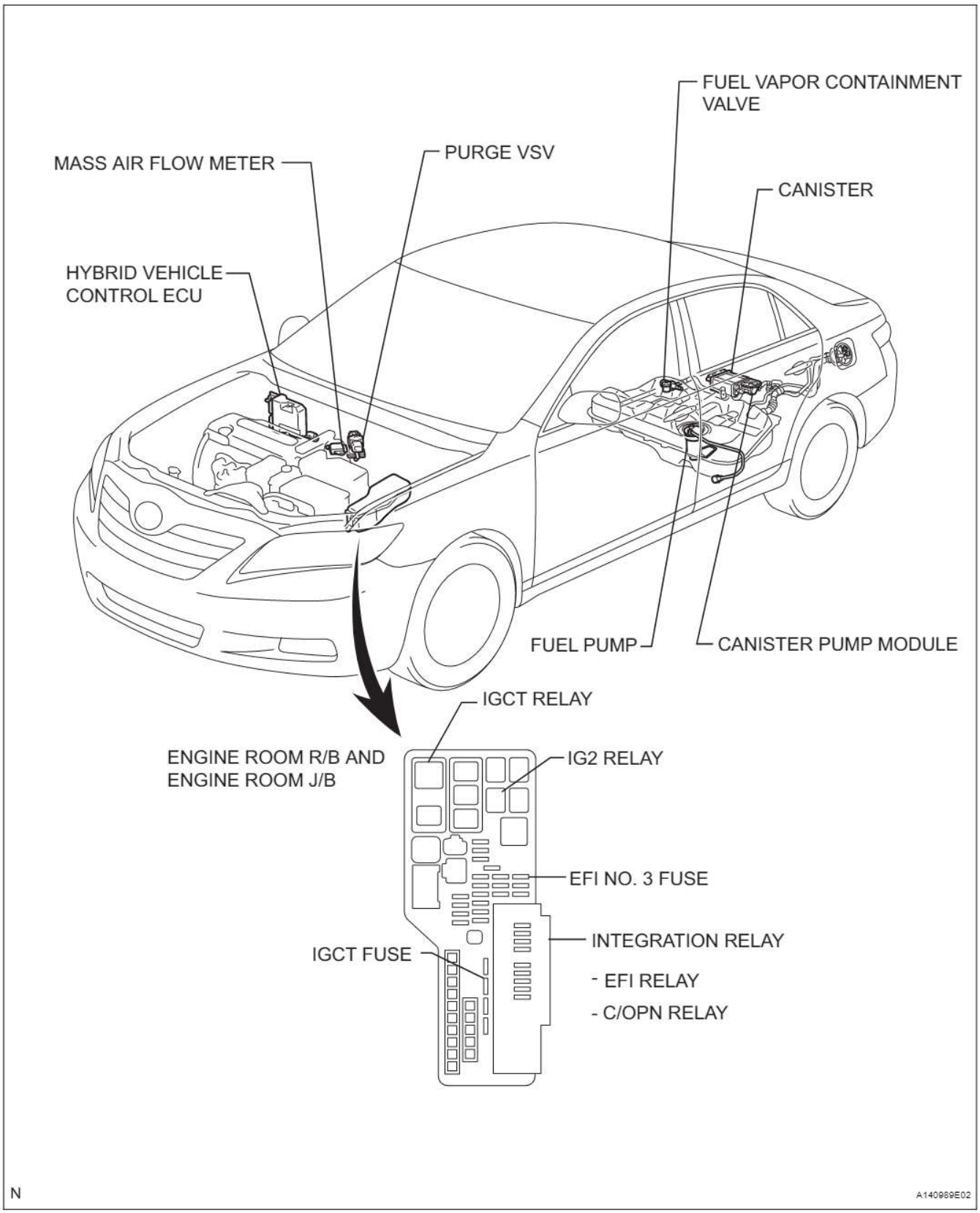
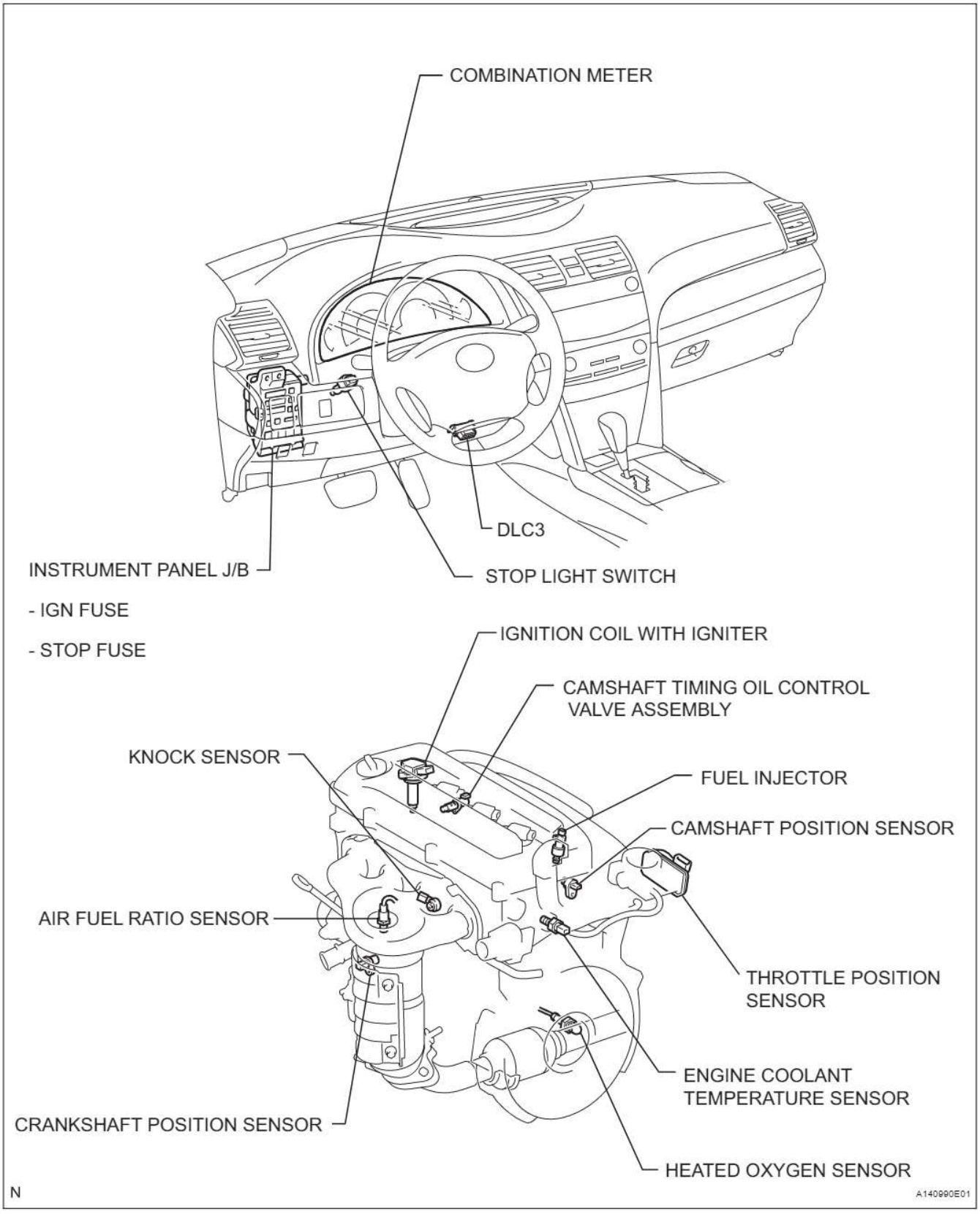
DEFINITION OF TERMS

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

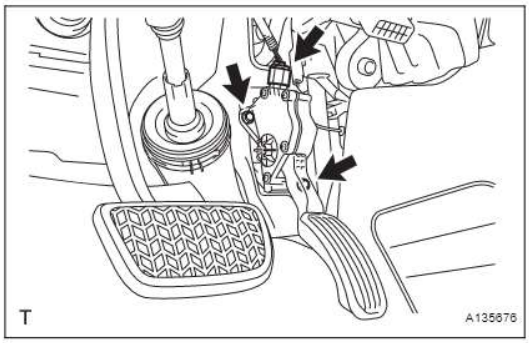
PARTS LOCATION




COMBINATION METER
DLC3
INSTRUMENT PANEL J/B
- IGN FUSE
- STOP FUSE
STOP LIGHT SWITCH
IGNITION COIL WITH IGNITER
CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY
KNOCK SENSOR
FUEL INJECTOR
CAMSHAFT POSITION SENSOR
AIR FUEL RATIO SENSOR
THROTTLE POSITION SENSOR
ENGINE COOLANT TEMPERATURE SENSOR
CRANKSHAFT POSITION SENSOR
HEATED OXYGEN SENSOR
N
A140990E01

INSTALLATION

1. **INSTALL ACCELERATOR PEDAL ROD**
   NOTICE:
   - **Avoid physical shock to the accelerator pedal assembly.**
   - **Do not disassemble the accelerator pedal assembly.**



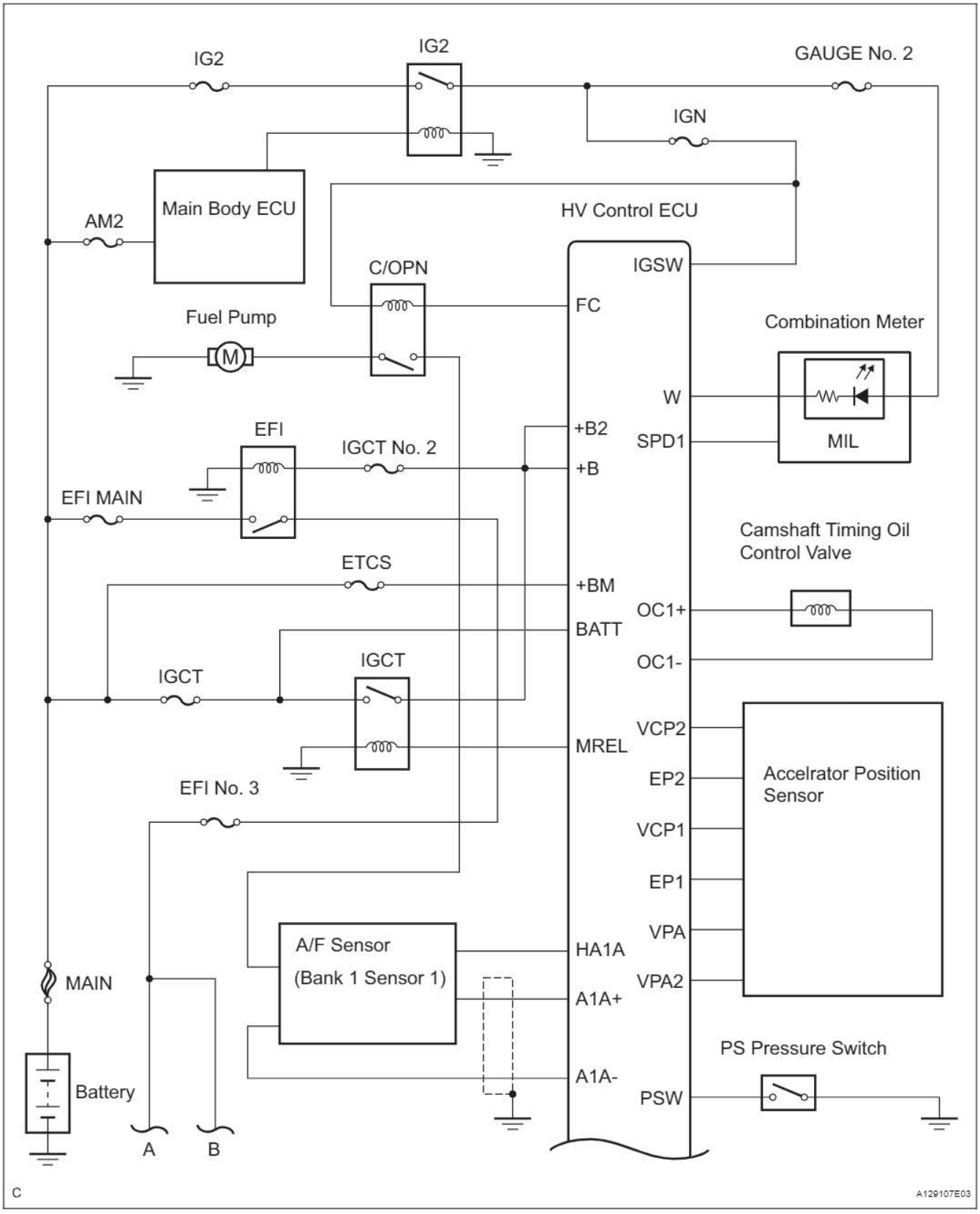
(a) Install the accelerator pedal rod with the 2 bolts.
Torque: 5.4 N*m (55 kgf*cm, 48 in.*lbf)

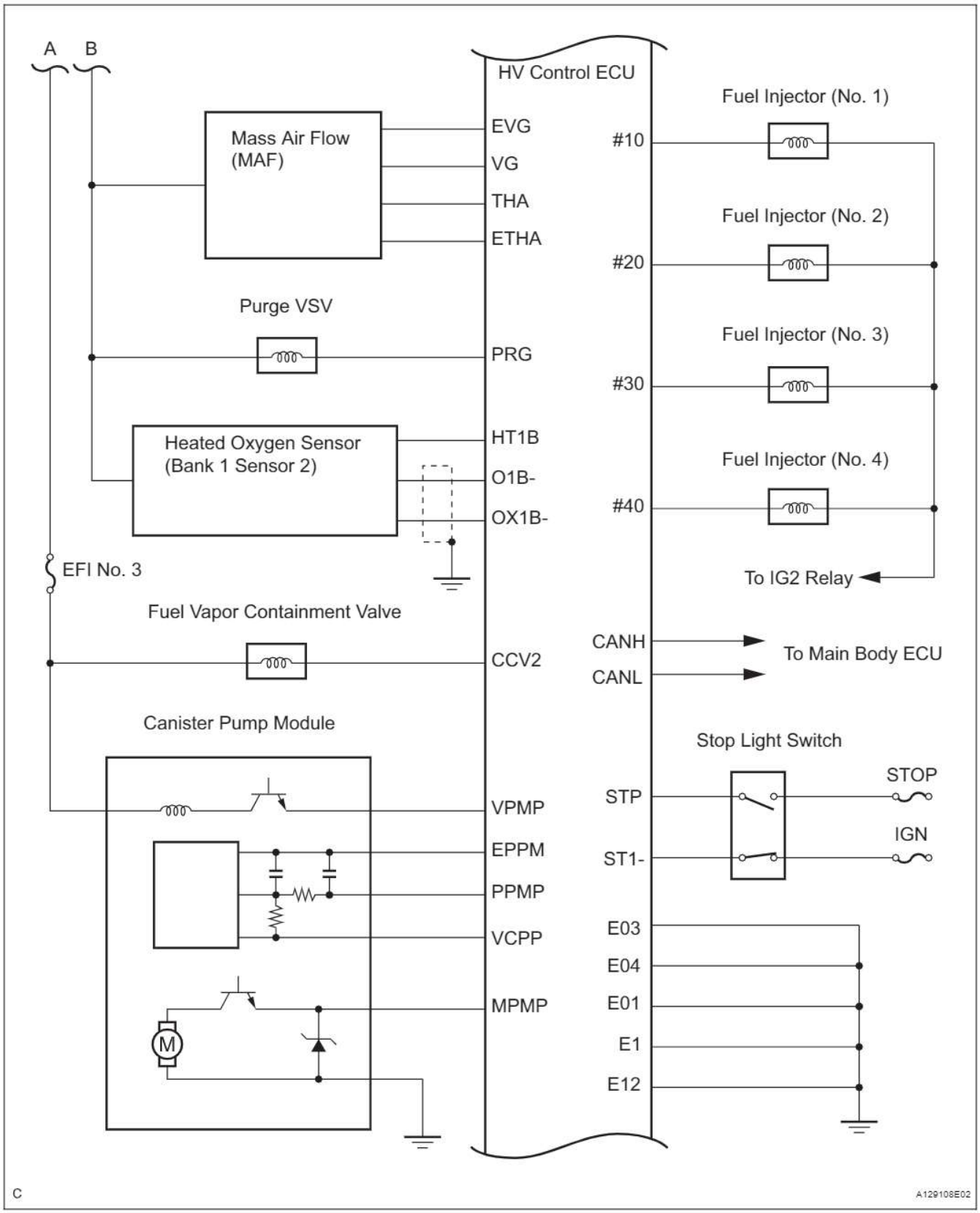
(b) Connect the accelerator pedal position sensor connector.

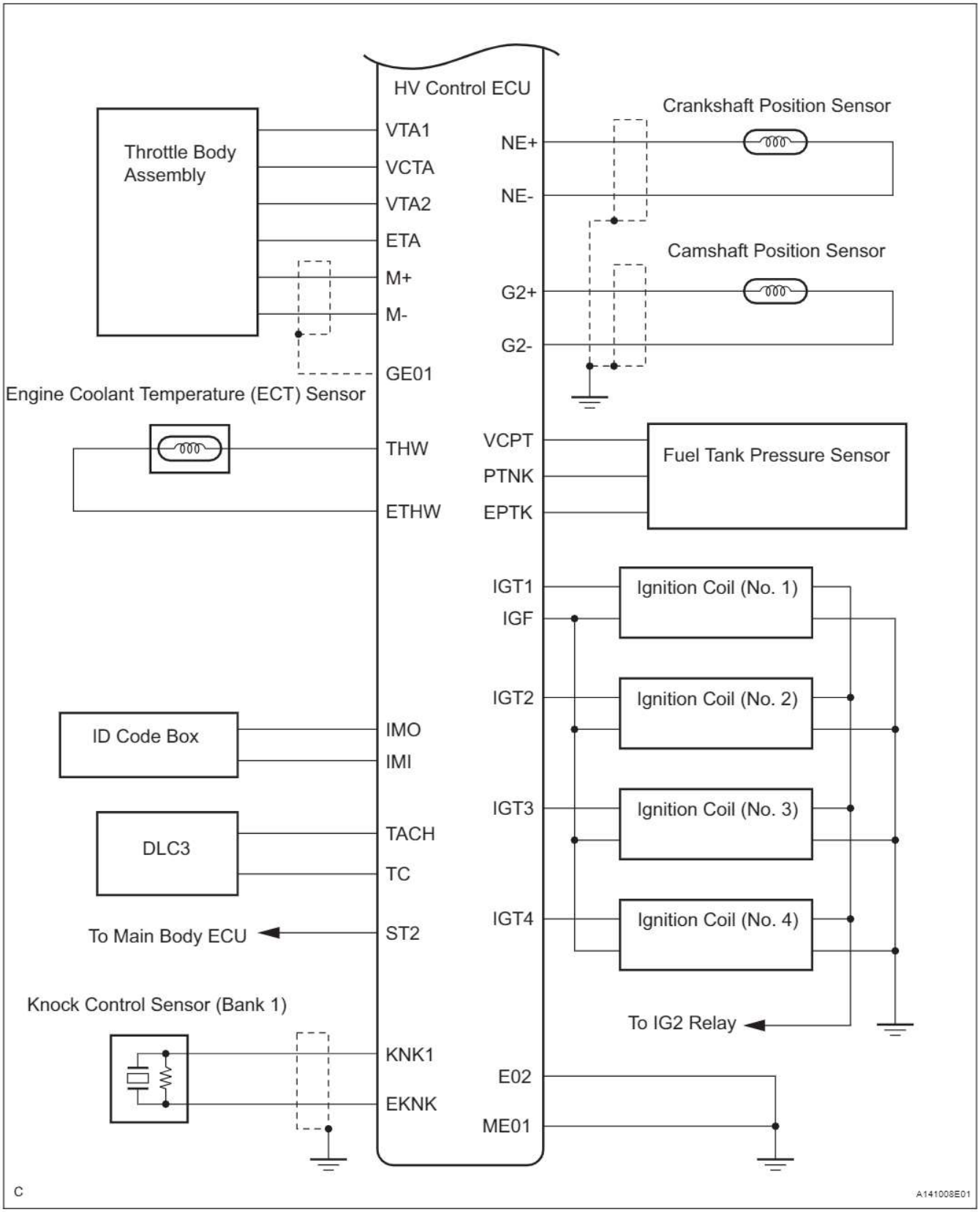
ES

ES

SYSTEM DIAGRAM




A
B
HV Control ECU
Mass Air Flow (MAF)
EVG
VG
THA
ETHA
Purge VSV
PRG
Heated Oxygen Sensor (Bank 1 Sensor 2)
HT1B
O1B-
OX1B-
EFI No. 3
Fuel Vapor Containment Valve
CCV2
Canister Pump Module
VPMP
EPPM
PPMP
VCPP
MPMP
M
Fuel Injector (No. 1)
#10
Fuel Injector (No. 2)
#20
Fuel Injector (No. 3)
#30
Fuel Injector (No. 4)
#40
To IG2 Relay
CANH
CANL
To Main Body ECU
Stop Light Switch
STP
ST1-
STOP
IGN
E03
E04
E01
E1
E12
C
A129108E02


HV Control ECU
Throttle Body Assembly
VTA1
VCTA
VTA2
ETA
M+
M-
GE01
Engine Coolant Temperature (ECT) Sensor
THW
ETHW
Crankshaft Position Sensor
NE+
NE-
Camshaft Position Sensor
G2+
G2-
VCPT
PTNK
EPTK
Fuel Tank Pressure Sensor
IGT1
IGF
Ignition Coil (No. 1)
IGT2
Ignition Coil (No. 2)
ID Code Box
IMO
IMI
IGT3
Ignition Coil (No. 3)
DLC3
TACH
TC
IGT4
Ignition Coil (No. 4)
To Main Body ECU
ST2
To IG2 Relay
Knock Control Sensor (Bank 1)
KNK1
EKNK
E02
ME01
C
A141008E01

HOW TO PROCEED WITH TROUBLESHOOTING

HINT:
The intelligent tester should be used in steps 3, 4, 5, 7 and 10.

1	VEHICLE BROUGHT TO WORKSHOP

NEXT

2	CUSTOMER PROBLEM ANALYSIS

NEXT

3	CONNECT INTELLIGENT TESTER TO THE DLC3

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

NEXT

4	CHECK DTC AND FREEZE FRAME DATA

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

NEXT

5	CLEAR DTC AND FREEZE FRAME DATA

NEXT

6	CONDUCT VISUAL INSPECTION

NEXT

7	SET CHECK MODE DIAGNOSIS

NEXT

8	CONFIRM PROBLEM SYMPTOMS

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

Result

Result	Proceed to
Malfunction does not occur	A
Malfunction occurs	B

B → GO TO STEP 10

A

9	SIMULATE SYMPTOMS

ES

NEXT

10	CHECK FOR DTC

Result

Result	Proceed to
Trouble code	A
No code	B

B → GO TO STEP 12

A

11	REFER TO DTC CHART

NEXT

GO TO STEP 14

12	CONDUCT BASIC INSPECTION

Result

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

B → GO TO STEP 17

A

13	REFER TO PROBLEM SYMPTOMS TABLE

Result

Result	Proceed to
Malfunctioning circuit confirmed	A

Result	Proceed to
Malfunctioning parts confirmed	B

B → GO TO STEP 17

A

14 CHECK ECM POWER SOURCE CIRCUIT

NEXT

15 CONDUCT CIRCUIT INSPECTION

ES

Result

Result	Proceed to
Malfunction not confirmed	A
Malfunction confirmed	B

B → GO TO STEP 18

A

16 CHECK FOR INTERMITTENT PROBLEMS

NEXT

GO TO STEP 18

17 CONDUCT PARTS INSPECTION

NEXT

18 IDENTIFY PROBLEM

NEXT

19 ADJUST AND/OR REPAIR

NEXT

20	CONDUCT CONFIRMATION TEST

NEXT

END

ES

CHECK FOR INTERMITTENT PROBLEMS

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

1. Clear the DTCs (See page ES-31).
2. Switch the ECM from normal mode to check mode using an intelligent tester (See page ES-34).
3. Perform a simulation test (See page IN-67).
4. Check and wiggle the harness(es), connector(s) and terminal(s).

ES

ES

BASIC INSPECTION

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

1 CHECK BATTERY VOLTAGE

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

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

NG → **CHARGE OR REPLACE BATTERY**

OK

2 CHECK WHETHER ENGINE CRANKS

NG → **PROCEED TO PROBLEM SYMPTOMS TABLE**

OK

3 CHECK WHETHER ENGINE STARTS

NG → **GO TO STEP 6**

OK

4 CHECK AIR FILTER

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

NG → **REPLACE AIR FILTER**

OK

5 CHECK IDLING SPEED

NG → **PROCEED TO PROBLEM SYMPTOMS TABLE**

OK

6	CHECK FUEL PRESSURE

NG → PROCEED TO PAGE AND CONTINUE TO TROUBLESHOOT

OK

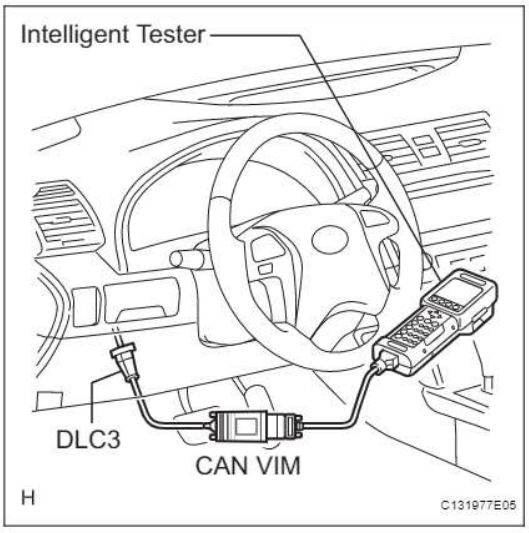
7	CHECK FOR SPARKS

NG → PROCEED TO PAGE AND CONTINUE TO TROUBLESHOOT

OK

PROCEED TO PROBLEM SYMPTOMS TABLE

INITIALIZATION



1. PERFORM INITIALIZATION

(a) Apply the parking brake and chock the vehicle.

(b) Connect the intelligent tester to the DLC3.

(c) Put the engine in the inspection mode (See page ES-35).

(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.

(e) Warm up the engine with the A/C switch off until the coolant temperature becomes 83°C (181°F) or more.

(f) Select the following menu items: DIAGNOSIS / OBD/MOBD /HV ECU / DATA LIST / SOC.

(g) Move the shift lever to the N position, set the A/C switch to MAX cool or turn on the front defroster, and leave the vehicle until the SOC value becomes below 40%.
HINT:
If the SOC is substantially below 40%, the auxiliary battery may go dead. Therefore, do not allow the SOC to reach substantially below 40%.

(h) Move the shift lever to the P position and turn the power switch off.

(i) Disconnect the negative terminal from the auxiliary battery and leave it for 1 minute or more.

(j) Reconnect the negative terminal to the auxiliary battery and turn the power switch on (IG).

(k) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.

(l) Check that the engine coolant temperature is 83°C (181°F) or more.
HINT:
If the engine coolant temperature is below 83°C (181°F), start the engine by depressing the accelerator pedal with the shift lever in the P position to increase the coolant temperature.

(m) Select the following menu items: DIAGNOSIS / ENHANCED OBDII / DATA LIST / PRIMARY / CALCLOAD.

(n) Move the shift lever to the D position while depressing the brake pedal with your left foot.

(o) Depress the accelerator pedal with your right foot while firmly depressing the brake pedal with your left foot, and maintain an engine load value of 45% or more (60 to 70% of full acceleration) for approximately 30 seconds.
NOTICE:
Do not perform this step for 40 seconds or more.

(p) Shift the shift lever to the P position. Turn the power switch off and then wait for 5 seconds before putting the vehicle into the READY-on state again.
(q) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / USER DATA / ISC LEARNING.
(r) Check that the air conditioner is off. Lightly depress the accelerator pedal and release it when the engine starts.
(s) Check that "COMPLETE" is displayed on the intelligent tester screen.
HINT:
- If "ISC LEARNING" is not completed within 1 minute, repeat steps (o) through (r).
- The engine will usually stop when "ISC LEARNING" is completed. However, the engine will not stop even when "ISC LEARNING" is completed in such cases when the charge level of the auxiliary battery is decreased.

ES

CHECKING MONITOR STATUS

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

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

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

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

1. PERFORM MONITOR DRIVE PATTERN

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

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester ON.
(d) Clear the DTCs.
(e) Run the vehicle in accordance with the applicable drive pattern described in READINESS MONITOR DRIVE PATTERN (See page ES-17). Do not turn the power switch off.

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

2. ACCESS MONITOR RESULT

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

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

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

HINT:

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

3. CHECK COMPONENT STATUS

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

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

HINT:

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

4. MONITOR RESULT INFORMATION

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

A/F Sensor Bank 1 Sensor 1:

Monitor ID	Test ID	Scaling	Unit	Description
$01	$8E	Multiply by 0.001	V	A/F sensor deterioration level
$01	$91	Multiply by 0.004	mA	A/F sensor current

HO2S Bank 1 Sensor 2:

Monitor ID	Test ID	Scaling	Unit	Description
$02	$07	Multiply by 0.001	V	Minimum sensor voltage
$02	$08	Multiply by 0.001	V	Maximum sensor voltage
$02	$8F	Multiply by 0.0003	g	Maximum oxygen storage capacity

Catalyst-Bank 1:

Monitor ID	Test ID	Scaling	Unit	Description
$21	$A9	Multiply by 0.0003	No dimension	Oxygen storage capacity of catalyst bank 1

EVAP:

Monitor ID	Test ID	Scaling	Unit	Description
$3D	$CB	Multiply by 0.001	kPa	Test value for leak detection pump OFF stuck (P2401)
$3D	$CD	Multiply by 0.001	kPa	Test value for leak detection pump ON stuck (P2402)
$3D	$CE	Multiply by 0.001	kPa	Test value for vent valve OFF stuck (P2420)
$3D	$CF	Multiply by 0.001	kPa	Test value for vent valve ON stuck (P2419)
$3D	$D0	Multiply by 0.001	kPa	Test value for reference orifice low flow (P043E)
$3D	$D1	Multiply by 0.001	kPa	Test value for reference orifice high flow (P043F)
$3D	$D4	Multiply by 0.001	kPa	Test value for purge VSV close stuck (P0441)
$3D	$D5	Multiply by 0.001	kPa	Test value for purge VSV open stuck (P0441)
$3D	$D7	Multiply by 0.001	kPa	Test value for purge flow insufficient (P0441)
$3D	$D8	Multiply by 0.001	kPa	Test value for canister small leak (P1420)
$3D	$D9	Multiply by 0.001	kPa	Test value for canister gross leak (P1421)
$3D	$DA	Multiply by 0.001	kPa	Test value for fuel tank small leak (P1422)
$3D	$DB	Multiply by 0.001	kPa	Test value for fuel tank gross leak (P1423)
$3D	$DC	Multiply by 0.001	kPa	Test value for fuel vapor-containment valve close stuck (P2451)
$3D	$DD	Multiply by 0.001	kPa	Test value for fuel vapor-containment valve open stuck (P2450)

Misfire:

Monitor ID	Test ID	Scaling	Unit	Description
$A1	$0B	Multiply by 1	Time	Exponential Weighted Moving Average (EWMA) misfire for all cylinders: Misfire counts for last 10 driving cycles-Total
$A1	$0C	Multiply by 1	Time	Misfire rate for all cylinders: Misfire counts for last/current driving cycles-Total
$A2	$0B	Multiply by 1	Time	EWMA misfire for cylinder 1: Misfire counts for last 10 driving cycles-Total
$A2	$0C	Multiply by 1	Time	Misfire rate for cylinder 1: Misfire counts for last/current driving cycle-Total
$A3	$0B	Multiply by 1	Time	EWMA misfire for cylinder 2: Misfire counts for last 10 driving cycles-Total
$A3	$0C	Multiply by 1	Time	Misfire rate for cylinder 2: Misfire counts for last/current driving cycle-Total
$A4	$0B	Multiply by 1	Time	EWMA misfire for cylinder 3: Misfire counts for last 10 driving cycles-Total
$A4	$0C	Multiply by 1	Time	Misfire rate for cylinder 3: Misfire counts for last/current driving cycle-Total
$A5	$0B	Multiply by 1	Time	EWMA misfire for cylinder 4: Misfire counts for last 10 driving cycles-Total
$A5	$0C	Multiply by 1	Time	Misfire rate for cylinder 4: Misfire counts for last/current driving cycle-Total
$A6	$0B	Multiply by 1	Time	EWMA misfire for cylinder 5: Misfire counts for last 10 driving cycles-Total
$A6	$0C	Multiply by 1	Time	Misfire rate for cylinder 5: Misfire counts for last/current driving cycle-Total
$A7	$0B	Multiply by 1	Time	EWMA misfire for cylinder 6: Misfire counts for last 10 driving cycles-Total
$A7	$0C	Multiply by 1	Time	Misfire rate for cylinder 6: Misfire counts for last/current driving cycle-Total

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 DTC (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, enter the following menus: 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 state 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 (included in hybrid vehicle control ECU) has lost battery power or blown a fuse.
- DTCs have been cleared.
- The conditions for running the Readiness Monitor have not been met.

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

CAUTION:

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

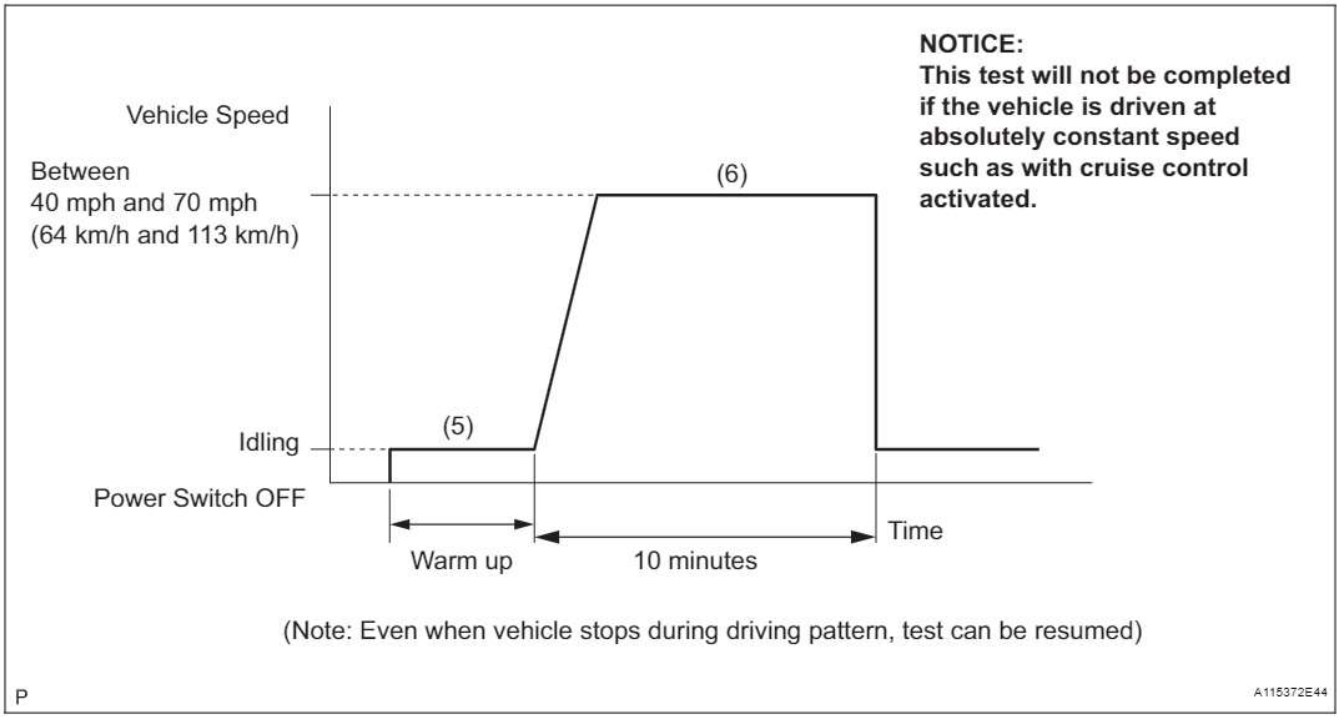
NOTICE:

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

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

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

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



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

(b) Drive Pattern
(1) Connect an intelligent tester to the DLC3.
(2) Turn the power switch on (IG).
(3) Turn the tester on.
(4) Clear the DTCs (if set) (See page ES-31).
(5) Put the engine in inspection mode (See page ES-35), and warm it up.
(6) Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes.

(c) Monitor Status
Check the Readiness Monitor status displayed on the tester.
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 and 95°F).
– The intake air temperature is between 4.4°C and 35°C (40°F and 95°F).
– Vehicle was driven in the city area (or on free-way) for 10 minutes or more.

(b) Monitor Conditions
(1) Turn the power 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.

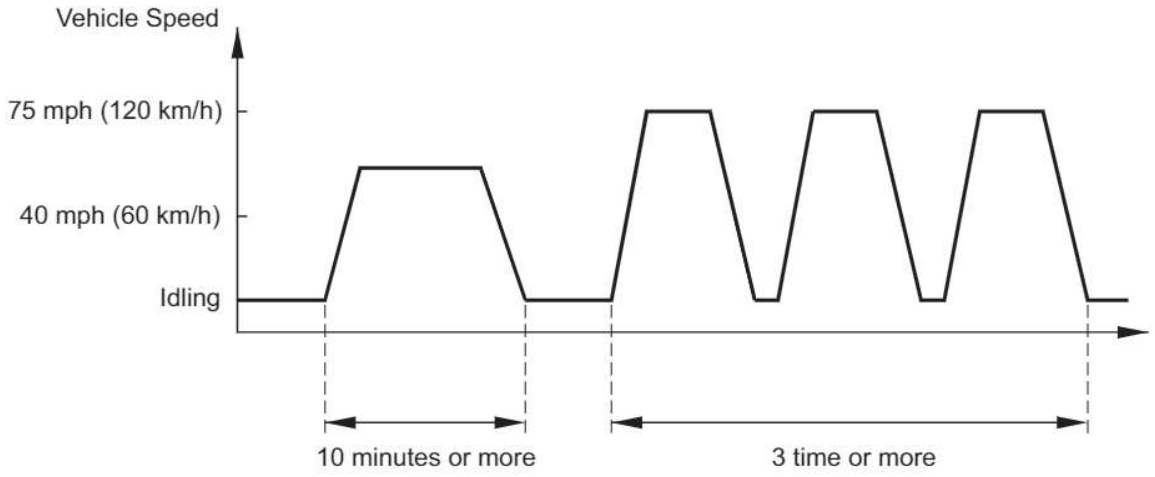
(c) Monitor Status
(1) Connect an intelligent tester to the DLC3.
(2) Turn the power switch on (IG).
(3) Turn the tester on.
(4) Check the Readiness Monitor status displayed on the tester.

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)

Monitor Driving Pattern

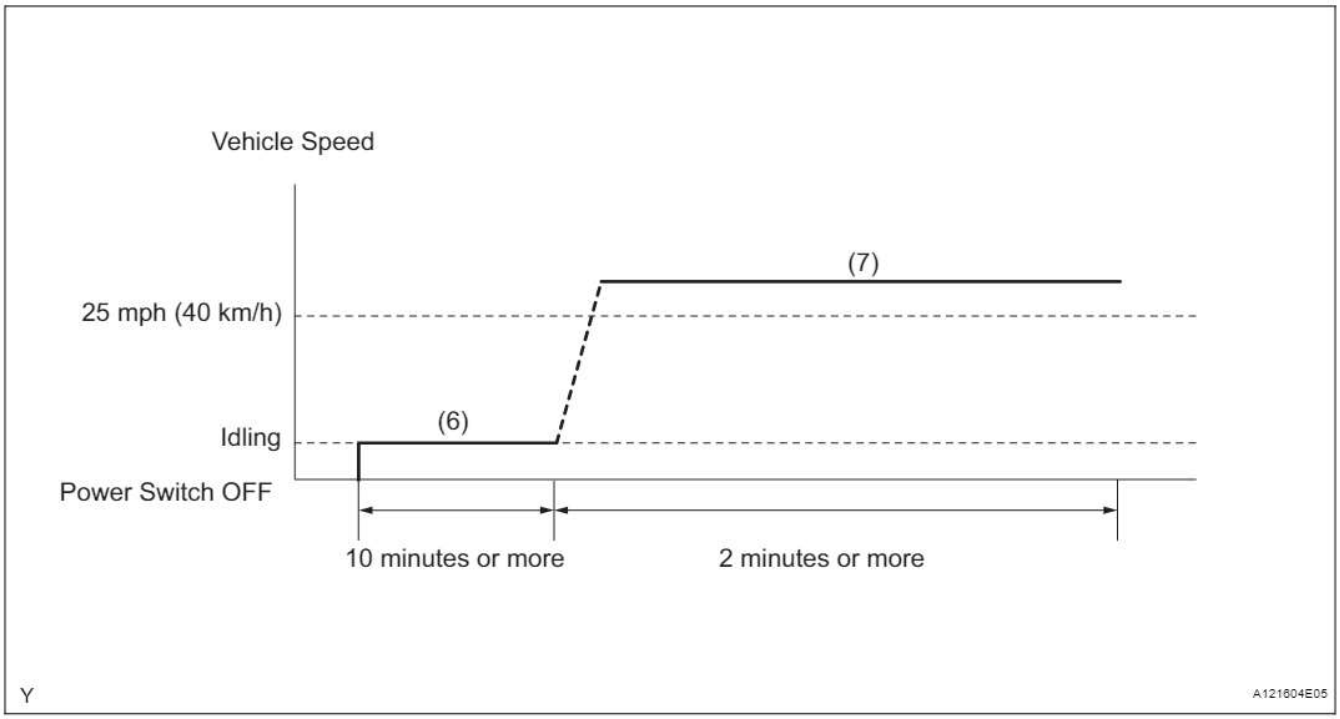
Engine Coolant Temperature: 75°C (167°F) or more



(a) Drive Pattern for front A/F sensor and HO2 sensor
(1) Connect an intelligent tester to the DLC3.
(2) Turn the power switch on (READY).
(3) Turn the tester on.
(4) Clear the DTCs (See page ES-31).
(5) Warm up the engine until the engine coolant temperature reaches 75°C (167°F) or higher.
(6) Drive the vehicle at between 40 mph (60 km/h) and 75 mph (120 km/h) for 10 minutes or more.
(7) Repeat the following drive pattern 3 times or more:
- Drive the vehicle at 75 mph (120 km/h).
- Release the accelerator pedal and stop the vehicle.

(b) Monitor Status
(1) Check the Readiness Monitor status displayed on the tester.
(2) If the status does not switch to COMPL (complete), perform the 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.
(2) Turn the power switch on (IG).
(3) Turn the tester on.
(4) Clear the DTCs (if set) (See page ES-31).
(5) Put the engine in inspection mode (See page ES-35).
(6) Allow the engine to idle for 10 minutes or more.
(7) Drive the vehicle at 25 mph (40 km/h) or more for at least 2 minutes.

(c) Monitor Status
(1) Check the Readiness Monitor status displayed on the tester.
If the status does not switch to COMPL (complete), make sure that the preconditions have been met, and repeat steps through (5) to (7) described in the Drive Pattern above.

PROBLEM SYMPTOMS TABLE

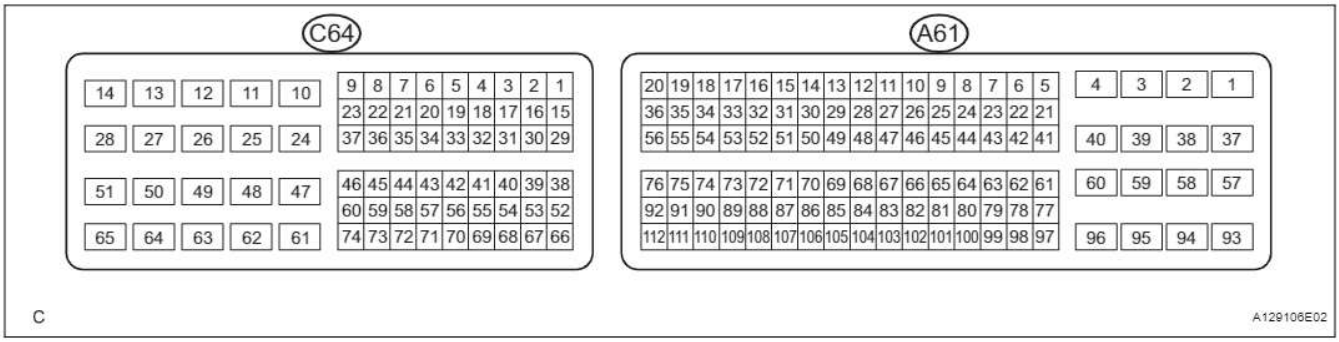
When the malfunction is not confirmed in the diagnostic trouble code check and the problem still cannot be confirmed in the basic inspection, use this table and troubleshoot according to the priority order given below.

SFI SYSTEM:

Symptom	Suspected Area	See page
Engine does not crank (Does not start)	1. Immobilizer system	EI-7
	2. Generator	HV-157
	3. Hybrid system	HV-15
	4. Park/neutral position switch	HV-90
No initial combustion (Does not start)	1. ECM (Included in HV Control ECU) power source circuit	ES-356
	2. Fuel pump control circuit	ES-368
	3. ECM (Included in HV Control ECU)	-
Engine cranks normally but difficult to start	1. Fuel pump control circuit	ES-368
	2. Compression	EM-3
Difficult to start with cold engine	1. Ignition system	IG-3
	2. Spark plug	IG-5
	3. Fuel pump control circuit	ES-368
	4. Injector	FU-14
Difficult to start with warm engine	1. Injector	FU-14
	2. Ignition system	IG-3
	3. Spark plug	IG-5
	4. Fuel pump control circuit	ES-368
High engine idle speed (Poor idling)	1. ECM (Included in HV Control ECU) power source circuit	ES-356
	2. Electronic throttle control system	ES-395
	3. Air induction system	-
	4. PCV hose	EC-4
Low engine idle speed (Poor idling)	1. Fuel pump control circuit	ES-368
	2. Electronic throttle control system	ES-395
	3. Air induction system	-
	4. PCV hose	EC-4
Rough idling (Poor idling)	1. Compression	EM-3
	2. Fuel pump control circuit	ES-368
	3. Electronic throttle control system	ES-395
	4. Air induction system	-
	5. PCV hose	EC-4
Hunting (Poor idling)	1. ECM (Included in HV Control ECU) power source circuit	ES-356
	2. Fuel pump control circuit	ES-368
	3. Spark plug	IG-5
	4. Ignition system	IG-3
	5. Injector	FU-14
	6. Electronic throttle control system	ES-395
	7. Air induction system	-
	8. PCV hose	EC-4
Hesitation/ Poor acceleration (Poor driveability)	1. Fuel pump control circuit	ES-368
	2. Spark plug	IG-5
	3. Ignition system	IG-3
	4. Injector	FU-14

Symptom	Suspected Area	See page
Surging (Poor driveability)	1. Spark plug	IG-5
	2. Fuel pump control circuit	ES-368
	3. Ignition system	IG-3
	4. Injector	FU-14
Engine stalls soon after starting	1. Fuel pump control circuit	ES-368
	2. Spark plug	IG-5
	3. Ignition system	IG-3
	4. Injector	FU-14
Unable/difficult to refuel	Refueling valve (canister)	EC-10

TERMINALS OF ECM



HINT:

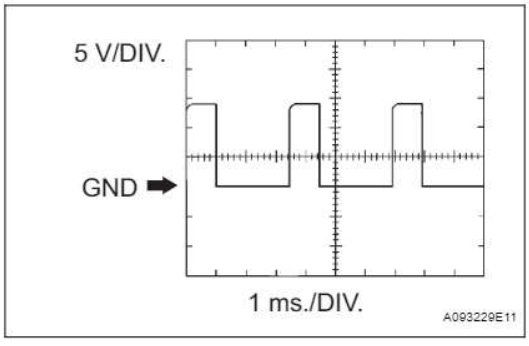
The standard normal voltage between each pair of the ECM (included in hybrid vehicle control ECU) terminals is shown in the table below. The appropriate conditions for checking each pair of the terminals are also indicated. The result of checks should be compared with the standard normal voltage for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

Symbols (Terminal No.)	Wiring Color	Terminal Description	Condition	Specified Condition
BATT (A61-4) - E1 (C64-14)	W - W-B	Battery (for measuring battery voltage and for ECM memory)	Always	9 to 14 V
+BM (A61-3) - E1 (C64-14)	LG - W-B	Power source of throttle motor	Always	9 to 14 V
IGSW (A61-57) - E1 (C64-14)	Y - W-B	Power switch	Power switch ON (IG)	9 to 14 V
+B (A61-2) - E1 (C64-14)	Y - W-B	Power source of ECM	Power switch ON (IG)	9 to 14 V
+B2 (A61-1) - E1 (C64-14)	Y - W-B	Power source of ECM	Power switch ON (IG)	9 to 14 V
OC1+ (C64-16) - OC1- (C64-15)	W - R	Camshaft timing oil control valve (OCV) (Intake side (bank 1))	Power switch ON (IG)	Pulse generation (See waveform 1)
MREL (A61-93) - E1 (C64-14)	B - W-B	EFI MAIN relay	Power switch ON (IG)	9 to 14 V
VCTA (C64-71) - ETA (C64-72)	B - P	Power source for sensors (specific voltage)	Power switch ON (IG)	4.5 to 5.0 V
VCPT (A61-75) - EPTK (A61-81)	LG - BR	Power source for sensors (specific voltage)	Power switch ON (IG)	4.5 to 5.0 V
VCPP (A61-64) - EPPM (C64-76)	Y - BR	Power source for sensors (specific voltage)	Power switch ON (IG)	4.5 to 5.0 V
VG (C64-74) - EVG (C64-73)	SB - W	Mass air flow meter	Idling, Shift lever position P or N, A/C switch OFF	0.5 to 3.0 V
THA (C64-59) - ETHA (C64-45)	P - B	Intake air temperature sensor	Idling, Intake air temperature 20°C (68°F)	0.5 to 3.4 V
THW (C64-60) - ETHW (C64-46)	B - P	Engine coolant temperature sensor	Idling, Engine coolant temperature 80°C (176°F)	0.2 to 1.0 V
VTA1 (C64-58) - ETA (C64-72)	Y - P	Throttle position sensor (for engine control)	Power switch ON (IG), Throttle valve fully closed	0.5 to 1.2 V
VTA1 (C64-58) - ETA (C64-72)	Y - P	Throttle position sensor (for engine control)	Power switch ON (IG), Throttle valve fully open	3.2 to 4.8 V
VTA2 (C64-57) - ETA (C64-72)	W - P	Throttle position sensor (for sensor malfunction detection)	Power switch ON (IG), Accelerator pedal released	2.1 to 3.1 V

Symbols (Terminal No.)	Wiring Color	Terminal Description	Condition	Specified Condition
VTA2 (C64-57) - ETA (C64-72)	W - P	Throttle position sensor (for sensor malfunction detection)	Power switch ON (IG), Accelerator pedal depressed	4.5 to 5.0 V
VPA (A61-106) - EP1 (A61-88)	R - G	Accelerator pedal position sensor (for engine control)	Power switch ON (IG), Accelerator pedal released	0.5 to 1.1 V
VPA (A61-106) - EP1 (A61-88)	R - G	Accelerator pedal position sensor (for engine control)	Power switch ON (IG), Accelerator pedal depressed	2.6 to 4.5 V
VPA2 (A61-105) - EP2 (A61-87)	L - Y	Accelerator pedal position sensor (for sensor malfunctioning detection)	Power switch ON (IG), Accelerator pedal released	1.2 to 2.0 V
VPA2 (A61-105) - EP2 (A61-87)	L - Y	Accelerator pedal position sensor (for sensor malfunctioning detection)	Power switch ON (IG), Accelerator pedal depressed	3.4 to 5.0 V
VCP1 (A61-108) - EP2 (A61-87)	BR - Y	Power source of accelerator pedal position sensor (for VPA)	Power switch ON (IG)	4.5 to 5.0 V
VCP2 (A61-107) - EP2 (A61-87)	W - Y	Power source of accelerator pedal position sensor (for VPA2)	Power switch ON (IG)	4.5 to 5.0 V
HA1A (C64-62) - E04 (C64-48)	G - W	A/F sensor heater	Idling	Below 3.0 V
HA1A (C64-62) - E04 (C64-48)	G - W	A/F sensor heater	Power switch ON (IG)	9 to 14 V
A1A+ (C64-39) - E1 (C64-14)	L - W-B	A/F sensor	Power switch ON (IG)	3.3 V*
A1A- (C64-38) - E1 (C64-14)	P - W-B	A/F sensor	Power switch ON (IG)	3.0 V*
HT1B (C64-37) - E1 (C64-14)	LG - W-B	Heated oxygen sensor heater	Idling	Below 3.0 V
HT1B (C64-37) - E1 (C64-14)	LG - W-B	Heated oxygen sensor heater	Power switch ON (IG)	9 to 14 V
OX1B (C64-53) - O1B- (C64-52)	W - BR	Heated oxygen sensor	Maintain engine speed at 2,500 rpm for 2 minutes after warming up sensor	Pulse generation (See waveform 2)
#10 (C64-50) - E1 (C64-14) #20 (C64-54) - E1 (C64-14) #30 (C64-49) - E1 (C64-14) #40 (C64-63) - E1 (C64-14)	R - W-B R - W-B Y - W-B L - W-B	Injector	Power switch ON (IG)	0 to 5 V
#10 (C64-50) - E1 (C64-14) #20 (C64-54) - E1 (C64-14) #30 (C64-49) - E1 (C64-14) #40 (C64-63) - E1 (C64-14)	R - W-B R - W-B Y - W-B L - W-B	Injector	Idling	Pulse generation (See waveform 3)
KNK1 (C64-67) - EKNK (C64-66)	G - R	Knock sensor	Maintain engine speed at 4,000 after warming up	Pulse generation (See waveform 4)
G2+ (C64-55) - G2 (C64-54)	Y - BR	Variable valve timing (VVT) sensor (Intake side (bank 1))	Idling	Pulse generation (See waveform 5)
NE+ (C64-69) - NE- (C64-68)	G - R	Crankshaft position sensor	Idling	Pulse generation (See waveform 5)
IGT1 (C64-5) - E1 (C64-14) IGT2 (C64-4) - E1 (C64-14) IGT3 (C64-3) - E1 (C64-14) IGT4 (C64-2) - E1 (C64-14)	W - W-B L - W-B G - W-B LG - W-B	Ignition coil (ignition signal)	Idling	Pulse generation (See waveform 6)
IGF (C64-1) - E1 (C64-14)	BR - W-B	Ignition coil (ignition confirmation signal)	Power switch ON (IG)	4.5 to 5.0 V
IGF (C64-1) - E1 (C64-14)	BR - W-B	Ignition coil (ignition confirmation signal)	Idling	Pulse generation (See waveform 6)
PRG (C64-17) - E1 (C64-14)	O - W-B	Purge VSV	Power switch ON (IG)	9 to 14 V

Symbols (Terminal No.)	Wiring Color	Terminal Description	Condition	Specified Condition
PRG (C64-17) - E1 (C64-14)	O - W-B	Purge VSV	Idling	Pulse generation (See waveform 7)
SPDI (A61-21) - E1 (C64-14)	L - W-B	Speed signal from combination meter	Power switch ON (IG), Rotate driving wheel slowly	Pulse generation (See waveform 8)
ST2 (A61-57) - E1 (C64-14)	R - W-B	Starter signal	Power switch on (READY)	9 to 14 V
STP (A61-56) - E1 (C64-14)	W - W-B	Stop light switch	Brake pedal depressed	7.5 to 14 V
STP (A61-56) - E1 (C64-14)	W - W-B	Stop light switch	Brake pedal released	Below 1.5 V
ST1- (A61-55) - E1 (C64-14)	GR - W-B	Stop light switch (opposite to STP terminal)	Power switch ON (IG), Brake pedal depressed	Below 1.5 V
ST1- (A61-55) - E1 (C64-14)	GR - W-B	Stop light switch (opposite and STP terminal)	Power switch ON (IG), Brake pedal released	7.5 to 14 V
M+ (C64-10) - ME01 (C64-13)	G - B	Throttle actuator	Idling with warm engine	Pulse generation (See waveform 9)
M- (C64-11) - ME01 (C64-13)	R - B	Throttle actuator	Idling with warm engine	Pulse generation (See waveform 10)
FC (A61-94) - E1 (C64-14)	Y - W-B	Fuel pump control	Power switch ON (IG)	9 to 14 V
FC (A61-94) - E1 (C64-14)	Y - W-B	Fuel pump control	Idling	0 to 3 V
W (A61-22) - E1 (C64-14)	BR - W-B	MIL	Power switch ON (IG)	Below 3.0 V
W (A61-22) - E1 (C64-14)	BR - W-B	MIL	Idling	0 to 3 V
TC (A61-3) - E1 (C64-14)	P - W-B	Terminal TC of DLC 3	Power switch ON (IG)	9 to 14 V
VPMP (A61-42) - E1 (C64-14)	W - W-B	Vent valve (built into pump module)	Power switch ON (IG)	9 to 14 V
MPMP (A61-45) - E1 (C64-14)	G - W-B	Vacuum pump (built into pump module)	Vacuum pump OFF	0 to 3 V
MPMP (A61-45) - E1 (C64-14)	G - W-B	Vacuum pump (built into pump module)	Vacuum pump ON	9 to 14 V
PPMP (A61-66) - EPPM (C64-76)	B - BR	Pressure sensor (built into pump module)	Power switch ON (IG)	3 to 3.6 V
CANH (A61-20) - E1 (C64-14)	B - W-B	CAN communication line	Power switch ON (IG)	Pulse generation (See waveform 11)
CANL (A61-19) - E1 (C64-14)	W - W-B	CAN communication line	Power switch ON (IG)	Pulse generation (See waveform 12)
PTNK (A61-35) - EPTK (A61-81)	GR - BR	Fuel tank pressure sensor	Power switch ON (IG)	0.5 to 4.5 V
CCV2 (A61-45) - E1 (C64-14)	V - W-B	Fuel vapor-containment valve	Close valve ON (Open)	Below 1.0 V
			Close valve OFF (Close)	10 to 14 V

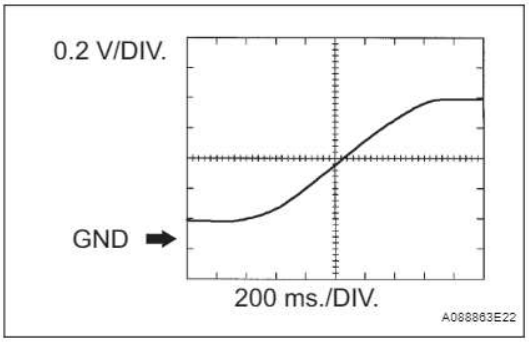
HINT:
*: The ECM terminal voltage is constant regardless of the output voltage from the sensor.



1. WAVEFORM 1
Camshaft timing oil control valve (OCV):

ECM Terminal Name	Between OC1+ and OC1-
Tester Range	5 V/DIV., 1 ms./DIV.
Condition	Idling

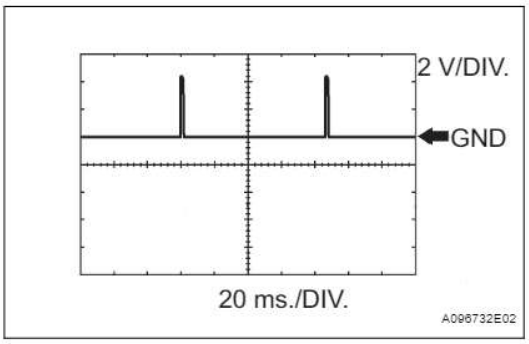
HINT:
The wavelength becomes shorter as the engine rpm increases.



2. WAVEFORM 2
Heated oxygen sensor:

ECM Terminal Name	Between OX1B and O1B-
Tester Range	0.2 V/DIV., 200 ms./DIV.
Condition	Engine speed maintained at 2,500 rpm for 2 minutes after warming up engine

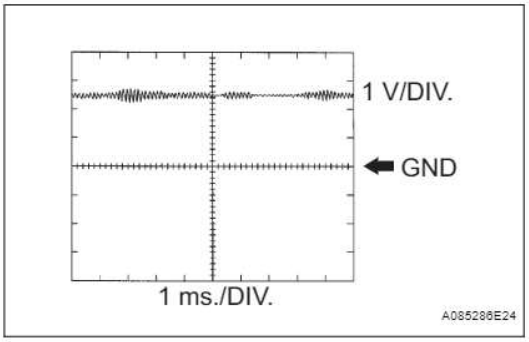
HINT:
In DATA LIST, item O2S B1 S2 shows the values input to the ECM from the heated oxygen sensor.



3. WAVEFORM 3
Injector No. 1 (to No. 6) injection signal:

ECM Terminal Name	Between #10 (to #40) and E1
Tester Range	2 V/DIV., 20 ms./DIV.
Condition	Idling

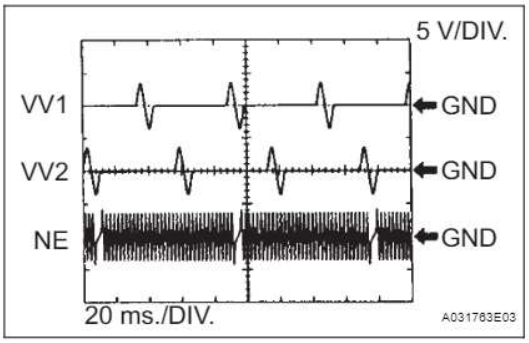
HINT:
The wavelength becomes shorter as the engine rpm increases.



4. WAVEFORM 4
Knock sensor:

ECM Terminal Name	Between KNK1 and EKNK
Tester Range	0.01 to 10 V/DIV., 0.01 to 10 ms./DIV.
Condition	Engine speed maintained a 4,000 rpm after warming up engine

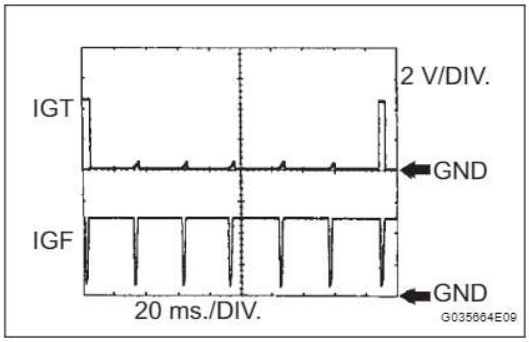
HINT:
- The wavelength becomes shorter as the engine rpm increases.
- The waveforms and amplitudes displayed differ slightly depending on the vehicle.



5. WAVEFORM 5
Crankshaft position sensor and VVT:

ECM Terminal Name	Between G2+ and G2- Between NE+ and NE-
Tester Range	5 V/DIV., 20 ms./DIV.
Condition	Idling

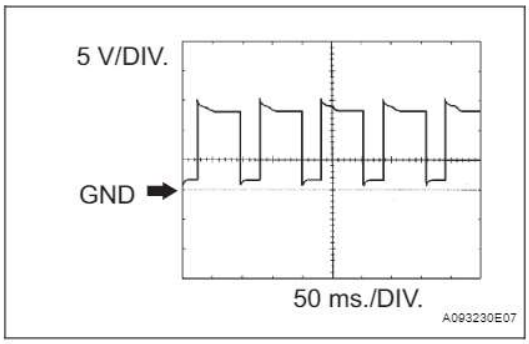
HINT:
The wavelength becomes shorter as the engine rpm increases.



6. WAVEFORM 6
Igniter IGT signal (from ECM to igniter) and Igniter IGF signal (from igniter to ECM):

ECM Terminal Name	Between IGT (1 to 4) and E1 Between IGF and E1
Tester Range	2 V/DIV., 20 ms./DIV.
Condition	Idling

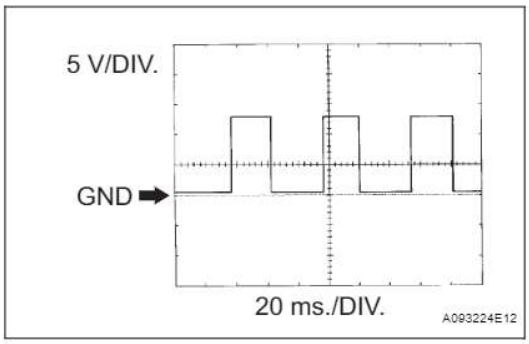
HINT:
The wavelength becomes shorter as the engine rpm increases.



7. WAVEFORM 7
Purge VSV:

ECM Terminal Name	Between PRG and E1
Tester Range	5 V/DIV., 50 ms./DIV.
Condition	Idling

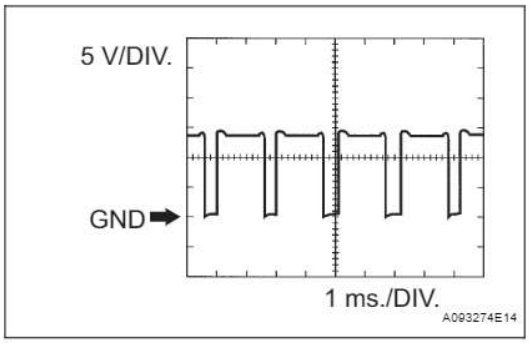
HINT:
If the waveform is not similar to the illustration, check the waveform again after idling for 10 minutes or more.



8. WAVEFORM 8
Vehicle speed signal:

ECM Terminal Name	Between SPDI and E1
Tester Range	2 V/DIV., 20 ms./DIV.
Condition	Driving at 12 mph (20 km/h)

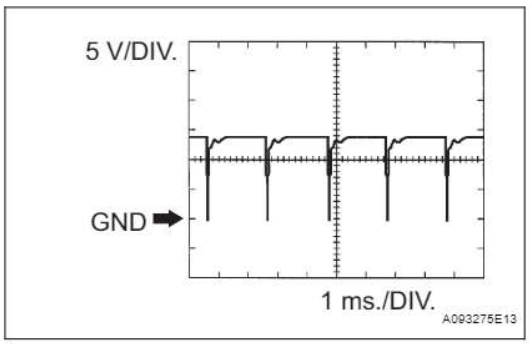
HINT:
The wavelength becomes shorter as the vehicle speed increases.



9. WAVEFORM 9
Throttle actuator positive terminal:

ECM Terminal Name	Between M+ and ME01
Tester Range	5 V/DIV., 1 ms./DIV.
Condition	Idling with warm engine

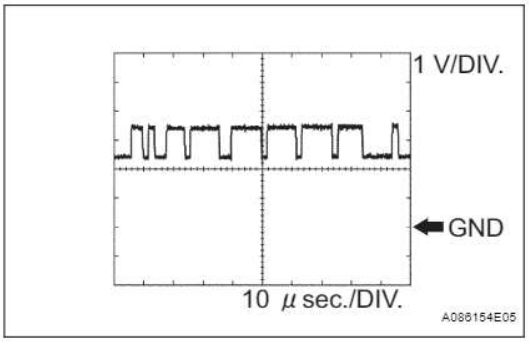
HINT:
The duty ratio varies depending on the throttle actuator operation.



10. WAVEFORM 10
Throttle actuator negative terminal:

ECM Terminal Name	Between M- and ME01
Tester Range	5 V/DIV., 1 ms./DIV.
Condition	Idling with warm engine

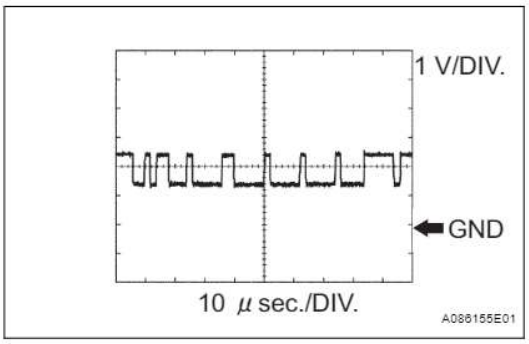
HINT:
The duty ratio varies depending on the throttle actuator operation.



11. WAVEFORM 11
CAN communication signal:

ECM Terminal Name	Between CANH and E1
Tester Range	1 V/DIV., 10 μs/DIV.
Condition	Stop engine and Power switch ON (IG)

HINT:
The waveform varies depending on the CAN communication signal.



12. WAVEFORM 12
CAN communication signal:

ECM Terminal Name	Between CANL and E1
Tester Range	1 V/DIV., 10 μs/DIV.
Condition	Stop engine and Power switch ON (IG)

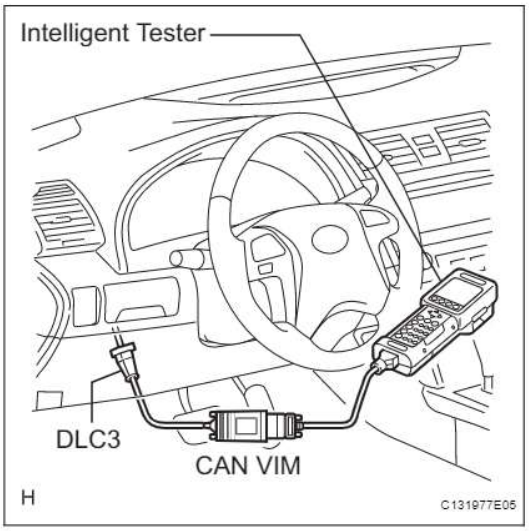
HINT:
The waveform varies depending on the CAN communication signal.



DIAGNOSIS SYSTEM

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

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



(c) The computer itself.
In addition, the applicable DTCs (Diagnostic Trouble Codes) prescribed by SAE J2012 are recorded on 3 consecutive trips, the MIL turns off automatically but the DTCs remain recorded in the ECM (Included in Hybrid Vehicle Control ECU) memory.
To check for DTCs, connect the intelligent tester to the DLC3. The tester displays DTCs, freeze frame data, and a variety of the engine data. The DTCs and freeze frame data can be erased with the tester.
In order to enhance OBD function on vehicles and develop the Off-Board diagnosis system, CAN communication is introduced in this system (CAN: Controller Area Network). It minimizes a gap between technician skills and vehicle technology. CAN is a network, which uses a pair of data transmission lines, spanning multiple computers

and sensors. It allows a high speed communication between the systems and simplification of the wire harness connection. Since this system is equipped with the CAN communication, connecting the CAN VIM (VIM: Vehicle Interface Module) with the intelligent tester is necessary to display any information from the ECM (Included in Hybrid Vehicle Control ECU). (Also the communication between the intelligent tester and the ECM (Included in Hybrid Vehicle Control ECU) uses CAN communication signal). When confirming the DTCs and any data of the ECM (Included in Hybrid Vehicle Control ECU), connect the CAN VIM between the DLC3 and the intelligent tester.

2. NORMAL MODE AND CHECK MODE

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

3. 2-TRIP DETECTION LOGIC

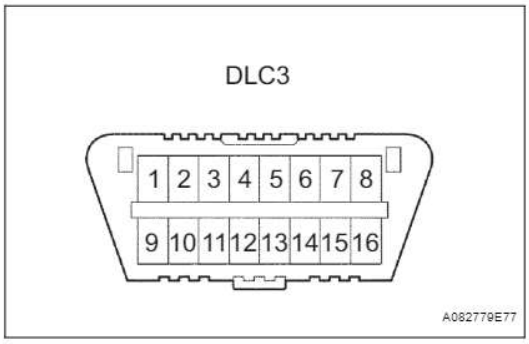
When a malfunction is first detected, the malfunction is temporarily stored in the ECM (Included in Hybrid Vehicle Control ECU) memory (1st trip). If the same malfunction is detected during the next subsequent drive cycle, the MIL is illuminates (2nd trip).

4. FREEZE FRAME DATA

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

5. DLC3 (Data link Connector 3)

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



Symbols	Terminal No.	Names	Reference Terminal	Results	Condition
SIL	7	Bus "+" line	5 - Signal ground	Pulse generation	During transmission
CG	4	Chassis ground	Body ground	1 Ω or less	Always
SG	5	Signal ground	Body ground	1 Ω or less	Always
BAT	16	Battery ground	Body ground	9 to 14 V	Always

Symbols	Terminal No.	Names	Reference Terminal	Results	Condition
CANH	6	CAN "High" line	CANL	54 to 69 Ω	Power switch OFF
CANH	6	CAN "High" line	Battery positive	1 MΩ or higher	Power switch OFF
CANH	6	CAN "High" line	CG	1 kΩ or higher	Power switch OFF
CANL	14	CAN "Low" line	Battery positive	1 MΩ or higher	Power switch OFF
CANL	14	CAN "Low" line	CG	1 kΩ or higher	Power switch OFF

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

- If communication is normal: Inspect the DLC3 on the original vehicle.
- If communication is still not possible: The problem is probably in the tester itself. Consult the Service Department listed in the instruction manual.

6. BATTERY VOLTAGE

Battery voltage:
11 to 14 V

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

7. MIL (Malfunction Indicator Lamp)

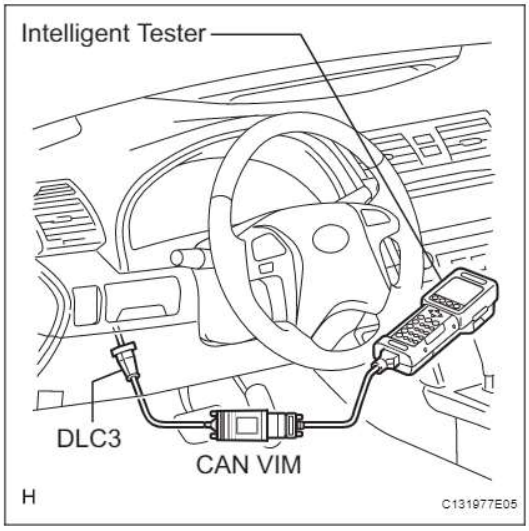
(a) The MIL is illuminated when the power switch is first turned on (the engine is not running).

(b) The MIL should turn OFF when the engine is started. If the MIL remains illuminated, the diagnosis system has detected malfunctions or abnormalities in the system.
HINT:
If the MIL is not illuminated when the power switch is first turned on, check the MIL circuit (See page ES-373).

DTC CHECK / CLEAR

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

- DTCs which are stored in the ECM (Included in Hybrid Vehicle Control ECU) can be displayed on an intelligent tester. An intelligent tester can display current and pending DTCs.
- The same DTCs are not set if the ECM (Included in Hybrid Vehicle Control ECU) dose not detect the same malfunction again during a second consecutive driving cycle. However, such malfunctions, detected on only one occasion, are stored as pending DTCs.



1. **CHECK DTC (Using an intelligent tester)**
   (a) Connect an intelligent tester to the DLC3.
   (b) Turn the power switch on (IG).
   (c) Turn the tester on.
   (d) Enter the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
   (e) Check for DTC(s) and freeze frame data, and then write them down.
   (f) Check the details of the DTC(s) (See page ES-45).
2. **CLEAR DTC**
   (a) Connect an intelligent tester to the DLC3.
   (b) Turn the power switch on (IG).
   (c) Turn the tester on.
   (d) Enter the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CLEAR CODES.
   (e) Press the YES button.

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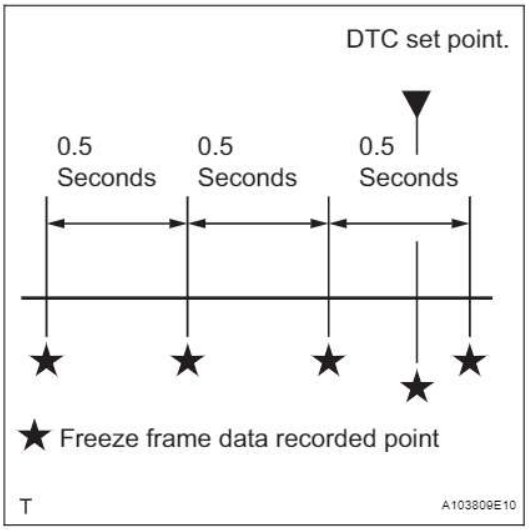
FREEZE FRAME DATA

1. DESCRIPTION

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

The intelligent tester displays freeze frame data recorded at five different points: 1) 3 times before the DTC is set, 2) once when the DTC is set, and 3) once after the DTC is set. The data can be used to simulate the vehicle's condition around the time of the malfunction. The data may be helpful in determining the cause of a malfunction. It may also be helpful in determining whether a DTC is being caused by a temporary malfunction.

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.



2. LIST OF FREEZE FRAME DATA

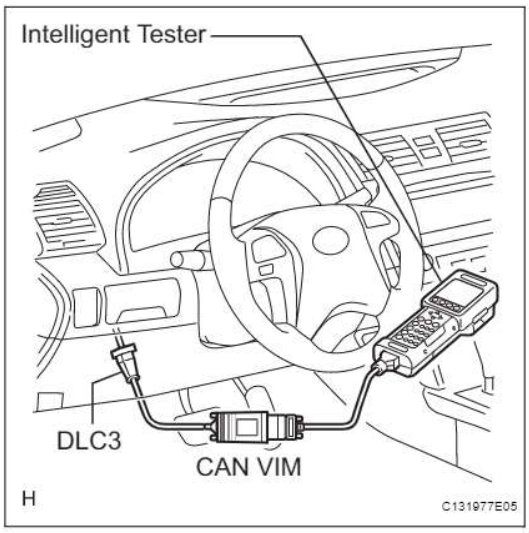
Tester Display	Measurement Item/Range	Diagnostic Note
IGN ADVANCE	Ignition advance	-
CALC LOAD	Calculate load	Calculated load by ECM (Included in HV control ECU)
VEHICLE LOAD	Vehicle load	-
MAF	Mass air flow volume	If value approximately 0.0 g/s: • Mass air flow meter power source circuit open or short • 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, sensor circuit open If value 140°C, sensor circuit shorted
INTAKE AIR	Intake air temperature	If value -40°C, sensor circuit open If value 140°C, sensor circuit shorted
AIR-FUEL PATIO	Air-fuel ratio	-
AMBIENT TEMP	Ambient temperature	-
PURGE DENSITY	Learning value of purge density	-
PURGE FLOW	Purge flow	-
EVAP PURGE VSV	EVAP purge VSV duty ratio	-
KNOCK CRRT VAL	Correction learning value of knocking	-
KNOCK FB VAL	Feedback value of knocking	-
THROTTLE POS	Throttle position	Read value with power switch ON (IG) (Do not start engine)
THROTTLE POS	Throttle sensor positioning	Read value with power switch ON (IG) (Do not start engine)
THROTTLE POS #2	Throttle sensor positioning #2	-

Tester Display	Measurement Item/Range	Diagnostic Note
THROTTLE MOT	Throttle motor	-
O2S B1 S2	Heated oxygen sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
AFS B1 S1	A/F sensor output	Performing INJ VOL or A/F CONTROL function of ACTIVE TEST enables technician to check output voltage of sensor
TOTAL FT #1	Total fuel trim	-
SHORT FT #1	Short-term fuel trim	Short-term fuel compensation used to maintain air-fuel ratio at stoichiometric air-fuel ratio
LONG FT #1	Long-term fuel trim	Overall fuel compensation carried out in long-term to compensate for a continual deviation of short-term fuel trim from central value
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
O2FT B1 S2	Fuel trim at heated oxygen sensor	Same as SHORT FT #1
AF FT B1 S1	Fuel trim at A/F sensor	-
CAT TEMP B1 S1	Catalyst temperature	-
CAT TEMP B1 S2	Catalyst temperature	-
INI COOL TEMP	Initial engine coolant temperature	-
INI INTAKE TEMP	Initial intake air temperature	-
INJ VOL	Injection volume	-
INJECTOR	Injection period of No.1 cylinder	-
CTP SW	Closed throttle position switch	-
STOP LIGHT SW	Stop light switch	-
ENG OIL PRES SW	Engine oil pressure switch signal	Always ON while engine is running
BATTERY VOLTAGE	Battery voltage	-
ATM PRESSURE	Atmospheric pressure	-
EVAP (Purge) VSV	EVAP Purge VSV	-
FUEL PUMP/SPD	Fuel pump/speed status	-
VVT CTRL B1	VVT control status (bank 1)	-
TANK BYPASS VSV	Tank bypass VSV	-
TC/TE1	TC and TE1 terminals of DLC3	-
VVTL AIM ANGL#1	VVT aim angle (bank1)	-
VVT CHNG ANGL#1	VVT change angle (bank 1)	-
VVT OCV D B1	VVT OCV operation duty (bank 1)	-
FC IDL	Idle fuel cut	ON: when throttle valve fully closed and engine speed over 1,500 rpm
FC TAU	FC TAU	Fuel cut being performed under very light load to prevent incomplete engine combustion
IGNITION	Ignition	-
CYL #1	Cylinder #1 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 ALL	All cylinder misfire rate	Displayed only during idling

Tester Display	Measurement Item/Range	Diagnostic Note
MISFIRE RPM	Misfire RPM	-
MISFIRE RPM	Misfire RPM	-
MISFIRE LOAD	Misfired load	-
MISFIRE MARGIN	Misfire monitoring	-
ENG RUN TIME	Accumulated engine running time	-
TIME DTC CLEAR	Cumulative time after DTC cleared	-
DIST DTC CLEAR	Accumulated distance from DTC cleared	-
WU CYC DTC CLEAR	Warm-up cycle after DTC cleared	-
VACUUM PUMP	Vacuum pump	ON: Operate
EVAP VENT VAL	EVAP system vent valve	ON: Close
FAN MOTOR	Electric fan motor	ON: Operate
FUEL FILLER OPN	Fuel filler opener	ON: Open
FVCV	Fuel vapor-containment valve	ON: Open
REQ ENG TRQ	Requested engine torque	-
HV TRGT ENG SPD	HV target engine speed	-
ACT ENGINE TRQ	Actual engine torque	-
EST ENGINE TRQ	Estimated engine torque	-
ENG RUN TIME	Engine run time	-
ENGINE RUN TIME	Request engine run time	-
IGNITION TIME	Judge time engine ignition	-
OUTPUT TIME	Judge time engine output	-
FUEL. LEVEL	Fuel level	-
ISC LEARNING	ISC learning	-
FUEL CUT	Fuel cut for engine stop request	-
INDPNDNT OPR	Engine Independent operation	-
RACING	Racing operation	-
WARM UP	Request warm-up	-
INDPNDNT CNTRL	Engine independent control	-
ISC LEARN VAL	ISC learning control	-
FUEL LID	Fuel lid	-
FUEL LID SW	Fuel lid switch	ON: Open
MODEL CODE	Identifying the model code	AUH40L
ENGINE TYPE	Identifying the engine type	2AZFXE
CYLINDER NUMBER	Identifying the cylinder number	4
DESTINATION	Identifying the destination	A (America)
MODEL YEAR	Identifying the model year	200#
SYSTEM	Identifying the engine system	HV

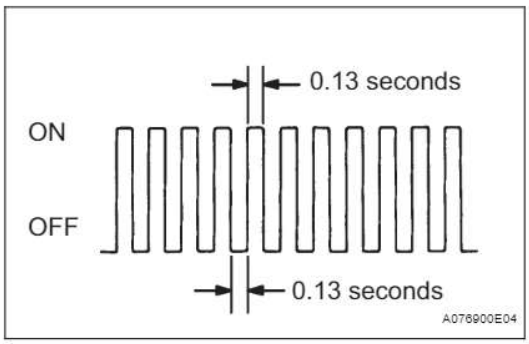
CHECK MODE PROCEDURE

HINT:
Intelligent tester only:
Compared to the normal mode, check mode is more sensitive to malfunctions. Therefore, check mode can detect the malfunctions that cannot be detected in normal mode.
NOTICE:
All the stored DTCs and freeze frame data are erased if: 1) the ECM is changed from normal mode to check mode or vice versa; or 2) the power switch is turned from on (ON) 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 positive voltage 11 V or more.
(2) Throttle valve fully closed.
(3) Transmission in the P or N positions.
(4) A/C switched OFF.
(b) Turn the power switch off.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the power switch on (IG).
(e) Turn the tester on.
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / CHECK MODE.
(g) Switch the ECM (Included in Hybrid Vehicle Control ECU) from normal mode to check mode.



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

INSPECTION MODE PROCEDURE

HINT:
Before performing the DATA LIST and ACTIVE TEST of the engine with the intelligent tester, be sure to put the system into the inspection mode using the following procedures.

1. ACTIVATING INSPECTION MODE

(a) Perform the following steps (1) through (4) in 60 seconds.
(1) Turn the power switch on (IG).
(2) Fully depress the accelerator pedal twice with the transmission in the P position.
(3) Fully depress the accelerator pedal twice with the transmission in the N position.
(4) Fully depress the accelerator pedal twice with the transmission in the P position.
(5) Check that "FWD MAINTENANCE MODE" on the multi-information display and master warning light is illuminated in the combination meter.
(6) Start the engine.

FAIL-SAFE CHART

If any of the following DTCs are set, the ECM (Included in Hybrid Vehicle Control ECU) enters fail-safe mode to allow the vehicle to be driven temporarily.

DTC	Component	Fail-Safe Operation	Fail Safe Deactivation Condition
P0031, P0032	Air-Fuel Ratio (A/F) Sensor Heater	ECM turns off A/F sensor heater	Power switch off
P0037, P0038	Heated Oxygen Sensor (HO2S) Heater	ECM turns off HO2 sensor heater	Power switch off
	High pressure side fuel pump	• Stop the high side fuel pump • Limit the engine speed to 2,000 rpm or less	Pass condition detected
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 (ECTS)	ECM cuts off throttle actuator current and throttle valve returns 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 power switch turned off
P0327, P0328, P0332 and P0333	Knock Sensor	ECM sets ignition timing to maximum retard.	Power switch off
P0351 to P0356	Igniter	ECM cuts fuel	Pass condition detected

NOTICE:

***: The vehicle can be driven slowly when the accelerator pedal is depressed gently. 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:

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

NOTICE:

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

(a) Put the engine in inspection mode (See page ES-35).
(b) Warm up the engine.
(c) Turn the power switch off.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the power switch on (IG).
(f) Turn the tester on.
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST.
(h) Check the values by referring to the table below.

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
INJECTOR	Injection period of No. 1 cylinder/ Min.: 0 ms, Max.: 32.64 ms	1.5 to 2.7 ms: Idling (Inspection mode)	-
IGN ADVANCE	Ignition timing advance for No. 1 cylinder/Min.: -64 deg., Max.: 63.5 deg.	BTDC 5 to 25° : Idling (Inspection mode)	-
CALC LOAD	Calculated load by ECM/Min.: 0%, Max.: 100%	• 11 to 30%: Idling (Inspection mode) • 12.1 to 30% : Running without load (2,500 rpm)	-
VEHICLE LOAD	Vehicle load/Min.: 0%, Max.: 25700%	Actual vehicle load	-
MAF	Air flow rate from MAF meter/Min.: 0 g/s , Max.: 655 g/s	2.0 to 4.3 g/s: Idling (Inspection mode) 2.4 to 8 g/s: 2,500 rpm (without load)	If value approximately 0.0 g/s: • Mass air flow meter power source circuit open • VG circuit open or short If value 160.0 g/s or more: • E2G circuit open
ENGINE SPD	Engine speed/Min.: 0 rpm, Max.: 16,383 rpm	900 rpm: Idling (Inspection mode)	-
VEHICLE SPD	Vehicle speed/Min.: 0 km/h, Max.: 255 Km/h	Actual vehicle speed	Speed indicated on speedometer
COOLANT TEMP	Engine coolant temperature/Min.: -40°C, Max.: 140°C	80 to 100°C (176 to 212°F): After warming up	• If value -40°C (-40°F): sensor circuit open • If value 140°C (284°F): sensor circuit shorted
INTAKE AIR	Intake air temperature/Min.: -40°C, Max.: 140°C	Equivalent to ambient 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/Min.: 0 ,Max.: 1.999	0.8 to 1.2 : During idling (Inspection mode)	-

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
AMBIENT TEMP	Ambient air temperature/Min.: -40°C, Max.: 215°C	Equivalent to ambient air temperature	• If the value is -40°C: sensor circuit open • If the value is 215°C: sensor circuit shorted
PURGE DENSITY	Learning value of purge density/ Min.: -50, Max.: 350	-30 to 1% Idling (Inspection mode)	Service data
EVAP PURGE FLOW	Purge flow/Min.: 0%, Max.: 102.4%	0 to 100%: Idling (Inspection mode)	-
EVAP PURGE VSV	Purge VSV control duty/Min.: 0%, Max.: 100%	0 to 20%: Idling	Order signal from ECM
VAPOR PRESS PUMP	EVAP vapor pressure/Min.: 0 kPa, Max.: 327.675 kPa	-	-
VAPOR PRESS CALC	Vapor pressure (calculated)/Min.: -5.632 kPa, Max.715.264 kPa	-	-
KNOCK CRRT VAL	Correction learning value of knocking/Min: -64 CA, Max.: 1,984 CA	0 to 21°CA: Driving at 47 mph (75 km/h)	Service data
KNOCK FB VAL	Feedback value of knocking/Min: -64 CA, Max.: 1,984 CA	-21 to 0°CA: Driving at 47 mph (75 km/h)	Service data
VAPOR PRESS TANK	Vapor pressure/Min.: 33.853 kPa, Max.: 125.596 kPa	Atmospheric pressure: Fuel tank cap removed	Pressure inside fuel tank monitored by vapor pressure sensor
CLUTCH	Clutch current/Min.: 0 A, Max.: 2.49 A	-	-
THRTL LEARN VAL	Throttle valve fully closed (learned value)/Min.: 0 V, Max.: 5 V	0.4 to 0.8 V	-
FAIL #1	Whether or not fail safe function is executed/ON or OFF	ETCS has failed: ON	-
SYS GUARD JUDGE	System guard/ON or OFF	-	ETCS service data
THROTTLE POS	Absolute throttle position sensor/ Min.: 0%, Max.: 100%	• 0 to 24%: Throttle fully closed • 64 to 96%: Throttle fully open	Read value with intrusive operation (active test)
THROTTLE IDL POS	Whether or not throttle position sensor is detecting idle/ON or OFF	Idling: ON (Inspection mode)	Read value with intrusive operation (active test)
THRTL REQ POS	Throttle requirement position/Min.: 0 V, Max.: 5 V	0.5 to 1.0 V: Idling (Inspection mode)	-
THROTLLE POS	Throttle sensor positioning/Min.: 0%, Max.: 100%	0 to 10%: Idling (Inspection mode)	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.: 4.9 V	-	ETCS freeze data
THROTTLE POS #2	Throttle position sensor No. 2 output voltage/Min.: 0 V, Max.: 4.9 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 open	-
THROTTLE POS #2	Throttle position No. 2/Min.: 0 V, Max.: 5 V	• 2.1 to 3.1 V: Throttle fully closed • 4.5 to 5.5 V: Throttle fully open	Read value with intrusive operation (active test)
THRTL COMND VAL	Throttle position command value/ Min.: 0 V, Max.: 4.98 V	0.5 to 4.8 V	ETCS service data
THROTTLE SSR #1	Throttle sensor opener position No. 1/Min.: 0 V, Max.: 4.98 V	0.6 to 1.0 V	ETCS service data

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
THROTTLE SSR #2	Throttle sensor opener position No. 2/Min.: 0 V, Max.: 4.98 V	2.0 to 2.6 V	ETCS service data
THRTL SSR #1 AD	Throttle sensor opener position No. 1 (AD)/Min.: 0 V, Max.: 4.98 V	0.6 to 0.9 V	ETCS service data
THROTTLE MOT	Throttle motor current/Min.: 0 A, Max.: 80 A	0 to 3.0 A: Idling (Inspection mode)	-
THROTTLE MOT	Whether or not throttle motor control is permitted/ON or OFF	Idling: ON (Inspection mode)	-
THROTTLE MOT	Throttle motor/Min.: 0%, Max.: 100%	0.5 to 40%: Idling (Inspection mode)	-
THROTTLE MOT	Throttle motor current/Min.: 0 A, Max.: 19.92 A	0 to 3.0 A: Idling (Inspection mode)	-
THROTL OPN DUTY	Throttle motor opening duty ratio/ Min.: 0%, Max.: 100%	0 to 40%: During idling (Inspection mode)	When accelerator pedal depressed, duty ratio increased
THROTL CLS DUTY	Throttle motor closed duty ratio/ Min.: 0%, Max.: 100%	0 to 40%: During idling (Inspection mode)	When accelerator pedal released quickly, duty ratio increased
THROTL MOT (OPN)	Throttle motor duty ratio (open)/ Min.: 0%, Max.: 100%	-	ETCS service data
THROTL 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 at 47 mph (75 km/h)	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 voltage for bank 1 sensor 1/Min.: 0 V Max.: 7.999 V	2.8 to 3.8 V: Idling (Inspection mode)	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 (Inspection mode)	-
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
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 (Inspection mode)	• 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	Short-term fuel trim associated with bank 1 sensor 2/Min.: -100%, Max.: 99.2%	-	Same as SHORT FT #1
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	-

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
AFS B1 S1	A/F sensor (bank 1 sensor 1) current/Min.: -128 mA, Max.: 127.99 mA	-0.5 to 0.5 mA: idling	-
CAT TEMP B1S1	Catalyst temperature (Bank 1, sensor 1)/Min.: -40°C, Max.: 6,513.5°C	-	-
CAT TEMP B1S2	Catalyst temperature (Bank 1, sensor 2)/Min.: -40°C, Max.: 6,513.5°C	-	-
S O2S B1S2	HO2 impedance bank 1 sensor 2/ Min.: 0 ohm, Max, 21247.68 ohm	5 to 15,000 ohm: Driving at constant vehicle speed	-
INI COOL TEMP	Initial engine coolant temperature/ Min.: -40°C, Max.: 120°C	Coolant temperature when engine started	Service data
INI INTAKE TEMP	Initial intake air temperature/Min.: -40°C, Max.: 120°C	Intake air temperature when engine started	Service data
INJ VOL	Injection volume (Cylinder 1)/Min.: 0 ml, Max.: 2.048 ml	0 to 0.5 ml	Fuel volume for 10 injections
CTP SW	Closed throttle position switch/ON or OFF	• ON: Throttle fully closed • OFF: Throttle open	-
ENG OIL PRES SW	Engine oil pressure switch signal/ 0: OFF, 1: ON	Indicating ON while engine is running	-
FUEL LID	Fuel lid position switch/Open or Close	ON: Open	-
STOP LIGHT SW	Stop light switch/ON or OFF	ON: Brake pedal depressed	-
FUEL LID SW	Fuel lid open switch/ON or OFF	ON: Open	-
+BM	Whether or not electric throttle control system power is inputted/ ON or OFF	Idling: ON (Inspection mode)	-
+BM VOLTAGE	+BM voltage/Min.: 0, Max.: 19.92	10 to 15 V: Idling (Inspection mode)	ETCS service data
BATTERY VOLTAGE	Battery voltage/Min.: 0, Max.: 65.535 V	9 to 14 V: Idling (Inspection mode)	-
ACTUATOR POWER	Actuator power supply/ON or OFF	Idling: ON (Inspection mode)	-
ATM PRESSURE	Atmospheric pressure/Min.: 0 kPa, Max.: 255 kPa	Equivalent to atmospheric pressure (absolute pressure)	-
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
EVAP VENT VAL	Key-off EVAP system vent valve status/ON or OFF	-	Active Test support data
TC/TE1	TC and TE1 terminal of DLC3/ON or OFF	-	-
FVCV	Key-off EVAP system vapor-containment valve status/ON or OFF	-	Active Test support data
FUEL FILLER OPN	Fuel lid opener motor actuating status/On or OFF	OFF: Motor is not actuated	Active Test support data
VVTL AIM ANGL #1	VVT aim angle (bank 1)/Min.: 0%, Max.: 100%	0%: Idling (Inspection mode)	VVT duty signal value during intrusive operation

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
VVT CHNG ANGL #1	VVT change angle/Min.: 0°FR, Max.: 60°FR	0 to 5°FR: Idling (Inspection mode)	Displacement angle during intrusive operation
VVT OCV DUTY B1	VVT OCV operation duty/Min.: 0%, Max.: 100%	0%: Idling (Inspection mode)	Requested duty value for intrusive operation
FC IDL	Fuel cut idle/ON or OFF	ON: Fuel cut operation	FC IDL = "ON" when throttle valve fully closed and engine speed over 2,800 rpm
FC TAU	Fuel cut TAU/ Fuel cut with very light load/ON or OFF	ON: Fuel cut operating	Fuel cut being performed under very light load to prevent incomplete engine combustion
IGNITION	Ignition counter/Min.: 0, Max.: 800	0 to 800	-
CYL #1, #2, #3, #4	Misfire ratio of cylinder 1 to 4/Min.: 0, Max.: 255	0%	This item displayed only during idling
CYL ALL	All cylinders misfire rate/Min.: 0, Max.: 255	0 to 35	-
MISFIRE RPM	Engine RPM for first misfire range/Min.: 0 rpm, Max.: 6,375 rpm	0 rpm: Misfire 0	-
MISFIRE LOAD	Engine load for first misfire range/ Min.: 0 g/rev, Max.: 3.98 g/rev	0 g/rev: Misfire 0	-
MISFIRE MARGIN	Misfire monitoring/Min.: -100%, Max.: 99.22%	-100 to 99.22%	Misfire detecting margin
#CODES	#Codes/Min.: 0, Max.: 255	-	Number of detected DTCs
CHECK MODE	Check mode/0: OFF, 1: ON	ON: Check mode ON	See page ES-34
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 B1	Check mode result for air-fuel ratio sensor (bank 1)/0: COMPL, 1: INCMPL	-	-
MIL	MIL status/ON or OFF	ON: MIL ON	-
MIL ON RUN DIST	MIL ON run distance/Min.: 0 second, Max.: 65,535 seconds	Distance after DTC detected	-
MIL ON RUN TIME	Running time from MIL ON/Min.: 0 minute, Max.: 65,535 minutes	Equivalent to running time after MIL ON	-
ENG RUN TIME	Engine run time/Min.: 0 second, Max.: 255 seconds	Time after engine start	Service data
TIME DTC CLEAR	Time after DTC cleared/Min.: 0 minute, Max.: 65,535 minutes	Equivalent to time after DTCs erased	-
DIST DTC CLEAR	Distance after DTC cleared/Min.: 0 km/h, Max.: 65,535 km/h	Equivalent to drive distance 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	-
COMP MON	Comprehensive component monitor/NOT AVL or AVAIL	-	-
FUEL MON	Fuel system monitor/NOT AVL or AVAIL	-	-
MISFIRE MON	Misfire monitor/NOT AVL or AVAIL	-	-
O2S (A/FS) MON	O2S (A/FS) monitor/NOT AVL or AVAIL	-	-
EVAP MON	EVAP monitor/NOT AVL or AVAIL	-	-

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
CAT MON	Catalyst monitor/NOT AVL or AVAIL	-	-
O2S(A/FS) MON	OS2 (A/FS) monitor/INCMPL or COMPL	-	-
EVAP MON	EVAP monitor/INCMPL or COMPL	-	-
CAT MON	Catalyst monitor/INCMPL or COMPL	-	-
CCM ENA	Comprehensive component monitor/UNABLE or ENABLE	-	-
CCM CMPL	Comprehensive component monitor/COMPL or INCMPL	-	-
FUEL ENA	Fuel system monitor/UNABLE or ENABLE	-	-
FUEL CMPL	Fuel system monitor/COMPL or INCMPL	-	-
MISFIRE ENA	Misfire monitor/UNABLE or ENABLE	-	-
MISFIRE CMPL	Misfire monitor/COMPL or INCMPL	-	-
EGR ENA	EGR monitor/UNABLE or ENABLE	-	-
EGR CMPL	EGR monitor/COMPL or INCMPL	-	-
HTR ENA	O2S (A/FS) heater monitor/ UNABLE or ENABLE	-	-
HTR CMPL	O2S (A/FS) heater monitor/ COMPL or INCMPL	-	-
O2S(A/FS) ENA	O2S(A/FS) monitor/UNABLE or ENABLE	-	-
O2S (A/FS) CMPL	O2S(A/FS) monitor/COMPL or INCMPL	-	-
ACRF ENA	A/C monitor/UNABLE or ENABLE	-	-
ACRF CMPL	A/C monitor/COMPL or INCMPL	-	-
AIR ENA	2nd air monitor/UNABLE or ENABLE	-	-
AIR CMPL	2nd air monitor/COMPL or INCMPL	-	-
EVAP ENA	EVAP monitor/UNABLE or ENABLE	-	-
EVAP CMPL	EVAP monitor/COMPL or INCMPL	-	-
HCAT ENA	Heated catalyst monitor/UNABLE or ENABLE	-	-
HCAT CMPL	Heated catalyst monitor/COMPL or INCMPL	-	-
CAT ENA	Catalyst monitor/UNABLE or ENABLE	-	-
CAT CMPL	Catalyst monitor/COMPL or INCMPL	-	-
REQ ENG TRQ	Repuested engine torque/Min.: 0kW, Max.: 16383.75 kW	0 to 110 kW	Flag information for hybrid vehicle
HV TRGT ENG SPD	HV target engine speed/Min.: 0 rpm, Max.: 6375 rpm	0 to 6000 rpm	Flag information for hybrid vehicle
ACT ENGINE TRQ	Actual engine torque/Min.: -128 Nm, Max.: 510 N.m	-187 to 187 Nm	Flag information for hybrid vehicle
EST ENGINE TRQ	Estimated engine torque/Min.: 0 Nm, Max.: 510 Nm	0 to 187 Nm	Flag information for hybrid vehicle

Tester Display	Measurement Item/Range	Normal Condition *1	Diagnostic Note
ENGINE RUN TIME	Engine run time/Min.: 0 second, Max.: 255 seconds	0 to 255 seconds	Flag information for hybrid vehicle
ENGINE RUN TIME	Request engine run time/Min.: 0 second, Max.: 25.5 seconds	0 to 25.5 seconds	Flag information for hybrid vehicle
IGNITION TIME	Judgment time for ignition of engine/Min.: 0 second, Max.: 25.5 seconds	0 to 25.5 seconds	Flag information for hybrid vehicle
OUTPUT TIME	Judgment time for engine output/ Min.: 0 second, Max.: 25.5 seconds	0 to 25.5 seconds	Flag information for hybrid vehicle
EST PORT TEMP	Estimated intake port temperature/Min.: -40°C, Max.: 215°C	80 to 100°C	Flag information for hybrid vehicle
FUEL LEVEL	Fuel level/0: EMPTY, 1: NOT EMPTY	-	-
ISC LEARNING	ISC learning/0: INCMPL, 1: COMPL	-	-
FUEL CUT	Fuel cut for engine stop request/0: OFF, 1: ON	-	-
INDPNDNT OPR	Engine independent operation/0: NOT OPR, 1: OPERATE	-	-
RACING	Racing operation/0: NOT OPR, 1: OPERATE	-	-
WARM UP	Request engine warm-up/0: NOT REQ, 1: REQUEST	-	-
INDPNDNT CNTRL	Engine independent control operation/0: NOT OPR, 1: OPERATE	-	-
ISC LEARN VAL	ISC learning value/Max: 19.92L/s, Min.: 0 L/s	-	Flag information for hybrid vehicle
MODEL CODE	Model code	-	Identifying model code: AHV40L
ENGINE TYPE	Engine type	-	Identifying engine type: 2AZFXE
CYLINDER NUMBER	Cylinder number/Min.: 0, Max.: 255	-	Identifying cylinder number: 4
DESTINATION	Destination	-	Identifying destination: A (America)
MODEL YEAR	Model year/Min.: 1,900, Max.: 2,155	-	Identifying model year: 200#
SYSTEM	System identification	-	Identifying engine system: HV

HINT:
*1: If no idling conditions are specified, the transmission gear selector lever should be in the N or P position, and the A/C switch and all accessory switches should be OFF.

2. ACTIVE TEST

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

(a) Put the engine in inspection mode (See page ES-35).
(b) Connect the intelligent tester to the DLC3.

(c) Turn the power switch on (IG).
(d) Turn the tester on.
(e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST.
(f) Perform the ACTIVE TEST by referring to the below.

Tester Display	Test Part	Control Range	Diagnostic Note
INJ VOL	Change injection volume	Between -12.5 and 24.8%	• All injectors tested at same time • Perform test at less than 3,000 rpm • Injection volume can be changed in 1% graduations within control range
A/F CONTROL	Change injection volume	Lower by 12.5% or increase by 24.8%	• Perform test at less than 3,000 rpm • A/F CONTROL enables 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, and press YES and ENTER followed by F4
EVAP VSV (ALONE)	Activate purge VSV control	ON/OFF	-
FUEL PUMP /SPD	Activate fuel pump (C/OPN Relay)	ON/OFF	-
TC/TE1	Turn on and off TC and TE1 connection	ON/OFF	• ON: TC and TE1 connected • OFF: TC and TE1 disconnected
FC IDL PROHBT	Prohibit idling fuel cut control	ON/OFF	-
COOLING FAN	Control electric cooling fan	ON/OFF	Test possible when following conditions met: • Power switch on (IG) • Engine is stopped
ETCS OPEN SLOW	Throttle actuator	ON: Throttle valve opens slowly	Test possible when following conditions met: • Power switch ON (IG) • Engine stopped • Accelerator pedal fully depressed (APP: 58 degrees or more)
ETCS CLOSE SLOW	Throttle actuator	ON: Throttle valve closes slowly	Same as above
ETCS OPEN FAST	Throttle actuator	ON: Throttle valve opens fast	Same as above
ETCS CLOSE FAST	Throttle actuator	ON: Throttle valve closes fast	Same as above
VVT B1	Control VVT (bank 1)	-128 to 127% This value added to present OCV control duty 100%: Maximum advance -100%: Maximum retard	Engine stall or rough idle when VVT actuator operated by 100%. Test possible during idle.
VVT CTRL B1	Turn on and off OCV (Oil Control Valve)	ON/OFF	• Engine stalls or idles roughly when OCV turned ON • Normal engine running or idling when OCV off
VACCUM PUMP	Vaccum pump	ON/OFF	-
VENT VALVE	Vent valve	ON/OFF	-
FUEL FILLER OPN	Fuel lid opener control	ON: Open	-
FVCV	Fuel vapor-containment valve control	ON: Open OFF: Close	-

Tester Display	Test Part	Control Range	Diagnostic Note
FUEL CUT #1	Cylinder #1 injector fuel cut	ON/OFF	Test possible during vehicle stopping and engine idling.
FUEL CUT #2	Cylinder #2 injector fuel cut	ON/OFF	Same as above
FUEL CUT #3	Cylinder #3 injector fuel cut	ON/OFF	Same as above
FUEL CUT #4	Cylinder #4 injector fuel cut	ON/OFF	Same as above

3. SYSTEM CHECK

HINT:

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

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

Tester Display	Test Part	Control Range	Diagnostic Note
EVAP SYS CHECK (AUTO OPERATION)	Perform 9 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-317)
EVAP SYS CHECK (MANUAL OPERATION)	Perform 9 steps in order to operate EVAP key-off monitor automatically	35°C (95°F) or less	• Used to detect malfunctioning parts • Refer to EVAP System (See page ES-317)

DIAGNOSTIC TROUBLE CODE CHART

HINT:
Parameters listed in the chart may be different than your readings depending on the type of instruments and other factors.
If any DTCs are displayed during a check mode DTC check, check the circuits for the DTCs listed in the table below. For details of each DTC, refer to the page indicated.

SFI SYSTEM:

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P0010	Camshaft Position "A" Actuator Circuit (Bank 1)	1. Open or short in OCV circuit 2. OCV 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-54
P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)	1. Valve timing 2. OCV 3. OCV filter 4. Camshaft timing gear assembly 5. Hybrid vehicle control ECU	Comes on	DTC stored	ES-58
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	1. Valve timing 2. OCV 3. OCV filter 4. Camshaft timing gear assembly 5. Hybrid vehicle control ECU	Comes on	DTC stored	ES-58
P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)	1. Mechanical system (Timing chain has jumped tooth or chain stretched) 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-64
P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)	1. Open in A/F sensor heater circuit 2. A/F sensor heater (sensor 1) 3. Integration relay (EFI MAIN relay) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-67
P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)	1. Short in A/F sensor heater circuit 2. A/F sensor heater (sensor 1) 3. Integration relay (EFI MAIN relay) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-67
P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)	1. Open in HO2 sensor heater circuit 2. HO2 sensor heater (sensor 2) 3. Integration relay (EFI MAIN relay) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-73
P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)	1. Short in HO2 sensor heater circuit 2. HO2 sensor heater (sensor 2) 3. Integration relay (EFI MAIN relay) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-73
P0100	Mass or Volume Air Flow Circuit	1. Open or short in MAF meter circuit 2. MAF meter 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-78
P0101	Mass Air Flow Circuit Range / Performance Problem	1. Mass Air Flow (MAF) meter 2. Air induction system 3. PCV hose connections	Comes on	DTC stored	ES-85
P0102	Mass or Volume Air Flow Circuit Low Input	1. Open or short in MAF meter circuit 2. MAF meter 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-78
P0103	Mass or Volume Air Flow Circuit High Input	1. Open or short in MAF meter circuit 2. MAF meter 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-78
P0110	Intake Air Temperature Circuit Malfunction	1. Open or short in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-89
P0112	Intake Air Temperature Circuit Low Input	1. Short in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-89

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P0113	Intake Air Temperature Circuit High Input	1. Open in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-89
P0115	Engine Coolant Temperature Circuit Malfunction	1. Open or short in ECT sensor circuit 2. ECT sensor 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-95
P0116	Engine Coolant Temperature Circuit Range / Performance Problem	1. Thermostat 2. ECT sensor	Comes on	DTC stored	ES-101
P0117	Engine Coolant Temperature Circuit Low Input	1. Short in ECT sensor 2. ECT sensor 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-95
P0118	Engine Coolant Temperature Circuit High Input	1. Open in ECT sensor circuit 2. ECT sensor 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-95
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction	1. Throttle Position (TP) sensor (built into throttle body) 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	ES-111
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. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
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. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control	1. ECT sensor 2. Cooling system 3. Thermostat	Comes on	DTC stored	ES-113
P0128	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)	1. Thermostat 2. Cooling system 3. ECT sensor 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-116
P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)	1. Open or short in HO2 sensor (sensor 2) circuit 2. HO2 sensor (sensor 2) 3. HO2 sensor heater (sensor 2) 4. Air-fuel Ratio (A/F) sensor (sensor 1) 5. Integration relay (EFI MAIN relay) 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-119
P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)	1. Open in HO2 sensor (sensor 2) circuit 2. HO2 sensor (sensor 2) 3. HO2 sensor heater (sensor 2) 4. Integration relay (EFI MAIN relay) 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-119
P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)	1. Short in HO2 sensor (sensor 2) circuit 2. HO2 sensor (sensor 2) 3. ECM internal circuit malfunction	Comes on	DTC stored	ES-119
P0141	Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)	1. HO2 sensor heater 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-73

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P0171	System Too Lean (Bank 1)	1. Air induction system 2. Injector blockage 3. Mass Air Flow (MAF) meter 4. Engine Coolant Temperature (ECT) sensor 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (sensor 1) circuit 8. A/F sensor (sensor 1) 9. A/F sensor heater (sensor 1) 10. Integration relay (EFI MAIN relay) 11. A/F sensor heater and EFI MAIN relay circuits 12. PCV valve and hose 13. PCV hose connections 14. Hybrid vehicle control ECU	Comes on	DTC stored	ES-137
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 (sensor 1) circuit 8. A/F sensor (sensor 1) 9. A/F sensor heater (sensor 1) 10. Integration relay (EFI MAIN relay) 11. A/F sensor heater and EFI MAIN relay circuits 12. Hybrid vehicle control ECU	Comes on	DTC stored	ES-137
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	1. TP sensor (built into throttle body) 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
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. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
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. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
P0300	Random / Multiple Cylinder Misfire Detected	1. Open or short in engine wire harness 2. Connector connection 3. Vacuum hose connections 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. Hybrid vehicle control ECU	Comes on	DTC stored	ES-146

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P0301	Cylinder 1 Misfire Detected	1. Open or short in engine wire harness 2. Connector connection 3. Vacuum hose connections 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. Hybrid vehicle control ECU	Comes on	DTC stored	ES-146
P0302	Cylinder 2 Misfire Detected	1. Open or short in engine wire harness 2. Connector connection 3. Vacuum hose connections 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. Hybrid vehicle control ECU	Comes on	DTC stored	ES-146
P0303	Cylinder 3 Misfire Detected	1. Open or short in engine wire harness 2. Connector connection 3. Vacuum hose connections 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. Hybrid vehicle control ECU	Comes on	DTC stored	ES-146
P0304	Cylinder 4 Misfire Detected	1. Open or short in engine wire harness 2. Connector connection 3. Vacuum hose connections 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. Hybrid vehicle control ECU	Comes on	DTC stored	ES-146
P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)	1. Short in knock sensor circuit 2. Knock sensor 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-159

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)	1. Open in knock sensor curcuit 2. Knock sensor 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-159
P0335	Crankshaft Position Sensor "A" Circuit	1. Open or short in CKP sensor circuit 2. CKP sensor 3. CKP sensor plate 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-163
P0340	Camshaft Position Sensor "A" Circuit (Bank 1 or Single Sensor)	1. Open or short in CMP sensor circuit 2. CMP sensor 3. Camshaft 4. Jumped tooth of timing chain 5. Hybrid vehicle control ECU	Comes on	DTC stored	ES-169
P0351	Ignition Coil "A" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 4) between ignition coil with igniter and hybrid vehicle control ECU 3. No. 1 to No. 4 ignition coils with igniters 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-173
P0352	Ignition Coil "B" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 4) between ignition coil with igniter and hybrid vehicle control ECU 3. No. 1 to No. 4 ignition coils with igniters 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-173
P0353	Ignition Coil "C" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 4) between ignition coil with igniter and hybrid vehicle control ECU 3. No. 1 to No. 4 ignition coils with igniters 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-173
P0354	Ignition Coil "D" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 4) between ignition coil with igniter and hybrid vehicle control ECU 3. No. 1 to No. 4 ignition coils with igniters 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-173
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	1. Front exhaust pipe (with TWC) 2. Gas leakage from exhaust system 3. Air-Fuel Ratio (A/F) sensor (sensor 1) 4. Heated Oxygen (HO2) sensor (sensor 2)	Comes on	DTC stored	ES-182
P043E	Evaporative Emission System Reference Orifice Clog Up	1. Canister pump module (Reference orifice, leak detection pump, vent valve) 2. Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) 3. EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-189
P043F	Evaporative Emission System Reference Orifice High Flow	1. Canister pump module (Reference orifice, leak detection pump, vent valve) 2. Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) 3. EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-189

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P0441	Evaporative Emission Control System Incorrect Purge Flow	1. EVAP VSV 2. Connector / wire harness (EVAP VSV - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU 4. Pump module 5. Leakage from EVAP system 6. Leakage from EVAP line (EVAP VSV - Intake manifold)	Comes on	DTC stored	ES-194
P0450	Evaporative Emission Control System Pressure Sensor / Switch	1. Pump module 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-201
P0451	Evaporative Emission Control System Pressure Sensor Range / Performance	1. Pump module 2. Connector / wire harness (Pump module - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-201
P0452	Evaporative Emission Control System Pressure Sensor / Switch Low Input	1. Pump module 2. Connector / wire harness (Pump module - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-201
P0453	Evaporative Emission Control System Pressure Sensor / Switch High Input	1. Pump module 2. Connector / wire harness (Pump module - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-201
P0505	Idle Control System Malfunction	1. ETCS 2. Air induction system 3. PCV hose connections 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-210
P050A	Cold Start Idle Air Control System Performance	1. Throttle body assembly 2. Mass air flow meter 3. Air induction system 4. PCV hose connections 5. VVT system 6. Air cleaner filter element 7. Hybrid vehicle control ECU	Comes on	DTC stored	ES-214
P050B	Cold Start Ignition Timing Performance	1. Throttle body assembly 2. Mass air flow meter 3. Air induction system 4. PCV hose connections 5. VVT system 6. Air cleaner filter element 7. Hybrid vehicle control ECU	Comes on	DTC stored	ES-214
P0560	System Voltage	1. Open in back up power source circuit 2. Battery 3. Battery terminals 4. EFI MAIN fuse 5. Hybrid vehicle control ECU	Comes on	DTC stored	ES-220
P0604	Internal Control Module Random Access Memory (RAM) Error	Hybrid vehicle control ECU	Comes on	DTC stored	ES-224
P0606	ECM / PCM Processor	Hybrid vehicle control ECU	Comes on	DTC stored	ES-226
P0607	Control Module Performance	Hybrid vehicle control ECU	Comes on	DTC stored	ES-229
P0657	Actuator Supply Voltage Circuit / Open	Hybrid vehicle control ECU	Comes on	DTC stored	ES-231
P1420	Evaporative Emission Canister Small Leak	1. Leakage from EVAP line (Canister - Fuel vapor-containment valve) 2. Leakage from EVAP line (Purge VSV - Canister) 3. Pump module 4. Leakage from canister	Comes on	DTC stored	ES-233
P1421	Evaporative Emission Canister Gross Leak	Same above	Comes on	DTC stored	ES-233

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P1422	Fuel Tank Small Leak	1. Leakage from EVAP line (Canister - Fuel vapor-containment valve) 2. Leakage from EVAP line (Purge VSV - Canister) 3. Pump module 4. Leakage from canister	Comes on	DTC stored	ES-238
P1423	Fuel Tank Gross Leak	Same above	Comes on	DTC stored	ES-238
P1450	Fuel Tank Pressure Sensor	1. Fuel tank pressure sensor 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-243
P1451	Fuel Tank Pressure Sensor Range/ Performance	1. Fuel tank pressure sensor 2. Connector / wire harness (Fuel tank pressure sensor - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-243
P1452	Fuel Tank Pressure Sensor Low Input	1. Fuel tank pressure sensor 2. Connector / wire harness (Fuel tank pressure sensor - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-243
P1453	Fuel Tank Pressure Sensor High Input	1. Fuel tank pressure sensor 2. Connector / wire harness (Fuel tank pressure sensor - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-243
P2102	Throttle Actuator Control Motor Circuit Low	1. Open in throttle actuator circuit 2. Throttle actuator 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-252
P2103	Throttle Actuator Control Motor Circuit High	1. Short in throttle actuator circuit 2. Throttle actuator 3. Throttle valve 4. Throttle body assembly 5. Hybrid vehicle control ECU	Comes on	DTC stored	ES-252
P2111	Throttle Actuator Control System - Stuck Open	1. Throttle actuator 2. Throttle body 3. Throttle valve	Comes on	DTC stored	ES-256
P2112	Throttle Actuator Control System - Stuck Closed	1. Throttle actuator 2. Throttle body 3. Throttle valve	Comes on	DTC stored	ES-256
P2118	Throttle Actuator Control Motor Current Range / Performance	1. Open in ETCS power source circuit 2. Battery 3. Battery terminals 4. ETCS fuse 5. Hybrid vehicle control ECU	Comes on	DTC stored	ES-259
P2119	Throttle Actuator Control Throttle Body Range / Performance	1. ETCS 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-266
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. Hybrid vehicle control ECU	Comes on	DTC stored	ES-104
P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)	1. Open or short in A/F sensor (sensor 1) circuit 2. A/F sensor (sensor 1) 3. A/F sensor heater (sensor 1) 4. Integration relay (EFI MAIN relay) 5. A/F sensor heater and EFI MAIN relay circuits 6. Hybrid vehicle control ECU 7. A/F sensor	Comes on	DTC stored	ES-269

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	1. Open or short in A/F sensor (sensor 1) circuit 2. A/F sensor (sensor 1) 2. A/F sensor heater (sensor 1) 3. Integration relay (EFI MAIN relay) 4. A/F sensor heater and EFI MAIN relay circuits 5. Hybrid vehicle control ECU 6. A/F sensor	Comes on	DTC stored	ES-269
P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)	1. Open or short in A/F sensor (sensor 1) circuit 2. A/F sensor (sensor 1) 3. A/F sensor heater (sensor 1) 4. Integration relay (EFI MAIN relay) 5. A/F sensor heater and EFI MAIN relay circuits 6. Hybrid vehicle control ECU	Comes on	DTC stored	ES-283
P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	1. Open or short in A/F sensor (sensor 1) circuit 2. A/F sensor (sensor 1) 3. A/F sensor heater (sensor 1) 4. Integration relay (EFI MAIN relay) 5. A/F sensor heater and EFI MAIN relay circuits 6. Hybrid vehicle control ECU	Comes on	DTC stored	ES-283
P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	1. Open or short in A/F sensor (sensor 1) circuit 2. A/F sensor (sensor 1) 3. A/F sensor heater (sensor 1) 4. Integration relay (EFI MAIN relay) 5. A/F sensor heater and EFI MAIN relay circuits 6. Hybrid vehicle control ECU	Comes on	DTC stored	ES-283
P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	1. Open or short in A/F sensor (sensor 1) circuit 2. A/F sensor (sensor 1) 3. A/F sensor heater (sensor 1) 4. Integration relay (EFI MAIN relay) 5. A/F sensor heater and EFI MAIN relay circuits 6. Hybrid vehicle control ECU	Comes on	DTC stored	ES-283
P2401	Evaporative Emission Leak Detection Pump Stuck OFF	1. Canister pump module (Reference orifice, leak detection pump, vent valve) 2. Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) 3. EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-189
P2402	Evaporative Emission Leak Detection Pump Stuck ON	1. Canister pump module (Reference orifice, leak detection pump, vent valve) 2. Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) 3. EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-189

DTC Code	Detection Item	Trouble Area	MIL	Memory	See page
P2419	Evaporative Emission System Switching Valve Control Circuit Low	1. Canister pump module (Reference orifice, leak detection pump, vent valve) 2. Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) 3. EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) 4. Hybrid vehicle control ECU	Comes on	DTC stored	ES-189
P2420	Evaporative Emission System Switching Valve Control Circuit High	1. Canister pump module (Reference orifice, leak detection pump, vent valve) 2. Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-289
P2450	Fuel Vapor-containment Valve Stuck Open	1. Fuel vapor-containment valve 2. Connector / wire harness (Fuel vapor-containment valve - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-293
P2451	Fuel Vapor-containment Valve Stuck Close	1. Fuel vapor-containment valve 2. Connector / wire harness (Fuel vapor-containment valve - Hybrid vehicle control ECU) 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-293
P2610	ECM / PCM Internal Engine Off Timer Performance	Hybrid vehicle control ECU	Comes on	DTC stored	ES-298
P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)	1. Open or short in A/F sensor circuit 2. A/F sensor 3. Hybrid vehicle control ECU	Comes on	DTC stored	ES-300
P3190	Poor Engine Power	1. Air induction system 2. Throttle body 3. Fuel pressure 4. Engine 5. Mass air flow meter 6. Out of fuel 7. Engine coolant temperature sensor 8. Crankshaft position sensor 9. Camshaft position sensor 10. Hybrid vehicle control ECU	Comes on	DTC stored	ES-307
P3191	Engine does not Start	1. Air induction system 2. Throttle body 3. Fuel pressure 4. Engine 5. Mass air flow meter 6. Out of fuel 7. Engine coolant temperature sensor 8. Crankshaft position sensor 9. Camshaft position sensor 10. Hybrid vehicle control ECU	Comes on	DTC stored	ES-307
P3193	Fuel Run Out	1. Out of fuel 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-307
U0001	High Speed CAN Communication Circuit	Hybrid vehicle control ECU	Comes on	DTC stored	ES-314
U0293	Lost Communication with HV ECU	1. Wire harness 2. Hybrid vehicle control ECU	Comes on	DTC stored	ES-316

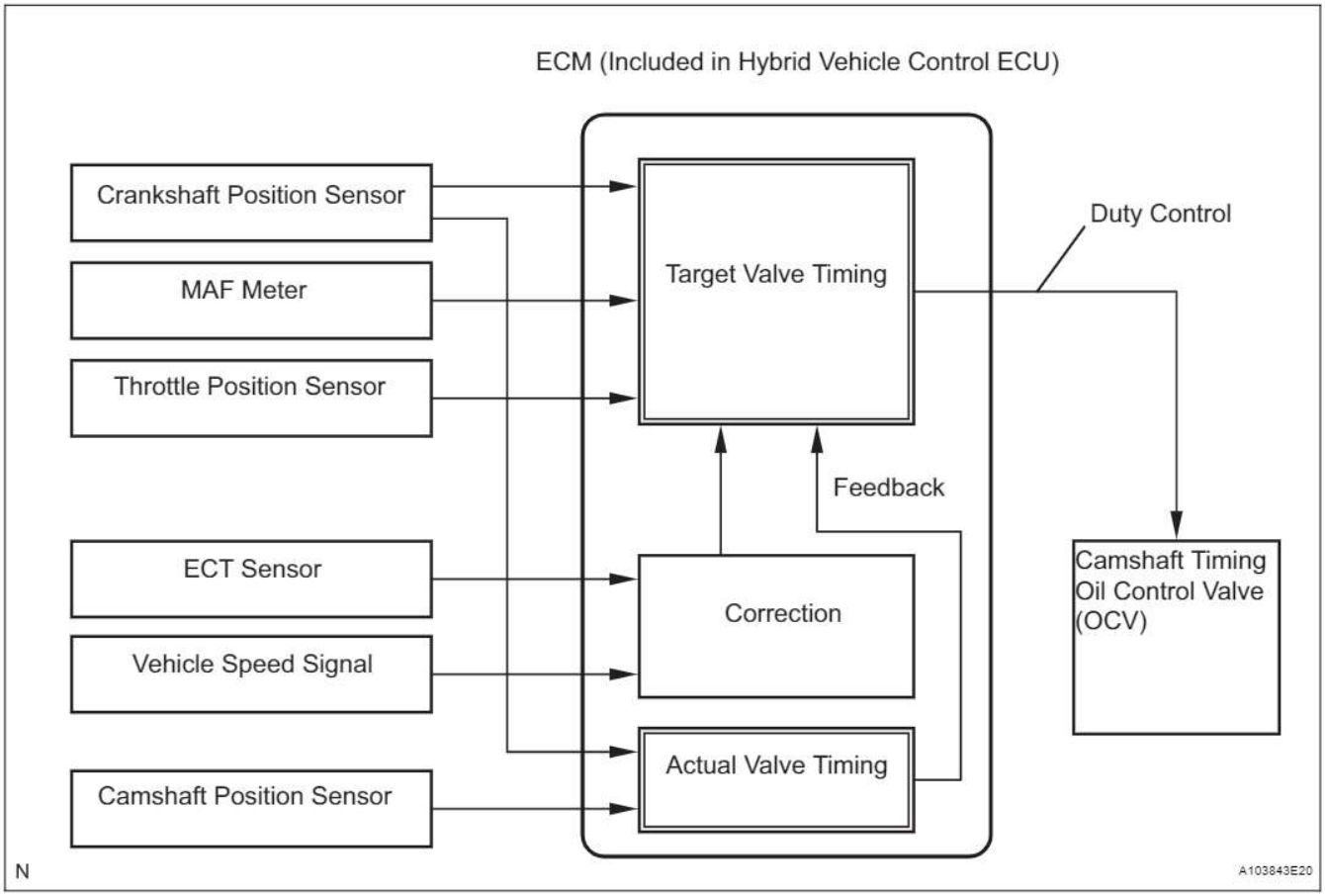
*1: Blinks when a terrible misfire is detected.

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

DESCRIPTION

The Variable Valve Timing (VVT) system includes the ECM (included in hybrid vehicle control ECU), OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV, based on the signals transmitted by several sensors. The VVT controller regulates the 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.

ES



DTC No.	DTC Detection Conditions	Trouble Areas
P0010	Open or short in OCV circuit (1-trip detection logic)	• Open or short in OCV circuit • OCV • Hybrid vehicle control ECU

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

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 supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft.
After the ECM sends the target duty-cycle control signal to the OCV, the ECM monitors the OCV current to establish an actual duty-cycle. The ECM determines the existence of a malfunction and sets the DTC when the actual duty-cycle ratio varies from the target duty-cycle ratio.

MONITOR STRATEGY

Related DTCs	P0010: VVT OCV range check
Required Sensors/Components (Main)	VVT OCV
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	1 second
MIL Operation	Immediate
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None
All of following conditions met	-
Starter	OFF
Power switch	ON
Time after power switch OFF to ON	0.5 seconds or more

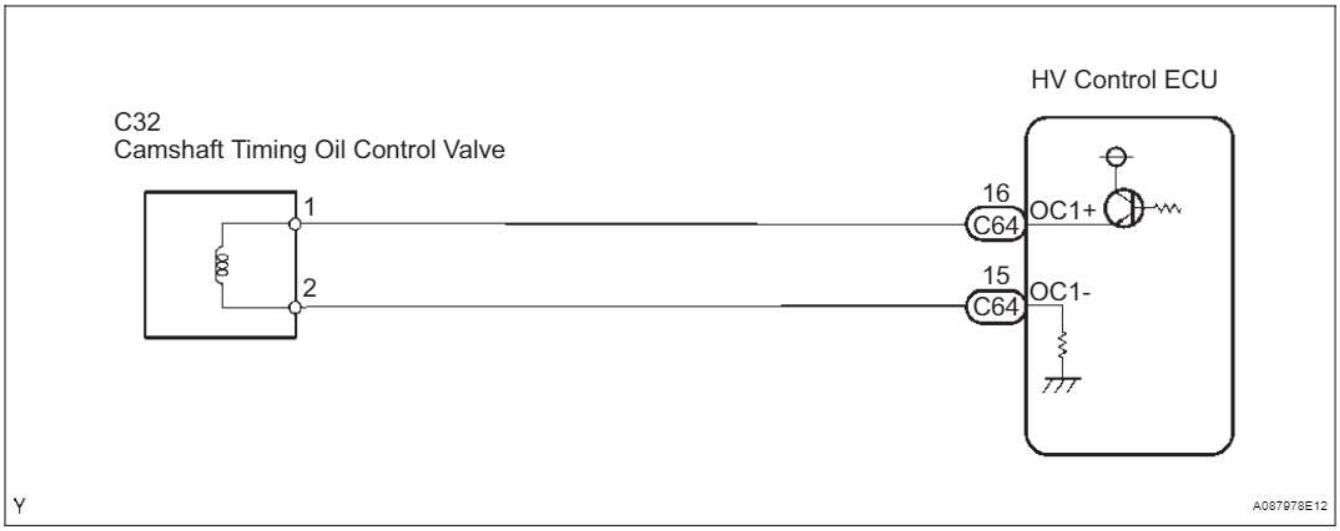
TYPICAL MALFUNCTION THRESHOLDS

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

COMPONENT OPERATING RANGE

VVT OCV duty ratio	3 to 100%

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM (include in hybrid vehicle control ECU) records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1.
(f) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

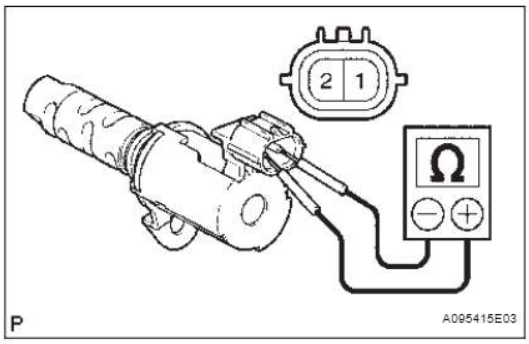
OK

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

OK → CHECK FOR INTERMITTENT PROBLEMS

NG

2 **INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY**

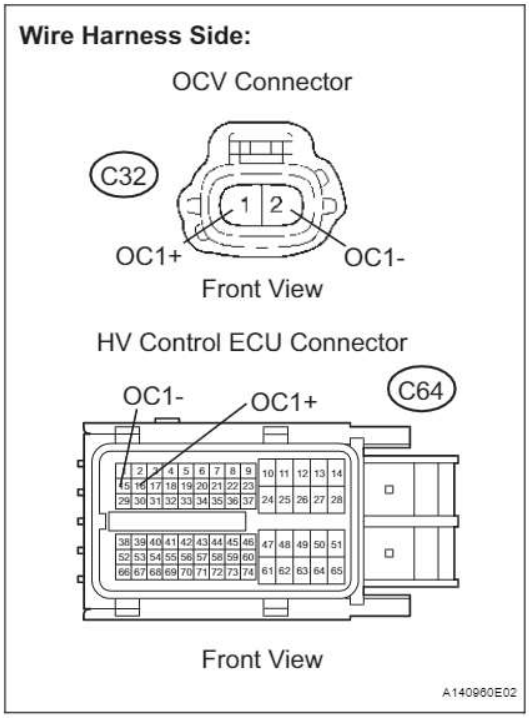


(a) Disconnect the C32 OCV connector.
(b) Measure the resistance between the terminals of the OCV.
Standard resistance:
6.9 to 7.9 Ω at 20°C (68°F)
(c) Reconnect the OCV connector.

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

OK

3 **CHECK HARNESS AND CONNECTOR (OCV - HV CONTROL ECU)**



(a) Disconnect the C32 OCV connector.
(b) Disconnect the A61 hybrid vehicle control ECU connector.
(c) Measure the resistance according to the value(s) in the table below.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
C32-1 (OC1+) - C64-16 (OC1+)	Below 1 Ω
C32-2 (OC1-) - C64-15 (OC1-)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C32-1 (OC1+) or C64-16 (OC1+) - Body ground	10 kΩ or higher
C32-2 (OC1-) or C64-15 (OC1-) - Body ground	10 kΩ or higher

(d) Reconnect the OCV connector.
(e) Reconnect the hybrid vehicle control ECU connector.

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

OK

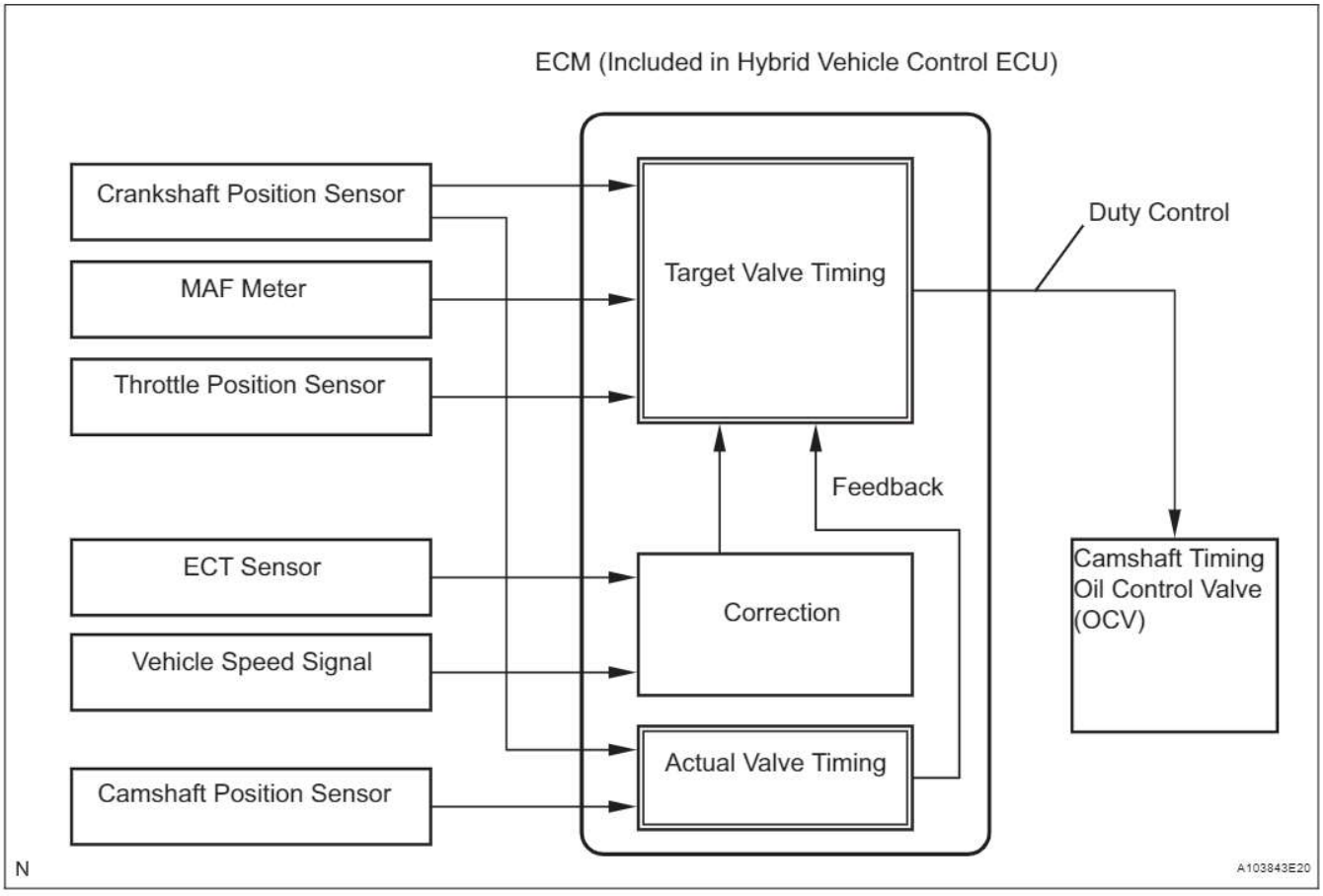
REPLACE HYBRID VEHICLE CONTROL ECU

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

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

DESCRIPTION

The VVT system includes the ECM (include in hybrid vehicle control ECU), Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV, based on the signals transmitted by several sensors. The VVT controller regulates the 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
P0011	Advanced camshaft timing: With warm engine and engine speed of between 800 rpm and 4,000 rpm, all conditions (1), (2) and (3) met (1-trip detection logic): 1. Difference between target and actual intake valve timings more than 5°CA (Crankshaft Angle) for 4.5 seconds 2. Current intake valve timing fixed (timing changes less than 5°CA in 5 seconds) 3. Variations in VVT controller timing more than 19°CA of maximum delayed timing (malfunction in advance timing)	• Valve timing • OCV • OCV filter • Camshaft timing gear assembly • Hybrid vehicle control ECU
P0012	Retarded camshaft timing: With warm engine and engine speed of between 800 rpm and 4,000 rpm, all conditions (1), (2) and (3) met (2-trip detection logic): 1. Difference between target and actual intake valve timings more than 5°CA (Crankshaft Angle) for 4.5 seconds 2. Current intake valve timing fixed (timing changes less than 5°CA in 5 seconds) 3. Variations in VVT controller timing 19°CA or less of maximum delayed timing (malfunction in retarded timing)	• Valve timing • OCV • OCV filter • Camshaft timing gear assembly • Hybrid vehicle control ECU

ES

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 supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft. If the difference between the target and actual intake valve timings is large, and changes in the actual intake valve timing are small, the ECM interprets this as a VVT controller stuck malfunction and sets a DTC.

Example:

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

1. The difference between the target and actual intake valve timing 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.

DTC P0011 (Advanced Cam Timing) is subject to 1-trip detection logic.

DTC P0012 (Retarded Cam Timing) is subject to 2-trip detection logic.

These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or presence of foreign objects in the OCV.

The monitor will run if all of 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 camshaft timing P0012: Retarded camshaft timing
Required Sensors/Components (Main)	VVT OCV and VVT Actuator
Required Sensors/Components (Related)	Crankshaft position sensor, camshaft position sensor and engine coolant temperature sensor
Frequency of Operation	Once per driving cycle
Duration	Within 10 seconds

MIL Operation	Advanced camshaft timing: Immediate Retarded camshaft timing: 2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0100 - P0103 (MAF meter) P0115 - P0118 (ECT sensor) P0125 (Insufficient ECT for closed loop) P0335 (CKP sensor) P0340 (CMP sensor) P0351 - P0354 (Igniter)
Battery voltage	11 V or more
Engine RPM	800 to 4,000 rpm
ECT	75°C (167°F) to 100°C (212°F)

ES

TYPICAL MALFUNCTION THRESHOLDS

Advanced camshaft timing:

All of following conditions met	-
Crank angle between reference position and actual intake camshaft angle	62°CA or more
Valve timing	No change at advanced valve timing

Retard camshaft timing:

All of following conditions met	-
Crank angle between reference point and actual intake camshaft angle	Less than 62°CA
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-56).

INSPECTION PROCEDURE

NOTICE:

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

HINT:

If DTC P0011 or P0012 is present, check the VVT (Variable Valve Timing) system.
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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

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

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

(d) Read the DTCs.

Result

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

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

B → GO TO DTC CHART

A

ES

2 PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1.
(f) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK

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

NG → Go to step 4

OK

3 CHECK WHETHER DTC OUTPUT RECURS (DTC P0011 OR P0012)

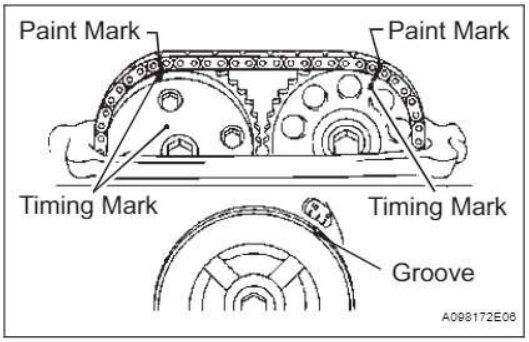
(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Put the engine in inspection mode (See page ES-35).
(e) Warm up the engine.
(f) Switch the hybrid vehicle control ECU from normal mode to check mode using the tester.
(g) Drive the vehicle for more than 10 minutes.
(h) Read the DTCs using the tester.
OK:
No DTC output.

NG → Go to step 4

OK

END

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

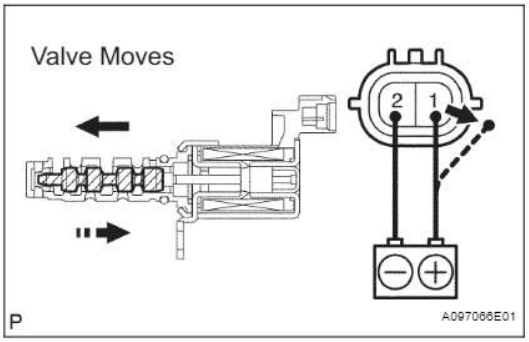


(a) Remove the cylinder head cover.
(b) Turn the crankshaft pulley, and align its groove with the timing mark "0" on the timing chain cover.
(c) Check that the timing marks on the camshaft timing sprocket and camshaft timing gear are facing upward as shown in the illustration.
If not, turn the crankshaft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

NG → ADJUST VALVE TIMING

OK

5	INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV)

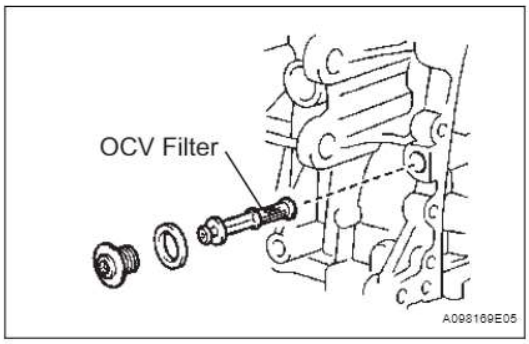


(a) Remove the OCV.
(b) Measure the resistance between the terminals of the OCV.
Standard resistance:
6.9 to 7.9 Ω at 20°C (68°F)
(c) Apply positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.
OK:
Valve moves quickly.
(d) Reinstall the OCV.

NG → REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

OK

6	INSPECT OIL CONTROL VALVE FILTER



(a) Remove the generator.
(b) Remove the OCV filter.
(c) Check that the filter is not clogged.
OK:
Filter is not clogged.
(d) Reinstall the OCV filter.
(e) Reinstall the generator.

NG → **CLEAN 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 power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Put the engine in inspection mode (See page ES-35).
(e) Warm up the engine.
(f) Switch the hybrid vehicle control ECU from normal mode to check mode using the tester.
(g) Drive the vehicle for more than 10 minutes.
(h) Read the output DTCs using the tester.
Standard:
No DTC output.
HINT:
DTC P0011 or P0012 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.

OK → **SYSTEM IS OK**

NG

REPLACE HYBRID VEHICLE CONTROL ECU

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

DESCRIPTION

In the VVT (Variable Valve Timing) system, the appropriate intake valve open and close timing is controlled by the ECM (included in hybrid vehicle control ECU). The ECM performs intake valve control by performing the following: 1) controlling the camshaft and camshaft timing oil control valve, and operating the camshaft timing gear; and 2) changing the relative positions of the gaps between the camshaft and crankshaft.

DTC No.	DTC Detection Conditions	Trouble Areas
P0016	Deviation in crankshaft and camshaft position sensor signals (2-trip detection logic)	• Mechanical system (Timing chain has jumped tooth or chain stretched) • Hybrid vehicle control ECU

ES

MONITOR DESCRIPTION

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 supplied 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.

- VVT learning value: Less than 25°CA, or more than 51°CA.
- Above condition continues for 18 seconds or more.

This DTC indicates that the angle between the intake camshaft and the crankshaft is incorrect due to factors such as the timing chain having jumped a tooth.
This monitor begins to run after the engine has idled for 5 minutes.

MONITOR STRATEGY

Related DTCs	P0016: Camshaft timing misalignment at idling
Required Sensors/Components	VVT actuator
Required Sensors/Components	Camshaft position sensor, Crankshaft position sensor
Frequency of Operation	Once per driving cycle
Duration	Within 1 minute
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0011 (VVT system 1 - advance) P0012 (VVT system 1 - retarded) P0115 - P0118 (ECT sensor)
Engine RPM	800 to 1,000 rpm

TYPICAL MALFUNCTION THRESHOLDS

One of following conditions met	-
VVT learning value when camshaft maximum retarded	Less than 27.8°CA

VVT learning value when camshaft maximum retarded	More than 48°CA

WIRING DIAGRAM

Refer to DTC P0335 (See page ES-163).

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

1	CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TOOTH OF TIMING CHAIN) (See page ES-68)

NG → Go to step 3

OK

2	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT → Go to step 4

3	ADJUST VALVE TIMING

NEXT

4	CHECK WHETHER DTC OUTPUT RECURS

NOTICE:

After replacing the hybrid vehicle control ECU or adjusting intake valve timing, confirm that the DTC output does not recur.

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear DTCs (See page ES-31).
(e) Switch the hybrid vehicle control ECU from normal mode to check mode using the tester (See page ES-34).
(f) Put the engine in inspection mode (See page ES-35).
(g) Warm up the engine.
(h) Allow the engine to idle for 1 minute or more, and then drive the vehicle for 1 minute or more.
(i) Confirm that no DTC is set, using the tester.

OK:

No DTC output

NEXT

END

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)

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.

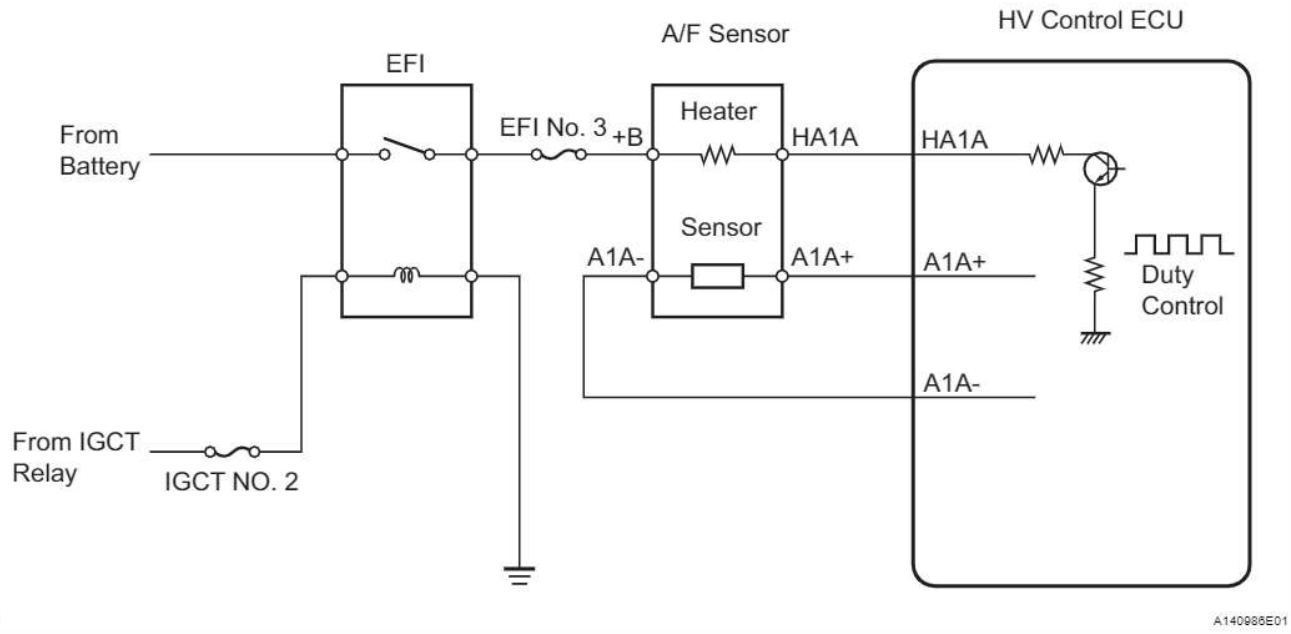
ES

DESCRIPTION

Refer to DTC P2195 (See page ES-269).

HINT:
- When either of these DTCs is set, the ECM (included in hybrid vehicle control ECU) enters fail-safe mode. In fail-safe mode, the ECM turns off the A/F sensor heater. Fail-safe mode continues until the power 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	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 (sensor 1) • Integration relay (EFI MAIN relay) • Hybrid vehicle control ECU
P0032	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 (sensor 1) • Integration relay (EFI MAIN relay) • Hybrid vehicle control ECU

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 gases.

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 a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.

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 becomes inaccurate, as a result, the ECM is 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 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 is set.

MONITOR STRATEGY

Related DTCs	P0031: A/F sensor heater open/short (Low electrical current) P0032: A/F sensor heater open/short (High electrical current)
Required Sensors/Components (Main)	A/F sensor heater
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	10 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	None

P0031:

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

P0032:

Time after engine start	10 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P0031:

A/F sensor heater current	Less than 0.8 A

P0032:

A/F sensor heater current	More than 10 A

COMPONENT OPERATING RANGE

A/F sensor heater current	0.9 to 9.9 A

WIRING DIAGRAM

Refer to DTC P2195 (See page ES-273).

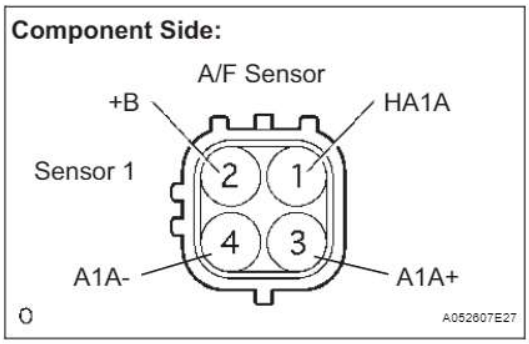
INSPECTION PROCEDURE

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

1 INSPECT AIR-FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the C15 A/F sensor connector.

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

Standard resistance

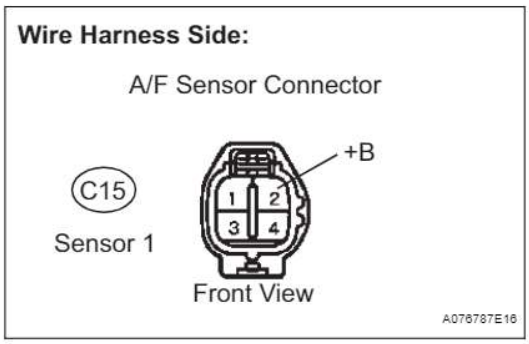
Tester Connections	Specified Conditions
1 (HA1A) - 2 (+B)	1.8 to 3.4 Ω at 20°C (68°F)
1 (HA1A) - 4 (A1A-)	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → REPLACE AIR-FUEL RATIO SENSOR

OK

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



(a) Disconnect the C15 A/F sensor connector.

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

(c) Measure the voltage between the terminal of the C15 A/F sensor connector and body ground.

Standard voltage

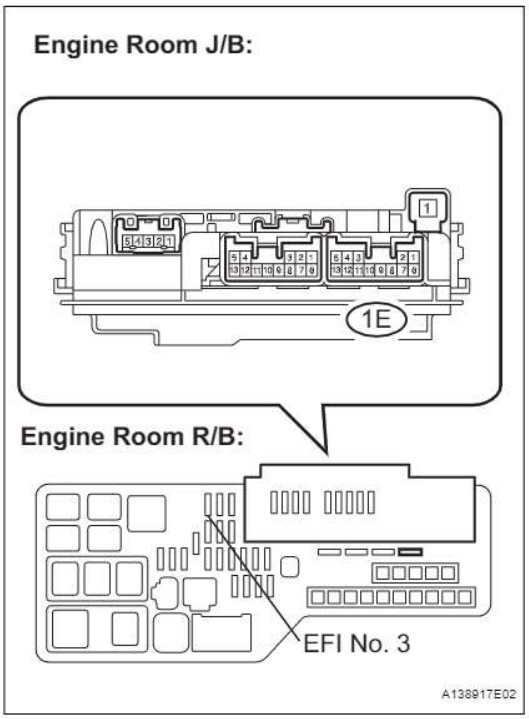
Tester Connections	Specified Conditions
C15-2 (+B) - Body ground	9 to 14 V

(d) Reconnect the A/F sensor connector.

OK → Go to step 5

NG

3	INSPECT INTEGRATION RELAY (EFI RELAY)



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

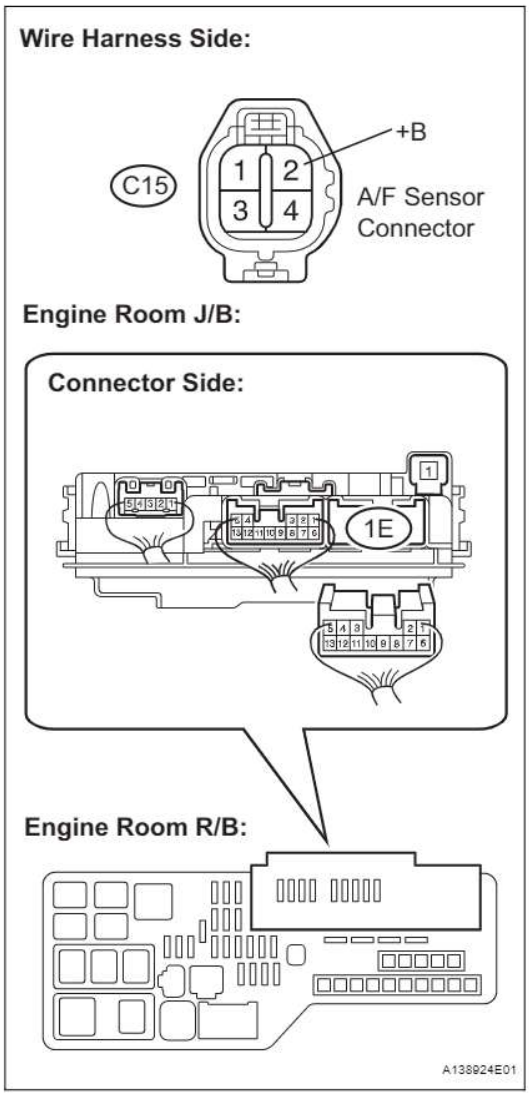
Tester Connections	Specified Conditions
1E-7 - 1E-12	10 kΩ or higher
	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

(d) Reinstall the integration relay.

NG → REPLACE INTEGRATION RELAY

OK

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



(a) Disconnect the C15 A/F sensor connector.
(b) Remove the integration relay from the engine room R/B and J/B.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C15-2 (+B) - 1E-7 (Engine room R/B and J/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C15-2 (+B) or 1E-7 (Engine room R/B and J/B) - Body ground	10 kΩ or higher

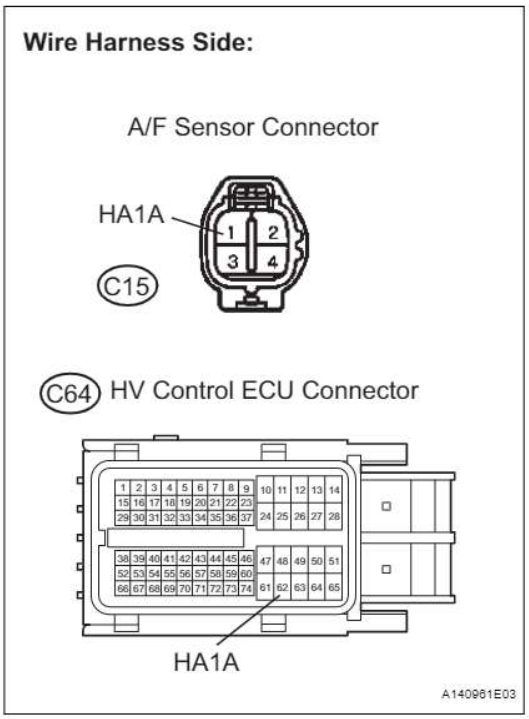
(d) Reconnect the A/F sensor connector.
(e) Reinstall the integration relay.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT

5 CHECK HARNESS AND CONNECTOR (A/F SENSOR - HV CONTROL ECU)



(a) Disconnect the C15 A/F sensor connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C15-1 (HA1A) - C64-62 (HA1A)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C15-1 (HA1A) or C64-62 (HA1A) - Body ground	10 kΩ or higher

(d) Reconnect the A/F sensor connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Put the engine in inspection mode (See page ES-35).
(f) Allow the engine to idle for 1 minute or more.
(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(h) Read the DTCs.

Result

Display (DTC Output)	Proceed to
No output	A
P0031 or P0032	B

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

CHECK FOR INTERMITTENT PROBLEMS

DTC	P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)

DTC	P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)

DTC	P0141	Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)

DESCRIPTION

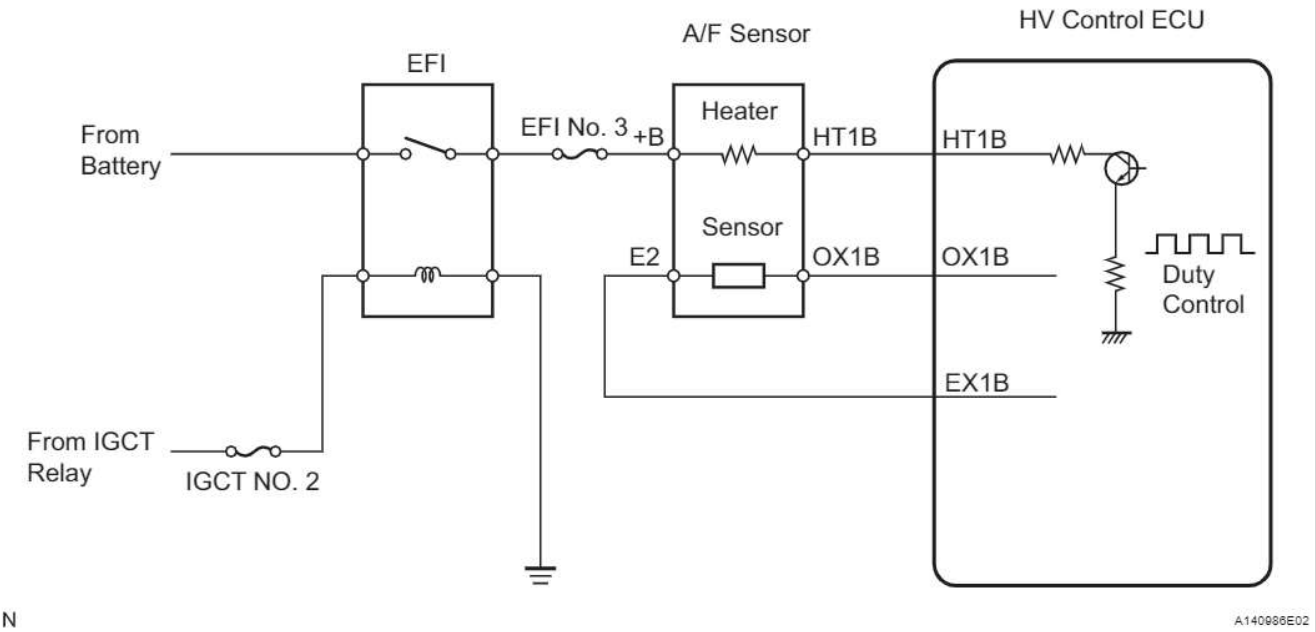
ES

Refer to DTC P0136 (See page ES-119).

HINT:

- When any of these DTCs are set, the ECM (included in hybrid vehicle control ECU) enters fail-safe mode. In fail-safe mode, the ECM turns off the Heated Oxygen (HO2) Sensor heater. Fail-safe mode continues until the power 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	Heated Oxygen (HO2) sensor heater current less than 0.3 A (1-trip detection logic)	• Open in HO2 sensor heater circuit • HO2 sensor heater (sensor 2) • Integration relay (EFI MAIN relay) • Hybrid vehicle control ECU
P0038	Heated Oxygen (HO2) sensor heater current more than 2 A (1-trip detection logic)	• Short in HO2 sensor heater circuit • HO2 sensor heater (sensor 2) • Integration relay (EFI MAIN relay) • Hybrid vehicle control ECU
P0141	Cumulative heater resistance correction value exceeds the acceptable threshold. (2-trip detection logic)	• HO2 sensor heater • Hybrid vehicle control ECU

MONITOR DESCRIPTION

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

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

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

The ECM constantly monitors the current applied to the heater. If the ECM detects an open or short circuit, the ECM turns the MIL on and sets a DTC.

ES

If a malfunction is detected, the ECM cuts off the current applied to the heater.

Example:

The ECM sets DTC P0038 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 is set.

MONITOR STRATEGY

Related DTCs	P0037: Heated oxygen sensor heater range check (Low electrical current) P0038: Heated oxygen sensor heater range check (High electrical current) P0141: Heated oxygen sensor heater performance
Required Sensors/Components (Main)	Heated oxygen sensor heater
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous: P0037 and P0038 Once per driving cycle: P0141
Duration	1 second: P0037 and P0038 10 seconds: P0141
MIL Operation	Immediate: P0037 and P0038 2 driving cycles: P0141
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	None

P0037:

Battery voltage	10.5 to 20 V

P0038:

Battery voltage	10.5 to 20 V

TYPICAL MALFUNCTION THRESHOLDS

P0037:

Heater current	Less than 0.3 A

P0038:

Heater current	More than 2 A

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)

WIRING DIAGRAM

Refer to DTC P0136 (See page ES-126).

CONFIRMATION DRIVING PATTERN

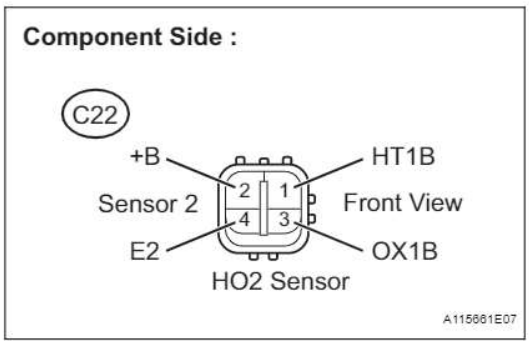
These DTCs are detected when the engine idles for 110 seconds or more.

INSPECTION PROCEDURE

HINT:
Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.
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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

1 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



(a) Disconnect the C22 Heated Oxygen (HO2) sensor connector.
(b) Measure the resistance according to the value(s) in the table below.

Standard resistance

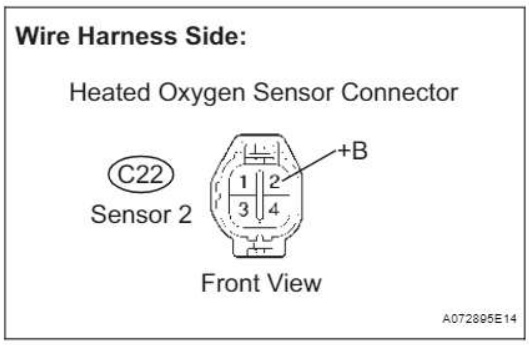
Tester Connections	Specified Conditions
1 (HT1B) - 2 (+B)	11 to 16 Ω at 20°C (68°F)
1 (HT1B) - 4 (E2)	10 kΩ or higher

(c) Reconnect the HO2 sensor connector.

NG → REPLACE HEATED OXYGEN SENSOR

OK

2 CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)



(a) Disconnect the C22 HO2 sensor connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage between the terminals of the C22 HO2 sensor connector and body ground.

Standard voltage

Tester Connections	Specified Conditions
C22-2 (+B) - Body ground	9 to 14 V

(d) Reconnect the HO2 sensor connector.

OK → Go to step 5

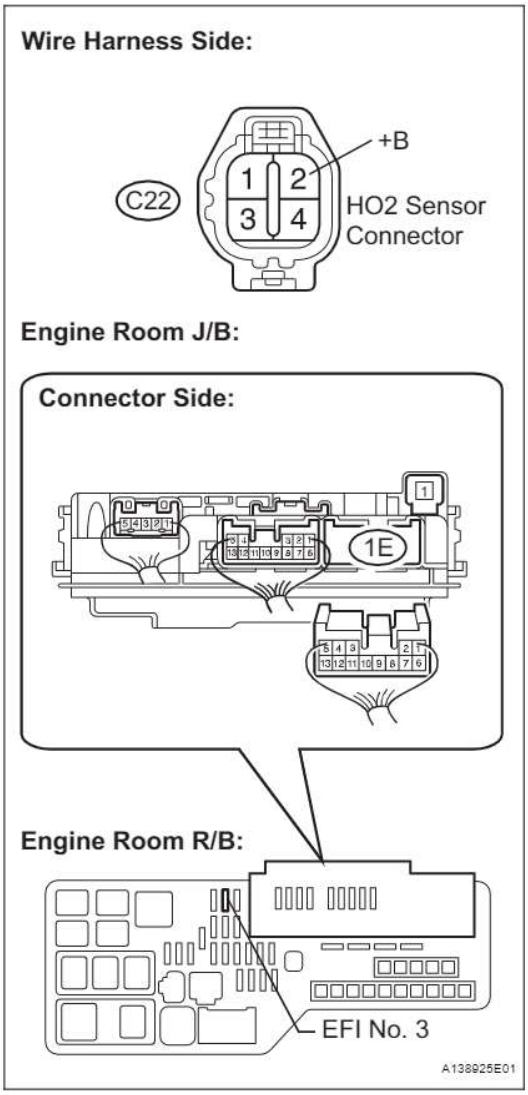
NG

3	INSPECT INTEGRATION RELAY (EFI RELAY) (See page ES-76)

NG → REPLACE INTEGRATION RELAY

OK

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



(a) Check the EFI No. 3 fuse.
(b) Disconnect the C22 HO2 sensor connector.
(c) Remove the integration relay from the engine room R/B and J/B.
(d) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C22-2 (+B) - 1E-6 (Engine room R/B and J/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C22-2 (+B) or 1E-6 (Engine room R/B and J/B) - Body ground	10 kΩ or higher

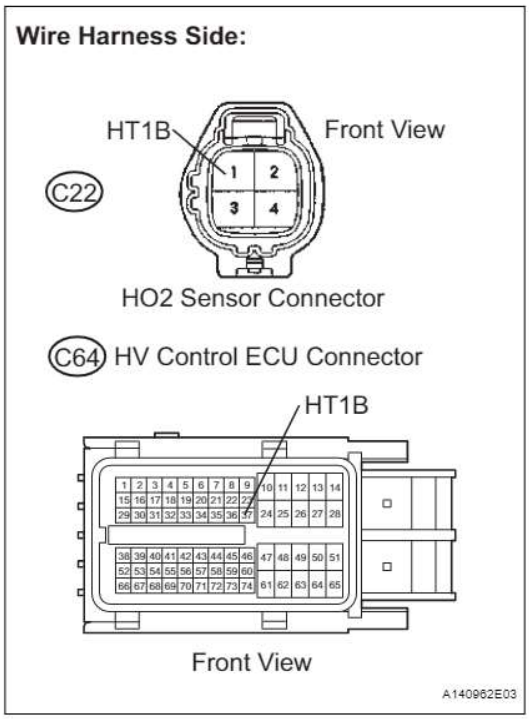
(e) Reconnect the HO2 sensor connector.
(f) Reinstall the integration relay.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT

5 CHECK HARNESS AND CONNECTOR (HO2 SENSOR - HV CONTROL ECU)



(a) Disconnect the C22 HO2 sensor connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C22-1 (HT1B) - C64-37 (HT1B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C22-1 (HT1B) or C64-37 (HT1B) - Body ground	10 kΩ or higher

(d) Reconnect the HO2 sensor connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

6 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Put the engine in inspection mode (See page ES-35).
(f) Allow the engine to idle for 2 minutes or more.
(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(h) Read the DTCs.

Result

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

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

CHECK FOR INTERMITTENT PROBLEMS

DTC	P0100	Mass or Volume Air Flow Circuit
DTC	P0102	Mass or Volume Air Flow Circuit Low Input
DTC	P0103	Mass or Volume Air Flow Circuit High Input

DESCRIPTION

The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the throttle valve.

The ECM (included in hybrid vehicle control ECU) uses this information to determine the fuel injection time and to provide the appropriate air-fuel ratio.

ES

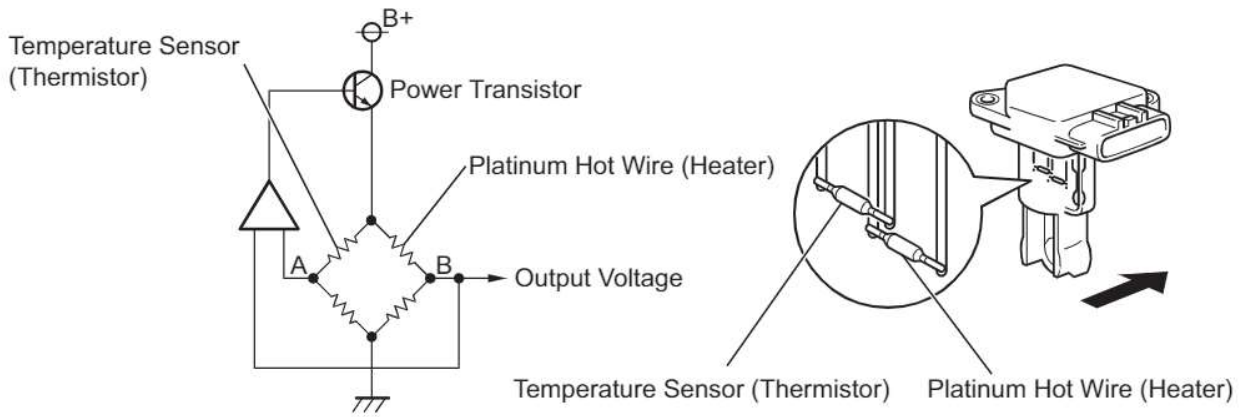
Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.

By applying a specific electrical current to the wire, the ECM heats it to a given temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components in the MAF meter. The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.

The circuit is constructed so that the platinum hot wire and the temperature sensor create 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	MAF meter voltage less than 0.2 V, or more than 4.9 V for 3 seconds (1-trip detection logic)	• Open or short in MAF meter circuit • MAF meter • Hybrid vehicle control ECU
P0102	MAF meter voltage less than 0.2 V for 3 seconds (1-trip detection logic)	• Open or short in MAF meter circuit • MAF meter • Hybrid vehicle control ECU
P0103	MAF meter voltage more than 4.9 V for 3 seconds (1-trip detection logic)	• Open or short in MAF meter circuit • MAF meter • Hybrid vehicle control ECU

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

Mass Air Flow Rate (g/sec.)	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 E2G circuit

MONITOR DESCRIPTION

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

MONITOR STRATEGY

Related DTCs	P0100: MAF meter range check (Fluctuating) P0102: MAF meter range check (Low voltage) P0103: MAF 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

Monitor runs whenever following DTCs not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0100:

MAF meter voltage	Less than 0.2 V, or more than 4.9 V

P0102:

MAF meter voltage	Less than 0.2 V

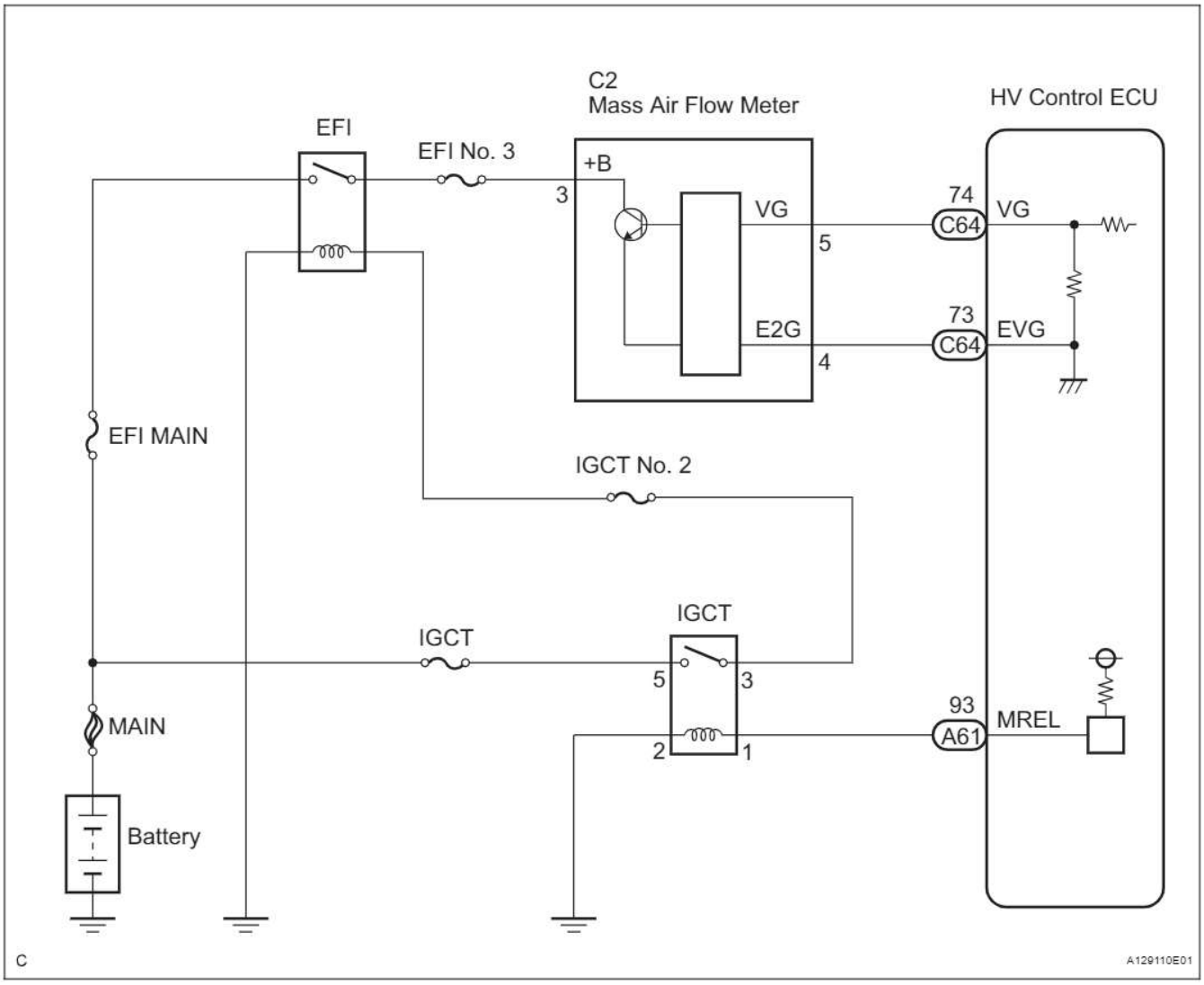
P0103:

MAF meter voltage	More than 4.9 V

COMPONENT OPERATING RANGE

MAF 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

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

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(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 (g/sec.)	Proceed to
0.0	A

Mass Air Flow Rate (g/sec.)	Proceed to
271.0 or more	B
Between 1.0 and 270.0 (*1)	C

HINT:
*1: The value must change when the throttle valve is opened or closed with the engine running.

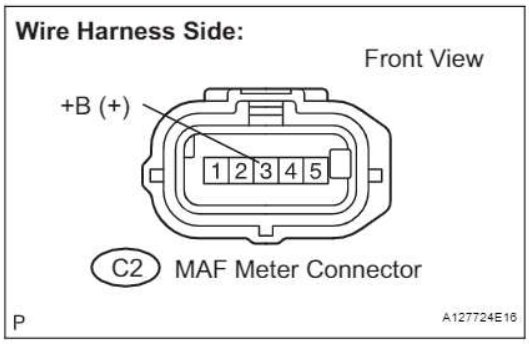
B → Go to step 6

C → CHECK FOR INTERMITTENT PROBLEMS

A

ES

2 INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)



(a) Disconnect the C2 Mass Air Flow (MAF) meter connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage between the terminal of the wire harness side connector and body ground.
Standard voltage

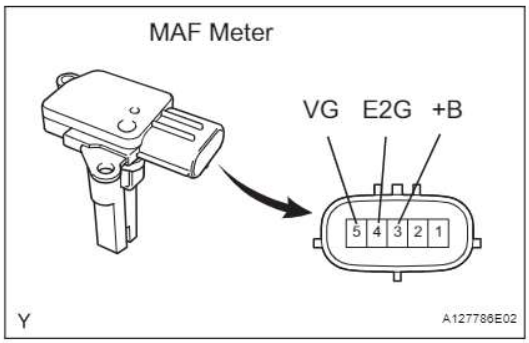
Tester Connections	Specified Conditions
C2-3 (+B) - Body ground	9 to 14 V

(d) Reconnect the MAF meter connector.

NG → Go to step 5

OK

3 INSPECT MASS AIR FLOW METER (VG VOLTAGE)



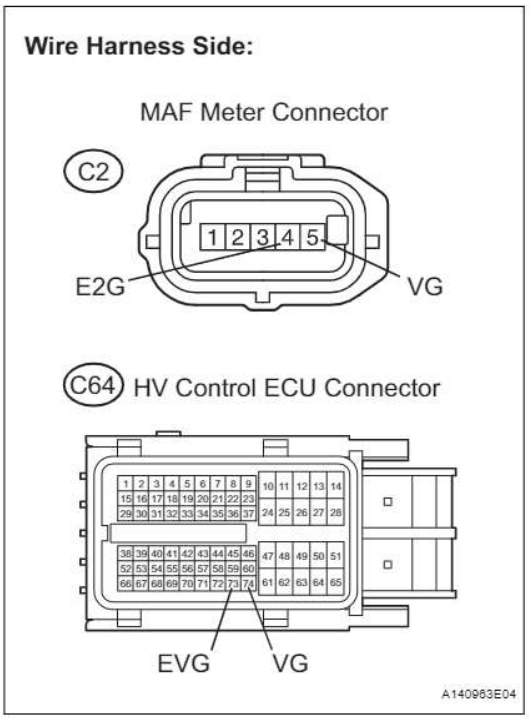
(a) Output voltage inspection.
(1) Apply battery voltage across terminals +B and E2G.
(2) Connect the positive (+) tester probe to terminal VG, and the negative (-) tester probe to terminal E2G.
(3) Measure the voltage.
Standard voltage

Tester Connections	Specified Conditions
5 (VG) - 4 (E2G)	0.2 to 4.9 V

NG → REPLACE MASS AIR FLOW METER

OK

4	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - HV CONTROL ECU)



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C2-5 (VG) - C64-74 (VG)	Below 1 Ω
C2-4 (E2G) - C64-73 (EVG)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C2-5 (VG) or C64-74 (VG) - Body ground	10 kΩ or higher

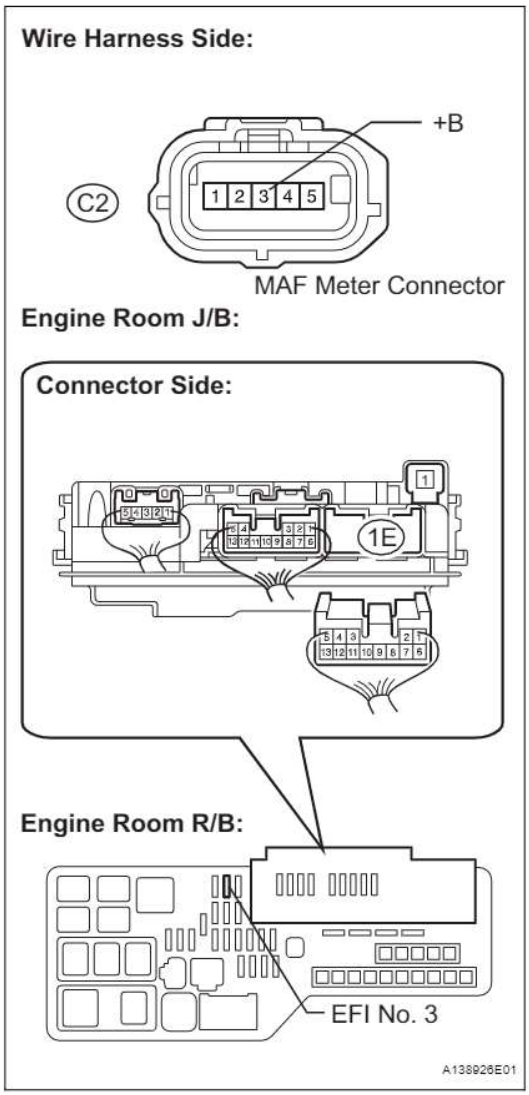
(d) Reconnect the MAF meter connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE HYBRID VEHICLE CONTROL ECU

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



(a) Check the EFI No. 1 fuse.
(b) Disconnect the C2 MAF meter connector.
(c) Remove the integration relay from the engine room R/B and J/B.
(d) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C2-3 (+B) - 1E-6	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C2-3 (+B) or 1E-6 - Body ground	10 kΩ or higher

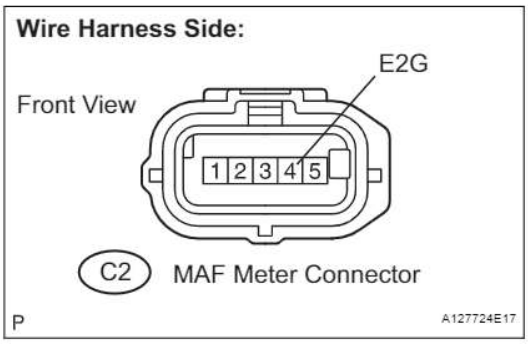
(e) Reconnect the MAF meter connector.
(f) Reinstall the integration relay.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECU POWER SOURCE CIRCUIT

6	CHECK HARNESS AND CONNECTOR (SENSOR GROUND)



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

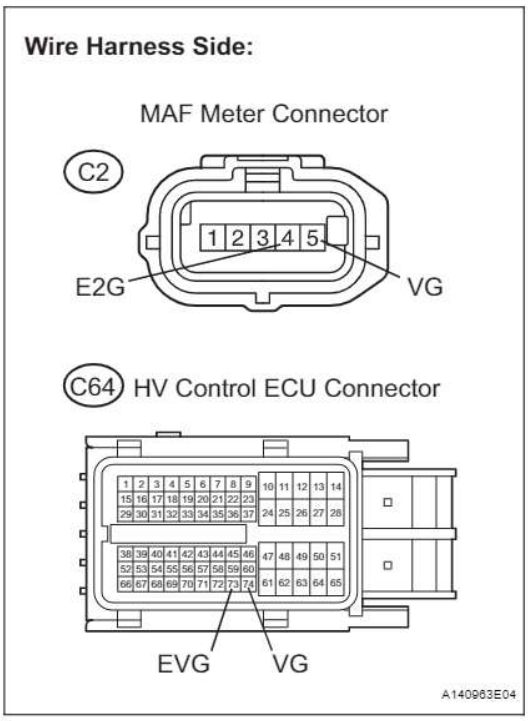
Standard resistance

Tester Connections	Specified Conditions
C2-4 (E2G) - Body ground	Below 1 Ω

OK → REPLACE MASS AIR FLOW METER

NG

7	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - HV CONTROL ECU)



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C2-5 (VG) - C64-74 (VG)	Below 1 Ω
C2-4 (E2G) - C64-73 (EVG)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C2-5 (VG) or C64-74 (VG) - Body ground	10 kΩ or higher

(d) Reconnect the MAF meter connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0101	Mass Air Flow Circuit Range / Performance Problem

DESCRIPTION

Refer to DTC P0100 (See page ES-78).

DTC No.	DTC Detection Conditions	Trouble Areas
P0101	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) Output voltage of MAF meter more than 2.2 V (varies with throttle position sensor voltage).	• Mass Air Flow (MAF) meter • Air induction system • PCV hose connections
	Condition (a) and (b) continue for more than 6 seconds (2-trip detection logic): (a) Engine speed is more than 500 rpm (b) Output voltage of MAF meter less than 0.93 V (varies with throttle position sensor voltage).	

ES

MONITOR DESCRIPTION

The MAF meter is a sensor that measures the amount of air flowing through the throttle valve. The ECM (include in hybrid vehicle control ECU) uses this information to determine the fuel injection time and to provide an appropriate air-fuel ratio. Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air. By applying a specific electrical current to the wire, the ECM heats it to a specific temperature. The flow of incoming air cools both the wire and an internal thermistor, affecting their resistance. To maintain a constant current value, the ECM varies the voltage applied to these components of the MAF meter. The voltage level is proportional to the airflow through the sensor, and the ECM uses it to calculate the intake air volume.

The ECM monitors the average engine load value ratio to check the MAF meter for malfunctions. The average engine load value ratio is obtained by comparing the average engine load calculated from the MAF meter output to the average engine load estimated from the driving conditions, such as the engine speed and the throttle opening angle. If the average engine load value ratio is below the threshold value, the ECM determines that the intake air volume is low, and if the average engine load value ratio is above the threshold value, the ECM determines that the intake air volume is high.

If this is detected in 2 consecutive driving cycles, the MIL is illuminated and a DTC is set.

MONITOR STRATEGY

Related DTCs	P0101: Mass air flow meter rationality
Required Sensors/Components (Main)	Mass air flow meter
Required Sensors/Components (Related)	Crankshaft Position (CKP) sensor, Engine Coolant Temperature (ECT) sensor and Throttle Position (TP) sensor
Frequency of Operation	Continuous
Duration	10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for closed loop) P0335 (CKP sensor) P0340 (CMP sensor)
Speed	Less than 2,000 rpm

Engine coolant temperature	70°C (158°F) or more

Mass Air Flow Meter Rationality (High Voltage):

Engine speed	Less than 2,000 rpm
Engine coolant temperature	70 °C (158 °F) or higher
IAT sensor circuit	OK
ECT sensor circuit	OK
CKP sensor circuit	OK
TP sensor circuit	OK
Canister pressure sensor circuit	OK
EVAP leak detection pump	OK
EVAP vent valve	OK

ES

Mass Air Flow Meter Rationality (Low Voltage):

Engine speed	More than 500 rpm
Fuel out	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 0.93 V (Varies with throttle position sensor voltage)

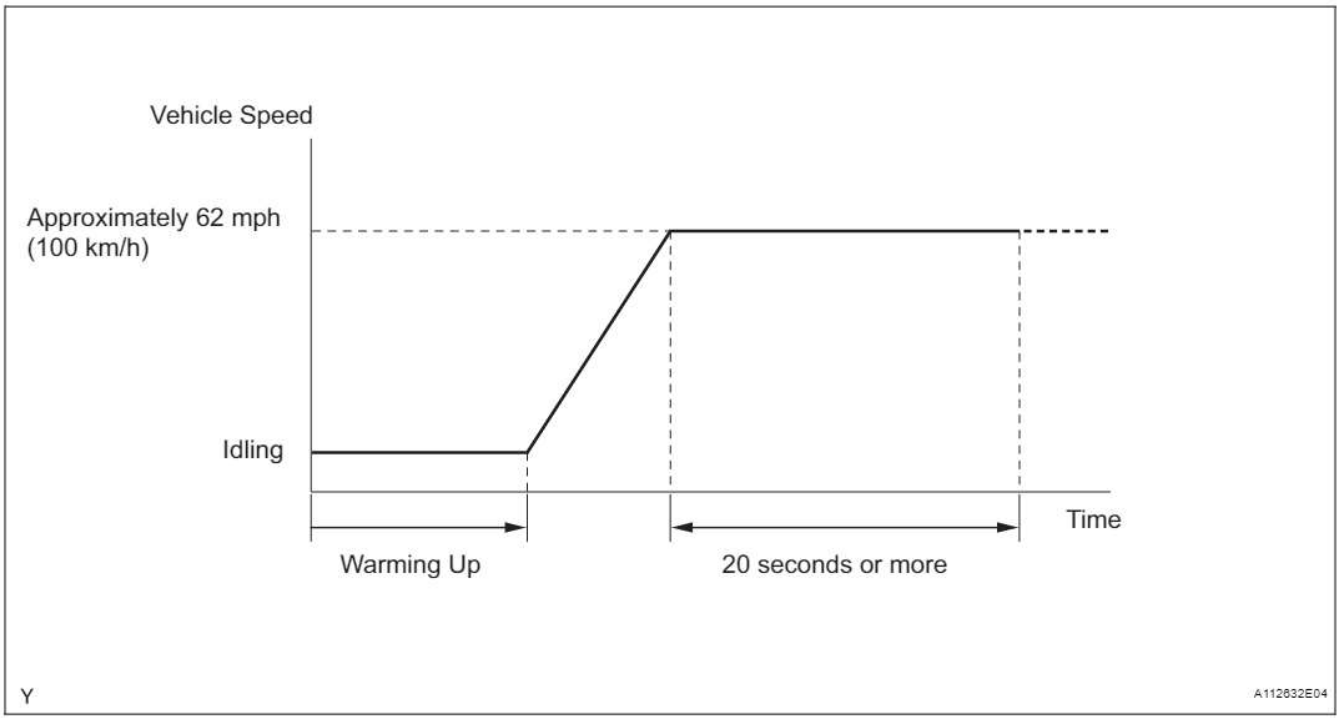
WIRING DIAGRAM

Refer to DTC P0100 (See page ES-80).

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the mass air flow performance monitor.



1. Connect the intelligent tester to the DLC3.

2. Turn the power switch on (IG).
3. Turn the tester on.
4. Clear the DTCs (See page ES-31).
5. Put the engine in inspection mode (See page ES-35).
6. Warm it up until the engine coolant temperature reaches 70°C (158°F) or higher.
7. Drive the vehicle at approximately 62 mph (100 km/h) for 20 seconds or more.
8. 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.

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

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

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

Result

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

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

B → GO TO DTC CHART

A

2 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

3 CHECK PCV HOSE (HOSE CONNECTION)

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

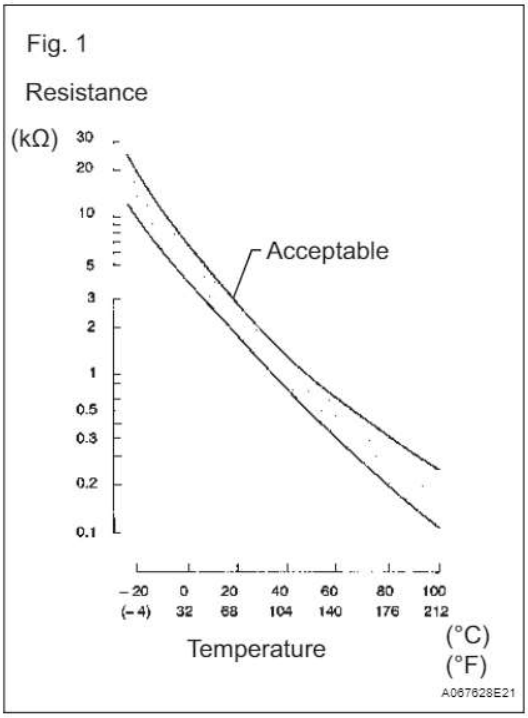
NG → REPAIR OR REPLACE PCV HOSE

OK

REPLACE MASS AIR FLOW METER

DTC	P0110	Intake Air Temperature Circuit Malfunction
DTC	P0112	Intake Air Temperature Circuit Low Input
DTC	P0113	Intake Air Temperature Circuit High Input

DESCRIPTION



The Intake Air Temperature (IAT) sensor, mounted on the Mass Air Flow (MAF) meter, monitors the IAT. The IAT sensor has a built-in thermistor with a resistance that varies according to the temperature of the intake air. When the IAT 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 (include in hybrid vehicle control ECU) as voltage changes (see Fig. 1).

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

Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve 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.	DTC Detection Conditions	Trouble Areas
P0110	Open or short in IAT sensor circuit for 0.5 seconds (1-trip detection logic)	• Open or short in IAT sensor circuit • IAT sensor (built into MAF meter) • Hybrid vehicle control ECU
P0112	Short in IAT sensor circuit for 0.5 seconds (1-trip detection logic)	• Short in IAT sensor circuit • IAT sensor (built into MAF meter) • Hybrid vehicle control ECU
P0113	Open in IAT sensor circuit for 0.5 seconds (1-trip detection logic)	• Open in IAT sensor circuit • IAT sensor (built into MAF meter) • Hybrid vehicle control ECU

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 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.

ES

Example:
If the sensor output voltage is more than 4.91 V for 0.5 seconds or more, the ECM determines that there is an open in the IAT sensor circuit, and sets DTC P0113. Conversely, if the output voltage is less than 0.18 V 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: IAT sensor range check (Fluctuating) P0112: IAT sensor range check (Low voltage) P0113: IAT sensor range check (High voltage)
Required Sensors/Components (Main)	IAT sensor
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0110:

IAT sensor voltage	Less than 0.18 V, or more than 4.91 V

P0112:

IAT sensor voltage [IAT]	Less than 0.18 V [More than 140°C (284°F)]

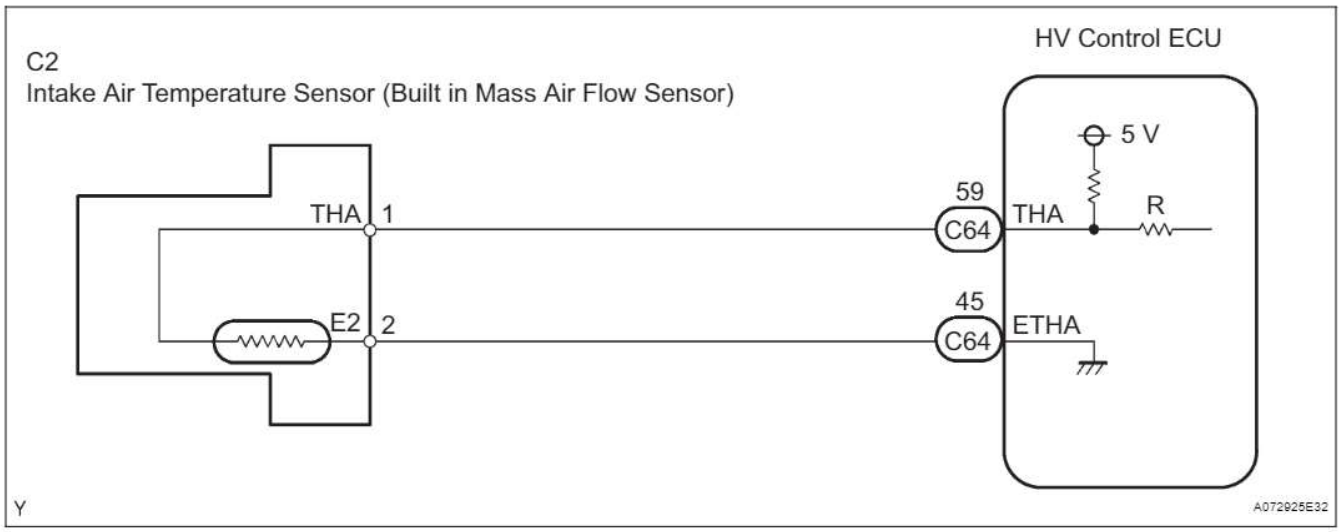
P0113:

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

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	READ DTC OUTPUT

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

Result

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

B → Go to step 6

C → Go to step 3

A

2	READ VALUE USING INTELLIGENT TESTER (INTAKE AIR TEMPERATURE)

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

(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(e) Read the value displayed on the tester.
Standard:
Same as actual Intake Air Temperature (IAT).

Result

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

ES

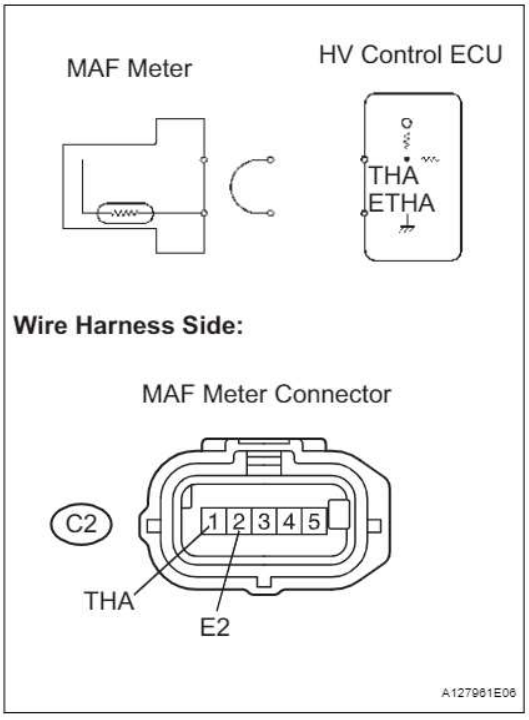
HINT:
- If there is an open circuit, the intelligent tester indicates -40°C (-40°F).
- If there is a short circuit, the intelligent tester indicates 140°C (284°F) or higher.

B → **Go to step 5**

C → **CHECK FOR INTERMITTENT PROBLEMS**

A

3 READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

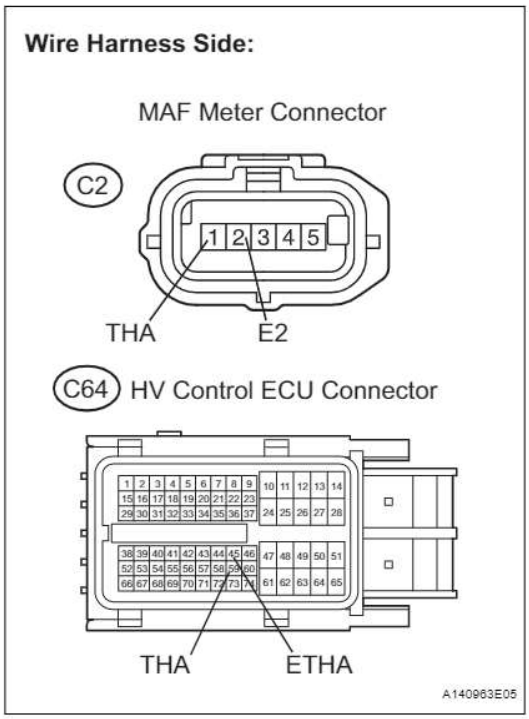


(a) Confirm good connection of the Mass Air Flow (MAF) meter.
(b) Disconnect the C2 MAF meter connector.
(c) Connect terminals THA and E2 of the MAF meter wire harness side connector.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the power switch on (IG).
(f) Turn the tester on.
(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(h) Read the value displayed on the tester.
Standard value:
140°C (284°F) or higher
(i) Reconnect the MAF meter connector.

OK → **REPLACE MASS AIR FLOW METER**

NG

4	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - HV CONTROL ECU)



(a) Confirm good connection of the hybrid vehicle control ECU connectors.
(b) Disconnect the C2 MAF meter connector.
(c) Disconnect the C64 hybrid vehicle control ECU connector.
(d) Measure the resistance.
Standard resistance

Tester Connections	Specified Conditions
C2-1 (THA) - C64-59 (THA)	Below 1 Ω
C2-2 (E2) - C64-45 (ETHA)	Below 1 Ω

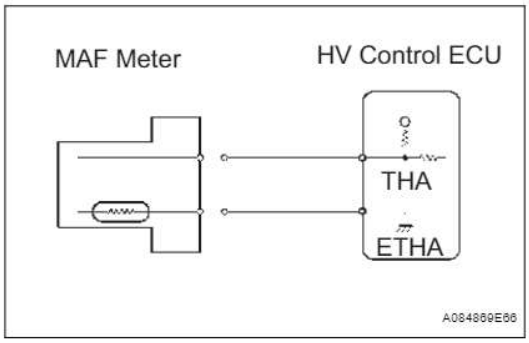
(e) Reconnect the MAF meter connector.
(f) Reconnect the hybrid vehicle control ECU connector.

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

OK

REPLACE HYBRID VEHICLE CONTROL ECU

5	READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

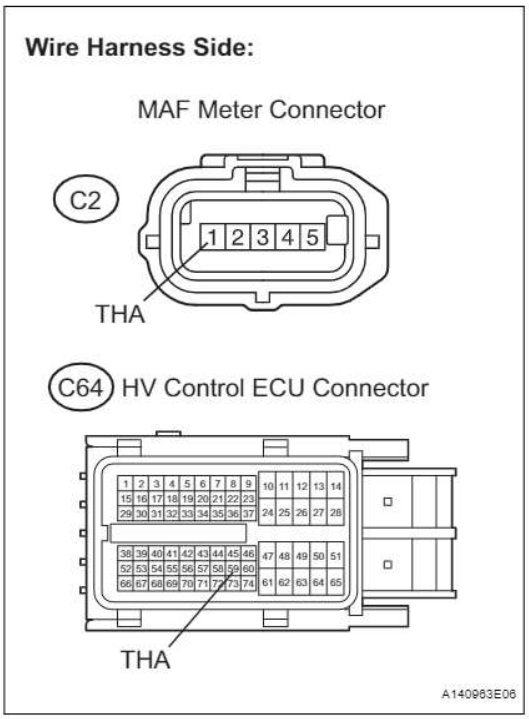


(a) Disconnect the C2 MAF meter connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the power switch on (IG).
(d) Turn the tester on.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(f) Read the value displayed on the tester.
Standard value:
-40°C (-40°F)
(g) Reconnect the MAF meter connector.

OK → **REPLACE MASS AIR FLOW METER**

NG

6	CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - HV CONTROL ECU)



(a) Disconnect the C2 MAF meter connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance

Tester Connections	Specified Conditions
C2-1 (THA) or C64-59 (THA) - Body ground	10 kΩ or higher

(d) Reconnect the MAF meter connector.
(e) Reconnect the hybrid vehicle control ECU connector.

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

OK

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0115	Engine Coolant Temperature Circuit Malfunction

DTC	P0117	Engine Coolant Temperature Circuit Low Input

DTC	P0118	Engine Coolant Temperature Circuit High Input

DESCRIPTION

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

The structure of the sensor and its connection to the ECM (included in hybrid vehicle control ECU) are the same as those of the Intake Air Temperature (IAT) sensor.

ES

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.	DTC Detection Conditions	Trouble Areas
P0115	Open or short in ECT sensor circuit for 0.5 seconds (1-trip detection logic)	• Open or short in ECT sensor circuit • ECT sensor • Hybrid vehicle control ECU
P0117	Short in ECT sensor circuit for 0.5 seconds (1-trip detection logic)	• Short in ECT sensor • ECT sensor • Hybrid vehicle control ECU
P0118	Open in ECT sensor circuit for 0.5 seconds (1-trip detection logic)	• Open in ECT sensor circuit • ECT sensor • Hybrid vehicle control ECU

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 output voltage from the sensor. The ECM monitors the sensor voltage and uses this value to calculate the ECT. When the sensor output voltage deviates from the normal operating range, the ECM interprets this as a fault in the ECT sensor and sets a DTC.

Example:

If the sensor output voltage is more than 4.91 V 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 less than 0.14 V 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: ECT sensor range check (Fluctuating) P0117: ECT sensor range check (Low voltage) P0118: ECT sensor range check (High voltage)
Required Sensors/Components (Main)	ECT sensor
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	0.5 seconds
MIL Operation	Immediate
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None

TYPICAL MALFUNCTION THRESHOLDS

P0115:

ECT sensor voltage	Less than 0.14 V, or more than 4.91 V

P0117:

ECT sensor voltage [ECT]	Less than 0.14 V [More than 140°C (284°F)]

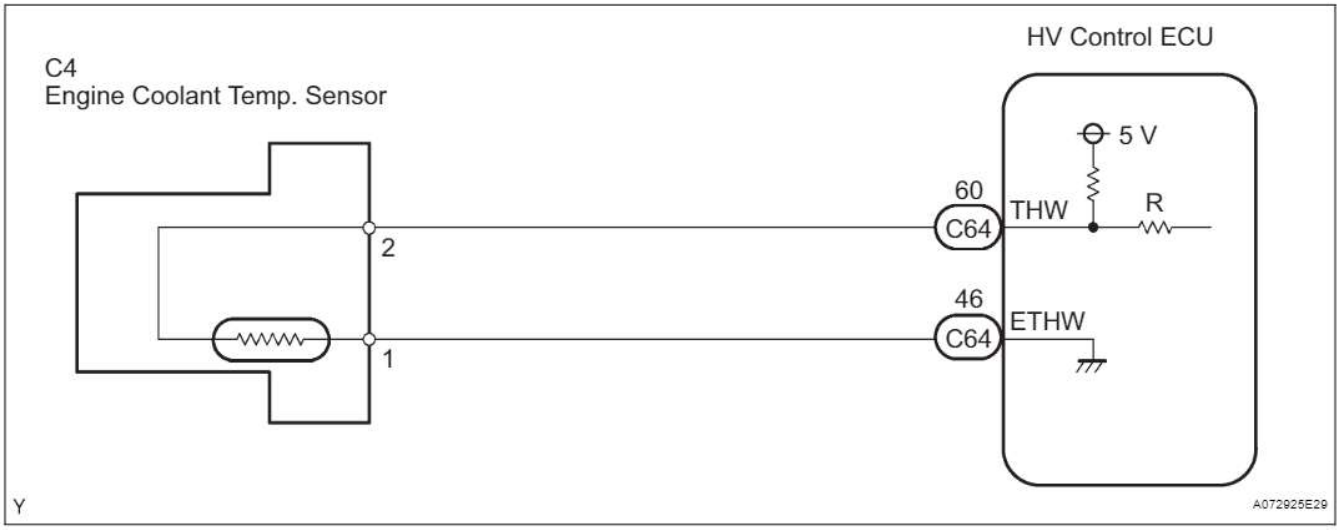
P0118:

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

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data, from the time the malfunction occurred.

1 READ OUTPUT DTC

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

Result

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

B → Go to step 5

C → Go to step 3

A

2 READ VALUE USING INTELLIGENT TESTER (ENGINE COOLANT TEMPERATURE)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power 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 value:
Between 80°C and 100°C (167°F and 212°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 100°C (176°F and 212°F)	C

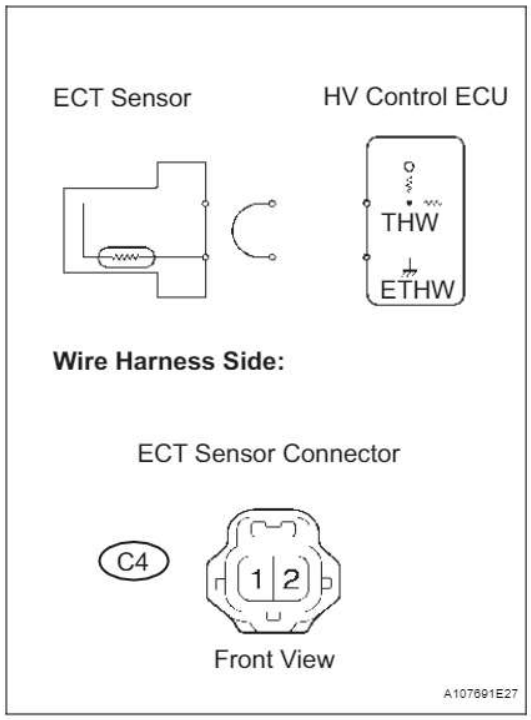
HINT:
- If there is an open circuit, the intelligent tester indicates -40°C (-40°F).
- If there is a short circuit, the intelligent tester indicates 140°C (284°F) or higher.

B → Go to step 5

C → CHECK FOR INTERMITTENT PROBLEMS

A

3 READ VALUE USING INTELLIGENT TESTER (CHECK FOR OPEN IN WIRE HARNESS)

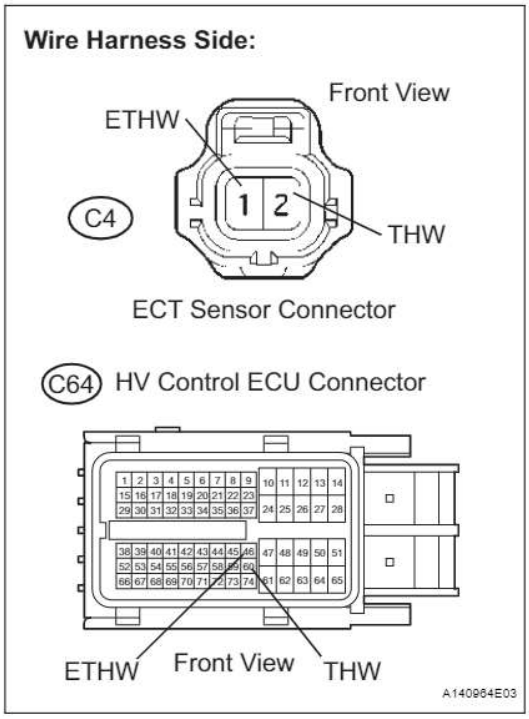


(a) Confirm good condition of the Engine Coolant Temperature (ECT) sensor.
(b) Disconnect the C4 ECT sensor connector.
(c) Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the power switch on (IG).
(f) Turn the tester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

OK → REPLACE ENGINE COOLANT TEMPERATURE SENSOR

NG

4	CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - HV CONTROL ECU)



(a) Confirm good connection of the hybrid vehicle control ECU connectors.
(b) Disconnect the C4 ECT sensor connector.
(c) Disconnect the C64 hybrid vehicle control ECU connector.
(d) Measure the resistance.
Standard resistance

Tester Connections	Specified Conditions
C4-2 (THW) - C64-60 (THW)	Below 1 Ω
C4-1 (E2) - C64-46 (ETHW)	Below 1 Ω

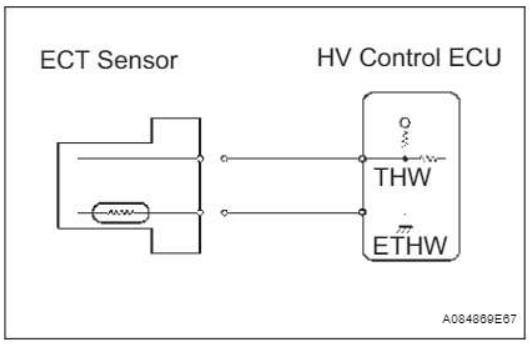
(e) Reconnect the ECT sensor connector.
(f) Reconnect the hybrid vehicle control ECU connector.

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

OK →

REPLACE HYBRID VEHICLE CONTROL ECU

5	READ VALUE USING INTELLIGENT TESTER (CHECK FOR SHORT IN WIRE HARNESS)

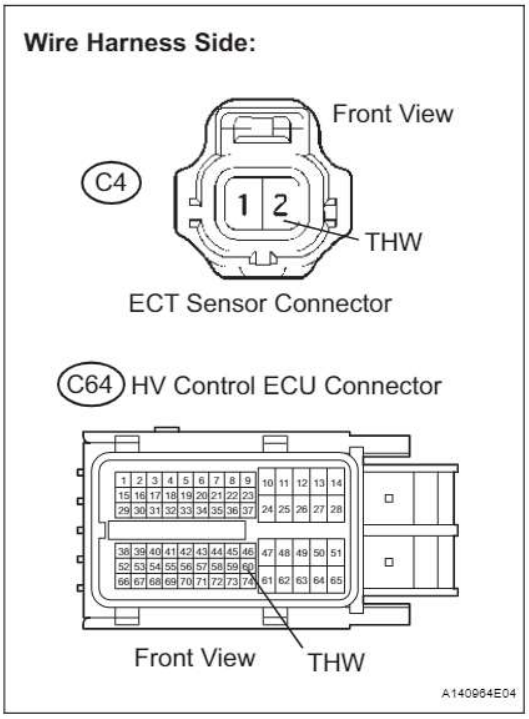


(a) Disconnect the C4 ECT sensor connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the power switch on (IG).
(d) Turn the tester on.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(f) Read the value displayed on the tester.
Standard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

OK → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

NG →

6	CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - HV CONTROL ECU)



(a) Disconnect the C4 ECT sensor connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance

Tester Connections	Specified Conditions
C4-2 (THW) or C64-60 (THW) - Body ground	10 kΩ or higher

(d) Reconnect the ECT sensor connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0116	Engine Coolant Temperature Circuit Range / Performance Problem

DESCRIPTION

Refer to DTC P0115 (See page ES-95).

DTC No.	DTC Detection Conditions	Trouble Areas
P0116	When either of following conditions met (2-trip detection logic): • When cold engine started and engine warmed up, Engine Coolant Temperature (ECT) sensor value does not change. • After warmed up engine started, ECT sensor value does not change when engine stopped and then next cold engine start performed.	• Thermostat • ECT sensor

ES

MONITOR DESCRIPTION

Engine coolant temperature (ECT) sensor cold start monitor

When a cold engine start is performed and then the engine is warmed up, if the ECT sensor value does not change, it is determined that a malfunction has occurred. If this is detected in 2 consecutive driving cycles, the MIL is illuminated and a DTC is set.

ECT sensor soak monitor

After a warmed up engine is started, if the ECT sensor value does not change when the engine is stopped and then the next cold engine start is performed, it is determined that a malfunction has occurred. If this is detected in 2 consecutive driving cycles, the MIL is illuminated and a DTC is set.

MONITOR STRATEGY

Related DTCs	P0116: Engine coolant temperature (ECT) sensor output stuck at low engine coolant temperature P0116: ECT sensor output stuck at high engine coolant temperature
Required Sensors/Components (Main)	ECT sensor
Required Sensors/Components (Related)	Crankshaft position sensor, intake air temperature sensor and mass air flow meter
Frequency of Operation	Once per driving cycle
Duration	250 seconds
MIL Operation	2 driving cycles: ETC 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:

Monitor runs whenever following DTCs not present	P0100 to P0103: Mass air flow meter
Cumulative idle off period	250 seconds or more
Speed increase by 18.6 mph (30km/h) or more	10 times or more
Engine coolant temperature at engine start	35 to 60°C (95 to 140°F)
Intake air temperature after engine start	-6.7°C (20°F) or more

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

Monitor runs whenever following DTCs not present	P0100 to P0103: Mass air flow meter
Engine coolant temperature at engine start	60°C (140°F) or more
Intake air temperature after 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 stopped for 20 seconds or more and accelerated to more than 43.5 mph (70 km/h) within 40 seconds.
*2: 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)

ES

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

ECT	ECT sensor value changes in accordance with actual ECT

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

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

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

Result

Display (DTC Output)	Proceed to
P0116	A
P0116 and other DTCs	B

B → GO TO DTC CHART

A

2 INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-12).
(b) Measure the valve opening temperature of the thermostat.

Standard value:
80°C to 84°C (176°F 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-13).

NG → **REPLACE THERMOSTAT**

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR

ES

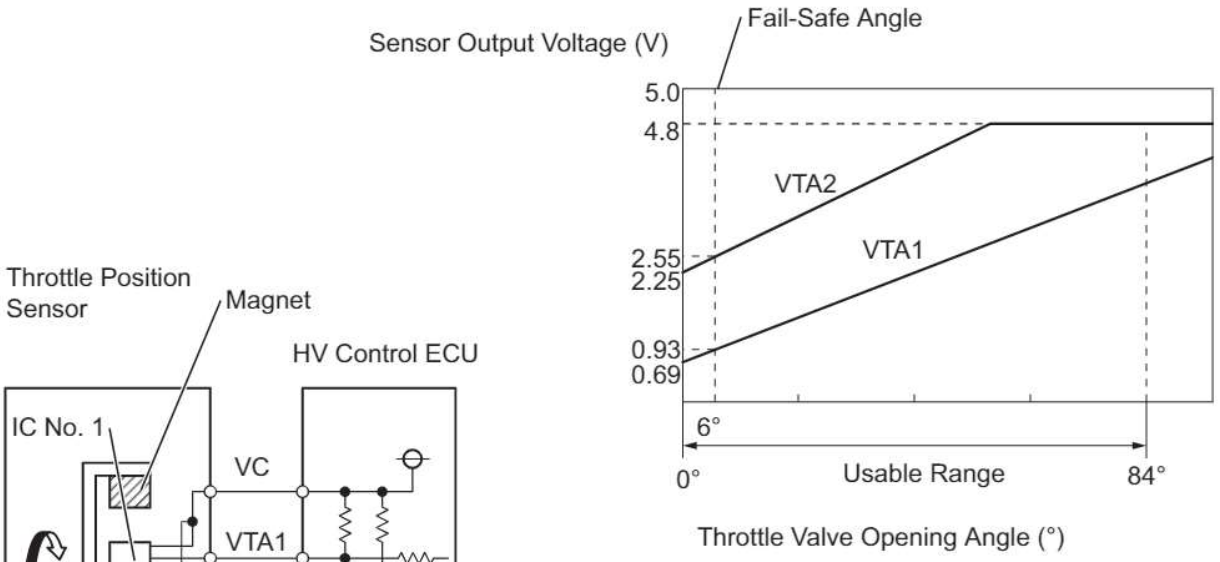
DTC	P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction
DTC	P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input
DTC	P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input
DTC	P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit
DTC	P0222	Throttle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

ES

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

DESCRIPTION

The TP sensor is mounted on the throttle body, and detects the opening angle of the throttle valve. This sensor is a non-contact type. It uses Hall-effect elements in order to yield accurate signals even in extreme driving conditions, such as at high speeds as well as very low speeds.
The TP sensor has two sensor circuits which each transmits a signal, VTA1 and VTA2. VTA1 is used to detect the throttle valve angle and VTA2 is used to detect malfunctions in VTA1. The sensor signal voltages vary between 0 V and 5 V in proportion to the throttle valve opening angle, and are transmitted to the VTA terminals of the ECM (included in hybrid vehicle control ECU).
As the valve closes, the sensor output voltage decreases and as the valve opens, the sensor output voltage increases. The ECM calculates the throttle valve opening angle according to these signals and controls the throttle actuator in response to driver inputs. These signals are also used in calculations such as air-fuel ratio correction, power increase correction and fuel-cut control.



Note:

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

Between 10 % and 22 %: Throttle valve fully closed

Between 66 % and 98 %: Throttle valve fully open

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

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DTC No.	DTC Detection Conditions	Trouble Areas
P0120	Output voltage of VTA1 quickly fluctuates beyond lower and upper malfunction thresholds for 2 seconds when accelerator pedal depressed (1-trip detection logic)	• Throttle Position (TP) sensor (built into throttle body) • Hybrid vehicle control ECU
P0122	Output voltage of VTA1 0.2 V or less for 2 seconds when accelerator pedal depressed (1-trip detection logic)	• TP sensor (built into throttle body) • Short in VTA1 circuit • Open in VC circuit • Hybrid vehicle control ECU
P0123	Output voltage of VTA1 4.535 V or more for 2 seconds when accelerator pedal depressed (1-trip detection logic)	• TP sensor (built into throttle body) • Open in VTA1 circuit • Open in E2 circuit • Short between VC and VTA1 circuits • Hybrid vehicle control ECU
P0220	Output voltage of VTA2 quickly fluctuates beyond lower and upper malfunction thresholds for 2 seconds when accelerator pedal depressed (1-trip detection logic)	• TP sensor (built into throttle body) • Hybrid vehicle control ECU

DTC No.	DTC Detection Conditions	Trouble Areas
P0222	Output voltage of VTA2 1.75 V or less for 2 seconds when accelerator pedal depressed (1-trip detection logic)	• TP sensor (built into throttle body) • Short in VTA2 circuit • Open in VC circuit • Hybrid vehicle control ECU
P0223	Output voltage of VTA2 4.8 V or more, and VTA1 between 0.2 V and 2.02 V for 2 seconds when accelerator pedal depressed (1-trip detection logic)	• TP sensor (built into throttle body) • Open in VTA2 circuit • Open in E2 circuit • Short between VC and VTA2 circuits • Hybrid vehicle control ECU
P2135	Either condition (a) or (b) met (1-trip detection logic): (a) Difference between output voltages of VTA1 and VTA2 0.02 V or less for 0.5 seconds or more (b) Output voltage of VTA1 0.2 V or less, and VTA2 1.75 V or less, for 0.4 seconds or more	• Short between VTA1 and VTA2 circuits • TP sensor (built into throttle body) • Hybrid vehicle control ECU

ES

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 #1 AND THROTTLE POS #2.
- THROTTLE POS #1 denotes the VTA1 signal, and THROTTLE POS #2 denotes the VTA2 signal.

Reference (Normal Condition):

Tester Display	Accelerator Pedal Fully Released	Accelerator Pedal Fully Depressed
THROTTLE POS #1	0.5 to 1.1 V	3.3 to 4.9 V
THROTTLE POS #2	2.1 to 3.1 V	4.6 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 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 10 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) 0.5 seconds: P2135 Case 1 0.4 seconds: P2135 Case 2
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None
Either of following condition A or B met	-
A. Power switch ON (IG)	0.012 seconds or more
B. Electronic throttle actuator power	ON

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 or more, and 2.02 V or less	4.8 V or more

P2135 Case 1:

Difference between VTA1 and VTA2 voltages	0.02 V or less

P2135 Case 2:

VTA1 voltage	0.2 V or less
VTA2 voltage	1.75 V or less

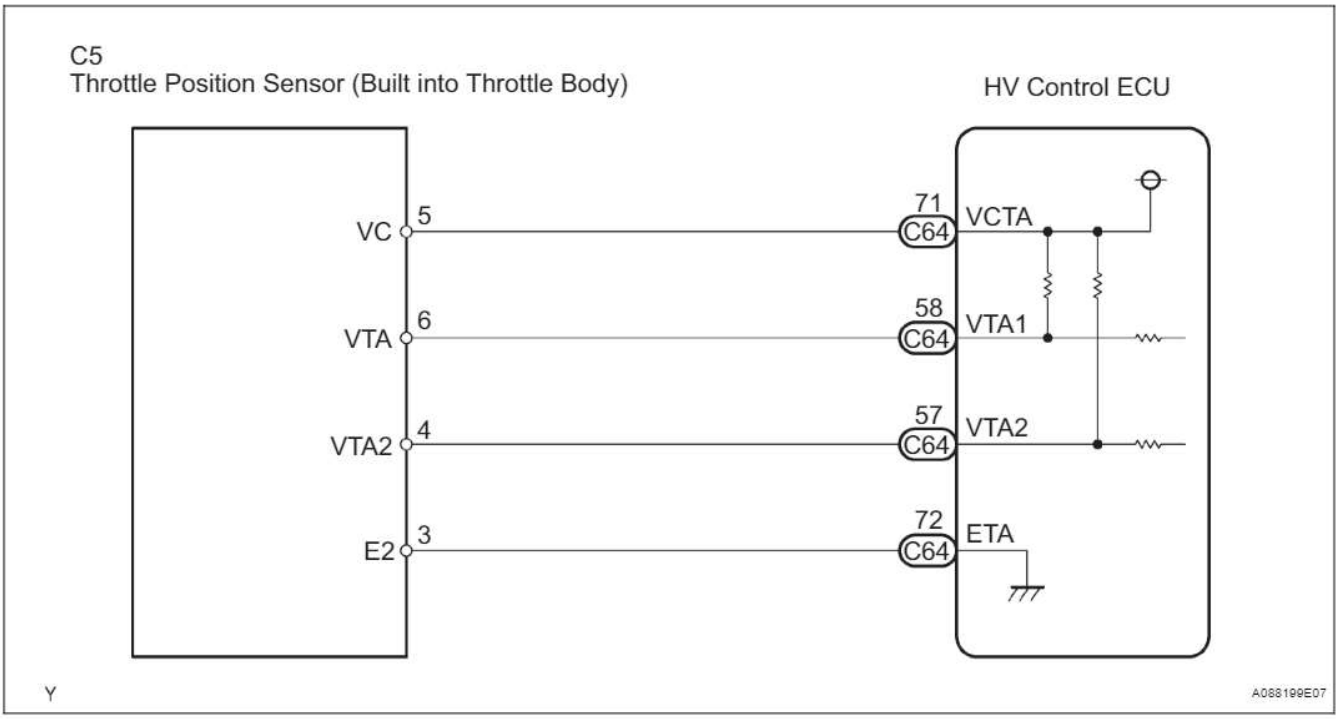
COMPONENT OPERATING RANGE

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

FAIL-SAFE

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

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	READ VALUE USING INTELLIGENT TESTER (THROTTLE POS #1 AND THROTTLE POS #2)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ETCS / THROTTLE POS #1 and THROTTLE POS #2.
(d) Check the values displayed on the tester.

Result

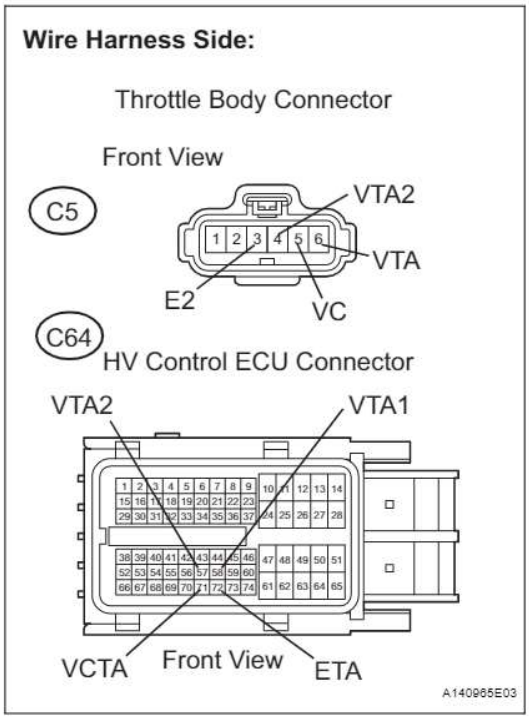
TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Areas	Proceed to
0 V to 0.2 V	0 V to 0.2 V	0 V to 0.2 V	0 V to 0.2 V	VC circuit open	A
4.5 V to 5.0 V	4.5 V to 5.0 V	4.5 V to 5.0 V	4.5 V to 5.0 V	E2 circuit open	
0 V to 0.2 V, or 4.5 V to 5.0 V	2.4 V to 3.4 V (Fail-safe)	0 V to 0.2 V, or 4.5 V to 5.0 V	2.4 V to 3.4 V (Fail-safe)	VTA1 circuit open or ground short	
0.7 V to 1.3 V (Fail-safe)	0 V to 0.2 V, or 4.5 V to 5.0 V	0.7 V to 1.3 V (Fail-safe)	0 V to 0.2 V, or 4.5 V to 5.0 V	VTA2 circuit open or ground short	
0.5 V to 1.1 V	2.1 V to 3.1 V	3.3 V to 4.9 V (Not fail-safe)	4.6 V to 5.0 V (Not fail-safe)	TP sensor circuit normal	B

HINT:
TP#1 denotes THROTTLE POS #1, and TP#2 denotes THROTTLE POS #2.

B → Go to step 5

A

2 CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - HV CONTROL ECU)



(a) Disconnect the C5 throttle body connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C5-5 (VC) - C64-71 (VCTA)	Below 1 Ω
C5-6 (VTA) - C64-58 (VTA1)	Below 1 Ω
C5-4 (VTA2) - C64-57 (VTA2)	Below 1 Ω
C5-3 (E2) - C64-72 (ETA)	Below 1 Ω

Standard resistance (Check for short)

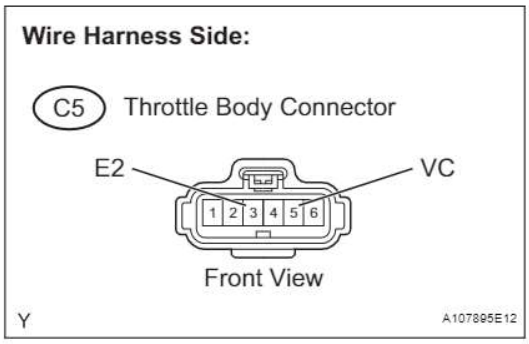
Tester Connections	Specified Conditions
C5-5 (VC) or C64-71 (VCTA) - Body ground	10 kΩ or higher
C5-6 (VTA) or C64-58 (VTA1) - Body ground	10 kΩ or higher
C5-4 (VTA2) or C64-57 (VTA2) - Body ground	10 kΩ or higher

(d) Reconnect the throttle body connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3 INSPECT HYBRID VEHICLE CONTROL ECU (VC VOLTAGE)



(a) Disconnect the C5 throttle body connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage between the terminals of the throttle body connector.

Standard voltage

Tester Connections	Specified Conditions
C5-5 (VC) - C5-3 (E2)	4.5 to 5.5 V

(d) Reconnect the throttle body connector.

NG → REPLACE HYBRID VEHICLE CONTROL ECU

OK

4	REPLACE THROTTLE BODY ASSEMBLY

NEXT

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Put the engine in inspection mode (See page ES-35).
(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 the DTCs.

ES

Result

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

B → SYSTEM IS OK

A

REPLACE HYBRID VEHICLE CONTROL ECU

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-104).

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)

ES

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 (included in hybrid vehicle control ECU) performs several checks to confirm proper operation of the TP sensor and VTA1.
For each throttle opening angle, a specific voltage difference is expected between the outputs of VTA1 and VTA2. If the output voltage difference between the two signals deviates from the normal 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

Monitor runs whenever following DTCs not present	P0120 - P0223, P2135 (TP sensor)
Either of following conditions A or B set	-
A. Power switch	ON
B. Electric throttle motor power	ON

TYPICAL MALFUNCTION THRESHOLDS

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

FAIL-SAFE

When this DTC, as well as other DTCs relating to ETCS (Electronic Throttle Control System) malfunctions, is set, the ECM enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator off, and the throttle valve is returned to a 6° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel-cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the power 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0121)

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

Result

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

B → GO TO DTC CHART

A

REPLACE THROTTLE BODY ASSEMBLY

DTC	P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control

DESCRIPTION

Refer to DTC P0115 (See page ES-95).

DTC No.	DTC Detection Conditions	Trouble Areas
P0125	Engine Coolant Temperature (ECT) does not reach closed-loop enabling temperature for 20 minutes (this period varies with ECT at engine start) (2-trip detection logic)	• ECT sensor • Cooling system • Thermostat

MONITOR DESCRIPTION

ES

The resistance of the ECT sensor varies in proportion to the actual ECT. The ECT supplies a constant voltage to the sensor and monitors the signal output voltage of the sensor. The signal voltage output varies according to the changing resistance of the sensor. After the engine is started, the ECT is monitored through this signal. If the ECT sensor indicates that the engine is not yet warm enough for closed-loop fuel control, despite a specified period of time having elapsed since the engine was started, the ECM (included in hybrid vehicle control ECU) 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 about 1 minute running time, the ECT sensor still indicates that the engine is not warm enough to begin closed-loop fuel (air-fuel ratio feedback) control. The ECM interprets this as a malfunction in the sensor or cooling system and sets the DTC.

MONITOR STRATEGY

Related DTCs	P0125: Insufficient engine coolant temperature for closed-loop fuel control
Required Sensors/Components (Main)	Thermostat, cooling system
Required Sensors/Components (Related)	Engine coolant temperature sensor and mass air flow meter
Frequency of Operation	Once per driving cycle
Duration	56.4 seconds or more: Engine coolant temperature is -8.34°C (-15°F) or more at engine start 100.3 seconds or more: Engine coolant temperature is -19.45 to -8.34°C (-35 to -15°F) at engine start 20 minutes or more: Engine coolant temperature is less than -19.45°C (-35°F) at engine start
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

Time until actual engine coolant temperature reaches closed-loop fuel control enabling temperature	56.4 seconds or more: Engine coolant temperature is -8.34°C (-15°F) or more at engine start 100.3 seconds or more: Engine coolant temperature is -19.45 to -8.34°C (-35 to -15°F) at engine start 20 minutes or more: Engine coolant temperature is less than -19.45°C (-35°F) at engine start

WIRING DIAGRAM

Refer to DTC P0115 (See page ES-96).

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

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

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

Result

Display (DTC Output)	Proceed to
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-12).
(b) Check the valve opening temperature of the thermostat.
Standard value:
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-13).

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 malfunctions.

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.

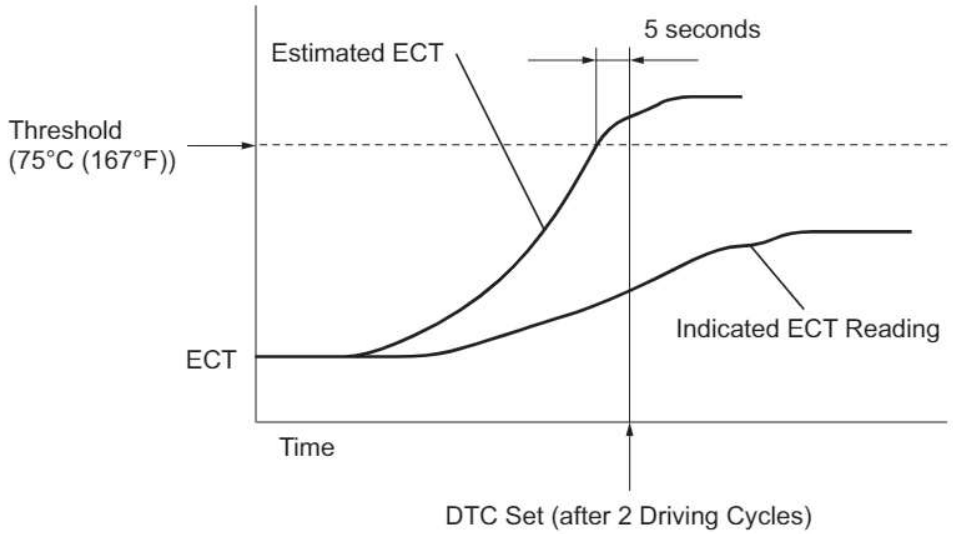
DESCRIPTION

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

DTC No.	DTC Detection Conditions	Trouble Areas
P0128	Conditions (a), (b) and (c) 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 • Hybrid vehicle control ECU

ES

MONITOR DESCRIPTION



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The ECM (included in hybrid vehicle control ECU) 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	650 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0010 (VVT OCV) P0011 (VVT System 1 - Advance) P0012 (VVT System 1 - Retard) P0031, P0032 (A/F sensor heater - Sensor 1) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0351 - P0354 (Igniter) P0500 (VSS) P2196 (A/F sensor - rationality) P2A00 (A/F sensor - slow response)
Battery voltage	11 V or more
Either of following conditions 1 or 2 met:	-
1. All of following conditions met:	-
• ECT at engine start - IAT at engine start	-15°C to 7°C (-27°F to 12.6°F)
• ECT at engine start	-10°C to 56°C (14°F to 133°F)
• IAT at engine start	-10°C to 56°C (14°F to 133°F)
2. All of following conditions met:	-
• ECT at engine start - IAT at engine start	More than 7°C (12.6°F)
• ECT at engine start	56°C (133°F) or less
• IAT at engine start	-10°C (14°F) or more
Accumulated time at vehicle speed of 80 mph (128 km/h) or more	Less than 20 seconds

TYPICAL MALFUNCTION THRESHOLDS

Duration that both following conditions (a) and (b) met	5 seconds or more
(a) Estimated ECT	75°C (167°F) or more
(b) ECT sensor output	Below 75°C (167°F)

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0128)

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

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

Result

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

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

ES

B → GO TO DTC CHART

A

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 malfunctions.

NG → REPAIR OR REPLACE COOLING SYSTEM

OK

3 INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-12).
(b) Measure the valve opening temperature of the thermostat.
Standard value:
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-13).

NG → REPLACE THERMOSTAT

OK

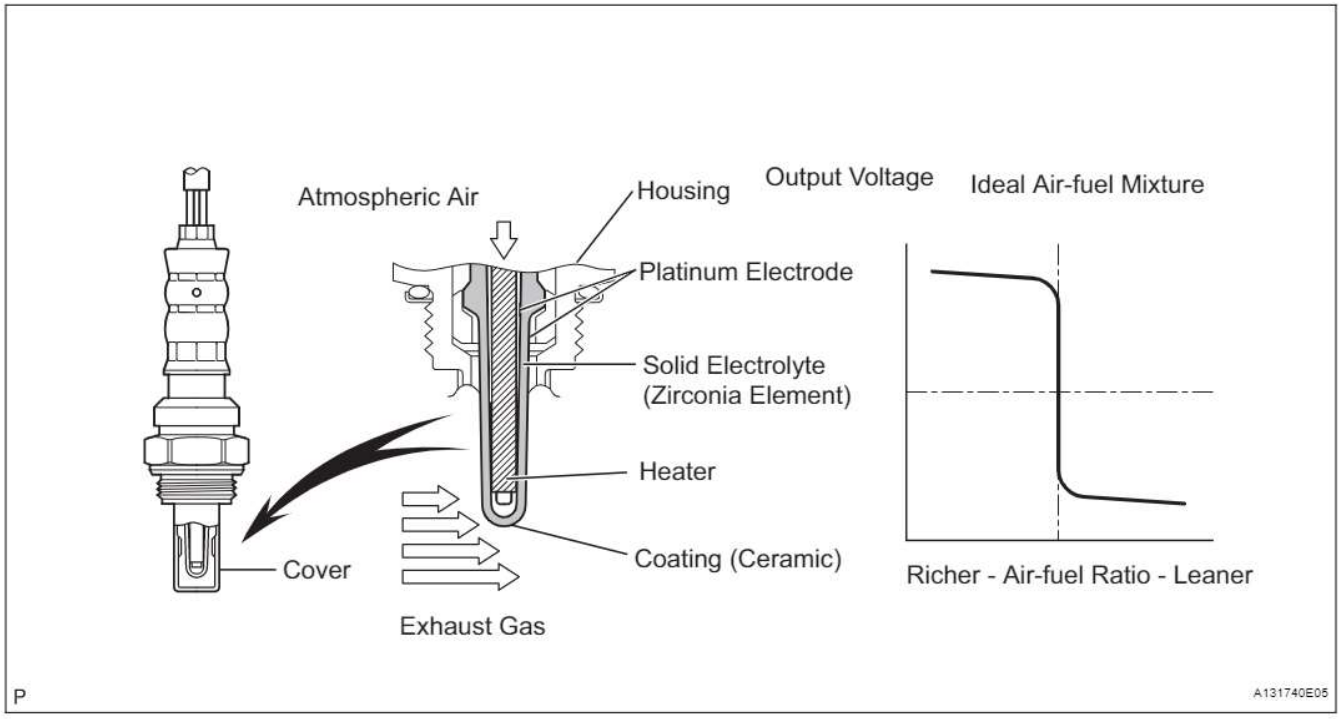
REPLACE HYBRID VEHICLE CONTROL ECU

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)

DESCRIPTION

ES

A three-way catalytic converter (TWC) is used in order to convert the carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxide (NOx) into less harmful substances. To allow the TWC to function effectively, it is necessary to keep the air-fuel ratio of the engine near the stoichiometric air-fuel ratio. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, the Heated Oxygen (HO2) sensor is used.
The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).
When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas 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	• Abnormal voltage output: During active air-fuel ratio control, following conditions (a) and (b) met for certain period of time (2-trip detection logic): (a) Heated Oxygen (HO2) sensor voltage does not decrease to less than 0.59 V (b) HO2 sensor voltage does not increase to more than 0.21 V • Low impedance: Sensor impedance less than 5 Ω for more than 30 seconds when ECM presumes sensor to be warmed up and operating normally (2-trip detection logic)	• Open or short in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • HO2 sensor heater (sensor 2) • Air-fuel Ratio (A/F) sensor (sensor 1) • Integration relay (EFI MAIN relay) • Gas leakage from exhaust system
P0137	• Low voltage (open): During active air-fuel ratio control, following conditions (a) and (b) 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 be warmed up and operating normally (2-trip detection logic)	• Open in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • HO2 sensor heater (sensor 2) • Integration relay (EFI MAIN relay) • Gas leakage from exhaust system
P0138	• High voltage (short): During active air-fuel ratio control, following conditions (a) and (b) met for certain period of time (2-trip detection logic): (a) HO2 sensor voltage output more than 0.59 V (b) Target air-fuel ratio lean • Extremely high voltage (short): HO2 sensor voltage output exceeds 1.2 V for more than 10 seconds (2-trip detection logic)	• Short in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • ECM internal circuit malfunction

ES

MONITOR DESCRIPTION

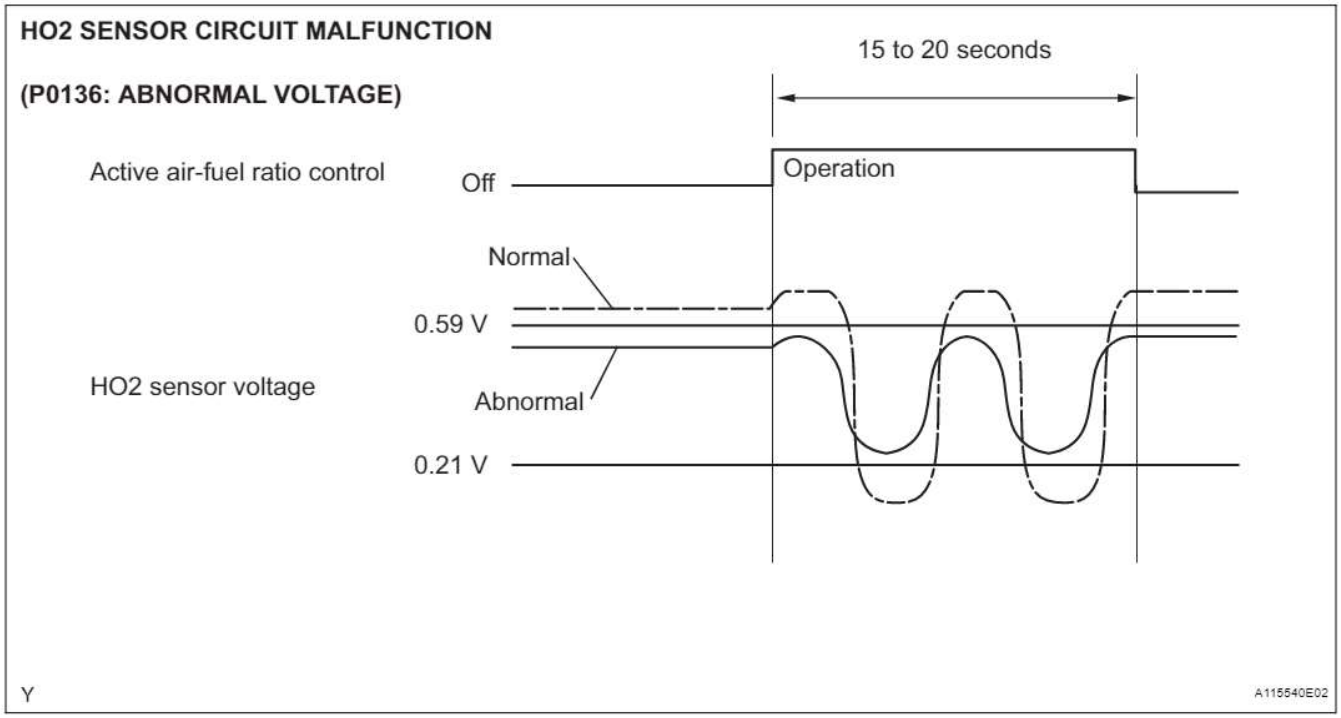
Active Air-Fuel Ratio Control

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 (abnormal voltage output), P0137 (open circuit) and P0138 (short circuit).

Abnormal Voltage Output of HO2 Sensor (DTC P0136)

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



Open or Short in Heated Oxygen (HO2) Sensor Circuit (DTC P0137 or P0138)

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 decreases significantly, 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. 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.

HINT:

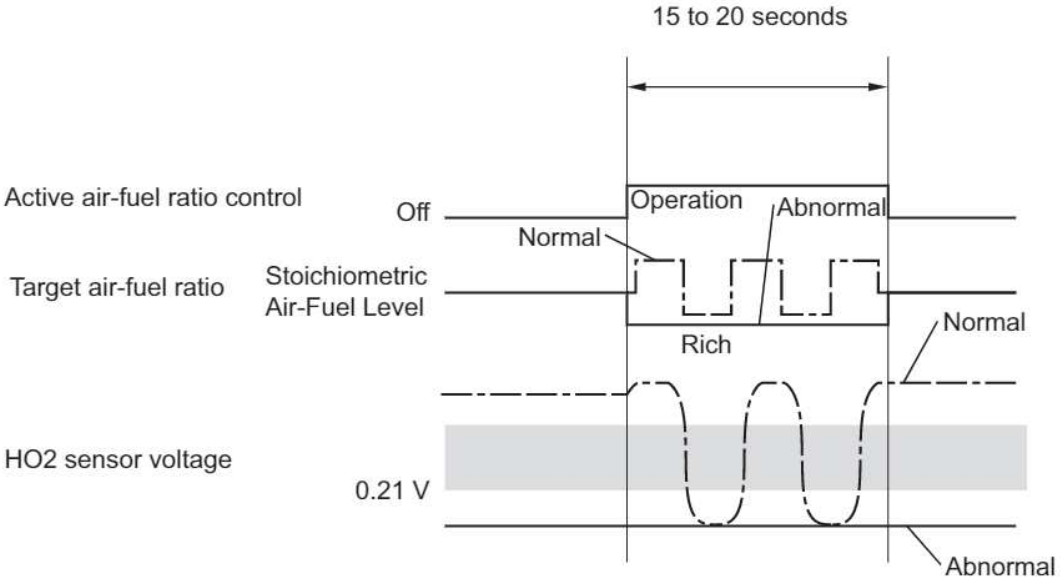
DTC P0138 is also set if the HO2 sensor voltage output is more than 1.2 V for 10 seconds or more.

*: 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-182).

ES

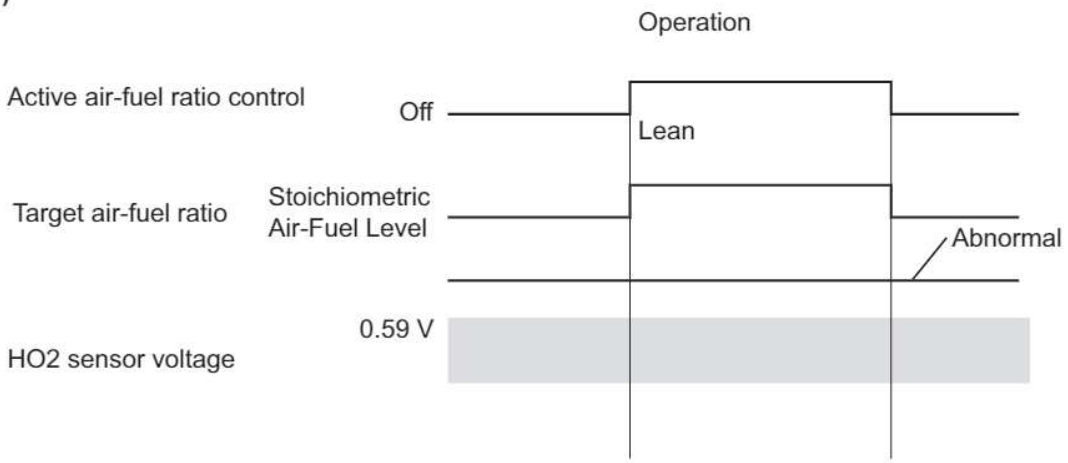
HO2 SENSOR CIRCUIT LOW VOLTAGE

(P0137: OPEN)



HO2 SENSOR CIRCUIT HIGH VOLTAGE

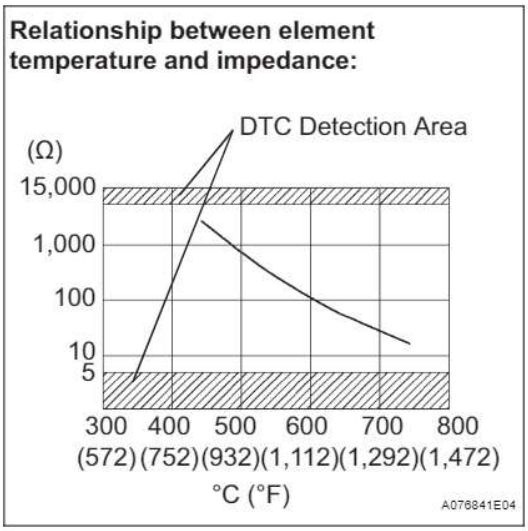
(P0138: SHORT)



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High or Low Impedance of Heated Oxygen (HO2) Sensor (DTC P0136 or P0137)



During normal air-fuel ratio feedback control, there are small variations in the exhaust gas oxygen concentration. In order to continuously monitor the slight variations in 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.
- DTC P0136 indicates deterioration of the HO2 sensor. The ECM sets this DTC by calculating the impedance of the sensor when the typical enabling conditions are satisfied (2 driving cycles).
- DTC P0137 indicates an open or short circuit in the HO2 sensor (2 driving cycles). The ECM sets this DTC when the impedance of the sensor exceeds the threshold 15 kΩ.

MONITOR STRATEGY

Related DTCs	P0136: Heated oxygen sensor output voltage (Abnormal voltage output) P0136: Heated oxygen sensor impedance (Low) P0137: Heated oxygen sensor output voltage (Low voltage) P0137: Heated oxygen sensor impedance (High) P0138: Heated oxygen sensor output voltage (High voltage) P0138: Heated oxygen sensor output voltage (Extremely high)
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: Other
Duration	20 seconds: Active air-fuel ratio control detection 60 seconds: Heated oxygen sensor impedance (High) 30 seconds: Heated oxygen sensor impedance (Low) 10 seconds: Output voltage (Stuck high)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	P0031, 32 (A/F Sensor heater - Sensor 1) P0037, 38 (O2 Sensor heater - Sensor 2) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0455, P0456 (EVAP system) P0500 (VSS) P2196 (A/F Sensor - rationality) P2A00 (A/F Sensor - slow response)

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

Active air-fuel ratio control	Executing
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
Idling	ON
Engine RPM	Less than 3,200 rpm
A/F sensor status	Activated
Fuel system status	Closed loop
Fuel cut	OFF
Engine load	10 to 70%
Shift position	1 or more

Heated Oxygen Sensor Impedance (Low):

Battery voltage	11 V or more
Estimated rear HO2 sensor 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 rear HO2 sensor temperature	450°C (842°F) or more
ECM monitor	Completed
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 (Abnormal Voltage Output):

Either of following conditions met:	1 or 2
1. All of following conditions (a), (b) and (c) 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)	2.3 g or more
2. All of following conditions (d), (e) and (f) met	-
(d) Commanded air-fuel ratio	14.9 or more

(e) Rear HO2 sensor voltage	0.21 to 0.59 V
(f) OSC	2.3 g or more

Heated Oxygen Sensor Output Voltage (Low):

All of following conditions (a), (b) and (c) met	-
(a) Commanded air-fuel ratio	14.3 or less
(b) Rear HO2 sensor voltage	Less than 0.21 V
(c) OSC	2.3 g or more

Heated Oxygen Sensor Output Voltage (High):

All of following conditions (a), (b) and (c) met	-
(a) Commanded air-fuel ratio	14.9 or more
(b) Rear HO2 sensor voltage	More than 0.59 V
(c) OSC	2.3 g or more

Heated Oxygen Sensor Impedance (Low):

Duration of following condition met	30 seconds or more
Heated oxygen sensor impedance	Less than 5 Ω

Heated Oxygen Sensor Impedance (High):

Duration of following condition met	60 seconds or more
Heated oxygen sensor impedance	15 kΩ or more

Heated Oxygen Sensor Output Voltage (Extremely High):

Duration of following condition met	10 seconds or more
Heated oxygen sensor voltage	1.2 V or more

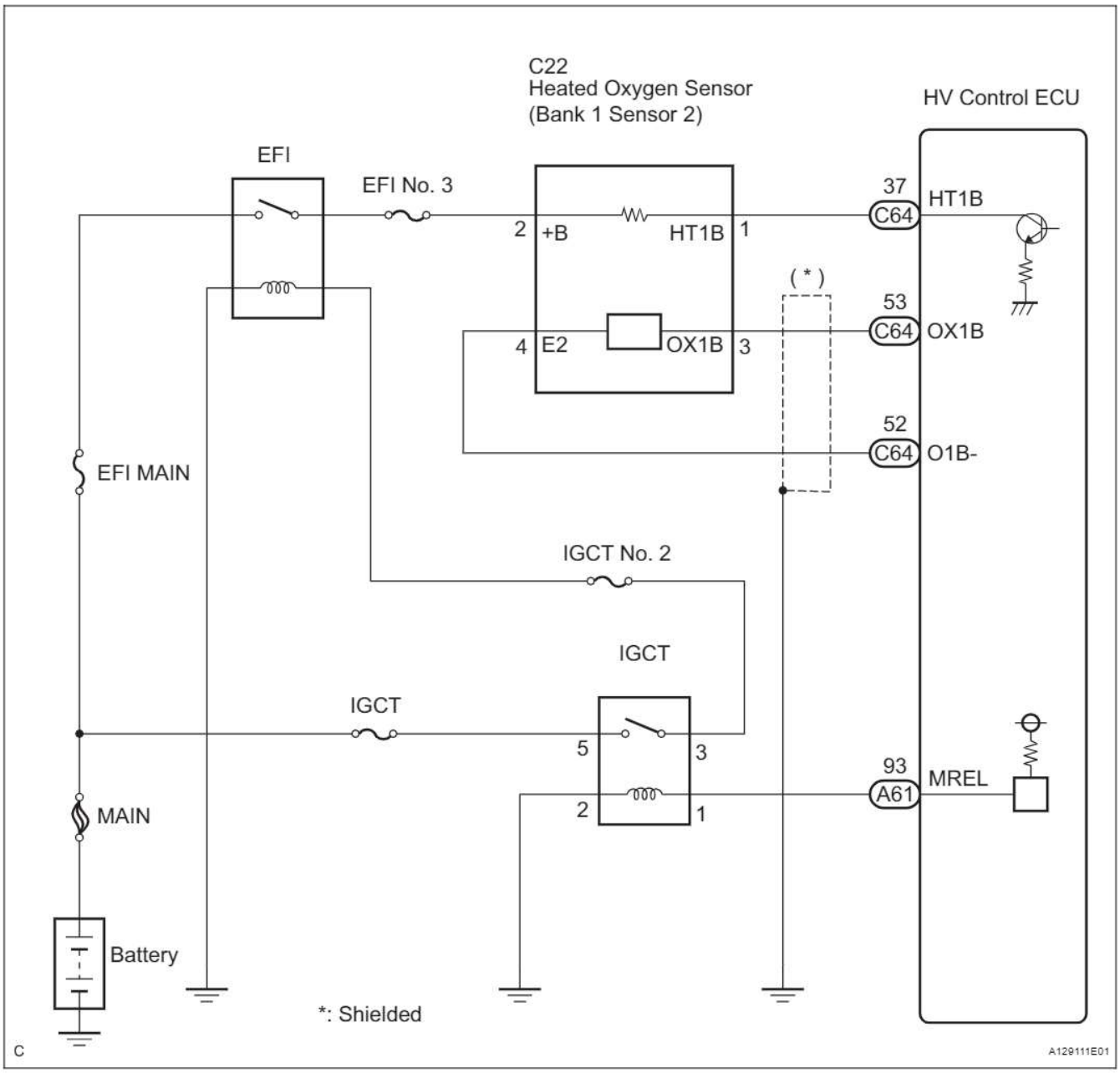
COMPONENT OPERATING RANGE

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 (See page ES-182).

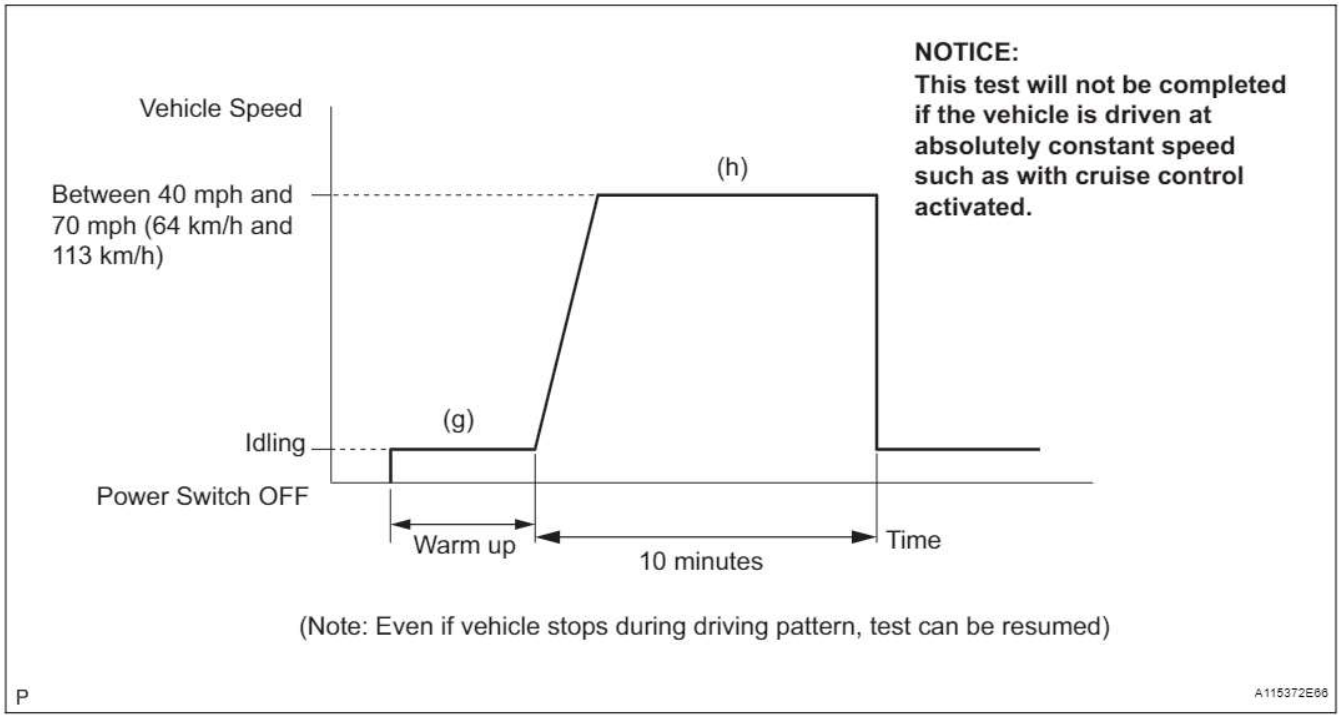
WIRING DIAGRAM

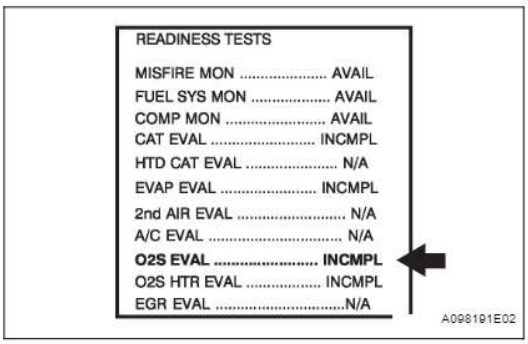


CONFIRMATION DRIVING PATTERN

HINT:

- This confirmation driving pattern is used in the "PERFORM CONFIRMATION DRIVING PATTERN" procedure of the following diagnostic troubleshooting procedure.
- 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.





(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (if set) (See page ES-31).
(e) Select the following menu items: DIAGNOSIS / CARB OBD II / READINESS TESTS.
(f) Check that O2S EVAL is INCMPL (incomplete).
(g) Put the engine in inspection mode (See page ES-35), and warm it up.
(h) Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes.
(i) Note the state of the Readiness Tests items. Those items will change to COMPL (complete) as the O2S EVAL monitor operates.
(j) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES and check if any DTCs (any pending DTCs) are set.
HINT:
If O2S EVAL does not change to COMPL, and any pending DTCs fail to be set, extend the driving time.

INSPECTION PROCEDURE

HINT:
Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.
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 the intelligent tester.
(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(f) Perform the A/F CONTROL operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(g) Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2) displayed on the tester.

ES

HINT:
- The A/F CONTROL operation lowers the fuel injection volume by 12.5% or increases the injection volume by 25%.
- The sensors react in accordance with increases and decreases in the fuel injection volume.

Standard

Tester Display (Sensor)	Injection Volumes	Status	Voltages
AFS B1 S1 (A/F)	+25%	Rich	Less than 3.0
	-12.5%	Lean	More than 3.35
O2S B1 S2 (HO2)	+25%	Rich	More than 0.5
	-12.5%	Lean	Less than 0.4

NOTICE:
The A/F sensor has an output delay of a few seconds and the 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 Areas
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.5 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.5 V Less than 0.4 V		
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage Almost no reaction		

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Areas
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 and graph 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 B1 S1 and O2S B1 S2; then press the YES button and then the ENTER button followed by the F4 button.
HINT:

- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.
- If the OX1B wire from the hybrid vehicle control ECU connector is short-circuited to the +B wire, DTC P0138 will be set.

ES

1	READ OUTPUT DTC

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

Result

Display (DTC output)	Proceed to
P0138	A
P0137	B
P0136	C

B → Go to step 14

C → Go to step 7

A

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / O2S B1 S2.
(d) Allow the engine to idle.
(e) Read the Heated Oxygen (HO2) sensor output voltage while idling.

Result

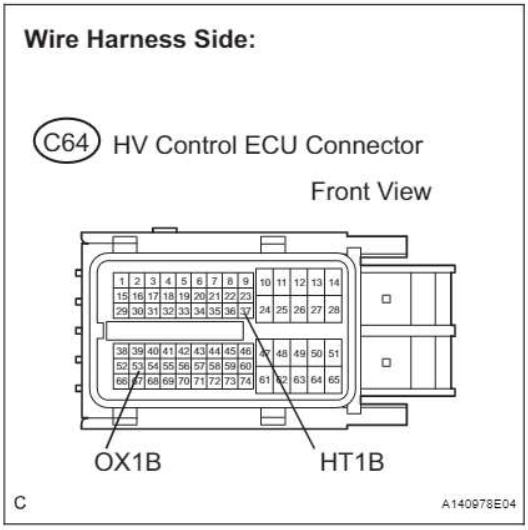
HO2 Sensor Output Voltages	Proceed to
More than 1.2 V	A
Less than 1.0 V	B

B → Go to step 5

A

3 CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT)

ES



(a) Turn the power switch off and wait for 5 minutes.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.
Standard resistance

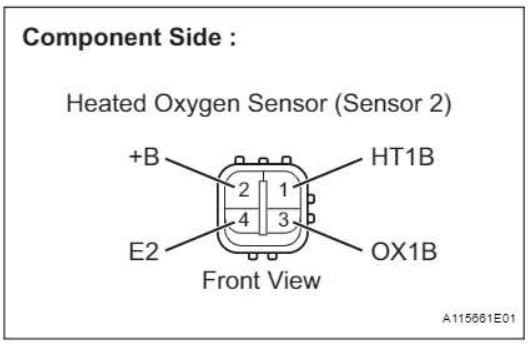
Tester Connections	Specified Conditions
C64-37 (HT1B) - C64-53 (OX1B)	10 kΩ or higher

(d) Reconnect the hybrid vehicle control ECU connector.

OK → REPLACE HYBRID VEHICLE CONTROL ECU

NG

4 INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)



(a) Disconnect the C22 HO2 sensor connector.
(b) Measure the resistance.
Standard resistance

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

NEXT

6	CHECK WHETHER DTC OUTPUT RECURS (DTC P0138)

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

ES

Result

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

B → CHECK FOR INTERMITTENT PROBLEMS

A

REPLACE HEATED OXYGEN SENSOR

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Put the engine in inspection mode (See page ES-35).
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / O2S B1 S2.
(e) After warming up the engine, run the engine at an engine speed of 2,500 rpm for 3 minutes.
(f) Read the output voltage of the HO2 sensor when the engine rpm is suddenly increased.
HINT:
Quickly accelerate the engine to 4,000 rpm 3 times using the accelerator pedal.
Standard voltage:
Fluctuates between 0.4 V or less and 0.5 V or more.

NG → Go to step 14

OK

8	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

9	CHECK WHETHER DTC OUTPUT RECURS (DTC P0136)

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

Result

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

ES

B → CHECK FOR INTERMITTENT PROBLEMS

A

10	REPLACE HEATED OXYGEN SENSOR

NEXT

11	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

12	CHECK WHETHER DTC OUTPUT RECURS (DTC P0136)

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

Result

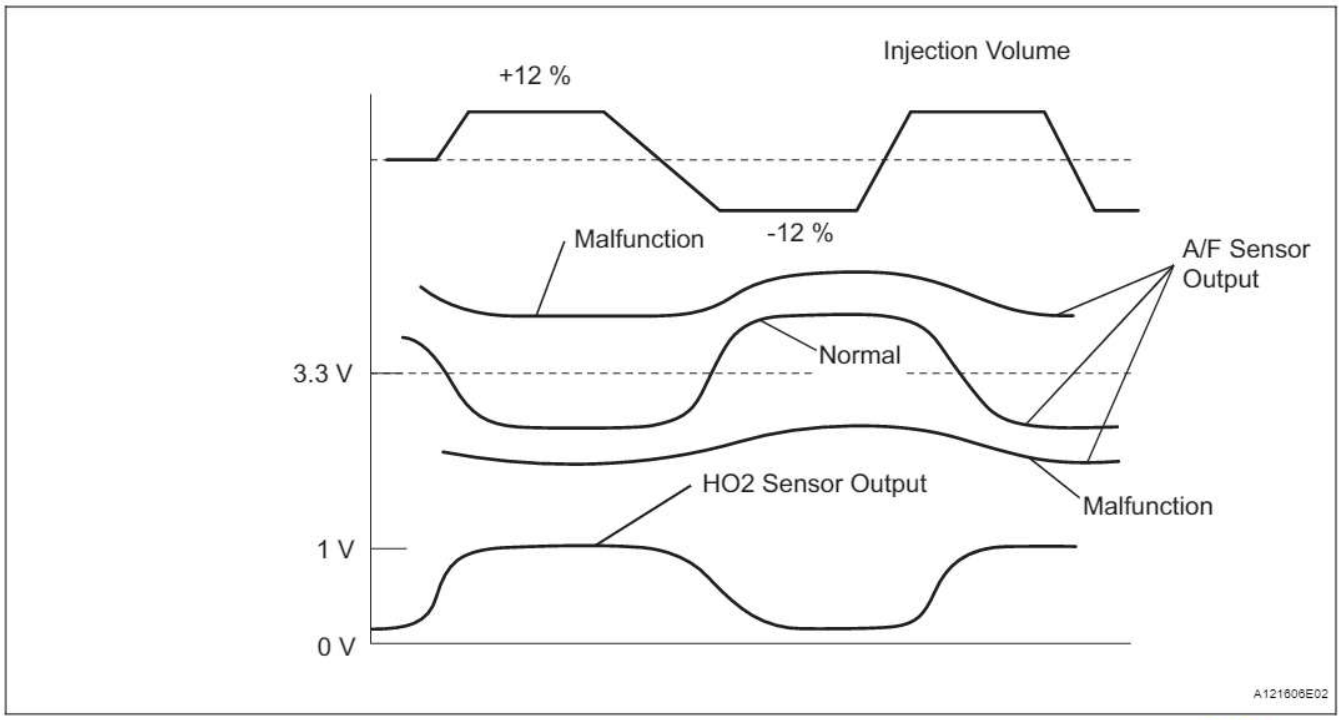
Display (DTC Output)	Proceed to
P0136	A
No output	B

B → END

A

13	PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)

(a) Connect the intelligent tester to the DLC3.



(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INJ VOL.
(f) 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 B1 S1, and the HO2 sensor is displayed as O2S B1 S2, on the intelligent tester.

Result

Tester Display (Sensor)	Voltage Variations	Proceed to
AFS B1 S1 (A/F)	Alternates between more and less than 3.3 V	OK
	Remains at more than 3.3 V	NG
	Remains at less than 3.3 V	NG

HINT:
A normal HO2 sensor voltage (O2S B1 S2) 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.

NG → REPLACE AIR-FUEL RATIO SENSOR

OK

CHECK AND REPAIR EXTREMELY RICH OR LEAN ACTUAL AIR FUEL RATIO (FUEL SYSTEM, EXHAUST GAS LEAKAGE, ETC.)

14	CHECK FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

ES

OK

15	INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

(a) Check the heated oxygen sensor resistance (See page EC-26).

NG → REPLACE HEATED OXYGEN SENSOR

OK

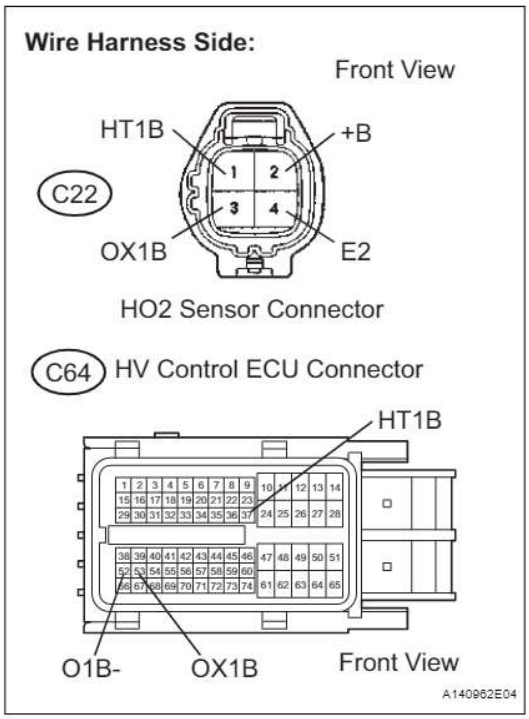
16	INSPECT INTEGRATION RELAY (EFI RELAY)

(a) Check the EFI relay (See page ES-407).

NG → REPLACE INTEGRATION RELAY (EFI RELAY)

OK

17	CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - HV CONTROL ECU)



(a) Disconnect the C22 HO2 sensor connector.
(b) Turn the power 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
C22-2 (+B) - Body ground	9 to 14 V

(d) Turn the power switch off.
(e) Disconnect the C64 hybrid vehicle control ECU connector.
(f) Measure the resistance.

Standard resistance (Check for open)

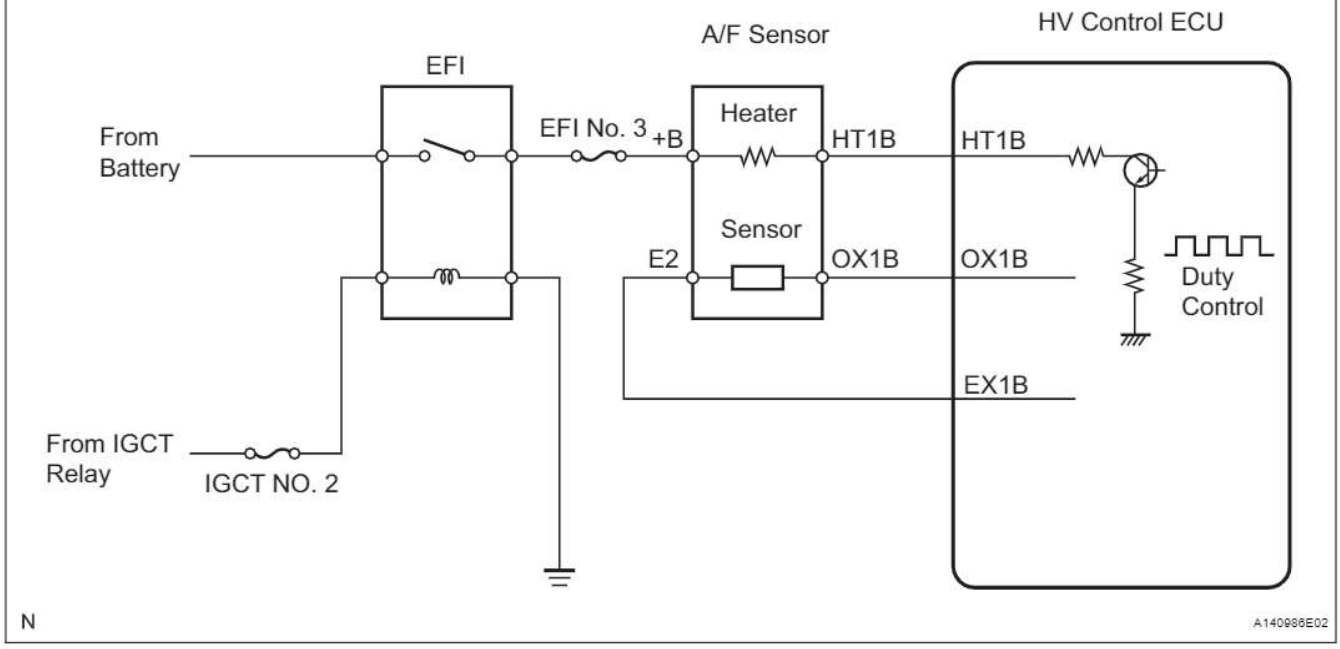
Tester Connections	Specified Conditions
C22-1 (HT1B) - C64-37 (HT1B)	Below 1 Ω
C22-3 (OX1B) - C64-53 (OX1B)	Below 1 Ω
C22-4 (E2) - C64-52 (O1B-)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C22-1 (HT1B) or C64-37 (HT1B) - Body ground	10 kΩ or higher
C22-3 (OX1B) or C64-53 (OX1B) - Body ground	10 kΩ or higher
C22-4 (E2) or C64-52 (O1B-) - Body ground	10 kΩ or higher

(g) Reconnect the HO2 sensor connector.
(h) Reconnect the hybrid vehicle control ECU connector.

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)

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 the 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 (included in hybrid vehicle control ECU) illuminates the MIL and sets a DTC.

ES

DTC No.	DTC Detection Conditions	Trouble Areas
P0171	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 (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • PCV valve and hose • PCV hose connections • Hybrid vehicle control ECU
P0172	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 (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU

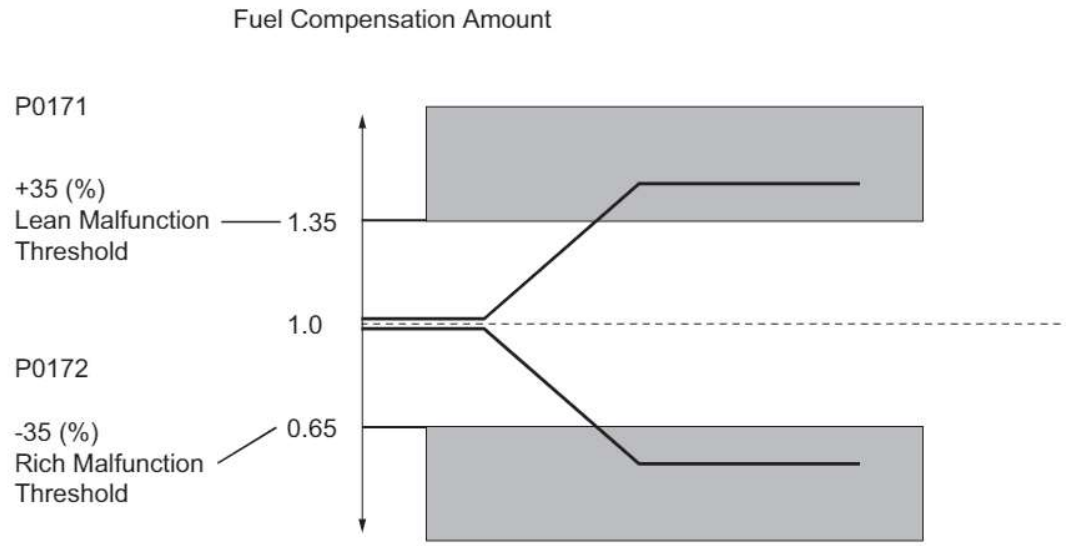
HINT:

- When DTC P0171 is set, the actual air-fuel ratio is on the lean side. When DTC P0172 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 may be set. The MIL is then illuminated.
- When the total of the short-term and long-term fuel trim values is within 20% (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 threshold, the ECM interprets this as a fault in the fuel system and sets a DTC.
Example:
The average fuel trim learning value is +35% or more or -35% or less, the ECM interprets this as a fuel system malfunction.

ES



MONITOR STRATEGY

Related DTCs	P0171: Fuel trim lean P0172: Fuel trim rich
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	Within 10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0010 (VVT OCV) P0011 (VVT System 1 - Advance) P0012 (VVT System 1 - Retard) P0031, P0032 (A/F sensor heater - Sensor 1) P0100 - P0103 (MAF meter) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0335 (CKP sensor) P0340 (CMP sensor) P0351 - P0354 (Igniter) P0500 (VSS)
Fuel system status	Closed loop
Battery voltage	11 V or more
Either of following conditions 1 or 2 set	-
1. Engine RPM	Below 1,400 rpm
2. Intake air amount per revolution	0.22 g/rev or more
Catalyst monitor	Not executed

ES

TYPICAL MALFUNCTION THRESHOLDS

Purge-cut	Executing
Either of following conditions 1 or 2 met	-
1. Average of short-term fuel trim and long-term fuel trim	35% or more (varies with ECT)
2. Average of short-term fuel trim and long-term fuel trim	-35% or less (varies with ECT)

WIRING DIAGRAM

Refer to DTC P2195 (See page ES-273).

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.
- 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 OR P0172)

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

Result

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

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

B → GO TO DTC CHART

A

2 PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(f) 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).
(g) Monitor the output voltages of the A/F and HO2 sensors (AFS B1S1 and O2S B1S2) displayed on the tester.

Result:

The A/F sensor reacts in accordance with increases and decreases in the fuel injection volume:
+25% = Rich output:
Less than 3.0 V
-12.5% = Lean output:
More than 3.35 V

NOTICE:
The A/F sensor has an output delay of a few seconds and the 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 Areas
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.5 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.5 V Less than 0.4 V		

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Areas
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		Extremely rich or lean actual air-fuel ratio • Injector leakage or blockage • Gas leakage from exhaust system • Fuel pressure • MAF meter • ECT sensor • Air induction system • PCV hose connections
	Output Voltage Almost no reaction	NG	Output Voltage Almost no reaction	NG	

ES

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

Result

Result	Proceed to
Case 1	C
Case 2	B
Case 3	A

B → Go to step 11

C → Go to step 15

A

3	READ VALUE USING INTELLIGENT TESTER (MAF)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(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 1 g/sec. and 3 g/sec. (shift position: N, A/C: OFF).
MAF at an engine speed of 2,500 rpm:
Between 2 g/sec. and 6 g/sec. (shift position: N, A/C: OFF).

NG → REPLACE MASS AIR FLOW METER

OK

4	READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power 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 100°C (167°F and 212°F).

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR

OK

5	CHECK PCV HOSE (HOSE CONNECTIONS)

(a) Check PCV hose connections.

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

NG → REPAIR OR REPLACE PCV HOSE

OK

6	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

7	CHECK FOR SPARK AND IGNITION (See page ES-160)

NG → REPAIR OR REPLACE IGNITION SYSTEM

OK

8	CHECK FOR EXHAUST GAS LEAK

(a) Check for exhaust gas leakage.
OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK ↓

9	CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-9).
Standard pressure:
304 to 343 kPa (3.1 to 3.5 kgf/cm^2, 44.1 to 49.7 psi)

NG → REPAIR OR REPLACE FUEL SYSTEM

OK ↓

10	INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

(a) Check the injection volume (See page FU-14).
Standard injection volume:
45 to 58 cm^3 (2.9 to 3.5 cu in.) per 15 seconds

NG → REPLACE FUEL INJECTOR

OK ↓

11	INSPECT AIR-FUEL RATIO SENSOR (HEATER RESISTANCE) (See page ES-75)

NG → REPLACE AIR-FUEL RATIO SENSOR

OK ↓

12	INSPECT INTEGRATION RELAY (EFI RELAY) (See page ES-76)

NG → REPLACE INTEGRATION RELAY

OK ↓

13	CHECK HARNESS AND CONNECTOR (A/F SENSOR - HV CONTROL ECU) (See page ES-287)

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

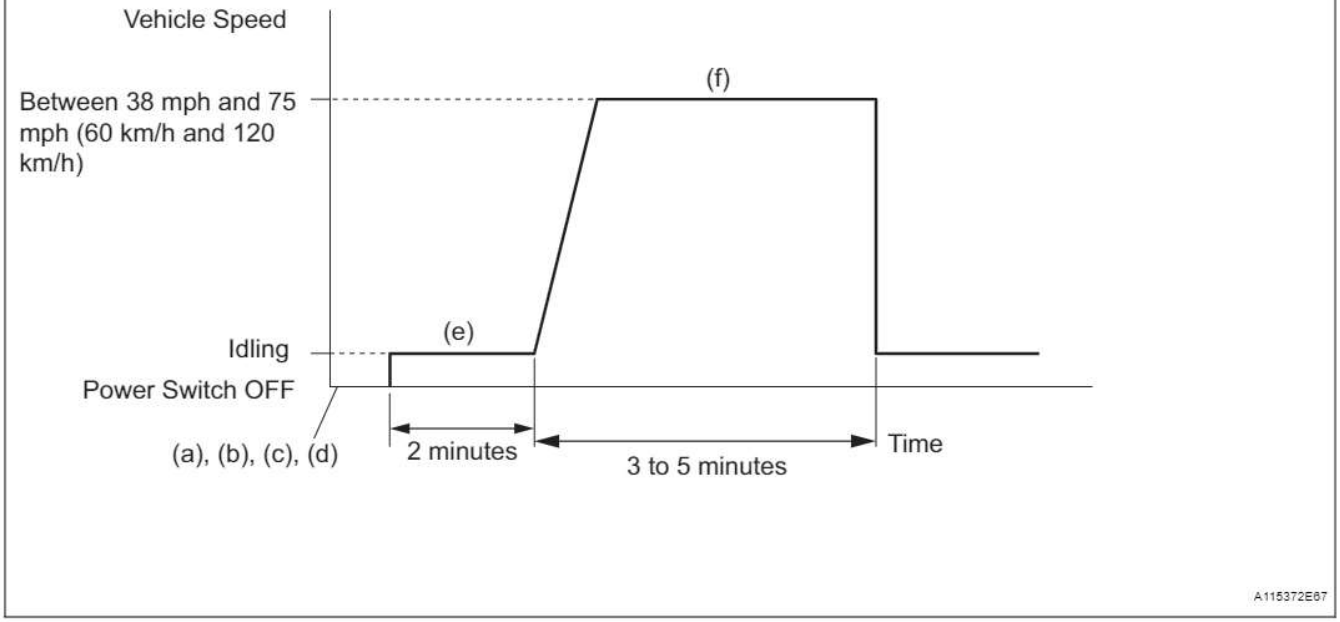
OK

14	REPLACE AIR-FUEL RATIO SENSOR

NEXT

15	PERFORM CONFIRMATION DRIVING PATTERN

ES



(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Switch the ECM from normal mode to check mode using the tester (See page ES-34).
(e) Put the engine in inspection mode (See page ES-35), and warm it up with all the accessories switched OFF.
(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.
HINT:
If the system is still malfunctioning, the MIL will be illuminated during step (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 OR P0172)

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

Result

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

B → Go to step 3

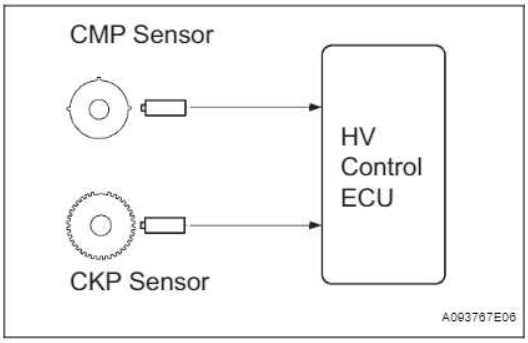
A

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

ES

DESCRIPTION



When the engine misfires, high concentrations of hydrocarbons (HC) enter the exhaust gas. Extremely high HC concentration levels can cause increases 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 these increases in emissions and to limit the possibility of thermal damage, the ECM (included in hybrid vehicle control ECU) 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 rate exceeds the threshold level, 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 detected (2-trip detection logic)	• Open or short in engine wire harness • Connector connection • 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 valve and hose • PCV hose connections • Air induction system • Hybrid vehicle control ECU
P0301 P0302 P0303 P0304	Misfiring of specific cylinder detected (2-trip detection logic)	

When DTCs for misfiring cylinders are randomly set, but DTC P0300 is not set, 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.

MONITOR DESCRIPTION

The ECM illuminates the MIL and sets a DTC when either 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 50 misfires per 1,000 crankshaft revolutions) occurs 4 times in sequential crankshaft revolutions.

The ECM flashes the MIL and sets a DTC when either of the following conditions, which could cause 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.

ES

MONITOR STRATEGY

Related DTCs	P0300: Multiple cylinder misfire P0301: Cylinder 1 misfire P0302: Cylinder 2 misfire P0303: Cylinder 3 misfire P0304: Cylinder 4 misfire
Required Sensors/Components (Main)	Crankshaft position sensor and camshaft position sensor
Required Sensors/Components (Related)	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:

Monitor runs whenever following DTCs not present	P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0327, P0328 (Knock sensor) P0335 (CKP sensor) P0340 (CMP sensor) P0500 (VSS)
Battery voltage	8 V or more
VVT system	Not operated by scan tool
Engine RPM	750 to 6,400 rpm
Either of following conditions (a) or (b) met	-
(a) ECT at engine start	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-damaged-misfire (MIL blinks):

All of following conditions 1, 2 and 3 met	Crankshaft 200 revolutions x 3
1. Driving cycles	1st

2. Check mode	OFF
3. Engine RPM	Less than 3.500 rpm
Except above	Crankshaft 200 revolutions

TYPICAL MALFUNCTION THRESHOLDS

Monitor period of emission-related-misfire:

Misfire rate	2.2% or more

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

Number of misfire per 200 revolutions	118 or more (varies with intake air amount and RPM)

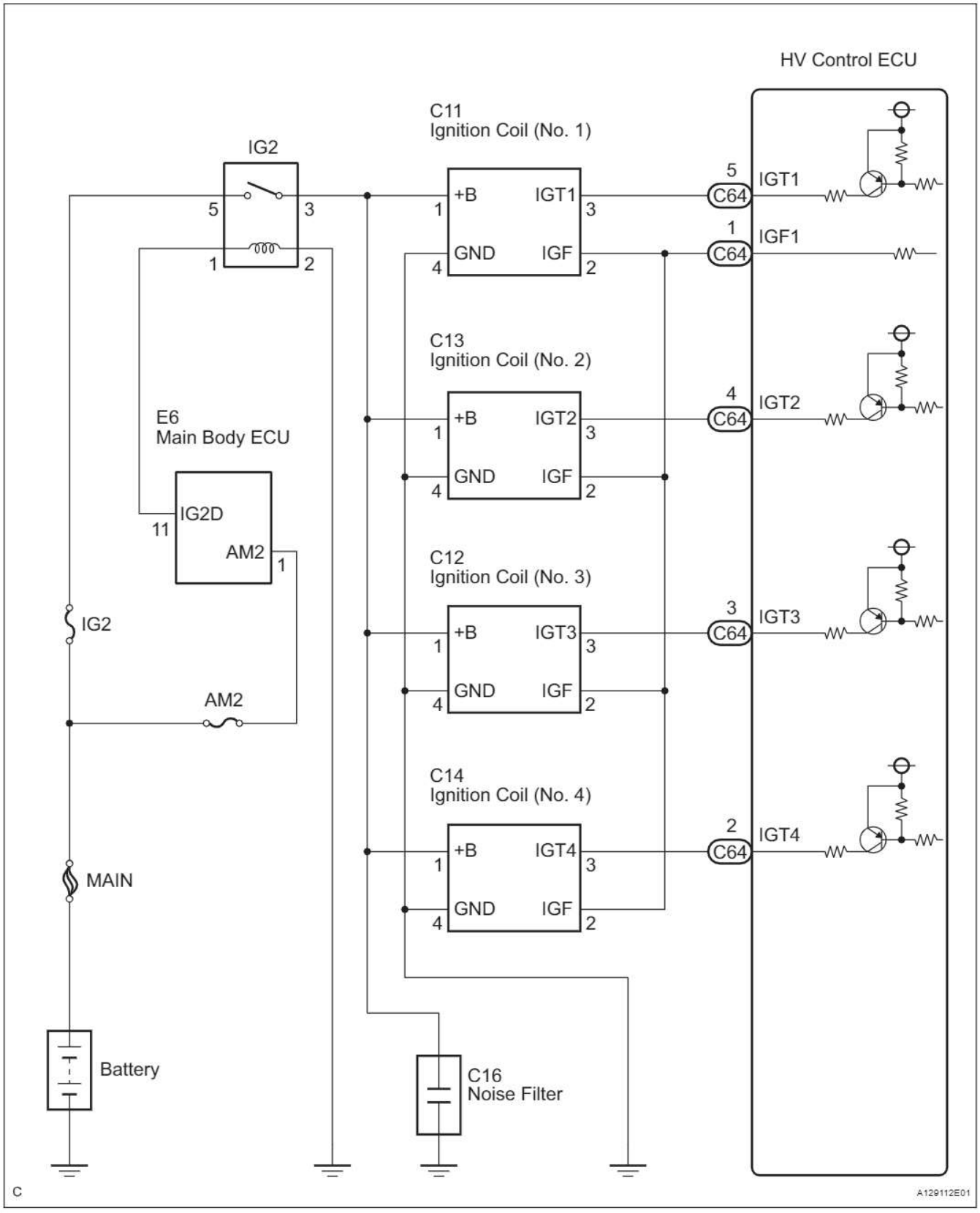
ES

MONITOR RESULT

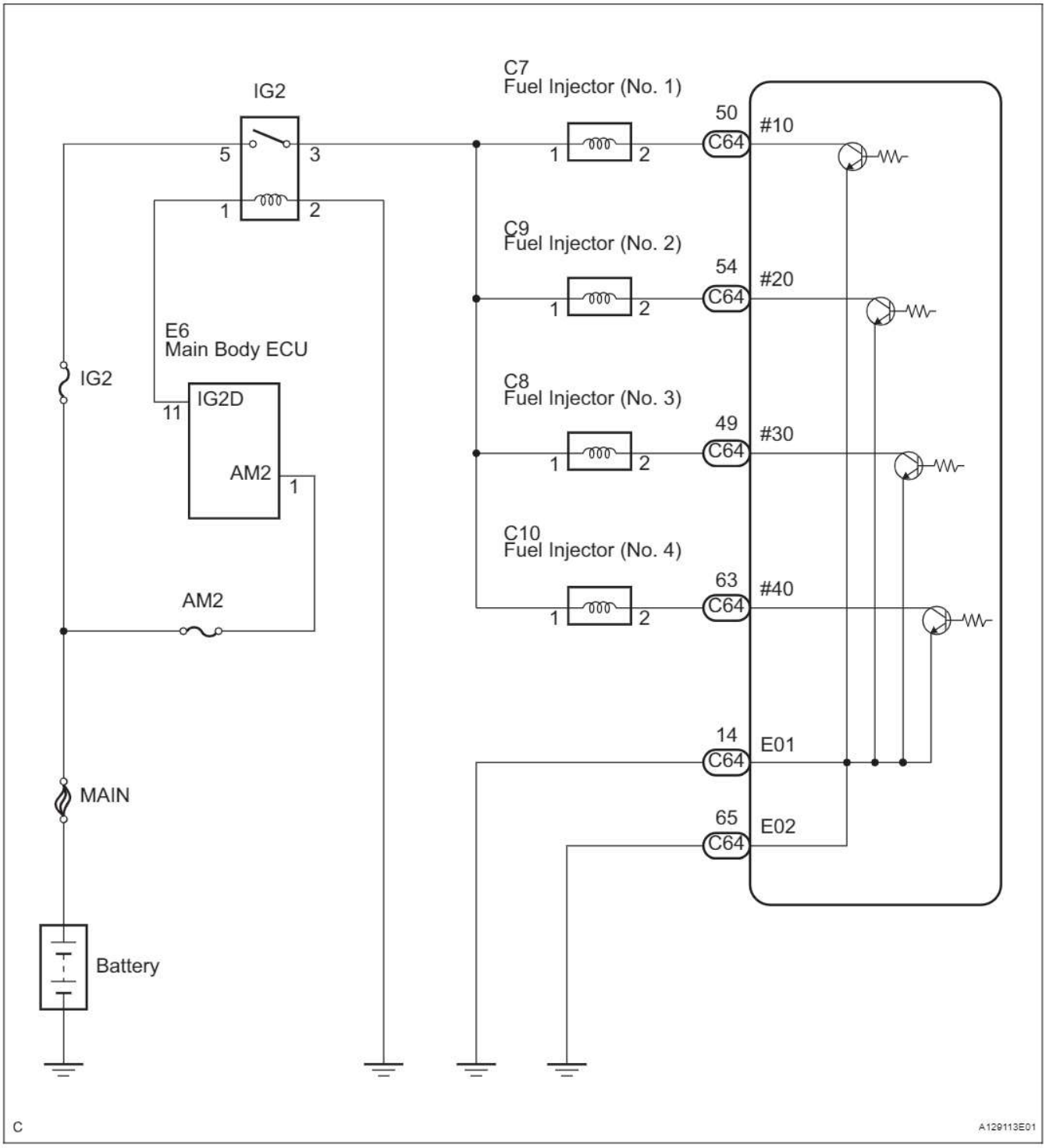
Refer to CHECKING MONITOR STATUS (See page ES-14).

WIRING DIAGRAM

Wiring diagram of the ignition system.



Wiring diagram of the injector circuit.



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the power switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (See page ES-17).
6. Read the misfire counts of each cylinder (CYL #1 to #4) 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 conditions, such as an engine rpm and engine load, shown in 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 power 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 power switch off and wait for at least 5 seconds.

ES

INSPECTION PROCEDURE

HINT:

- If any DTCs other than 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.
- 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:
  (a) The fuel level is low.
  (b) Improper fuel is used.
  (c) The spark plugs are dirty.
  (d) The problem is complex due to multiple factors.
- After finishing repairs, check that no misfires occur in each cylinder (CYL #1, #2, #3 and #4).
- Be sure to confirm that no misfiring cylinder DTCs are set again by conducting the confirmation driving pattern, after the repairs.
- For 6 and 8 cylinder engines, the ECM intentionally does not set the specific misfiring cylinder DTCs at a high engine RPM. If misfires only occur during high engine RPM driving, only DTC P0300 is set.
  In the event of DTC P0300 being present, perform the following operations:
  (a) Clear the DTC (See page ES-31).
  (b) Start the engine and conduct the confirmation driving pattern.
  (c) Read the misfiring rates of each cylinder or DTC(s) using the tester.
  (d) Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.
  (e) After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not set.
- When either SHORT FT #1 or LONG FT #1 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), misfires occurred only while warming up the engine.

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

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

Result

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

ES

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

B → GO TO DTC CHART

A

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power 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 values indicate the vehicle conditions under which the misfire occurred.

NEXT

3	CHECK PCV HOSE (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 AND #4)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).

(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / CYL #1, #2, #3 and #4.
(f) Put the engine in inspection mode (See page ES-35).
(g) Read each value for CYL #1 to #4 displayed on the tester. If no misfire counts occur in any cylinders, perform the following procedures:
  (1) Shift the gear selector lever to the D position.
  (2) Check CYL #1 to #4.
  (3) If misfire counts are still not displayed, perform steps (h) and (i) and then check the misfire counts again.
(h) Drive the vehicle with the MISFIRE RPM and MISFIRE LOAD noted in the "READ VALUE USING INTELLIGENT TESTER (MISFIRE RPM AND MISFIRE LOAD)" procedures above.
(i) Read the CYL #1 to #4 or DTCs displayed on the tester.

Result

Misfire Count	Proceed to
Most misfires occur in only 1 or 2 cylinders	A
3 cylinders or more have equal misfire counts	B

HINT:
- If it is difficult to reproduce misfires for each cylinder, check the DATA LIST item, MISFIRE MARGIN. Try to find vehicle driving conditions that lower the MISFIRE MARGIN value. Values above 30% are considered normal.
- If the freeze frame data's record of the ECT is below 75°C (167°F), misfire may be detected only when the engine is cold.
- If the freeze frame data's record of the ENGINE RUN TIME is below 120 seconds, misfire may be detected immediately after the engine is started.

B → Go to step 14

A

5 PERFORM ACTIVE TEST USING INTELLIGENT TESTER (FUEL CUT #1 TO #4)

(a) Put the engine in inspection mode (See page ES-35).
(b) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / FUEL CUT#1 (to #4).
(c) If a cylinder has a high misfire count, cut fuel to that cylinder. Compare the misfire count of the cylinder before fuel cut and after fuel cut.

Result

Misfire Count in Each Cylinder	Proceed to
Misfire count of cylinder before fuel cut and after fuel cut roughly the same	A
Misfire count of cylinder before fuel cut lower than after fuel cut	B

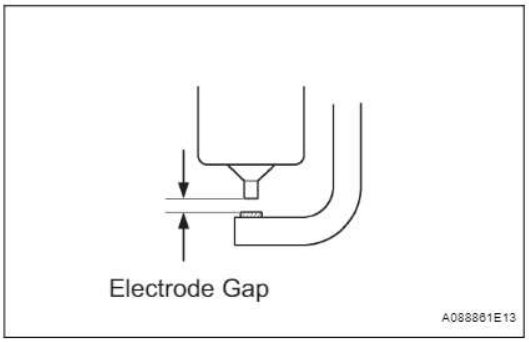
NOTICE:
This ACTIVE TEST cannot be performed while the vehicle is being driven.
HINT:
If the misfire count of the cylinder before and after the fuel cut are roughly the same, the cylinder is misfiring.
If the misfire count of the cylinder before the fuel cut is lower than after the fuel cut, the cylinder misfires sometimes.

B	Go to step 11

A

ES

6 CHECK SPARK PLUG



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

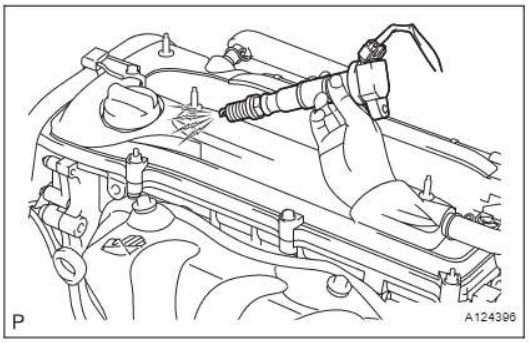
Manufacturers	Products
DENSO	SK20R11
NGK	IFR6A11

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

7 CHECK FOR SPARKS AND IGNITION



(a) Remove the ignition coil from the cylinder head.
(b) Install the spark plug onto the ignition coil.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the power switch on (IG) and turn the tester on.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / FUEL CUT ALL.
(f) Attach the spark plug assembly to the cylinder head.
(g) Perform the FUEL CUT ALL operation (press the RIGHT or LEFT button to change to ON).
NOTICE:
When FUEL CUT ALL is OFF and the engine is cranked, fuel injection will occur.
(h) Crank the engine for less than 2 seconds and check the spark.
OK:
Sparks jump across electrode gap.

(i) Install the ignition coil.

NG → Go to step 9

OK

8	CHECK CYLINDER COMPRESSION PRESSURE (MISFIRING CYLINDER)

(a) Measure the cylinder compression pressure of the misfiring cylinder.

OK → Go to step 10

NG

ES

CHECK ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

9	CHANGE WITH NORMAL SPARK PLUG AND CHECK SPARK OF MISFIRING CYLINDER (MISFIRING CYLINDER)

(a) Change the installed spark plug with a spark plug that functions normally.

(b) Perform a spark test.

CAUTION:
Always disconnect all injector connectors.
NOTICE:
Do not crank the engine for more than 2 seconds.

(1) Install the spark plug to the ignition coil and connect the ignition coil connector.
(2) Disconnect the injector connector.
(3) Ground the spark plug.
(4) Check if sparks occur while the engine is being cranked.

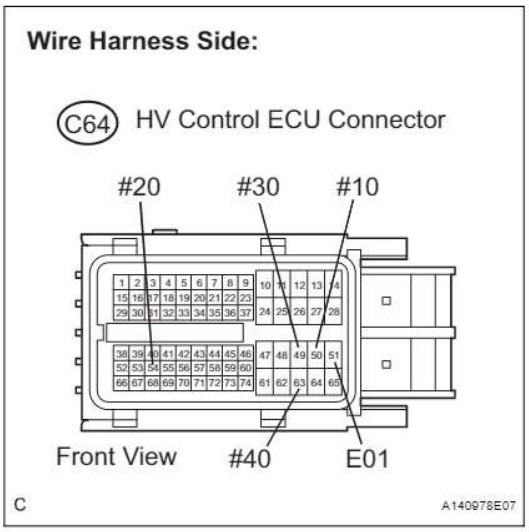
OK:
Sparks jump across electrode gap.

NG → REPLACE IGNITION COIL ASSEMBLY

OK

REPLACE SPARK PLUG

10 INSPECT HV CONTROL ECU TERMINAL VOLTAGE (MISFIRING CYLINDER)



(a) Disconnect the C64 hybrid vehicle control ECU connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage between the terminals of the hybrid vehicle control ECU connector.

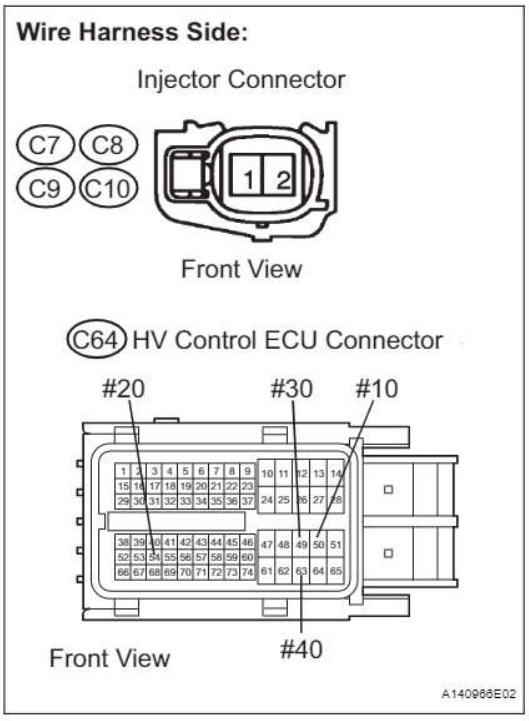
Standard voltage

Tester Connections	Specified Conditions
C64-50 (#10) - C64-51 (E01)	9 to 14 V
C64-54 (#20) - C64-51 (E01)	9 to 14 V
C64-49 (#30) - C64-51 (E01)	9 to 14 V
C64-63 (#40) - C64-51 (E01)	9 to 14 V

OK → Go to step 12

NG

11 CHECK HARNESS AND CONNECTOR (INJECTOR - HV CONTROL ECU)



(a) Disconnect the injector connector (of the misfiring cylinder).
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Turn the power switch on (IG).
(d) Measure the resistance and voltage between the injector and the hybrid vehicle control ECU connector terminals.

Standard voltage

Cylinder	Tester Connections	Specified Conditions
No. 1	C7-1 - Ground	9 to 14 V
No. 2	C9-1 - Ground	9 to 14 V
No. 3	C8-1 - Ground	9 to 14 V
No. 4	C10-1 - Ground	9 to 14 V

Standard resistance

Cylinder	Tester Connections	Specified Conditions
No. 1	C7-2 - Ground	10 kΩ or higher
	C7-2 - C64-50 (#10)	Below 1 Ω
No. 2	C9-2 - Ground	10 kΩ or higher
	C9-2 - C64-54 (#20)	Below 1 Ω
No. 3	C8-2 - Ground	10 kΩ or higher
	C8-2 - C64-49 (#30)	Below 1 Ω
No. 4	C10-2 - Ground	10 kΩ or higher
	C10-2 - C64-63 (#40)	Below 1 Ω

(e) Reconnect the injector connector.
(f) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

12 CHECK FUEL INJECTOR (MISFIRING CYLINDER)

(a) Check the injector injection (whether fuel volume is high or low, and whether injection pattern is poor).

NG → REPLACE FUEL INJECTOR ASSEMBLY

OK

ES

13 CHECK VALVE CLEARANCE (MISFIRING CYLINDER)

NG → ADJUST VALVE CLEARANCE

OK

14 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

15 CHECK VALVE TIMING

NG → ADJUST VALVE TIMING

OK

16 CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-9).

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

OK

17	READ VALUE USING INTELLIGENT TESTER (COOLANT TEMP) (See page ES-148)

NG → REPLACE ENGINE COOLANT TEMPERATURE SENSOR

OK

18	READ VALUE USING INTELLIGENT TESTER (MAF) (See page ES-147)

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)

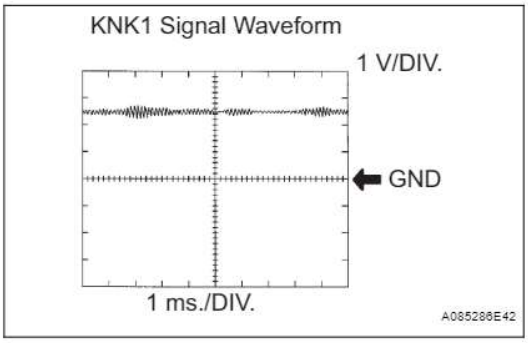
DESCRIPTION

Flat type knock sensors (non-resonant type) have structures that can detect vibrations over a wide band of frequencies: between approximately 6 kHz and 15 kHz.
The knock sensor is fitted onto the engine block to detect engine knocking.
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed. The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

ES

DTC No.	DTC Detection Condition	Trouble Area
P0327	Output voltage of knock sensor less than 0.5 V (1-trip detection logic)	• Short in knock sensor circuit • Knock sensor • Hybrid vehicle control ECU
P0328	Output voltage of knock sensor more than 4.5 V (1-trip detection logic)	• Open in knock sensor circuit • Knock sensor • Hybrid vehicle control ECU

HINT:
When any of DTCs P0327 and P0328 are set, the ECM (included in hybrid vehicle control ECU) enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the power switch is turned off.
Reference: Inspection using an oscilloscope



The correct waveform is as shown.

Items	Contents
Terminals	KNK1 - EKNK
Equipment Settings	1 V/DIV. 1 ms./DIV.
Conditions	Keep engine speed at 4,000 rpm with warm engine

MONITOR DESCRIPTION

If the output voltage transmitted by the knock sensor remains low or high for more than 1 second, the ECM (included in hybrid vehicle control ECU) interprets this as a malfunction in the sensor circuit, and sets a DTC.
The monitor for DTCs P0327 and P0328 begins to run when 5 seconds have elapsed since the engine was started.
If the malfunction is not repaired successfully, either DTC P0327 or P0328 is set 5 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0327: Knock sensor range check (Low voltage) P0328: Knock sensor range check (High voltage)
Required Sensors/Components (Main)	Knock sensor
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	1 second
MIL Operation	Immediate
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None
Battery voltage	10.5 V or more
Time after engine start	5 seconds or more
Power switch	ON
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

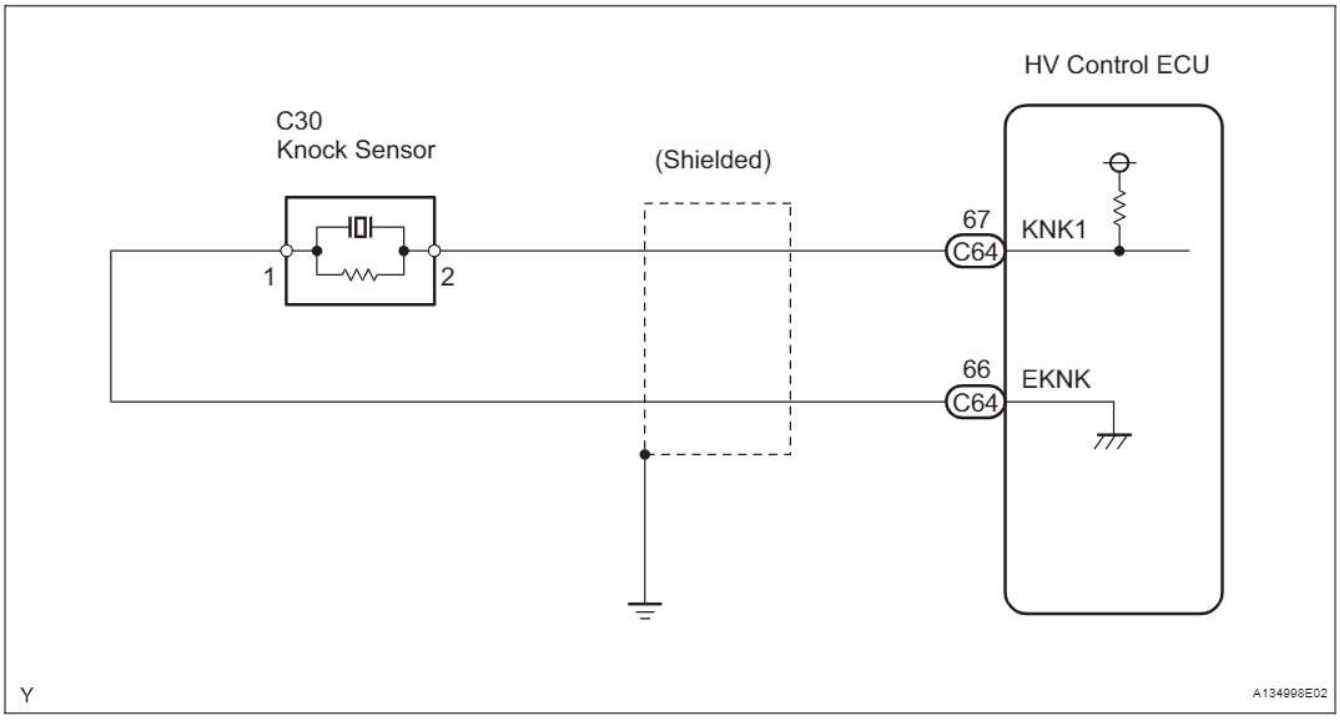
Knock Sensor Range Check (Low voltage) P0327:

Knock sensor voltage	Less than 0.5 V

Knock Sensor Range Check (High voltage) P0328:

Knock sensor voltage	More than 4.5 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1 READ VALUE USING INTELLIGENT TESTER (KNOCK FB VAL)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / USER DATA / KNOCK FB VAL.
(f) Read the values displayed on the tester while driving the vehicle.
Standard:
The values change.
HINT:

Malfunction does not occur	Knock Feedback Values change
Malfunctions occur	Knock Feedback Values do not change

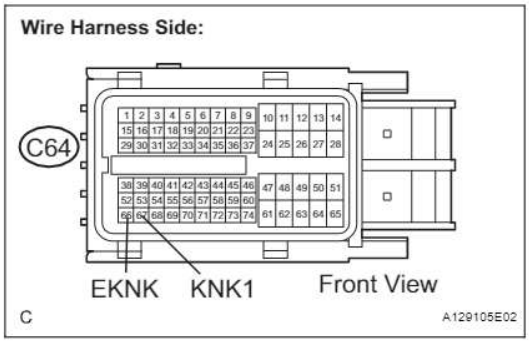
The knock feedback value change can be confirmed by running the engine with a high load, for example, by activating the air conditioning system and revving up the engine.

NG → **Go to step 2**

OK →

CHECK FOR INTERMITTENT PROBLEMS

2 CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)



(a) Disconnect the C64 hybrid vehicle control ECU connector.
(b) Measure the resistance between the terminals.
Standard

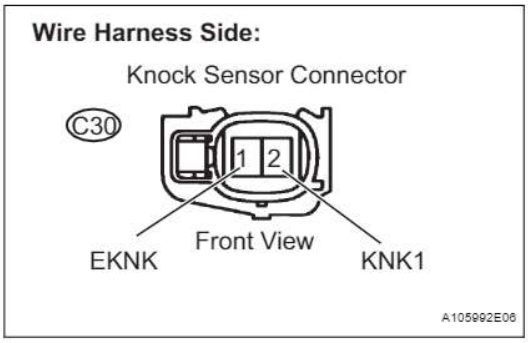
Tester Connection	Specified Condition
C64-67 (KNK1) - C64-66 (EKNK)	120 to 280 kΩ at 20°C (68°F)

(c) Reconnect the hybrid vehicle control ECU connector.

NG → **Go to step 4**

OK →

3	INSPECT ECM (KNK1 VOLTAGE)



(a) Disconnect the C30 knock sensor connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage between the knock sensor terminals.
Standard voltage

Tester Connection	Specified Condition
C30-2 (KNK1) - C30-1 (EKNK)	4.5 to 5.5 V

(d) Reconnect the knock sensor connector.

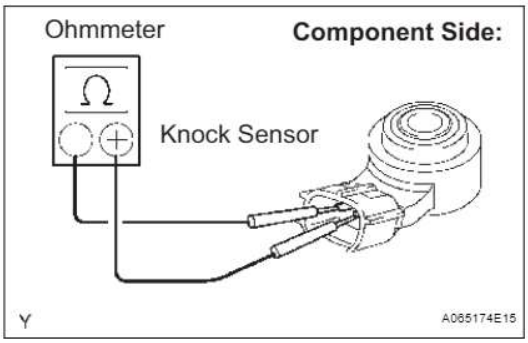
NOTICE:
Fault may be intermittent. Check the wire harness and connectors carefully and retest.

NG → REPLACE HYBRID VEHICLE CONTROL ECU

OK →

CHECK FOR INTERMITTENT PROBLEMS

4	INSPECT KNOCK SENSOR



(a) Remove the knock sensor.
(b) Measure the resistance between the terminals.
Standard resistance

Tester Connection	Specified Condition
2 (KNK1) - 1 (EKNK)	120 to 280 kΩ at 20°C (68°F)

(c) Reinstall the knock sensor.

NG → REPLACE KNOCK SENSOR

OK →

REPAIR OR REPLACE HARNESS OR CONNECTOR

DTC	P0335	Crankshaft Position Sensor "A" Circuit

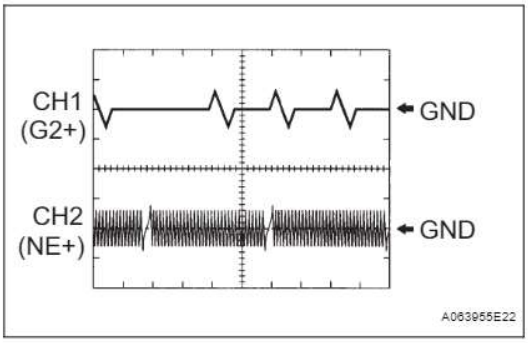
DESCRIPTION

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 wound copper wire, an iron core and magnet. The sensor plate rotates and, as each tooth passes through the pickup coil, a pulse signal is created. The pickup coil generates 34 signals per engine revolution. Based on these signals, the ECM (included in hybrid vehicle control ECU) 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	When either condition below is met: • 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 • CKP sensor plate • Hybrid vehicle control ECU

ES

Reference: Inspection using an oscilloscope.



HINT:
- The correct waveform is as shown.
- G2+ stands for the Camshaft Position (CMP) sensor signal, and NE+ stands for the CKP sensor signal.
- Grounding failure of the shielded wire may cause noise in waveforms.

Items	Contents
Terminals	CH1: G2+ - G2- CH2: NE+ - NE-
Equipment Settings	5 V/DIV. 20 ms./DIV.
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: CKP sensor range check or rationality
Required Sensors/Components (Main)	CKP sensor
Required Sensors/Components (Related)	CMP sensor
Frequency of Operation	Continuous
Duration	3 times
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	None

Case 1:

Time after starter OFF to ON	0 seconds or more
Number of CMP sensor signal pulse	6 times
Battery voltage	7 V or more
CMP sensor circuit failure	Not detected
Power switch	ON

Case 2:

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

TYPICAL MALFUNCTION THRESHOLDS

Case 1:

Number of CKP sensor signal pulse	44 or less, and 58 or more

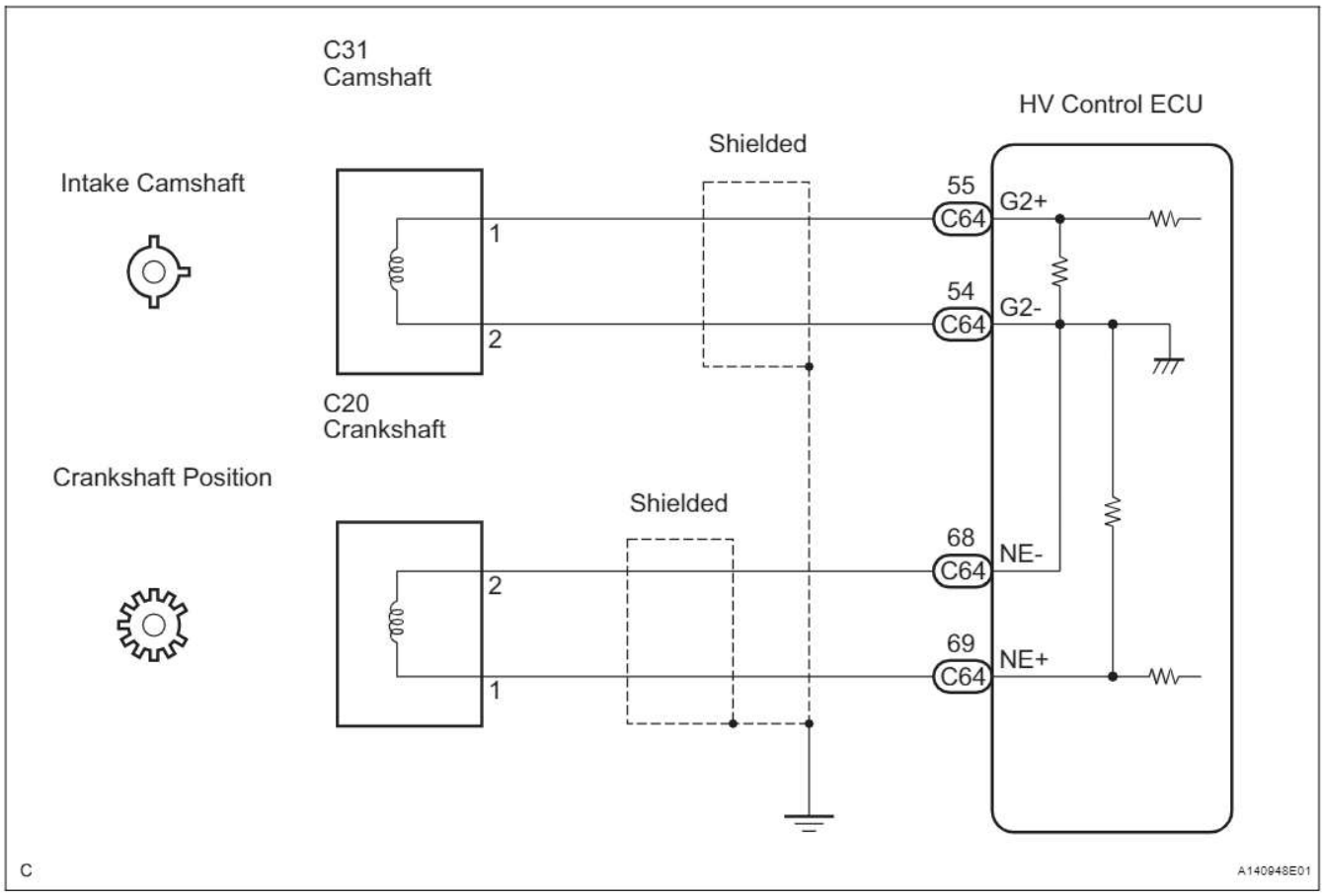
Case 2:

Engine speed signal	No signal

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If no problem is found through this diagnostic troubleshoot procedure, troubleshoot the engine mechanical systems.
- Check the engine speed. The engine speed can be checked by using the intelligent tester. To check, follow the operation below:
  (a) Connect the intelligent tester to the DLC3.
  (b) Put the engine in inspection mode (See page ES-35).
  (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 output voltage 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	READ VALUE USING INTELLIGENT TESTER (ENGINE SPD)

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

(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / ENGINE SPD.
(e) Put the engine in inspection mode (See page ES-35).
(f) Read the values displayed on the tester while the engine is running.
Standard:
Correct values are displayed.
HINT:
- To check the engine speed change, display the graph on the tester.
- If the engine does not start, check the engine speed while cranking.
- If the engine speed indicated on the tester remains zero (0), there may be an open or short in the Crankshaft Position (CKP) sensor circuit.

OK → **CHECK FOR INTERMITTENT PROBLEMS**

NG

2 INSPECT CRANKSHAFT POSITION SENSOR (RESISTANCE)

Component Side:



CKP Sensor

G037727E07

(a) Disconnect the C20 CKP sensor connector.
(b) Measure the resistance between terminals 1 and 2.
Standard resistance

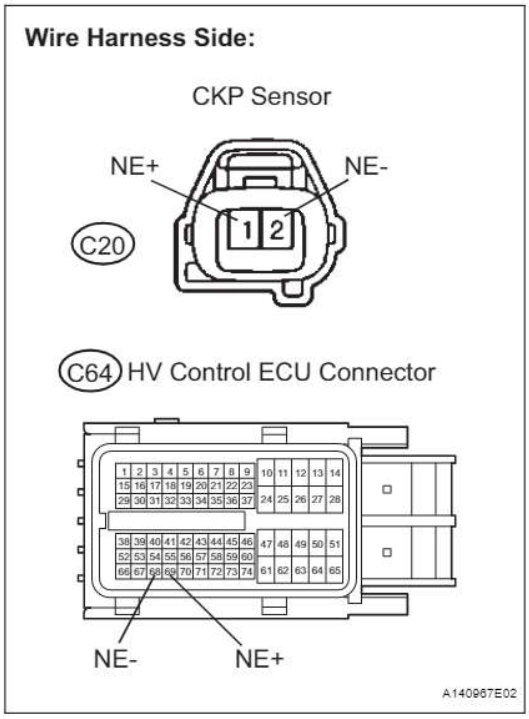
Tester Connections	Conditions	Specified Conditions
1 - 2	Cold	985 to 1,600 Ω
1 - 2	Hot	1,265 to 1,890 Ω

HINT:
Terms "cold" and "hot" refer to the temperature of the sensor. "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

3 CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - HV CONTROL ECU)



(a) Disconnect the C20 CKP sensor connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C20-1 (NE+) - C64-69 (NE+)	Below 1 Ω
C20-2 (NE-) - C64-68 (NE-)	Below 1 Ω

Standard resistance (Check for short)

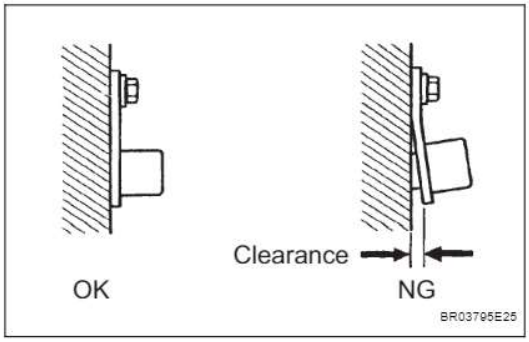
Tester Connections	Specified Conditions
C20-1 (NE+) or C64-69 (NE+) - Body ground	10 kΩor higher
C20-2 (NE-) or C64-68 (NE-) - Body ground	10 kΩor higher

(d) Reconnect the hybrid vehicle control ECU connector.
(e) Reconnect the CKP sensor connector.

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

OK

4 CHECK CRANKSHAFT POSITION SENSOR (SENSOR INSTALLATION)



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

NG → **SECURELY REINSTALL SENSOR**

OK

5 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 → **REPLACE CRANKSHAFT POSITION SENSOR PLATE**

OK

6	REPLACE CRANKSHAFT POSITION SENSOR

NEXT

7	CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Put the engine in inspection mode (See page ES-35).
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read the DTCs.

Result

Display (DTC Output)	Proceed to
No output	A
P0335	B

HINT:
If the engine does not start, replace the hybrid vehicle control ECU.

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

END

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

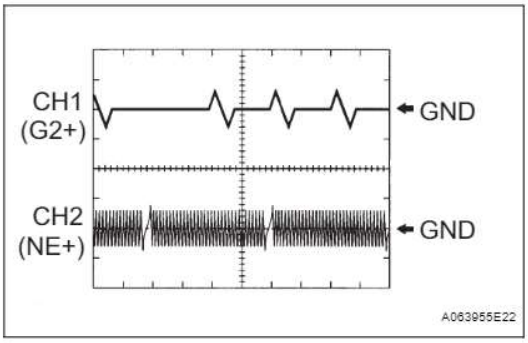
DESCRIPTION

The Camshaft Position (CMP) sensor consists of a magnet and an iron core which is wrapped with copper wire, and is installed onto the cylinder head. When the camshaft rotates, each of 3 teeth on the camshaft passes through the CMP sensor. This activates the internal magnet in the sensor, generating a voltage in the copper wire. The camshaft rotation is synchronized with the crankshaft rotation. When the crankshaft turns twice, the voltage is generated 3 times in the CMP sensor. The generated voltage in the sensor acts as a signal, allowing the ECM (included in hybrid vehicle control ECU) to detect the camshaft position. This signal is then used to control ignition timing, fuel injection timing, and the VVT system.

ES

DTC No.	DTC Detection Conditions	Trouble Areas
P0340	Camshaft/Crankshaft misalignment detected at engine speed of 600 rpm or more (1 trip detection logic)	• Open or short in CMP sensor circuit • CMP sensor • Camshaft • Jumped tooth of timing chain • Hybrid vehicle control ECU

HINT:
DTC P0340 indicates a malfunction relating to the CMP sensor (+) circuit (the wire harness between the ECM and CMP sensor, and the CMP sensor itself).
Reference: Inspection using an oscilloscope



HINT:
- The correct waveform is as shown in the illustration.
- G2+ stands for the CMP sensor signal, and NE+ stands for the Crankshaft Position (CKP) sensor signal.
- Grounding failure of the shielded wire may cause noise in waveforms.

Items	Contents
Terminals	CH1: G2+ - G2- CH2: NE+ - NE-
Equipment Settings	5 V/DIV., 20 ms./DIV.
Conditions	Cranking or idling

MONITOR DESCRIPTION

If no signal is transmitted by the CMP sensor despite the engine revolving, or the rotation of the camshaft and the crankshaft is not synchronized, 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	P0340: Camshaft position sensor range check P0340: Camshaft position/crankshaft position misalignment
Required Sensors/Components (Main)	Camshaft Position (CMP) sensor

Required Sensors/Components (Related)	Crankshaft Position (CKP) sensor
Frequency of Operation	Continuous
Duration	5 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None
Engine speed	600 rpm or more
Starter	OFF

ES

TYPICAL MALFUNCTION THRESHOLDS

Camshaft Position Sensor Range Check:

CMP sensor signal	No signal

Camshaft Position/Crankshaft Position Misalignment:

Camshaft position and crankshaft position phase	Misaligned

COMPONENT OPERATING RANGE

CMP sensor	• CMP sensor output voltage fluctuates while camshaft revolving • 3 CMP sensor signals per 2 crankshaft revolutions

WIRING DIAGRAM

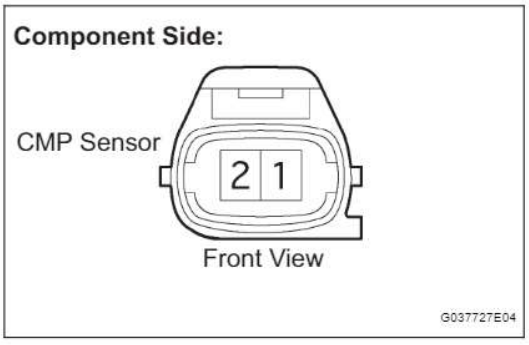
Refer to DTC P0335 (See page ES-165).

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	INSPECT CAMSHAFT POSITION SENSOR (RESISTANCE)



(a) Disconnect the C31 Camshaft Position (CMP) sensor connector.

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

Standard resistance

Tester Connections	Conditions	Specified Conditions
1 - 2	Cold	835 to 1,400 Ω
1 - 2	Hot	1,060 to 1,645 Ω

HINT:

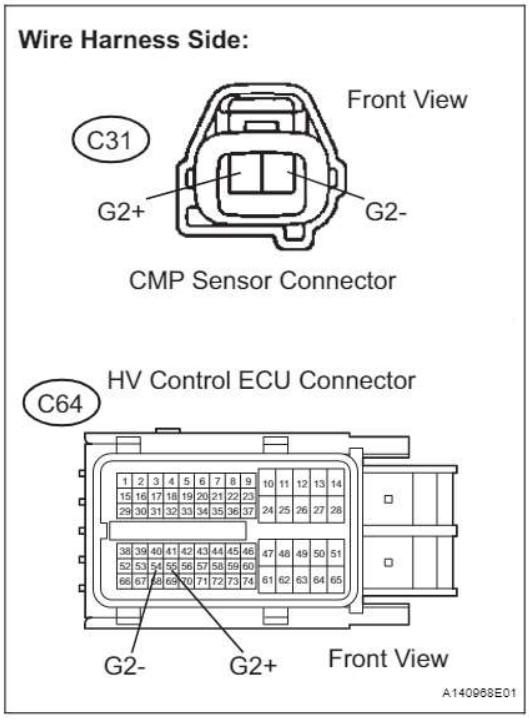
Terms "cold" and "hot" refer to the temperature of the sensor. "Cold" means approximately -10 to 50°C (14 to 122°F). "Hot" means approximately 50 to 100°C (122 to 212°F).

(c) Reconnect the CMP sensor connector.

NG → REPLACE CAMSHAFT POSITION SENSOR

OK

2 CHECK HARNESS AND CONNECTOR (CAMSHAFT POSITION SENSOR - HV CONTROL ECU)



(a) Disconnect the C31 CMP sensor connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C31-1 (G2+) - C64-55 (G2+)	Below 1 Ω
C31-2 (G2-) - C64-54 (G2-)	Below 1 Ω

Standard resistance (Check for short)

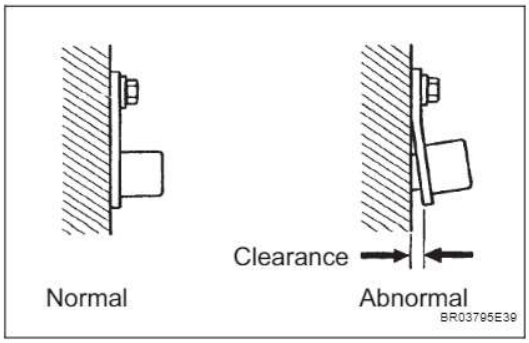
Tester Connections	Specified Conditions
C31-1 (G2+) or C64-55 (G2+) - Body ground	10 kΩor higher
C31-2 (G2-) or C64-54 (G2-) - Body ground	10 kΩor higher

(d) Reconnect the hybrid vehicle control ECU connector.
(e) Reconnect the CMP sensor connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3 CHECK CAMSHAFT POSITION SENSOR (SENSOR INSTALLATION)



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

NG → SECURELY REINSTALL SENSOR

OK

4 CHECK VALVE TIMING (See page ES-68)

NG → ADJUST VALVE TIMING

OK

5	CHECK CAMSHAFT

(a) Check the teeth of the camshaft.
OK:
Camshaft teeth do not have any cracks or deformation.

NG → REPLACE CAMSHAFT

OK

ES

6	REPLACE CAMSHAFT POSITION SENSOR

NEXT

7	CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Put the engine in inspection mode (See page ES-35).
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
(g) Read the DTCs.

Result

Display (DTC Output)	Proceed to
No output	A
P0340	B

HINT:
If the engine does not start, replace the hybrid vehicle control ECU.

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

END

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

DESCRIPTION

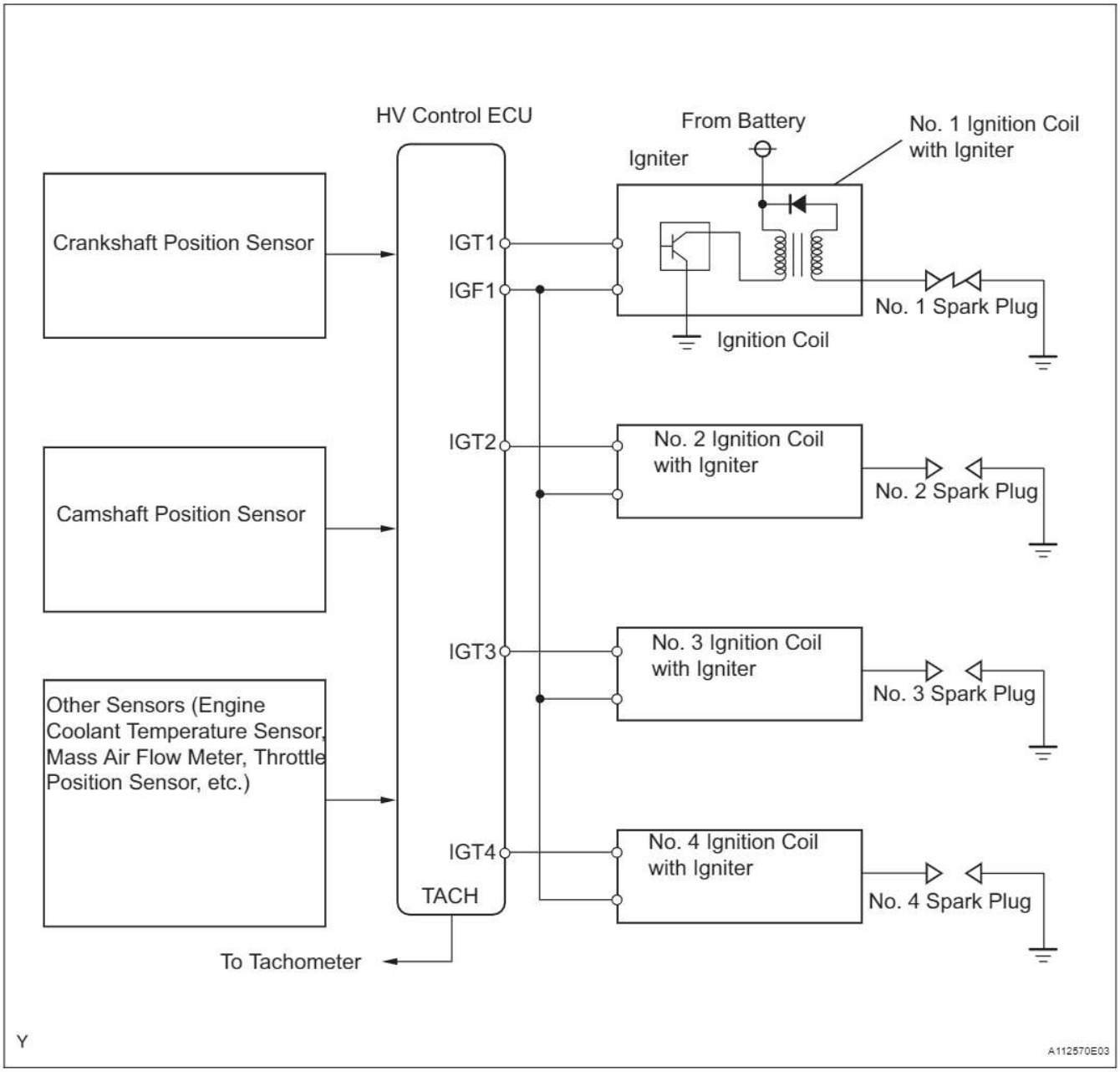
HINT:

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

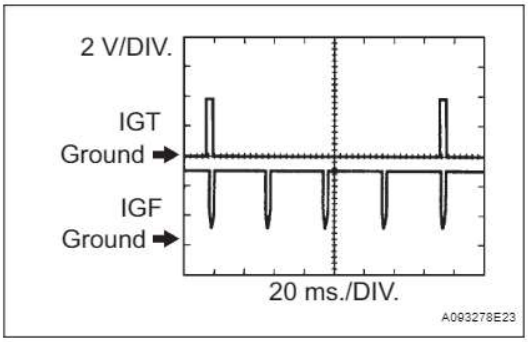
A Direct Ignition System (DIS) is used on this vehicle.

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. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. The sparks of the spark plugs pass from the center electrode to the ground electrodes.

The ECM (included in hybrid vehicle control ECU) 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, a powerful 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	No IGF signal to ECM while engine running (1-trip detection logic)	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 4) between ignition coil with igniter and hybrid vehicle control ECU • No. 1 to No. 4 ignition coils with igniters • Hybrid vehicle control ECU

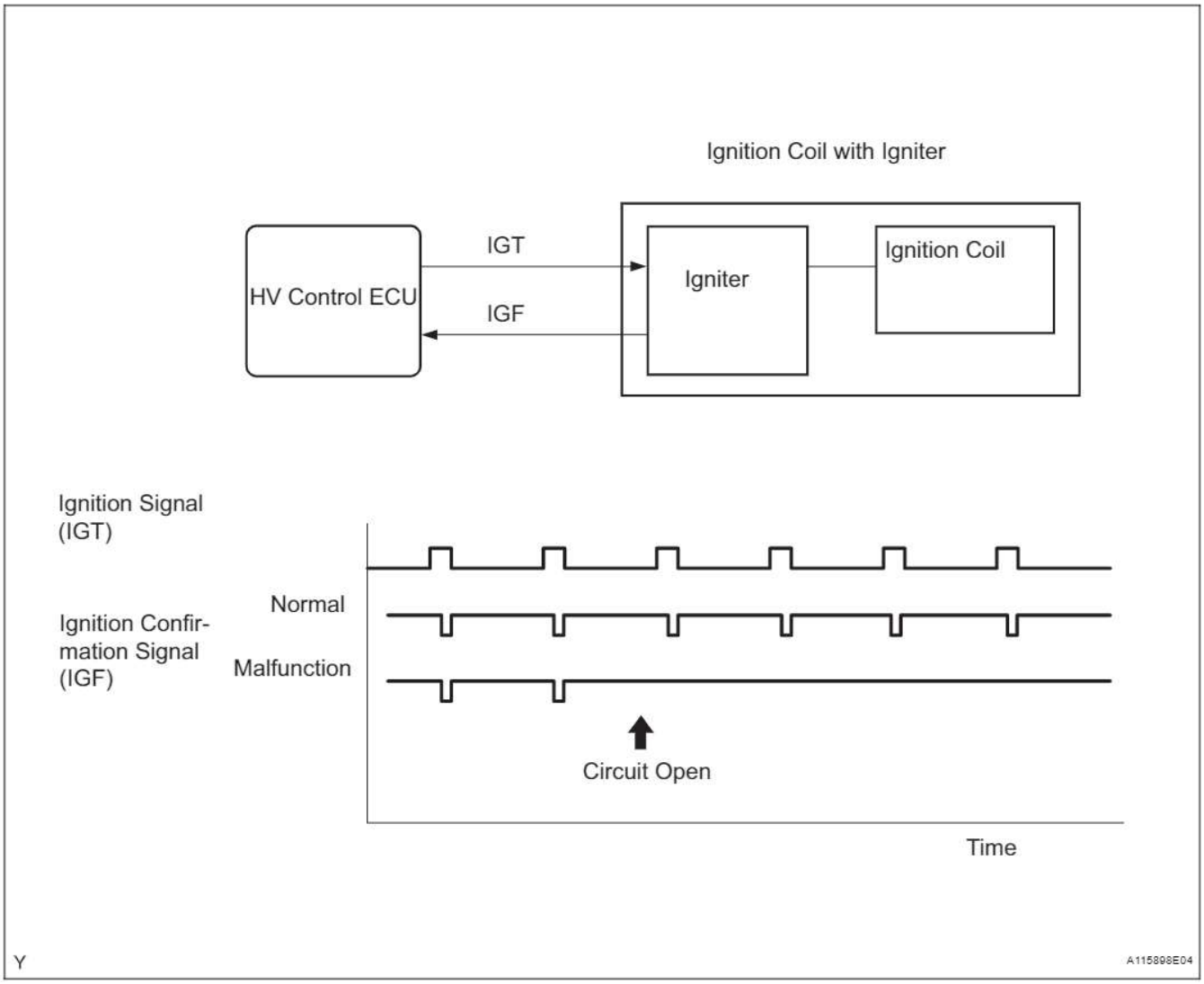


Reference: Inspection using an oscilloscope.
While cranking or idling the engine, check the waveform between terminals IGT (1 to 4) and E1, and IGF1 and E1 of the ECM connector.

ES

Items	Contents
Terminals	CH1: IGT1, IGT2, IGT3, IGT4 - E1 CH2: IGF1 - E1
Equipment Settings	2 V/DIV. 20 ms./DIV.
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 1 second 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
Required Sensors/Components (Main)	Igniter
Required Sensors/Components (Related)	Crankshaft position sensor
Frequency of Operation	Continuous
Duration	0.512 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None
Either of following conditions A or B met	-

A. Engine RPM	1,500 rpm or less
B. Starter	OFF
Either of following conditions C or D met	-
C. Both of following conditions (a) and (b) met	-
(a) Engine speed	500 rpm or less
(b) Battery voltage	6 V or more
D. All of following conditions (a), (b) and (c) met	-
(a) Engine speed	More than 500 rpm
(b) Battery voltage	10 V or more
(c) Number of sparks after CPU reset	5 sparks or more

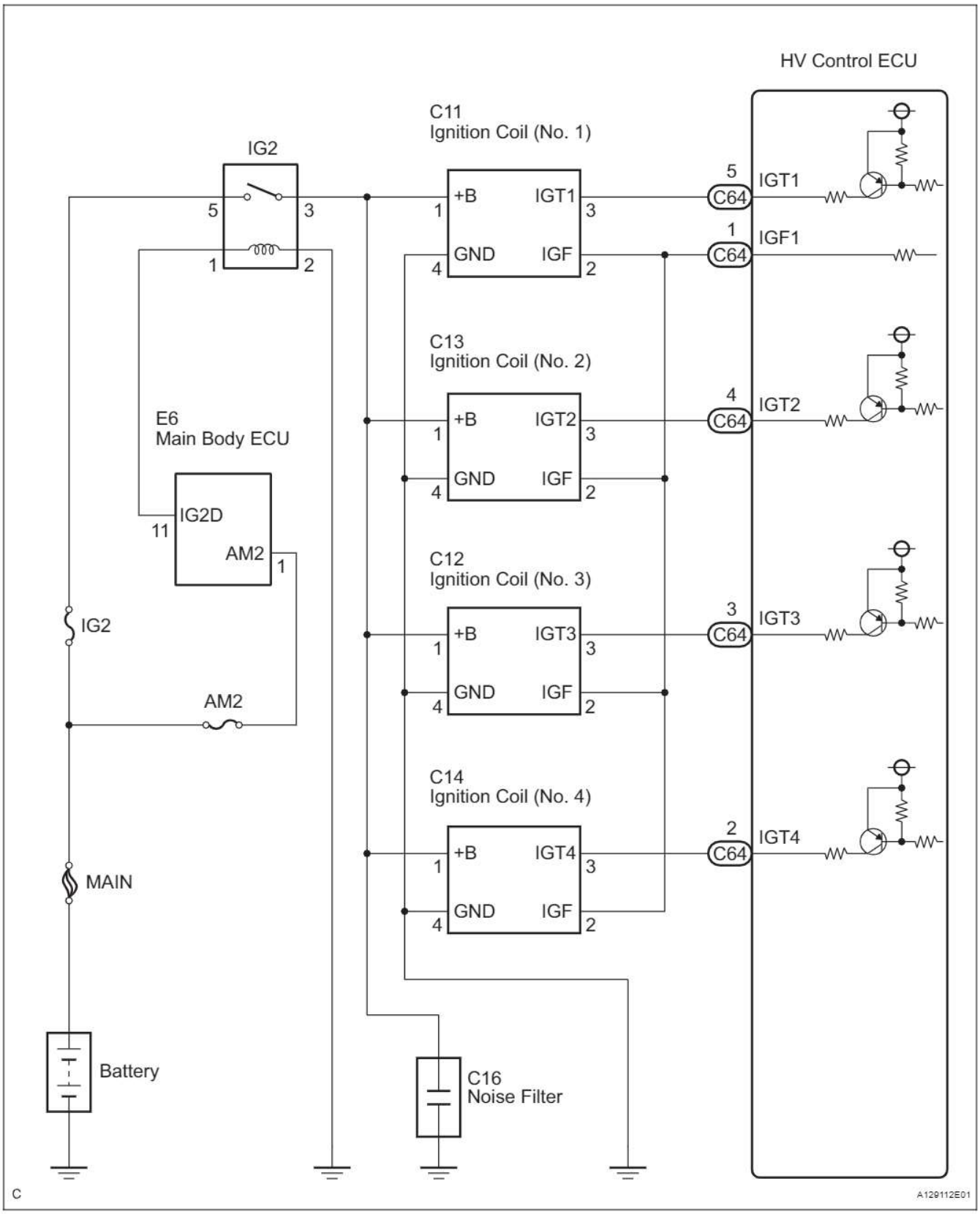
TYPICAL MALFUNCTION THRESHOLDS

IGF signal	ECM does not receive any IGF signal despite ECM sending IGT signal to igniter

COMPONENT OPERATING RANGE

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

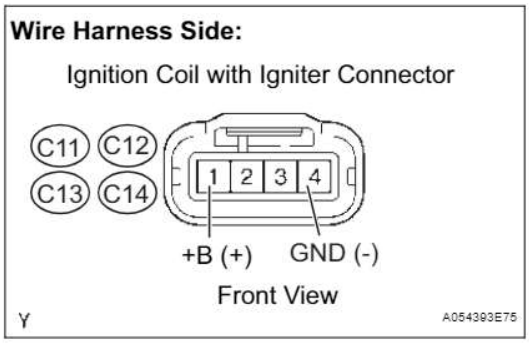
WIRING DIAGRAM



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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)



(a) Disconnect the ignition coil with igniter connector.
(b) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
C11-4 (GND) - Body ground	Below 1 Ω
C12-4 (GND) - Body ground	Below 1 Ω
C13-4 (GND) - Body ground	Below 1 Ω
C14-4 (GND) - Body ground	Below 1 Ω

(c) Turn the power switch on (IG).
(d) Measure the voltage between the terminals of the wire harness side connector.
Standard voltage

Tester Connections	Specified Conditions
C11-1 (+B) - C11-4 (GND)	9 to 14 V
C12-1 (+B) - C12-4 (GND)	9 to 14 V
C13-1 (+B) - C13-4 (GND)	9 to 14 V
C14-1 (+B) - C14-4 (GND)	9 to 14 V

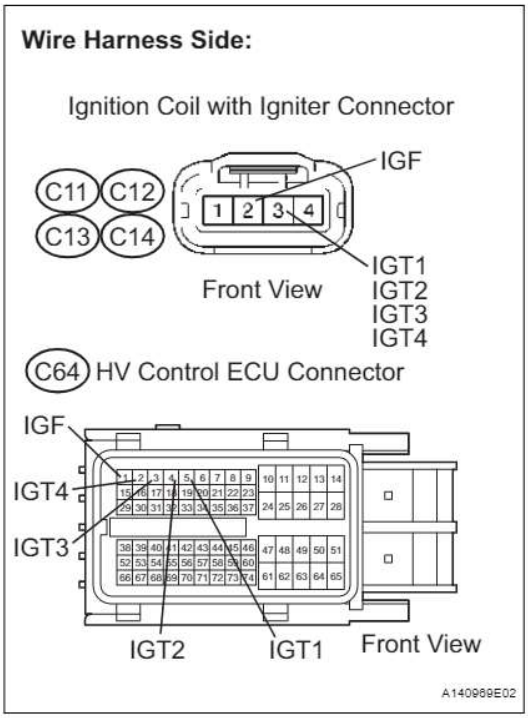
(e) Reconnect the ignition coil with igniter connector.

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

OK

ES

2 CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - HV CONTROL ECU)



(a) Disconnect the ignition coil with connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C11-2 (IGF) - C64-1 (IGF1)	Below 1 Ω
C12-2 (IGF) - C64-1 (IGF1)	Below 1 Ω
C13-2 (IGF) - C64-1 (IGF1)	Below 1 Ω
C14-2 (IGF) - C64-1 (IGF1)	Below 1 Ω

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C11-3 (IGT1) - C64-5 (IGT1)	Below 1 Ω
C12-3 (IGT2) - C64-4 (IGT2)	Below 1 Ω
C13-3 (IGT3) - C64-3 (IGT3)	Below 1 Ω
C14-3 (IGT4) - C64-2 (IGT4)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C11-2 (IGF) or C64-1 (IGF1) - Body ground	10 kΩ or higher
C12-2 (IGF) or C64-1 (IGF1) - Body ground	10 kΩ or higher
C13-2 (IGF) or C64-1 (IGF1) - Body ground	10 kΩ or higher
C14-2 (IGF) or C64-1 (IGF1) - Body ground	10 kΩ or higher

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C11-3 (IGT1) or C64-5 (IGT1) - Body ground	10 kΩ or higher
C12-3 (IGT2) or C64-4 (IGT2) - Body ground	10 kΩ or higher
C13-3 (IGT3) or C64-3 (IGT3) - Body ground	10 kΩ or higher
C14-3 (IGT4) or C64-2 (IGT4) - Body ground	10 kΩ or higher

(d) Reconnect the hybrid vehicle control ECU connector.
(e) Reconnect the ignition coil with igniter connector.

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

OK

3 CHECK WHETHER DTC OUTPUT RECURS (DTC P0351, P0352, P0353 OR P0354)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Shuffle arrangement of the ignition coils with igniters (among No. 1 to No. 4 cylinders).
NOTICE:
Do not shuffle the connectors.
(e) Perform a simulation test.

(f) Check the DTCs displayed on the tester.

Result

Display (DTC Output)	Proceed to
Same DTC output	A
Different ignition coil DTC output	B

B → REPLACE IGNITION COIL ASSEMBLY

A

REPLACE HYBRID VEHICLE CONTROL ECU

ES

DTC	P0420	Catalyst System Efficiency Below Threshold (Bank 1)

MONITOR DESCRIPTION

The ECM (included in hybrid vehicle control ECU) uses sensors mounted in front of and behind the Three-Way Catalytic Converter (TWC) to monitor its efficiency.
The first sensor, the Air-Fuel Ratio (A/F) sensor, sends pre-catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor, sends post-catalyst information to the ECM.
In order to detect any deterioration in the TWC, the ECM calculates the Oxygen Storage Capacity (OSC) of the TWC. This calculation is based on the voltage output of the HO2 sensor while performing active air-fuel ratio control, rather than the conventional detecting method, which uses the locus ratio.
The OSC value is an indication of the oxygen storage capacity of the TWC. When the vehicle is being driven with a warm engine, active air-fuel ratio control is performed for approximately 15 to 20 seconds. When it is performed, the ECM deliberately sets the air-fuel ratio to lean or rich levels. If the rich-lean cycle of the HO2 sensor is long, the OSC becomes greater. There is a direct correlation between the OSCs of the HO2 sensor and the TWC.
The ECM uses the OSC value to determine the state of the TWC. If any deterioration has occurred, it illuminates the MIL and sets the DTC.

DTC No.	DTC Detection Conditions	Trouble Areas
P0420	OSC value smaller than standard value under active air-fuel ratio control (2-trip detection logic)	• Front exhaust pipe (with TWC) • Gas leakage from exhaust system • Air-Fuel Ratio (A/F) sensor (sensor 1) • Heated Oxygen (HO2) sensor (sensor 2)

MONITOR STRATEGY

Related DTCs	P0420: Catalyst Deterioration
Required Sensors/Components (Main)	A/F sensor and HO2 sensor
Required Sensors/Components (Related)	Intake air temperature sensor, mass air flow meter, crankshaft position sensor and engine coolant temperature sensor
Frequency of Operation	Once per driving cycle
Duration	About 30 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0011 (VVT System 1 - Advance) P0012 (VVT System 1 - Retard) P0031, 32 (A/F Sensor heater - Sensor 1) P0037, 38 (O2 Sensor heater - Sensor 2) P0100 - P0103 (MAF meter) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0136 (O2 Sensor - Sensor 2) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0351 - P0354 (Igniter) P0500 (VSS) P2196 (A/F Sensor - rationality) P2A00 (A/F Sensor - slow response)
Battery voltage	11 V or more
Intake air temperature	-10°C (14°F) or more

Engine coolant temperature	75°C (167°F) or more
Atmospheric pressure	76 kPa (570 mmHg) or more
Idling	OFF
Engine RPM	Less than 3,200 rpm
A/F sensor status	Activated
Fuel system status	Closed loop
Engine load	10 to 70%
All of following conditions (a), (b) and (c) met	-
(a) Mass air flow rate	10 to 28 g/sec.
(b) Estimated front catalyst temperature	600 to 800°C (1,112 to 1,472°F)
(c) Estimated rear catalyst temperature	430 to 675°C (800 to 1,247°F)
Rear HO2 sensor heater monitor	Completed

TYPICAL MALFUNCTION THRESHOLDS

Oxygen Storage Capacity (OSC) of Three-Way Catalytic Converter (TWC)	Less than 0.07 g

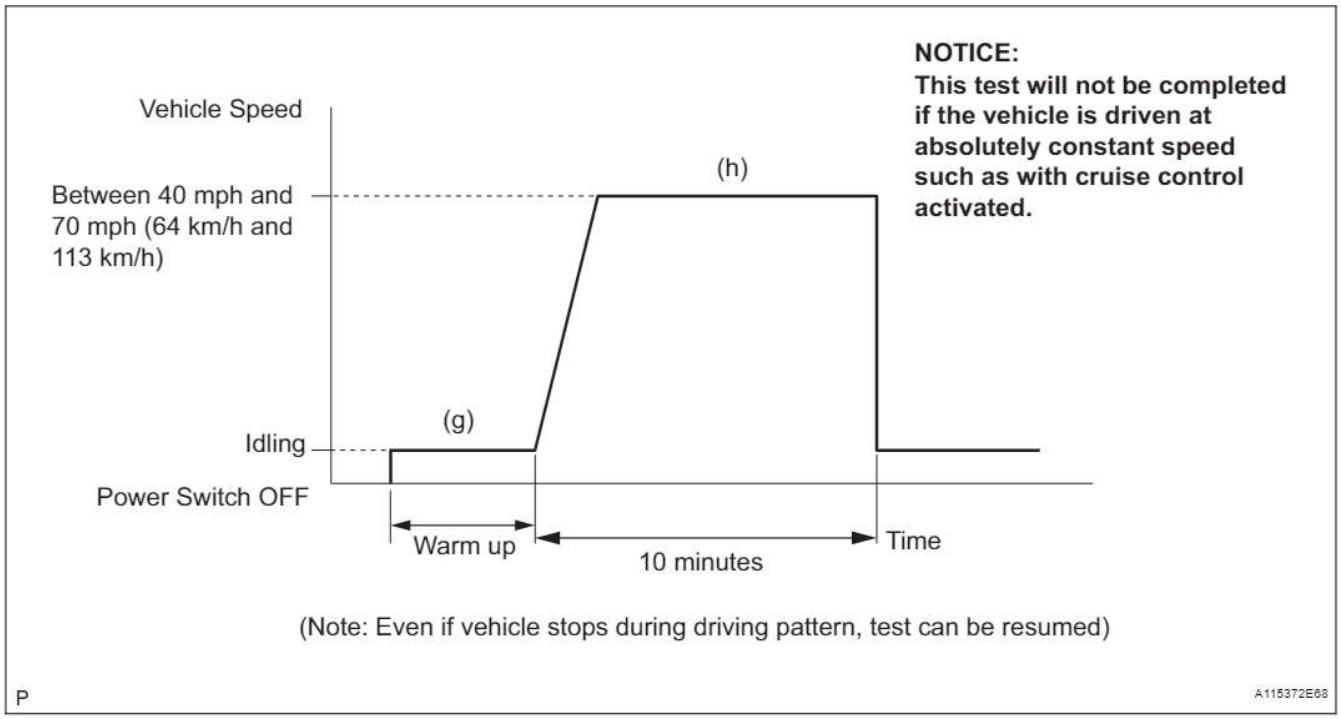
MONITOR RESULT

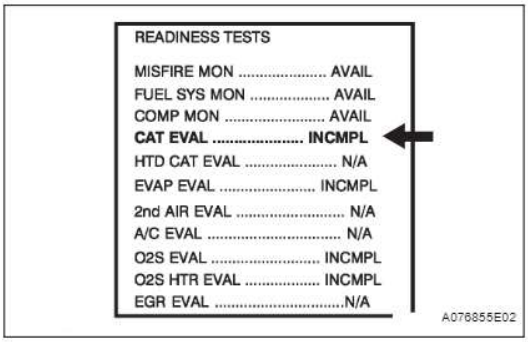
Refer to CHECKING MONITOR STATUS (See page ES-14).

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the catalyst monitor. This is very useful for verifying completion of a repair.

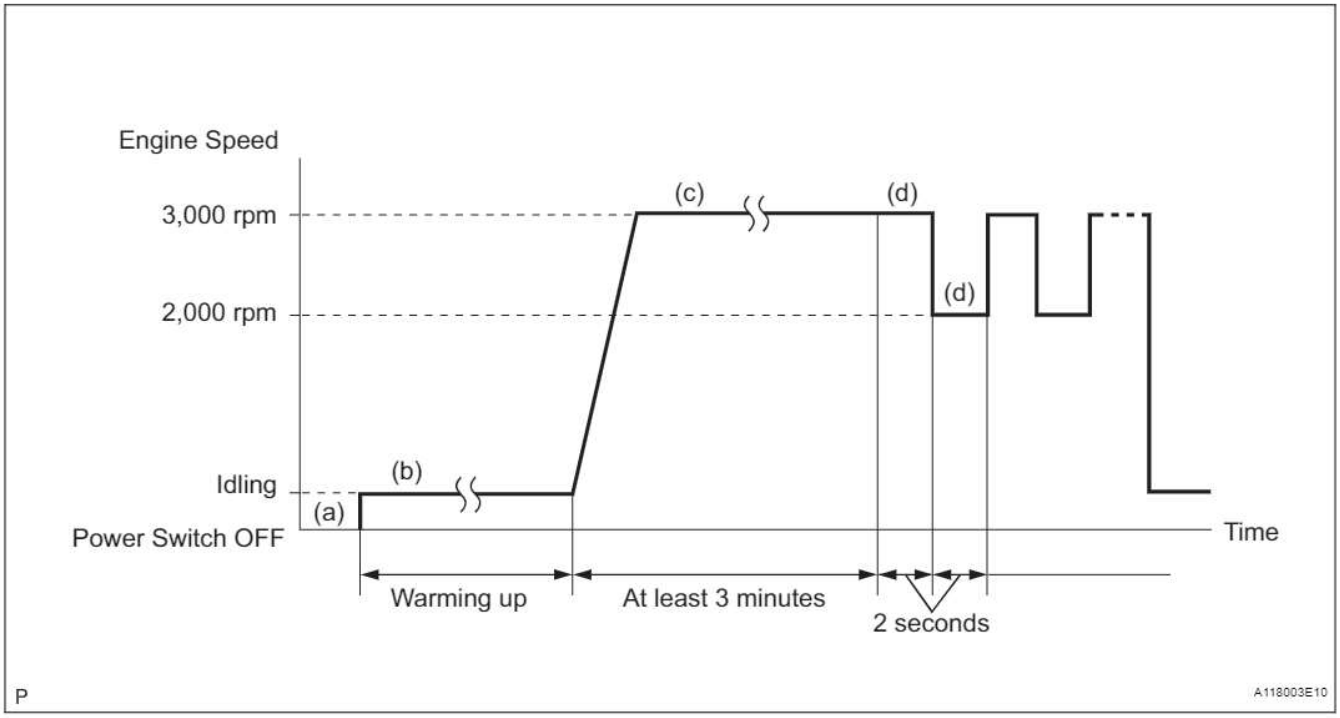




(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (if set) (See page ES-31).
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / USER DATA / CAT CMPL.
(f) Check that CAT CMPL is INCMPL (incomplete).
(g) Put the engine in inspection mode (See page ES-35), and warm it up.
(h) Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes.
(i) Note the state of the Readiness Tests items. Those items will change to COMPL (complete) as CAT CMPL monitor operates.
(j) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES and check if any DTCs (any pending DTCs) are set.
HINT:
If CAT CMPL does not change to COMPL, and any pending DTCs fail to be set, extend the driving time.

CONDITIONING FOR SENSOR TESTING

HINT:
Perform the operation with the engine speeds and time 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.



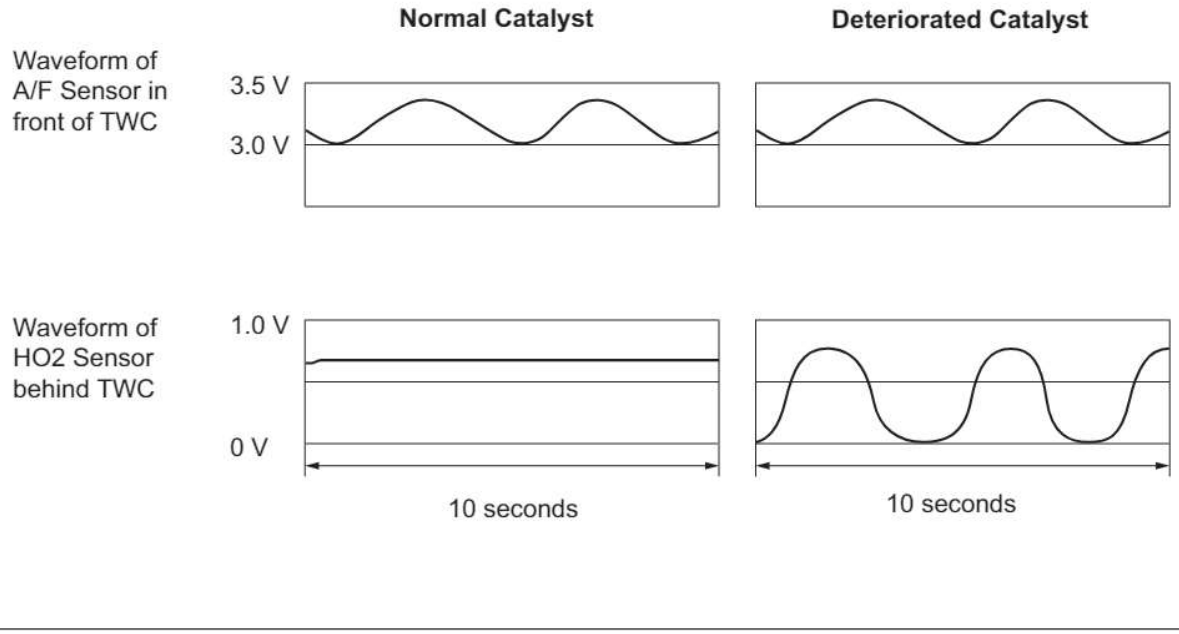
(a) Connect the intelligent tester to the DLC3.

(b) Put the engine in inspection mode (See page ES-35), and warm it up with all the accessories switched OFF, until the engine coolant temperature stabilizes.
(c) Run the engine at an engine speed of between 2,500 rpm and 3,000 rpm for at least 3 minutes.
(d) While running the engine at 3,000 rpm and 2,000 rpm alternating at 2 second intervals, check the waveforms of the A/F and HO2 sensors using the tester.
HINT:

- If either voltage output of the Air-Fuel Ratio (A/F) or Heated Oxygen (HO2) sensor does not fluctuate, or there is a noise in the waveform of either sensor, 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

Voltage output when active air-fuel ratio control not performed:



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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420)

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

Result

Display (DTC Output)	Proceed to
P0420	A

Display (DTC Output)	Proceed to
P0420 and other DTCs	B

HINT:
If any DTCs other than P0420 are output, troubleshoot those DTCs first.

B → GO TO DTC CHART

A

2 PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)

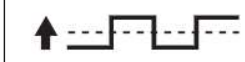
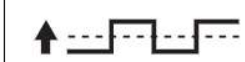
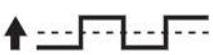
ES

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(f) 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).
(g) Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2) displayed on the tester.

Result:

A/F sensor reacts in accordance with increases and decreases in fuel injection volume:
+25% = Rich output:
Less than 3.0 V
-12.5% = Lean output:
More than 3.35 V

NOTICE:
The A/F sensor has an output delay of a few seconds and the 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 Areas
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• Catalyst • Exhaust gas leakage
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.5 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.5 V Less than 0.4 V		

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Areas
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%		Extremely rich or lean actual air-fuel ratio • Injector • Fuel pressure • Gas leakage from exhaust system
	Output Voltage Almost no reaction	 NG	Output Voltage Almost no reaction	 NG	

Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1 S1 and O2S B1 S2; then press the YES button and then the ENTER button followed by the F4 button.

Result

Result	Proceed to
Case 1	A
Case 2	B
Case 3	C
Case 4	D

B → REPLACE AIR-FUEL RATIO SENSOR

C → Go to step 4

D → CHECK CAUSE OF EXTREMELY RICH OR LEAN ACTUAL AIR-FUEL RATIO, REPLACE FAULTY AREA AND GO TO NEXT STEP

A

3 INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

REPLACE THREE-WAY CATALYTIC CONVERTER (BOTH FRONT AND REAR CATALYSTS (FRONT EXHAUST PIPE))

4	INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

REPLACE HEATED OXYGEN SENSOR

DTC	P043E	Evaporative Emission System Reference Orifice Clog Up
DTC	P043F	Evaporative Emission System Reference Orifice High Flow
DTC	P2401	Evaporative Emission Leak Detection Pump Stuck OFF
DTC	P2402	Evaporative Emission Leak Detection Pump Stuck ON
DTC	P2419	Evaporative Emission System Switching Valve Control Circuit Low

DTC SUMMARY

DTC No.	Monitoring Item	DTC Detection Condition	Trouble Area	Detection Timing	Detection Logic
P043E	Reference orifice clogged	P043E, P043F, P2401, P2402 and P2419 present when one of following conditions met during key-off EVAP monitor: • Reference orifice clogged • Reference orifice high-flow • Leak detection pump ON stuck • Leak detection pump OFF stuck • Vent valve ON (close) stuck	• Canister pump module (Reference orifice, leak detection pump, vent valve) • Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) • EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) • Hybrid vehicle control ECU	Power switch OFF	2-trips
P043F	Reference orifice high-flow				
P2401	Leak detection pump stuck OFF				
P2402	Leak detection pump stuck ON				
P2419	Vent valve stuck closed				

DESCRIPTION

Refer to the EVAP System (See page ES-317).

INSPECTION PROCEDURE

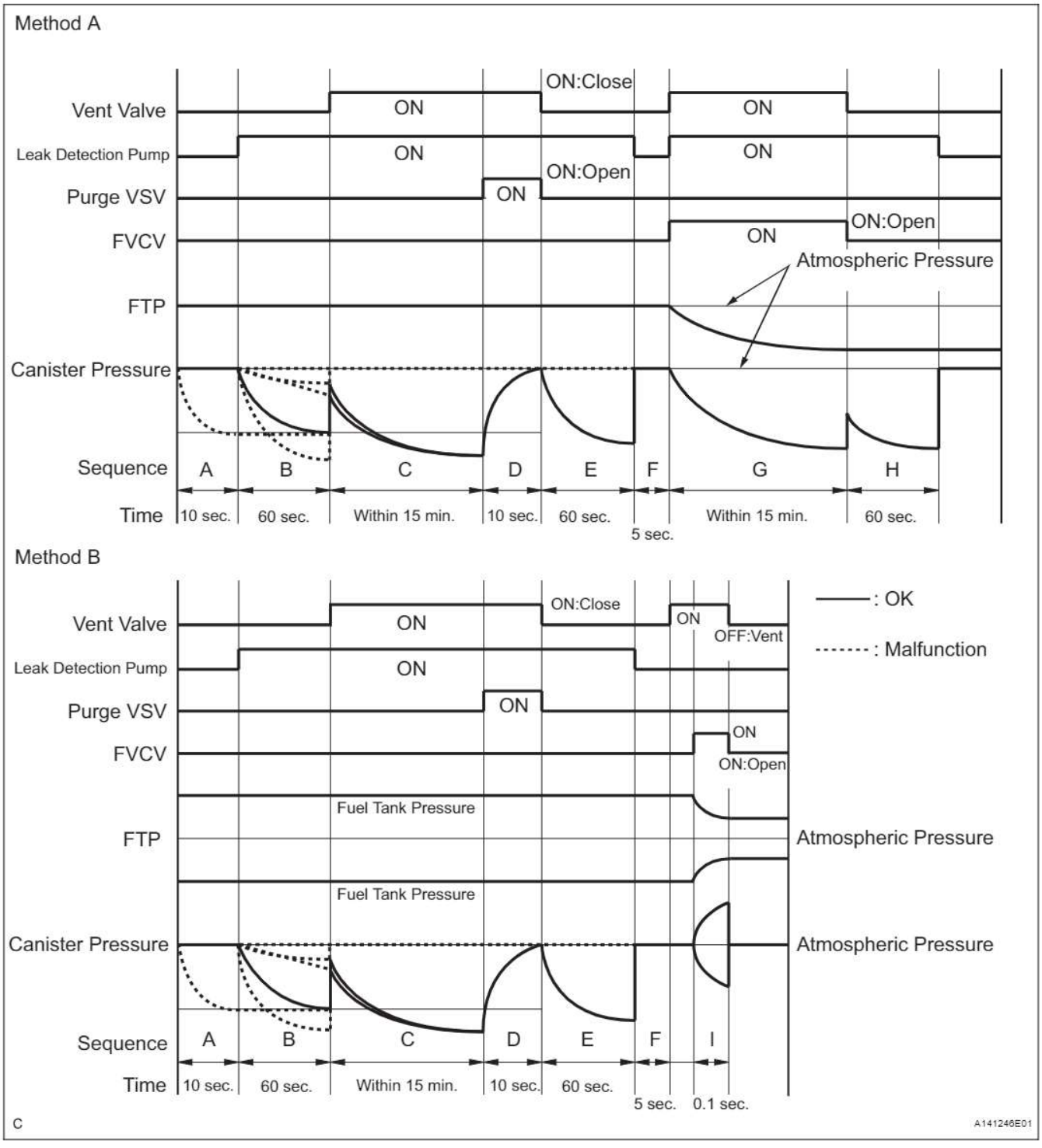
Refer to the EVAP System (See page ES-328).

MONITOR DESCRIPTION

In sequence B and E, the leak detection pump creates negative pressure (vacuum) through the reference orifice. The EVAP system pressure is then measured by the ECM, using the canister pressure sensor, to determine the reference pressure. If the pressure is one of the following conditions, the ECM illuminates the MIL and sets the DTC (2-trip detection logic).

- Canister pressure is lower than the malfunction criterion (ex. 724 mmHg).
- Canister pressure is higher than the malfunction criterion (ex. 752 mmHg).

- Canister pressure is not saturated within 60 seconds.
- Canister pressure difference of sequence B and sequence E is large.



MONITOR STRATEGY

Required Sensors/Components (Main)	Canister pump module
Required Sensors/Components (Related)	A/F sensor, rear HO2S, IAT sensor, MAF meter, crankshaft position sensor, ECT sensor
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	-
EVAP key-off monitor runs when all of the following conditions are met:	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	Below 2.5 mph (4 km/h)
Power switch	OFF
Engine condition	Not running
Canister pressure sensor malfunction (P0450, P0451, P0452 and P0453)	Not detected
FTP sensor malfunction (P1451, P1452 and P1453)	Not detected
Purge VSV	Not operated by scan tool
Vent valve	Not operated by scan tool
Leak detection pump	Not operated by scan tool
Both of the following conditions are met before power switch OFF	Conditions 1 and 2
1. Duration that vehicle is being driven	5 minutes or more
2. Purge flow	Executed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)
Time after engine stopped	5 hours

Example of restart time

First time	7 hours
Second time	9 hours and 30 minutes

Key-off monitor sequence 1 to 15

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met:	-
Atmospheric pressure change for 10 seconds	Less than 0.3 kPa (2.25 mmHg) for 1 second

2. First reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2 and 3
1. EVAP pressure 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.38 to -7.93 mmHg)
3. Reference pressure	Saturated

3. Vent valve stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after vent valve ON (Closed)	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction for canister

Next sequence is run if the following condition is met:	-
Vacuum introduction time	15 minutes or less

5. Purge VSV stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after Purge VSV ON (Open).	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3 and 4
1. EVAP pressure 1.9 sec. after reference pressure measurement	-1 kPa (-7.5 mmHg) or less

2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the first and second	Less than 0.7 kPa (5.25 mmHg)

7. Canister leak

Next sequence is run if the following condition is met:	-
Canister leak when vacuum introduction was complete	Second reference pressure or less

8. Fuel vapor-containment valve (FVCV stuck closed check)

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 kPa (-15 mmHg) or less, or 3 kPa (22.5 mmHg) or more
2. FTP change while FVCV and vent valve are open	0.5 kPa (3.75 mmHg) or more

ES

9. Vacuum introduction for fuel tank

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 to 3 kPa (-15 to 22.5 mmHg)
2. Vacuum introduction time	15 minutes or less

10. FVCV stuck closed check

Next sequence is run if the following condition is met:	
FTP change when vacuum introduction for fuel tank	0.5 kPa (3.75 mmHg)

11. FTP sensor stuck check

Next sequence is run if the following condition is met:	
FTP change when FVCV closed	0.35 kPa (2.6 mmHg) or less

12 Third reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3, and 4
1. FTP 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the second and third	Less than 0.7 kPa (5.25 mmHg)

13. Fuel tank leak check

Sequence is run if the following condition is met:	
FTP when vacuum introduction for fuel tank was complete	Less than third reference pressure

14. FTP sensor stuck check

Next sequence is run if the following condition is met:	-
FTP change while FVCV and vent valve are open	Less than 0.35 kPa (2.6 mmHg)

15. Atmospheric pressure measurement

Monitor is complete if the following condition is met:	-
Atmospheric pressure difference between sequence 1 and 8	0.3 kPa (2.25 mmHg) or less

TYPICAL MALFUNCTION THRESHOLDS

"Saturated" indicates that the EVAP pressure change is less than 0.1 kPa (0.75 mmHg) in 30 seconds.

One of the following conditions is met:	-
FTP just after reference pressure measurement began	More than -1 kPa (-7.5 mmHg)
Reference pressure	Less than -4.85 kPa (-36.4 mmHg)
Reference pressure	-1.057 kPa (-7.93 mmHg) or more
Reference pressure	Not saturated
Reference pressure difference between the first and second	0.7 kPa (5.25 mmHg) or more

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-325).

DTC	P0441	Evaporative Emission Control System Incorrect Purge Flow

DTC SUMMARY

DTC No.	Monitoring Item	DTC Detection Condition	Trouble Area	Detection Timing	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 the start and at the 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 stuck open	• Purge VSV • Connector / wire harness (Purge VSV - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU • Pump module • Leakage from EVAP system	Power switch off	2-trips
P0441	Purge VSV stuck closed	After EVAP leak check is 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 at the end of the check. If pressure does not return to near atmospheric pressure, ECM determines that purge valve stuck closed	• Purge VSV • Connector / wire harness (Purge VSV - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU • Pump module • Leakage from EVAP system	Power switch off	2-trips
P0441	Purge flow	While engine running, the following conditions are successively met: • Negative pressure is not created in EVAP system when Purge VSV turned ON (open) • EVAP system pressure change is less than 0.5 kPa (3.75 mmHg) when vent valve turned ON (closed) • Atmospheric pressure change between before and after purge flow monitor is less than 0.1 kPa (0.75 mmHg)	• Purge VSV • Connector / wire harness (Purge VSV - Hybrid Vehicle Control ECU) • Leakage from EVAP line (Purge VSV - Intake manifold) • Hybrid vehicle control ECU	While engine running	2-trips

DESCRIPTION

Refer to the EVAP System (See page ES-317).

MONITOR DESCRIPTION

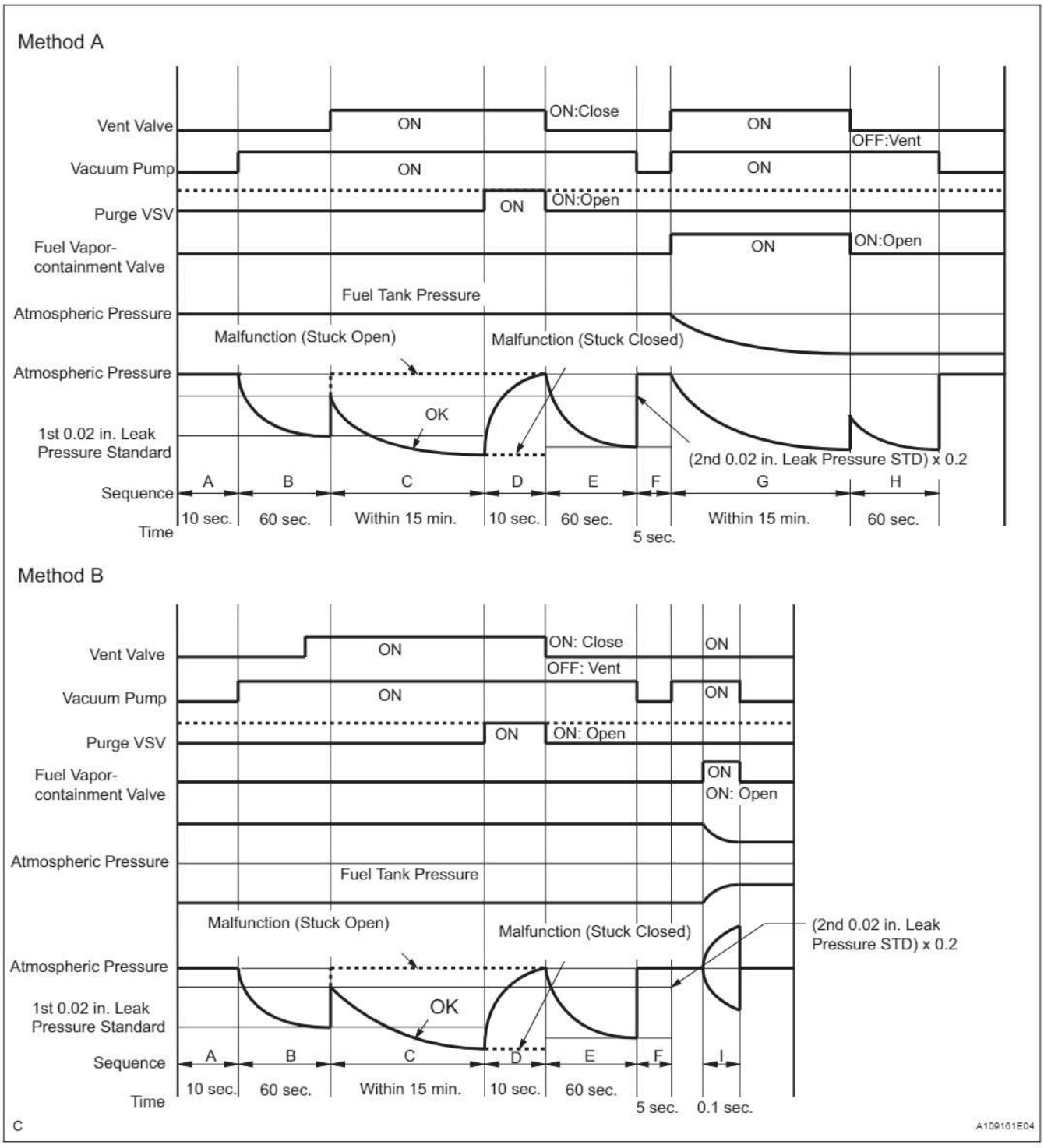
The two monitors, Key-Off and Purge Flow, are used to detect malfunctions relating to DTC P0441. The Key-Off monitor is initiated by the ECM (included in the hybrid vehicle control ECU) internal timer, known as the soak timer, 5 hours* after the power switch is turned off. The purge flow monitor runs while the engine is running.

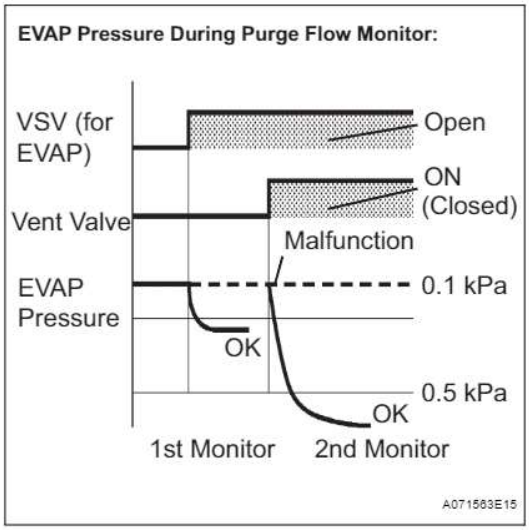
1. KEY-OFF MONITOR

(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 (included in the hybrid vehicle control ECU) using the pressure sensor. If the stabilized system pressure is higher than [second 0.02 inch leak pressure standard x 0.2], the ECM (included in the hybrid vehicle control ECU) 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 begins 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 (included in the hybrid vehicle control ECU) 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 (included in the hybrid vehicle control ECU) 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 (included in the hybrid vehicle control ECU) interprets this as the Purge VSV being stuck closed. The ECM illuminates the MIL and sets DTC P0441 (2-trip detection logic).

Atmospheric pressure check:
In order to ensure reliable malfunction detection, the variation in atmospheric pressure, before and after conduction of the purge flow monitor is measured by the ECM.

ES

MONITOR STRATEGY

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 (VVT System 1 - Advance) P0012 (VVT System 1 - Retard) P0021 (VVT System 2 - Advance) P0022 (VVT System 2 - Retard) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120-P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0308 (Misfire) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0351 - P0356 (Ignitor) P0450 - 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
Pressure sensor or pump module malfunction (P0450, P0452, P0453)	Not detected

Purge VSV	Not operated by scan tool
EVAP system check	Not detected 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 are 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
Power switch	OFF
Engine Condition	Not running
Key-off duration	5 hours or 7 hours or 9 hours and 30 minutes
Pressure sensor of pump module malfunction (P1450, P1452, P1453)	Not detected
Purge VSV	Not operated by scan tool
Vent valve	Not operated by scan tool
Leak detection pump	Not operated by scan tool
Both of the following conditions (a) and (b) are met before key off:	
(a) Duration that vehicle is being driven	5 minutes or more
(b) Purge flow	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 15

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met:	-
Atmospheric pressure change for 10 seconds	Less than 0.3 kPa (2.25 mmHg) for 1 second

2. First reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2 and 3
1. EVAP pressure 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.38 to -7.93 mmHg)
3. Reference pressure	Saturated

3. Vent valve stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after vent valve ON (Closed)	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction for canister

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. Vacuum introduction time	15 minutes or less
2. FTP	Saturated

5. Purge VSV stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after Purge VSV ON (Open).	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3 and 4
1. EVAP pressure when 1.9 sec. after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the first and second	0.7 kPa (5.25 mmHg) or less

7. Canister leak

Next sequence is run if the following condition is met:	-
Canister leak when vacuum introduction was complete	Second reference pressure or less

8. Fuel vapor-containment valve (FVCV stuck closed check)

Sequence 14 is run if all of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 kPa (-15 mmHg) or less, or 3 kPa (22.5 mmHg) or more
2. FTP change while FVCV and vent valve are open	0.5 kPa (3.75 mmHg) or more

9. Vacuum introduction for fuel tank

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 to 3 kPa (-15 to 22.5 mmHg)
2. Vacuum introduction time	15 minutes or less

ES

10. FVCV stuck closed check

Next sequence is run if the following condition is met:	
FTP change when vacuum introduction for fuel tank	0.5 kPa (3.75 mmHg)

11. FTP sensor stuck check

Next sequence is run if the following condition is met:	
FTP change when FVCV closed	0.35 kPa (2.6 mmHg) or less

12. Third reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3, and 4
1. FTP 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or more
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between second and third	Less than 0.7 kPa (5.25 mmHg)

13. Fuel tank leak check

Sequence is run if the following condition is met:	
FTP when vacuum introduction for fuel tank was complete	Less than third reference pressure

14. FTP sensor stuck check

Next sequence is run if the following condition is met:	-
FTP change while FVCV and vent valve are open	Less than 0.35 kPa (2.6 mmHg)

15. Atmospheric pressure measurement

Monitor is complete if the following condition is met:	-
Atmospheric pressure difference between sequence 1 and 8	0.3 kPa (2.25 mmHg) or less

TYPICAL MALFUNCTION THRESHOLDS

Purge VSV stuck open:

EVAP pressure when vacuum introduction for canister was complete	Higher than reference pressure x 0.2

Purge VSV stuck open and closed:

EVAP pressure change for 10 seconds after purge VSV ON	Less than 0.3 kPa (2.25 mmHg)

Purge flow:

Both of the following conditions are met:	Conditions (a) and (b)
(a) EVAP pressure change when purge operation is started	Less than 0.1 kPa (0.75 mmHg)
(b) EVAP pressure change during purge operation when vent valve is closed	Less than 0.5 kPa (3.75 mmHg)

MONITOR RESULT

Refer to the EVAP System (See page ES-317).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-317).

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

DTC No.	Monitoring Item	DTC Detection Condition	Trouble Area	Detection Timing	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 • Hybrid vehicle control ECU	• EVAP monitoring (Power switch off) • Power switch ON (IG)	1-trip
P0451	Pressure sensor abnormal voltage fluctuation	Sensor output voltage fluctuates frequently in certain time period.	• Pump module • Connector / wire harness (Pump module - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (Power switch off) • Engine switch running	2-trips
P0451	Pressure sensor constant voltage	Sensor output voltage does not vary in certain time period.	• Pump module • Connector / wire harness (Pump module - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (Power switch off)	2-trips
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 - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (Power switch off) • Power switch ON (IG)	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 - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (Power switch off) • Power switch ON (IG)	1-trip

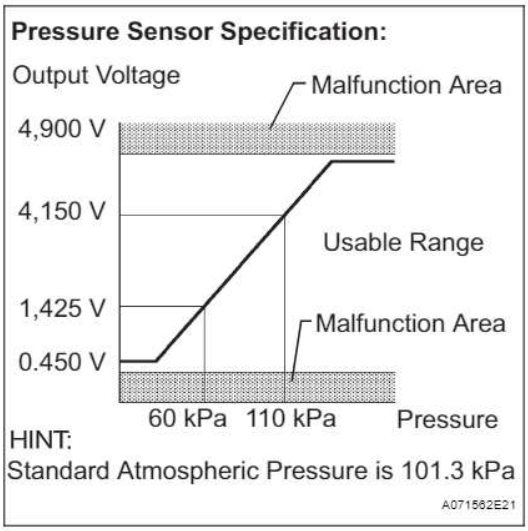
HINT:
The pressure sensor is built into the pump module.

DESCRIPTION

Refer to the EVAP System (See page ES-317).

MONITOR DESCRIPTION

1. DTC P0450: Pressure sensor abnormal voltage fluctuation
   If the pressure sensor output voltage 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 (included in the hybrid vehicle control ECU) 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 output voltage fluctuates rapidly for 10 seconds, the ECM (included in the hybrid vehicle control ECU) 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 output voltage does not change for 10 seconds, the ECM interprets this as the sensor voltage being constant, 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 output voltage is below 0.45 V, the ECM (included in the hybrid vehicle control ECU) 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 (included in the hybrid vehicle control ECU) 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).

MONITOR STRATEGY

Required Sensors/Components	Pump module
Frequency of Operation	Once per driving cycle: P0451 sensor constant voltage Continuous: P0451 sensor abnormal voltage fluctuation, P0450, P0452 and P0453
Duration	0.5 seconds: P0450, P0452, P0453 Within 15 seconds: P0451
MIL Operation	Immediate: P0450, P0452, P0453 2 driving cycles: P0451

Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

P0451 (Noise Monitor):

Atmospheric pressure	70 kPa (525 mmHg) to 110 kPa (825 mmHg)
Battery voltage	8 V or more
Intake air temperature	4.4 to 35°C (40 to 95°F)
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
Either of the following conditions is met:	A or B
A. Power switch	ON
B. Soak time (Power switch off time)	5 hours

ES

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

P0451 (Stuck Monitor):

Atmospheric pressure	Less than 70 kPa (525 mmHg) or 110 kPa (825 mmHg) or more
Battery voltage	10.5 V or more
Intake air temperature	4.4 to 35°C (40 to 95°F)
EVAP pressure sensor malfunction (P0450, P0452, P0453)	Not detected
Soak time (Power switch off time)	5 hours

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

P0450, P0452 and P0453:

The monitor will run whenever these DTCs are not present	None
Battery voltage	8 V or more
Starter	OFF
Power switch	ON

TYPICAL MALFUNCTION THRESHOLDS

1. P0450: Pressure sensor chattering

EVAP Pressure	Less than 42.11 kPa (315.82 mmHg), or more than 123.761 kPa (928.207 mmHg)

2. P0451: Pressure sensor noise

Frequency that EVAP pressure change is 0.3 kPa or more	10 times or more in 10 seconds

3. P0451: Pressure sensor stuck

EVAP pressure change during reference pressure measurement	Less than 0.65 kPa (4.87 mmHg)

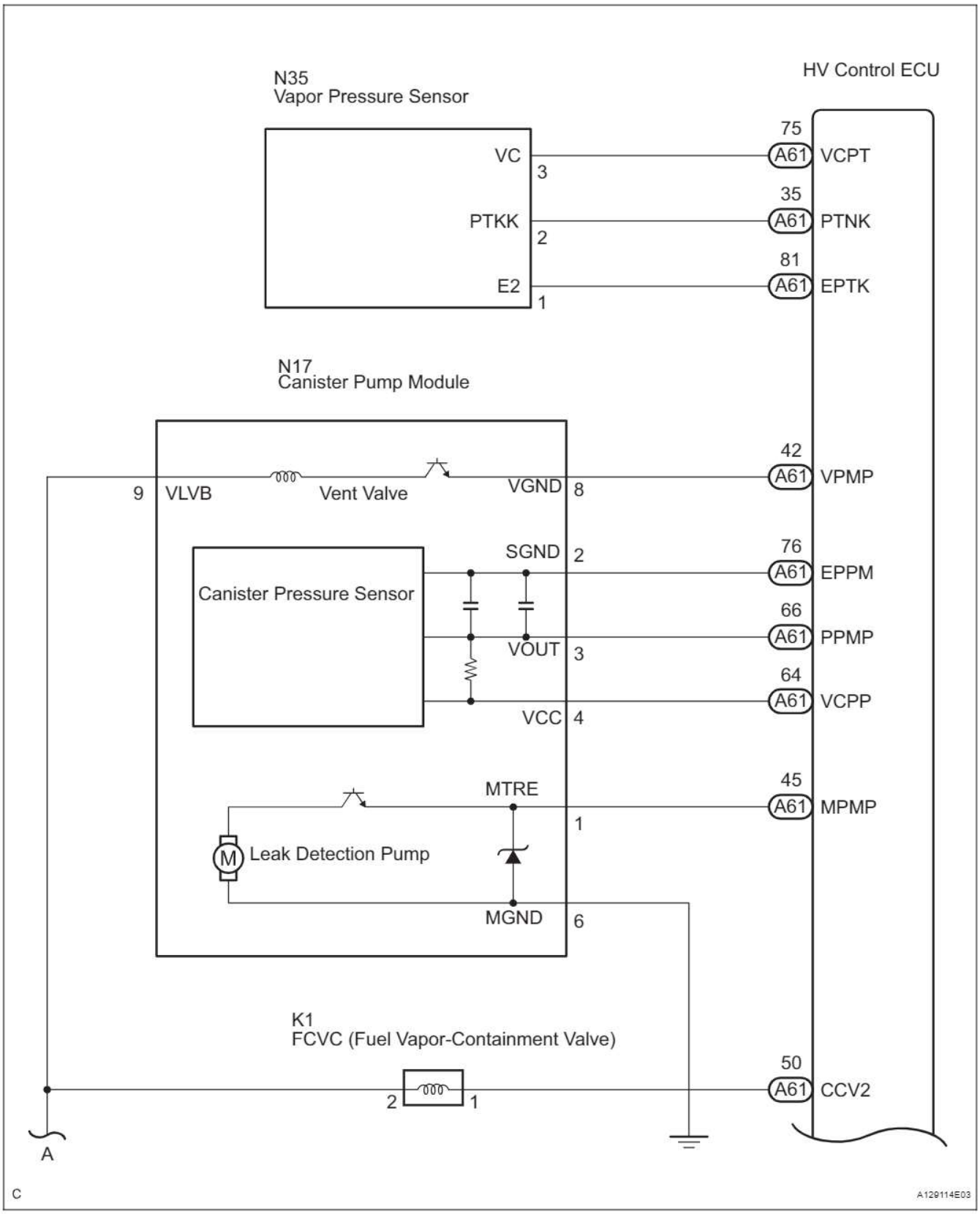
4. P0452: Pressure sensor low voltage

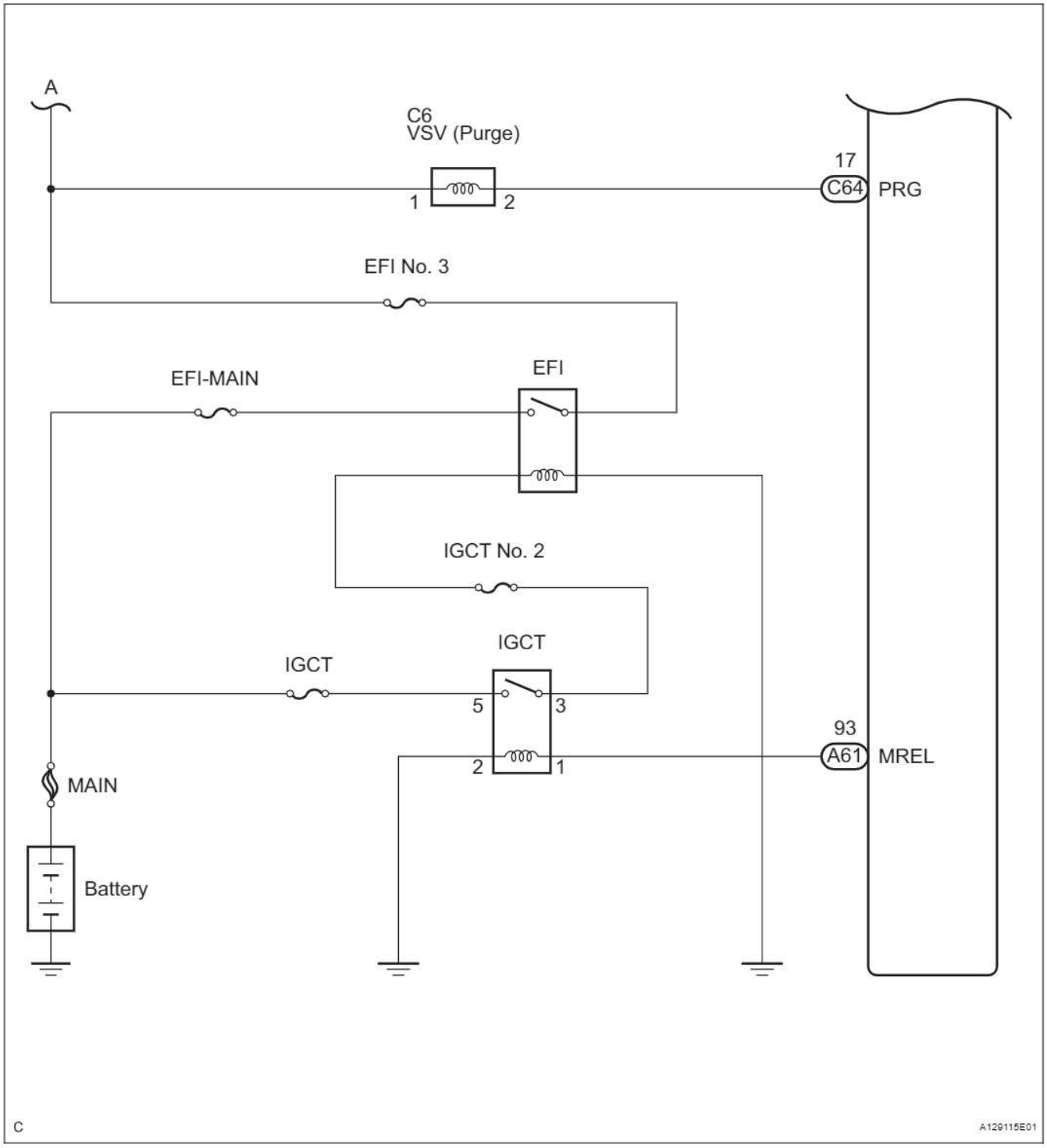
EVAP Pressure	Less than 42.11 kPa (315.82 mmHg)

5. P0453: Pressure sensor high voltage

EVAP Pressure	More than 123.761 kPa (928.207 mmHg)

WIRING DIAGRAM





ES

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 power switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read the DTCs.
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / EVAP / VAPOR PRESS PUMP.
(g) Read the EVAP (Evaporative Emission) pressure displayed on the tester.

ES

Result

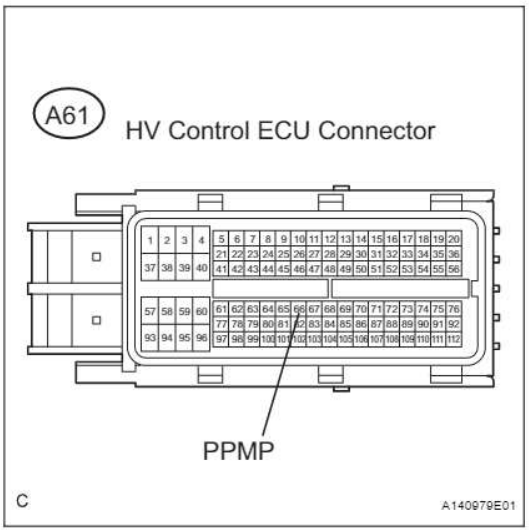
Display (DTC Output)	Test Result	Suspected Trouble Area	Proceed to
P0451	-	• Pressure sensor	C
P0450 and/or P0452	Less than 45 kPa (338 mmHg)	• Wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor) • Pressure sensor • Short in hybrid vehicle control ECU	A
P0450 and/or P0453	More than 120 kPa (900 mmHg)	• Wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor) • Pressure sensor • Open in hybrid vehicle control ECU	B

B → Go to step 4

C → GO TO EVAP INSPECTION PROCEDURE

A

2	CHECK HARNESS AND CONNECTOR (PUMP MODULE CONTROL ECU)



(a) Turn the power switch off.
(b) Disconnect the A61 hybrid vehicle control ECU connector.
(c) Measure the resistance between the PPMP terminal of the hybrid vehicle control ECU connector and body ground.

Result

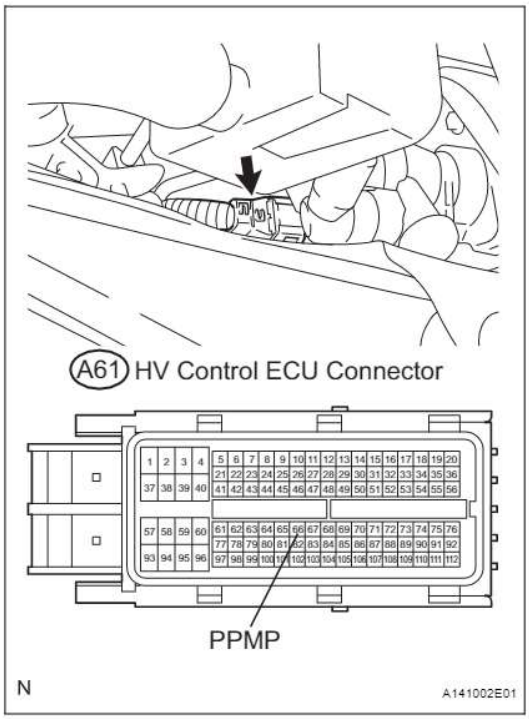
Test Result	Suspected Trouble Area	Proceed to
10 Ω or less	• Wire harness/ connector (HV Control ECU - pressure sensor) • Short in pressure sensor circuit	A
10 kΩ or more	• Wire harness/ connector (Hybrid Vehicle Control ECU - pressure sensor) • Short in hybrid vehicle control ECU	B

(d) Reconnect the hybrid vehicle control ECU connector.

B	Go to step 7

A

3 CHECK HARNESS AND CONNECTOR (PUMP MODULE - HV CONTROL ECU)



(a) Disconnect the N17 canister connector.
(b) Disconnect the A61 hybrid vehicle control ECU connector.
(c) Measure the resistance between the PPMP terminal of the hybrid vehicle control ECU connector and body ground.

Result

Test Result	Suspected Trouble Area	Proceed to
10 kΩ or more	• Short in pressure sensor circuit	A
10 Ω or less	• Short in wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor)	B

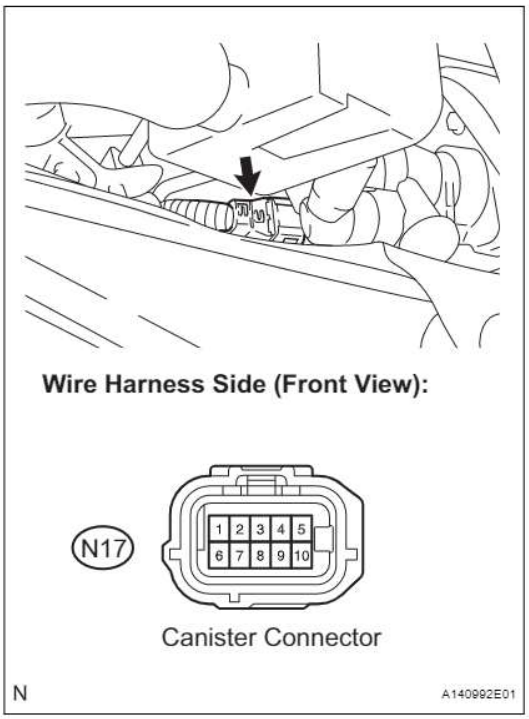
(d) Reconnect the canister connector.
(e) Reconnect the hybrid vehicle control ECU connector.

A	Go to step 5
B	Go to step 6

ES

ES

4	CHECK HARNESS AND CONNECTOR (PUMP MODULE - HV CONTROL ECU)



(a) Disconnect the N17 canister connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage and resistance according to the value(s) in the table below.

Standard

Tester Connection	Specified Condition
N17-4 - Body ground	4.5 to 5.0 V
N17-3 - Body ground	4.5 to 5.0 V
N17-2 - Body ground	100 Ω or less

Result

Test Result	Suspected Trouble Area	Proceed to
Voltage and resistance within standard ranges	• Open in pressure sensor circuit	A
Voltage and resistance outside standard ranges	• Open in wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor)	B

(d) Reconnect the canister connector.

A	Go to step 5
B	Go to step 6

5	REPLACE CHARCOAL CANISTER

NEXT	Go to step 8

6	REPAIR OR REPLACE HARNESS OR CONNECTOR

HINT:
If the exhaust tail pipe has been removed, go to the next step before reinstalling it.

NEXT	Go to step 8

7	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT	Go to step 8

8	CHECK WHETHER DTC OUTPUT RECURS (AFTER REPAIR)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Wait for at least 60 seconds.

(d) Enter the following menus: 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	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 (included in hybrid vehicle control ECU), 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 connections • Hybrid vehicle control ECU

ES

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 are met:

- The learned idling air flow volume remains at the maximum or minimum volume 5 times or more during a drive cycle.
- After driving at 6.25 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.

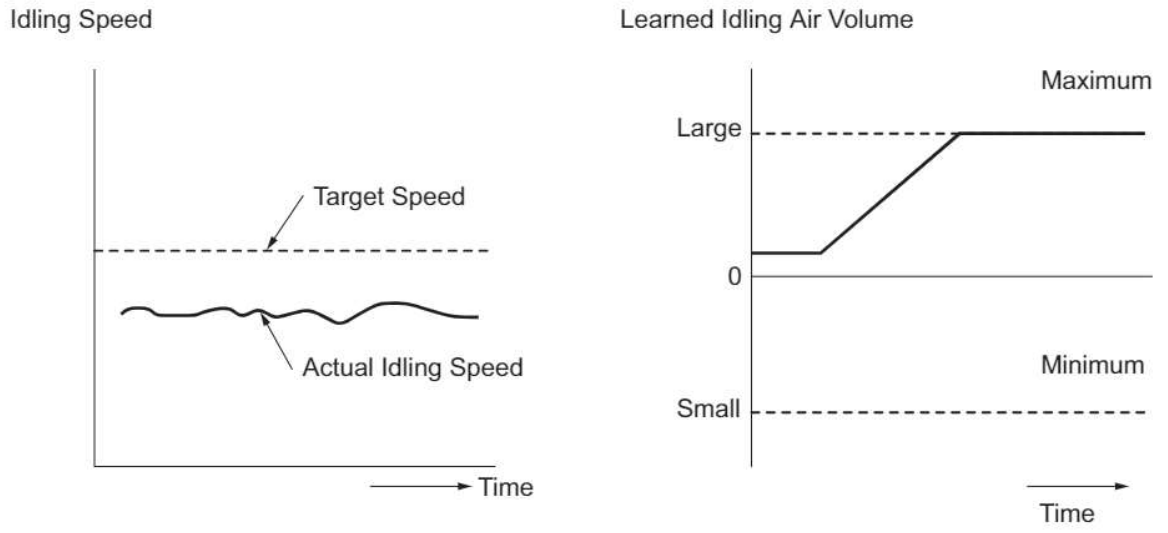
Example:

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.

HINT:

*: Threshold idling speed varies with engine load.

Example:



Y A121611E02

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	Once per driving cycle: Functional check Continuous: Range check
Duration	10 minutes: Functional check 10 seconds: Range check
MIL Operation	2 driving cycles: Functional check Immediate: Range check
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Engine	Running

TYPICAL MALFUNCTION THRESHOLDS

Either of following conditions 1 or 2 met	-
1. Frequency that both of following conditions (a) and (b) set	5 times or more
(a) Engine rpm - Target engine rpm	Less than -100 rpm, or more than 150 rpm
(b) Vehicle condition	Stop after vehicle was driven by 6.25 mph (10 km/h) or more
2. Frequency that both of following conditions (c) and (d) set	Once
(c) Engine rpm - Target engine rpm	Less than -100 rpm, or more than 150 rpm

(d) IAC flow rate learning value	1.1 L/sec. or less, or 7 L/sec. or more

INSPECTION PROCEDURE

HINT:

- The following conditions may also cause DTC P0505 to be set:
  (a) The throttle valve is not fully closed. (e.g. The accelerator pedal is slightly depressed by something such as a floor carpet overlapping the accelerator pedal.)
- 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

1 CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0505)

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

(a) Check the throttle valve condition.
OK:
Throttle valve is not contaminated with foreign objects and moves smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY

OK ↓

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P050A	Cold Start Idle Air Control System Performance

DTC	P050B	Cold Start Ignition Timing Performance

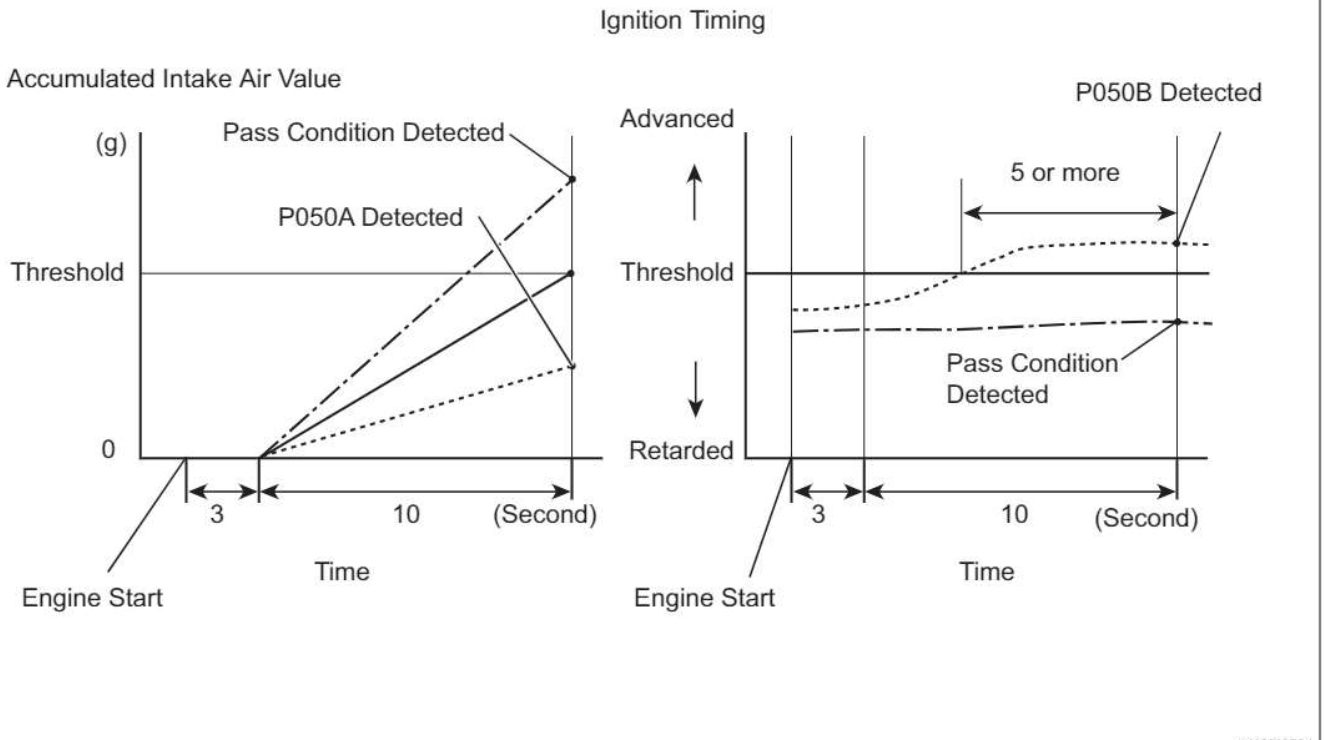
DESCRIPTION

The Electronic Throttle Control System (ETCS) controls the engine idling speed. The ETCS operates the throttle actuator to open and close the throttle valve, and adjusts the intake air amount to achieve the target idling speed.
In addition, the ECM (included in hybrid vehicle control ECU) retards the ignition timing and the ETCS increases the intake air amount to quickly increase the catalyst temperature at cold start to reduce emissions.

ES

DTC No.	DTC Detection Conditions	Trouble Areas
P050A	Accumulated intake air amount during 10 seconds of idling after cold start is less than threshold (2-trip detection logic)	• Throttle body assembly • Mass air flow meter • Air induction system • PCV hose connections • VVT system • Air cleaner filter element • Hybrid vehicle control ECU
P050B	Ignition timing retard value insufficient for 5 seconds or more during 10 seconds of P050A monitoring duration at cold start (2-trip detection logic)	• Throttle body assembly • Mass air flow meter • Air induction system • PCV hose connections • VVT system • Air cleaner filter element • Hybrid vehicle control ECU

MONITOR DESCRIPTION



The ECM monitors the intake air amount during idling and the ignition timing.
When the Engine Coolant Temperature (ECT) is between -10°C and 50°C (14°F and 122°F), the ECM calculates the idling intake air amount for 10 seconds, beginning 3 seconds after the engine starts.
When the accumulated value is below the threshold, the ECM interprets this as a malfunction in the Idle Speed Control (ISC) system at cold start.
The ECM also monitors the ignition timing at cold start, and judges it to be incorrect when it is advanced to the same value for a warm engine for 5 seconds or more of the 10-second monitoring period.
Example:
P050A is detected when all conditions below are met (2-trip detection logic):
1. The ECT is between -10°C and 50°C (14°F and 122°F) when the engine starts.
2. The engine idles for 13 seconds after engine start.
3. The accumulated intake air amount is below the threshold.

The ECM sets the DTC and illuminates the MIL 13 seconds after the engine is next started.

NOTICE:

When the negative battery terminal is disconnected during inspection or repairs, the ISC learning values are cleared. The ISC learning must be performed by warming up the engine and idling for 5 minutes with the ECT at 75°C (167°F) or more because DTCs cannot be detected with the ISC learning values cleared.

MONITOR STRATEGY

Related DTCs	P050A: Idle speed control problem at cold P050B: Idle ignition timing problem at cold
Required Sensors/Components (Main)	Mass air flow meter
Required Sensors/Components (Related)	Engine Coolant Temperature (ECT) sensor, throttle position sensor, vehicle speed sensor

Frequency of Operation	Once per driving cycle
Duration	10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

P050A:

Battery voltage	8 V or more
Time after engine start	3 seconds or more
Starter	OFF
ECT at engine start	-10°C (14°F) or more
ECT	-10 to 50°C (14 to 122°F)
Engine idling time	3 seconds or more
Fuel-cut	OFF
Vehicle speed	Less than 1.875 mph (3 km/h)
Time after shift position changed (A/T)	1 second or more
Atmospheric pressure	76 kPa (570 mmHg) or more

P050B:

Battery voltage	8 V or more
Time after engine start	3 seconds or more
Starter	OFF
ECT at engine start	-10°C (14°F) or more
ECT	-10 to 50°C (14 to 122°F)
Engine idling time	3 seconds or more
Fuel-cut	OFF
Vehicle speed	Less than 1.875 mph (3 km/h)

TYPICAL MALFUNCTION THRESHOLDS

P050A:

Accumulated air flow amount (A/T)	Varies with ECT (Example: Less than 1.44 g)

P050B:

Accumulated time when ignition timing retard value insufficient	5 seconds 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P050A AND/OR P050B)

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

Result

Display (DTC Output)	Proceed to
P050A and/or P050B	A
P050A and/or P050B and other DTCs	B

HINT:
If any DTCs other than P050A and P050B are output, troubleshoot those DTCs first.

B → GO TO DTC CHART

A

2 READ VALUE USING INTELLIGENT TESTER (FUEL TRIM)

HINT:
Calculate the total fuel trim values to check the characteristic deviation of the mass air flow meter.

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / SHORT FT #1 and LONG FT #1.
(e) Read the values displayed on the tester.
(f) Add together the SHORT FT #1 and LONG FT #1 values to obtain the total FUEL TRIM.

OK:
Total of SHORT FT #1 and LONG FT #1 values is between -20% and 20%.

OK → Go to step 12

NG

3 PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE OCV)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1.
(f) Check the engine speed while operating the Oil Control Valve (OCV) using the tester.

OK

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

NG → Go to step 8

OK

4	CHECK PCV HOSE (HOSE CONNECTIONS)

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

NG → **Go to step 9**

OK

5	CHECK AIR INDUCTION SYSTEM

ES

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

NG → **Go to step 10**

OK

6	CHECK AIR CLEANER FILTER ELEMENT SUB-ASSEMBLY

(a) Visually check that the air cleaner filter element is not excessively contaminated with dirt or oil.
OK:
Air cleaner filter element is not excessively contaminated with dirt or oil.

NG → **Go to step 11**

OK

7	REPLACE MASS AIR FLOW METER

NEXT → **Go to step 15**

8	CHECK AND REPAIR VVT SYSTEM

NEXT → **Go to step 15**

9	REPAIR OR REPLACE PCV HOSE

NEXT → **Go to step 15**

10	REPAIR OR REPLACE AIR INDUCTION SYSTEM

NEXT → **Go to step 15**

11	REPLACE AIR CLEANER FILTER ELEMENT SUB-ASSEMBLY

NEXT → Go to step 15

12	CHECK THROTTLE VALVE

(a) Check for deposits around the throttle valve and throttle valve condition.

OK:

No deposits around throttle valve and throttle valve moves smoothly.

NG → Go to step 14

OK

13	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT → Go to step 15

14	REPAIR OR REPLACE THROTTLE BODY ASSEMBLY

NEXT → Go to step 15

15	CHECK WHETHER DTC OUTPUT RECURS (DTC P050A AND/OR P050B)

NOTICE:

In this operation, the engine must be cold (the same level as the engine coolant temperature recorded in the freeze frame data).

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Switch the ECM from normal mode to check mode using the tester (See page ES-34).
(f) Start the engine to idle for a minute.

OK:

Stable fast idling.

(g) Read the DTCs.

OK:

No DTC output.

NEXT

END

DTC	P0560	System Voltage

DESCRIPTION

The battery supplies electricity to the ECM (included in hybrid vehicle control ECU) even when the power 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, the memory is 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 • Battery • Battery terminals • EFI MAIN fuse • Hybrid vehicle control ECU

ES

HINT:
If DTC P0560 is set, the ECM does not store other DTCs or the data stored in the ECM are partly erased.

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

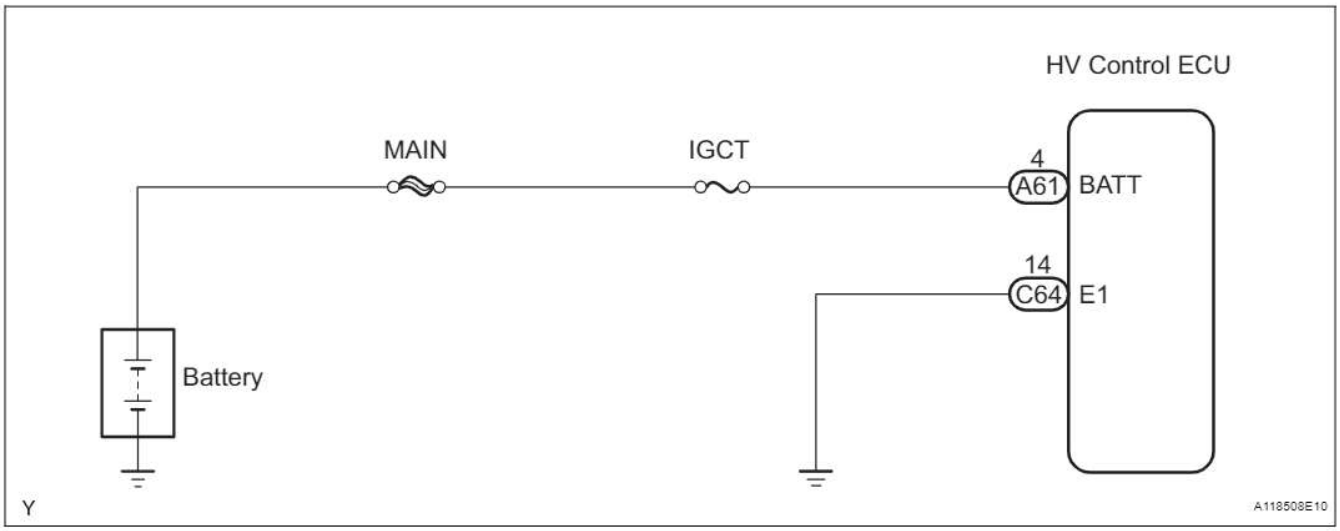
TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None

TYPICAL MALFUNCTION THRESHOLDS

ECM power source	Less than 3.5 V

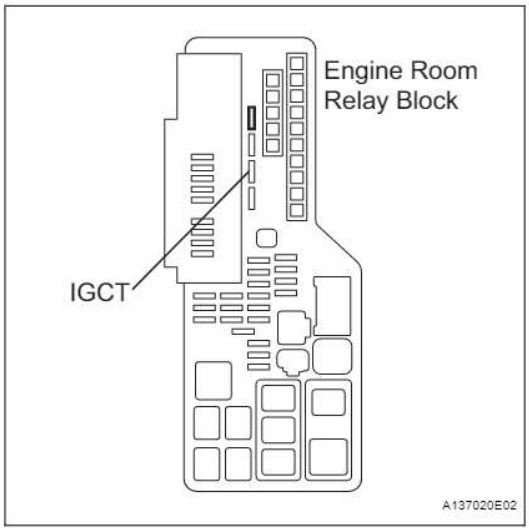
WIRING DIAGRAM



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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	CHECK FUSE (IGCT FUSE)

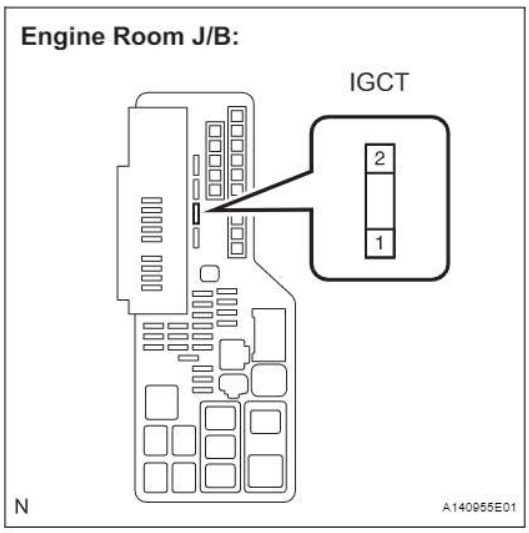


(a) Remove the EFI MAIN fuse and P/I fuse from the engine room R/B and J/B.
(b) Measure the resistance of the IGCT fuse.
Standard resistance:
Below 1 Ω
(c) Reinstall the IGCT fuse.

NG → **CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE**

OK

2	CHECK HARNESS AND CONNECTOR (HV CONTROL ECU - IGCT FUSE, IGCT FUSE - BATTERY)



(a) Check the harness and the connector between the IGCT fuse and hybrid vehicle control ECU.
(1) Remove the IGCT fuse from the engine room R/B and J/B.
(2) Disconnect the A61 hybrid vehicle control ECU connector.
(3) Measure the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
2 (IGCT fuse) - A61-4 (BATT)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
2 (IGCT fuse) or A61-4 (BATT) - Body ground	10 kΩ or higher

(4) Reconnect the hybrid vehicle control ECU connector.
(5) Reinstall the IGCT fuse.
(b) Check the harness and the connector between the IGCT fuse and battery.
(1) Remove the IGCT fuse from the engine room R/B and J/B.

(2) Disconnect the positive battery terminal.
(3) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Battery positive terminal - 1 (IGCT fuse)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
Battery positive terminal or 1 (IGCT fuse) - Body ground	10 kΩ or higher

(4) Reconnect the positive battery terminal.
(5) Reinstall the IGCT fuse.

ES

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

OK

3 INSPECT BATTERY

(a) Check that the battery is not depleted.
OK:
Battery is not depleted

NG → **REPLACE BATTERY**

OK

4 CHECK BATTERY TERMINAL

(a) Check that the battery terminals are not loose or corroded.
OK:
Battery terminals are not loose or corroded

NG → **REPAIR OR REPLACE BATTERY TERMINAL**

OK

5 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Turn the power switch off and turn the tester off.
(e) Put the engine in inspection mode (See page ES-35).
(f) Turn the tester on.
(g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(h) Read the DTCs.

Result

Display (DTC Output)	Proceed to
P0560	A

Display (DTC Output)	Proceed to
No output	B

B → CHECK FOR INTERMITTENT PROBLEMS

A

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0604	Internal Control Module Random Access Memory (RAM) Error

DESCRIPTION

The ECM (included in hybrid vehicle control ECU) continuously monitors its internal memory status. This self-check ensures that the ECM is functioning properly. It is diagnosed by internal "mirroring" of the main CPU and sub CPU to detect the Random Access Memory (RAM) errors. If outputs from these CPUs are different and deviate from the standards, the ECM will illuminate the MIL and set a DTC immediately.

DTC	DTC Setting Condition	Trouble Area
P0604	ECM RAM errors	Hybrid vehicle control ECU

ES

MONITOR STRATEGY

Related DTC	P0604: ECM RAM error
Required sensors/Components	ECM
Frequency of Operation	Continuous
Duration	16 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever this DTC is not present	None

TYPICAL MALFUNCTION THRESHOLDS

Main CPU and sub CPU mirroring	Fail

INSPECTION PROCEDURE

1	CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0604)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear the DTC.
(e) Turn the engine switch off.
(f) Disconnect the battery negative terminal and wait for 1 minute.
(g) Connect the battery negative terminal.
(h) Turn the engine switch on (IG).
(i) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(j) Read the DTCs.

Result

Display (DTC output)	Proceed to
P0604	A
No output DTC	B

B → CHECK FOR INTERMITTENT PROBLEMS

A

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0606	ECM / PCM Processor

DESCRIPTION

The ECM (included in hybrid vehicle control ECU) continuously monitors its internal processors (CPUs), A/F sensor transistors and heated oxygen sensor (HO2S) transistors. This self-check ensures that the ECM is functioning properly. These are diagnosed by internal "mirroring" of the main and sub CPUs to detect the processors error. If outputs from the processors deviate from the standards, the ECM will illuminate the MIL and set a DTC immediately.

DTC	DTC Setting Condition	Trouble Area
P0606	• ECM CPUs malfunction • A/F sensor transistors malfunction • HO2S transistors malfunction	• Exhaust gas leak • HO2 Sensor • Hybrid vehicle control ECU

ES

MONITOR STRATEGY

Related DTC	P0606: ECM range check
Required sensors/Components (main)	ECM
Required sensors/Components (sub)	APP sensor, TP sensor, Brake switch, Cruise control, A/F sensor HO2S
Frequency of Operation	Continuous
Duration	60 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever this DTC is not present	None
Engine	Running
Estimated A/F sensor temperature	450 to 800°C (842 to 1,472°F)
Estimated HO2S temperature	450 to 800°C (842 to 1,472°F)

TYPICAL MALFUNCTION THRESHOLDS

Difference of main APP and sub APP	0.3 V or more
Difference of main TP and sub TP	0.3 V or more
Difference of main brake switch signal and sub brake switch signal	Different
Cruise control	Fail
A/F sensor transistors	Fail
HO2S transistors	Fail

INSPECTION PROCEDURE

1	CHECK FOR EXHAUST GAS LEAK

(a) Allow the engine to idle.
(b) Check for exhaust gas leak around the heated oxygen sensor.

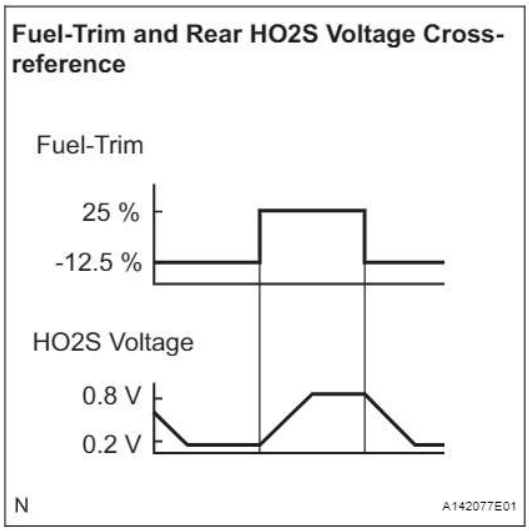
OK:

No leak from the heated oxygen sensor.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

2 CHECK HEATED OXYGEN SENSOR



(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) Enter the following menus: DIAGNOSIS / ENHANCED 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 HO2 sensor 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 in the fuel injection volume.

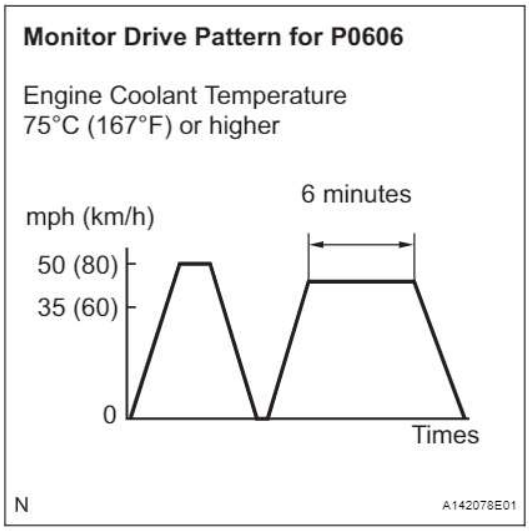
Standard voltage

Tester Display (Sensor)	Injection Volume	Voltage
O2S B1S2 or O2S B2S2	-12.5%	Less than 0.2 V
	+25%	More than 0.8 V

NG → REPLACE HEATED OXYGEN SENSOR

OK

3 CHECK WHETHER DTC OUTPUT RECURS (IN ADDITION TO DTC P0606)



(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear the DTC.
(e) Turn the engine switch off.
(f) Disconnect the battery negative terminal and wait for 1 minute.
(g) Connect the battery negative terminal.
(h) Start the engine.
(i) Perform the drive pattern.
(1) Warm up the engine.
(2) Accelerate the vehicle to 50 mph (80 km/h) and stop the vehicle.
(3) Drive the vehicle at 35 to 50 mph (60 to 80 km/h) for 5 minutes or more.
(j) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.

(k) Read the DTCs.
Result

Display (DTC output)	Proceed to
P0606	A
No output DTC	B

B → CHECK FOR INTERMITTENT PROBLEMS

A → REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0607	Control Module Performance

DESCRIPTION

The ECM (included in hybrid vehicle control ECU) continuously monitors its main and sub CPUs. This self-check ensures that the ECM is functioning properly. If outputs from the CPUs are different and deviate from the standards, the ECM will illuminate the MIL and set a DTC immediately.
The ECM also monitors the cruise control cancel circuit. If this circuit malfunctions, the ECM will set a DTC immediately (MIL is not illuminated).

DTC No.	DTC Detection Condition	Trouble Area
P0607	• ECM main CPU error • ECM sub CPU error • Cruise control cancel circuit malfunction	Hybrid vehicle control ECU

ES

NOTICE:
First check for an exhaust gas leak around the HO2S if P0606 is present. An exhaust gas leak generates noise in the HO2S output. The ECM may interpret this as an HO2S transistor malfunction.

MONITOR STRATEGY

Related DTC	P0607: ECM CPU malfunction
Required sensors/Components	ECM
Frequency of Operation	Continuous
Duration	Within 1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever this DTC is not present	None

TYPICAL MALFUNCTION THRESHOLDS

Either of the following conditions is met:	Condition A or B
A. All of the following conditions are met:	Conditions (a), (b) and (c)
(a) CPU reset	1 time or more
(b) Leaned TP - learned APP	0.4 V or more
Throttle actuator	OFF
B. CPU reset	2 times or more

INSPECTION PROCEDURE

1	CHECK WHETHER DTC OUTPUT RECURS (IN ADDITION TO DTC P0607)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear the DTC.
(e) Turn the engine switch off.
(f) Disconnect the battery negative terminal and wait for 1 minute.
(g) Connect the battery negative terminal.

(h) Turn the engine switch on (IG).
(i) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(j) Read the DTCs.

Result

Display (DTC output)	Proceed to
P0607	A
No output DTC	B

B → CHECK FOR INTERMITTENT PROBLEMS

A

ES

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P0657	Actuator Supply Voltage Circuit / Open

DESCRIPTION

The ECM (included in hybrid vehicle control ECU) monitors the output voltage to the throttle actuator. This self-check ensures that the ECM is functioning properly. The output voltage usually is 0 V when the engine switch is turned off. If the output voltage is higher than 7 volts when the engine switch is turned off, the ECM will illuminate the MIL and set a DTC when the engine switch is turned on.

DTC	DTC Setting Condition	Trouble Area
P0657	Throttle actuator power supply error	Hybrid vehicle control ECU

MONITOR STRATEGY

Related DTC	P0657: ETCS power supply
Required sensors/Components (main)	ECM
Required sensors/Components (sub)	Throttle actuator
Frequency of Operation	Once per driving cycle
Duration	Within 1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever this DTC is not present	None
Engine switch	From ON to OFF

TYPICAL MALFUNCTION THRESHOLDS

Throttle actuator power supply	7 V or more

INSPECTION PROCEDURE

1	CHECK WHETHER DTC OUTPUT RECURS (IN ADDITION TO DTC P0657)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the engine switch on (IG).
(c) Turn the tester on.
(d) Clear the DTC.
(e) Turn the engine switch off.
(f) Disconnect the battery negative terminal and wait for 1 minute.
(g) Connect the battery negative terminal.
(h) Turn the engine switch on (IG) for 10 seconds.
(i) Turn the engine switch off.
(j) Turn the engine switch on (IG).
(k) Enter the following menus: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(l) Read the DTCs.

Result

Display (DTC output)	Proceed to
P0657	A

Display (DTC output)	Proceed to
No output DTC	B

B → CHECK FOR INTERMITTENT PROBLEMS

A

REPLACE HYBRID VEHICLE CONTROL ECU

ES

DTC	P1420	Evaporative Emission Canister Small Leak

DTC	P1421	Evaporative Emission Canister Gross Leak

DTC SUMMARY

DTC No.	Monitoring Item	DTC Detection Condition	Trouble Area	Detection Timing	Detection Logic
P1420	EVAP small 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 the start and at the end of leak check. If stabilized pressure is higher than second 0.02 inch leak pressure standard, ECM determines that EVAP system has a small leakage.	• Leakage from EVAP line (Canister -Fuel vapor-containment valve) • Leakage from EVAP line (Purge VSV - Canister) • Pump module • Leakage from canister	Power switch off	2-trips
P1421	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 the start and at the 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 stuck open	Same above	Power switch off	2-trips

ES

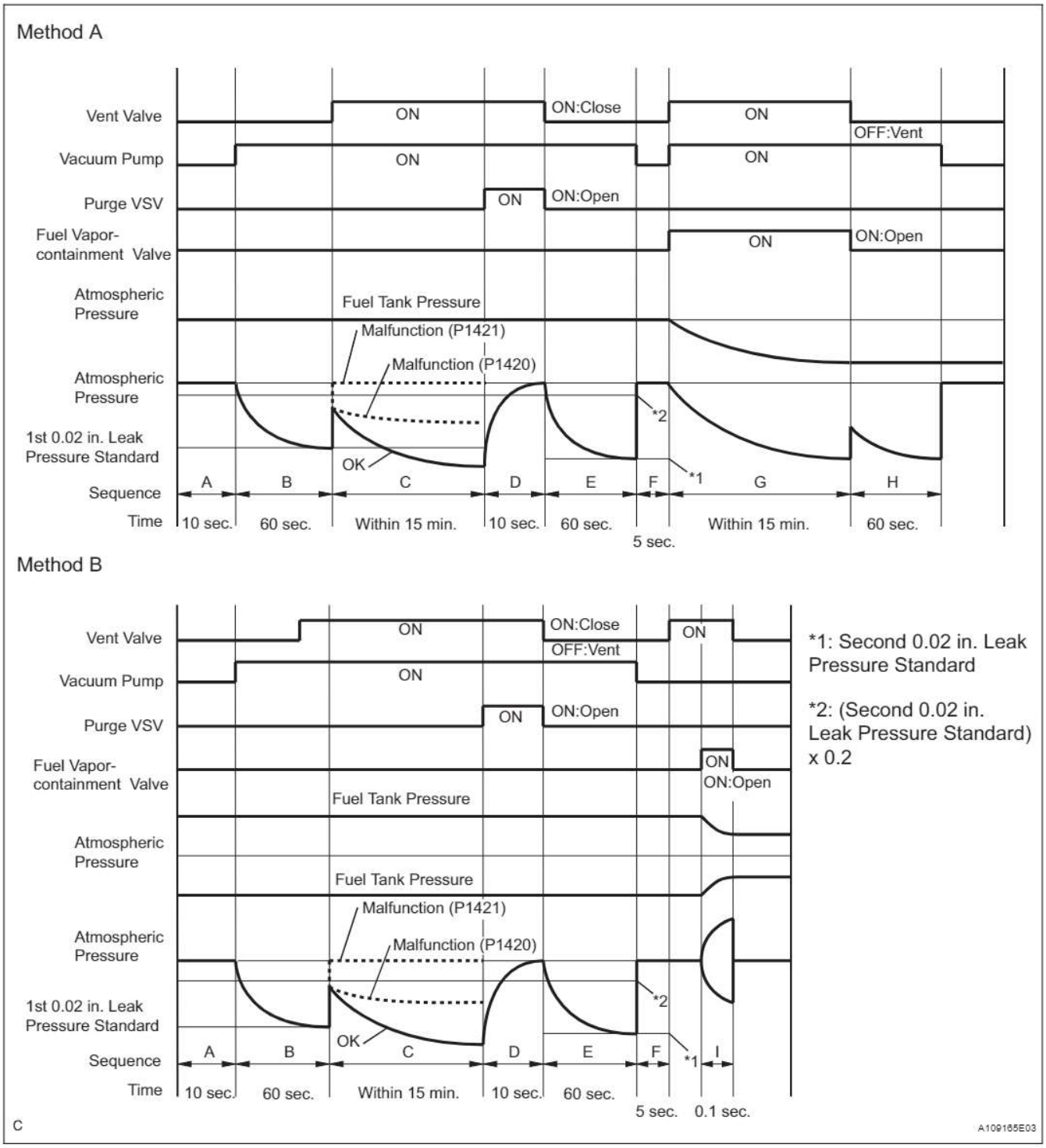
DESCRIPTION

Refer to EVAP System (See page ES-317).

MONITOR DESCRIPTION

1. P1420: EVAP (Evaporative Emission) 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 the second 0.02 inch leak pressure standard, the ECM (included in the hybrid vehicle control ECU) determines that the EVAP system has a large leakage. The ECM illuminates the MIL and sets the DTC (2-trip detection logic).

2. P1421: EVAP very 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 (included in the hybrid vehicle control ECU) determines that the EVAP system has a large leakage. The ECM illuminates the MIL and sets the DTC (2-trip detection logic).



MONITOR STRATEGY

Required Sensors/Components	Purge VSV and pump module
Frequency of Operation	Once per driving cycle

Duration	Within 15 minutes (varies with the amount of fuel in tank)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	
EVAP key-off monitor runs when all of the following conditions are met:	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	Below 2.5 mph (4 km/h)
Power switch	OFF
Engine condition	Not running
Pressure sensor (built in pump module) malfunction (P0450, P0451, P0452 and/or P0453)	Not detected
Purge VSV	Not operated by scan tool
Vent valve	Not operated by scan tool
Leak detection pump	Not operated by scan tool
Both of the following conditions are met before power switch OFF	Conditions 1 and 2
1. Duration that vehicle is being driven	5 minutes or more
2. Purge flow	Executed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)
Time after engine stopped	5 hours

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

Key-off monitor sequence 1 to 15

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met:	-
Atmospheric pressure change for 10 sec.	Less than 0.3 kPa (2.25 mmHg) for 1 second

2. First reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2 and 3
1. EVAP pressure 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.38 to -7.93 mmHg)
3. Reference pressure	Saturated within 1 minute

3. Vent valve stuck closed check

Next sequence is run if the following condition is met:	-
EVAP change for 10 seconds after vent valve ON (Closed)	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction for canister

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. Vacuum introduction time	12 minutes or less
2. EVAP pressure	Saturated

5. Purge VSV stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after purge VSV ON (Open).	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2 and 3
1. EVAP pressure 1.9 sec. after reference pressure measurement began	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the first and second	0.7 kPa (5.25 mmHg) or less

7. Canister leak check

Next sequence is run if the following condition is met:	-
EVAP pressure when vacuum introduction was complete	Less than second reference pressure

8. Fuel vapor-containment valve (FVCV stuck closed check)

ES

Sequence 14 is run if all of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 kPa (-15 mmHg) or less, or 3 kPa (22.5 mmHg) or more
2. FTP change while FVCV and vent valve are open	0.5 kPa (3.75 mmHg) or more

9. Vacuum introduction for fuel tank

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 to 3 kPa (-15 to 22.5 mmHg)
2. Vacuum introduction time	15 minutes or less

10. FVCV stuck closed check

Next sequence is run if the following condition is met:	
FTP change when vacuum introduction for fuel tank	0.5 kPa (3.75 mmHg)

11. FTP sensor stuck check

Next sequence is run if the following condition is met:	
FTP change when FVCV closed	0.35 kPa (2.6 mmHg) or less

12. Third reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3, and 4
1. FTP 1.9 seconds after reference pressure measurement began	-1 kPa (-7.5 mmHg) or more
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the second and third	Less than 0.7 kPa (5.25 mmHg)

13. Fuel tank leak check

Sequence is run if the following condition is met:	
FTP when vacuum introduction for fuel tank was complete	Less than third reference pressure

14. FTP sensor stuck check

Next sequence is run if the following condition is met:	-
FTP change while FVCV and vent valve are open	Less than 0.35 kPa (2.6 mmHg)

15. Atmospheric pressure measurement

Monitor is complete if the following condition is met:	-
Atmospheric pressure difference between sequence 1 and 8	0.3 kPa (2.25 mmHg) or less

TYPICAL MALFUNCTION THRESHOLDS

"Saturated" indicates that the EVAP pressure change is less than 0.75 mmHg (0.1 kPa) in 30 seconds.

P1421: EVAP gross leak

EVAP pressure when vacuum introduction complete	Higher than reference pressure x 0.2

P1420: EVAP small leak

EVAP pressure when vacuum introductions complete	Between conditions 1 and 2
Condition 1	Higher than second reference pressure
Condition 2	Lower than reference pressure x 0.2
Atmospheric pressure (absolute pressure)	70 kPa (525 mmHg) or more, and less than 110 kPa (825 mmHg)

MONITOR RESULT

Refer to EVAP System (See page ES-325).

INSPECTION PROCEDURE

Refer to EVAP System (See page ES-328).

DTC	P1422	Fuel Tank Small Leak

DTC	P1423	Fuel Tank Gross Leak

DTC SUMMARY

DTC No.	Monitoring Item	Malfunction Detection Condition	Trouble Area	Detection Timing	Detection Logic
P1422	Fuel tank small leak	Vacuum pump creates negative pressure (vacuum) in fuel tank and fuel tank pressure is measured. 0.02 inch leak pressure standard is measured at the start and at the end of leak check. If stabilized pressure is higher than third 0.02 inch leak pressure standard, ECM (Included in Hybrid Vehicle Control ECU) determines that fuel tank has a small leakage.	• Leakage from EVAP line (Canister - Fuel vapor-containment valve) • Leakage from EVAP line (Purge VSV - Canister) • Pump module • Leakage from canister	Power switch off	2-trips
P1423	Fuel tank gross leak	Vacuum pump creates negative pressure (vacuum) in fuel tank and fuel tank pressure is measured. 0.02 inch leak pressure standard is measured at the start and at the end of leak check. If stabilized pressure is higher than [third 0.02 inch leak pressure standard x 0.2], ECM (Included in Hybrid Vehicle Control ECU) determines that fuel tank has a large leakage.	Same above	Power switch off	2-trips

ES

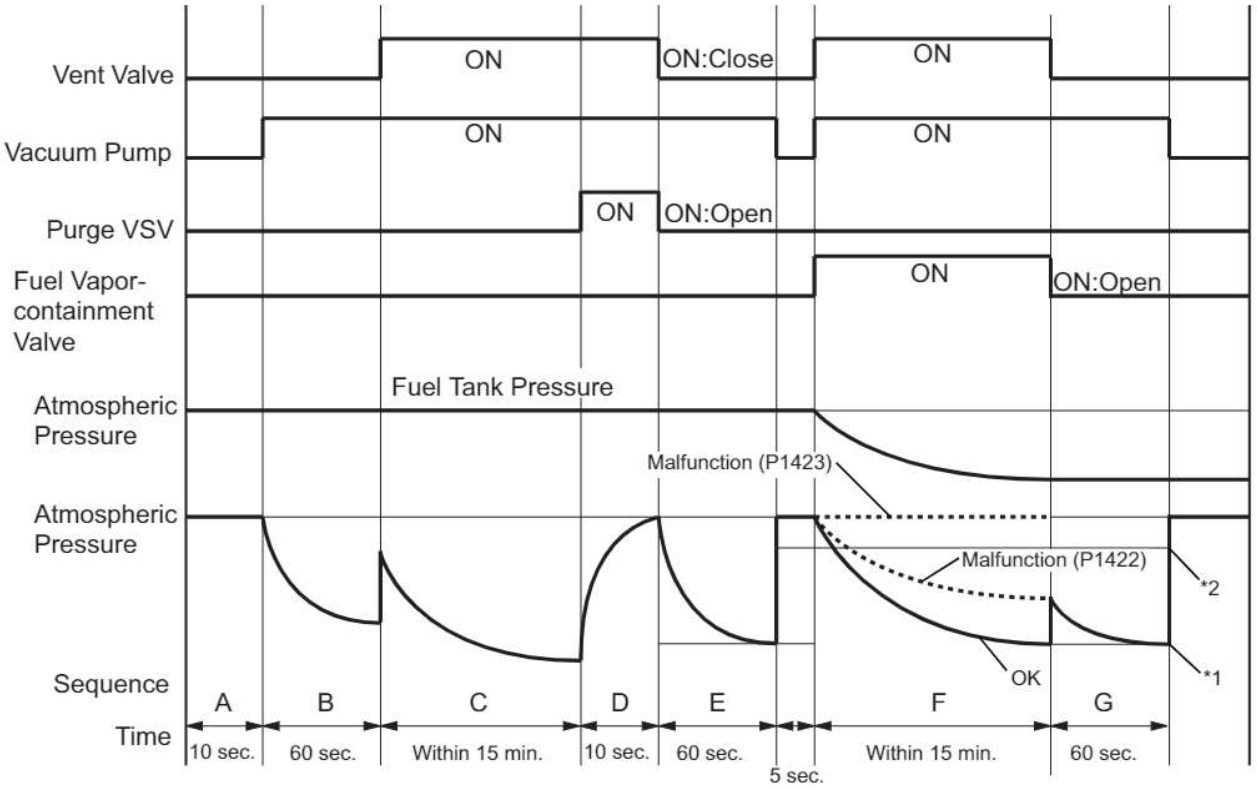
DESCRIPTION

Refer to the EVAP System (See page ES-317).

MONITOR DESCRIPTION

1. P1422: Fuel tank very small leak
   In operation G, the vacuum pump creates negative pressure (vacuum) in the fuel tank and the fuel tank pressure is measured. If the stabilized system pressure is higher than the third 0.02 inch leak pressure standard, the ECM (included in the hybrid vehicle control ECU) determines that the fuel tank has a large leakage. The ECM illuminates the MIL and sets the DTC (2-trip detection logic).

2. P1423: Fuel tank gross leak
In operation G, the vacuum pump creates negative pressure (vacuum) in the fuel tank and the fuel tank pressure is measured. If the stabilized system pressure is higher than [third 0.02 inch leak pressure standard x 0.2] (near atmospheric pressure), the ECM (included in the hybrid vehicle control ECU) determines that the fuel tank has a large leakage. The ECM illuminates the MIL and sets the DTC (2-trip detection logic).



*1: Third 0.02 in. Leak Pressure Standard

*2: (Third 0.02 in. Leak Pressure Standard) x 0.2

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MONITOR STRATEGY

Required Sensors/Components	Fuel tank and pump module
Frequency of Operation	Once per driving cycle

Duration	Within 15 minutes (varies with the amount of fuel in tank)
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever these DTCs are not present	
EVAP key-off monitor runs when all of the following conditions are met:	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	Below 2.5 mph (4 km/h)
Power switch	OFF
Engine condition	Not running
FTP sensor malfunction (P1450, P1452 and/or P1453)	Not detected
Purge VSV	Not operated by scan tool
Vent valve	Not operated by scan tool
Leak detection pump	Not operated by scan tool
Both of the following conditions are met before power switch OFF:	Conditions 1 and 2
1. Duration that vehicle is being driven	5 minutes or more
2. Purge flow	Executed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)
Time after engine stopped	5 hours

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

Key-off monitor sequence 1 to 15

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met:	-
Atmospheric pressure change for 10 seconds	Less than 0.3 kPa (2.25 mmHg) for 1 second

2. First reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, and 3
1. EVAP pressure 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.38 to -7.93 mmHg)
3. Reference pressure	Saturated

3. Vent valve stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after vent valve ON (Closed)	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction for canister

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. Vacuum introduction time	15 minutes or less
2. FTP	Saturated

5. Purge VSV stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after purge VSV ON (Open)	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3 and 4

1. EVAP pressure 1.9 sec. after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the first and second	0.7 kPa (5.25 mmHg) or less

7. Canister leak

Next sequence is run if the following condition is met:	-
Canister leak when vacuum introduction was complete	Second reference pressure or less

8. Fuel vapor-containment valve (FVCV stuck closed check)

Sequence 14 is run if all of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 kPa (-15 mmHg) or less, or 3 kPa (22.5 mmHg) or more
2. FTP change while FVCV and vent valve are open	0.5 kPa (3.75 mmHg) or more

ES

9. Vacuum introduction for fuel tank

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 to 3 kPa (-15 to 22.5 mmHg)
2. Vacuum introduction time	15 minutes or less

10. FVCV stuck closed check

Next sequence is run if the following condition is met:	
FTP change when vacuum introduction for fuel tank	0.5 kPa (3.75 mmHg)

11. FTP sensor stuck check

Next sequence is run if the following condition is met:	
FTP change when FVCV closed	0.35 kPa (2.6 mmHg) or less

12. Third reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3, and 4
1. FTP 1.9 seconds after reference pressure measurement began	-1 kPa (-7.5 mmHg) or more
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the second and third	Less than 0.7 kPa (5.25 mmHg)

13. Fuel tank leak check

Sequence is run if the following condition is met:	
FTP when vacuum introduction for fuel tank was complete	Less than third reference pressure

14. FTP sensor stuck check

Next sequence is run if the following condition is met:	-
FTP change while FVCV and vent valve are open	Less than 0.35 kPa (2.6 mmHg)

15. Atmospheric pressure measurement

Monitor is complete if the following condition is met:	0.3 kPa (2.25 mmHg) or less
Atmospheric pressure difference between sequence 1 and 8	0.3 kPa (2.25 mmHg) or less

TYPICAL MALFUNCTION THRESHOLDS

"Saturated" indicateds that the fuel tank pressure change is less than 0.1 kPa (0.75 mmHg) in 30 seconds.

P1423: Fuel tank gross leak

FTP when vacuum introduction complete	Higher than reference pressure x 0.2

P1422: Fuel tank small leak

FTP when vacuum introduction is complete	Between conditions 1 and 2
Condition 1	Higher than the second reference pressure

Condition 2	Lower than reference pressure x 0.2
Atmospheric pressure (absolute pressure)	70 kPa (525 mmHg) or more, and less than 110 kPa (825 mmHg)

MONITOR RESULT

Refer to EVAP System (See page ES-325).

INSPECTION PROCEDURE

Refer to EVAP System (See page ES-328).

DTC	P1450	Fuel Tank Pressure Sensor
DTC	P1451	Fuel Tank Pressure Sensor Range/Performance
DTC	P1452	Fuel Tank Pressure Sensor Low Input
DTC	P1453	Fuel Tank Pressure Sensor High Input

DTC SUMMARY

DTC No.	Monitoring Item	DTC Detection Condition	Trouble Area	Detection Timing	Detection Logic
P1450	Pressure sensor abnormal voltage fluctuation	Sensor output voltage rapidly fluctuates beyond upper and lower malfunction thresholds for 0.5 seconds.	• Fuel tank pressure sensor • Hybrid vehicle control ECU	• Power switch on	1-trip
P1451	Pressure sensor abnormal voltage fluctuation	Sensor output voltage fluctuates frequently in certain time period.	• Fuel tank pressure sensor • Connector / wire harness (Fuel tank pressure sensor - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (power switch off) • Engine running	2-trips
P1451	Pressure sensor constant voltage	Sensor output voltage does not vary in certain time period.	• Fuel tank pressure sensor • Connector / wire harness (Fuel tank pressure sensor - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (power switch off)	2-trips
P1452	Pressure sensor voltage low	Sensor output voltage is less than 0.45 V for 0.5 seconds.	• Fuel tank pressure sensor • Connector / wire harness (Fuel tank pressure sensor - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (power switch off) • Power switch on	1-trip
P1453	Pressure sensor voltage high	Sensor output voltage is more than 4.9 V for 0.5 seconds.	• Fuel tank pressure sensor • Connector / wire harness (Fuel tank pressure sensor - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	• EVAP monitoring (power switch off) • Power switch on	1-trip

ES

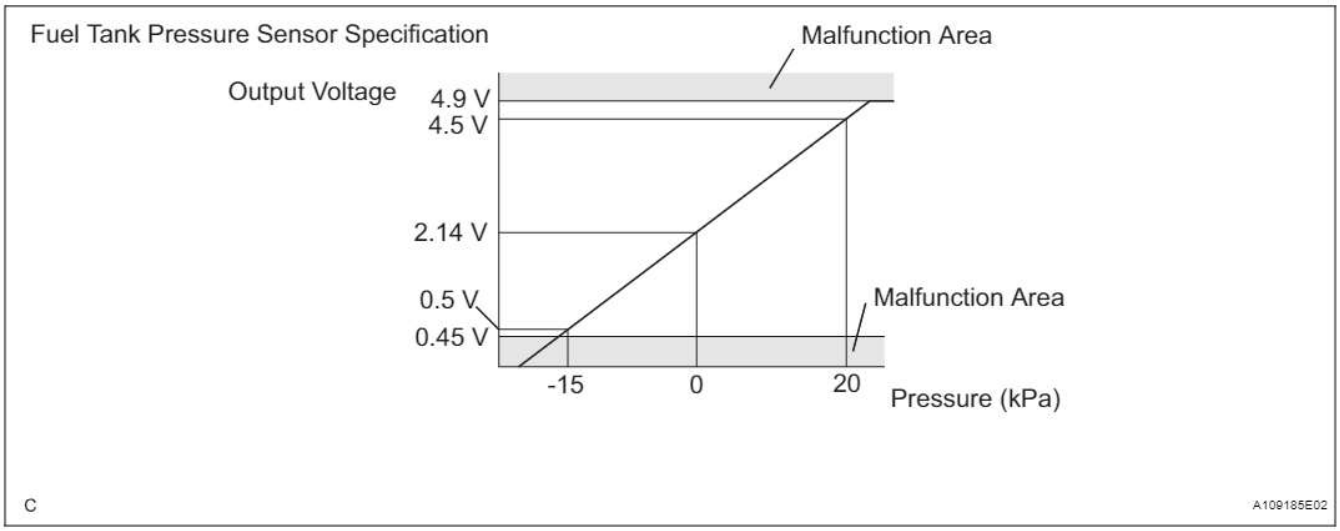
DESCRIPTION

Refer to EVAP System (See page ES-317).

ES

MONITOR DESCRIPTION

1. DTC P1451: Pressure sensor abnormal voltage fluctuation or being constant
   If the pressure sensor output voltage fluctuates rapidly for 10 seconds, the ECM (included in the hybrid vehicle control ECU) 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 output voltage does not change for 10 seconds, the ECM interprets this as the sensor voltage being constant, and stops the monitor. The ECM then illuminates the MIL and sets the DTC.
   (Both the malfunctions are detected by 2-trip detection logic).



2. DTC P1452: Pressure sensor voltage low
   If the pressure sensor output voltage is below 0.45 V, the ECM (included in the hybrid vehicle control ECU) 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).
3. DTC P1453: Pressure sensor voltage high
   If the pressure sensor voltage output is 4.9 V or more, the ECM (included in the hybrid vehicle control ECU) 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).

MONITOR STRATEGY

Required Sensors/Components	Pump module
Frequency of Operation	Once per driving cycle: P1451 sensor constant voltage Continuous: P1451 sensor abnormal voltage fluctuation, P1452 and P1453
Duration	0.5 seconds: P1452, P1453 Within 15 seconds: P1451
MIL Operation	Immediate: P1452, P1453 2 driving cycles: P1451
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

P1451: (Noise Monitor)

Atmospheric pressure	70 kPa (525 mmHg) to 110 kPa (825 mmHg)
Battery voltage	10.5 V or more
Intake air temperature	4.4 to 35°C (40 to 95°F)

EVAP pressure sensor malfunction (P1450, P1452, P1453)	Not detected
Either of the following conditions is met	A or B
A. Engine	Running
B. Soak time (power switch off time)	5 hours

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

P1451: (Stuck Monitor)

Atmospheric pressure	Less than 70 kPa (525 mmHg) or 110 kPa (825 mmHg) or more
Battery voltage	10.5 V or more
Intake air temperature	4.4 to 35°C (40 to 95°F)
EVAP pressure sensor malfunction (P1450, P1452, P1453)	Not detected
Soak time (power switch off time)	5 hours

ES

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

P1450, P1452 and P1453:

The monitor will run whenever these DTCs are not present	None
Battery voltage	8 V or more
Starter	OFF
Power switch	ON

TYPICAL MALFUNCTION THRESHOLDS

1. P1450: Fuel tank pressure sensor

Fuel tank pressure	Less than -17.187 kPa (-128.93 mmHg), or more than 23.5 kPa (176.69 mmHg)

2. P1451: Pressure sensor noise

Frequency that fuel tank pressure change is 0.3 kPa or more	10 times or more in 10 seconds

3. P1451: Pressure sensor stuck

Fuel tank pressure change during reference pressure measurement	Less than 0.35 kPa (2.63 mmHg)

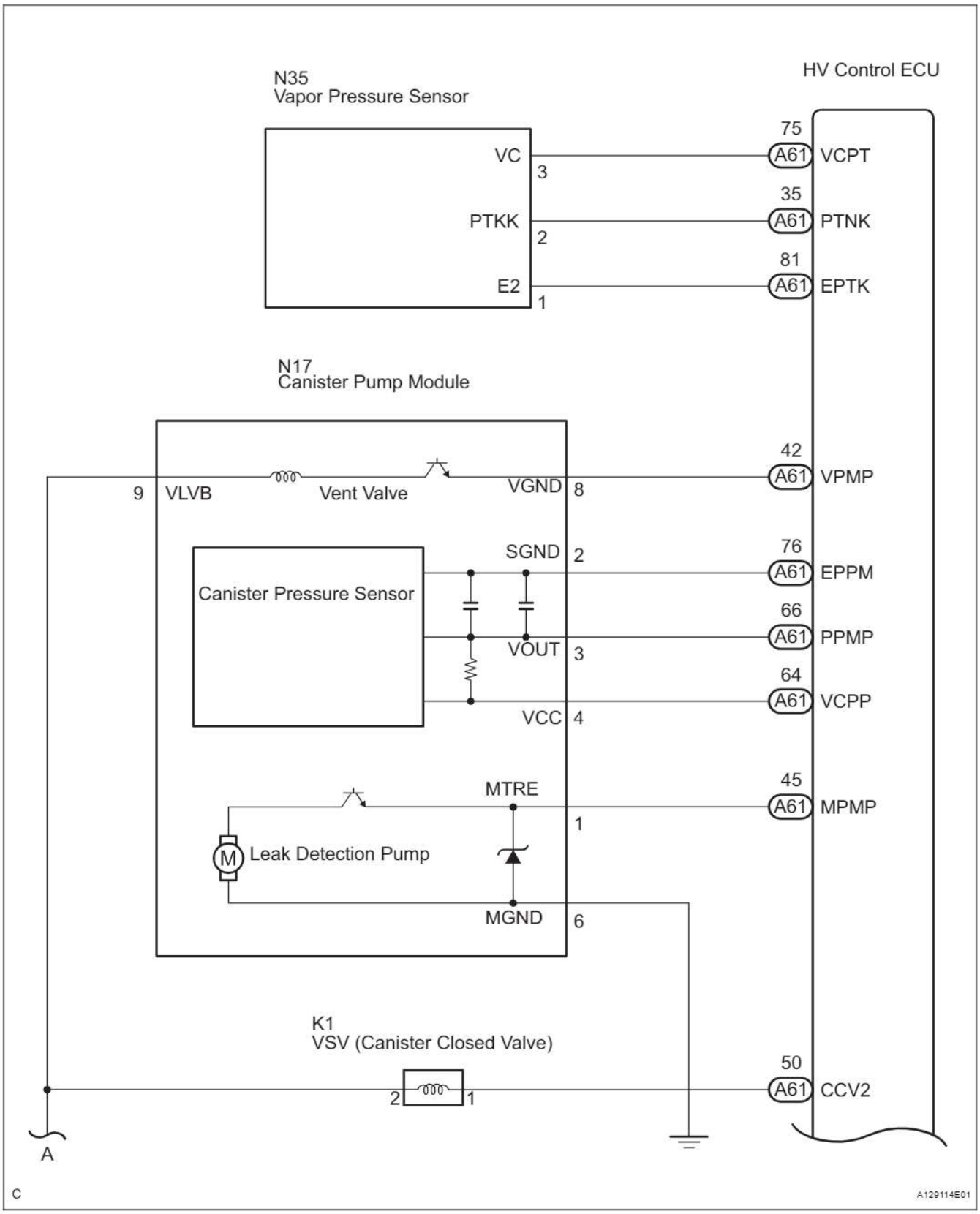
4. P1452: Pressure sensor low voltage

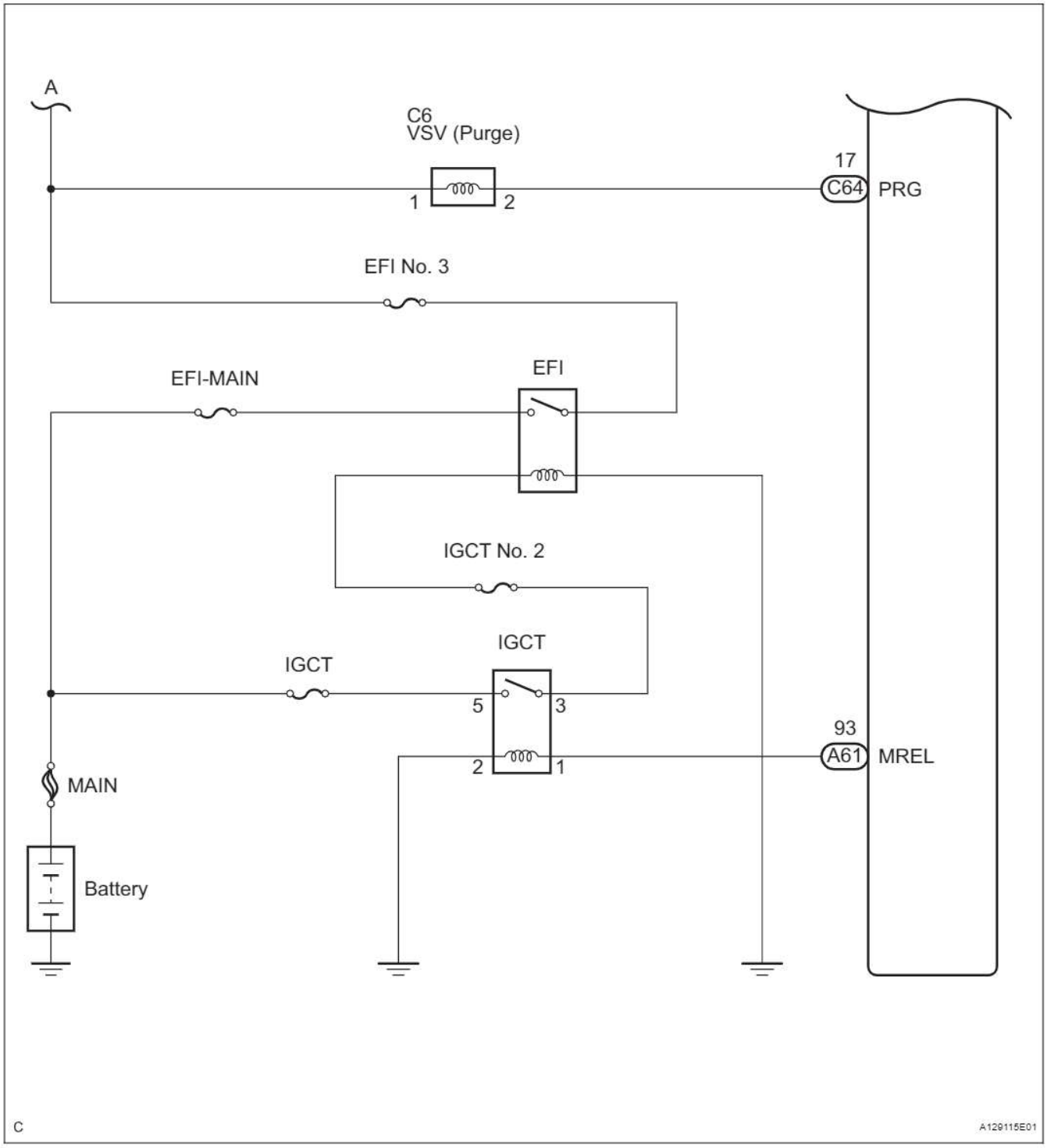
Fuel tank pressure	Less than -17.187 kPa (-128.93 mmHg)

5. P1453: Pressure sensor high voltage

Fuel tank pressure	More than 23.5 kPa (176.69 mmHg)

WIRING DIAGRAM





ES

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.**

ES

1	CONFIRM DTC AND FUEL TANK PRESSURE

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read the DTCs.
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / EVAP / VAPOR PRESS TANK.
(g) Read the EVAP (Evaporative Emission) pressure displayed on the tester.

Result

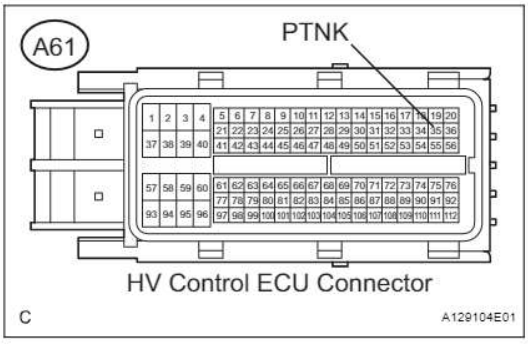
Display (DTC Output)	Test Result	Suspected Trouble Area	Proceed to
P1451	-	• Pressure sensor	C
P1450 and/or P1452	Less than -17.187 kPa (-128.93 mmHg)	• Wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor) • Pressure sensor • Short in ECM (included in hybrid vehicle control ECU) circuit	A
P1450 and/or P1453	More than 23.5 kPa (176.69 mmHg)	• Wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor) • Pressure sensor • Open in ECM (included in hybrid vehicle control ECU) circuit	B

B → Go to step 4

C → GO TO EVAP INSPECTION PROCEDURE

A

2	CHECK HARNESS AND CONNECTOR (FUEL TANK PRESSURE SENSOR - HV CONTROL ECU)



(a) Turn the power switch off.
(b) Disconnect the A61 hybrid vehicle control ECU connector.
(c) Measure the resistance between the PTNK terminal of the hybrid vehicle control ECU connector and body ground.

Result

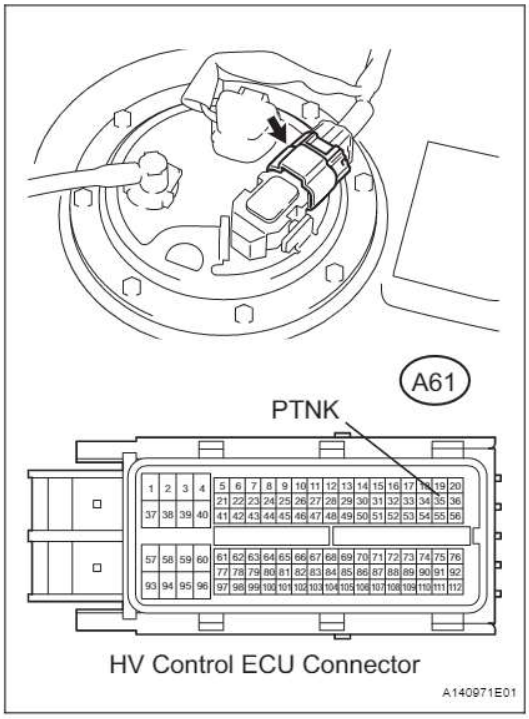
Test Result	Suspected Trouble Area	Proceed to
10 Ω or less	• Wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor) • Short in pressure sensor circuit	A
10 kΩ or more	• Wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor) • Short in ECM (included in hybrid vehicle control ECU) circuit	B

(d) Reconnect the hybrid vehicle control ECU connector.

B	Go to step 7

A

3	CHECK HARNESS AND CONNECTOR (VAPOR PRESSURE SENSOR - HV CONTROL ECU)



(a) Remove the fuel tank assembly.
(b) Disconnect the N35 vapor pressure sensor connector.
(c) Disconnect the A61 hybrid vehicle control ECU connector.
(d) Measure the resistance between the PTNK terminal of the hybrid vehicle control ECU connector and body ground.

ES

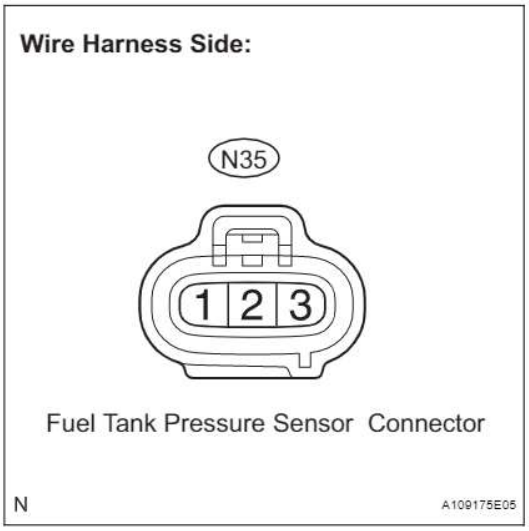
Result

Test Result	Suspected Trouble Area	Proceed to
10 kΩ or more	Short in pressure sensor circuit	A
10 Ω or less	Short in wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor)	B

(e) Reconnect the pressure sensor connector.
(f) Reconnect the hybrid vehicle control ECU connector.

A	Go to step 5
B	Go to step 6

4	CHECK HARNESS AND CONNECTOR (VAPOR PRESSURE SENSOR - HV CONTROL ECU)



(a) Remove the fuel tank assembly.
(b) Disconnect the N35 vapor pressure sensor connector.
(c) Turn the power switch on (IG).
(d) Measure the voltage and resistance according to the value(s) in the table below.

Standard

Tester Connection	Specified Condition
N35-3 - Body ground	4.5 to 5.0 V
N35-2 - Body ground	100 Ω or less

Result

Test Result	Suspected Trouble Area	Proceed to
Voltage and resistance within standard ranges	Open in pressure sensor circuit	A
Voltage and resistance outside standard ranges	Open in wire harness/connector (Hybrid Vehicle Control ECU - pressure sensor)	B

(e) Reconnect the canister connector.

B → Go to step 6

A

5	REPLACE FUEL TANK PRESSURE SENSOR

NEXT → Go to step 8

6	REPAIR OR REPLACE HARNESS AND CONNECTOR

HINT:
If the exhaust tail pipe has been removed, go to the next step before reinstalling it.

NEXT → Go to step 8

7	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT → Go to step 8

8	CHECK WHETHER DTC OUTPUT RECURS (AFTER REPAIR)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Wait for at least 60 seconds.
(d) Enter the following menus: 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

ES

COMPLETED

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 (included in hybrid vehicle control ECU) 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.

ES

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 80% or more (b) Throttle actuator current 0.5 A or less	• Open in throttle actuator circuit • Throttle actuator • Hybrid vehicle control ECU
P2103	Either of following conditions met (1-trip detection logic): • Hybrid IC diagnosis signal failure • Hybrid IC current limiter port failure	• Short in throttle actuator circuit • Throttle actuator • Throttle valve • Throttle body assembly • Hybrid vehicle control ECU

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 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 up 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	2 seconds: P2102 0.1 seconds or 0.6 seconds: P2103
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None

P2102:

Throttle actuator	Activated

Duty-cycle ratio to open throttle actuator	80% or more
Throttle actuator power supply	8 V or more

P2103:

Throttle actuator	Activated
Throttle actuator power supply	8 V or more
Battery voltage	8 V or more
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

P2102:

Throttle actuator current	Less than 0.5 A

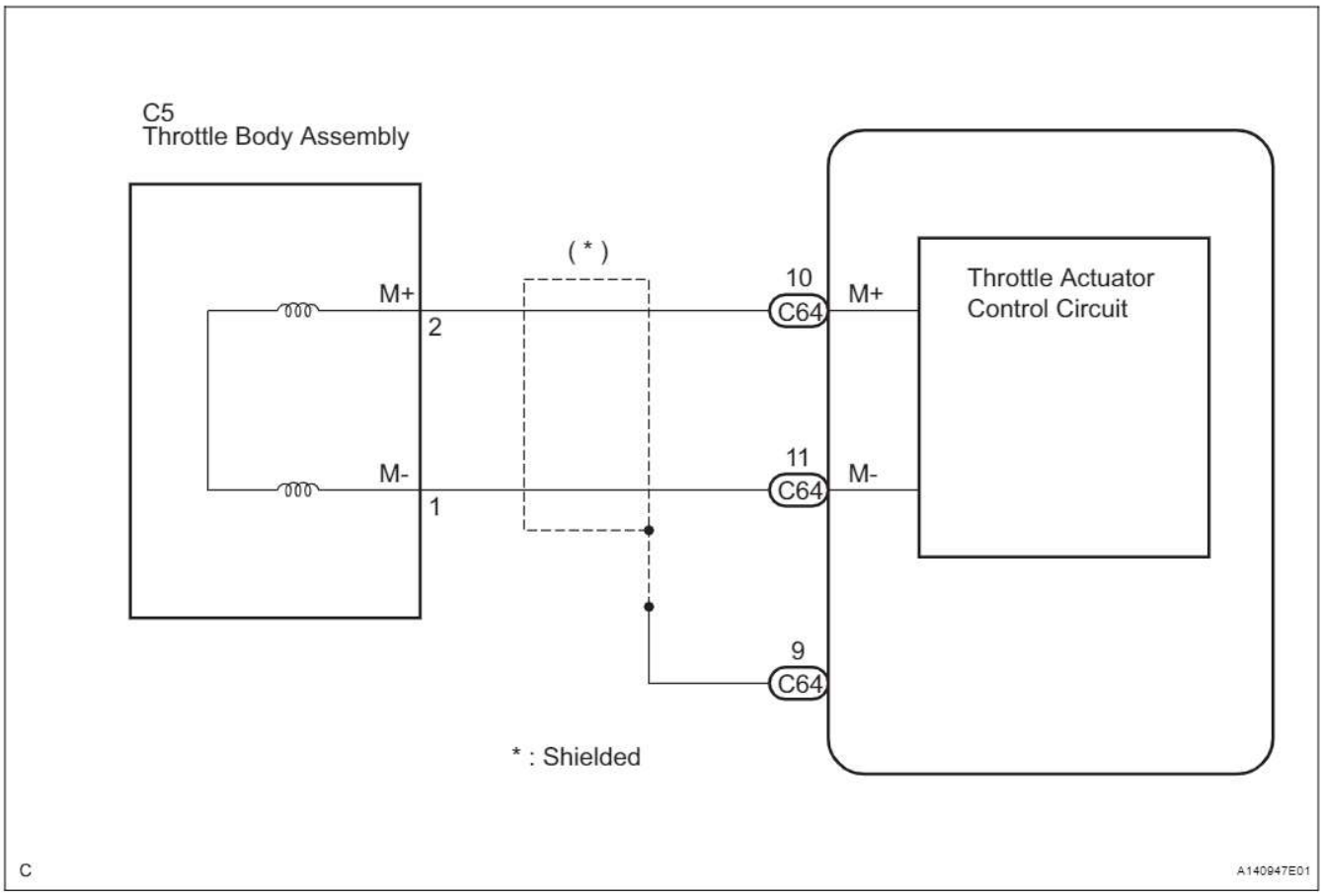
P2103:

Hybrid IC current limiter port	Fail

FAIL-SAFE

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

WIRING DIAGRAM



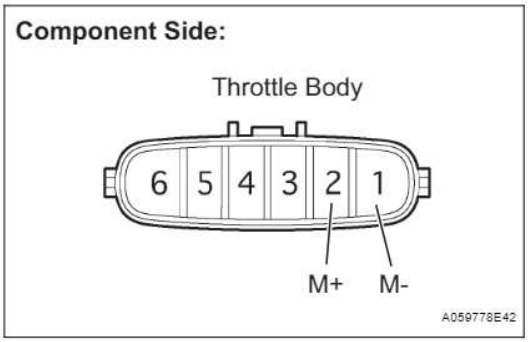
INSPECTION PROCEDURE

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.
- The throttle actuator current (THROTTLE MOT) and the throttle actuator duty ratio (THROTL OPN DUTY / THROTL CLS DUTY) can be read using the intelligent tester. However, the ECM shuts off the throttle actuator current when the ETCS malfunctions.

1	INSPECT THROTTLE BODY (RESISTANCE OF THROTTLE ACTUATOR)

Component Side:



(a) Disconnect the C5 throttle body connector.
(b) Measure the resistance of the throttle actuator.

Standard resistance

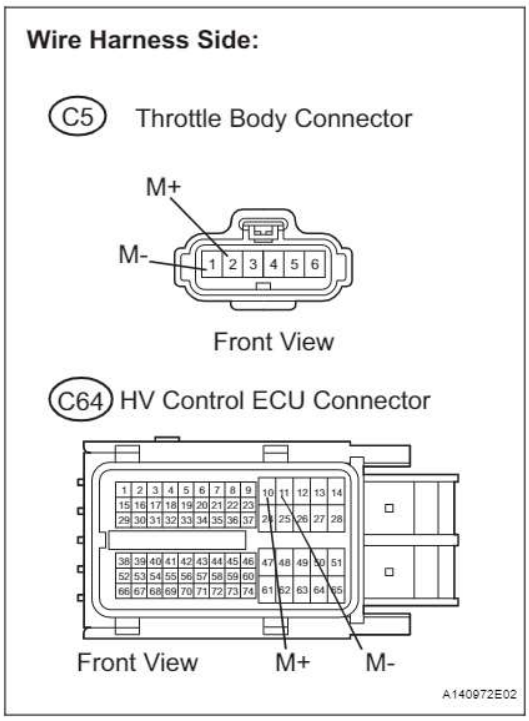
Tester Connections	Specified Conditions
2 (M+) - 1 (M-)	0.3 to 100 Ω at 20°C (68°F)

(c) Reconnect the throttle body connector.

NG → REPLACE THROTTLE BODY ASSEMBLY

OK

2	CHECK HARNESS AND CONNECTOR (THROTTLE ACTUATOR - HV CONTROL ECU)



(a) Disconnect the C5 throttle body connector.
(b) Disconnect the C64 hybrid vehicle control ECU connector.
(c) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
C5-2 (M+) - C64-10 (M+)	Below 1 Ω
C5-1 (M-) - C64-11 (M-)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C5-2 (M+) or C64-10 (M+) - Body ground	10 kΩ or higher
C5-1 (M-) or C64-11 (M-) - Body ground	10 kΩ or higher

(d) Reconnect the throttle body connector.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3	INSPECT THROTTLE BODY ASSEMBLY

(a) Check for foreign objects between the throttle valve and the housing.

OK:

No foreign objects between throttle valve and housing.

NG → REMOVE FOREIGN OBJECT AND CLEAN THROTTLE BODY

OK

4	INSPECT THROTTLE VALVE

(a) Check if the throttle valve opens and closes smoothly.

OK:

Throttle valve opens and closes smoothly.

NG → REPLACE THROTTLE BODY ASSEMBLY

OK

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	P2111	Throttle Actuator Control System - Stuck Open

DTC	P2112	Throttle Actuator Control System - Stuck Closed

SYSTEM DESCRIPTION

The throttle actuator is operated by the ECM (included in hybrid vehicle control ECU), 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 in order that it can control the throttle actuator, and therefore the throttle valve, appropriately in response to driver inputs.

ES

HINT:

This ETCS (Electronic Throttle Control System) does not use a throttle cable.

DTC No.	DTC Detection Condition	Trouble Area
P2111	ECM (included in hybrid vehicle control ECU) 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 (included in hybrid vehicle control ECU) determines that there is a malfunction in the ETCS when the throttle valve remains at a 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:

Monitor runs whenever following DTCs not present	None

P2111 (Throttle actuator stuck open):

All of following conditions met	-
System guard*	ON
Throttle actuator current	2 A or more
Duty cycle to close throttle	80% or more

P2112 (Throttle actuator stuck closed):

All of following conditions met	-
System guard*	ON

Throttle actuator current	2 A or more
Duty cycle to open throttle	80% or more

TYPICAL MALFUNCTION THRESHOLDS

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 (included in hybrid vehicle control ECU) enters fail-safe mode. During fail-safe mode, the ECM cuts the current to the throttle actuator off, and the throttle valve is returned to a 6° throttle angle by the return spring. The ECM then adjusts the engine output by controlling the fuel injection (intermittent fuel-cut) and ignition timing, in accordance with the accelerator pedal opening angle, to allow the vehicle to continue at a minimal speed. If the accelerator pedal is depressed gently, the vehicle can be driven slowly.
Fail-safe mode continues until a pass condition is detected, and the power switch is then turned off.

ES

WIRING DIAGRAM

Refer to DTC P2102 (See page ES-254).

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data, from the time the malfunction occurred.

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2111 or P2112)

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

Result

Display (DTC Output)	Proceed to
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 BODY (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 BODY ASSEMBLY

OK

ES

3	CHECK WHETHER DTC OUTPUT RECURS (DTC P2111 OR P2112)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-34).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Put the engine in inspection mode (See page ES-35).
(f) Fully depress and release the accelerator pedal quickly (to fully open and close the throttle valve).
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES
(h) Read the DTCs.

Result

Display (DTC Output)	Proceed to
No DTC	A
P2111 or P2112	B

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

CHECK FOR INTERMITTENT PROBLEMS

DTC	P2118	Throttle Actuator Control Motor Current Range / Performance

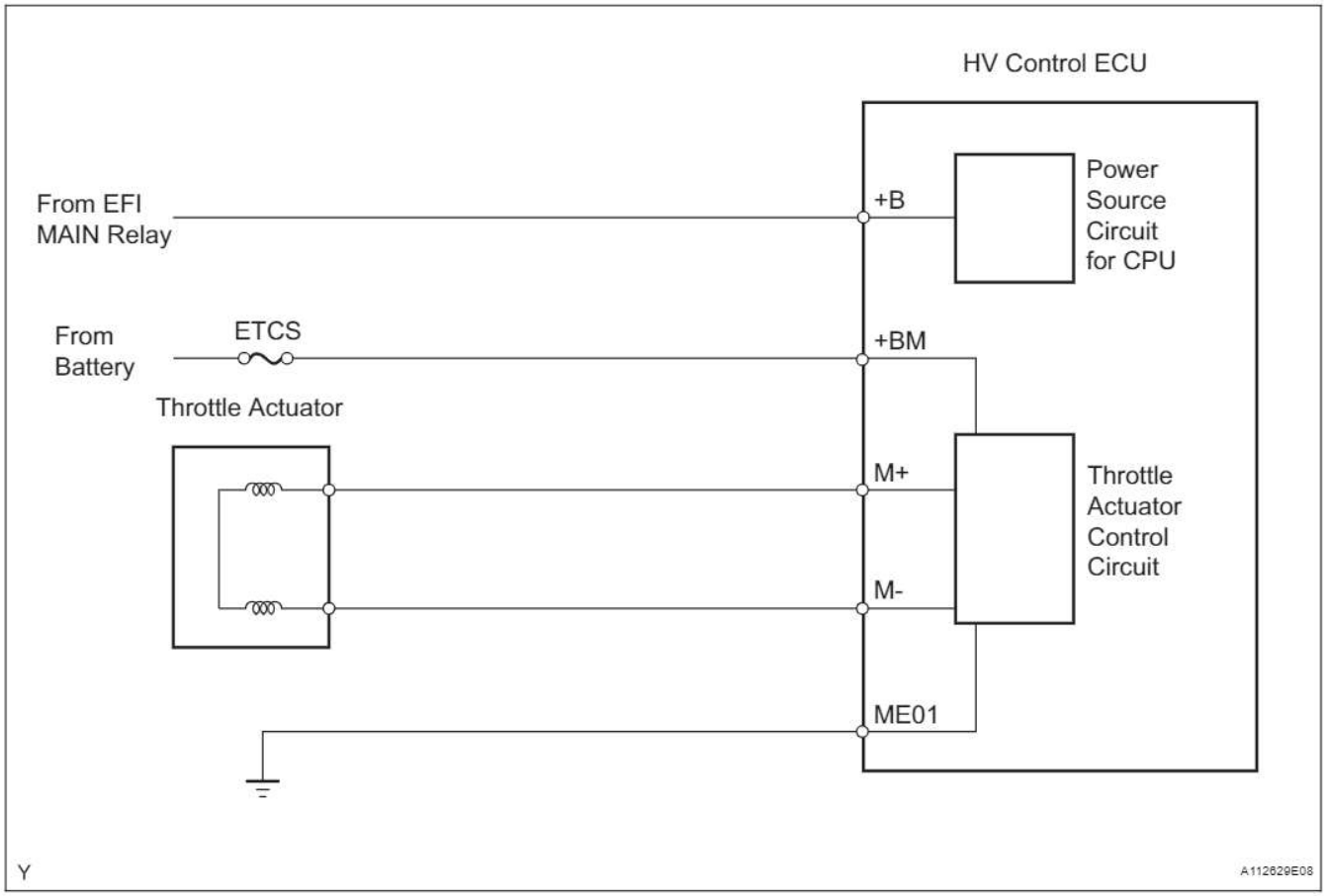
DESCRIPTION

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 (included in hybrid vehicle control ECU) 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 power 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.

ES



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 • Battery • Battery terminals • ETCS fuse • Hybrid vehicle control ECU

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

ES

Monitor runs whenever following DTCs not present	None
Battery voltage	8 V or more
Electronic throttle actuator power	ON

TYPICAL MALFUNCTION THRESHOLDS

Throttle actuator power supply voltage (+BM)	Less than 4 V

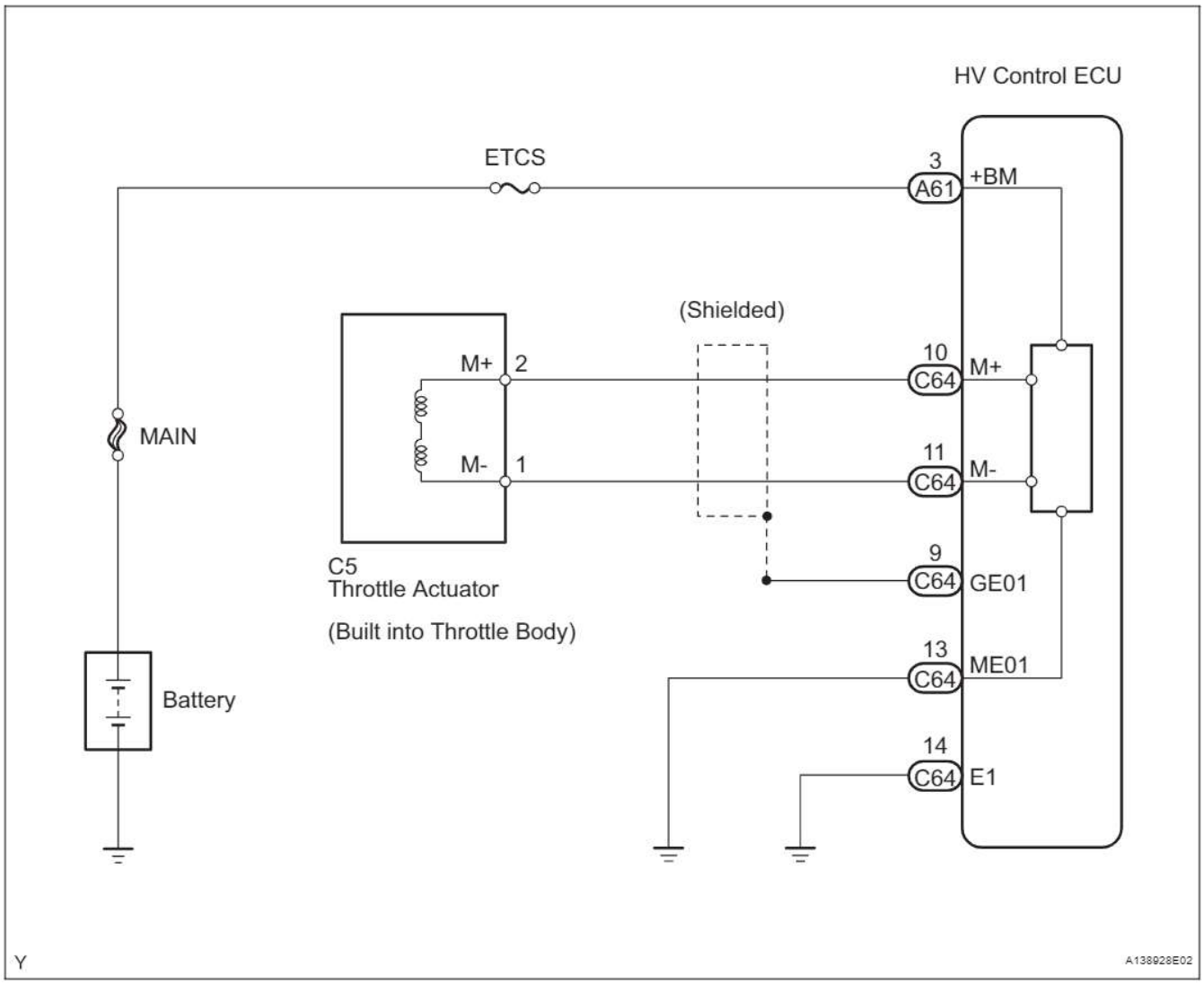
COMPONENT OPERATING RANGE

Throttle actuator power supply voltage (+BM)	9 to 14 V

FAIL-SAFE

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

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	READ VALUE USING INTELLIGENT TESTER (+BM VOLTAGE)

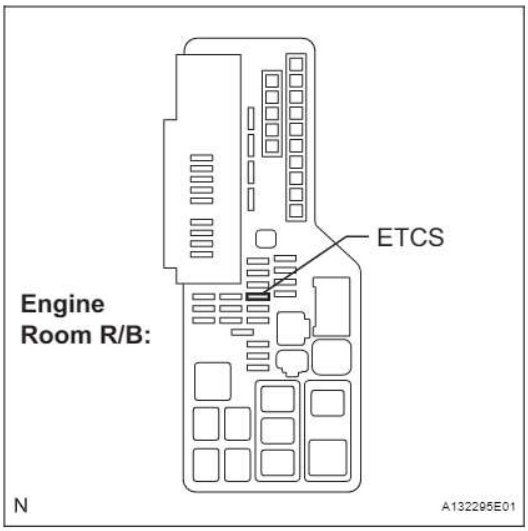
(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / +BM VOLTAGE.
(e) Read the value displayed on the tester.

Standard voltage:
9 to 14 V

OK → Go to step 5

NG

2	CHECK FUSE (ETCS FUSE)

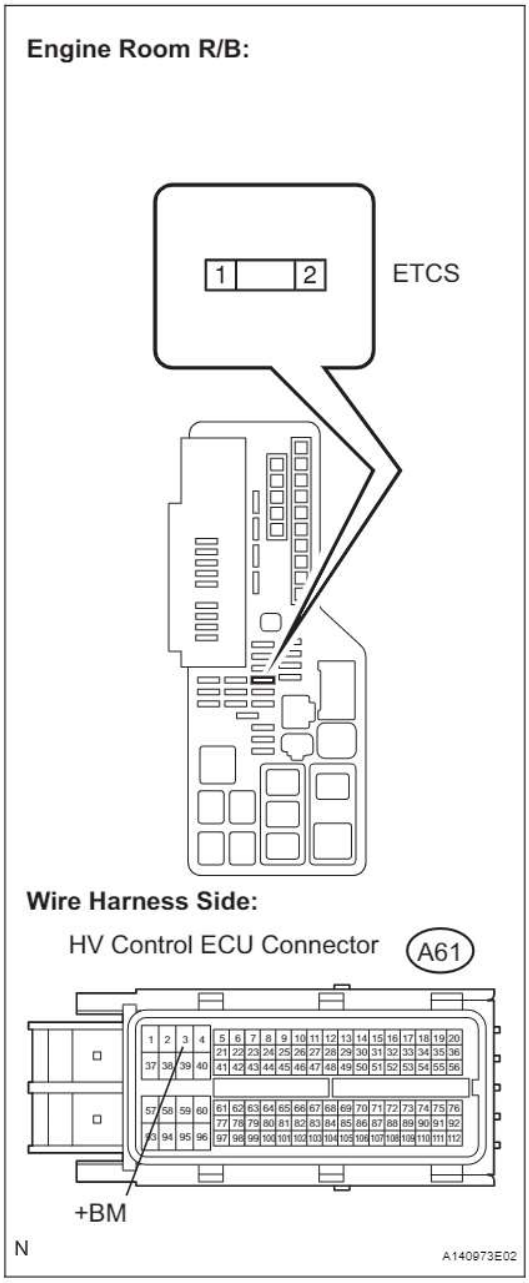


(a) Remove the ETCS fuse from the engine room R/B and J/B.
(b) Measure the ETCS fuse resistance.
Standard resistance:
Below 1 Ω
(c) Reinstall the ETCS fuse.

NG → **CHECK FOR SHORTS IN ALL HARNESSES AND CONNECTORS CONNECTED TO FUSE AND REPLACE FUSE**

OK

3	CHECK HARNESS AND CONNECTOR (HV CONTROL ECU - ETCS FUSE, ETCS FUSE - BATTERY)



(a) Check the harness and connector between the ETCS fuse and hybrid vehicle control ECU.
(1) Remove the ETCS fuse from the engine room relay block.
(2) Disconnect the A61 hybrid vehicle control ECU connector.
(3) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
2 (ETCS fuse) - A61-3 (+BM)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
2 (ETCS fuse) or A61-3 (+BM) - Body ground	10 kΩ or higher

(4) Reinstall the ETCS fuse.
(5) Reconnect the hybrid vehicle control ECU connector.

(b) Check the harness and connector between the ETCS fuse and positive battery cable.
(1) Remove the ETCS fuse from the engine room relay block.
(2) Disconnect the cable from the positive (+) battery terminal.
(3) Measure the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
Positive battery cable - 1 (ETCS fuse)	Below 1 Ω

Standard resistance (Check for short)

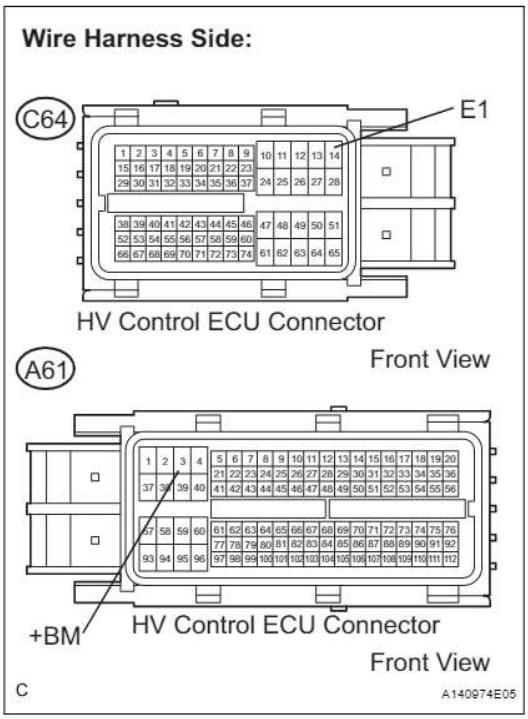
Tester Connections	Specified Conditions
Positive battery cable or 1 (ETCS fuse) - Body ground	10 kΩ or higher

(4) Reinstall the ETCS fuse.
(5) Reconnect the cable to the positive (+) battery terminal.

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

OK

4	INSPECT HYBRID VEHICLE CONTROL ECU (+BM VOLTAGE)



(a) Disconnect the A61 and C64 hybrid vehicle control ECU connectors.

(b) Measure the voltage between the terminals of the A61 and C64 hybrid vehicle control ECU connectors.

Standard voltage

Tester Connections	Specified Conditions
A61-3 (+BM) - C64-14 (E1)	9 to 14 V

(c) Reconnect the hybrid vehicle control ECU connectors.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR (TERMINAL E1 - BODY GROUND)**

OK

REPLACE HYBRID VEHICLE CONTROL ECU

5	INSPECT BATTERY

(a) Check that the battery is not depleted.

OK:

Battery is not depleted

NG → **REPLACE BATTERY**

OK

6	CHECK BATTERY TERMINAL

(a) Check that the battery terminals and hybrid vehicle control ECU ground are not loose or corroded.

OK:

Battery terminals and hybrid vehicle control ECU ground are not loose or corroded

NG → **REPAIR OR REPLACE BATTERY TERMINAL**

OK

CHECK FOR INTERMITTENT PROBLEMS

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 (included in hybrid vehicle control ECU). 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 • Hybrid vehicle control ECU

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	Within 1 second
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None

TYPICAL MALFUNCTION THRESHOLDS

Either of following conditions A or B met	-
A. Difference between commanded closed throttle position and current closed throttle position	0.3 V or more for 1 second
B. Difference between commanded open throttle position and current open throttle position	0.3 V or more for 0.6 seconds

FAIL-SAFE

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

Fail-safe mode continues until a pass condition is detected, and the power switch is then turned off.

WIRING DIAGRAM

Refer to DTC P2102 (See page ES-254).

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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

ES

1	CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2119)

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

Result

Display (DTC Output)	Proceed to
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.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Allow the engine to idle for 15 seconds.
CAUTION:
Exercise extreme care and take precautions in steps (f) and (g) below. 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.
(g) While depressing the brake pedal securely, fully depress the accelerator pedal for 5 seconds.
(h) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

HINT:
The output voltage of the throttle position sensor can be checked during step (g) using the intelligent tester. Variations in the output voltage indicate that the throttle actuator is in operation. To check the output voltage using the intelligent tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ETCS / THROTTLE POS #1.
OK:
No DTC output.

(i) Read the DTCs.

NG → **REPLACE THROTTLE BODY ASSEMBLY**

ES

OK

CHECK FOR INTERMITTENT PROBLEMS

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)

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.

ES

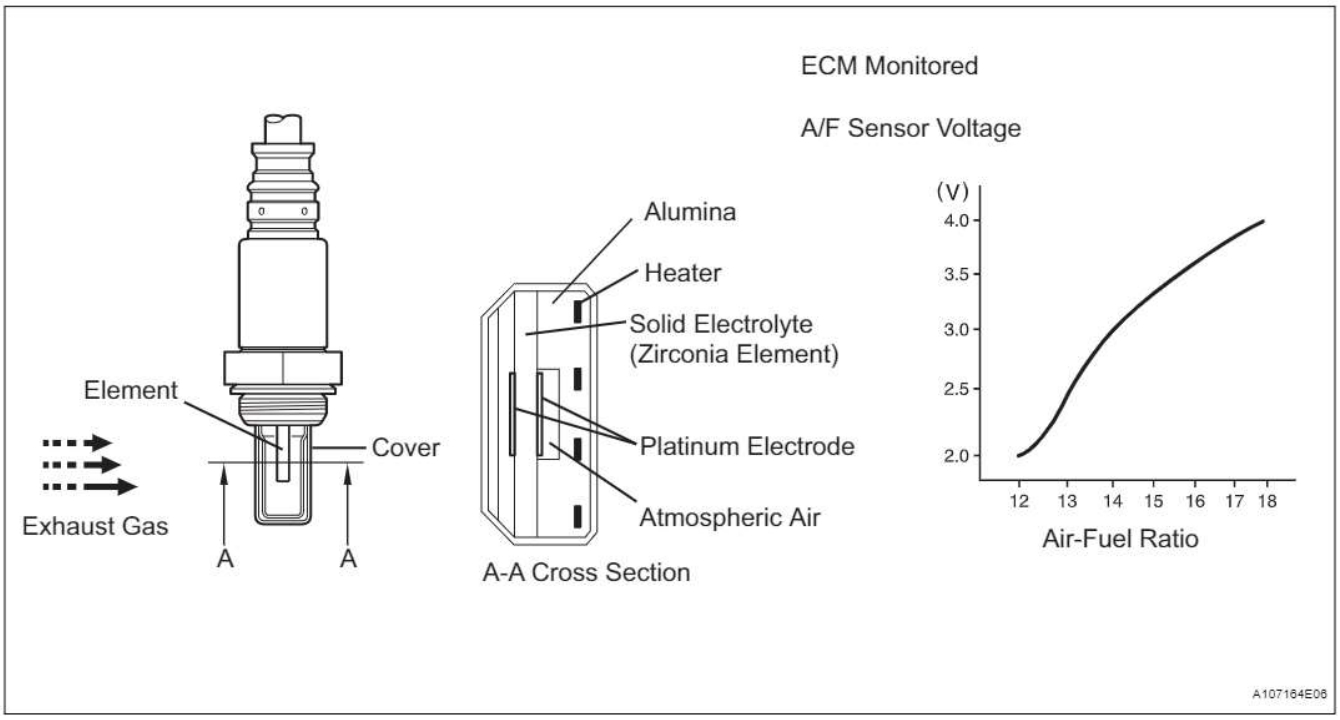
DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air-fuel ratio. This sensor voltage is used to provide the ECM (included in hybrid vehicle control ECU) 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 of 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 air-fuel ratio detection. In addition, the sensor and heater portions are narrower than the conventional type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

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

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted into 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	Conditions (a) and (b) continue for 10 seconds or more (2-trip detection logic): (a) A/F sensor voltage more than 3.8 V (b) Heated Oxygen (HO2) sensor voltage 0.15 V or more	• Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU
	While fuel-cut operation performed (during vehicle deceleration), A/F sensor current 3.6 mA or more for 3 seconds (2-trip detection logic)	• A/F sensor • Hybrid vehicle control ECU
P2196	Conditions (a) and (b) continue for 10 seconds or more (2-trip detection logic): (a) A/F sensor voltage less than 2.8 V for 10 seconds (b) HO2 sensor voltage less than 0.6 V	• Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU
	While fuel-cut operation performed (during vehicle deceleration), A/F sensor current less than 1.0 mA for 3 seconds (2-trip detection logic)	• A/F sensor • Hybrid vehicle control ECU

ES

HINT:

- When either of these DTCs is set, check the A/F sensor output voltage by selecting the following menu items on the intelligent tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / AFS B1 S1.
- Short-term fuel trim values can also be read using the intelligent tester.
- The ECM regulates the voltages at the A1A+ and A1A- terminals of the ECM to a constant level. Therefore, the A/F sensor output voltage cannot be confirmed without using the intelligent tester.
- If the A/F sensor is malfunctioning, the ECM sets DTC P2195 or P2196.

MONITOR DESCRIPTION

Sensor voltage detection monitor

Under the air-fuel ratio feedback control, if the A/F sensor output voltage 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:

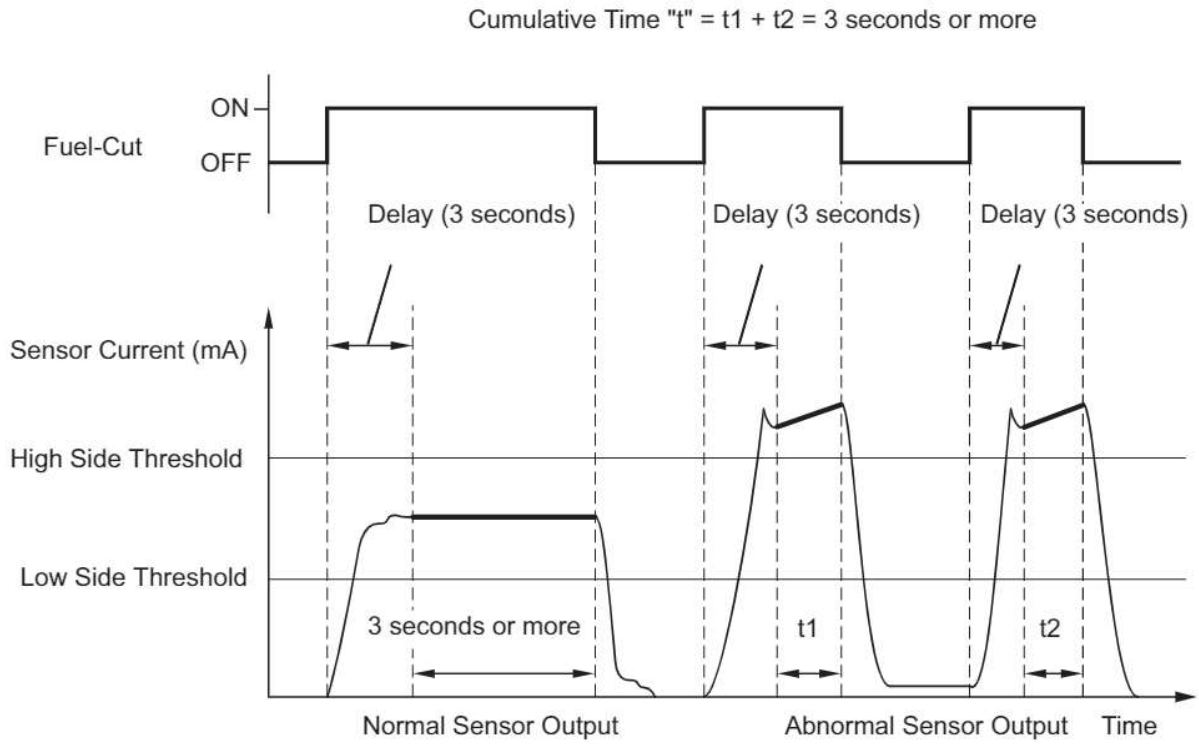
If the A/F sensor output voltage is less than 2.8 V (very rich condition) for 10 seconds, despite the rear HO2 sensor output voltage being less than 0.6 V, the ECM sets DTC P2196. Alternatively, if the A/F sensor output voltage is more than 3.8 V (very lean condition) for 10 seconds, despite the rear HO2 sensor output voltage 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 less than 1.0 mA for more than 3 seconds of cumulative time, the ECM sets DTC P2196 (low-side stuck).

A/F Sensor Current Monitor:



MONITOR STRATEGY

Related DTCs	P2195: A/F sensor signal stuck lean P2196: A/F sensor signal stuck rich
Required Sensors/Components (Main)	A/F sensor
Required Sensors/Components (Related)	HO2 sensor
Frequency of Operation	Continuous
Duration	10 seconds: Sensor voltage detection monitor 3 seconds: Sensor current detection monitor
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	P0031, P0032 (A/F sensor heater - Sensor 1) P0037, P0038 (O2 sensor heater - Sensor 2) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0136 (O2 Sensor - Sensor 2) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0455, P0456 (EVAP system) P0500 (VSS)

Sensor voltage detection monitor (Lean side malfunction P2195):

Duration while all of following conditions 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):

Duration while all of following conditions 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

ES

Sensor current detection monitor P2195 and P2196:

Battery voltage	11 V or more
Atmospheric pressure	76 kPa (570 mmHg) or more
A/F sensor status	Activated
Continuous time of fuel cut	3 to 10 seconds
ECT	75°C (167°F) or more

TYPICAL MALFUNCTION THRESHOLDS

Sensor voltage detection monitor (Lean side malfunction P2195):

A/F sensor voltage	More than 3.8 V for 10 seconds

Sensor voltage detection monitor (Rich side malfunction P2196):

A/F sensor voltage	Less than 2.8 V for 10 seconds

Sensor current detection monitor (High side malfunction P2195):

A/F sensor current during fuel cut	3.6 mA or more

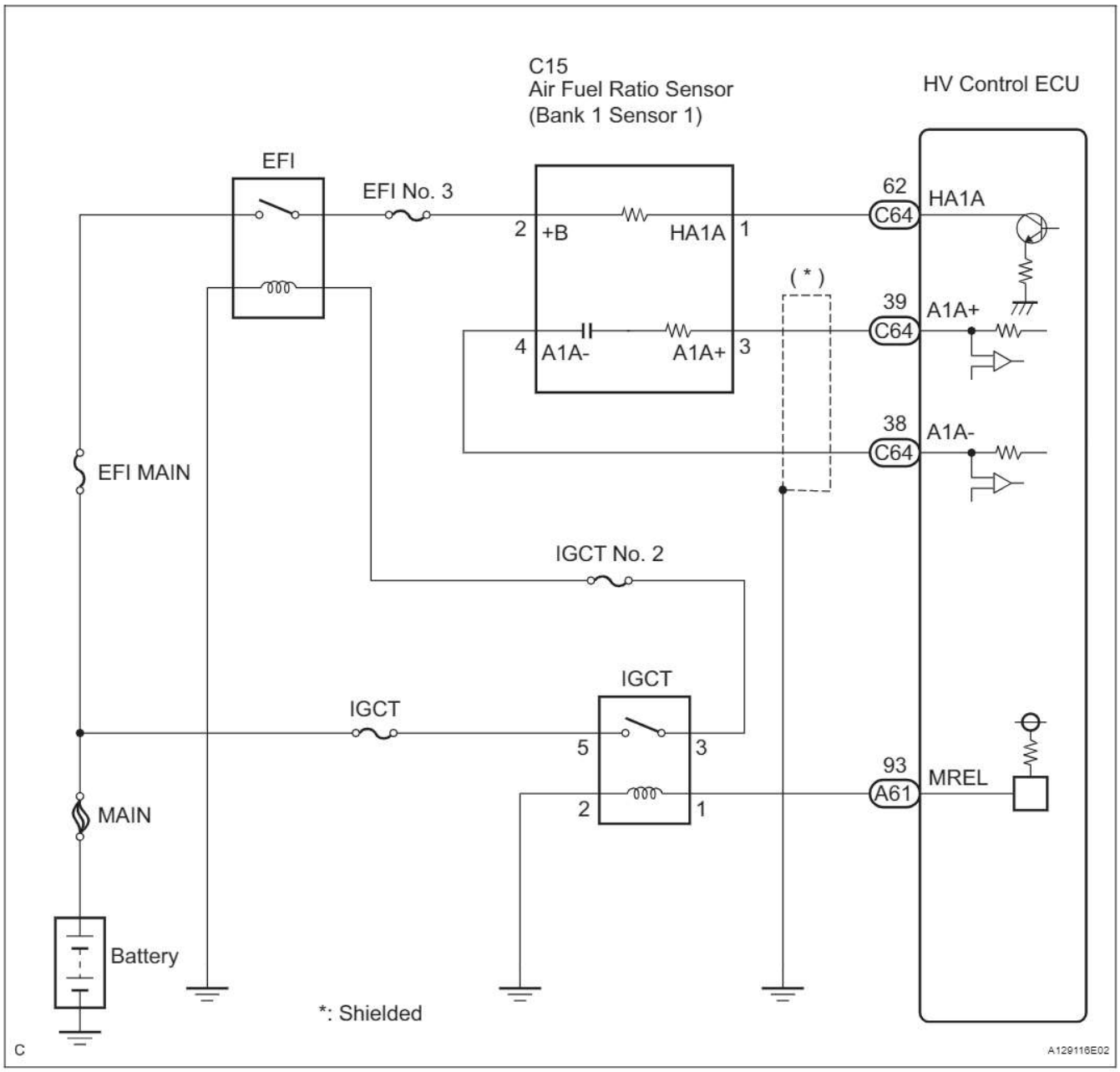
Sensor current detection monitor (Rich side malfunction P2196):

A/F sensor current during fuel cut	Less than 1 mA

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-14).

WIRING DIAGRAM

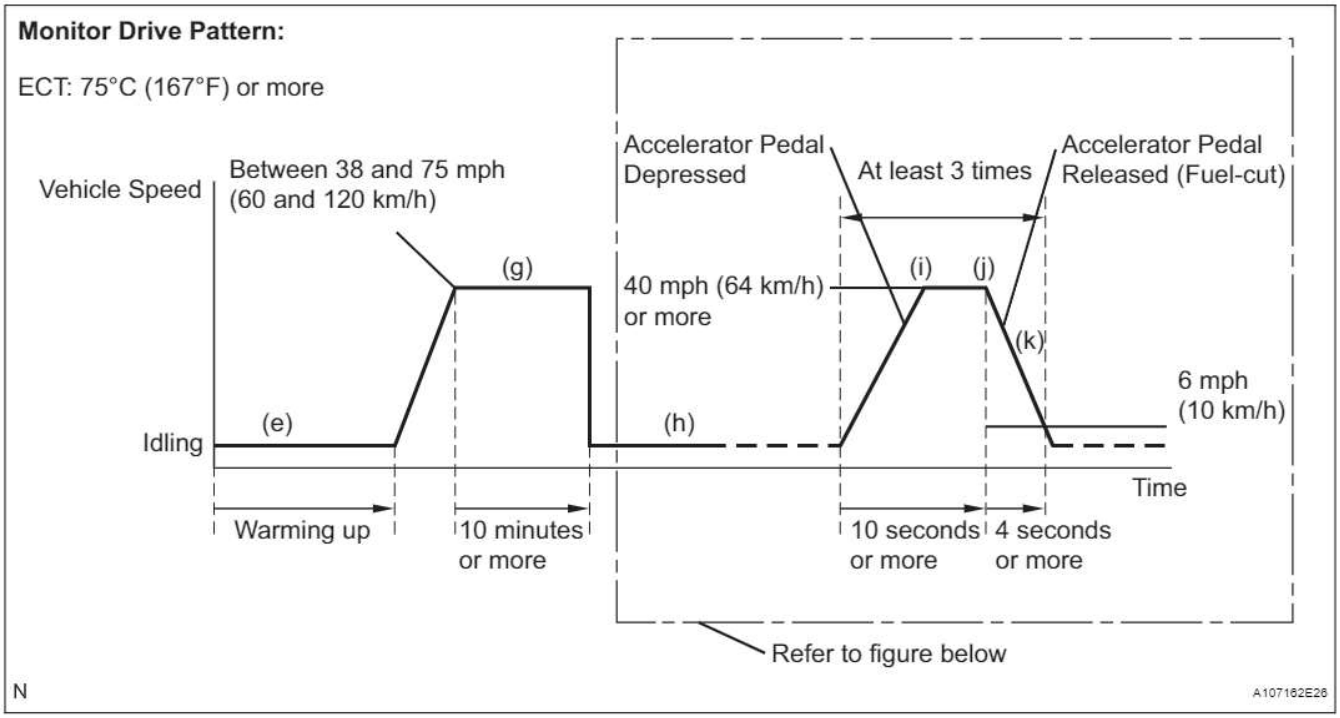


ES

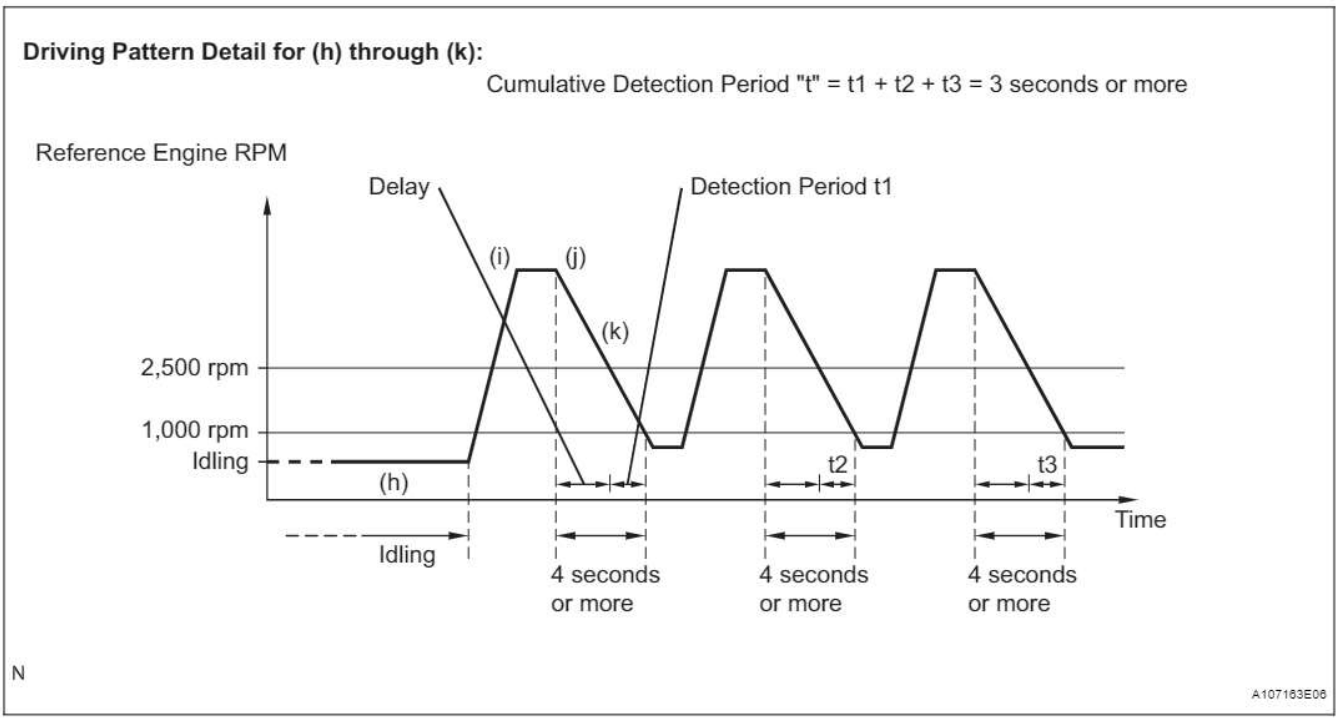
CONFIRMATION DRIVING PATTERN

This confirmation driving pattern is used in the "PERFORM CONFIRMATION DRIVING PATTERN" procedure of the following diagnostic troubleshooting procedure.

Monitor Drive Pattern:



Driving Pattern Detail for (h) through (k):



(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (See page ES-31).
(e) Put the engine in inspection mode (See page ES-35), warm it up until the ECT reaches 75°C (167°F) or higher.
(f) On the intelligent tester, select the following menu items to check the fuel-cut status: DIAGNOSIS / ENHANCED OBD II / DATA LIST / USER DATA / FC IDL.
(g) Drive the vehicle at between 38 mph (60 km/h) and 75 mph (120 km/h) for at least 10 minutes.
(h) Change the transmission to the 2nd gear.

(i) Drive the vehicle at a proper vehicle speed to perform fuel-cut operation.
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 resumes at 1,000 rpm).

(j) Accelerate the vehicle to 40 mph (64 km/h) or more by depressing the accelerator pedal for at least 10 seconds.
(k) Soon after performing step (j) above, release the accelerator pedal for at least 4 seconds without depressing the brake pedal, in order to execute fuel-cut control.
(l) Allow the vehicle to decelerate until the vehicle speed declines to less than 6 mph (10 km/h).
(m) Repeat steps from (h) through (k) above at least 3 times in one driving cycle.
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.

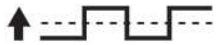
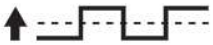
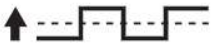
INSPECTION PROCEDURE

HINT:
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) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(f) Perform the A/F CONTROL operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(g) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2) 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%.
- The sensors react in accordance with increases and decreases in the fuel injection volume.

Standard

Tester Display (Sensor)	Injection Volume	Status	Voltages
AFS B1 S1 (A/F)	+25%	Rich	Less than 3.0
	-12.5%	Lean	More than 3.35
O2S B1 S2 (HO2)	+25%	Rich	More than 0.5
	-12.5%	Lean	Less than 0.4

NOTICE:
The A/F sensor has an output delay of a few seconds and the HO2 sensor (sensor 2) output has a maximum output delay of approximately of 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Areas
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.5 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.5 V Less than 0.4 V		
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage Almost no reaction		
4	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1 S1 and O2S B1 S2, and press the YES button and then the ENTER button followed by the F4 button.
HINT:

- DTC P2A00 may be set when the air-fuel ratio is stuck rich or 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.
- 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 OR P2196)

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

Result

Display (DTC Output)	Proceed to
P2195 or P2196	A
P2195 or P2196 and other DTCs	B

HINT:
If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → GO TO DTC CHART

A

ES

2 READ VALUE USING INTELLIGENT TESTER (TEST VALUE OF A/F SENSOR)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Drive the vehicle in accordance with the drive pattern described in CONFIRMATION DRIVING PATTERN.
(e) Select the following menu items: 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 B1 S1; 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 (1.0 mA or more, and less than 3.6 mA)	A
Outside normal range (Less than 1.0 mA, or 3.6 mA or more)	B

B → Go to step 12

A

3 READ VALUE USING INTELLIGENT TESTER (OUTPUT VOLTAGE OF A/F SENSOR)

(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.

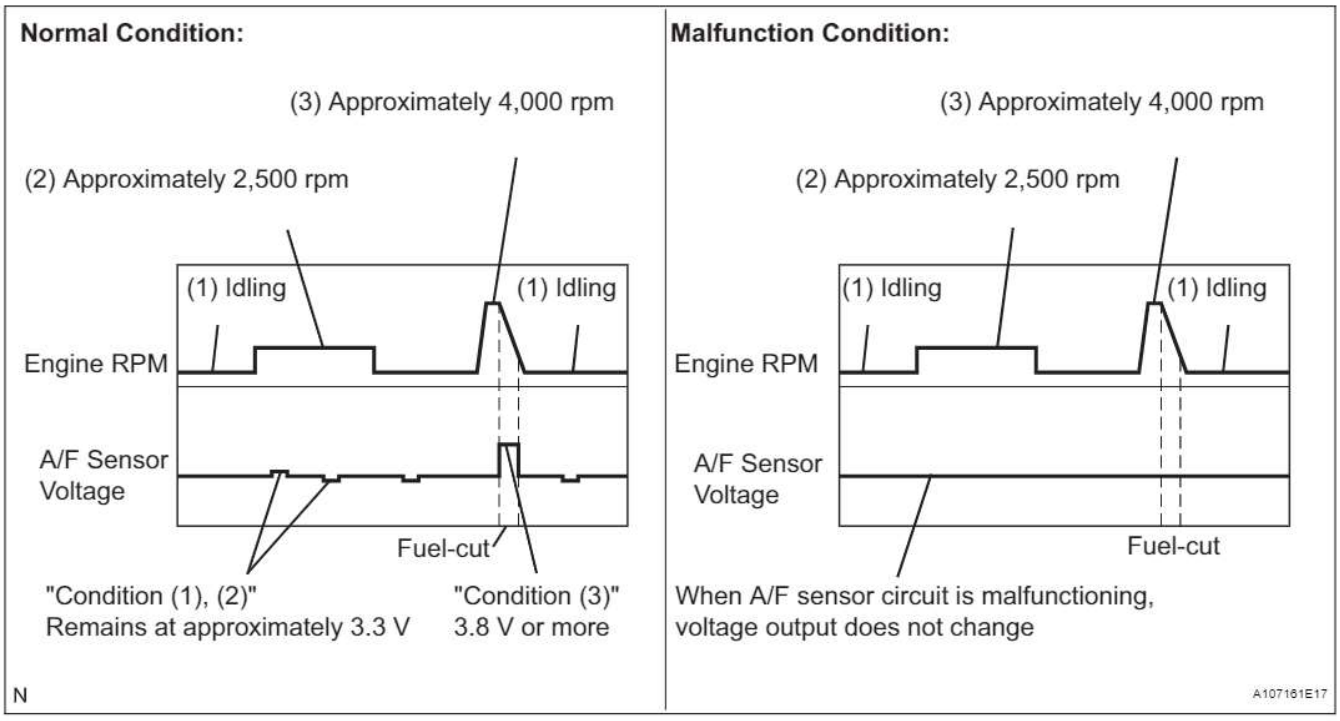
(d) Warm up the A/F sensor at an engine speed of 2,500 rpm for 90 seconds.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / SNAPSHOT / MANUAL SNAPSHOT / USER DATA / AFS B1 S1 and ENGINE SPD.
(f) Check the A/F sensor voltage 3 times, when the engine is in each of the following conditions:
(1) While idling (check for at least 30 seconds)
(2) At an engine speed of approximately 2,500 rpm (without any sudden changes in engine speed)
(3) Drive the vehicle at a constant speed of between 40 mph and 70 mph (65 km/h and 113 km/h) and then quickly release the accelerator pedal so that the throttle valve is fully closed.

ES

Standard voltage

Conditions	A/F Sensor Voltage Variations	Reference
(1) and (2)	Remains at approximately 3.3 V	Between 3.1 V and 3.5 V
(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.



- If the output voltage of the A/F sensor remains at approximately 3.3 V (see Malfunction Condition diagram) under any conditions, including those above, 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 above, 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 is translated 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.

NG → Go to step 9

OK

4 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5 CHECK WHETHER DTC OUTPUT RECURS (DTC P2195 OR P2196)

(a) Read the 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 or P2196	A
No output	B

B → END

A

6	REPLACE AIR-FUEL RATIO SENSOR

NEXT

7	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

ES

8	CHECK WHETHER DTC OUTPUT RECURS (DTC P2195 OR P2196)

(a) Read the 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 or P2196	B

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

END

9	INSPECT AIR-FUEL RATIO SENSOR (HEATER RESISTANCE) (See page ES-75)

NG → REPLACE AIR-FUEL RATIO SENSOR

OK

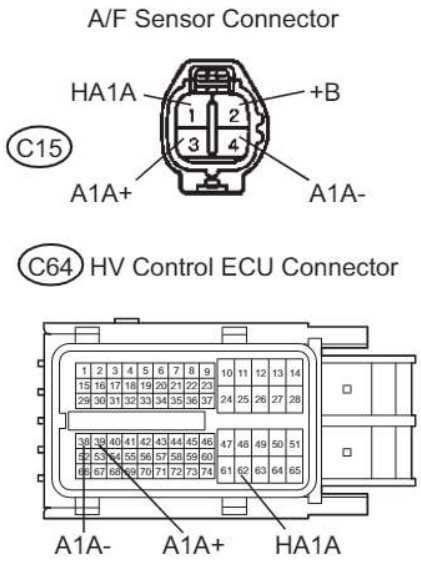
10	INSPECT INTEGRATION RELAY (EFI RELAY) (See page ES-76)

NG → REPLACE INTEGRATION RELAY (EFI MAIN RELAY)

OK

11	CHECK HARNESS AND CONNECTOR (A/F SENSOR - HV CONTROL ECU)

Wire Harness Side:



(a) Disconnect the C15 A/F sensor connector.
(b) Turn the power 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
C15-2 (+B) - Body ground	9 to 14 V

(d) Turn the power switch off.
(e) Disconnect the C64 hybrid vehicle control ECU connector.
(f) Measure the resistance.

Standard resistance (Check for open)

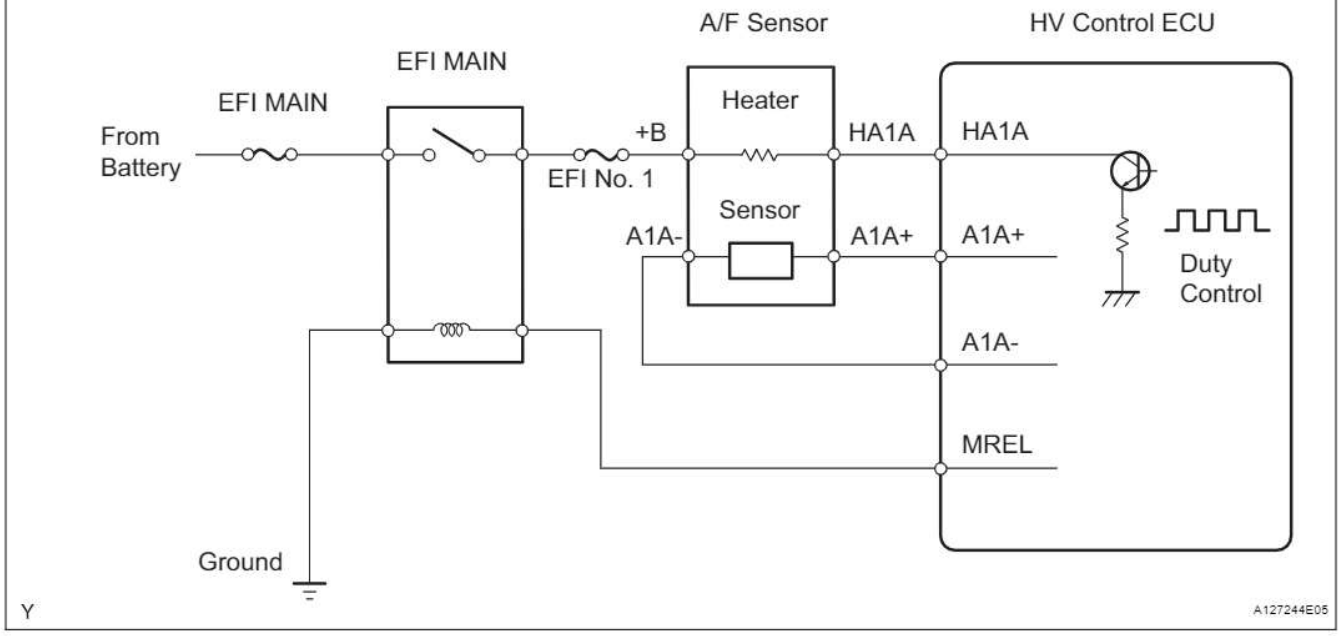
Tester Connections	Specified Conditions
C15-1 (HA1A) - C64-62 (HA1A)	Below 1 Ω
C15-3 (A1A+) - C64-39 (A1A+)	Below 1 Ω
C15-4 (A1A-) - C64-38 (A1A-)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C15-1 (HA1A) or C64-62 (HA1A) - Body ground	10 kΩ or higher
C15-3 (A1A+) or C64-39 (A1A+) - Body ground	10 kΩ or higher
C15-4 (A1A-) or C64-38 (A1A-) - Body ground	10 kΩ or higher

(g) Reconnect the hybrid vehicle control ECU connector.
(h) Reconnect the A/F sensor connector.

Reference (System Diagram of Sensor 1):



NG	REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

12	REPLACE AIR-FUEL RATIO SENSOR

NEXT

13	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

ES

14	CHECK WHETHER DTC OUTPUT RECURS (DTC P2195 OR P2196)

(a) Read the 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 or P2196	B

B → REPLACE HYBRID VEHICLE CONTROL ECU

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	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)

ES

DESCRIPTION

Refer to DTC P2195 (See page ES-269).

DTC No.	DTC Detection Conditions	Trouble Areas
P2238	• Case 1: Condition (a) or (b) continues for 5.0 seconds or more (2-trip detection logic): (a) AF+ voltage 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 (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU
P2239	AF+ voltage more than 4.5 V for 5.0 seconds or more (2-trip detection logic)	• Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU
P2252	AF- voltage 0.5 V or less for 5.0 seconds or more (2-trip detection logic)	• Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU
P2253	AF- voltage more than 4.5 V for 5.0 seconds or more (2-trip detection logic)	• Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • Integration relay (EFI MAIN relay) • A/F sensor heater and EFI MAIN relay circuits • Hybrid vehicle control ECU

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 output voltage deviates greatly from the standard range, the ECM determines that there is an open or short in the A/F sensor circuit.

MONITOR STRATEGY

Related DTCs	P2238: A/F sensor open circuit between AF+ and AF- P2238: A/F sensor short circuit between AF+ and AF- P2238: A/F sensor short circuit between AF+ and GND P2239: A/F sensor short circuit between AF+ and +B P2252: A/F sensor short circuit between AF- and GND P2253: A/F sensor 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	10 seconds: A/F sensor open circuit between AF+ and AF- 5 seconds: Other
MIL Operation	2 driving cycles
Sequence of Operation	None

ES

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	P0031, P0032 (A/F sensor heater - Sensor 1) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0455, P0456 (EVAP system) P0500 (VSS)

P2238 (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+ and AF- terminal voltages	0.1 to 0.8 V
ECT	5°C (41°F) or more (varies with ECT at engine start)
Engine	Running
Fuel-cut	OFF
Time after fuel-cut OFF	10 seconds or more
A/F sensor heater	ON
Battery voltage	10.5 V or more
Power switch	ON
Time after power switch is OFF to ON	5 seconds or more

Other:

Battery voltage	10.5 V or more
Power switch	ON
Time after power switch is OFF to ON	5 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P2238 (Open circuit between AF+ and AF-):

A/F sensor admittance	Below 0.022 1/Ω

P2238 (Short circuit between AF+ and GND):

AF+ terminal voltage	0.5 V or less

P2238 (Short circuit between AF+ and AF-):

Difference between AF+ and AF- terminal voltages	0.1 V or less

P2239 (Short circuit between AF+ and +B):

AF+ terminal voltage	More than 4.5 V

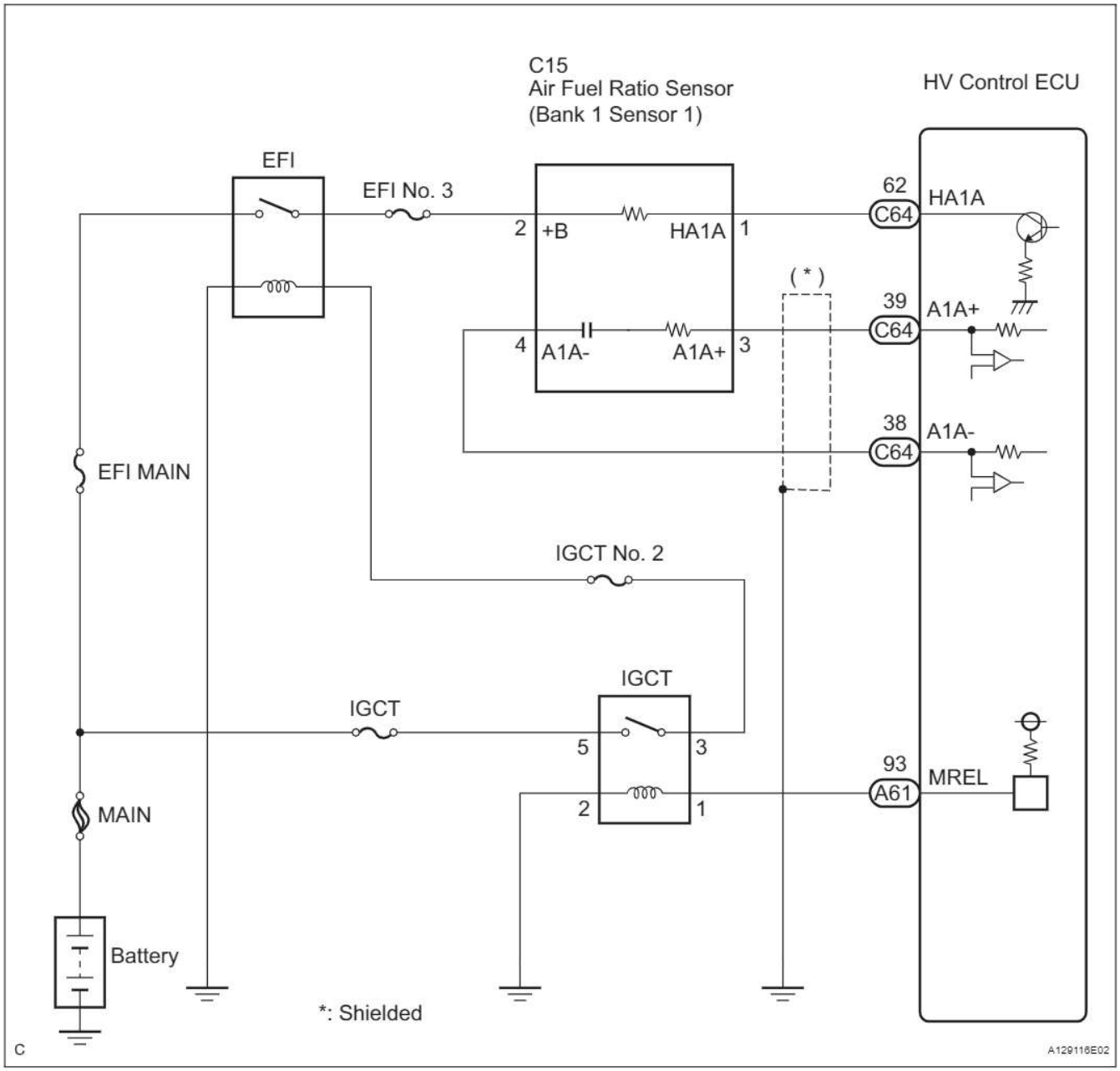
P2252 (Short circuit between AF- and GND):

AF- terminal voltage	0.5 V or less

P2253 (Short circuit between AF- and +B):

AF- terminal voltage	More than 4.5 V

WIRING DIAGRAM



INSPECTION PROCEDURE

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.

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 the intelligent tester.
(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (See page ES-35).
(c) Turn the tester on.
(d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(f) Perform the A/F CONTROL operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(g) Monitor the output voltages of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2) 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%.
- The sensors react in accordance with increases and decreases in the fuel injection volume.

Standard

Tester Display (Sensor)	Injection Volume	Status	Voltages
AFS B1 S1 (A/F)	+25%	Rich	Less than 3.0
	-12.5%	Lean	More than 3.35
O2S B1 S2 (HO2)	+25%	Rich	More than 0.5
	-12.5%	Lean	Less than 0.4

NOTICE:
The A/F sensor has an output delay of a few seconds and the 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 Areas
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.5 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.5 V Less than 0.4 V		

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Areas
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	

ES

Following the A/F CONTROL procedure enables technicians to check and graph the output voltages 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 B1 S1 and O2S B1 S2; then press the YES button and then the ENTER button followed by the F4 button.
HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1 INSPECT AIR-FUEL RATIO SENSOR (HEATER RESISTANCE) (See page ES-75)

NG → REPLACE AIR-FUEL RATIO SENSOR

OK

2 INSPECT INTEGRATION RELAY (EFI RELAY) (See page ES-76)

NG → REPLACE INTEGRATION RELAY (EFI MAIN RELAY)

OK

3 CHECK HARNESS AND CONNECTOR (A/F SENSOR - HV CONTROL ECU) (See page ES-287)

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4	REPLACE AIR-FUEL RATIO SENSOR

NEXT

5	CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Clear the DTCs (See page ES-31).
(d) Put the engine in inspection mode (See page ES-35).
(e) Allow the engine to idle for 5 minutes or more.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
(g) Read the pending DTCs.

ES

Result

Display (DTC Output)	Proceed to
No output	A
P2238, P2239, P2252 or P2253	B

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

END

DTC	P2420	Evaporative Emission System Switching Valve Control Circuit High

DTC SUMMARY

DTCs	Monitoring Item	Malfunction Detection Condition	Trouble Area	Detection Timing	Detection Logic
P2420	Vent valve stuck open (vent)	Vent valve open stuck is detected during EVAP key-off monitor	• Canister pump module (Reference orifice, leak detection pump, vent valve) • Connector / wire harness (Canister pump module - Hybrid vehicle control ECU) • Hybrid vehicle control ECU	Power switch OFF	2-trips

ES

DESCRIPTION

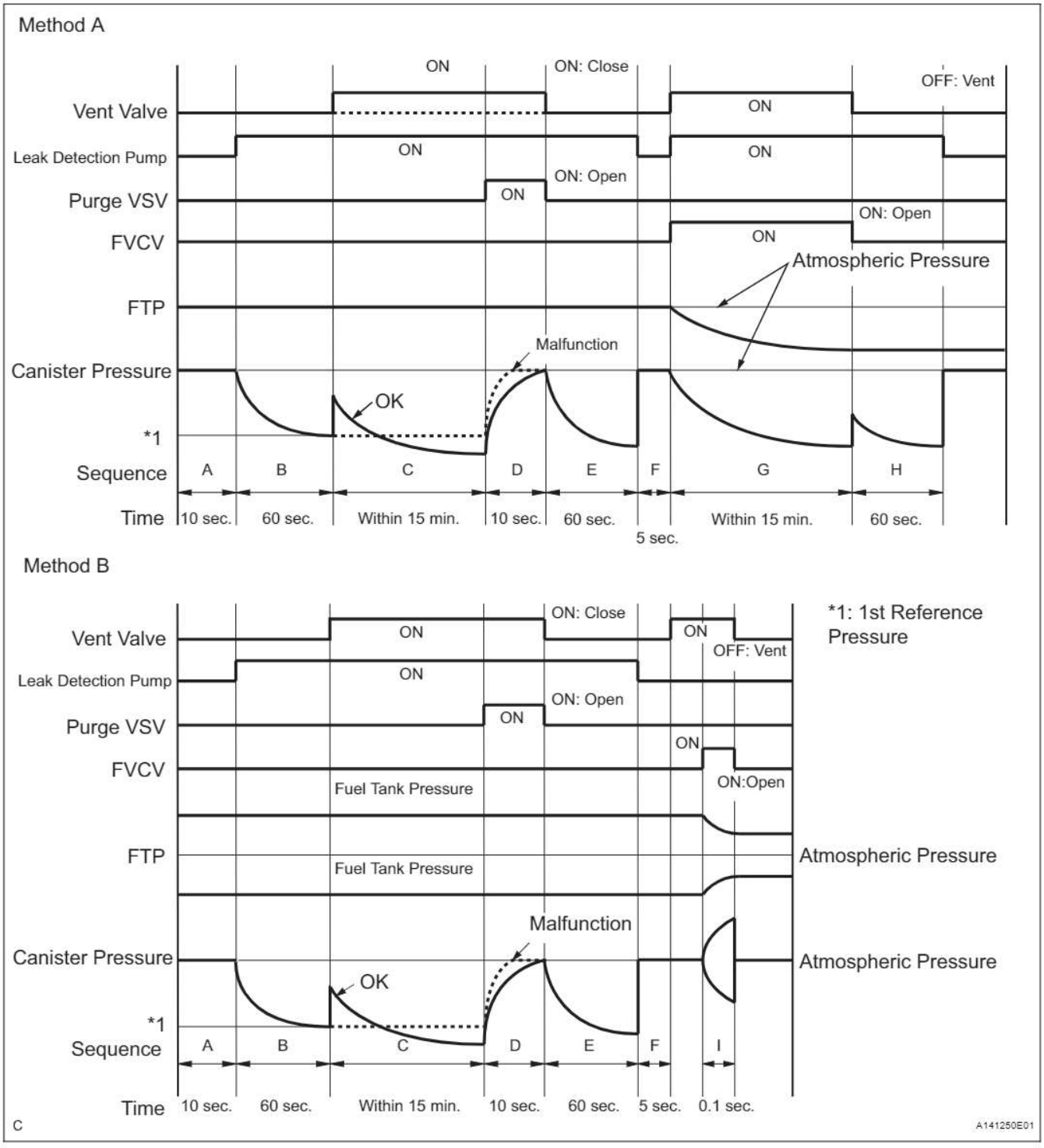
The description can be found in EVAP (Evaporative Emission) System (See page ES-317).

INSPECTION PROCEDURE

Refer to EVAP System (See page ES-328).

MONITOR DESCRIPTION

Vent valve stuck open (vent)
In operation C, the vent valve turns ON (closes) and the EVAP system pressure is then measured by the ECM, using the canister 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.



MONITOR STRATEGY

Required Sensors/Components (Main)	Purge VSV and canister 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	-
EVAP key-off monitor runs when all of the following conditions are met:	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	Below 2.5 mph (4 km/h)
Power switch	OFF
Engine condition	Not running
Canister pressure sensor malfunction (P0450, P0451, P0452 and P0453)	Not detected
FTP sensor malfunction (P1451, P1452 and P1453)	Not detected
Purge VSV	Not operated by scan tool
Vent valve	Not operated by scan tool
Leak detection pump	Not operated by scan tool
Both of the following conditions are met before power switch OFF	Conditions 1 and 2
1. Duration that vehicle is being driven	5 minutes or more
2. Purge flow	Executed
ECT	4.4 to 35°C (40 to 95°F)
IAT	4.4 to 35°C (40 to 95°F)
Time after engine stopped	5 hours

Example of restart time

First time	7 hours
Second time	9 hours and 30 minutes

Key-off monitor sequence 1 to 15

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met:	-
Atmospheric pressure change for 10 seconds	Less than 0.3 kPa (2.25 mmHg) for 1 second

2. First reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2 and 3
1. EVAP pressure 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.38 to -7.93 mmHg)
3. Reference pressure	Saturated

3. Vent valve stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after vent valve ON (Closed)	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction for canister

Next sequence is run if the following condition is met:	-
Vacuum introduction time	15 minutes or less

5. Purge VSV stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after Purge VSV ON (Open).	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3 and 4
1. EVAP pressure 1.9 sec. after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated

4. Reference pressure difference between the first and second	Less than 0.7 kPa (5.25 mmHg)

7. Canister leak

Next sequence is run if the following condition is met:	-
Canister leak when vacuum introduction was complete	Second reference pressure or less

8. Fuel vapor-containment valve (FVCV stuck closed check)

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 kPa (-15 mmHg) or less, or 3 kPa (22.5 mmHg) or more
2. FTP change while FVCV and vent valve are open	0.5 kPa (3.75 mmHg) or more

9. Vacuum introduction for fuel tank

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 to 3 kPa (-15 to 22.5 mmHg)
2. Vacuum introduction time	15 minutes or less

ES

10. FVCV stuck closed check

Next sequence is run if the following condition is met:	
FTP change when vacuum introduction for fuel tank	0.5 kPa (3.75 mmHg)

11. FTP sensor stuck check

Next sequence is run if the following condition is met:	
FTP change when FVCV closed	0.35 kPa (2.6 mmHg) or less

12 Third reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3, and 4
1. FTP 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the second and third	Less than 0.7 kPa (5.25 mmHg)

13. Fuel tank leak check

Sequence is run if the following condition is met:	
FTP when vacuum introduction for fuel tank was complete	Less than third reference pressure

14. FTP sensor stuck check

Next sequence is run if the following condition is met:	-
FTP change while FVCV and vent valve are open	Less than 0.3 kPa (2.25 mmHg)

15. Atmospheric pressure measurement

Monitor is complete if the following condition is met:	-
Atmospheric pressure difference between sequence 1 and 8	0.35 kPa (2.6 mmHg) or less

TYPICAL MALFUNCTION THRESHOLDS

"Saturated" indicates that the EVAP pressure change is less than 0.286 kPa (2.14 mmHg) in 60 seconds.

Vent valve stuck open (vent)

EVAP pressure change after EVAP canister vent valve is ON	Less than 0.3 kPa (2.25 mmHg)

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-325).

DTC	P2450	Fuel Vapor-containment Valve Stuck Open

DTC	P2451	Fuel Vapor-containment Valve Stuck Close

DTC SUMMARY

DTC No.	Monitoring Item	DTC Detection Condition	Trouble Area	Detection Timing	Detection Logic
P2450	Fuel vapor-containment valve stuck open	One of the following condition is met when FTP is between -2 kPa (-15 mmHg) and 3 kPa (22.5 mmHg). • FTP change when vacuum introduction for fuel tank is less than 0.5 kPa (3.75 mmHg) • EVAP pressure change when FVCV is open is less than 0.9 kPa (6.75 mmHg)	• Fuel vapor-containment valve • Connector / wire harness (Fuel vapor-containment valve - Hybrid Vehicle Control ECU) • Hybrid vehicle control ECU	Power switch off	2-trips
P2451	Fuel vapor-containment valve stuck closed	One of the following conditions are met when FTP is between -2 kPa (-15 mmHg) and 3 kPa (22.5 mmHg). • FTP change when vacuum introduction for canister is less than 0.5 kPa (3.75 mmHg) • EVAP pressure when vacuum introduction for canister was complete is higher than (third reference pressure x 0.2)	• Fuel vapor-containment valve • Connector / wire harness (Fuel vapor-containment valve - Hybrid Vehicle Control ECU • Hybrid vehicle control ECU	Power switch off	2-trips

ES

DESCRIPTION

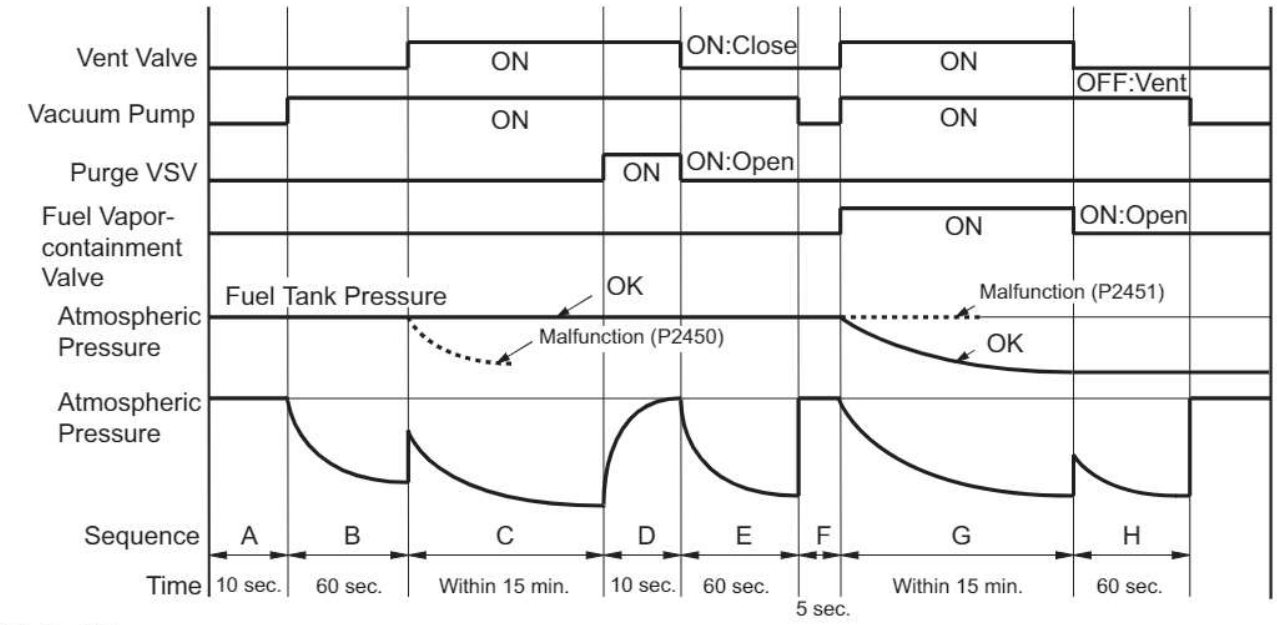
Refer to EVAP System (See page ES-317).

MONITOR DESCRIPTION

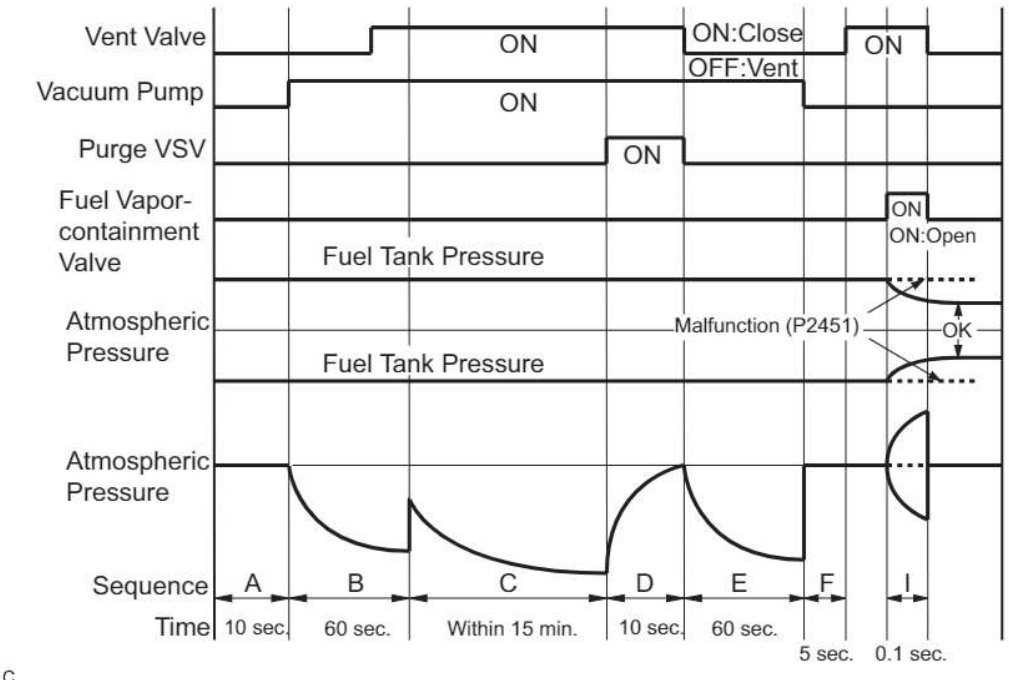
1. P2450: Fuel vapor-containment valve (FVCV) stuck open
   During sequence C, the vacuum pump creates vacuum pressure in the EVAP system. If the pressure in the fuel tank drops, the ECM (included in hybrid vehicle control ECU) determines that the fuel vapor-containment valve is stuck open. The ECM then illuminates the MIL and sets the DTC. (This DTC is set according to 2-trip detection logic.)

2. P2451: Fuel vapor-containment valve (FVCV) stuck closed (vent)
During sequence G, the fuel vapor-containment valve opens to allow vacuum pressure generated by the vacuum pump into the fuel tank. If the pressure in the fuel tank does not drop, the ECM determines that the fuel vapor-containment valve is stuck closed. The ECM then illuminates the MIL and sets the DTC. (This DTC is set according to 2-trip detection logic.)
During sequence I, the fuel vapor-containment valve opens to allow atmospheric pressure into the fuel tank. If there is no change in fuel tank pressure, the ECM determines that the fuel vapor-containment valve is stuck closed. The ECM then illuminates the MIL and sets the DTC. (This DTC is set according to 2-trip detection logic.)

Method A



Method B



C A109164E03

MONITOR STRATEGY

Required Sensors/Components	Pump module
Frequency of Operation	Once per driving cycle: P0451 sensor constant voltage Continuous: P0451 sensor abnormal voltage fluctuation, P0450, P0452 and P0453
Duration	0.5 seconds: P0450, P0452, P0453 Within 15 seconds: P0451
MIL Operation	Immediate: P0450, P0452, P0453 2 driving cycles: P0451
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

EVAP key-off monitor runs when all of the following conditions are met:	-
Atmospheric pressure	70 to 110 kPa (525 to 825 mmHg)
Battery voltage	10.5 V or more
Vehicle speed	Below 2.5 mph (4 km/h)
Power switch	OFF
FTP sensor malfunction (P0450, P0451, P0452 and P0453)	Not detected
Purge VSV	Not operated by scan tool
Vent valve	Not operated by scan tool
Leak detection pump	Not operated by scan tool
Both of the following conditions are met before power switch OFF:	Conditions 1 and 2
1. Duration that vehicle is being 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)
Time after engine stop	5 hours

Example of restart time:

First time	7 hours
Second time	9 hours and 30 minutes

Key-off monitor sequence 1 to 15

1. Atmospheric pressure measurement

Next sequence is run if the following condition is met:	-
Atmospheric pressure change for 10 seconds	Less than 0.3 kPa (2.25 mmHg) for 1 second

2. First reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2 and 3
1. EVAP pressure 1.9 seconds after reference pressure measurement	-1 kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.38 to -7.93 mmHg)
3. Reference pressure	Saturated

3. Vent valve stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after vent valve ON (Closed)	0.3 kPa (2.25 mmHg) or more

4. Vacuum introduction for canister

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. Vacuum introduction time	15 minutes or less
2. FTP	Saturated

5. Purge VSV stuck closed check

Next sequence is run if the following condition is met:	-
EVAP pressure change for 10 seconds after purge VSV ON (Open)	0.3 kPa (2.25 mmHg) or more

6. Second reference pressure measurement

Next sequence is run if all of the following conditions are met:	Conditions 1, 2, 3 and 4
1. EVAP pressure 1.9 sec. after reference pressure measurement	-1kPa (-7.5 mmHg) or less
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.92 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the first and second	0.7 kPa (5.25 mmHg) or less

7. Canister leak

Next sequence is run if the following condition is met:	-
Canister leak when vacuum introduction was complete	Second reference pressure or less

8. Fuel vapor-containment valve (FVCV stuck closed check)

Sequence 14 is run if all of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 kPa (-15 mmHg) or less, or 3 kPa (22.5 mmHg) or more
2. FTP change while FVCV and vent valve are open	3.75 mmHg (0.5 kPa) or more

9. Vacuum introduction for fuel tank

Next sequence is run if both of the following conditions are met:	Conditions 1 and 2
1. FTP when EVAP monitor started	-2 to 3 kPa (-15 to 22.5 mmHg)
2. Vacuum introduction time	15 minutes or less

10. FVCV stuck closed check

Next sequence is run if the following condition is met:	
FTP change when vacuum introduction for fuel tank	0.5 kPa (5.25 mmHg)

11. FTP sensor stuck check

Next sequence is run if the following condition is met:	
FTP change when FVCV closed	0.35 kPa (2.6 mmHg) or less

12. Third reference pressure measurement

Next sequence is run if all of the following conditions are met::	Conditions 1, 2, 3, and 4
1. FTP 1.9 seconds after reference pressure measurement began	-1 kPa (-7.5 mmHg) or more
2. Reference pressure	-4.85 to -1.057 kPa (-36.4 to -7.93 mmHg)
3. Reference pressure	Saturated
4. Reference pressure difference between the second and third	Less than 0.7 kPa (5.25 mmHg)

13. Fuel tank leak check

Sequence is run if the following conditions is met:	
FTP when vacuum introduction for fuel tank was complete	Less than third reference pressure

14. FTP sensor stuck check

Next sequence is run if the following condition is met:	-
FTP change while FVCV and vent valve are open	Less than 0.35 kPa (2.6 mmHg)

15. Atmospheric pressure measurement

Monitor is complete if the following condition is met:	-
Atmospheric pressure difference between sequence 1 and 8	0.3 kPa (2.25 mmHg) or less

TYPICAL MALFUNCTION THRESHOLDS

"Saturated" indicates that the EVAP pressure change is less than 0.286 kPa (2.14 mmHg) in 60 seconds.

P2450: Fuel vapor-containment valve stuck open

One of the following conditions is met when FTP is between -2 kPa (-15 mmHg) and 3 kPa (22.5 mmHg)	1 or 2
1. Both of the following conditions met	(a) or (b)
(a) FTP	-2 to 3 kPa (-15 to 22.5 mmHg)
(b) FTP change when vacuum introduction for fuel tank	More than 0.5 kPa (3.75 mmHg)
1. Both of the following conditions met	(a) or (b)
(a) FTP	-2 to 3 kPa (-15 to 22.5 mmHg)
(b) Canister pressure change when FVCV is open	More than 0.9 kPa (6.75 mmHg)

P2451: Fuel vapor-containment valve stuck closed

One of the following conditions is met when FTP is between -2 kPa (-15 mmHg) and 3 kPa (22.5 mmHg)	1 or 2
1. FTP change when vacuum introduction for fuel tank	Less than 0.5 kPa (3.75 mmHg)
2. Canister pressure when vacuum introduction for canister was complete	Higher than reference pressure x 0.2

ES

MONITOR RESULT

Refer to EVAP System (See page ES-325).

INSPECTION PROCEDURE

Refer to EVAP System (See page ES-328).

DTC	P2610	ECM / PCM Internal Engine Off Timer Performance

DTC SUMMARY

DTC No.	Monitoring Item	Malfunction Detection Condition	Trouble Area	Detection Timing	Detection Logic
P2610	Soak timer (built into hybrid vehicle control ECU)	Hybrid vehicle control ECU internal malfunction	Hybrid vehicle control ECU	Engine running	2-trips

DESCRIPTION

To ensure the accuracy of the EVAP (Evaporative Emission) monitor values, the soak timer, which is built into the ECM (included in the hybrid vehicle control ECU), measures 5 hours (+/- 15 minutes) from when the power switch is turned off, before the monitor begins to run. This allows the fuel to cool down, which stabilizes the Fuel Tank Pressure (FTP). When 5 hours have elapsed, the ECM turns on.

MONITOR DESCRIPTION

5 hours after the power switch is turned off, the soak timer activates the ECM (included in the hybrid vehicle control ECU) 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. The ECM illuminates the MIL and sets the DTC (2-trip detection logic).

MONITOR STRATEGY

Required Sensors/Components	Hybrid vehicle control ECU
Frequency of Operation	Once per driving cycle
Duration	600 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Case 1:

The monitor will run whenever these DTCs are not present	None
Power switch	ON
Engine	Running
Battery voltage	8 V or more
Starter	OFF

Case 2 and Case 3:

Soak time	20 minutes or more
Battery voltage	8 V or more
Power switch	ON
Starter	OFF

TYPICAL MALFUNCTION THRESHOLDS

Case 1:

Soak timer measurement when hybrid vehicle control ECU CPU clock counts 10 minutes	Less than 7 minutes or more than 13 minutes

Case 2:

History hybrid vehicle control ECU had woken up by internal engine off timer	Yes
How long vehicle has been soaked	Less than programmed period

Case 3:

History hybrid vehicle control ECU had woken up by internal engine off timer	No
How long vehicle has been soaked	More than or equal to programmed period

INSPECTION PROCEDURE

HINT:

- DTC P2610 is set if an internal ECM (included in the hybrid vehicle control ECU) 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data, from the time the malfunction occurred.

1	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT

2	CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Clear the DTCs (See page ES-31).
(d) Put the engine in inspection mode (See page ES-35).
(e) Wait for 10 minutes or more.
(f) On the tester, enter the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC / INFO / PENDING CODEs.
(g) If no pending DTC is displayed, the repair has been successfully completed.

NEXT

END

DTC	P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)

HINT:
Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.

DESCRIPTION

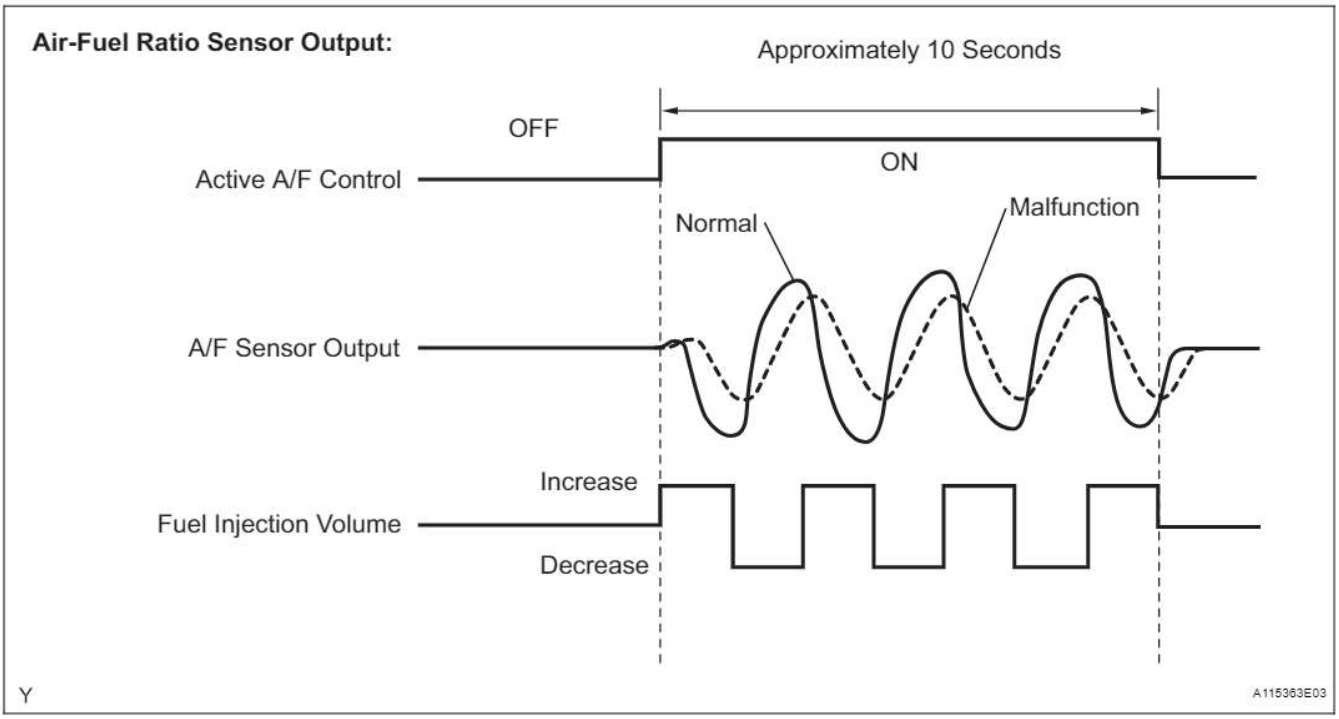
Refer to DTC P2195 (See page ES-269).

DTC No.	DTC Detection Conditions	Trouble Areas
P2A00	Calculated value of air-fuel ratio (A/F) sensor response rate deterioration level less than threshold (2-trip detection logic)	• Open or short in A/F sensor circuit • A/F sensor • Hybrid vehicle control ECU

ES

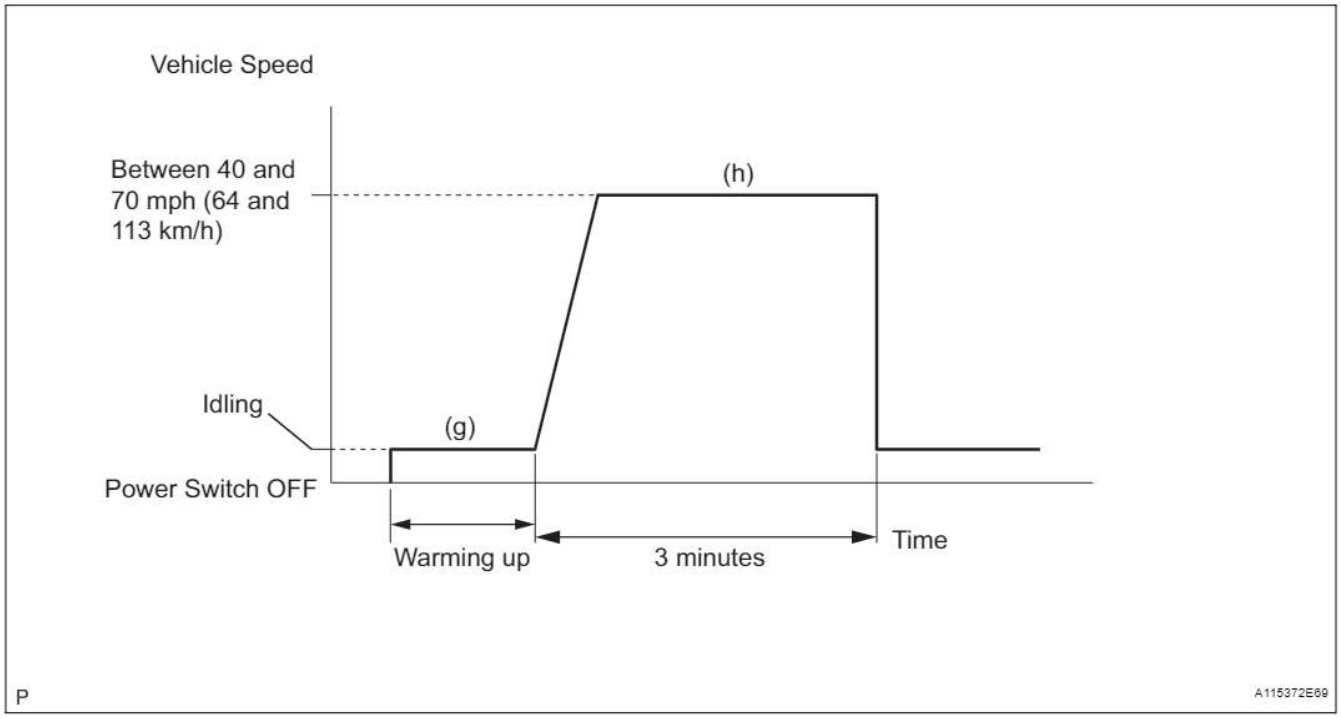
MONITOR DESCRIPTION

After the engine is warmed up, the ECM (included in hybrid vehicle control ECU) performs air-fuel ratio feedback control to maintain the air-fuel ratio at the stoichiometric level. In addition, active A/F control is performed for approximately 10 seconds after the preconditions are met in order to measure the A/F sensor response rate. During active A/F control, the ECM forcibly increases and decreases the injection volume 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 control and uses it to calculate the A/F sensor response rate deterioration level.
If the A/F sensor response rate deterioration level is less than the threshold, the ECM interprets this as a malfunction and sets the DTC.

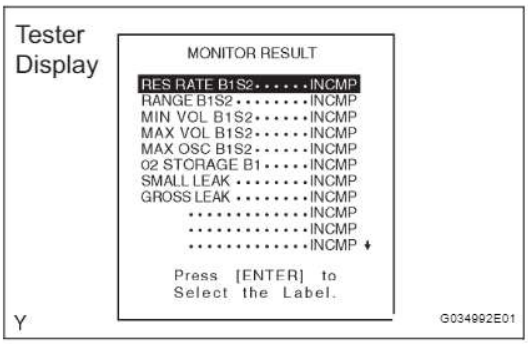


CONFIRMATION DRIVING PATTERN

HINT:
Performing this confirmation pattern will activate the A/F sensor response monitor.



(a) Connect the intelligent tester to the DLC3.



(b) Turn the power switch on (IG).
(c) Turn the tester on.
(d) Clear the DTCs (if set) (See page ES-31).
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / MONITOR RESULT.
(f) Check that RES RATE B1S1 is INCOMP.
(g) Put the engine in inspection mode (See page ES-35), and warm it up.
(h) Drive the vehicle at a constant speed of between 40 mph and 70 mph (64 km/h and 113 km/h) for 3 minutes.
(i) Check the monitor result values on the intelligent tester by selecting the following menu items: DIAGNOSIS / ENHANCED OBD II / MONITOR INFO / TEST RESULT.
(j) 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-17).
HINT:
Completion of all A/F sensor monitors is required to change the value in TEST RESULT.
(k) Note the value of the Monitor Result.
(l) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
(m) Check if any DTCs (any pending DTCs) are set.

MONITOR STRATEGY

Related DTCs	P2A00: Air-Fuel Ratio (A/F) sensor 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

ES

Monitor runs whenever following DTCs not present	P0031, 32 (A/F Sensor heater - Sensor 1) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0455, P0456 (EVAP system) P0500 (VSS) P2196 (A/F Sensor - rationality)
Active A/F control	Performing
Active A/F control performed when following conditions met	-
Engine coolant temperature	75°C (167°F) or more
Battery voltage	11 V or more
Idle	OFF
Engine RPM	Less than 4,000 rpm
A/F sensor status	Activated
Fuel-cut	OFF
Engine load	10 to 70%
Shift position	1 or more
Catalyst monitor	Not yet
Intake air amount	2.5 to 11 g/sec.

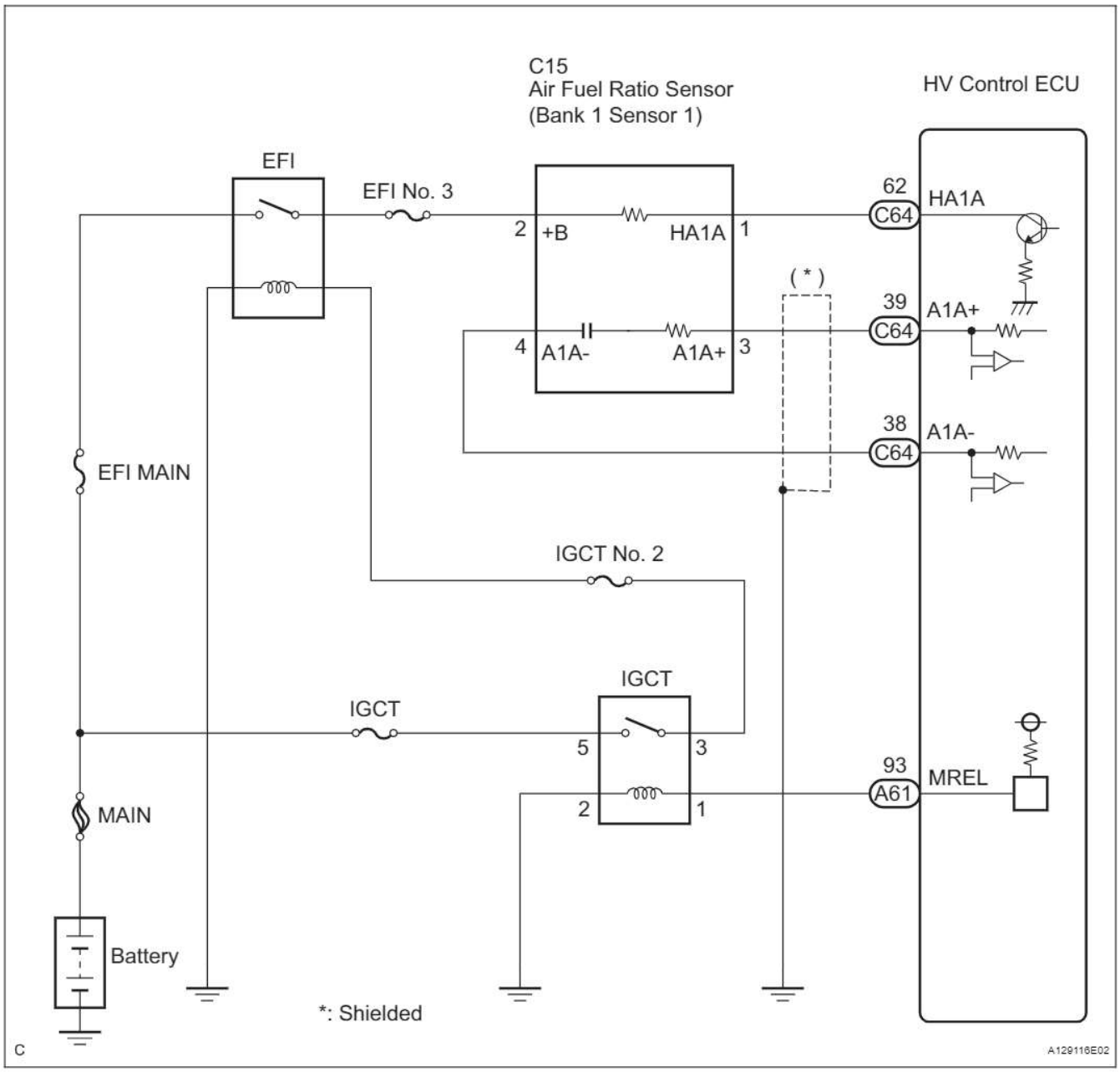
TYPICAL MALFUNCTION THRESHOLDS

Response rate deterioration level	Less than 0.25 V

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-14).

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Intelligent tester only:

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

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

(a) Connect the intelligent tester to the DLC3.

(b) Put the engine in inspection mode (See page ES-35).

(c) Turn the tester on.

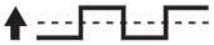
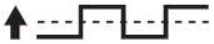
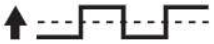
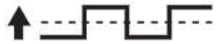
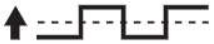
(d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.

(e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(f) Perform the A/F CONTROL operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(g) Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2) 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%.
- The sensors react in accordance with increases and decreases in the fuel injection volume.

Standard

Tester Display (Sensor)	Injection Volumes	Status	Voltages
AFS B1 S1 (A/F)	+25%	Rich	Less than 3.0
	-12.5%	Lean	More than 3.35
O2S B1 S2 (HO2)	+25%	Rich	More than 0.5
	-12.5%	Lean	Less than 0.4

NOTICE:
The A/F sensor has an output delay of a few seconds and the 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 Areas
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.5 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.5 V Less than 0.4 V		
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage Almost no reaction		
4	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction		Output voltage Almost no reaction		

Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1 S1 and O2S B1 S2; and press the YES button and then the ENTER button followed by the F4 button.

HINT:

- DTC P2A00 may be 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 help determine if the vehicle was moving or stationary, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1 CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00)

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

Result

Display (DTC Output)	Proceed to
P2A00	A
P2A00 and other DTCs	B

If any DTCs relating to the A/F sensor (DTCs for the A/F sensor heater or A/F sensor admittance) are output, troubleshoot those DTCs first.

B → GO TO DTC CHART

A

2 INSPECT AIR-FUEL RATIO SENSOR (HEATER RESISTANCE) (See page ES-75)

NG → REPLACE AIR-FUEL RATIO SENSOR

OK

3 CHECK HARNESS AND CONNECTOR (HV CONTROL ECU - AIR-FUEL RATIO SENSOR) (See page ES-287)

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

4 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

5	CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00)

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

Result

Display (DTC Output)	Proceed to
P2A00	A
No output	B

ES

B → CHECK FOR INTERMITTENT PROBLEMS

A

6	REPLACE AIR-FUEL RATIO SENSOR

NEXT

7	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

8	CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00)

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

Result

Display (DTC Output)	Proceed to
No output	A
P2A00	B

B → REPLACE HYBRID VEHICLE CONTROL ECU

A

END

DTC	P3190	Poor Engine Power

DTC	P3191	Engine does not Start

DTC	P3193	Fuel Run Out

DESCRIPTION

From the HV ECU, the ECM (included in hybrid vehicle control ECU) receives data such as power output required for the engine (required output), estimated torque produced by the engine (estimated torque), engine RPM of control target (target RPM), whether the engine is in start mode or not. Then, based on the required output and target RPM, the ECM (included in hybrid vehicle control ECU) calculates a target torque that is to be produced by the engine and compares it with the estimated torque. If the estimated torque is very low compared with the target torque, or the engine start mode continues for the specific duration calculated by water temperature, an abnormal condition is detected.

ES

DTC No.	DTC Detection Condition	Trouble Area
P3190	Following conditions continue at a fixed engine RPM or a fixed length of time: • Communication with HV ECU is normal • Engine RPM is a fixed value or more • Engine start mode is not active • Target torque is a fixed value • Ratio of estimated torque against target torque is less than 20%	• Air induction system • Throttle body • Fuel pressure • Engine • Mass Air flow meter • Out of fuel • Engine coolant temperature sensor • Crankshaft position sensor • Camshaft position sensor • Hybrid vehicle control ECU
P3191	Following conditions continue at a fixed engine RPM or a fixed length of time: • Communication with HV ECU is normal • Engine RPM is a fixed value or more • Engine start mode is active	• Air induction system • Throttle body • Fuel pressure • Engine • Mass Air flow meter • Out of fuel • Engine coolant temperature sensor • Crankshaft position sensor • Camshaft position sensor • Hybrid vehicle control ECU
P3193	Following conditions are met: • Fuel low level signal input into ECM (Included in hybrid vehicle control ECU) • Detection condition for P3190 or P3191 is satisfied	• Out of fuel • Hybrid vehicle control ECU

MONITOR DESCRIPTION

The ECM (Included in hybrid vehicle control ECU) and hybrid vehicle control ECU are connected by a communication line called CAN. The ECM (included in hybrid vehicle control ECU) sends information on the engine speed and other data to the hybrid vehicle control ECU while the hybrid vehicle control ECU sends the information such as a requirement for the engine power to the ECM (included in hybrid vehicle control ECU) using the CAN communication line. When the communication between the ECM (included in hybrid vehicle control ECU) and hybrid vehicle control ECU is normal and the following items becomes specific conditions, the ECM (included in hybrid vehicle control ECU) will illuminate the MIL and set a DTC.

1. Engine speed
2. Power switch
3. Target torque
4. Ratio of target torque against estimated torque
5. Fuel level

MONITOR STRATEGY

Related DTCs	P3190: Poor engine power P3191: Engine does not start P3193: Fuel run out
Required sensors/components	Main sensors: Crankshaft position sensor Related sensors: Hybrid vehicle control ECU
Frequency of operation	Continuous
Duration	100 engine revolutions and 6 seconds
MIL operation	Immediately
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

ES

Monitor runs whenever following DTCs not present	None
Fuel cut operation	Not operated
Engine speed	650 rpm or more (varies with engine coolant temperature)

TYPICAL MALFUNCTION THRESHOLDS

Case1: P3190

Time for low engine torque	100 engine revolutions or more, and 6 seconds or more (varies with engine coolant temperature)
Fuel level	Not empty

Case2: P3191

Engine start no-determination time (received from HV ECU)	100 engine revolutions or more, and 6 seconds or more (varies with engine coolant temperature)
Fuel level	Not empty

Case3: P3193

Time for low engine torque or Engine start no-determination time	100 engine revolutions or more, and 6 seconds or more (varies with engine coolant temperature)
Fuel level	Empty

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester or the OBD II scan tool. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P3190, P3191 AND/OR P3193)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Turn the intelligent tester or the OBD II scan tool on.
(d) On the intelligent tester, select the items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read the DTCs using the intelligent tester or the OBD II scan tool.

Result

Display (DTC output)	Proceed to
P3190, P3191 and/or P3193	A

Display (DTC output)	Proceed to
P3190, P3191 and/or P3193, and other DTCs	B

HINT:
If any other codes besides P3190, P3191 and/or P3193 are output, perform troubleshooting for those DTCs first.

B → GO TO DTC CHART

A

2 CHECK FOR FUEL (SHORTAGE OF FUEL)

NG → REFILL FUEL

OK

3 CHECK AIR INDUCTION SYSTEM

OK:
The air induction system has no leakage and blockages.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM

OK

4 CHECK FOR SYMPTOMS

(a) Check for unusual noise or vibration when starting the engine or when the engine is revving up.

OK:
Unusual noise and vibration do not occur.

NG → REPAIR OR REPLACE MALFUNCTIONING PARTS, COMPONENT AND AREA

OK

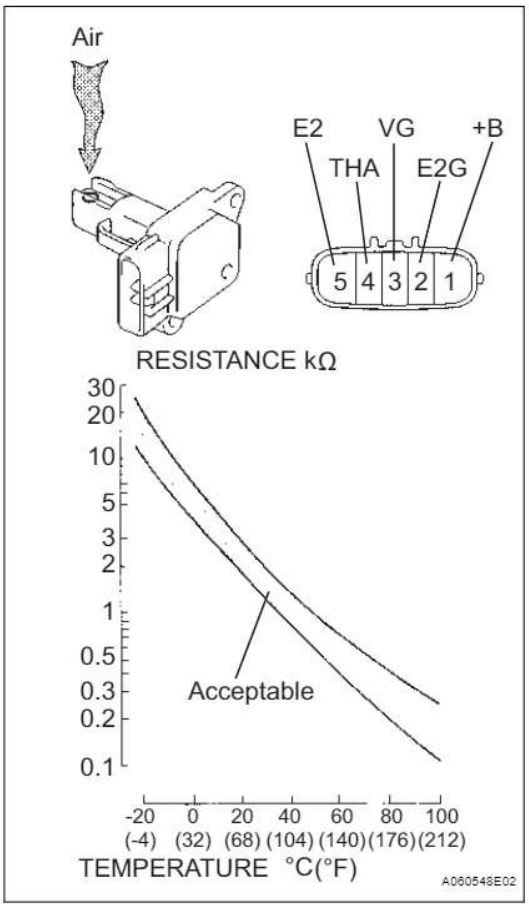
5 CHECK FUEL PRESSURE

(a) Check the fuel pressure (See page FU-9).
Standard:
304 to 343 kPa (3.1 to 3.5 kgf/cm^2, 44.1 to 49.7 psi)

NG → CHECK AND REPLACE FUEL SYSTEM

OK

6	INSPECT MASS AIR FLOW METER ASSEMBLY



(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF.
Standard:
0.54 g/s or less
(d) Inspect resistance.
(1) Measure the resistance between the terminals of the mass air flow meter.
Standard resistance

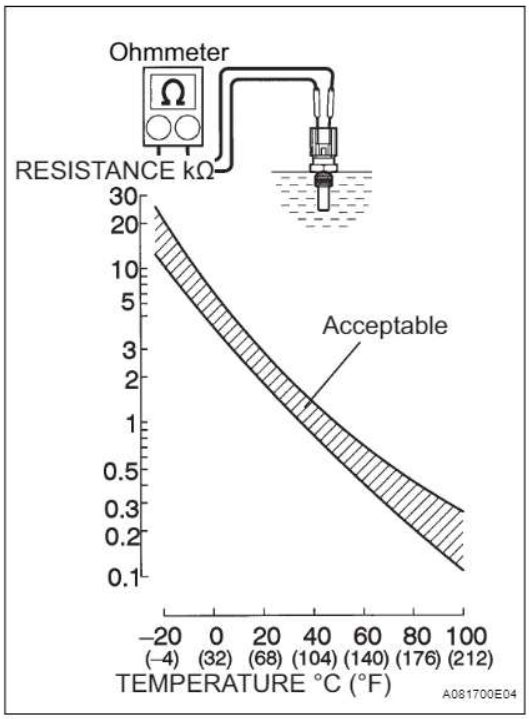
Tester Connection	Specified Condition
THA (4) - E2 (5)	13.6 to 18.4 kΩ at -20°C (-4°F)
THA (4) - E2 (5)	2.21 to 2.69 kΩ at 20°C (68°F)
THA (4) - E2 (5)	0.49 to 0.67 kΩ at 60°C (140°F)

(e) Reinstall the mass air flow meter.

NG → **REPLACE MASS AIR FLOW METER ASSEMBLY**

OK

7 INSPECT ENGINE COOLANT TEMPERATURE SENSOR



(a) Remove the engine coolant temperature sensor.
(b) Measure the resistance between the terminals of the engine coolant temperature sensor.
Standard resistance

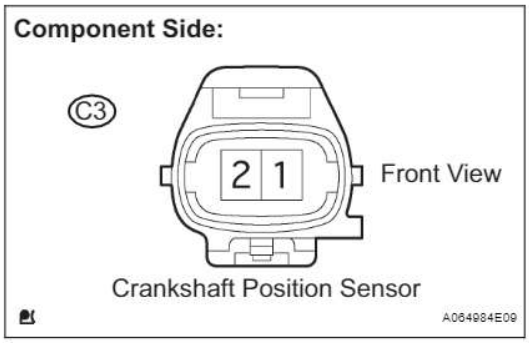
Tester Connection	Specified Condition
1 - 2	2 to 3 kΩ at 20°C (68°F)
1 - 2	0.2 to 0.4 kΩ at 80°C (176°F)

NOTICE:
In case of checking the engine coolant temperature sensor in water, be careful not to allow water to contact the terminals. After checking, dry the sensor.
HINT:
Alternate procedure: Connect an ohmmeter to the installed engine coolant temperature sensor and read the resistance. Use an infrared thermometer to measure the engine temperature in the immediate vicinity of the sensor. Compare these values to the resistance/temperature graph. Change the engine temperature (warm up or allow to cool down) and repeat the test.
(c) Reinstall the engine coolant temperature sensor.

NG → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

OK

8 INSPECT CRANKSHAFT POSITION SENSOR



(a) Disconnect the C3 crankshaft position sensor connector.
(b) Measure the resistance between the terminals of the crankshaft position sensor connector.
Standard resistance

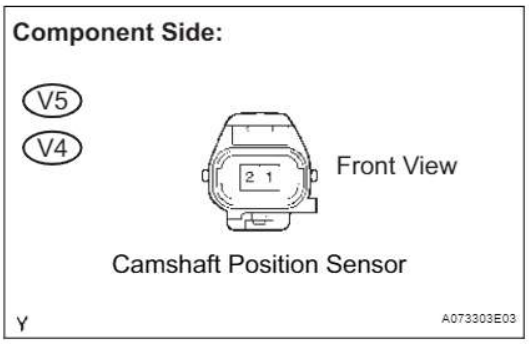
Tester Connection	Specified Condition
1 - 2	985 to 1,600 Ω at cold
1 - 2	1,265 to 1,890 Ω at hot

(c) Reconnect the crankshaft position sensor connector.
NOTICE:
Terms "cold" and "hot" refer to the temperature of the coils. "Cold" means approximately -10°C to 50°C (14°F to 122°F). "Hot" means approximately 50°C to 100°C (122°F to 212°F).

NG → **REPLACE CRANKSHAFT POSITION SENSOR**

OK

9 INSPECT CAMSHAFT POSITION SENSOR



(a) Disconnect the V5 and V4 camshaft position sensor connectors.
(b) Measure the resistance between the terminals of camshaft position sensor connector.
Standard resistance

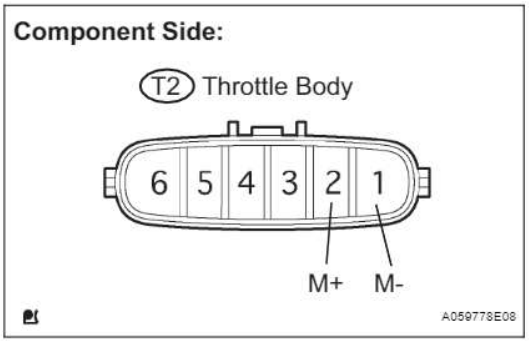
Tester Connection	Specified Condition
1 - 2	1,630 to 2,740 Ω at cold
1 - 2	2,065 to 3, 225 Ω at hot

(c) Reconnect the camshaft position sensor connector.
NOTICE:
Terms "cold" and "hot" refer to the temperature of the coils. "Cold" means approximately -10°C to 50°C (14°F to 122°F). "Hot" means approximately 50°C to 100°C (122°F to 212°F).

NG → **REPLACE CAMSHAFT POSITION SENOR**

OK

10 INSPECT THROTTLE CONTROL MOTOR



(a) Disconnect the throttle control motor connector.
(b) Using an ohmmeter, measure the motor resistance between terminals 1 (M-) and 2 (M+).
Standard resistance

Tester Connection	Specified Condition
1 - 2	0.3 to 100 Ω at 20°C (68°F)

NG → **REPLACE THROTTLE BODY ASSEMBLY**

OK

11 INSPECT THROTTLE POSITION SENSOR

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the intelligent tester on.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ETCS / THROTTLE SSR #1 and THROTTLE SSR #2.
(d) Check the values displayed on the tester.

Standard voltage

Item	Condition	Specified Condition
THROTTLE SSR #1	Throttle fully closed	2.15 to 2.35 V
	Throttle fully open	4.5 to 5.0 V

Item	Condition	Specified Condition
THROTTLE SSR #2	Throttle fully closed	0.66 to 0.76 V
	Throttle fully open	3.8 to 4.2 V

NG → REPLACE THROTTLE BODY ASSEMBLY

OK

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	U0001	High Speed CAN Communication Circuit

DESCRIPTION

The engine control unit and the transmission control unit are located inside the ECM (Included in hybrid vehicle control ECU). The engine control unit intercommunicates with the transmission control ECU using the Controller Area Network (CAN).
If there is a problem in this intercommunication, the ECM sets a DTC.

DTC No.	DTC Detection Condition	Trouble Area
U0001	Following conditions are met for 2 seconds (1-trip detection logic): (a) Power switch on (IG) (b) Battery voltage is 10.5 V or more (c) No intercommunication between engine control ECU and hybrid vehicle control ECU	Hybrid vehicle control ECU

ES

MONITOR STRATEGY

Related DTCs	U0001: Verify communication
Required Sensors/Components (Main)	Hybrid vehicle control ECU
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	10.6 seconds
MIL Operation	immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Battery Voltage	10.5 V or more (0.5 second or more)
Power switch	ON

TYPICAL MALFUNCTION THRESHOLDS

Communication between hybrid vehicle control ECU and TCM	No communication

INSPECTION PROCEDURE

1	CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC U0001)

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

Result

Display (DTC output)	Proceed to
U0001	A
U0001 and other DTCs	B

B	GO TO DTC CHART

A

REPLACE HYBRID VEHICLE CONTROL ECU

DTC	U0293	Lost Communication with HV ECU

DESCRIPTION

The controller Area Network (CAN) is a serial data communication system for real-time applications. It is a multiplex communication system designed for on-vehicle use that provides a superior communication speed of 500 kbps and a capability to detect malfunctions. Through the combination of the CANH and CANL bus lines, the CAN is able to maintain communication based on differential voltage.

DTC No.	DTC Detecting Condition	Trouble Area
U0293	When communication with hybrid vehicle control ECU is interrupted	• Wire harness • Hybrid vehicle control ECU

ES

MONITOR STRATEGY

Related DTCs	U0001: Lost communication with hybrid vehicle control ECU
Required Sensors/Components (Main)	ECM
Frequency of Operation	Continuous
Duration	0.68 seconds
MIL Operation	immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Battery Voltage	10.5 V or more (0.5 second or more)
Power switch	ON

TYPICAL MALFUNCTION THRESHOLDS

Communication signal	No signal from hybrid vehicle control ECU

INSPECTION PROCEDURE

Refer to CAN Communication System (See page CA-7).

EVAP System

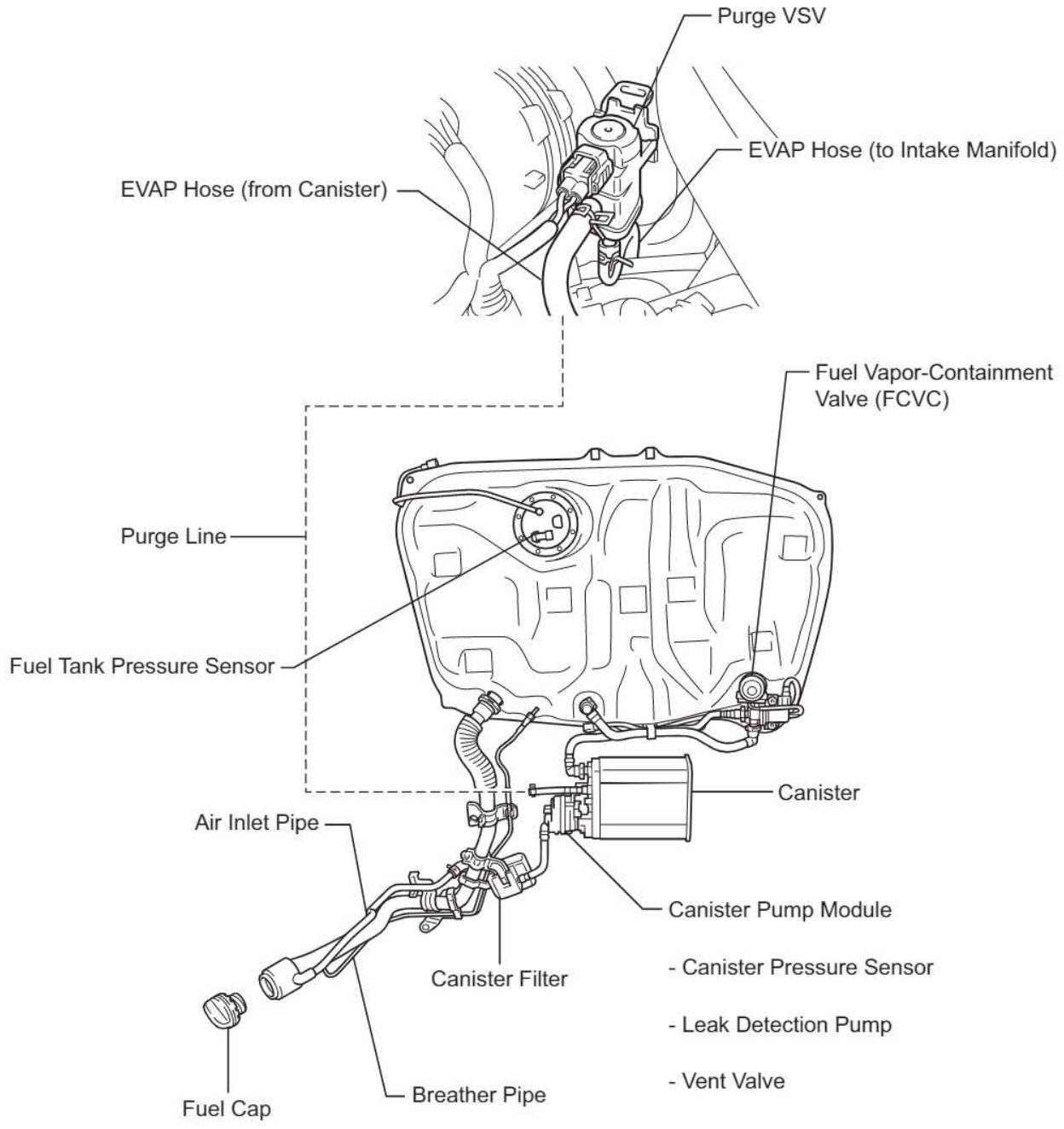
DESCRIPTION

While the engine is running, if a predetermined condition (closed loop, etc.) is met, the purge VSV is opened by the ECM (included in hybrid vehicle control ECU) and stored fuel vapors in the canister are purged to the intake manifold. The ECM will change the duty cycle ratio of the purge VSV to control purge flow volume.

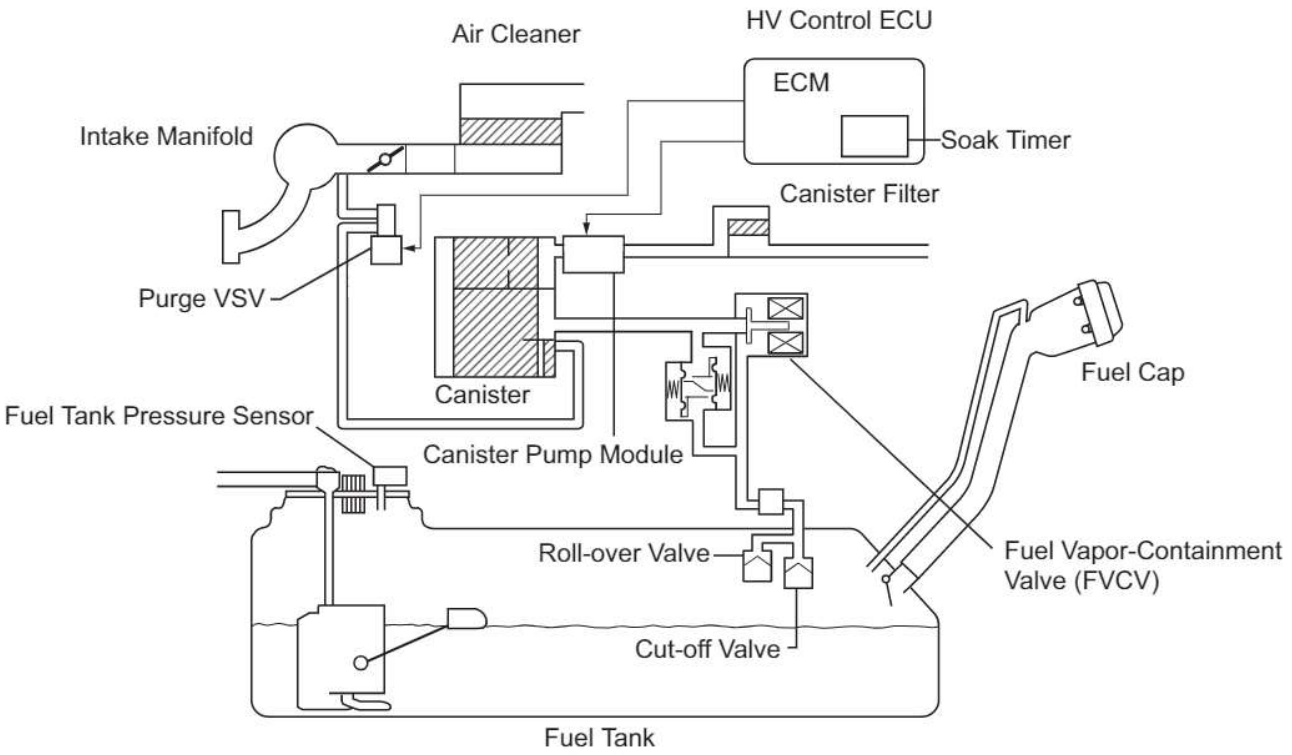
Purge flow volume is also determined by the intake manifold pressure. Atmospheric pressure is allowed into the canister through the vent valve to ensure that purge flow is maintained when negative pressure (vacuum) is applied to the canister.

The ECM monitors the condition of both the key-off monitor and purge flow monitor to ensure proper operation of the EVAP system.

Location of EVAP (Evaporative Emission) System:



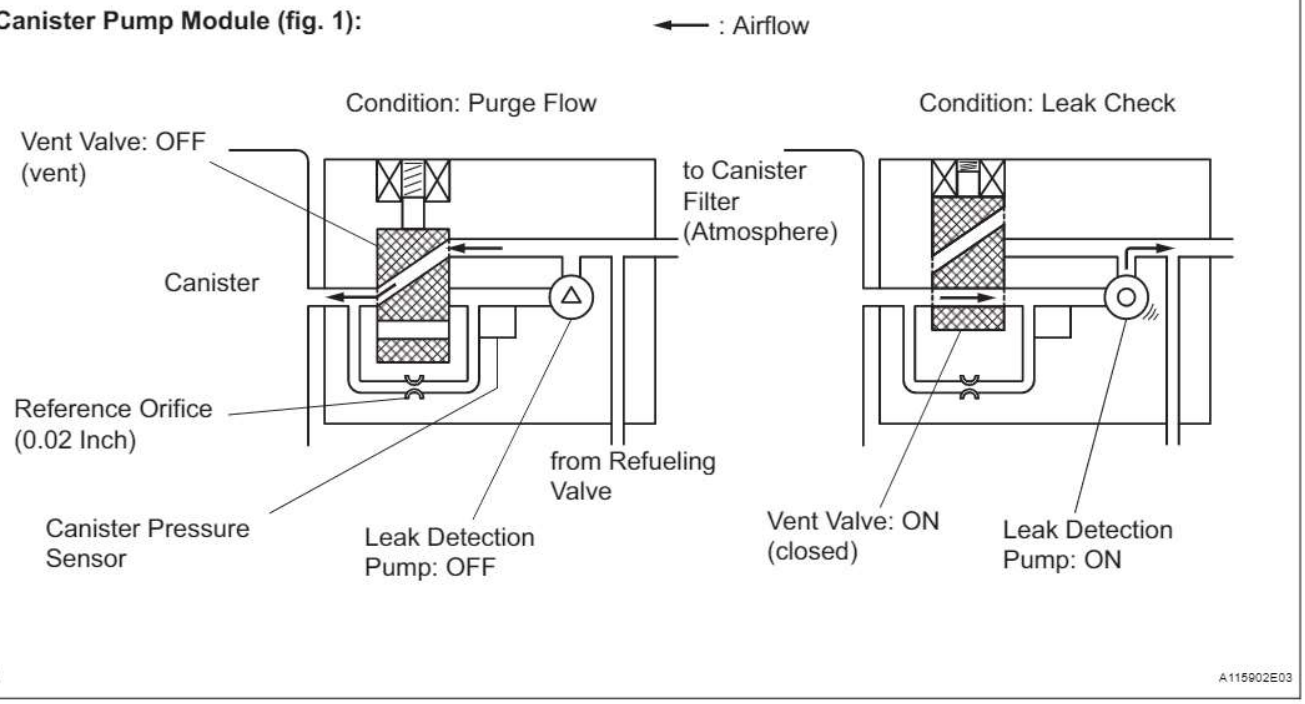
EVAP System Circuit



Component	Operation
Canister	Contains activated charcoal to absorb EVAP that is created in fuel tank.
Cut-off valve	Located in the fuel tank. Valve closes by its own weight when vehicle is overturned to prevent fuel from spilling out.
Purge VSV	Opens or closes line between canister and intake manifold. ECM opens and closes purge VSV to control EVAP purge flow. ECM opens purge valve to purge vapor gas that was absorbed by canister to intake manifold. ECM controls EVAP volume purged to intake manifold by duty cycle (current-carrying time) to purge valve. (ON: Open, OFF: Closed)
Roll-over valve	Located in fuel tank. Valve floats and closes when fuel tank is filled to 100%. Also, valve closes by its own weight when vehicle is over turned to prevent fuel from spilling out.
Soak timer	Built into ECM. Soak timer counts power switch OFF time.
Fuel vapor-containment valve (FVCV)	Opens and closes line between fuel tank and canister. When vehicle is stopped, this valve closes to keep vapor in the tank and prevent it from being absorbed in canister. During refueling, valve opens and vapor is absorbed in canister. When driving, valve acts to change pressure in the tank slightly positive.
Fuel tank pressure sensor	Converts fuel tank pressure into voltage and outputs that voltage. ECM supplies a constant voltage of 5 V to pressure sensor and uses feedback from sensor to monitor fuel tank pressure. (fig. 3)
Canister pump module	(a) to (e) below are canister pump module components. Canister pump module cannot be disassembled.
(a) Vent valve	Vents and closes EVAP system. When ECM turns valve ON, EVAP system is closed. When, ECM turns valve OFF, EVAP system is vented. Negative pressure (vacuum) created in EVAP system to check EVAP leaks by closing purge VSV, turning on vent valve (closed) and operating vacuum pump (refer to fig. 1).
(b) Canister pressure sensor	Indicates EVAP pressure as voltage 5 V is applied by ECM. ECM detects EVAP system pressure using this voltage (refer to fig. 2).
(c) Check valve	Composed of nylon ball and spring. Valve blocks off atmosphere from the vacuum pump.
(d) Leak detection pump	Negative pressure (vacuum) is created in EVAP system for leak check.

Component	Operation
(e) Reference orifice	Diameter is 0.02 inch. Negative pressure (vacuum) is created in reference orifice to measure reference pressure by closing purge VSV, turning off vent valve (vent) and operating leak detection pump. Reference pressure indicates criterion of EVAP small leak.

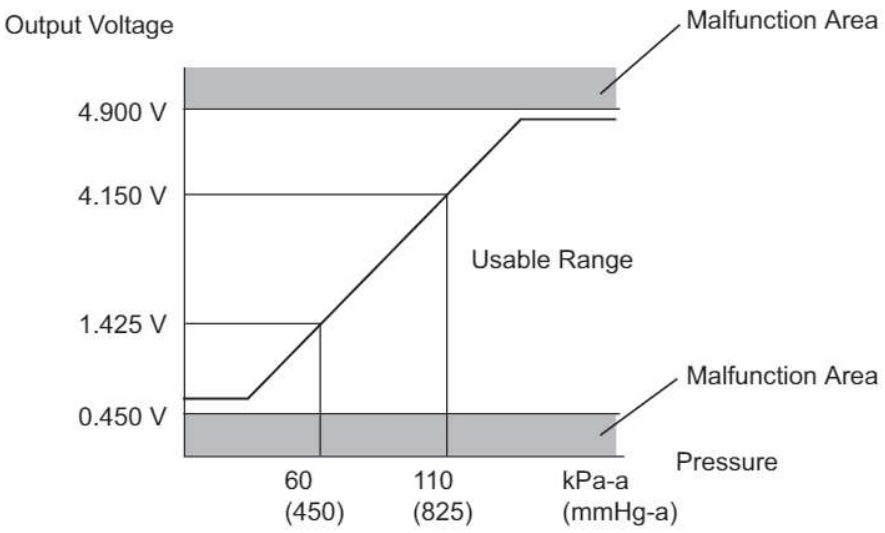
Canister Pump Module (fig. 1):



Y

A115902E03

Canister Pressure Sensor Specification (fig. 2):

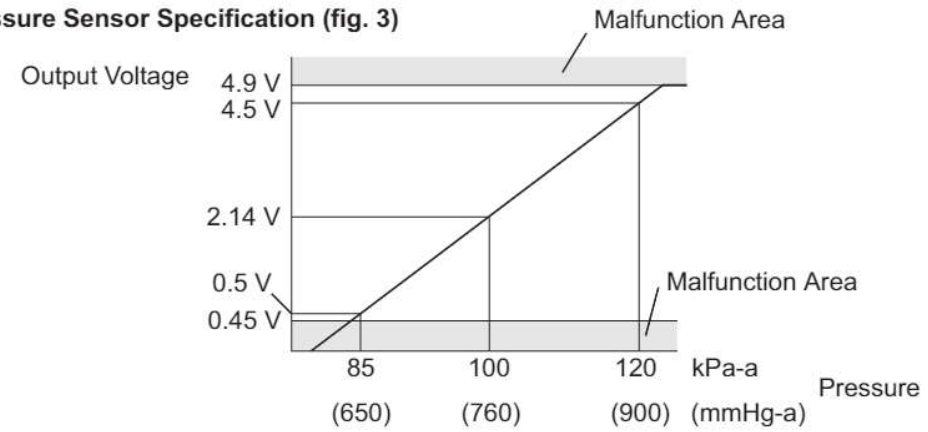


HINT:

Standard atmospheric pressure is 101.3 kPa-a (760 mmHg-a)

A115543E08

Fuel Tank Pressure Sensor Specification (fig. 3)



ES

Key-off monitor

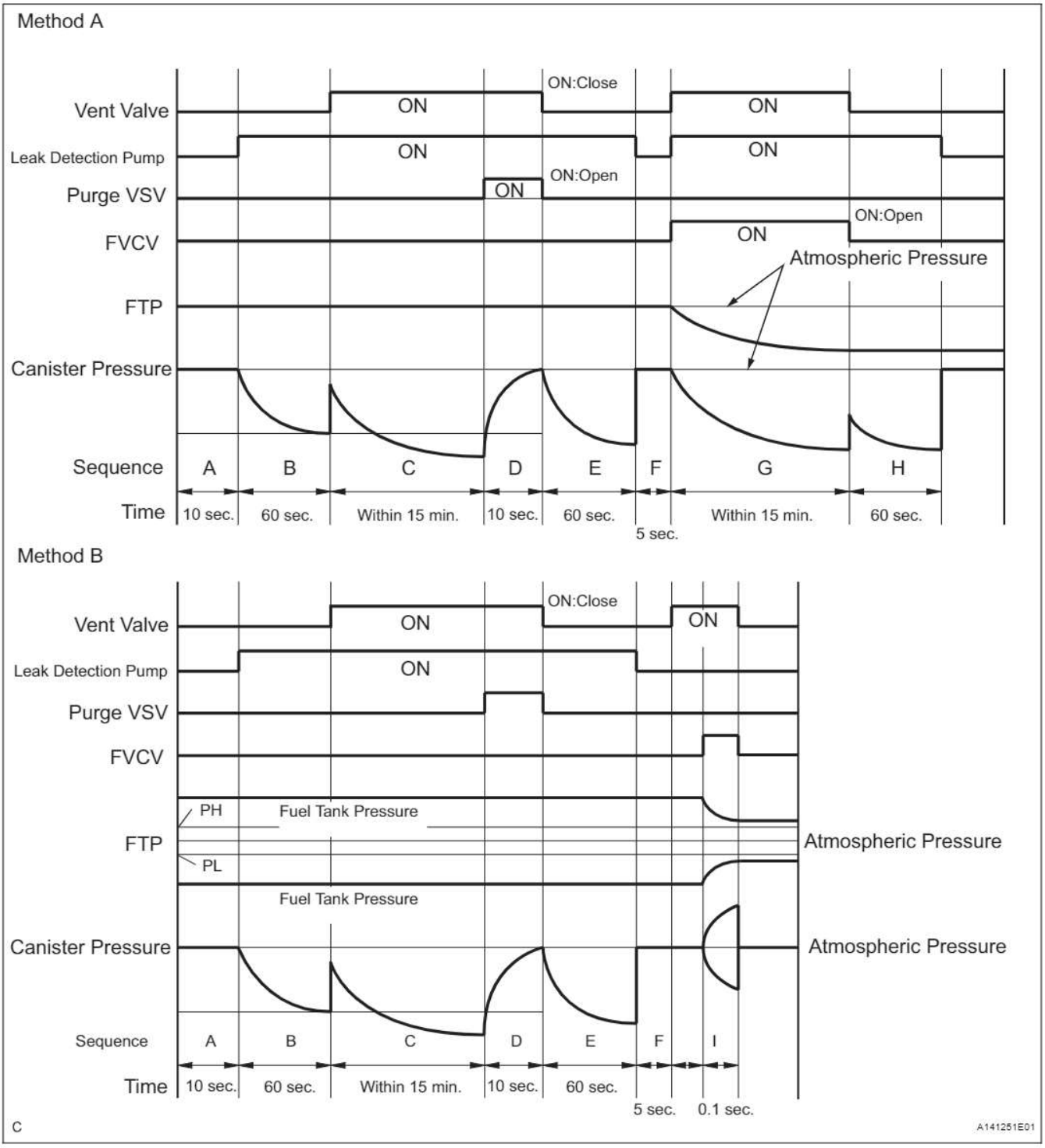
This monitoring system checks for canister pump module malfunctions and leaks from the EVAP and closed tank systems. Be sure to leave the vehicle for at least 5 hours to sufficiently cool the fuel and stabilize fuel tank pressure. This makes EVAP system monitoring more accurate.

HINT:

If the engine coolant temperature is 35°C (95°F) or more, 5 hours after the power switch has been turned off, the ECM will begin performing a monitor check after another 2 hours. If the engine coolant temperature is still 35°C (95°F) or more, 7 hours after the power switch has been turned off, the ECM will begin performing a monitor check after another 2.5 hours.

There are two methods for monitoring the EVAP system.

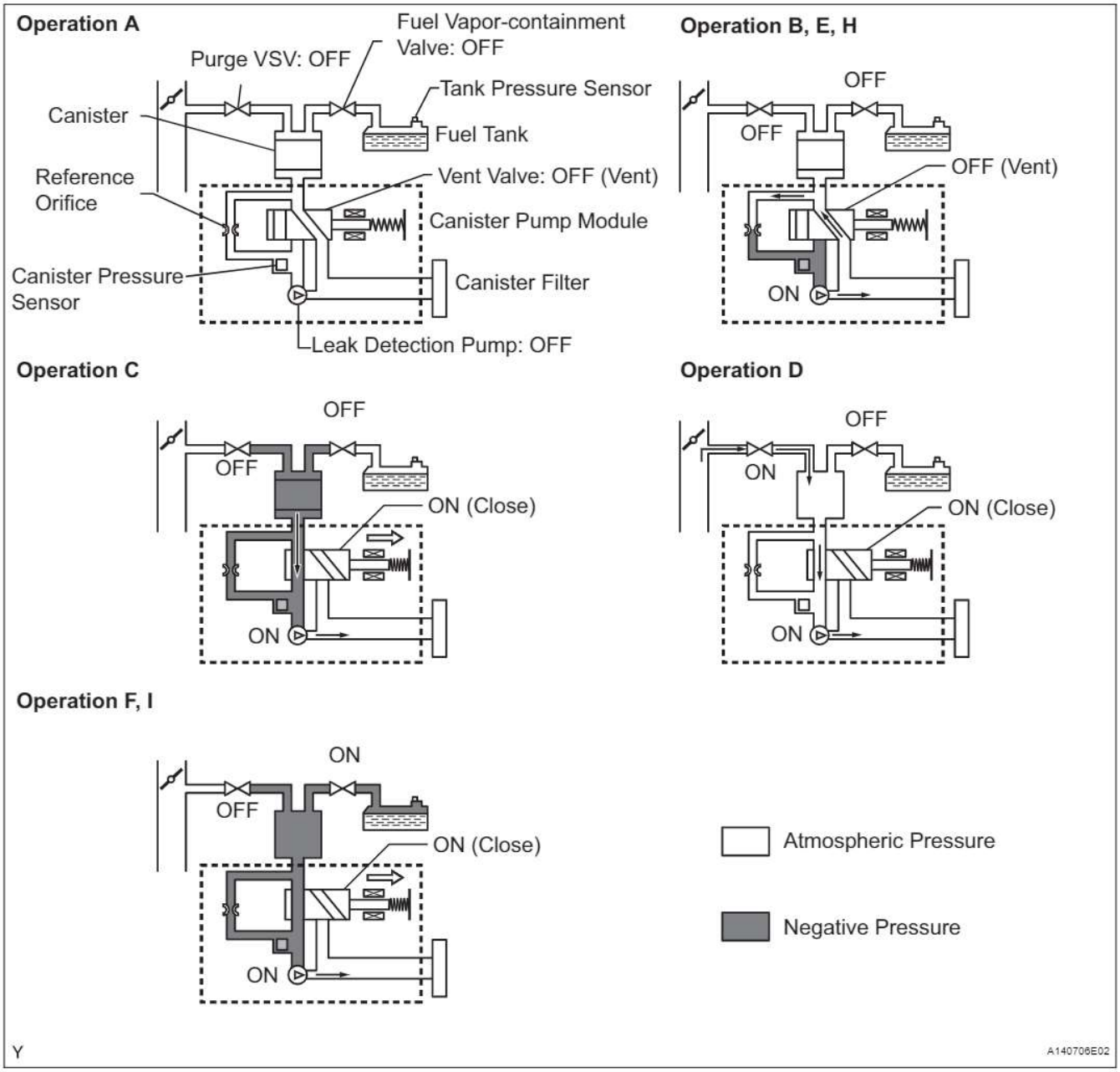
1. If the fuel tank pressure is higher or lower than the atmospheric pressure, the system determines that there are no leaks in the closed tank system and the system will check for leaks from the piping and canister between the purge VSV and canister pump module. (Method A)
2. If the fuel tank pressure is almost the same as the atmospheric pressure, vacuum pressure will enter the fuel tank and the system will check for leaks from the fuel tank after checking for leaks from the canister. (Method B)



Sequence	Operation	Description	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after power switch turned OFF.	-
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure is 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 reference pressure measurement	In order to determine reference pressure standard, leak detection pump creates negative pressure (vacuum) through reference orifice and then ECM checks if leak detection pump and vent valve operate normally.	60 seconds

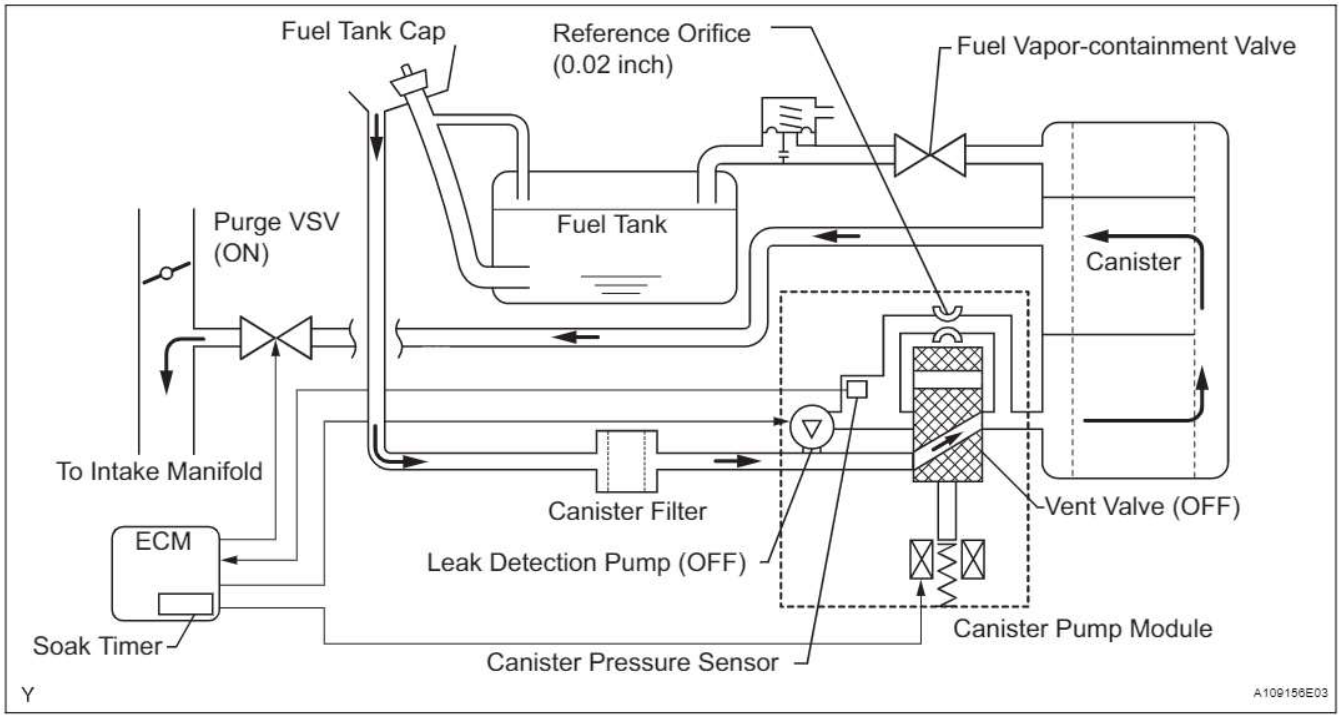
Sequence	Operation	Description	Duration
C	EVAP system pressure measurement	Vent valve is turned ON (closed) to shut EVAP system. Negative pressure (vacuum) is created in EVAP system, and EVAP system pressure is then measured. Write down measured values as they will be used in leak check. If EVAP pressure does not stabilize within 15 minutes, ECM cancels EVAP system monitor.	15 minutes
D	Purge VSV monitor	Purge VSV opens and then EVAP system pressure is measured by ECM. Large increase indicates normal.	10 seconds
E	Second reference pressure measurement	After second reference pressure measurement, leak check is performed by comparing the first and second reference pressure standards. If stabilized system pressure is higher than the second reference pressure standard, ECM determines that EVAP system has a leakage.	60 seconds
F		Fuel tank pressure is compared with atmospheric pressure. If tank pressure is higher than PH or lower than PL, ECM determines that EVAP system is normal and runs sequence I in method B. If tank pressure is around atmospheric pressure, ECM performs sequence G in method A.	5 seconds
G	Fuel tank pressure measurement	Vent valve is turned ON (closed). Fuel vapor-containment valve opens to allow negative pressure into the fuel tank and fuel tank pressure is measured. Write down measured values because they will be used in leak check. If fuel tank pressure does not stabilize within 15 minutes, ECM stops monitoring.	15 minutes*
H	Third reference pressure measurement	After 3rd reference pressure measurement, leak check of fuel tank is performed. If recorded fuel tank pressure is higher than 3rd reference pressure, ECM determines that EVAP system has leakage.	60 seconds
I	Fuel vapor-containment valve close stuck check	Fuel vapor-containment valve is opened for a certain period of time to check whether the valve is stuck closed.	0.1 second
J	Final check	Atmospheric pressure is measured and then monitoring result is recorded by ECM.	-

HINT:
*: If there is only a small amount of fuel in the fuel tank, stabilizing the EVAP pressure takes longer than usual.



Purge flow monitor

If EVAP system pressure change is less than 7.5 mmHg (1 kPa) when the engine is running and the purge VSV is turned ON (closed), the ECM determines that the purge flow is insufficient.



RELATED DTCS

DTC No.	Monitoring Item
P043E	Reference orifice low flow (built into canister pump module)
P043F	Reference orifice high flow (built into canister pump module)
P0441	• Purge VSV close stuck • Purge VSV open stuck • Insufficient purge flow
P1420	Small leak from canister
P1421	Gross leak from canister
P1422	Small leak from fuel tank
P1423	Gross leak from fuel tank
P2401	Leak detection pump OFF stuck (built into canister pump module)
P2402	Leak detection pump ON stuck (built into canister pump module)
P2419	Vent valve ON (close) stuck (built into canister pump module)
P2420	Vent valve OFF (vent) stuck (built into canister pump module)
P2450	Fuel vapor-containment valve open stuck
P2451	Fuel vapor-containment valve close stuck

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-14).

CONFIRMATION DRIVING PATTERN

1. KEY-OFF MONITOR DRIVE PATTERN

(a) Connect the intelligent tester to the DLC3.

(b) Confirm the following conditions are satisfied:

- The fuel level is less than 90%.
- The altitude is less than 8,000 ft. (2,400 m).
- The vehicle is stopped (the vehicle speed is less than 2 mph).
- The ECT is 4.4 to 35°C (40 to 95°F).

- The IAT is 4.4 to 35°C (40 to 95°F).

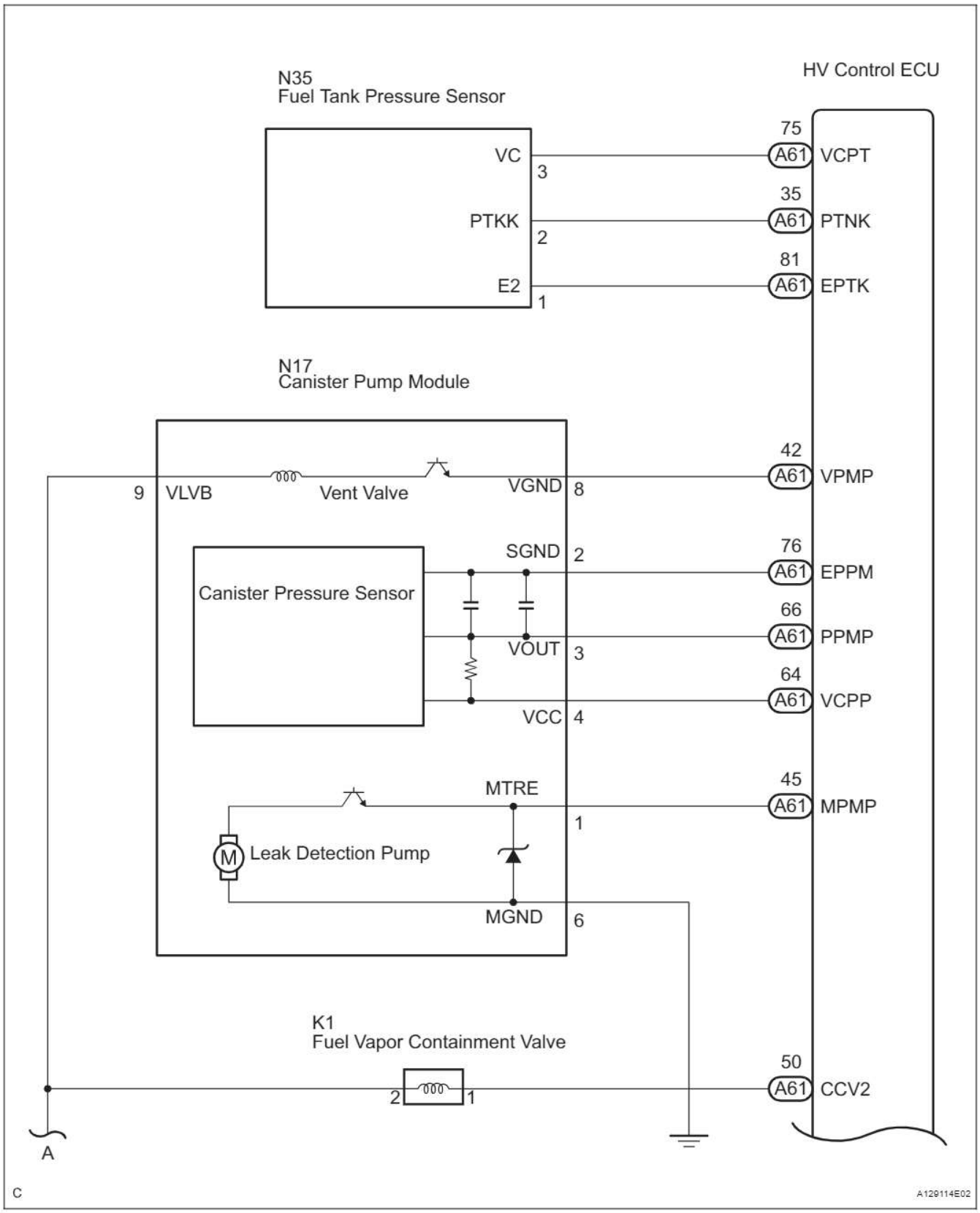
(c) Perform the drive pattern:
(1) Allow the engine to idle for 5 minutes or more.
(2) Turn the power switch off and wait 6 hours.
(d) Check the monitor status with the intelligent tester.

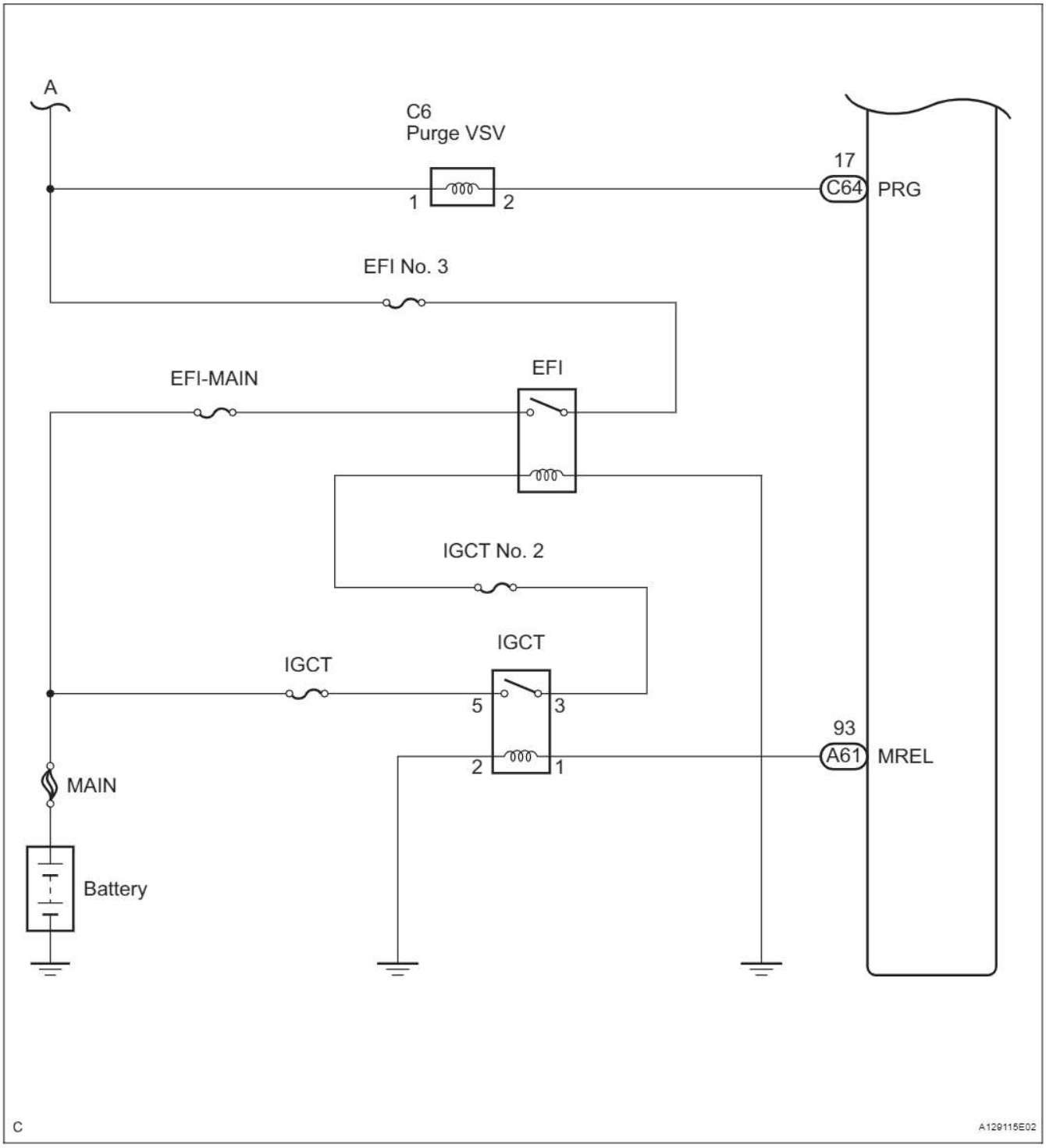
2. PURGE FLOW MONITOR DRIVE PATTERN (P0441)

(a) Connect the intelligent tester to the DLC3.
(b) Confirm that the following conditions are satisfied:
- The Engine Coolant Temperature (ECT) is more than 4.4°C (40°F).
- The Intake Air Temperature (IAT) is more than 4.4°C (40°F).

(c) Perform the drive pattern:
(1) Remove and reinstall the fuel cap to release the fuel tank pressure.
(2) Warm up the engine until the ECT reaches 75°C (167°F) or more.
(3) Run the engine at 2,500 rpm once.
(4) Allow the engine to idle and turn on the air conditioning (A/C) for 1 minute.
(d) Check the monitor status with the intelligent tester.

WIRING DIAGRAM





INSPECTION PROCEDURE

1	CONFIRM DTC

(a) Turn the power switch off and wait 10 seconds.
(b) Turn the power switch on (IG).
(c) Turn the power switch off and wait 10 seconds.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the power switch on (IG) and turn the tester on.

(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Confirm the DTCs.

DTC and Malfunction Cross-Reference:

DTC	Suspected Malfunction
P043E, P043F, P2401, P2402 and P2419	• Reference orifice low flow • Reference orifice high flow • Leak detection pump OFF stuck • Leak detection pump ON stuck • Vent valve ON (close) stuck
P2420	Vent valve OFF (vent) stuck
P0441	Purge VSV close stuck
P0441 and P1421	• Gross leak from canister • Purge VSV open stuck
P1420	Small leak from canister
P1422	Small leak from fuel tank
P1423	Gross leak from fuel tank
P1423 and P2450	FVCV open stuck
P2451	FVCV close stuck

ES

NEXT

2	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (AUTOMATIC OPERATION))

NOTICE:

- **In EVAP SYSTEM CHECK (AUTOMATIC OPERATION), a series of 6 EVAP SYSTEM CHECK steps are performed automatically. A maximum of 15 minutes is required.**
- **Do not perform EVAP SYSTEM CHECK when the fuel tank is more than 90% full because the cut-off valve may be closed and the leak check of the fuel tank is unavailable.**
- **Do not run the engine.**
- **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 with the intelligent tester.
(b) Remove the fuel tank cap and reinstall the fuel cap.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / EVAP SYS CHECK / AUTO OPERATION.
(d) After EVAP SYSTEM CHECK is completed, check for DTCs.

Result

DTC	Result	Proceed to
Set	A malfunction occurs and troubleshooting can be performed	A
Not set	No malfunctions occur and it is difficult to perform troubleshooting	B
DTC is not set and any of the current DTCs (P1422, P1423, or P2450) is set	DTCs have set because of the fuel cap loosening	C

B	Go to step 33
C	END

A

3 IDENTIFICATION OF TROUBLE AREAS

(a) Identification of trouble areas according to DTCs.
(b) Refer to the table below to determine the next procedure according to the output DTCs.

ES

Result

DTC	Suspected Malfunction	Proceed to
P0441, P1420, P1421, P1422, P1423, P2450 and/or P2451	• Purge VSV open stuck • Purge VSV close stuck • Gross leak from canister • Small leak from canister • Gross leak from fuel tank • Small leak from fuel tank • FVCV open stuck • FVCV close stuck	A
P043E, P043F, P2401, P2402, P2419 and/or P2420	• Reference orifice low flow • Reference orifice high flow • Leak detection pump OFF stuck • Leak detection pump ON stuck • Vent valve ON (close) stuck • Vent valve OFF (vent) stuck	B

B	Go to step 11

A

4 IDENTIFICATION OF TROUBLE AREAS

(a) Identification of trouble areas according to DTCs.
(b) Refer to the table below to determine the next procedure according to the output DTCs.

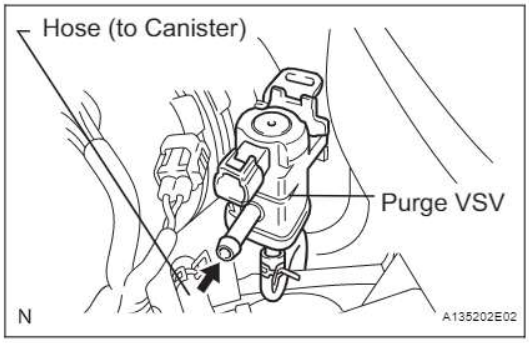
Result

DTC	Suspected Malfunction	Proceed to
P0441	Purge VSV close stuck	A
P0441 and P1421	•Gross leak from canister •Purge VSV open stuck	B
P1420	Small leak from canister	
P1422	Small leak from fuel tank	C
P1423	Gross leak from fuel tank	
P1423 and P2450	FVCV open stuck	D
P2451	FVCV close stuck	

B	Go to step 18
C	Go to step 21
D	Go to step 23

A

5 CHECK VACUUM HOSE (PURGE VSV - INTAKE MANIFOLD)



(a) Disconnect the hose (to intake manifold) from the purge VSV.
(b) Put the engine in inspection mode (See page ES-35).
(c) Use your finger and confirm that the purge VSV has suction.

ES

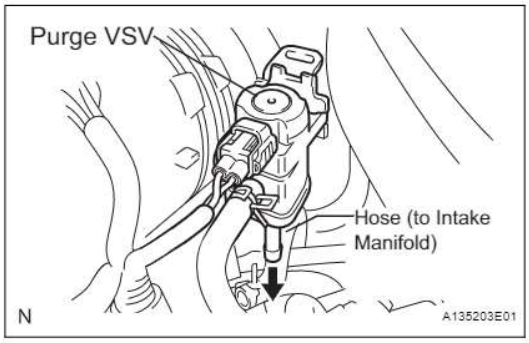
Result

Result	Proceed to
There is suction. Conclusion: EVAP hose between purge VSV and intake manifold is normal.	OK
There is no suction. Conclusion: Problem in intake manifold or hose between purge VSV and intake manifold	NG

NG → Go to step 32

OK

6 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (PURGE VSV)



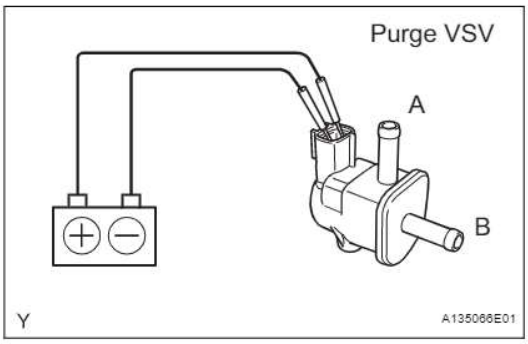
(a) Disconnect the hose (to canister) from the purge VSV.
(b) Put the engine in inspection mode (See page ES-35).
(c) Enter the following menu: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / EVAP VSV (ALONE).
(d) Turn the purge VSV OFF (Purge VSV: OFF).
(e) Use your finger and confirm that the purge VSV has no suction.
(f) Turn the purge VSV ON (Purge VSV: ON).
(g) Use your finger to confirm that the purge VSV has suction.

OK:
Purge VSV functions normally

OK → Go to step 32

NG

7	CHECK PURGE VSV



(a) Remove the purge VSV.
(b) Apply compressed air to the purge VSV, confirm that no air flows from A to B as shown in the illustration.
(c) Apply battery voltage to the purge VSV.
(d) While applying compressed air, confirm that air flows from A to B as shown in the illustration.

ES

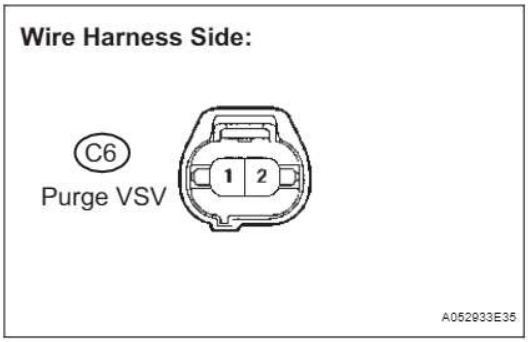
Result

Result	Proceed to
Air flows from A to B. Conclusion: purge VSV is normal.	OK
No air flows from A to B. Conclusion: purge VSV is malfunctioning.	NG

NG → Go to step 27

OK

8	CHECK HARNESS AND CONNECTOR (PURGE VSV - EFI NO.2 FUSE)



(a) Disconnect the C6 purge VSV connector.
(b) Turn the power switch on (IG).
(c) Measure the voltage between terminal 1 of the E18 connector and body ground.

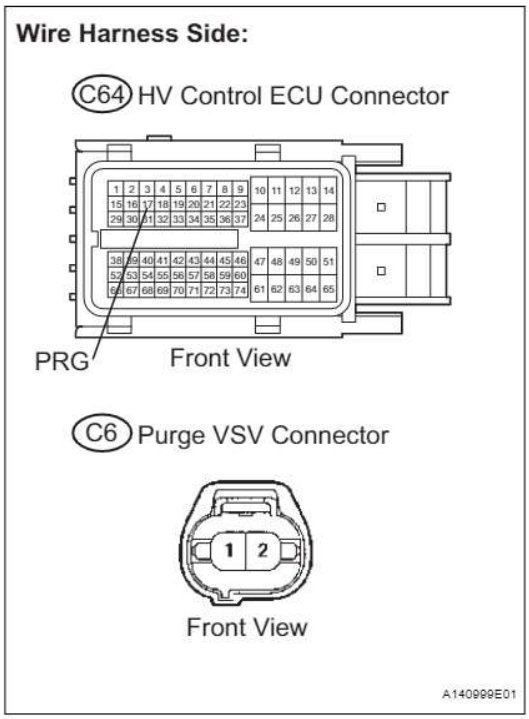
Result

Result	Proceed to
11 to 14 V Conclusion: No problem exists on power source's wires.	OK
Except above Conclusion: Problem in wire or connector between purge VSV and ECM.	NG

NG → Go to step 31

OK

9	CHECK HARNESS AND CONNECTOR (PURGE VSV - HV CONTROL ECU)



(a) Disconnect the C64 hybrid vehicle control ECU connector and the C6 purge VSV connector.
(b) Measure the resistance.

Standard resistance

Tester Connection	Specified Condition
PRG (C64-17) - C6-2	10 Ω or less
PRG (C64-17) - Body ground	10 kΩ or more
C6-2 - Body ground	10 kΩ or more

NG → Go to step 31

OK

10	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

11	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (VACUUM PUMP)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG).
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VACUUM PUMP.
(d) Turn the leak detection pump ON with the tester.
(e) Touch the canister pump module and check if the pump is moving.

OK:

Pump operates

NG → Go to step 13

OK

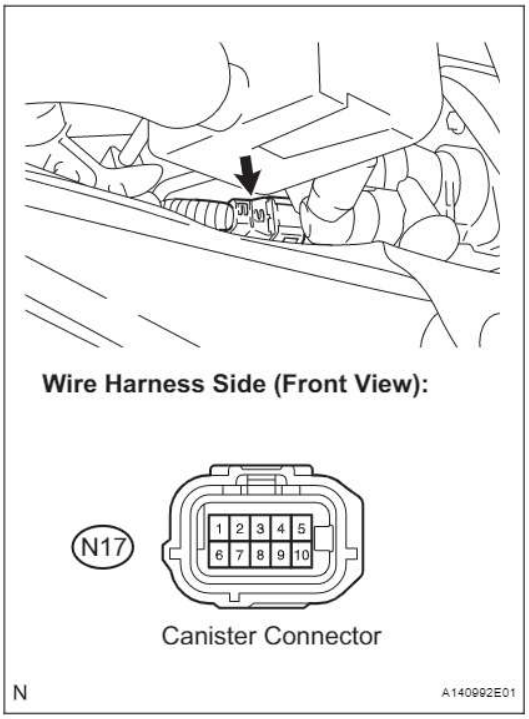
ES

12	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (VENT VALVE)

(a) Remove the canister lower cover.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the power switch on (IG).
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VENT VALVE.
(e) Touch the canister pump module, use the tester to turn the vent valve ON and OFF, and check if the vent valve is moving.
OK:
Vent valve vibration can be felt.

OK	Go to step 28
NG	Go to step 16

13	PERFORM ACTIVE TEST BY INTELLIGENT TESTER (VACUUM PUMP)



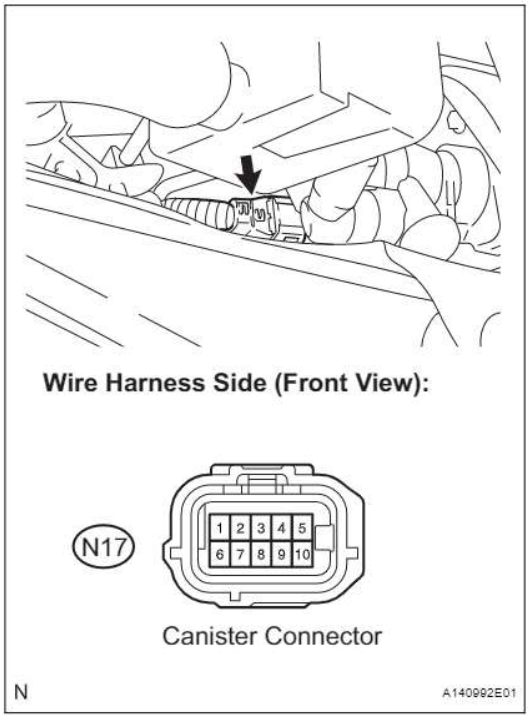
(a) Turn the power switch off.
(b) Remove the canister lower cover.
(c) Disconnect the canister pump module connector.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the power switch on (IG).
(f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VACUUM PUMP.
(g) Turn the leak detection pump ON with the tester.
(h) Measure the voltage between MTRB terminal 1 of the canister pump module connector and body ground when the leak detection pump is turned ON and OFF using the tester.
Standard voltage:
10 to 14 V

NG	Go to step 15

OK

14	CHECK HARNESS AND CONNECTOR (CANISTER PUMP MODULE - BODY GROUND)

(a) Remove the canister lower cover.

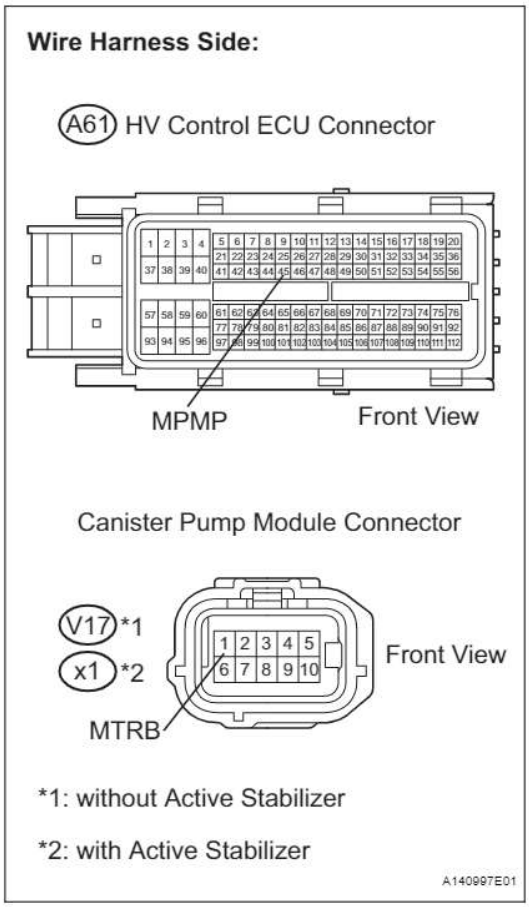


(b) Disconnect the canister pump module connector.
(c) Measure the resistance between the MGND terminal of the canister pump module and body ground.
Standard resistance:
Below 1 Ω

OK	Go to step 28
NG	Go to step 32

ES

15 CHECK HARNESS AND CONNECTOR (ECM - CANISTER PUMP MODULE)



(a) Disconnect the A53 ECM connector.
(b) Disconnect the canister pump module connector.
(c) Measure the resistance between the MPMP terminal of the ECM connector and the MTRB terminal of the canister pump module connector.
Standard resistance:
without Active Stabilizer

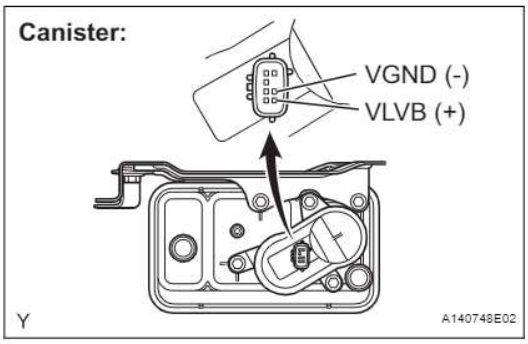
Tester Connection	Specified Condition
MPMP (A53-16) - MTRB (V17-1)	10 Ω or less
MPMP (A53-16) or MTRB (V17-1) - Body ground	10 kΩ or more

with Active Stabilizer

Tester Connection	Specified Condition
MPMP (A53-16) - MTRB (x1-1)	10 Ω or less
MPMP (A53-16) or MTRB (x1-1) - Body ground	10 kΩ or more

OK	Go to step 26
NG	Go to step 32

16	INSPECT CANISTER PUMP MODULE (VENT VALVE OPERATION)



(a) Turn the power switch off.
(b) Remove the canister lower cover.
(c) Disconnect the canister pump module connector.
(d) Apply battery voltage to the VLVB and VGND terminals of the canister pump module.
(e) Touch the canister pump module to confirm the vent valve operation.

ES

Result

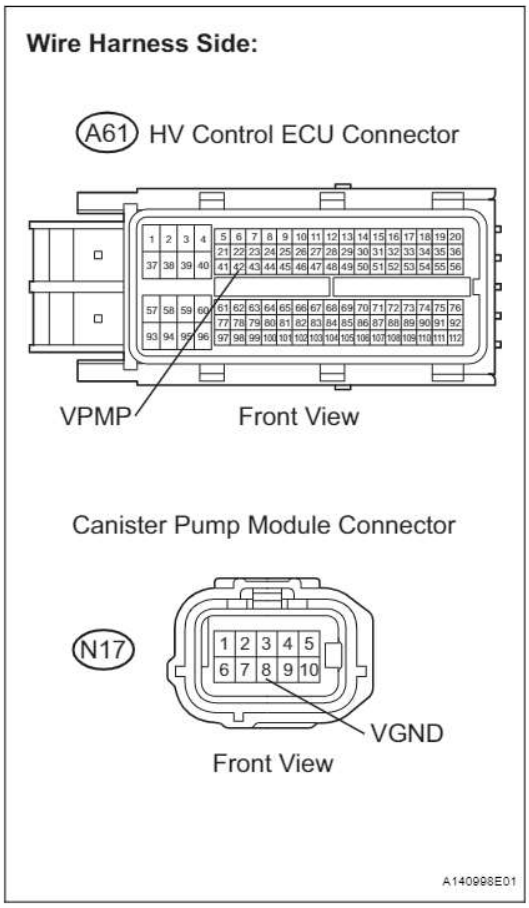
Test Results	Suspected Trouble Areas	Proceed to
Operating	1. Wire harness between vent valve and ECM 2. ECM	A
Not operating	Vent valve	B

(f) Reconnect the canister connector.

B → Go to step 28

A

17	CHECK HARNESS AND CONNECTOR (CANISTER PUMP MODULE - HV CONTROL ECU)



(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Disconnect the canister pump module connector.
(c) Measure the resistance between the VPMP terminal of the ECM connector and the VGND terminal of the canister pump module connector.

Standard resistance

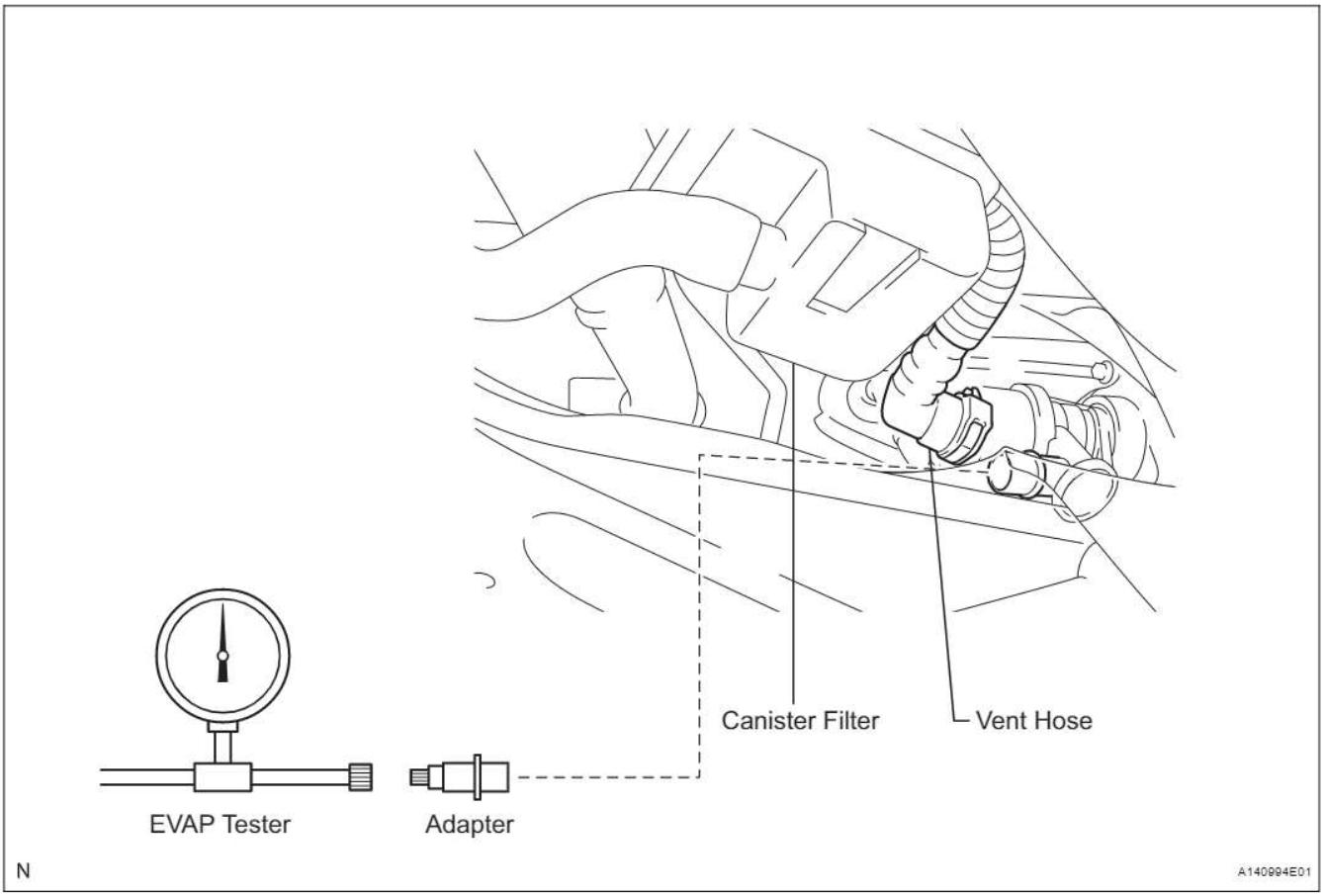
Tester Connection	Specified Condition
VPMP (A61-42) - VGND (N17-8)	10 Ω or less
VPMP (A61-42) or VGND (N17-8) - Body ground	10 kΩ or more

(d) Reconnect the hybrid vehicle control ECU connector.
(e) Reconnect the canister pump module connector.

OK	Go to step 26
NG	Go to step 31

ES

18	LOCATE EVAP LEAK PART (PURGE VSV - CANISTER)



(a) Disconnect the vent hose.
(b) Connect the EVAP tester to the vent hose with the adapter.
(c) Pressurize the EVAP system to 3.2 to 3.7 kPa (24 to 28 mmHg).
(d) Apply soapy water to the piping and connecting parts of the EVAP system.
(e) Look for areas where bubbles appear. This indicates the leak point.
(f) Repair or replace the leak point.
HINT:
Disconnect the hose between the canister and the fuel tank from the canister. Block the canister side and conduct an inspection. In this way, the fuel tank can be excluded as an area suspected of causing fuel leaks.

NEXT

19	REPLACE MALFUNCTIONING PARTS, COMPONENT AND AREA

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

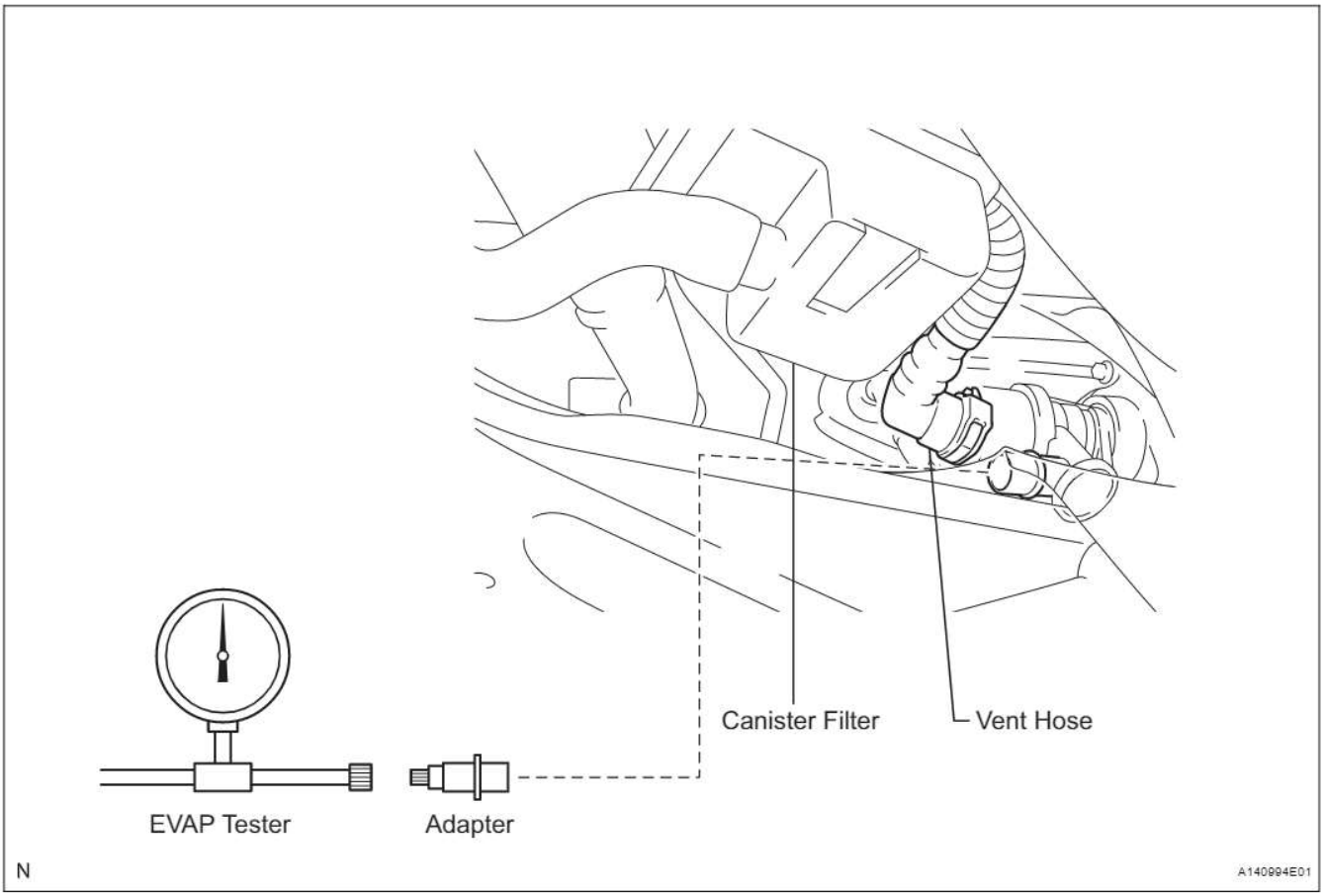
20	CHECK FUEL TANK CAP ASSEMBLY

(a) Check if the fuel cap is tightened until a few "click" sounds are heard.
(b) If you have the EVAP tester, check the fuel cap using the fuel cap adaptor.
  (1) Install the fuel cap to the fuel cap adaptor, and connect the hose from the EVAP tester's pump.
  (2) Pressurize the fuel cap adaptor to between 24 and 28 mmHg for 45 seconds.
  (3) Stop the pump and seal the fuel cap adaptor.
  (4) Wait 2 minutes.
  (5) Confirm that the pressure is higher than 15 mmHg.
  OK:
  Higher than 15 mmHg

NG → **Go to step 30**

OK

21	LOCATE EVAP LEAK PART (FUEL VAPOR-CONTAINMENT VALVE - FUEL TANK)



(a) Disconnect the vent hose.
(b) Connect the EVAP tester to the vent hose with the adapter.
(c) Connect the intelligent tester to DLC3.
(d) Turn the power switch on (IG).
(e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / FVCV.
(f) Turn the fuel vapor-containment valve ON with the tester.
(g) Pressurize the EVAP system to 3.2 to 3.7 kPa (24 to 28 mmHg).
(h) Apply soapy water to the piping and connecting parts of the EVAP system.
(i) Look for areas where bubbles appear. This indicates the leak point.
(j) Repair or replace the leak point.
HINT:
Disconnect the hose between the canister and the fuel tank from the canister. Block the canister side and conduct an inspection. In this way, the fuel tank can be excluded as an area suspected of causing fuel leaks.

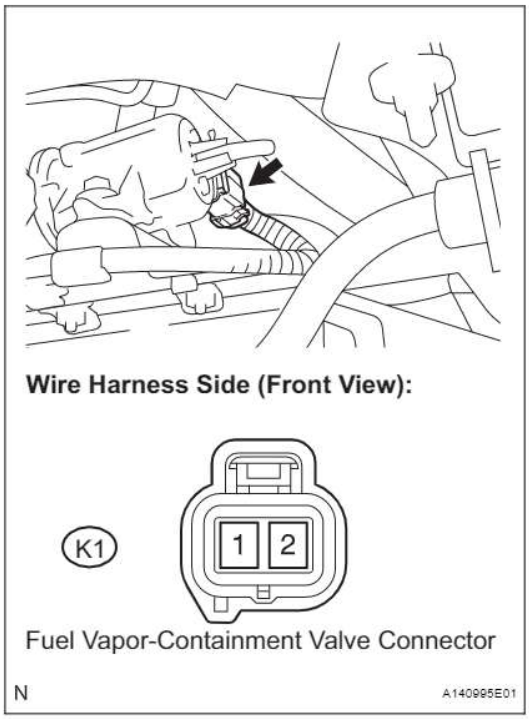
NEXT

22	REPLACE MALFUNCTIONING PART

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

23	CHECK FUEL VAPOR-CONTAINMENT VALVE ASSEMBLY (POWER SOURCE CIRCUIT)



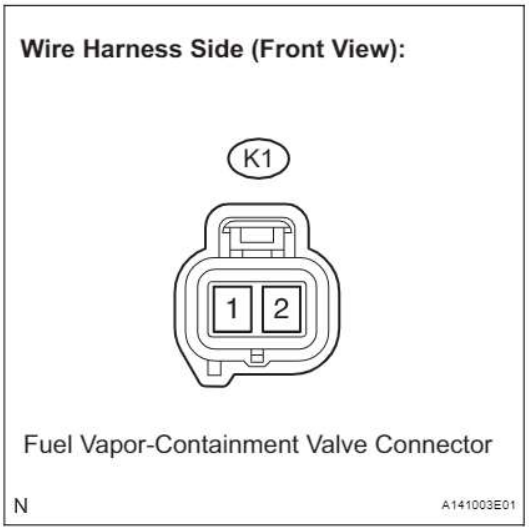
(a) Disconnect the K1 fuel vapor-containment valve connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the power switch on (IG).
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / TANK CLS VALVE.
(e) Turn the fuel vapor-containment valve ON with the tester.
(f) Measure the voltage between terminals 5 and 6 of the eV1 connector.
Standard voltage:
10 to 14 V

OK	Go to step 29

NG

ES

24	CHECK HARNESS AND CONNECTOR (FUEL VAPOR-CONTAINMENT VALVE - EFI NO. 2 FUSE)

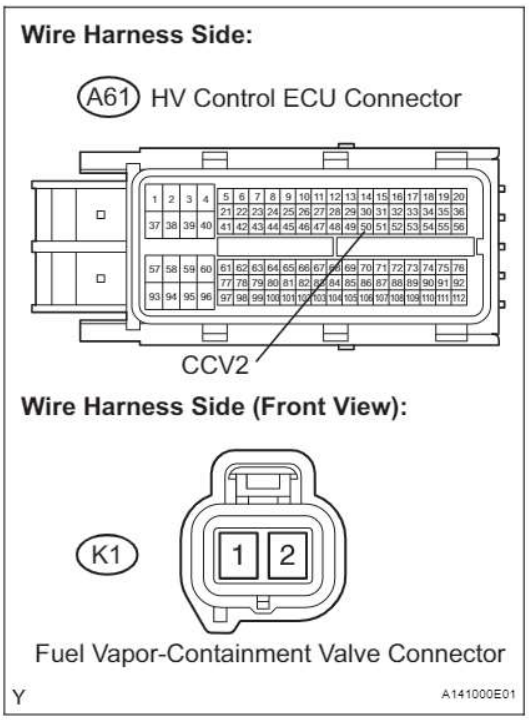


(a) Disconnect the K1 fuel vapor-containment valve.
(b) Measure the voltage between terminal eV1-6 and body ground.
Standard voltage:
10 to 14 V

NG → **Go to step 31**

OK

25	CHECK HARNESS AND CONNECTOR (FUEL VAPOR-CONTAINMENT VALVE ASSEMBLY - ECM)



(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Disconnect the K1 fuel vapor-containment valve.
(c) Measure the resistance.
Standard resistance

Tester Connection	Specified Condition
CCV2 (A61-50) - K1-1	10 Ω or less
CCV2 (A61-50) or K1-1 - Body ground	10 kΩ or more

NG → **Go to step 31**

OK

26	REPLACE HYBRID VEHICLE CONTROL ECU

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

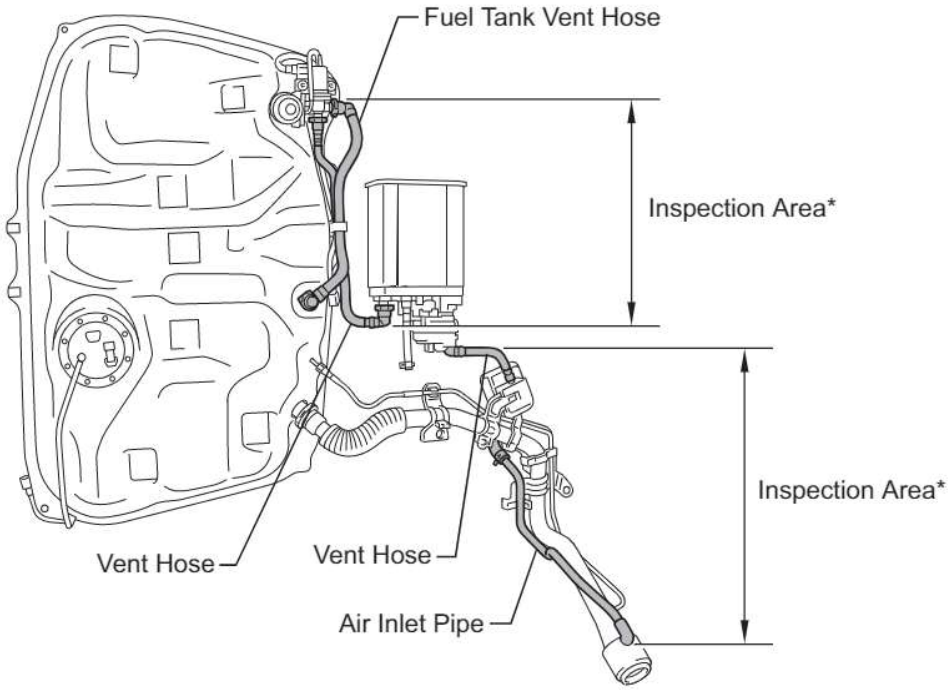
27	REPLACE PURGE VSV

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

28	REPLACE CANISTER ASSEMBLY

(a) Replace the canister assembly (See page EC-9).
NOTICE:
When replacing the canister, check the canister pump module interior and related pipes for water, fuel and other liquids. If liquids are present, check for disconnections and/or cracks in the following: 1) the pipe from the air inlet port to the canister pump module; 2) the canister filter; and 3) the hose from the canister to the fuel tank.



NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

29	REPLACE FUEL VAPOR-CONTAINMENT VALVE

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

30	REPLACE FUEL TANK CAP

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

31	REPAIR OR REPLACE HARNESS AND CONNECTOR

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

32	REPAIR OR REPLACE VACUUM HOSE

NEXT

PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

33	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION))

HINT:
In the manual operation check, the EVAP system can be checked in signal steps. Valve operation and pressure in each step can also be checked.

(a) Clear the DTCs (See page ES-31).
(b) Remove the fuel tank cap and reinstall the fuel cap.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / EVAP SYS CHECK / MANUAL OPERATION.

NOTICE:

- **In EVAP SYSTEM CHECK (AUTO OPERATION), the series of 9 EVAP SYSTEM CHECK steps is performed automatically. It takes a maximum of approximately 18 minutes.**
- **Do not perform 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 EVAP SYSTEM CHECK, keep the temperature below 35°C (95°F).**

Tester Display

Display	Detail
Atm Press Check	The number of steps and step names are displayed
PURGE VSV	Purge VSV condition is displayed: ON (Open) / OFF (Closed)
VENT VALVE	Vent valve condition is displayed: ON (Closed) / OFF (Vent)
LEAK DETECTION PUMP	Leak detection pump condition is displayed: ON / OFF

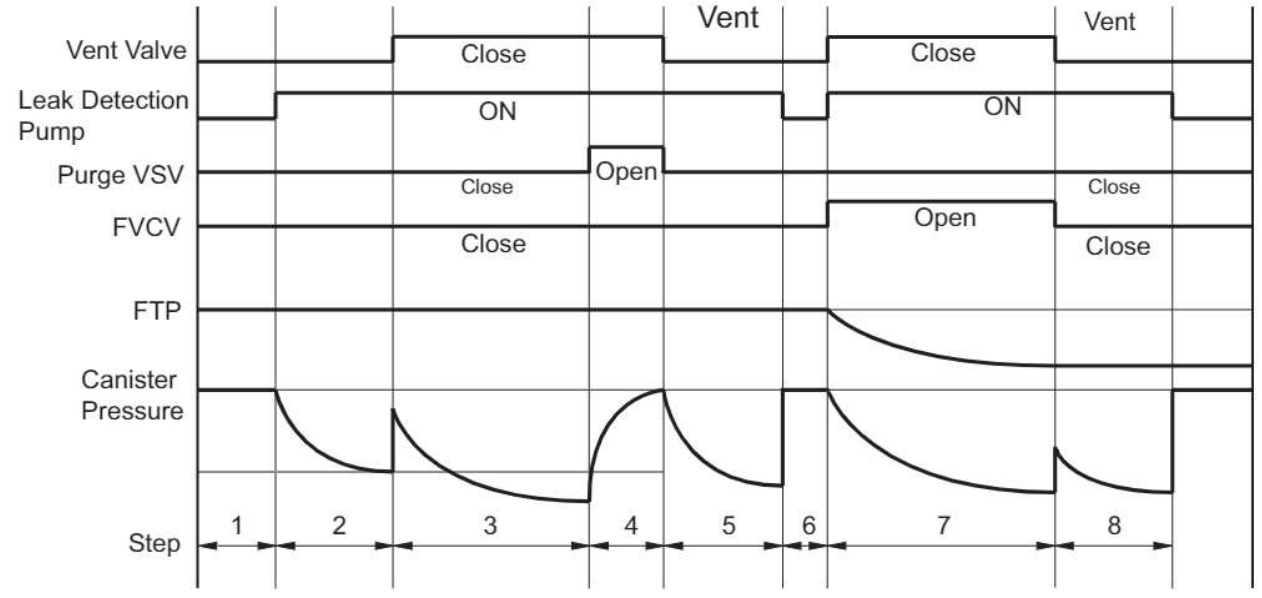
Display	Detail
FVCV	Fuel vapor-containment valve condition is displayed: ON (Open) / OFF (Closed)
TANK PRESS	Fuel tank pressure (Gauge pressure)
VAPOR PRESS	EVAP pressure (Gauge pressure)
VAPOR PRESS	EVAP pressure (Absolute pressure)
Time (Step)	Elapsed time for each step
Time (VSV)	Accumulated purge VSV open time
Time (PUMP)	Accumulated leak detection pump operating time

Manual Operation Step

Step	Operation
1. Atm Press Check 1	Atmospheric pressure measurement
2. Ref Press Check 1	First reference pressure measurement
3. Leak Check	EVAP system pressure measurement
4. Purge VSV Check	Purge VSV monitor
5. Ref Press Check 2	Second reference pressure measurement
6. Resetting	Resetting
7. Tank Leak Check	Fuel tank pressure measurement
8. Ref Press Check 3	Third reference pressure measurement

ES

Timing Chart



NEXT

34	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 1))

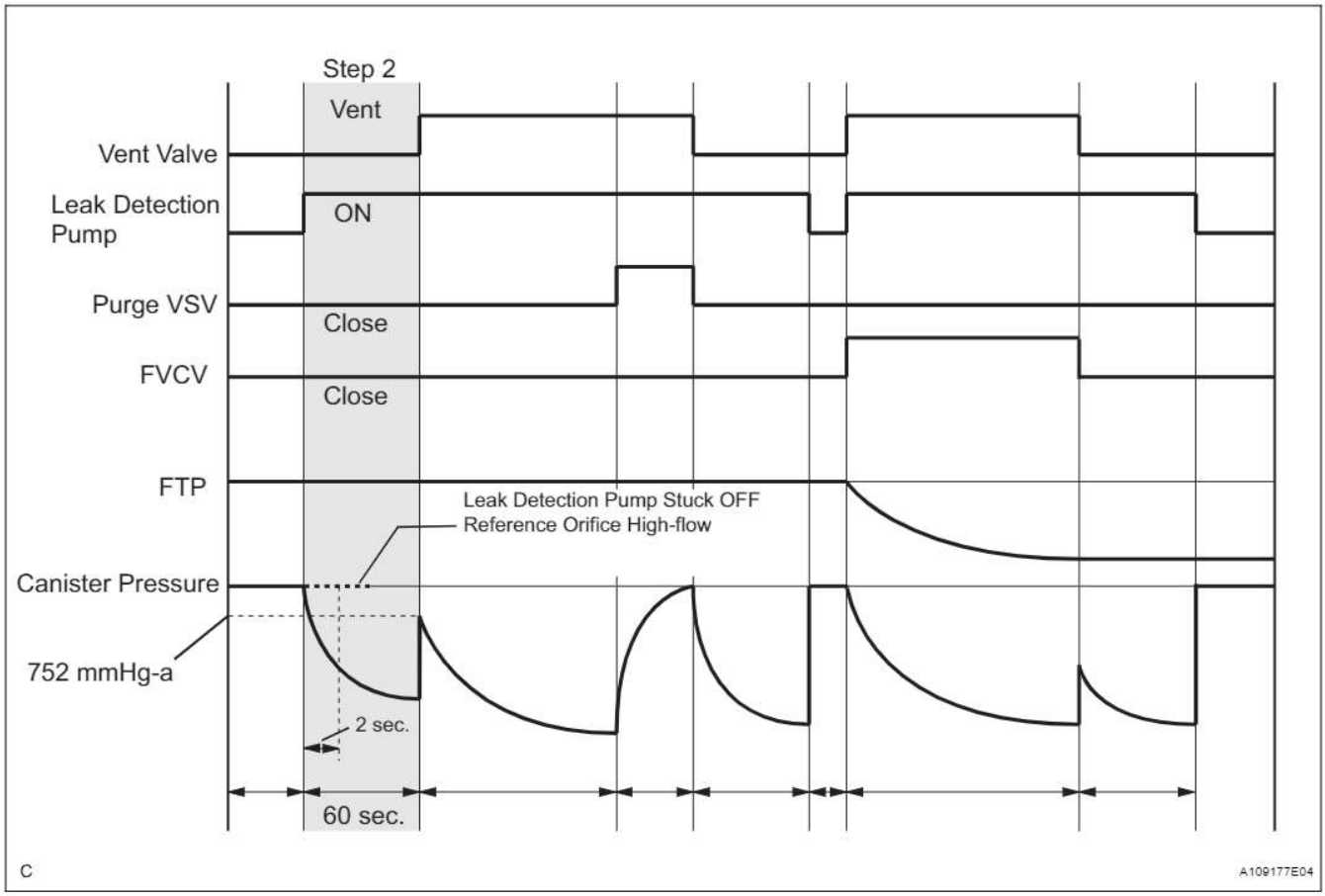
(a) Select step 1 and wait 10 seconds.

NEXT

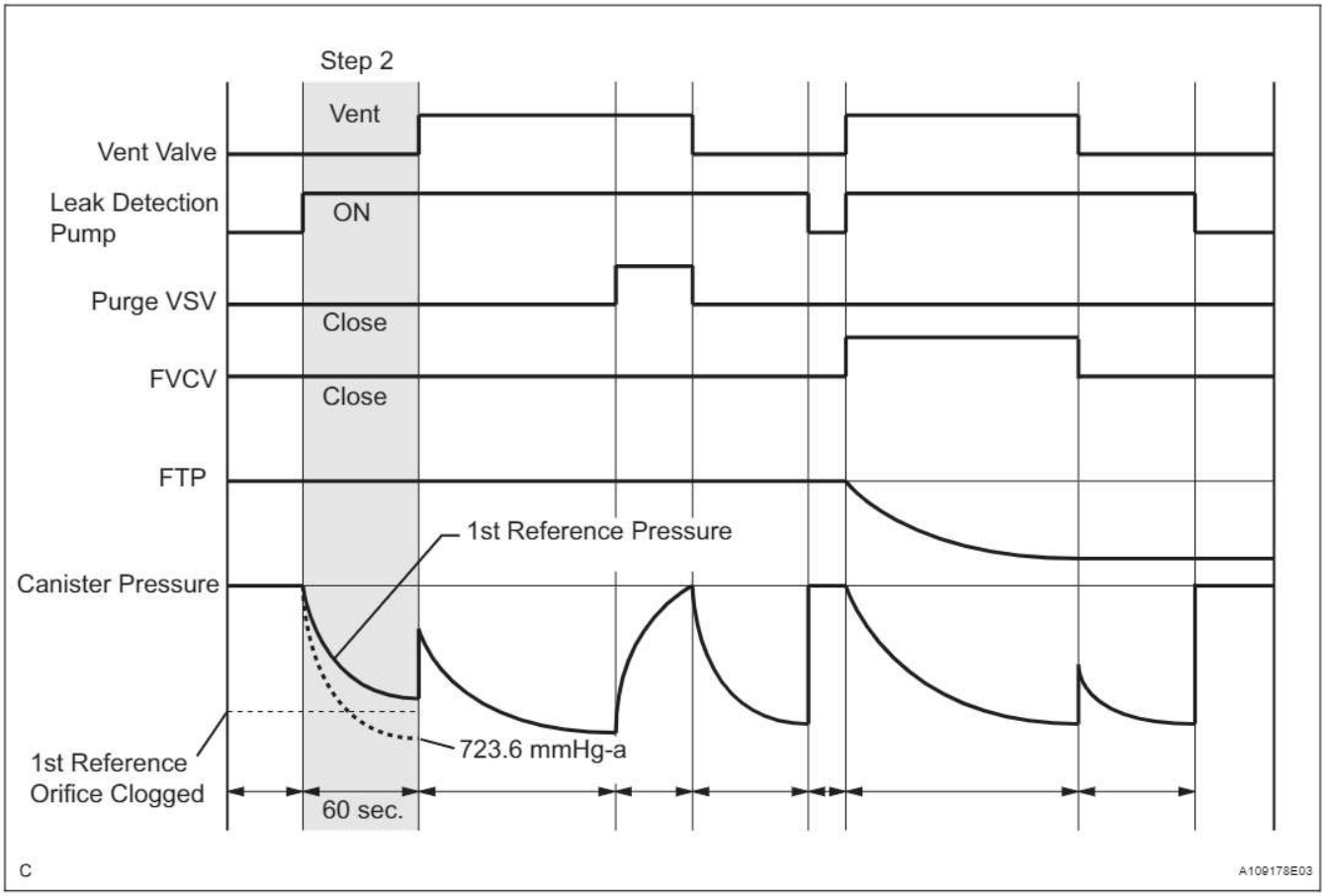
35	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 2))

(a) Perform step 2.
(b) Check the EVAP pressure 2 seconds after the leak detection pump is activated*.
*: The leak detection pump begins to operate at the start of step 2.

ES



(c) Check the EVAP pressure again when it has stabilized. This pressure is the first reference pressure standard.



Result

Test Result	Suspected Trouble Area	Proceed to
EVAP pressure in step (b) is between 723.6 mmHg-a and 752 mmHg-a	Not yet determined	A
EVAP pressure in step (b) is 752 mmHg-a or more	• Reference orifice high-flow • Leak detection pump stuck OFF	B
EVAP pressure in step (b) is below 723.6 mmHg-a	Reference orifice clogged	C

B → Go to step 11

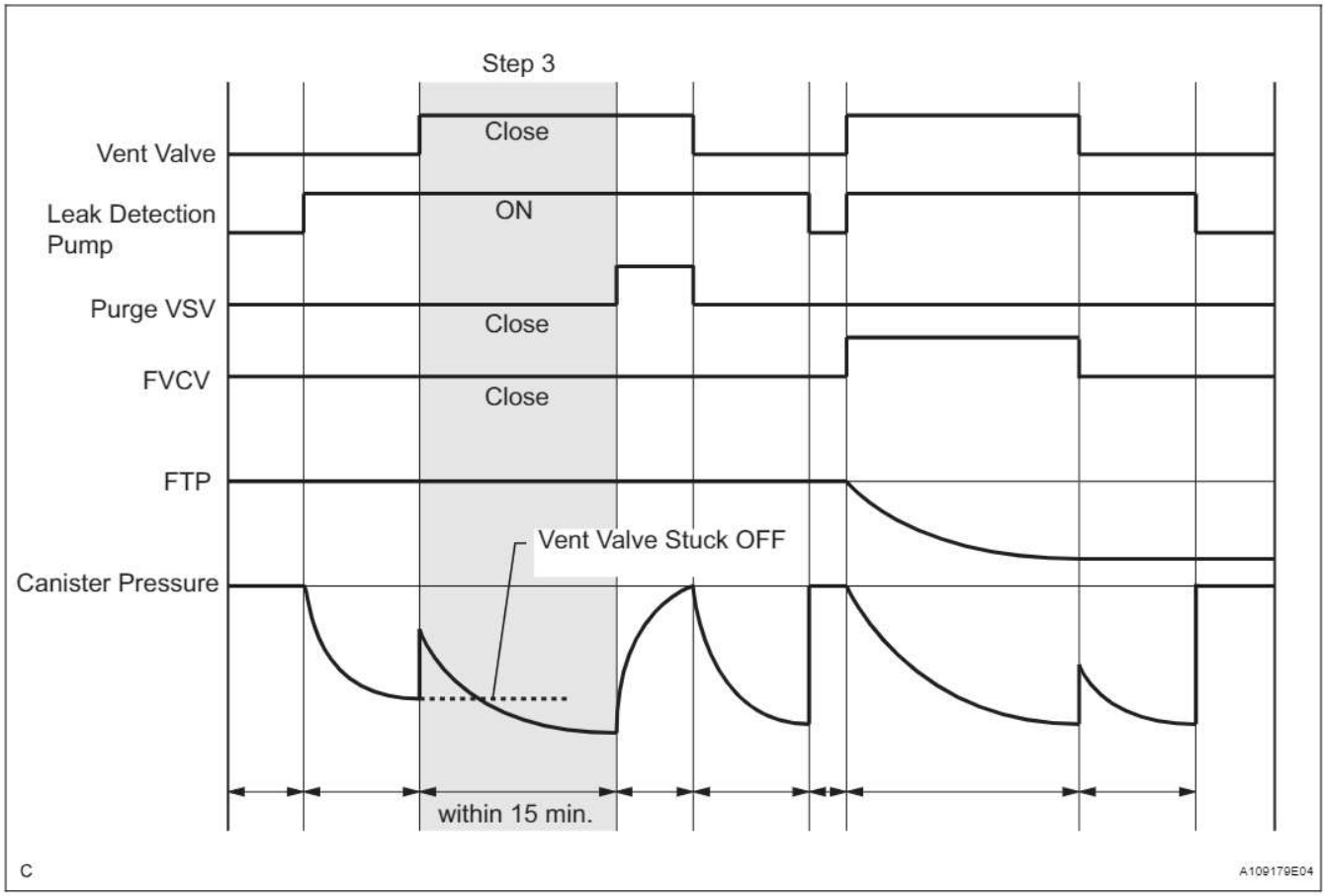
C → Go to step 28

A

36	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 3))

(a) Perform step 3.

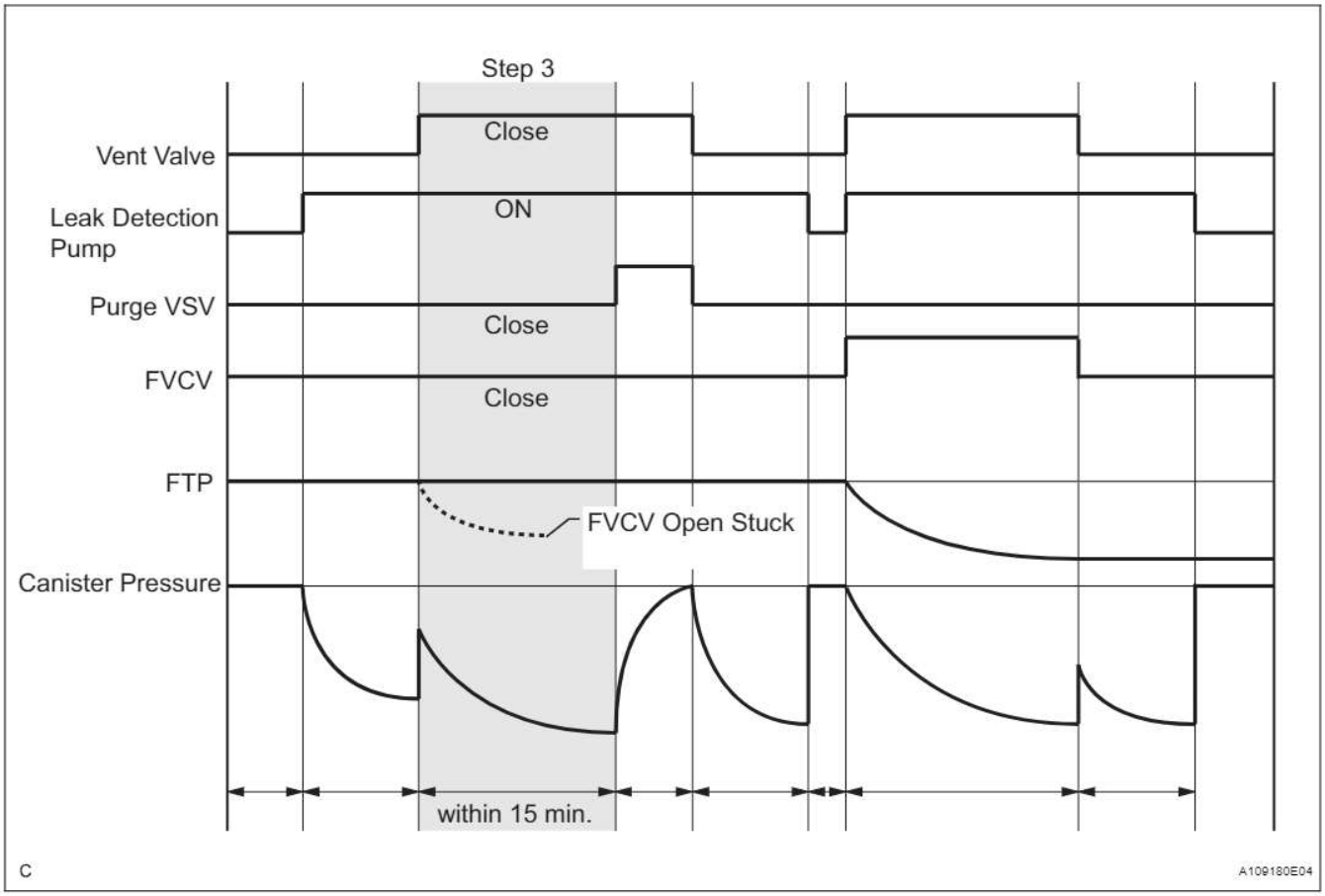
(b) Check the EVAP pressure change in step 3.



Result

Test Result	Suspected Trouble Area	Proceed to
EVAP pressure change in step (b) is 762 mmHg-a or more	Not yet determined	A
EVAP pressure in step (b) is below 762 mmHg-a	Vent valve stuck OFF	B

(c) Check the fuel tank pressure change in step 3.

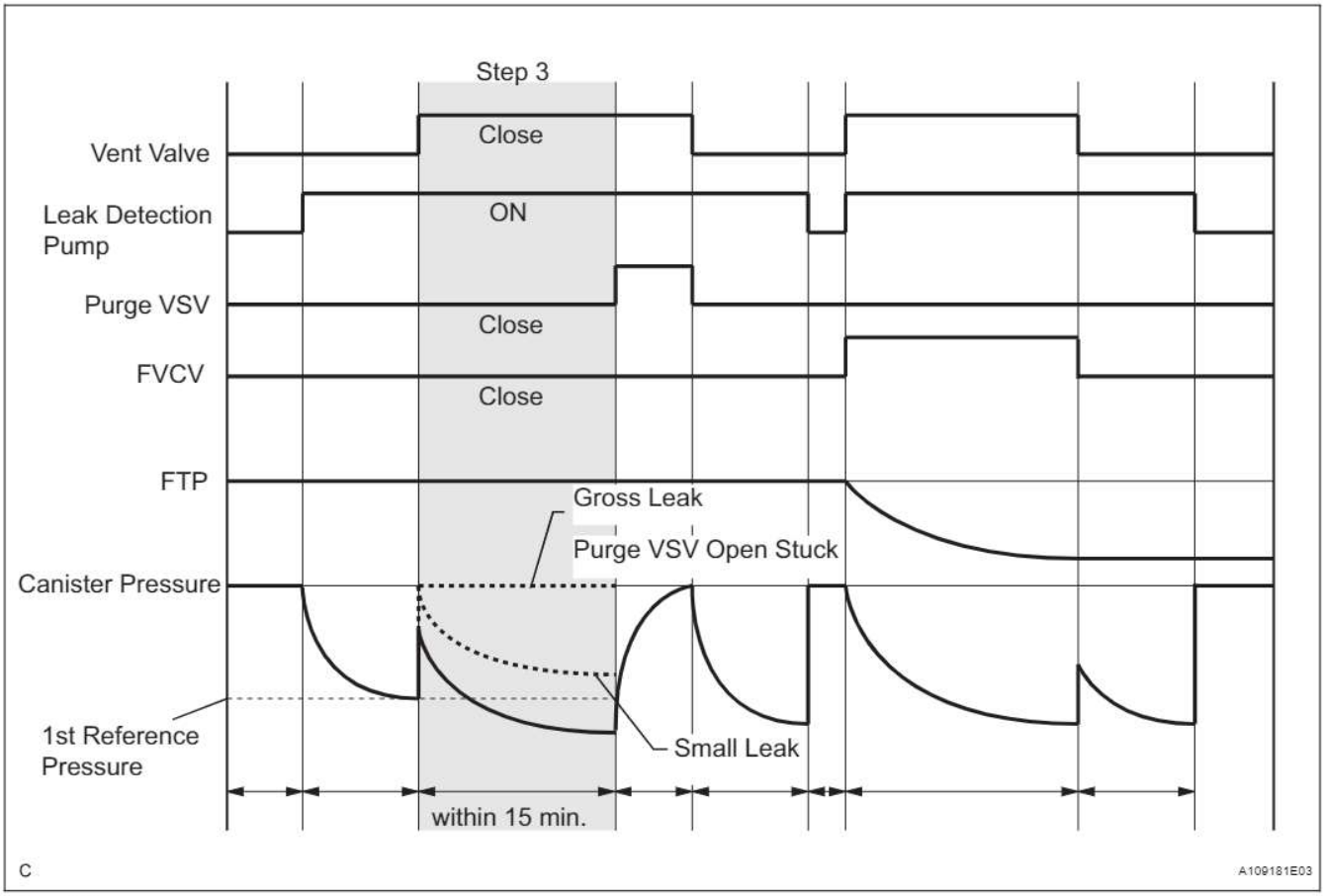


Result

Test Result	Suspected Trouble Area	Proceed to
Fuel tank pressure in step (b) is below 763.7 mmHg-a	Not yet determined	A
Fuel tank pressure change in step (b) is 763.7 mmHg-a or more	Fuel vapor-containment valve (FVCV) ON (open) stuck	C

(d) Check the EVAP pressure again when it has stabilized. This pressure is the canister leak pressure standard.

(e) Compare the first reference pressure with the canister leak pressure.



Result

Test Result	Suspected Trouble Area	Proceed to
Lower than first reference pressure	Not yet determined	A
First reference pressure or higher	• Purge VSV open stuck • Leakage from line between purge VSV and canister	D

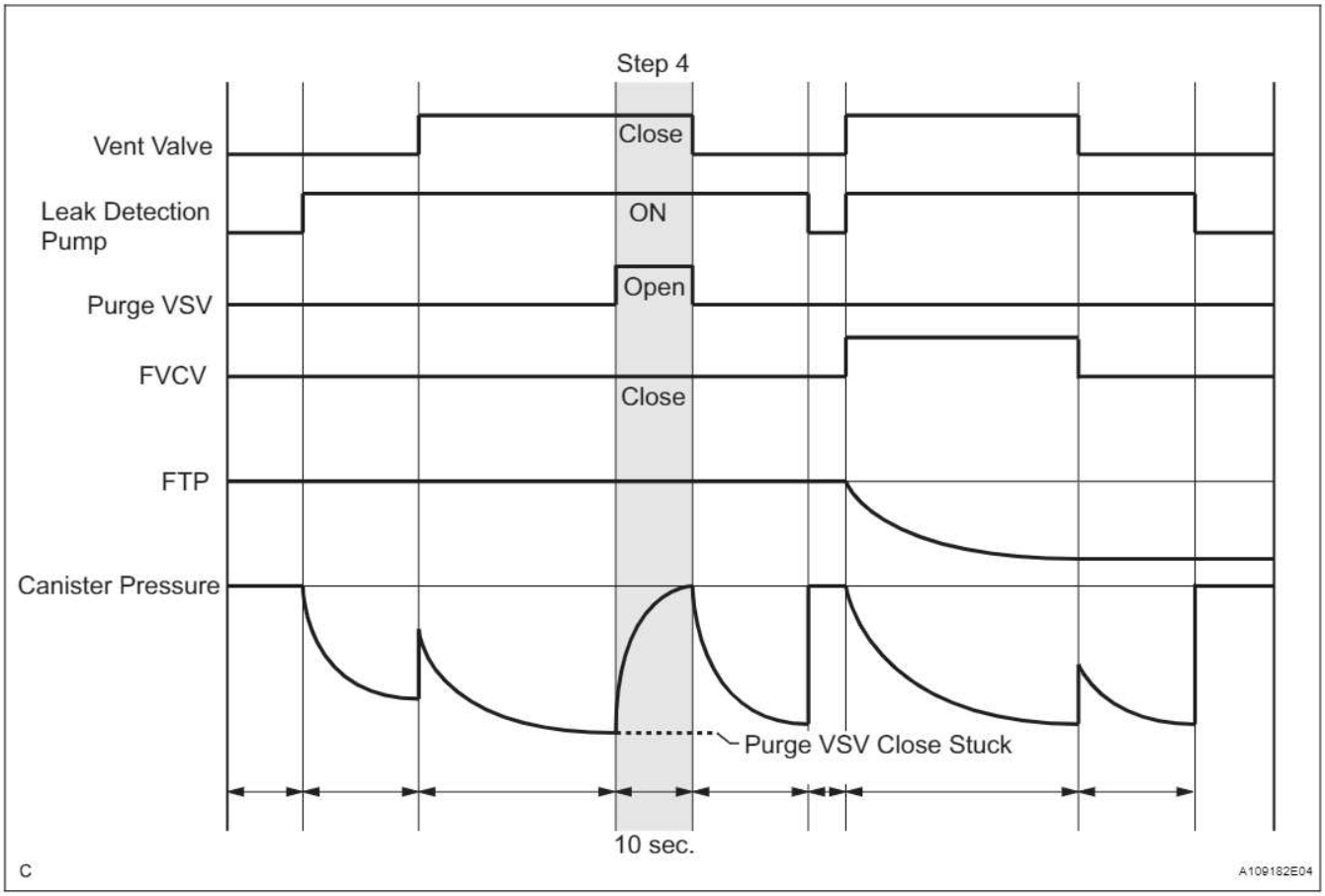
B	Go to step 16
C	Go to step 23
D	Go to step 18

A

37	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 4))

(a) Perform step 4.

(b) Check the EVAP pressure change in step 4.



Result

Test Result	Suspected Trouble Area	Proceed to
EVAP pressure change in step (b) is 762 mmHg-a or more	Not yet determined	A
EVAP pressure in step (b) is below 762 mmHg-a	Purge VSV close stuck	B

B → Go to step 5

A

38	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 5))

(a) Perform step 5 and wait 60 seconds.
(b) Check the EVAP pressure. This pressure is the second reference pressure standard.

NEXT

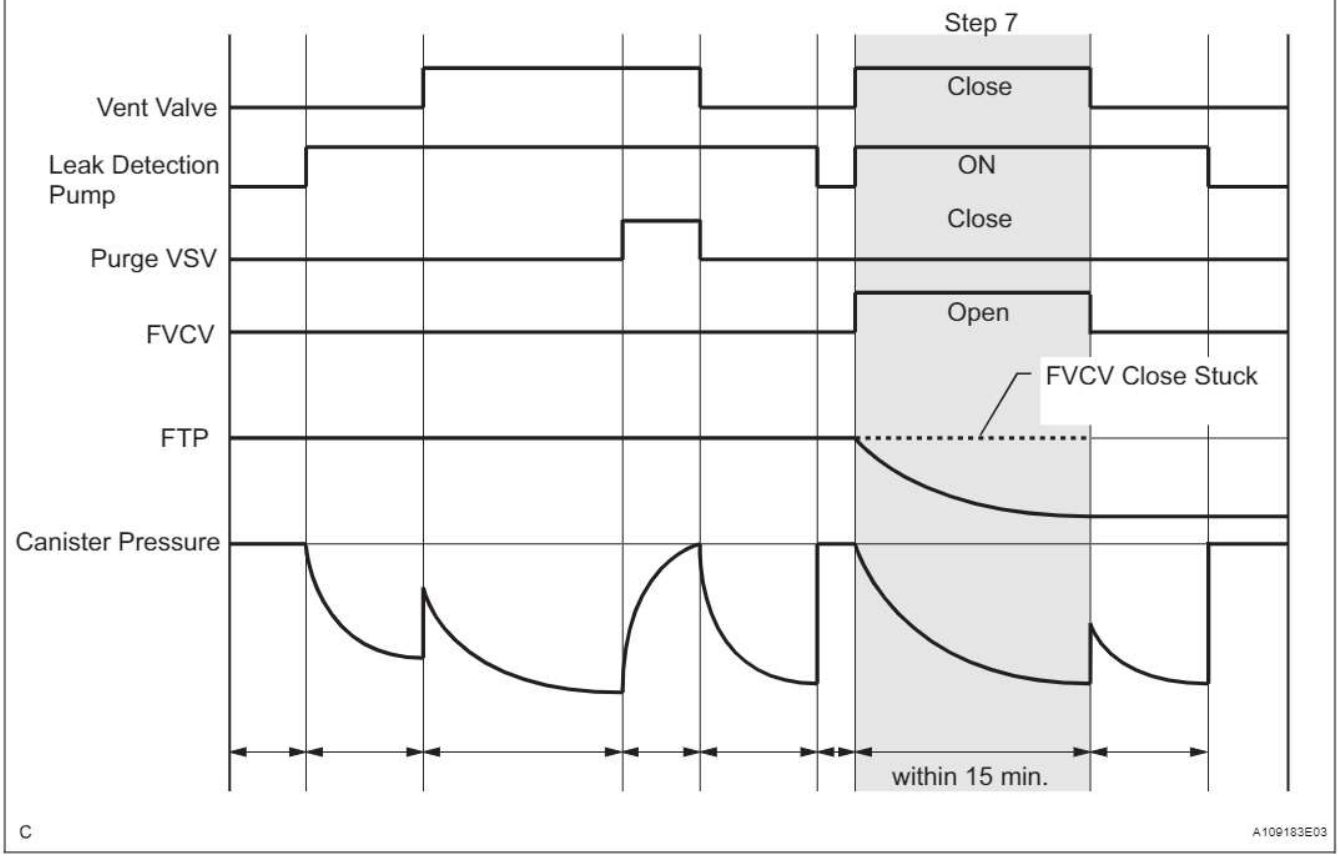
39	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 6))

(a) Perform step 6 and wait 5 seconds.

NEXT

40	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 7))

(a) Perform step 7.
(b) Check that the tank pressure and EVAP pressure change.
(c) Check the tank pressure again when it has stabilized. This pressure is the fuel tank leak pressure standard.



Result

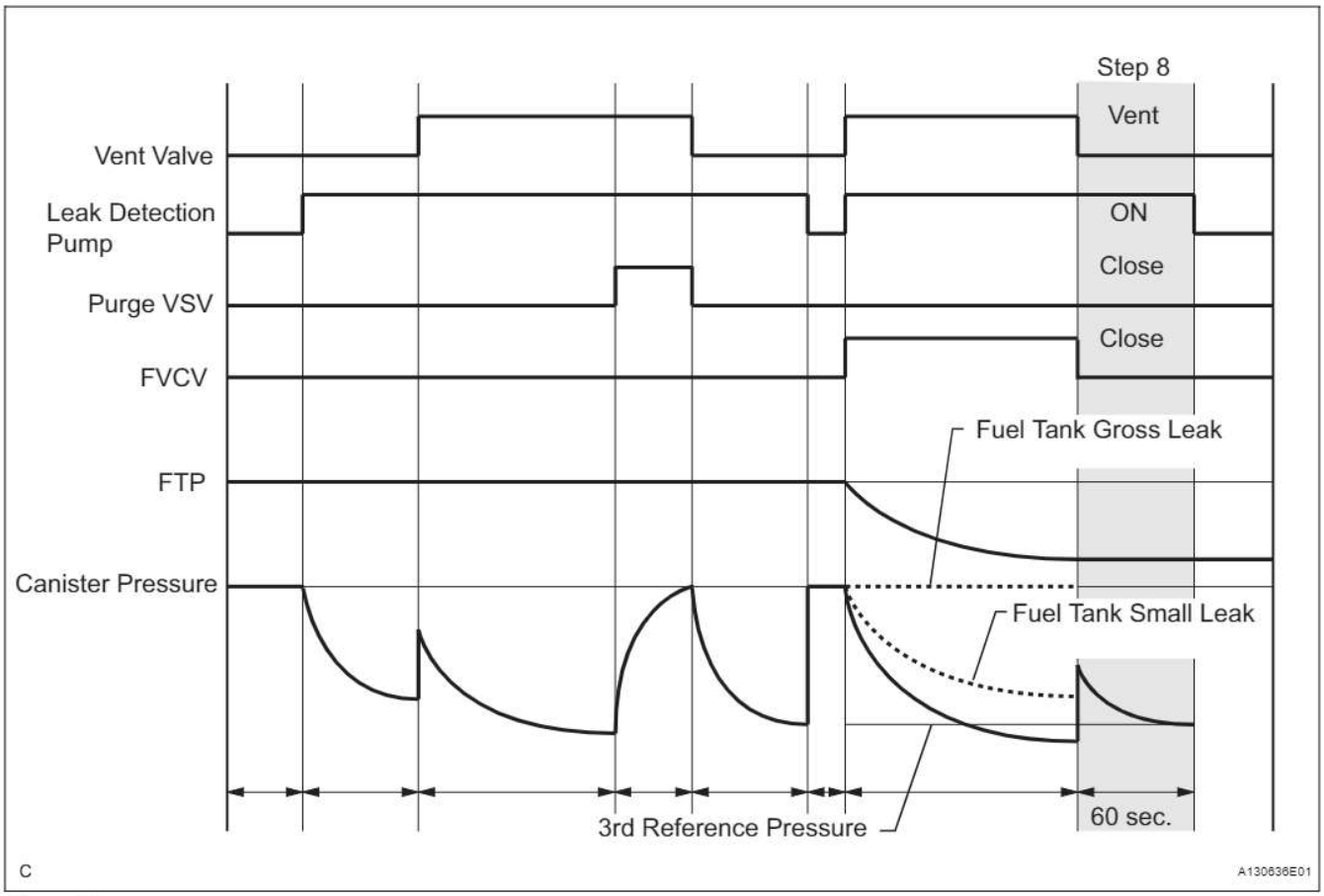
Test Result	Suspected Trouble Area	Proceed to
Tank pressure change is more than 766.7 mmHg-a and EVAP pressure is more than 752.5 mmHg-a	Not yet determined	A
Tank pressure change is less than 766.7 mmHg-a and EVAP pressure is less than 752.5 mmHg-a	Fuel vapor-containment valve (FVCV) OFF (close) stuck	B

B → Go to step 23

A

41	PERFORM SYSTEM CHECK (EVAP SYSTEM CHECK (MANUAL OPERATION STEP 8))

(a) Perform step 8 and wait 60 seconds.
(b) Check the EVAP pressure. This pressure is the third reference pressure standard.
(c) Compare the tank pressure checked in step 8 with the third reference pressure.



Result

Test Result	Suspected Trouble Area	Proceed to
Lower than third reference pressure	Not yet determined	A
Third reference pressure or higher	Leakage from line between fuel vapor-containment valve and fuel tank	B

B → Go to step 20

A

42 PERFORM CONFIRMATION DRIVING PATTERN

(a) KEY-OFF MONITOR DRIVE PATTERN
(1) Connect the intelligent tester to the DLC3.
(2) Confirm the following conditions are satisfied:
- The fuel level is less than 90%.
- The altitude is less than 8,000 ft. (2,400 m).
- The vehicle is stopped (the vehicle speed is less than 2 mph).
- The ECT is 4.4 to 35°C (40 to 95°F.)
- The IAT is 4.4 to 35°C (40 to 95°F).
- Drive the vehicle in a city area or on free-way for 10 minutes or more.

(3) Perform the drive pattern:
1. Allow the engine to idle for 5 minutes or more.
2. Turn the power switch off and wait 6 hours.

(4) Check the monitor status with the intelligent tester.

(b) PURGE FLOW MONITOR DRIVE PATTERN (P0441)

(1) Connect the intelligent tester to the DLC3.

(2) Confirm that the following conditions are satisfied:

- The Engine Coolant Temperature (ECT) is more than 4.4°C (40°F).
- The Intake Air Temperature (IAT) is more than 4.4°C (40°F).

(3) Perform the drive pattern:

1. Remove and reinstall the fuel cap to release the fuel tank pressure.
2. Warm up the engine until the ECT reaches 75°C (167°F) or more.
3. Drive vehicle in a city area or on free-way for 10 minutes or more.

(4) Check the monitor status with the intelligent tester.

NEXT

PERFORM EVAP SYSTEM (EVAP SYSTEM CHECK AGAIN (AUTOMATIC OPERATION))

ECM Power Source Circuit

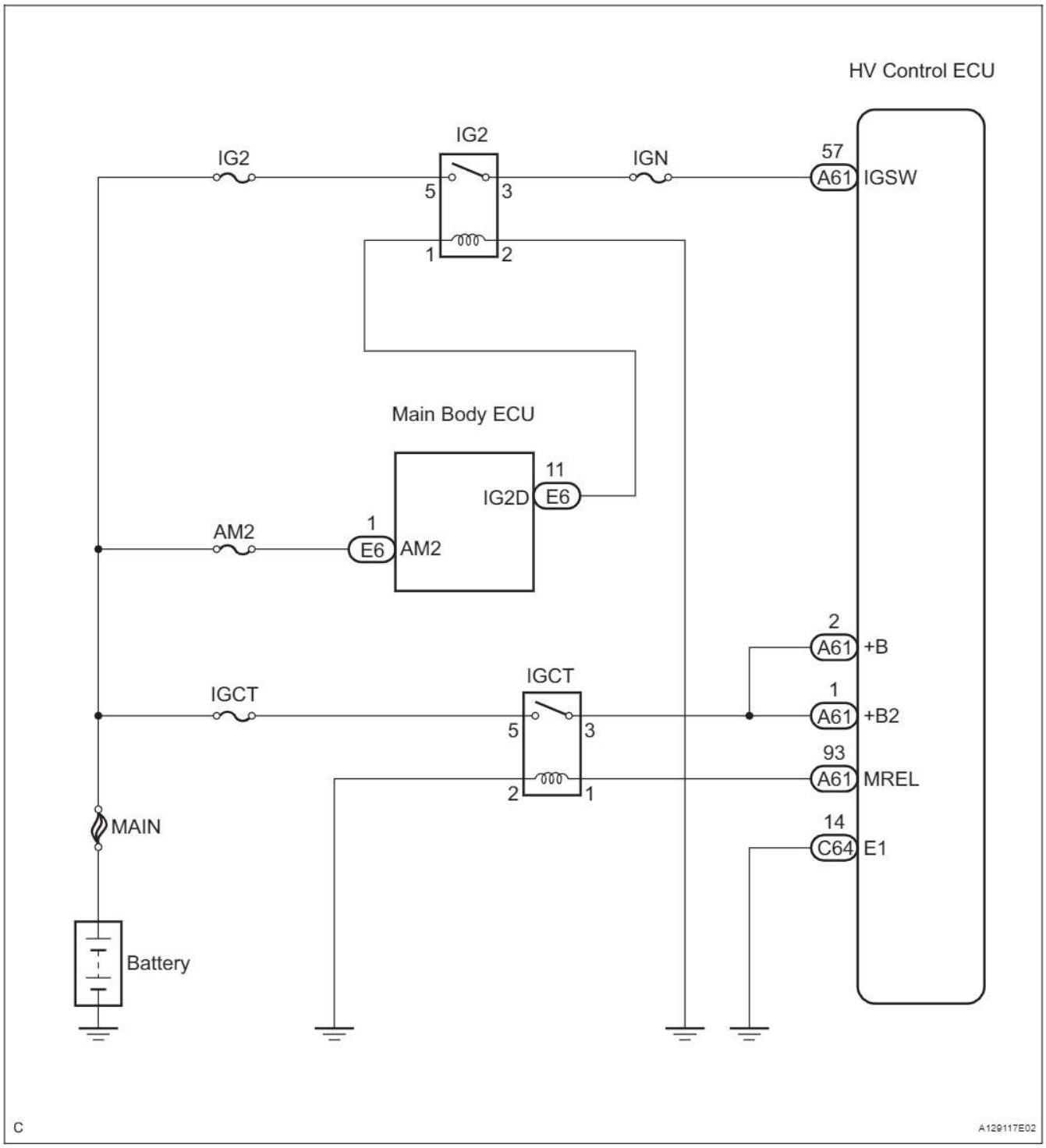
DESCRIPTION

When the power switch is turned on (IG), the battery voltage is applied to terminal IGSW of the hybrid vehicle control ECU. The hybrid vehicle control ECU MREL output signal causes a current to flow to the coil, closing the contacts of the IGCT relay and supplying power to terminal +B of the hybrid vehicle control ECU.

If the power switch is turned off, the hybrid vehicle control ECU holds the IGCT relay ON for a maximum of 2 seconds to allow for the initial setting of the throttle valve.

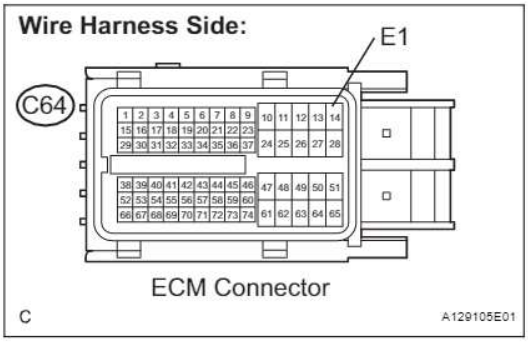
When the power switch is turned on (IG), voltage from the hybrid vehicle control ECU MREL terminal applies to the IGCT relay. This causes the contacts of the IGCT relay to close, which supplies power to terminal +B or +B1 of the hybrid vehicle control ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

1 CHECK HARNESS AND CONNECTOR (HV CONTROL ECU - BODY GROUND)



(a) Disconnect the C64 hybrid vehicle control ECU connector.
(b) Measure the resistance between the terminal and body ground.
Standard resistance

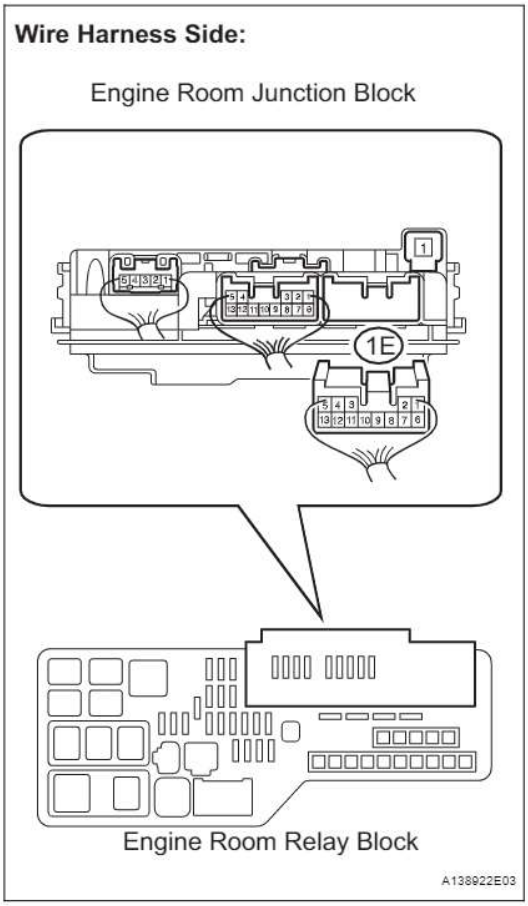
Tester Connection	Specified Condition
E1 (C64-81) - Body ground	Below 1 Ω

(c) Reconnect the hybrid vehicle control ECU connector.

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

OK

2 CHECK ENGINE ROOM JUNCTION BLOCK (IGCT RELAY VOLTAGE)



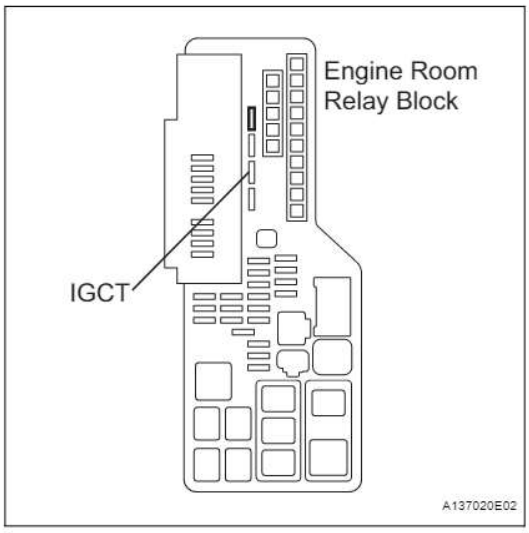
(a) Remove the engine room junction block from the engine room R/B.
(b) Turn the power switch on (IG).
(c) Measure the voltage between the terminal and body ground.
Standard voltage

Tester Connection	Specified Condition
5 - Body ground	9 to 14 V

OK → **Go to step 5**

NG

3	INSPECT IGCT FUSE

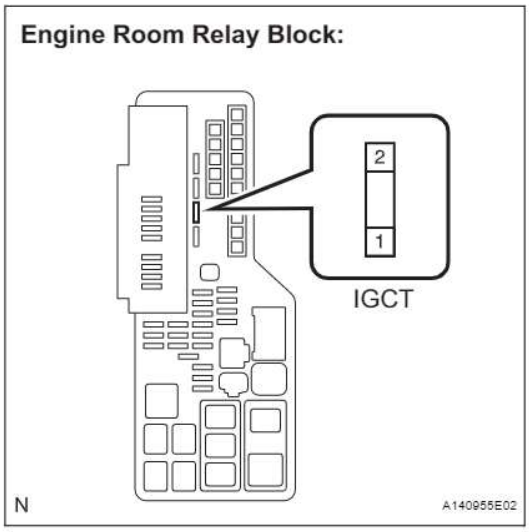


(a) Remove the IGCT fuse from the engine room R/B.
(b) Measure the IGCT fuse resistance.
Standard resistance:
Below 1 Ω
(c) Reinstall the IGCT fuse.

NG → **REPLACE IGCT FUSE**

OK

4	CHECK HARNESS AND CONNECTOR (IGCT FUSE - BATTERY)



(a) Disconnect the positive battery terminal.
(b) Remove the IGCT fuse from the engine room R/B.
(c) Measure the resistance between the terminals.
Standard resistance (Check for open)

Tester Connection	Specified Condition
1 - Positive battery terminal	Below 1 Ω

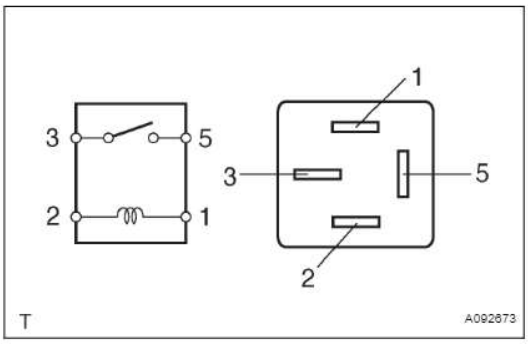
(d) Reinstall the IGCT fuse.
(e) Reconnect the positive battery terminal.

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

OK

PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE

5 INSPECT IGCT RELAY



(a) Remove the IGCT relay from the engine room R/B.
(b) Measure the resistance between the terminals.

Standard resistance

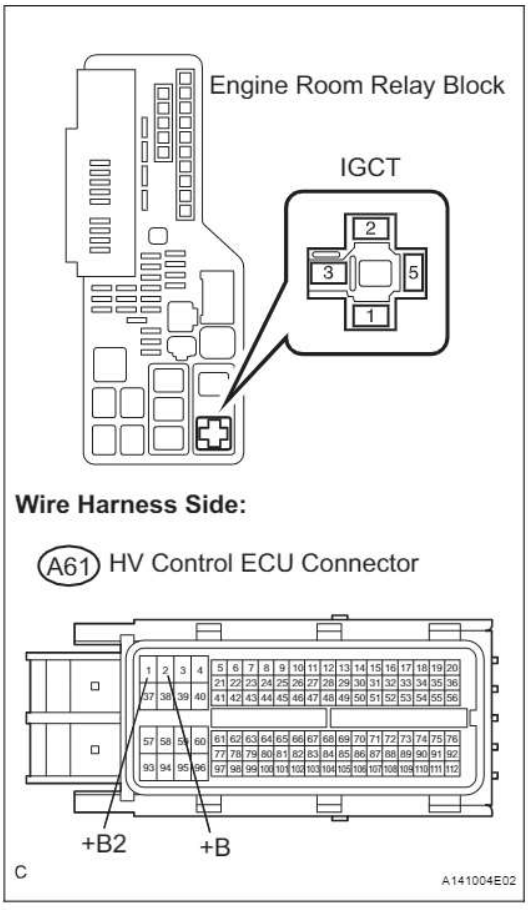
Tester Connection	Specified Condition
3 - 5	10 kΩ or higher
3 - 5	Below 1 Ω (Apply battery voltage between terminals 1 and 2)

(c) Reinstall the IGCT relay.

NG → REPLACE IGCT RELAY

OK

6 CHECK HARNESS AND CONNECTOR (HV CONTROL ECU - IGCT RELAY)



(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Remove the engine IGCT relay from the engine room R/B.
(c) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
IGCT relay (3) - +B (A61-2)	Below 1 Ω
IGCT relay (3) - +B2 (A61-1)	Below 1 Ω

Standard resistance (Check for short)

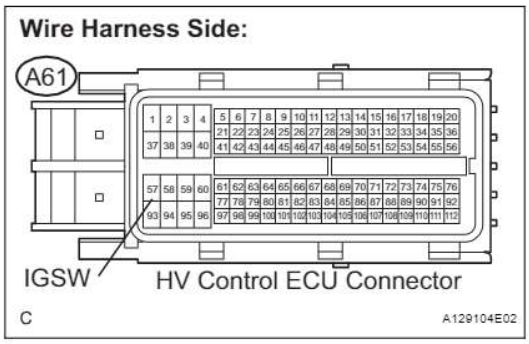
Tester Connection	Specified Condition
IGCT relay (3) or +B (A61-2) - Body ground	10 kΩ or higher
IGCT relay (3) or +B2 (A61-1) - Body ground	10 kΩ or higher

(d) Reinstall the engine room junction block.
(e) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

7 INSPECT ECM (IGSW VOLTAGE)



(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Measure the voltage between the terminal and body ground.
Standard voltage

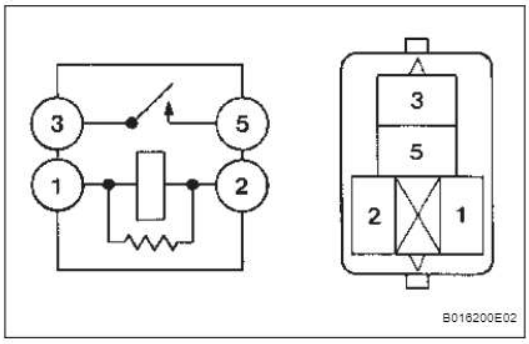
Tester Connection	Specified Condition
IGSW (A61-57) - Body ground	9 to 14 V

(c) Reconnect the hybrid vehicle control ECU connector.

OK → Go to step 10

NG

8 INSPECT IG2 RELAY



(a) Remove the IG2 relay from the engine room R/B.
(b) Measure the resistance between the terminals.
Standard resistance

Tester Connection	Specified Condition
3 - 5	10 kΩ or higher
3 - 5	Below 1 Ω (Apply battery voltage between terminals 1 and 2)

(c) Reinstall the IG2 relay.

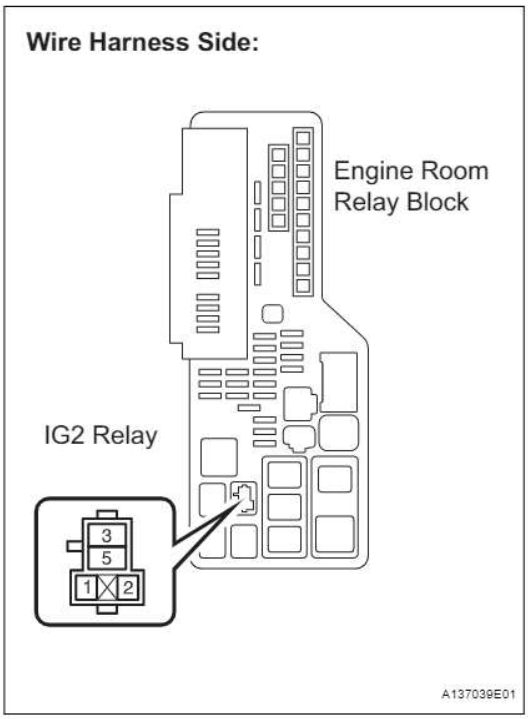
NG → REPLACE IG2 RELAY

OK

ES

ES

9	CHECK HARNESS AND CONNECTOR (IG2 RELAY - BODY GROUND)



(a) Remove the IG2 relay from the engine room R/B.
(b) Measure the resistance between the terminal and body ground.

Standard resistance

Tester Connection	Specified Condition
IG2 relay terminal 2 - Body ground	Below 1 Ω

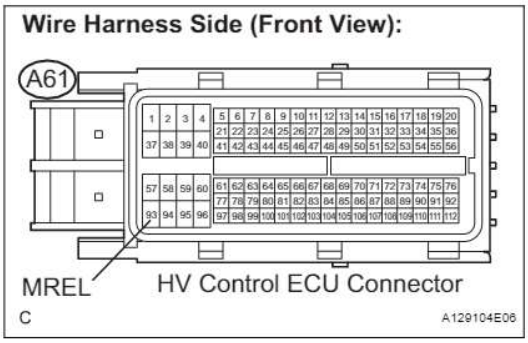
(c) Reinstall the IG2 relay.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

GO TO SMART ACCESS SYSTEM WITH PUSH-BUTTON START

10	CHECK HARNESS AND CONNECTOR (HV CONTROL ECU - BODY GROUND)



(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Measure the resistance between the terminal and body ground.

Standard resistance

Tester Connection	Specified Condition
MREL (A61-93) - Body ground	Below 1 Ω

(c) Reconnect the hybrid vehicle control ECU connector.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

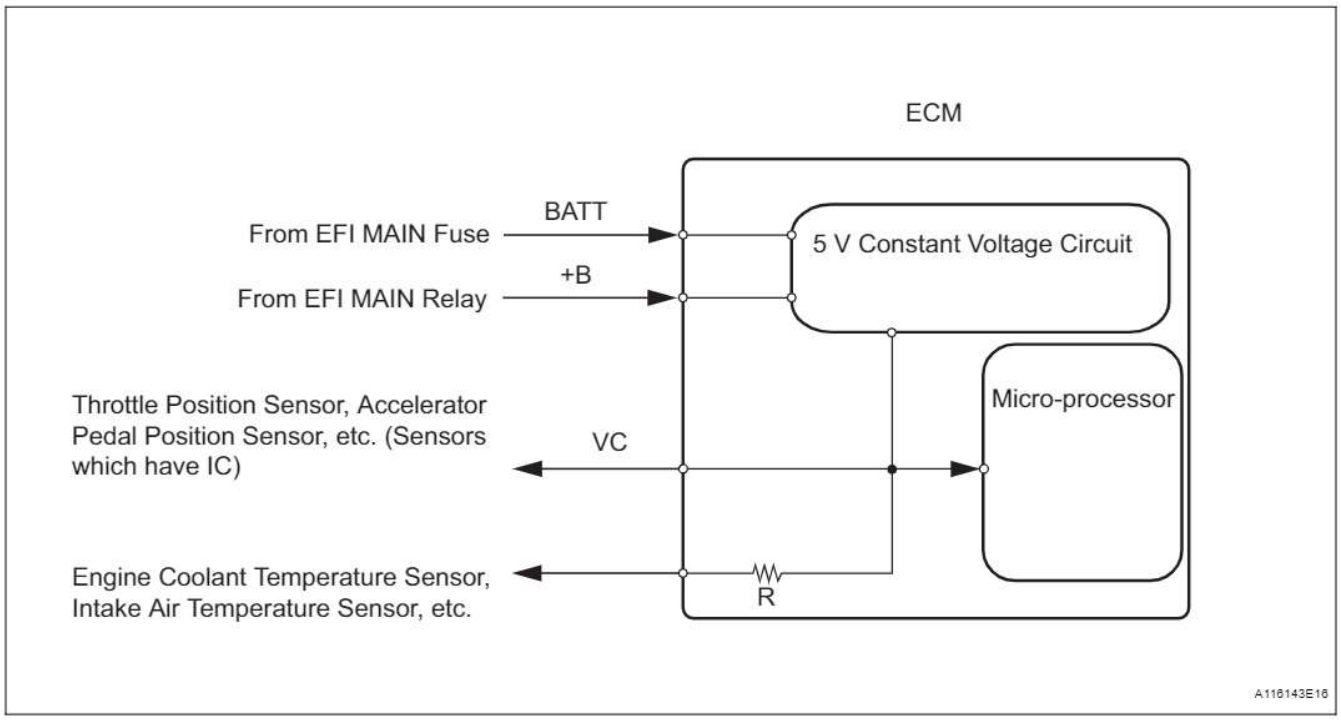
OK

REPLACE HYBRID VEHICLE CONTROL ECU

VC Output Circuit

DESCRIPTION

The ECM constantly generates 5 V power from the battery voltages supplied to the +B (BATT) terminal to operate the Micro-processor. The ECM also provides this power to the sensors through the VC output circuit.

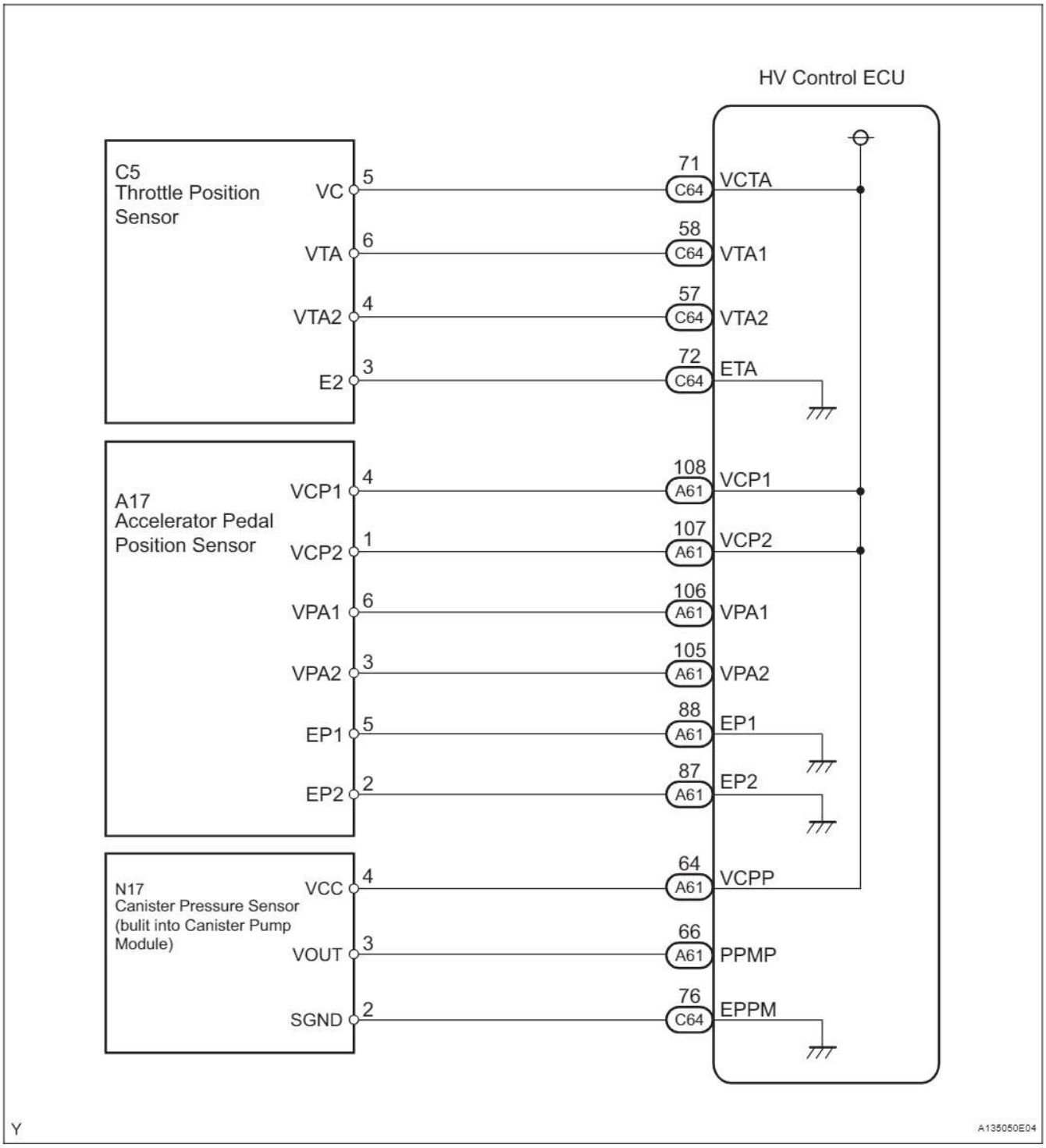


When the VC circuit is short-circuited, the Micro-processor in the ECM (included in hybrid vehicle control ECU) and sensors that are supplied with power through the VC circuit are deactivated because the power is not supplied from the VC circuit. Under this condition, the system does not start up and the MIL does not illuminate even if the system malfunctions.

HINT:

Under normal conditions, the MIL is illuminated for several seconds when the power switch is first turned on. The MIL goes off when the engine is started.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	CHECK MIL

(a) Check that the Malfunction Indicator Lamp (MIL) lights up when turning the power switch on (IG).
OK:
MIL lights up

OK → SYSTEM IS OK

NG

2 CHECK COMMUNICATION BETWEEN INTELLIGENT TESTER AND ECM

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and tester on.
(c) Check the communication between the tester and hybrid vehicle control ECU.

Result

Result	Proceed to
Communication is possible	A
Communication is not possible	B

A → GO TO MIL CIRCUIT

B

3 CHECK MIL (THROTTLE POSITION SENSOR)

(a) Disconnect the C5 throttle body connector.
(b) Turn the power switch on (IG).
(c) Check the MIL.

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

(d) Reconnect the throttle body connector.

A → REPLACE THROTTLE BODY ASSEMBLY

B

4 CHECK MIL (ACCELERATOR PEDAL POSITION SENSOR)

(a) Disconnect the A17 accelerator pedal position sensor connector.
(b) Turn the power switch on (IG).
(c) Check the MIL.

Result

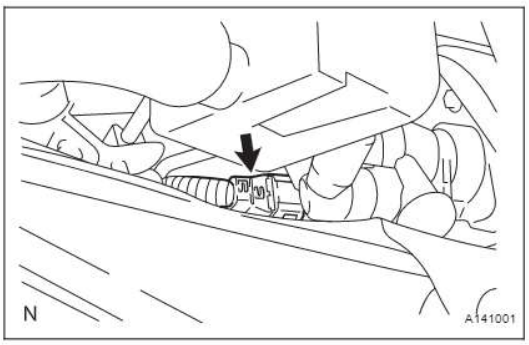
Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

(d) Reconnect the accelerator pedal position sensor connector.

A → REPLACE ACCELERATOR PEDAL POSITION SENSOR

B

5	CHECK MIL (CANISTER PUMP MODULE)



(a) Disconnect the N17 canister pump module connector.
(b) Turn the power switch on (IG).
(c) Check the MIL.

ES

Result

Result	Proceed to
MIL illuminates	A
MIL does not illuminate	B

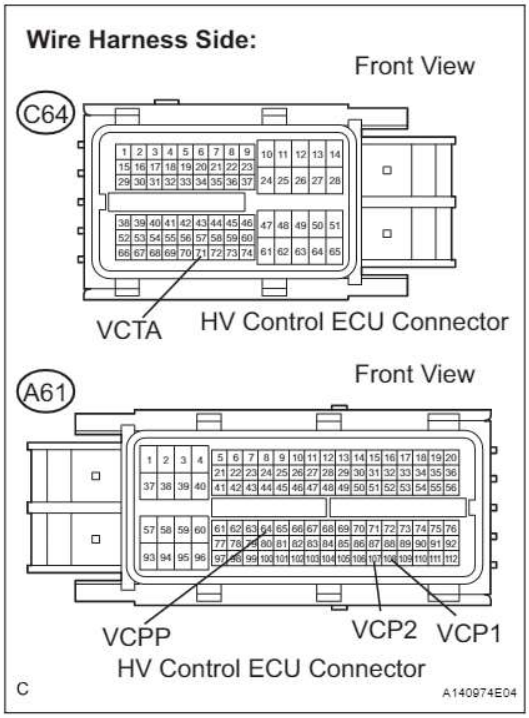
(d) Reconnect the canister pump module connector.

A → REPLACE CHARCOAL CANISTER ASSEMBLY

B

6	CHECK HARNESS AND CONNECTOR

(a) Disconnect the C5 throttle body connector.
(b) Disconnect the A17 accelerator pedal position sensor connector.
(c) Disconnect the N17 canister pump module connector.



(d) Disconnect the A61 and C64 hybrid vehicle control ECU connectors.

(e) Measure the resistance.

Standard resistance (Check for short)

Tester Connections	Specified Conditions
C64-71 (VCTA) - Body ground	10 kΩ or higher
A61-108 (VCP1) - Body ground	10 kΩ or higher
A61-107 (VCP2) - Body ground	10 kΩ or higher
A61-64 (VCPP) - Body ground	10 kΩ or higher

(f) Reconnect the throttle body connector.

(g) Reconnect the accelerator pedal position sensor connector.

(h) Reconnect the canister pump module connector.

(i) Reconnect the battery current sensor connector.

(j) Reconnect the hybrid vehicle control ECU connectors.

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

OK

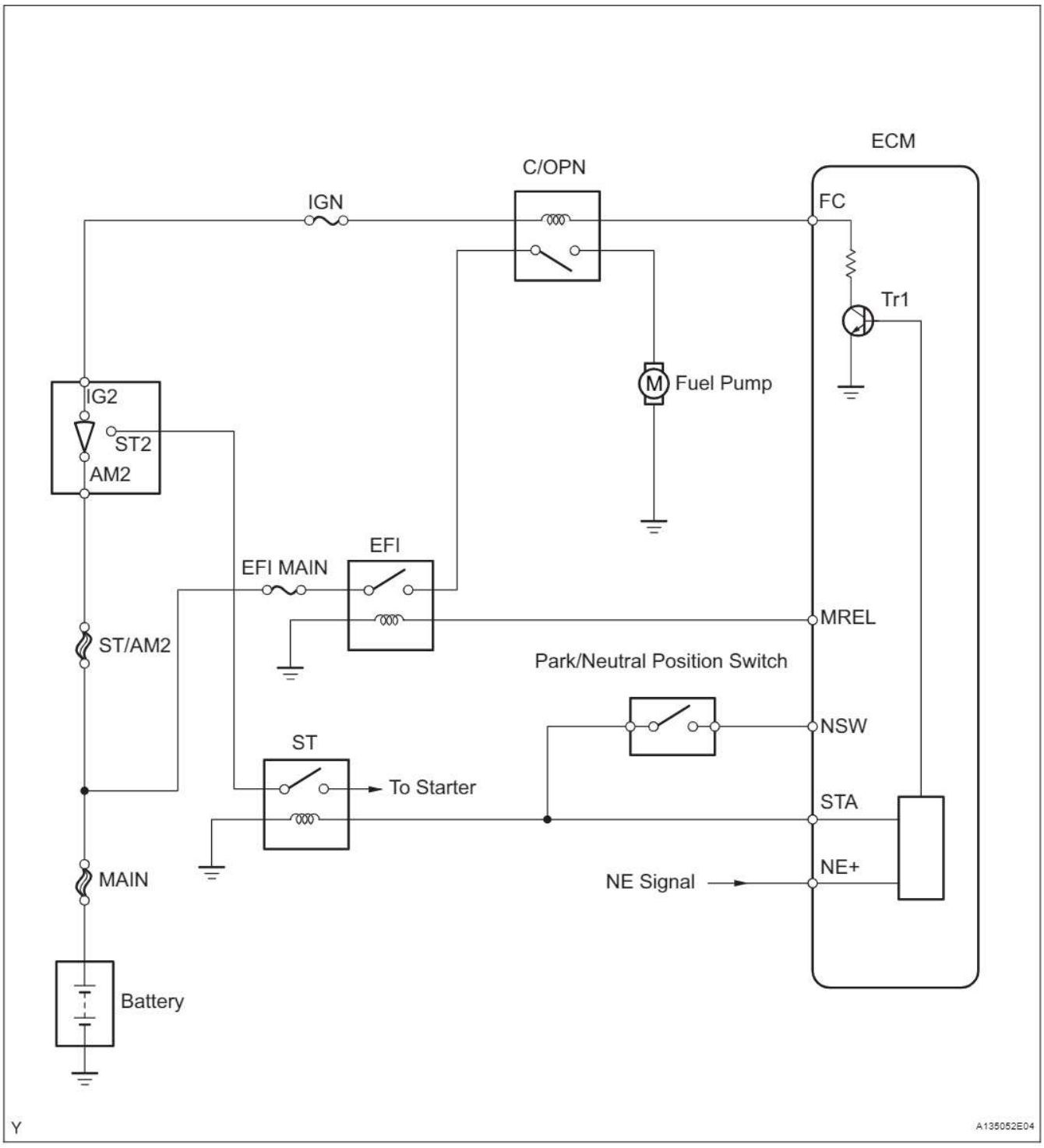
REPLACE HYBRID VEHICLE CONTROL ECU

ES

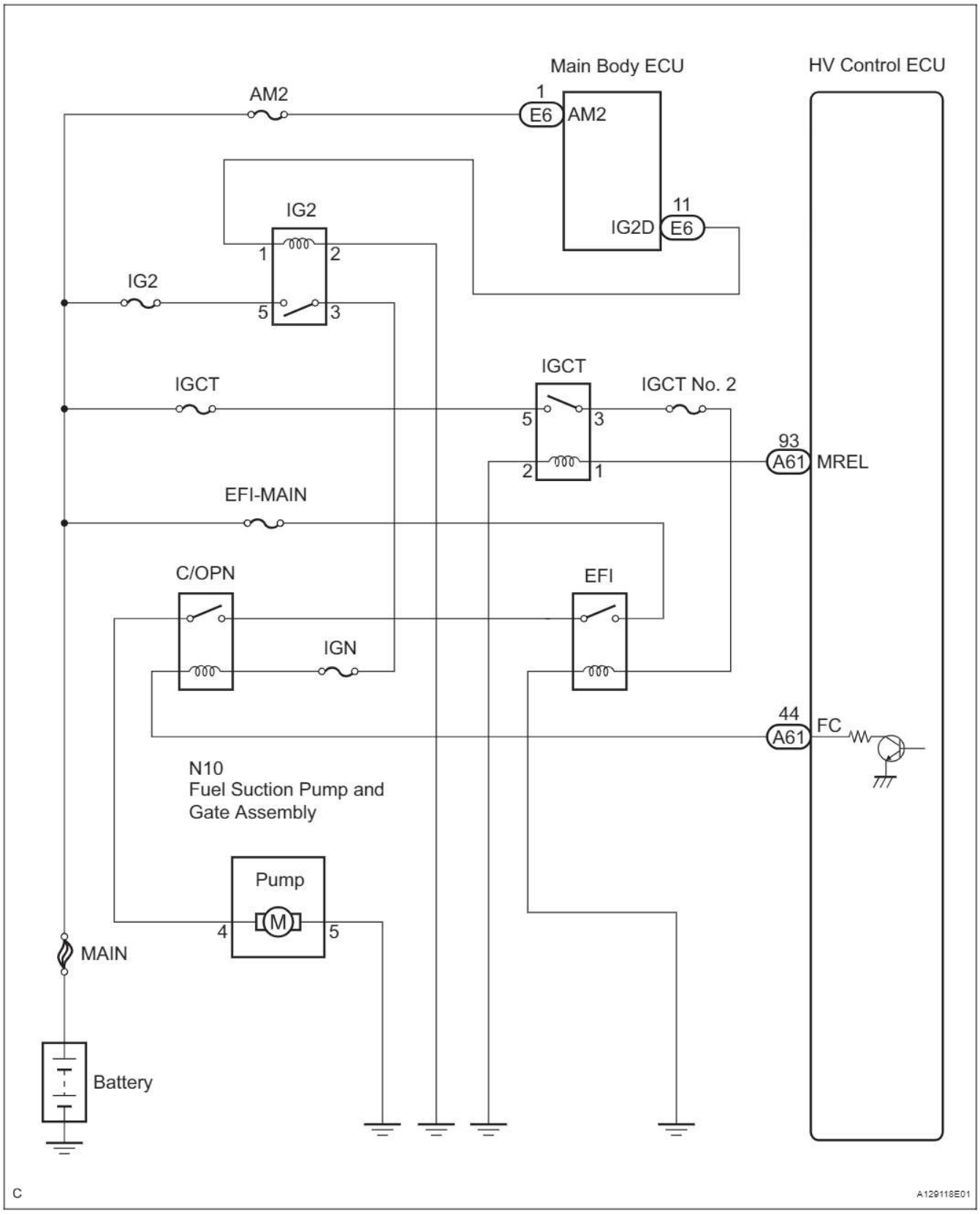
Fuel Pump Control Circuit

DESCRIPTION

When the engine is cranked, the starter relay drive signal output from the STAR terminal of the ECM (included in hybrid vehicle control ECU) is input into the STA terminal of the ECM, and NE signal generated by the crankshaft position sensor is also input into the NE+ terminal. Thus, the ECM interprets that the engine is cranked, and turns the transistor Tr1 in the ECM internal circuit ON. The current flows to the C/OPN (Circuit Opening) relay by turning the Tr1 ON. Then, the fuel pump operates.
While the NE signal is input into the ECM, when the engine is running, the ECM turns the Tr1 on continuously.



WIRING DIAGRAM



INSPECTION PROCEDURE

1	PERFORM ACTIVE TEST USING INTELLIGENT TESTER (OPERATE C/OPN RELAY)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power 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 the fuel pump operation sound occurs when performing the Active Test on the tester.
OK:
Fuel pump operating sound occurs.

ES

NG → **Go to step 2**

OK →

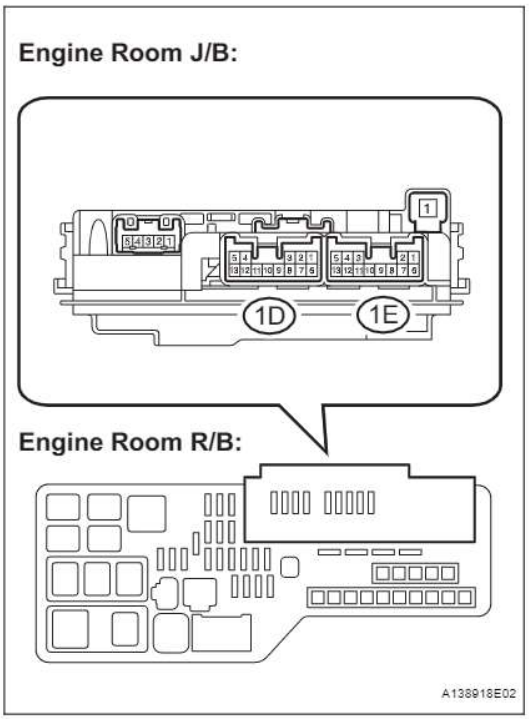
PROCEED TO NEXT CIRCUIT INSPECTION SHOWN IN PROBLEM SYMPTOMS TABLE

2	CHECK ECM POWER SOURCE CIRCUIT

NG → **REPAIR OR REPLACE ECM POWER SOURCE CIRCUIT**

OK →

3	INSPECT ENGINE ROOM J/B (C/OPN RELAY)



(a) Remove the engine room J/B from the engine room R/B.
(b) Inspect the C/OPN relay.
(1) Measure the C/OPN relay resistance.
Standard resistance

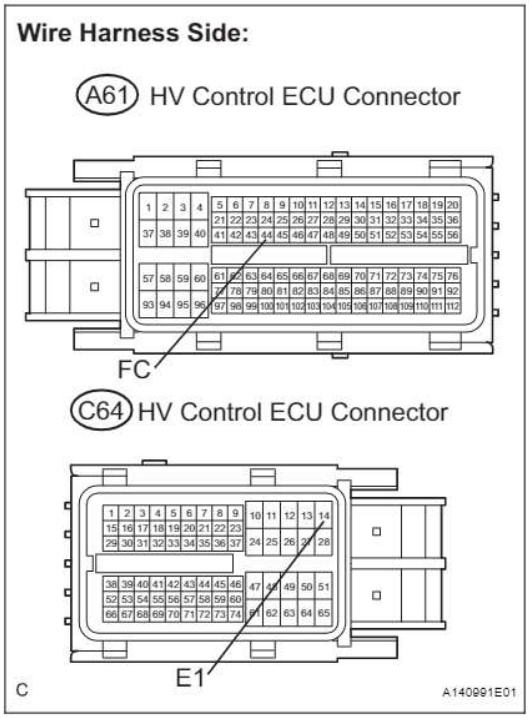
Tester Connection	Specified Condition
1E-7 - 1E-13	10 kΩ or higher
	Below 1 Ω (Apply battery voltage between terminals 1D-12 and 1E-8)

(c) Reinstall the engine room J/B.

NG → **REPLACE ENGINE ROOM J/B**

OK

4	INSPECT ECM (FC VOLTAGE)



(a) Disconnect the A61 and C64 hybrid vehicle control ECU connectors.

(b) Measure the voltage between the terminals of the A24 and C24 ECM connectors.

Standard voltage

Tester Connection	Specified Condition
A61-44 (FC) - C64-14 (E1)	9 to 14 V

(c) Reconnect the hybrid vehicle control ECU connectors.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR (ECM - BATTERY)

ES

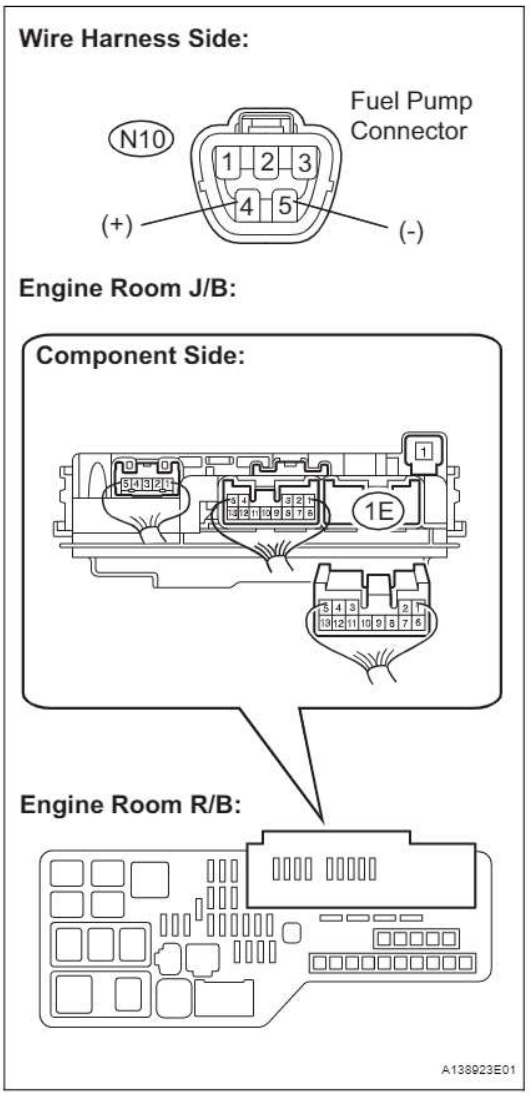
OK

5	INSPECT FUEL PUMP

NG → REPLACE FUEL PUMP

OK

6	CHECK HARNESS AND CONNECTOR (C/OPN RELAY - FUEL PUMP - BODY GROUND)



(a) Check the harness and the connectors between the engine room J/B and the fuel pump.
(1) Remove the engine room J/B from the engine room R/B.
(2) Disconnect the 1E engine room J/B connector.
(3) Disconnect the N10 fuel pump connector.
(4) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
1E-13 - N10-4 (Fuel pump)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
1E-13 or N10-4 (Fuel pump) - Body ground	10 kΩ or higher

(b) Check the harness and the connectors between the fuel pump and body ground.
(1) Disconnect the N10 fuel pump connector.
(2) Measure the resistance.

Standard resistance (Check for open)

Tester Connection	Specified Condition
N10-5 (Fuel pump) - Body ground	Below 1 Ω

(c) Reconnect the engine room J/B connector.
(d) Reconnect the fuel pump connector.
(e) Reinstall the engine room J/B.

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

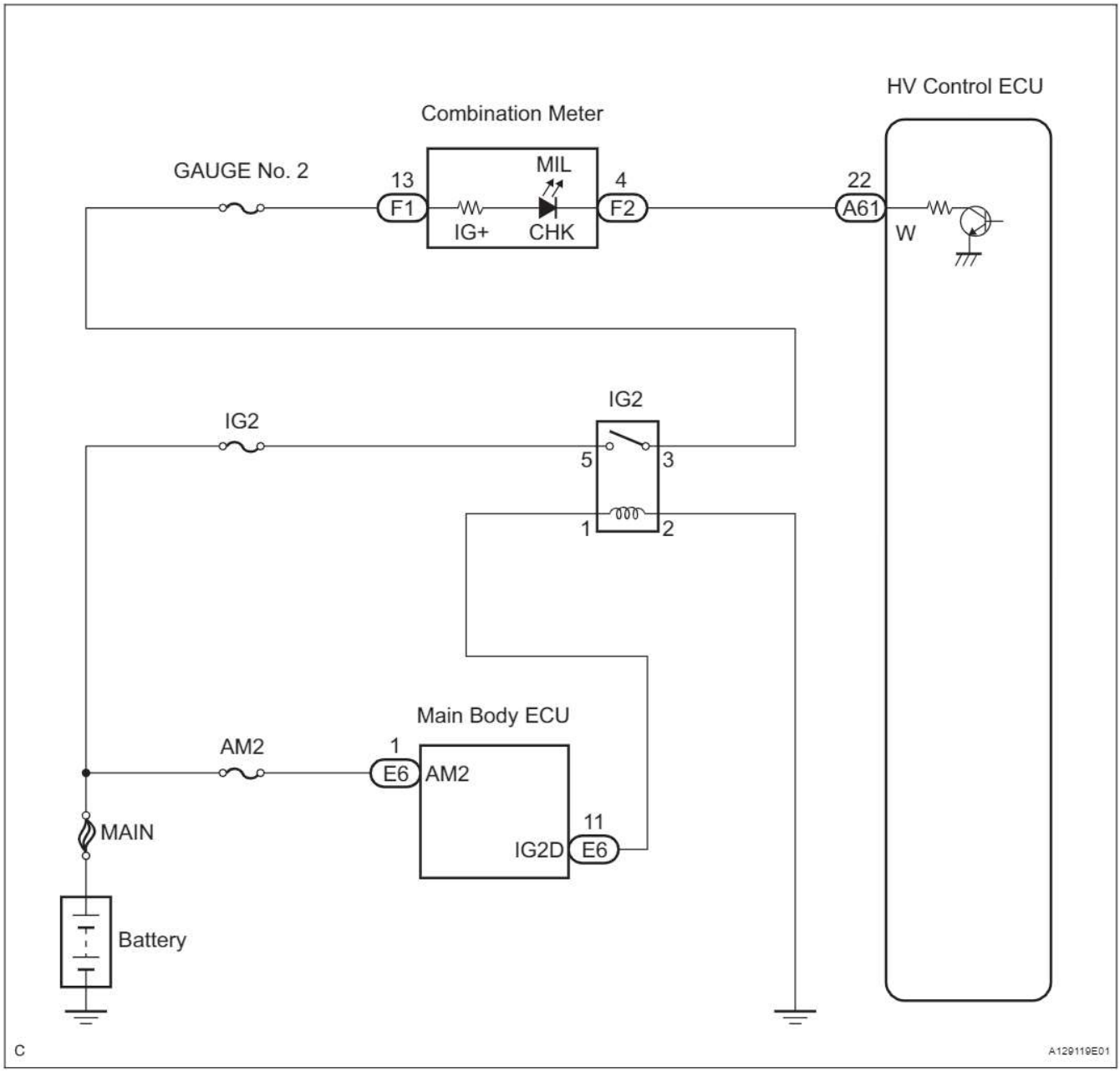
REPLACE HYBRID VEHICLE CONTROL ECU

MIL Circuit

DESCRIPTION

The MIL (Malfunction Indicator Lamp) is used to indicate vehicle malfunction detections by the ECM (included in hybrid vehicle control ECU). When the power 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 power 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

1	CHECK MIL CONDITION (MIL IS ILLUMINATED)

(a) Perform troubleshooting in accordance with the table below.

Conditions	Proceed to
MIL remains ON	A
MIL does not illuminate	B

B → Go to step 5

ES

A

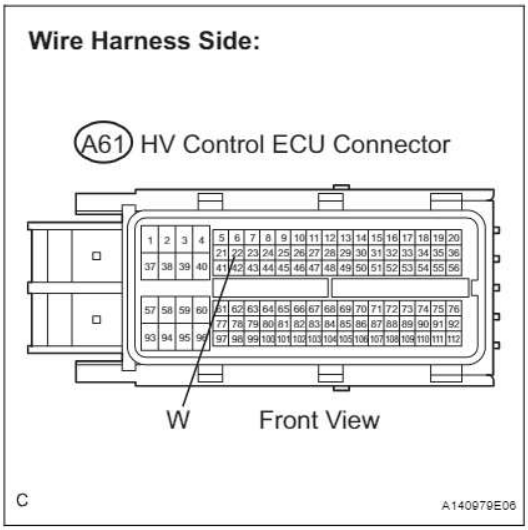
2	CHECK MIL CONDITION (WHETHER MIL TURNS OFF)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch on (IG) and turn the tester on.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Check if any DTCs have been stored. Note down any DTCs.
(e) Clear the DTCs (See page ES-31).
(f) Check if the MIL goes off.
Standard:
MIL should go off.

OK → **REPAIR CIRCUITS INDICATED BY OUTPUT DTCS**

NG

3	CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT IN WIRE HARNESS)

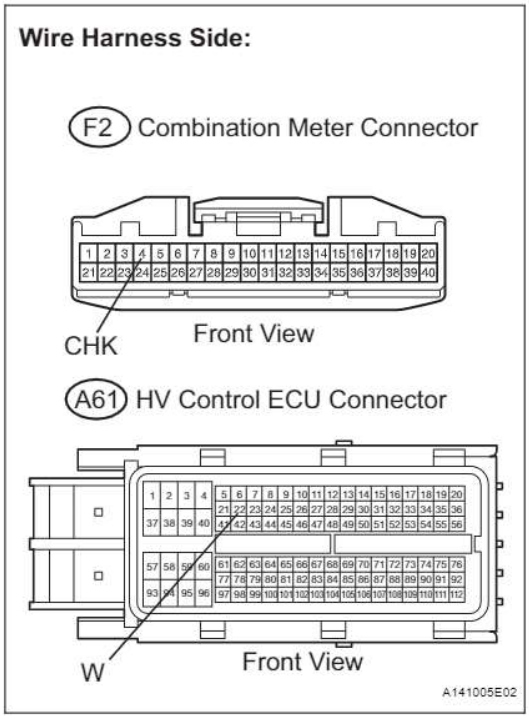


(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Turn the power switch on (IG).
(c) Check that the MIL is not illuminated.
OK:
MIL is not illuminated.
(d) Reconnect the hybrid vehicle control ECU connector.

OK → **REPLACE HYBRID VEHICLE CONTROL ECU**

NG

4	CHECK HARNESS AND CONNECTOR (COMBINATION METER - HV CONTROL ECU)



(a) Disconnect the A61 hybrid vehicle control ECU connector.
(b) Disconnect the F2 combination meter connector.
(c) Measure the resistance.
Standard resistance (Check for short)

Tester Connections	Specified Conditions
A61-22 (W) or F2-4 (CHK) - Body ground	10 kΩ or higher

(d) Reconnect the hybrid vehicle control ECU connector.
(e) Reconnect the combination meter connector.

OK → REPAIR OR REPLACE COMBINATION METER ASSEMBLY

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

5	CHECK MIL CONDITION (MIL ILLUMINATED)

(a) Check if the MIL is illuminated when the power switch is turned on (IG).
OK:
MIL should be illuminated.

OK → SYSTEM IS OK

NG

6	CHECK THAT ENGINE START

(a) Turn the power switch on (IG).
(b) Put the engine in inspection mode (See page ES-35).
Result

Result	Proceed to
Engine starts	A
Engine does not start*	B

HINT:
*: The intelligent tester cannot communicate with the hybrid vehicle control ECU.

B → GO TO VC OUTPUT CIRCUIT

A

7	INSPECT COMBINATION METER ASSEMBLY (MIL CIRCUIT)

(a) Check the MIL circuit (See page ME-17).

NG → REPAIR OR REPLACE COMBINATION METER ASSEMBLY

OK

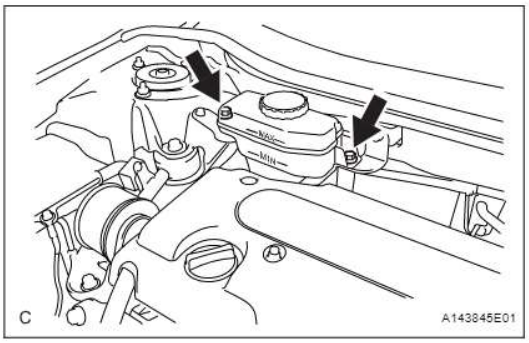
CHECK AND REPLACE HARNESS OR CONNECTOR (COMBINATION METER - HV CONTROL ECU)

ES

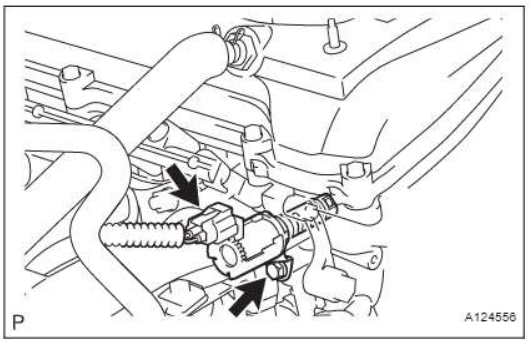
REMOVAL

1. **REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-90)**

2. **SEPARATE BRAKE MASTER CYLINDER RESERVOIR SUB-ASSEMBLY**
   (a) Remove the 2 bolts and separate the brake master cylinder reservoir sub-assembly.



3. **REMOVE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY**
   (a) Disconnect the camshaft timing oil control valve assembly connector.
   (b) Remove the bolt and camshaft timing oil control valve assembly.



INSPECTION

1. INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

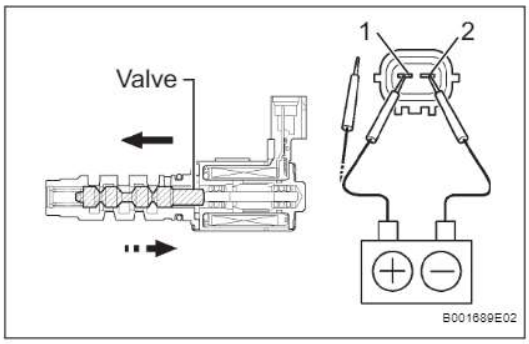
(a) Resistance inspection.

(1) Using an ohmmeter, measure the resistance between the terminals.

Standard resistance:

6.9 to 7.9 Ω at 20°C (68°F)

If necessary, replace the camshaft timing oil control valve assembly.



(b) Movement inspection.

(1) Connect the positive (+) lead from the battery to terminal 1 and the negative (-) lead to terminal 2, and check the movement of the valve.

NOTICE:

Confirm that the valve moves freely and does not stick in any position.

If necessary, replace the camshaft timing oil control valve assembly.

HINT:

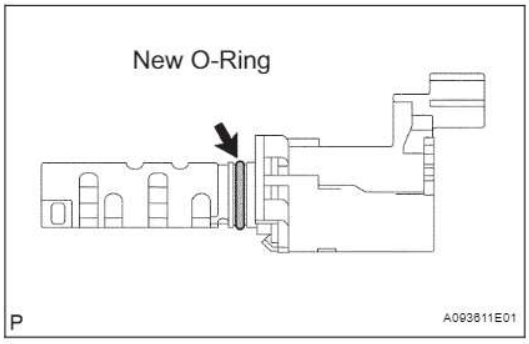
Accumulation of foreign objects causes subtle pressure leaks. The subtle pressure leaks will cause the camshaft to advance, and this will cause a DTC to be set.

ES

INSTALLATION

1. INSTALL CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

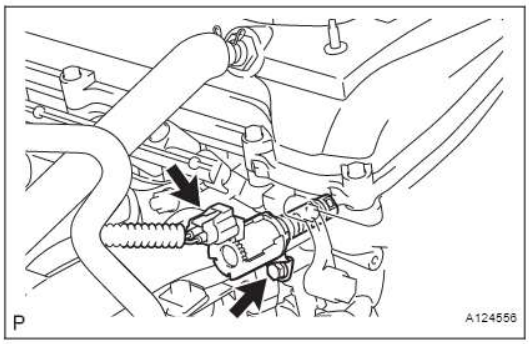
(a) Apply a light coat of engine oil to an O-ring of the camshaft timing oil control valve assembly sensor.

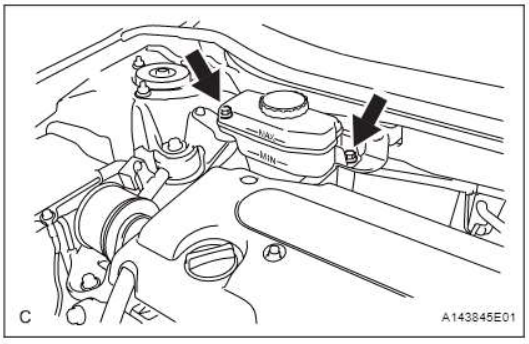


(b) Install the camshaft timing oil control valve assembly with the bolt.

Torque: 9.0 N*m (92 kgf*cm, 80 in.*lbf)

(c) Connect the camshaft timing oil control valve assembly connector.

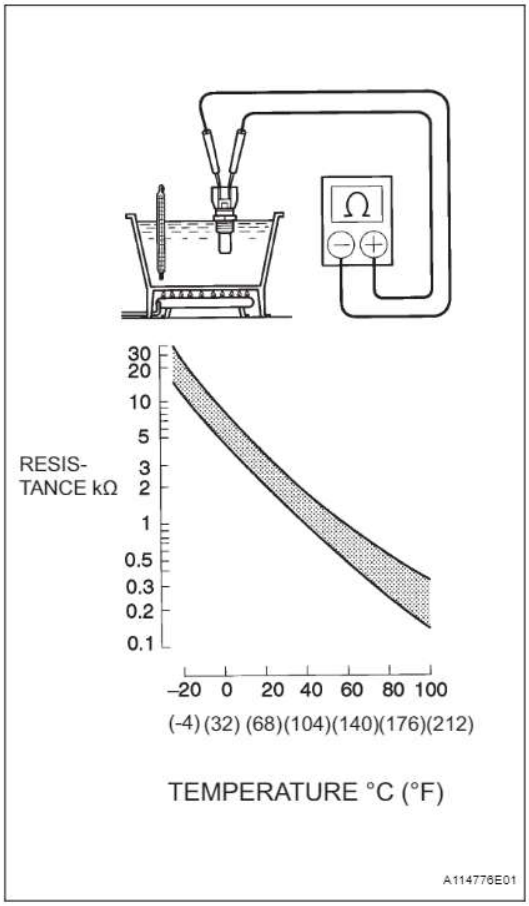




2. **INSTALL BRAKE MASTER CYLINDER RESERVOIR SUB-ASSEMBLY**
   (a) Install the brake master cylinder reservoir sub-assembly with the 2 bolts.
   Torque: 8.0 N*m (82 kgf*cm, 71 in.*lbf)

3. **INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-114)**

ES



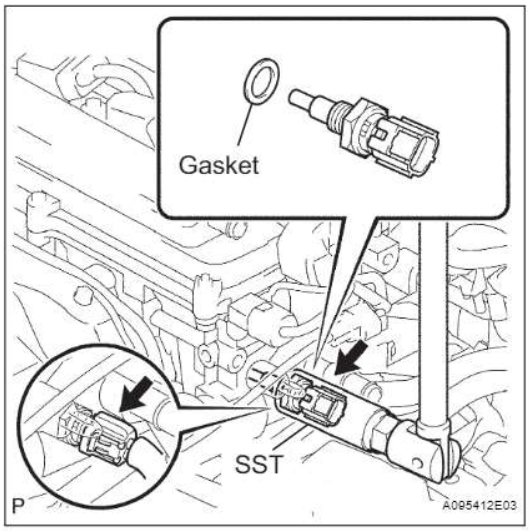
INSPECTION

1. **INSPECT ENGINE COOLANT TEMPERATURE SENSOR**
   (a) Using an ohmmeter, measure the resistance between the terminals.
   Standard resistance

Condition	Specified Condition
20°C (68°F)	2.32 to 2.59 kΩ
80°C (176°F)	0.310 to 0.326 kΩ

   If the result is not as specified, replace the sensor.
   NOTICE:
   In case of checking the water temperature sensor in water, do not allow water to go into the terminals. After checking, dry the sensor.

ES



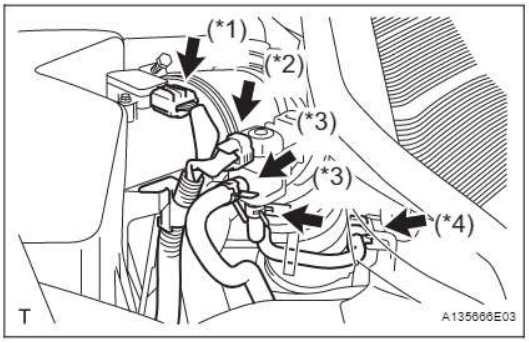
INSTALLATION

1. **INSTALL ENGINE COOLANT TEMPERATURE SENSOR**
   (a) Install a new gasket onto the engine coolant temperature sensor.
   (b) Using SST, install the engine coolant temperature sensor.
   SST 09817-33190
   Torque: 20 N*m (204 kgf*cm, 15 ft.*lbf)
   (c) Connect the engine coolant temperature sensor connector.
2. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-113)**
3. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-398)**
4. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-113)**
5. **ADD ENGINE COOLANT (See page CO-5)**
6. **INSPECT FOR COOLANT LEAK (See page CO-1)**
7. **INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-114)**

ES

REMOVAL

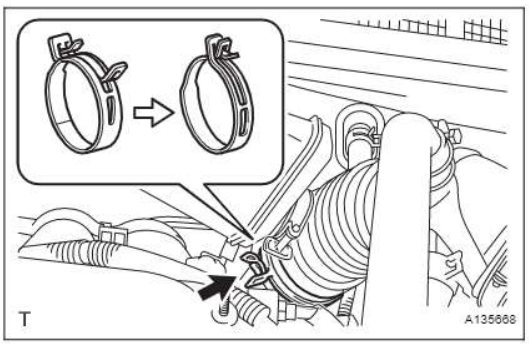
1. **DRAIN ENGINE COOLANT (See page CO-5)**
2. **REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-90)**
3. **REMOVE AIR CLEANER CAP SUB-ASSEMBLY**



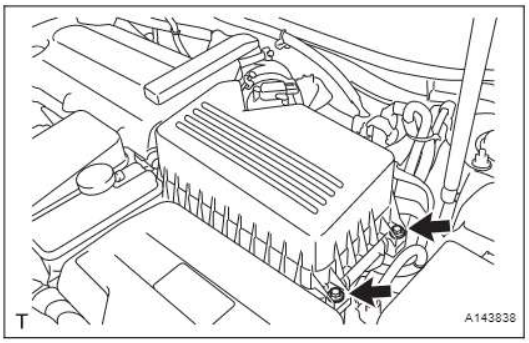
(a) Disconnect the mass air flow meter connector (*1).
(b) Disconnect the purge VSV connector (*2).
(c) Disconnect the 2 purge VSV vacuum hoses (*3).
(d) Disconnect the purge line hose from the clamp (*4).



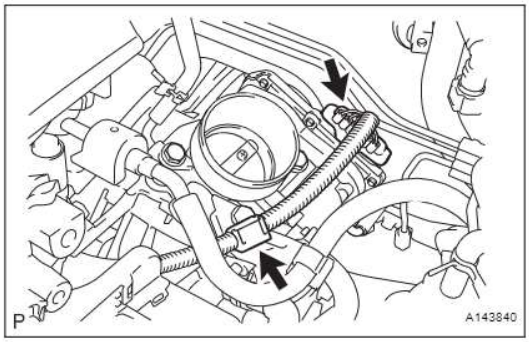
(e) Disconnect the No. 2 ventilation hose from the air cleaner hose.



(f) Lock the No. 1 air cleaner hose clamp, and then disconnect the No. 1 air cleaner hose from the throttle body.

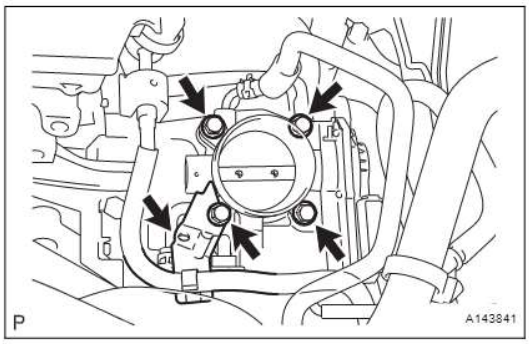


(g) Remove the 2 bolts and air cleaner cap.
(h) Remove the air cleaner filter element from the air cleaner case.

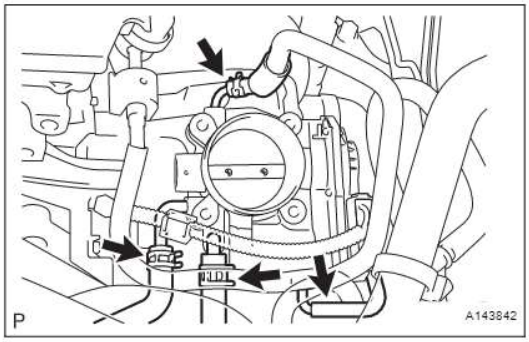


4. REMOVE THROTTLE BODY

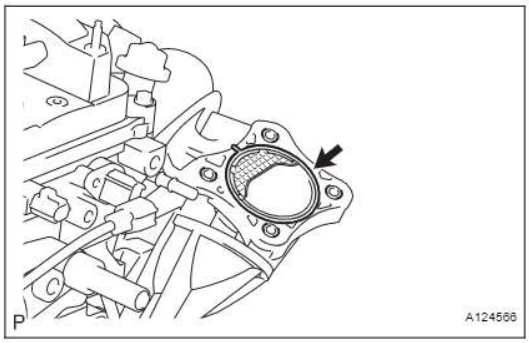
(a) Disconnect the throttle position sensor connector and wire harness clamp.



(b) Remove the 4 bolts, and then remove the fuel pipe support and throttle body.



(c) Disconnect the purge line hose from the throttle body.
(d) Disconnect the water by-pass hose from the throttle body.
(e) Disconnect the No. 2 water by-pass hose from the throttle body.
(f) Disconnect the No. 1 throttle body hose from the throttle body.



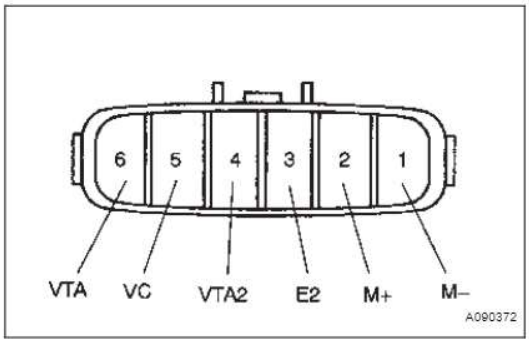
(g) Remove the gasket from the intake manifold.

INSPECTION

1. INSPECT THROTTLE BODY ASSEMBLY

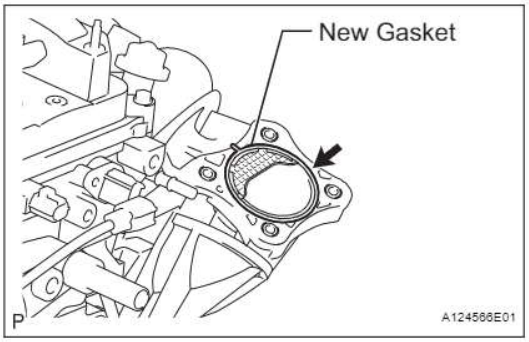
(a) Using an ohmmeter, measure the resistance between the terminals.

Standard resistance



Symbols (terminal No.)	Resistance	Temperature
M+ (2) - M- (1)	0.3 to 100 Ω	20°C (68°F)

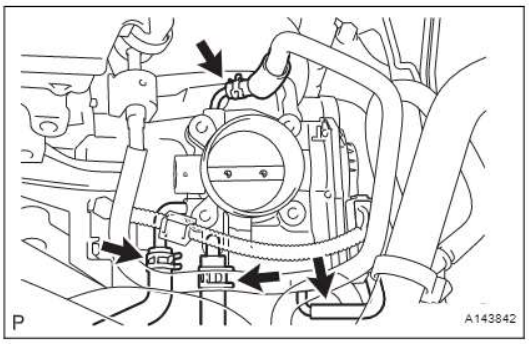
If the result is not as specified, replace the throttle body assembly.



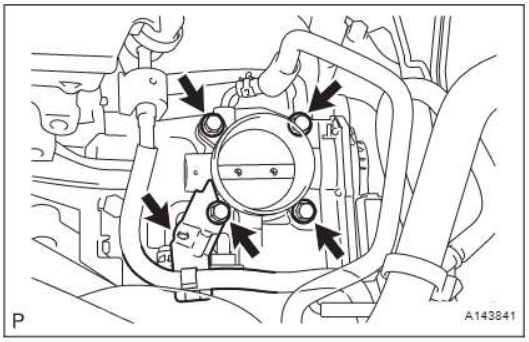
INSTALLATION

1. INSTALL THROTTLE BODY

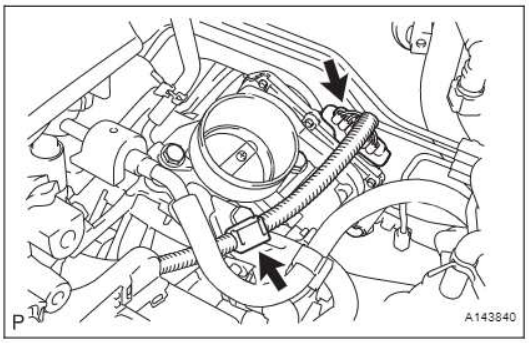
(a) Install a new gasket onto the intake manifold.



(b) Connect the purge line hose to the throttle body.
(c) Connect the water by-pass hose to the throttle body.
(d) Connect the No. 2 water by-pass hose to the throttle body.
(e) Connect the No. 1 throttle body hose to the throttle body.



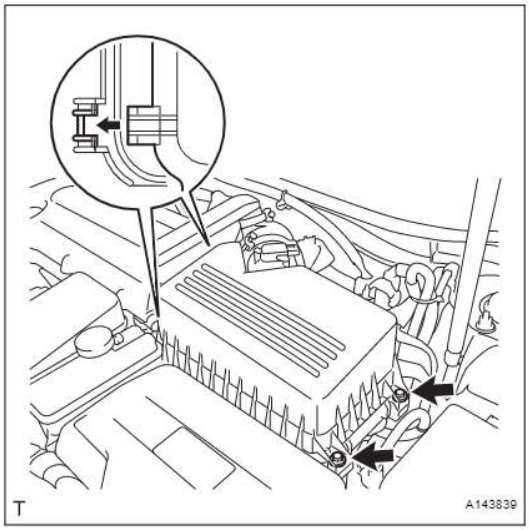
(f) Install the throttle body and fuel pipe clamp with the 4 bolts.
Torque: 30 N*m (305 kgf*cm, 22 ft.*lbf)
(g) Connect the fuel tube into the clamp.



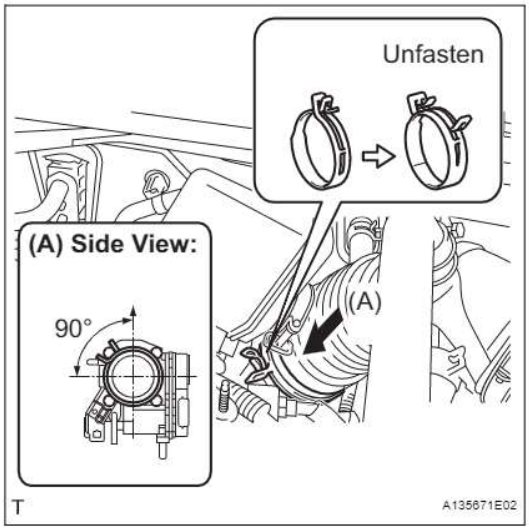
(h) Connect the throttle position sensor connector.
(i) Connect the wire harness clamp.

2. INSTALL AIR CLEANER CAP SUB-ASSEMBLY

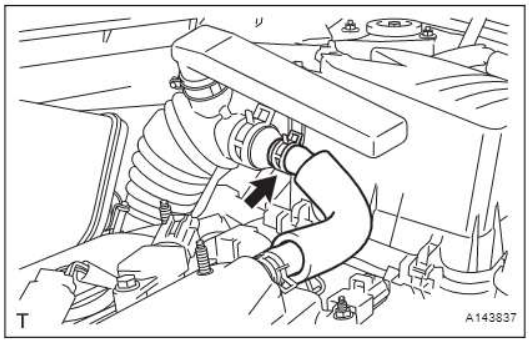
(a) Install the air cleaner filter element onto the air cleaner case.



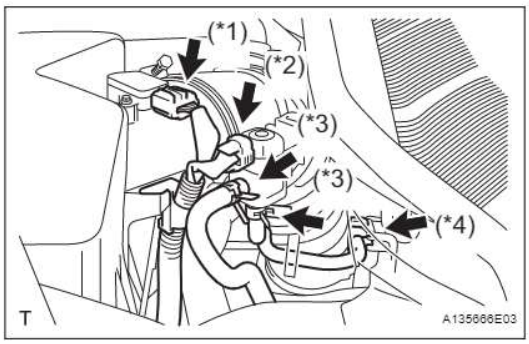
(b) Insert the hinges. Install the air cleaner cap sub-assembly with the 2 bolts.



(c) Align the matchmarks of the No. 1 air cleaner hose and throttle body. Connect the air cleaner hose No. 1 to the throttle body and unfasten the No. 1 air cleaner hose clamp.
NOTICE:
Make sure that the hose clamp is at the correct angle.



(d) Connect the No. 2 ventilation hose to the air cleaner hose.



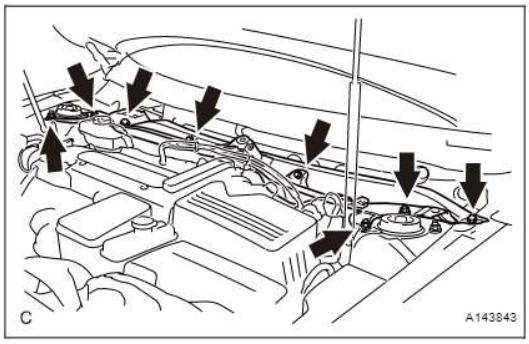
(e) Connect the purge line hose to the clamp (*1).
(f) Connect the 2 purge VSV vacuum hoses (*2).
(g) Connect the purge VSV connector (*3).
(h) Connect the mass air flow meter connector (*4).

3. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-113)**
4. **ADD ENGINE COOLANT (See page CO-5)**
5. **INSPECT FOR COOLANT LEAK (See page CO-1)**

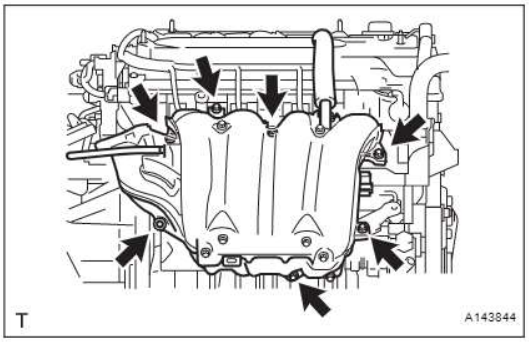
6. INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY
(See page EM-114)

REMOVAL

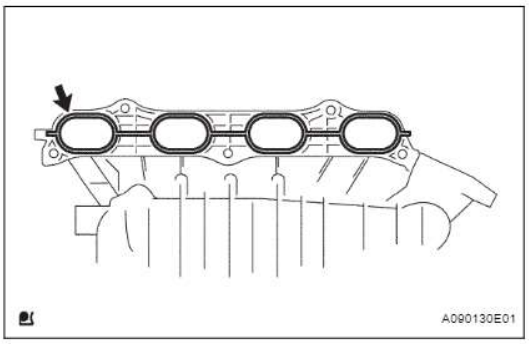
1. DISCHARGE FUEL SYSTEM PRESSURE (See page FU-36)
2. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL
3. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-90)
4. DRAIN ENGINE COOLANT (See page CO-5)
5. REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-9)
6. REMOVE WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-9)
7. REMOVE FRONT FENDER TO COWL SIDE SEAL LH (See page WW-9)
8. REMOVE FRONT FENDER TO COWL SIDE SEAL RH (See page WW-9)
9. REMOVE COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-10)
10. SEPARATE BRAKE MASTER CYLINDER RESERVOIR SUB-ASSEMBLY
11. REMOVE WINDSHIELD WIPER MOTOR AND LINK (See page WW-10)
12. REMOVE COWL TOP PANEL OUTER SUB-ASSEMBLY
    (a) Remove the 4 bolts, 4 nuts and cowl top panel outer sub-assembly.



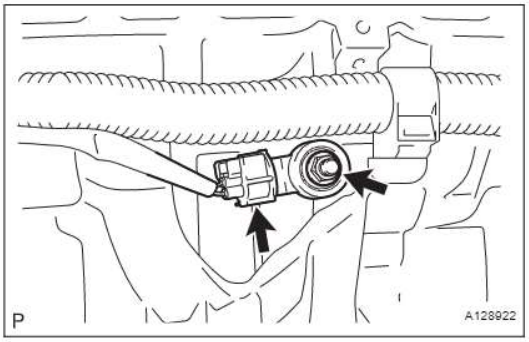
13. REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-395)
14. REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-90)
15. REMOVE THROTTLE BODY (See page ES-396)
16. DISCONNECT FUEL TUBE (See page FU-12)
17. REMOVE FUEL DELIVERY PIPE WITH INJECTOR (See page FU-13)
18. REMOVE INTAKE MANIFOLD
    (a) Disconnect the union to check valve hose from the brake booster.



(b) Disconnect the camshaft timing oil control valve connector.
(c) Remove the wire harness clamp.
(d) Remove the union to check valve hose from the vacuum hose clamp.
(e) Remove the 5 bolts, 2 nuts and intake manifold.



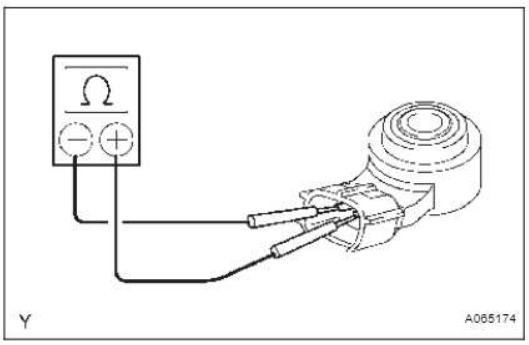
(f) Remove the gasket from the intake manifold.



19. REMOVE KNOCK SENSOR
(a) Disconnect the knock sensor connector.
(b) Remove the nut and knock sensor.

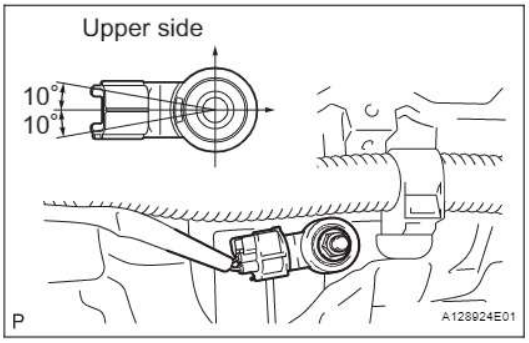
INSPECTION

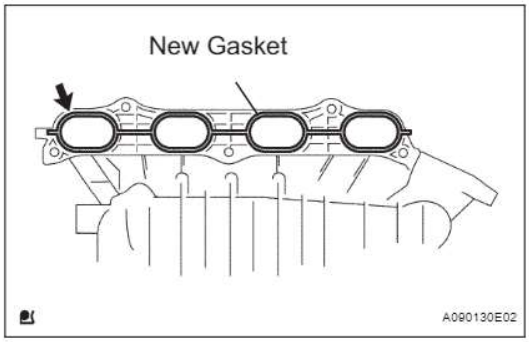
1. KNOCK CONTROL SENSOR
(a) Using an ohmmeter, measure the resistance between the terminals.
Standard resistance:
120 to 280 kΩ at 20°C (68°F)
If the resistance is not specified, replace the sensor.



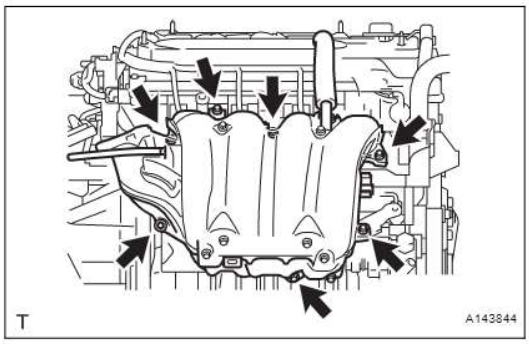
INSTALLATION

1. INSTALL KNOCK SENSOR
(a) Install the knock sensor with the nut.
Torque: 20 N*m (204 kgf*cm, 15 ft.*lbf)
NOTICE:
Make sure that the knock sensor is in the correct position.
(b) Connect the knock sensor connector.



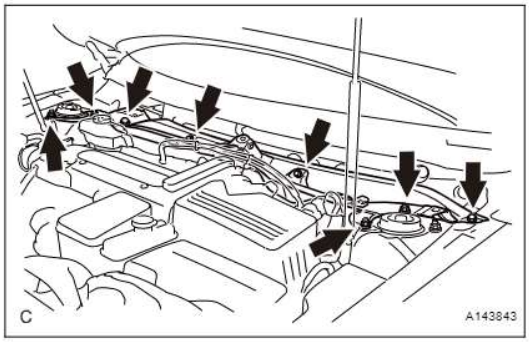


2. **INSTALL INTAKE MANIFOLD**
   (a) Install a new gasket into the intake manifold.



   (b) Install the intake manifold with the 5 bolts and 2 nuts.
   Torque: 30 N*m (306 kgf*cm, 22 ft.*lbf)
   (c) Fit the union to check valve hose into the vacuum hose clamp.
   (d) Install the wire harness clamp.
   (e) Connect the camshaft timing oil control valve connector.
   (f) Connect the union to check valve hose to the brake booster.

3. **INSTALL FUEL DELIVERY PIPE WITH INJECTOR (See page FU-15)**
4. **INSTALL FUEL TUBE (See page FU-16)**
5. **INSTALL THROTTLE BODY (See page ES-397)**
6. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-113)**
7. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-398)**
8. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-113)**
9. **CONNECT CABLE TO NEGATIVE BATTERY TERMINAL (See page EM-113)**
10. **ADD ENGINE COOLANT (See page CO-5)**
11. **INSPECT FOR COOLANT LEAK (See page CO-1)**
12. **INSPECT FOR FOR FUEL LEAK (See page FU-9)**
13. **INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-114)**



14. **INSTALL COWL TOP PANEL OUTER SUB-ASSEMBLY**
   (a) Install the cowl top panel outer sub-assembly with the 4 bolts and 4 nuts.
   Torque: Bolt
   5.0 N*m (51 kgf*cm, 44 in.*lbf)
   Nut
   85 N*m (867 kgf*cm, 63 ft.*lbf)
15. **INSTALL BRAKE MASTER CYLINDER RESERVOIR SUB-ASSEMBLY (See page ES-383)**

ES

16. **INSTALL WINDSHIELD WIPER MOTOR AND LINK (See page WW-13)**
17. **INSTALL COWL TOP VENTILATOR LOUVER SUB-ASSEMBLY (See page WW-14)**
18. **INSTALL FRONT FENDER TO COWL SIDE SEAL LH (See page WW-14)**
19. **INSTALL FRONT FENDER TO COWL SIDE SEAL RH (See page WW-14)**
20. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY LH (See page WW-14)**
21. **INSTALL WINDSHIELD WIPER ARM AND BLADE ASSEMBLY RH (See page WW-15)**
22. **PERFORM INITIALIZATION**
    (a) Perform initialization procedure (See page IN-43).
    NOTICE:
    Some vehicle systems require initialization after reconnecting the cable to the negative battery terminal.

ES

SFI SYSTEM

PRECAUTION

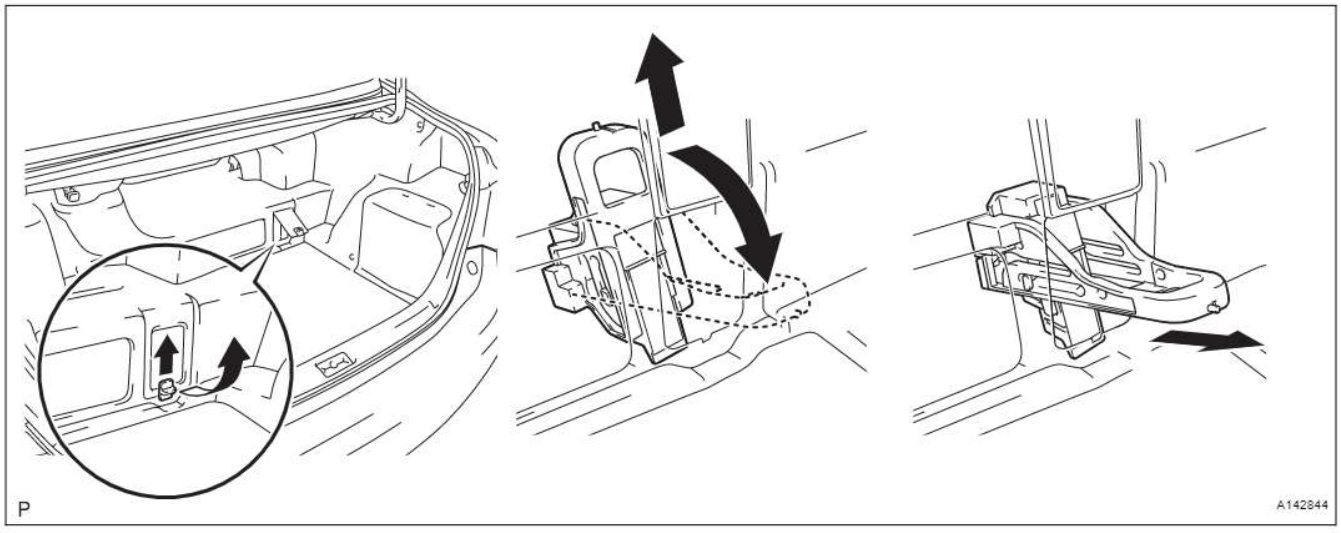
NOTICE:
When disconnecting the negative (-) battery cable, initialize the following systems after the terminal is reconnected.

System	See procedure
SFI system	ES-13

1. PRECAUTIONS FOR INSPECTING HYBRID CONTROL SYSTEM

(a) Before inspecting the high-voltage system or disconnecting the low voltage connector of the inverter with converter assembly, take safety precautions, such as wearing insulated gloves and removing the service plug grip to prevent electrical shocks. After removing the service plug grip, put it in your pocket to prevent other technicians from accidentally reconnecting it while you are working on the high-voltage system.
NOTICE:
Turning the power switch on (READY) with the service plug grip removed could cause a malfunction. Do not turn the power switch on (READY) unless instructed by the repair manual.

(b) After disconnecting the service plug grip, wait for at least 10 minutes before touching any of the high-voltage connectors or terminals.



HINT:
Waiting for at least 10 minutes is required to discharge the high-voltage capacitor inside the inverter with converter assembly.

(c) Turn the power switch off, wear insulated gloves, and disconnect the negative terminal of the auxiliary battery before touching any of the orange-colored wires of the high-voltage system.

(d) Turn the power switch off before performing any resistance checks.
(e) Turn the power switch off before disconnecting or reconnecting any connectors.

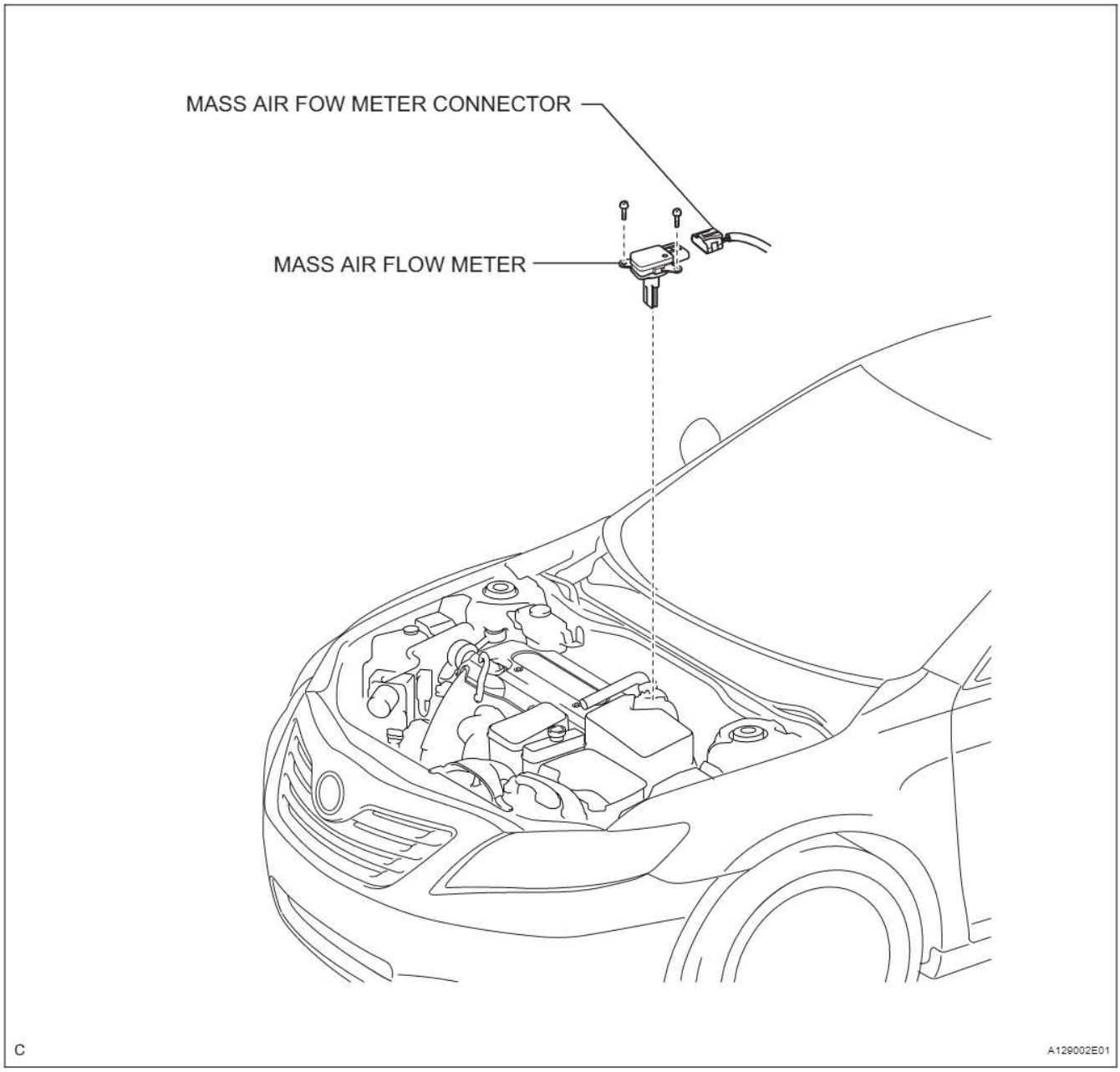
2. PRECAUTIONS FOR HYBRID CONTROL SYSTEM ACTIVATION

(a) When the warning light is illuminated, or the auxiliary battery has been disconnected and reconnected, attempting to turn the power switch on (READY) may not start the system (the system may not enter the READY-on state) on the first attempt. If so, turn the power switch off and reattempt to turn the power switch on (READY).

ES

MASS AIR FLOW METER

COMPONENTS



ES

ON-VEHICLE INSPECTION

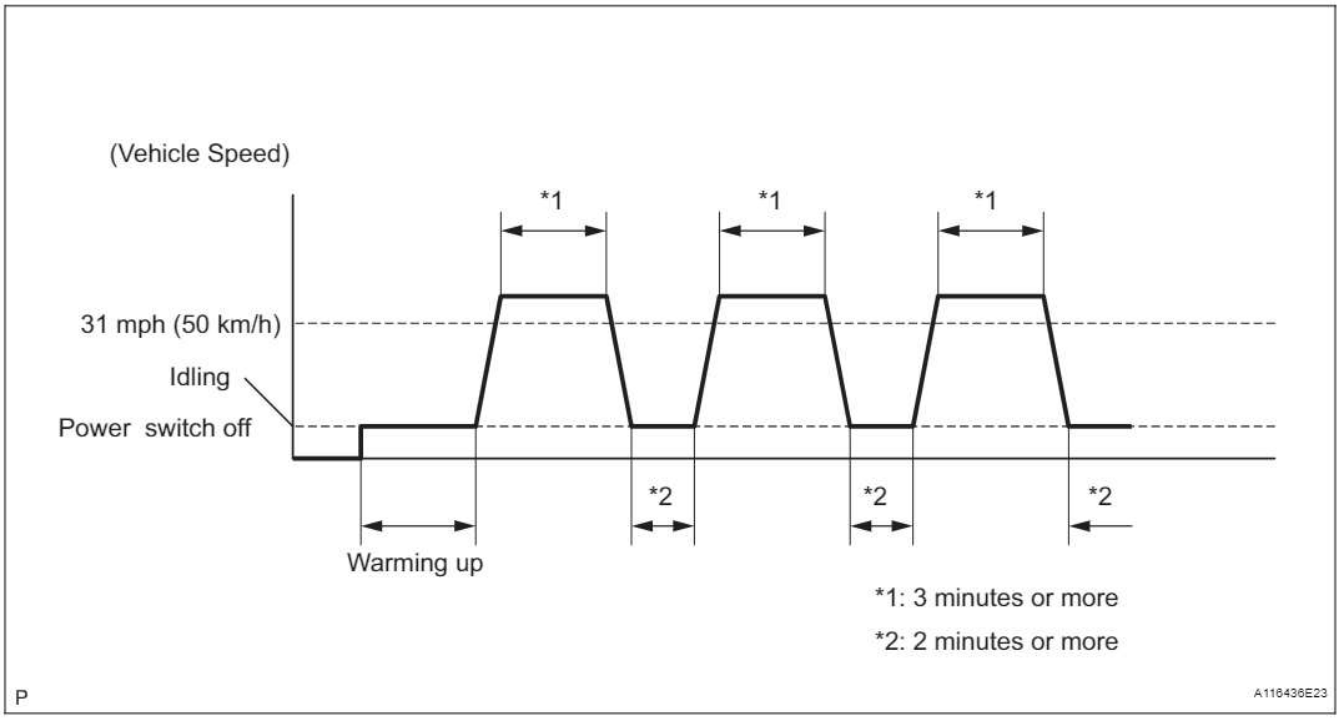
NOTICE:

- **Perform the MAF meter inspection according to 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.**

1. INSPECT MASS AIR FLOW METER

(a) Perform confirmation driving pattern.

(1) Connect the intelligent tester to the DLC3.
(2) Turn the power switch on (IG).
(3) Turn the intelligent tester on.
(4) Clear the DTCs (See page ES-31).
(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 50 km/h (31 mph) or more for 3 to 5 minutes (*1).
(7) Allow the engine to idle for 2 minutes (*2).
(8) Perform steps (*1) and (*2) at least 3 times.



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

(1) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / LONG FT#1.
(2) Read the values displayed on the tester.
Standard value:
Within -15 to +15 %
If the result is not within the specified range, perform the inspection below.

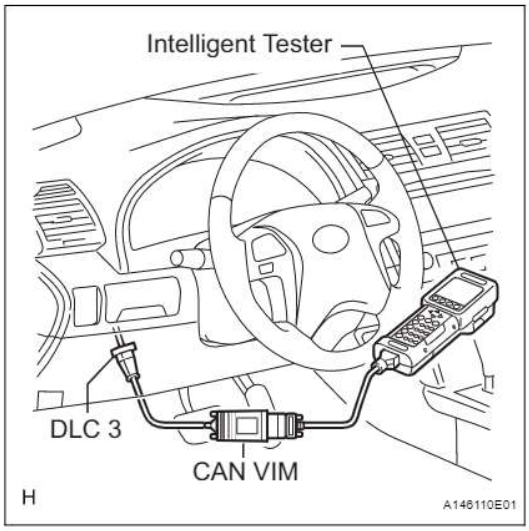
(c) Read values using the intelligent tester (MAF).
NOTICE:
- **Turn off the engine.**
- **Perform the inspection with the vehicle indoors and on a level surface.**
- **Perform the inspection of the MAF meter while it is installed to the air cleaner case (installed to the vehicle).**
- **During the test,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

(1) Turn the power switch on (IG).

(2) Turn the intelligent tester on.

(3) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF.

(4) Wait 30 seconds, and read the values on the intelligent tester.
Standard condition:
Less than 0.51 g/sec.
- If the result is not as specified, replace the MAF meter.
- If the result is within the specified range, inspect the cause of extremely rich or lean air fuel ratio.

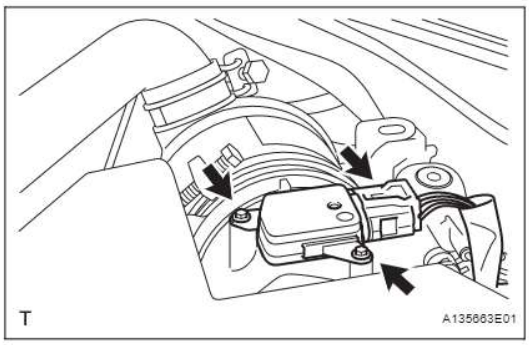


REMOVAL

1. REMOVE MASS AIR FLOW METER

(a) Disconnect the mass air flow meter connector.

(b) Remove the 2 screws and mass air flow meter.

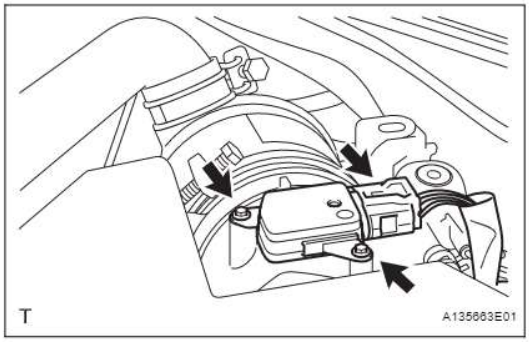


INSTALLATION

1. INSTALL MASS AIR FLOW METER

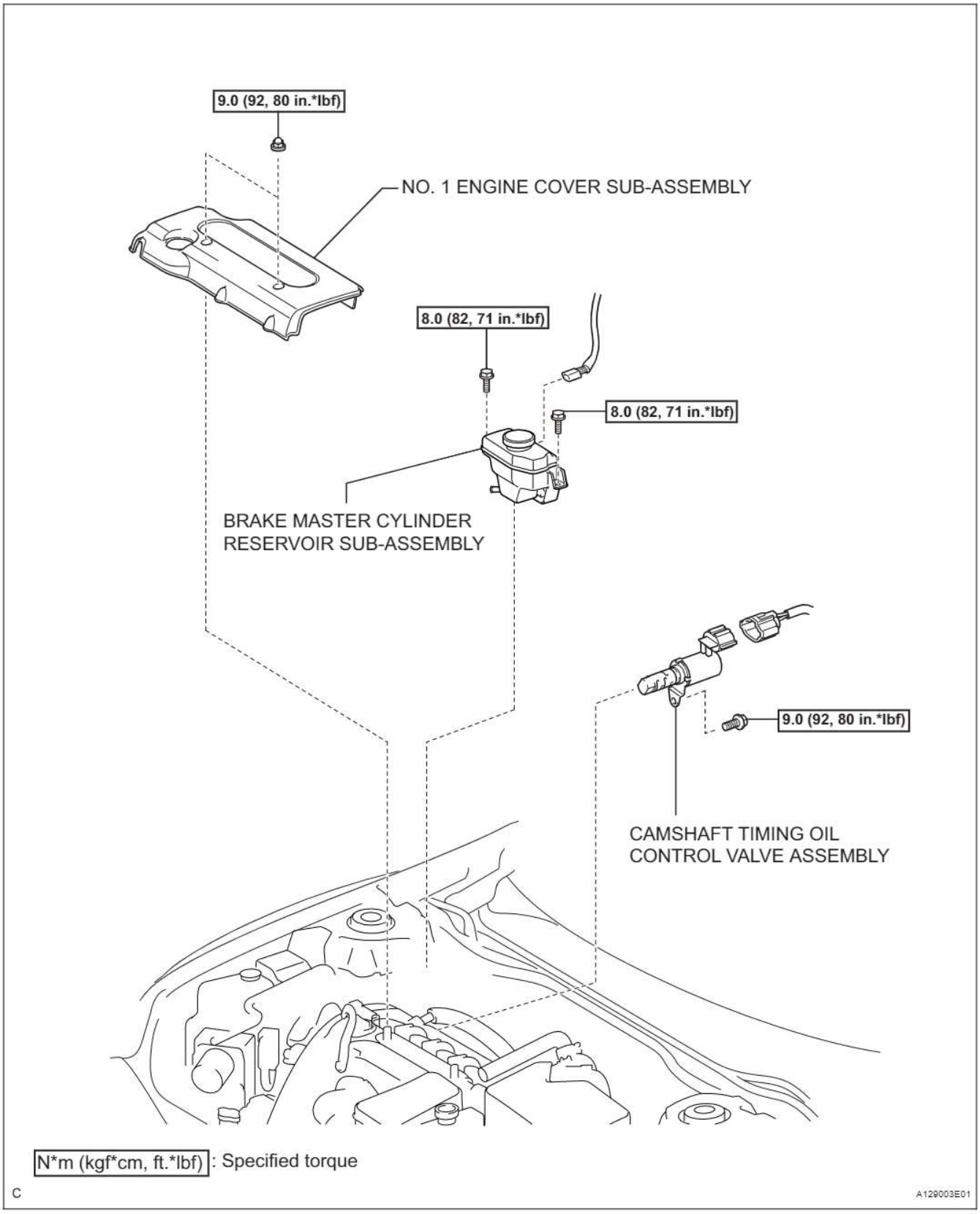
(a) Install the mass air flow meter with the 2 screws.

(b) Connect the mass air flow meter connector.



CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

COMPONENTS

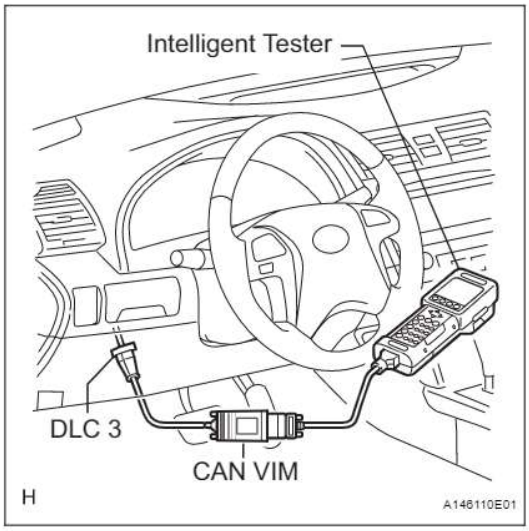


ON-VEHICLE INSPECTION

1. INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

(a) Put the engine in inspection mode (See page ES-35).

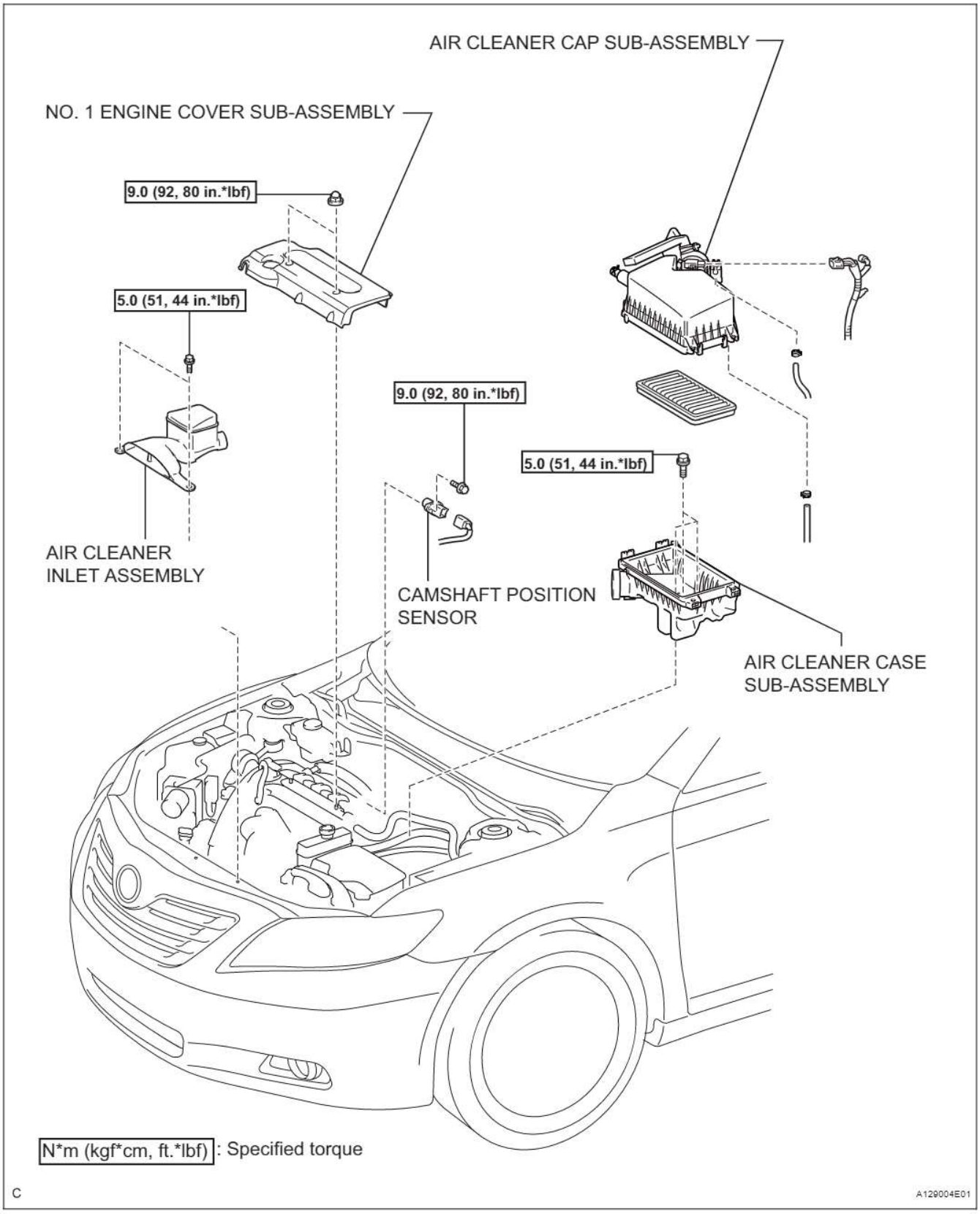
(b) Connect the intelligent tester to the DLC3.
(c) Turn the power switch ON (IG).
(d) Turn the tester on.
(e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST.
(f) Perform the ACTIVE TEST by referring to the below.



Intelligent Tester Displays	Test Details	Control Ranges	Diagnostic Note
VVT CTRL B1	Turn OCV on and off (Oil Control Valve)	ON/OFF	• Engine stalls or idles roughly when OCV turned ON • Normal engine running or idling when OCV is off

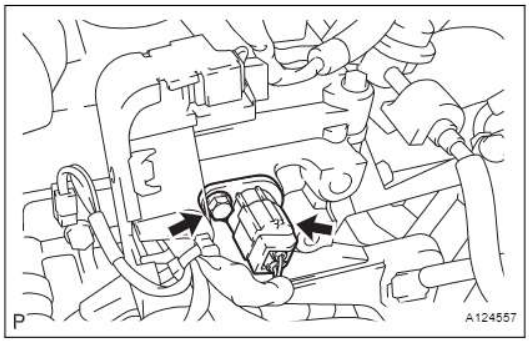
CAMSHAFT POSITION SENSOR

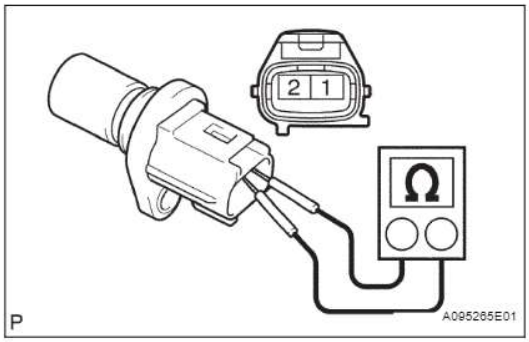
COMPONENTS



REMOVAL

1. REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-90)
2. REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-90)
3. REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-395)
4. REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-90)
5. REMOVE CAMSHAFT POSITION SENSOR
   (a) Disconnect the camshaft position sensor connector.
   (b) Remove the bolt and camshaft position sensor.



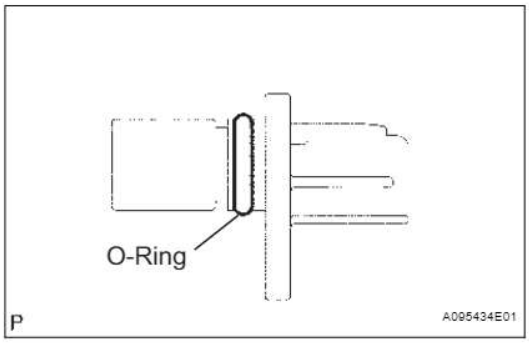


INSPECTION

1. INSPECT CAMSHAFT POSITION SENSOR
   (a) Measure the resistance of the sensor.
   Standard resistance

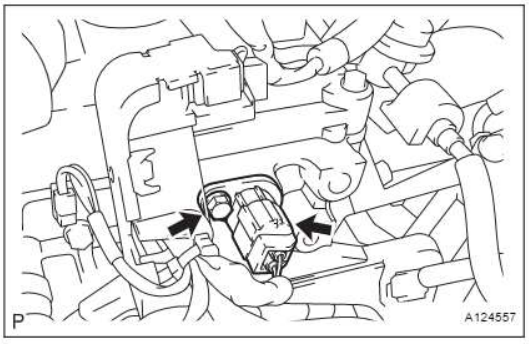
Tester Connection	Specified Condition
1 (G+) - 2 (G-)	835 to 1,400 Ω at Cold
1 (G+) - 2 (G-)	1,060 to 1,645 Ω at Hot

NOTICE:
"Cold" and "Hot" mean the temperature of the coils themselves. "Cold" is from -10 to 50°C (14 to 122°F) and "Hot" is from 50 to 100°C (122 to 212°F).
If the result is not as specified, replace the camshaft position sensor.



INSTALLATION

1. INSTALL CAMSHAFT POSITION SENSOR
   (a) Apply a light coat of engine oil to the O-ring of the sensor.
   NOTICE:
   Make sure that the O-ring is not cracked or jammed when installing it.



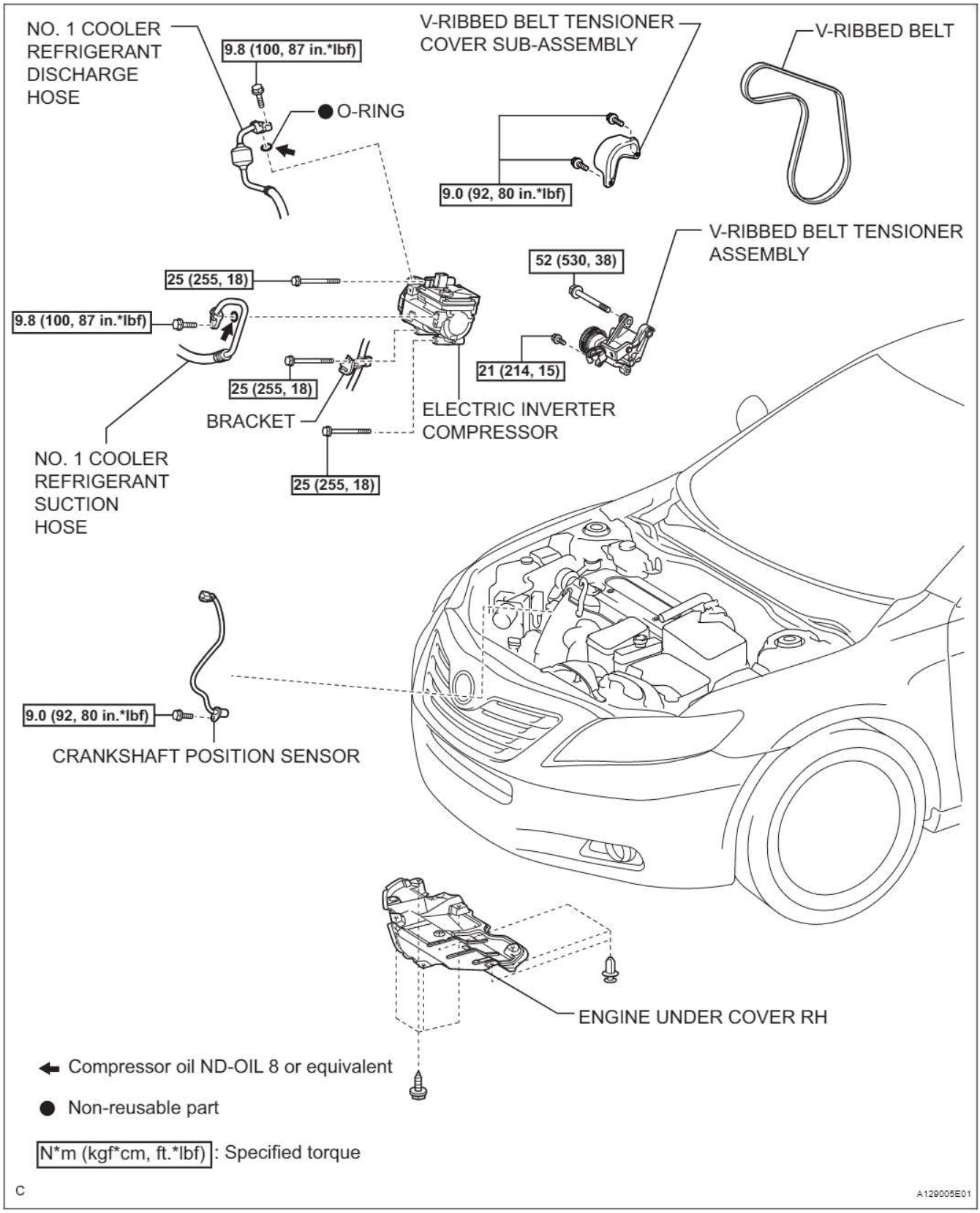
(b) Install the camshaft position sensor with the bolt.
Torque: 9.0 N*m (92 kgf*cm, 80 in.*lbf)
(c) Connect the camshaft position sensor connector.

2. **INSTALL AIR CLEANER CASE SUB-ASSEMBLY (See page EM-113)**
3. **INSTALL AIR CLEANER CAP SUB-ASSEMBLY (See page ES-395)**
4. **INSTALL AIR CLEANER INLET ASSEMBLY (See page EM-113)**
5. **INSPECT FOR OIL LEAK**
6. **INSTALL NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-114)**

ES

CRANKSHAFT POSITION SENSOR

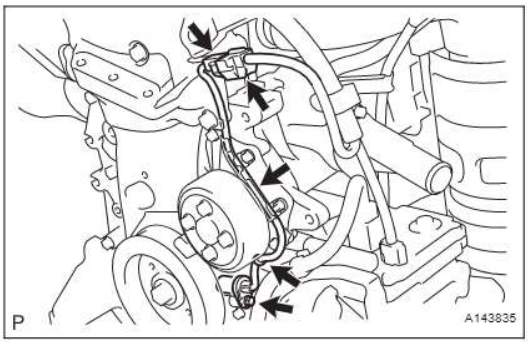
COMPONENTS

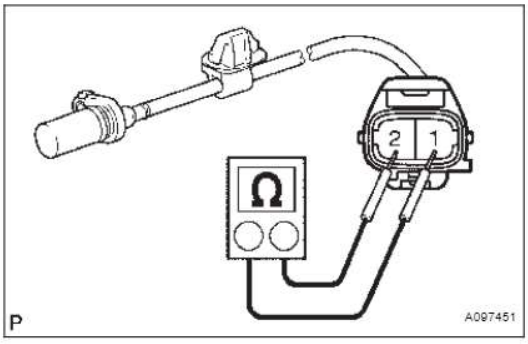


ES

REMOVAL

1. RECOVER REFRIGERANT FROM REFRIGERATION SYSTEM (See page AC-169)
2. DRAIN ENGINE COOLANT (See page CO-5)
3. DISCONNECT CABLE FROM NEGATIVE BATTERY TERMINAL
4. REMOVE SERVICE PLUG GRIP (See page HB-86)
5. REMOVE NO. 2 ENGINE ROOM SIDE LH COVER
6. REMOVE CONNECTOR COVER ASSEMBLY
7. CHECK TERMINAL VOLTAGE
8. INSTALL CONNECTOR COVER ASSEMBLY
9. INSTALL NO. 2 ENGINE ROOM SIDE LH COVER
10. REMOVE V-RIBBED BELT TENSIONER COVER SUB-ASSEMBLY (See page EM-6)
11. REMOVE V-RIBBED BELT (See page EM-6)
12. REMOVE V-RIBBED BELT TENSIONER ASSEMBLY (See page EM-100)
13. DISCONNECT RADIATOR HOSE OUTLET (See page AC-230)
14. DISCONNECT NO. 1 COOLER REFRIGERANT SUCTION HOSE (See page AC-230)
15. DISCONNECT NO. 1 COOLER REFRIGERANT DISCHARGE HOSE (See page AC-230)
16. REMOVE ELECTRIC INVERTER COMPRESSOR (See page AC-230)
17. REMOVE CRANKSHAFT POSITION SENSOR
    (a) Disconnect the crankshaft position sensor connector.
    (b) Remove the connector clamp and wire harness clamp.
    (c) Remove the wire harness clamp bracket from the wire harness.
    (d) Remove the bolt, and then remove the crankshaft position sensor.



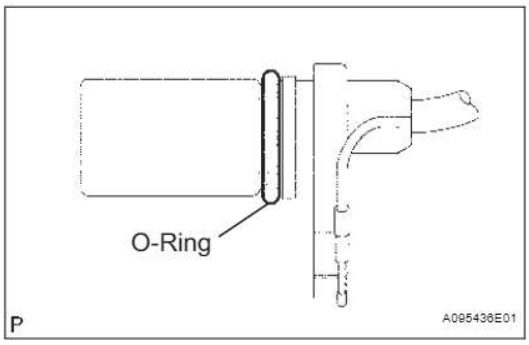


INSPECTION

1. INSPECT CRANKSHAFT POSITION SENSOR
   (a) Using an ohmmeter, measure the resistance between the terminals.
   Standard resistance

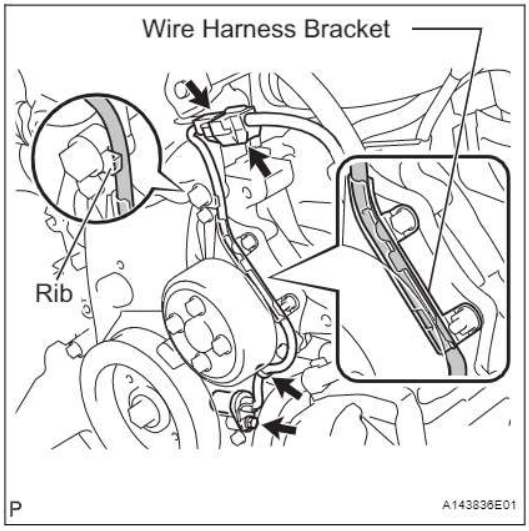
Temperature	Specified Condition
Cold	985 to 1,600 Ω
Hot	1,265 to 1,890 Ω

NOTICE:
"Cold" and "Hot" mean the temperature of the coils themselves. "Cold" is from -10 to 50°C (14 to 122°F) and "Hot" is from 50 to 100°C (122 to 212°F).
If the resistance is not as specified, replace the sensor.



INSTALLATION

1. **INSTALL CRANKSHAFT POSITION SENSOR**
   (a) Apply a light coat of engine oil to the O-ring on the crankshaft position sensor.



   (b) Install the crankshaft position sensor with the bolt.
   Torque: 9.0 N*m (92 kgf*cm, 80 in.*lbf)
   (c) Connect the crankshaft position sensor connector.
2. **INSTALL ELECTRIC INVERTER COMPRESSOR (See page AC-232)**
3. **CONNECT NO. 1 COOLER REFRIGERANT DISCHARGE HOSE (See page AC-233)**
4. **CONNECT NO. 1 COOLER REFRIGERANT SUCTION HOSE (See page AC-233)**
5. **CONNECT RADIATOR HOSE OUTLET (See page AC-233)**
6. **INSTALL V-RIBBED BELT TENSIONER ASSEMBLY (See page EM-103)**
7. **INSTALL V-RIBBED BELT (See page EM-6)**
8. **INSTALL V-RIBBED BELT TENSIONER COVER SUB-ASSEMBLY (See page EM-7)**
9. **INSTALL SERVICE PLUG GRIP (See page HB-97)**
10. **CONNECT CABLE TO NEGATIVE BATTERY TERMINAL**
11. **ADD ENGINE COOLANT (See page CO-5)**
12. **INSPECT FOR COOLANT LEAK (See page CO-1)**
13. **CHARGE WITH REFRIGERANT (See page AC-169)**
14. **WARM UP COMPRESSOR (See page AC-171)**
15. **INSPECT FOR REFRIGERANT LEAK (See page AC-171)**

16. PERFORM INITIALIZATION

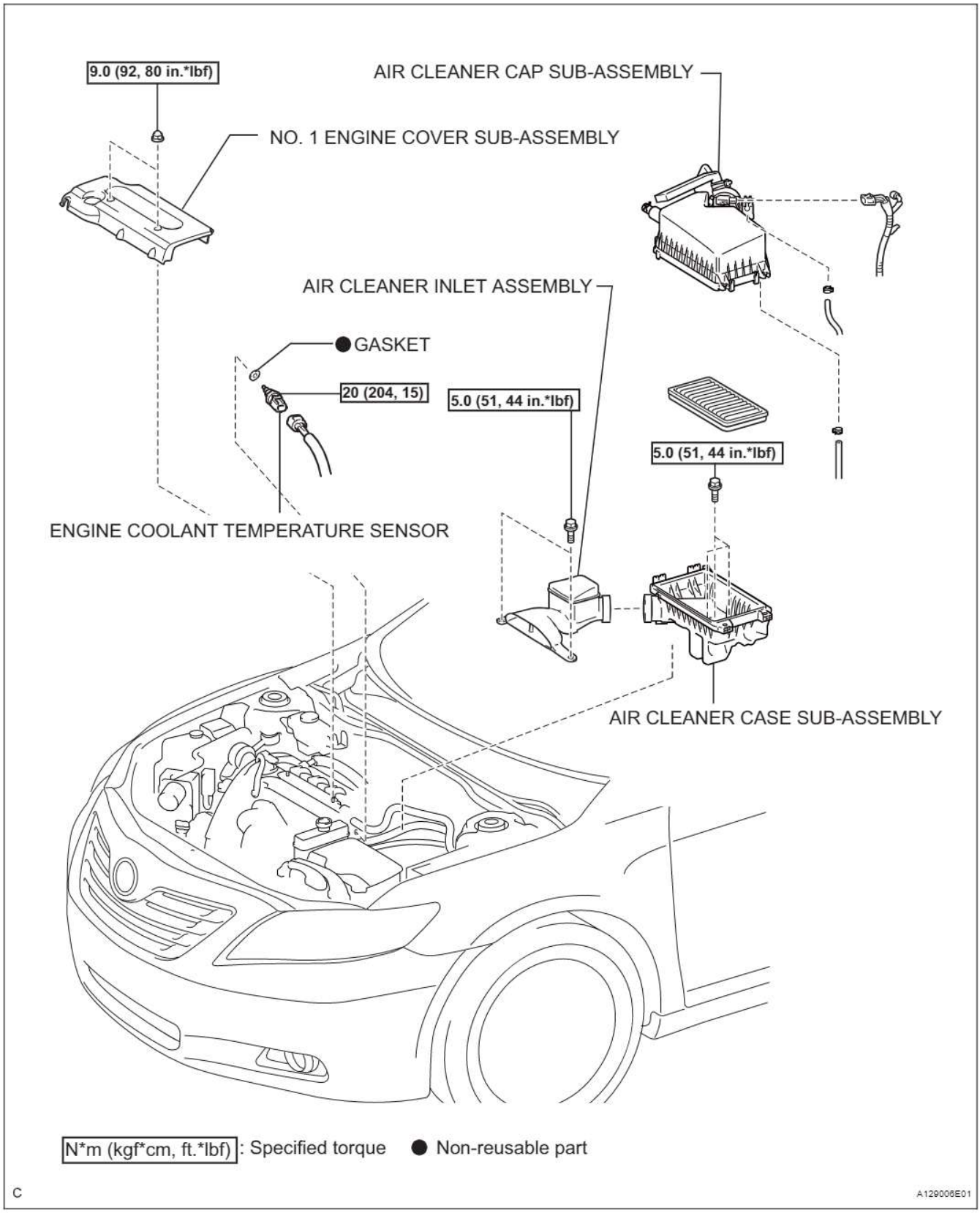
(a) Perform initialization procedure (See page IN-43).

NOTICE:

Some vehicle systems require initialization after reconnecting the cable to the negative battery terminal.

ENGINE COOLANT TEMPERATURE SENSOR

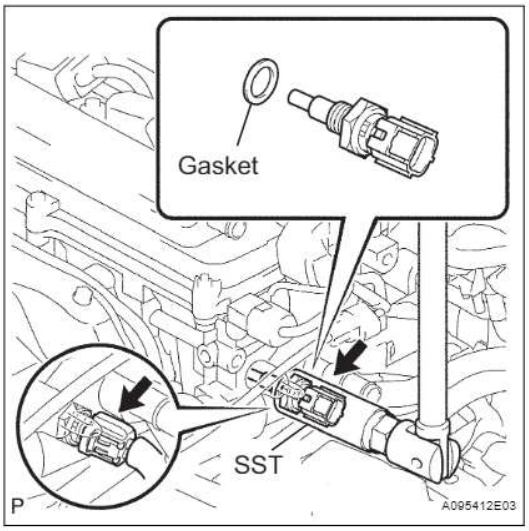
COMPONENTS



ES

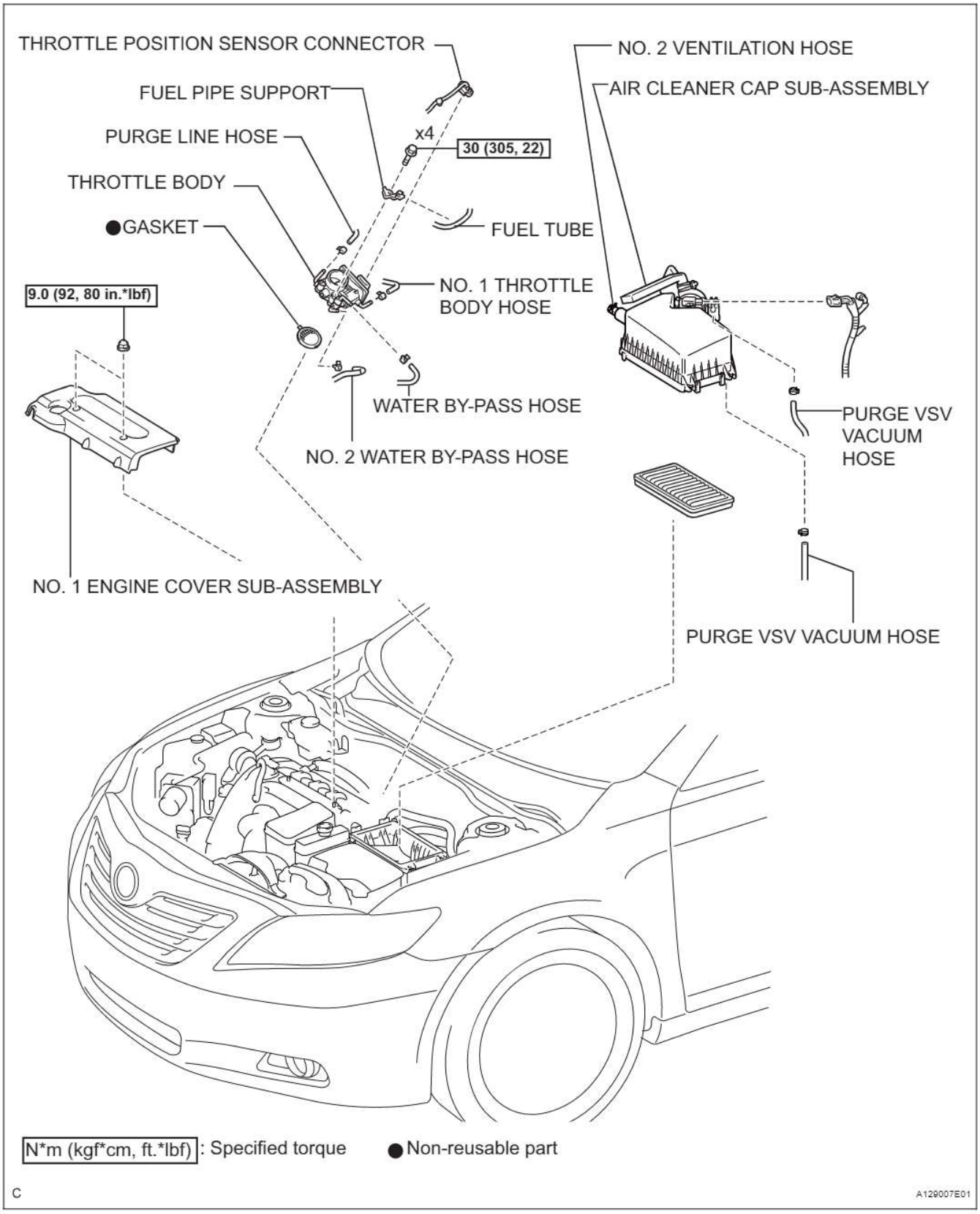
REMOVAL

1. **DRAIN ENGINE COOLANT (See page CO-5)**
2. **REMOVE NO. 1 ENGINE COVER SUB-ASSEMBLY (See page EM-90)**
3. **REMOVE AIR CLEANER INLET ASSEMBLY (See page EM-90)**
4. **REMOVE AIR CLEANER CAP SUB-ASSEMBLY (See page ES-395)**
5. **REMOVE AIR CLEANER CASE SUB-ASSEMBLY (See page EM-90)**
6. **REMOVE ENGINE COOLANT TEMPERATURE SENSOR**
   (a) Disconnect the engine coolant temperature sensor connector.
   (b) Using SST, remove the engine coolant temperature sensor and gasket.
   SST 09817-33190



THROTTLE BODY

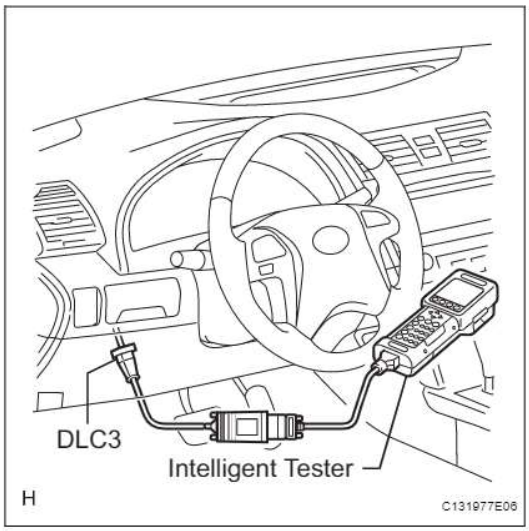
COMPONENTS



ON-VEHICLE INSPECTION

1. INSPECT THROTTLE BODY ASSEMBLY

(a) Listen to the throttle control motor operating sounds.
  (1) Turn the power switch on (IG).
  (2) When pressing the accelerator pedal position sensor lever, listen to the running motor. Make sure that no friction noise comes from the motor.
  If friction noise exists, replace the throttle body assembly.

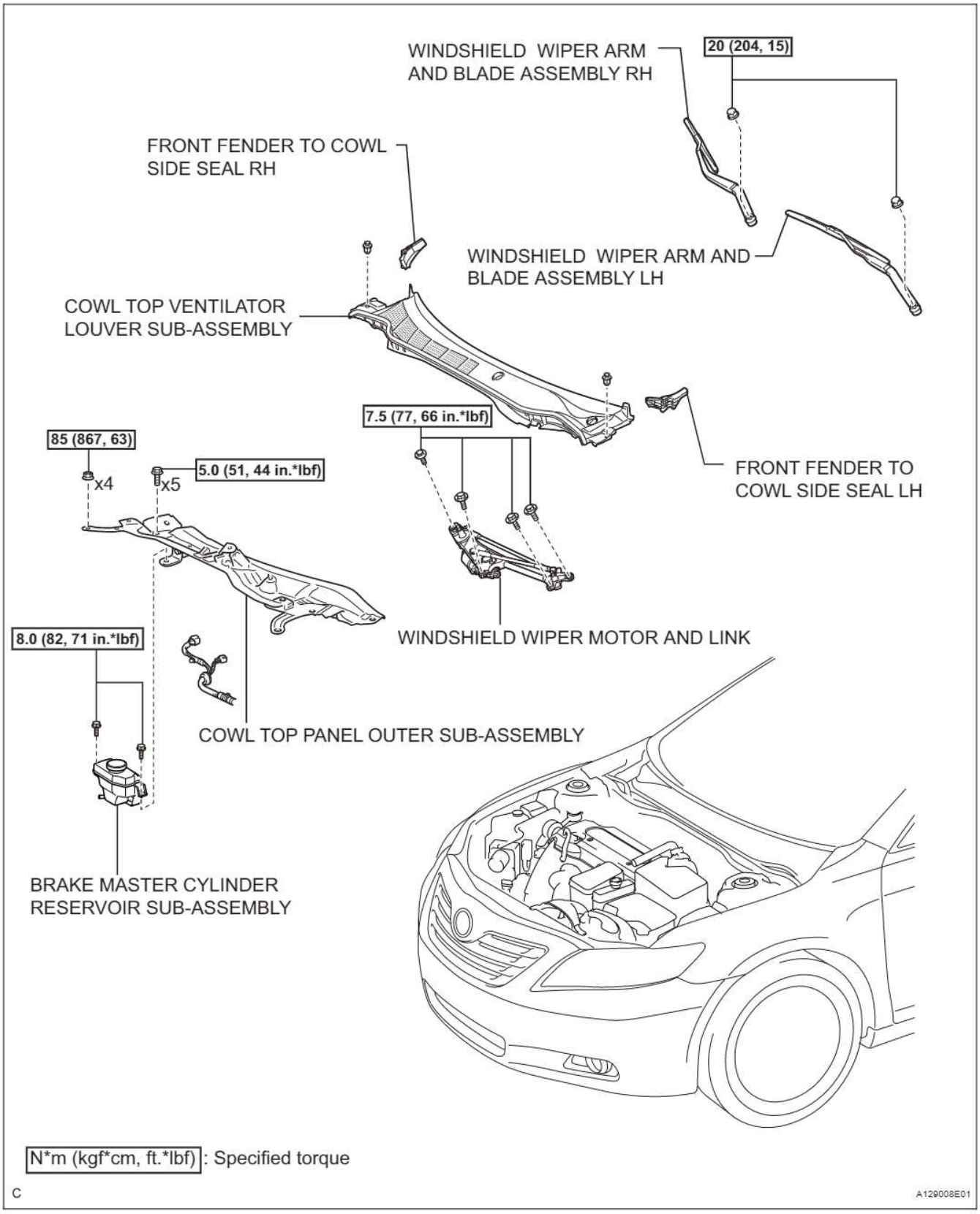


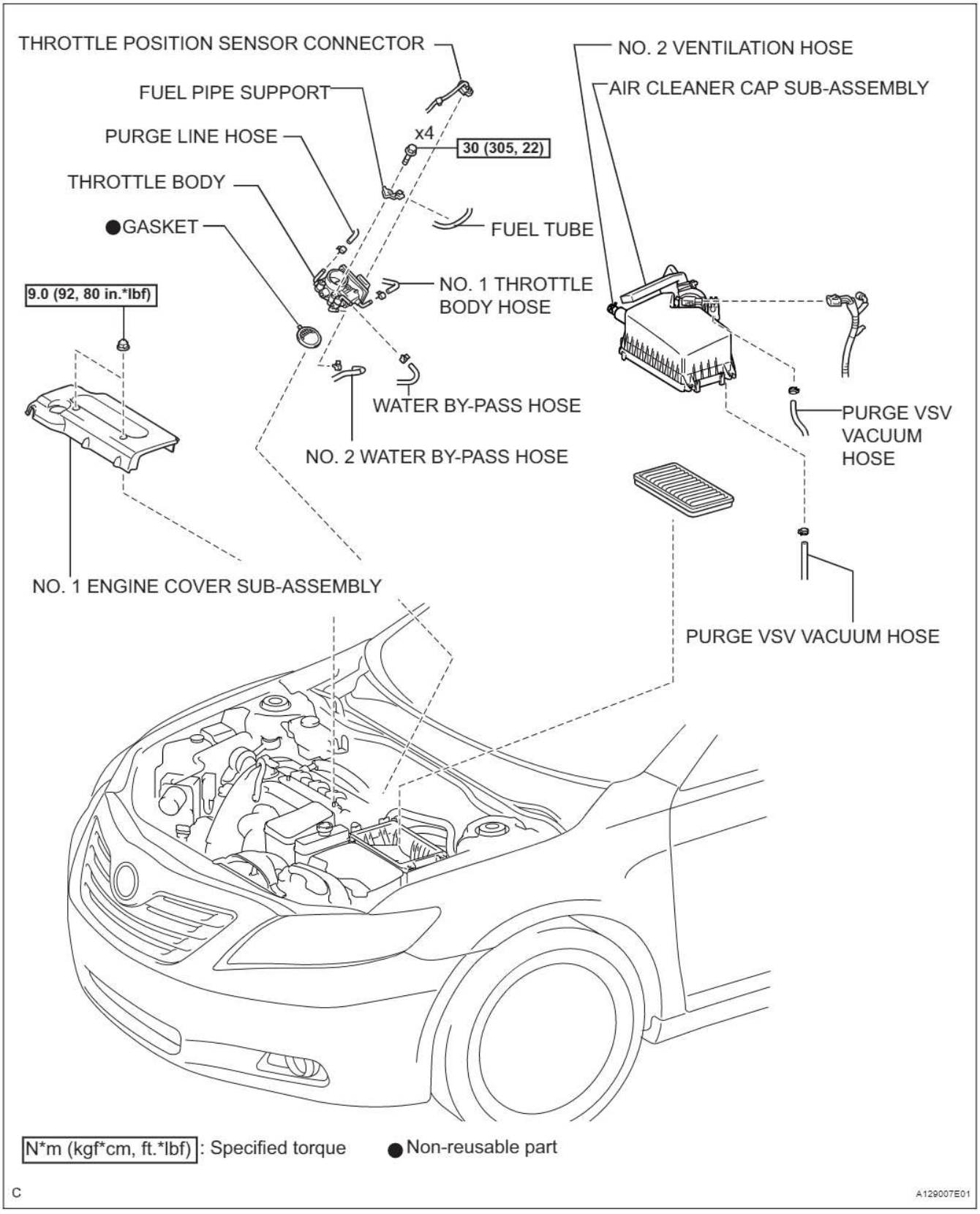
(b) Inspect the throttle position sensor.
  (1) Connect the intelligent tester to the DLC3.
  (2) Turn the power switch on (IG).
  (3) Check that the MIL turns off.
  (4) Under CURRENT DATA, the throttle valve opening percentage (THROTTLE POS) should be within the standard range below.
  Standard throttle valve opening percentage: 60% or more
  If the percentage is less than 60%, replace the throttle body assembly.
  NOTICE:
  When checking the throttle valve opening percentage, the transmission should be in neutral.

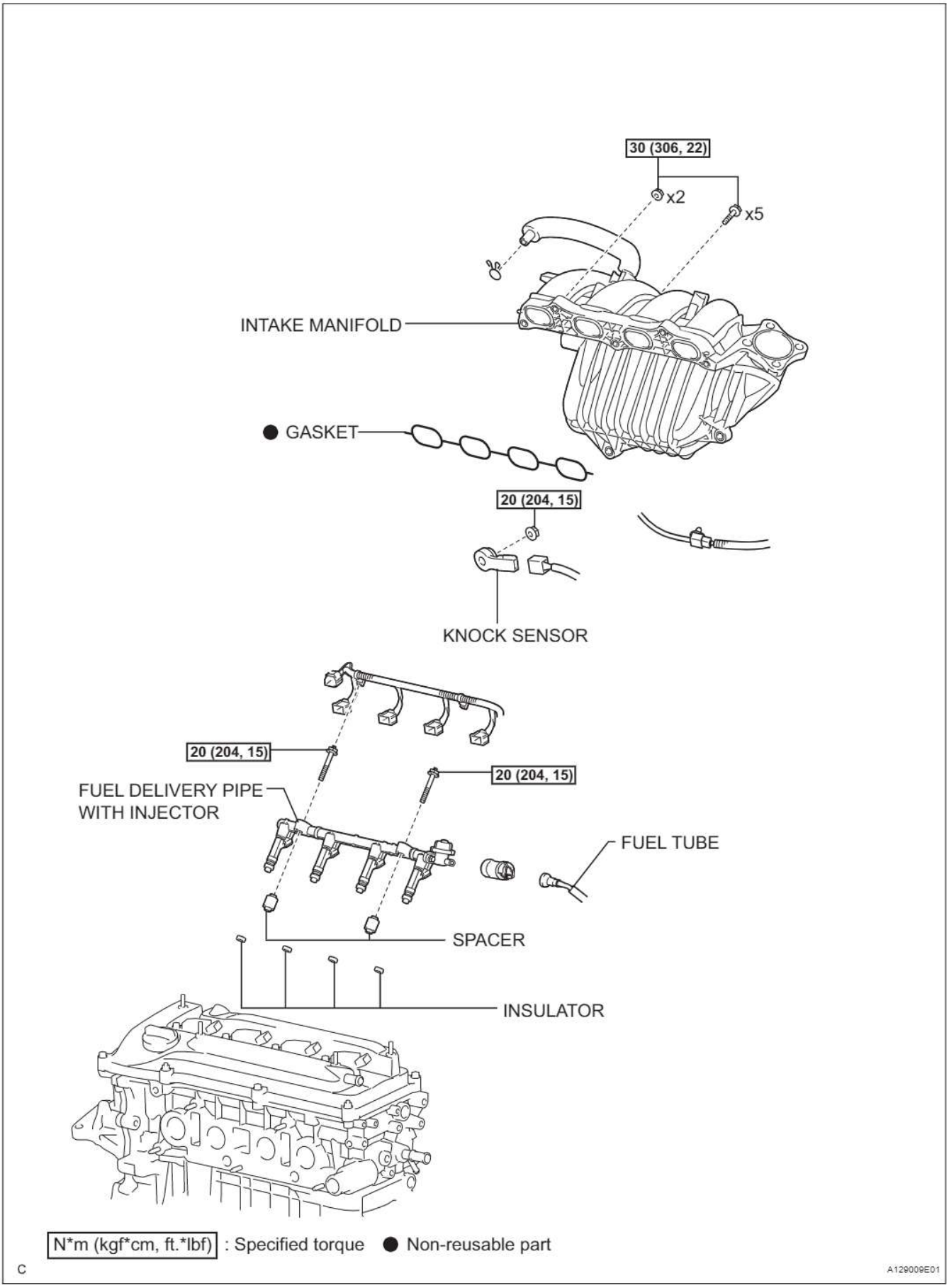
ES

KNOCK SENSOR

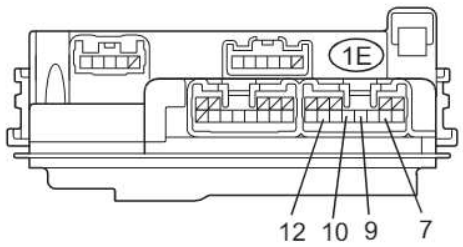
COMPONENTS




THROTTLE POSITION SENSOR CONNECTOR
FUEL PIPE SUPPORT
PURGE LINE HOSE
THROTTLE BODY
●GASKET
9.0 (92, 80 in.*lbf)
x4
30 (305, 22)
FUEL TUBE
NO. 1 THROTTLE BODY HOSE
WATER BY-PASS HOSE
NO. 2 WATER BY-PASS HOSE
NO. 2 VENTILATION HOSE
AIR CLEANER CAP SUB-ASSEMBLY
PURGE VSV VACUUM HOSE
NO. 1 ENGINE COVER SUB-ASSEMBLY
PURGE VSV VACUUM HOSE
N*m (kgf*cm, ft.*lbf): Specified torque
● Non-reusable part
C
A129007E01


30 (306, 22)
x2
x5
INTAKE MANIFOLD
● GASKET
20 (204, 15)
KNOCK SENSOR
20 (204, 15)
20 (204, 15)
FUEL DELIVERY PIPE WITH INJECTOR
FUEL TUBE
SPACER
INSULATOR
N*m (kgf*cm, ft.*lbf) : Specified torque ● Non-reusable part
C
A129009E01

Engine Room R/B Unit D:



A137364E01

EFI RELAY

INSPECTION

1. INSPECT EFI RELAY

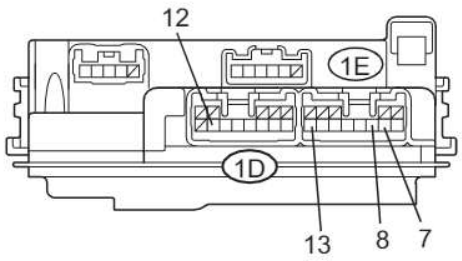
(a) Using an ohmmeter, measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Specified Condition
1E-7 - 1E-12	10 kΩ or higher
1E-7 - 1E-12	Below 1 Ω (Battery voltage is applied between terminals 1E-9 and 1E-10)

ES

Engine Room R/B Unit D:



A137364E04

CIRCUIT OPENING RELAY

INSPECTION

1. INSPECT CIRCUIT OPENING RELAY

(a) Using an ohmmeter, measure the resistance according to the value(s) in the table below.

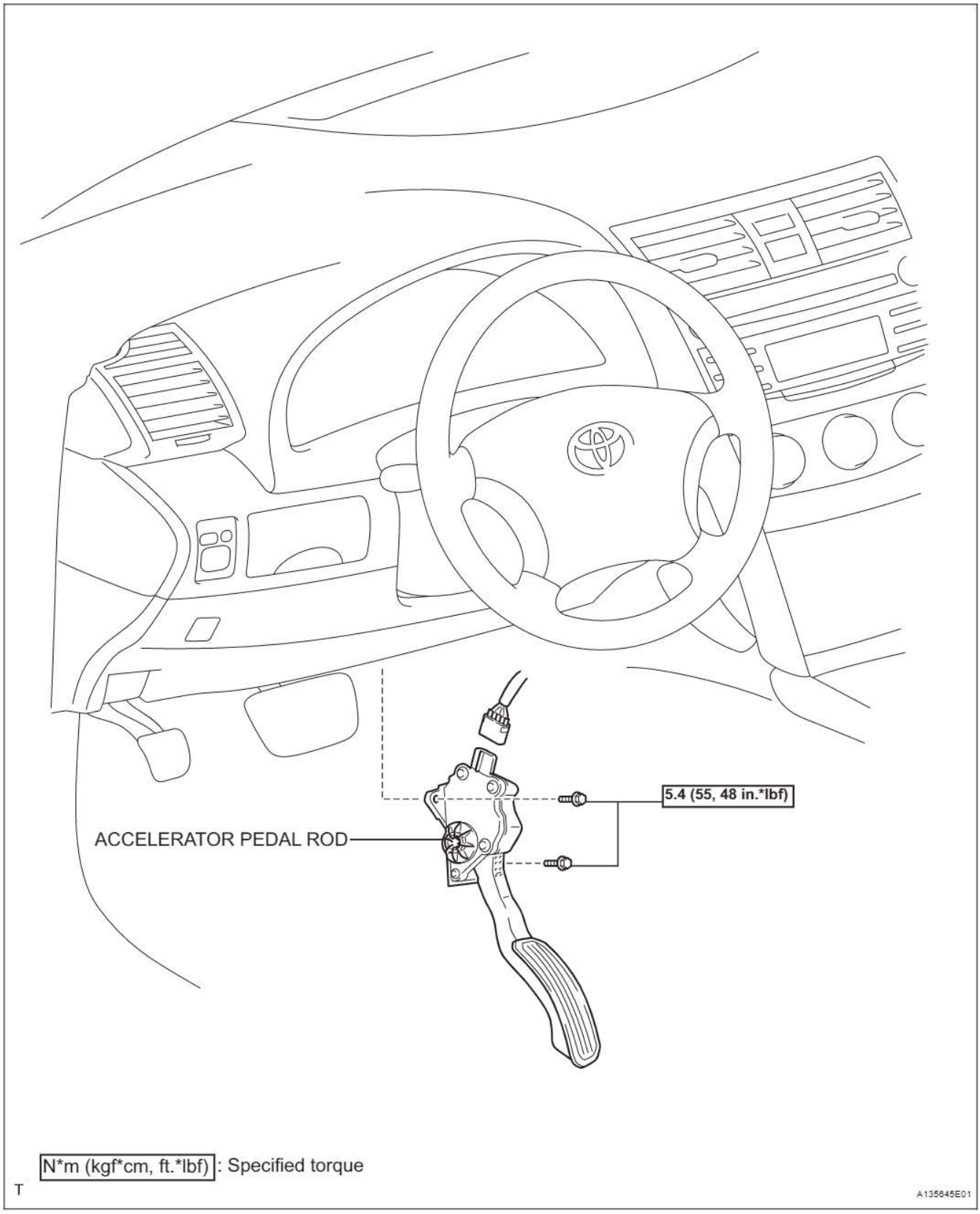
Standard resistance

Tester Connection	Specified Condition
1E-7 - 1E-13	10 kΩ or higher
1E-7 - 1E-13	Below 1 Ω (Battery voltage is applied between terminals 1E-8 and 1D-12)

ES

ACCELERATOR PEDAL ROD

COMPONENTS

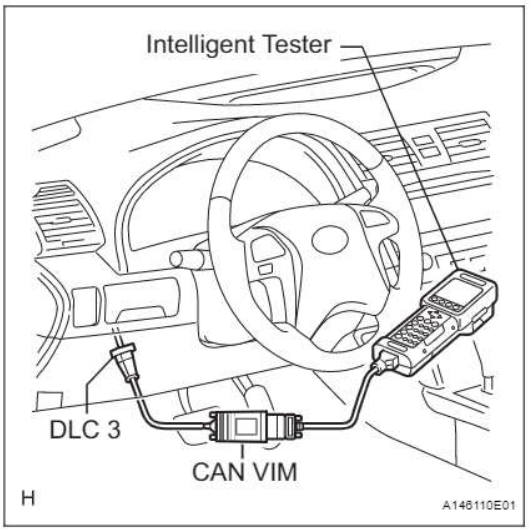


ES

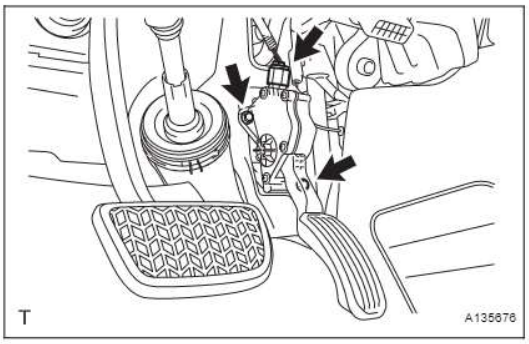
ON-VEHICLE INSPECTION

1. CHECK ACCELERATOR PEDAL ROD

(a) Put the engine in inspection mode (See page ES-35).
(b) Warm up the engine.
(c) Turn the power switch off.
(d) Connect the intelligent tester to the DLC3.
(e) Turn the power switch ON (IG).
(f) Turn the tester on.
(g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST.
(h) Check the values by referring to the table below.



Intelligent Tester Display	Measurement: Range (Display)	Normal Condition *1	Diagnostic Note
ACCEL POS #1 (Accelerator pedal position #1)	Accelerator pedal position sensor No. 1 / Min.: 0%, Max.: 100%	Accelerator pedal depressed: Changes with accelerator pedal pressure	-
ACCEL POS #2 (Accelerator pedal position #2)	Accelerator pedal position sensor No. 2 / Min.: 0%, Max.: 100%	Accelerator pedal depressed: Changes with accelerator pedal pressure	-



REMOVAL

1. REMOVE ACCELERATOR PEDAL ROD

(a) Disconnect the accelerator pedal position sensor connector.
(b) Remove the 2 bolts and accelerator pedal rod.