$02	$07	Multiply by 0.001 [V]	Minimum sensor voltage	Minimum test limit	Maximum test limit
$02	$08	Multiply by 0.001 [V]	Maximum sensor voltage	Minimum test limit	Maximum test limit
$02	$8F	Multiply by 0.001 [g]	Maximum oxygen storage capacity	0	Maximum test limit

If the sensor voltage is outside the standard values, the ECM interprets this as a malfunction and sets a DTC.

WIRING DIAGRAM

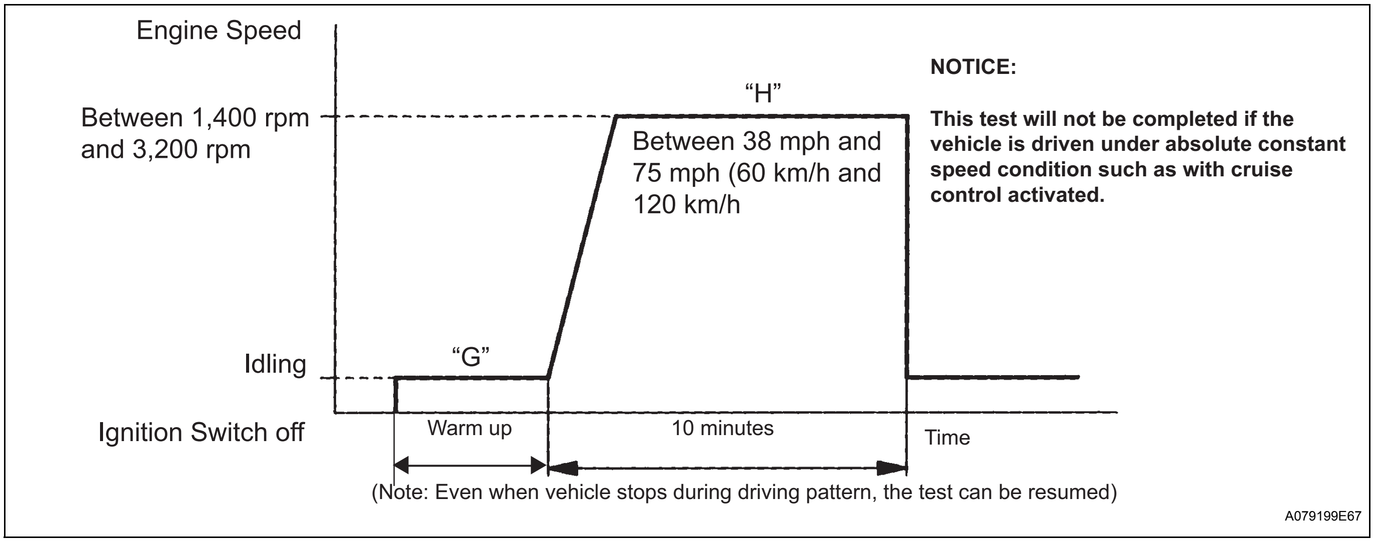


ES

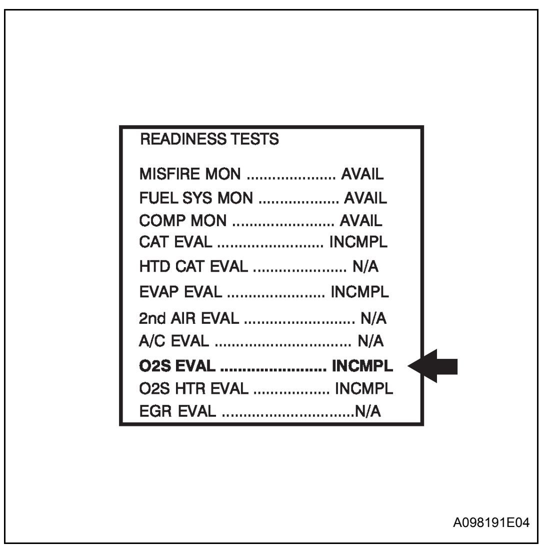
CONFIRMATION DRIVING PATTERN

HINT:

- This confirmation driving pattern is used in steps 5, 8 and 11 of the following diagnostic troubleshooting procedure when using the intelligent tester.
- Performing this confirmation 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.



1. Connect the intelligent tester to the DLC3 (Procedure A).



2. Turn the ignition switch on (IG) (Procedure B).
3. Turn the tester on (Procedure C).
4. Clear DTCs (where set) (See page ES-44) (Procedure D).
5. Select the following menu items: DIAGNOSIS / CARB OBD II / READINESS TESTS (Procedure E).
6. Check that O2S EVAL is INCMPL (incomplete) (Procedure F).
7. Start the engine and warm it up (Procedure G).
8. Drive the vehicle at between 38 mph and 75 mph (60 km/h and 120 km/h) for at least 10 minutes (Procedure H).
9. Note the state of the Readiness Tests items. Those items will change to COMPL (complete) as O2S EVAL monitor operates (Procedure I).
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 (Procedure J).
    HINT:
    If O2S EVAL does not change to COMPL, and any pending DTCs fail to set, extend the driving time.

INSPECTION PROCEDURE

HINT:
For use of the 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 the 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. Select the following menu items on the tester: 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.
   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 and decreases in the fuel injection volume.

Standard voltage

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

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	 OK	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	NG	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	 OK	Output Voltage Almost no reaction	NG	

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
4	Injection volume +25 % -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

– Following the A/F CONTROL procedure enables technicians to check the graph of the voltage outputs of both the A/F and HO2 sensors.
– To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2. Press the YES button and then the ENTER button. Then press the F4 button.

ES

HINT:
- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.
- 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.
- 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) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read 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 INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

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

(c) Select the following menu items: 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.

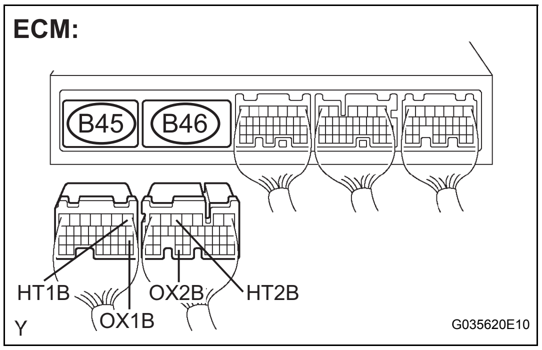
Result

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

B → Go to step 5

A

3 CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT)



(a) Turn the ignition switch off and wait for 5 minutes.
(b) Disconnect the B45 or B46 ECM connector.
(c) Measure the resistance.
Standard resistance

Tester Connections	Specified Conditions
HT1B (B45-1) - OX1B (B45-18)	10 kΩ or higher
HT2B (B46-5) - OX2B (B46-33)	10 kΩ or higher

(d) Reconnect the ECM connector.

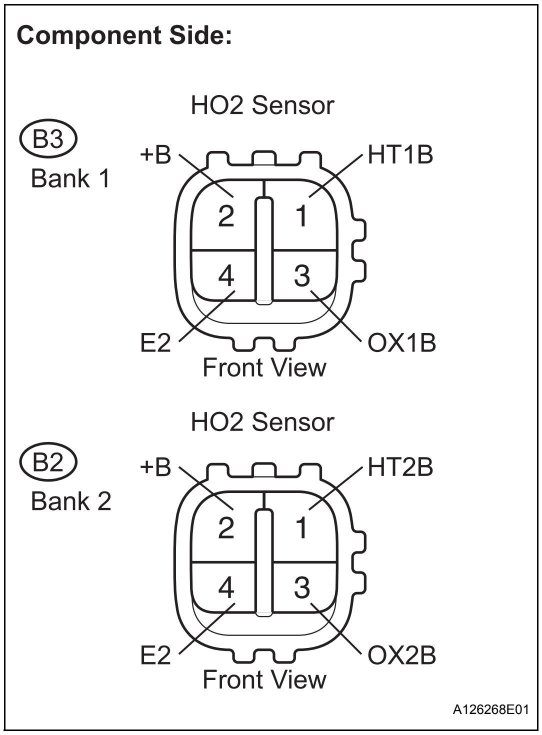
NG → Go to step 4

OK

REPLACE ECM

ES

4	INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)



(a) Disconnect the B3 or B2 Heated Oxygen (HO2) sensor connector.

(b) Measure the resistance between the terminals of the HO2 sensor connector.

Standard resistance:

Bank 1

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

Bank 2:

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

(c) Reconnect the HO2 sensor connector.

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR

5	PERFORM CONFIRMATION DRIVING PATTERN

(a) Perform confirmation driving pattern (See page ES-26).

NEXT

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

(a) Connect the intelligent tester to the DLC3.

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

(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

(d) Read DTCs.

Result

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

B → **CHECK FOR INTERMITTENT PROBLEMS**

A

REPLACE HEATED OXYGEN SENSOR

7 READ VALUE OF INTELLIGENT TESTER (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

(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) Select the following menu items: 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:
Fluctuates between 0.4 V or less and 0.5 V or more.

NG → **Go to step 14**

OK

8 PERFORM CONFIRMATION DRIVING PATTERN

(a) Perform confirmation driving pattern (See page ES-26).

NEXT

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read 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 heated oxygen sensor (See page EC-22).

NEXT

11 PERFORM CONFIRMATION DRIVING PATTERN

(a) Perform confirmation driving pattern (See page ES-26).

NEXT

ES

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

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

Result

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

B → REPAIR COMPLETED

A

13 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (INJECTION VOLUME)

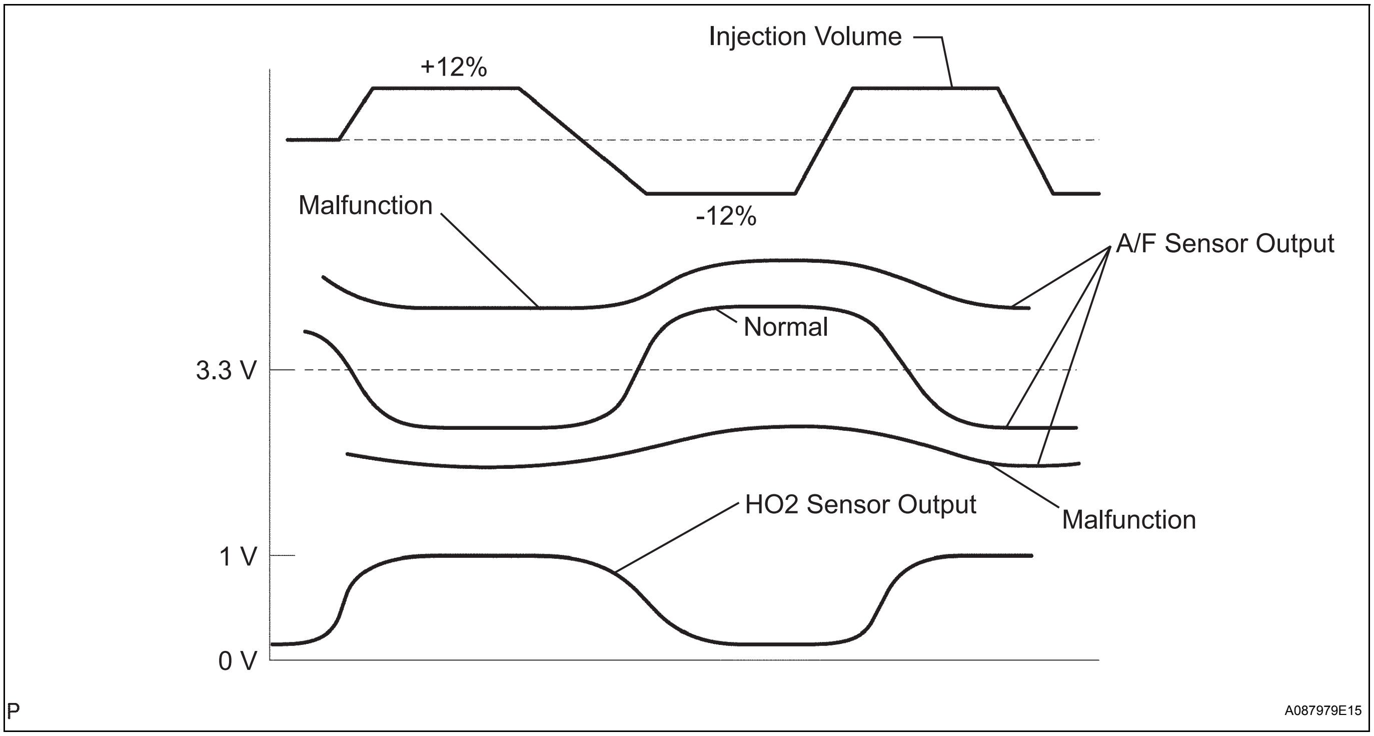
(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INJ VOL.
(e) Change the fuel injection volume using the tester, monitoring the voltage output of Air-Fuel Ratio (A/F) and HO2 sensors 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 Variations	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 at more than 3.3 V	NG

Tester Display (Sensor)	Voltage Variations	Proceed to
AFS B1S1 (A/F) AFS B2S1 (A/F)	Remains at 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 at either less or more than 3.3 V despite the HO2 sensor indicating a normal reaction, the A/F sensor is malfunctioning.



ES

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

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

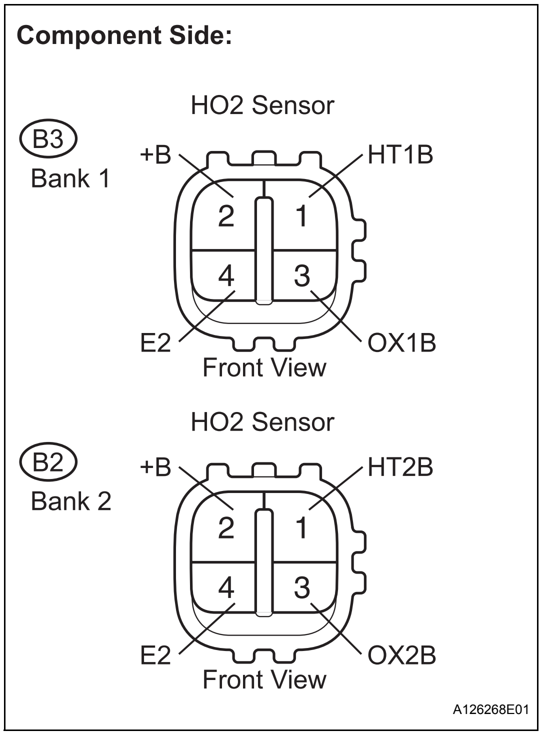
14	**CHECK FOR EXHAUST GAS LEAKAGE**

OK:
No gas leakage.

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

OK

15	INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



(a) Disconnect the B3 or B2 Heated Oxygen (HO2) sensor connector.
(b) Measure the resistance between the terminals of the HO2 sensor connector.
Standard resistance:
Bank 1

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

Bank 2

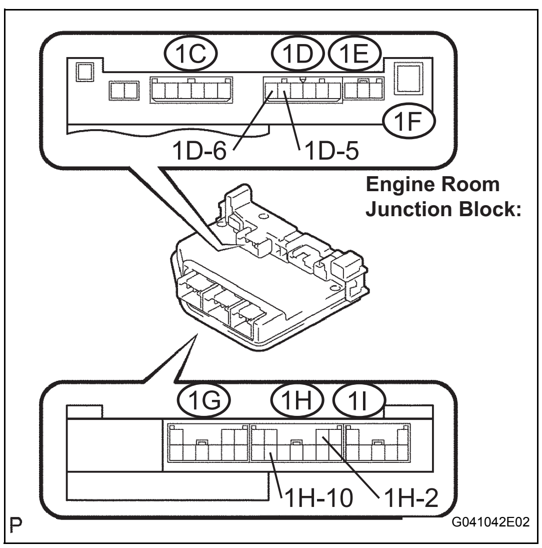
Tester Connections	Specified Conditions
HT2B (1) - +B (2)	11 to 16 Ω at 20°C (68°F)
HT2B (1) - E2 (4)	10 kΩ or higher

(c) Reconnect the HO2 sensor connector.

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

16	INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (EFI RELAY)



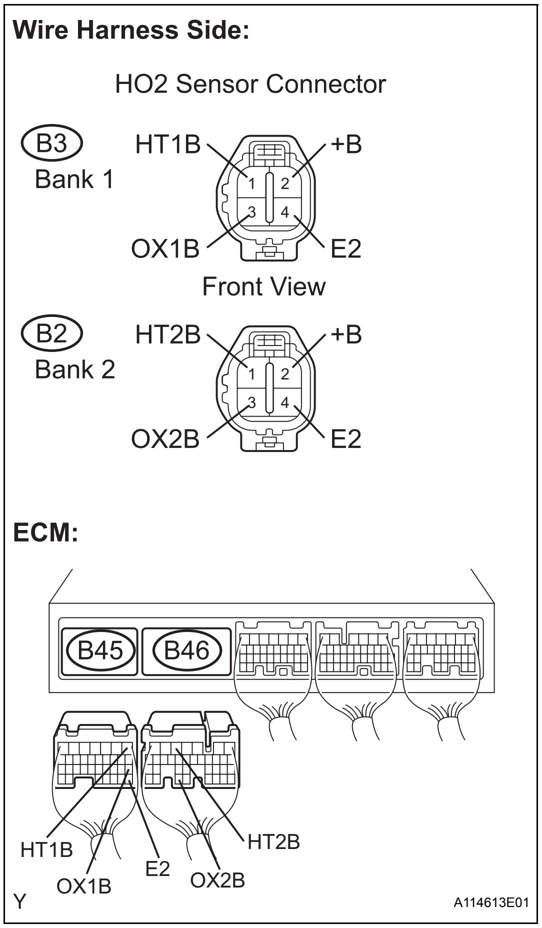
(a) Remove the engine room junction block.
(b) Measure the EFI relay resistance.
Standard resistance

Tester Connections	Specified Conditions
1D-5 - 1D-6	10 kΩ or higher
1D-5 - 1D-6	Below 1 Ω (when battery voltage applied to terminals 1H-10 and 1H-2)

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

OK

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



(a) Disconnect the B2 or B3 HO2 sensor connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the +B terminal of the HO2 sensor connector and body ground.
Standard voltage

Tester Connections	Specified Conditions
+B (B3-2) - Body ground	9 V to 14 V
+B (B3-2) - Body ground	9 V to 14 V

(d) Turn the ignition switch off.
(e) Disconnect the B45 and B46 ECM connectors.
(f) Measure the resistance.
Standard resistance (Check for open)

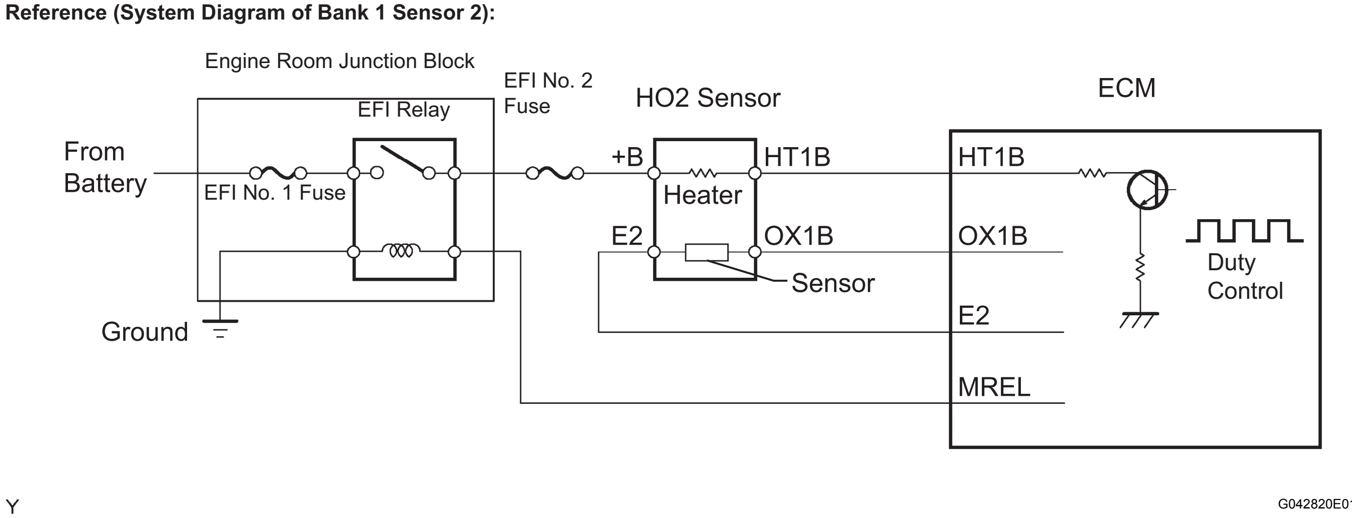
Tester Connections	Specified Conditions
HT1B (B3-1) - HT1B (B45-1)	Below 1 Ω
OX1B (B3-3) - OX1B (B45-18)	Below 1 Ω
E2 (B3-4) - E2 (B45-28)	Below 1 Ω
HT2B (B2-1) - HT2B (B46-5)	Below 1 Ω
OX2B (B2-3) - OX2B (B46-33)	Below 1 Ω
E2 (B2-4) - E2 (B45-28)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HT1B (B3-1) or HT1B (B45-1) - Body ground	10 kΩ or higher
OX1B (B3-3) or OX1B (B45-18) - Body ground	10 kΩ or higher
E2 (B3-4) or E2 (B45-28) - Body ground	10 kΩ or higher
HT2B (B2-1) or HT2B (B46-5) - Body ground	10 kΩ or higher
OX2B (B2-3) or OX2B (B46-33) - Body ground	10 kΩ or higher
E2 (B2-4) or E2 (B45-28) - Body ground	10 kΩ or higher

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

Reference (System Diagram of Bank 1 Sensor 2):



NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE HEATED OXYGEN SENSOR

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.

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 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.

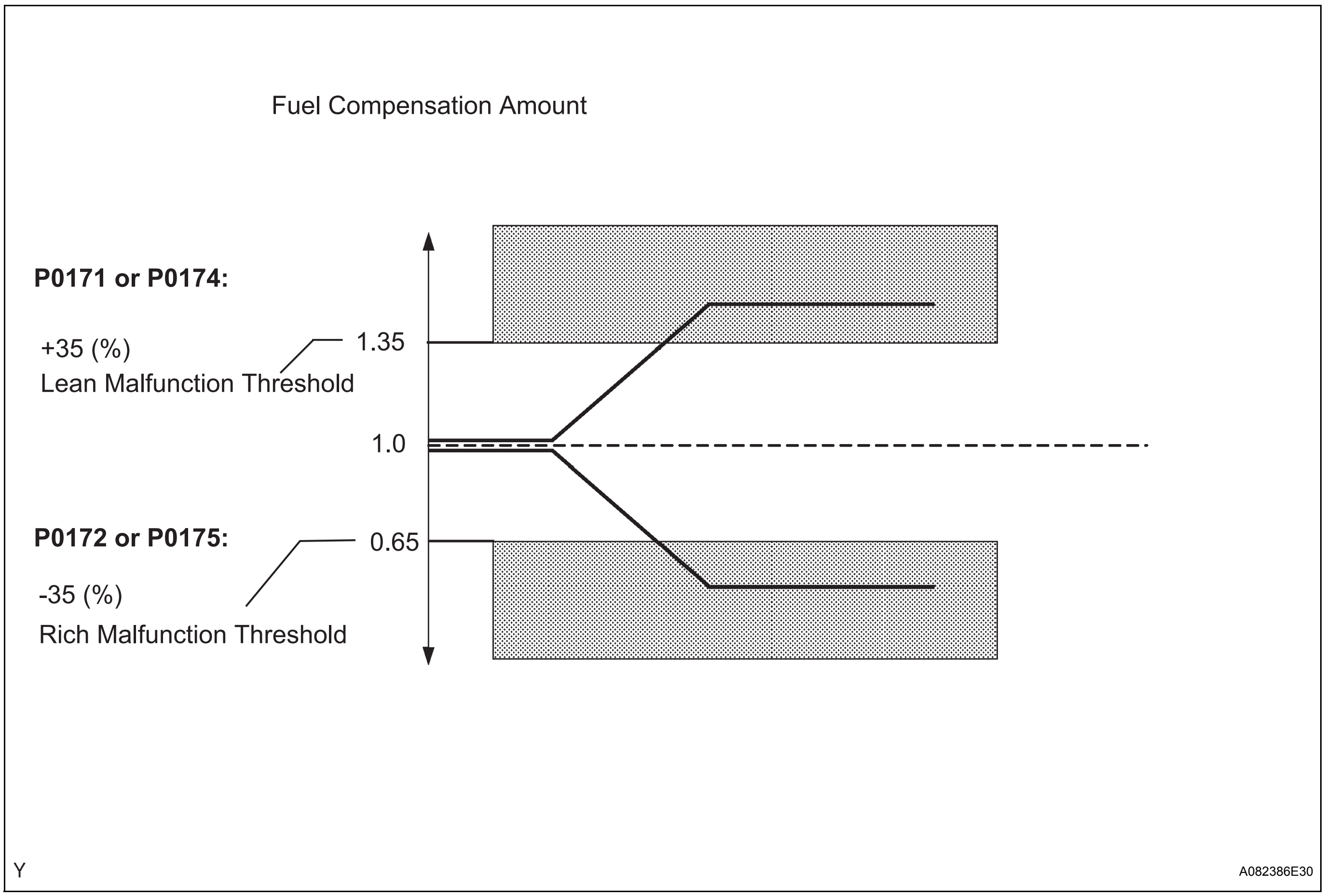
- When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is more than 75°C [167°F]), the system is functioning normally.

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 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.



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

TYPICAL ENABLING CONDITIONS

Fuel-trim:

The monitor will run whenever these DTCs are not present	P0010, P0020 (VVT VSV1, 2), P0011, P0012 (VVT System-Advance, Retard), P0021, P0022(VVT System2-Adavance, Retard), P0031, P0031, P0032, P0051, P0052 (A/F Sensor heater Sensor 1), P0100, P0101, P0102, P0103 (MAF Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223 , P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1, 2), P0351, P0352, P0353, P0354, P0356 (Ignitor), P0500 (VSS),
Fuel system status	Closed-loop
Battery voltage	11 V or more
Either of following conditions met	Condition 1 or 2
1. Engine RPM	Below 1,100 rpm
2. Intake air amount per revolution	0.22 g/rev or more
Catalyst monitor	No executed

TYPICAL MALFUNCTION THRESHOLDS

Fuel trim:

Purge-cut	Executing
Either of following conditions met	Condition 1 or 2
1. Average between short-term fuel trim and long-term fuel trim	35% or more at 80°C (176°F) of ECT
2. Average between short-term fuel trim and long-term fuel trim	-35% or less at 80°C (176°F) of ECT

WIRING DIAGRAM

Refer to DTC P2195 (See page ES-317).

INSPECTION PROCEDURE

HINT:
For use of the 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 the 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. Select the following menu items on the tester: DIAGNOSIS / ENHANCEDOBD 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.
   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 and decreases in the fuel injection volume.

Standard voltage

Tester Display (Sensor)	Injection Volumes	Status	Voltages
AFS B1S1 or AFS B2S1 (A/F)	+25%	Rich	Less than 3.0

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

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	OK	Output Voltage More than 0.55 V Less than 0.4 V	OK	
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	NG	Output Voltage More than 0.55 V Less than 0.4 V	OK	
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	OK	Output Voltage Almost no reaction	NG	
4	Injection volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

– Following the A/F CONTROL procedure enables technicians to check the graph of the voltage outputs of both the A/F and HO2 sensors.
– To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2. Press the YES button and then the ENTER button. Then press 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.
- A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.
- A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171, P0172, P0174 OR P0175)

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

Result

Display (DTC Output)	Proceed to
P0171, P0172, P0174 or P0175	A
P0171, P0172, P0174 or P0175 and other DTCs	B

HINT:
If any DTCs other than P0171, P0172, P0174 or P0175 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2	CHECK PCV HOSE CONNECTIONS

OK:
PCV hose is connected correctly and is not damaged.

NG → **REPAIR OR REPLACE PCV HOSE**

OK

3	CHECK AIR INDUCTION SYSTEM

(a) Check the air induction system for vacuum leakage.
OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM**

OK

4	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (A/F CONTROL)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) 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).

ES

ES

(f) Monitor the voltage outputs of A/F and HO2 sensors (AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2) displayed on the tester.
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 and decreases in the fuel injection volume.

Standard voltage

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

Result

Status AFS B1S1 or AFS B2S1	Status O2S B1S2 or O2S B2S2	A/F Condition and A/F Sensor Condition	Misfires	Suspected Trouble Areas	Proceed to
Lean/Rich	Lean/Rich	Normal	-	-	C
Lean	Lean	Actual air-fuel ratio lean	May occur	• PCV valve and hose • PCV hose connections • Injector blockage • Gas leakage from exhaust system • Air induction system • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor	A
Rich	Rich	Actual air-fuel ratio rich	-	• Injector leakage or blockage • Gas leakage from exhaust system • Ignition system • Fuel pressure • MAF meter • ECT sensor	A
Lean	Lean/Rich	A/F sensor malfunction	-	A/F sensor	B
Rich	Lean/Rich	A/F sensor malfunction	-	A/F sensor	B

Lean: During A/F CONTROL, the A/F sensor output voltage (AFS) is consistently more than 3.35 V, and the HO2 sensor output voltage (O2S) is consistently less than 0.4 V.
Rich: During A/F CONTROL, the AFS is consistently less than 3.0 V, and the O2S is consistently more than 0.55 V.
Lean/Rich: During A/F CONTROL of the ACTIVE TEST, the output voltage of the heated oxygen sensor alternates correctly.

B — Go to step 11

C — Go to step 15

A

5	READ VALUE OF INTELLIGENT TESTER (COOLANT TEMP)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(d) Read the COOLANT TEMP twice, when the engine is both cold and warmed up.

Standard:
With cold engine:
Same as ambient air temperature.
With warm engine:
Between 75°C and 95°C (167°F and 203°F)

NG → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

OK

6	READ VALUE OF INTELLIGENT TESTER (MAF)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF and COOLANT TEMP.
(d) Allow the engine to idle until the COOLANT TEMP reaches 75°C (167°F) or more.
(e) Read the MAF with the engine in an idling condition and at an engine speed of 2,500 rpm.

Standard:
MAF while engine idling:
Between 3.2 g/s and 4.7 g/s (shift position: N, A/C: OFF).
MAF at engine speed of 2,500 rpm:
Between 13.1 g/s and 18.9 g/s (shift position: N, A/C: OFF).

NG → **REPLACE MASS AIR FLOW METER**

OK

7	CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-7).

NG → **REPAIR OR REPLACE FUEL SYSTEM**

OK

ES

8	CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → **REPAIR OR REPLACE EXHAUST SYSTEM**

OK

9	CHECK FOR SPARKS AND IGNITION

(a) Check for sparks and ignition (See page IG-4).
HINT:
If the spark plugs or ignition system malfunctions, engine misfire may occur. The misfire count can be read using the intelligent tester. Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / CYL #1 (to CYL #6).

NG → **REPAIR OR REPLACE IGNITION SYSTEM**

OK

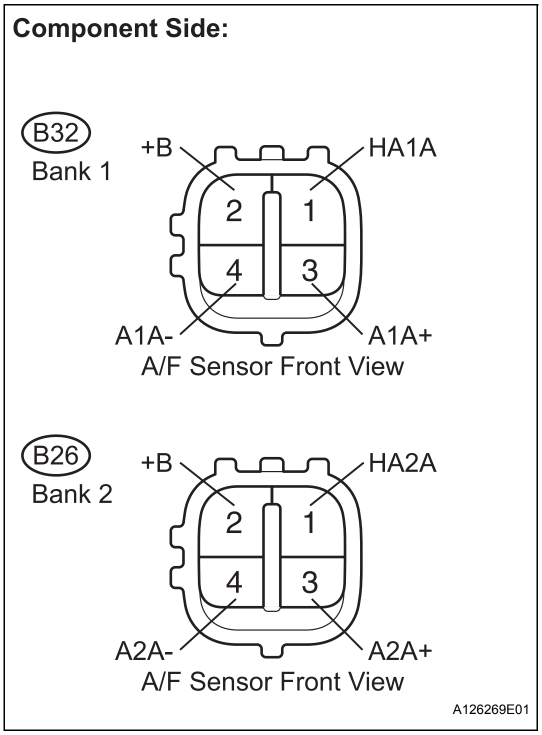
10	INSPECT FUEL INJECTOR ASSEMBLY (INJECTION AND VOLUME)

(a) Inspect the fuel injector assembly (See page FU-15).
HINT:
If the injectors malfunction, engine misfire may occur. The misfire count can be read using the intelligent tester. Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / CYL #1 (to CYL #6).

NG → **REPLACE FUEL INJECTOR ASSEMBLY**

OK

11	INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/F sensor connector.
Standard resistance:
Bank 1

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

Bank 2

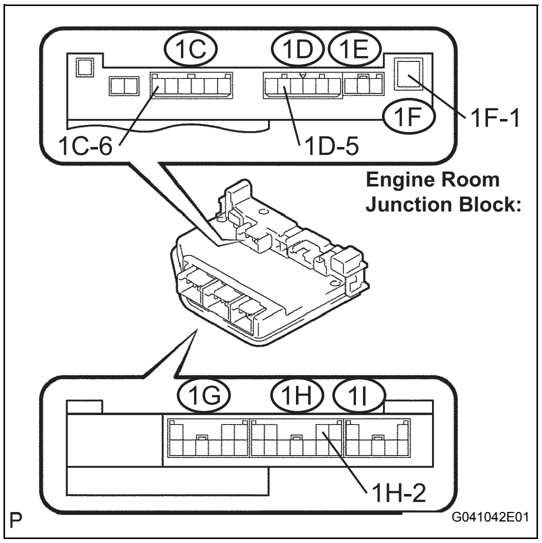
Tester Connections	Specified Conditions
HA2A (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HA2A (1) - A2A- (4)	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

12	INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (A/F SENSOR HEATER RELAY)



(a) Remove the engine room junction block.
(b) Measure the A/F sensor heater relay resistance.
Standard resistance

Tester Connections	Specified Conditions
1F-1 - 1C-6	10 kΩ or higher
1F-1 - 1C-6	Below 1 Ω (when battery voltage applied to terminals 1D-5 and 1H-2)

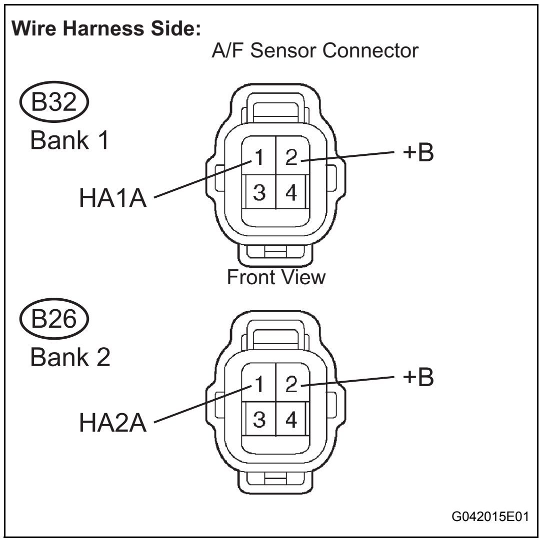
NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

OK

ES

ES

13 CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

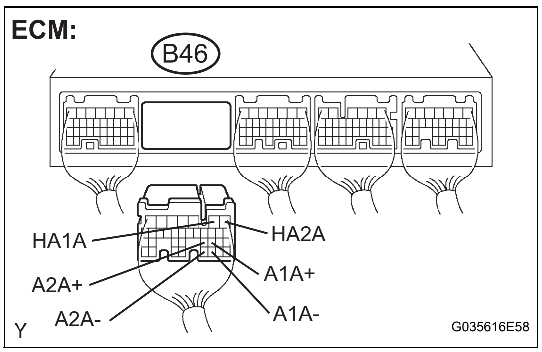


(a) Disconnect the B32 or B26 A/F sensor connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.

Standard voltage

Tester Connections	Specified Conditions
+B (B32-2) - Body ground	9 to 14 V
+B (B26-2) - Body ground	9 to 14 V

(d) Turn the ignition switch off.



(e) Disconnect the B46 ECM connector.
(f) Measure the resistance.

Standard resistance (Check for open)

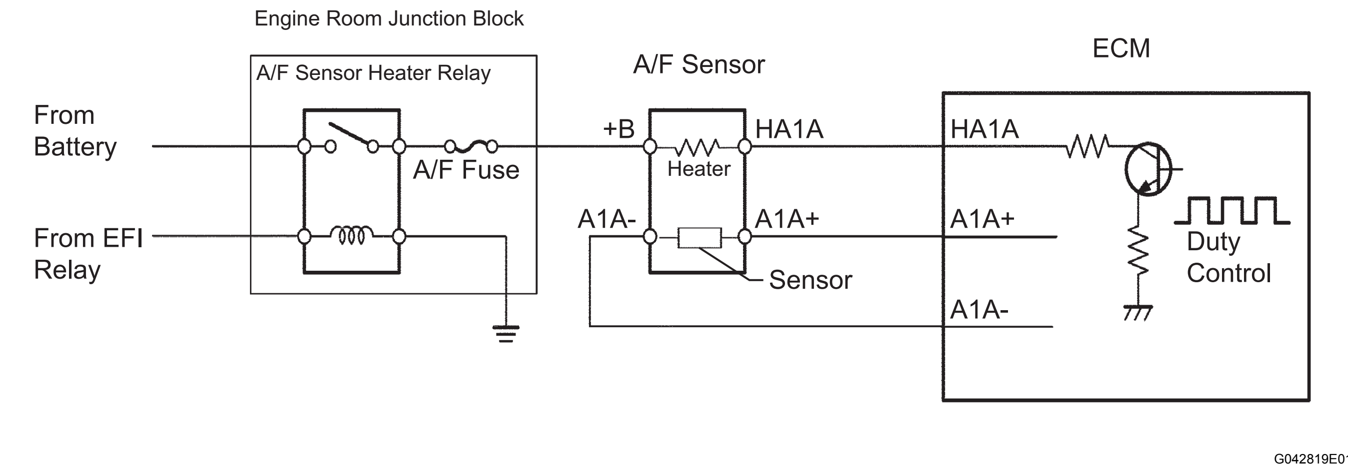
Tester Connections	Specified Conditions
HA1A (B32-1) - HA1A (B46-2)	Below 1 Ω
A1A+ (B32-3) - A1A+ (B46-22)	Below 1 Ω
A1A- (B32-4) - A1A- (B46-30)	Below 1 Ω
HA2A (B26-1) - HA2A (B46-1)	Below 1 Ω
A2A+ (B26-3) - A2A+ (B46-23)	Below 1 Ω
A2A- (B26-4) - A2A- (B46-31)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1A (B32-1) or HA1A (B46-2) - Body ground	10 kΩ or higher
A1A+ (B32-3) or A1A+ (B46-22) - Body ground	10 kΩ or higher
A1A- (B32-4) or A1A- (B46-30) - Body ground	10 kΩ or higher
HA2A (B26-1) or HA2A (B46-1) - Body ground	10 kΩ or higher
A2A+ (B26-3) or A2A+ (B46-23) - Body ground	10 kΩ or higher
A2A- (B26-4) or A2A- (B46-31) - Body ground	10 kΩ or higher

(g) Reconnect the ECM connector.
(h) Reconnect the A/F sensor connector.

Reference (System Diagram of Bank 1 Sensor 1):



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

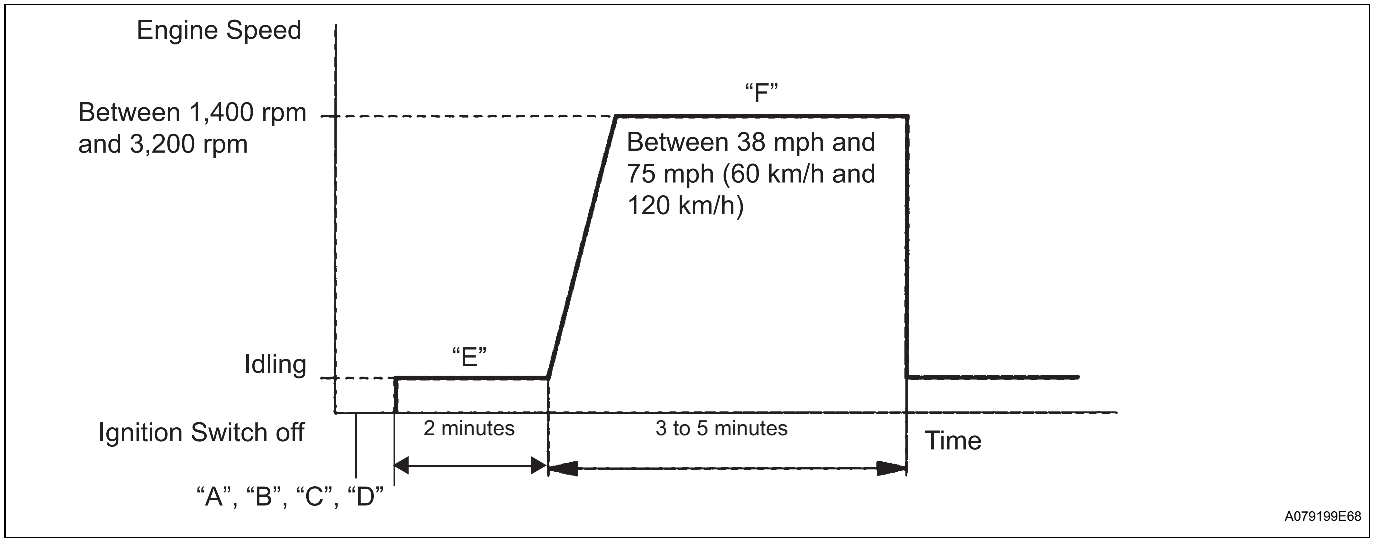
OK

14	REPLACE AIR FUEL RATIO SENSOR

NEXT

15	PERFORM CONFIRMATION DRIVING PATTERN

(a) Connect the intelligent tester to the DLC3 (Procedure A).
(b) Turn the ignition switch on (IG) and turn the tester on (Procedure B).
(c) Clear DTCs (See page ES-44) (Procedure C).
(d) Select the check mode using the tester (See page ES-48) (Procedure D).
(e) Start the engine and warm it up with all the accessories switched off (Procedure E).
(f) Drive the vehicle at between 38 mph and 75 mph (60 km/h and 120 km/h) and at an engine speed of between 1,400 rpm and 3,200 rpm for 3 to 5 minutes (Procedure F).



HINT:
If the system is still malfunctioning, the MIL will be illuminated during procedure "F".

NOTICE:
If the conditions in this test are not strictly followed, no malfunction will be detected.

NEXT

16 CHECK WHETHER DTC OUTPUT RECURS (DTC P0171, P0172, P0174 OR P0175)

(a) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
(b) Read DTCs.

Result

Display (DTC Output)	Proceed to
No output	A
P0171, P0172, P0174 or P0175	B

B → **Go to step 5**

A

END

DTC	P0300	Random / Multiple Cylinder Misfire Detected

DTC	P0301	Cylinder 1 Misfire Detected

DTC	P0302	Cylinder 2 Misfire Detected

DTC	P0303	Cylinder 3 Misfire Detected

DTC	P0304	Cylinder 4 Misfire Detected

DTC	P0305	Cylinder 5 Misfire Detected

DTC	P0306	Cylinder 6 Misfire Detected

DESCRIPTION

When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increase in exhaust emission levels. High concentrations of HC can also cause increases in the Three-Way Catalytic Converter (TWC) temperature, which may cause damage to the TWC. To prevent this increase in emissions and to limit the possibility of thermal damage, the ECM monitors the misfire rate. When the temperature of the TWC reaches the point of thermal degradation, the ECM blinks the MIL. To monitor misfires, the ECM uses both the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The CMP sensor is used to identify any misfiring cylinders and the CKP sensor is used to measure variations in the crankshaft rotation speed. Misfires are counted when the crankshaft rotation speed variations exceed predetermined thresholds.
If the misfire exceeds the threshold levels, and could cause emission deterioration, the ECM illuminates the MIL and sets a DTC.

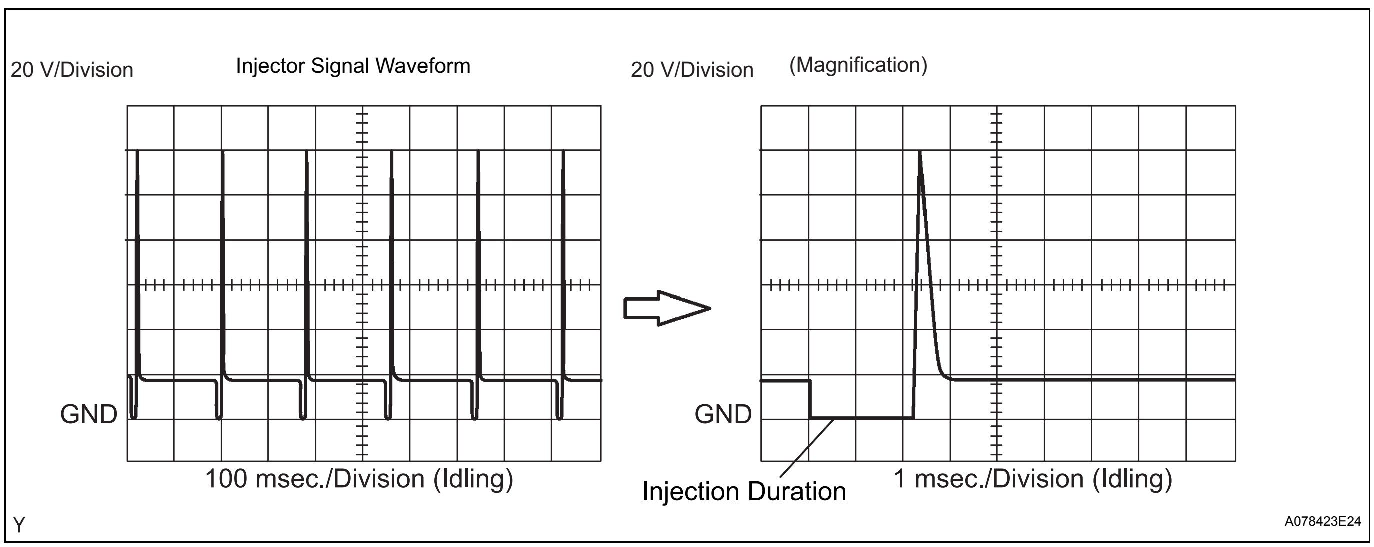
DTC No.	DTC Detection Conditions	Trouble Areas
P0300	Simultaneous misfiring of several cylinders are detected (2 trip detection logic)	• Open or short in engine wire harness • Connector connections • Vacuum hose connections • Ignition system • Injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve clearance • Valve timing • PCV hose • PCV • Air induction system • ECM

DTC No.	DTC Detection Conditions	Trouble Areas
P0301 P0302 P0303 P0304 P0305 P0306	Misfiring of specific cylinder is detected (2 trip detection logic)	• Open or short in engine wire harness • Connector connections • Vacuum hose connections • Ignition system • Injector • Fuel pressure • MAF meter • ECT sensor • Compression pressure • Valve clearance • Valve timing • PCV hose • PCV • Air induction system • ECM

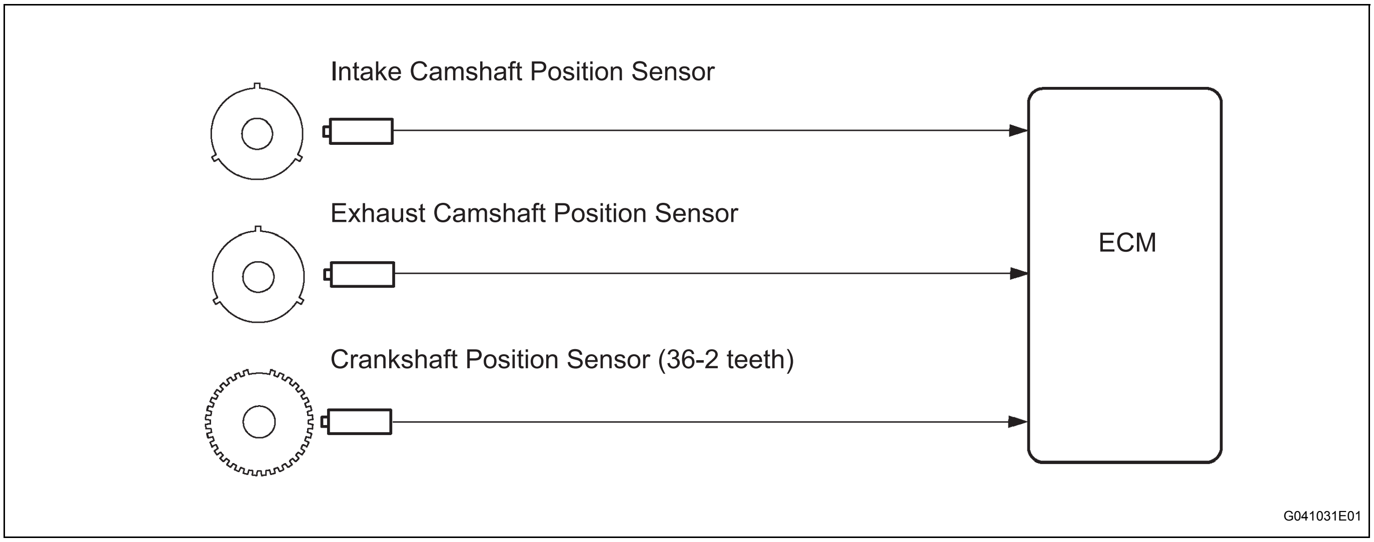
HINT:
When DTCs for misfiring cylinders are randomly set, but DTC P0300 is not set, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only set when several misfiring cylinders are detected at the same time.
Reference: Inspection using an oscilloscope
With the engine idling, check the waveform between terminals #10 to #60 and E01 of the ECM connectors.

Items	Contents
Terminals	#10 to #60 - E01
Equipment Settings	20 V/Division, 100 or 1 ms/Division
Conditions	Idling

HINT:
The correct waveform is as shown.



MONITOR DESCRIPTION



The ECM illuminates the MIL and sets a DTC when either one of the following conditions, which could cause emission deterioration, is detected (2 trip detection logic).

– Within the first 1,000 crankshaft revolutions of the engine starting, an excessive misfiring rate (approximately 20 to 50 misfires per 1,000 crankshaft revolutions) occurs once.
– After the first 1,000 crankshaft revolutions, an excessive misfiring rate (approximately 20 to 60 misfires per 1,000 crankshaft revolutions) occurs 4 times in sequential crankshaft revolutions.

The ECM flashes the MIL and sets a DTC when either one of the following conditions, which could cause the Three-Way Catalytic Converter (TWC) damage, is detected (2 trip detection logic).

– In every 200 crankshaft revolutions at a high engine rpm, the threshold misfiring percentage is recorded once.
– In every 200 crankshaft revolutions at a normal engine rpm, the threshold misfiring percentage is recorded 3 times.

MONITOR STRATEGY

Related DTCs	P0300: Multiple cylinder misfire P0301: Cylinder 1 misfire P0302: Cylinder 2 misfire P0303: Cylinder 3 misfire P0304: Cylinder 4 misfire P0305: Cylinder 5 misfire P0306: Cylinder 6 misfire
Required Sensors / Components (Main)	Injector, Ignition coil, Spark plug
Required Sensors / Components (Related)	Crankshaft, Camshaft, Engine coolant temperature and intake air temperature sensors and Mass air flow meter
Frequency of Operation	Continuous
Duration	1,000 to 4,000 crankshaft revolutions: Emission related misfire 200 to 600 crankshaft revolutions: Catalyst damaged misfire
MIL Operation	2 driving cycles: Emission related misfire MIL flashes immediately: Catalyst damaged misfire
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Misfire:

The monitor will run whenever these DTCs are not present	P0100, P0101, P0102, P0103 (MAF Sensor), P0110, P0112, P0113 (IAT Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223 , P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0327, P0328, P0332, P0333 (Knock Sensor), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1,2), P0500 (VSS),

Battery voltage	8 V or more
VVT system	No operate by scan tool
Engine RPM	400 to 6,500 rpm
All of following conditions met	Condition 1 and 2
1. Engine Coolant Temperature (ECT)	-10°C (14°F) or more
2. Either of following conditions met	Condition (a) or (b)
(a) Engine start ECT	More than -7°C (19°F)
(b) ECT	More than 20°C (68°F)
Fuel-cut	OFF

Monitor period of emission-related-misfire:

First 1,000 revolutions after engine start, or check mode	Crankshaft 1,000 revolutions
Except above	Crankshaft 1,000 revolutions x 4

Monitor period of catalyst-damage-misfire (MIL blinks):

All of following conditions 1, 2 and 3 are met	Crankshaft 200 revolutions
1. Driving cycle	1st
2. Check mode	OFF
3. Engine RPM	Less than 2,600 rpm
Except above	Crankshaft 200 revolutions x 3

TYPICAL MALFUNCTION THRESHOLDS

Monitor period of emission-related-misfire:

Misfire rate	1% or more

Monitor period of catalyst-damage-misfire (MIL blinks):

Number of misfire per 200 revolutions	94 or more (varies with intake air amount and RPM)
Paired cylinders misfire	Detected

MONITOR RESULT

Refer to Checking Monitor Status for detailed information (See page ES-25).

Misfire monitor - All cylinders

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A1	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A1	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

Misfire monitor - Cylinder 1

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A2	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A2	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

Misfire monitor - Cylinder 2

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A3	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A3	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

Misfire monitor - Cylinder 3

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A4	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A4	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

Misfire monitor - Cylinder 4

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A5	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A5	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

Misfire monitor - Cylinder 5

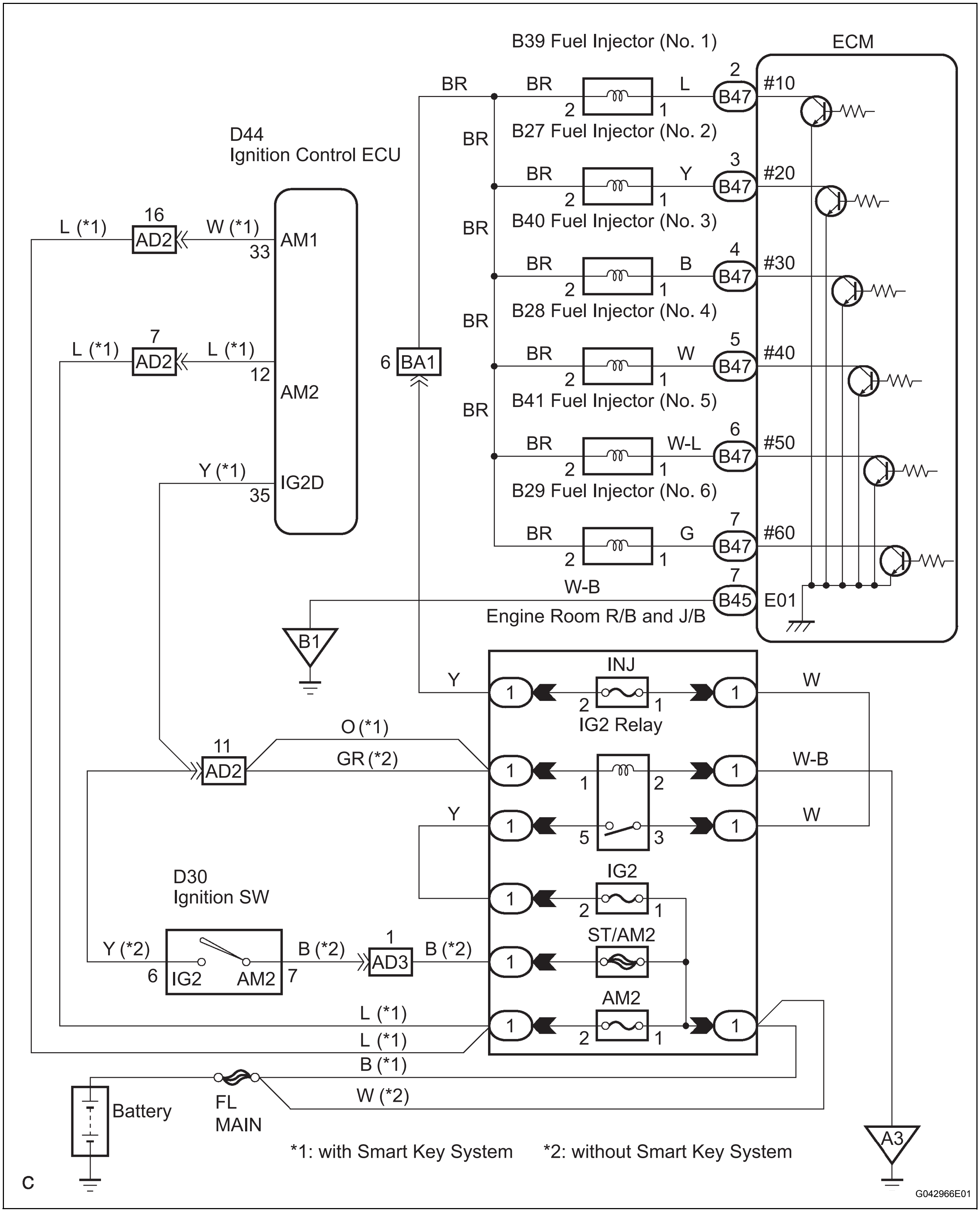
MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A6	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A6	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

Misfire monitor - Cylinder 6

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$A7	$0B	Multiply by 1 [time]	Exponential Weighted Moving Average misfire counts for last 10 driving cycles - total	0	65535
$A7	$0C	Multiply by 1 [time]	Misfire counts for last and current driving cycles - total	0	65535

WIRING DIAGRAM

Refer to DTC P0351 for the wiring diagram of the ignition system (See page ES-219).



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the ignition switch on (IG).
3. Turn the tester on.

4. Record the DTC(s) and freeze frame data.
5. Using the tester, select the check mode (See page ES-48).
6. Read the misfire counts of each cylinder (CYL #1 to #6) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the MISFIRE RPM and MISFIRE LOAD in the DATA LIST.
HINT:
In order to store misfire DTCs, it is necessary to drive the vehicle for the period of time shown in the table below, with the MISFIRE RPM and MISFIRE LOAD in the DATA LIST.

Engine RPM	Duration
Idling	3.5 minutes or more
1,000	3 minutes or more
2,000	1.5 minutes or more
3,000	1 minute or more

8. Check whether misfires have occurred by checking DTCs and freeze frame data.
HINT:
Do not turn the ignition switch off until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be erased.
9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the ignition switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:
- If any DTCs other than the misfire DTCs are output, 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.
- If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the freeze frame data.
- If the misfire still cannot be reproduced even though the conditions stored in the freeze frame data have been duplicated, one of the following factors is considered to be a possible cause of the problem:
  1. The fuel tank is low.
  2. Improper fuel is used.
  3. The spark plugs have been contaminated.
  4. The problem is complex.
- After finishing repairs, check the misfire counts of the cylinders (CYL #1, #2, #3, #4, #5 and #6).
- Be sure to confirm that no misfiring cylinder DTCs are set again by conducting the confirmation driving pattern, after repairs.
- For 6 and 8 cylinder engines, the ECM intentionally does not set the specific misfiring cylinder DTCs at high engine RPM. If misfires occur only in high engine RPM areas, only DTC P0300 is set.
  If DTC P0300 is present, perform the following operations:
  1. Clear the DTC (See page ES-44).
  2. Start the engine and conduct the confirmation driving pattern.
  3. Read the misfiring rates of each cylinder or DTC(s) using the tester.
  4. Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.
  5. After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not set.
- When one of SHORT FT #1, LONG FT #1, SHORT FT #2 or LONG FT #2 in the freeze frame data is outside the range of +-20%, the air-fuel ratio may be rich (?20% or less) or lean (+20% or more).
- When the COOLANT TEMP in the freeze frame data is less than 75°C (167°F), the misfires have occurred only while warming up the engine.

ES

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO MISFIRE TO DTCS)

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

Result

Display (DTC Output)	Proceed to
P0300, P0301, P0302, P0303, P0304, P0305 and/or P0306	A
P0300, P0301, P0302, P0303, P0304, P0305 and/or P0306 and other DTCs	B

HINT:
If any DTCs other than P0300, P0301, P0302, P0303, P0304, P0305 and P0306 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2	READ VALUE OF INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / MISFIRE RPM and MISFIRE LOAD.
(d) Read and note the MISFIRE RPM and MISFIRE LOAD (engine load) values.
HINT:
The MISFIRE RPM and MISFIRE LOAD indicate the vehicle conditions under which the misfire occurred.

NEXT

3	CHECK PCV HOSE CONNECTIONS

OK:
PCV hose is connected correctly and is not damaged.

NG → **REPAIR OR REPLACE PCV HOSE**

OK

4	CHECK MISFIRE COUNT (CYL #1, #2, #3, #4, #5 AND #6)

(a) Connect the intelligent tester to the DLC3 (Procedure "A").
(b) Turn the ignition switch on (IG) (Procedure "B").
(c) Turn the tester on (Procedure "C").

(d) Clear DTCs (See page ES-44) (Procedure "D").
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / CYL #1, #2, #3, #4, #5 and #6 (Procedure "E").
(f) Allow the engine to idle (Procedure "F").
(g) Read each value of CYL #1 to #6 displayed on the tester (Procedure "G").
  (1) Shift the gear selector lever to the D position.
  (2) Repeat procedures "E" to "G" above.
  (3) Check the CYL #1 to #6.
  (4) If misfire counts are still not displayed, perform procedures "I" and "J" and then check the misfire counts again.
(h) If no misfire counts occur in any cylinders, perform the following operations (Procedure "H").
(i) Drive the vehicle with the MISFIRE RPM and MISFIRE LOAD noted in step 2 (Procedure "I").
(j) Read the CYL #1 to #6 or DTCs displayed on the tester (Procedure "J").

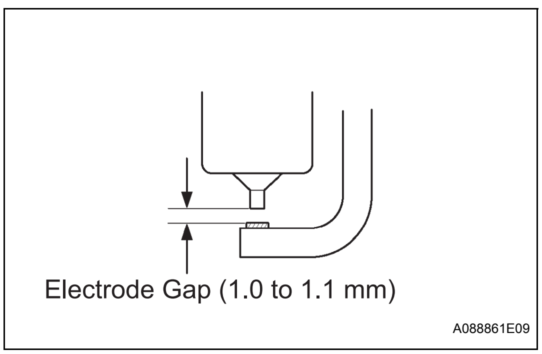
Result

Misfire Count	Proceed to
One or two cylinders have misfire counts	A
Three cylinders or more have misfire counts	B

B → **Go to step 12**

A

5 CHECK SPARK PLUG



(a) Remove the ignition coil and the spark plug of the misfiring cylinder.
(b) Measure the spark plug electrode gap.
Standard:
Between 1.0 mm and 1.1 mm (0.039 in. and 0.043 in.)
(c) Check the electrode for carbon deposits.
Require spark plug:

Manufacturers	Products
DENSO	FK20HR11

NOTICE:
If the electrode gap is larger than the standard, replace the spark plug. Do not adjust the electrode gap.

NG → **REPLACE SPARK PLUG**

OK

6	CHECK FOR SPARKS AND IGNITION (SPARK TEST)

(a) Disconnect the injector connectors to prevent the engine from starting.
(b) Install the spark plug to the ignition coil.
(c) Attach the spark plug assembly to the cylinder head cover (ground the spark plug).
(d) Crank the engine for less than 2 seconds and check the spark.
NOTICE:
Do not crank the engine for more than 2 seconds.
OK:
Sparks jump across electrode gap
(e) Reconnect the injector connectors.

NG → **Go to step 8**

OK

7	CHECK CYLINDER COMPRESSION PRESSURE OF MISFIRING CYLINDER

(a) Measure the cylinder compression pressure of the misfiring cylinder (See page EM-2).

OK → **Go to step 9**

NG

CHECK ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

8	CHANGE NORMAL SPARK PLUG AND CHECK SPARK OF MISFIRING CYLINDER

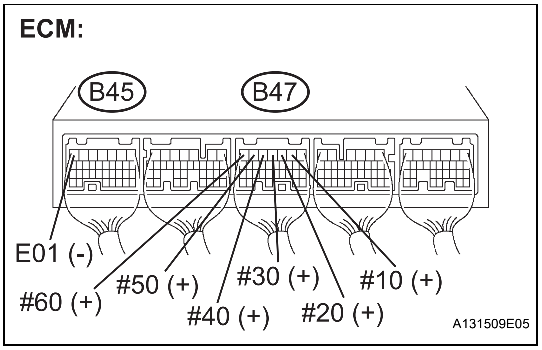
(a) Switch the spark plug to a spark plug that functions normally.
(b) Perform the spark test again (refer to step 6).
OK:
Sparks jump across electrode gap.

NG → **REPLACE SPARK PLUG**

OK

REPLACE IGNITION COIL ASSEMBLY

9	INSPECT ECM TERMINAL OF MISFIRING CYLINDER (#10, #20, #30, #40, #50 AND/OR #60 VOLTAGE)



(a) Turn the ignition switch on (IG).
(b) Measure the voltage between the terminals of the B45 and B47 ECM connector.

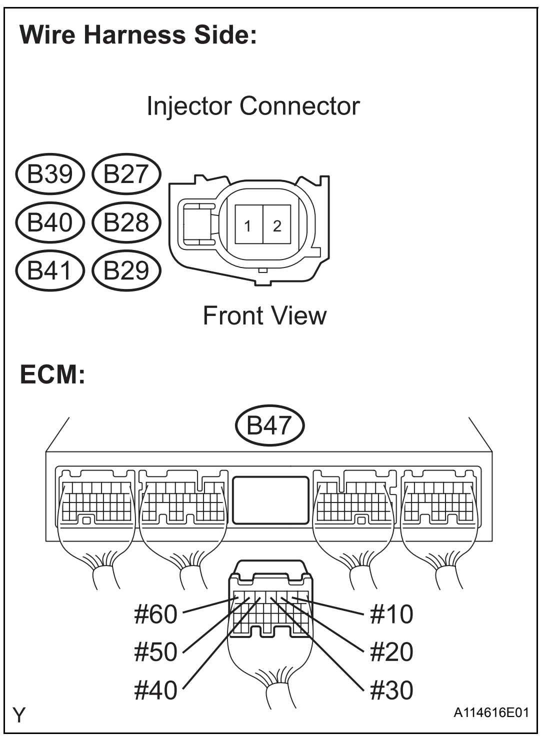
Standard voltage

Tester Connections	Specified Conditions
#10 (B47-2) - E01 (B45-7)	9 to 14 V
#20 (B47-3) - E01 (B45-7)	9 to 14 V
#30 (B47-4) - E01 (B45-7)	9 to 14 V
#40 (B47-5) - E01 (B45-7)	9 to 14 V
#50 (B47-6) - E01 (B45-7)	9 to 14 V
#60 (B47-7) - E01 (B45-7)	9 to 14 V

OK → **Go to step 11**

NG

10	CHECK HARNESS AND CONNECTOR (INJECTOR - ECM)



(a) Disconnect the injector connector (of the misfiring cylinder).
(b) Disconnect the B47 ECM connector.
(c) Turn the ignition switch on (IG).
(d) Measure the resistance and voltage between the injector and the ECM connector terminals.

Standard (Cylinder No. 1)

Tester Connections	Specified Conditions
B39-1 - Ground	11 to 14 V
B39-2 - Ground	10 kΩ or higher
B39-2 - #10 (B47-2)	Below 1 Ω

Standard (Cylinder No. 2)

Tester Connections	Specified Conditions
B27-1 - Ground	11 to 14 V
B27-2 - Ground	10 kΩ or higher
B27-2 - #20 (B47-3)	Below 1 Ω

Standard (Cylinder No. 3)

Tester Connections	Specified Conditions
B40-1 - Ground	11 to 14 V
B40-2 - Ground	10 kΩ or higher
B40-2 - #30 (B47-4)	Below 1 Ω

Standard (Cylinder No. 4)

Tester Connections	Specified Conditions
B28-1 - Ground	11 to 14 V
B28-2 - Ground	10 kΩ or higher
B28-2 - #40 (B47-5)	Below 1 Ω

Standard (Cylinder No. 5)

Tester Connections	Specified Conditions
B41-1 - Ground	11 to 14 V
B41-2 - Ground	10 kΩ or higher
B41-2 - #50 (B47-6)	Below 1 Ω

Standard (Cylinder No. 6)

Tester Connections	Specified Conditions
B29-1 - Ground	11 to 14 V
B29-2 - Ground	10 kΩ or higher
B29-2 - #60 (B47-7)	Below 1 Ω

(e) Reconnect the injector connector.
(f) Reconnect the ECM connector.

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

OK

11 CHECK FUEL INJECTOR OF MISFIRING CYLINDER

(a) Check the injector injection (whether fuel volume is high or low, and whether injection pattern is poor) (See page FU-15).

NG → **REPLACE FUEL INJECTOR ASSEMBLY**

OK

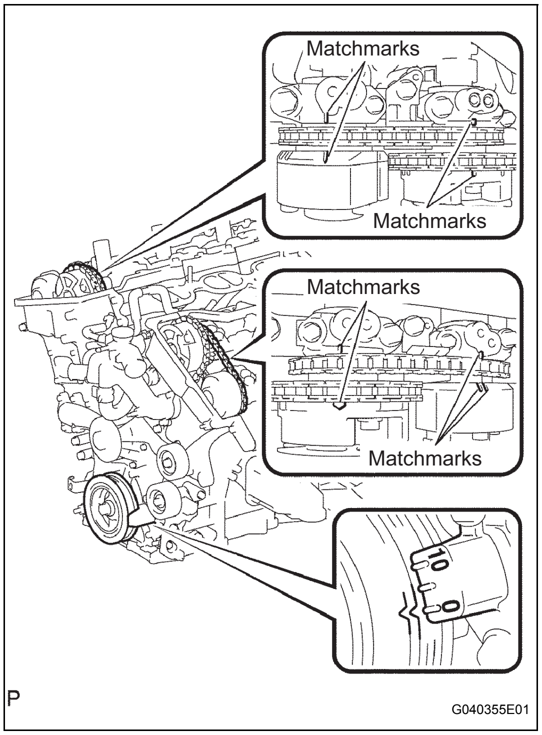
12 CHECK AIR INDUCTION SYSTEM

(a) Check the air induction system for vacuum leakage.
OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM**

OK

13	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 to align the matchmarks of the crankshaft.
(c) Align the notch of the crankshaft pulley to the "0" position.
(d) Check if the matchmarks of the camshaft pulley and camshaft bearing cap align.
(e) Turn the crankshaft clockwise by 360° if the matchmarks do not align. Check if they align once again.

OK:

The matchmarks of the camshaft pulley and the camshaft bearing cap align when the notch of the crankshaft pulley is in the "0" position.

NG → **ADJUST VALVE TIMING**

ES

OK

14	CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-7).

NG → **CHECK AND REPLACE FUEL PUMP, PRESSURE REGULATOR, FUEL PIPE LINE AND FILTER**

OK

15	READ VALUE OF INTELLIGENT TESTER (COOLANT TEMP)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(e) Read the COOLANT TEMP twice, when the engine is both cold and warmed up.

Standard:

With cold engine:

Same as ambient air temperature.

With warm engine:

Between 75°C and 95°C (167°F and 203°F).

NG → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

OK

16 READ VALUE OF INTELLIGENT TESTER (MAF)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF and COOLANT TEMP.
(e) Allow the engine to idle until the COOLANT TEMP reaches 75°C (167°F) or more.
(f) Read the MAF with the engine in an idling condition and at an engine speed of 2,500 rpm.

Standard:

MAF while engine idling:

Between 3.2 g/s and 4.7 g/s (shift position: N, A/C: OFF).

MAF at engine speed of 2,500 rpm:

Between 13.1 g/s and 18.9 g/s (shift position: N, A/C: OFF).

NG → **REPLACE MASS AIR FLOW METER**

OK

CHECK FOR INTERMITTENT PROBLEMS

DTC	P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)

DTC	P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)

DTC	P0332	Knock Sensor 2 Circuit Low Input (Bank 2)

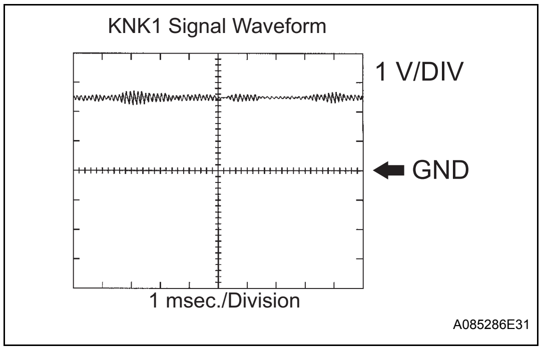
DTC	P0333	Knock Sensor 2 Circuit High Input (Bank 2)

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations over a wide band of frequencies: between approximately 6 kHz and 15 kHz.
Knock sensors are fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

DTC No.	DTC Detection Conditions	Trouble Areas
P0327 P0332	Output voltage of knock sensor 1 or 2 is less than 0.5 V (1 trip detection logic)	• Short in knock sensor 1 or 2 circuit • Knock sensor 1 or 2 • ECM
P0328 P0333	Output voltage of knock sensor 1 or 2 is more than 4.5 V (1 trip detection logic)	• Open in knock sensor 1 or 2 circuit • Knock sensor 1 or 2 • ECM

HINT:
When any of DTCs P0327, P0328, P0332 and P0333 are set, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the ignition switch is turned off.
Reference: Inspection using an oscilloscope



The correct waveform is as shown.

Items	Contents
Terminals	KNK1 - EKNK or KNK2 - EKN2
Equipment Settings	0.01 to 10 V/Division, 0.01 to 10 msec./ Division
Conditions	Keep engine speed at 4,000 rpm with warm engine

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When a spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress the spark knock.
The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and sets a DTC.

MONITOR STRATEGY

Related DTCs	P0327: Knock sensor (Bank 1) open/short (Low voltage) P0328: Knock sensor (Bank 1) open/short (High voltage) P0332: Knock sensor (Bank 2) open/short (Low voltage) P0333: Knock sensor (Bank 2) open/short (High voltage)
Required Sensors / Components (Main)	Knock sensor (Bank 1 and 2)
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Battery voltage	10.5 V or more
Time after engine start	5 seconds or more
Ignition switch	ON
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

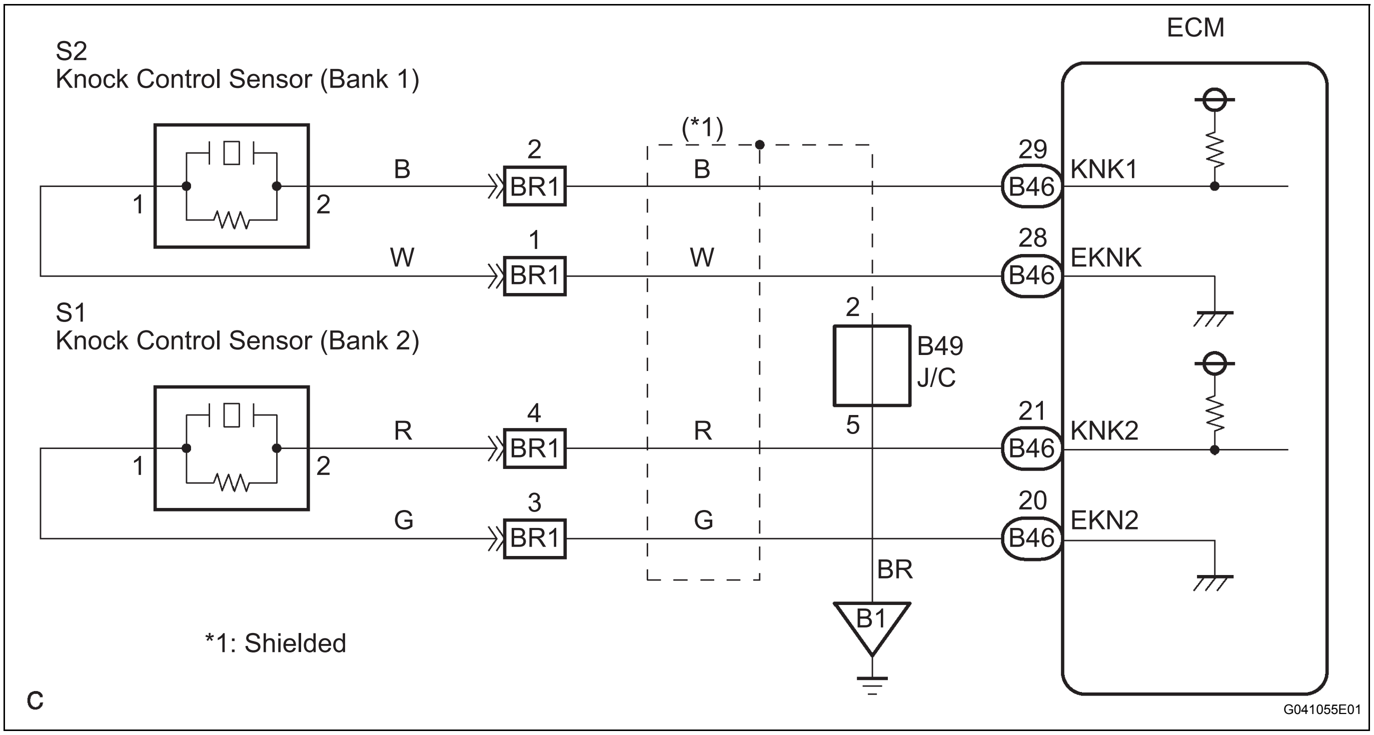
Knock Sensor Range Check (Low voltage) P0327 and P0332:

Knock sensor voltage	Less than 0.5 V

Knock Sensor Range Check (High voltage) P0328 and P0333:

Knock sensor voltage	More than 4.5 V

WIRING DIAGRAM

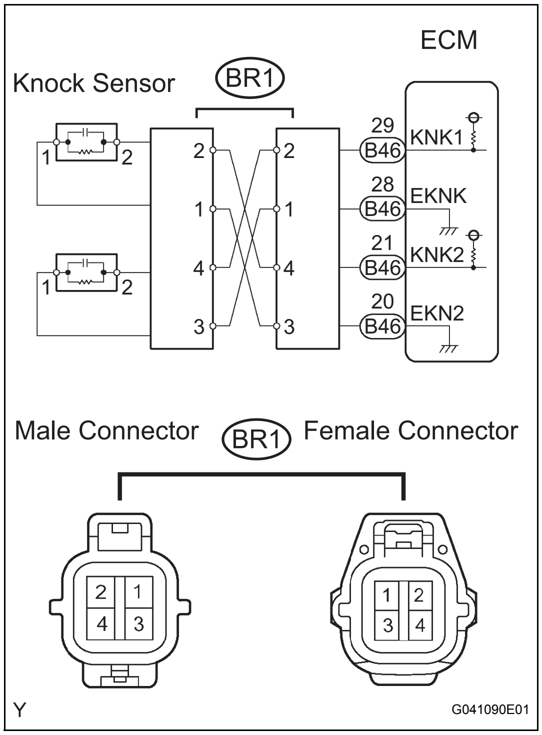


INSPECTION PROCEDURE

HINT:

- DTCs P0327 and P0328 are for the bank 1 knock sensor circuit.
- DTCs P0332 and P0333 are for the bank 2 knock sensor circuit.
- 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.

1	READ VALUE OF DTC OUTPUT (CHECK KNOCK SENSOR CIRCUIT)



(a) Disconnect the BR1 connector.
(b) Using lead wires, connect the connectors as follows.

Male Connector - Female Connector
Terminal 2 - Terminal 4
Terminal 1 - Terminal 3
Terminal 4 - Terminal 2
Terminal 3 - Terminal 1

(c) Warm up the engine.
(d) Run the engine at 3,000 rpm for 10 seconds or more.
(e) Connect the intelligent tester to the DLC3.
(f) Turn the ignition switch on (IG) and turn the intelligent tester on.
(g) Select the item: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(h) Read DTCs.

Result

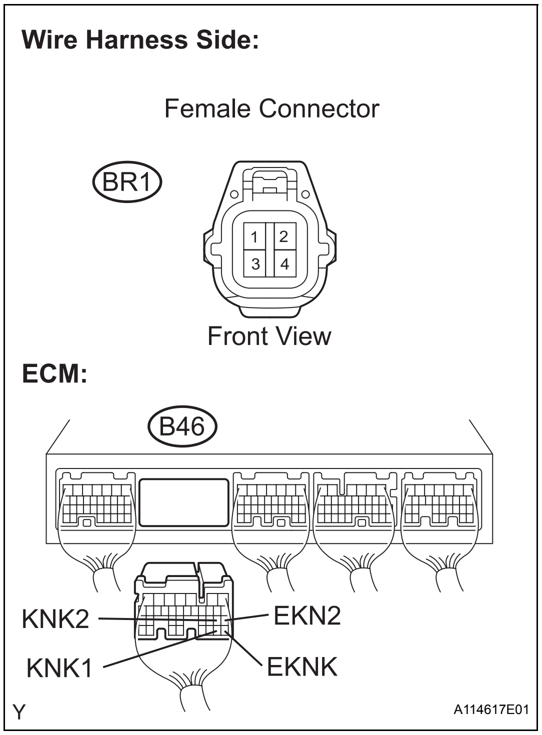
Display	Proceed to
DTCs are same as when vehicle brought in P0327, P0328 → P0327, P0328 or P0332, P0333 → P0332, P0333	**A**
DTCs are different from when vehicle brought in P0327, P0328 → P0332, P0333 or P0332, P0333 → P0327, P0328	**B**

(i) Reconnect the BR1 connector.

B → **Go to step 4**

A

2	CHECK HARNESS OR CONNECTOR (CONNECTOR - ECM)



(a) Disconnect the BR1 connector.
(b) Disconnect the B46 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
BR1 female connector 2 - KNK1 (B46-29)	Below 1 Ω
BR1 female connector 1 - EKNK (B46-28)	Below 1 Ω
BR1 female connector 4 - KNK2 (B46-21)	Below 1 Ω
BR1 female connector 3 - EKN2 (B46-20)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
BR1 female connector 2 or KNK1 (B46-29) - Body ground	10 kΩ or higher
BR1 female connector 1 or EKNK (B46-28) - Body ground	10 kΩ or higher
BR1 female connector 4 or KNK2 (B46-21) - Body ground	10 kΩ or higher
BR1 female connector 3 or EKN2 (B46-20) - Body ground	10 kΩ or higher

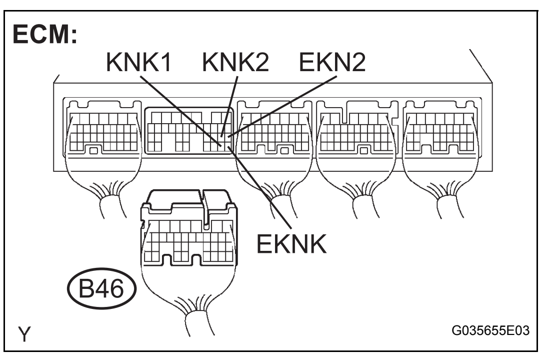
(d) Reconnect the connector.
(e) Reconnect the ECM connector.

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

ES

OK

3	INSPECT ECM



(a) Disconnect the B46 ECM connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the ECM terminals.
Standard voltage

Tester Connections	Specified Conditions
KNK1 (B46-29) - EKNK (B46-28)	4.5 to 5.5 V
KNK2 (B46-21) - EKN2 (B46-20)	4.5 to 5.5 V

(d) Reconnect the ECM connector.
NOTICE:
Fault may be intermittent. Check the wire harness and connectors carefully and retest.

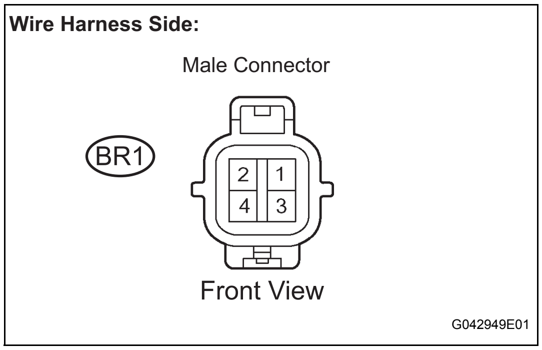
NG → **REPLACE ECM**

OK

OTHERS FOR INTERMITTENT PROBLEMS

ES

4 INSPECT KNOCK SENSOR



(a) Disconnect the BR1 connector.
(b) Measure the resistance between the terminals of the BR1 male connector.
Standard resistance

Tester Connections	Specified Conditions
BR1 male connector 1 - 2	120 to 280 kΩ
BR1 male connector 3 - 4	120 to 280 kΩ

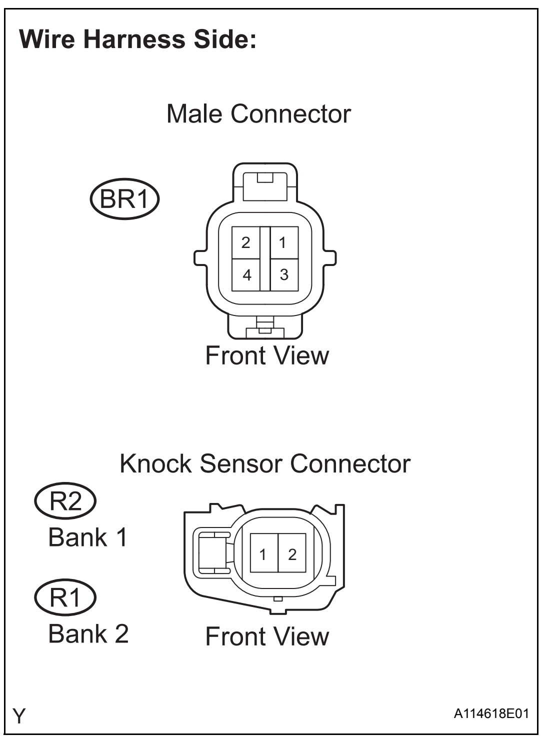
(c) Reconnect the connector.

OK → **OTHERS FOR INTERMITTENT PROBLEMS**

NG ↓

5 CHECK HARNESS AND CONNECTOR (CONNECTOR - KNOCK SENSOR)

HINT:
- If DTC P0327 or P0328 has changed to P0332 or P0333, check the knock sensor circuit on the right bank side.
- If DTC P0332 or P0333 has changed to P0327 or P0328, check the knock sensor circuit on the left bank side.



(a) Disconnect the BR1 connector.
(b) Disconnect the R1 and R2 knock sensor connectors.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
BR1 male connector 2 - R2-2	Below 1 Ω
BR1 male connector 1 - R2-1	Below 1 Ω
BR1 male connector 4 - R1-2	Below 1 Ω
BR1 male connector 3 - R1-1	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
BR1 male connector 2 or R2-2 - Body ground	10 kΩ or higher
BR1 male connector 1 or R2-1 - Body ground	10 kΩ or higher
BR1 male connector 4 or R1-2 - Body ground	10 kΩ or higher
BR1 male connector 3 or R1-1 - Body ground	10 kΩ or higher

(d) Reconnect the connector.
(e) Reconnect the knock sensor connector.

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

OK ↓

REPLACE KNOCK SENSOR

DTC	P0335	Crankshaft Position Sensor "A" Circuit

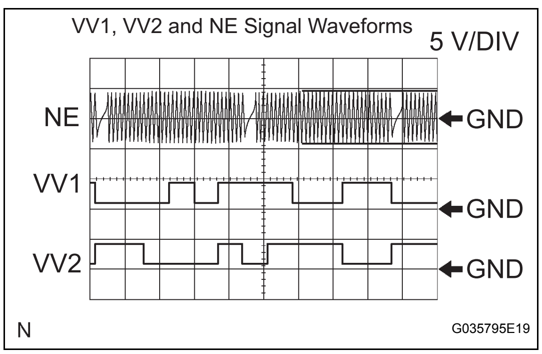
DTC	P0339	Crankshaft Position Sensor "A" Circuit Intermittent

DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a CKP sensor plate and a pickup coil. The sensor plate has 34 teeth and is installed on the crankshaft. The pickup coil is made of an iron core and a magnet.
The sensor plate rotates as each tooth passes through the pickup coil, and a pulse signal is created. The pickup coil generates 34 signals per engine revolution. Based on these signals, the ECM calculates the crankshaft position and engine RPM. Using these calculations, the fuel injection time and ignition timing are controlled.

DTC No.	DTC Detection Conditions	Trouble Areas
P0335	• No CKP sensor signal to ECM while cranking (1 trip detection logic) • No CKP sensor signal to ECM at engine speed of 600 rpm or more (1 trip detection logic)	• Open or short in CKP sensor circuit • CKP sensor • Sensor plate (CKP sensor plate) • ECM
P0339	Under conditions (a), (b) and (c), no CKP sensor signal to ECM for 0.05 seconds or more (1 trip detection logic): (a) Engine speed 1,000 rpm or more (b) Starter signal OFF (c) 3 seconds or more have lapsed since starter signal switched from ON to OFF	• Open or short in CKP sensor circuit • CKP sensor • Sensor plate (CKP sensor plate) • ECM

Reference: Inspection using an oscilloscope



HINT:
- The correct waveform is shown on the illustration.
- VV1+ and VV2+ stand for the VVT sensor signal, and NE+ stands for the CKP sensor signal.

Items	Contents
Terminals	VV1+ - VV1- VV2+ - VV2- NE+ - NE-
Equipment Settings	5 V/Division, 20 ms/Division
Conditions	Cranking or idling

MONITOR DESCRIPTION

If there is no signal from the CKP sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor.
If the malfunction is not repaired successfully, a DTC is set 10 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0335: Crankshaft position sensor range check during cranking P0335: Crankshaft position sensor range check during engine running
Required Sensors / Components (Main)	Crankshaft Position (CKP) sensor
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	Conditions met for 3 times: CKP sensor range check during cranking 0.016 seconds: CKP sensor range check during engine running
MIL Operation	Immediate
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

Crankshaft Position Sensor Range Check during Cranking P0335:

Starter	ON
Ignition switch	ON
Battery voltage	7 V or more
Minimum battery voltage while starter ON	Less than 11 V
Number of VVT sensor signal pulse	6
CMP sensor circuit fail	Not detected

Crankshaft Position Sensor Range Check during Engine Running P0335:

Engine speed	600 rpm or more
Starter	OFF
Time after starter from ON to OFF	3 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

Crankshaft Position Sensor Range Check during Cranking P0335:

Number of crankshaft position sensor signal pulse	132 or less, or 174 or more

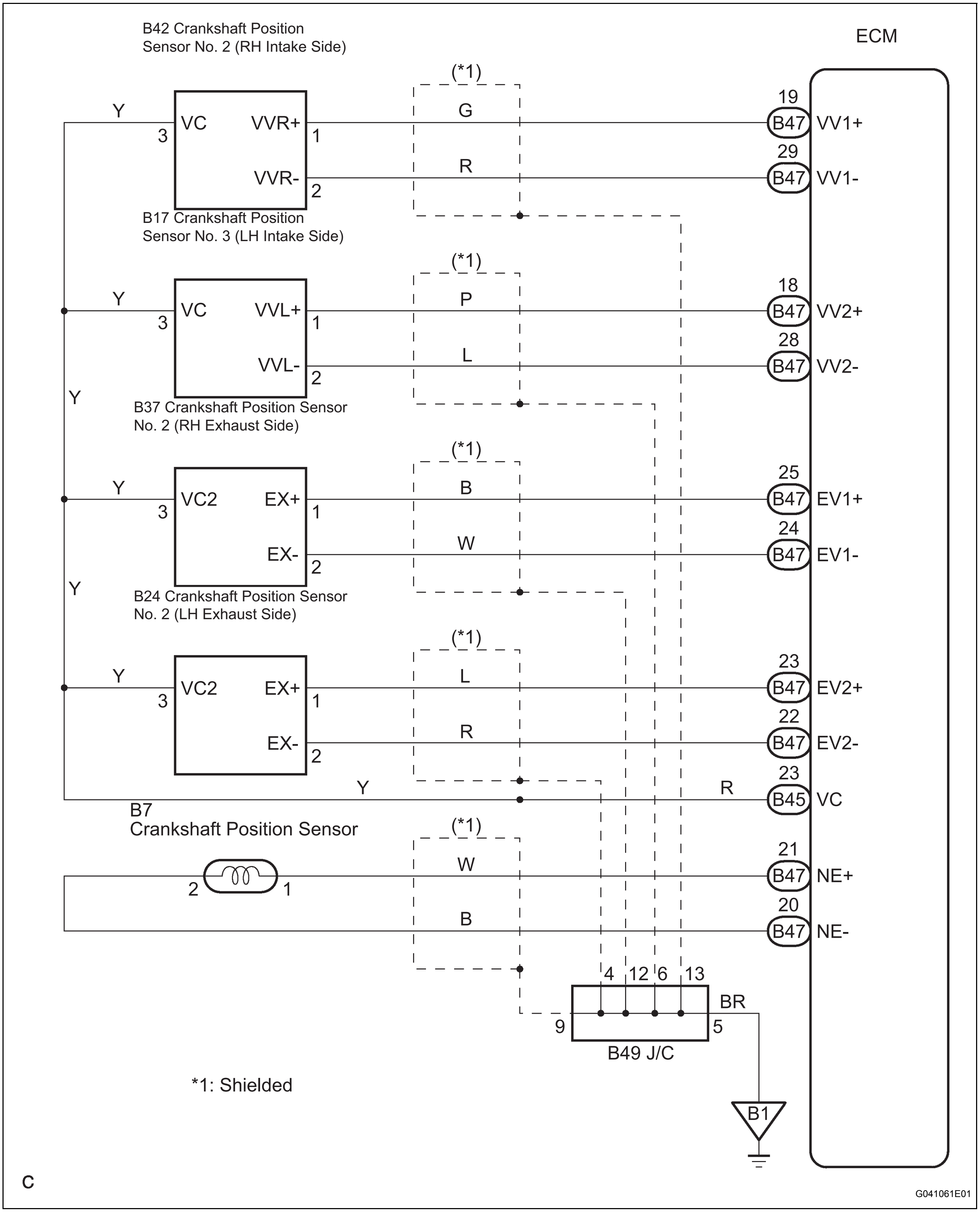
Crankshaft Position Sensor Range Check during Engine Running P0335:

CKP sensor signal	No signal for 0.016 seconds

COMPONENT OPERATING RANGE

CKP sensor	• CKP sensor output voltage fluctuates while crankshaft revolving • 34 CKP sensor signals per crankshaft revolution

WIRING DIAGRAM



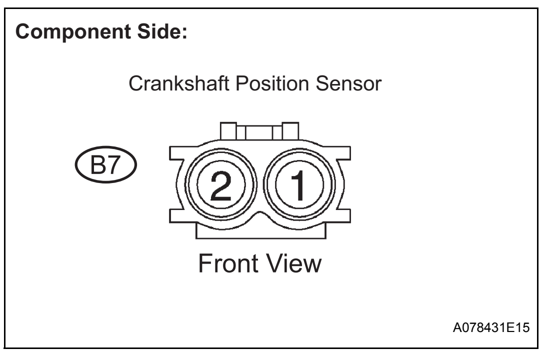
ES

INSPECTION PROCEDURE

HINT:

- If no problem is found by this diagnostic troubleshooting procedure, troubleshoot the engine mechanical systems.
- Check the engine speed. The engine speed can be checked by using the intelligent tester. The procedure for checking, follow the operation below:
  (a) Connect the intelligent tester to the DLC3.
  (b) Start the engine.
  (c) Turn the tester on.
  (d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / ENGINE SPD.
  The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as lower than the actual engine speed, if the CKP sensor voltage output is insufficient.
- 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.

1	INSPECT CRANKSHAFT POSITION SENSOR (RESISTANCE)



(a) Disconnect the B7 Crankshaft Position (CKP) sensor connector.

(b) Measure the resistance between terminals 1 and 2.

Standard resistance

Tester Connections	Specified Conditions
1 - 2	1,850 Ω to 2,450 Ω at 20°C (68°F)

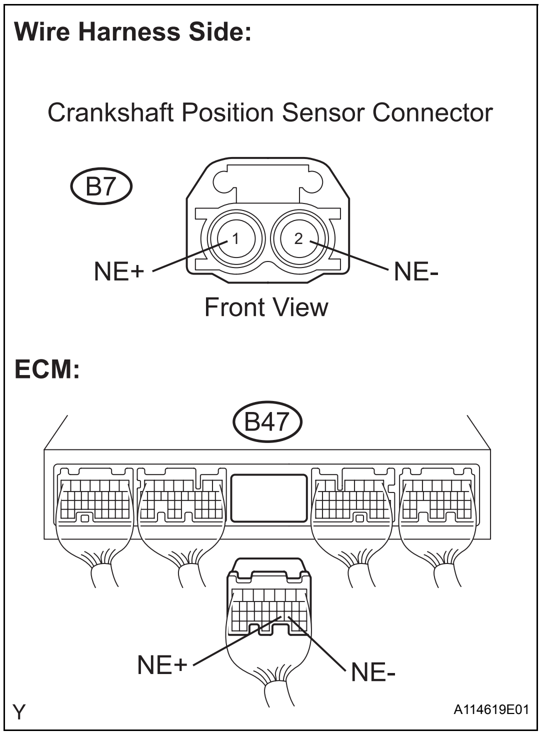
HINT:
Terms cold and hot refer to the temperature of the coils.
Cold means approximately -10° to 50°C (14° to 122°F).
Hot means approximately 50° to 100°C (122° to 212°F).

(c) Reconnect the CKP sensor connector.

NG → **REPLACE CRANKSHAFT POSITION SENSOR**

OK

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



(a) Disconnect the B7 CKP sensor connector.
(b) Disconnect the B47 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
NE+ (B7-1) - NE+ (B47-21)	Below 1 Ω
NE- (B7-2) - NE- (B47-20)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
NE+ (B7-1) or NE+ (B47-21) - Body ground	10 kΩ or higher
NE- (B7-2) or NE- (B47-20) - Body ground	10 kΩ or higher

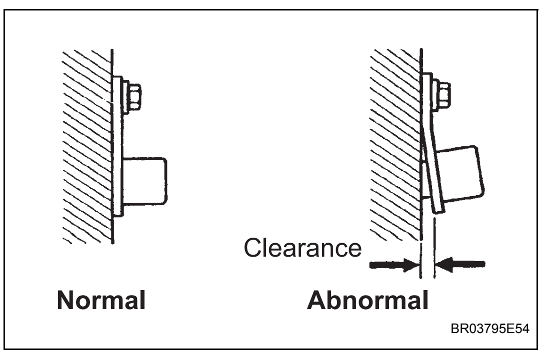
(d) Reconnect the ECM connector.
(e) Reconnect the CKP sensor connector.

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

ES

OK

3	CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)



(a) Check the CKP sensor installation.
OK:
Sensor is installed correctly.

NG → **REPAIR OR REPLACE CRANKSHAFT POSITION SENSOR**

OK

4	CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)

(a) Check the teeth of the sensor plate.
OK:
Sensor plate does not have any cracks or deformation.

NG → **REPAIR OR REPLACE CRANKSHAFT POSITION SENSOR PLATE**

OK

REPLACE ECM

DTC	P0340	Camshaft Position Sensor "A" Circuit (Bank 1 or Single Sensor)

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

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

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

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

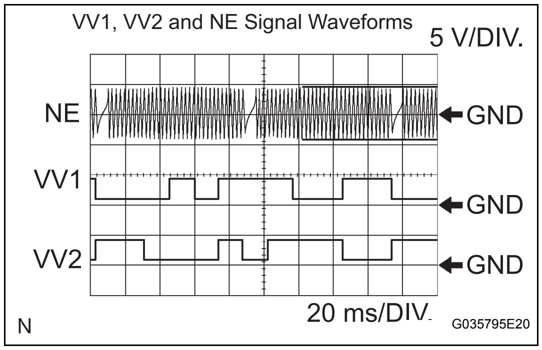
DTC	P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)

DESCRIPTION

The VVT sensor (G signal) consists of a magnet and MRE element.
The exhaust camshaft has 3 teeth on its inner circumference. When the camshaft gear rotates, the air gap changes between the protrusion on the gear and the pickup coil. The change affects the magnetic field, resulting in a change in the resistance of the MRE element. The crankshaft angle sensor plate has 34 teeth and outputs 34 signals every engine revolution. The ECM detects the standard crankshaft angle based on the G signal, actual crankshaft angle and engine speed by an NE signal.

DTC No.	DTC Detection Conditions	Trouble Areas
P0340 P0345	• Input voltage to ECM remains 0.3 V or less, or 4.7 V or higher for more than 5 seconds, when 2 or more seconds have elapsed after turning ignition switch ON (2 trip detection logic) • No VVT sensor signal to ECM during cranking (1 trip detection logic)	• Open or short in VVT sensor circuit for intake camshaft • VVT sensor for intake camshaft • Camshaft timing pulley • Jumped tooth of timing chain • ECM
P0342 P0347	Output voltage of VVT sensor is 0.3 V or less for 5 seconds (1 trip detection logic)	• Open or short in VVT sensor circuit for intake camshaft • VVT sensor for intake camshaft • Camshaft timing pulley • Jumped tooth of timing chain • ECM
P0343 P0348	Output voltage of VVT sensor is 4.7 V or more for 5 seconds (1 trip detection logic)	• Open or short in VVT sensor circuit for intake camshaft • VVT sensor for intake camshaft • Camshaft timing pulley • Jumped tooth of timing chain • ECM

Reference: Inspection using an oscilloscope



VV1, VV2 and NE Signal Waveforms

HINT:
- The correct waveform is shown on the illustration.
- VV1+ and VV2+ stand for the VVT sensor signal, and NE+ stands for the CKP sensor signal.

Items	Contents
Terminals	NE+ - NE- VV1+ - VV1- VV2+ - VV2-
Equipment Settings	5V/Division, 20ms/Division
Conditions	Cranking or idling

MONITOR DESCRIPTION

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

MONITOR STRATEGY

Related DTCs	P0340: Camshaft position sensor (Bank 1) open/short P0340: Camshaft position/Crankshaft position misalignment (Bank 1) P0340: Camshaft position sensor (Bank 1) range check (Fluctuating) P0342: Camshaft position sensor (Bank 1) range check (low voltage) P0343: Camshaft position sensor (Bank 1) range check (high voltage) P0345: VVT sensor (Bank 2) open/short P0345: VVT position/Crankshaft position misalignment (Bank 2) P0345: VVT position sensor (Bank 2) range check (Fluctuating) P0347: VVT position sensor (Bank 2) range check (low voltage) P0348: VVT position sensor (Bank 2) range check (high voltage)
Required Sensors / Components (Main)	VVT position sensor (Bank 1 and 2)
Required Sensors / Components (Related)	Crankshaft position sensor
Frequency of Operation	Continuous
Duration	4 seconds: P0340 (Camshaft position sensor range check), P0340, P0342, P0343 (Camshaft position sensor range check (Fluctuating, Low voltage, High voltage)) P0345 (VVT sensor range check (While starting engine)), P0345, P0347, P0348 (VVT sensor range check (Fluctuation, Low voltage, High voltage)) 5 seconds: Others
MIL Operation	2 driving cycles: P0340 (Camshaft position sensor range check), P0345 (VVT sensor range check (While starting engine)) Immediate: Others
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

Camshaft Position Sensor Range Check:

Starter	ON and not starter ON again
Minimal battery voltage while starter ON	Less than 11 V

Camshaft Position/Crankshaft Position Misalignment:

Engine RPM	600 rpm or more
Starter	OFF

Camshaft Position Sensor Range Check (Fluctuating, Low voltage, High voltage):

Starter	OFF
Ignition switch ON and time after ignition switch is OFF to ON	2 seconds or more

VVT sensor range check (While starting engine):

Starter	ON
Battery voltage while starter ON once at least	Less than 11 V

VVT sensor range check (After starting engine):

Engine RPM	600 rpm or more
Starter	OFF
Battery voltage	8 V or more
Ignition switch	ON

VVT sensor range check (Fluctuating, Low voltage, High voltage):

Starter	OFF
Ignition switch ON and time after ignition switch is OFF ON	2 seconds or more
Battery voltage	8 V or more

TYPICAL MALFUNCTION THRESHOLDS

Camshaft Position Sensor Range Check:

Camshaft position signal	No signal

Camshaft Position/Crankshaft Position Misalignment:

Camshaft position and crankshaft position phase	Mis-aligned

Camshaft Position Sensor Range Check (Fluctuating):

Camshaft position voltage	Less than 0.3 V, or more than 4.7 V

Camshaft Position Sensor Range Check (Low voltage):

Camshaft position voltage	Less than 0.3 V

Camshaft Position Sensor Range Check (High voltage):

Camshaft position voltage	More than 4.7 V

VVT sensor range check (While starting engine):

VVT sensor signal	No signal

VVT sensor range check (After starting engine):

VVT sensor signal	No signal

VVT sensor range check (Fluctuating):

VVT sensor voltage	Less than 0.3 V, or more than 4.7 V

VVT sensor range check (Low voltage):

VVT sensor voltage	Less than 0.3 V

VVT sensor range check (High voltage):

VVT sensor voltage	More than 4.7 V

COMPONENT OPERATING RANGE

VVT sensor voltage	0.3 to 4.7 V

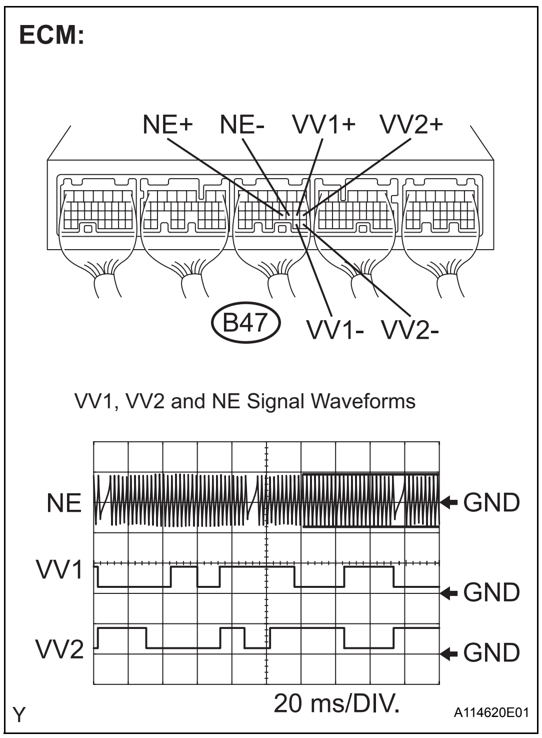
WIRING DIAGRAM

Refer to DTC P0335 (See page ES-205).

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.

1	CHECK ECM TERMINAL VOLTAGE



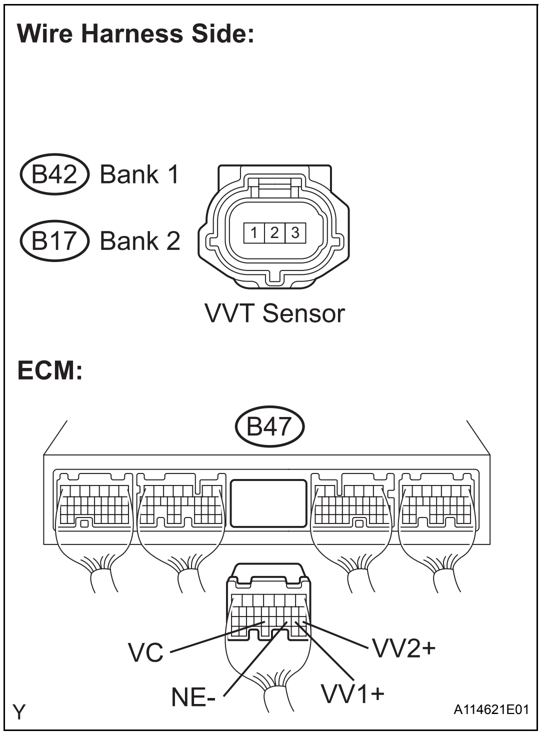
(a) Inspect the ECM using an oscilloscope.
(1) While the engine is idling, check the waveform between the terminals of the ECM connector.
OK

Tester Connections	Specified Conditions
VV1+ (B47-19) - VV1- (B47-29)	Correct waveform shown
VV2+ (B47-18) - VV2- (B47-28)	Correct waveform shown
NE+ (B47-21) - NE- (B47-20)	Correct waveform shown

OK → **REPLACE ECM**

NG

2 CHECK HARNESS AND CONNECTOR (VVT SENSOR - ECM)



(a) Disconnect the B17 or B42 VVT sensor connector.
(b) Disconnect the B47 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
VVT sensor (B42-1) - VV1+ (B47-19)	Below 1 Ω
VVT sensor (B17-1) - VV2+ (B47-18)	Below 1 Ω
VVT sensor (B17 or B42-3) - NE- (B47-20)	Below 1 Ω
VVT sensor (B17 or B42-3) - VC (B45-23)	Below 1 Ω

Standard resistance (Check for short)

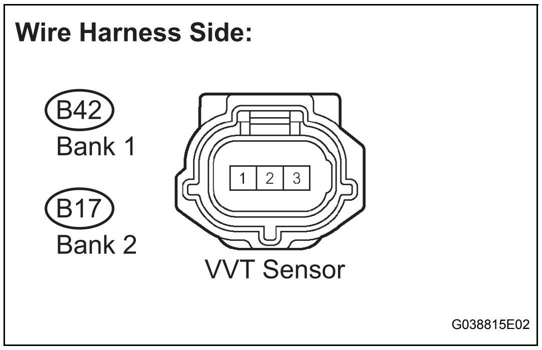
Tester Connections	Specified Conditions
VVT sensor (B42-1) or VV1+ (B47-19) - Body ground	10 kΩ or higher
VVT sensor (B17 -1) or VV2+ (B47-18) - Body ground	10 kΩ or higher
VVT sensor (B17 or B42-3) or NE- (B47-20) - Body ground	10 kΩ or higher
VVT sensor (B17 or B42-3) or VC (B45-23) - Body ground	10 kΩ or higher

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

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

OK

3 CHECK VVT SENSOR (SENSOR POWER SOURCE)



(a) Disconnect the B17 or B42 VVT sensor connector.
(b) Measure the voltage between the terminals of the VVT sensor.
Standard voltage

Tester Connections	Specified Conditions
3 - Body ground	4.5 to 5.0 V

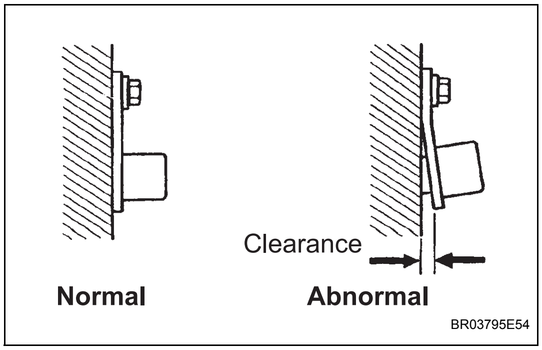
(c) Reconnect the VVT sensor connector.

NG → **REPAIR OR REPLACE ECM**

OK

ES

4	CHECK SENSOR INSTALLATION (VVT SENSOR)



(a) Check the VVT sensor installation.

OK:

Sensor is installed correctly.

NG → **REPAIR OR REPLACE VVT SENSOR**

OK

5	CHECK CAMSHAFT TIMING GEAR ASSEMBLY (TEETH OF PLATE)

(a) Check the teeth of the signal plate.

OK:

Sensor plate teeth do not have any cracks or deformation.

NG → **REPLACE CAMSHAFT TIMING GEAR ASSEMBLY**

OK

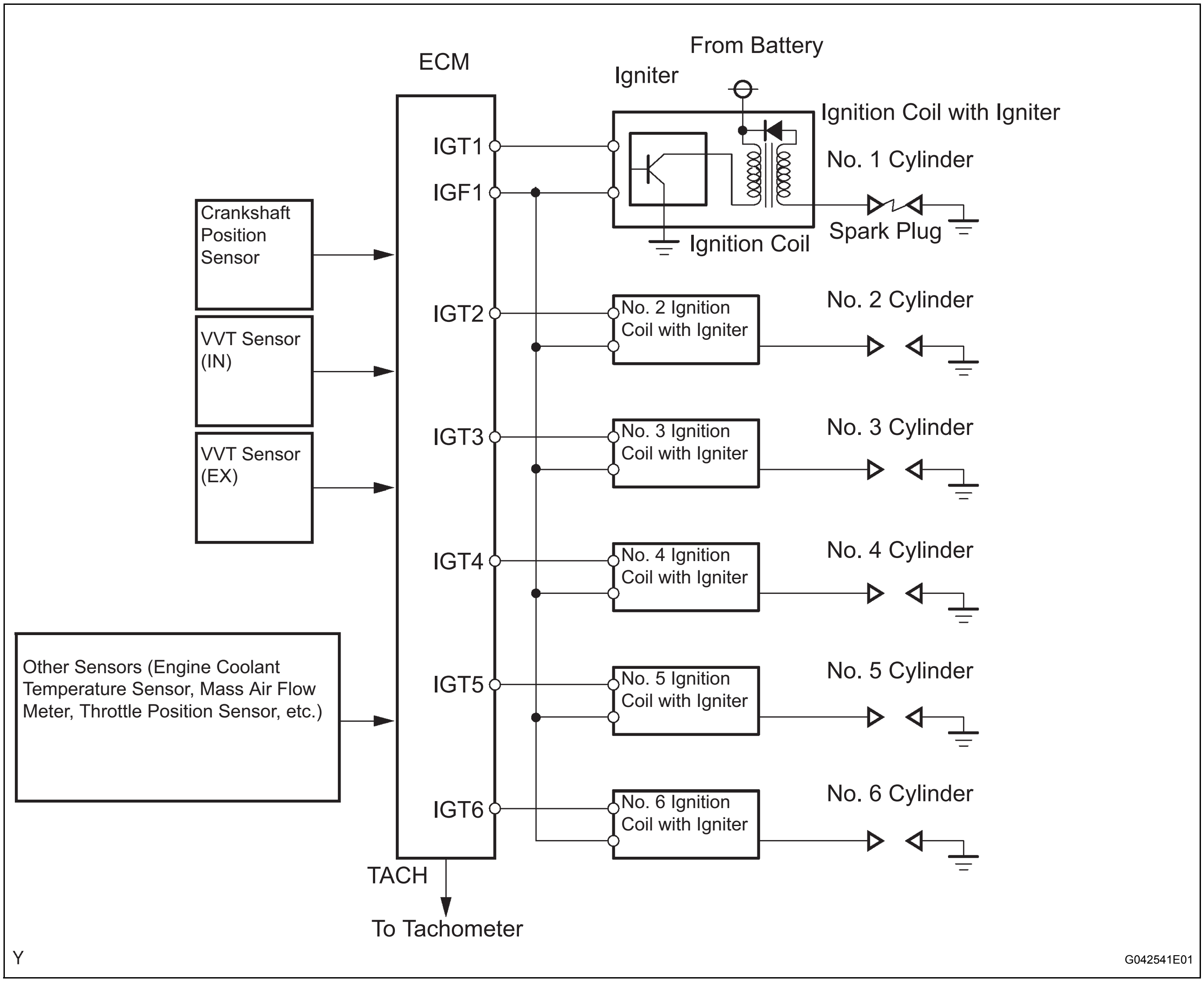
REPLACE ECM

DTC	**P0351**	**Ignition Coil "A" Primary / Secondary Circuit**
DTC	**P0352**	**Ignition Coil "B" Primary / Secondary Circuit**
DTC	**P0353**	**Ignition Coil "C" Primary / Secondary Circuit**
DTC	**P0354**	**Ignition Coil "D" Primary / Secondary Circuit**
DTC	**P0355**	**Ignition Coil "E" Primary / Secondary Circuit**
DTC	**P0356**	**Ignition Coil "F" Primary / Secondary Circuit**

HINT:
- These DTCs indicate malfunctions relating to the primary circuit.
- If DTC P0351 is set, check No. 1 ignition coil with igniter circuit.
- If DTC P0352 is set, check No. 2 ignition coil with igniter circuit.
- If DTC P0353 is set, check No. 3 ignition coil with igniter circuit.
- If DTC P0354 is set, check No. 4 ignition coil with igniter circuit.
- If DTC P0355 is set, check No. 5 ignition coil with igniter circuit.
- If DTC P0356 is set, check No. 6 ignition coil with igniter circuit.

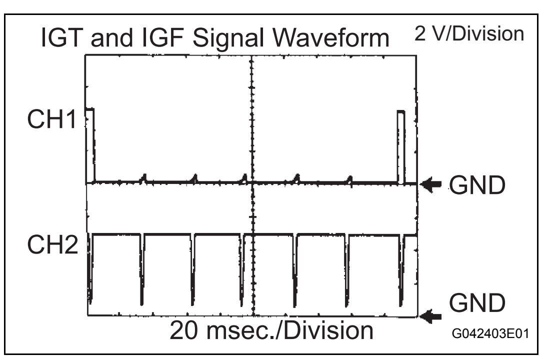
DESCRIPTION

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



DTC No.	DTC Detection Conditions	Trouble Areas
P0351 P0352 P0353 P0354 P0355 P0356	No IGF signal to ECM while engine running (1 trip detection logic)	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 6) between ignition coil with igniter and ECM • No. 1 to No. 6 ignition coils with igniters • ECM

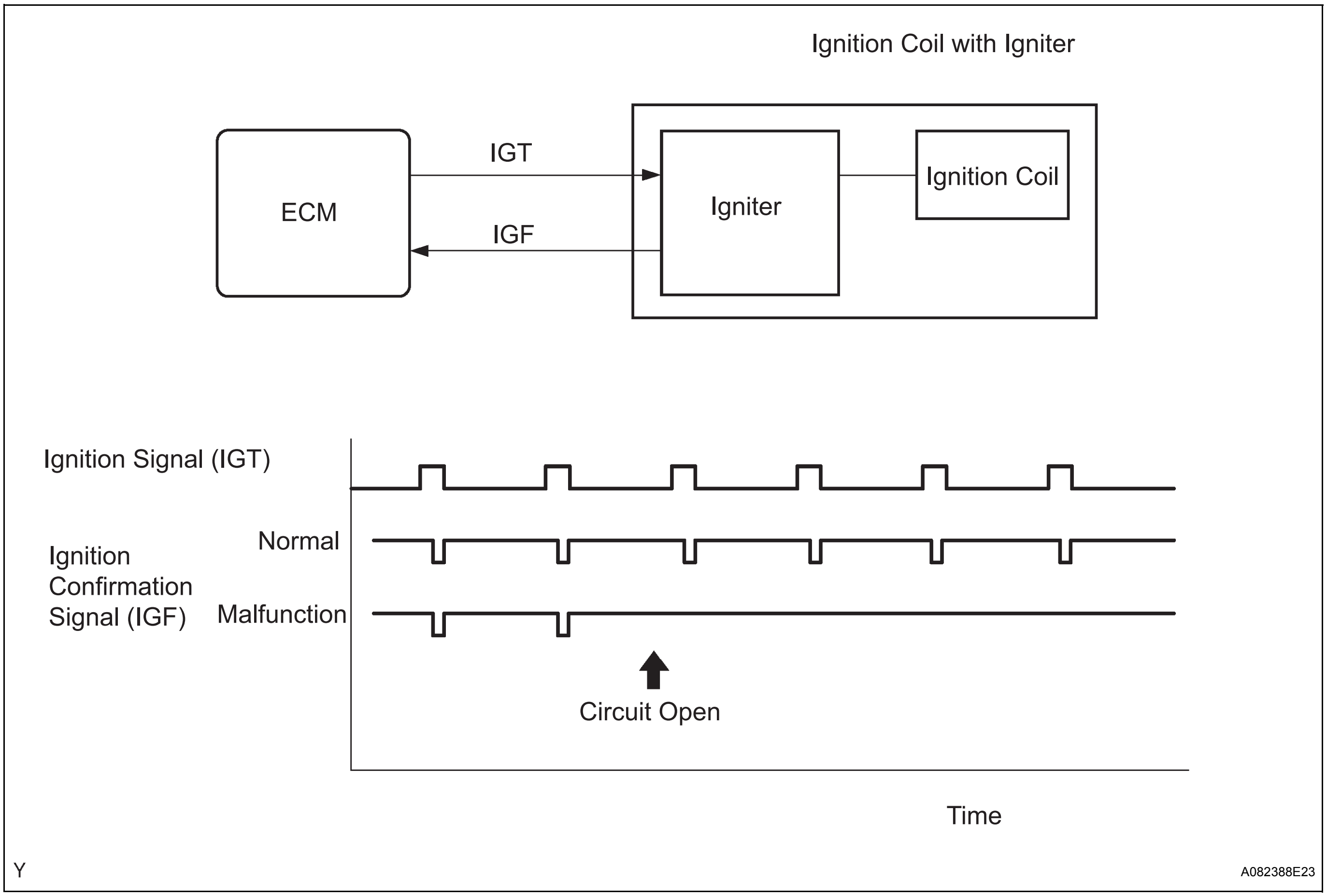
Reference: Inspection using an oscilloscope



While cranking or idling, check the waveform between terminals IGT (1 to 6) and E1, and IGF1 and E1 of the ECM connector.

Items	Contents
Terminals	CH1: IGT1, IGT2, IGT3, IGT4, IGT5, IGT6 - E1 CH2: IGF1 - E1
Equipment Settings	2 V/Division, 20 ms/Division
Conditions	Cranking or idling

MONITOR DESCRIPTION



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

MONITOR STRATEGY

Related DTCs	P0351: Igniter (Cylinder 1) malfunction P0352: Igniter (Cylinder 2) malfunction P0353: Igniter (Cylinder 3) malfunction P0354: Igniter (Cylinder 4) malfunction P0355: Igniter (Cylinder 5) malfunction P0356: Igniter (Cylinder 6) malfunction
Required Sensors / Components (Main)	Igniter (Cylinder 1 to 6)
Required Sensors / Components (Related)	Crankshaft position sensor
Frequency of Operation	Continuous
Duration	0.256 seconds and 5 sparks
MIL Operation	Immediate

ES

Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Either of following conditions met	Condition 1 or 2
1. Following conditions met:	Condition (a) and (b)
(a) Engine RPM	500 rpm or less
(b) Battery voltage	6 V or more
2. Following conditions met:	Condition (a) and (b)
(a) Engine RPM	More than 500 rpm
(b) Battery voltage	10 V or more

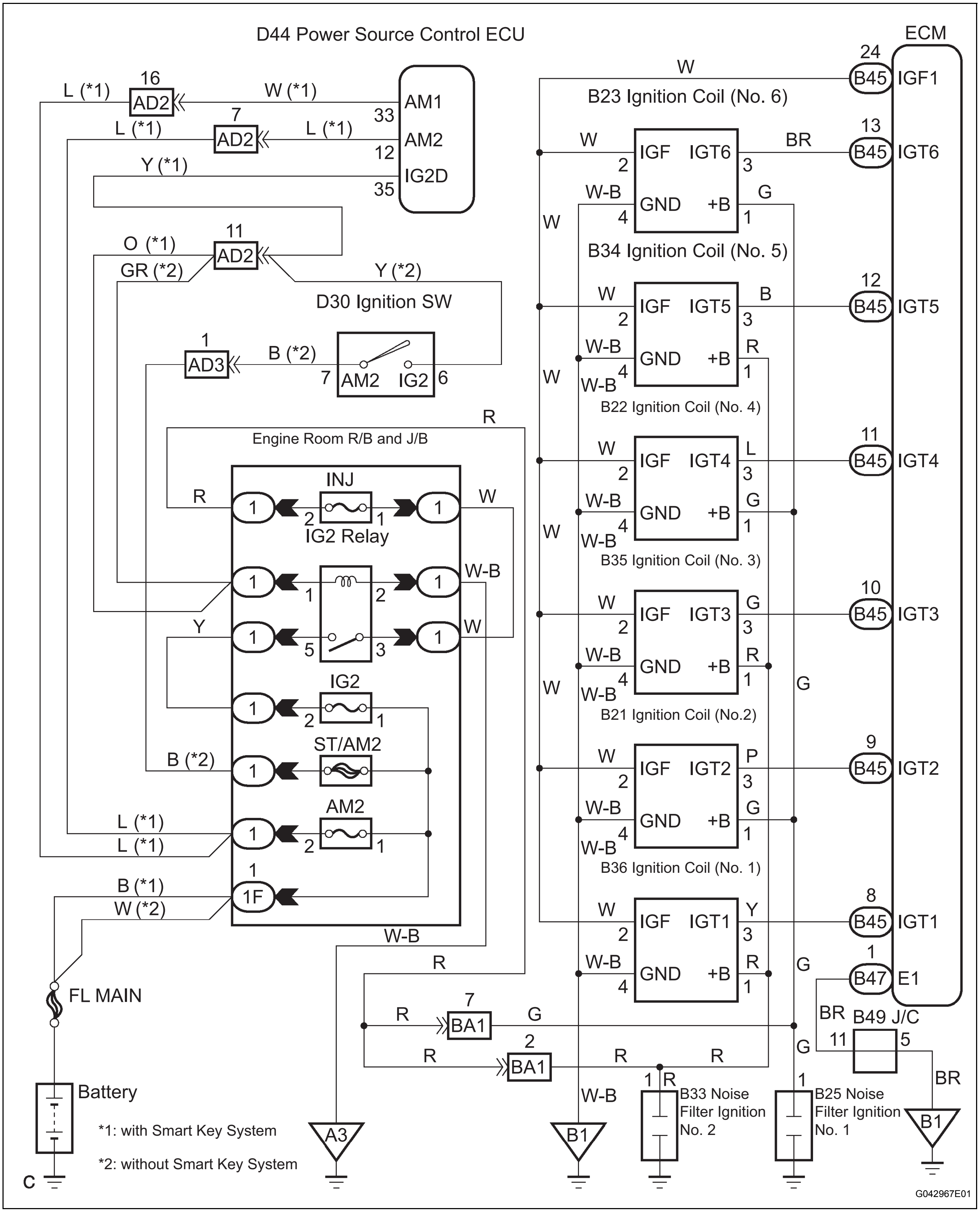
TYPICAL MALFUNCTION THRESHOLDS

Ignition signal fail count	More than 2 times
Ignition signal fail count is on the right:	When IGF does not return despite sending IGT.

COMPONENT OPERATING RANGE

IGF signal	Igniter transmits IGF signal when it receives IGT signal from ECM

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.

1	CHECK SPARK PLUG AND CHECK SPARK OF MISFIRING CYLINDER

HINT:

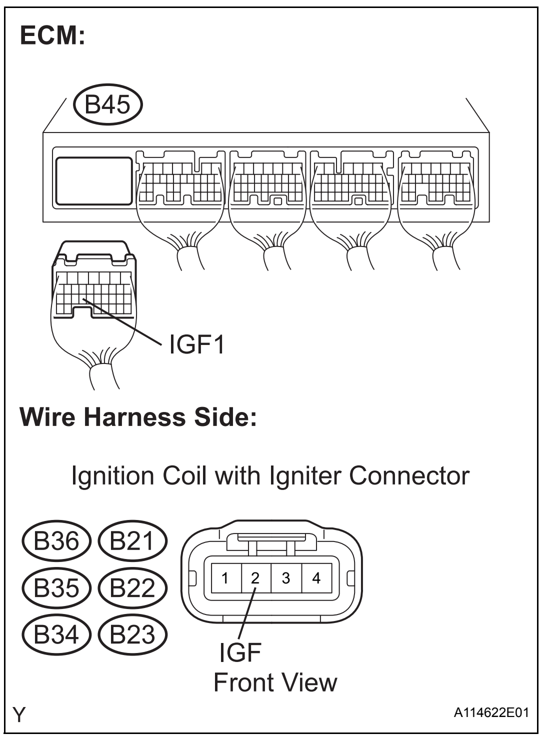
(See page IG-6)

NG → **Go to step 4**

ES

OK

2	CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM (IGF1 SIGNAL TERMINAL))



(a) Disconnect the B21, B22, B23, B34, B35 or B36 ignition coil with igniter connector.

(b) Disconnect the B45 ECM connector.

(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
IGF (B36-2) - IGF1 (B45-24)	Below 1 Ω
IGF (B21-2) - IGF1 (B45-24)	Below 1 Ω
IGF (B35-2) - IGF1 (B45-24)	Below 1 Ω
IGF (B22-2) - IGF1 (B45-24)	Below 1 Ω
IGF (B34-2) - IGF1 (B45-24)	Below 1 Ω
IGF (B23-2) - IGF1 (B45-24)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
IGF (B36-2) or IGF1 (B45-24) - Body ground	10 kΩ or higher
IGF (B21-2) or IGF1 (B45-24) - Body ground	10 kΩ or higher
IGF (B35-2) or IGF1 (B45-24) - Body ground	10 kΩ or higher
IGF (B22-2) or IGF1 (B45-24) - Body ground	10 kΩ or higher
IGF (B34-2) or IGF1 (B45-24) - Body ground	10 kΩ or higher
IGF (B23-2) or IGF1 (B45-24) - Body ground	10 kΩ or higher

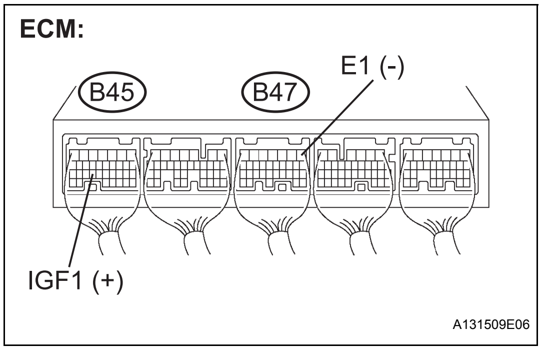
(d) Reconnect the ECM connector.

(e) Reconnect the ignition coil with igniter connector.

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

OK

3 INSPECT ECM (IGF1 VOLTAGE)



(a) Disconnect the ignition coil connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the terminals of the B45 and B47 ECM connector.

Standard voltage

Tester Connections	Specified Conditions
IGF1 (B45-24) - E1 (B47-1)	4.5 to 5.5 V

(d) Reconnect the ignition coil connector.

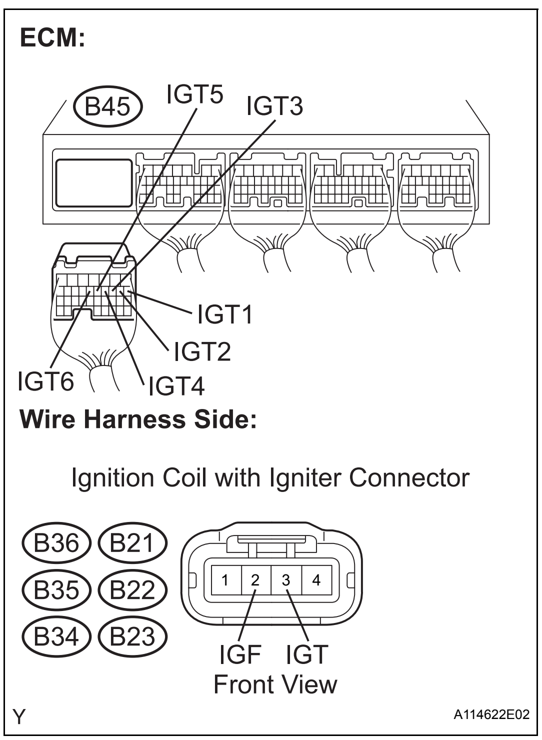
NG → **REPLACE ECM**

ES

OK

REPLACE IGNITION COIL ASSEMBLY

4 CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM (IGT SIGNAL TERMINAL))



(a) Disconnect the B21, B22, B23, B34, B35 or B36 ignition coil with igniter connector.
(b) Disconnect the B45 ECM connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
IGT (B36-3) - IGT1 (B45-8)	Below 1 Ω
IGT (B21-3) - IGT2 (B45-9)	Below 1 Ω
IGT (B35-3) - IGT3 (B45-10)	Below 1 Ω
IGT (B22-3) - IGT4 (B45-11)	Below 1 Ω
IGT (B34-3) - IGT5 (B45-12)	Below 1 Ω
IGT (B23-3) - IGT6 (B45-13)	Below 1 Ω

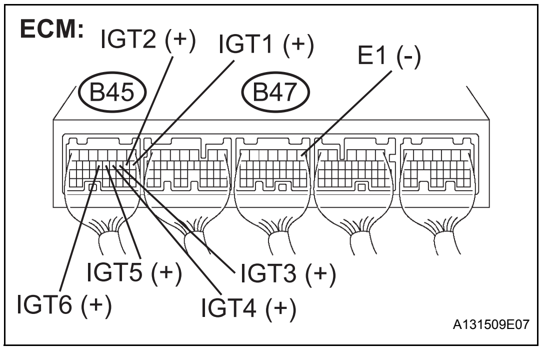
Standard resistance (Check for short)

Tester Connections	Specified Conditions
IGT (B36-3) or IGT1 (B45-8) - Body ground	10 kΩ or higher
IGT (B21-3) or IGT2 (B45-9) - Body ground	10 kΩ or higher
IGT (B35-3) or IGT3 (B45-10) - Body ground	10 kΩ or higher
IGT (B22-3) or IGT4 (B45-11) - Body ground	10 kΩ or higher
IGT (B34-3) or IGT5 (B45-12) - Body ground	10 kΩ or higher
IGT (B23-3) or IGT6 (B45-13) - Body ground	10 kΩ or higher

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

OK

5	INSPECT ECM (IGT1, IGT2, IGT3, IGT4, IGT5 OR IGT6 VOLTAGE)



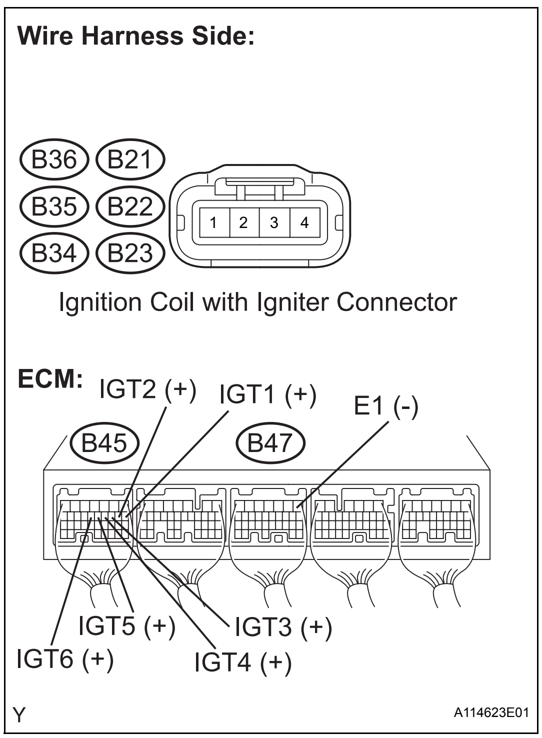
(a) Turn the ignition switch on (IG).
(b) Measure the voltage between the terminals of the B45 and B47 ECM connector.
Standard voltage

Tester Connections	Specified Conditions
IGT1 (B45-8) - E1 (B47-1)	0.1 to 4.5 V
IGT2 (B45-9) - E1 (B47-1)	0.1 to 4.5 V
IGT3 (B45-10) - E1 (B47-1)	0.1 to 4.5 V
IGT4 (B45-11) - E1 (B47-1)	0.1 to 4.5 V
IGT5 (B45-12) - E1 (B47-1)	0.1 to 4.5 V
IGT6 (B45-13) - E1 (B47-1)	0.1 to 4.5 V

NG → **REPLACE ECM**

OK

6	INSPECT ECM (IGT1, IGT2, IGT3, IGT4, IGT5 OR IGT6 VOLTAGE)



(a) Disconnect the B21, B22, B23, B34, B35 or B36 ignition coil connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the terminals of the B45 and B47 ECM connector.
Standard voltage

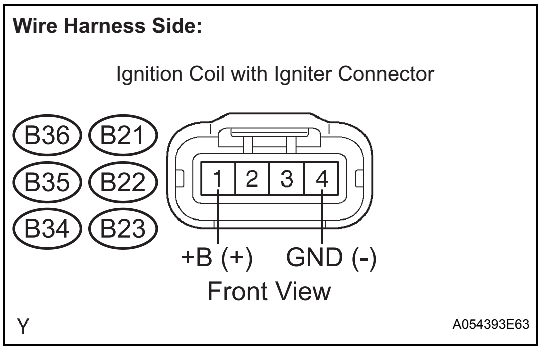
Tester Connections	Specified Conditions
IGT1 (B45-8) - E1 (B47-1)	4.5 V or more
IGT2 (B45-9) - E1 (B47-1)	4.5 V or more
IGT3 (B45-10) - E1 (B47-1)	4.5 V or more
IGT4 (B45-11) - E1 (B47-1)	4.5 V or more
IGT5 (B45-12) - E1 (B47-1)	4.5 V or more
IGT6 (B45-13) - E1 (B47-1)	4.5 V or more

(d) Reconnect the ignition coil connector.

NG → **REPLACE ECM**

OK

7	INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)



(a) Disconnect the B21, B22, B23, B34, B35 or B36 ignition coil with igniter connector.

(b) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
GND (B36-4) - Body ground	Below 1 Ω
GND (B21-4) - Body ground	Below 1 Ω
GND (B35-4) - Body ground	Below 1 Ω
GND (B22-4) - Body ground	Below 1 Ω
GND (B34-4) - Body ground	Below 1 Ω
GND (B23-4) - Body ground	Below 1 Ω

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

(d) Measure the voltage between the terminals of the wire harness side connector.

Standard voltage

Tester Connections	Specified Conditions
+B (B36-1) - GND (B36-4)	9 to 14 V
+B (B21-1) - GND (B21-4)	9 to 14 V
+B (B35-1) - GND (B35-4)	9 to 14 V
+B (B22-1) - GND (B22-4)	9 to 14 V
+B (B34-1) - GND (B34-4)	9 to 14 V
+B (B23-1) - GND (B23-4)	9 to 14 V

(e) Reconnect the ignition coil with igniter connector.

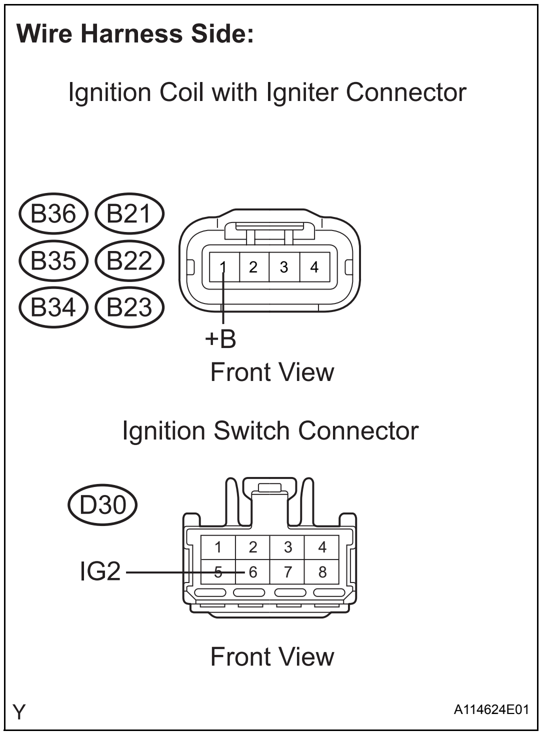
NG → **Go to step 8**

OK

REPLACE IGNITION COIL ASSEMBLY

ES

8	CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - IGNITION SWITCH)



(a) Disconnect the B36, B21, B35, B22, B34 or B23 ignition coil with igniter connector.
(b) Disconnect the I7 ignition switch connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
+B (B36-1) - IG2 (D30-6)	Below 1 Ω
+B (B21-1) - IG2 (D30-6)	Below 1 Ω
+B (B35-1) - IG2 (D30-6)	Below 1 Ω
+B (B22-1) - IG2 (D30-6)	Below 1 Ω
+B (B34-1) - IG2 (D30-6)	Below 1 Ω
+B (B23-1) - IG2 (D30-6)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
+B (B36-1) or IG2 (D30-6) - Body ground	10 kΩ or higher
+B (B21-1) or IG2 (D30-6) - Body ground	10 kΩ or higher
+B (B35-1) or IG2 (D30-6) - Body ground	10 kΩ or higher
+B (B22-1) or IG2 (D30-6) - Body ground	10 kΩ or higher
+B (B34-1) or IG2 (D30-6) - Body ground	10 kΩ or higher
+B (B23-1) or IG2 (D30-6) - Body ground	10 kΩ or higher

(d) Reconnect the ignition coil with igniter connector.
(e) Reconnect the ignition switch connector.

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

OK

REPLACE IGNITION COIL ASSEMBLY

DTC	P0365	Camshaft Position Sensor "B" Circuit (Bank 1)

DTC	P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)

DTC	P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)

DTC	P0390	Camshaft Position Sensor "B" Circuit (Bank 2)

DTC	P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)

DTC	P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)

DESCRIPTION

The VVT sensor (G signal) consists of a magnet and MRE element.
The exhaust camshaft has 3 teeth on its inner circumference. When the camshaft gear rotates, the air gap changes between the protrusion on the gear and the pickup coil. The change affects the magnetic field, resulting in a change in the resistance of the MRE element. The crankshaft angle sensor plate has 34 teeth and outputs 34 signals every engine revolution. The ECM detects the standard crankshaft angle based on the G signal, actual crankshaft angle and engine speed by an NE signal.

DTC No.	DTC Detection Conditions	Trouble Areas
P0365 P0390	STA ON: No VVT sensor signal to ECM during cranking for 4 seconds or more STA OFF: No VVT sensor signal to ECM with engine speed at 600 rpm or more	• Open or short in VVT sensor for exhaust camshaft circuit • VVT sensor for exhaust camshaft • Exhaust camshaft • ECM
P0367 P0368 P0392 P0393	No VVT sensor signal to ECM with engine speed at 600 rpm or more for 5 seconds or more. (1 trip detection logic)	• Open or short in VVT sensor for exhaust camshaft circuit • VVT sensor for exhaust camshaft • Exhaust camshaft • Jumped teeth of timing chain • ECM

MONITOR DESCRIPTION

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

MONITOR STRATEGY

Related DTCs	P0365: Exhaust camshaft sensor (Bank 1) open/short P0365: Exhaust camshaft sensor misalignment (Bank 1) P0367: Exhaust camshaft sensor (Bank 1) range check (low voltage) P0368: Exhaust camshaft sensor (Bank 1) range check (high voltage) P0390: Exhaust camshaft sensor (Bank 2) range check P0392: Exhaust camshaft sensor (Bank 2) range check (low voltage) P0393: Exhaust camshaft sensor (Bank 2) range check (high voltage)
Required Sensors / Components (Main)	Exhaust camshaft sensor (Bank 1 and 2)

Required Sensors / Components (Related)	Exhaust camshaft sensor
Frequency of Operation	Continuous
Duration	5 seconds: Exhaust camshaft sensor range check (After starting engine) 4 seconds: Others
MIL Operation	2 driving cycles: Exhaust camshaft sensor range check (After starting engine) Immediate: Others
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

Exhaust Camshaft Sensor Range Check (While starting engine):

Starter	ON
Battery voltage while starter ON once at least	Less than 11 V

Exhaust Camshaft Sensor Range Check (After starting engine):

Engine RPM	600 rpm or more
Starter	OFF
Battery voltage	8 V or more
Ignition Switch	ON

Exhaust Camshaft Sensor Range Check (Fluctuating, Low voltage, High voltage):

Starter	OFF
Ignition Switch ON and time after ignition switch is OFF to ON	2 seconds or more
Battery voltage	8 V or more

TYPICAL MALFUNCTION THRESHOLDS

Exhaust Camshaft Sensor Range Check (While starting engine):

Exhaust camshaft sensor signal	No signal

Exhaust Camshaft Sensor Range Check (After starting engine):

Exhaust camshaft sensor signal	No signal

Exhaust Camshaft Sensor Range Check (Fluctuating):

Exhaust camshaft sensor signal	Less than 0.3 V, or more than 4.7 V

Exhaust Camshaft Sensor Range Check (Low voltage):

Exhaust camshaft sensor signal	Less than 0.3 V

Exhaust Camshaft Sensor Range Check (High voltage):

Exhaust camshaft sensor signal	More than 4.7 V

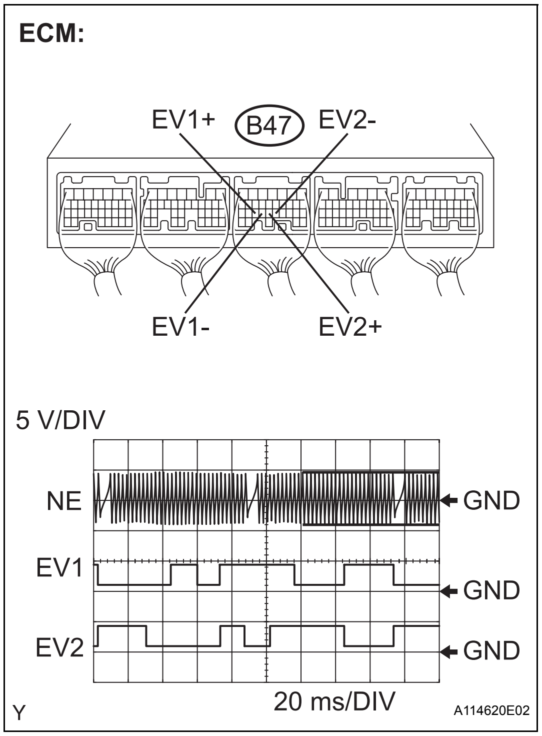
WIRING DIAGRAM

Refer to DTC P0335 (See page ES-205).

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.

1	CHECK ECM TERMINAL VOLTAGE



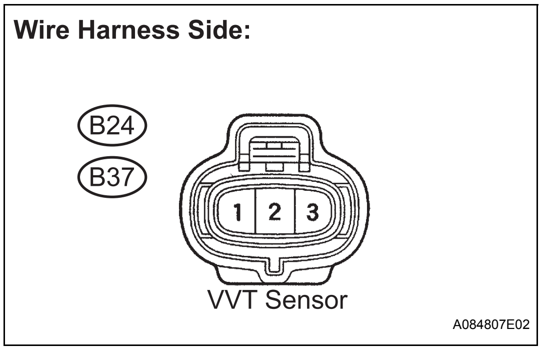
(a) Inspect using an oscilloscope.
(1) While the engine is idling, check the waveform of the ECM connector.
Standard

Tester Connections	Specified Conditions
EV1+ (B47-25) - EV1- (B47-24)	Correct waveform is as shown on the left
EV2+ (B47-23) - EV2- (B47-22)	Correct waveform is as shown on the left

OK → **REPLACE ECM**

NG

2	CHECK VVT SENSOR FOR EXHAUST CAMSHAFT (SENSOR POWER SOURCE)

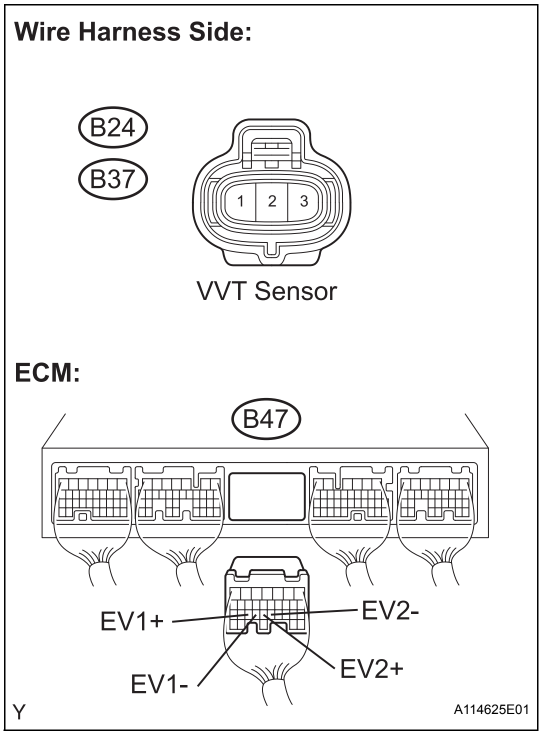


(a) Disconnect the VVT sensor connector.
(b) Measure the voltage between terminal 3 and body ground.
Standard voltage:
4.5 to 5.0 V

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

OK

3	CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR EXHAUST CAMSHAFT - ECM)



(a) Disconnect the VVT sensor for exhaust camshaft connector.
(b) Disconnect the B47 ECM connector.
(c) Measure the resistance between the wire harness side connectors.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VVT sensor (B37-1) - EV1+ (B47-25)	Below 1 Ω
VVT sensor (B37-2) - EV1- (B47-24)	Below 1 Ω
VVT sensor (B24-1) - EV2+ (B47-23)	Below 1 Ω
VVT sensor (B24-2) - EV2- (B47-22)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
VVT sensor (B37-1) - EV1+ (B47-25) - Body ground	10 kΩ or higher
VVT sensor (B37-2) - EV1- (B47-24) - Body ground	10 kΩ or higher
VVT sensor (B24-1) - EV2+ (B47-23) - Body ground	10 kΩ or higher
VVT sensor (B24-2) - EV2- (B47-22) - Body ground	10 kΩ or higher

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

OK

4	CHECK SENSOR INSTALLATION (VVT SENSOR FOR EXHAUST CAMSHAFT)

(a) Check the VVT sensor installation.
OK:
Sensor is installed correctly.

NG → **TIGHTEN SENSOR**

OK

5	CHECK EXHAUST CAMSHAFT (TEETH OF PLATE)

(a) Remove the cylinder head cover.
(b) Check the teeth of the signal plate.

NG → **REPLACE EXHAUST CAMSHAFT**

OK

REPLACE VVT SENSOR FOR EXHAUST CAMSHAFT

DTC	P0420	Catalyst System Efficiency Below Threshold (Bank 1)

DTC	P0430	Catalyst System Efficiency Below Threshold (Bank 2)

MONITOR DESCRIPTION

The ECM uses sensors mounted before and after the three-way catalyst (TWC) to monitor its efficiency. The first sensor, an Air Fuel ratio (A/F) sensor, sends pre-catalyst A/F ratio information to the ECM. The second sensor, a heated oxygen sensor (O2S), sends post-catalyst information to the ECM. The ECM compares these 2 signals to judge the efficiency of the catalyst and the catalyst's ability to store oxygen. During normal operation, the TWC stores and releases oxygen as needed. The capacity to store oxygen results in a low variation in the post-TWC exhaust stream.

If the catalyst is functioning normally, the waveform of the heated oxygen sensor slowly switches between RICH and LEAN. If the catalyst is deteriorated, the waveform will alternate frequently between RICH and LEAN. As the catalyst efficiency degrades, its ability to store oxygen is reduced and the catalyst output becomes more variable. When running the monitor, the ECM compares sensor 1 signals (A/F sensor) over a specific amount of time to determine catalyst efficiency. The ECM begins by calculating the signal length for both sensors (for the rear oxygen sensor, the ECM uses the output voltage signal length). If the oxygen sensor output voltage signal length is greater than the threshold (threshold is calculated based on the A/F sensor signal length), the ECM concludes that the catalyst is malfunctioning. The ECM will turn on the MIL and a DTC will be set.

DTC No.	DTC Detection Conditions	Trouble Areas
P0420	OSC value is smaller than standard value under active air-fuel ratio control (2 trip detection logic)	• Gas leakage from exhaust system • A/F sensor (bank 1 sensor 1) • HO2 sensor (bank 1 sensor 2) • Exhaust manifold (TWC)
P0430	OSC value is smaller than standard value under active air-fuel ratio control (2 trip detection logic)	• Gas leakage from exhaust system • A/F sensor (bank 2 sensor 1) • HO2 sensor (bank 2 sensor 2) • Exhaust manifold (TWC)

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 STRATEGY

Related DTCs	P0420: Catalyst Deterioration P0430: Catalyst Deterioration
Required Sensors / Components (Main)	TWC
Required Sensors / Components (Related)	A/F sensor, heated oxygen sensor, intake air temperature sensor, mass air flow meter, crankshaft position sensor and engine coolant temperature sensor
Frequency of Operation	Once per driving cycle
Duration	30 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	P0011, P0012 (VVT System-Advance, Retard), P0021, P0022 (VVT System2-Adavance, Retard), P0031, P0032, P0051, P0052 (A/F Sensor Heater Sensor 1), P0037, P0038, P0057, P0058 (O2 Sensor heater Sensor 2), P0100, P0101, P0102, P0103 (MAF Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223 , P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0136, P0137, P0138 (O2 Sensor 1), P0136 (O2 Sensor 2), P0171,P0172 (Fuel System), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1, 2), P0351, P0352, P0353, P0354, P0355, P0356 (Ignitor), P0500 (VSS), P2196 (A/F Sensor (Rationality)), P2A00, P2A03 (A/F Sensor (Slow Response))
Battery voltage	11 V or more
IAT	-10°C (14°F) or more
ECT	75°C (167°F) or more
Atmospheric pressure coefficient	0.75 or more
Idle	OFF
Engine RPM	Less than 3,200 rpm
A/F sensor	Activated
Fuel system status	Closed loop
Engine load	10 to 70%
All of the following conditions are met	Condition 1, 2 and 3
1. Mass air flow rate	5 to 50 g/sec.
2. Front catalyst temperature (estimated)	620 to 820°C (1,148 to 1,508°F)
3. Rear catalyst temperature (estimated)	100 to 900°C (212 to 1,652°F)
Rear HO2S monitor	Completed
Shift position	4th or more

TYPICAL MALFUNCTION THRESHOLDS

Oxygen Storage Capacity (OSC) of catalyst	Less than 0.008 g (0.0000176 lb)

MONITOR RESULT

Refer to Checking Monitor Status for detailed information (See page ES-25).

Catalyst bank 1 - Active A/F control method

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$21	$A9	Multiply by 0.0003 [no dimension]	Oxygen storage capacity of catalyst	Minimum test limit for catalyst	Maximum test limit for catalyst

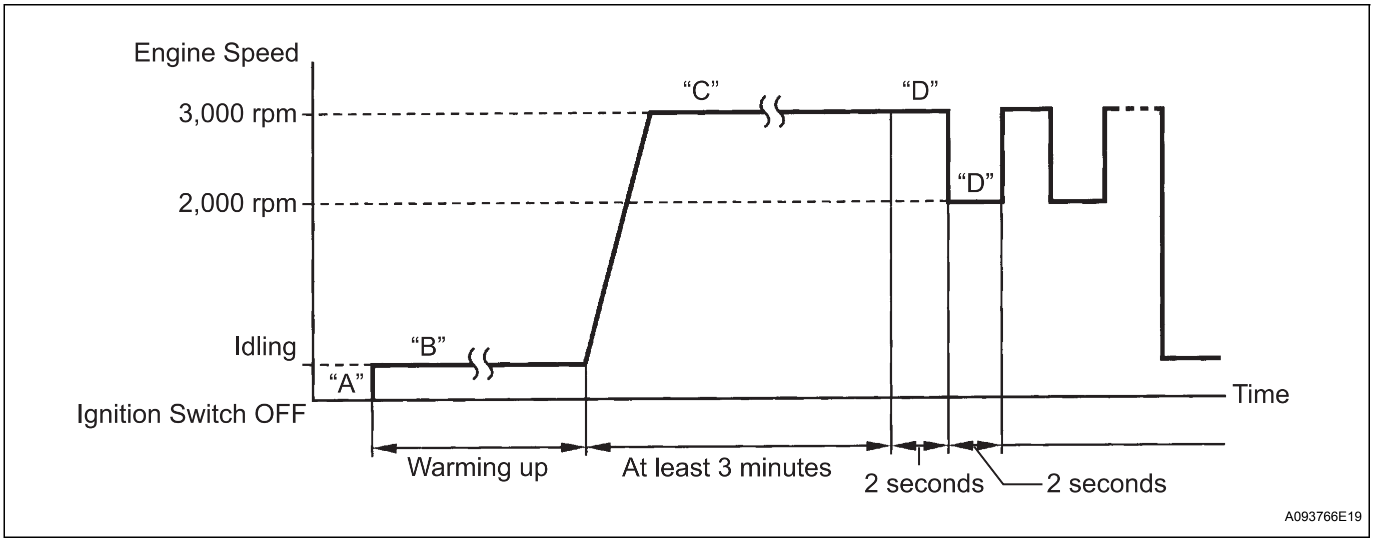
Catalyst bank 2 - Active A/F control method

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$22	$A9	Multiply by 0.0003 [no dimension]	Oxygen storage capacity of catalyst	Minimum test limit for catalyst	Maximum test limit for catalyst

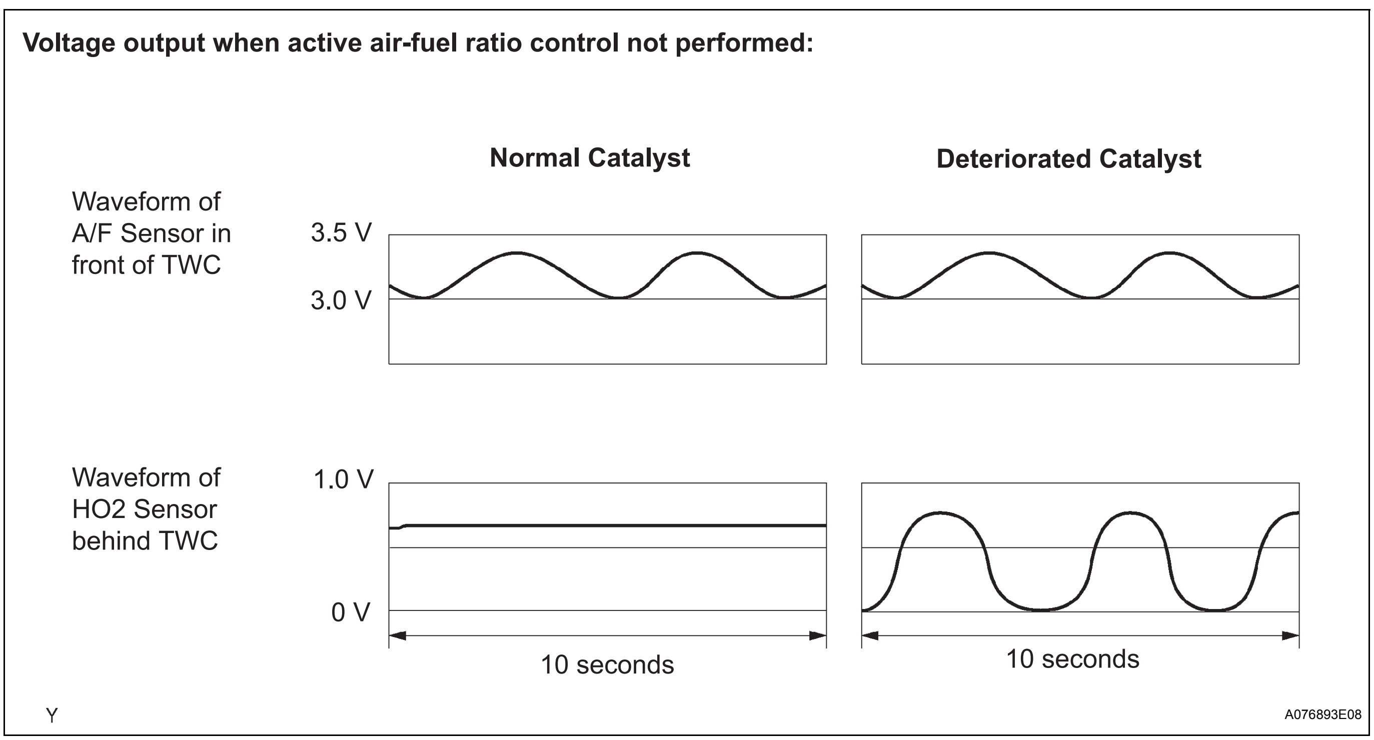
CONDITIONING FOR SENSOR TESTING

HINT:

Perform the operation with the engine speeds and durations described below prior to checking the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.



1. Connect the intelligent tester to the DLC3 (Procedure "A").
2. Start the engine and warm it up with all the accessories switched off, until the engine coolant temperature stabilizes (Procedure "B").
3. Run the engine at an engine speed of between 2,500 rpm and 3,000 rpm for at least 3 minutes (Procedure "C").
4. While running the engine at 3,000 rpm for 2 seconds and 2,000 rpm for 2 seconds, check the waveforms of the A/F and HO2 sensors using the tester (Procedure "D").
   HINT:
   - If either of the voltage outputs of the Air-Fuel Ratio (A/F) or Heated Oxygen (HO2) sensor does not fluctuate, or either of the sensors makes a noise, the sensor may be malfunctioning.
   - If the voltage outputs of both the sensors remain lean or rich, the air-fuel ratio may be extremely lean or rich. In such cases, perform the following A/F CONTROL using the intelligent tester.
   - If the Three-Way Catalytic Converter (TWC) has deteriorated, the HO2 sensor (located behind the TWC) voltage output fluctuates up and down frequently, even under normal driving conditions (active air-fuel ratio control is not performed).



ES

1. A/F CONTROL

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.

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) 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).
(f) 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.
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 and decreases in the fuel injection volume.

Standard voltage

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

CAUTION:
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	 OK	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	NG	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	 OK	Output Voltage Almost no reaction	NG	

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
4	Injection volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

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

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.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 AND/OR P0430)

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

Result

Display (DTC Output)	Proceed to
P0420 and/or P0430	A
P0420 and/or P0430 and other DTCs	B

HINT:
If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (A/F CONTROL)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.

ES

(e) 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).

(f) 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.

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 and decreases in the fuel injection volume.

Standard voltage

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

Result

Status AFS B1S1 or AFS B2S1	Status O2S B1S2 or O2S B2S2	A/F Condition and A/F and HO2 Sensor Conditions	Misfires	Suspected Trouble Areas	Proceed to
Lean/Rich	Lean/Rich	Normal	-	• Three-Way Catalytic Converter (TWC) • Gas leakage from exhaust system	A
Lean	Lean/Rich	A/F sensor malfunction	-	A/F sensor	B
Rich	Lean/Rich	A/F sensor malfunction	-	A/F sensor	B
Lean/Rich	Lean	HO2 sensor malfunction	-	• HO2 sensor • Gas leakage from exhaust system	C
Lean/Rich	Rich	HO2 sensor malfunction	-	• HO2 sensor • Gas leakage from exhaust system	C
Lean	Lean	Actual air-fuel ratio lean	May occur	• Extremely rich or lean actual air-fuel ratio • Gas leakage from exhaust system	A
Rich	Rich	Actual air-fuel ratio rich	-	• Extremely rich or lean actual air-fuel ratio • Gas leakage from exhaust system	A

Lean: During A/F CONTROL, the A/F sensor output voltage (AFS) is consistently more than 3.35 V, and the HO2 sensor output voltage (O2S) is consistently less than 0.4 V.
Rich: During A/F CONTROL, the AFS is consistently less than 3.0 V, and the O2S is consistently more than 0.55 V.
Lean/Rich: During A/F CONTROL of the ACTIVE TEST, the output voltage of the HO2 sensor alternates correctly.

B → **CHECK AND REPLACE AIR FUEL RATIO SENSOR**

C → **CHECK AND REPLACE HEATED OXYGEN SENSOR, AND CHECK AND REPAIR EXHAUST GAS LEAKAGE**

A

3	CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

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

OK

REPLACE THREE-WAY CATALYTIC CONVERTER (EXHAUST MANIFOLD LH OR RH)

DTC	P043E	Evaporative Emission System Reference Orifice Clog Up

DTC	P043F	Evaporative Emission System Reference Orifice High Flow

DTC SUMMARY

DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P043E	0.02 inch orifice clogged	Vacuum pump creates negative pressure through 0.02 inch orifice, and EVAP system pressure is measured to determine leak pressure standard. 0.02 inch leak pressure standard measured at start and end of leak check. If system pressure is lower than -4.85 kPa (-36.38 mmHg)*, ECM determines that 0.02 inch orifice has clogging malfunction.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM • Leakage from EVAP system	While ignition switch OFF	2 trip
P043F	0.02 inch orifice high-flow	Vacuum pump creates negative pressure through 0.02 inch orifice, and EVAP system pressure is measured to determine leak pressure standard. 0.02 inch leak pressure standard generated start and at end of leak check. If system pressure is higher than -1.06 kPa (-7.95 mmHg)*, ECM determines that 0.02 inch orifice has high-flow malfunction.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM • Leakage from EVAP system	While ignition switch OFF	2 trip

*: The threshold values vary according to the atmospheric pressure measured at the beginning of the EVAP system monitor. The values described in the table above are based on an atmospheric pressure of 100 kPa (750.1 mmHg) (absolute pressure).

HINT:

The 0.02 inch orifice is located inside the pump module.

DESCRIPTION

The circuit description can be found in the EVAP (Evaporative Emission) System (See page ES-370).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-373).

MONITOR DESCRIPTION

5 hours*1 after the ignition switch is turned off, the electric vacuum pump creates negative pressure (vacuum) in the EVAP (Evaporative Emission) system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.

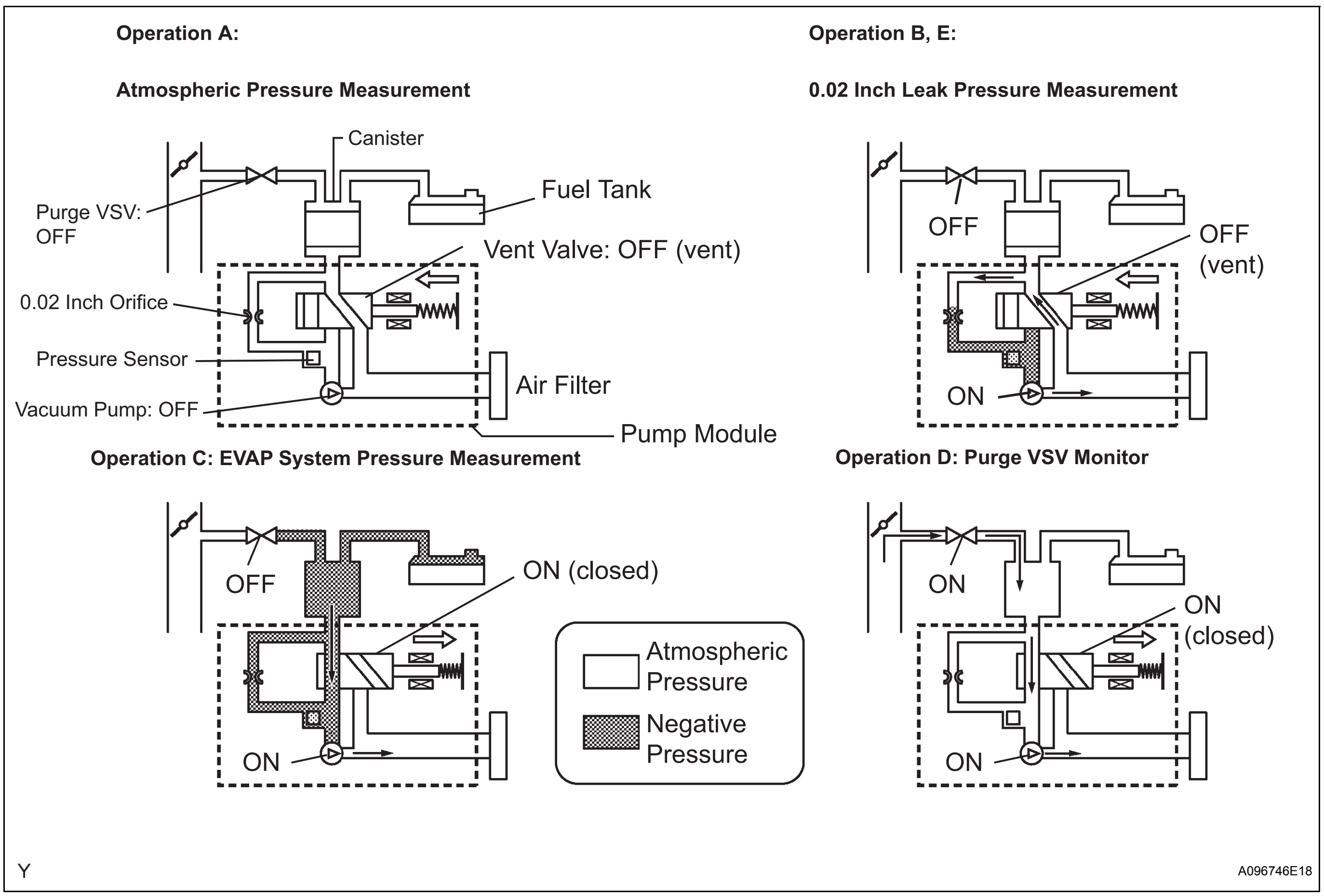
HINT:

*1: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned off, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned off, the monitor check starts 2.5 hours later.

Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned off.	-

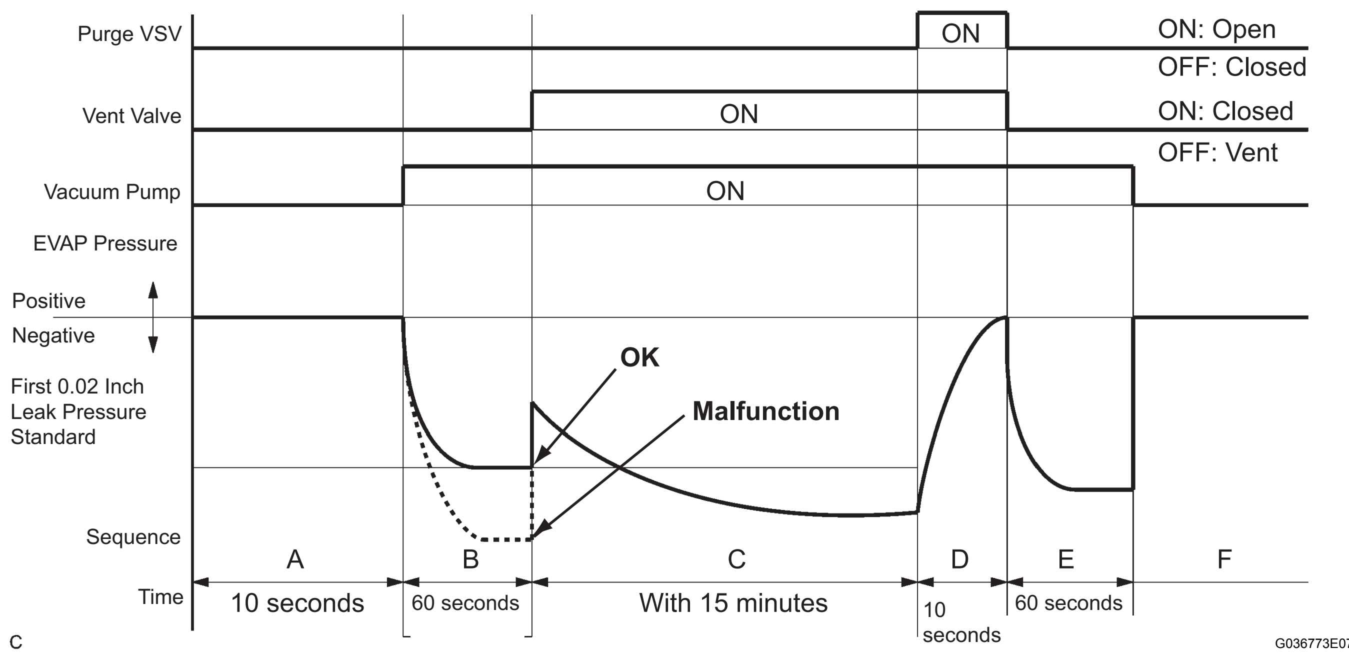
Sequence	Operations	Descriptions	Duration
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system is not between 70 kPa and 110 kPa (525 mmHg and 825 mmHg), ECM cancels EVAP system monitor.	10 seconds
B	First 0.02 inch leak pressure measurement	In order to determine 0.02 inch leak pressure standard, vacuum pump creates negative pressure (vacuum) through 0.02 inch orifice and then ECM checks if vacuum pump and vent valve operate normally.	60 seconds
C	EVAP system pressure measurement	Vent valve turned ON (closed) to shut EVAP system. Negative pressure (vacuum) is created in EVAP system, and EVAP system pressure then measured. Write down measured value as it will be used in leak check. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP system monitor.	15 minutes*2
D	Purge VSV monitor	Purge VSV is opened and then EVAP system pressure is measured by ECM. Large increase indicates normal.	10 seconds
E	Second 0.02 inch leak pressure measurement	After second 0.02 inch leak pressure measurement, leak check is performed by comparing first and second 0.02 inch leak pressure standards. If stabilized system pressure is higher than second 0.02 inch leak pressure standard, ECM determines that EVAP system leaking.	60 seconds
F	Final check	Atmospheric pressure is measured and then monitoring result is recorded by ECM.	-

*2: If there is only a small amount of fuel in the fuel tank, stabilizing the EVAP pressure takes longer than usual.



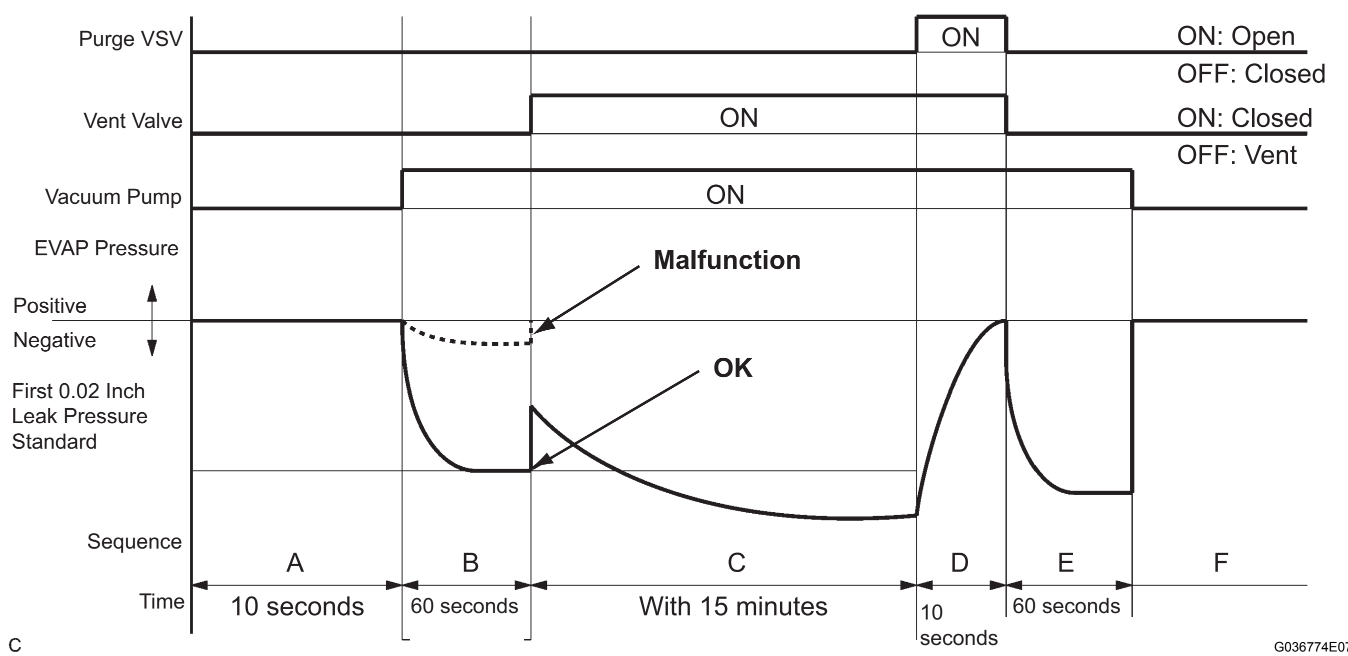
1. P043E: 0.02 inch orifice clogged
In operation B, the vacuum pump creates negative pressure (vacuum) through the 0.02 inch orifice. The EVAP system pressure is then measured by the ECM, using the pressure sensor, to determine the 0.02 inch leak pressure standard. If the pressure is lower than -4.85 kPa (-36.38 mmHg)*, the ECM interprets this as a clog malfunction in the 0.02 inch orifice, and stops the EVAP (Evaporative Emission) system monitor.
The ECM then illuminates the MIL and sets the DTC (2 trip detection logic).
*: The threshold varies according to the atmospheric pressure measured in operation A. The value described above is based on an atmospheric pressure of 100 kPa (750.1 mmHg): absolute pressure.

EVAP Pressure when 0.02 Inch Orifice Clogged:



2. P043F: 0.02 inch orifice high-flow
In operation B, the vacuum pump creates negative pressure (vacuum) through the 0.02 inch orifice. The EVAP system pressure is then measured by the ECM using the pressure sensor to determine the 0.02 inch leak pressure standard. If the pressure is higher than -1.06 kPa (-7.95 mmHg)*, the ECM interprets this as a high-flow malfunction in the 0.02 inch orifice, and stops the EVAP system monitor. The ECM then illuminates the MIL and sets the DTC (2 trip detection logic).
*: The threshold varies according to the atmospheric pressure measured in operation A. The value described above is based on a atmospheric pressure of 100 kPa (750.1 mmHg): absolute pressure.

EVAP Pressure when 0.02 Inch Orifice High-flow Malfunction:



ES

OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Related DTCs	P043E: 0.02 inch orifice clog (built-in pump module) P043F: 0.02 inch orifice high-flow (built-in pump module)
Required Sensors / Components	Pump module
Frequency of Operation	Once per driving cycle
Duration	Less than 2 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Key-off monitor is run when all of the following conditions met	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	2.5 mph (4 km/h) or less
Ignition switch	OFF
Time after key-off	5 or 7 or 9.5 hours

EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
EVAP canister purge valve	Not operated by scan tool
EVAP canister vent valve	Not operated by scan tool
EVAP leak detection pump	Not operated by scan tool
Both of the following conditions 1 and 2 set before key-off	-
1. Duration that vehicle has been driven	5 minutes or more
2. EVAP purge operation	Performed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)

Key-off monitor sequence 1 to 8

ES

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met	-
Atmospheric pressure change	Less than 0.3 kPa (2.25 mmHg) in 1 second

2. First reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2 and 3
1. EVAP pressure just after reference pressure measurement start	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated

3. EVAP canister vent valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after vent valve is ON	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction

Next sequence is run if the following condition is met	-
EVAP pressure	Saturated within 15 minutes

5. EVAP canister purge valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after purge valve is open	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2, 3 and 4
1. EVAP pressure just after reference pressure	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated
4. Difference between first reference pressure and second reference pressure	Less than 0.7 kPa (5.25 mmHg)

7. Leak check

Next sequence is run if the following condition is met	-
EVAP pressure when vacuum introduction is complete	Lower than second reference pressure

8. Atmospheric pressure measurement

EVAP monitor is complete if the following condition is met	-
Atmospheric pressure difference between sequence 1 and 8	Within 0.3 kPa (2.25 mmHg)

TYPICAL MALFUNCTION THRESHOLDS

One of following conditions met	-
EVAP pressure just after reference pressure measurement start	More than -1 kPa (-7.5 mmHg)
Reference pressure	Less than -4.85 kPa (-36.384 mmHg)
Reference pressure	-1.057 kPa (-7.929 mmHg) or more
Reference pressure	Not saturated
Difference between first reference pressure and second reference pressure	0.7 kPa (5.25 mmHg) or more

MONITOR RESULT

Refer to Monitor Result for detailed information (See page ES-25).

DTC	P0441	Evaporative Emission Control System Incorrect Purge Flow

DTC SUMMARY

DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P0441	Purge VSV (Vacuum Switching Valve) stuck open	Vacuum pump creates negative pressure (vacuum) in EVAP system and EVAP system pressure is measured. 0.02 inch leak pressure standard is measured at start and end of leak check. If stabilized pressure is higher than [second 0.02 inch leak pressure standard x 0.2], ECM determines that purge VSV is stuck open	• Purge VSV • Purge VSV circuit (between purge VSV and ECM) • Leakage from EVAP line (between purge VSV and intake manifold) • EVAP line clogged (between purge VSV and canister) • ECM	While ignition Switch OFF	2 trip
P0441	Purge VSV stuck closed	After EVAP leak check performed, purge VSV turned ON (open), and atmospheric air is introduced into EVAP system. 0.02 inch leak pressure standard is measured at the start and end of leak check. If pressure does not return to near atmospheric pressure, ECM determines that purge valve is stuck closed	• Purge VSV • Purge VSV circuit (between purge VSV and ECM) • Leakage from EVAP line (between purge VSV and intake manifold) • EVAP line clogged (between purge VSV and canister) • ECM	While ignition Switch OFF	2 trip
P0441	Purge flow	While engine running, the following conditions successively met: • Negative pressure is not created in EVAP system when purge VSV is turned ON (open) • EVAP system pressure change is less than 0.5 kPa (3.75 mmHg) when vent valve is turned ON (closed) • Atmospheric pressure change before and after purge flow monitor is less than 0.1 kPa (0.75 mmHg)	• Purge VSV • Purge VSV circuit (between purge VSV and ECM) • Leakage from EVAP line (between purge VSV and intake manifold) • EVAP line clogged (between purge VSV and canister) • ECM	While ignition Switch OFF	2 trip

DESCRIPTION

The circuit description can be found in the EVAP (Evaporative Emission) System (See page ES-370).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-373).

MONITOR DESCRIPTION

The two monitors, Key-Off and Purge Flow, are used to detect malfunctions relating to DTC P0441. The Key-Off monitor is initiated by the ECM internal timer, known as the soak timer, 5 hours[*1] after the ignition switch is turned off. The purge flow monitor runs while the engine is running.

1. KEY-OFF MONITOR

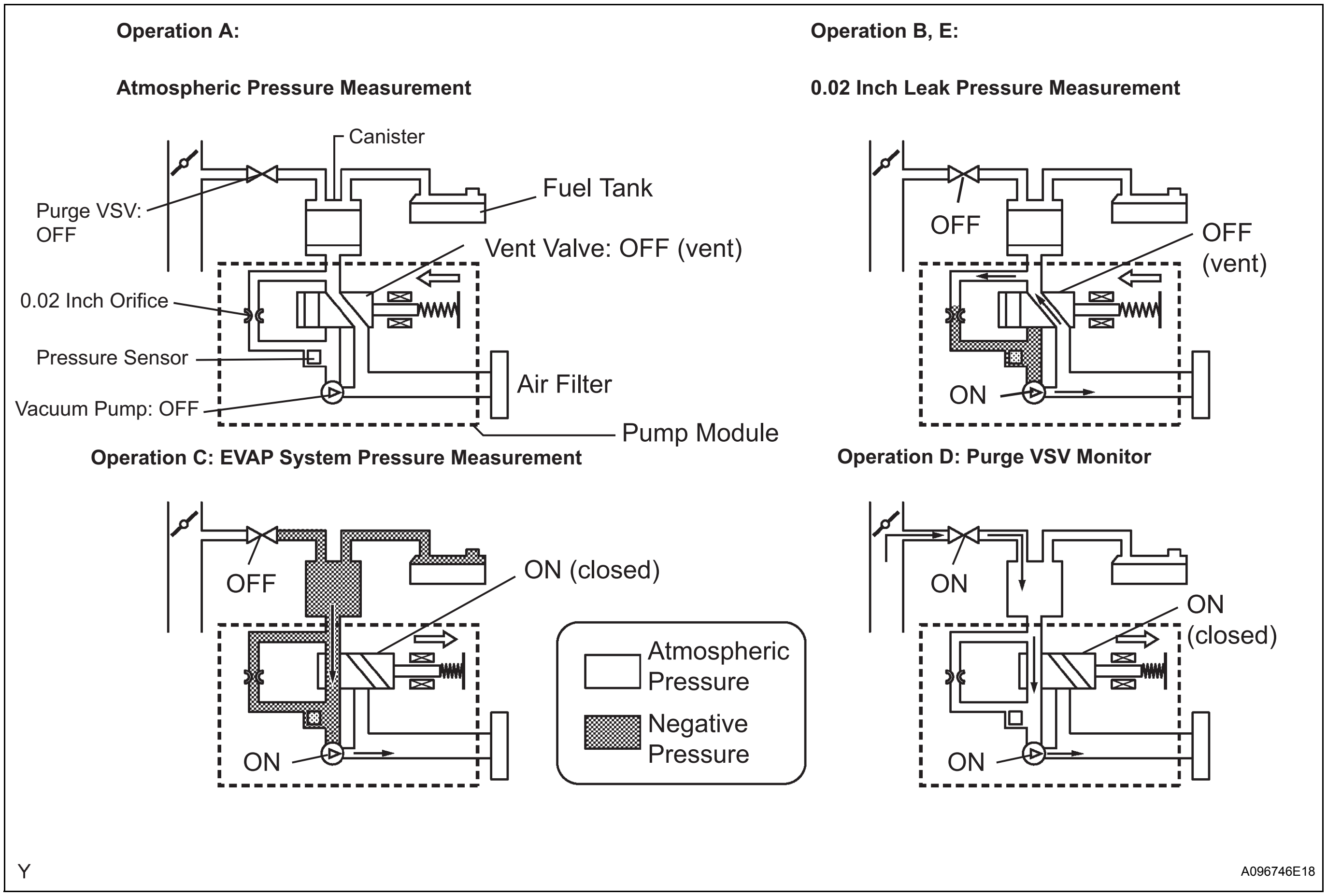
5 hours[*1] after the ignition switch is turned off, the electric vacuum pump creates negative pressure (vacuum) in the EVAP (Evaporative Emission) system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.

HINT:

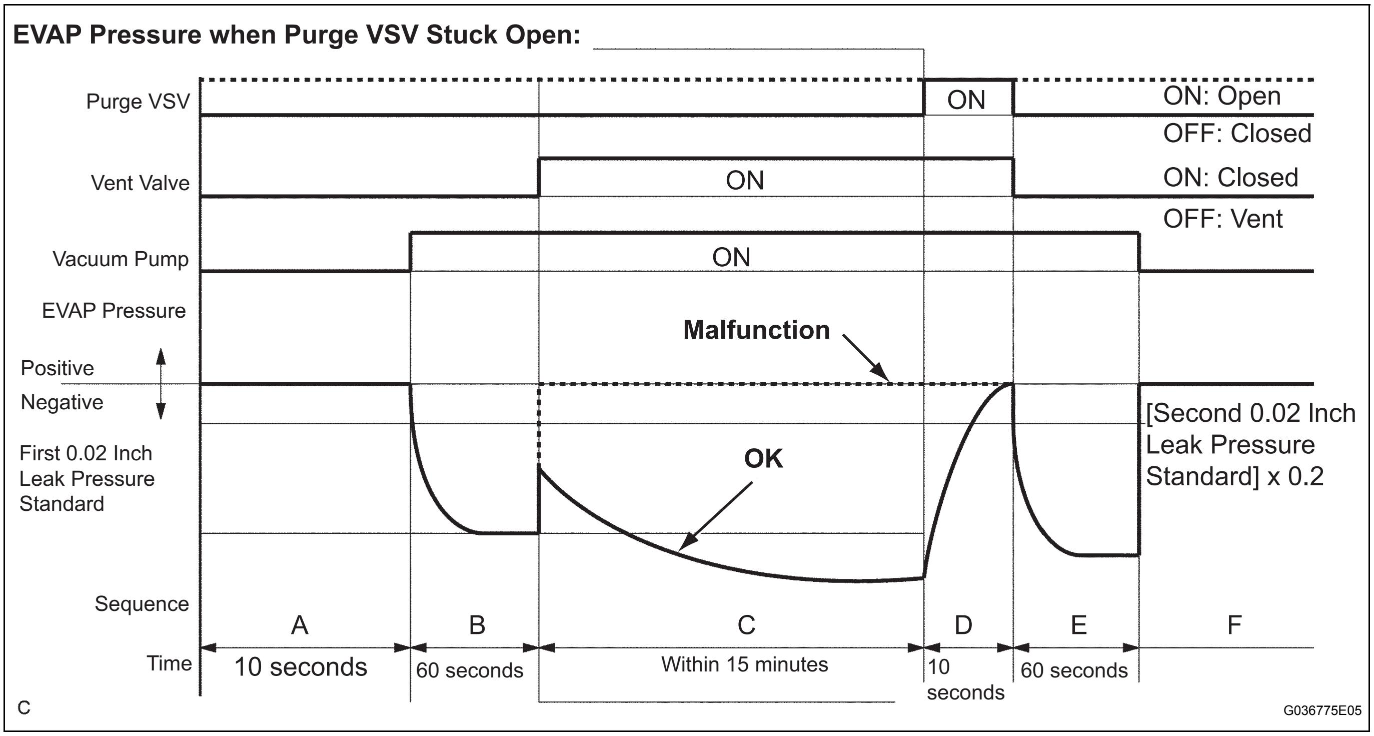
[*1]: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned off, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned off, the monitor check starts 2.5 hours later.

Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned off.	-
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system is not between 70 kPa and 110 kPa (525 mmHg and 825 mmHg), ECM cancels EVAP system monitor.	10 seconds
B	First 0.02 inch leak pressure measurement	In order to determine 0.02 inch leak pressure standard, vacuum pump creates negative pressure (vacuum) through 0.02 inch orifice and then ECM checks if vacuum pump and vent valve operate normally.	60 seconds
C	EVAP system pressure measurement	Vent valve turned ON (closed) to shut EVAP system. Negative pressure (vacuum) is created in EVAP system, and EVAP system pressure then measured. Write down measured value as it will be used in leak check. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP system monitor.	15 minutes[*2]
D	Purge VSV monitor	Purge VSV is opened and then EVAP system pressure is measured by ECM. Large increase indicates normal.	10 seconds
E	Second 0.02 inch leak pressure measurement	After second 0.02 inch leak pressure measurement, leak check is performed by comparing first and second 0.02 inch leak pressure standards. If stabilized system pressure is higher than second 0.02 inch leak pressure standard, ECM determines that EVAP system leaking.	60 seconds
F	Final check	Atmospheric pressure is measured and then monitoring result is recorded by ECM.	-

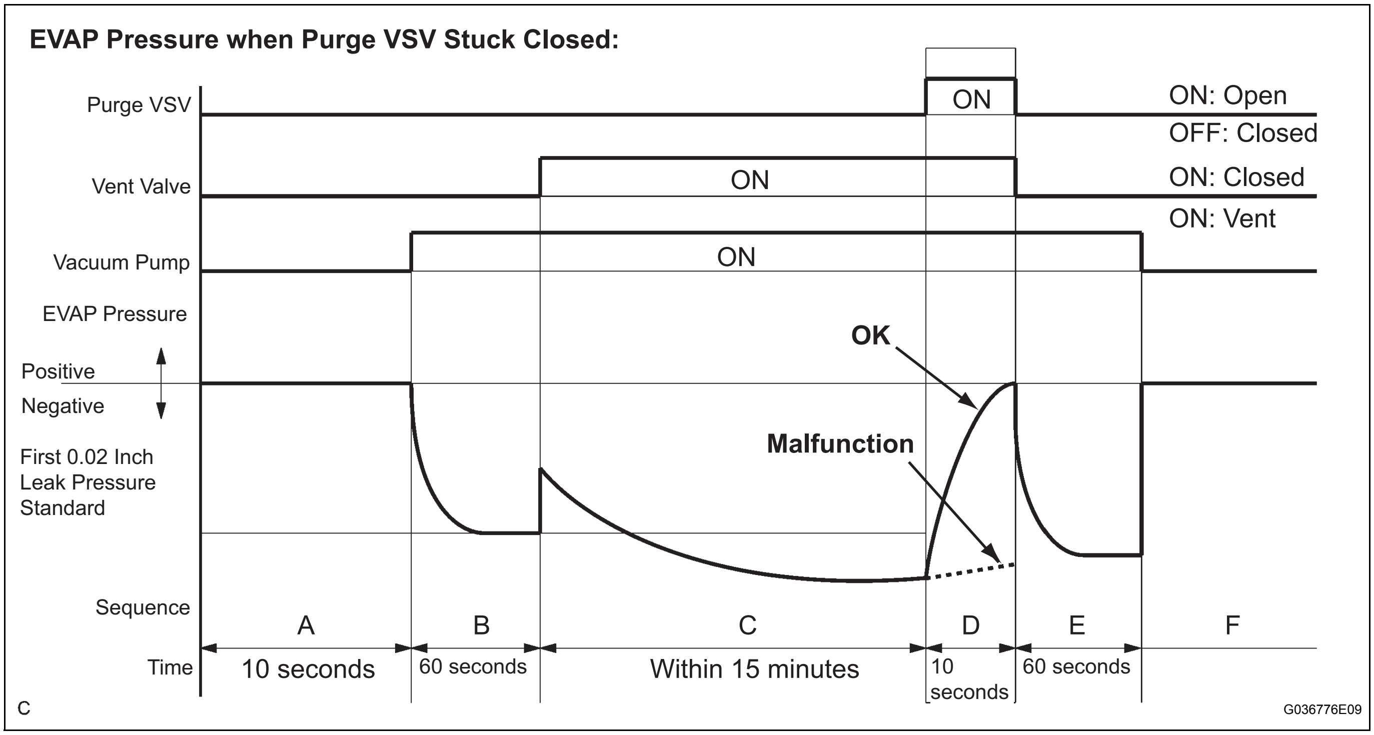
[*2]: If there is only a small amount of fuel in the fuel tank, stabilizing the EVAP pressure takes longer than usual.

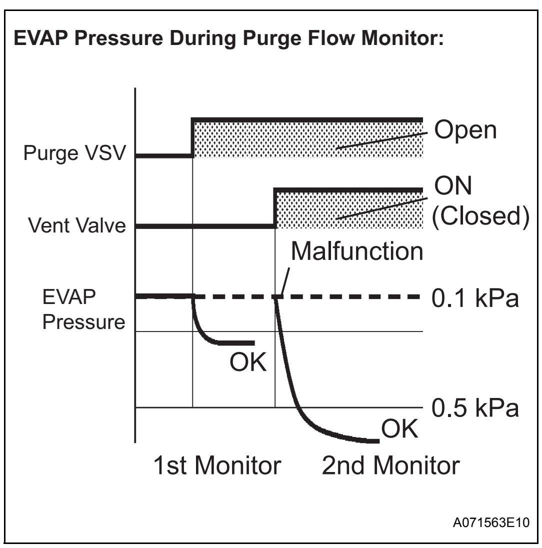

Operation A:
Atmospheric Pressure Measurement
Canister
Fuel Tank
Purge VSV: OFF
Vent Valve: OFF (vent)
0.02 Inch Orifice
Pressure Sensor
Air Filter
Vacuum Pump: OFF
Pump Module
Operation B, E:
0.02 Inch Leak Pressure Measurement
OFF
OFF (vent)
ON
Operation C: EVAP System Pressure Measurement
OFF
ON (closed)
ON
Atmospheric Pressure
Negative Pressure
Operation D: Purge VSV Monitor
ON
ON (closed)
ON
Y
A096746E18

(a) Purge VSV stuck open
In operation C, the vacuum pump creates negative pressure (vacuum) in the EVAP (Evaporative Emission) system. The EVAP system pressure is then measured by the ECM using the pressure sensor. If the stabilized system pressure is higher than [second 0.02 inch leak pressure standard x 0.2], the ECM interprets this as the purge VSV (Vacuum Switching Valve) being stuck open. The ECM illuminates the MIL and sets the DTC (2 trip detection logic).



(b) Purge VSV stuck closed
In operation D, the pressure sensor measures the EVAP (Evaporative Emission) system pressure. The pressure measurement for purge VSV monitor is begun when the purge VSV is turned on (open) after the EVAP leak check. When the measured pressure indicates an increase of 0.3 kPa (2.25 mmHg) or more, the purge VSV is functioning normally. If the pressure does not increase, the ECM interprets this as the purge VSV being stuck closed. The ECM illuminates the MIL and sets the DTC (2 trip detection logic).





2. **PURGE FLOW MONITOR**
The purge flow monitor consists of the two step monitors. The 1st monitor is conducted every time and the 2nd monitor is activated if necessary.
- The 1st monitor
While the engine is running and the purge VSV (Vacuum Switching Valve) is on (open), the ECM monitors the purge flow by measuring the EVAP pressure change. If negative pressure is not created, the ECM begins the 2nd monitor.
- The 2nd monitor
The vent valve is turned on (closed) and the EVAP pressure is then measured. If the variation in the pressure is less than 0.5 kPa (3.75 mmHg), the ECM interprets this as the purge VSV being stuck closed, and illuminates the MIL and sets DTC P0441 (2 trip detection logic).

Atmospheric pressure check:
In order to ensure reliable malfunction detection, the variation between the atmospheric pressures, before and after conduction of the purge flow monitor, is measured by the ECM.

OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Related DTCs	P0441: Purge VSV stuck open P0441: Purge VSV stuck closed P0441: Purge flow
Required Sensors / Components	Purge VSV and pump module
Frequency of Operation	Once per driving cycle
Duration	Within 15 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor is run whenever this DTC is not present	P0011, P0012 (VVT System-Advance, Retard), P0021, P0022 (VVT System2-Adavance, Retard), P0100, P0101, P0102, P0103 (MAF Sensor), P0110, P0112, P0113 (IAT Sensor),P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223 , P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0171,P0172 (Fuel System), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1, 2), P0351, P0352, P0353, P0354, P0355, P0356 (Ignitor), P0450, P0451, P0452, P0453 (EVAP pressure Sensor), P0500 (VSS)

Purge flow:

Engine	Running
ECT	4.4°C (40°F) or more
IAT	4.4°C (40°F) or more
EVAP pressure sensor	Not detected
EVAP canister purge valve	Not operated by scan tool
EVAP system check	Not operated by scan tool
Battery voltage	10 V or more
Purge duty cycle	8% or more

Purge VSV stuck open and closed:

Key-off monitor is run when all of the following conditions met	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	2.5 mph (4 km/h) or less
Ignition switch	OFF
Time after key-off	5 or 7 or 9.5 hours
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
EVAP canister purge valve	Not operated by scan tool
EVAP canister vent valve	Not operated by scan tool
EVAP leak detection pump	Not operated by scan tool
Both of the following conditions 1 and 2 set before key-off	-
1. Duration that vehicle has been driven	5 minutes or more
2. EVAP purge operation	Performed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)

Key-off monitor sequence 1 to 8

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met	-
Atmospheric pressure change	Less than 0.3 kPa (2.25 mmHg) in 1 second

2. First reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2 and 3
1. EVAP pressure just after reference pressure measurement start	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated

3. EVAP canister vent valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after vent valve is ON	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction

Next sequence is run if the following condition is met	-
EVAP pressure	Saturated within 15 minutes

5. EVAP canister purge valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after purge valve is open	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2, 3 and 4
1. EVAP pressure just after reference pressure	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated
4. Difference between first reference pressure and second reference pressure	Less than 0.7 kPa (5.25 mmHg)

7. Leak check

Next sequence is run if the following condition is met	-
EVAP pressure when vacuum introduction is complete	Lower than second reference pressure

8. Atmospheric pressure measurement

EVAP monitor is complete if the following condition is met	-
Atmospheric pressure difference between sequence 1 and 8	Within 0.3 kPa (2.25 mmHg)

TYPICAL MALFUNCTION THRESHOLDS

Purge flow:

Both of the following conditions are met	Condition (a) and (b)
(a) EVAP pressure change when purge flow is started	Less than 0.1 kPa (0.75 mmHg)
(b) EVAP pressure change during purge flow when EVAP pressure switching valve ON (closed)	Less than 0.5 kPa (3.75 mmHg)

EVAP VSV stuck open:

EVAP pressure when vacuum introduction is complete	Higher than reference pressure x 0.2

EVAP VSV stuck closed:

EVAP pressure change after EVAP canister purge valve is open	Less than 0.3 kPa (2.25 mmHg)

MONITOR RESULT

Refer to Monitor Result for detailed information (See page ES-25).

DTC	P0450	Evaporative Emission Control System Pressure Sensor / Switch

DTC	P0451	Evaporative Emission Control System Pressure Sensor Range / Performance

DTC	P0452	Evaporative Emission Control System Pressure Sensor / Switch Low Input

DTC	P0453	Evaporative Emission Control System Pressure Sensor / Switch High Input

DTC SUMMARY

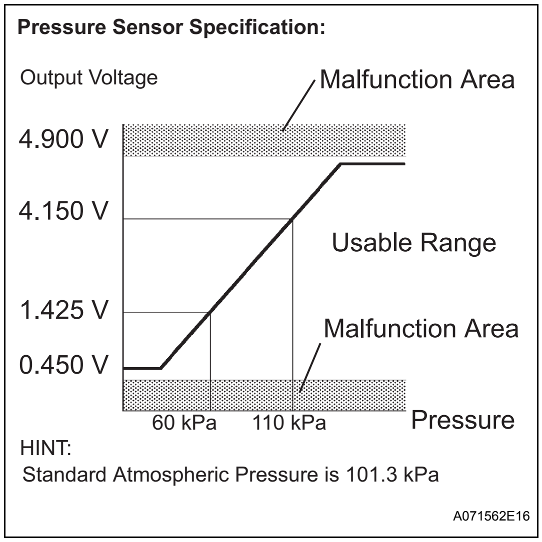
DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P0450	Pressure sensor abnormal voltage fluctuation	Sensor output voltage rapidly fluctuates beyond upper and lower malfunction thresholds for 0.5 seconds.	• Pump module • ECM	• EVAP monitoring (ignition OFF) • Ignition ON	1 trip
P0451	Pressure sensor abnormal voltage fluctuation	Sensor output voltage fluctuates frequently in certain time period.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM	• EVAP monitoring (ignition OFF) • Engine running	2 trip
P0451	Pressure sensor constant voltage	Sensor output voltage does not vary in certain time period.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM	EVAP monitoring (ignition OFF)	2 trip
P0452	Pressure sensor voltage low	Sensor output voltage is less than 0.45 V for 0.5 seconds.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM	• Ignition ON • EVAP monitoring (ignition OFF)	1 trip
P0453	Pressure sensor voltage high	Sensor output voltage is more than 4.9 V for 0.5 seconds.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM	• Ignition ON • EVAP monitoring (ignition OFF)	1 trip

HINT:
The pressure sensor is built into the pump module.

DESCRIPTION

The circuit description can be found in the EVAP (Evaporative Emission) Inspection Procedure (See page ES-370).

MONITOR DESCRIPTION



1. DTC P0450: Pressure sensor abnormal voltage fluctuation
   If the pressure sensor voltage output rapidly fluctuates between less than 0.45 V and more than 4.9 V, the ECM interprets this as an open or short circuit malfunction in the pressure sensor or its circuit, and stops the EVAP (Evaporative Emission) system monitor. The ECM then illuminates the MIL and sets the DTC (1 trip detection logic).
2. DTC P0451: Pressure sensor abnormal voltage fluctuation or being constant
   If the pressure sensor voltage output fluctuates rapidly for 10 seconds, the ECM stops the EVAP system monitor. The ECM interprets this as the pressure sensor voltage fluctuating, and stops the EVAP system monitor. The ECM then illuminates the MIL and sets the DTC.
   Alternatively, if the sensor voltage output does not change for 10 seconds, the ECM interprets this as the sensor being stuck, and stops the monitor. The ECM then illuminates the MIL and sets the DTC. (Both the malfunctions are detected by 2 trip detection logic.)
3. DTC P0452: Pressure sensor voltage low
   If the pressure sensor voltage output is below 0.45 V, the ECM interprets this as an open or short circuit malfunction in the pressure sensor or its circuit, and stops the EVAP system monitor. The ECM then illuminates the MIL and sets the DTC (1 trip detection logic).
4. DTC P0453: Pressure sensor voltage high
   If the pressure sensor voltage output is 4.9 V or more, the ECM interprets this as an open or short circuit malfunction in the pressure sensor or its circuit, and stops the EVAP system monitor. The ECM then illuminates the MIL and sets the DTC (1 trip detection logic).

OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Related DTCs	P0450: Evaporative emission control system pressure sensor/switch chattering P0451: Evaporative emission control system pressure sensor noise P0451: Evaporative emission control system pressure sensor stuck P0452: Evaporative emission control system pressure sensor/switch low input P0453: Evaporative emission control system pressure sensor/switch high input
Required Sensors / Components	Pump module
Frequency of Operation	Once pre driving cycle: P0451 sensor stuck Continuous: P0451 sensor noising, P0450, P0452 and P0453
Duration	Within 15 seconds: P0451 (Pressure sensor noise) Within 2 minutes: P0451 (Pressure sensor stuck) 0.5 seconds: P0450, P0452, P0453
MIL Operation	Immediate: P0450, P0452, P0453 2 driving cycles: P0451
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

P0451 (Noise monitor):

Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
IAT	4.4 to 35°C (40 to 95°F)
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
Either of the following conditions 1 or 2 is met	-
1. Engine condition	Running
2. Time after key-off	5 or 7 or 9.5 hours

P0451 (Stuck monitor):

Battery voltage	10.5 V or more
IAT	4.4 to 35°C (40 to 95°F)
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Time after key-off	5 or 7 or 9.5 hours

P0450, P0452 and P0453:

Ignition switch	ON
Battery voltage	ON
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

(a) P0450: Pressure sensor chattering

EVAP pressure	Less than 42.11 kPa (316 mmHg), or more than 123.761 kPa (928 mmHg)

(b) P0451: Pressure sensor noise

Frequency that EVAP pressure change is 0.3 kPa (2.25 mmHg) or more	10 times or more in 10 seconds

(c) P0451: Pressure sensor stuck

EVAP pressure change during reference pressure	Less than 0.65 kPa (4.876 mmHg)

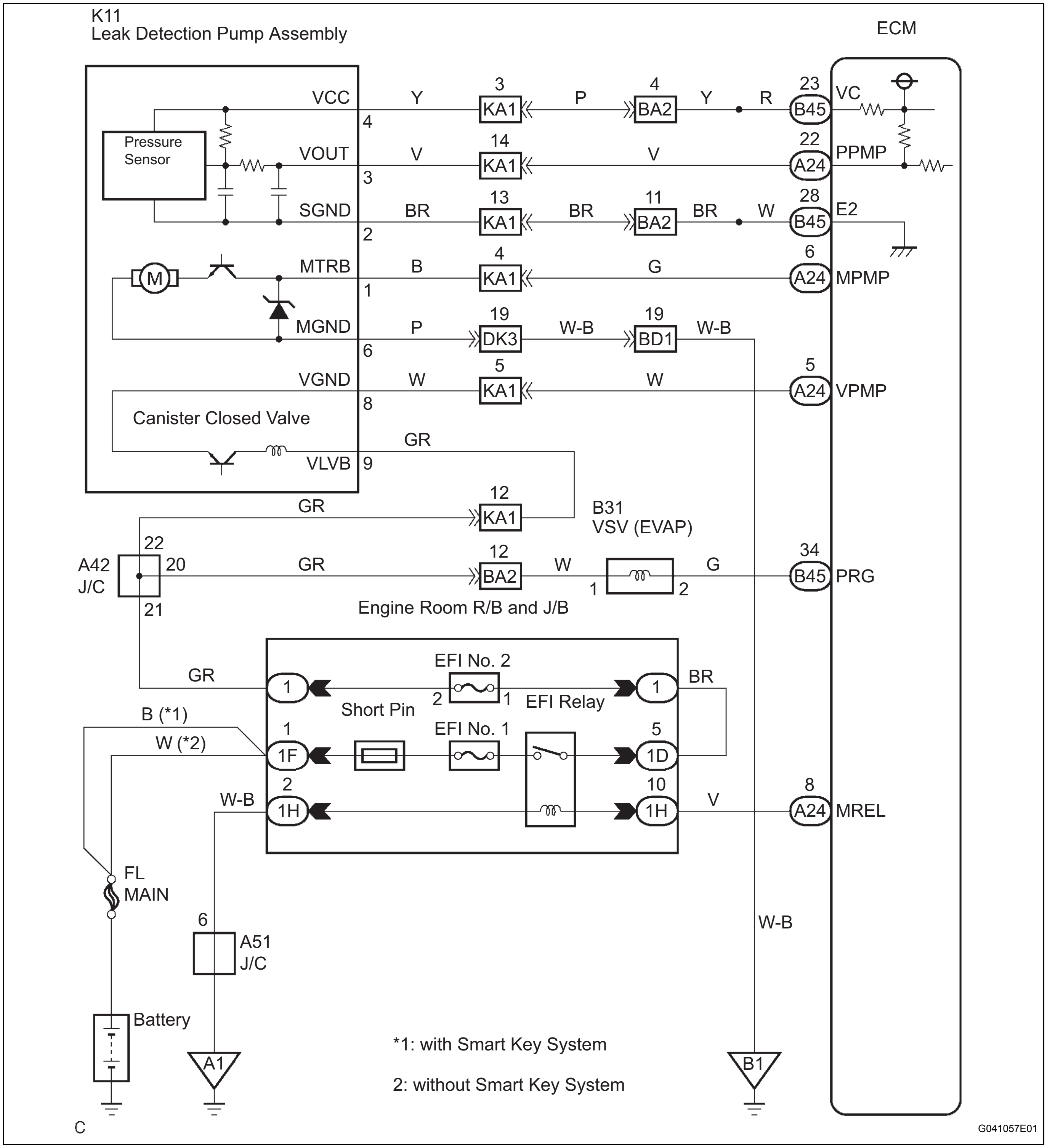
(d) P0452: Pressure sensor low voltage

EVAP pressure	Less than 42.11 kPa (316 mmHg)

(e) P0453: Pressure sensor high voltage

EVAP pressure	More than 123.761 kPa (928 mmHg)

WIRING DIAGRAM



INSPECTION PROCEDURE

NOTICE:

- **When a vehicle is brought into the workshop, leave it as it is. Do not change the vehicle condition. For example, do not tighten the fuel tank cap.**
- **Do not disassemble the pump module.**
- **The intelligent tester is required to conduct the following diagnostic troubleshooting procedure.**

1	CONFIRM DTC AND EVAP PRESSURE

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) (do not start the engine).
(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read DTCs.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / VAPOR PRESSURE.
(g) Read the EVAP (Evaporative Emission) pressure displayed on the tester.

Result

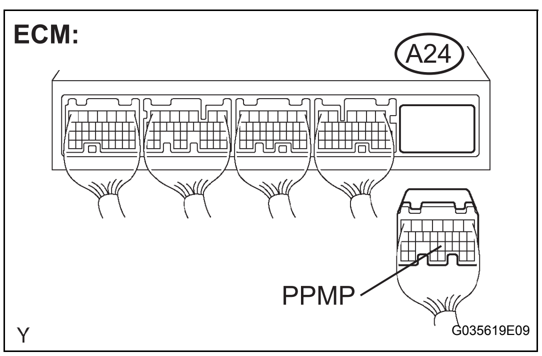
Display (DTC Output)	Test Results	Suspected Trouble Areas	Proceed to
P0451	-	Pressure sensor	C
P0452	Less than 45 kpa (338 mmHg)	• Wire harness/connector (ECM - pressure sensor) • Pressure sensor • Short in ECM circuit	A
P0453	More than 120 kPa (900 mmHg)	• Wire harness/connector (ECM - pressure sensor) • Pressure sensor • Open in ECM circuit	B

B → **Go to step 4**

C → **GO TO EVAP SYSTEM**

A

2	CHECK HARNESS AND CONNECTOR (PUMP MODULE - ECM)



(a) Turn the ignition switch off.
(b) Disconnect the A24 ECM connector.
(c) Measure the resistance between PPMP terminal of the ECM connector and the body ground.

Result

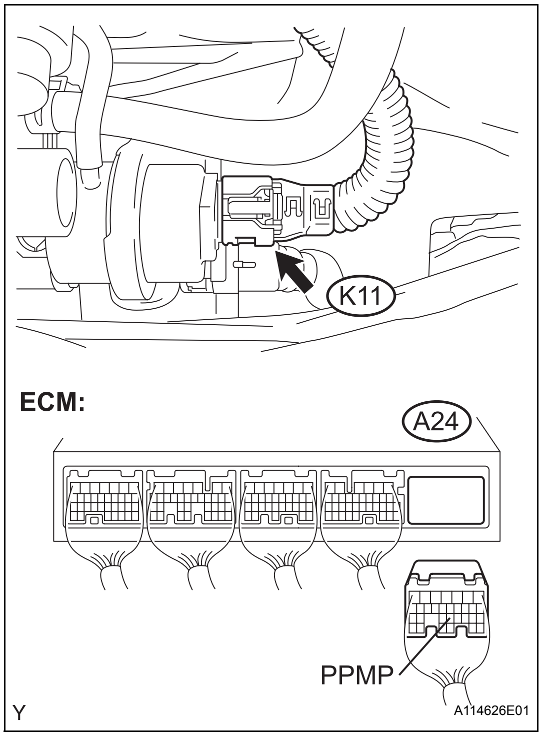
Test Results	Suspected Trouble Areas	Proceed to
10 Ω or less	• Wire harness/connector (ECM - pressure sensor) • Short in pressure sensor circuit	A
10 Ω or more	• Wire harness/connector (ECM - pressure sensor) • Short in ECM circuit	B

(d) Reconnect the ECM connector.

B → Go to step 8

A

3 CHECK HARNESS AND CONNECTOR (PUMP MODULE - ECM)



(a) Disconnect the K11 canister connector.
(b) Disconnect the A24 ECM connector.
(c) Measure the resistance between PPMP terminal of the ECM connector and the body ground.

Result

Test Results	Suspected Trouble Areas	Proceed to
10 kΩ or more	Short in pressure sensor circuit	A
10 kΩ or less	Short in wire harness/connector (ECM - pressure sensor)	B

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

B → Go to step 6

A

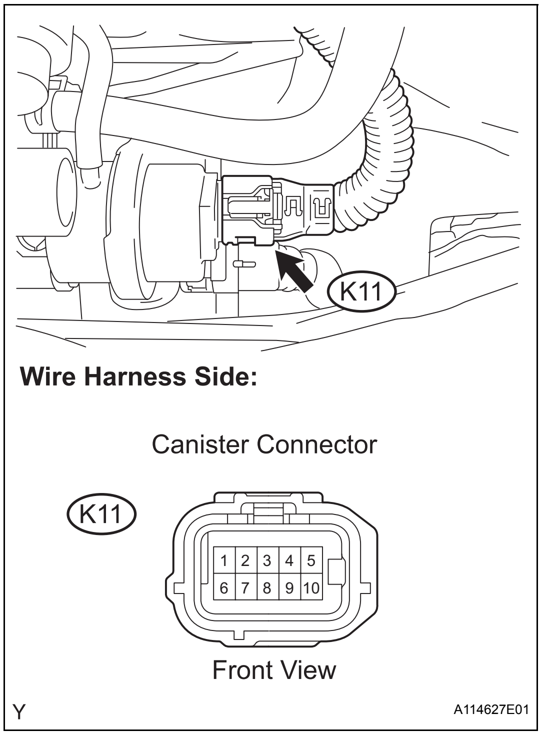
4 REPLACE CHARCOAL CANISTER ASSEMBLY

(a) Replace charcoal canister assembly (See page EC-13).
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG) and turn the tester on.
(d) Wait for at least 60 seconds.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
HINT:
If no pending DTC is displayed on the tester, the repair has been successfully completed.

NEXT

COMPLETED

5 CHECK HARNESS AND CONNECTOR (PUMP MODULE - ECM)



(a) Disconnect the K11 canister connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage and resistance of the K11 canister connector.

Standard

Tester Connections	Specified Conditions
K11-4 - Body ground	Between 4.5 V and 5.5 V
K11-3 - Body ground	Between 4.5 V and 5.5 V
K11-2 - Body ground	100 Ω or less

ES

Result

Test Results	Suspected Trouble Areas	Proceed to
Voltage and resistance is within standard ranges	Open in pressure sensor circuit	A
Voltage and resistance is outside standard ranges	Open in wire harness/connector (ECM - pressure sensor)	B

(d) Reconnect the canister connector.

B → Go to step 7

A

6 REPLACE CHARCOAL CANISTER ASSEMBLY

(a) Replace charcoal canister assembly (See page EC-13).
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG) and turn the tester on.
(d) Wait for at least 60 seconds.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
HINT:
If no pending DTC is displayed on the tester, the repair has been successfully completed.

NEXT

COMPLETED

7 REPAIR OR REPLACE WIRE HARNESS OR CONNECTORS

(a) Repair or replace wire harness or connectors.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG) and turn the tester on.
(d) Wait for at least 60 seconds.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
HINT:
If no pending DTC is displayed on the tester, the repair has been successfully completed.

NEXT

COMPLETED

8 REPLACE ECM

(a) Replace the ECM (See page ES-446).
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch on (IG) and turn the tester on.
(d) Wait for at least 60 seconds.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
HINT:
If no pending DTC is displayed on the tester, the repair has been successfully completed.

NEXT

COMPLETED

DTC	P0455	Evaporative Emission Control System Leak Detected (Gross Leak)

DTC	P0456	Evaporative Emission Control System Leak Detected (Very Small Leak)

DTC SUMMARY

DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P0455	EVAP gross leak	Vacuum pump creates negative pressure (vacuum) in EVAP system and EVAP system pressure is measured. 0.02 inch leak pressure standard is measured at start and end of leak check. If stabilized pressure is higher than [second 0.02 inch leak pressure standard x 0.2], ECM determines that EVAP system has large leakage.	• Fuel tank cap (loose) • Leakage from EVAP line (Canister - Fuel tank) • Leakage from EVAP line (Purge VSV - Canister) • Leakage from pump module • Leakage from fuel tank • Leakage from canister	While ignition switch OFF	2 trip
P0456	EVAP small leak	Vacuum pump creates negative pressure (vacuum) in EVAP system and EVAP system pressure measured. 0.02 inch leak pressure standard measured at start and end of leak check. If stabilized pressure is higher than second 0.02 inch leak pressure standard, ECM determines that EVAP system has small leakage.	Same above	While ignition switch OFF	2 trip

DESCRIPTION

The circuit description can be found in the EVAP (Evaporative Emission) System (See page ES-370).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-373).

MONITOR DESCRIPTION

5 hours*1 after the ignition switch is turned off, the electric vacuum pump creates negative pressure (vacuum) in the EVAP (Evaporative Emission) system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.

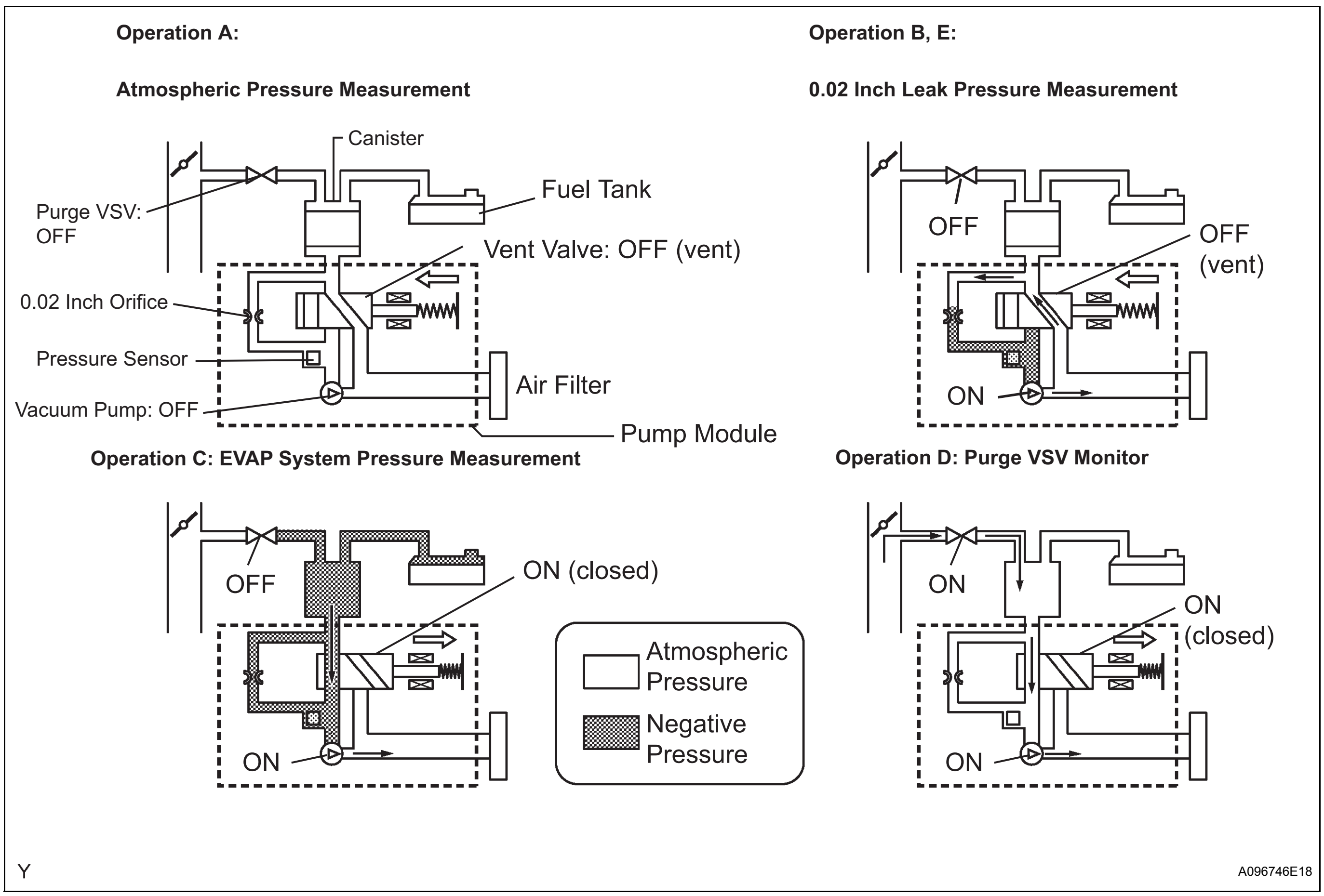
HINT:

*1: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned off, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned off, the monitor check starts 2.5 hours later.

Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned off.	-
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system is not between 70 kPa and 110 kPa (525 mmHg and 825 mmHg), ECM cancels EVAP system monitor.	10 seconds

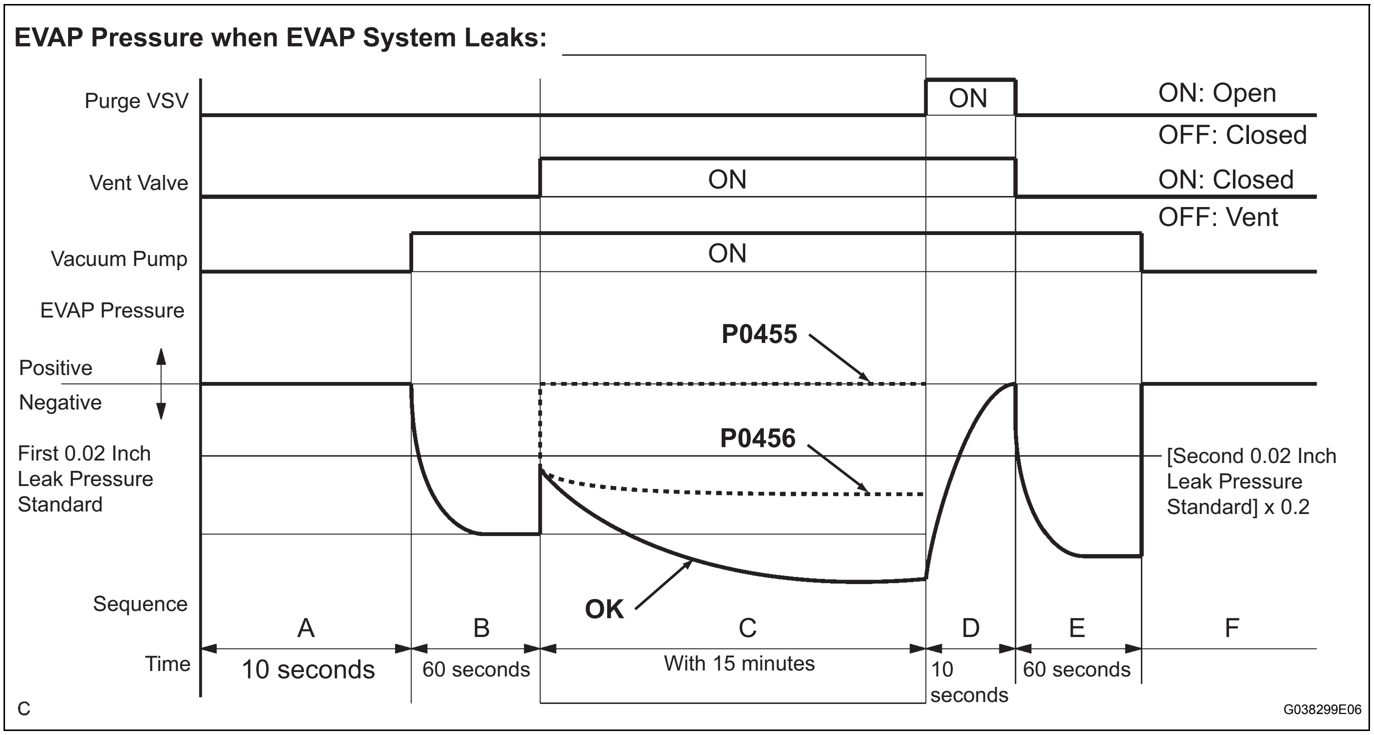
Sequence	Operations	Descriptions	Duration
B	First 0.02 inch leak pressure measurement	In order to determine 0.02 inch leak pressure standard, vacuum pump creates negative pressure (vacuum) through 0.02 inch orifice and then ECM checks if vacuum pump and vent valve operate normally.	60 seconds
C	EVAP system pressure measurement	Vent valve turned ON (closed) to shut EVAP system. Negative pressure (vacuum) is created in EVAP system, and EVAP system pressure then measured. Write down measured value as it will be used in leak check. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP system monitor.	15 minutes*2
D	Purge VSV monitor	Purge VSV is opened and then EVAP system pressure is measured by ECM. Large increase indicates normal.	10 seconds
E	Second 0.02 inch leak pressure measurement	After second 0.02 inch leak pressure measurement, leak check is performed by comparing first and second 0.02 inch leak pressure standards. If stabilized system pressure is higher than second 0.02 inch leak pressure standard, ECM determines that EVAP system leaking.	60 seconds
F	Final check	Atmospheric pressure is measured and then monitoring result is recorded by ECM.	-

*2: If there is only a small amount of fuel in the fuel tank, stabilizing the EVAP pressure takes longer than usual.



1. P0455: EVAP (Evaporative Emission) gross leak
   In operation C, the vacuum pump creates negative pressure (vacuum) in the EVAP system and the EVAP system pressure is measured. If the stabilized system pressure is higher than [second 0.02 inch leak pressure standard x 0.2] (near atmospheric pressure), the ECM determines that the EVAP system has a large leak, illuminates the MIL and sets the DTC (2 trip detection logic).

2. P0456: EVAP very small leak
   In operation C, the vacuum pump creates negative pressure (vacuum) in the EVAP system and the EVAP system pressure is measured. If the stabilized system pressure is higher than second 0.02 inch leak pressure standard, the ECM determines that the EVAP system has a small leak, illuminates the MIL and sets the DTC (2 trip detection logic).



OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Related DTCs	P0455: Gross leak detected P0456: Very small leak (0.020 inch hole) detected
Required Sensors / Components	Purge VSV and pump module
Frequency of Operation	Once per driving cycle
Duration	Within 15 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Key-off monitor is run when all of the following conditions met	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	2.5 mph (4 km/h) or less
Ignition switch	OFF
Time after key-off	5 or 7 or 9.5 hours
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
EVAP canister purge valve	Not operated by scan tool

EVAP canister vent valve	Not operated by scan tool
EVAP leak detection pump	Not operated by scan tool
Both of the following conditions 1 and 2 set before key-off	-
1. Duration that vehicle has been driven	5 minutes or more
2. EVAP purge operation	Performed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)

Key-off monitor sequence 1 to 8

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met	-
Atmospheric pressure change	Less than 0.3 kPa (2.25 mmHg) in 1 second

2. First reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2 and 3
1. EVAP pressure just after reference pressure measurement start	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated

3. EVAP canister vent valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after vent valve is ON	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction

Next sequence is run if the following condition is met	-
EVAP pressure	Saturated within 15 minutes

5. EVAP canister purge valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after purge valve is open	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2, 3 and 4
1. EVAP pressure just after reference pressure	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated
4. Difference between first reference pressure and second reference pressure	Less than 0.7 kPa (5.25 mmHg)

7. Leak check

Next sequence is run if the following condition is met	-
EVAP pressure when vacuum introduction is complete	Lower than second reference pressure

8. Atmospheric pressure measurement

EVAP monitor is complete if the following condition is met	-
Atmospheric pressure difference between sequence 1 and 8	Within 0.3 kPa (2.25 mmHg)

TYPICAL MALFUNCTION THRESHOLDS

P0455: EVAP gross leak

EVAP pressure when vacuum introduction is complete	Between reference pressure and reference pressure x 0.2

P0456: EVAP 0.02 inch leak

EVAP pressure when vacuum introduction is complete	Higher than reference pressure x 0.2

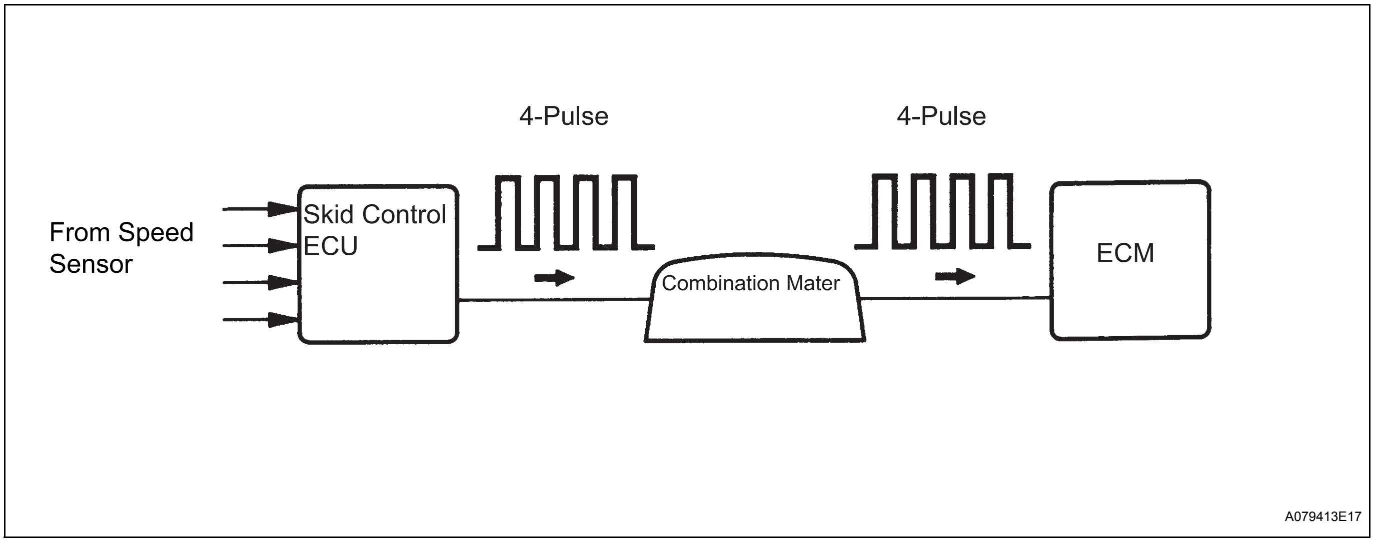
MONITOR RESULT

Refer to Monitor Result for detailed information (See page ES-25).

DTC	P0500	Vehicle Speed Sensor "A"

DESCRIPTION

Vehicles, which are equipped with ABS (Anti-lock Brake System), detect the vehicle speed using the skid control ECU and wheel speed sensor. The wheel speed sensor monitors the wheel rotation speed and sends a signal to the skid control ECU. The skid control ECU converts the wheel speed signal into a 4-pulse signal and transmits it to the ECM via the combination meter. The ECM determines the vehicle speed based on the frequency of the pulse signal.



DTC No.	DTC Detection Conditions	Trouble Areas
P0500	Satisfying all of the following conditions, 2 sec. (Intake air temperature: -10°C or more) or 8 sec. (Intake air temperature: less than -10°C) elapsed. (a) After 2 sec. (the engine coolant temperature: 20°C or more) or 30 sec. (the engine coolant temperature: less than 20°C) with the park/neutral position switch set to P, N position. (b) No abnormality of the throttle position sensor is detected. (c) After 0.5 sec. or more with the ignition switch turned ON. (d) No vehicle speed is signal to ECM. (e) The engine rpm is equal to the speed sensor rpm or more when the throttle opening angle is as shown below. 1. The throttle opening angle is less than 13° and the engine rpm is 2,350 or more. 2. The throttle opening angle is less than 21° and the engine rpm is 2,680 or more. 3. The throttle opening angle is less than 30° and the engine rpm is 2,835 or more. 4. The throttle opening angle is less than 30° and the engine rpm is 3,240 or more.	• Open or short in speed sensor circuit • Speed sensor • Combination meter • ECM • Skid control ECU

MONITOR DESCRIPTION

The ECM assumes that the vehicle is being driven when the engine speed is more than approx. 2,350 rpm over 30 seconds have passed since the park/neutral position switch was turned OFF. If there is no signal from the vehicle speed sensor with these conditions satisfied, the ECM concludes that the vehicle speed sensor is malfunctioning. The ECM will turn on the MIL and a DTC is set.

MONITOR STRATEGY

Related DTCs	P0500: Vehicle speed sensor "A" pulse input error
Required Sensors / Components (Main)	Vehicle Speed Sensor (VSS), Combination meter and Skid control ECU
Required Sensors / Components (Related)	Park/neutral Position (PNP) switch, Engine Coolant Temperature (ECT) sensor, Crankshaft Position (CKP) sensor and Mass Air Flow (MAF) meter
Frequency of Operation	Continuous
Duration	2 seconds
MIL Operation	Immediate
Sequence of Operation	None

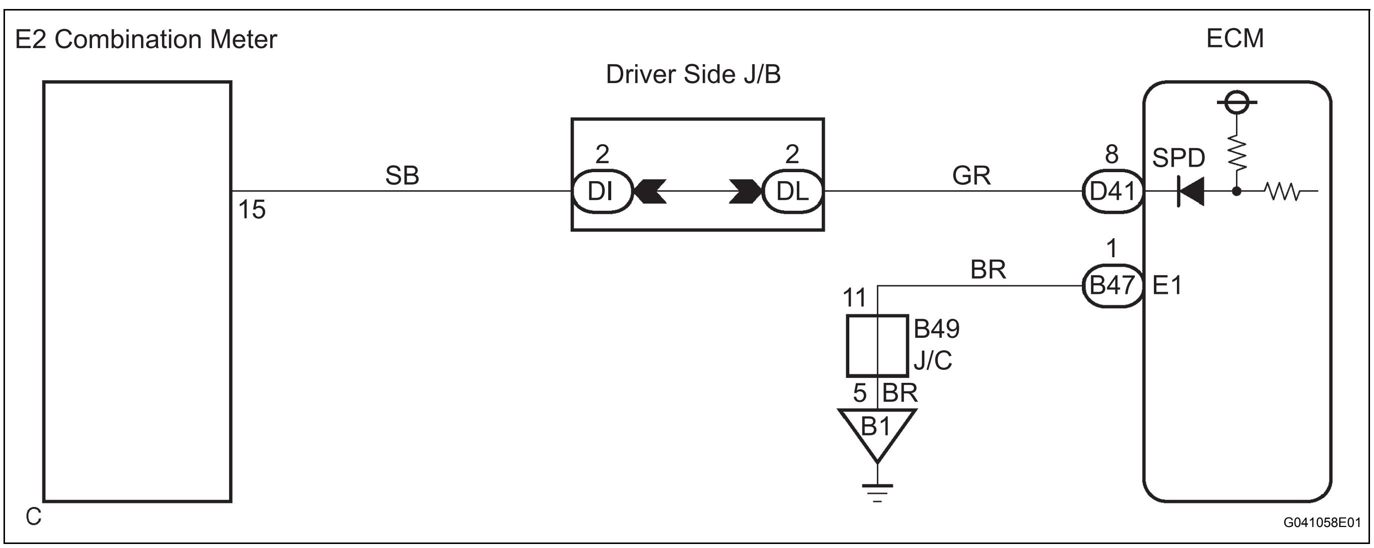
TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (TP)
Time after ignition switch OFF to ON	3 seconds or more
Engine	Running
Transmission counter gear speed	300 rpm or more
Battery voltage	8 V or more
Ignition switch	ON
Starter	OFF
Either of the following conditions is met	Condition 1 or 2
1. Both of the following conditions are met	Condition (a) or (b)
(a) ECT and ECT sensor	ECT is 20°C (68°F) or more and ECT sensor does not malfunction (P0115 or P0116)
(b) Time after PNP switch ON to OFF	10 seconds or more
2. Both of the following conditions are met	Condition (a) and (b)
(a) ECT and ECT sensor	ECT is less than 20°C (68°F) or ECT sensor malfunction (P0115 or P0116)
(b) Time after PNP switch ON to OFF	30 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

Vehicle speed sensor signal	No signal

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.

1 CHECK OPERATION OF SPEEDOMETER

(a) Drive the vehicle and check if the operation of the speedometer in the combination meter is normal.

OK:

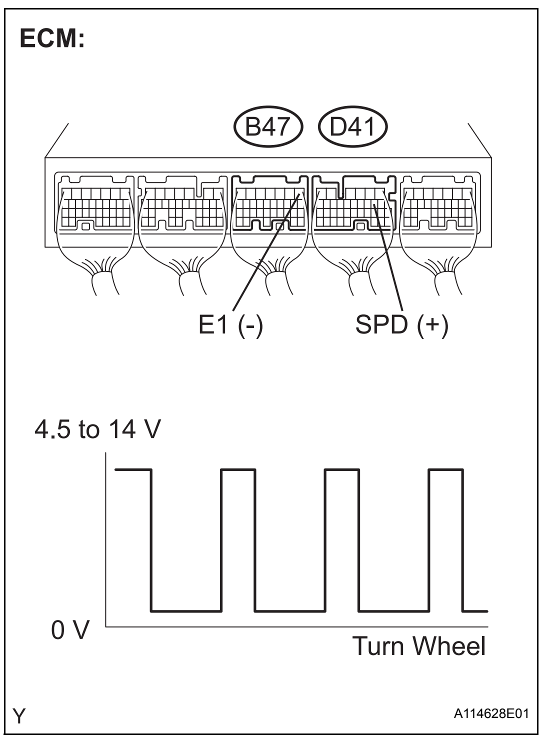
Actual vehicle speed and the speed indicated on the speedometer are the same.

HINT:
The vehicle speed sensor is operating normally if the speedometer reading is normal.

NG → **CHECK SPEEDOMETER CIRCUIT**

OK

2 INSPECT ECM (SPD VOLTAGE)



(a) Shift the shift lever to the N position.
(b) Jack up the vehicle.
(c) Turn the ignition switch on (IG).
(d) Check the voltage between the terminals of the B47 and D41 ECM connectors as the wheel is turned slowly.

OK

Tester Connections	Specified Conditions
SPD (D41-8) - E1 (B47-1)	Voltage generated intermittently

HINT:
The output voltage should fluctuate up and down similarly to the diagram on the left when the wheel is turned slowly.

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

OK

REPLACE ECM

DTC	P0504	Brake Switch "A" / "B" Correlation

DESCRIPTION

The stop light switch is a duplex system that transmits two signals: STP and ST1-. These two signals are used by the ECM to monitor whether or not the brake system is working properly. If the signals, which indicate the brake pedal is being depressed or released, are detected simultaneously, the ECM interprets this as a malfunction in the stop light switch and sets the DTC.

HINT:

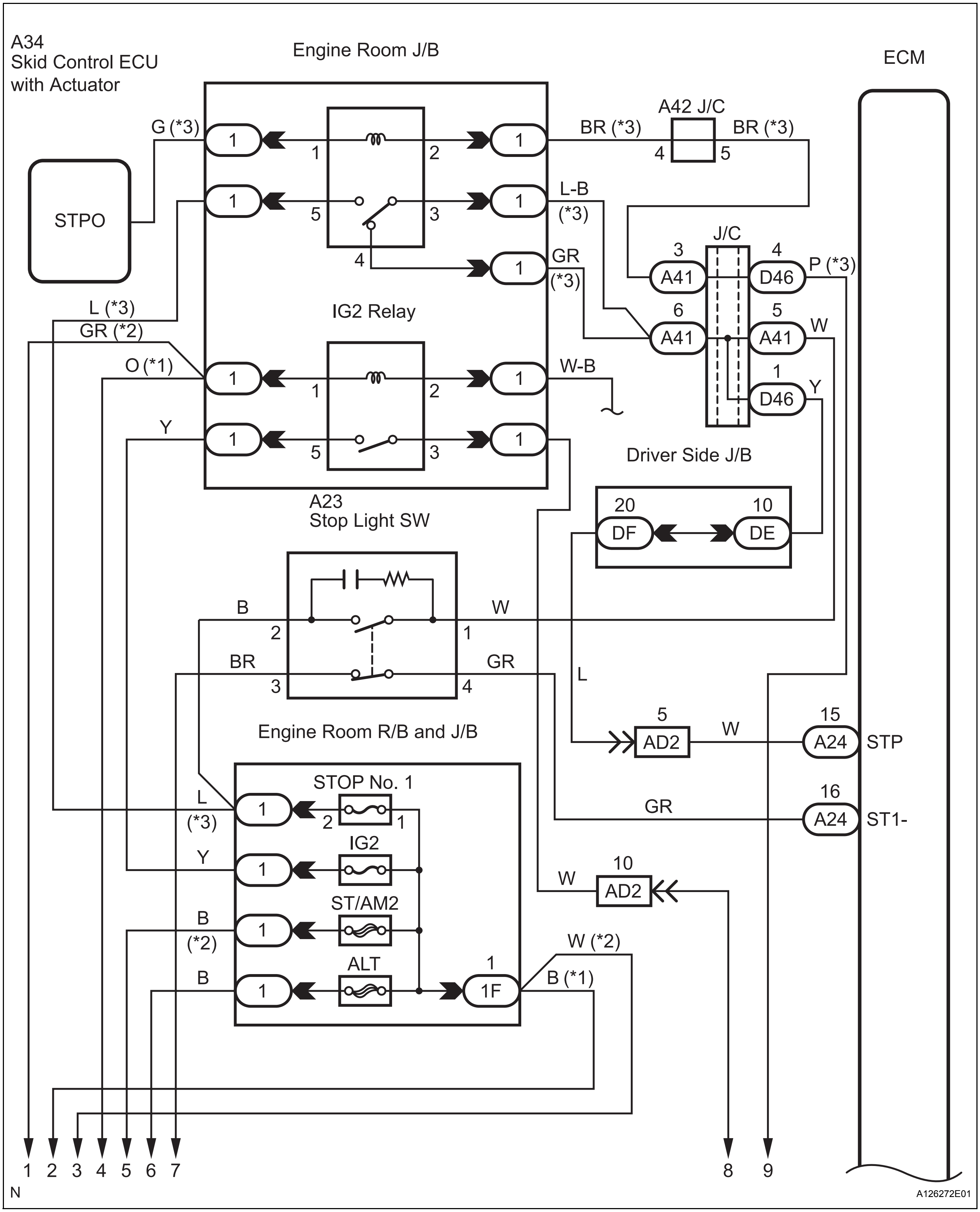
The normal conditions are as shown in the table below. The signals can be read using the intelligent tester.

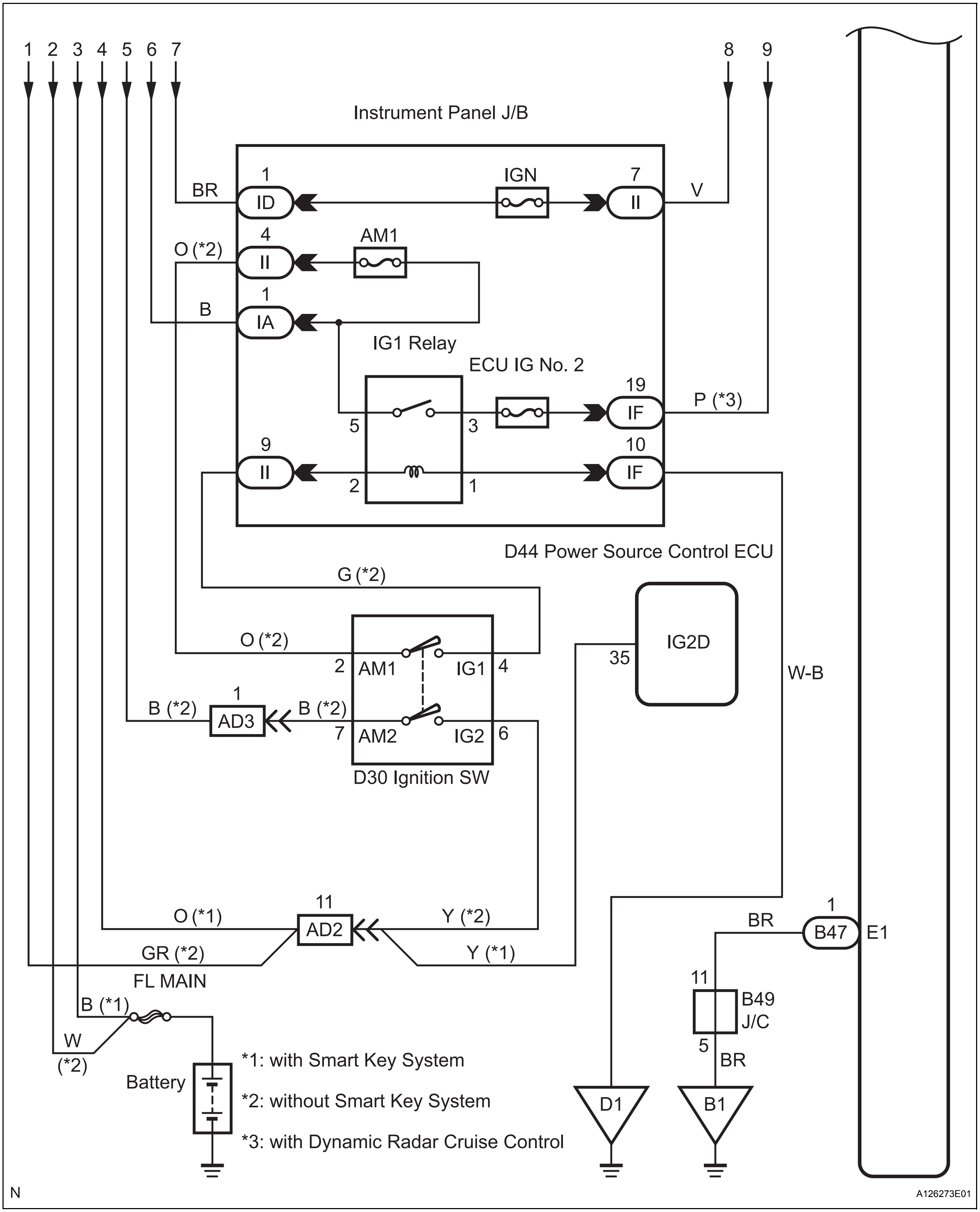
Signals	Brake Pedal Released	In Transition	Brake Pedal Depressed
STP	OFF	ON	ON
ST1-	ON	ON	OFF

DTC No.	DTC Detection Conditions	Trouble Areas
P0504	Conditions (a), (b) and (c) continue for 0.5 seconds or more (1 trip detection logic): (a) Ignition switch on (IG) (b) Brake pedal released (c) STP signal OFF when ST1- signal OFF	• Short in stop light switch signal circuit • STOP fuse • Stop light switch • ECM

ES

WIRING DIAGRAM




1 2 3 4 5 6 7
8 9
Instrument Panel J/B
BR
ID
1
IGN
7
II
V
O (*2)
4
II
AM1
B
1
IA
IG1 Relay
ECU IG No. 2
19
IF
P (*3)
5
3
9
II
10
IF
2
1
D44 Power Source Control ECU
G (*2)
IG2D
O (*2)
2
AM1
IG1
4
35
W-B
B (*2)
1
AD3
B (*2)
7
AM2
IG2
6
D30 Ignition SW
11
O (*1)
AD2
Y (*2)
1
BR
B47
E1
GR (*2)
Y (*1)
FL MAIN
11
B49
J/C
B (*1)
W
(*2)
5
BR
Battery
*1: with Smart Key System
*2: without Smart Key System
*3: with Dynamic Radar Cruise Control
D1
B1
N
A126273E01

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.

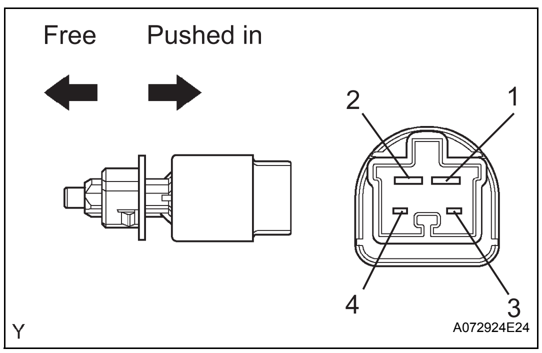
1	CHECK OPERATION OF STOP LIGHT

(a) Check whether the stop lights turn on and off normally when the brake pedal is depressed and released.
OK:
Stop lights turn on when brake pedal is depressed.

NG → **REPAIR OR REPLACE STOP LIGHT SWITCH CIRCUIT**

OK

2	INSPECT STOP LIGHT SWITCH ASSEMBLY



(a) Remove the stop light switch assembly.
(b) Measure the resistance.
Standard resistance

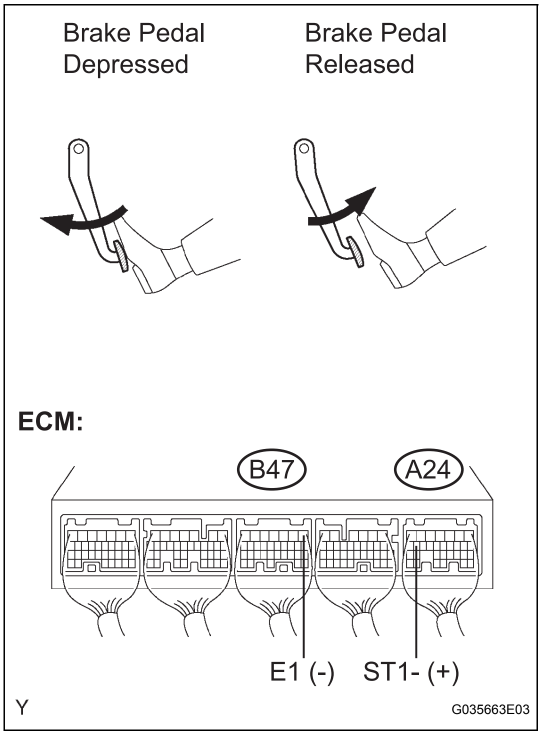
Switch Positions	Tester Connections	Specified Conditions
Switch pin free	1 - 2	Below 1 Ω
Switch pin free	3 - 4	10 kΩ or higher
Switch pin pushed in	1 - 2	10 kΩ or higher
Switch pin pushed in	3 - 4	Below 1 Ω

(c) Reinstall the stop light switch assembly.

NG → **REPLACE STOP LIGHT SWITCH ASSEMBLY**

OK

3	READ VALUE OF INTELLIGENT TESTER (STP SIGNAL AND ST1 - VOLTAGE)



(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / STOP LIGHT SW.
(d) Check the STP signal when the brake pedal is depressed and released.
Standard

Brake Pedal Operations	Specified Conditions
Depressed	STP signal ON
Released	STP signal OFF

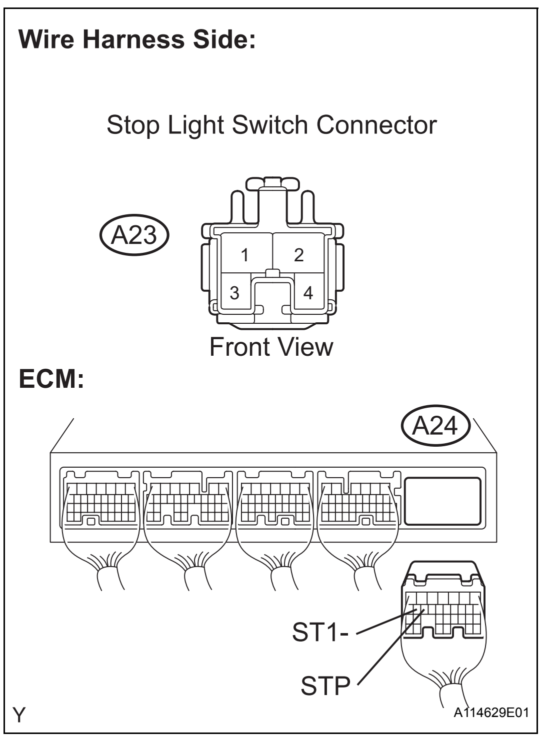
(e) Measure the voltage between the terminals of the A24 and B47 ECM connectors.
Standard voltage

Tester Connections	Brake Pedal Operations	Specified Conditions
ST1- (A24-16) - E1 (B47-1)	Depressed	Below 1.5 V
ST1- (A24-16) - E1 (B47-1)	Released	7.5 to 14 V

OK → **CHECK FOR INTERMITTENT PROBLEMS**

NG

4	CHECK HARNESS AND CONNECTOR (STOP LIGHT SWITCH - ECM)



(a) Disconnect the A23 stop light switch connector.
(b) Disconnect the A24 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
Stop light switch (A23-1) - STP (A24-15)	Below 1 Ω
Stop light switch (A23-4) - ST1- (A24-16)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Stop light switch (A23-1) or STP (A24-15) - Body ground	10 kΩ or higher
Stop light switch (A23-4) or ST1- (A24-16) - Body ground	10 kΩ or higher

(d) Reconnect the stop light switch connector.
(e) Reconnect the ECM connector.

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

ES

OK

REPLACE ECM

DTC P0505 Idle Control System Malfunction

DESCRIPTION

The idling speed is controlled by the ETCS (Electronic Throttle Control System). The ETCS is comprised of: 1) the one valve type throttle body; 2) the throttle actuator, which operates the throttle valve; 3) the Throttle Position (TP) sensor, which detects the opening angle of the throttle valve; 4) the Accelerator Pedal Position (APP) sensor, which detects the accelerator pedal position; and 5) the ECM, which controls the ETCS.
Based on the target idling speed, the ECM controls the throttle actuator to provide the proper throttle valve opening angle.

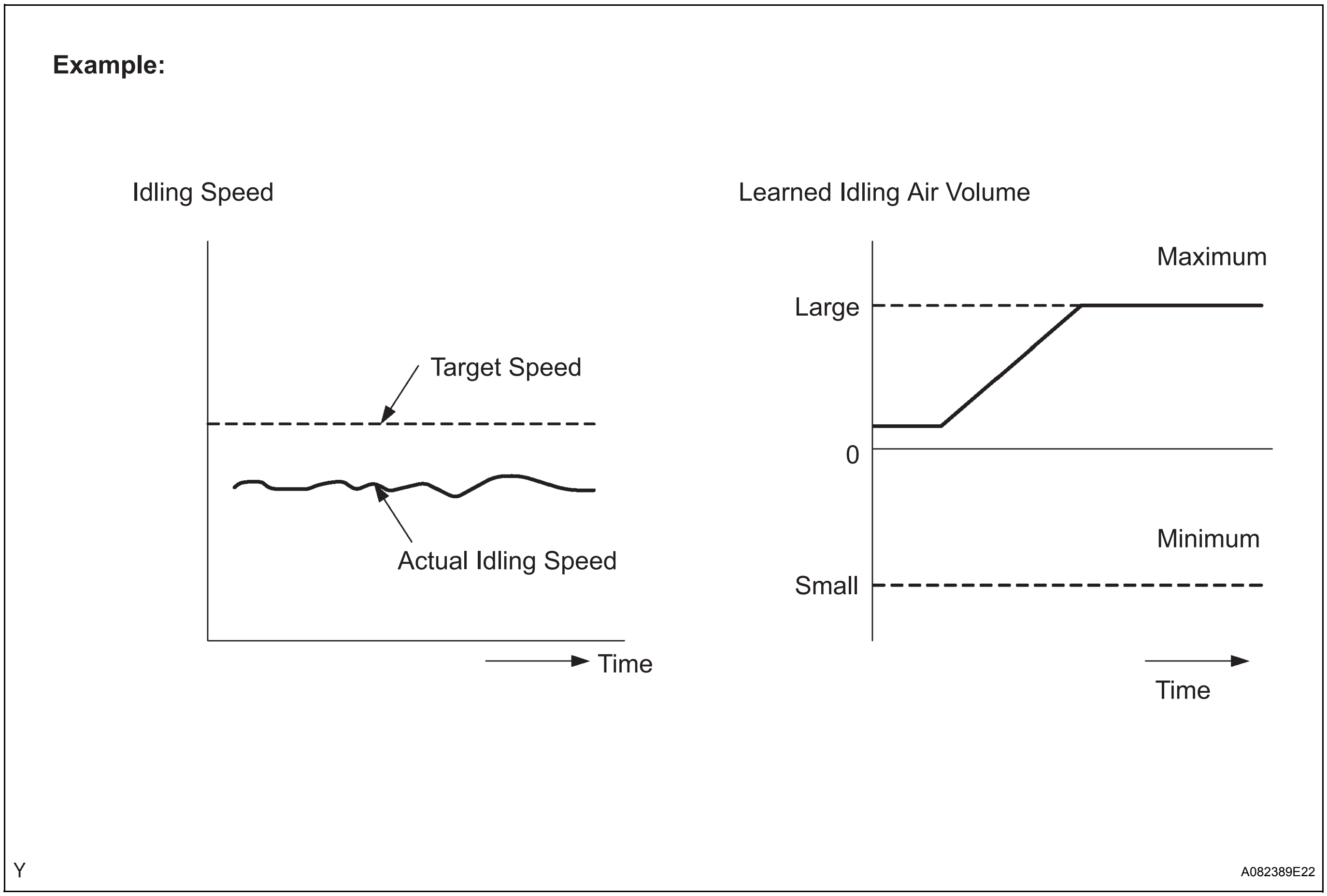
DTC No.	DTC Detection Conditions	Trouble Areas
P0505	Idling speed continues to vary greatly from target idling speed (2 trip detection logic)	• ETCS • Air induction system • PCV hose connection • ECM

MONITOR DESCRIPTION

The ECM monitors the idling speed and idling air flow volume to conduct Idle Speed Control (ISC). The ECM determines that the ISC system is malfunctioning if the following conditions apply:

- The learned idling air flow volume remains at the maximum or minimum volume 5 times or more during a drive cycle.
- While driving at 6 mph (10 km/h) or more, the actual engine idling speed varies from the target idling speed by between 100 rpm and 200 rpm, 5 times or more during a drive cycle.

Example:
If the actual idling speed varies from the target idling speed by more than 200 rpm* 5 times during a drive cycle, the ECM illuminates the MIL and sets the DTC.
*: Threshold idling speed varies with engine load.



MONITOR STRATEGY

Related DTCs	P0505: ISC Function
Required Sensors / Components (Main)	ETCS
Required Sensors / Components (Related)	Crankshaft position sensor, Engine coolant temperature sensor, and Vehicle speed sensor
Frequency of Operation	Continuous
Duration	10 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Functional check:

The monitor will run whenever these DTCs are not present	None
Engine	Running

Range check:

The monitor will run whenever these DTCs are not present	None
Time after first missing voltage change	10 seconds or more
Output signal duty	10% or more and 90% or less

Battery voltage	10 V or more

TYPICAL MALFUNCTION THRESHOLDS

Functional check:

Either of following conditions is met	Condition 1 or 2
1. Frequency that both of following conditions (a) and (b) met	5 times or more
(a) Engine RPM - target engine RPM	Below -100 rpm, or 150 rpm or more
(b) Vehicle condition	Stop after vehicle was driven by 6.25 mph (10.06 km/h) or more
2. Frequency that both of following conditions (a) and (b) met	Once
(a) Engine RPM - target engine RPM	Below -100 rpm, or 150 rpm or more
(b) IAC flow rate learning valve	1.3 L/sec. or less, or 8.5 L/sec. or more

ES

Range check:

Number of missing output voltage change	2,000 times or more

INSPECTION PROCEDURE

HINT:

- The following conditions may also cause DTC P0505 to be set:
  (a) The floor carpet overlapping slightly onto the accelerator pedal, causing the accelerator pedal to be slightly depressed and therefore the throttle valve position to be slightly open.
  (b) The accelerator pedal being not fully released.
- 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.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0505)

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

Result

Display (DTC Output)	Proceed to
P0505	A
P0505 and other DTCs	B

HINT:
If any DTCs other than P0505 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2	CHECK PCV HOSE CONNECTIONS

OK:
PCV hose is connected correctly and is not damaged.

NG → **REPAIR OR REPLACE PCV HOSE**

OK

3	CHECK AIR INDUCTION SYSTEM

ES

(a) Check the air induction system for vacuum leakage.
OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM**

OK

4	CHECK THROTTLE VALVE

(a) Check the throttle valve condition.
OK:
Normal

NG → **REPLACE THROTTLE WITH MOTOR BODY ASSEMBLY**

OK

REPLACE ECM

DTC P0560 System Voltage

MONITOR DESCRIPTION

The battery supplies electricity to the ECM even when the ignition switch is off. This power allows the ECM to store data such as DTC history, freeze frame data and fuel trim values. If the battery voltage falls below a minimum level, these memories are cleared and the ECM determines that there is a malfunction in the power supply circuit. When the engine is next started, the ECM illuminates the MIL and sets the DTC.

DTC No.	DTC Detection Conditions	Trouble Areas
P0560	Open in ECM back up power source circuit (1 trip detection logic)	• Open in back up power source circuit • EFI No. 1 fuse • ECM

HINT:
If DTC P0560 is set, the ECM does not store other DTCs.

MONITOR STRATEGY

Related DTCs	P0560: ECM system voltage
Required Sensors / Components (Main)	ECM
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	3 seconds
MIL Operation	Immediate (MIL illuminated after next engine start)
Sequence of Operation	None

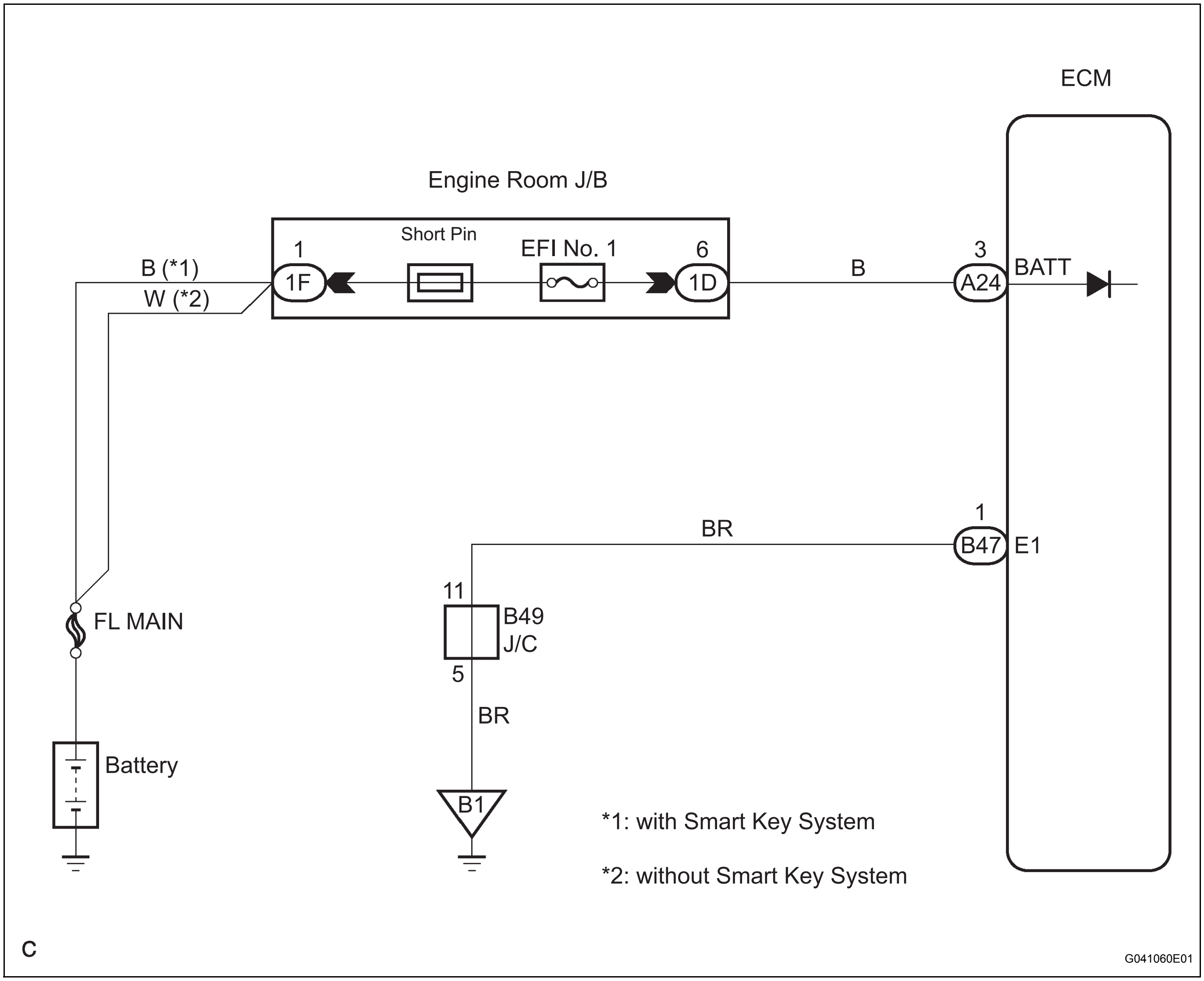
TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Stand-by RAM	Initialized

TYPICAL MALFUNCTION THRESHOLDS

ECM power source	Less than 3.5 V

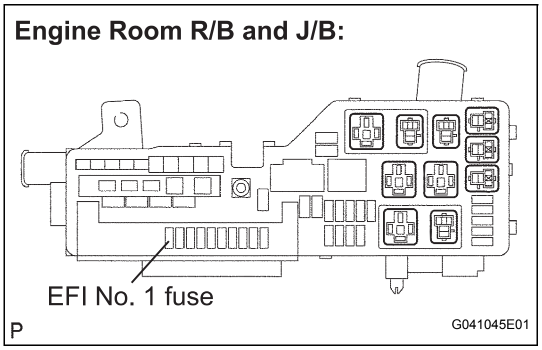
WIRING DIAGRAM



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.

1	CHECK FUSE (EFI FUSE)



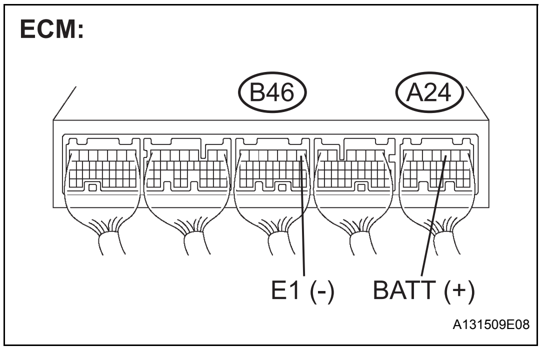
(a) Remove the EFI No.1 fuse from the engine room R/B and J/B.
(b) Measure the resistance.
Standard resistance:
Below 1 Ω
(c) Reinstall the EFI No. 1 fuse.

NG → **CHECK FOR SHORT IN ALL HARNESS AND COMPONENTS CONNECTED TO FUSE, AND REPLACE FUSE**

ES

OK

2	INSPECT ECM (BATT VOLTAGE)



(a) Measure the voltage between the terminals of the A24 and B47 ECM connectors.
Standard voltage

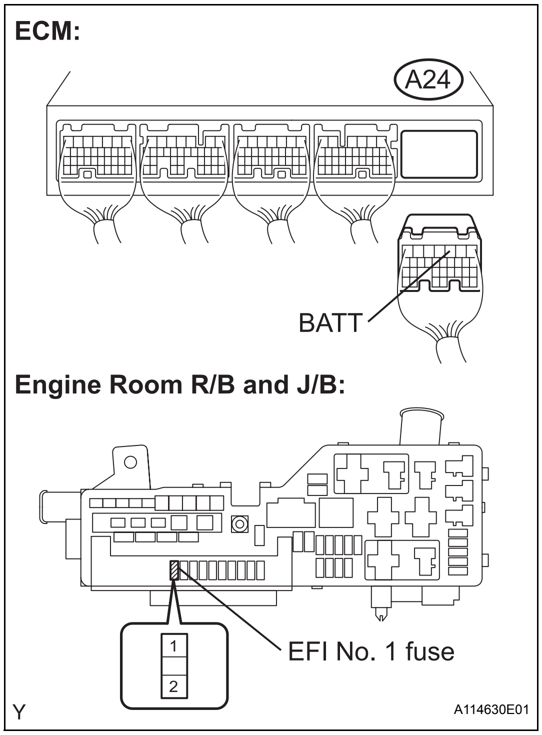
Tester Connections	Specified Conditions
BATT (A24-3) - E1 (B47-1)	9 to 14 V

NG → **Go to step 3**

OK

REPLACE ECM

3	CHECK HARNESS AND CONNECTOR (ECM - EFI FUSE, EFI FUSE - BATTERY)



(a) Check the harness and the connector between the EFI No. 1 fuse and ECM.
(1) Remove the EFI No. 1 fuse from the engine room R/B and J/B.
(2) Disconnect the A24 ECM connector.
(3) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
EFI No. 1 fuse (2) - BATT (A24-3)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
EFI No. 1 fuse (2) or BATT (A24-3) - Body ground	10 kΩ or higher

(4) Reconnect the ECM connector.
(5) Reinstall the EFI No. 1 fuse.

(b) Check the harness and the connector between the EFI No. 1 fuse and battery.
(1) Remove the EFI No. 1 fuse from the engine room R/B and J/B.
(2) Disconnect the negative battery cable.
(3) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Battery positive terminal - EFI No .1 fuse (1)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Battery positive terminal or EFI No. 1 fuse (1) - Body ground	10 kΩ or higher

(4) Reconnect the negative battery cable.
(5) Reinstall the EFI No. 1 fuse.

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

OK

4	INSPECT BATTERY

(a) Check that the battery is not depleted.

NG → **REPLACE BATTERY**

OK

CHECK AND REPLACE ENGINE ROOM RELAY BLOCK

DTC	P0604	Internal Control Module Random Access Memory (RAM) Error

DTC	P0606	ECM / PCM Processor

DTC	P0607	Control Module Performance

DTC	P0657	Actuator Supply Voltage Circuit / Open

MONITOR DESCRIPTION

The ECM continuously monitors its own internal memory status, internal circuits, and output signals transmitted to the throttle actuator. This self-check ensures that the ECM is functioning properly. If any malfunction is detected, the ECM sets the appropriate DTC and illuminates the MIL.
The ECM memory status is diagnosed by internal mirroring of the main CPU and the sub CPU to detect Random Access Memory (RAM) errors. The two CPUs also perform continuous mutual monitoring. The ECM illuminates the MIL and sets a DTC if: 1) outputs from the two CPUs are different or deviate from the standards, 2) the signals sent to the throttle actuator deviate from the standards, 3) a malfunction is found in the throttle actuator supply voltage, and 4) any other ECM malfunction is found.

DTC No.	DTC Detection Conditions	Trouble Areas
P0604 P0606 P0607 P0657	ECM internal error (1 trip detection logic)	ECM

MONITOR STRATEGY

Related DTCs	P0604: ECM RAM error P0606: ECM range check P0607: ECM CPU malfunction P0657: ETCS power supply
Required Sensors / Components (Main)	ECM
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	Within 1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None

TYPICAL MALFUNCTION THRESHOLDS

ECM RAM errors (P0604):

RAM mirror	RAM mirror check failure

ECM CPU range check (P0606):

Either of following conditions met:	-
Difference between throttle valve position of main CPU and throttle valve position of sub CPU	0.3 V or more
Difference between accelerator pedal position of main CPU and accelerator pedal position of sub CPU	0.3 V or more

ECM CPU malfunction (P0607):

Either of the following conditions met	Condition A or B
A. All of following condition met	Condition 1, 2 and 3
1. CPU reset	1 time
2. Learned TP - learned APP	0.4 V or more
3. Throttle actuator	OFF
B. CPU reset	2 times or more

Electronic throttle control system power supply function of ECM malfunctions (P0657):

ETCS (Electronic Throttle Control System) power supply when ignition switch turned to ON	7 V or more

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.

1	REPLACE ECM

(a) Replace the ECM (See page ES-446).

NEXT

END

DTC P0617 Starter Relay Circuit High

MONITOR DESCRIPTION

While the engine is being cranked, the positive battery voltage is applied to terminal STA of the ECM.
If the ECM detects the Starter Control (STA) signal while the vehicle is being driven, it determines that there is a malfunction in the STA circuit. The ECM then illuminates the MIL and sets the DTC.
This monitor runs when the vehicle is driven at 12.4 mph (20 km/h) for over 20 seconds.

DTC No.	DTC Detection Conditions	Trouble Areas
P0617	When conditions (a), (b) and (c) are met, positive (+B) battery voltage 10.5 V or more is applied to ECM for 20 seconds (1 trip detection logic): (a) Vehicle speed more than 12.4 mph (20 km/h) (b) Engine speed more than 1,000 rpm (c) STA signal ON	• Park/Neutral Position (PNP) switch • Starter relay circuit • Ignition switch • ECM

MONITOR STRATEGY

Related DTCs	P0617: Starter signal
Required Sensors / Components (Main)	STARTER relay, PNP switch, Clutch start switch and Ignition switch
Required Sensors / Components (Related)	Vehicle Speed Sensor (VSS), Crankshaft Position (CKP) sensor
Frequency of Operation	Continuous
Duration	20 seconds
MIL Operation	Immediate
Sequence of Operation	None

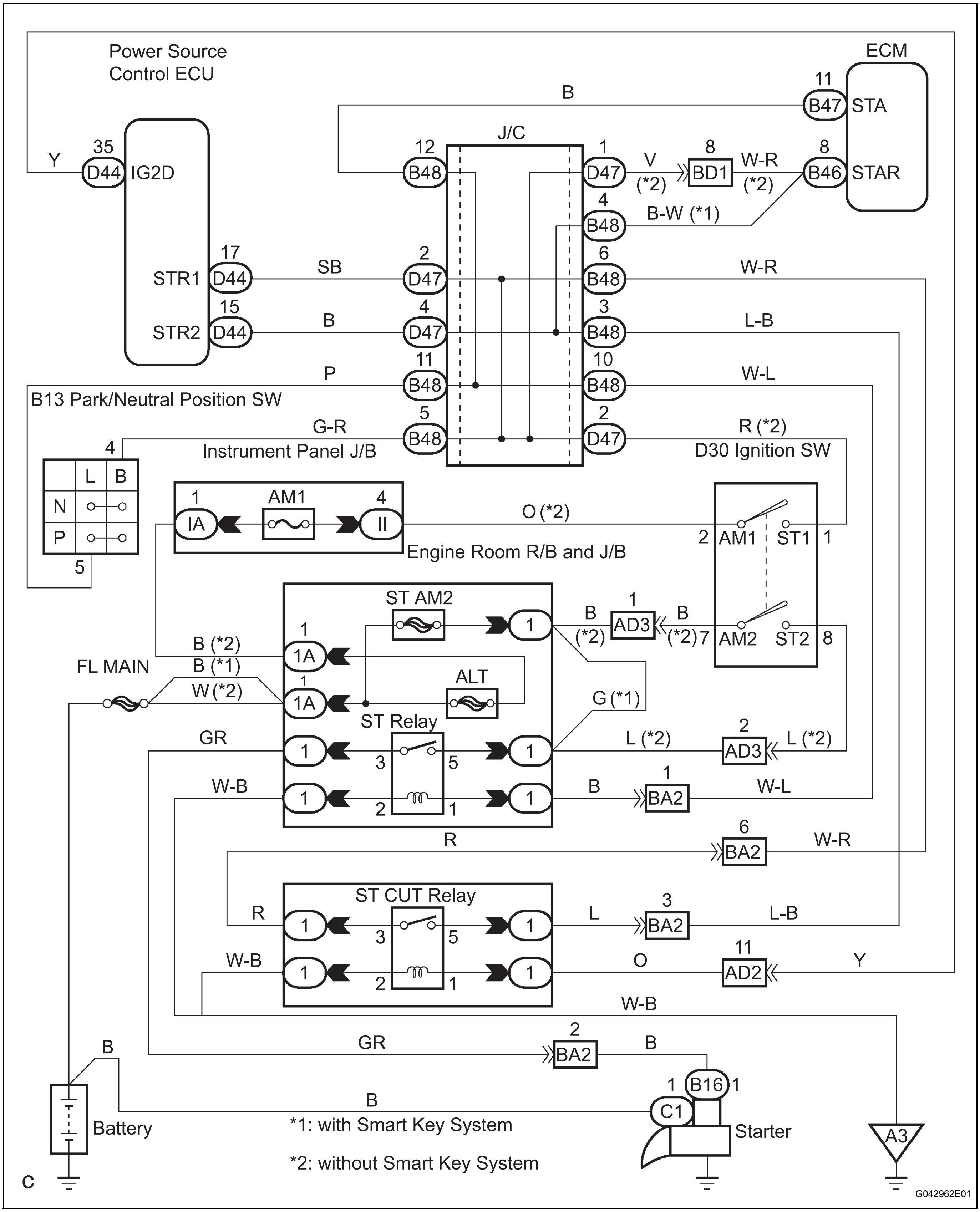
TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Battery voltage	10.5 V or more
Vehicle speed	12.4 mph (20 km/h) or more
Engine speed	1,000 rpm or more

TYPICAL MALFUNCTION THRESHOLDS

Starter signal	ON

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:

- The following troubleshooting flowchart is based on the premise that the engine is cranked normally. If the engine will not crank, proceed to the problem symptoms table (See page ES-30).
- 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.

1	READ VALUE OF INTELLIGENT TESTER (STARTER SIGNAL)

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / STARTER SIG.
(d) Check the value displayed on the tester when the ignition switch is turned on (IG) and START positions.

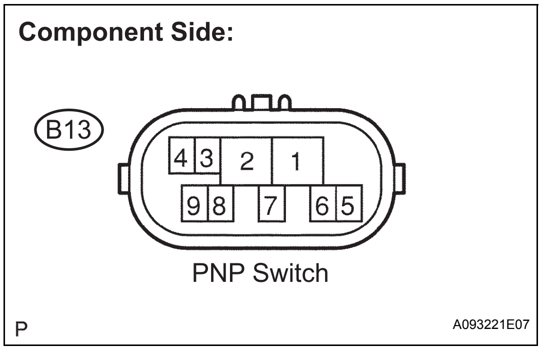
OK

Ignition Switch Positions	STARTER SIG
ON	OFF
START	ON

OK → **REPLACE ECM**

NG

2	INSPECT PARK/NEUTRAL POSITION SWITCH



(a) Inspect the Park/Neutral Position (PNP) switch.
(1) Disconnect the B13 PNP switch connector.
(2) Measure the resistance when the transmission gear selector lever is moved to each position.
Standard resistance

Gear Selector Lever Positions	Tester Connections	Specified Conditions
P	2 - 6, 4 - 5	Below 1 Ω
R	1 - 2	Below 1 Ω
N	2 - 9, 4 - 5	Below 1 Ω
D	2 - 7	Below 1 Ω
2	2 - 3	Below 1 Ω
L	2 - 8	Below 1 Ω

(3) Reconnect the PNP switch connector.

NG → **REPLACE PARK/NEUTRAL POSITION SWITCH**

OK

ES

3	READ VALUE OF INTELLIGENT TESTER (STARTER SIGNAL)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / STARTER SIG.
(d) Check the value displayed on the tester when the ignition switch is turned on (IG) and engine start.

OK

Ignition Switch Positions	STARTER SIG
ON	OFF
START	ON

OK → **SYSTEM OK**

NG

4	INSPECT IGNITION OR STARTER SWITCH ASSEMBLY

(a) Inspect the ignition or starter switch assembly (See page ST-85).

NG → **REPLACE IGNITION OR STARTER SWITCH ASSEMBLY**

OK

5	READ VALUE OF INTELLIGENT TESTER (STARTER SIGNAL)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / STARTER SIG.
(d) Check the value displayed on the tester when the ignition switch is turned on (IG) and engine start.

OK

Ignition Switch Positions	STARTER SIG
ON	OFF
START	ON

OK → **SYSTEM OK**

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

DTC	P0630	VIN not Programmed or Mismatch - ECM / PCM

DESCRIPTION

DTC P0630 is set when the Vehicle Identification Number (VIN) is not stored in the Engine Control Module (ECM) or the input VIN is not accurate. Input the VIN with the intelligent tester.

DTC No.	DTC Detection Conditions	Trouble Areas
P0630	• VIN is not stored in ECM • Input VIN in ECM is not accurate	ECM

MONITOR STRATEGY

Related DTCs	P0630: VIN not programmed
Required Sensors / Components (Main)	ECM
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	0.325 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Battery voltage	8 V or more
Ignition switch	ON
Ignition switch	OFF

TYPICAL MALFUNCTION THRESHOLDS

VIN code	Not programmed

COMPONENT OPERATING RANGE

VIN code	Programmed

INSPECTION PROCEDURE

1	READ CURRENT DTC

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

Result

Display (DTC Output)	Proceed to
P0630	**A**
P0630 and other DTCs	**B**

If any DTCs other than P0630 are output, troubleshoot those DTCs first.

ES

NOTICE:
If P0630 is set, the VIN must be input to the ECM using the intelligent tester. However, all DTCs are cleared automatically by the tester when inputting the VIN. If DTCs other than P0630 are set, check them first.

B → **GO TO DTC CHART**

A

2	INPUT VIN WITH INTELLIGENT TESTER

HINT:
Refer to "REGISTRATION" (See page ES-19).

NEXT

3	READ CURRENT DTC

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read DTC again.
Result:
DTC is not output (P0630).

NG → **REPLACE ECM**

OK

END

DTC	P2102	Throttle Actuator Control Motor Circuit Low

DTC	P2103	Throttle Actuator Control Motor Circuit High

DESCRIPTION

The throttle actuator is operated by the ECM and opens and closes the throttle valve using gears.
The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM. This feedback allows the ECM to appropriately control the throttle actuator and monitor the throttle opening angle as the ECM responds to driver inputs.
HINT:
This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC No.	DTC Detection Conditions	Trouble Areas
P2102	Conditions (a) and (b) continue for 2.0 seconds (1 trip detection logic): (a) Throttle actuator duty ratio exceeds 80% or more (b) Throttle actuator current is 0.5 A or less	• Open in throttle actuator circuit • Throttle actuator • ECM
P2103	Throttle actuator current is 7 A or more for 0.6 seconds (1 trip detection logic)	• Short in throttle actuator circuit • Throttle actuator • Throttle valve • Throttle body • ECM

MONITOR DESCRIPTION

The ECM monitors the electrical current through the electronic actuator, and detects malfunctions and open circuits in the throttle actuator based on this value. If the current is outside the standard range, the ECM determines that there is a malfunction in the throttle actuator. In addition, if the throttle valve does not function properly (for example, stuck on), the ECM determines that there is a malfunction. The ECM then illuminates the MIL and sets a DTC.
Example:
When the electrical current is more than 10 A, or less than 0.5 A and the throttle actuator duty ratio exceeds 80%, the ECM interprets this as the current being outside the standard range, and illuminates the MIL and sets a DTC.
If the malfunction is not repaired successfully, a DTC is set when the engine is quickly revved to a high rpm several times after the engine has idled for 5 seconds after engine start.

MONITOR STRATEGY

Related DTCs	P2102: Throttle actuator current (low current) P2103: Throttle actuator current (high current)
Required Sensors / Components (Main)	Throttle actuator (throttle body)
Required Sensors / Components (Related)	None
Frequency of Operation	Continuous
Duration	P2102: 2 seconds P2103: 25 times or 0.6 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None

P2102:

Throttle motor	ON
Duty-cycle ratio to open throttle actuator	80% or more
Throttle actuator power supply	8 V or more
Current motor current - Motor current at 0.016 sec. before	Less than 0.2 A

P2103:

Throttle motor	ON
Either of the following conditions met:	Condition 1 or 2
1. Throttle actuator power supply	8 V or more
2. Throttle actuator power	ON
Battery voltage	8 V or more
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

P2102:

Throttle actuator current	Less than 0.5 A

P2103:

Either of the following conditions met	Condition 1 or 2
1. Hybrid IC diagnosis signal	Fail for 25 times
2. Hybrid IC current limiter port	Fail for 0.6 seconds

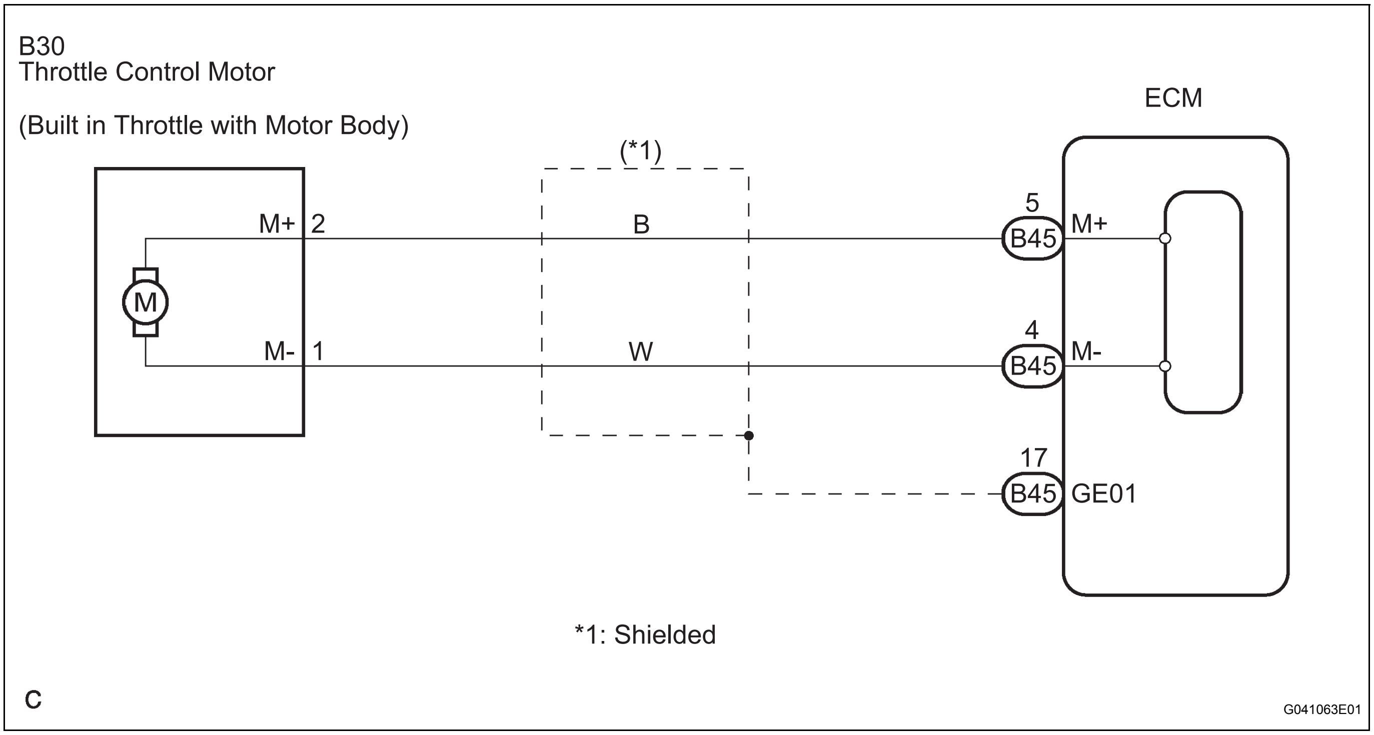
FAIL-SAFE

When either of these DTCs, 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 ignition switch is then turned off.

WIRING DIAGRAM

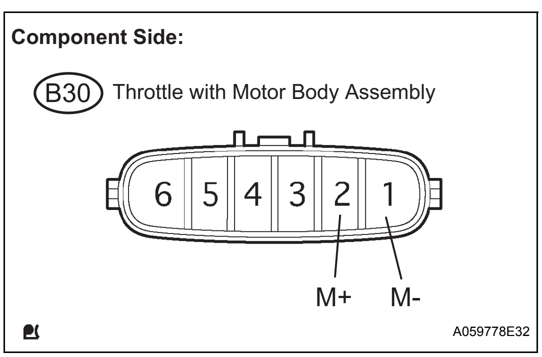


INSPECTION PROCEDURE

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.
- The throttle actuator current (THROTTLE MOT) and the throttle actuator duty ratio (THROTTLE OPN / THROTTLE CLS) can be read using the intelligent tester. However the ECM shuts off the throttle actuator current when the ETCS malfunctions.

1	INSPECT THROTTLE WITH MOTOR BODY ASSEMBLY (RESISTANCE OF THROTTLE CONTROL MOTOR)



(a) Disconnect the B30 throttle with motor body connector.

(b) Measure the resistance between the terminals of the throttle control motor.

Standard resistance

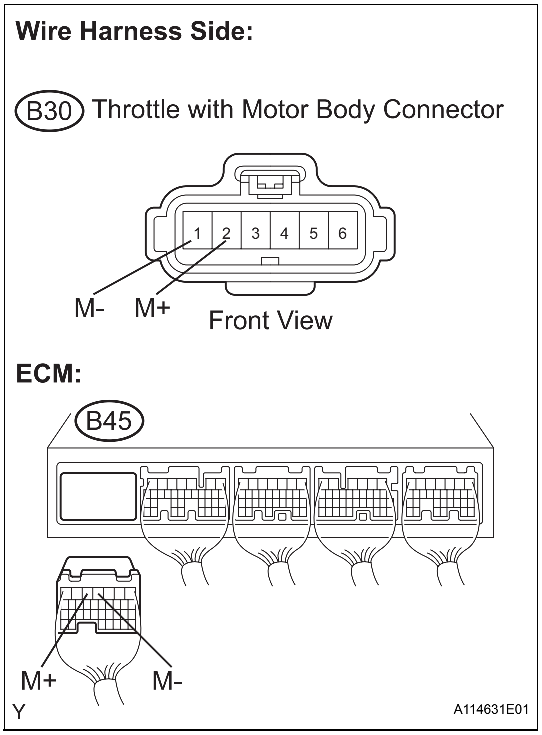
Tester Connections	Specified Conditions
M+ (B30-2) - M- (B30-1)	0.3 to 100 Ω at 20°C (68°F)

(c) Reconnect the throttle with motor body connector.

NG → **REPLACE THROTTLE WITH MOTOR BODY ASSEMBLY**

OK

2	CHECK HARNESS AND CONNECTOR (THROTTLE CONTROL MOTOR - ECM)



(a) Disconnect the B30 throttle with motor body connector.
(b) Disconnect the B45 ECM connector.
(c) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
M+ (B30-2) - M+ (B45-5)	Below 1 Ω
M- (B30-1) - M- (B45-4)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
M+ (B30-2) or M+ (B45-5) - Body ground	10 kΩ or higher
M- (B30-1) or M- (B45-4) - Body ground	10 kΩ or higher

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

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

OK

3	INSPECT THROTTLE WITH MOTOR BODY ASSEMBLY

(a) Check for foreign objects between the throttle valve and the housing.
OK:
Normal

NG → **REMOVE FOREIGN OBJECT AND CLEAN THROTTLE BODY**

OK

4	INSPECT THROTTLE VALVE

(a) Check if the throttle valve opens and closes smoothly.
OK:
The throttle valve opens and closes smoothly.

NG → **REPLACE THROTTLE WITH MOTOR BODY ASSEMBLY**

OK

REPLACE ECM

DTC	P2111	Throttle Actuator Control System - Stuck Open

DTC	P2112	Throttle Actuator Control System - Stuck Closed

DESCRIPTION

The throttle actuator is operated by the ECM, and opens and closes the throttle valve using gears. The opening angle of the throttle valve is detected by the Throttle Position (TP) sensor, which is mounted on the throttle body. The TP sensor provides feedback to the ECM so that it can control the throttle actuator, and the throttle valve, appropriately in response to driver inputs.
HINT:
This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC No.	DTC Detection Conditions	Trouble Areas
P2111	ECM signals throttle actuator to close, but stuck (1 trip detection logic)	• Throttle actuator • Throttle body • Throttle valve
P2112	ECM signals throttle actuator to open, but stuck (1 trip detection logic)	• Throttle actuator • Throttle body • Throttle valve

MONITOR DESCRIPTION

The ECM determines that there is a malfunction in the ETCS when the throttle valve remains at the fixed angle despite a high drive current from the ECM. The ECM illuminates the MIL and sets a DTC.
If the malfunction is not repaired successfully, a DTC is set when the accelerator pedal is fully depressed and released quickly (to fully open and close the throttle valve) after the engine is next started.

MONITOR STRATEGY

Related DTCs	P2111: Throttle actuator stuck open P2112: Throttle actuator stuck closed
Required Sensors / Components (Main)	Throttle actuator
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

P2111 (Throttle actuator stuck open):

All of following conditions met	-
System guard*	ON
Throttle actuator current	2 A or more
Throttle actuator close duty ratio	80% or more

P2112 (Throttle actuator stuck closed):

All of following conditions met	-
System guard*	ON
Throttle actuator current	2 A or more

Throttle actuator open duty-cycle	80% or more

*: System guard set when following conditions met

Throttle actuator	ON
Throttle actuator duty calculation	Executing
Throttle position sensor	Fail determined
Throttle actuator current-cut operation	Not executing
Throttle actuator power supply	4 V or more
Throttle actuator	Fail determined

TYPICAL MALFUNCTION THRESHOLDS

ES

P2111 (Throttle actuator stuck open):

TP sensor voltage change	No change

P2112 (Throttle actuator stuck closed):

TP sensor voltage change	No change

FAIL-SAFE

When either of these DTCs, 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 fully depressed slowly, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the ignition switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (See page ES-289).

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.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2111 OR P2112)

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

Result

Display (DTC Output)	Proceed to
P2111 or P2112	A
P2111 or P2112 and other DTCs	B

HINT:
If any DTCs other than P2111 or P2112 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2 INSPECT THROTTLE WITH MOTOR BODY ASSEMBLY (VISUALLY CHECK THROTTLE VALVE)

(a) Check for contamination between the throttle valve and the housing. If necessary, clean the throttle body. And check that the throttle valve moves smoothly.

OK:

Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → **REPLACE THROTTLE WITH MOTOR BODY ASSEMBLY**

OK

3 CHECK WHETHER DTC OUTPUT RECURS (DTC P2111 OR P2112)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Clear DTCs (See page ES-44).
(e) Start the engine, and fully depress and release the accelerator pedal quickly (to fully open and close the throttle valve).
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read DTCs.

Result

Display (DTC Output)	Proceed to
No DTC	A
P2111 or P2112	B

B → **REPLACE ECM**

A

CHECK FOR INTERMITTENT PROBLEMS

DTC	P2118	Throttle Actuator Control Motor Current Range / Performance

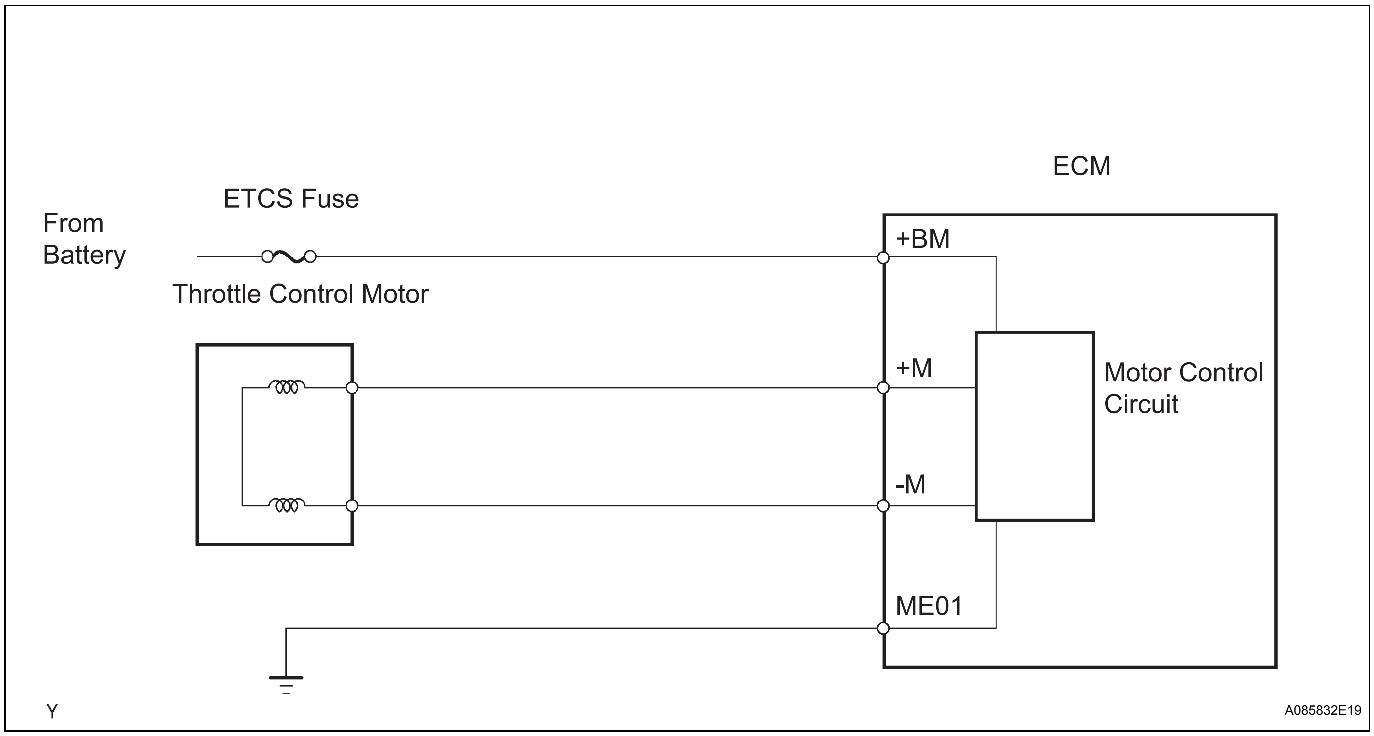
DESCRIPTION

The ETCS (Electronic Throttle Control System) has a dedicated power supply circuit. The voltage (+BM) is monitored and when it is low (less than 4 V), the ECM determines that there is a malfunction in the ETCS and cuts off the current to the throttle actuator.

When the voltage becomes unstable, the ETCS itself becomes unstable. For this reason, when the voltage is low, the current to the throttle actuator is cut. If repairs are made and the system returns to normal, turn the ignition switch off. The ECM then allows the current to flow to the throttle actuator so that it can be restarted.

HINT:

The ETCS does not use a throttle cable.



DTC No.	DTC Detection Conditions	Trouble Areas
P2118	Open in ETCS power source (+BM) circuit (1 trip detection logic)	• Open in ETCS power source circuit • ETCS fuse • ECM

MONITOR DESCRIPTION

The ECM monitors the battery supply voltage applied to the throttle actuator.

When the power supply voltage (+BM) drops below 4 V for 0.8 seconds or more, the ECM interprets this as an open in the power supply circuit (+BM). The ECM illuminates the MIL and sets the DTC.

If the malfunction is not repaired successfully, the DTC is set 5 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P2118: Throttle actuator power supply
Required Sensors / Components (Main)	Throttle actuator, throttle valve, ETCS fuse
Required Sensors / Components (Related)	None
Frequency of Operation	Continuous
Duration	0.8 seconds

MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Battery voltage	8 V or more
Actuator	ON

TYPICAL MALFUNCTION THRESHOLDS

Throttle actuator power supply voltage (+BM)	Less than 4 V

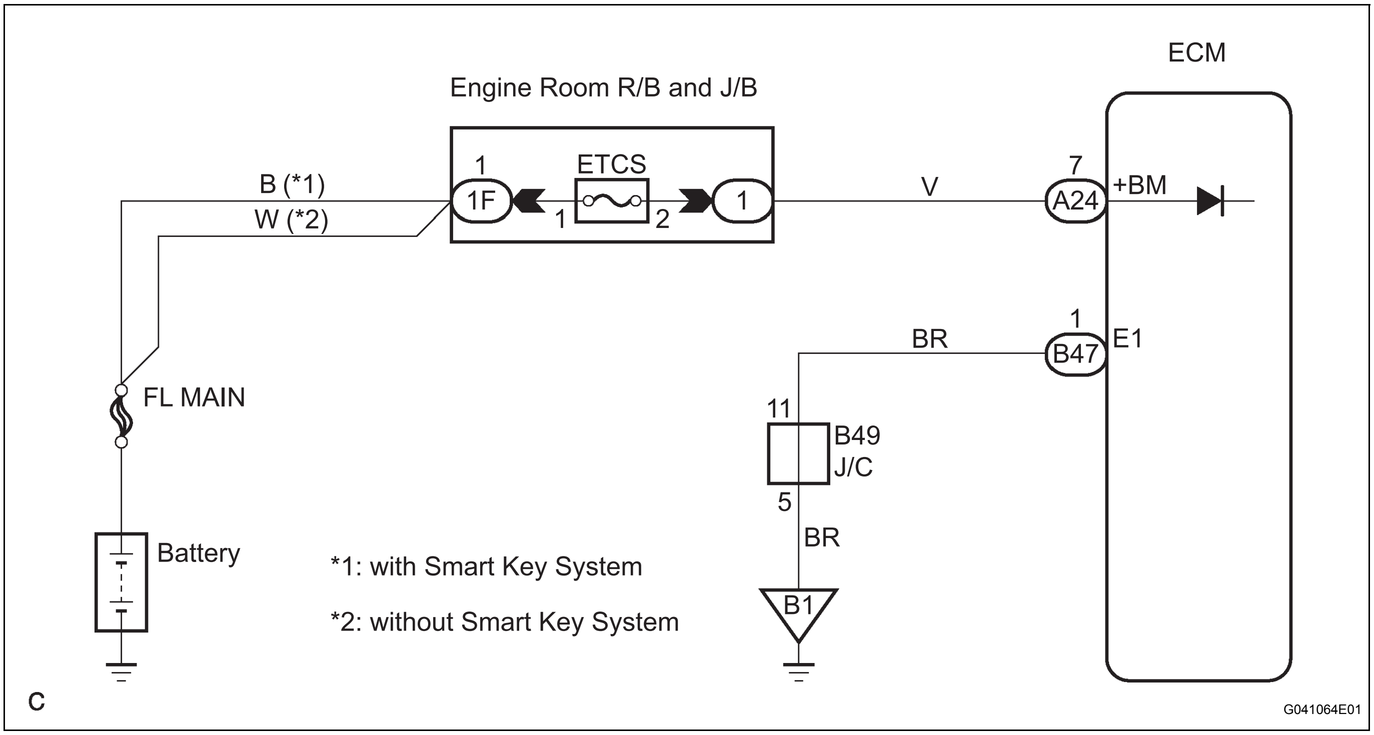
COMPONENT OPERATING RANGE

Throttle actuator power supply voltage	9 to 14 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 ignition switch is then turned off.

WIRING DIAGRAM

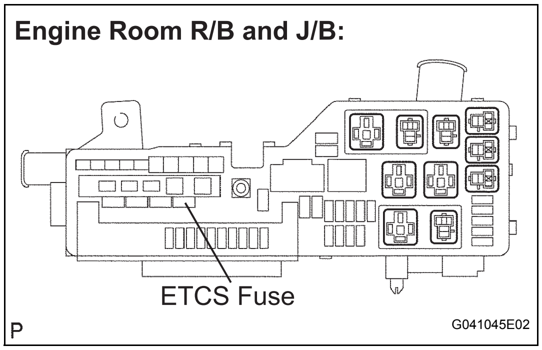


INSPECTION PROCEDURE

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.

1 CHECK FUSE (ETCS FUSE)



(a) Remove the ETCS fuse from the engine room R/B and J/B.

(b) Check the ETCS fuse resistance.

Standard resistance:

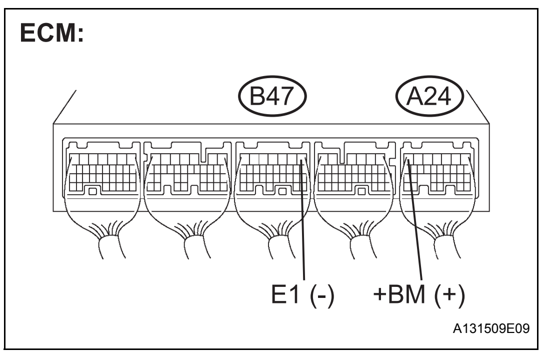
Below 1 Ω

(c) Reinstall the ETCS fuse.

NG → **CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE**

OK

2 INSPECT ECM (+BM VOLTAGE)



(a) Measure the voltage between the terminals of the A24 and B47 ECM connectors.

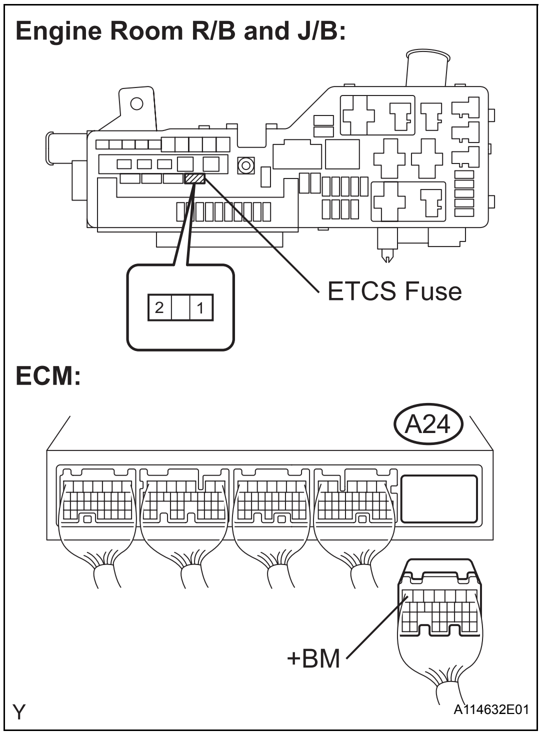
Standard voltage

Tester Connections	Specified Conditions
+BM (A24-7) - E1 (B47-1)	9 to 14 V

OK → **CHECK FOR INTERMITTENT PROBLEMS**

NG

3	CHECK HARNESS AND CONNECTOR (ECM - ETCS FUSE, ETCS FUSE - BATTERY)



(a) Check the harness and connector between the ETCS fuse and ECM.
(1) Remove the ETCS fuse from the engine room R/B and J/B.
(2) Disconnect the A24 ECM connector.
(3) Check the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
ETCS fuse (2) - +BM (A24-7)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
ETCS fuse (2) or +BM (A24-7) - Body ground	10 kΩ or higher

(4) Reconnect the ECM connector.
(b) Check the harness and connector between the ETCS fuse and positive battery cable.
(1) Disconnect the negative battery cable.
(2) Check the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
Positive battery cable - ETCS fuse (1)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Positive battery cable or ETCS fuse (1) - Body ground	10 kΩ or higher

(3) Reinstall the ETCS fuse.
(4) Reconnect the negative battery cable.

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

OK

REPLACE ECM

ES

DTC	P2119	Throttle Actuator Control Throttle Body Range / Performance

DESCRIPTION

The Electronic Throttle Control System (ETCS) is composed of the throttle actuator, Throttle Position (TP) sensor, Accelerator Pedal Position (APP) sensor, and ECM. The ECM operates the throttle actuator to regulate the throttle valve in response to driver inputs. The TP sensor detects the opening angle of the throttle valve, and provides the ECM with feedback so that the throttle valve can be appropriately controlled by the ECM.

DTC No.	DTC Detection Conditions	Trouble Areas
P2119	Throttle valve opening angle continues to vary greatly from target opening angle (1 trip detection logic)	• ETCS • ECM

ES

MONITOR DESCRIPTION

The ECM determines the actual opening angle of the throttle valve from the TP sensor signal. The actual opening angle is compared to the target opening angle commanded by the ECM. If the difference between these two values is outside the standard range, the ECM interprets this as a malfunction in the ETCS. The ECM then illuminates the MIL and sets the DTC.
If the malfunction is not repaired successfully, the DTC is set when the accelerator pedal is quickly released (to close the throttle valve) after the engine speed reaches 5,000 rpm by the accelerator pedal being fully depressed (fully open the throttle valve).

MONITOR STRATEGY

Related DTCs	P2119: ETCS malfunction
Required Sensors / Components (Main)	Throttle actuator
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
System guard*	ON
*System guard set when following conditions met	-
Throttle actuator	ON
Throttle actuator duty calculation	Executing
TP sensor	Fail determined
Throttle actuator current-cut operation	Not executing
Throttle actuator power supply	4 V or more
Throttle actuator	Fail determined

TYPICAL MALFUNCTION THRESHOLDS

Either of following conditions met	Condition A or B
A. Commanded closed TP - current closed TP	0.3 V or more
B. Commanded open TP - current open TP	0.3 V or more

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 fully depressed slowly, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the ignition switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (See page ES-289).

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.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2119)

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

Result

Display (DTC Output)	Proceed to
P2119	A
P2119 and other DTCs	B

HINT:
If any DTCs other than P2119 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2	CHECK WHETHER DTC OUTPUT RECURS (DTC P2119)

(a) Connect the intelligent tester to the DLC3 (Procedure "A").
(b) Turn the ignition switch on (IG) (Procedure "B").
(c) Turn the tester on (Procedure "C").
(d) Clear DTCs (See page ES-44) (Procedure "D").
(e) Allow the engine to idle for 15 seconds (Procedure "E").
CAUTION:
Perform the procedures "F" and "G" below with great care. Failure to do so may result in the vehicle unexpectedly rolling away.

(f) Securely apply the parking brake and move the gear selector lever to the D position (Procedure "F").

(g) While depressing the brake pedal securely, fully depress the accelerator pedal for 5 seconds (Procedure "G").

(h) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES (Procedure "H").

(i) Read DTCs (Procedure "I").

HINT:

The voltage output of the throttle position sensor can be checked during procedure "G" using the intelligent tester. Variations in the voltage output indicate that the throttle actuator is in operation. To check the voltage output using the intelligent tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / THROTTLE POS #1.

OK:

No DTC output.

ES

NG → **REPLACE THROTTLE WITH MOTOR BODY ASSEMBLY**

OK

NORMAL

DTC	**P2120**	**Throttle / Pedal Position Sensor / Switch "D" Circuit**

DTC	**P2122**	**Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input**

DTC	**P2123**	**Throttle / Pedal Position Sensor / Switch "D" Circuit High Input**

DTC	**P2125**	**Throttle / Pedal Position Sensor / Switch "E" Circuit**

DTC	**P2127**	**Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input**

DTC	**P2128**	**Throttle / Pedal Position Sensor / Switch "E" Circuit High Input**

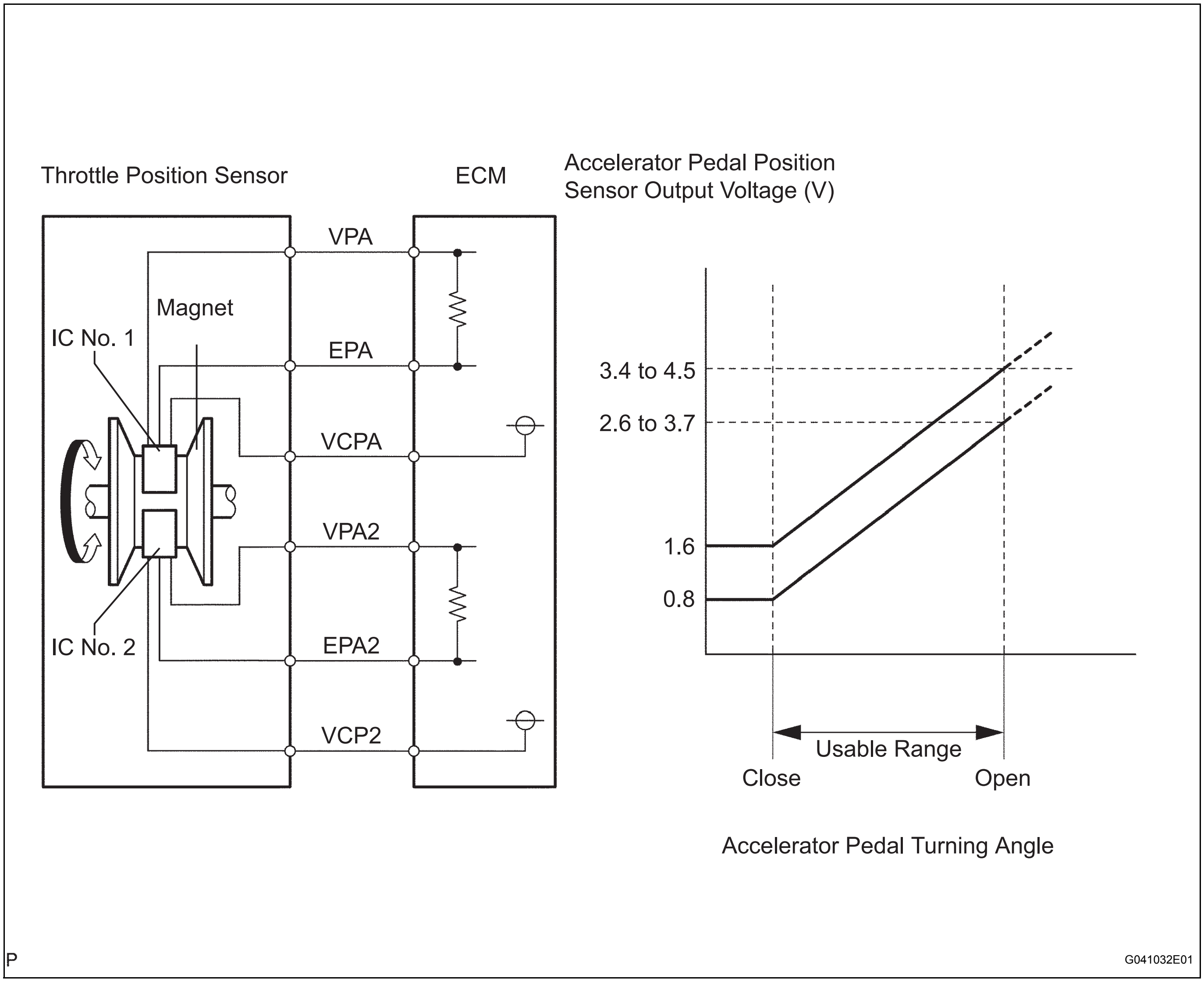
DTC	**P2138**	**Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation**

HINT:
These DTCs relate to the Accelerator Pedal Position (APP) sensor.

DESCRIPTION

HINT:
This ETCS (Electronic Throttle Control System) does not use a throttle cable.
The Accelerator Pedal Position (APP) sensor is integrated with the accelerator pedal bracket and has 2 sensor circuits: VPA (main) and VPA2 (sub). 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 voltage, which is applied to terminals VPA and VPA2 of the ECM, varies between 0 V and 5 V in proportion to the operating angle of the accelerator pedal (throttle valve). A signal from VPA indicates the actual accelerator pedal opening angle (throttle valve opening angle) and is used for engine control. A signal from VPA2 conveys the status of the VPA circuit and is used to check the APP sensor itself.
The ECM monitors the actual accelerator pedal opening angle (throttle valve opening angle) through the signals from VPA and VPA2, and controls the throttle actuator according to these signals.

ES



DTC No.	DTC Detection Conditions	Trouble Areas
P2120	VPA fluctuates rapidly beyond upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic)	• Accelerator Pedal Position (APP) sensor • ECM
P2122	VPA is 0.4 V or less for 0.5 seconds or more when accelerator pedal is fully released (1 trip detection logic)	• APP sensor • Open in VCP1 circuit • Open or ground short in VPA circuit • ECM
P2123	VPA is 4.8 V or more for 2.0 seconds or more (1 trip detection logic)	• APP sensor • Open in EPA circuit • ECM
P2125	VPA2 fluctuates rapidly beyond upper and lower malfunction thresholds for 0.5 seconds or more (1 trip detection logic)	• APP sensor • ECM
P2127	VPA2 is 1.2 V or less for 0.5 seconds or more when accelerator pedal is fully released (1 trip detection logic)	• APP sensor • Open in VCP2 circuit • Open or ground short in VPA2 circuit • ECM
P2128	Conditions (a) and (b) continue for 2.0 seconds or more (1 trip detection logic): (a) VPA2 is 4.8 V or more (b) VPA is between 0.4 V and 3.45 V	• APP sensor • Open in EPA2 circuit • ECM

DTC No.	DTC Detection Conditions	Trouble Areas
P2138	Condition (a) or (b) continues for 2.0 seconds or more (1 trip detection logic): (a) Difference between VPA and VPA2 is 0.02 V or less (b) VPA is 0.4 V or less and VPA2 is 1.2 V or less	• Short between VPA and VPA2 circuits • APP sensor • ECM

HINT:
When any of these DTCs are set, check the APP sensor voltage by selecting the following menu items on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / ACCEL POS #1 and ACCEL POS #2.

Trouble Areas	ACCEL POS #1 When AP Released	ACCEL POS #2 When AP Released	ACCEL POS #1 When AP Depressed	ACCEL POS #2 When AP Depressed
VCP circuit open	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V	0 to 0.2 V
Open or ground short in VPA circuit	0 to 0.2 V	1.2 to 2.0 V	0 to 0.2 V	3.4 to 5.0 V
Open or ground short in VPA2 circuit	0.5 to 1.1 V	0 to 0.2 V	2.6 to 4.5 V	0 to 0.2 V
EPA circuit open	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V	4.5 to 5.0 V
Normal condition	0.5 to 1.1 V	1.2 to 2.0 V	2.6 to 4.5 V	3.4 to 5.0 V

ES

HINT:
- Accelerator pedal positions are expressed as voltages.
- AP denotes for Accelerator Pedal.

MONITOR DESCRIPTION

When either of the voltage outputs of VPA or VPA2 deviates from the standard range, or the difference between the voltage outputs of the 2 sensor circuits is less than the threshold, the ECM determines that there is a malfunction in the APP sensor. The ECM then illuminates the MIL and sets a DTC.
Example:
When the voltage output of VPA drops below 0.4 V for more than 0.5 seconds when the accelerator pedal is fully depressed, DTC P2122 is set.
If the malfunction is not repaired successfully, a DTC is set 2 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P2120: Accelerator Pedal Position (APP) sensor 1 range check (fluctuating) P2122: APP sensor 1 range check (low voltage) P2123: APP sensor 1 range check (high voltage) P2125: APP sensor 2 range check (fluctuating) P2127: APP sensor 2 range check (low voltage) P2128: APP sensor 2 range check (high voltage) P2138: APP sensor range check (correlation)
Required Sensors / Components (Main)	APP sensor
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds: P2120, P2122, P2125 and P2127 2.0 seconds: P2123, P2128 and P2138
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Actuator	ON

TYPICAL MALFUNCTION THRESHOLDS

P2120:

Either of the following conditions is met	Condition A or B
A. VPA voltage when VPA2 is 0.04 V or more	0.4 V or less
B. VPA voltage	4.8 or more

P2122:

VPA voltage when VPA2 is 0.04 V or more	0.4 V or less

P2123:

VPA voltage	4.8 V or more

P2125:

Either of the following conditions is met	Condition A or B
A. VPA2 voltage when VPA is 0.04 V or more	1.2 V or less
B. VPA2 voltage when VPA is 0.4 to 3.45 V	4.8 V or more

P2127:

VPA2 voltage when VPA is 0.04 V or more	1.2 V or less

P2128:

VPA2 voltage when VPA is 0.4 to 3.45 V	4.8 V or more

P2138:

Either of following conditions met:	Condition A or B
Condition A	-
Difference between VPA and VPA 2 voltages	0.02 V or less
Condition B	-
VPA voltage	0.4 V or less
VPA2 voltage	1.2 V or less

COMPONENT OPERATING RANGE

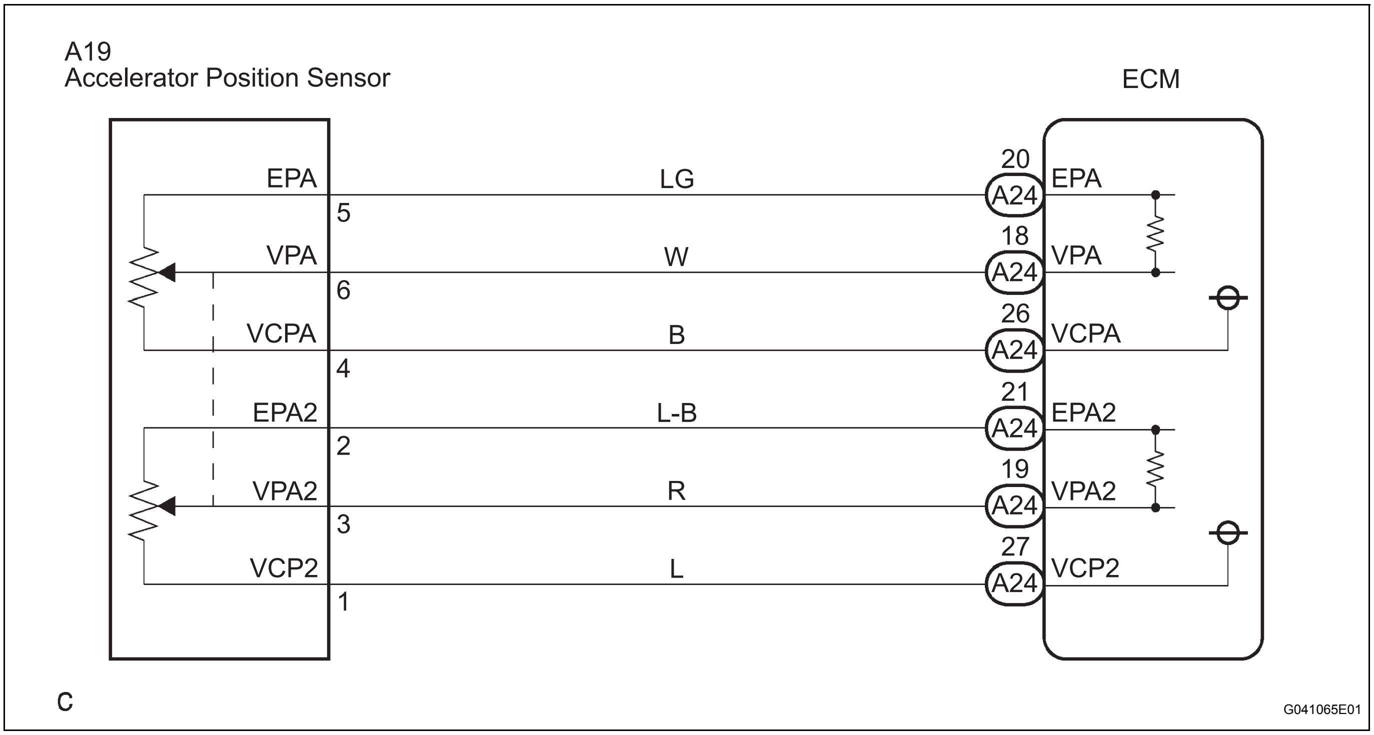
Parameter	Standard Value
VPA voltage	0.4 V to 4.8 V
VPA2 voltage	1.2 V to 4.8 V
Difference between VPA and VPA2 voltages	More than 0.02 V

FAIL-SAFE

When any of DTCs P2120, P2121, P2122, P2123, P2125, P2127, P2128 and P2138 are set, the ECM enters fail-safe mode. If either of the 2 sensor circuits malfunctions, the ECM uses the remaining circuit to calculate the accelerator pedal position to allow the vehicle to continue driving. If both of the circuits malfunction, the ECM regards the accelerator pedal as being released. As a result, the throttle valve is closed and the engine idles.

Fail-safe mode continues until a pass condition is detected, and the ignition switch is turned off.

WIRING DIAGRAM

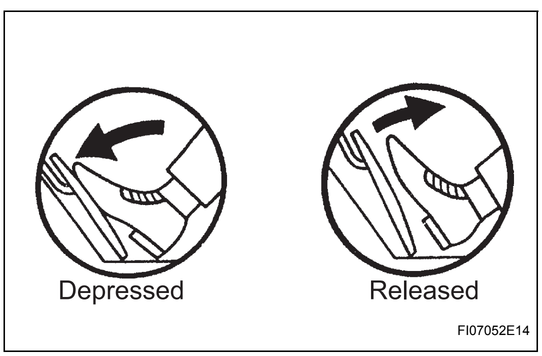


INSPECTION PROCEDURE

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.

1	READ VALUE OF INTELLIGENT TESTER (ACCEL POS #1 AND ACCEL POS #2)



(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester ON.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / ACCEL POS #1 and ACCEL POS #2.
(d) Read the values displayed on the tester.

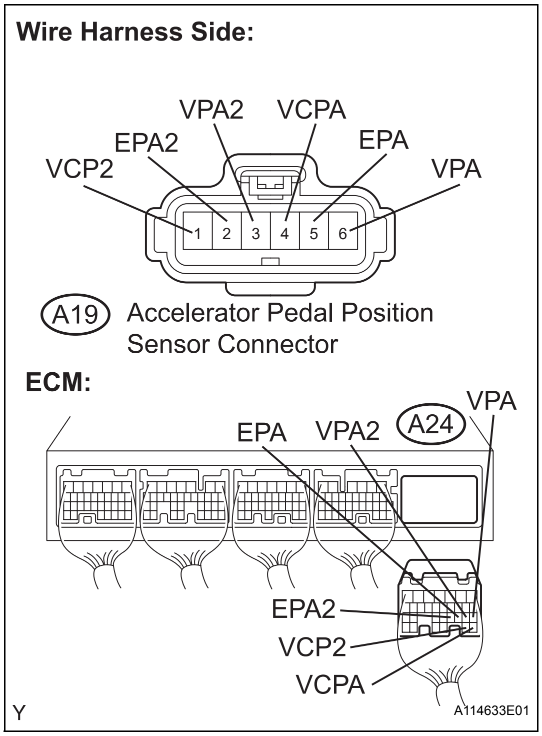
Standard voltage

Accelerator Pedal Operations	ACCEL POS #1 (AP#1)	ACCEL POS #2 (AP#2)
Released	0.5 to 1.1 V	1.2 to 2.0 V
Depressed	2.6 to 4.5 V	3.4 to 5.0 V

OK → **Go to step 5**

NG

2 CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)



(a) Disconnect the A19 Accelerator Pedal Position (APP) sensor connector.
(b) Disconnect the A24 ECM connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VPA (A19-6) - VPA (A24-18)	Below 1 Ω
EPA (A19-5) - EPA (A24-20)	Below 1 Ω
VCPA (A19-4) - VCPA (A24-26)	Below 1 Ω
VPA2 (A19-3) - VPA2 (A24-19)	Below 1 Ω
EPA2 (A19-2) - EPA2 (A24-21)	Below 1 Ω
VCP2 (A19-1) - VCP2 (A24-27)	Below 1 Ω

Standard resistance (Check for short)

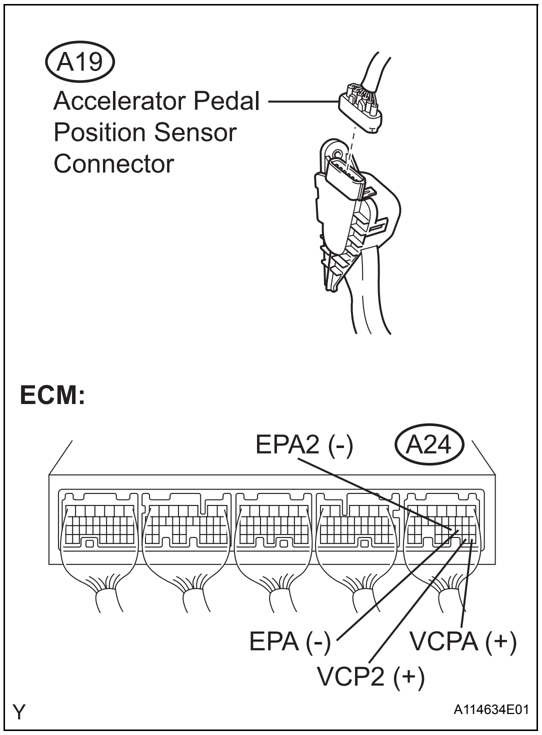
Tester Connections	Specified Conditions
VPA (A19-6) or VPA (A24-18) - Body ground	10 kΩ or higher
EPA (A19-5) or EPA (A24-20) - Body ground	10 kΩ or higher
VCPA (A19-4) or VCPA (A24-26) - Body ground	10 kΩ or higher
VPA2 (A19-3) or VPA2 (A24-19) - Body ground	10 kΩ or higher
EPA2 (A19-2) or EPA2 (A24-21) - Body ground	10 kΩ or higher
VCP2 (A19-1) or VCP2 (A24-27) - Body ground	10 kΩ or higher

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

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

OK

3	INSPECT ECM (VCPA AND VCP2 VOLTAGE)



(a) Disconnect the A19 APP sensor connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the terminals of the A24 ECM connector.

Standard voltage

Tester Connections	Specified Conditions
VCPA (A24-26) - EPA (A24-20)	4.5 to 5.0 V
VCP2 (A24-27) - EPA2 (A24-21)	4.5 to 5.0 V

(d) Reconnect the APP sensor connector.

ES

NG → **REPLACE ECM**

OK

4	REPLACE ACCELERATOR PEDAL

(a) Replace the accelerator pedal (See page ES-448).

NEXT

5	CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL 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 DTCs (See page ES-44).
(d) Start the engine.
(e) Allow the engine to idle for 15 seconds.
(f) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read DTCs.

Result

Display (DTC Output)	Proceed to
P2120, P2122, P2123, P2125, P2127, P2128 and/or P2138	A
No output	B

B → **SYSTEM OK**

A

REPLACE ECM

DTC	P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance

HINT:
This DTC relates to the Accelerator Pedal Position (APP) sensor.

DESCRIPTION

Refer to DTC P2120 (See page ES-301).

DTC No.	DTC Detection Conditions	Trouble Areas
P2121	Difference between VPA and VPA2 is less than 0.4 V, or more than 1.2 V for 0.5 second (1 trip detection logic)	• Accelerator position (APP) sensor • ECM

MONITOR DESCRIPTION

The accelerator pedal position sensor is mounted on the accelerator pedal bracket. The accelerator pedal position sensor has 2 sensor elements and 2 signal outputs: VPA and VPA2. VPA is used to detect the actual accelerator pedal angle (used for engine control) and VPA2 is used to detect malfunctions in VPA. When the difference between the voltage outputs of VPA and VPA2 deviates from the standard, the ECM determines that the accelerator pedal position sensor is a malfunctioning. The ECM turns on the MIL and the DTC is set.

MONITOR STRATEGY

Related DTCs	P2121: Accelerator pedal position (APP) sensor rationality
Required Sensors / Components (Main)	APP sensor
Required Sensors / Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Either of the following conditions is met.	Condition 1 or 2
1. Ignition switch	ON
2. Electronic throttle actuator power	ON

TYPICAL MALFUNCTION THRESHOLDS

Difference between VPA1 voltage (learned value) and VPA2 voltage (learned value)	Less than 0.4 V, or more than 1.2 V

FAIL-SAFE

The accelerator pedal position sensor has 2 (main and sub) sensor circuits. If a malfunction occurs in either of the sensor circuits, the ECM detects the abnormal signal voltage difference between the 2 sensor circuits and switches to limp mode. In limp mode, the functioning circuit is used to calculate the accelerator pedal opening angle to allow the vehicle to continue driving. If both circuits malfunction, the ECM regards the opening angle of the accelerator pedal as being fully closed. In this case, the throttle valve remains closed as if the engine is idling.

If a pass condition is detected and then the ignition switch is turned off, the fail-safe operation stops and the system returns to a normal condition.

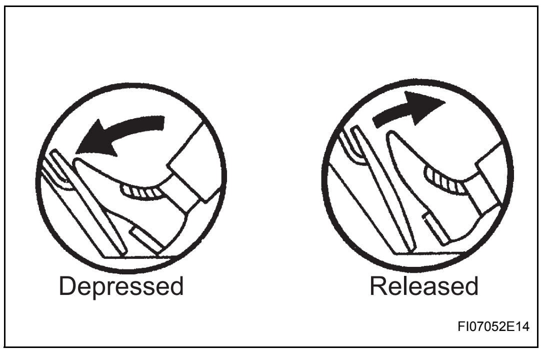
WIRING DIAGRAM

Refer to DTC P2120 (See page ES-305).

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.

1	READ VALUE OF INTELLIGENT TESTER (ACCEL POS #1 AND ACCEL POS #2)



(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / ACCEL POS #1 and ACCEL POS #2.
(d) Read the values displayed on the tester.

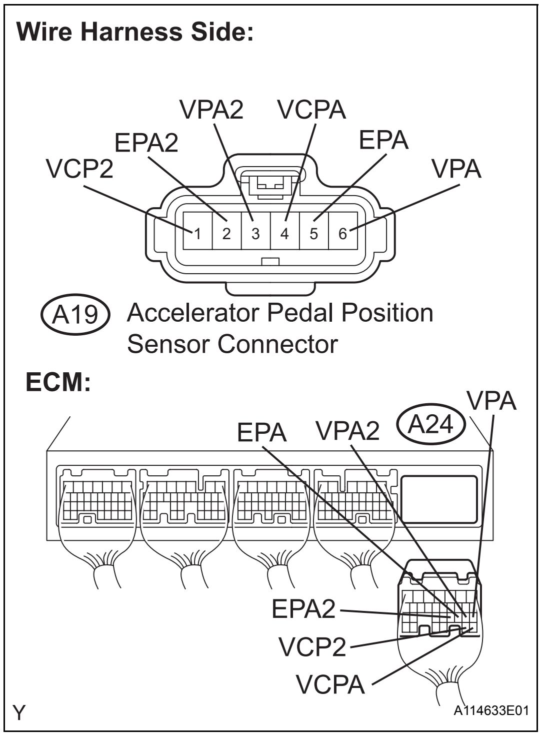
Standard voltage

Accelerator Pedal Operations	ACCEL POS #1 (AP#1)	ACCEL POS #2 (AP#2)
Released	0.5 to 1.1 V	1.2 to 2.0 V
Depressed	2.6 to 4.5 V	3.4 to 5.0 V

OK → Go to step 4

NG

2	CHECK HARNESS AND CONNECTOR (ACCELERATOR PEDAL POSITION SENSOR - ECM)



(a) Disconnect the A19 Accelerator Pedal Position (APP) sensor connector.
(b) Disconnect the A24 ECM connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VPA (A19-6) - VPA (A24-18)	Below 1 Ω
EPA (A19-5) - EPA (A24-20)	Below 1 Ω
VCPA (A19-4) - VCPA (A24-26)	Below 1 Ω
VPA2 (A19-3) - VPA2 (A24-19)	Below 1 Ω
EPA2 (A19-2) - EPA2 (A24-21)	Below 1 Ω
VCP2 (A19-1) - VCP2 (A24-27)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
VPA (A19-6) or VPA (A24-18) - Body ground	10 kΩ or higher
EPA (A19-5) or EPA (A24-20) - Body ground	10 kΩ or higher
VCPA (A19-4) or VCPA (A24-26) - Body ground	10 kΩ or higher
VPA2 (A19-3) or VPA2 (A24-19) - Body ground	10 kΩ or higher
EPA2 (A19-2) or EPA2 (A24-21) - Body ground	10 kΩ or higher
VCP2 (A19-1) or VCP2 (A24-27) - Body ground	10 kΩ or higher

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

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

OK

3	REPLACE ACCELERATOR PEDAL

(a) Replace the accelerator pedal (See page ES-448).

NEXT

4	CHECK WHETHER DTC OUTPUT RECURS (ACCELERATOR PEDAL 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 DTCs (See page ES-44).
(d) Start the engine.
(e) Allow the engine to idle for 15 seconds.
(f) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read DTCs.

Result

Display (DTC Output)	Proceed to
P2121	A
No output	B

B → **SYSTEM OK**

A

REPLACE ECM

DTC	P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)

DTC	P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)

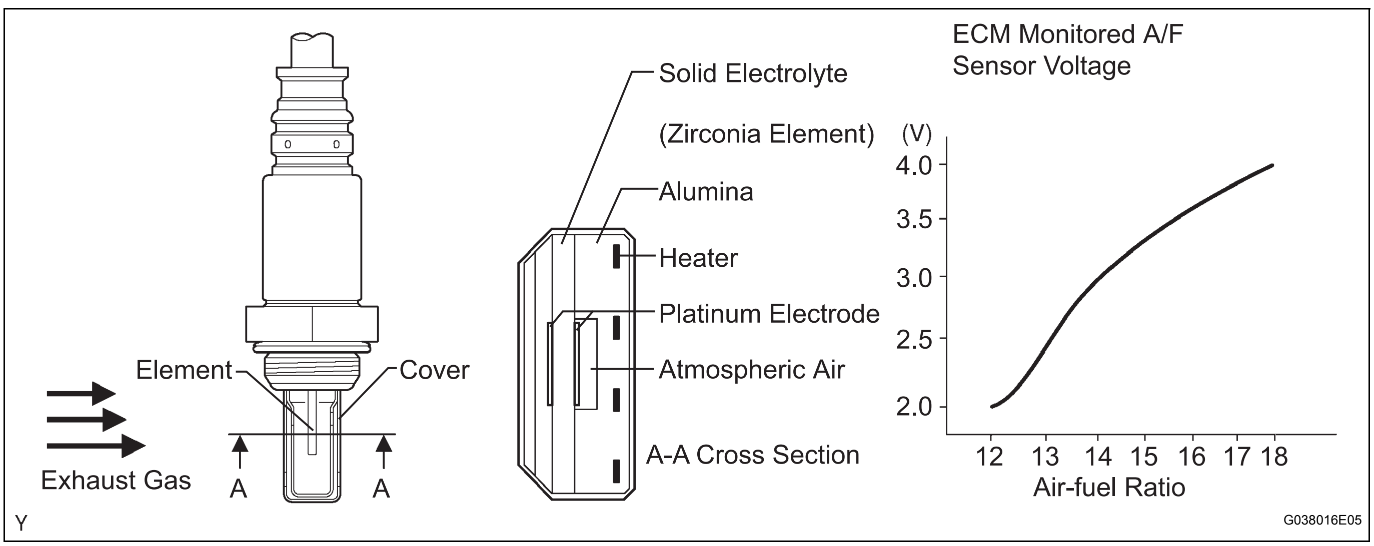
DTC	P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)

DTC	P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

HINT:
- Although the DTC titles say 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.

DESCRIPTION

The A/F sensor generates a 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 though the alumina, therefore the sensor activation is accelerated.
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.
*: 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.



DTC No.	DTC Detection Conditions	Trouble Areas
P2195 P2197	Conditions (a) and (b) continue for 2 seconds or more (2 trip detection logic): (a) Air-Fuel Ratio (A/F) sensor voltage is more than 3.8 V (b) Heated Oxygen (HO2) sensor voltage is 0.15 V or more	• Open or short in A/F sensor (bank 1, 2 sensor 1) circuit • A/F sensor (bank 1, 2 sensor 1) • A/F sensor (bank 1, 2 sensor 1) heater • A/F sensor heater relay • A/F sensor heater and relay circuits • Air induction system • Fuel pressure • Injector • ECM
P2195 P2197	While fuel-cut operation is performed (during vehicle deceleration), air-furl ratio (A/F) sensor current is 3.6 mA or more for 3 seconds (2 trip detection logic)	• A/F sensor • ECM
P2196 P2198	Conditions (a) and (b) continue for 2 seconds or more (2 trip detection logic): (a) A/F sensor voltage is less than 2.8 V (b) HO2 sensor voltage is less than 0.6 V	• Open or short in A/F sensor (bank 1, 2 sensor 1) circuit • A/F sensor (bank 1, 2 sensor 1) • A/F sensor (bank 1, 2 sensor 1) heater • A/F sensor heater relay • A/F sensor heater and relay circuits • Air induction system • Fuel pressure • Injector • ECM
P2196 P2198	While fuel-cut operation is performed (during vehicle deceleration), air-furl ratio (A/F) sensor current is less than 1.4 mA for 3 seconds (2 trip detection logic)	• A/F sensor • ECM

ES

HINT:
- DTCs P2195 and P2196 indicate malfunctions related to bank 1 A/F sensor circuit.
- DTCs P2197 and P2198 indicate malfunctions related to bank 2 A/F sensor circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that includes cylinder No. 2.
- When any of these DTCs are set, check the A/F sensor voltage output by selecting the following menu items on the intelligent tester: DIAGNOSIS / ENHANCED OBDII / DATA LIST / PRIMARY / AFS B1S1.
- Short-term fuel trim values can also be read using the intelligent tester.
- The ECM regulates the voltages at the A1A+, A2A+, A1A- and A2A- terminals of the ECM to a constant level. Therefore, the A/F sensor voltage output cannot be confirmed without using the intelligent tester.
- If a A/F sensor malfunction is detected, the ECM sets a DTC.

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor voltage output indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and sets a DTC.

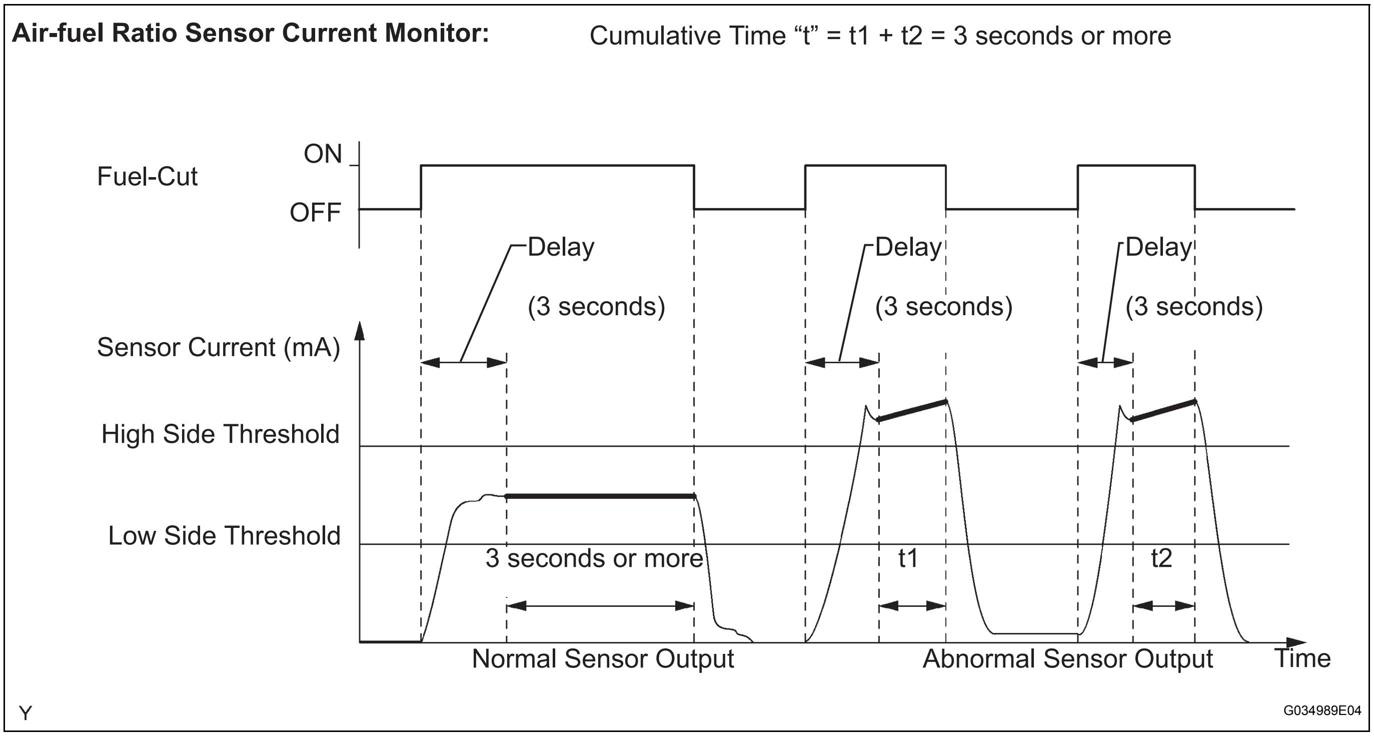
Example:

If the A/F sensor voltage output is less than 2.8 V (very rich condition) for 10 seconds, despite the HO2 sensor voltage output being less than 0.6 V, the ECM sets DTC P2196. Alternatively, if the A/F sensor voltage output is more than 3.8 V (very lean condition) for 10 seconds, despite the HO2 sensor voltage output being 0.15 V or more, DTC P2195 is set.

Sensor current detection monitor

A rich air-fuel mixture causes a low A/F sensor current, and a lean air-fuel mixture causes a high A/F sensor current. Therefore, the sensor output becomes low during acceleration, and it becomes high during deceleration with the throttle valve fully closed. The ECM monitors the A/F sensor current during fuel-cut and detects any abnormal current values.

If the A/F sensor output is 3.6 mA or more for more than 3 seconds of cumulative time, the ECM interprets this as a malfunction in the A/F sensor and sets DTC P2195 (high-side stuck). If the A/F sensor output is 1.0 mA or less for more than 3 seconds of cumulative time, the ECM sets DTC P2196 (low-side stuck).



MONITOR STRATEGY

Related DTCs	P2195: A/F sensor (Bank 1) signal stuck lean P2196: A/F sensor (Bank 1) signal stuck rich P2197: A/F sensor (Bank 2) signal stuck lean P2198: A/F sensor (Bank 2) signal stuck rich
Required Sensors / Components (Main)	A/F sensor
Required Sensors / Components (Related)	HO2 sensor
Frequency of Operation	Continuous
Duration	Sensor voltage detection monitor: 10 seconds Sensor current detection monitor: 3 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	P0031, P0032, P0051, P0052 (A/F Sensor heater Sensor 1), P0037, P0038 (O2 Sensor heater Sensor 2), P0100, P0101, P0102, P0103 (MAF Sensor), P0110, P0112, P0113 (IAT Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0220, P0222, P0223 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0136, P0156 (O2 Sensor 2), P0171, P0172 (Fuel System), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0335 (CKP Sensor), P0340 (VVT Sensor 1, 2), P0450, P0451, P0452, P0453 (EVAP System), P0500 (VSS)

Sensor voltage detection monitor (Lean side malfunction P2195, P2197):

Duration while all of following conditions are met	2 seconds or more
Rear HO2 sensor voltage	0.15 V or more
Time after engine start	30 seconds or more
A/F sensor status	Activated
Fuel system status	Closed-loop
Engine	Running

Sensor voltage detection monitor (Rich side malfunction P2196, P2198):

Duration while all of following conditions are met	2 seconds or more
Rear HO2 sensor voltage	Below 0.6 V
Time after engine start	30 seconds or more
A/F sensor status	Activated
Fuel system status	Closed-loop
Engine	Running

Sensor Current detection monitor P2195, P2196, P2197 P2198

Battery voltage	11 V or more
Atmospheric pressure	0.75 or more
Air-fuel ratio sensor status	Activated
Engine coolant temperature	75°C (167°F) or more
Continuous time of fuel-cut	3 to 10 seconds

TYPICAL MALFUNCTION THRESHOLDS

Sensor voltage detection monitor (Lean side malfunction P2195, P2197):

A/F sensor voltage	More than 3.8 V

Sensor voltage detection monitor (Rich side malfunction P2196, P2198):

A/F sensor voltage	Less than 2.8 V

Sensor current detection monitor (High side malfunction P2195, P2197):

Air-fuel ratio sensor current during fuel cut	3.6 mA or more

Sensor current detection monitor (Rich side malfunction P2196, P2198):

Air-fuel ratio sensor current during fuel cut	Less than 1.57 mA

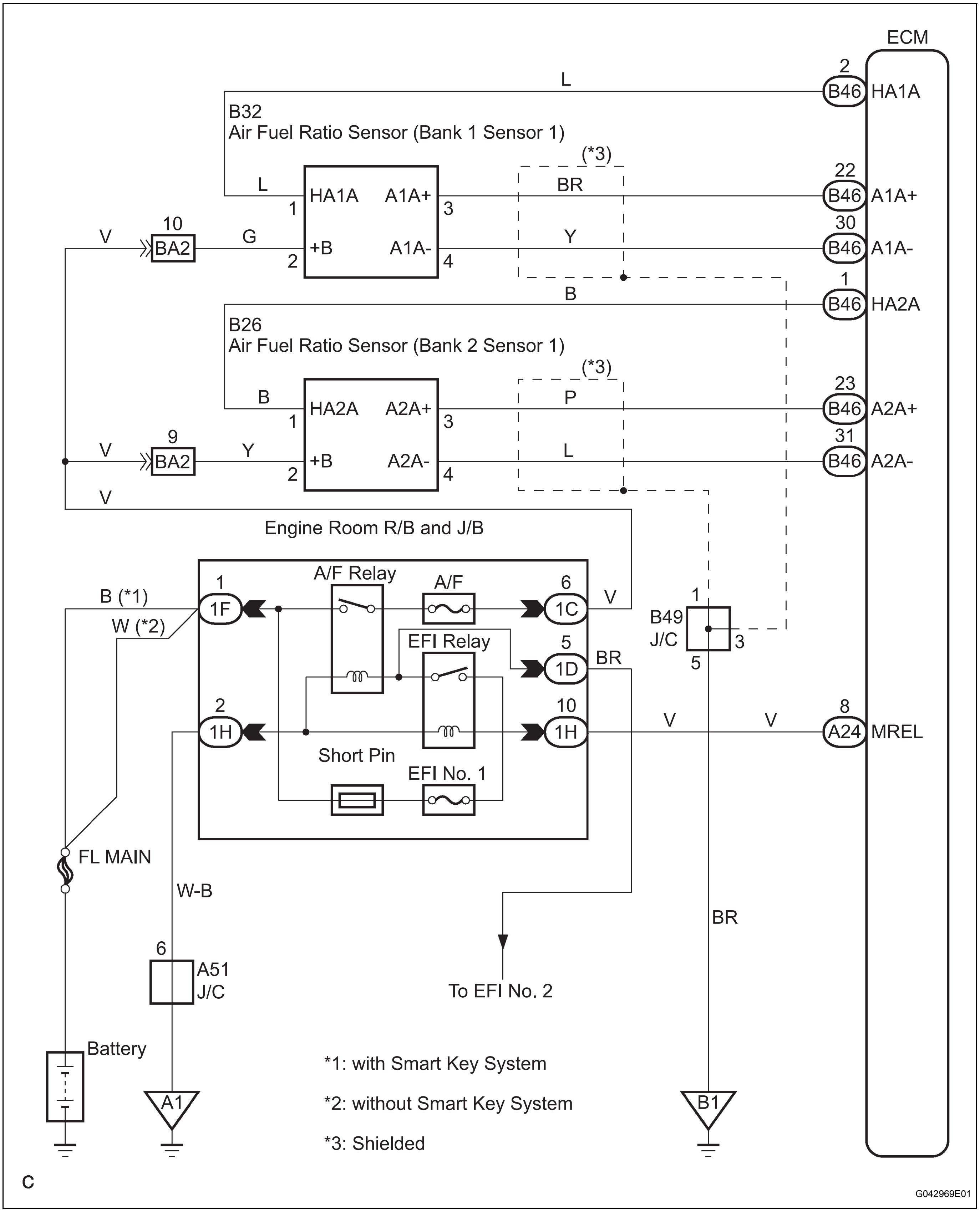
MONITOR RESULT

Refer to Checking Monitor Status for detailed information (See page ES-25).

Air-fuel ratio sensor current

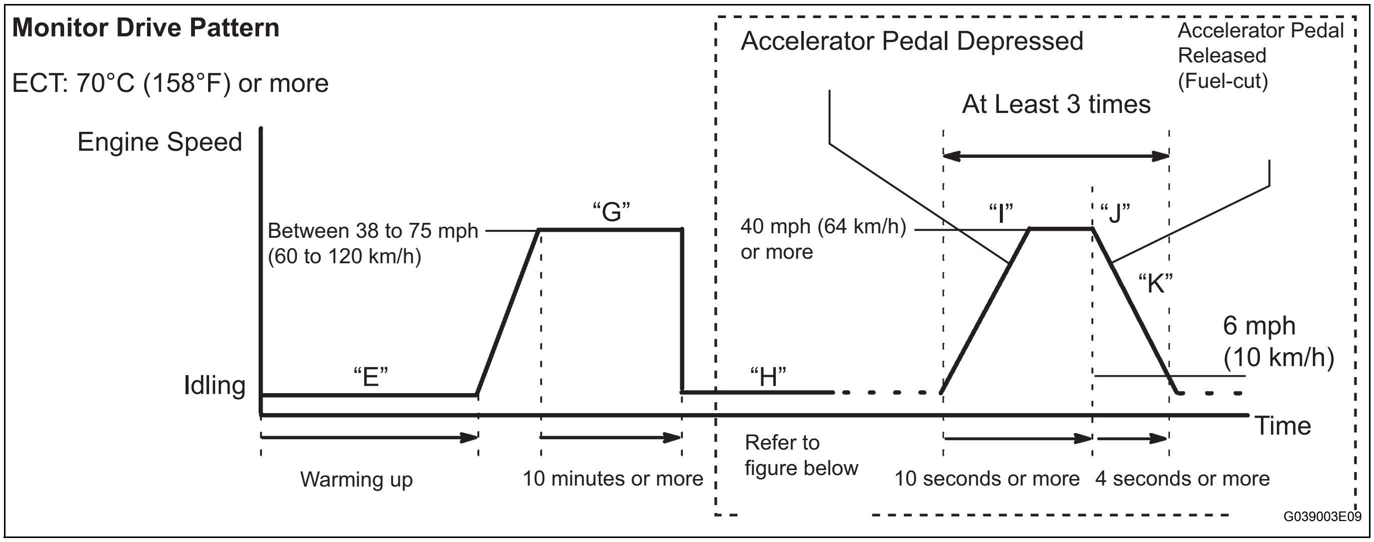
MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$01	$91	Multiply by 0.003 [mA]	Air-fuel ratio sensor current for bank 1 sensor 1	Malfunction criterion for low side rationality	Malfunction criterion for high side rationality

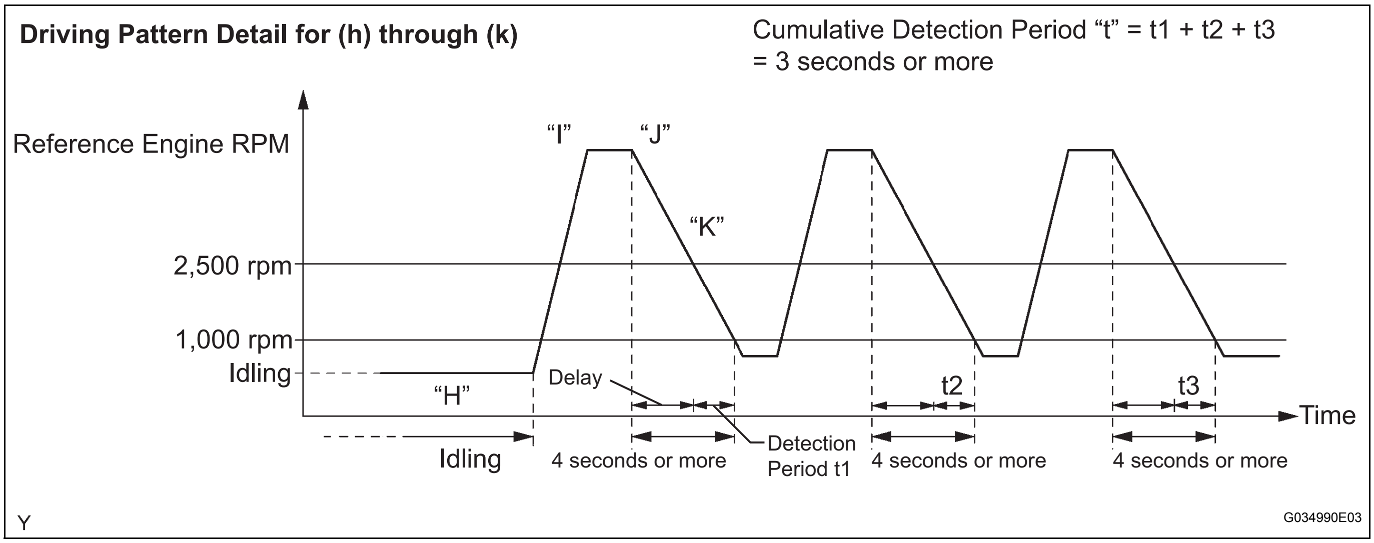
WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN

This confirmation driving pattern is used in steps 4, 7, 17, and 21 of the following diagnostic troubleshooting procedure when using the intelligent tester.





1. Connect the intelligent tester to the DLC3 (Procedure "A").
2. Turn the ignition switch on (IG) (Procedure "B").
3. Turn the tester on (Procedure "C").
4. Clear DTCs (See page ES-44) (Procedure "D").
5. Start the engine, and warm it up until the ECT reaches 70°C (158°F) or higher (Procedure "E").
6. Select the following menu items on the tester to check the fuel-cut status: DIAGNOSIS / ENHANCED OBD II / DATA LIST / USER DATA / FC IDLE (Procedure "F").
7. Drive the vehicle at between 38 mph (60 km/h) and 75 mph (120 km/h) for at least 10 minutes (Procedure "G").
8. Change the transmission to 2nd gear (Procedure "H").
9. Drive the vehicle at proper vehicle speed to perform fuel-cut operation (refer to the following HINT) (Procedure "I").
   HINT:
   Fuel-cut is performed when the following conditions are met:
   - Accelerator pedal is fully released.
   - Engine speed is 2,500 rpm or more (fuel injection returns at 1,000 rpm).
10. Accelerate the vehicle to 40 mph (64 km/h) or more by depressing the accelerator pedal for at least 10 seconds (Procedure "J").
11. Soon after performing procedure "J" on the previous page, release the accelerator pedal for at least 4 seconds without depressing the brake pedal, in order to execute fuel-cut control (Procedure "K").
12. Allow the vehicle to decelerate until the vehicle speed declines to less than 6 mph (10 km/h) (Procedure "L").

13. Repeat procedures from "H" through "K" in this section at least 3 times per driving cycle (Procedure "M").
HINT:
Completion of all A/F sensor monitors is required to change the value in TEST RESULT.
CAUTION:
Strictly observe posted speed limits, traffic laws, and road conditions when performing these drive patterns.

INSPECTION PROCEDURE

HINT:
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.

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) 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).
(f) 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.
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 and decreases in the fuel injection volume.

Standard voltage

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

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	 OK	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	NG	Output Voltage More than 0.55 V Less than 0.4 V	 OK	

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	 OK	Output Voltage Almost no reaction	NG	
4	Injection volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

– Following the A/F CONTROL procedure enables technicians to check the graph of the voltage outputs of both the A/F and HO2 sensors.
– To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2. Press the YES button and then the ENTER button. Then press 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.
- A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.
- A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.

1 CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO P2195, P2196, P2197 OR P2198)

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

Result

Display (DTC Output)	Proceed to
P2195, P2196, P2197 or P2198	A
P2195, P2196, P2197 or P2198 and other DTCs	B

HINT:
If any DTCs other than P2195, P2196, P2197 or P2198 are output, troubleshoot those DTCs first.

B → **DTC CAUSED BY RUNNING OUT OF FUEL**

A

ES

ES

2	READ VALUE OF INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester ON.
(c) Clear DTCs (See page ES-44).
(d) Allow the vehicle to drive in accordance with the drive pattern described in the CONFIRMATION DRIVING PATTERN.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / MONITOR STATUS.
(f) Check that the status of O2S MON is COMPL.
If the status is still INCMPL, drive the vehicle according to the driving pattern again.
HINT:
- AVAIL indicates that the component has not been monitored yet.
- COMPL indicates that the component is functioning normally.
- INCMPL indicates that the component is malfunctioning.

(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / TEST RESULT / RANGE B1S1, then press the ENTER button.
(h) Check the test value of the A/F sensor output current during fuel-cut.

Result

Test Value	Proceed to
Within normal range (1.4 mA or more, and less than 3.6 mA)	A
Outside normal range (Less than 1.4 mA, or 3.6 mA or more)	B

B → **Go to step 20**

A ↓

3	READ VALUE OF INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine.
(c) Turn the tester on.
(d) Warm up the Air-Fuel Ratio (A/F) sensor at an engine speed of 2,500 rpm for 90 seconds.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / SNAPSHOT / MANUAL SNAPSHOT / USER DATA / AFS B1S1 or AFS B2S1 and ENGINE SPD.
(f) Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:
(1) While idling (check for at least 30 seconds) (Step (1))

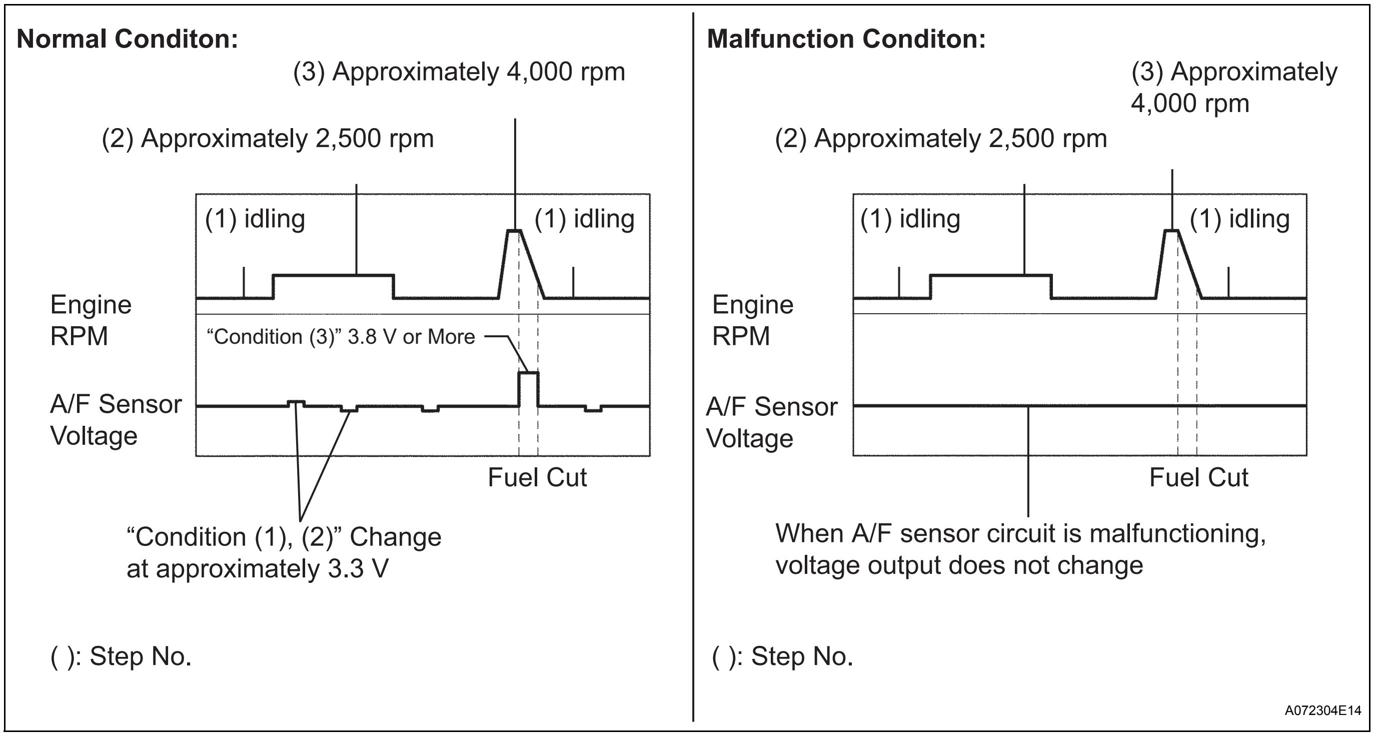
(2) At an engine speed of approximately 2,500 rpm (without any sudden changes in engine speed) (Step (2))

(3) Raise the engine speed to 4,000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed (Step (3)).

Standard voltage

Conditions	A/F Sensor Voltage Variations	Reference
Steps (1) and (2)	Changes at approximately 3.3 V	Between 3.1 V and 3.5 V
Step (3)	Increases to 3.8 V or more	This occurs during engine deceleration (when fuel-cut performed)

HINT:
For more information, see the diagrams below.



HINT:
- If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those described on the previous page, the A/F sensor may have an open circuit. (This will also happen if the A/F sensor heater has an open circuit.)
- If the output voltage of the A/F sensor remains at either approximately 3.8 V or more, or 2.8 V or less (see Malfunction Condition diagram) under any conditions, including those described on the previous page, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.

- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven over 10 mph (16 km/h) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

ES

NG → **Go to step 10**

OK

4 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5 CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

(a) Read DTCs using the intelligent tester.
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

Result

Display (DTC Output)	Proceed to
P2195, P2196, P2197 or P2198	A
No output	B

B → **Go to step 9**

A

6 REPLACE AIR FUEL RATIO SENSOR

(a) Replace the air fuel ratio sensor (See page EC-20).

NEXT

7 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8	CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

(a) Read DTCs using the intelligent tester.
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

Result

Display (DTC Output)	Proceed to
No output	A
P2195, P2196, P2197 or P2198	B

B → **REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN**

ES

A

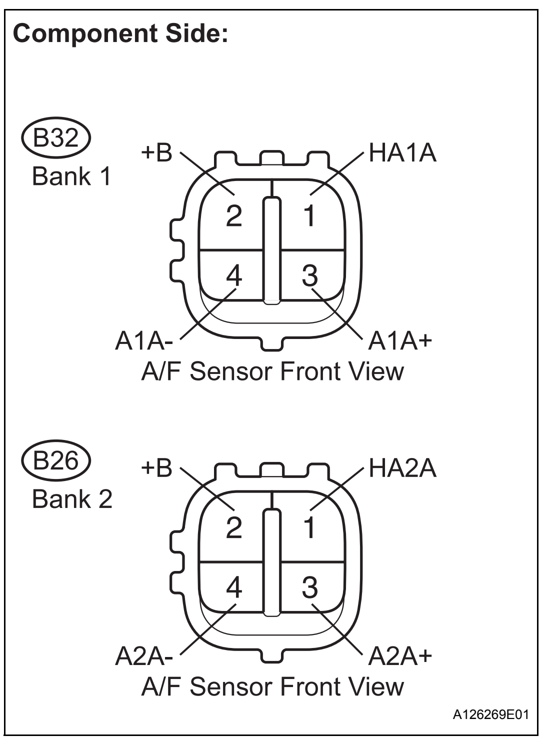
9	CONFIRM WHETHER VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → **CHECK FOR INTERMITTENT PROBLEMS**

YES

DTC CAUSED BY RUNNING OUT OF FUEL

10	INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/F sensor connector.

Standard resistance:

Bank 1

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

Bank 2

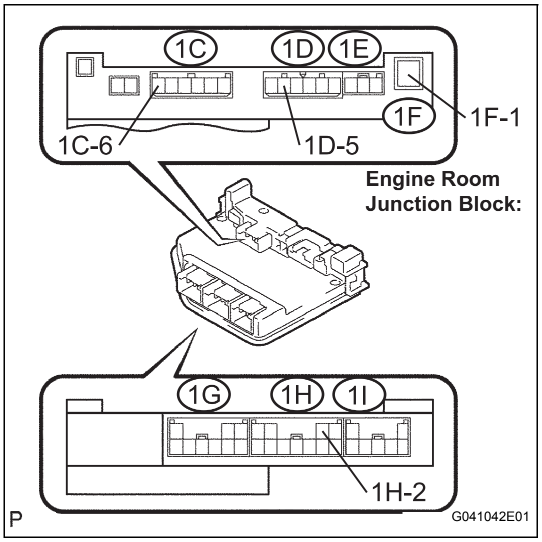
Tester Connections	Specified Conditions
HA2A (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HA2A (1) - A2A- (4)	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

11	INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (A/F SENSOR HEATER RELAY)



(a) Remove the engine room junction block.
(b) Measure the A/F sensor heater relay resistance.
Standard resistance

Tester Connections	Specified Conditions
1F-1 - 1C-6	10 kΩ or higher
1F-1 - 1C-6	Below 1 Ω (when battery voltage applied to terminals 1D-5 and 1H-2)

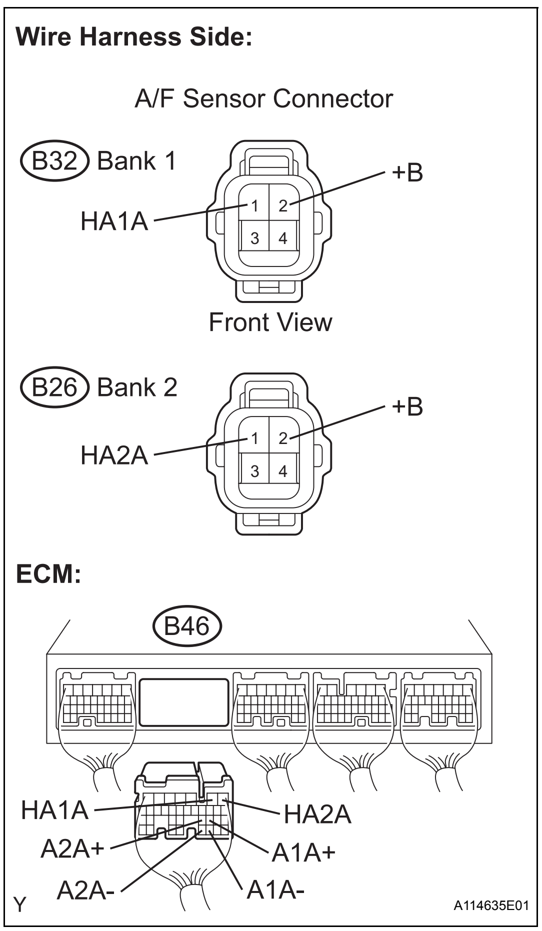
(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

ES

OK

12	CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.
Standard voltage

Tester Connections	Specified Conditions
+B (B32-2) - Body ground	9 to 14 V
+B (B26-2) - Body ground	9 to 14 V

(d) Turn the ignition switch off.
(e) Disconnect the B46 ECM connector.
(f) Measure the resistance between the terminals of A/F sensor connector and ECM connector.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
HA1A (B32-1) - HA1A (B46-2)	Below 1 Ω
A1A+ (B32-3) - A1A+ (B46-22)	Below 1 Ω
A1A- (B32-4) - A1A- (B46-30)	Below 1 Ω
HA2A (B26-1) - HA2A (B46-1)	Below 1 Ω
A2A+ (B26-3) - A2A+ (B46-23)	Below 1 Ω
A2A- (B26-4) - A2A- (B46-31)	Below 1 Ω

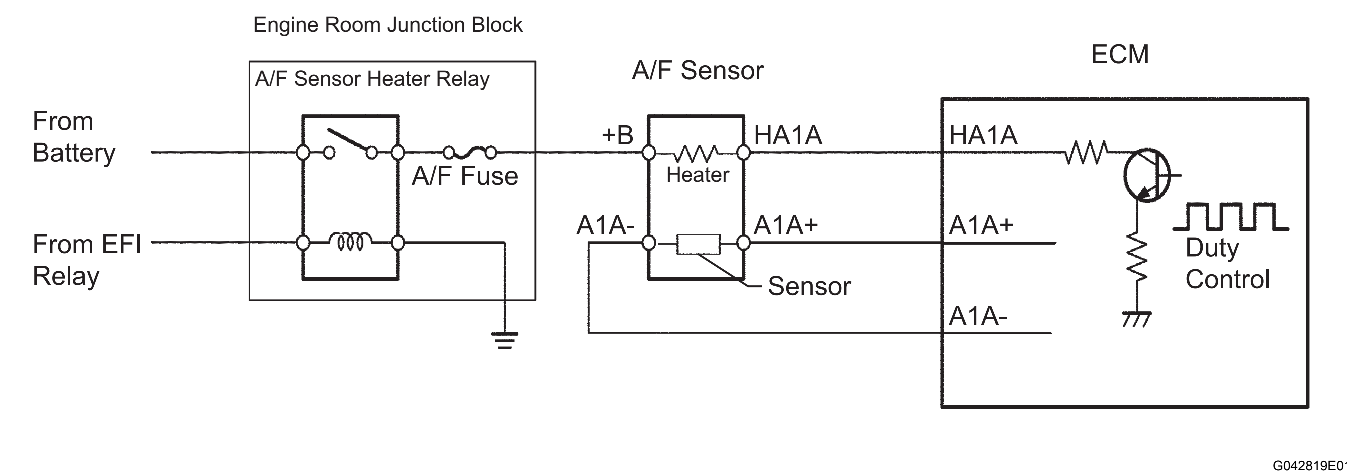
Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1A (B32-1) or HA1A (B46-2) - Body ground	10 kΩ or higher
A1A+ (B32-3) or A1A+ (B46-22) - Body ground	10 kΩ or higher
A1A- (B32-4) or A1A- (B46-30) - Body ground	10 kΩ or higher
HA2A (B26-1) or HA2A (B46-1) - Body ground	10 kΩ or higher

Tester Connections	Specified Conditions
A2A+ (B26-3) or A2A+ (B46-23) - Body ground	10 kΩ or higher
A2A- (B26-4) or A2A- (B46-31) - Body ground	10 kΩ or higher

(g) Reconnect the ECM connector.
(h) Reconnect the A/F sensor connector.

Reference (System Diagram of Bank 1 Sensor 1):



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

OK

13 CHECK AIR INDUCTION SYSTEM

(a) Check the air induction system for vacuum leakage.
OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM**

OK

14 CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-7).

NG → **REPAIR OR REPLACE FUEL SYSTEM**

OK

15 INSPECT FUEL INJECTOR ASSEMBLY

(a) Check the injector injection (whether fuel volume is high or low, and whether injection pattern is poor) (See page FU-15).

NG → **REPLACE FUEL INJECTOR ASSEMBLY**

OK

16	REPLACE AIR FUEL RATIO SENSOR

(a) Replace the air fuel ratio sensor (See page EC-20).

NEXT

17	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

18	CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

(a) Read DTCs using the intelligent tester.
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

Result

Display (DTC Output)	Proceed to
No output	A
P2195, P2196, P2197 or P2198	B

B → **REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN**

A

19	CONFIRM WHETHER VEHICLE HAS RUN OUT OF FUEL IN PAST

NO → **CHECK FOR INTERMITTENT PROBLEMS**

YES

DTC CAUSED BY RUNNING OUT OF FUEL

20	REPLACE AIR FUEL RATIO SENSOR

(a) Replace the air fuel ratio sensor (See page EC-20).

NEXT

21	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

22 CHECK WHETHER DTC OUTPUT RECURS (DTC P2195, P2196, P2197 OR P2198)

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

Result

Display (DTC Output)	Proceed to
No output	A
P2195, P2196, P2197 or P2198 (A/F sensor pending DTCs)	B

B → **REPLACE ECM**

A

END

DTC	P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)

DTC	P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)

DTC	P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)

DTC	P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)

DTC	P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)

DTC	P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)

DTC	P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)

DTC	P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

HINT:
- Although the DTC titles say 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.

DESCRIPTION

Refer to DTC P2195 (See page ES-313).

DTC No.	DTC Detection Conditions	Trouble Areas
P2238 P2241	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) AF+ voltage is 0.5 V or less (b) (AF+) - (AF-) = 0.1 V or less • Case 2: A/F sensor admittance: Less than 0.022 1/Ω (2 trip detection logic)	• 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 relay circuits • ECM
P2239 P2242	AF+ voltage is more than 4.5 V for 5.0 seconds or more (2 trip detection logic)	• 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 • A/F sensor heater relay • A/F sensor heater and relay circuits • ECM

DTC No.	DTC Detection Conditions	Trouble Areas
P2252 P2255	AF- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic)	• 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 • A/F sensor heater relay • A/F sensor heater and relay circuits • ECM
P2253 P2256	AF- voltage is more than 4.5 V for 5.0 seconds or more (2 trip detection logic)	• 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 • A/F sensor heater relay • A/F sensor heater and relay circuits • ECM

HINT:
- DTC P2238, P2239, P2252 and P2253 indicate malfunctions related to the bank 1 A/F sensor circuit.
- DTC P2241, P2242, P2255 and P2256 indicate malfunctions related to the bank 2 A/F sensor circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that includes cylinder No. 2.

MONITOR DESCRIPTION

The Air-Fuel Ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or voltage output deviates greatly from the standard range, the ECM determines that there is an open or short malfunction in the A/F sensor circuit.

MONITOR STRATEGY

Related DTCs	P2238: A/F sensor (Bank 1) open circuit between AF+ and AF- P2238: A/F sensor (Bank 1) short circuit between AF+ and AF- P2238: A/F sensor (Bank 1) short circuit between AF+ and GND P2239: A/F sensor (Bank 1) short circuit between AF+ and +B P2241: A/F sensor (Bank 2) open circuit between AF+ and AF- P2241: A/F sensor (Bank 2) short circuit between AF+ and AF- P2241: A/F sensor (Bank 2) short circuit between AF+ and GND P2242: A/F sensor (Bank 2) short circuit between AF+ and +B P2252: A/F sensor (Bank 1) short circuit between AF- and GND P2253: A/F sensor (Bank 1) short circuit between AF- and +B P2255: A/F sensor (Bank 2) short circuit between AF- and GND P2256: A/F sensor (Bank 2) short circuit between AF- and +B
Required Sensors / Components (Main)	A/F sensor
Required Sensors / Components (Related)	Engine Coolant Temperature (ECT) sensor, Crankshaft position sensor
Frequency of Operation	Once per driving cycle
Duration	P2238 and P2241 (open circuit between AF+ and AF-): 10 seconds Others: 5 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None

P2238 and P2241 (open circuit between AF+ and AF-):

AF+ terminal voltage	0.5 to 4.5 V
AF- terminal voltage	0.5 to 4.5 V
Difference between AF+ terminal and AF- terminal voltage	0.1 to 0.8 V
ECT	5°C (41°F) or more

Engine	Running
Fuel-cut	OFF
Time after fuel-cut OFF	5 seconds or more
A/F sensor heater	ON
Battery voltage	11 V or more
Ignition switch	ON
Time after ignition switch is OFF to ON	5 seconds or more

Others:

Battery voltage	11 V or more
Ignition switch	ON
Time after ignition switch is OFF to ON	5 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P2238 and P2241 (Open circuit between AF+ and AF-):

A/F sensor admittance	Below 0.022 1/Ω

P2238 and P2241 (Short circuit between AF+ and GND):

AF+ terminal voltage	0.5 V or less

P2238 and P2241 (Short circuit between AF+ and AF-):

Difference between AF+ terminal and AF- terminal voltage	0.1 V or less

P2239 and P2242 (Short circuit between AF+ and +B):

AF+ terminal voltage	More than 4.5 V

P2252 and P2255 (Short circuit between AF- and GND):

AF- terminal voltage	0.5 V or less

P2253 and P2256 (Short circuit between AF- and +B):

AF- terminal voltage	More than 4.5 V

WIRING DIAGRAM

Refer to DTC P2195 (See page ES-317).

INSPECTION PROCEDURE

HINT:
For use the 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 the intelligent tester.

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester on.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) 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).

(f) 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.
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 and decreases in the fuel injection volume.

Standard voltage

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

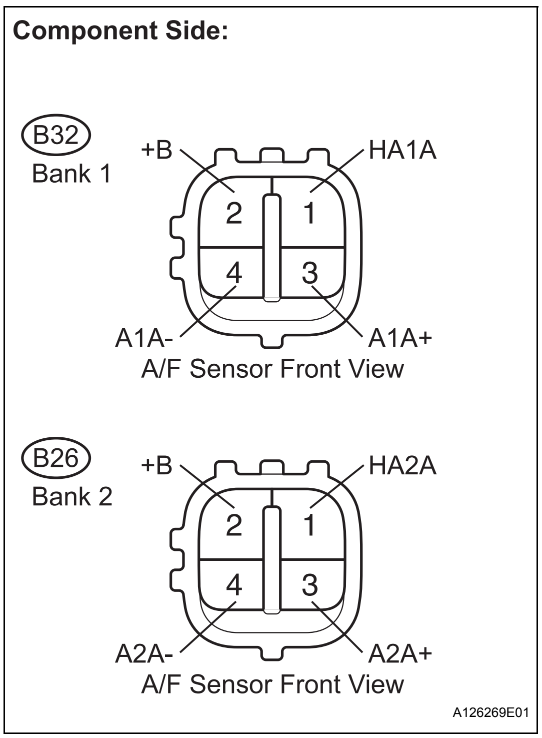
NOTICE:
The Air-Fuel Ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

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	OK	Output Voltage More than 0.55 V Less than 0.4 V	OK	
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	NG	Output Voltage More than 0.55 V Less than 0.4 V	OK	
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	OK	Output Voltage Almost no reaction	NG	
4	Injection volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

– Following the A/F CONTROL procedure enables technicians to check the graph of the voltage outputs of both the A/F and HO2 sensors.

– To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2. Press the YES button and then the ENTER button. Then press 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.
- A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.
- A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.

1 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/F sensor connector.

Standard resistance:

Bank 1

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

Bank 2

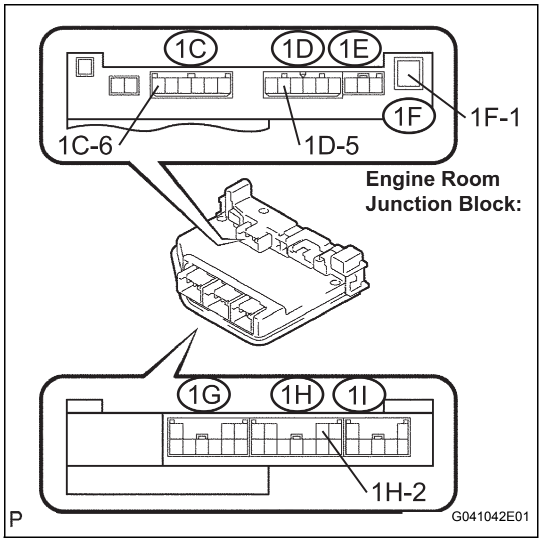
Tester Connections	Specified Conditions
HA1A (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HA1A (1) - A1A- (4)	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

2	INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (A/F SENSOR HEATER RELAY)



(a) Remove the engine room junction block.
(b) Measure the A/F sensor heater relay resistance.
Standard resistance

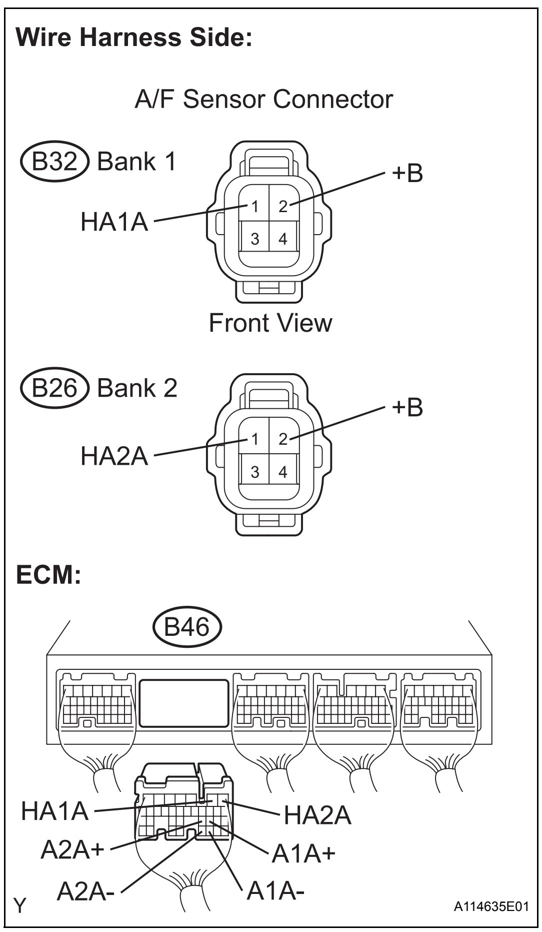
Tester Connections	Specified Conditions
1F-1 - 1C-6	10 kΩ or higher
1F-1 - 1C-6	Below 1 Ω (when battery voltage applied to terminals 1D-5 and 1H-2)

(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

OK

3	CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.
Standard voltage

Tester Connections	Specified Conditions
+B (B32-2) - Body ground	9 to 14 V
+B (B26-2) - Body ground	9 to 14 V

(d) Turn the ignition switch off.
(e) Disconnect the B46 ECM connector.
(f) Measure the resistance between the terminals of A/F sensor connector and ECM connector.
Standard resistance (Check for open)

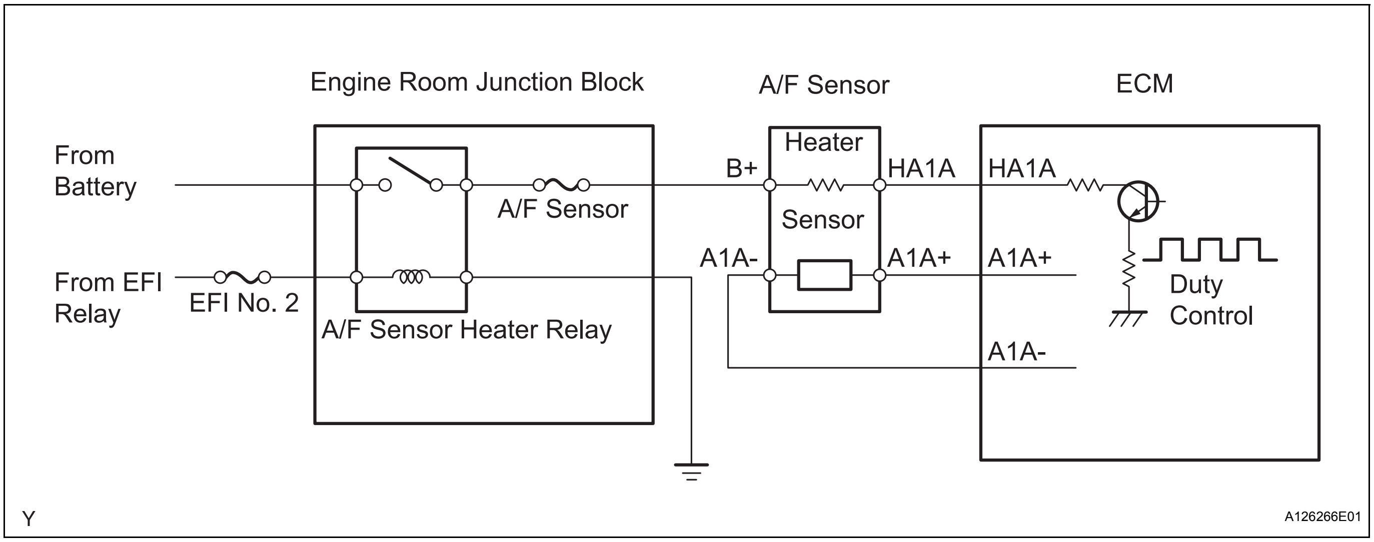
Tester Connections	Specified Conditions
HA1A (B32-1) - HA1A (B46-2)	Below 1 Ω
A1A+ (B32-3) - A1A+ (B46-22)	Below 1 Ω
A1A- (B32-4) - A1A- (B46-30)	Below 1 Ω
HA2A (B26-1) - HA2A (B46-1)	Below 1 Ω
A2A+ (B26-3) - A2A+ (B46-23)	Below 1 Ω
A2A- (B26-4) - A2A- (B46-31)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1A (B32-1) or HA1A (B46-2) - Body ground	10 kΩ or higher
A1A+ (B32-3) or A1A+ (B46-22) - Body ground	10 kΩ or higher
A1A- (B32-4) or A1A- (B46-30) - Body ground	10 kΩ or higher
HA2A (B26-1) or HA2A (B46-1) - Body ground	10 kΩ or higher

Tester Connections	Specified Conditions
A2A+ (B26-3) or A2A+ (B46-23) - Body ground	10 kΩ or higher
A2A- (B26-4) or A2A- (B46-31) - Body ground	10 kΩ or higher

(g) Reconnect the ECM connector.
(h) Reconnect the A/F sensor connector.



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

OK ↓

REPLACE ECM

DTC	P2401	Evaporative Emission System Leak Detection Pump Control Circuit Low

DTC	P2402	Evaporative Emission System Leak Detection Pump Control Circuit High

DTC SUMMARY

DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P2401	Vacuum pump stuck OFF	Vacuum pump creates negative pressure through 0.02 inch orifice, and EVAP system pressure is measured to determine leak pressure standard. 0.02 inch leak pressure standard is measured at start and end of leak check. If system pressure is higher than -1.06 kPa (-7.95 mmHg)*, or lower than -4.85 kPa (-36.38 mmHg)*, ECM determines that vacuum pump stuck OFF.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM • Leakage from EVAP system	While ignition switch off	2 trip
P2402	Vacuum pump stuck ON	Vacuum pump creates negative pressure through 0.02 inch orifice, and EVAP system pressure is measured to determine leak pressure standard. If system pressure is higher than -1.06 kPa (-7.95 mmHg)*, or lower than -4.85 kPa (-36.38 mmHg)*, ECM determines that vacuum pump stuck ON.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM	While ignition switch off	2 trip

*: The threshold values vary according to the atmospheric pressure measured in operation A. The values described in the table above are based on an atmospheric pressure of 100 kPa (750.1 mmHg).
HINT:
The vacuum pump is built into the pump module.

DESCRIPTION

The circuit description can be found in the EVAP (Evaporative Emission) System (See page ES-370).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-373).

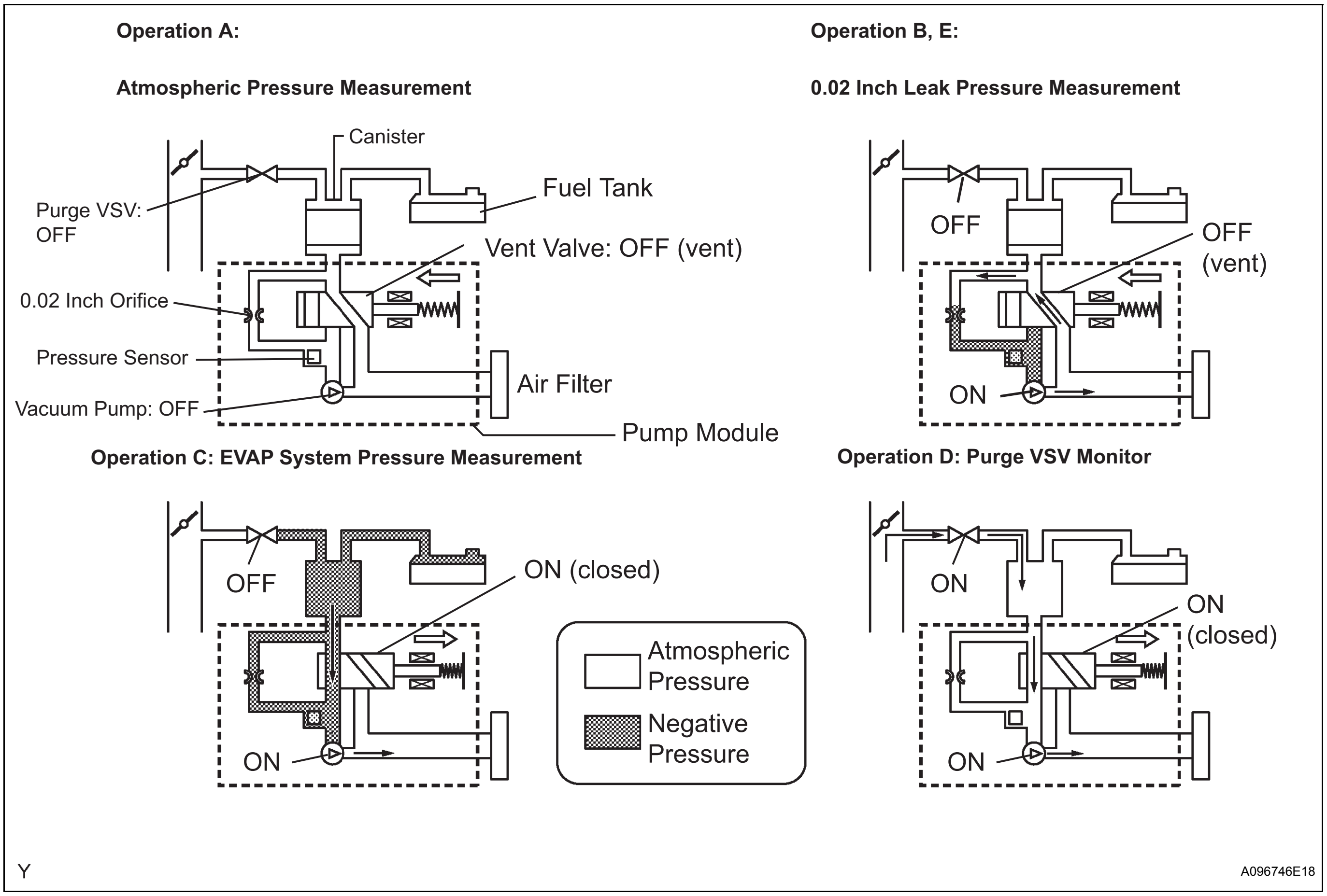
MONITOR DESCRIPTION

5 hours*1 after the ignition switch is turned off, the electric vacuum pump creates negative pressure (vacuum) in the EVAP (Evaporative Emission) system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.
HINT:
*1: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned off, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned off, the monitor check starts 2.5 hours later.

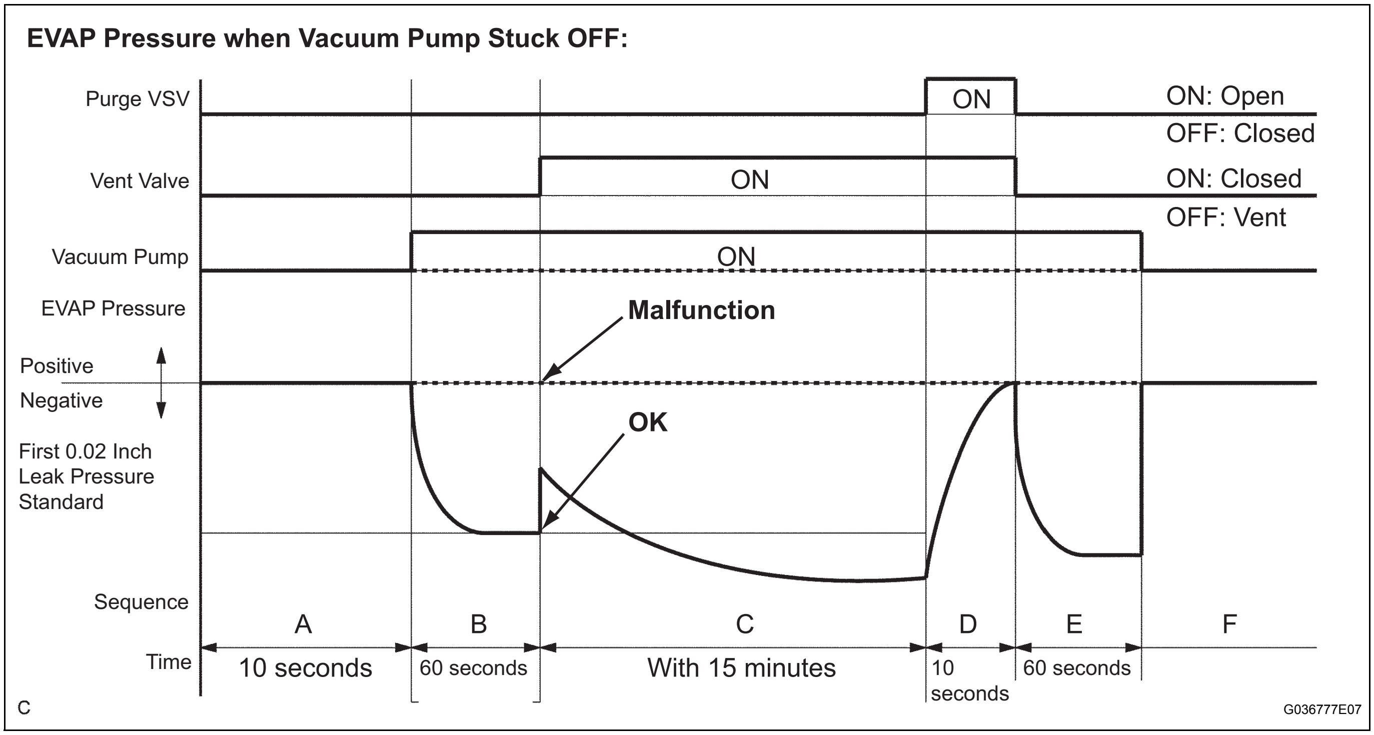
Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned to OFF.	-
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system is not between 70 kPa and 110 kPa (525 mmHg and 825 mmHg), ECM cancels EVAP system monitor.	10 seconds

Sequence	Operations	Descriptions	Duration
B	First 0.02 inch leak pressure measurement	In order to determine 0.02 inch leak pressure standard, vacuum pump creates negative pressure (vacuum) through 0.02 inch orifice and then ECM checks if vacuum pump and vent valve operate normally.	60 seconds
C	EVAP system pressure measurement	Vent valve turned ON (closed) to shut EVAP system. Negative pressure (vacuum) is created in EVAP system, and EVAP system pressure then measured. Write down measured value as it will be used in leak check. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP system monitor.	15 minutes*2
D	Purge VSV monitor	Purge VSV is opened and then EVAP system pressure is measured by ECM. Large increase indicates normal.	10 seconds
E	Second 0.02 inch leak pressure measurement	After second 0.02 inch leak pressure measurement, leak check is performed by comparing first and second 0.02 inch leak pressure standards. If stabilized system pressure is higher than second 0.02 inch leak pressure standard, ECM determines that EVAP system leaking.	60 seconds
F	Final check	Atmospheric pressure is measured and then monitoring result is recorded by ECM.	-

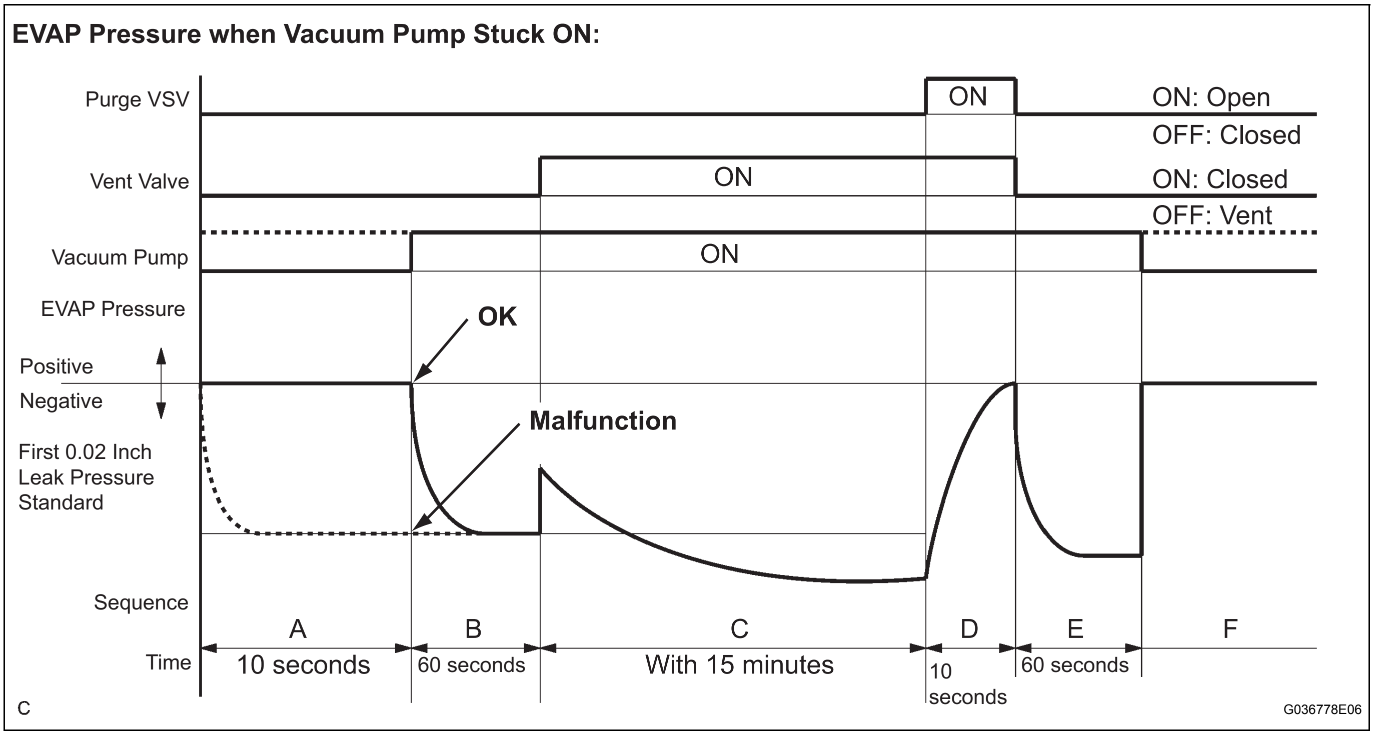
*2: If there is only a small amount of fuel in the fuel tank, stabilizing the EVAP pressure takes longer than usual.



1. P2401: Vacuum pump stuck OFF
   In operation B, the vacuum pump creates negative pressure (a vacuum) through the 0.02 inch orifice. The EVAP (Evaporative Emission) system pressure is then measured by the ECM, using the pressure sensor, to determine the 0.02 inch leak pressure standard. If the pressure is higher than -1.06 kPa (-7.95 mmHg)*, or lower than -4.85 kPa (-36.38 mmHg)*, the ECM interprets this as the vacuum pump being stuck OFF (not operating). The ECM illuminates the MIL and sets the DTC (2 trip detection logic).
   *: The thresholds vary according to the atmospheric pressure measured in operation A. The values described above are based on an atmospheric pressure of 100 kPa (750.1 mmHg): absolute pressure.



2. P2402: Vacuum pump stuck ON
   In operation B, the vacuum pump creates negative pressure (a vacuum) through the 0.02 inch orifice. The EVAP (Evaporative Emission) system pressure is then measured by the ECM, using the pressure sensor, to determine the 0.02 inch leak pressure standard. If the pressure is higher than -1.06 kPa (-7.95 mmHg)*, or lower than -4.85 kPa (-36.38 mmHg)*, the ECM interprets this as the vacuum pump being stuck ON (remaining ON all the time). The ECM illuminates the MIL and sets the DTC (2 trip detection logic).
   *: The thresholds vary according to the atmospheric pressure measured in operation A. The values described above are based on an atmospheric pressure of 100 kPa (750.1 mmHg): absolute pressure.



HINT:
The detection logic of DTCs P2401 and P2402 is the same because in both cases the 0.02 inch leak pressure standard measured in operation B is compared to the atmospheric pressure registered in operation A. The ECM calculates the difference between these pressures by deducting [the 0.02 inch leak pressure standard] from [the stored atmospheric pressure], and uses this to monitor the EVAP system pressure change.

OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Related DTCs	P2401: Vacuum pump stuck OFF P2402: Vacuum pump stuck ON
Required Sensors / Components	Purge VSV and pump module
Frequency of Operation	Once per driving cycle
Duration	Within 2 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None

Key-off monitor is run when all of the following conditions met	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	2.5 mph (4 km/h) or less
Ignition switch	OFF
Time after key-off	5 or 7 or 9.5 hours
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
EVAP canister purge valve	Not operated by scan tool
EVAP canister vent valve	Not operated by scan tool
EVAP leak detection pump	Not operated by scan tool
Both of the following conditions 1 and 2 set before key-off	-
1. Duration that vehicle has been driven	5 minutes or more
2. EVAP purge operation	Performed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)

Key-off monitor sequence 1 to 8

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met	-
Atmospheric pressure change	Less than 0.3 kPa (2.25 mmHg) in 1 second

2. First reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2 and 3
1. EVAP pressure just after reference pressure measurement start	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated

3. EVAP canister vent valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after vent valve is ON	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction

Next sequence is run if the following condition is met	-
EVAP pressure	Saturated within 15 minutes

5. EVAP canister purge valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after purge valve is open	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2, 3 and 4
1. EVAP pressure just after reference pressure	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated
4. Difference between first reference pressure and second reference pressure	Less than 0.7 kPa (5.25 mmHg)

7. Leak check

Next sequence is run if the following condition is met	-
EVAP pressure when vacuum introduction is complete	Lower than second reference pressure

8. Atmospheric pressure measurement

EVAP monitor is complete if the following condition is met	-
Atmospheric pressure difference between sequence 1 and 8	Within 0.3 kPa (2.25 mmHg)

TYPICAL MALFUNCTION THRESHOLDS

One of the following conditions met	-
EVAP pressure just after reference pressure measurement start	More than -1 kPa (-7.5 mmHg)
Reference pressure	Less than -4.85 kPa (-36.384 mmHg)
Reference pressure	-1.057 kPa (-7.929 mmHg) or more
Reference pressure	Not saturated
Difference between first reference pressure and second reference pressure	0.7 kPa (5.25 mmHg)

MONITOR RESULT

Refer to Monitor Result for detailed information (See page ES-25).

DTC	P2419	Evaporative Emission System Switching Valve Control Circuit Low

DTC	P2420	Evaporative Emission System Switching Valve Control Circuit High

DTC SUMMARY

DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P2419	Vent valve stuck closed	Vacuum pump creates negative pressure through 0.02 inch orifice and EVAP system pressure measured to determine leak pressure standard. If system pressure is higher than -1.06 kPa (-7.95 mmHg)* 4 seconds after vacuum pump turned ON, ECM determines that vent valve is stuck closed.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM	While ignition switch OFF	2 trip
P2420	Vent valve stuck open (vent)	Vacuum pump creates negative pressure through 0.02 inch orifice and EVAP system pressure measured to determine leak pressure standard. 0.02 inch leak pressure standard measured at start and at end of leak check. If system pressure does not increase by more than 0.3 kPa (2.25 mmHg) within 10 seconds after vent valve turned ON, ECM determines that vent valve is stuck closed.	• Pump module • Connector/wire harness (Pump module - ECM) • ECM • Leakage from EVAP system	While ignition switch OFF	2 trip

*: The threshold value varies according to the atmospheric pressure measured in operation A. The value described above is based on an atmospheric pressure of 100 kPa (750.1 mmHg): absolute pressure.
HINT:
The vent valve is built into the pump module.

DESCRIPTION

The circuit description can be found in the EVAP (Evaporative Emission) System (See page ES-370).

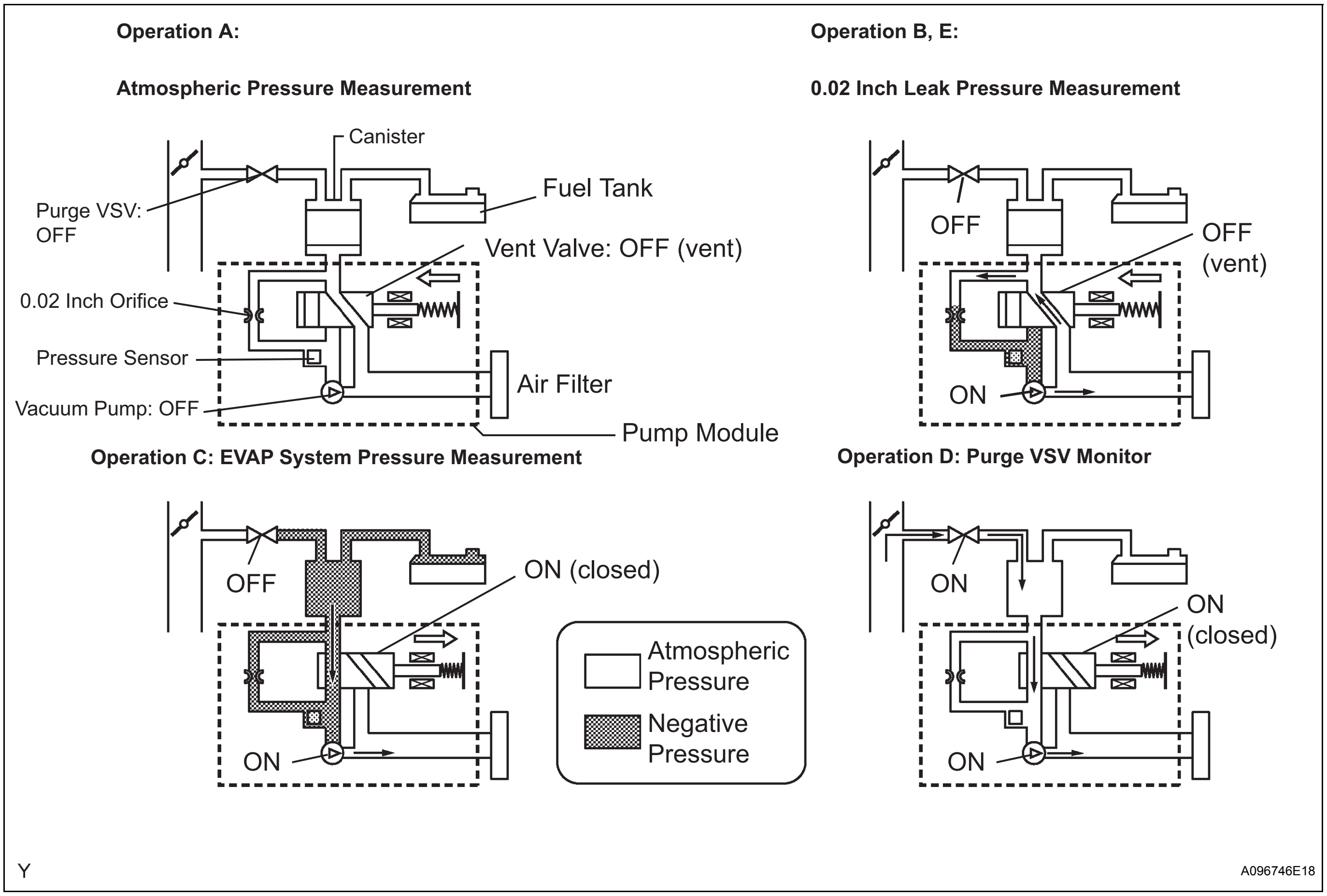
MONITOR DESCRIPTION

5 hours*1 after the ignition switch is turned off, the electric vacuum pump creates negative pressure (vacuum) in the EVAP (Evaporative Emission) system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.
HINT:
*1: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned off, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned off, the monitor check starts 2.5 hours later.

Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned off.	-
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system is not between 70 kPa and 110 kPa (525 mmHg and 825 mmHg), ECM cancels EVAP system monitor.	10 seconds
B	First 0.02 inch leak pressure measurement	In order to determine 0.02 inch leak pressure standard, vacuum pump creates negative pressure (vacuum) through 0.02 inch orifice and then ECM checks if vacuum pump and vent valve operate normally.	60 seconds

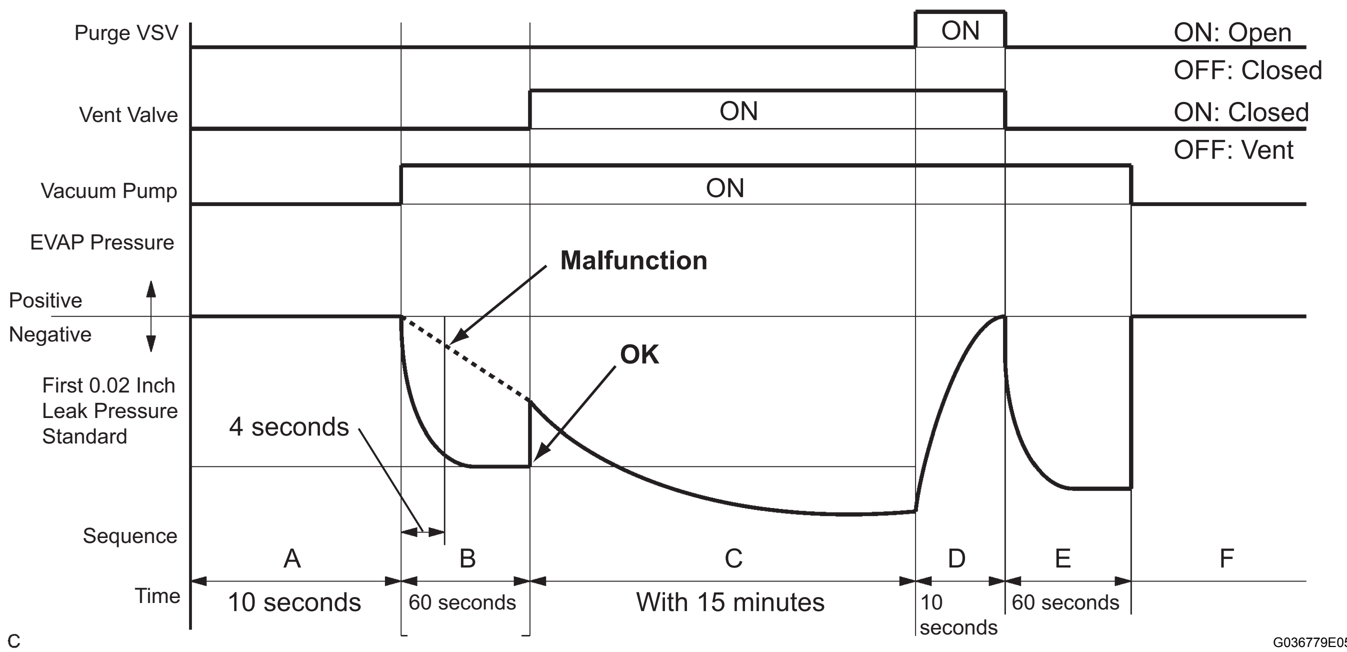
Sequence	Operations	Descriptions	Duration
C	EVAP system pressure measurement	Vent valve is turned ON (closed) to shut EVAP system. Negative pressure (vacuum) is created in EVAP system, and then EVAP system pressure is measured. Write down measured value as they will be used in leak check. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP system monitor.	15 minutes*2
D	Purge VSV monitor	Purge VSV is opened and then EVAP system pressure is measured by ECM. Large increase indicates normal.	10 seconds
E	Second 0.02 inch leak pressure measurement	After second 0.02 inch leak pressure measurement, leak check is performed by comparing first and second 0.02 inch leak pressure standards. If stabilized system pressure is higher than second 0.02 inch leak pressure standard, ECM determines that there is a leak in EVAP system.	60 seconds
F	Final check	Atmospheric pressure is measured and then monitoring result is recorded by ECM.	-

*2: If only a small amount of fuel is in the fuel tank, it takes longer for the EVAP pressure to stabilize.

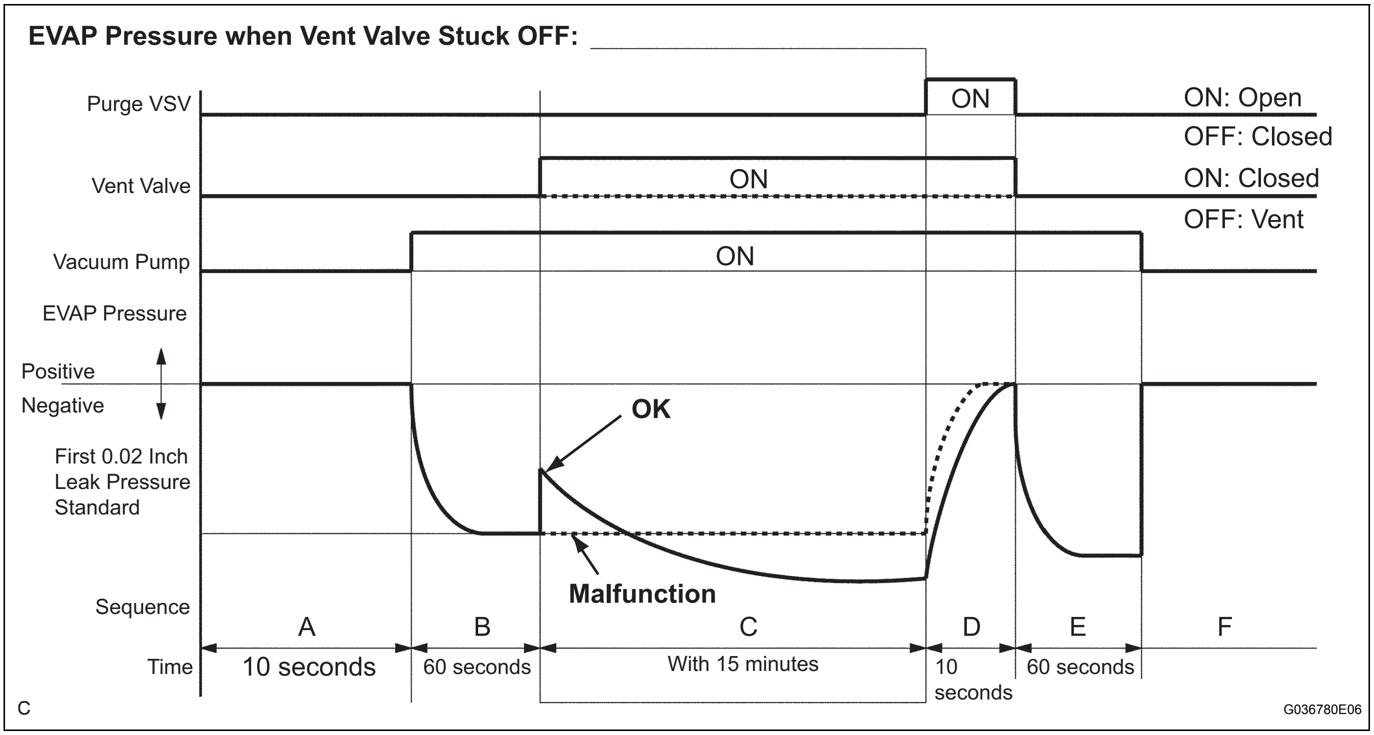


1. P2419: Vent valve stuck closed
   In operation B, the vacuum pump creates negative pressure (a vacuum) through the 0.02 inch orifice. The EVAP (Evaporative Emission) system pressure is then measured by the ECM, using the pressure sensor, to determine the 0.02 inch leak pressure standard. If the pressure exceeds -1.06 kPa (-7.95 mmHg)* 4 seconds after the vacuum pump is turned ON, the ECM interprets this as the vent valve being stuck closed. The ECM illuminates the MIL and sets the DTC (2 trip detection logic).
   *: The threshold varies according to the atmospheric pressure measured in operation A. The value described above is based on an atmospheric pressure of 100 kPa (750.1 mmHg): absolute pressure.

EVAP Pressure when Vent Valve Stuck ON:



2. P2420: Vent valve stuck open (vent)
   In operation C, the vent valve turns ON (closes) and the EVAP (Evaporative Emission) system pressure is then measured by the ECM, using the pressure sensor, to conduct an EVAP leak check. If the pressure does not increase when the vent valve is open, the ECM interprets this as the vent valve being stuck open. The ECM illuminates the MIL and sets the DTC.



OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Required Sensors / Components	Purge VSV and pump module
Frequency of Operation	Once per driving cycle
Duration	Within 2 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Key-off monitor is run when all of the following conditions met	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	2.5 mph (4 km/h) or less
Ignition switch	OFF
Time after key-off	5 or 7 or 9.5 hours
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
EVAP canister purge valve	Not operated by scan tool
EVAP canister vent valve	Not operated by scan tool
EVAP leak detection pump	Not operated by scan tool

Both of the following conditions 1 and 2 set before key-off	-
1. Duration that vehicle has been driven	5 minutes or more
2. EVAP purge operation	Performed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)

Key-off monitor sequence 1 to 8

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met	-
Atmospheric pressure change	Less than 0.3 kPa (2.25 mmHg) in 1 second

2. First reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2 and 3
1. EVAP pressure just after reference pressure measurement start	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated

3. EVAP canister vent valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after vent valve is ON	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction

Next sequence is run if the following condition is met	-
EVAP pressure	Saturated within 15 minutes

5. EVAP canister purge valve close stuck check

Next sequence is run if the following condition is met	-
EVAP pressure change after purge valve is open	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if the following conditions are met	Condition 1, 2, 3 and 4
1. EVAP pressure just after reference pressure	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.384 to -7.929 mmHg)
3. Reference pressure	Saturated
4. Difference between first reference pressure and second reference pressure	Less than 0.7 kPa (5.25 mmHg)

7. Leak check

Next sequence is run if the following condition is met	-
EVAP pressure when vacuum introduction is complete	Lower than second reference pressure

8. Atmospheric pressure measurement

EVAP monitor is complete if the following condition is met	-
Atmospheric pressure difference between sequence 1 and 8	Within 0.3 kPa (2.25 mmHg)

TYPICAL MALFUNCTION THRESHOLDS

P2419: vent valve stuck closed

One of the following conditions met	-
EVAP pressure just after reference pressure measurement start	More than -1 kPa (-7.5 mmHg)
Reference pressure	Less than -4.85 kPa (-36.384 mmHg)
Reference pressure	-1.057 kPa (-7.929 mmHg) or more

Reference pressure	Not saturated
Difference between first reference pressure and second reference pressure	0.7 kPa (5.25 mmHg) or more

P2420: vent valve stuck open

EVAP pressure change after EVAP canister vent valve is ON	Less than 0.3 kPa (2.25 mmHg)

MONITOR RESULT

Refer to Monitor Result for detailed information (See page ES-25).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-373).

DTC	P2610	ECM / PCM Internal Engine Off Timer Performance

DTC SUMMARY

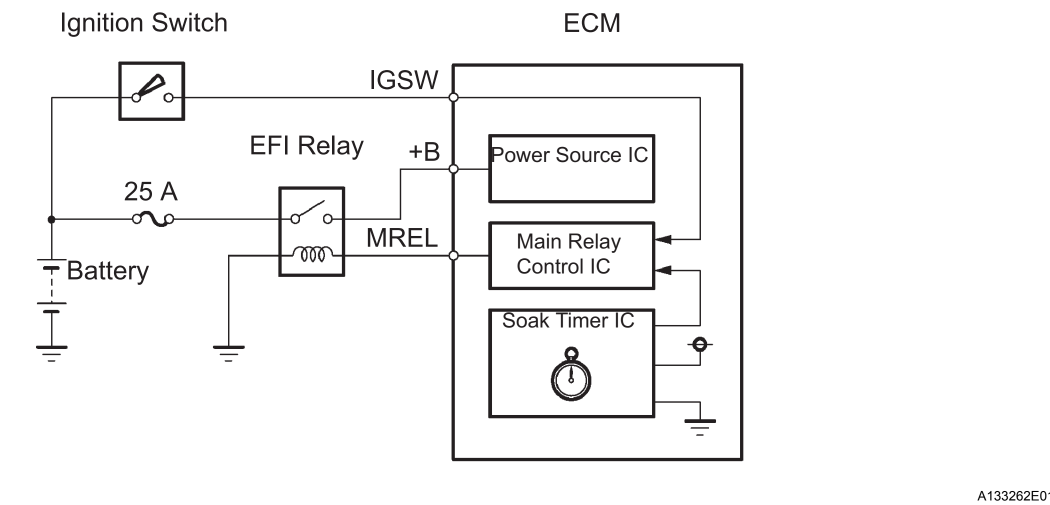
DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P2610	Soak timer (built into ECM)	ECM internal malfunction	ECM	Engine running	2 trip

DESCRIPTION

ES

To ensure the accuracy of the EVAP (Evaporative Emission) monitor values, the soak timer, which is built into the ECM, measures 5 hours (+- 15 minutes) from when the ignition switch is turned off, before the monitor is run. This allows the fuel to cool down, which stabilizes the Fuel Tank Pressure (FTP). When 5 hours have elapsed, the ECM turns on.

Soak Timer Circuit:



MONITOR DESCRIPTION

5 hours after the ignition switch is turned off, the soak timer activates the ECM to begin the EVAP system monitor. While the engine is running, the ECM monitors the synchronization of the soak timer and the CPU clock. If these two are not synchronized, the ECM interprets this as a malfunction, illuminates the MIL and sets the DTC (2 trip detection logic).

OBD II MONITOR SPECIFICATIONS

MONITOR STRATEGY

Required Sensors / Components	ECM
Frequency of Operation	Once per driving cycle
Duration	10 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	None
Ignition switch	ON

Engine	Running
Battery voltage	8 V or more
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

Soak timer measurement when ECM CPU clock counts 10 minutes	Less than 7 minutes or more than 13 minutes

INSPECTION PROCEDURE

HINT:

- DTC P2610 is set if an internal ECM problem is detected. Diagnostic procedures are not required.ECM replacement is required.
- 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.

ES

1	REPLACE ECM

(a) Replace the ECM (See page ES-446).

NEXT

2	CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Clear DTCs (See page ES-44).
(d) Start the engine and wait for 10 minutes or more.
(e) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
(f) If no pending DTC is displayed, the repair has been successfully completed.

OK:

No DTC output.

NG → **CHECK FOR INTERMITTENT PROBLEMS**

OK

END

DTC	P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC	P2A03	A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)

HINT:
- DTC P2A00 indicates malfunctions related to the bank 1 A/F sensor.
- DTC P2A03 indicates malfunctions related to the bank 2 A/F sensor.
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that includes cylinder No. 2.
- Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.

ES

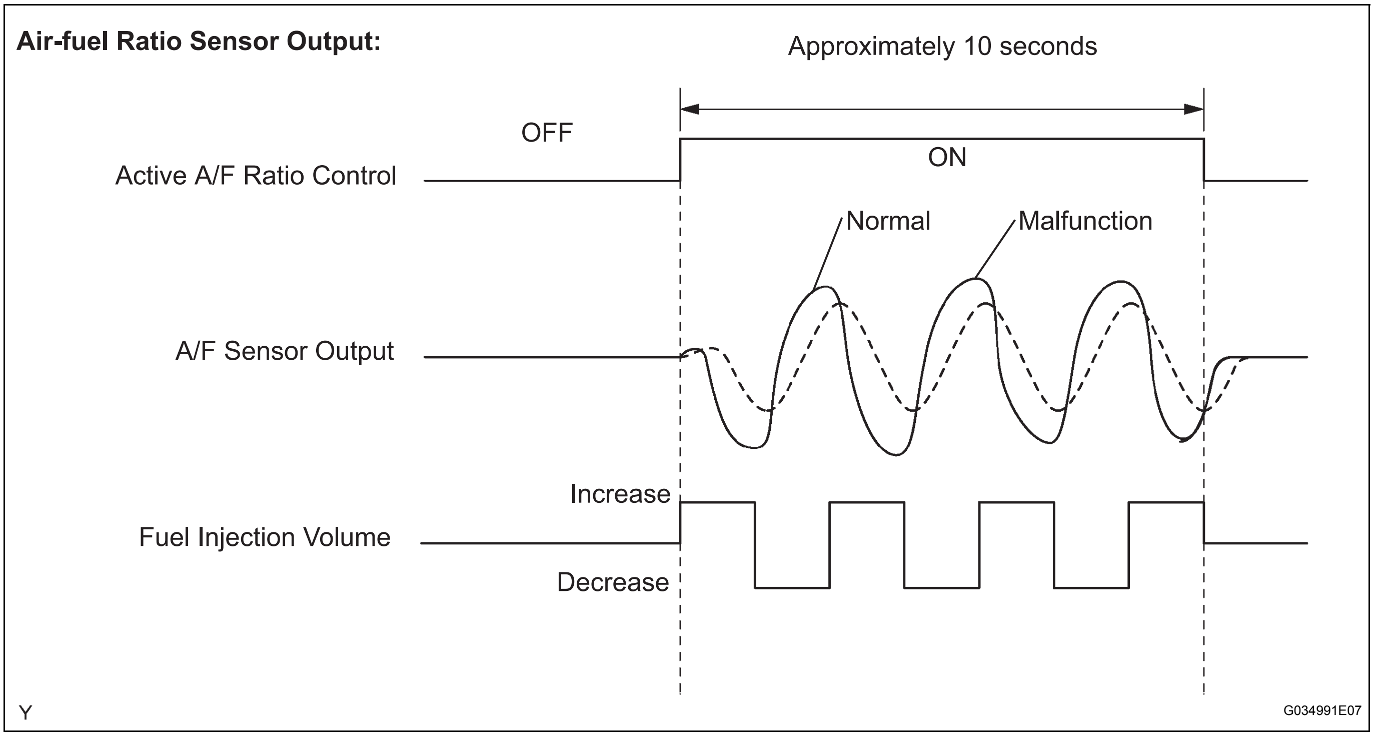
DESCRIPTION

Refer to DTC P2195 (See page ES-313).

DTC No.	DTC Detection Conditions	Trouble Areas
P2A00 P2A03	Calculated value for air-fuel ratio (A/F) sensor response rate deterioration level is less than threshold	• Open or short in A/F sensor circuit • A/F sensor • ECM

MONITOR DESCRIPTION

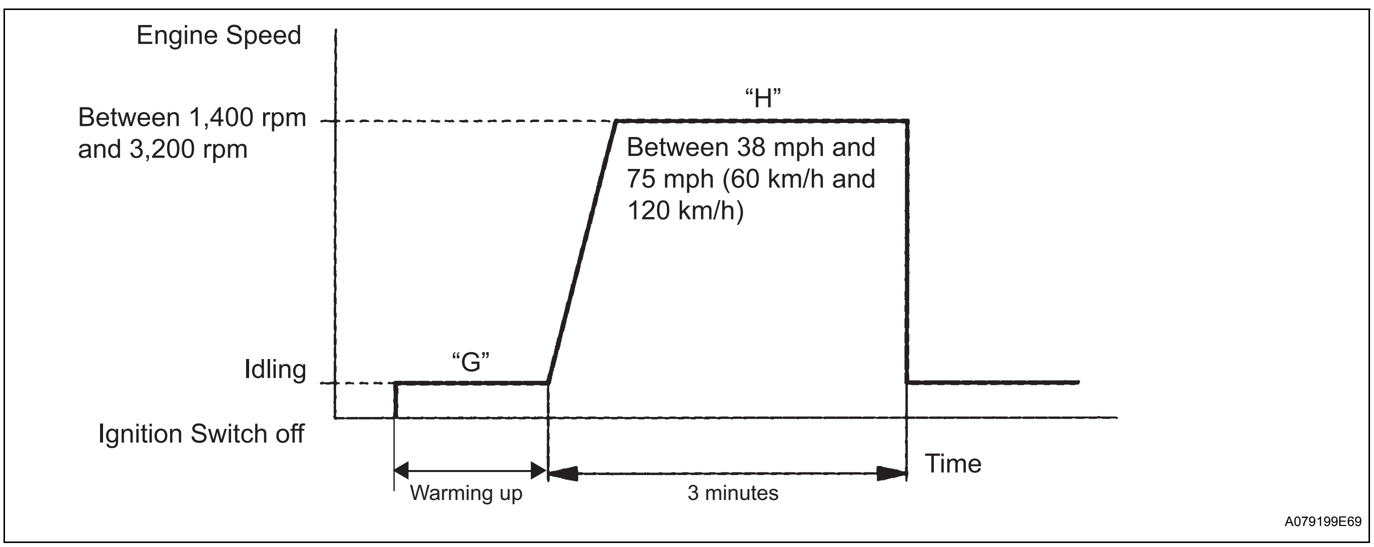
After the engine is warmed up, the ECM performs air-fuel ratio feedback control to maintain the air-fuel ratio at the stoichiometric level. In addition, active A/F ratio control is performed for approximately 10 seconds after preconditions are met in order to measure the A/F sensor response rate. During active A/F ratio control, the ECM forcibly increases and decreases the injection volume to a certain amount, based on the stoichiometric air-fuel ratio learned during normal air-fuel ratio control, and measures the A/F sensor response rate. The ECM receives a signal from the A/F sensor while performing active A/F ratio control and uses it to calculate the A/F sensor response rate deterioration level.
If the value for A/F sensor response rate deterioration level is less than the threshold, the ECM interprets this as a malfunction and sets the DTC.



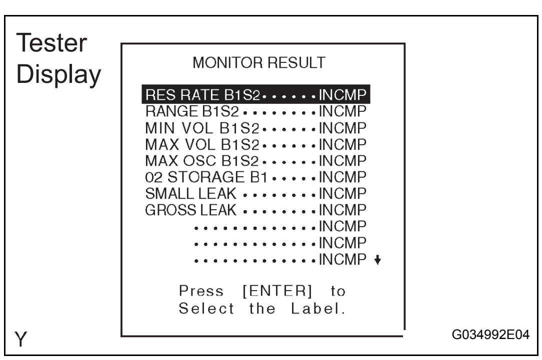
CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the A/F sensor response monitor.



1. Connect the intelligent tester to the DLC3 (Procedure "A").



2. Turn the ignition switch on (IG) (Procedure "B").
3. Turn the tester on (Procedure "C").
4. Clear DTCs (where set) (Procedure "D").
5. Select the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / MONITOR RESULT (Procedure "E").
6. Check that AFS B1 is INCOMPL (Procedure "F").
7. Start the engine and warm it up (Procedure "G").
8. Drive the vehicle at between 38 mph and 75 mph (60 km/h and 120 km/h) for 3 minutes. However, the vehicle should be driven at a constant speed (Procedure "H").
9. Check the monitor result values on the intelligent tester by selecting the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / TEST RESULT (Procedure "I").
10. If the values indicated on the tester do not change, perform READINESS MONITOR DRIVE PATTERN for the A/F sensor and the heated oxygen sensor (See page ES-26) (Procedure "J").
    HINT:
    Completion of all A/F sensor monitors is required to change the value in TEST RESULT.
11. Note the value of the Monitor Result (Procedure "K").
12. Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES (Procedure "L").
13. Check if any DTCs (any pending DTCs) are set (Procedure "M").

MONITOR STRATEGY

Related DTCs	P2A00: A/F sensor (Bank 1) slow response P2A03: A/F sensor (Bank 2) slow response
Required Sensors / Components (Main)	A/F sensor
Required Sensors / Components (Related)	Vehicle speed sensor, Crankshaft position sensor
Frequency of Operation	Once per driving cycle
Duration	10 to 15 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	P0031, P0032, P0051, P0052 (A/F Sensor heater Sensor 1), P0100, P0101, P0102, P0103 (MAF Sensor), P0110, P0112, P0113 (IAT Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0171, P0172 (Fuel System), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1, 2, P0450, P0451, P0452, P0453 (EVAP System), P0500 (VSS), P2196, P2198 (A/F Sensor (Rationality))
Active A/F control	Performing
Active A/F control is performed when the following conditions met	-
Engine coolant temperature	75°C (167°F) or more
Battery voltage	11 V or more
Fuel-cut	OFF
Engine RPM	Less than 4,000 rpm
A/F sensor status	Activated
Engine load	10 to 70%
Shift position	2 or more
Catalyst monitor	Not yet
Idle	OFF
Intake air amount	2.5 to 8.2 g/s

TYPICAL MALFUNCTION THRESHOLDS

Response rate deterioration level	Less than 0.2 V

MONITOR RESULT

Refer to Checking Monitor Status for detailed information (See page ES-25).

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$01	$8E	Multiply by 0.0003 [no dimension]	Response rate deterioration level for bank 1 sensor 1	Malfunction criterion for response rate deterioration	Maximum test limit

WIRING DIAGRAM

Refer to DTC P2195 (See page ES-317).

INSPECTION PROCEDURE

HINT:

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.

(a) Connect the intelligent tester to the DLC3.

(b) Start the engine and turn the tester on.

(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.

(d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.

(e) 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).

(f) 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.

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 and decreases in the fuel injection volume.

Standard voltage

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

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.

ES

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	 OK	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	NG	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	 OK	Output Voltage Almost no reaction	NG	
4	Injection volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

– Following the A/F CONTROL procedure enables technicians to check the graph of the voltage outputs of both the A/F and HO2 sensors.

– To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2. Press the YES button and then the ENTER button. Then press the F4 button.

HINT:

- DTC P2A00 or P2A03 may be also set when the air-fuel ratio is stuck rich or lean.
- A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.
- A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.
- 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.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00 AND/OR P2A03)

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

(e) Read DTCs.

Result

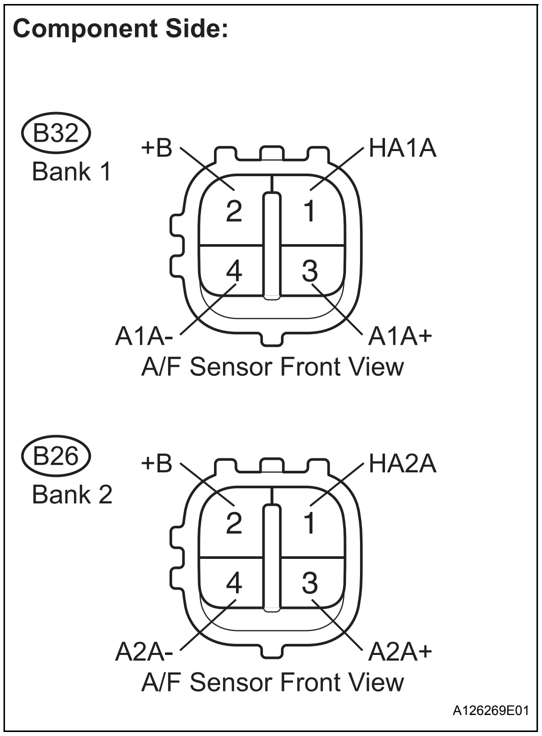
Display (DTC Output)	Proceed to
P2A00 and/or P2A03	A
P2A00 and/or P2A03 and other DTCs	B

HINT:
If any DTCs other than P2A00 or P2A03 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/ sensor connector.
Standard resistance:
Bank 1

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

Bank 2

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

(c) Reconnect the A/F sensor connector.

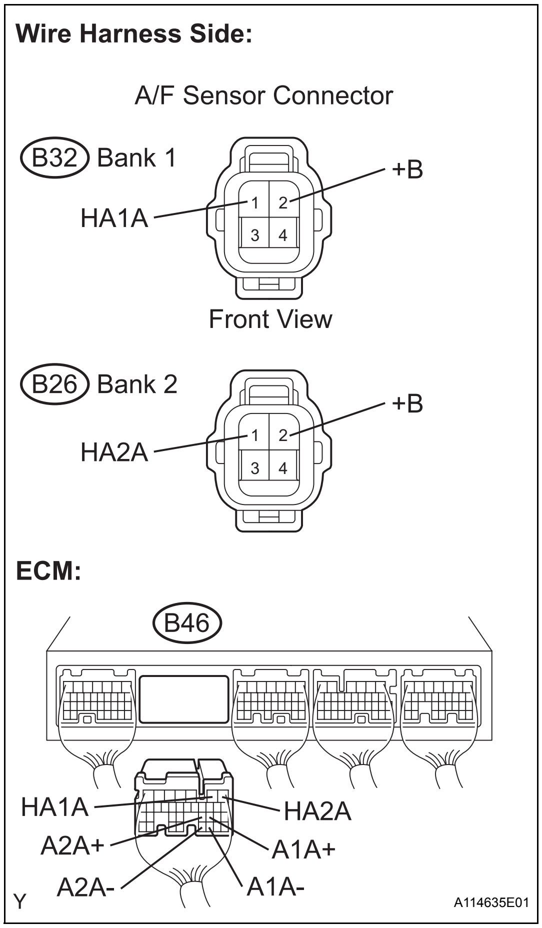
NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

ES

ES

3	CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)



(a) Disconnect the B26 or B32 A/F sensor connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.

Standard voltage

Tester Connections	Specified Conditions
+B (B32-2) - Body ground	9 to 14 V
+B (B26-2) - Body ground	9 to 14 V

(d) Turn the ignition switch off.
(e) Disconnect the B46 ECM connector.
(f) Measure the resistance between the terminals of the A/F sensor connector and ECM connector.

Standard resistance (Check for open)

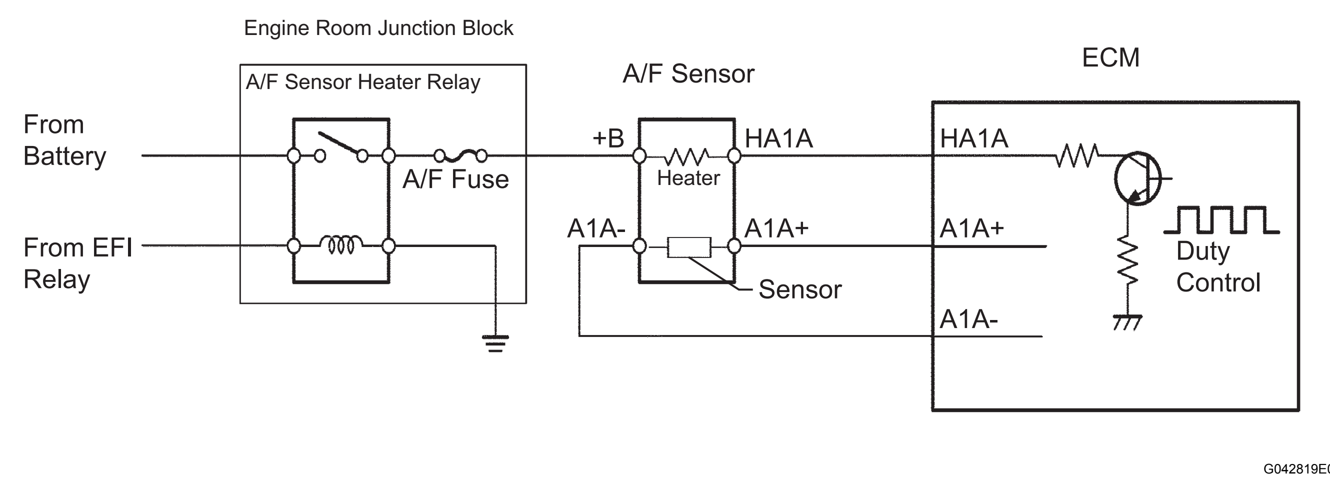
Tester Connections	Specified Conditions
HA1A (B32-1) - HA1A (B46-2)	Below 1 Ω
A1A+ (B32-3) - A1A+ (B46-22)	Below 1 Ω
A1A- (B32-4) - A1A- (B46-30)	Below 1 Ω
HA2A (B26-1) - HA2A (B46-1)	Below 1 Ω
A2A+ (B26-3) - A2A+ (B46-23)	Below 1 Ω
A2A- (B26-4) - A2A- (B46-31)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1A (B32-1) or HA1A (B46-2) - Body ground	10 kΩ or higher
A1A+ (B32-3) or A1A+ (B46-22) - Body ground	10 kΩ or higher
A1A- (B32-4) or A1A- (B46-30) - Body ground	10 kΩ or higher
HA2A (B26-1) or HA2A (B46-1) - Body ground	10 kΩ or higher
A2A+ (B26-3) or A2A+ (B46-23) - Body ground	10 kΩ or higher
A2A- (B26-4) or A2A- (B46-31) - Body ground	10 kΩ or higher

(g) Reconnect the ECM connector.
(h) Reconnect the A/F sensor connector.

Reference (System Diagram of Bank 1 Sensor 1):



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

OK

4 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5 CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

(a) Read DTCs using the intelligent tester.
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

Result

Display (DTC Output)	Proceed to
P2A00 and/or P2A03	A
No output	B

B → **CHECK FOR INTERMITTENT PROBLEMS**

A

6 REPLACE AIR FUEL RATIO SENSOR

(a) Replace the air fuel ratio sensor (See page EC-20).

NEXT

7 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8 CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00 AND/OR P2A03)

(a) Read DTCs using the intelligent tester.
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

Result

Display (DTC Output)	Proceed to
No output	A
P2A00 and/or P2A03	B

B → **CHECK EXTREMELY RICH OR LEAN ACTUAL AIR FUEL RATIO (REFER TO DTC P0171 PROCEDURE)**

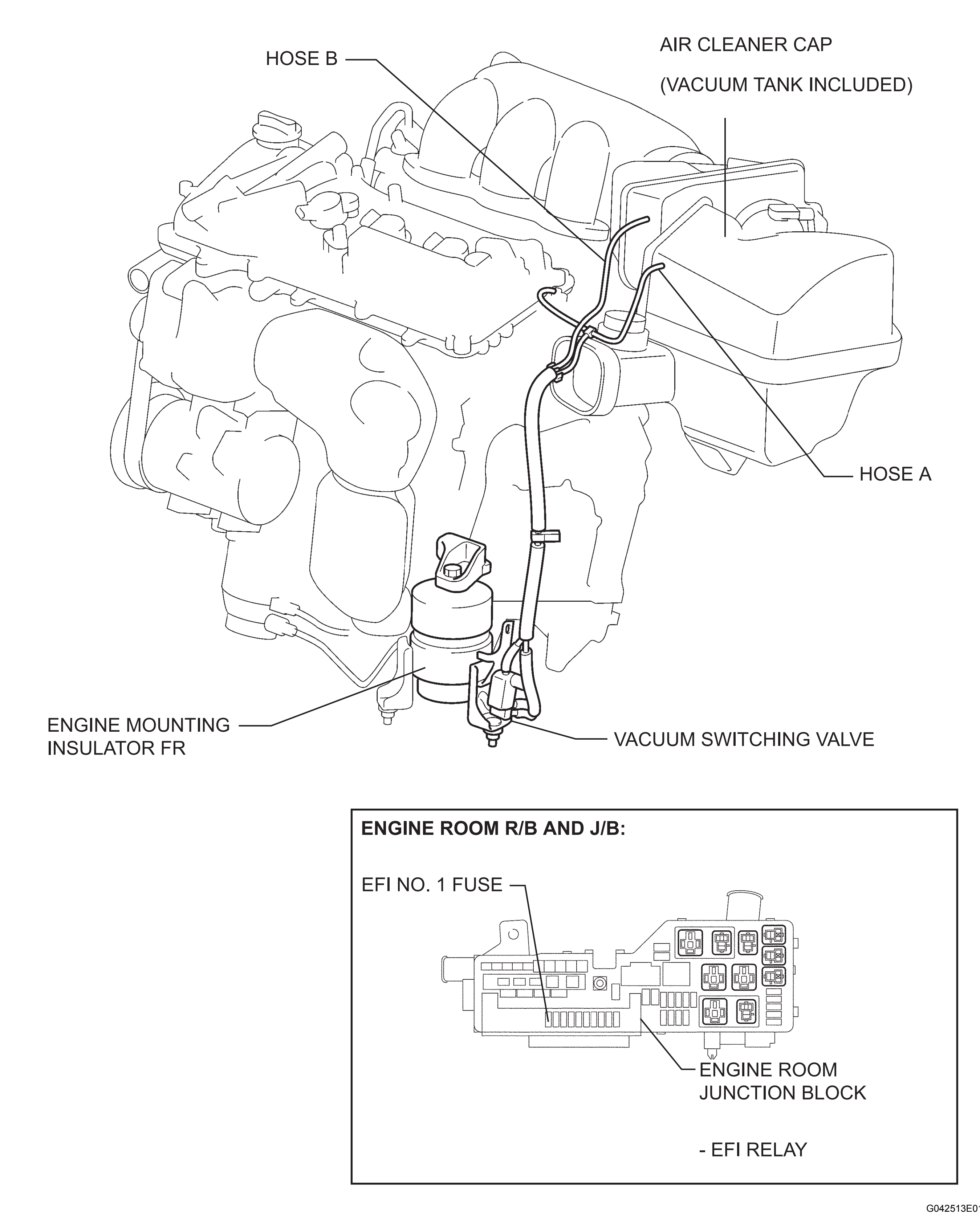
A

END

Active Control Engine Mount System

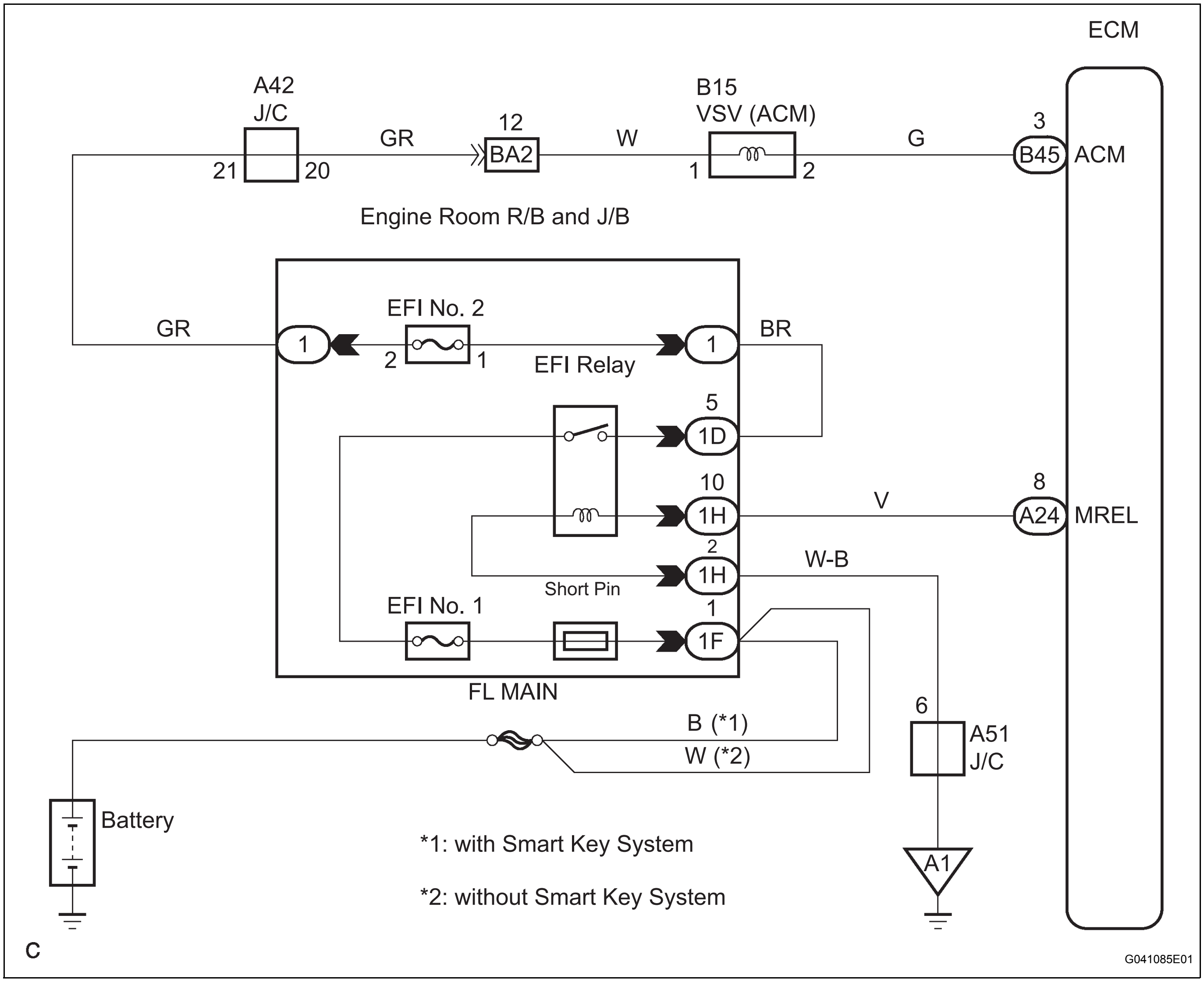
DESCRIPTION

LOCATION



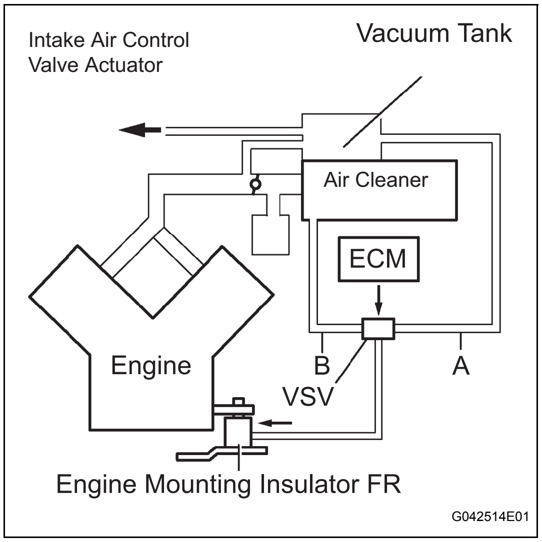
The Active Control Engine Mount (ACM) system decreases engine vibration at low engine speed using the ACM VSV. The VSV is controlled by a pulse signal transmitted to the VSV from the ECM. The frequency of this pulse signal is matched to the engine speed to decrease engine vibration.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	CHECK VACUUM HOSES

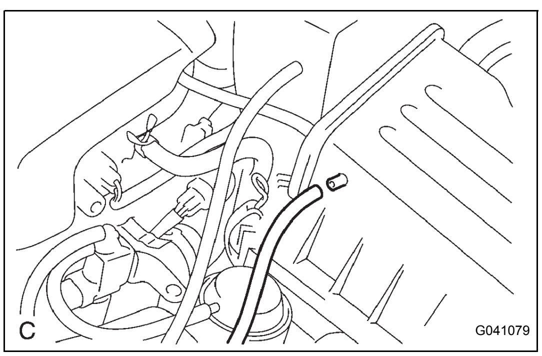


(a) If the hose is damaged, replace the vacuum hose assembly.
(b) Check the air and vacuum hoses for looseness, disconnection and blockage.

NG → **REPAIR OR REPLACE VACUUM HOSES**

OK

2	CHECK VACUUM



(a) Start the engine.
(b) Disconnect the vacuum hose from the air cleaner cap.
(c) Check that an unconnected port located on the vacuum tank applies suction to your finger.
OK:
Vacuum pressure exists
(d) Reconnect the vacuum hose.

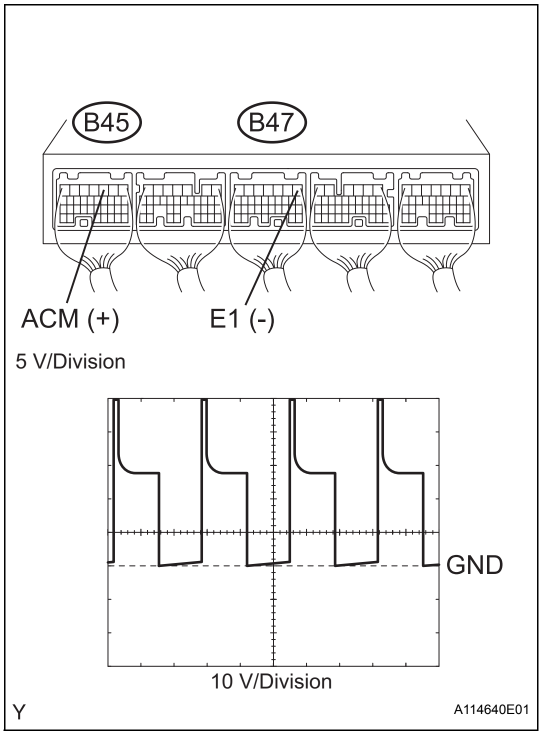
NG → **CHECK AND REPLACE VACUUM SOURCE AND HOSES**

OK

ES

ES

3 INSPECT ECM



(a) Connect the oscilloscope between terminals ACM and E1 of the B45 and B47 ECM connectors.
(b) Warm up the engine to normal operating temperature.
(c) Turn the A/C switch on.
(d) Measure the voltage between terminals ACM and E1 of the ECM connectors.

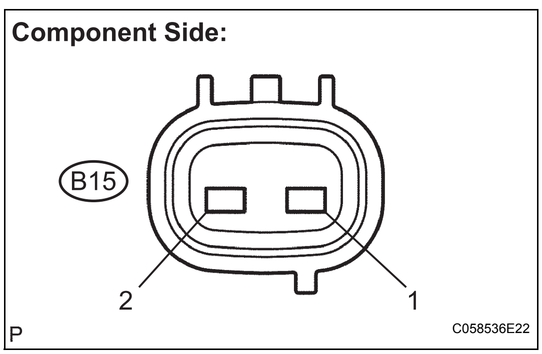
Standard voltage

Condition	Voltage
Shift position is D, and engine speed is 850 rpm or less	Pulse generation
Shift position is D, and engine speed is 950 rpm or more	9 to 14 V
Shift position is P	9 to 14 V

OK → **Go to step 6**

NG ↓

4 INSPECT DUTY VACUUM SWITCHING VALVE (RESISTANCE)



(a) Disconnect the B15 VSV for ACM connector.
(b) Measure the resistance between terminals 1 and 2.

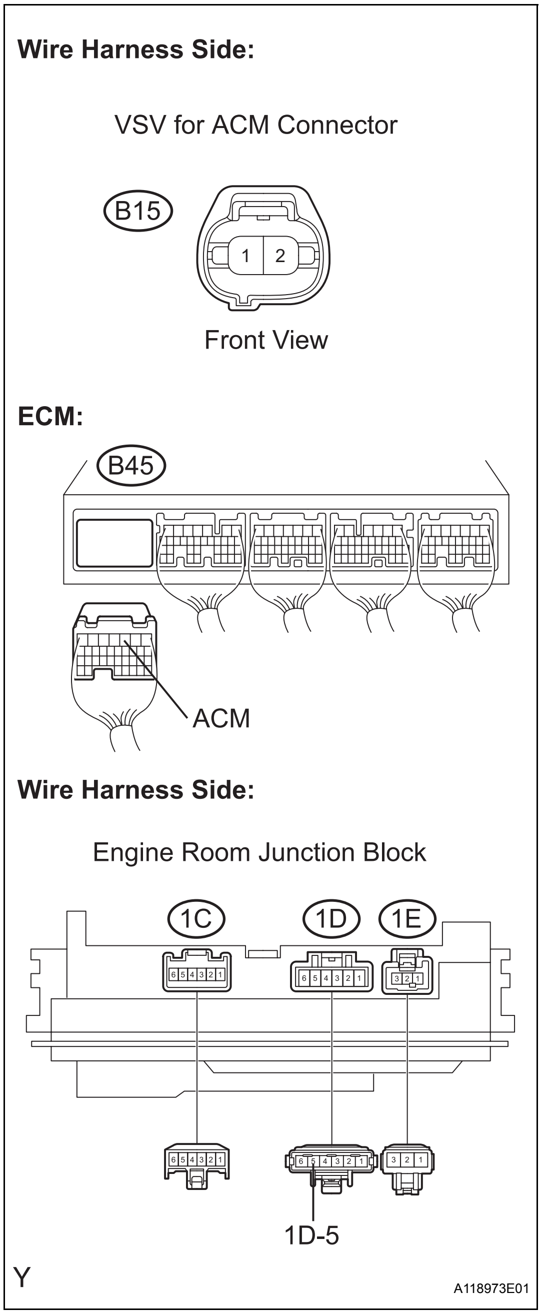
Standard resistance:
19 to 21 Ω at 20°C (68°F)

(c) Reconnect the VSV for ACM connector.

NG → **REPLACE DUTY VACUUM SWITCHING VALVE**

OK ↓

5	CHECK HARNESS AND CONNECTOR (VSV FOR ACM - ECM, VSV FOR ACM - EFI RELAY)



(a) Check the wire harness between the VSV for ACM connector and the ECM connector.
  (1) Disconnect the B15 VSV for ACM connector.
  (2) Disconnect the B45 ECM connector.
  (3) Measure the resistance between the wire harness side connectors.
  Standard resistance (Check for open)

Tester Connections	Specified Conditions
VSV for ACM (B15-2) - ACM (B45-3)	Below 1 Ω

  Standard resistance (Check for open)

Tester Connections	Specified Conditions
VSV for ACM (B15-2) or ACM (B45-3) - Body ground	10 kΩ or higher

  (4) Reconnect the ECM connector.

(b) Check the wire harness between the VSV for ACM and the EFI relay.
  (1) Remove the engine room junction block.
  (2) Measure the resistance between the wire harness side connectors.
  Standard resistance (Check for open)

Tester Connections	Specified Conditions
VSV for ACM (B15-1) - engine room junction block (EFI relay) (1D-5)	Below 1 Ω

  (3) Reconnect the VSV for ACM connector.
  (4) Reinstall the engine room junction block.

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

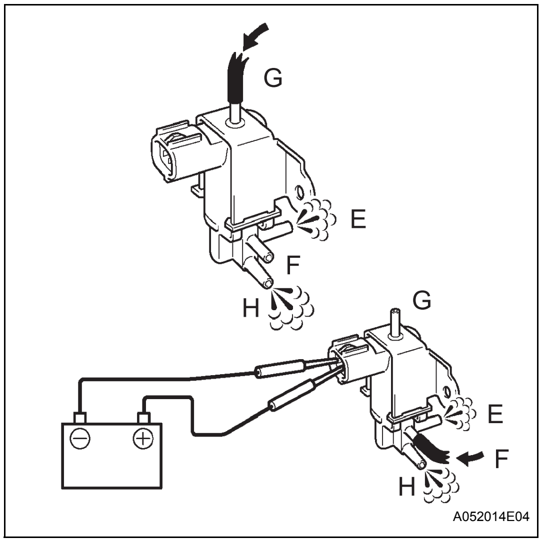
OK

REPLACE ECM

ES

ES

6	INSPECT DUTY VACUUM SWITCHING VALVE (OPERATION)

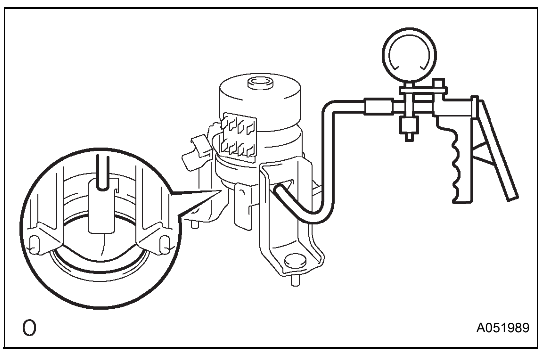


(a) Remove the VSV for ACM.
(b) Check operation of the VSV for ACM when positive battery voltage is applied to the terminals of the VSV for ACM connector.
Positive battery voltage is not applied:
The air from pipe G is flowing out through pipes E and H.
Positive battery voltage is applied:
The air from pipe F is flowing out through pipes E and H.
(c) Reinstall the VSV for ACM.

NG → **REPLACE DUTY VACUUM SWITCHING VALVE**

OK

7	INSPECT ENGINE MOUNTING INSULATOR ASSEMBLY FRONT



(a) Disconnect the vacuum hose from the front engine mount insulator.
(b) Using vacuum pump, apply vacuum of 80 kPa (600 mmHg, 25 in.Hg) and wait for 1 minute.
(c) Check that there is no change in the needle movement of the vacuum pump gauge.
(d) Check that there is no fluid leakage caused by a break in the diaphragm.
OK:
Vacuum pressure exists
(e) Reconnect the vacuum hose.

NG → **REPLACE ENGINE MOUNTING INSULATOR ASSEMBLY FRONT**

OK

SYSTEM OK

EVAP System

RELATED DTCS

DTCs	Monitoring Items	See procedure
P043E	0.02 inch orifice clogged (built into pump module)	ES-236
P043F	0.02 inch orifice high-flow (built into pump module)	
P0441	• Purge VSV (Vacuum Switching Valve) stuck closed • Purge VSV stuck open • Purge flow	ES-242
P0450	Pressure sensor (built into pump module) voltage abnormal fluctuation	ES-249
P0451	• Pressure sensor (built into pump module) noise • Pressure sensor (built into pump module) signal becomes fixed/flat	
P0452	Pressure sensor (built into pump module) voltage low	
P0453	Pressure sensor (built into pump module) voltage high	
P0455	EVAP gross leak	ES-257
P0456	EVAP small leak	
P2401	Vacuum pump stuck OFF (built into pump module)	ES-336
P2402	Vacuum pump stuck ON (built into pump module)	
P2419	Vent valve stuck ON (closed) (built into pump module)	ES-342
P2420	Vent valve stuck OFF (vent) (built into pump module)	
P2610	Soak timer (built into ECM)	ES-348

If any EVAP system DTCs are set, the malfunctioning area can be determined using the table below.

Malfunctioning Areas \ DTCs	P043E P043F	P0441	P0450	P0451	P0452	P0453	P0455	P0456	P2401 P2402	P2419	P2420
0.02 inch orifice clogged	●								●	●	
0.02 inch orifice high-flow	●								●	●	
Purge VSV stuck open		●					●				
Purge VSV stuck closed		●									
Pressure sensor stuck				●							
Pressure sensor noise				●							
Pressure sensor low output			●		●						
Pressure sensor high output			●			●					
Gross leak		●					●				
Small leak								●			
Vacuum pump stuck OFF	●								●	●	
Vacuum pump stuck ON	●								●	●	
Vent valve stuck ON (closed)	●								●	●	
Vent valve stuck OFF (vent)											●

Y A106731E15

NOTICE:
If the 0.02 inch reference pressure difference between the first and second checks is greater than the specification, the DTCs corresponding to the reference pressure (P043E, P043F, P0441, P0455, P0456, P2401, P2420) will be all stored.

CONFIRMATION DRIVING PATTERN

HINT:
After a repair, check Monitor Status by performing the Key-Off Monitor Confirmation and Purge Flow Monitor Confirmation described below.

1. KEY-OFF MONITOR CONFIRMATION

(a) Preconditions
The monitor will not run unless:
(1) The vehicle has been driven for 10 minutes or more (in a city area or on a freeway)
(2) The fuel tank is less than 90% full
(3) The altitude is less than 8,000 ft (2,400 m)
(4) The Engine Coolant Temperature (ECT) is between 4.4°C and 35°C (40°F and 95°F)
(5) The Intake Air Temperature (IAT) is between 4.4°C and 35°C (40°F and 95°F)
(6) The vehicle remains stationary (the vehicle speed is 0 mph [0 km/h])

(b) Monitor Conditions
(1) Allow the engine to idle for at least 5 minutes.

(2) Turn the ignition switch off and wait for 6 hours (8 or 10.5 hours).
HINT:
Do not start the engine until checking MONITOR STATUS. If the engine is started, the steps described above must be repeated.

(c) Monitor Status
(1) Connect an intelligent tester to the DLC3.
(2) Turn the ignition switch on (IG) and turn the tester on.
(3) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR STATUS.
(4) Check the Monitor Status displayed on the tester.
HINT:
If INCMP is displayed, the monitor is not completed. Make sure that the preconditions have been met, and perform the Monitor Conditions again.

2. PURGE FLOW MONITOR CONFIRMATION (P0441)

HINT:
Perform this monitor confirmation after the Key-Off Monitor Confirmation shows COMPL (complete).

(a) Preconditions
The monitor will not run unless:
- The vehicle has been driven for 10 minutes or more (in a city area or on a freeway)
- The ECT is between 4.4°C and 35°C (40°F and 95°F)
- The IAT is between 4.4°C and 35°C (40°F and 95°F)

(b) Monitor Conditions
(1) Release the pressure from the fuel tank by removing and reinstalling the fuel tank cap.
(2) Warm the engine up until the ECT reaches more than 75°C (167°F).
(3) Increase the engine speed to 3,000 rpm once.
(4) Allow the engine to idle and turn the A/C ON for 1 minute.

(c) Monitor Status
(1) Turn the ignition switch off.
(2) Connect the intelligent tester to the DLC3.
(3) Turn the ignition switch to on (IG) and turn the tester on.
(4) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR STATUS.
(5) Check the Monitor Status displayed on the tester.
HINT:
If INCMP is displayed, the monitor is not completed. Make sure that the preconditions have been met, and perform the Monitor Conditions again.

ES

MONITOR RESULT

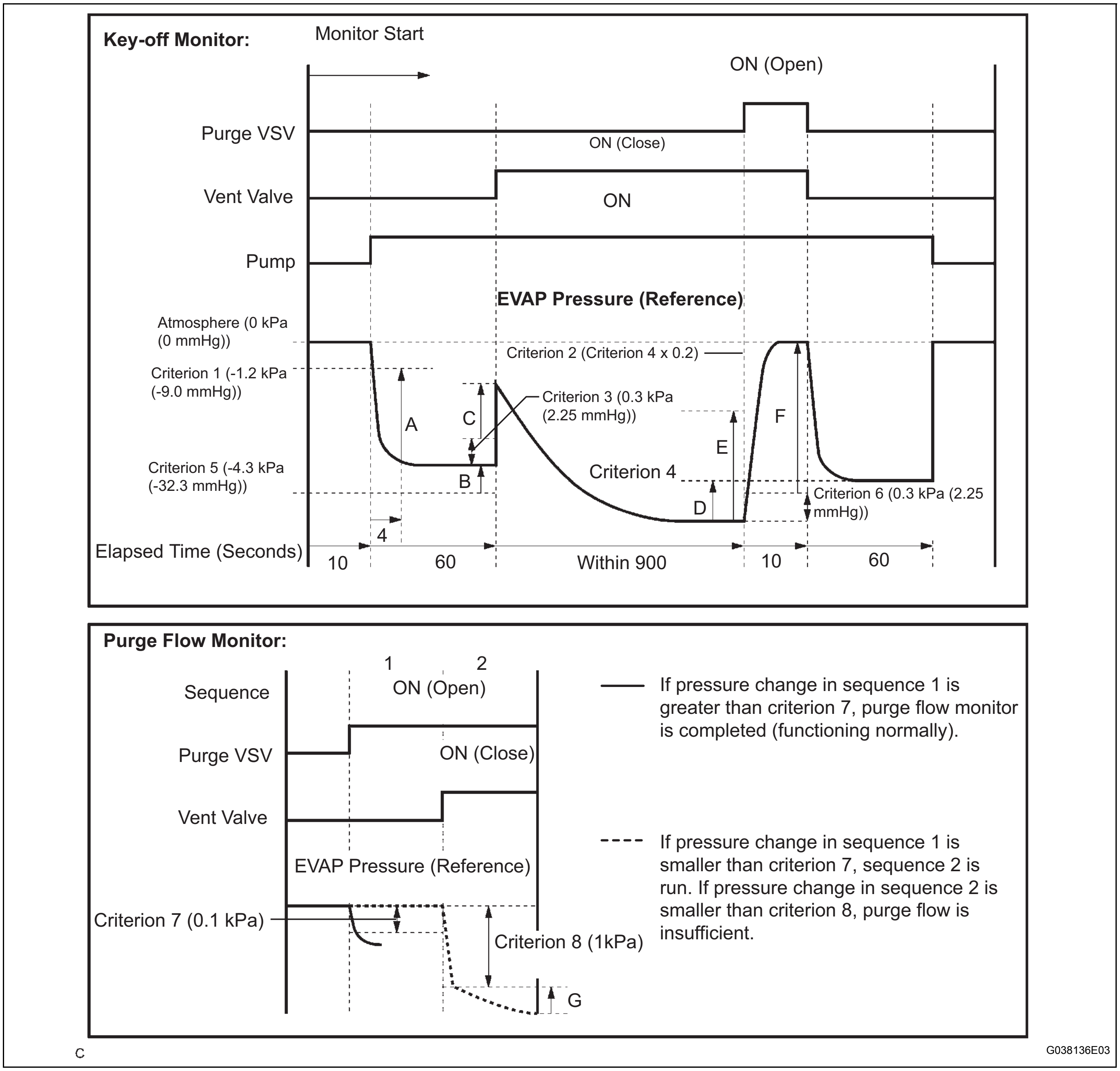
Refer to Checking Monitor Status for detailed information (See page ES-25).
The test value and test limit information are described as shown in the following table. This information is included under MONITOR RESULT in the emissions-related DTC sections:
– MID (Monitor Identification Data) is assigned to each emissions-related component.
– TID (Test Identification Data) is assigned to each test value.
– Scaling is used to calculate the test value indicated on generic OBD II scan tools.

Thermostat

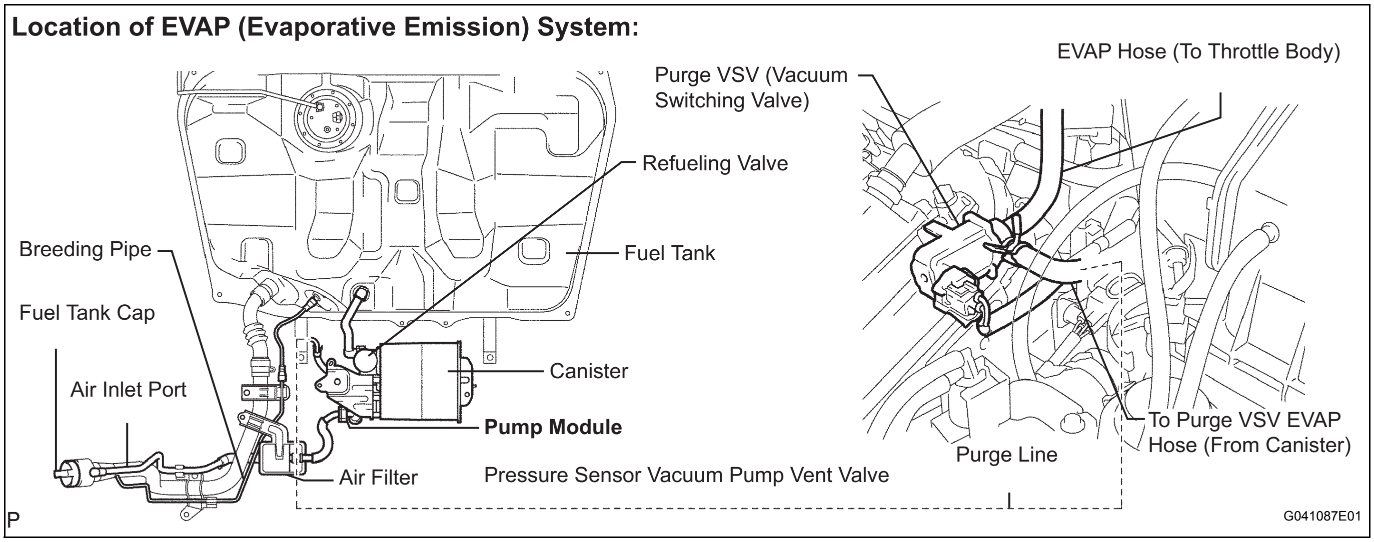
MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$3D	$C9	Multiply by 0.01 [kPa]	Test value for small leak (P0456) Refer to pressure D*	Minimum test limit for small leak	Maximum test limit for small leak
$3D	$CA	Multiply by 0.01 [kPa]	Test value for gross leak (P0455) Refer to pressure E*	Minimum test limit for gross leak	Maximum test limit for gross leak
$3D	$CB	Multiply by 0.01 [kPa]	Test value for vacuum pump stuck OFF (P2401) Refer to pressure A*	Minimum test limit for vacuum pump stuck OFF	Maximum test limit for vacuum pump stuck OFF
$3D	$CD	Multiply by 0.01 [kPa]	Test value for vacuum pump stuck ON (P2402) Refer to pressure A*	Minimum test limit for vacuum pump stuck ON	Maximum test limit for vacuum pump stuck ON

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
$3D	$CE	Multiply by 0.01 [kPa]	Test value for vent valve stuck OFF (vent) (P2420) Refer to pressure C*	Minimum test limit for vent valve stuck ON	Maximum test limit for vent valve stuck ON
$3D	$CF	Multiply by 0.01 [kPa]	Test value for vent valve stuck ON (P2419) Refer to pressure A*	Minimum test limit for vent valve stuck OFF	Maximum test limit for vent valve stuck OFF
$3D	$D0	Multiply by 0.01 [kPa]	Test value for 0.02 inch orifice low flow (P043E) Refer to pressure B*	Minimum test limit for 0.02 inch orifice low flow	Maximum test limit for 0.02 inch orifice low flow
$3D	$D1	Multiply by 0.01 [kPa]	Test value for 0.02 inch orifice high flow (P043F) Refer to pressure A*	Minimum test limit for 0.02 inch orifice high flow	Maximum test limit for 0.02 inch orifice high flow
$3D	$D4	Multiply by 0.01 [kPa]	Test value for purge VSV stuck close (P0441) Refer to pressure F*	Minimum test limit for purge VSV stuck closed	Maximum test limit for purge VSV stuck closed
$3D	$D5	Multiply by 0.01 [kPa]	Test value for purge VSV stuck open (P0441) Refer to pressure E*	Minimum test limit for purge VSV stuck open	Maximum test limit for purge VSV stuck open
$3D	$D7	Multiply by 0.01 [kPa]	Test value for purge flow (P0441) Refer to pressure G*	Minimum test limit for purge flow	Maximum test limit for purge flow

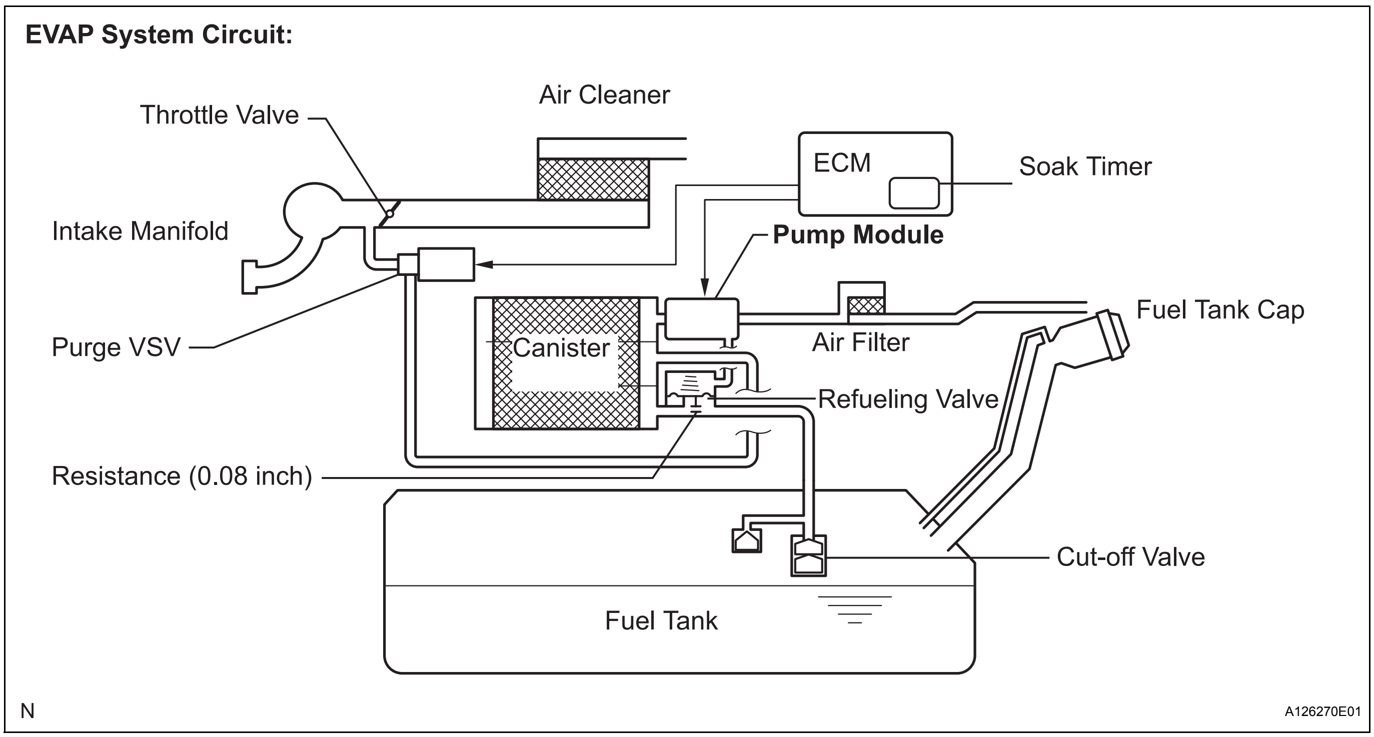
* Pressures A to G are indicated as shown in the diagram on the next page.



DESCRIPTION



HINT:
The canister is located near the fuel tank, underneath the body.



While the engine is running, if a predetermined condition (closed- loop, etc.) is met, the purge VSV is opened by the ECM and stored fuel vapors in the canister are purged to the intake manifold. The ECM changes the duty cycle ratio of the purge VSV to control purge flow volume.
The purge flow volume is also determined by the intake manifold pressure. Atmospheric pressure is allowed into the canister through the vent valve to ensure that the purge flow is maintained when the negative pressure (vacuum) is applied to the canister.
The following two monitors run to confirm appropriate EVAP system operation.

1. **Key-off monitor**

This monitor checks for EVAP (Evaporative Emission) system leaks and pump module malfunctions. The monitor starts 5 hours* after the ignition switch is turned off. More than 5 hours are required to allow the fuel to cool down to stabilize the Fuel Tank Pressure (FTP), thus making the EVAP system monitor more accurate.

The electric vacuum pump creates negative pressure (vacuum) in the EVAP system, and the pressure is measured. Finally, the ECM monitors for leaks from the EVAP system and malfunctions in both the pump module and purge VSV, based on the EVAP pressure.

HINT:

*: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned off, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned off, the monitor check starts 2.5 hours later.

2. **Purge flow monitor**

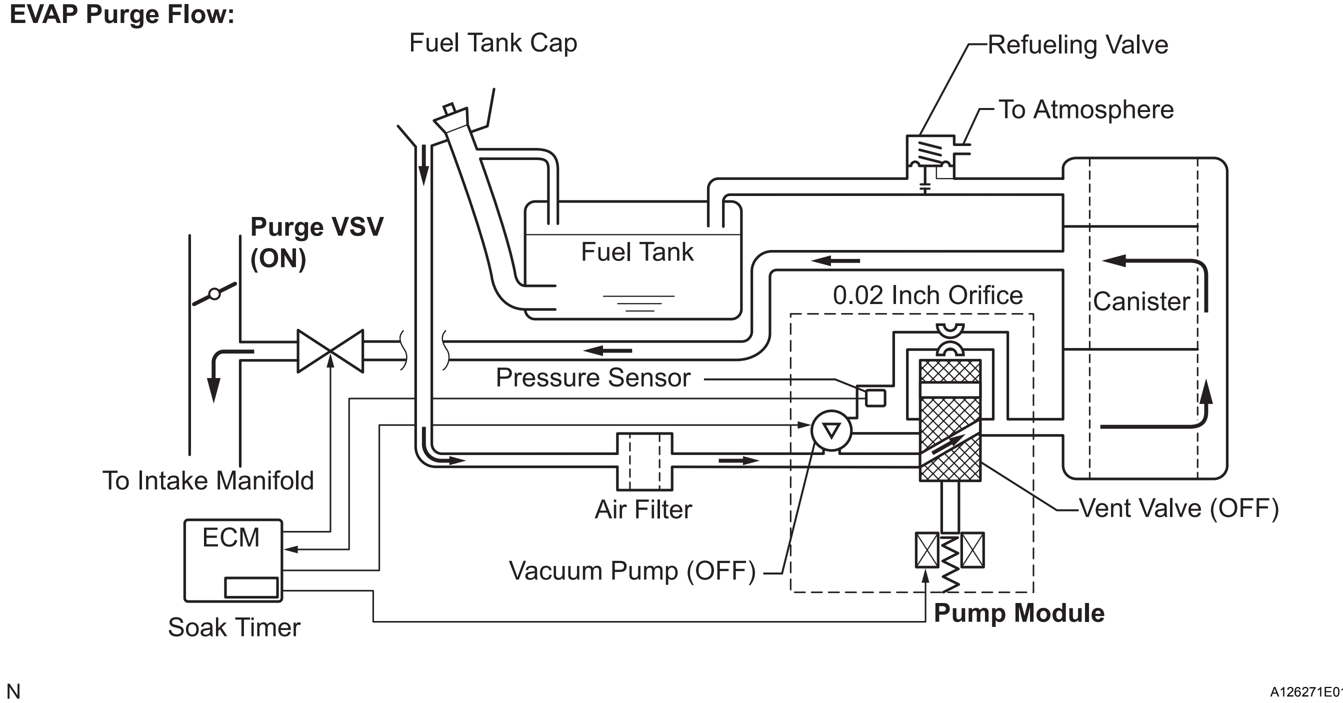
The purge flow monitor consists of the two monitors. The 1st monitor is always conducted every time and the 2nd monitor is activated if necessary.

- The 1st monitor
  While the engine is running and the purge VSV (Vacuum Switching Valve) is ON (open), the ECM monitors the purge flow by measuring the EVAP pressure change. If negative pressure is not created, the ECM begins the 2nd monitor.
- The 2nd monitor
  The vent valve is turned OFF (open) and the EVAP pressure is then measured. If the variation in the pressure is less than 0.5 kPa (3.75 mmHg), the ECM interprets this as the purge VSV being stuck closed, and illuminates the MIL and sets DTC P0441 (2 trip detection logic).

Atmospheric pressure check:

In order to ensure reliable malfunction detection, the variation between the atmospheric pressures, before and after conduction of the purge flow monitor, is measured by the ECM.

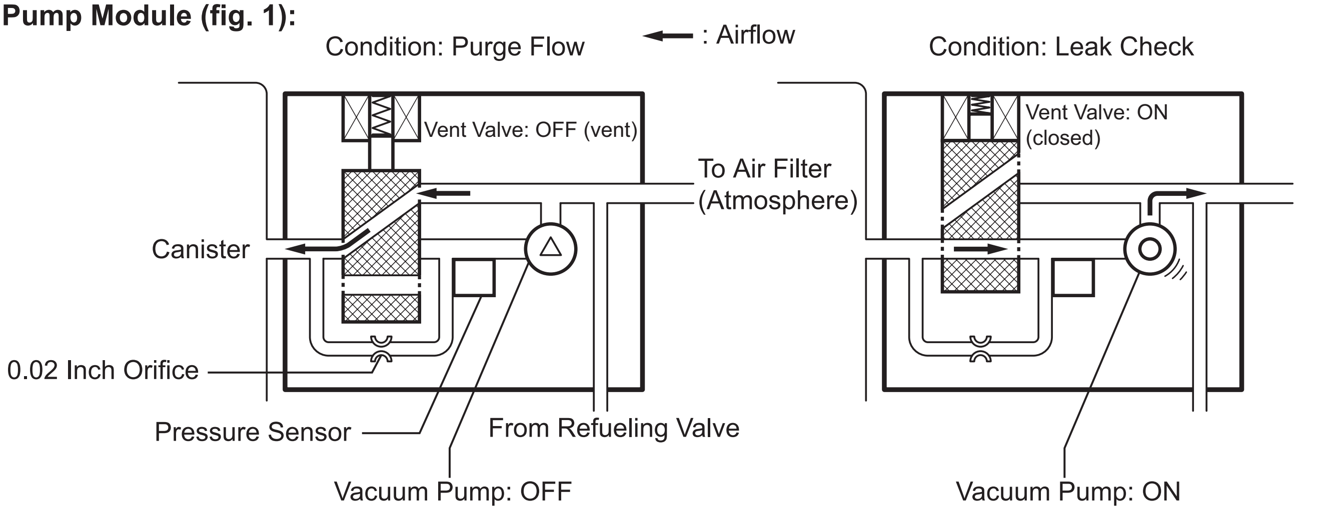
EVAP Purge Flow:



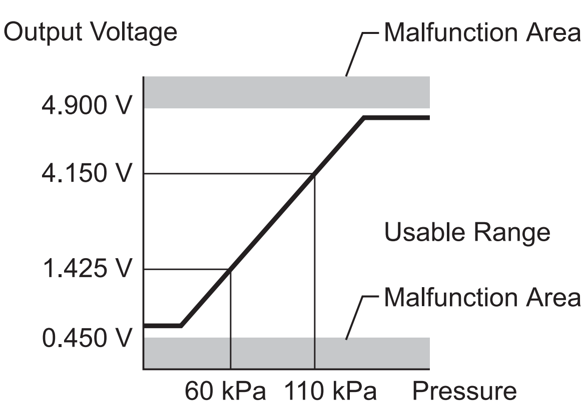
Components	Operations
Canister	Contains activated charcoal to absorb EVAP (Evaporative Emissions) generated in fuel tank.
Cut-off valve	Located in fuel tank. Valve floats and closes when fuel tank is 100% full.
Purge VSV (Vacuum Switching Valve)	Opens or closes line between canister and intake manifold. ECM uses purge VSV to control EVAP purge flow. In order to discharge EVAP absorbed by canister to intake manifold, ECM opens purge VSV. EVAP discharge volume to intake manifold is controlled by purge VSV duty cycle ratio (current-carrying time). (Open: ON, Close: OFF)

Components	Operations
Refueling valve	Controls EVAP pressure from fuel tank to canister. Valve consists of diaphragm, spring and restrictor (diameter: 0.08 inch). When fuel vapor and pressure inside fuel tank increase, valve opens. While EVAP is purged, valve closes and restrictor prevents a large amount of vacuum from affecting pressure in fuel tank. Valve is opened while refueling. When valve is open, adding fuel into fuel tank is possible.
Roll-over valve	Located in fuel tank. Valve closes by its own weight when vehicle overturns to prevent fuel from spilling out.
Service port	Used for connecting vacuum gauge for inspecting EVAP system.
Soak timer	Built into ECM. To ensure accurate EVAP monitor, measures 5 hours (+- 15 min.) after ignition switch turned off. This allows fuel to cool down, stabilizing Fuel Tank Pressure (FTP). When approx 5 hours elapsed, ECM activates.
Pump module	Consists of (a) to (d) below. Pump module cannot be disassembled.
(a) Vent valve	Vents and closes EVAP system. When ECM turns valve ON, EVAP system closed. When ECM turns valve OFF, EVAP system is vented. Negative pressure (vacuum) is created in EVAP system to check for EVAP leaks by closing purge VSV, vent valve (closed) and operating vacuum pump are turned on (refer to fig. 1).
(b) Pressure sensor	Indicates pressure as voltages. ECM supplies regulated 5 V to pressure sensor, and uses feedback from sensor to monitor EVAP system pressure (refer to fig 2).
(c) Vacuum pump	Creates negative pressure (vacuum) in EVAP system for leak check.
(d) 0.02 inch orifice	Has an opening with 0.02 inch diameter. Vacuum is produced through orifice by closing purge VSV, turning off vent valve and operating vacuum pump, to monitor 0.02 inch leak pressure. 0.02 inch leak pressure indicates a small leak of EVAP.

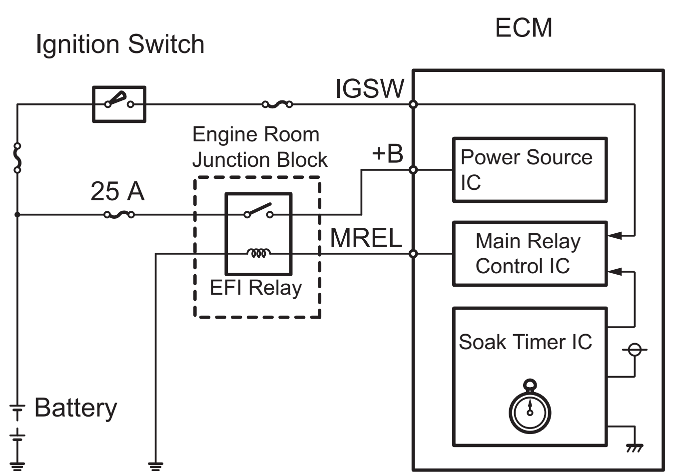
Pump Module (fig. 1):



Pressure Sensor Specification (fig. 2):



Soak Timer Circuit (fig. 3):



P

A118976E01

WIRING DIAGRAM

Refer to DTC P0450 (See page ES-252).

INSPECTION PROCEDURE

NOTICE:

An intelligent tester is required to conduct the following diagnostic troubleshooting procedure.

HINT:

- Using intelligent tester monitor results enables the EVAP (Evaporative Emission) system to be confirmed.
- 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.

1	CONFIRM DTC

(a) Turn the ignition switch OFF and wait for 10 seconds.
(b) Turn the ignition switch on (IG).
(c) Turn the ignition switch off and wait for 10 seconds.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the ignition switch on (IG) and turn the tester on.
(f) Select the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Confirm DTCs and freeze frame data.
If any EVAP system DTCs are set, the malfunctioning area can be determined using the table below.

DTCs / Malfunctioning Areas	P043E P043F	P0441	P0450	P0451	P0452	P0453	P0455	P0456	P2401 P2402	P2419	P2420
0.02 inch orifice clogged	●								●	●	
0.02 inch orifice high-flow	●								●	●	
Purge VSV stuck open		●					●				
Purge VSV stuck closed		●									
Pressure sensor signal becomes fixed/flax				●							
Pressure sensor noise				●							
Pressure sensor voltage low			●		●						
Pressure sensor voltage high			●			●					
Gross leak		●					●				
Small leak								●			
Vacuum pump stuck OFF	●								●	●	
Vacuum pump stuck ON	●								●	●	
Vent valve stuck ON (closed)	●								●	●	
Vent valve stuck OFF (vent)											●

Y

A106731E16

NOTICE:
If the 0.02 inch reference pressure difference between the first and second checks is greater than the specification, the DTCs corresponding to the reference pressure (P043E, P043F, P0441, P0455, P0456, P2401 and P2420) will all be stored.

NEXT

2	PERFORM EVAP SYSTEM CHECK (AUTO OPERATION)

NOTICE:
- **In the EVAP SYSTEM CHECK (AUTO OPERATION), the series of 5 EVAP SYSTEM CHECK steps is performed automatically by the intelligent tester. It takes a maximum of approximately 18 minutes.**
- **Do not perform the EVAP SYSTEM CHECK when the fuel tank is more than 90% full because the cut-off valve may be closed and making the leak check of the fuel tank unavailable.**
- **Do not run the engine in this step.**

- **When the temperature of the fuel is 35°C (95°F) or more, a large amount of vapor forms and any check results become inaccurate. When performing the EVAP SYSTEM CHECK, keep the temperature below 35°C (95°F).**

(a) Connect the intelligent tester to the DLC3.

(b) Clear DTCs (See page ES-44).

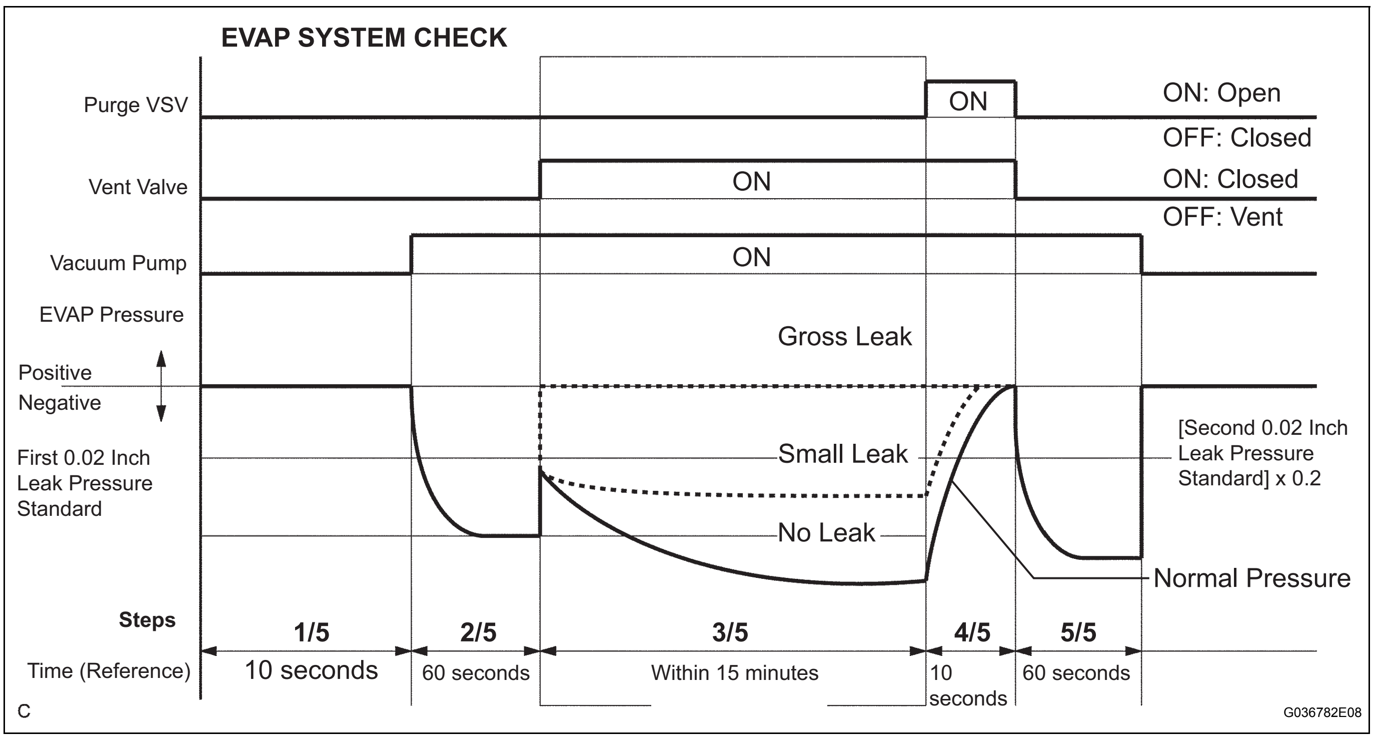
(c) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / EVAP SYS CHECK / AUTO OPERATION.

(d) After the EVAP SYSTEM CHECK is completed, check for pending DTCs by selecting the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
HINT:
If no pending DTC is displayed, perform the Monitor Confirmation after this repair is completed. After this confirmation, check for pending DTCs. If no DTC is displayed, the EVAP system is normal.

ES

NEXT

3	PERFORM EVAP SYSTEM CHECK (MANUAL OPERATION)



NOTICE:

- **In the EVAP SYSTEM CHECK (MANUAL OPERATION), the series of 5 EVAP SYSTEM CHECK steps is performed manually by the intelligent tester.**
- **Do not perform the EVAP SYSTEM CHECK when the fuel tank is more than 90% full because the cut-off valve may be closed and making the leak check of the fuel tank unavailable.**

- **Do not run the engine in this step.**
- **When the temperature of the fuel is 35°C (95°F) or more, a large amount of vapor forms and any check results become inaccurate. When performing the EVAP SYSTEM CHECK, keep the temperature below 35°C (95°F).**

(a) Connect the intelligent tester to the DLC3.

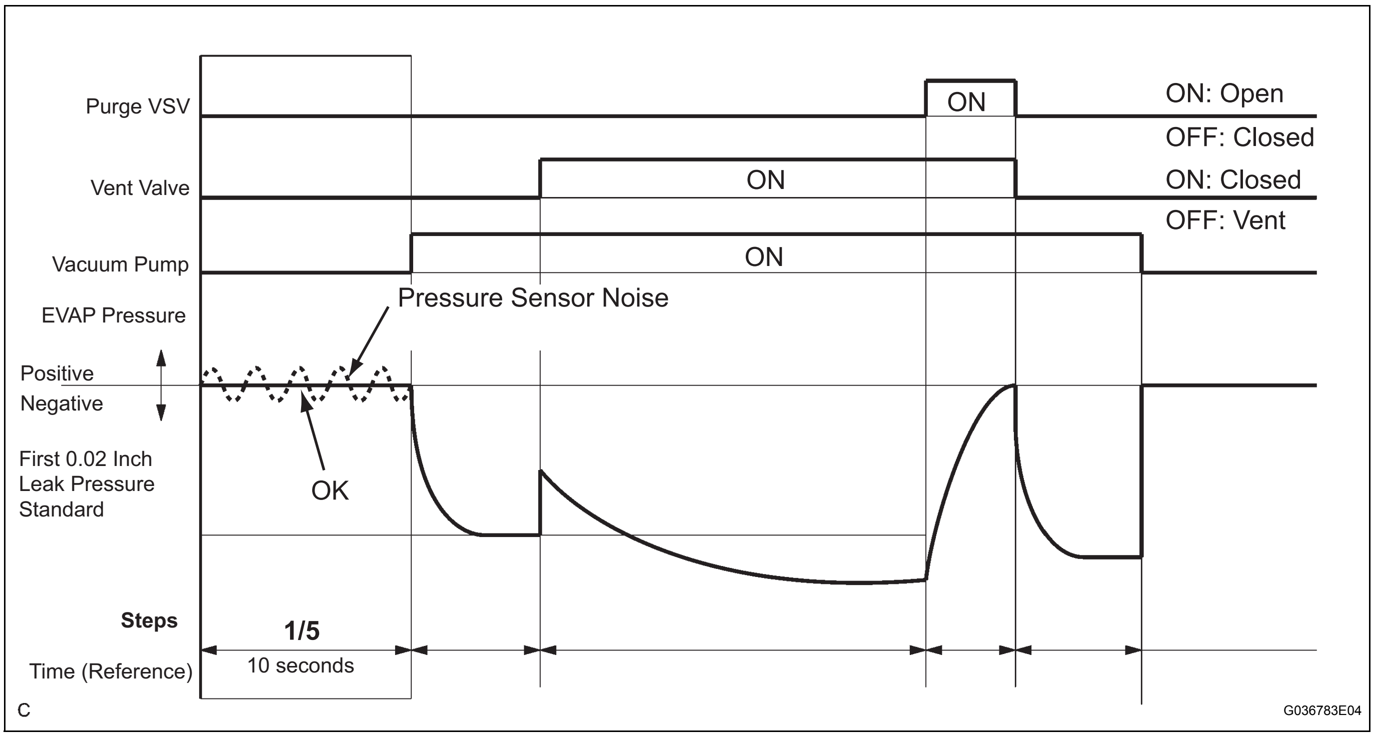
(b) Clear DTCs (See page ES-44).

(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / EVAP SYS CHECK / MANUAL OPERATION.

NEXT

ES

4	PERFORM EVAP SYSTEM CHECK (STEP 1/5)



(a) Check the EVAP pressure in step 1/5.

Result

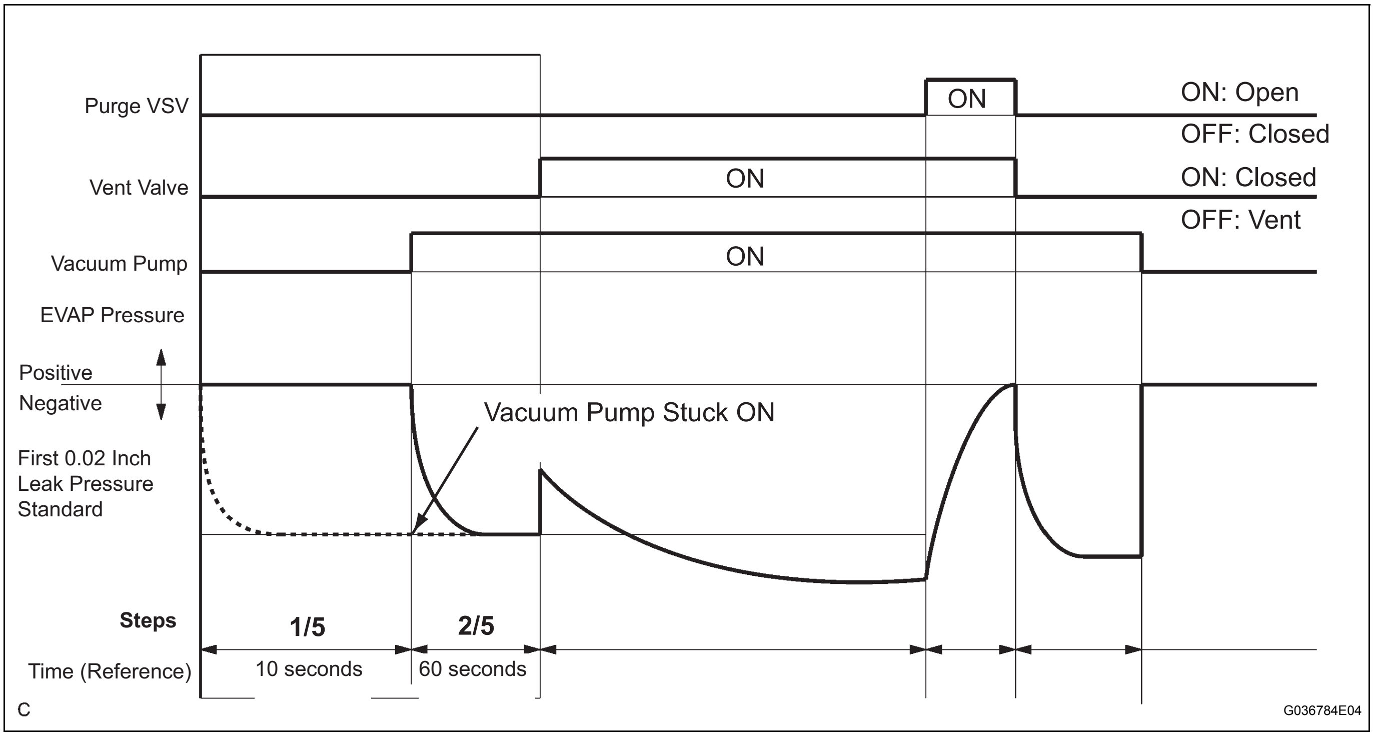
DTCs*	Test Results	Suspected Trouble Areas	Proceed to
-	Virtually no variation in EVAP pressure	Not yet determined	A
P0451	EVAP pressure fluctuates by +-0.3 kPa (2.25 mmHg) or more	Pressure sensor noising	B

*: The DTCs relating to the EVAP system displayed on the intelligent tester when checking.

B **Go to step 30**

A

5	PERFORM EVAP SYSTEM CHECK (STEP 1/5 TO 2/5)



(a) Check the EVAP pressure in step 1/5 and 2/5.

Result

DTCs*	Test Results	Suspected Trouble Areas	Proceed to
-	Virtually no variation in EVAP pressure during step 1/5. Then decreases to 0.02 inch leak pressure standard*	Not yet determined	A
P2402	Small difference between EVAP pressures during steps 1/5 and 2/5	Vacuum pump stuck ON	B

*: The DTCs related to the EVAP system are displayed on the intelligent tester when checking.

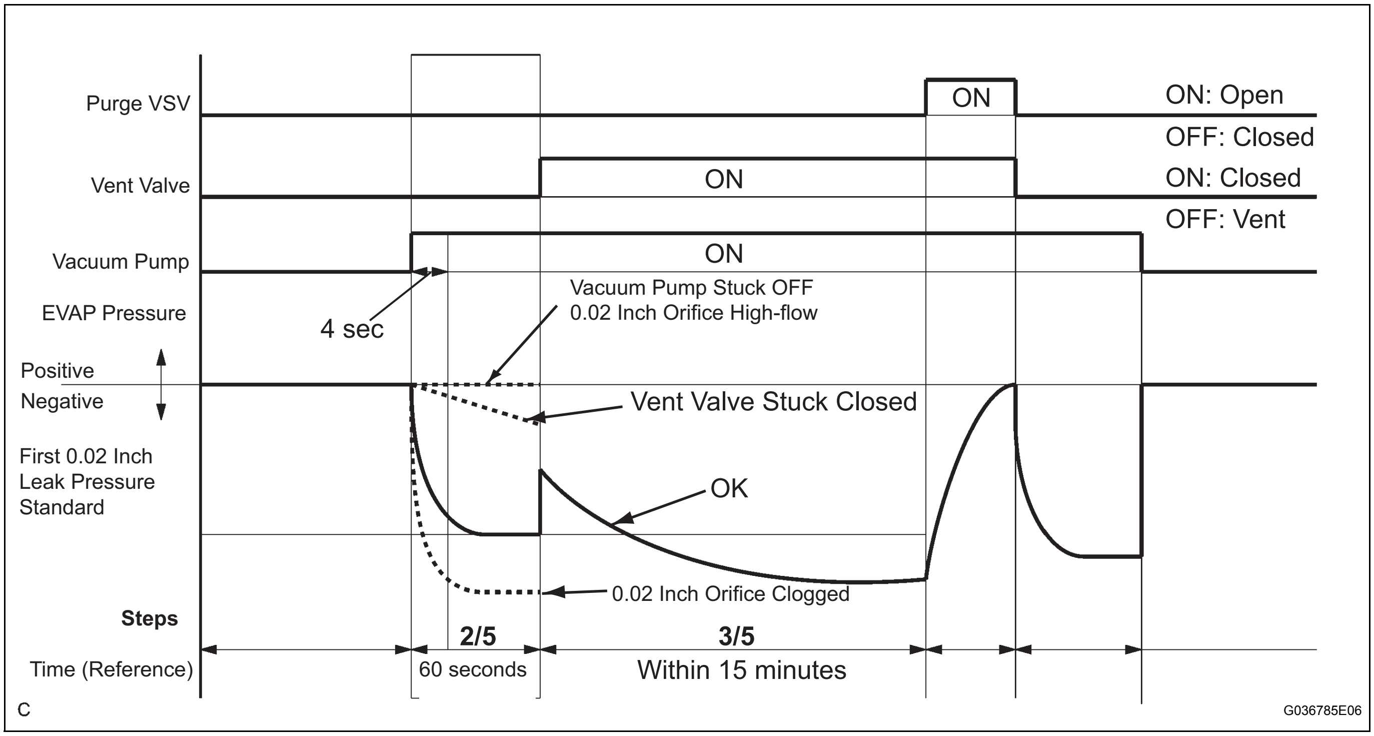
HINT:

The first 0.02 inch leak pressure standard is the value determined in step 2/5.

B — **Go to step 23**

A

6	PERFORM EVAP SYSTEM CHECK (STEP 2/5)



HINT:
Make a note of the pressures checked steps (a) and (b) below.

(a) Check the EVAP pressure 4 seconds after the vacuum pump is activated*1 (Step (a)).

(b) Check the EVAP pressure again when it has stabilized. This pressure is the 0.02 inch leak pressure standard (Step (b)).
*1: The vacuum pump begins to operate as step 1/5 is proceeded to step 2/5.

Result

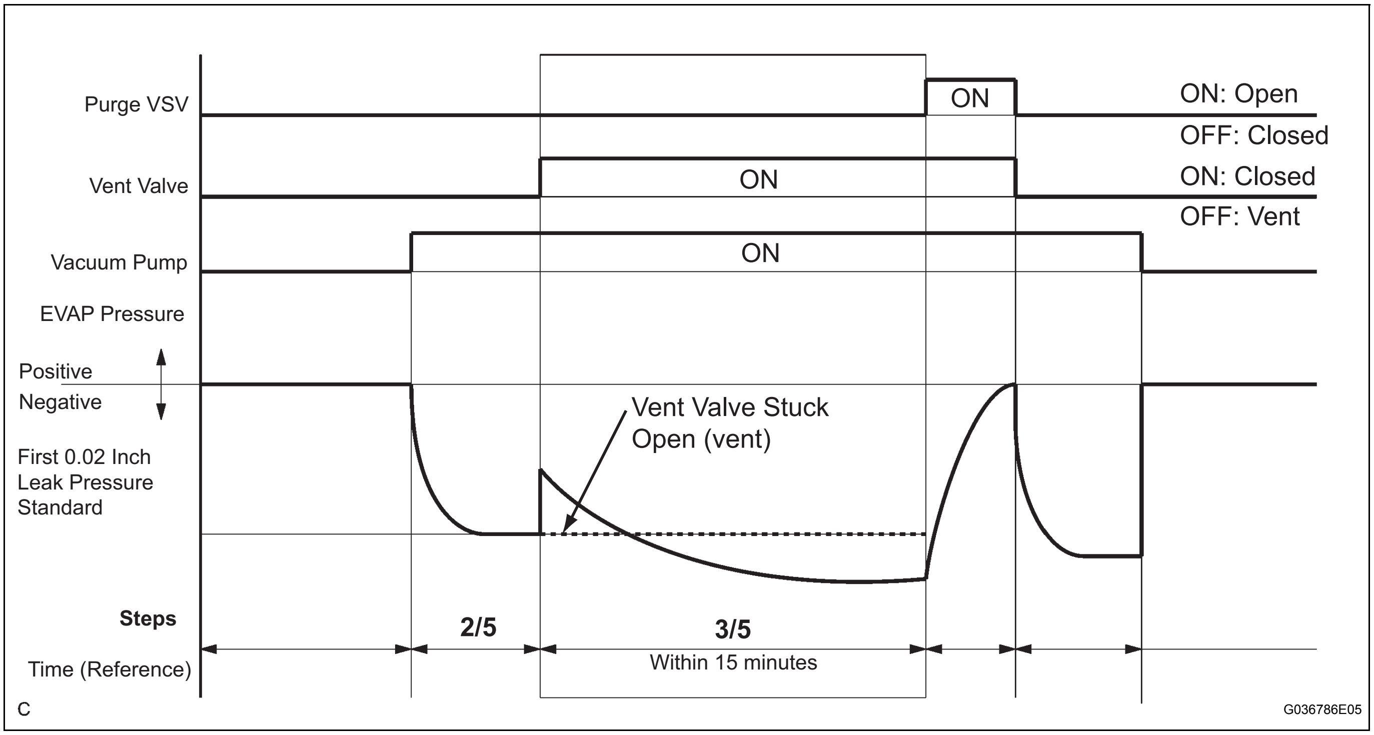
DTCs*2	Test Results	Suspected Trouble Areas	Proceed to
-	EVAP pressure in step (b) is between -4.85 kPa and -1.06 kPa (-36.38 mmHg and -7.95 mmHg)	Not yet determined	A
P043F and P2401	EVAP pressure in step (b) is -1.06 kPa (-7.95 mmHg) or more	• 0.02 inch orifice high-flow • Vacuum pump stuck OFF	B
P043E	EVAP pressure in step (b) is than -4.85 kPa (-36.38 mmHg)	0.02 inch orifice clogged	C
P2419	EVAP pressure in step (a) is more than -1.06 kPa (-7.95 mmHg)	Vent valve stuck closed	D

*2: The DTCs related to the EVAP system displayed on the intelligent tester when checking.

B	Go to step 11
C	Go to step 30
D	Go to step 19

A

7	PERFORM EVAP SYSTEM CHECK (STEP 2/5 TO 3/5)



(a) Check the EVAP pressure increase in step 3/5.

Result

DTCs*	Test Results	Suspected Trouble Areas	Proceed to
-	EVAP pressure increases by 0.3 kPa (2.25 mmHg) or more within 10 seconds of proceeding from step 2/5 to step 3/5	Not yet determined	A
P2420	No variation in EVAP pressure even after proceeding from step 2/5 to step 3/5	Vent valve stuck open (vent)	B
P0451	No variation in EVAP pressure during steps 1/5 through 3/5	Pressure sensor malfunction	C

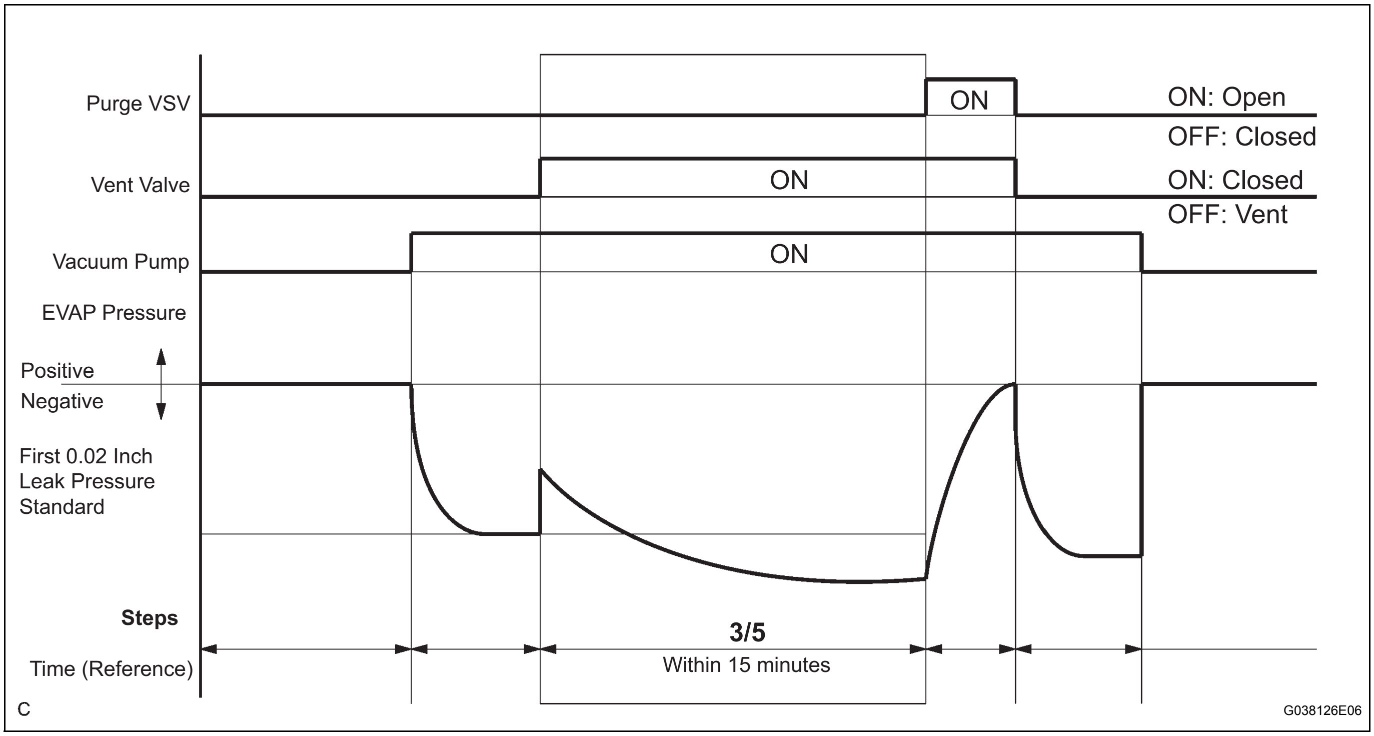
*: The DTCs related to the EVAP system displayed on the intelligent tester when checking.

B **Go to step 20**

C **Go to step 30**

A

8	PERFORM EVAP SYSTEM CHECK (STEP 3/5)



(a) Wait until the EVAP pressure change is less than 0.1 kPa (0.75 mmHg) for 30 seconds.

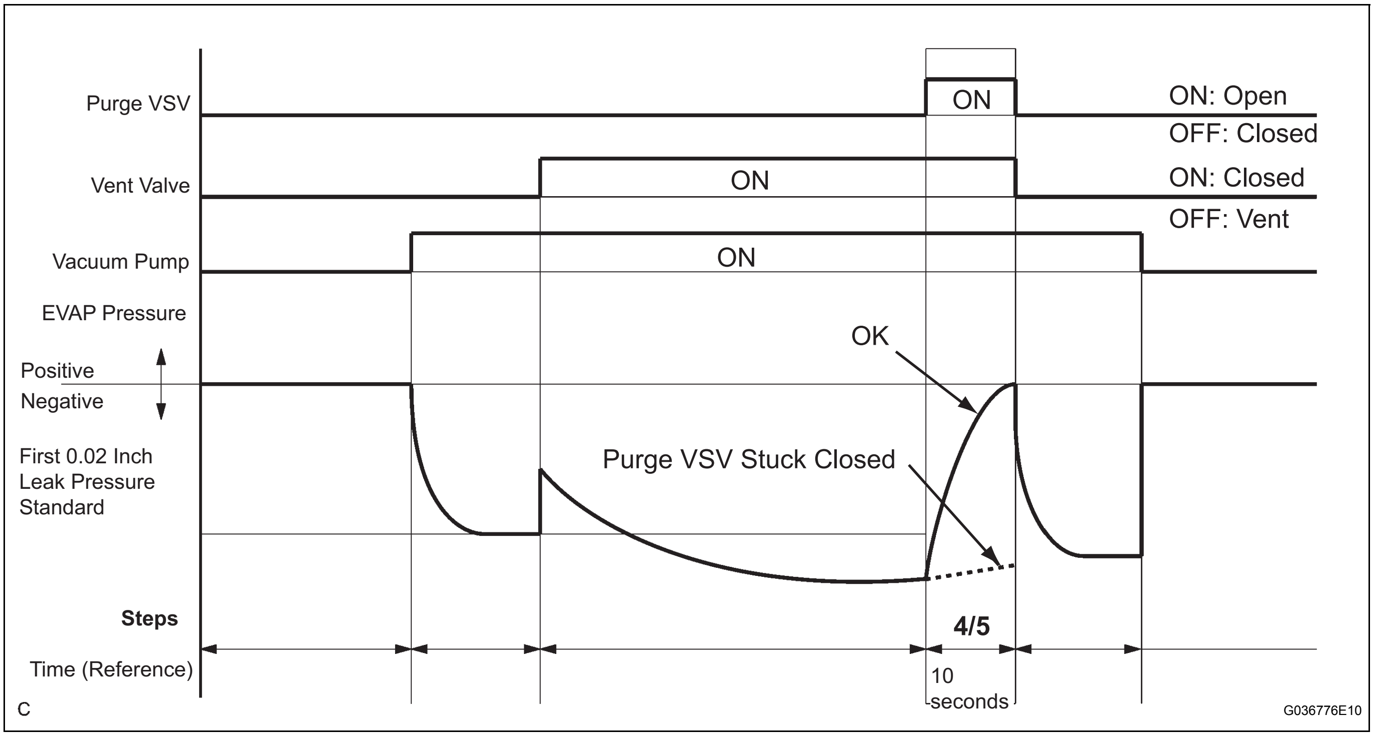
(b) Measure the EVAP pressure and record it.

HINT:

A few minutes are required for the EVAP pressure to become saturated. When there is little fuel in the fuel tank, it takes up to 15 minutes.

NEXT

9	PERFORM EVAP SYSTEM CHECK (STEP 4/5)



(a) Check the EVAP pressure in step 4/5.

Result

DTCs*	Test Results	Suspected Trouble Areas	Proceed to
-	EVAP pressure increases by 0.3 kPa (2.25 mmHg) or more within 10 seconds of proceeding from step 3/5 to step 4/5	Not yet determined	A
P0441	EVAP pressure increases by 0.3 kPa (2.25 mmHg) or more within 10 seconds of proceeding from step 3/5 to step 4/5	Problems in EVAP hose between pure VSV and intake manifold	B
P0441	Variation in EVAP pressure less than 0.3 kPa (2.25 mmHg) for 10 seconds, after proceeding from step 3/5 to step 4/5	Purge VSV stuck closed	C

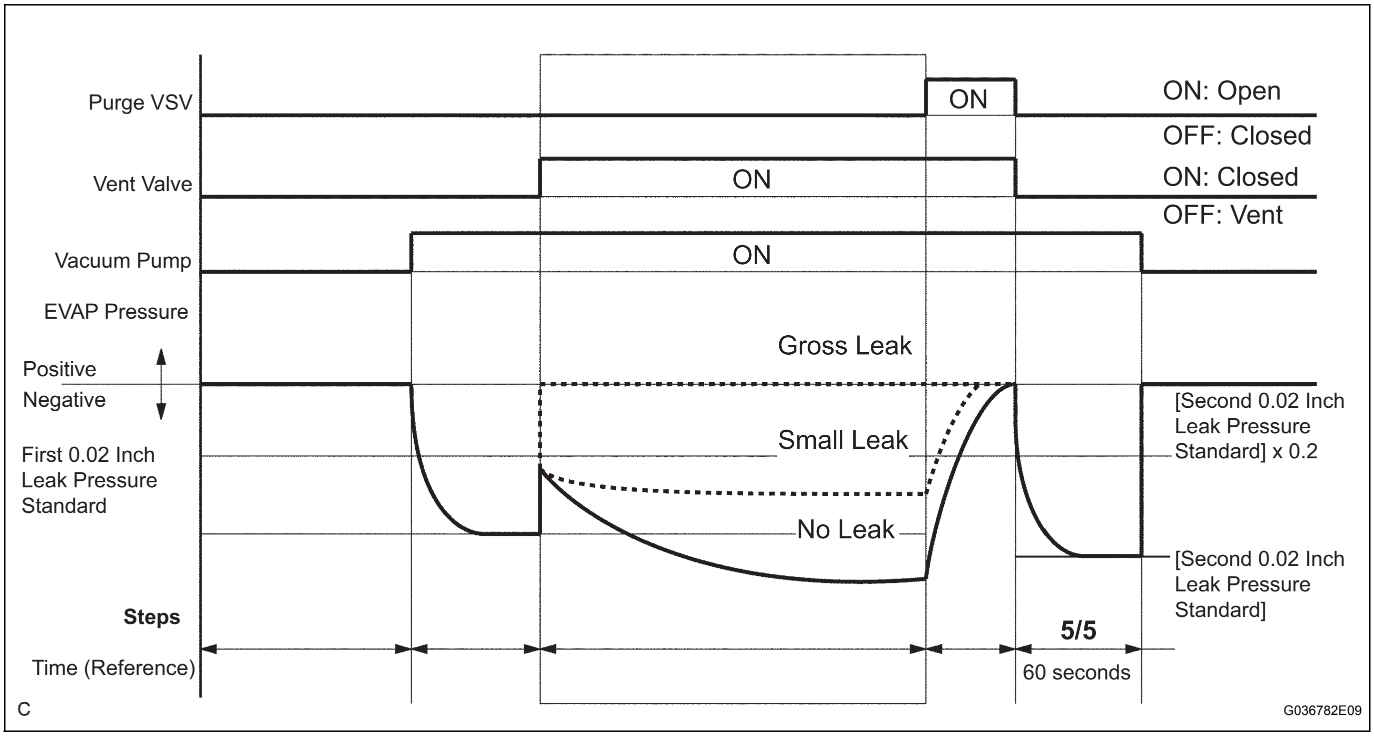
*: The DTCs related to the EVAP system displayed on an intelligent tester when checking.

B → **Go to step 15**

C → **Go to step 12**

A

10	PERFORM EVAP SYSTEM CHECK (STEP 5/5)



(a) Check the EVAP pressure in step 5/5.
(b) Compare the EVAP pressure in step 3/5 and the second 0.02 inch leak pressure standard (step 5/5).

Result

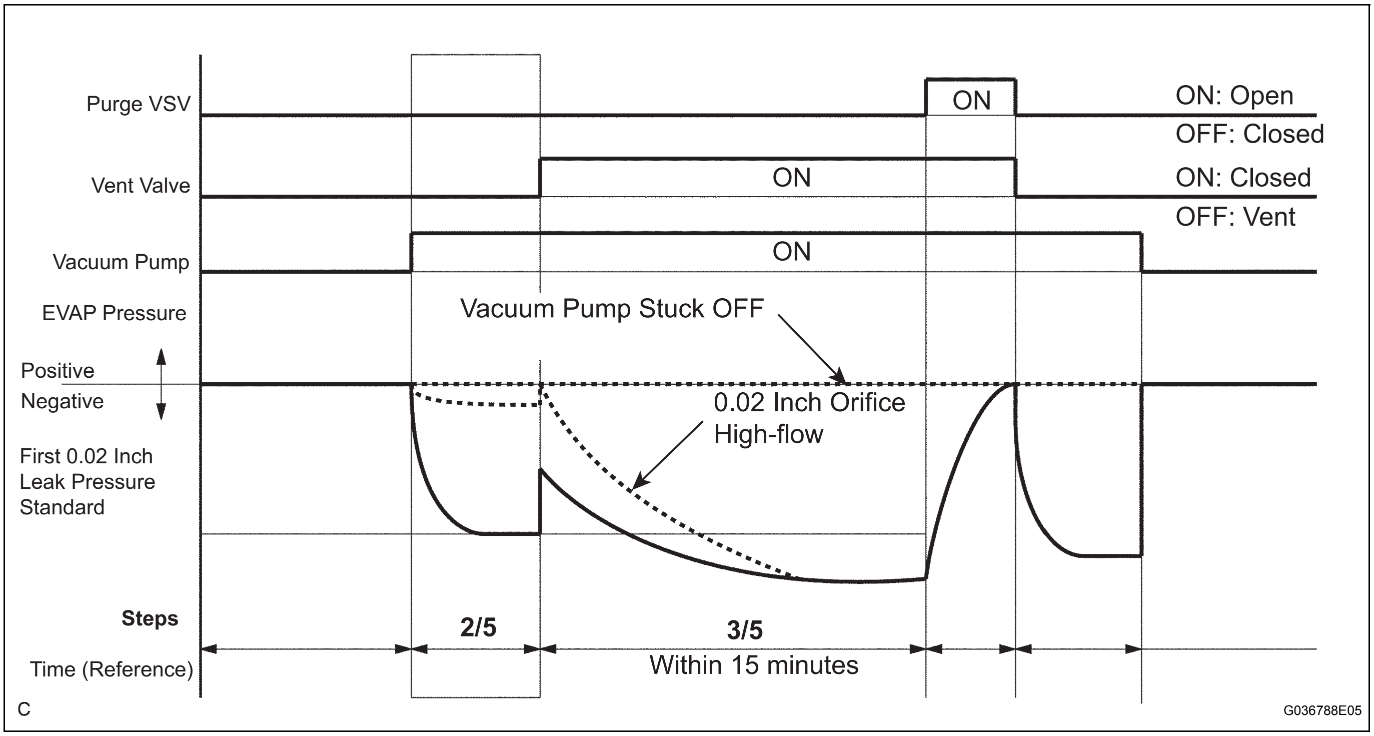
DTCs*	Test Results	Suspected Trouble Areas	Proceed to
-	EVAP pressure (step 3/5) lower than second 0.02 inch leak pressure standard (step 5/5)	Not yet determined (no leafage from EVAP system)	A
P0441 and P0455	EVAP pressure (step 3/5) higher than [second 0.02 inch leak pressure standard (step 5/5) x 0.2]	• Purge VSV stuck open • EVAP gross leak	B
P0456	EVAP pressure (step 3/5) higher than second 0.02 inch leak pressure standard (step 5/5)	EVAP small leak	C

*: The DTCs related to the EVAP system are displayed on the intelligent tester when checking.

A → **Go to step 36**

B → **Go to step 12**

11	PERFORM EVAP SYSTEM CHECK (STEP 3/5)



(a) Check the EVAP pressure in step 3/5.

Result

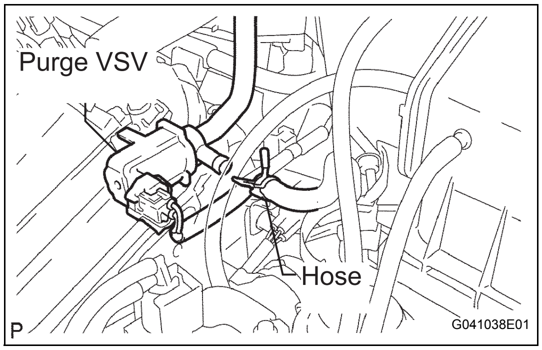
DTCs*	Test Results	Suspected Trouble Areas	Proceed to
P043F	EVAP pressure is less than [0.02 inch leak pressure standard] measured in step 2/5	0.02 inch orifice high-flow	A
P2401	EVAP pressure is almost the same as [0.02 inch leak pressure standard] measure in step 2/5	Vacuum pump stuck OFF	B

*: The DTCs related to the EVAP system are displayed on the intelligent tester when checking.

HINT:
The first 0.02 inch leak pressure standard is the value determined in step 2/5.

A	Go to step 30
B	Go to step 23

12	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (PURGE VSV)



(a) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / EVAP VSV (ALONE).
(b) Disconnect the hose (connected to the canister) from the purge VSV.
(c) Start the engine.
(d) Using the tester, turn off the purge VSV (EVAP VSV: OFF).
(e) Confirm that the purge VSV has no suction with your fingers.
(f) Using the tester, turn on the purge VSV (EVAP VSV: ON).
(g) Confirm that the purge VSV has suction with your fingers.

Result

Test Results	Suspected Trouble Areas	Proceed to
No suction when purge VSV turned OFF, and suction applied when turned ON	-	A
Suction applied when purge VSV turned OFF	Purge VSV stuck open	B
No suction when purge VSV turned ON	• Purge VSV stuck closed • Problems with EVAP hose between purge VSV and throttle body	C

(h) Reconnect the hose.

B	Go to step 14
C	Go to step 15

A

13	CHECK FUEL TANK CAP ASSEMBLY

(a) Check that the fuel tank cap is correctly installed and confirm the fuel tank cap meets OEM specification.
HINT:
If an EVAP tester is available, check the fuel tank cap using the tester.
(1) Tighten the fuel tank cap
(2) Remove the fuel tank cap and install it onto a fuel tank cap adaptor.
(3) Connect an EVAP tester pump hose to the adaptor, and pressurize the cap to 3.2 to 3.7 kPa (24 to 28 mmHg) using an EVAP tester pump.
(4) Seal the adaptor and wait for 2 minutes.
(5) Check the pressure. If the pressure is 2 kPa (15 mmHg) or more, the fuel tank cap is normal.

Result

Test Results	Suspected Trouble Areas	Proceed to
Fuel tank cap correctly installed	-	A
Fuel tank cap loose	• Fuel tank cap improperly installed • Defective fuel tank cap • Fuel tank cap does not meet OEM specifications	B
No fuel tank cap	-	C

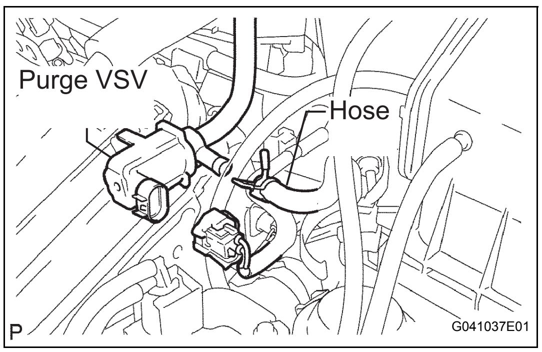
A → Go to step 29

B → Go to step 27

C → Go to step 28

ES

14 INSPECT VACUUM SWITCHING VALVE NO.1



(a) Turn the ignition switch off.
(b) Disconnect the B31 purge VSV connector.
(c) Disconnect the hose (connected to the canister) from the purge VSV.
(d) Start the engine.
(e) Confirm that the purge VSV has no suction with your fingers.

Result

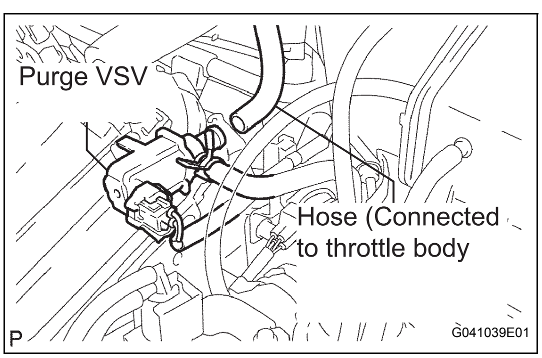
Test Results	Suspected Trouble Areas	Proceed to
No suction	ECM	A
Suction applied	Purge VSV	B

(f) Reconnect the purge VSV connector.
(g) Reconnect the hose.

A → Go to step 35

B → Go to step 31

15 CHECK EVAP HOSE (PURGE VSV - THROTTLE BODY)



(a) Disconnect the hose (connected to the throttle body) from the purge VSV.
(b) Start the engine.
(c) Confirm that the hose has suction with your fingers.

Result

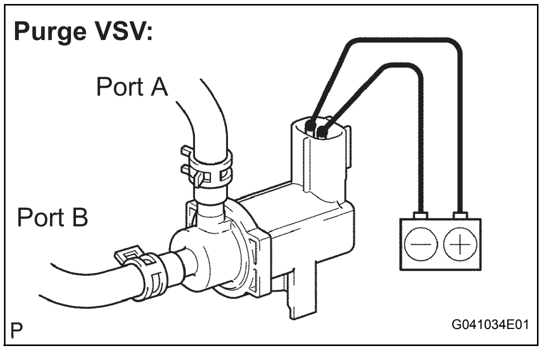
Test Results	Suspected Trouble Areas	Proceed to
Suction applied	-	A
No suction	• Throttle body • EVAP hose between purge VSV and throttle body	B

(d) Reconnect the hose.

B → Go to step 26

A

16 INSPECT VACUUM SWITCHING VALVE NO.1 (PURGE VSV)



(a) Remove the purge VSV.
(b) Apply battery voltage to the terminals of the purge VSV.
(c) Using compressed air, confirm that air flows from port A to port B.

Result

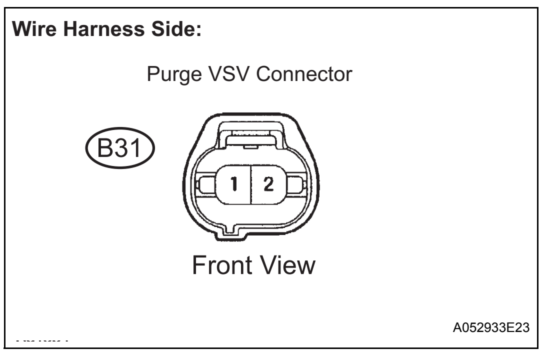
Test Results	Suspected Trouble Area	Proceed to
Air flowed	-	A
No air flow	Purge VSV	B

(d) Install the purge VSV.

B **Go to step 31**

A

17 CHECK HARNESS AND CONNECTOR (POWER SOURCE OF PURGE VSV)



(a) Disconnect the B31 purge VSV connector.
(b) Turn the ignition switch on (IG).
(c) Measure the voltage between terminal 1 of the purge VSV connector and the body ground.

Result

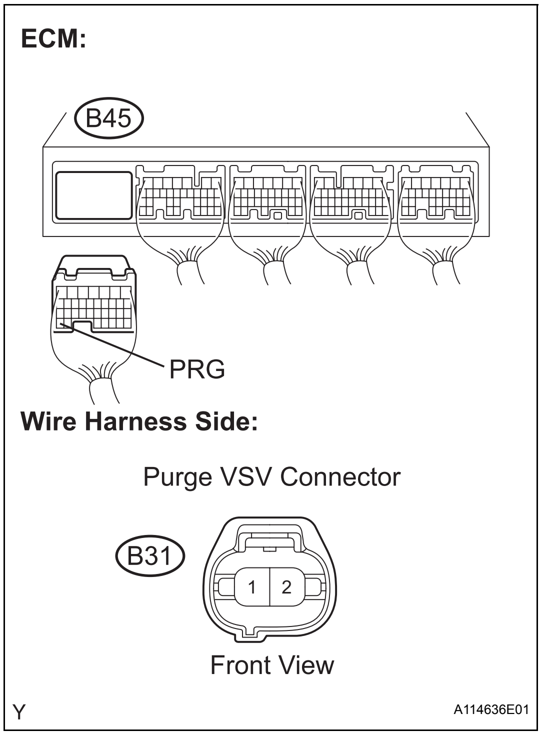
Test Results	Suspected Trouble Areas	Proceed to
Between 11 V and 14 V	-	A
Other than result above	Wire harness or connectors between purge VSV and ECM	B

(d) Reconnect the purge VSV connector.

B **Go to step 32**

A

18	CHECK HARNESS AND CONNECTOR (PURGE VSV - ECM)



(a) Disconnect the B45 ECM connector and the B31 purge VSV connector.
(b) Measure the resistance between the terminals of the purge VSV connector and ECM connector.
Standard resistance

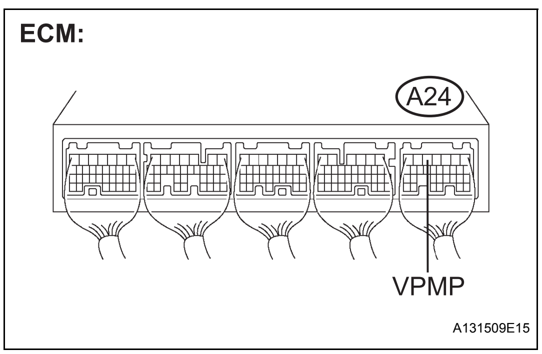
Tester Connections	Specified Conditions
B45-34 (PRG) - B31-1	Below 1 Ω
B45-34 (PRG) - Body ground	10 kΩ or higher
B31-1 - Body ground	10 kΩ or higher

(c) Reconnect the purge VSV connector.
(d) Reconnect the ECM connector.

OK	**Go to step 35**
NG	**Go to step 32**

ES

19	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (FOR VENT VALVE)

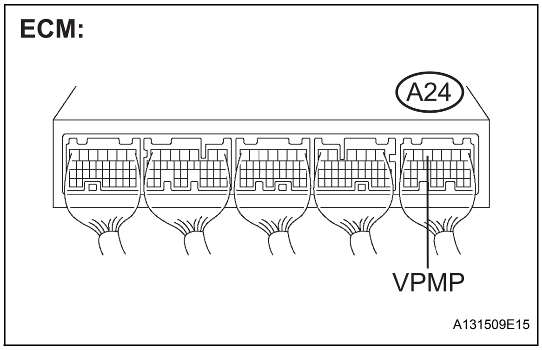


(a) Turn the ignition switch on (IG).
(b) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VENT VALVE.
(c) Measure the voltage between terminal VPMP of the ECM connector and the body ground when the vent valve is turned ON (close) and OFF (vent) using the tester.
Result

Test Results	Suspected Trouble Areas	Proceed to
Between 9 V and 14 V when OFF Below 3 V when ON	Vent valve	A
Below 3 V when OFF and ON	ECM	B

A	**Go to step 22**
B	**Go to step 35**

20 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (FOR VENT VALVE)



(a) Turn the ignition switch on (IG).
(b) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VENT VALVE (ALONE).
(c) Measure the voltage between terminal VPMP of the ECM connector and the body ground when the vent valve is turned ON (close) and OFF (vent) using the tester.

Result

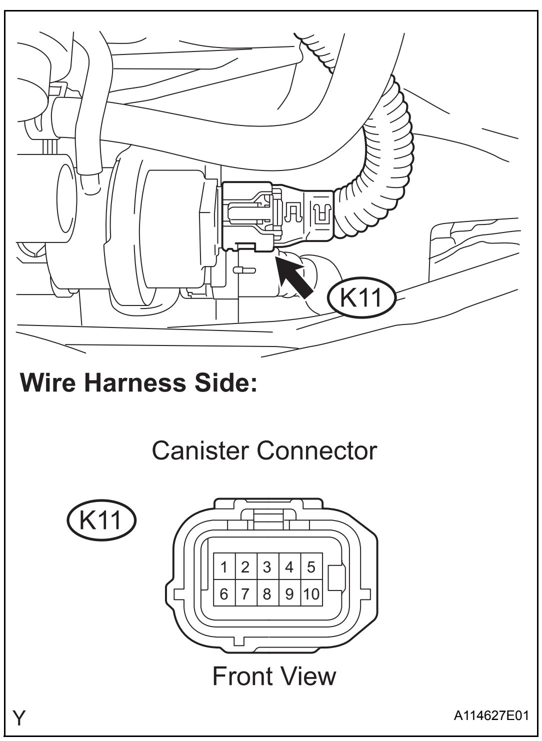
Test Results	Suspected Trouble Areas	Proceed to
Between 3 V when OFF and ON	Power source of vent valve	A
Between 9 V and 14 V when OFF Below 3 V when ON	Vent valve	B
Between 9 V and 14 V when OFF and ON	ECM	C

B → **Go to step 22**

C → **Go to step 35**

A

21 INSPECT PUMP MODULE (POWER SOURCE FOR VENT VALVE)



(a) Turn the ignition switch off.
(b) Disconnect the K11 canister connector.
(c) Turn the ignition switch on (IG).
(d) Measure the voltage between terminal 9 of the canister connector and the body ground.

Result

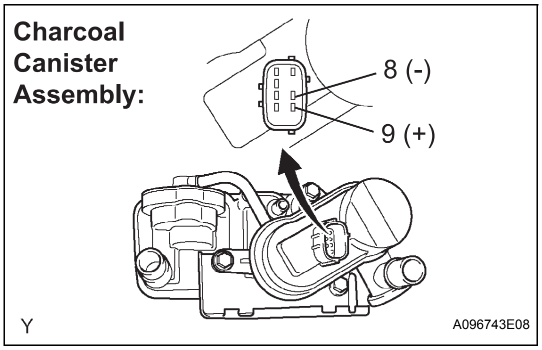
Test Results	Suspected Trouble Areas	Proceed to
Between 9 V and 14 V	-	A
Between 0 V and 3 V	Power source wire harness of vent valve	B

(e) Reconnect the canister connector.

B → **Go to step 32**

A

22 INSPECT PUMP MODULE (VENT VALVE OPERATION)



(a) Turn the ignition switch to off.
(b) Disconnect the K11 canister connector.
(c) Apply the battery voltage to terminals 9 and 8 of the pump module.
(d) Touch the pump module to confirm the vent valve operation.

Result

Test Results	Suspected Trouble Areas	Proceed to
Operating	Wire harness between vent valve and ECM	A
Not operating	Vent valve	B

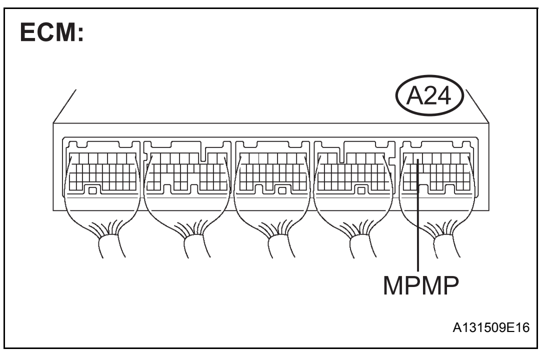
(e) Reconnect the canister connector.

A → **Go to step 32**

B → **Go to step 30**

ES

23 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (FOR PUMP MODULE (VACUUM PUMP))



(a) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VACUUM PUMP.
(b) Measure the voltage between terminal MPMP of the ECM connector and the body ground when the vacuum pump is turned ON and OFF using the tester.

Result

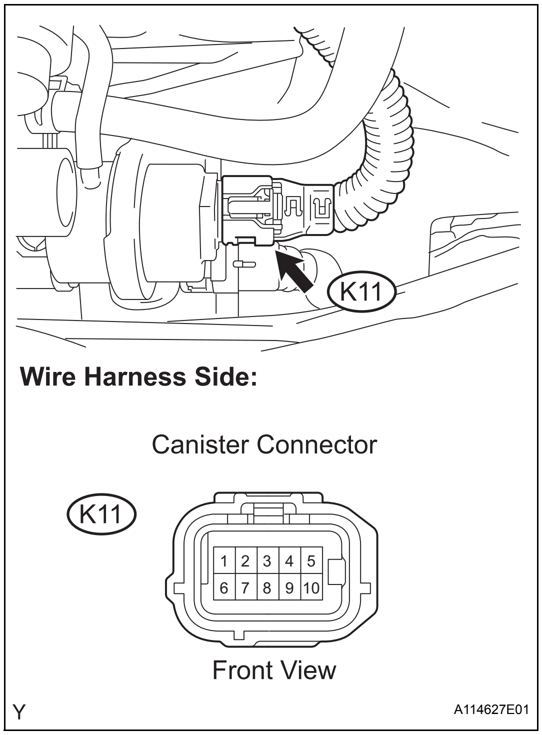
Test Results	Suspected Trouble Areas	Proceed to
Between 0 V and 3 V when OFF Between 9 V and 14 V when ON	-	A
Between 9 V and 14 V when OFF Between 0 V and 3 V when ON	ECM	B

B → **Go to step 35**

A

ES

24 CHECK HARNESS AND CONNECTOR (PUMP MODULE - ECM)



(a) Turn the ignition switch off.
(b) Disconnect the K11 canister connector.
(c) Turn the ignition switch on (IG).
(d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VACUUM PUMP.
(e) Turn the vacuum pump ON.
(f) Measure the voltage between terminal 1 of the canister connector and the body ground.

Result

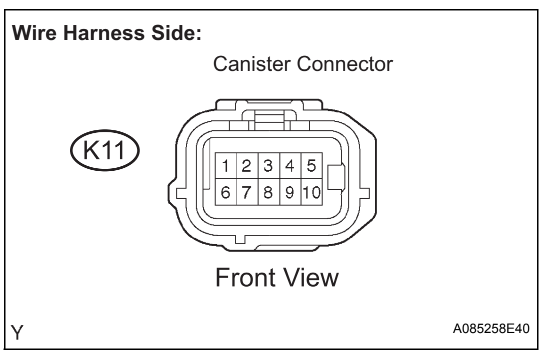
Test Results	Suspected Trouble Areas	Proceed to
Between 9 V and 14 V	-	A
Between 0 V and 3 V	Wire harness between ECM and vacuum pump	B

(g) Reconnect the canister connector.

B → **Go to step 32**

A

25 CHECK HARNESS AND CONNECTOR (PUMP MODULE - GROUND)



(a) Disconnect the K11 canister connector.
(b) Turn the ignition switch to off.
(c) Check the resistance between terminal 6 of the canister connector and the body ground.

Result

Test Results	Suspected Trouble Areas	Proceed to
Below 1 Ω	Vacuum Pump	A
10 kΩ or higher	Wire harness between vacuum pump and body ground	B

(d) Reconnect the canister connector.

A → **Go to step 30**

B → **Go to step 32**

26 INSPECT THROTTLE WITH MOTOR BODY ASSEMBLY

(a) Stop the engine.
(b) Disconnect the EVAP hose from the throttle body.
(c) Start the engine.
(d) Confirm that the port of the throttle body has suction with your fingers.

Result

Test Results	Suspected Trouble Areas	Proceed to
Suction applied	EVAP hose between throttle body and purge VSV	A
No suction	Throttle body	B

(e) Reconnect the EVAP hose.

A → **Go to step 33**

B → **Go to step 34**

27 CORRECTLY REINSTALL OR REPLACE FUEL TANK CAP

HINT:
- When reinstalling the fuel tank cap, tighten it until a few click sounds are heard.
- When replacing the fuel tank cap, use a fuel tank cap that meets OEM specifications, and tighten it until a few click sounds are heard.

NEXT → **Go to step 37**

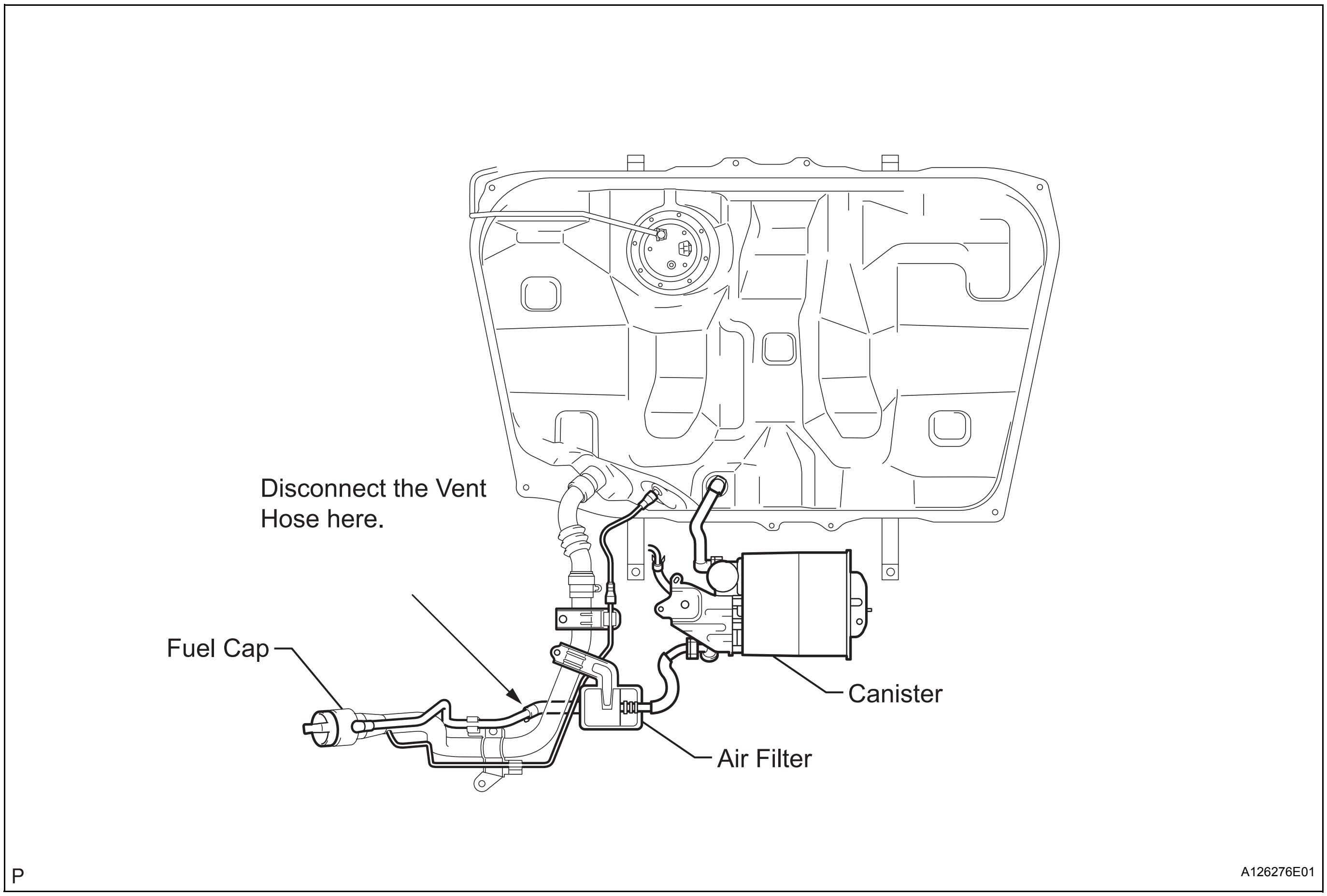
28 REPLACE FUEL TANK CAP ASSEMBLY

HINT:
When installing the fuel tank cap, tighten it until a few click sounds are heard.

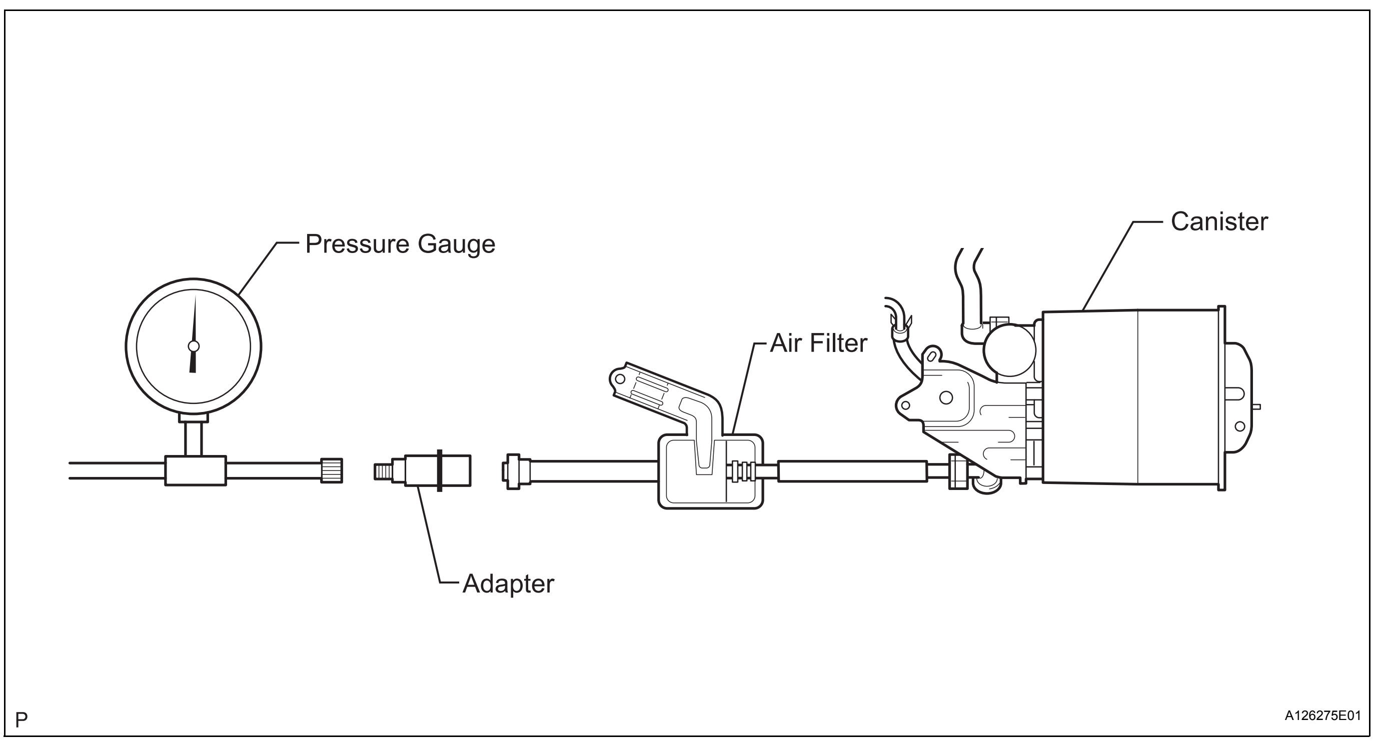
NEXT → **Go to step 37**

29 LOCATE EVAP LEAK

(a) Disconnect the vent hose.



(b) Connect the EVAP pressure tester tool to the canister with the adapter.



(c) Pressurize the EVAP system by 3.2 to 3.7 kPa (24 to 28 mmHg).

(d) Apply soapy water to the piping and the connecting parts of the EVAP system.
(e) Look for areas where bubbles appear. This indicates leak point.
(f) Repair or replace the leak point.

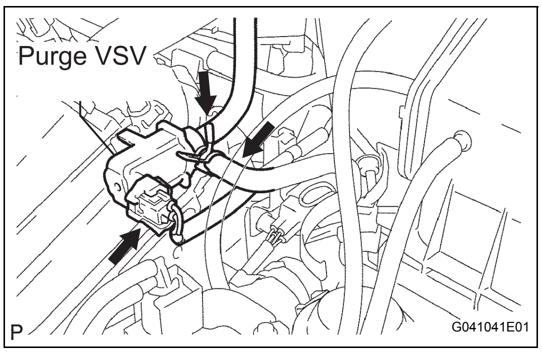
NEXT → Go to step 37

30	REPLACE CHARCOAL CANISTER ASSEMBLY

NEXT → Go to step 37

ES

31	REPLACE VACUUM SWITCHING VALVE NO.1 (PURGE VSV)



(a) Disconnect the connector and 2 hoses from the purge VSV.
(b) Remove the purge VSV.
(c) Install a new purge VSV.
(d) Reconnect the connector and 2 hoses.

NEXT → Go to step 37

32	REPAIR OR REPLACE HARNESS OR CONNECTOR

NEXT → Go to step 37

33	REPLACE EVAP HOSE (THROTTLE BODY - PURGE VSV)

NEXT → Go to step 37

34	INSPECT THROTTLE WITH MOTOR BODY ASSEMBLY

(a) Remove the throttle body (See page ES-434).
(b) Check that the EVAP purge port of the throttle body is not clogged. If necessary, replace the throttle body.

NEXT → Go to step 37

35	REPLACE ECM

(a) Replace the ECM (See page ES-446).

NEXT → Go to step 37

36	REPAIR OR REPLACE PARTS AND COMPONENTS INDICATED BY OUTPUT DTCS

(a) Repair the malfunctioning areas indicated by the DTCs that had been confirmed when the vehicle was brought in.

NEXT

37	PERFORM EVAP SYSTEM CHECK (AUTO OPERATION)

ES

NOTICE:
- **In the EVAP SYSTEM CHECK (AUTO OPERATION), the series of 5 EVAP SYSTEM CHECK steps are performed automatically. It takes a maximum of approximately 18 minutes.**
- **Do not perform the EVAP SYSTEM CHECK when the fuel tank is more than 90% full because the cut-off valve may be closed, making the leak check of the fuel tank unavailable.**
- **Do not run the engine in this step.**
- **When the temperature of the fuel is 35°C (95°F) or more, a large amount of vapor forms and any check results become inaccurate. When performing an EVAP SYSTEM CHECK, keep the temperature below 35°C (95°F).**

(a) Clear the DTCs (See page ES-44).
(b) On the intelligent tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / EVAP SYS CHECK / AUTO OPERATION.
(c) After the SYSTEM CHECK is completed, check for pending DTCs by selecting the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
HINT:
If no pending DTC is found, the repair has been successfully completed.

NEXT

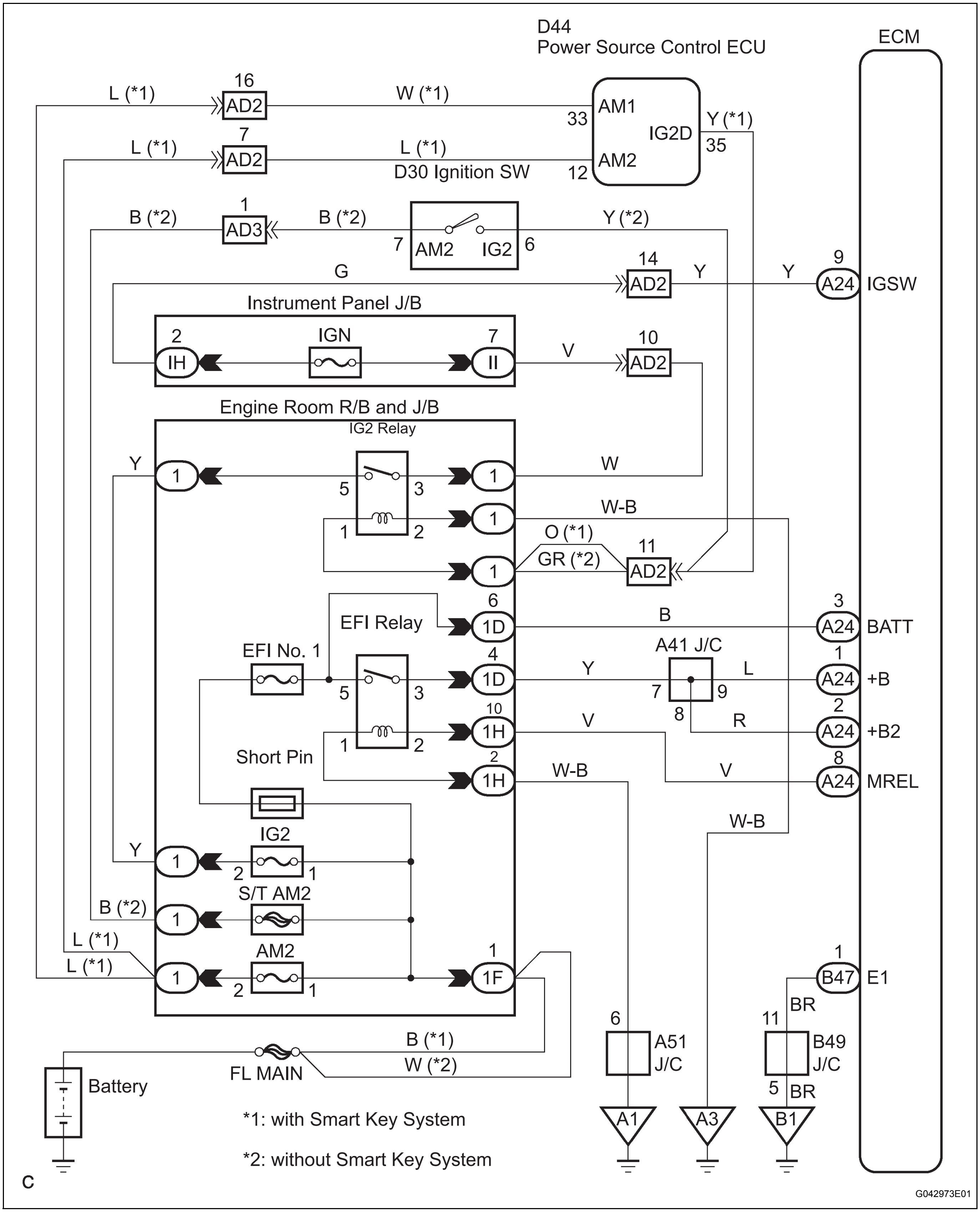
COMPLETED

ECM Power Source Circuit

DESCRIPTION

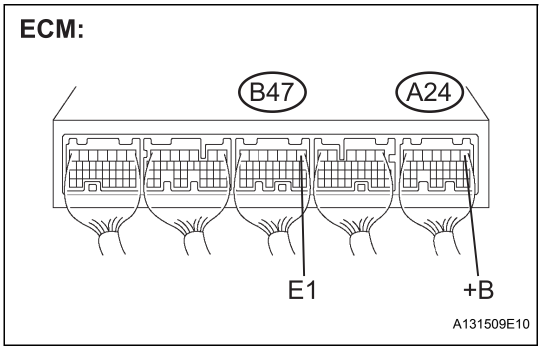
When the ignition switch is turned on (IG), the battery voltage is applied to terminal IGSW of the ECM. The ECM MREL output signal causes a current to flow to the coil, closing the contacts of the EFI relay and supplying power to terminal +B of the ECM.
If the ignition switch is turned off, the ECM holds the EFI relay ON for a maximum of 2 seconds to allow for the initial setting of the throttle valve.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	INSPECT ECM (+B VOLTAGE)



(a) Turn the ignition switch on (IG).
(b) Measure the voltage between the terminals of the A24 and B47 ECM connectors.
Standard voltage

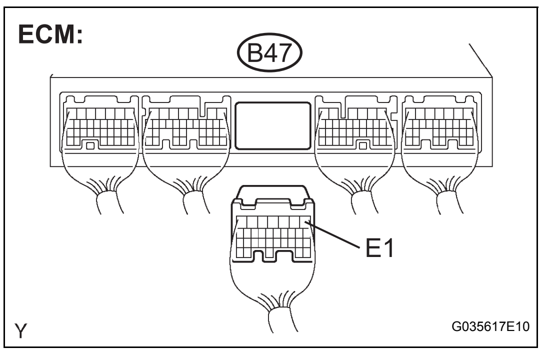
Tester Connections	Specified Conditions
+B (A24-1) - E1 (B47-1)	9 to 14 V

OK → **PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE**

ES

NG

2	CHECK HARNESS AND CONNECTOR (ECM - BODY GROUND)



(a) Disconnect the B47 ECM connector.
(b) Measure the resistance between the terminal of the ECM connector and body ground.
Standard resistance (Check for open)

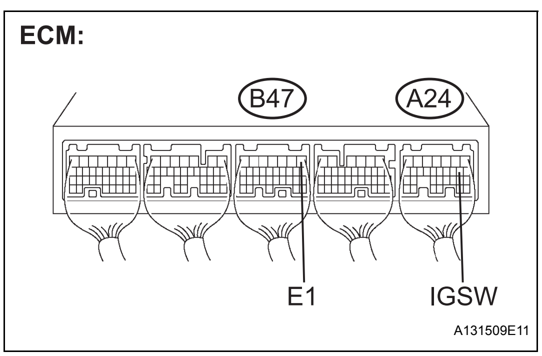
Tester Connections	Specified Conditions
E1 (B47-1) - Body ground	Below 1 Ω

(c) Reconnect the ECM connector.

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

OK

3	INSPECT ECM (IGSW VOLTAGE)



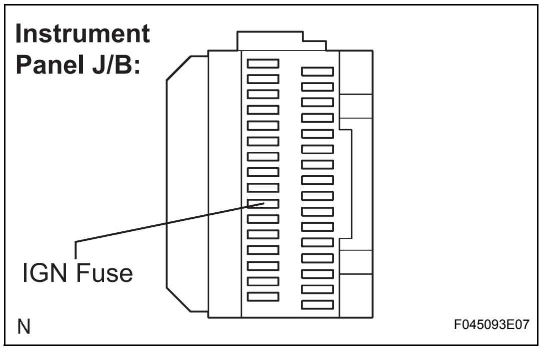
(a) Turn the ignition switch on (IG).
(b) Measure the voltage between the terminals of the A24 and B47 ECM connectors.
Standard voltage

Tester Connections	Specified Conditions
IGSW (A24-9) - E1 (B47-1)	9 to 14 V

OK → **Go to step 6**

NG

4 CHECK FUSE (IGN FUSE)



(a) Remove the IGN fuse from the instrument panel J/B.
(b) Measure the IGN fuse resistance.
Standard resistance:
Below 1 Ω
(c) Reinstall the IGN fuse.

NG → **CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE**

OK

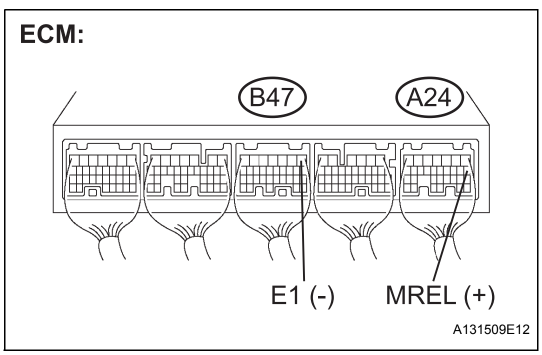
5 INSPECT IGNITION OR STARTER SWITCH ASSEMBLY

(a) Inspect the ignition or starter switch assembly (See page ST-85).

NG → **REPLACE IGNITION OR STARTER SWITCH ASSEMBLY**

OK

6 INSPECT ECM (MREL VOLTAGE)



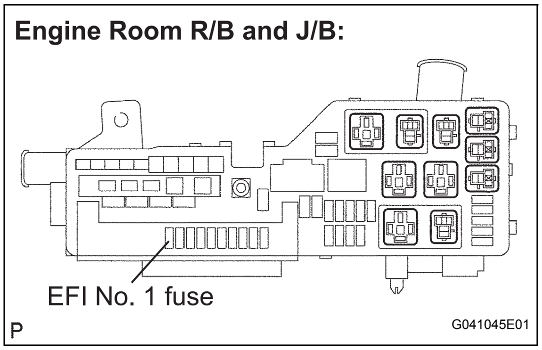
(a) Turn the ignition switch on (IG).
(b) Measure the voltage between the terminals of the A24 and B47 ECM connectors.
Standard voltage

Tester Connections	Specified Conditions
MREL (A24-8) - E1 (B47-1)	9 to 14 V

NG → **REPLACE ECM**

OK

7 CHECK FUSE (EFI FUSE)



(a) Remove the EFI No. 1 fuse from the engine room R/B and J/B.

(b) Measure the EFI No. 1 fuse resistance.

Standard resistance:

Below 1 Ω

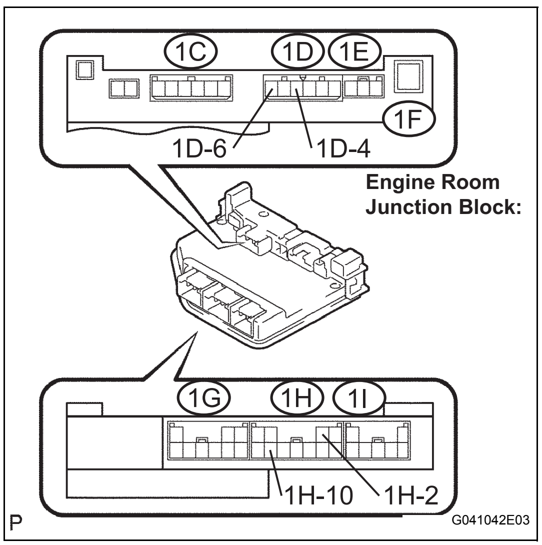
(c) Reinstall the EFI No. 1 fuse.

NG → **CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE**

ES

OK

8 INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (EFI RELAY)



(a) Remove the engine room junction block.

(b) Measure the EFI relay resistance.

Standard resistance

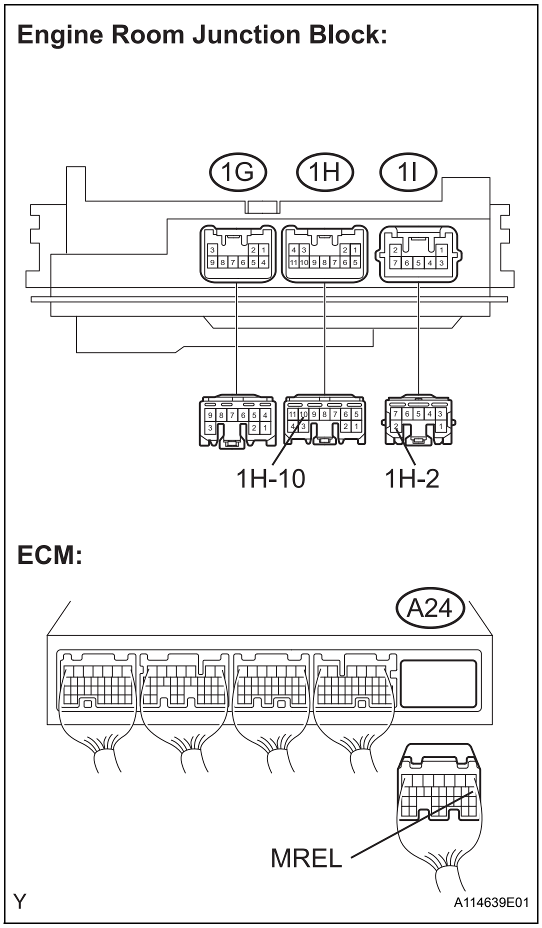
Tester Connections	Specified Conditions
1D-4 - 1D-6	10 kΩ or higher
1D-4 - 1D-6	Below 1 Ω (when battery voltage applied to terminals 1H-10 and 1H-2)

(c) Reinstall the engine room junction block.

NG → **REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY**

OK

9	CHECK HARNESS AND CONNECTOR (EFI RELAY - ECM, EFI RELAY - BODY GROUND)



(a) Check the harness and connector between the EFI relay and ECM.
(1) Remove the engine room junction block.
(2) Disconnect the A24 ECM connector.
(3) Measure the resistance between the terminals of the ECM connector and engine room junction block (EFI relay).

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Engine Room Junction Block (EFI relay) (1H-10) - MREL (A24-8)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Engine Room Junction Block (EFI relay) (1H-10) or MREL (A24-8) - Body ground	10 kΩ or higher

(b) Check the harness and connector between the engine room junction block (EFI relay) and body ground.
(1) Measure the resistance between the terminal of the engine room junction block (EFI relay) and body ground.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Engine Room Junction Block (EFI relay) (1H-2) - Body ground	Below 1 Ω

(2) Reinstall the engine room junction block.
(3) Reconnect the ECM connector.

OK → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

NG

CHECK AND REPLACE HARNESS AND CONNECTOR (TERMINAL +B OF ECM - BATTERY POSITIVE TERMINAL)

ES

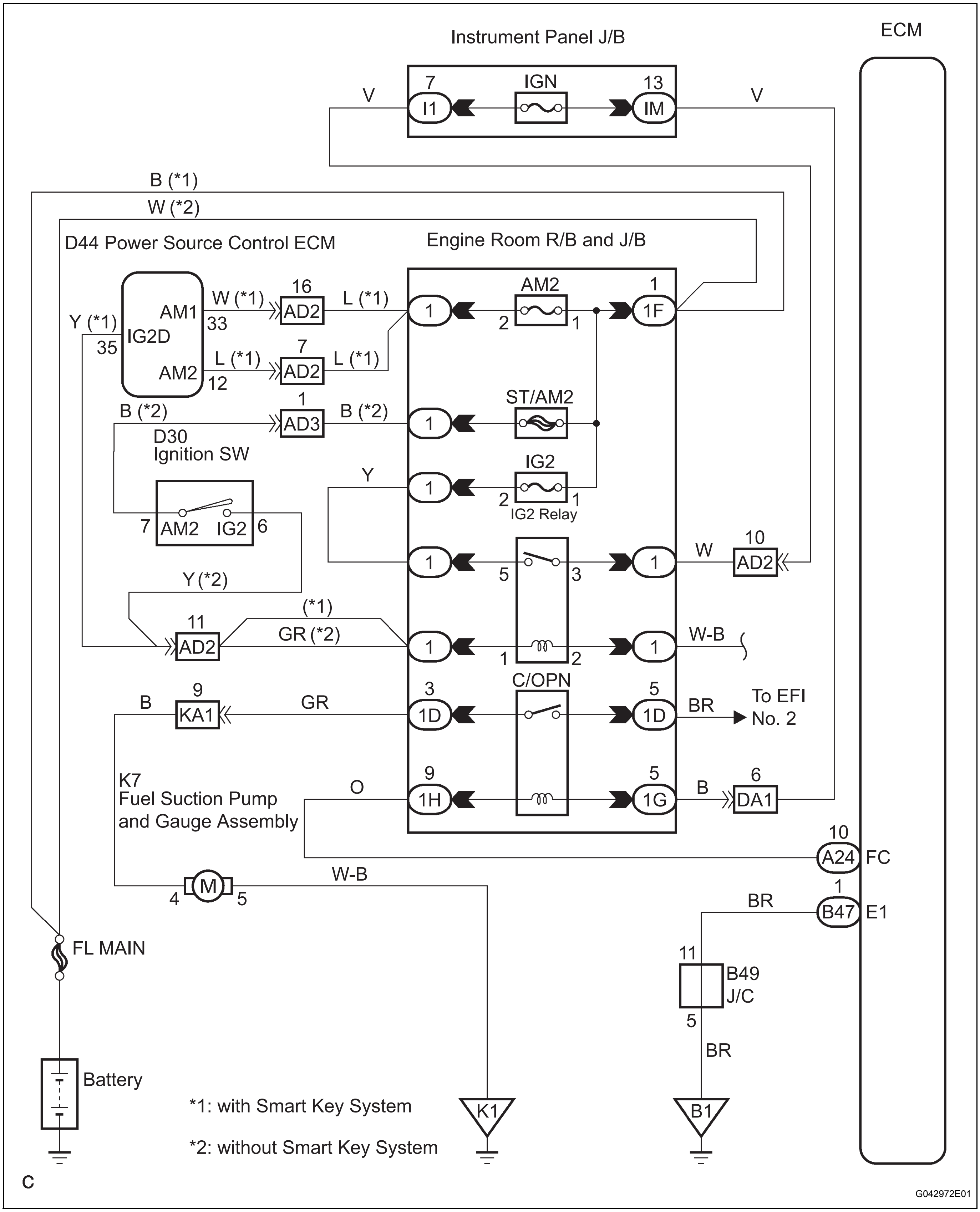
Fuel Pump Control Circuit

DESCRIPTION

In the diagram below, when the engine is cranked, current flows from terminal ST1 (STR1) of the ignition switch (power source control ECU) to the starter relay (Marking: ST) coil and also current flows to terminal STA of ECM (STA signal).
When the STA signal and NE signal are input to the ECM, Tr is turned ON, current flows to coil of the circuit opening relay (Marking: C/OPN), the relay switches on, power is supplied to the fuel pump and the fuel pump operates.
While the NE signal is generated (engine running), the ECM keeps Tr ON (circuit opening relay ON) and the fuel pump also keeps operating.

ES

WIRING DIAGRAM



INSPECTION PROCEDURE

1	CHECK FUEL PUMP OPERATION

(a) Check if there is pressure in the fuel inlet hose (See page FU-7).
HINT:
If there is fuel pressure, you will hear the sound of fuel flowing.

OK → Go to step 5

NG

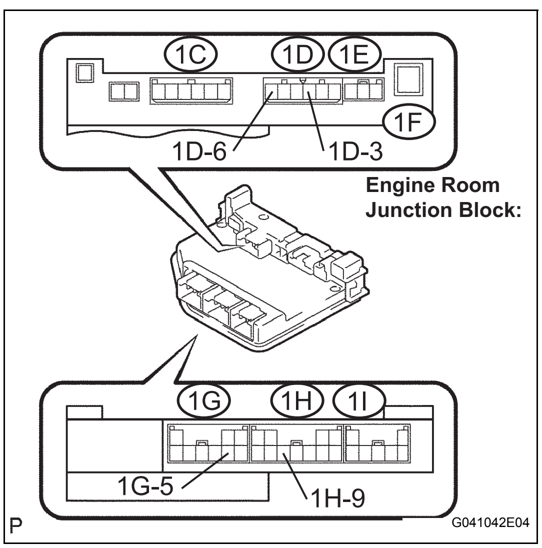
2	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATION OF CIRCUIT OPENING RELAY)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / FUEL PUMP/ SPD.
(d) Check whether operating sounds can be heard while operating the relay using the tester.
OK:
Operating sounds can be heard from the relay.

OK → Go to step 5

NG

3	INSPECT ENGINE ROOM JUNCTION BLOCK ASSEMBLY (CIRCUIT OPENING RELAY)



(a) Remove the engine room junction block.
(b) Measure the circuit opening relay resistance.
Standard resistance

Tester Connections	Specified Conditions
1D-5 - 1D-3	10 kΩ or higher
1D-5 - 1D-3	Below 1 Ω (when battery voltage applied to terminals 1G-5 and 1H-9)

(c) Reinstall the engine room junction block.

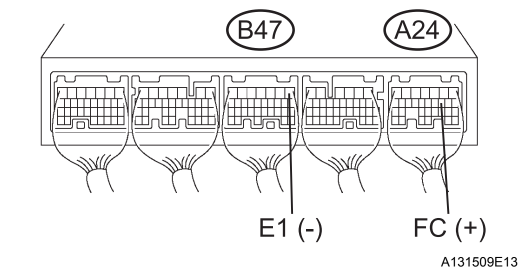
NG → REPLACE ENGINE ROOM JUNCTION BLOCK ASSEMBLY

OK

ES

4	INSPECT ECM (FC VOLTAGE)

ECM:



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

(b) Measure the voltage between the terminals of the A24 and B47 ECM connectors.

Standard voltage

Tester Connections	Specified Conditions
FC (A24-10) - E1 (B47-1)	9 to 14 V

OK → **REPLACE ECM**

NG ↓

CHECK AND REPLACE HARNESS AND CONNECTOR (ENGINE ROOM JUNCTION BLOCK - IGNITION SWITCH)

5	INSPECT ECM POWER SOURCE CIRCUIT

HINT:

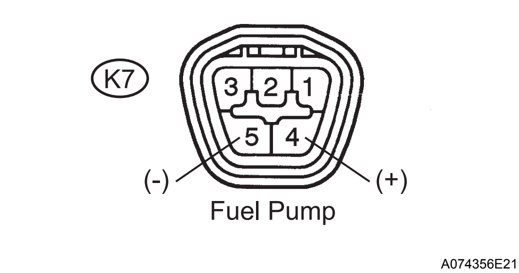
Refer to "ECM POWER SOURCE CIRCUIT" (See page ES-395).

NG → **REPAIR OR REPLACE ECM POWER SOURCE CIRCUIT**

OK ↓

6	INSPECT FUEL PUMP ASSEMBLY

Component Side:



(a) Inspect fuel pump resistance.

(1) Disconnect the K7 fuel pump connector.

(2) Measure the resistance between terminals 4 and 5.

Standard resistance:

0.2 to 3.0 Ω at 20°C (68°F)

(b) Inspect fuel pump operation.

(1) Apply battery voltage to both terminals. Check that the fuel pump operates.

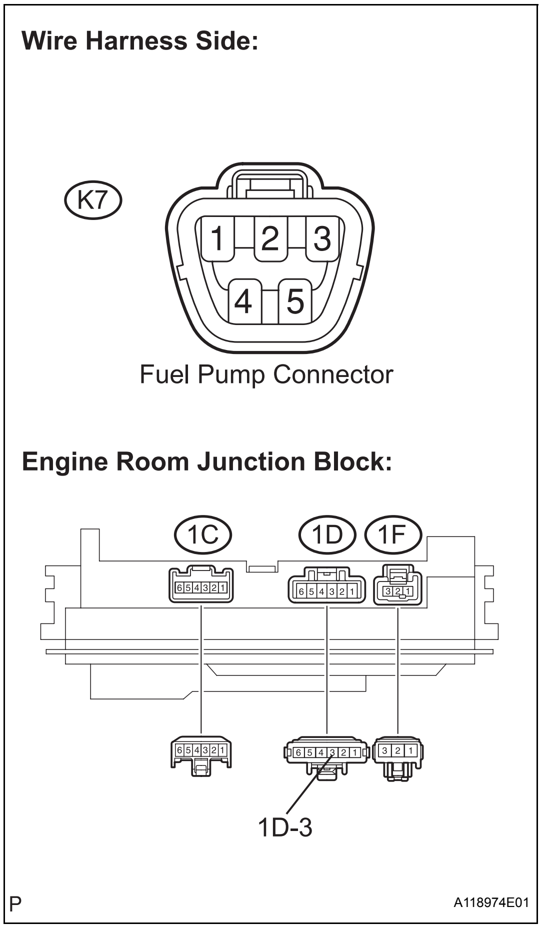
NOTICE:

- **These tests must be done quickly (within 10 seconds) to prevent the coil from burning out.**
- **Keep the fuel pump as far away from the battery as possible.**
- **Always switch at the battery side.**

NG → **REPLACE FUEL PUMP ASSEMBLY**

OK ↓

7	CHECK HARNESS AND CONNECTOR (FUEL PUMP - CIRCUIT OPENING RELAY, FUEL PUMP - BODY GROUND)



(a) Check the harness and connector between the fuel pump and circuit opening relay.
(1) Disconnect the K7 fuel pump connector.
(2) Remove the engine room junction block.
(3) Measure the resistance between the terminals of the engine room junction block (circuit opening relay) and fuel pump connector.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Fuel pump (K7-4) - Engine room junction block (circuit opening relay) (1D-3)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Fuel pump (K7-4) or Engine room junction block (circuit opening relay) (1D-3) - Body ground	10 kΩ or higher

(4) Reconnect the fuel pump connector.
(5) Reinstall the engine room junction block.

(b) Check the harness and connector between the fuel pump and body ground.
(1) Disconnect the fuel pump connector.
(2) Measure the resistance between the terminal of the fuel pump connector and body ground.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Fuel pump (K7-5) - Body ground	Below 1 Ω

(3) Reconnect the fuel pump connector.

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

OK

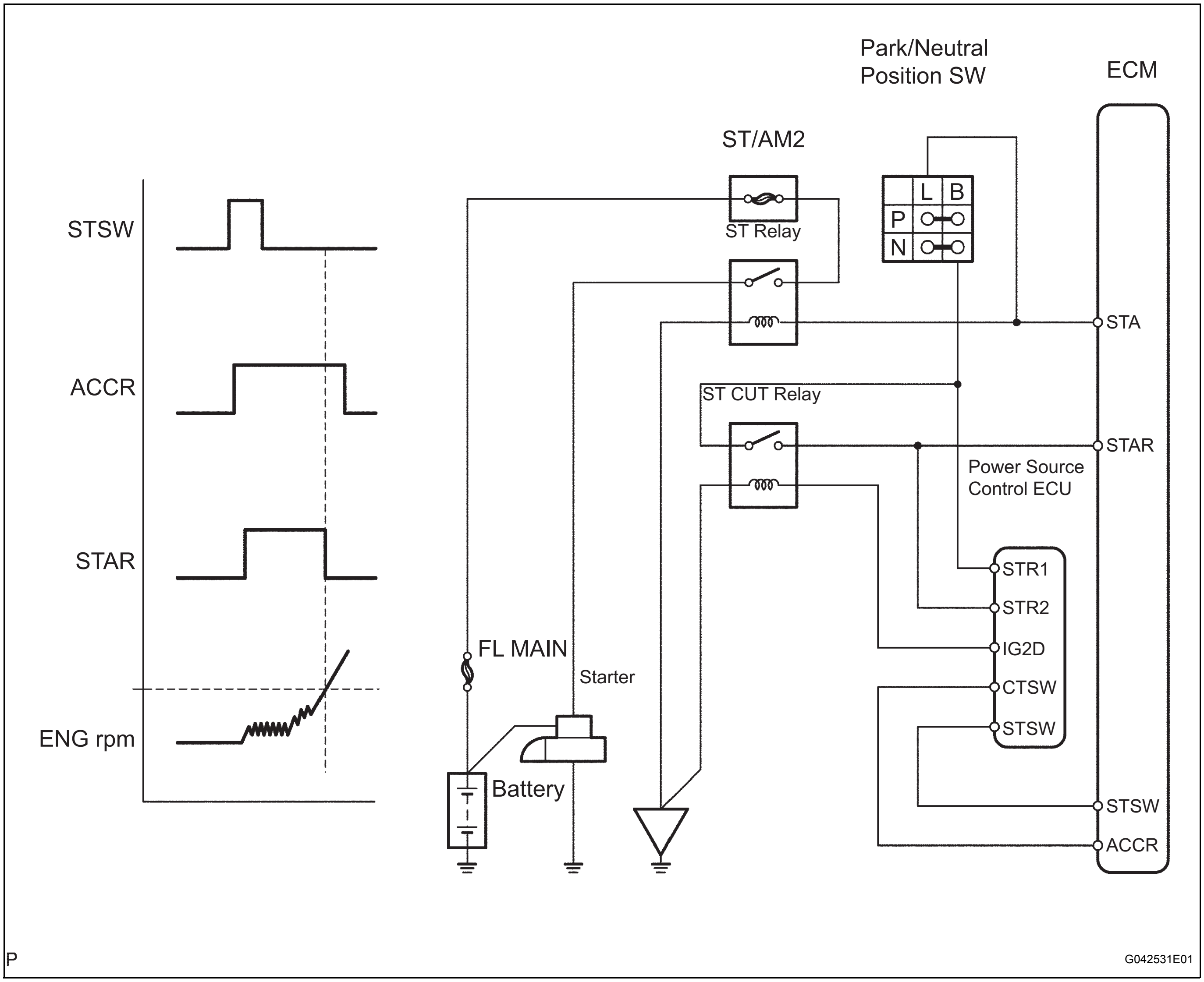
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE

ES

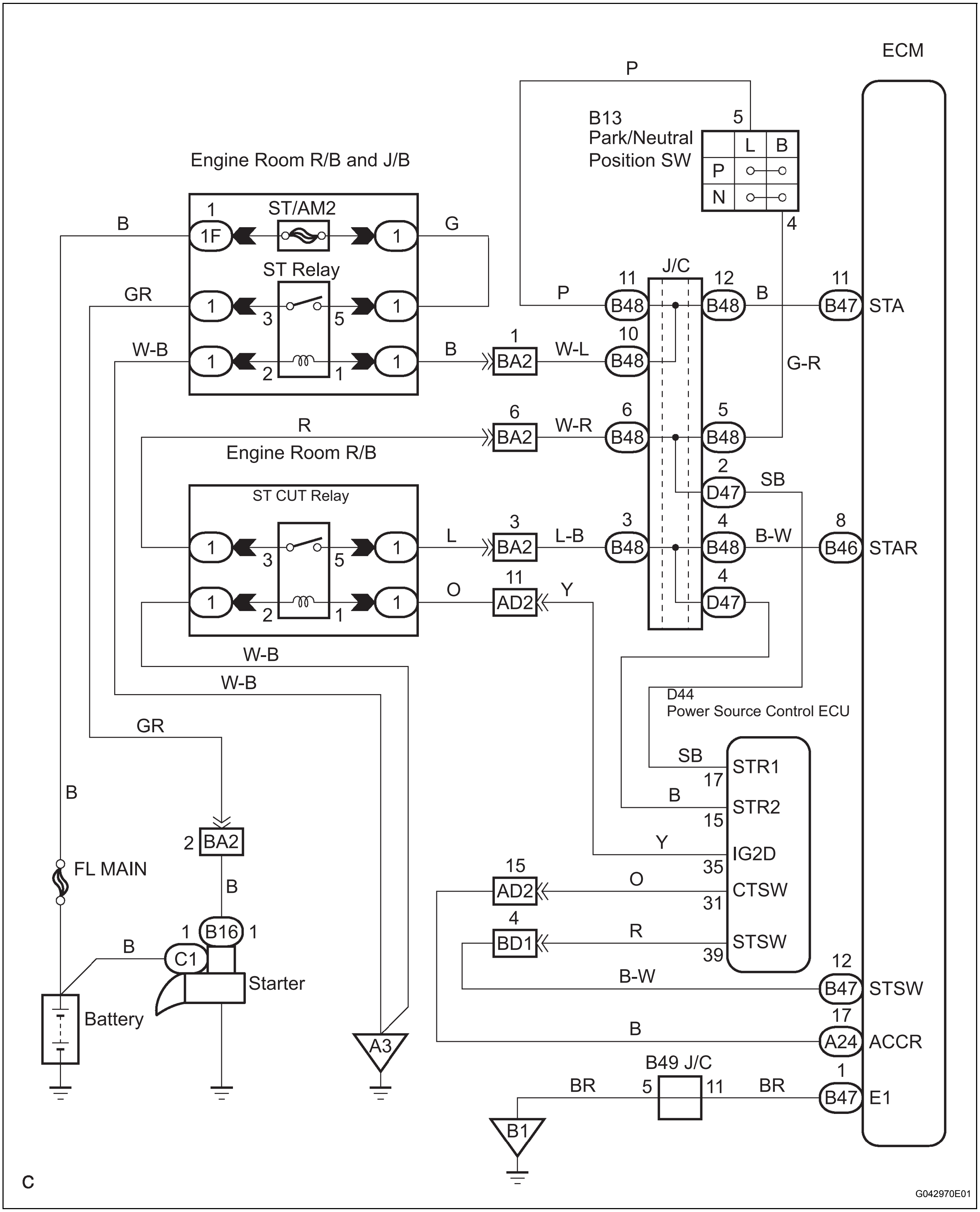
Cranking Holding Function Circuit

DESCRIPTION

When the ECM detects a start signal from the engine switch, this system monitors the engine rpm and continues to operate the starter until it has determined that the engine has started (engine speed reaches approximately 500 rpm). Furthermore, even if the ECM detects a start signal from the ignition switch, it will not operate the starter if it has determined that the engine has already started.



WIRING DIAGRAM



INSPECTION PROCEDURE

1 CHECK OPERATION OF ENGINE CRANKING

(a) When pushing the engine switch to start the engine, check if the starter motor starts.

OK → **PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE**

NG

2 CHECK DTC FOR PUSH BUTTON START

(a) Check the DTC for push button start (See page ST-22).

A	Normal System Code
B	Malfunction Code

B → **REPLACE PUSH BUTTON START SYSTEM**

A

3 READ VALUE OF INTELLIGENT TESTER (STA SIGNAL)

(a) Connect the intelligent tester to the DLC3.
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / STARTER SIG. Read the values.

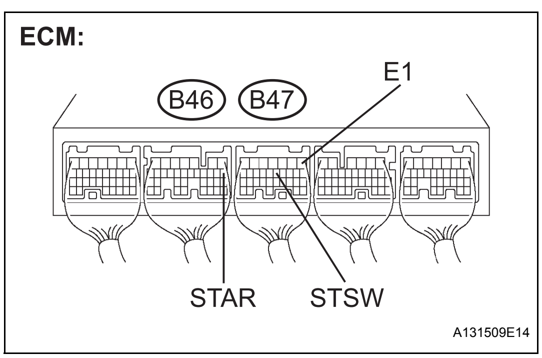
Standard

STARTER SIG	Ignition Switch Position
OFF	ON
ON	START

OK → **Go to step 6**

NG

4 INSPECT ECM (STAR AND STSW VOLTAGE)



(a) Measure the voltage between the terminals of the B46 and B47 ECM connectors, while cranking the engine.

Standard voltage

Tester Connection	Specified Condition
STAR (B46-8) - E1 (B47-1)	9 to 14 V
STSW (B47-12) - E1 (B47-1)	9 to 14 V

Result

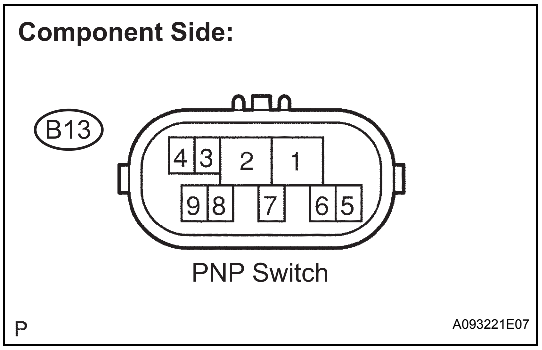
Terminal STAR	Terminal STSW	Proceed to
9 to 14 V	9 to 14 V	A
0 V	9 to 14 V	B
0 V	0 V	C

B → REPLACE ECM

C → Go to step 10

A

5 INSPECT PARK/NEUTRAL POSITION SWITCH ASSEMBLY



(a) Inspect the Park/Neutral Position (PNP) switch.
 (1) Disconnect the B13 PNP switch connector.
 (2) Measure the resistance when the transmission gear selector lever is moved to each position.
 Standard resistance

Gear Selector Lever Positions	Tester Connections	Specified Conditions
P	2 - 6, 4 - 5	Below 1 Ω
R	1 - 2	Below 1 Ω
N	2 - 9, 4 - 5	Below 1 Ω
D	2 - 7	Below 1 Ω
2	2 - 3	Below 1 Ω
L	2 - 8	Below 1 Ω

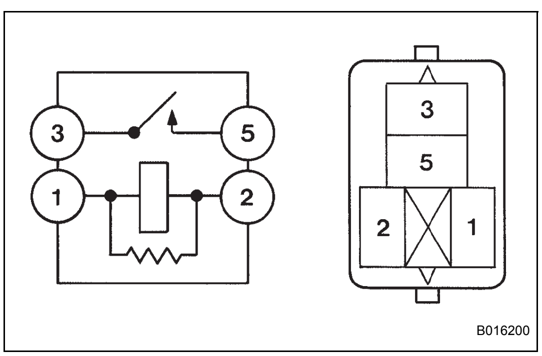
 (3) Reconnect the PNP switch connector.

NG → REPLACE PARK/NEUTRAL POSITION SWITCH ASSEMBLY

OK

CHECK AND REPLACE HARNESS AND CONNECTOR (PARK/NEUTRAL POSITION SWITCH - ECM)

6 INSPECT STARTER RELAY



(a) Remove the starter relay and starter cut relay from the engine room R/B and J/B.
(b) Check for continuity in the relays.
 Standard

Tester Connections	Specified Conditions
1 - 2	Continuity
3 - 5	No continuity
3 - 5	Continuity (Apply battery voltage to terminals 1 and 2)

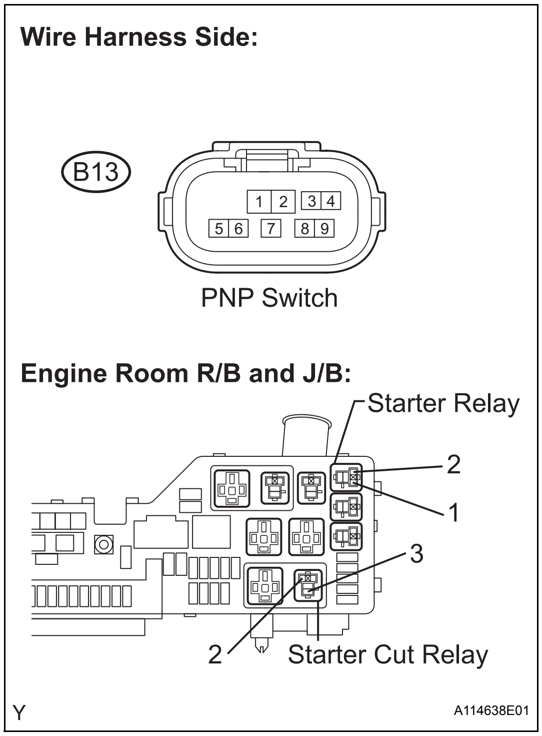
(c) Reinstall the starter relay and starter cut relay.

NG → REPLACE STARTER RELAY

OK

ES

7	CHECK HARNESS AND CONNECTOR (PARK/NEUTRAL POSITION SWITCH - STARTER RELAY)



(a) Check the harness and connector between the park/neutral position switch, starter relay and starter cut relay.
(1) Disconnect the B13 park/neutral position switch connector.
(2) Remove the starter relay and starter cut relay from the engine room R/B and J/B.
(3) Check for continuity between the wire harness side connectors.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Park/neutral position switch (B13-5) - Engine room R/B and J/B (Starter relay terminal 1)	Below 1 Ω
Park/neutral position switch (B13-4) - Engine room R/B and J/B (Starter cut relay terminal 3)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Park/neutral position switch (B13-5) or Engine room R/B and J/B (Starter relay terminal 1) - Body ground	10 kΩ or higher
Park/neutral position switch (B13-4) or Engine room R/B and J/B (Starter cut relay terminal 3) - Body ground	10 kΩ or higher

(4) Reconnect the park/neutral position switch connector.

(b) Check the harness and connector between the starter relay, starter cut relay and body ground.
(1) Check for continuity between each relay and body ground.

Standard resistance (Check for open)

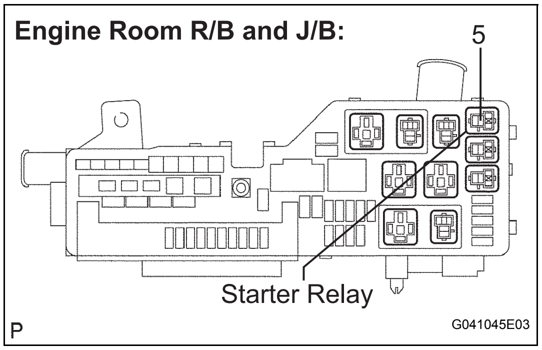
Tester Connections	Specified Conditions
Engine room R/B and J/B (Starter relay terminal 2) - Body ground	Below 1 Ω
Engine room R/B and J/B (Starter cut relay terminal 2) - Body ground	Below 1 Ω

(2) Reinstall the starter relay and starter cut relay.

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

OK

8	INSPECT ENGINE ROOM RELAY BLOCK (STARTER RELAY VOLTAGE)



(a) Remove the starter relay from the engine room R/B and J/B.

(b) Measure the voltage between the terminal of the engine room R/B and J/B and body ground.

Standard voltage

Tester Connections	Specified Conditions
Engine room R/B and J/B (Starter relay terminal 5) - Body ground	9 to 14 V

(1) Reinstall the starter relay.

NG → **CHECK AND REPLACE HARNESS AND CONNECTOR (STARTER RELAY - BATTERY)**

ES

OK

9	INSPECT STARTER ASSEMBLY

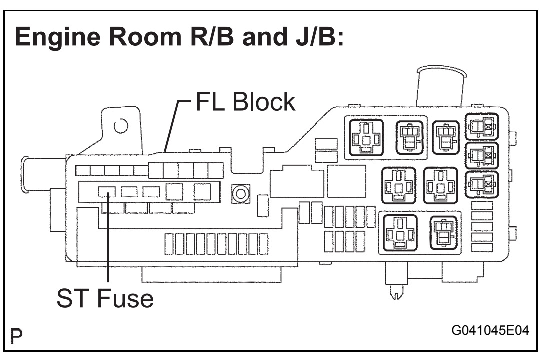
(a) Inspect the starter assembly (See page ST-74).

NG → **REPAIR OR REPLACE STARTER ASSEMBLY**

OK

CHECK AND REPLACE HARNESS AND CONNECTOR (STARTER RELAY - STARTER, STARTER - BATTERY)

10	CHECK FUSE (ST)



(a) Check for continuity in the ST fuse.

Standard:

Continuity

NG → **CHECK FOR SHORT IN ALL HARNESSES AND CONNECTORS CONNECTED ST FUSE AND REPLACE FL BLOCK**

OK

11	INSPECT PUSH START SWITCH

(a) Inspect the push start switch (See page ST-83).

NG → **REPLACE PUSH START SWITCH**

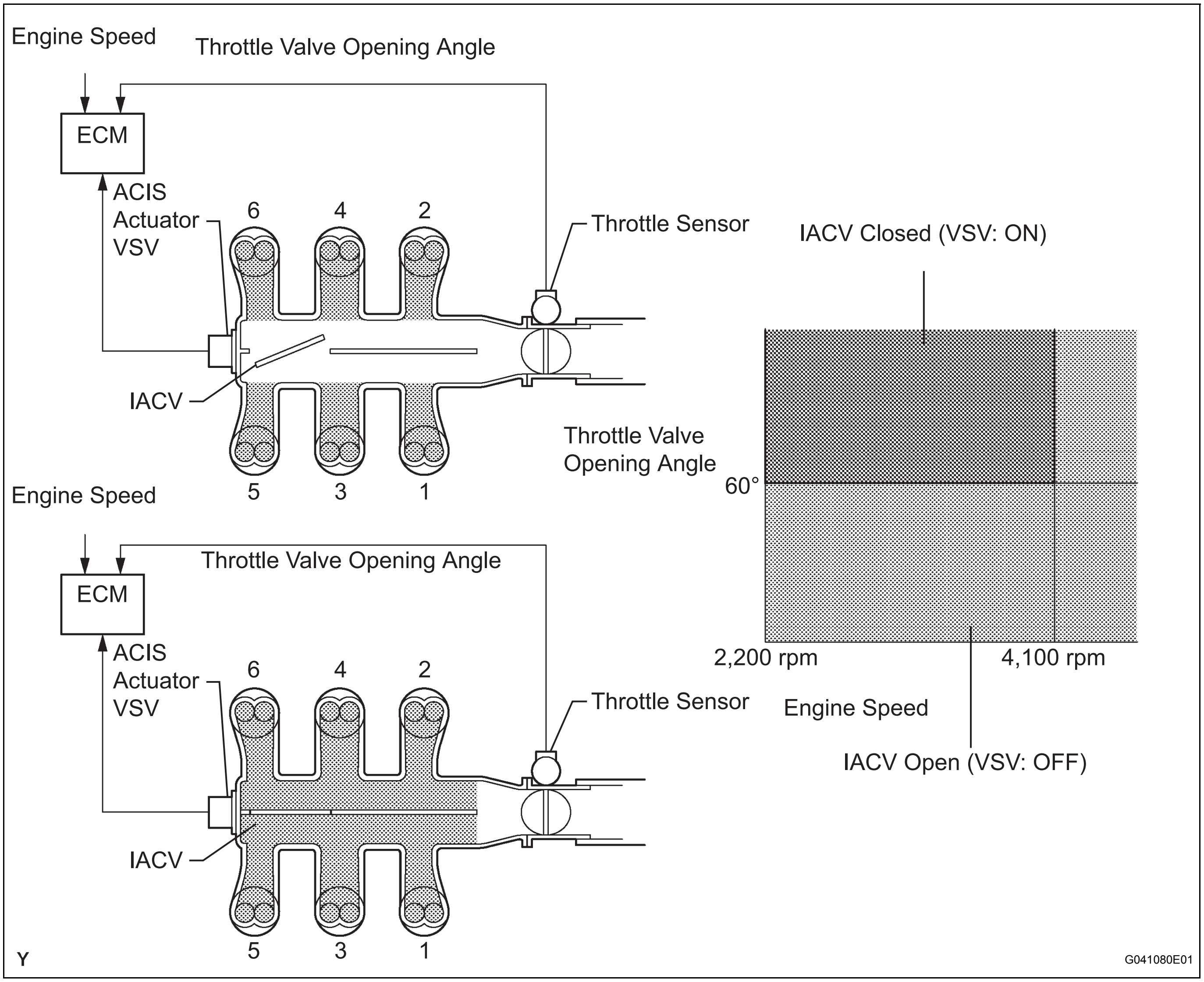
OK

REPLACE POWER SOURCE CONTROL ECU

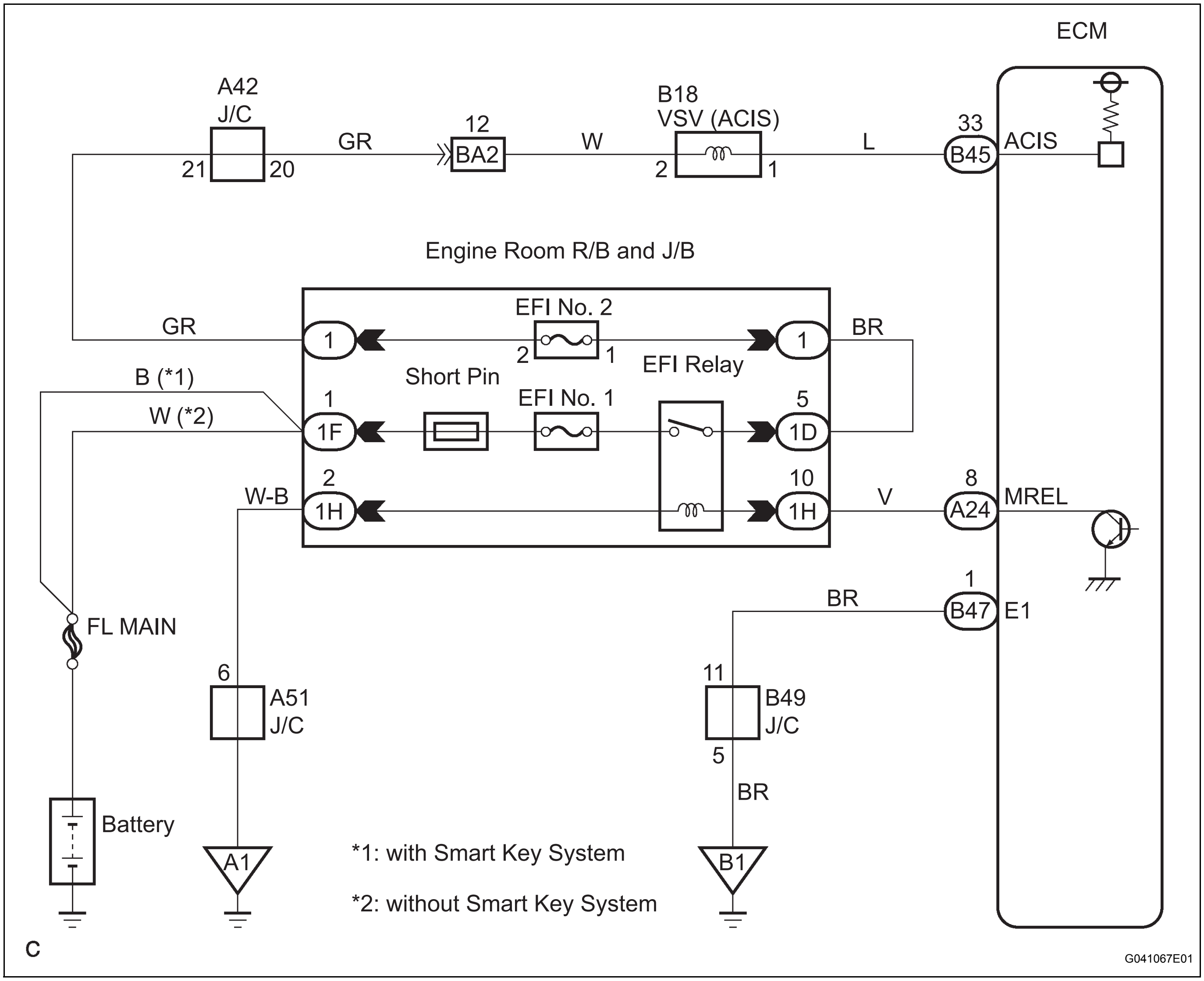
ACIS Control Circuit

DESCRIPTION

This circuit opens and closes the Intake Air Control Valve (IACV) in response to changes in the engine load in order to increase the intake efficiency (ACIS: Acoustic Control Induction System).
When the engine speed is between 2,200 and 4,100 rpm and the throttle valve opening angle is 60° or more, the ECM supplies current to the VSV (ON status), to close the IACV. Under other conditions, the VSV is usually OFF and the IACV is open.



WIRING DIAGRAM



INSPECTION PROCEDURE

1	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATE VSV FOR ACIS)

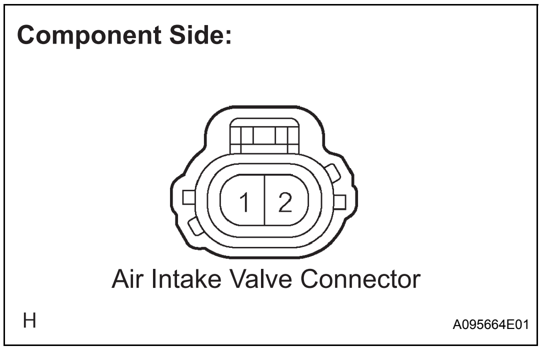
(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the intelligent tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INTAKE CTL VSV1. Operate the VSV for AICS.

OK:
Operational noise can be heard.

OK → **PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE**

NG

2	CHECK INTAKE AIR CONTROL VALVE (OPERATION)



(a) Disconnect the B18 air intake valve connector.
(b) Apply battery voltage between the terminals of the air intake valve connector.
(c) Check the air intake valve operation.

OK:

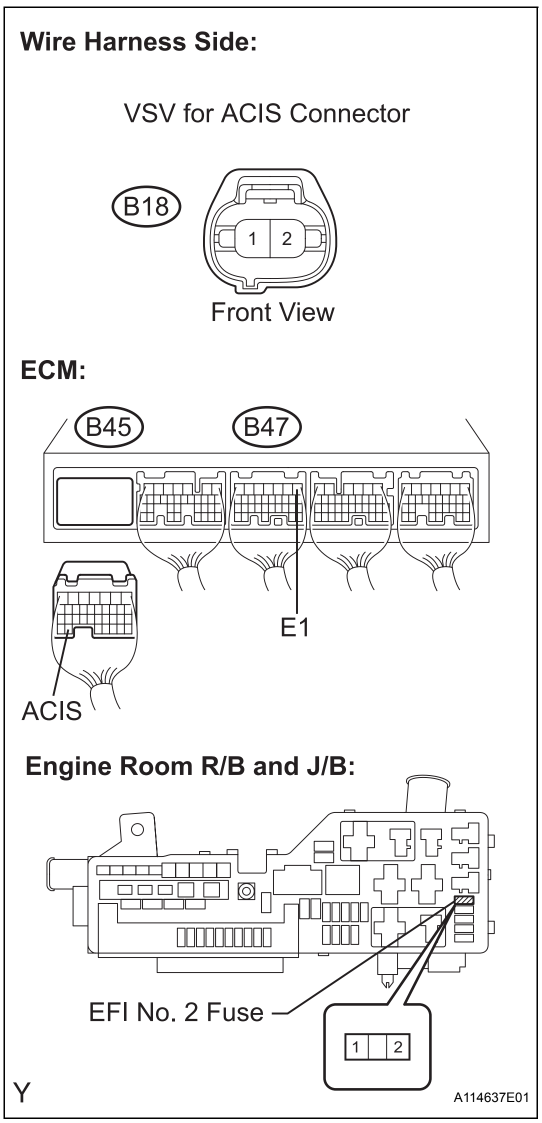
Operational noise can be heard.

NG → **REPLACE INTAKE AIR SURGE TANK**

ES

OK

3	CHECK HARNESS AND CONNECTOR (VSV FOR ACIS - ECM, VSV FOR ACIS - EFI NO.2 RELAY)



(a) Check the wire harness and connectors between the VSV for ACIS and ECM.
  (1) Disconnect the B18 VSV for ACIS connector.
  (2) Disconnect the B45 ECM connector.
  (3) Measure the resistance between the terminals of the VSV for ACIS connector and ECM connector.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VSV for ACIS (B18-1) - ACIS (B45-33)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
VSV for ACIS (B18-1) or ACIS (B45-33) - E1 (B47-1)	10 kΩ or higher

  (4) Reconnect the VSV for ACIS connector.
  (5) Reconnect the ECM connector.

(b) Check the wire harness between the VSV for ACIS and EFI relay.
  (1) Disconnect the B18 VSV for ACIS connector.
  (2) Remove the EFI No. 2 fuse from the engine room R/B and J/B.
  (3) Measure the resistance of the VSV for ACIS connector and engine room R/B and J/B (EFI No. 2 fuse).

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VSV for ACIS (B18-2) - Engine Room R/B and J/B (EFI No. 2 relay) (2)	Below 1 Ω

  (4) Reconnect the VSV for ACIS connector.
  (5) Reinstall the EFI No. 2 fuse.

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

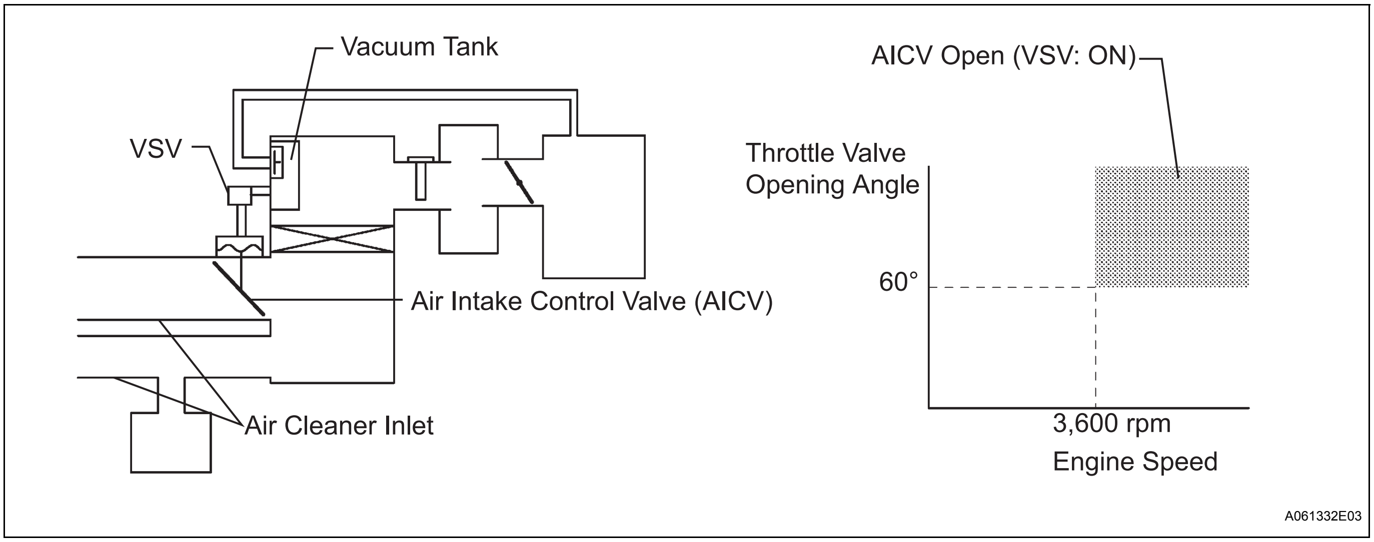
OK

REPLACE ECM

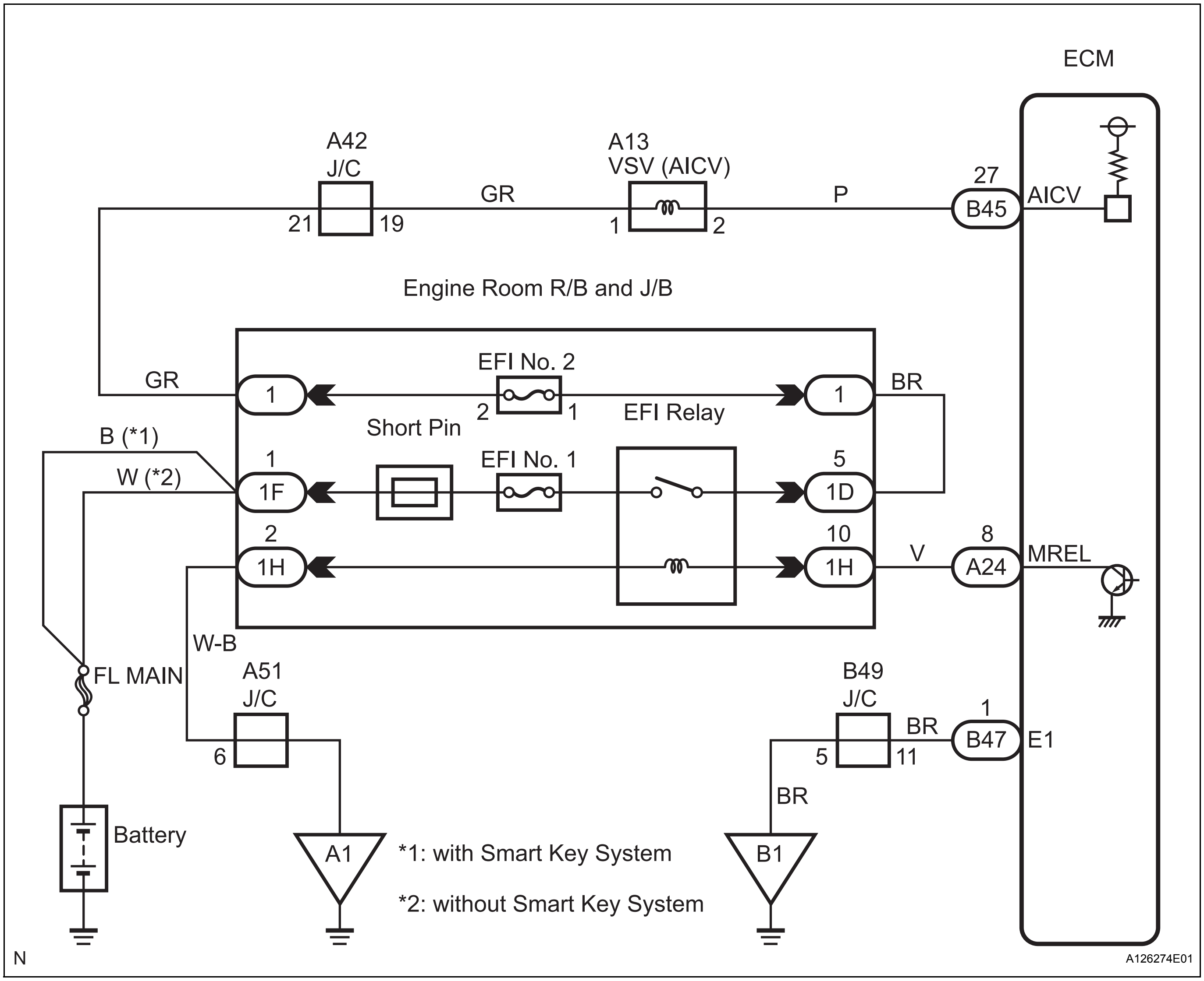
Air Intake Control Circuit

DESCRIPTION

The air cleaner is equipped with two inlets, one of which is opened or closed by the Air Intake Control Valve (AICV). This system reduces intake noise and increases engine power at low to high engine speeds range.
When the engine is operating in the low-to-mid speed range, this control operates the AICV to close one of the air cleaner inlets. When the engine speed is more than 3,600 rpm and the opening angle of the throttle valve is more than 60°, the ECM activates the VSV and opens the AICV.

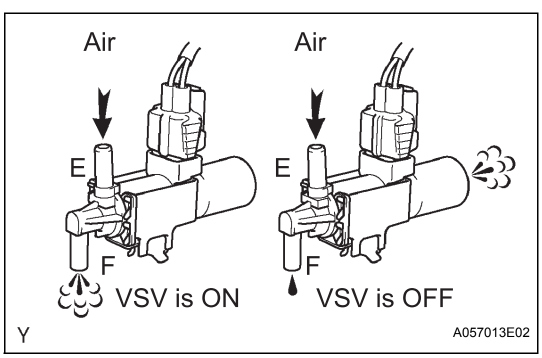


WIRING DIAGRAM



INSPECTION PROCEDURE

1	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (VSV FOR AICV)



(a) Turn the ignition switch on (IG) and turn the intelligent tester ON.

(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INTAKE CTL VSV1 and operate the VSV for AICV.

(c) Check the operation of the VSV when the VSV is operated by the intelligent tester.

Standard

Tester Operation	Specified Condition
VSV is ON	Air from port E flows out through port F
VSV is OFF	Air from port E flows out through the air filter

OK	Go to step 4

NG

2 CHECK VSV (FOR AICV)

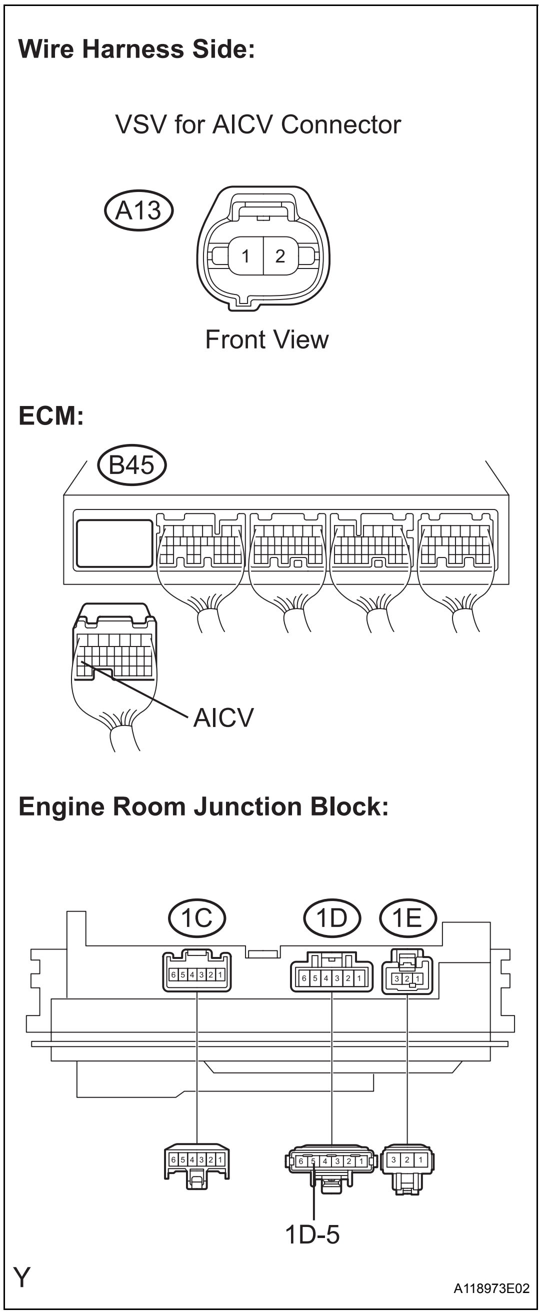
(a) Inspect the intake air control valve assembly (See page IT-3).

NG → **REPLACE INTAKE AIR CONTROL VALVE ASSEMBLY**

OK

ES

3 CHECK HARNESS AND CONNECTOR (VSV FOR AICV - ECM, VSV FOR AICV - EFI RELAY)



(a) Check the wire harness between the VSV for AICV connector and the ECM connector.
  (1) Disconnect the A13 VSV for AICV connector.
  (2) Disconnect the B45 ECM connector.
  (3) Measure the resistance between the wire harness side connectors.

Standard resistance (Check for open)

Tester Connection	Specified Condition
VSV for AICV (A13-2) - AICV (B45-27)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VSV for AICV (A13-2) or AICV (B45-27) - Body ground	10 kΩ or higher

  (4) Reconnect the ECM connector.

(b) Check the wire harness between the VSV for AICV and the EFI relay.
  (1) Remove the engine room junction block.
  (2) Measure the resistance between the wire harness side connectors.

Standard resistance (Check for open)

Tester Connection	Specified Condition
VSV for AICV (A13-1) - engine room junction block (EFI relay) (1D-5)	Below 1 Ω

  (3) Reconnect the VSV for AICV connector.
  (4) Reinstall the engine room junction block.

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

OK

4	INSPECT VACUUM TANK

(a) Inspect the vacuum tank (See page IT-3).

NG → **REPAIR OR REPLACE AIR CLEANER CAP**

OK

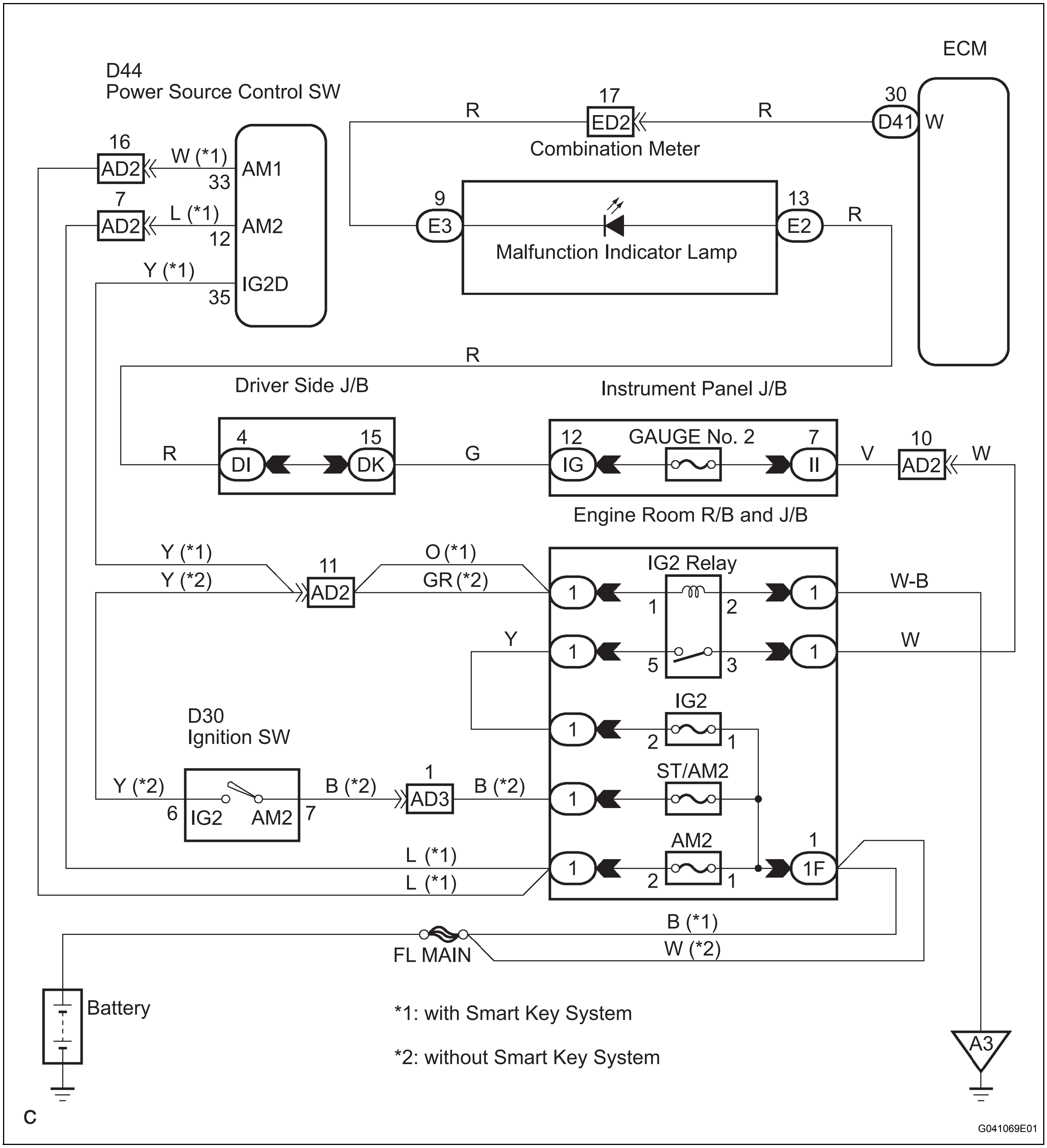
REPLACE ECM

MIL Circuit

DESCRIPTION

The MIL (Malfunction Indicator Lamp) is used to indicate vehicle malfunction detections by the ECM.
By turning the ignition switch on (IG), power is supplied to the MIL circuit, and the ECM provides the circuit ground, which illuminates the MIL.
The MIL operation can be checked visually: When the ignition switch is first turned on (IG), the MIL should be illuminated and should then turn off. If the MIL remains illuminated or is not illuminated, conduct the following troubleshooting procedure using the intelligent tester.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Troubleshoot each trouble symptom in accordance with the table below.

MIL remains illuminated	Start inspection from step 1
MIL not illuminated	Start inspection from step 3

1	CHECK WHETHER MIL TURNS OFF

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch on (IG).
(c) Turn the tester on.
(d) Check whether any DTCs have been stored (See page ES-44). Note them down if necessary.
(e) Clear the DTCs (See page ES-44).
(f) Check if the MIL turns off.

OK:

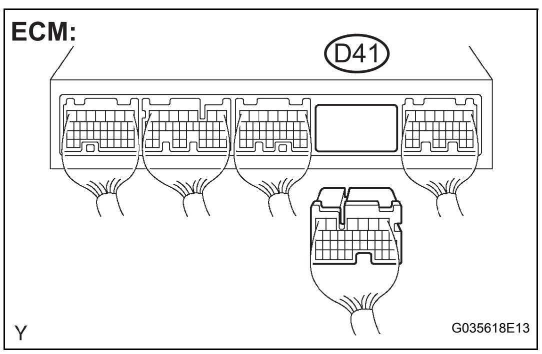
MIL should turn off.

OK → **REPAIR CIRCUIT INDICATED BY OUTPUT DTC**

ES

NG

2	CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT IN WIRE HARNESS)



(a) Disconnect the D41 ECM connector.
(b) Turn the ignition switch on (IG).
(c) Check that the MIL is not illuminated.

OK:

MIL is not illuminated.

(d) Reconnect the ECM connector.

OK → **REPLACE ECM**

NG

CHECK AND REPLACE HARNESS AND CONNECTOR (COMBINATION METER - ECM)

3	CHECK THAT MIL IS ILLUMINATED

(a) Check if the MIL is illuminated when the ignition switch is turned on (IG).

OK:

MIL should be illuminated.

OK → **SYSTEM OK**

NG

4	INSPECT COMBINATION METER ASSEMBLY (MIL CIRCUIT)

(a) See the combination meter troubleshooting procedure (See page ME-13).

NG

REPAIR OR REPLACE BULB OR COMBINATION METER ASSEMBLY

OK

CHECK AND REPLACE HARNESS AND CONNECTOR (COMBINATION METER - ECM)

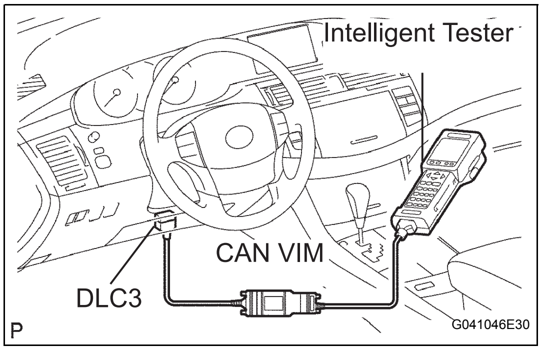
MASS AIR FLOW METER

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.

(3) Turn the tester on.

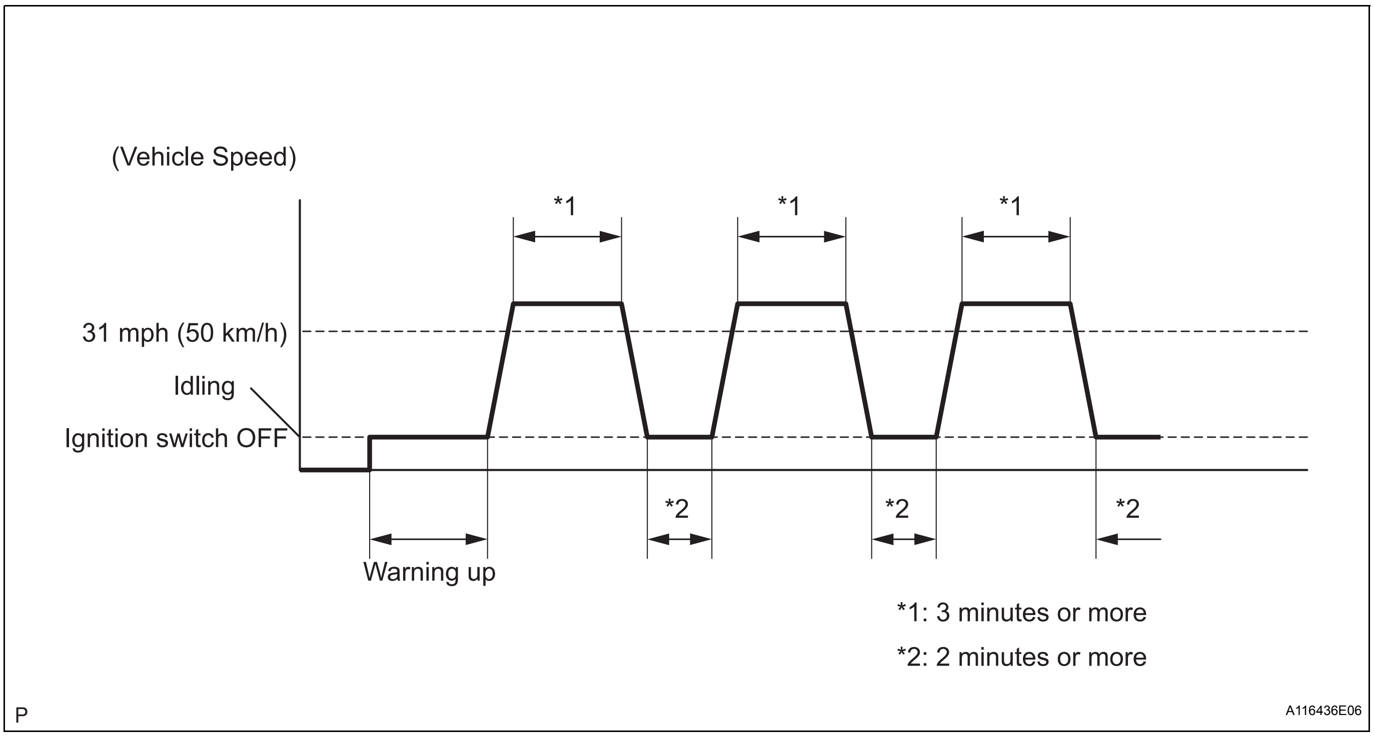
(4) Clear the DTCs (See page ES-44).

(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) Let the engine idle (accelerator pedal fulley released) for 2 minutes or more. *2

(8) Perform steps *1 and *2 at least 3 times or more.



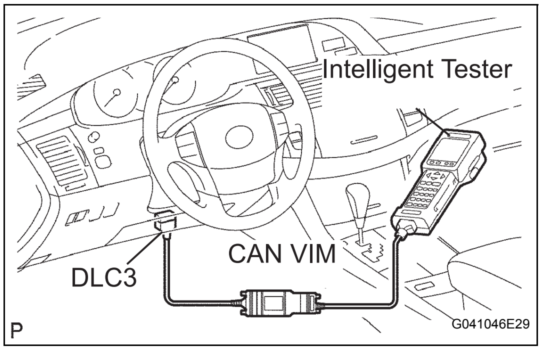
(b) Read value using the intelligent tester (LONG FT#1).

(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 value 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.
(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 0.33 g/s
- 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).

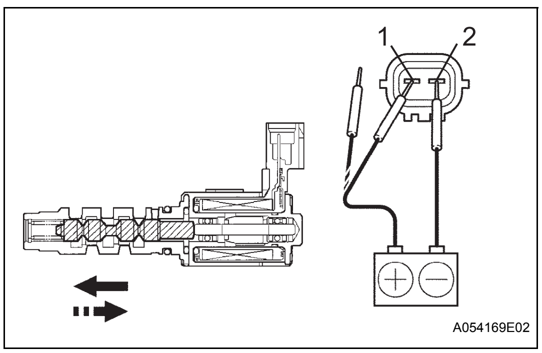


CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

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 by the intelligent tester.
   OK

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



INSPECTION

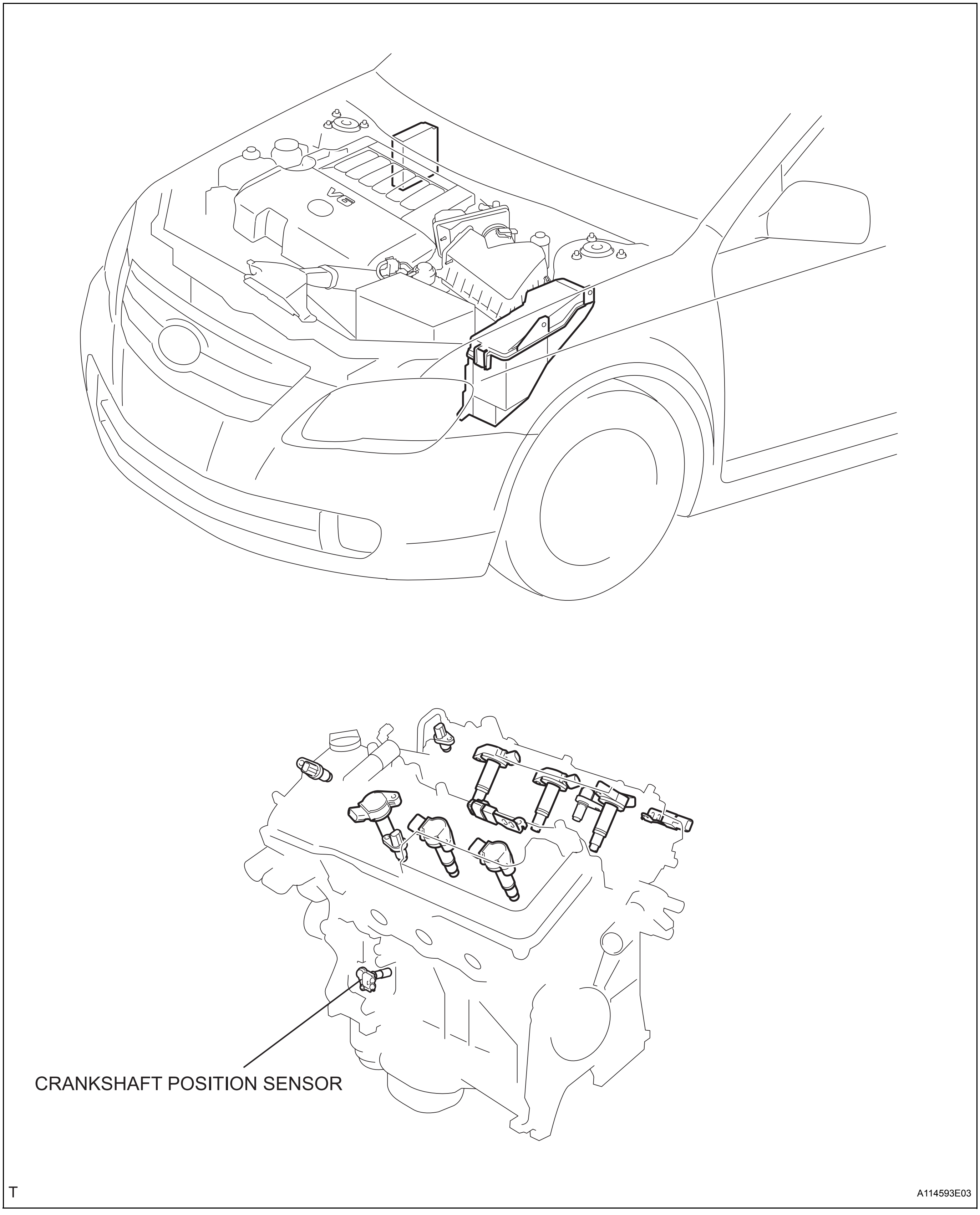
1. **INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY**
   (a) Using an ohmmeter, measure the resistance between the terminals.
   (b) Connect the battery's positive (+) lead to terminal 1 and negative (-) lead to terminal 2. Check the movement of the valve.
   OK:

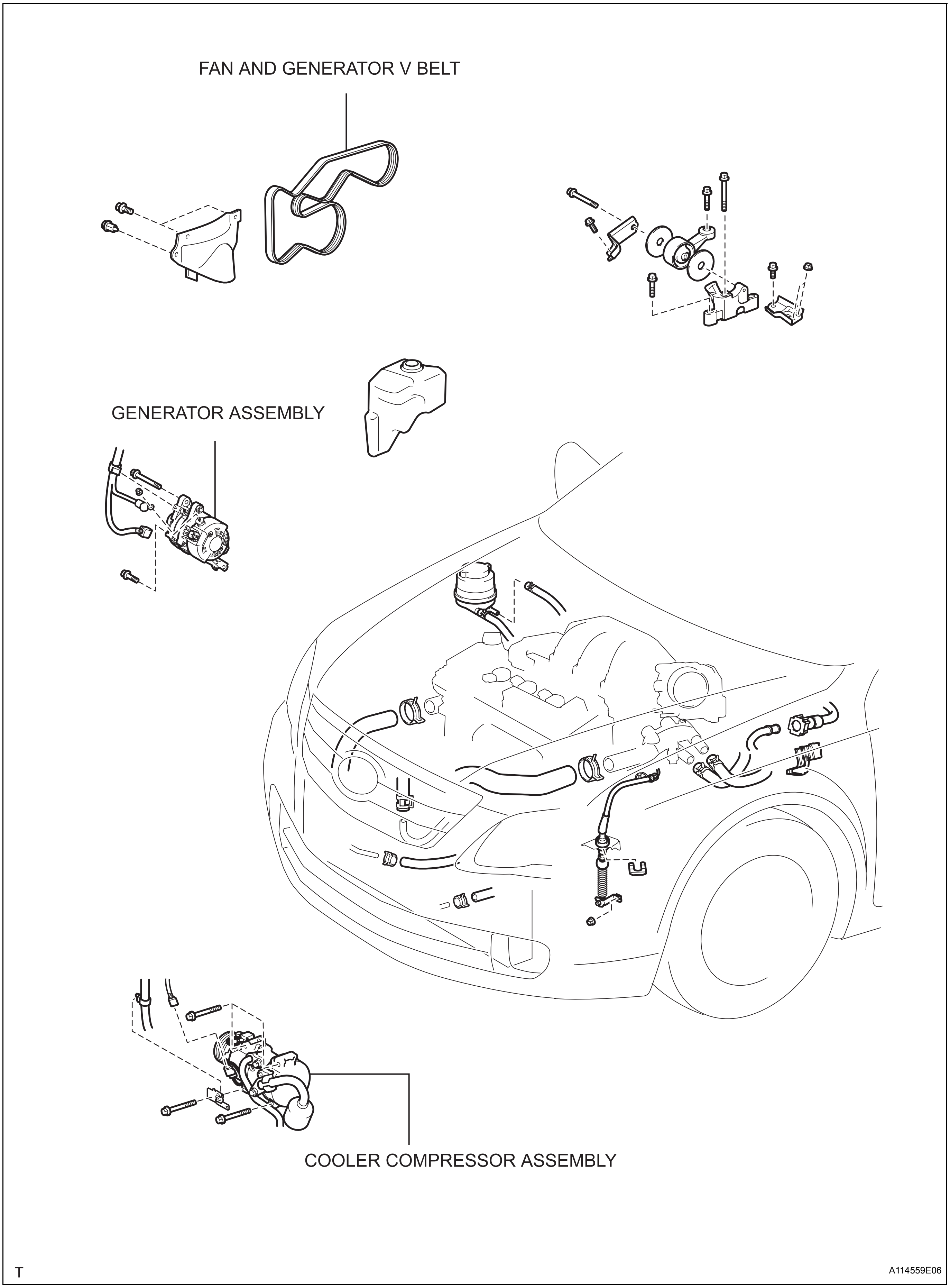
Condition	Result
Battery positive voltage is applied	Valve moves in left arrow direction shown in illustration
Battery positive voltage is cut off	Valve moves in right arrow direction shown in illustration

If operation is not as specified, replace the valve.

CRANKSHAFT POSITION SENSOR

COMPONENTS

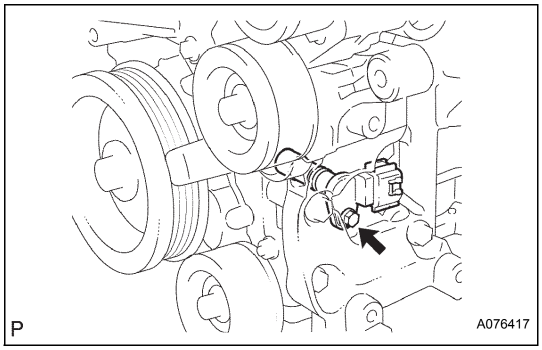


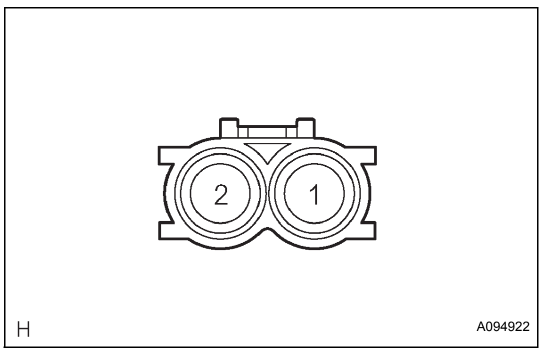

FAN AND GENERATOR V BELT
GENERATOR ASSEMBLY
COOLER COMPRESSOR ASSEMBLY
T
A114559E06

ES

REMOVAL

1. **DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL**
2. **REMOVE FAN AND GENERATOR V BELT (See page EM-28)**
3. **REMOVE GENERATOR ASSEMBLY (See page CH-9)**
4. **DISCONNECT COOLER COMPRESSOR ASSEMBLY (See page EM-32)**
5. **REMOVE CRANKSHAFT POSITION SENSOR**
   (a) Disconnect the crankshaft position sensor connector.
   (b) Remove the bolt and crankshaft position sensor.



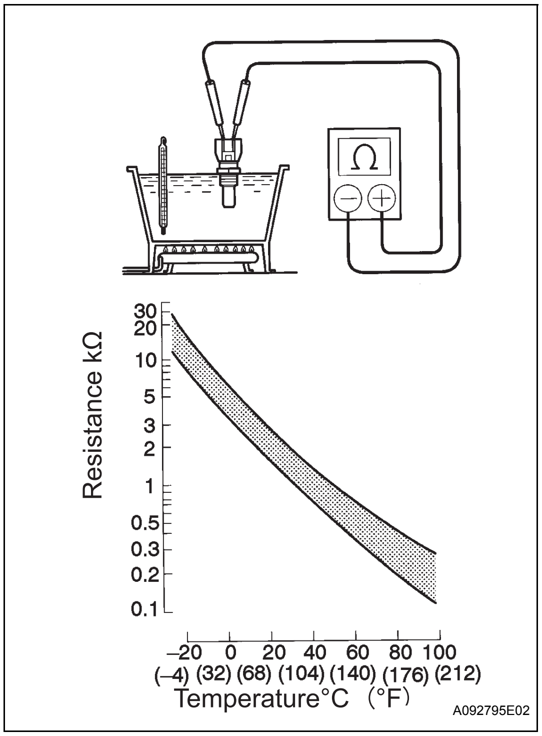


INSPECTION

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

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 (See page EM-41)**
3. **INSTALL GENERATOR ASSEMBLY (See page CH-15)**
4. **INSTALL FAN AND GENERATOR V BELT (See page EM-46)**
5. **CONNECT CABLE TO NEGATIVE BATTERY TERMINAL**
6. **PERFORM SYSTEM INITIALIZE**
   Some systems need initialization when disconnecting the cable from the negative battery terminal.



ENGINE COOLANT TEMPERATURE SENSOR

INSPECTION

1. INSPECT ENGINE COOLANT TEMPERATURE SENSOR

(a) Measure the resistance between the terminals.

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

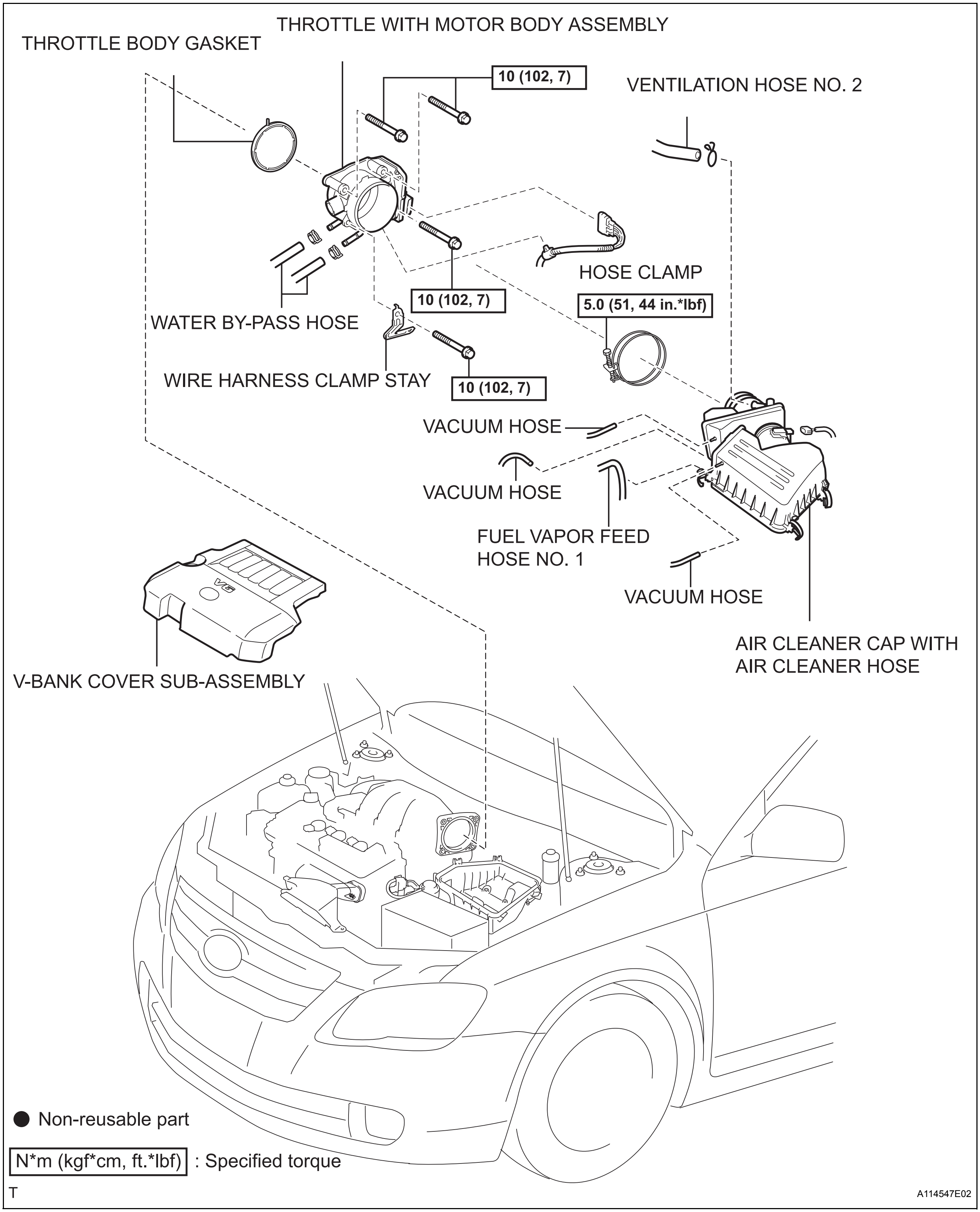
If the result is not as specified, replace the sensor.

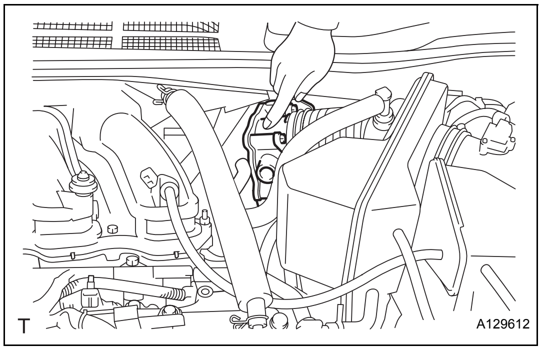
NOTICE:

If checking the ECT sensor in the water, keep the terminals dry. After the check, wipe the sensor.

THROTTLE BODY

COMPONENTS





ON-VEHICLE INSPECTION

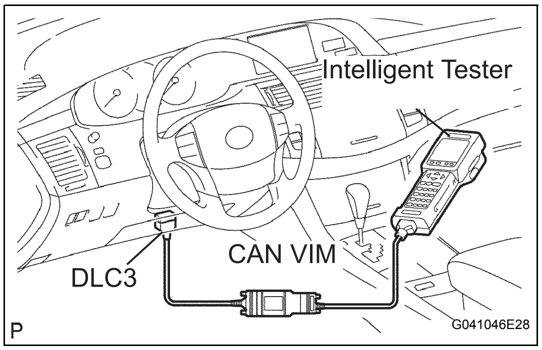
1. INSPECTION THROTTLE BODY

(a) Inspect the throttle control motor for operating sound.

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

(2) When turning the accelerator pedal position sensor lever, check the running sound 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-434).



(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 does not light up.

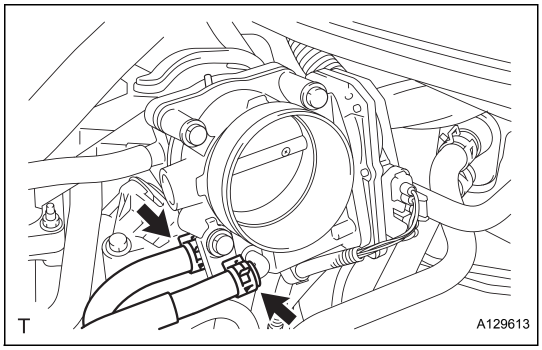
(4) Check that, under the CURRENT DATA, THROTTLE POS (throttle valve opening percentage) is within the standard value below.

Standard throttle valve opening percentage:
60 % or more

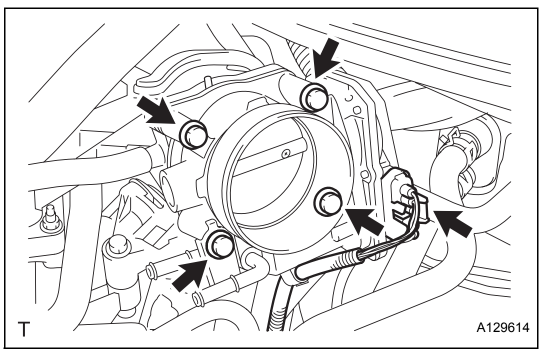
If operation is not as specified, check the throttle position sensor, wiring and ECM (See page ES-434).

REMOVAL

1. **DRAIN ENGINE COOLANT (See page CO-7)**
2. **DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL**
3. **REMOVE V-BANK COVER SUB-ASSEMBLY (See page FU-12)**
4. **REMOVE AIR CLEANER CAP WITH AIR CLEANER HOSE (See page FU-12)**
5. **SEPARATE WATER BY-PASS HOSE**
   (a) Disconnect the 2 water by-pass hoses from the throttle w/ motor body assembly.

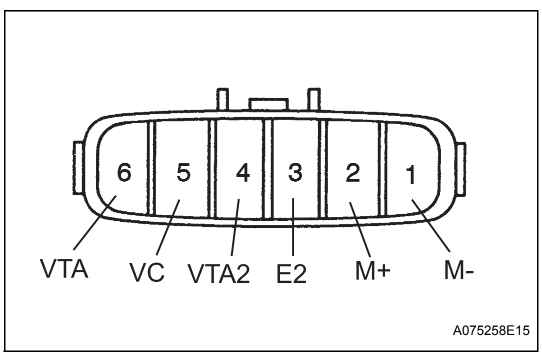


6. **REMOVE THROTTLE WITH MOTOR BODY ASSEMBLY**
   (a) Disconnect the throttle w/ motor body assembly connector.
   (b) Remove the 4 bolts and throttle w/ motor body assembly from the intake air surge tank.
   (c) Remove the throttle body gasket from the intake air surge tank.



INSPECTION

1. **INSPECT THROTTLE WITH MOTOR BODY ASSEMBLY**
   (a) Measure the resistance between the terminals.
   Resistance

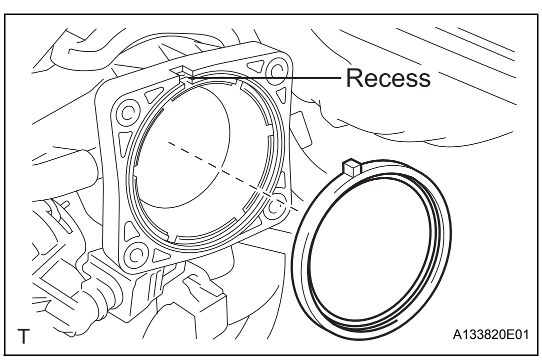


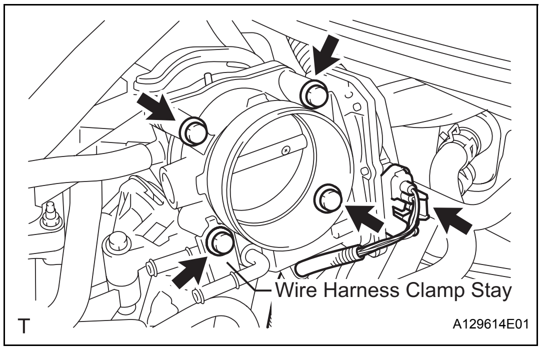
Tester Connection	Condition	Specified Condition
2 (M+) - 1 (M-)	20°C (68°F)	0.3 to 100 Ω
5 (VC) - 3 (E2)	20°C (68°F)	1.2 to 3.2 kΩ

If the result is not as specified, replace the throttle body assembly.

INSTALLATION

1. **INSTALL THROTTLE WITH MOTOR BODY ASSEMBLY**
   (a) Install a new throttle body gasket to the intake air surge tank.

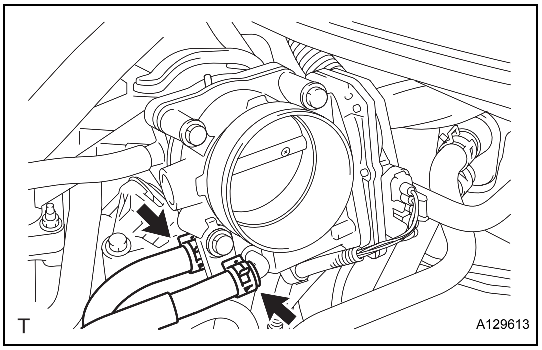




(b) Install the throttle w/ motor body assembly and wire harness clamp stay to the intake air surge tank with the 4 bolts.

Torque: 10 N*m (102 kgf*cm, 7 ft.*lbf)

(c) Connect the throttle w/ motor body assembly connector.



2. CONNECT WATER BY-PASS HOSE

(a) Connect the 2 water by-pass hoses to the throttle w/ motor body assembly.

3. INSTALL AIR CLEANER CAP WITH AIR CLEANER HOSE (See page FU-18)

4. CONNECT CABLE TO NEGATIVE BATTERY TERMINAL

5. ADD ENGINE COOLANT (See page CO-7)

6. CHECK FOR ENGINE COOLANT LEAKS (See page CO-8)

7. INSTALL V-BANK COVER SUB-ASSEMBLY (See page FU-19)

8. PERFORM SYSTEM INITIALIZE

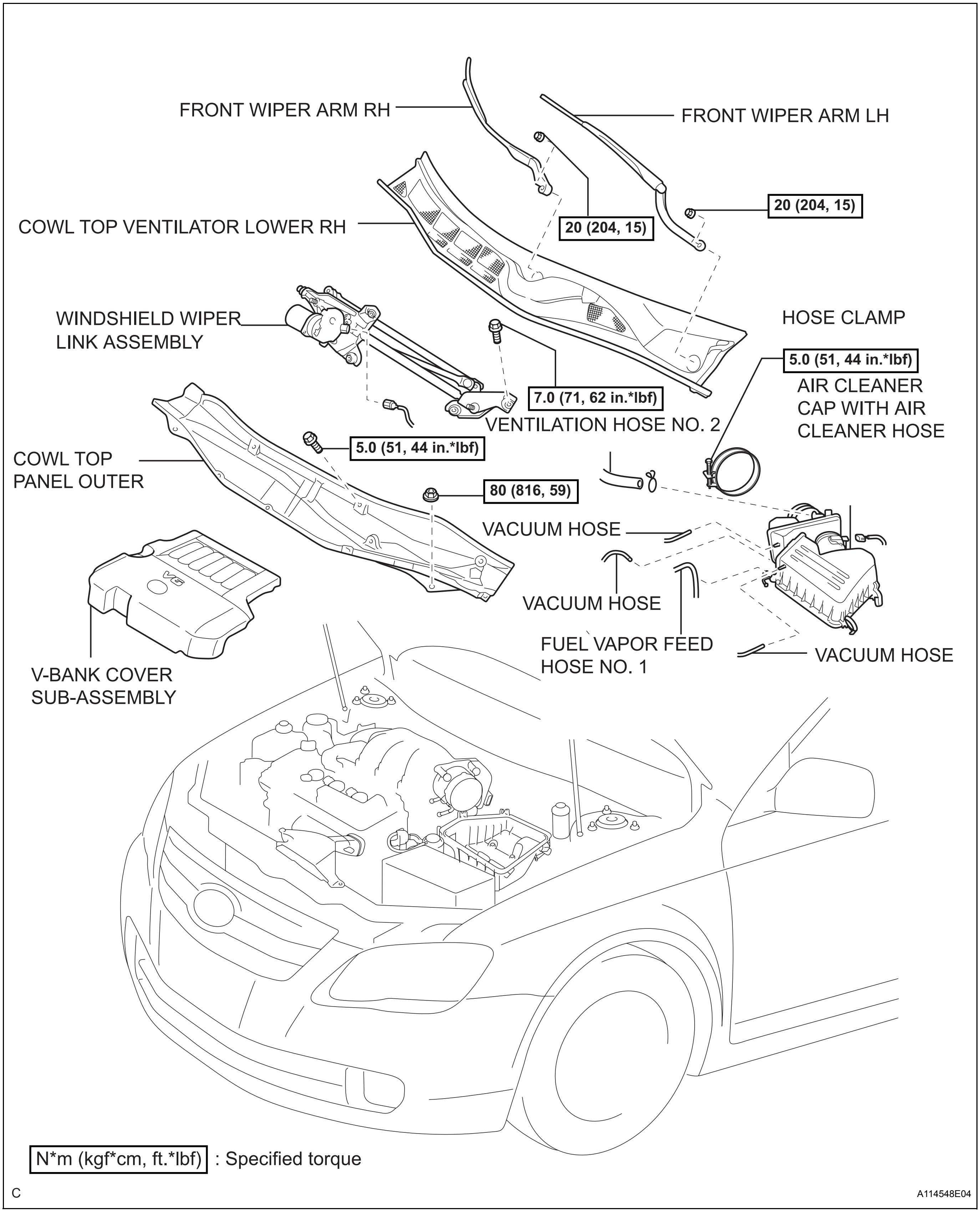
Some systems need initialization when disconnecting the battery terminal.

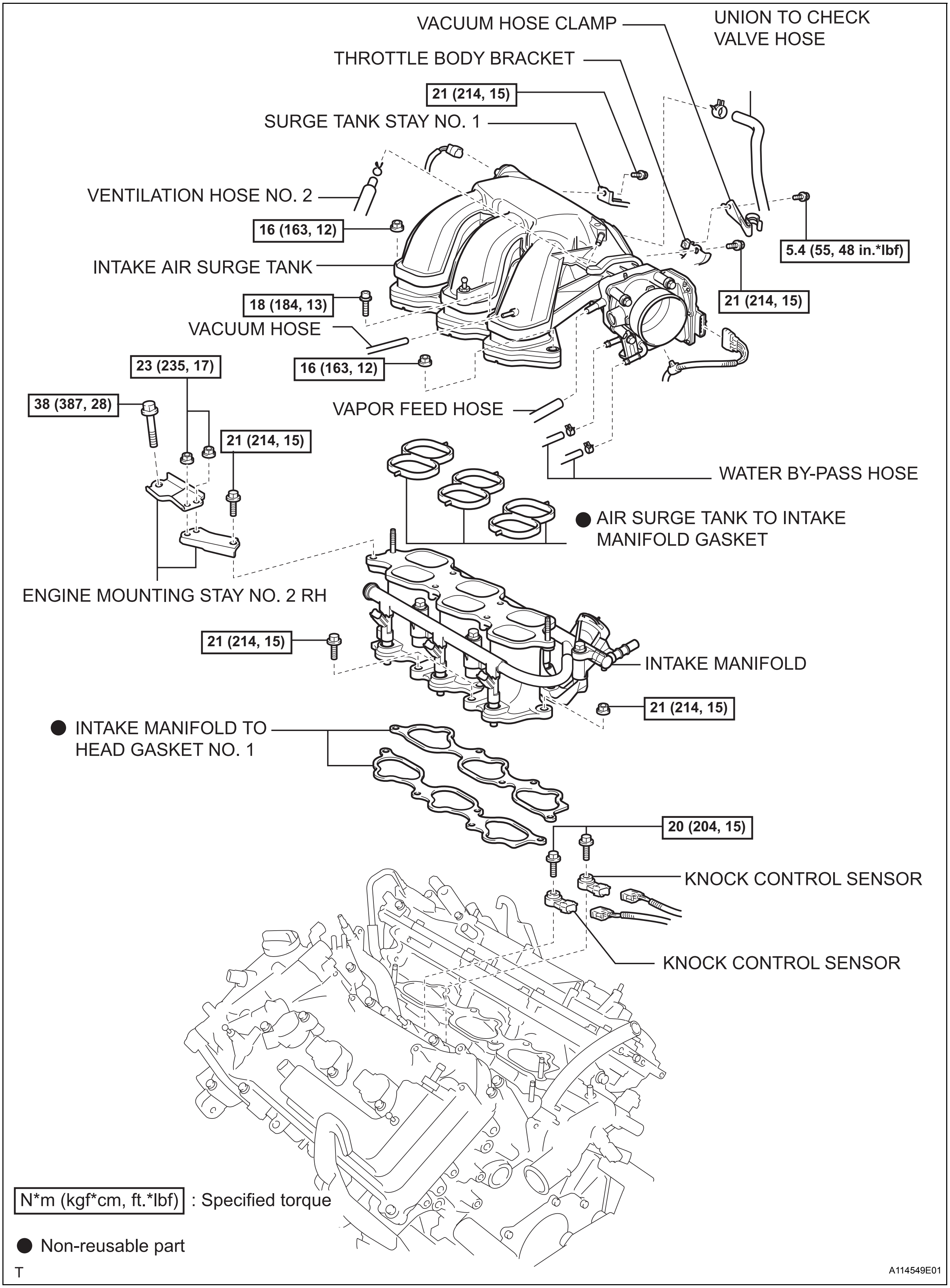
9. CHECK FUNCTION OF THROTTLE BODY (See page ES-433)

ES

KNOCK SENSOR

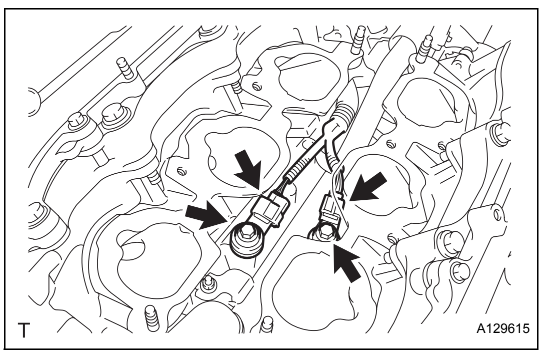
COMPONENTS




VACUUM HOSE CLAMP
UNION TO CHECK VALVE HOSE
THROTTLE BODY BRACKET
21 (214, 15)
SURGE TANK STAY NO. 1
VENTILATION HOSE NO. 2
16 (163, 12)
INTAKE AIR SURGE TANK
5.4 (55, 48 in.*lbf)
18 (184, 13)
21 (214, 15)
VACUUM HOSE
16 (163, 12)
23 (235, 17)
38 (387, 28)
VAPOR FEED HOSE
21 (214, 15)
WATER BY-PASS HOSE
AIR SURGE TANK TO INTAKE MANIFOLD GASKET
ENGINE MOUNTING STAY NO. 2 RH
21 (214, 15)
INTAKE MANIFOLD
21 (214, 15)
INTAKE MANIFOLD TO HEAD GASKET NO. 1
20 (204, 15)
KNOCK CONTROL SENSOR
KNOCK CONTROL SENSOR
N*m (kgf*cm, ft.*lbf) : Specified torque
Non-reusable part
T
A114549E01

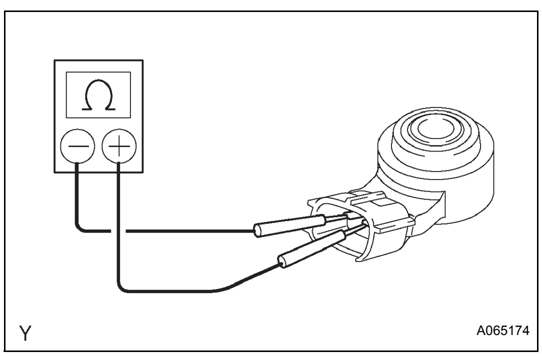
REMOVAL

1. **PREVENT GASOLINE FROM SPILLING OUT**
2. **DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL**
3. **DRAIN ENGINE COOLANT (See page CO-7)**
4. **REMOVE WINDSHIELD WIPER MOTOR & LINK ASSEMBLY (See page WW-38)**
5. **REMOVE COWL TOP PANEL OUTER (See page BR-20)**
6. **REMOVE V-BANK COVER SUB-ASSEMBLY (See page FU-12)**
7. **REMOVE AIR CLEANER CAP WITH AIR CLEANER HOSE (See page FU-12)**
8. **REMOVE INTAKE AIR SURGE TANK (See page FU-12)**
9. **REMOVE INTAKE MANIFOLD**
10. **REMOVE KNOCK CONTROL SENSOR**



(a) Disconnect the 2 knock control sensor connectors.
(b) Remove the 2 bolts and 2 knock control sensors.

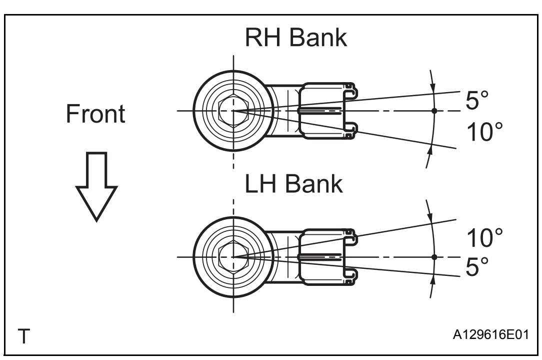
INSPECTION



1. **INSPECT KNOCK CONTROL SENSOR**

(a) Using an ohmmeter, measure the resistance between the terminals.
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**
3. **INSTALL INTAKE AIR SURGE TANK**
4. **INSTALL AIR CLEANER CAP WITH AIR CLEANER HOSE**

5. **CONNECT CABLE TO NEGATIVE BATTERY TERMINAL**
6. **ADD ENGINE COOLANT (See page CO-7)**
7. **CHECK FOR ENGINE COOLANT LEAKS (See page CO-8)**
8. **INSPECT FOR FUEL LEAKS (See page FU-7)**
9. **INSTALL V-BANK COVER SUB-ASSEMBLY (See page FU-19)**
10. **INSTALL COWL TOP PANEL OUTER (See page BR-23)**
11. **INSTALL WINDSHIELD WIPER MOTOR & LINK ASSEMBLY (See page WW-40)**
12. **PERFORM SYSTEM INITIALIZE**
    Some systems need initialization when disconnecting the battery terminal.
13. **CHECK FUNCTION OF THROTTLE BODY (See page ES-433)**

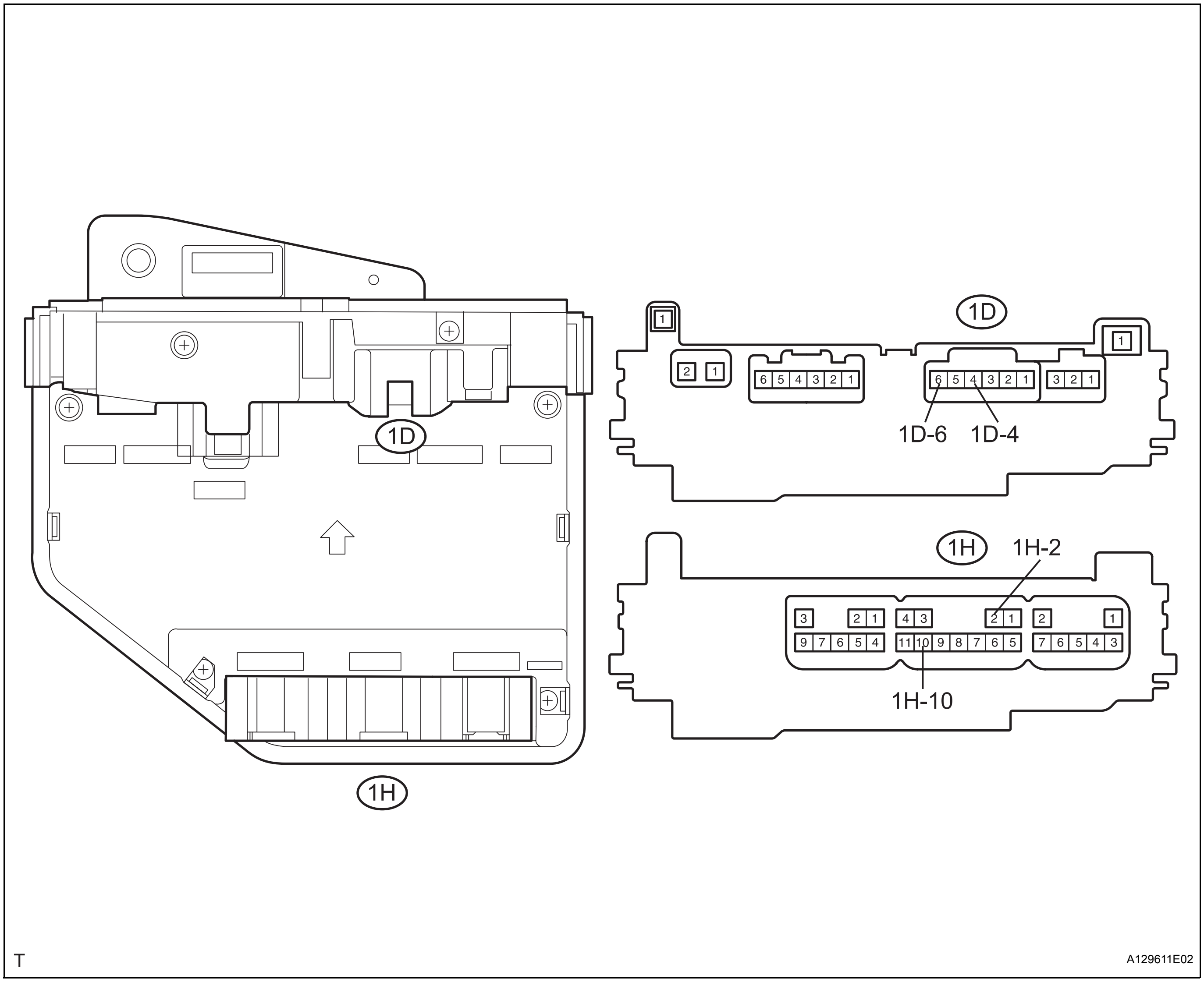
EFI RELAY

INSPECTION

1. INSPECT EFI RELAY

(a) Inspect EFI relay

(1) Using an ohmmeter, measure the resistance between the terminals.



Resistance

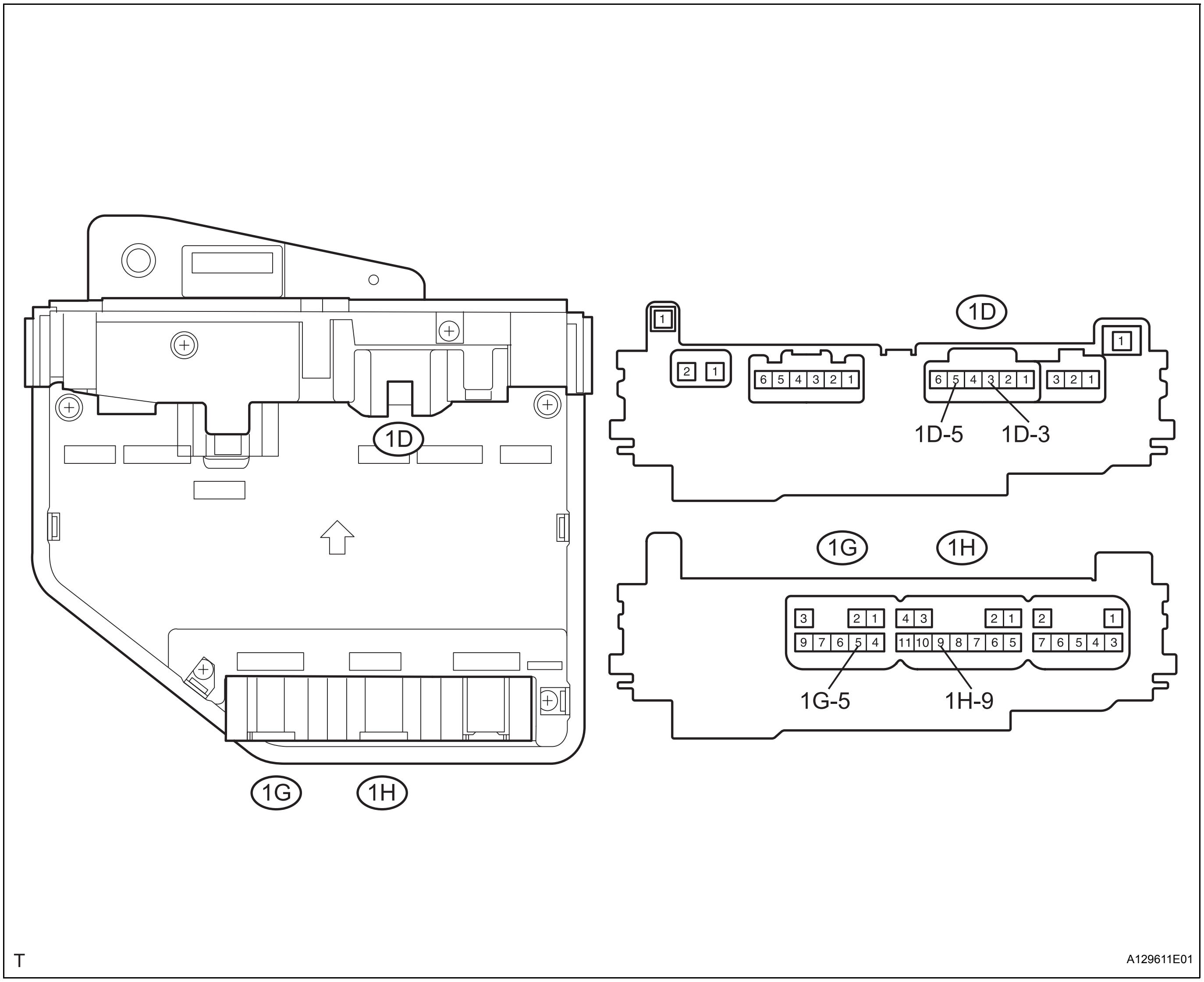
Tester Connection	Specified Condition
1D-4 - 1D-6	10 kΩ or higher
1D-4 - 1D-6	Below 1 Ω (Apply battery voltage to terminals 1H-10 and 1H-2)

If the result is not as specified, replace the engine room junction block assembly.

CIRCUIT OPENING RELAY

INSPECTION

1. **INSPECT CIRCUIT OPENING RELAY**
   (a) Inspect circuit opening relay
      (1) Using an ohmmeter, measure the resistance between the terminals.



Resistance

Tester Connection	Specified Condition
1D-5 - 1D-3	10 kΩ or higher
1D-5 - 1D-3	Below 1 Ω (Apply battery voltage to terminals 1G-5 and 1H-9)

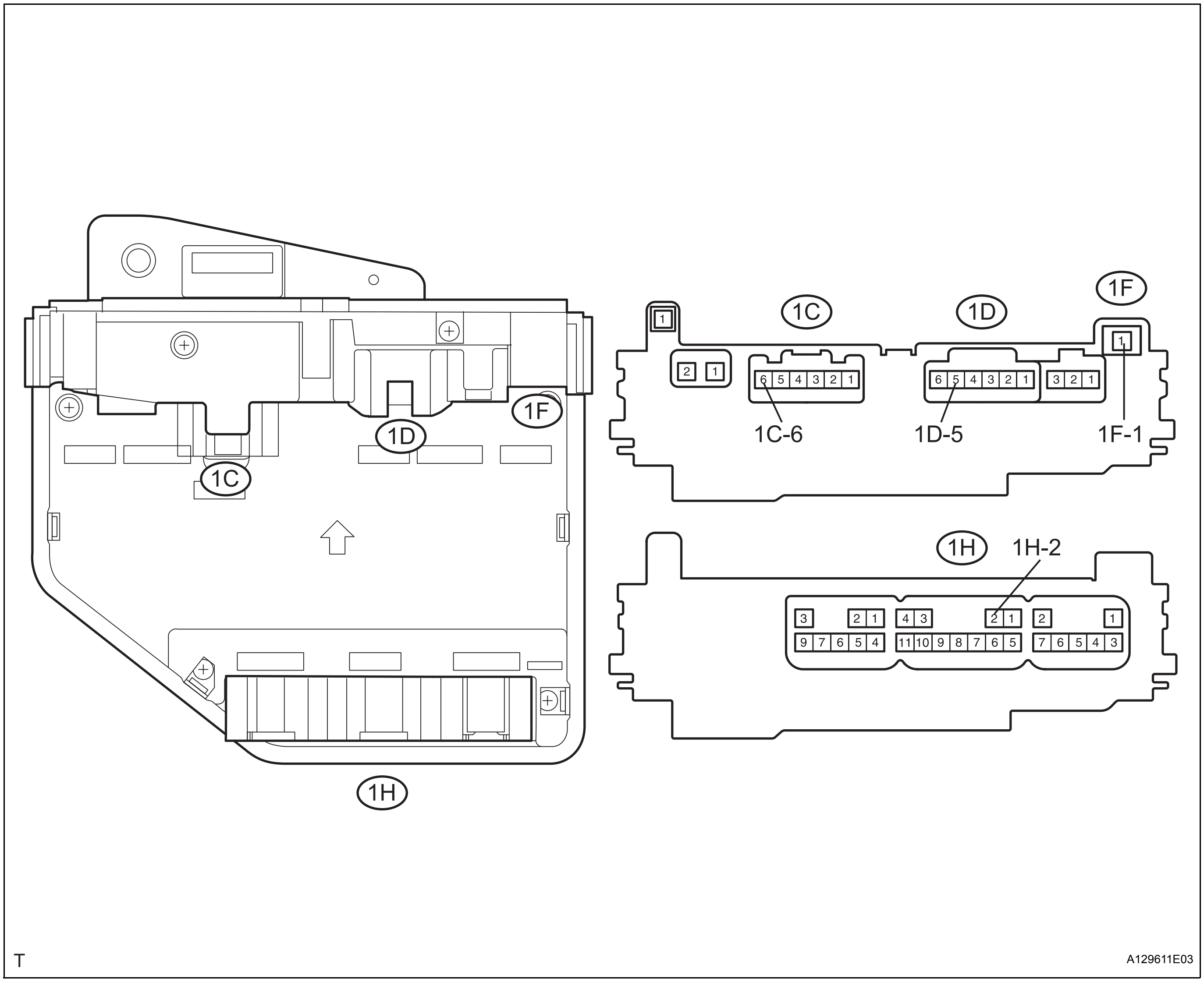
If the result is not as specified, replace the engine room junction block assembly.

ES

AIR FUEL RATIO SENSOR RELAY

INSPECTION

1. **INSPECT AIR FUEL RATIO SENSOR RELAY**
   (a) Inspect A/F relay
      (1) Using an ohmmeter, measure the resistance between the terminals.



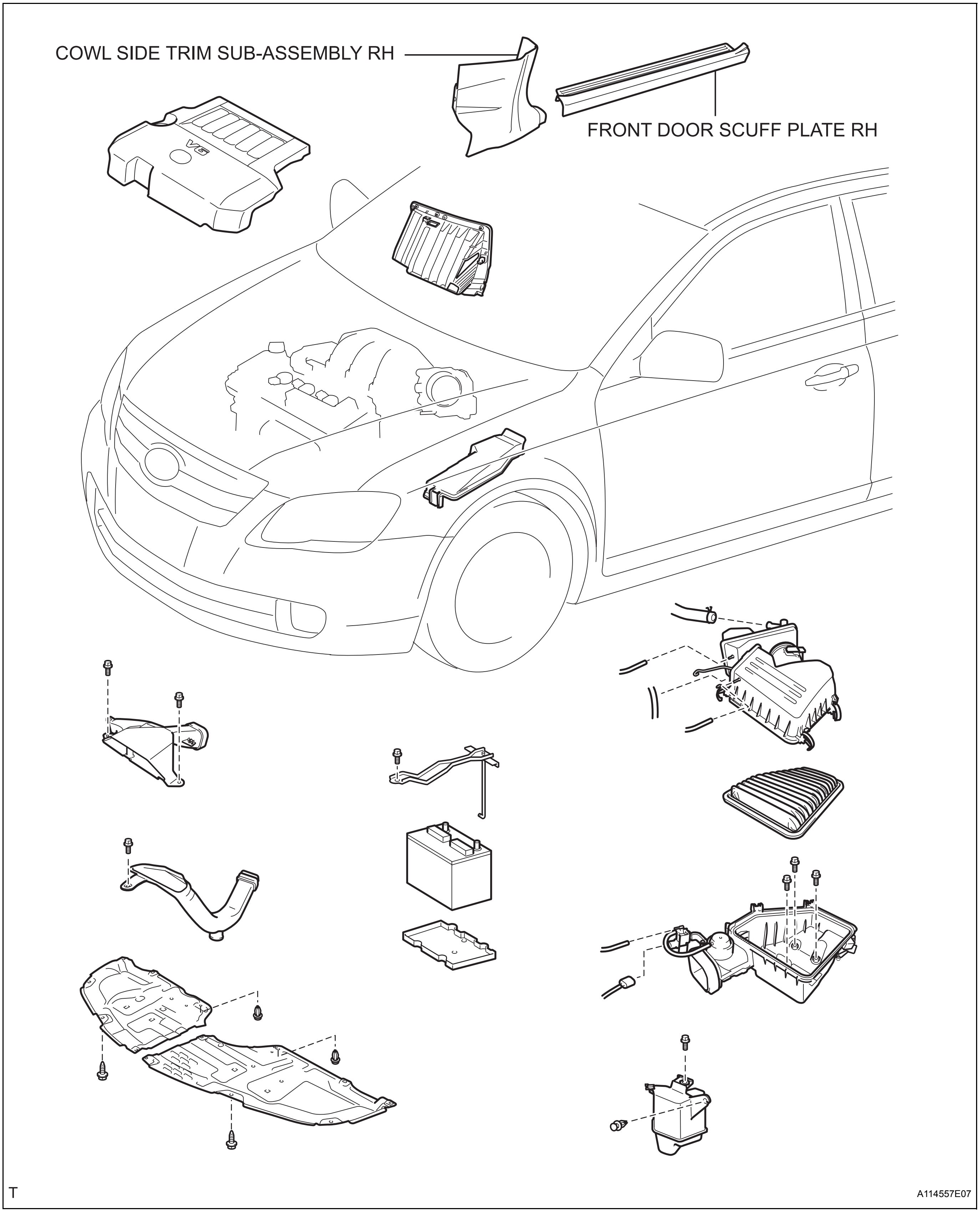
Resistance

Tester Connection	Specified Condition
1F-1 - 1C-6	10 kΩ or higher
1F-1 - 1C-6	Below 1 Ω (Apply battery voltage to terminals 1D-5 and 1H-2)

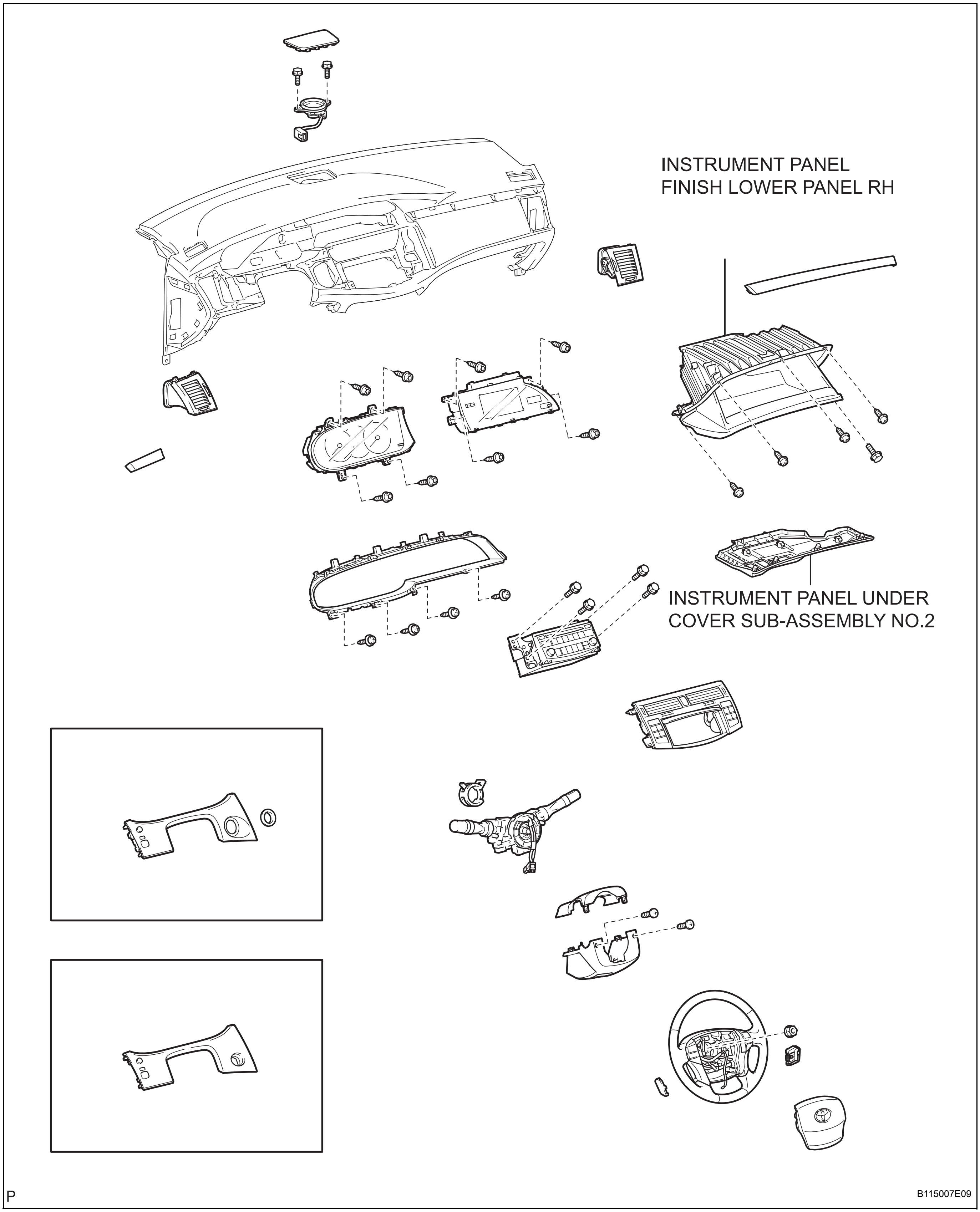
If the result is not as specified, replace the engine room junction block assembly.

ECM

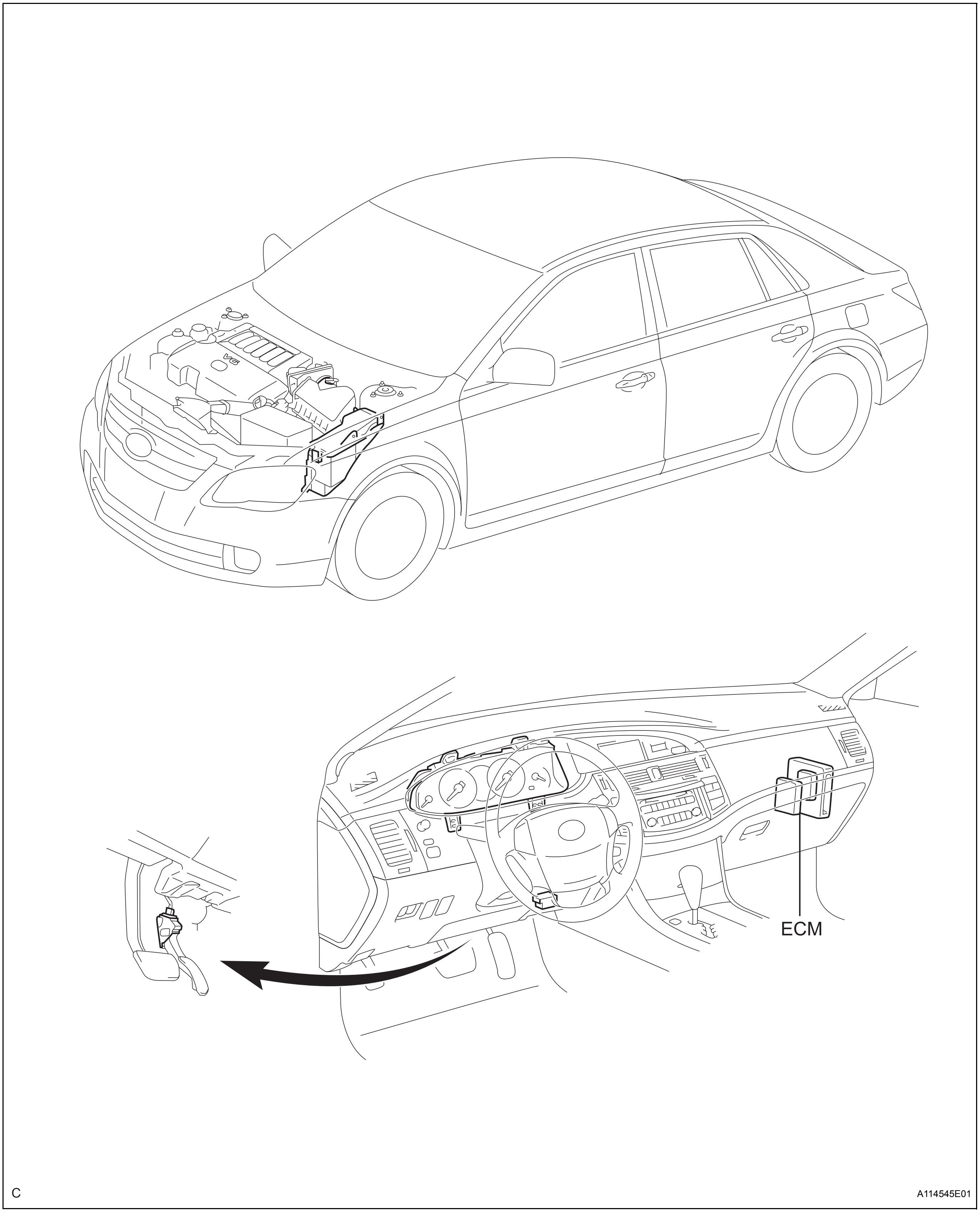
COMPONENTS



ES


INSTRUMENT PANEL
FINISH LOWER PANEL RH
INSTRUMENT PANEL UNDER
COVER SUB-ASSEMBLY NO.2
P
B115007E09

ES



REMOVAL

1. **DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL**

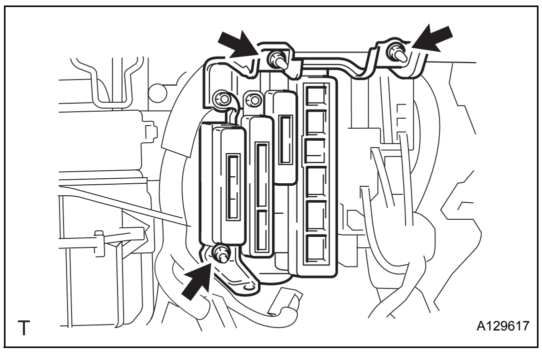
2. **REMOVE FRONT DOOR SCUFF PLATE RH (See page IR-12)**

3. **REMOVE COWL SIDE TRIM SUB-ASSEMBLY RH (See page IR-12)**

4. **REMOVE INSTRUMENT PANEL UNDER COVER SUB-ASSEMBLY NO.2 (See page IP-11)**

5. **REMOVE INSTRUMENT PANEL FINISH LOWER PANEL RH (See page IP-11)**

6. **REMOVE ECM**



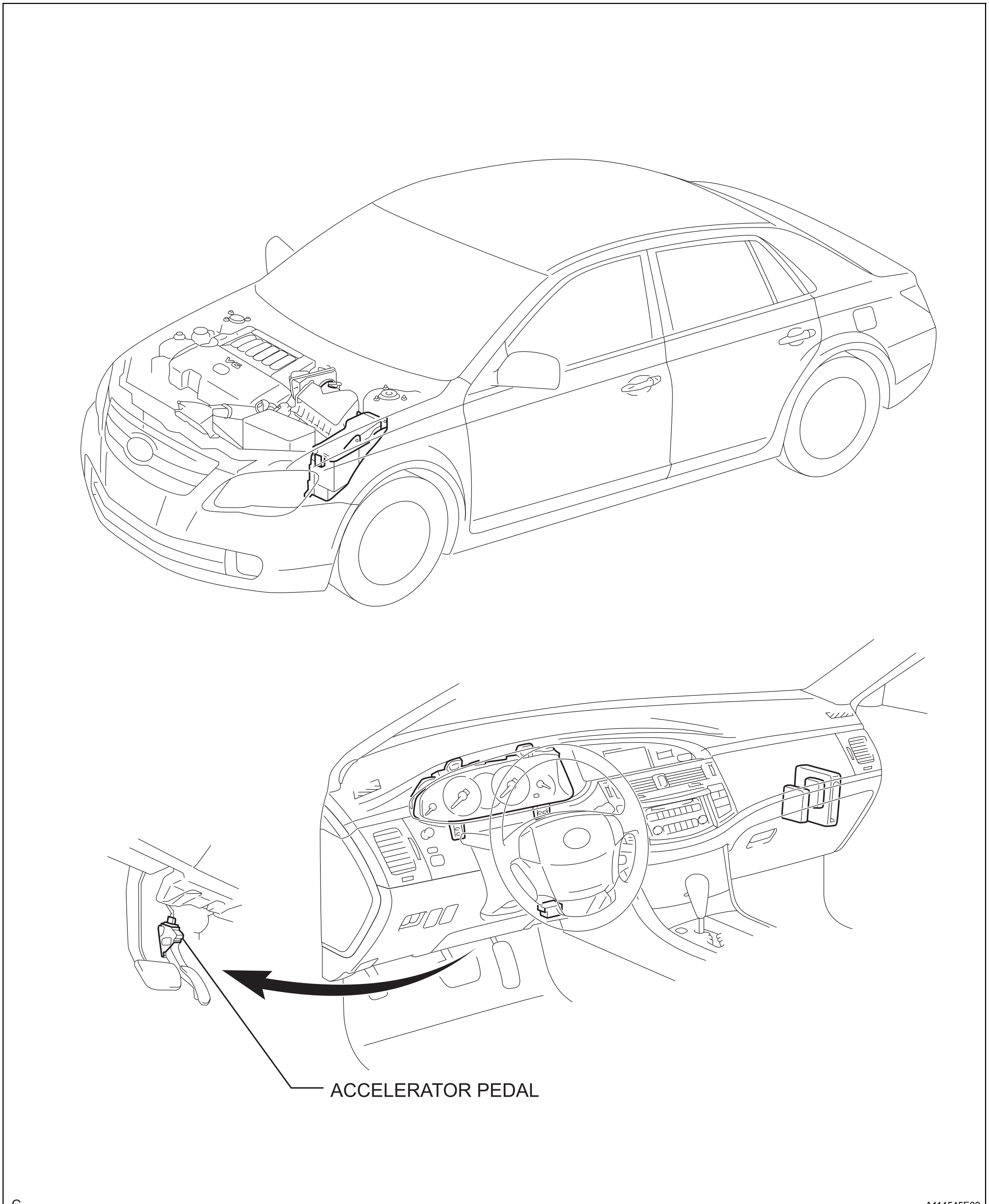
(a) Disconnect the 5 connectors from the ECM.
(b) Remove the 2 nuts, bolt and ECM.
(c) Remove the 2 screws to separate the ECM bracket from the ECM.
(d) Remove the 2 screws to separate the ECM bracket No. 2 from the ECM.

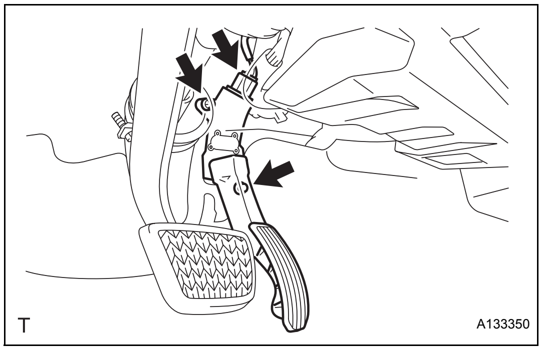
INSTALLATION

1. **INSTALL ECM**
   (a) Install the ECM bracket No. 2 to the ECM with the 2 screws.
   (b) Install the ECM bracket to the ECM with the 2 screws.
   (c) Install the ECM with the 2 nuts and bolt.
   Torque: 5.5 N*m (56 kgf*cm, 49 in.*lbf)
   (d) Connect the 5 connectors to the ECM.
2. **CONNECT CABLE TO NEGATIVE BATTERY TERMINAL**
3. **INSTALL GLOVE COMPARTMENT DOOR ASSEMBLY**
4. **INSTALL INSTRUMENT PANEL UNDER COVER SUB-ASSEMBLY NO.2**
5. **INSTALL COWL SIDE TRIM SUB-ASSEMBLY RH**
6. **INSTALL FRONT DOOR SCUFF PLATE RH**
7. **PERFORM SYSTEM INITIALIZE**
   Some systems need initialization when disconnecting the battery terminal.

ACCELERATOR PEDAL

COMPONENTS





REMOVAL

1. **REMOVE ACCELERATOR PEDAL**
   (a) Disconnect the accelerator pedal connector.
   (b) Remove the 2 nuts 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 nuts.

Torque: 5.4 N*m (55 kgf*cm, 48 in.*lbf)

(b) Connect the accelerator pedal connector.