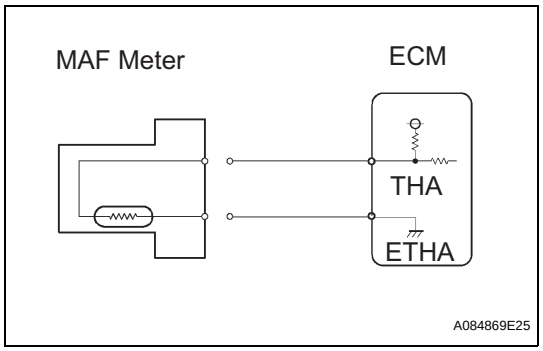
OK

CONFIRM GOOD CONNECTION TO ECM. IF OK, REPLACE ECM

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

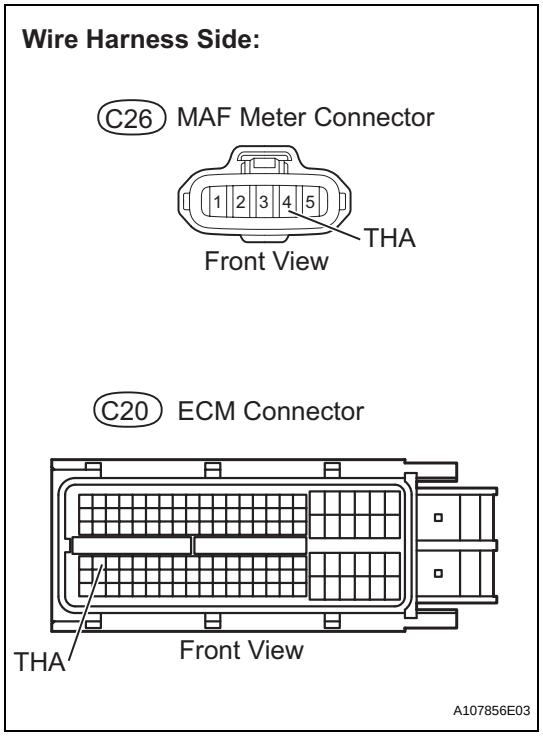


(a) Disconnect the C26 MAF meter connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch to ON.
(d) Turn the tester ON.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
(f) Read the value displayed on the tester.
Standard:
-40°C (-40°F)
(g) Reconnect the MAF meter connector.

OK → **REPLACE MASS AIR FLOW METER**

NG

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



(a) Disconnect the C26 MAF meter connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.
Standard resistance

Tester Connections	Specified Conditions
THA (C26-4) or THA (C20-65) - Body ground	10 kΩ or higher

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

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

OK

REPLACE ECM

ES

DTC	P0115	Engine Coolant Temperature Circuit Malfunction

DTC	P0117	Engine Coolant Temperature Circuit Low Input

DTC	P0118	Engine Coolant Temperature Circuit High Input

DESCRIPTION

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

ES

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

HINT:

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

DTC No.	Proceed To	DTC Detection Conditions	Trouble Areas
P0115	Step 1	Open or short in ECT sensor circuit for 0.5 seconds (1 trip detection logic)	• Open or short in ECT sensor circuit • ECT sensor • ECM
P0117	Step 4	Short in ECT sensor circuit for 0.5 seconds (1 trip detection logic)	• Short in ECT sensor • ECT sensor • ECM
P0118	Step 2	Open in ECT sensor circuit for 0.5 seconds (1 trip detection logic)	• Open in ECT sensor circuit • ECT sensor • ECM

HINT:

When any of these DTCs are set, check the ECT by selecting the following menu items on an 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

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)]

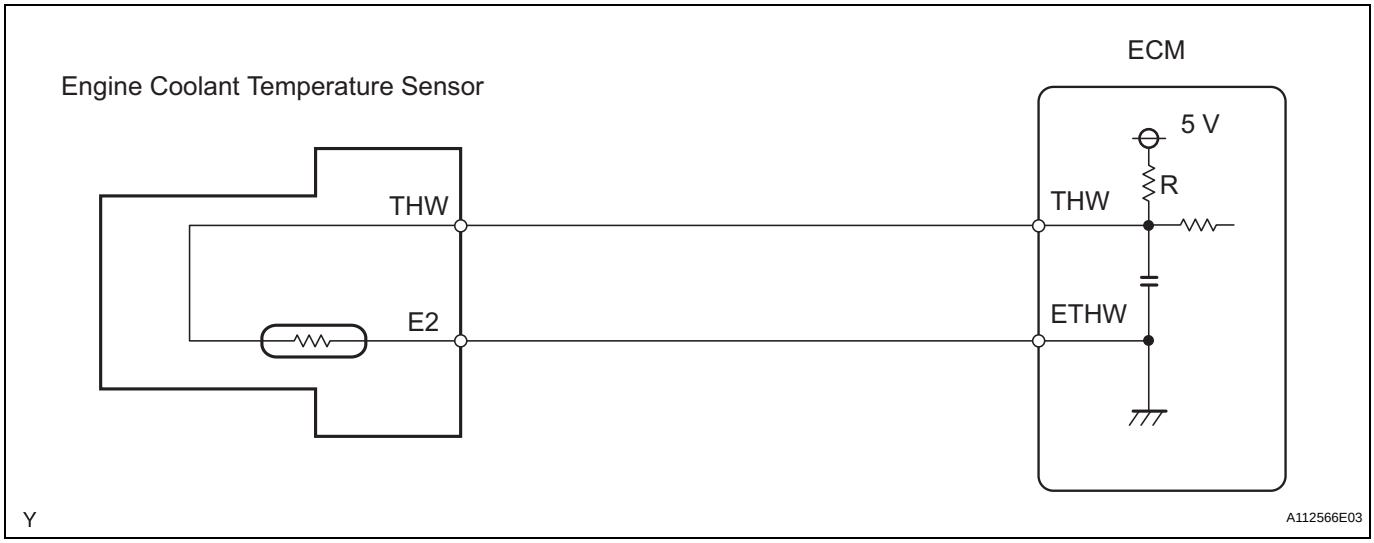
P0118:

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 an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 COOLANT TEMPERATURE)

(a) Connect an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(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:
75°C to 100°C (167°F to 212°F) with warm engine.

Result

Temperature Displayed	Proceed To
-40°C (-40°F)	A
140°C (284°F) or higher	B
75°C to 100°C (167°F to 212°F)	C

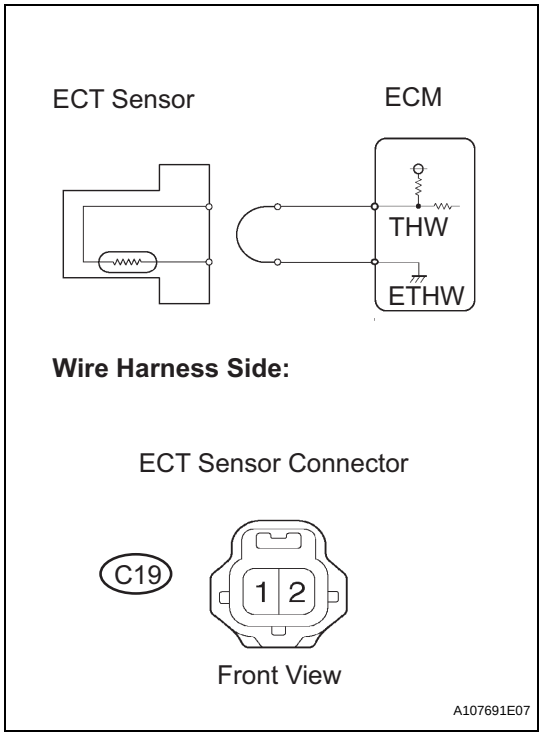
HINT:
- If there is an open circuit, the intelligent tester indicates -40°C (-40°F).
- If there is a short circuit, the intelligent tester indicates 140°C (284°F) or higher.

B → Go to step 4

C → CHECK FOR INTERMITTENT PROBLEMS

A

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

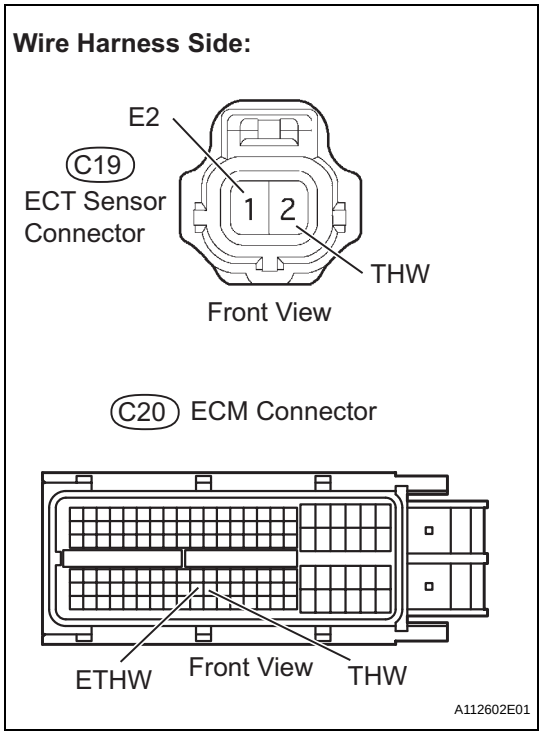


(a) Disconnect the C19 Engine Coolant Temperature (ECT) sensor connector.
(b) Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch to ON.
(e) Turn the tester ON.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(g) Read the value displayed on the tester.
Standard:
140°C (284°F) or higher.
(h) Reconnect the ECT sensor connector.

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

NG

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



(a) Disconnect the C19 ECT sensor connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.
Standard resistance

Tester Connections	Specified Conditions
THW (C19-2) - THW (C20-97)	Below 1 Ω
E2 (C19-1) - ETHW (C20-96)	

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

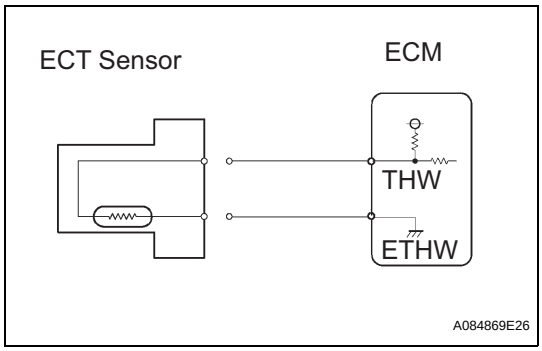
NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

ES

OK

GOOD CONNECTION TO ECM. IF OK, REPLACE ECM

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

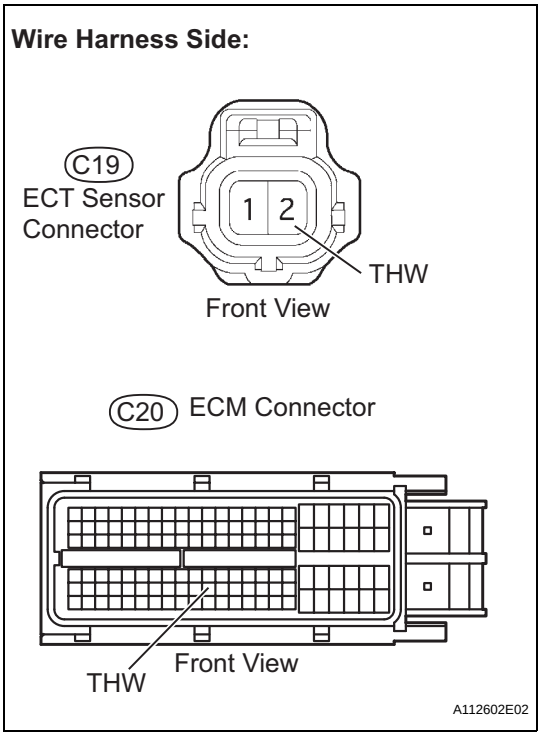


(a) Disconnect the C19 ECT sensor connector.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch to ON.
(d) Turn the tester ON.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(f) Read the value displayed on the tester.
Standard:
-40°C (-40°F)
(g) Reconnect the ECT sensor connector.

OK → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

NG

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



(a) Disconnect the C19 ECT sensor connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.
Standard resistance

Tester Connections	Specified Conditions
THW (C19-2) or THW (C20-97) - Body ground	10 kΩ or higher

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

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

OK

REPLACE ECM

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, if ECT sensor value does not change when engine stopped and then next cold engine start performed, it determined that malfunction has occurred.	• 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 cold start monitor P0116: ECT sensor soak monitor
Required Sensors/Components (Main)	ECT sensor
Required Sensors/Components (Related)	None
Frequency of Operation	Once per driving cycle
Duration	180 seconds or more
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

ECT Sensor cold start monitor:

Monitor runs whenever following DTCs not present	P0100 to P0103: Mass Air Flow (MAF) meter P0110 to P0113: Intake Air Temperature (IAT) sensor
Battery voltage	10.5 V or more
Time after engine start	1 second or more
ECT at engine start	Less than 60°C (140°F)
IAT sensor circuit	OK
Soak time	5 hours or more
Accumulated MAF	498.77 g or more
Engine	Running
Fuel cut	OFF
Difference between ECT at engine start and IAT	Less than 40°C (72°F)

ECT Sensor soak monitor:

Monitor runs whenever following DTCs not present	P0100 to P0103: MAF meter P0110 to P0113: IAT sensor
Battery voltage	10.5 V or more
Engine	Running
Soak time	5 hours or more
Either (a) or (b) condition met	-
(a) ECT	60°C (140°F) or more
(b) Accumulated MAF	862.59 g or more

TYPICAL MALFUNCTION THRESHOLDS

ECT Sensor cold start monitor:

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

ECT Sensor soak monitor:

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

COMPONENT OPERATING RANGE

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 an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED II / DTC INFO / CURRENT CODES.
(e) Read the DTC.

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-18).

(b) Check the valve opening temperature of the thermostat.
Standard:
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-19).

NG → **REPLACE THERMOSTAT**

OK

ES

REPLACE ENGINE COOLANT TEMPERATURE SENSOR

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

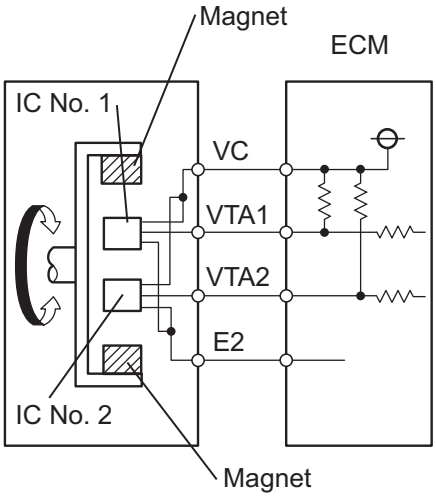
HINT:
These DTCs relate to the Throttle Position (TP) sensor.

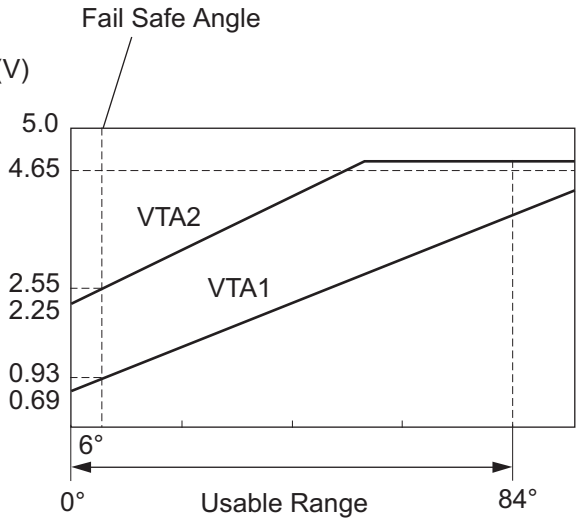
DESCRIPTION

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

ES

Throttle Position Sensor





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°)

Y

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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) • ECM
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 • ECM
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 • ECM
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) • ECM

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 • ECM
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 • ECM
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) • ECM

ES

HINT:
- When any of these DTCs are set, check the throttle valve opening angle by selecting the following menu items on an intelligent tester: DIAGNOSIS / ENHANCED OBD ll / 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 the proper operation of the TP sensor.
- A specific voltage difference is expected between the sensor terminals, VTA1 and VTA2, for each throttle valve opening angle. If the difference between VTA1 and VTA2 is incorrect, the ECM interprets this as a malfunction in the sensor, and sets a DTC.
- VTA1 and VTA2 each have a specific voltage range. If VTA1 or VTA2 is outside the normal operating range, the ECM interprets this as a malfunction in the sensor, and sets a DTC.
- VTA1 and VTA2 should never be close to the same voltage level. If VTA1 is within 0.02 V of VTA2, the ECM determines that there is a short circuit in the sensor, and sets a DTC.

If the malfunction is not repaired successfully, a DTC is set 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) 10 seconds: P0120, P0122, P0123, P0220, P0222 and P0223 (Accelerator pedal OFF) 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. Ignition switch ON	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

ES

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

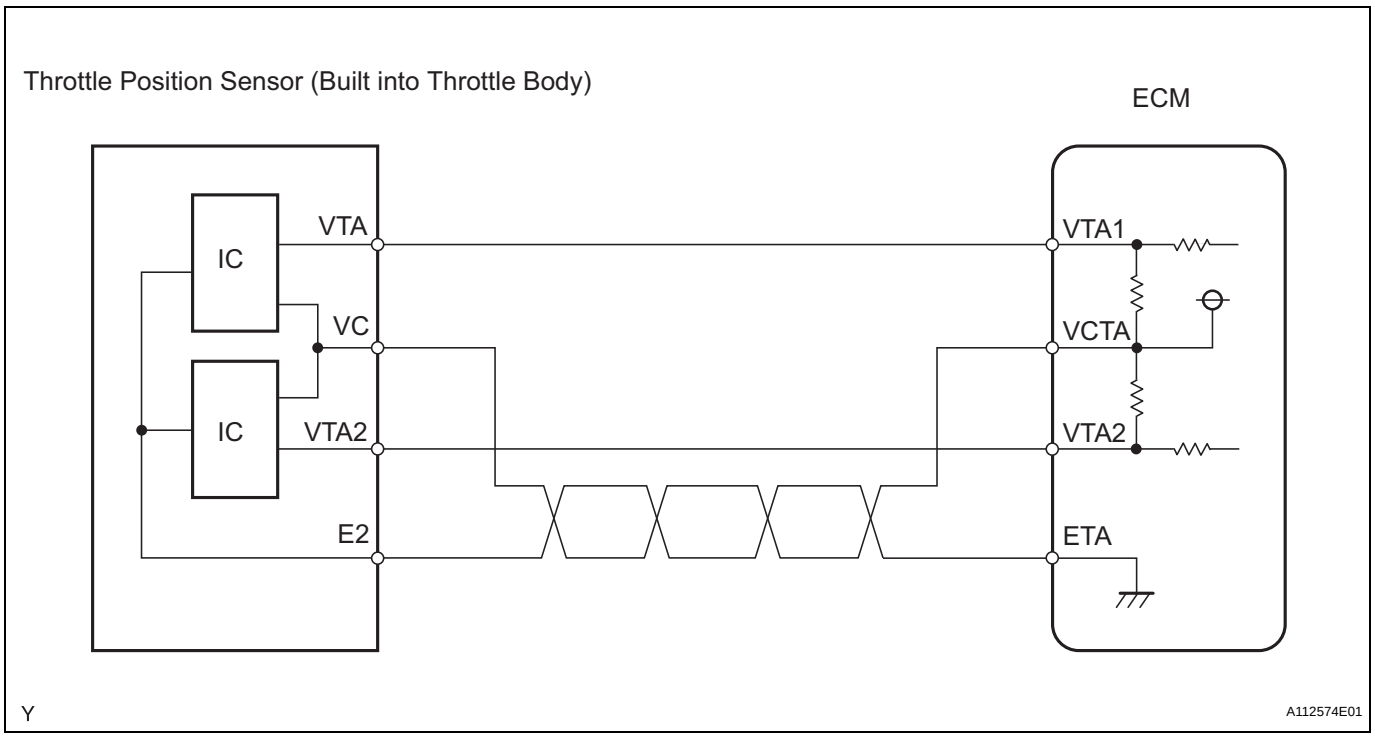
COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON 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

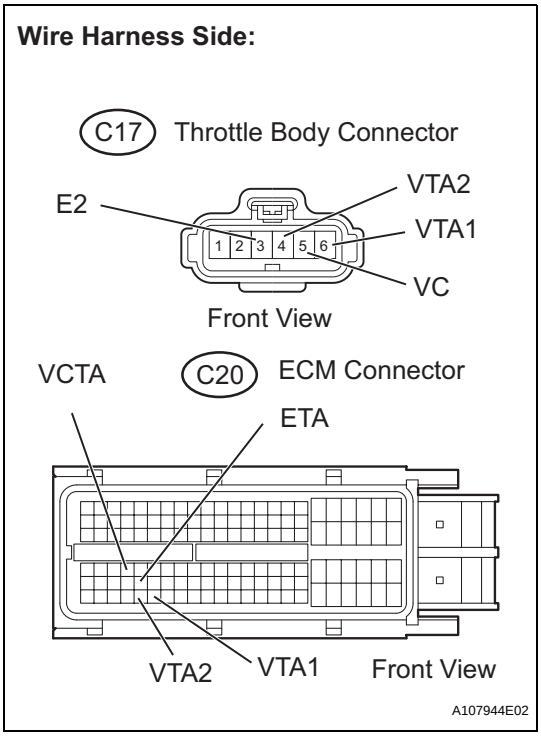
TP#1 (VTA1) When Accelerator Pedal Released	TP#2 (VTA2) When Accelerator Pedal Released	TP#1 (VTA1) When Accelerator Pedal Depressed	TP#2 (VTA2) When Accelerator Pedal Depressed	Trouble Areas	Proceed To
0 V to 0.2 V	0 V to 0.2 V	0 V to 0.2 V	0 V to 0.2 V	VC circuit open	A
4.5 V to 5.0 V	4.5 V to 5.0 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 - ECM)



(a) Disconnect the C17 throttle body connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
VC (C17-5) - VCTA (C20-67)	Below 1 Ω
VTA (C17-6) - VTA1 (C20-115)	
VTA2 (C17-4) - VTA2 (C20-114)	
E2 (C17-3) - ETA (C20-91)	

Standard resistance (Check for short)

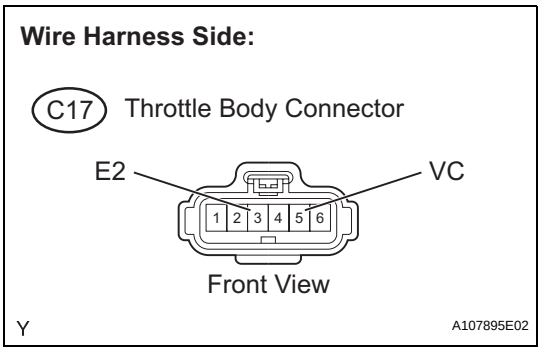
Tester Connections	Specified Conditions
VC (C17-5) or VCTA (C20-67) - Body ground	10 kΩ or higher
VTA (C17-6) or VTA1 (C20-115) - Body ground	
VTA2 (C17-4) or VTA2 (C20-114) - Body ground	

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

NG → REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3 INSPECT ECM (VC VOLTAGE)



(a) Disconnect the C17 throttle body connector.
(b) Turn the ignition switch to ON.
(c) Measure the voltage between the terminals of the throttle body connector.

Standard voltage

Tester Connections	Specified Conditions
VC (C17-5) - E2 (C17-3)	4.5 to 5.5 V

(d) Reconnect the throttle body connector.

NG → REPLACE ECM

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 ignition switch to ON and turn the tester ON.
(c) Clear DTCs (See page ES-34).
(d) Start the engine.
(e) Allow the engine to idle for 15 seconds or more.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read DTCs.

ES

Result

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

B → SYSTEM OK

A

REPLACE ECM

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

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

DESCRIPTION

Refer to DTC P0120 (See page ES-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)

MONITOR DESCRIPTION

The ECM uses the TP sensor to monitor the throttle valve opening angle.
This sensor transmits two signals: VTA1 and VTA2. VTA1 is used to detect the throttle opening angle and VTA2 is used to detect malfunctions in VTA1. The ECM performs several checks to confirm the proper operation of the TP sensor and VTA1.
For each throttle opening angle, a specific voltage difference is expected between the outputs of VTA1 and VTA2. If the output voltage difference between the two signals deviates from the normal operating range, the ECM interprets this as a malfunction of the TP sensor. The ECM illuminates the MIL and sets the DTC.
If the malfunction is not repaired successfully, the DTC is set 2 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0121: TP sensor rationality
Required Sensors/Components (Main)	TP sensor
Required Sensors/Components (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. Ignition 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 firmly and gently, the vehicle can be driven slowly. Fail-safe mode continues until a pass condition is detected, and the ignition switch is then turned to OFF.

INSPECTION PROCEDURE

HINT:

Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read DTCs.

Result

Display (DTC output)	Proceed To
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 engine start ECT) (2 trip detection logic)	• ECT sensor • Cooling system • Thermostat

ES

MONITOR DESCRIPTION

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 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	62 seconds: Engine coolant temperature at engine start -3.3°C (26°F) or more 112 seconds: Engine coolant temperature at engine start -14.5° to -3.3°C (5.9° to 26°F) 20 minutes: Engine coolant temperature at engine start less than -14.5°C (5.9°F)
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 fail	Not detected

TYPICAL MALFUNCTION THRESHOLDS

Time until actual engine coolant temperature reaches closed-loop fuel control enabling temperature	62 seconds or more: Engine coolant temperature at engine start -3.3°C (26°F) or more 112 seconds or more: Engine coolant temperature at engine start -14.5° to -3.3°C (5.9° to 26°F) 20 minutes or more: Engine coolant temperature at engine start less than -14.5°C (5.9°F)

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 an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read DTCs.

Result

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

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

B → GO TO DTC CHART

A

2	INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-18).
(b) Check the valve opening temperature of the thermostat.
Standard:
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-19).

NG → REPLACE THERMOSTAT

OK

3	CHECK COOLING SYSTEM

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

NG → **REPAIR OR REPLACE COOLING SYSTEM**

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR

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

HINT:
This DTC relates to the thermostat.

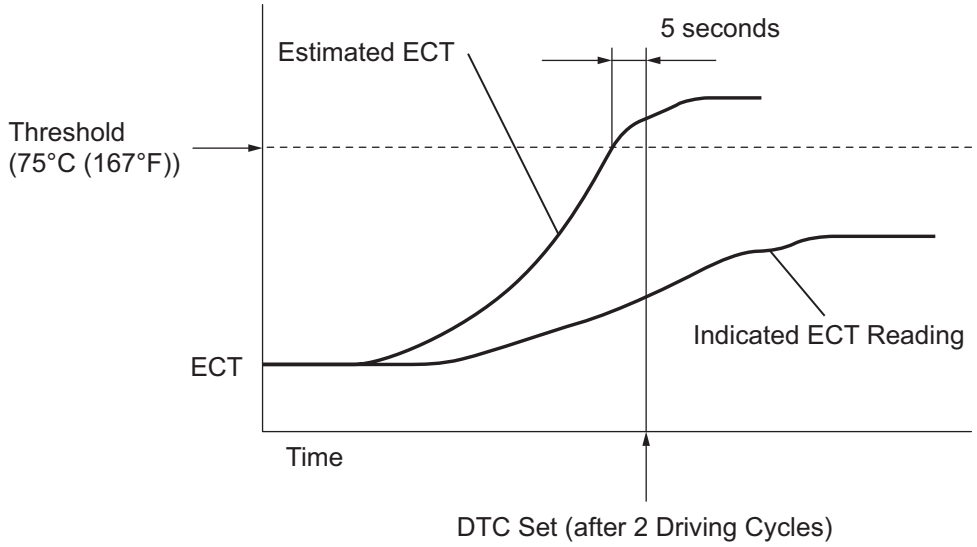
DESCRIPTION

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

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

ES

MONITOR DESCRIPTION



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

MONITOR STRATEGY

Related DTCs	P0128: Coolant Thermostat
Required Sensors/Components (Main)	Thermostat

Required Sensors/Components (Related)	Engine Coolant Temperature (ECT) sensor, Intake Air Temperature (IAT) sensor, Vehicle speed sensor
Frequency of Operation	Once per driving cycle
Duration	900 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

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 (Ignitor) 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 80 mph (128 km/h) or more of vehicle speed	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 an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.

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

Result

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

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

B → **GO TO DTC CHART**

A

2 CHECK COOLING SYSTEM

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

NG → **REPAIR OR REPLACE COOLING SYSTEM**

OK

3 INSPECT THERMOSTAT

(a) Remove the thermostat (See page CO-18).
(b) Check the valve opening temperature of the thermostat.
Standard:
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-19).

NG → **REPLACE THERMOSTAT**

OK

REPLACE ECM

ES

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)

ES

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

DESCRIPTION

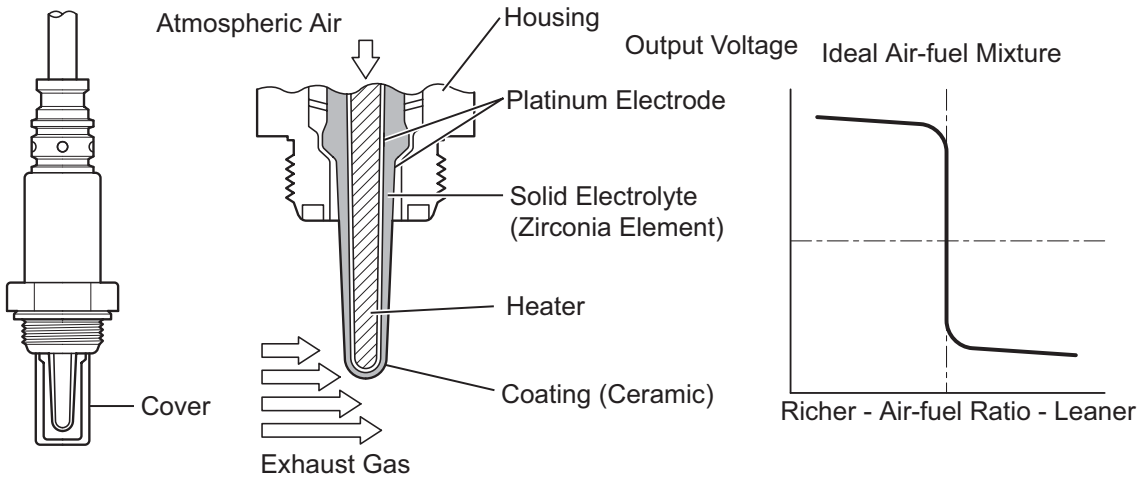
In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel level. For the purpose of helping the ECM to deliver accurate air-fuel ratio control, a Heated Oxygen (HO2) sensor is used.

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

When the air-fuel ratio becomes lean, the oxygen concentration in the exhaust gas 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 0.21 V (b) HO2 sensor voltage does not increase to more than 0.59 V • Low impedance*: Sensor impedance less than 5 Ωfor more than 30 seconds when ECM presumes sensor to being warmed up and operating normally (2 trip detection logic)	• Open or short in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • HO2 sensor heater (sensor 2) • Air-fuel Ratio (A/F) sensor (sensor 1) • Integration relay (EFI 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 being 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 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 0.59 V or more (b) Target air-fuel ratio lean • Extremely high voltage (short)*: HO2 sensor voltage output exceeds 1.2 V for more than 10 seconds (2 trip detection logic)	• Short in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • ECM internal circuit malfunction

*: Only for vehicles except those with Mexico specifications.

MONITOR DESCRIPTION

Active Air-Fuel Ratio Control

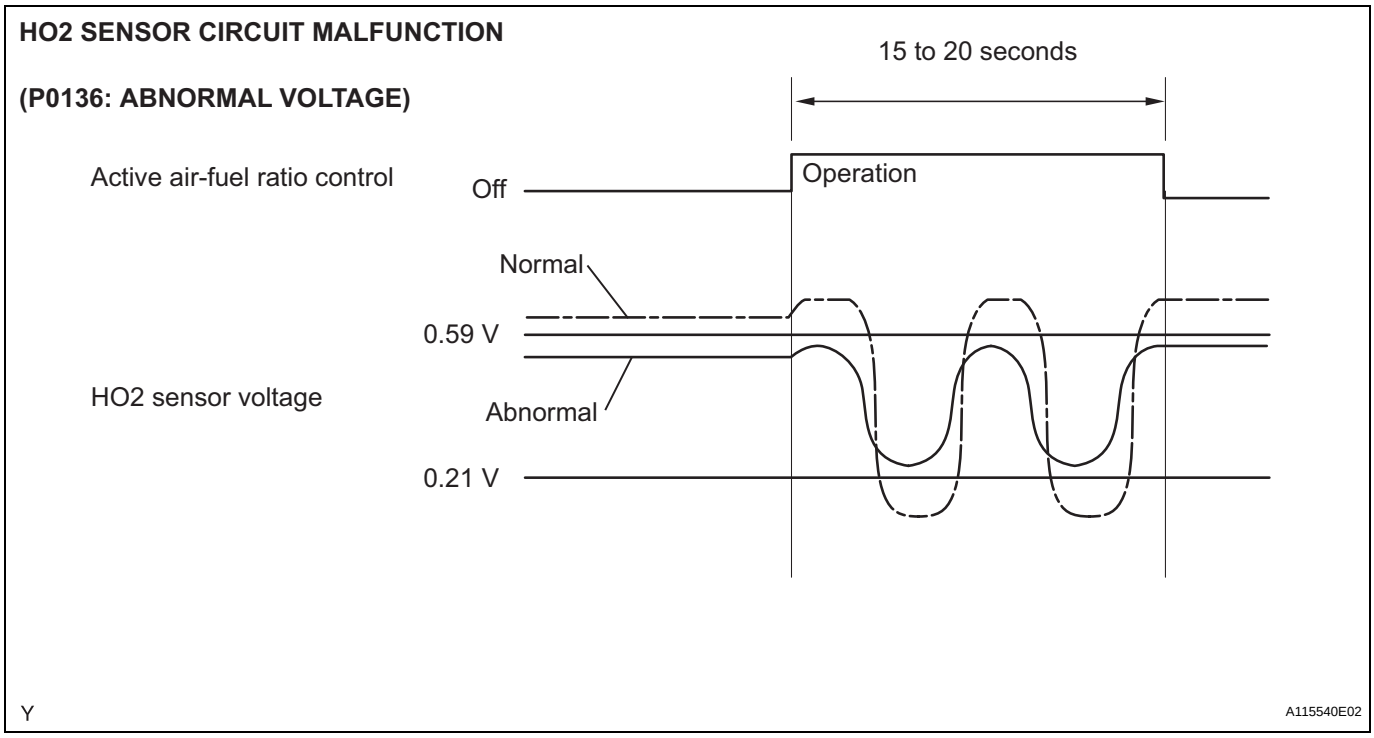
The ECM usually performs air-fuel ratio feedback control so that the Air-Fuel Ratio (A/F) sensor output indicates a near stoichiometric air-fuel level. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to 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)

ES

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.

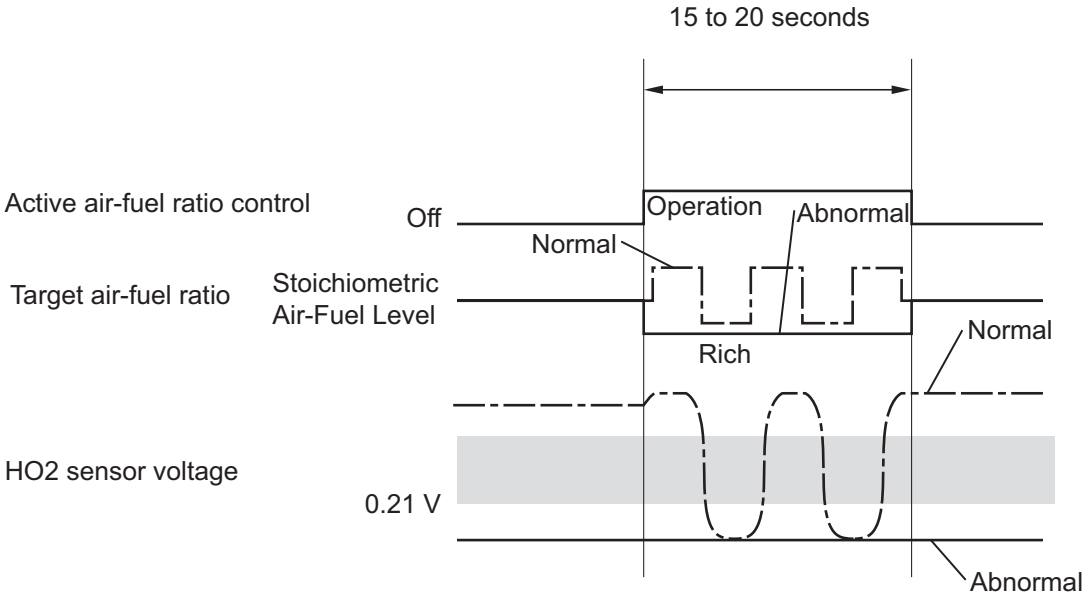
HINT:

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-180).

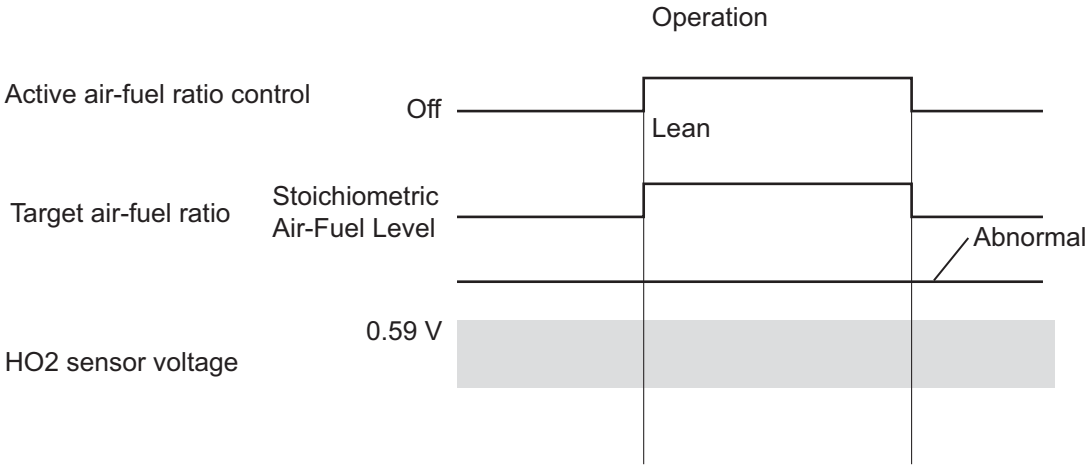
HO2 SENSOR CIRCUIT LOW VOLTAGE

(P0137: OPEN)



HO2 SENSOR CIRCUIT HIGH VOLTAGE

(P0138: SHORT)



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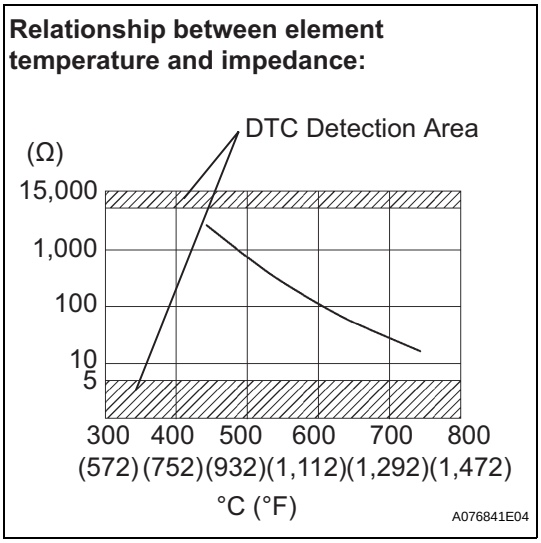
High or Low Impedance of Heated Oxygen (HO2) Sensor (DTC P0136 or P0137)



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 the 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 cycle).
- DTC P0137 indicates an open or short circuit in the HO2 sensor (2 driving cycle). 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: Others
Duration	20 seconds: Active air-fuel ratio control detection 90 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)

ES

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	OFF
Engine RPM	Less than 4,000 rpm
A/F sensor status	Activated
Fuel system status	Closed loop
Fuel cut	OFF
Engine load	10 to 80 %
Shift position	4th or 5th (M/T) 3rd or 4th (A/T)

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)	1.7 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	1.7 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	1.7 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	1.7 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	90 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

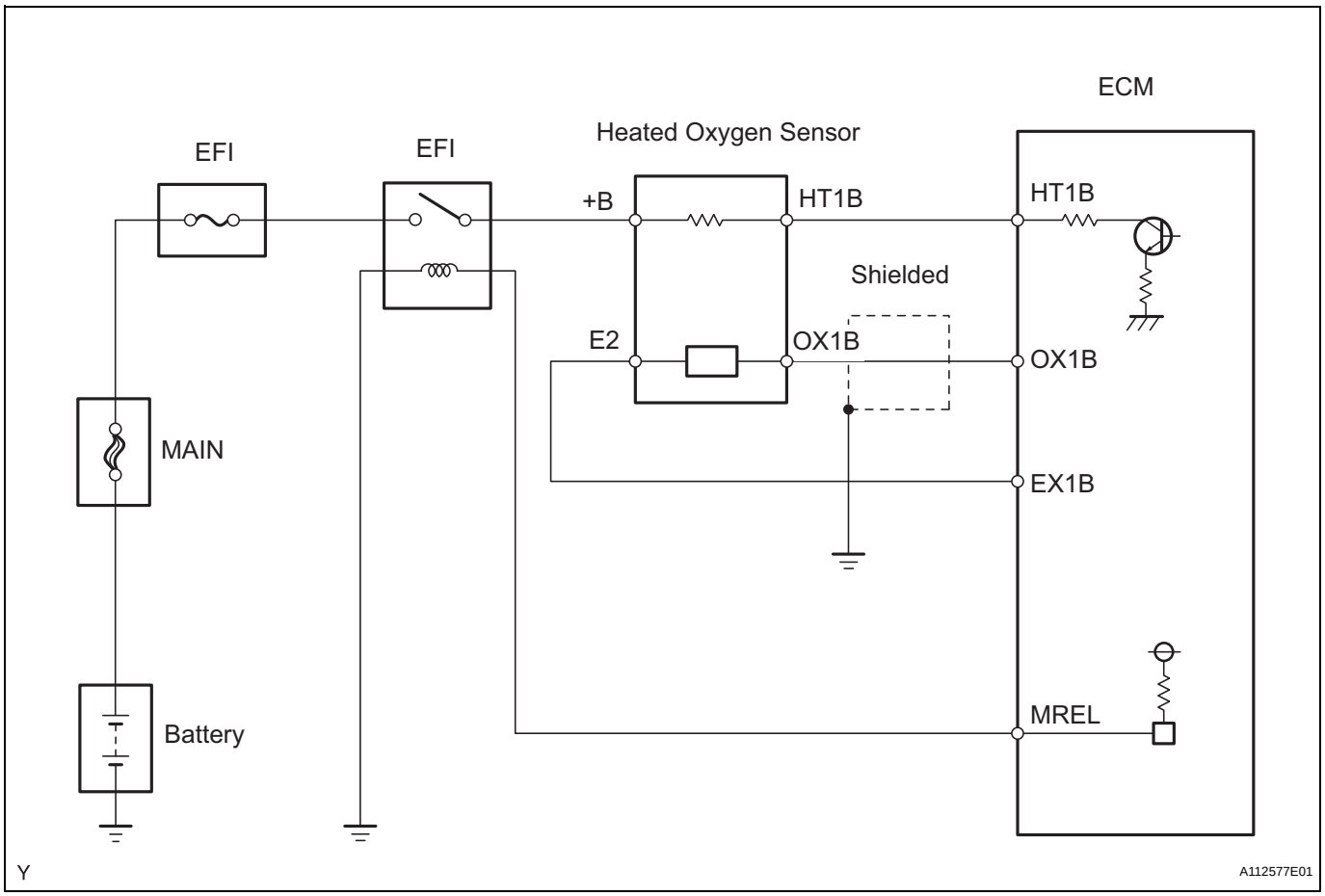
COMPONENT OPERATING RANGE

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-17).

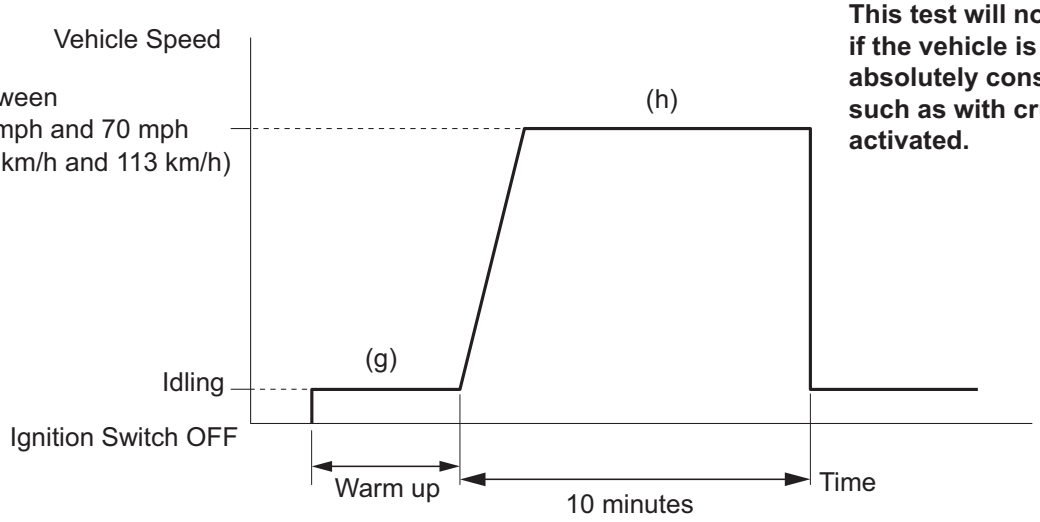
WIRING DIAGRAM



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.



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

(Note: Even if vehicle stops during driving pattern, test can be resumed)

P

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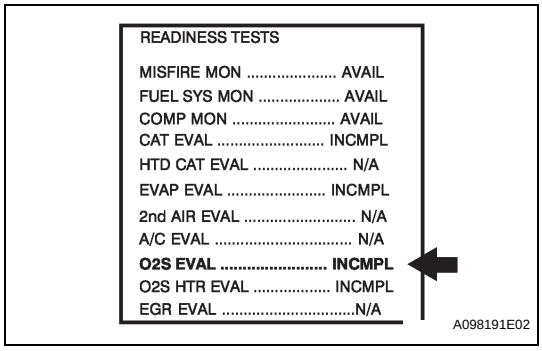


A098191E02

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Clear DTCs (where set) (See page ES-34).
(e) Select the following menu items: DIAGNOSIS / CARB OBD II / READINESS TESTS.
(f) Check that O2S EVAL is INCMPL (incomplete).
(g) Start the engine 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 set, extend the driving time.

INSPECTION PROCEDURE

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

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

(a) Connect an intelligent tester to the DLC3.
(b) Start the engine and turn the tester ON.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) Perform the A/F CONTROL operation with the engine idling (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1 S1 and O2S B1 S2) displayed on the tester.

HINT:

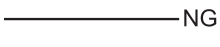
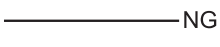
- The A/F CONTROL operation lowers the fuel injection volume by 12.5 % or increases the injection volume by 25 %.
- The sensors react in accordance with increases and decreases in the fuel injection volume.

ES

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:

- Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 ECM connector is short-circuited to the +B wire, DTC P0138 will be set.

ES

1	READ OUTPUT DTC

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

Result

Display (DTC output)	Proceed To
P0138	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 ignition switch to ON 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.

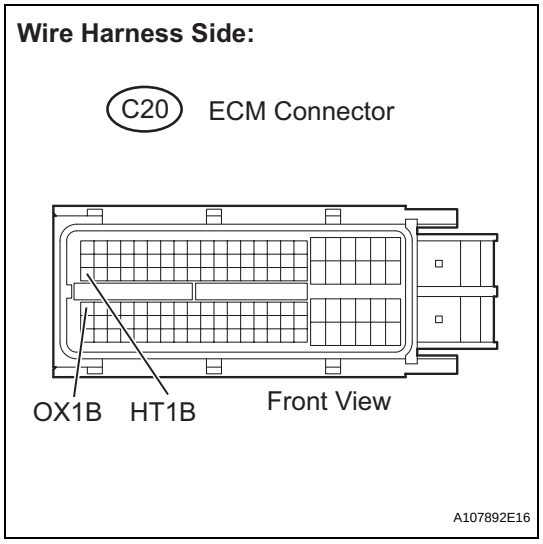
Result

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)



(a) Turn the ignition switch to OFF and wait for 5 minutes.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.
Standard resistance

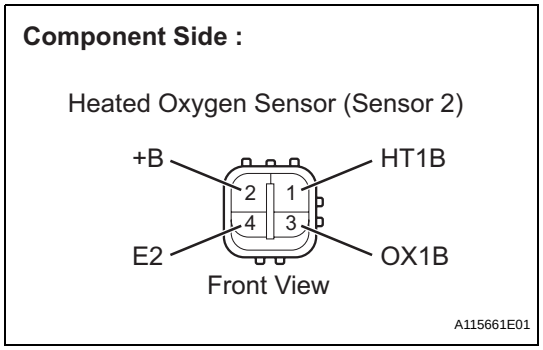
Tester Connections	Specified Conditions
HT1B (C20-47) - OX1B (C20-64)	10 kΩ or higher

(d) Reconnect the ECM connector.

OK → REPLACE ECM

NG

4	INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)



(a) Disconnect the D28 HO2 sensor connector.
(b) Check the resistance.
Standard resistance

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

(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 DTCs.

ES

Result

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

B → CHECK FOR INTERMITTENT PROBLEMS

A

REPLACE HEATED OXYGEN SENSOR

ES

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Start the engine.
(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:
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 DTCs.

Result

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

B → CHECK FOR INTERMITTENT PROBLEMS

A

10	REPLACE HEATED OXYGEN SENSOR

NEXT

11	PERFORM CONFIRMATION DRIVING PATTERN

NEXT

ES

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 DTCs.

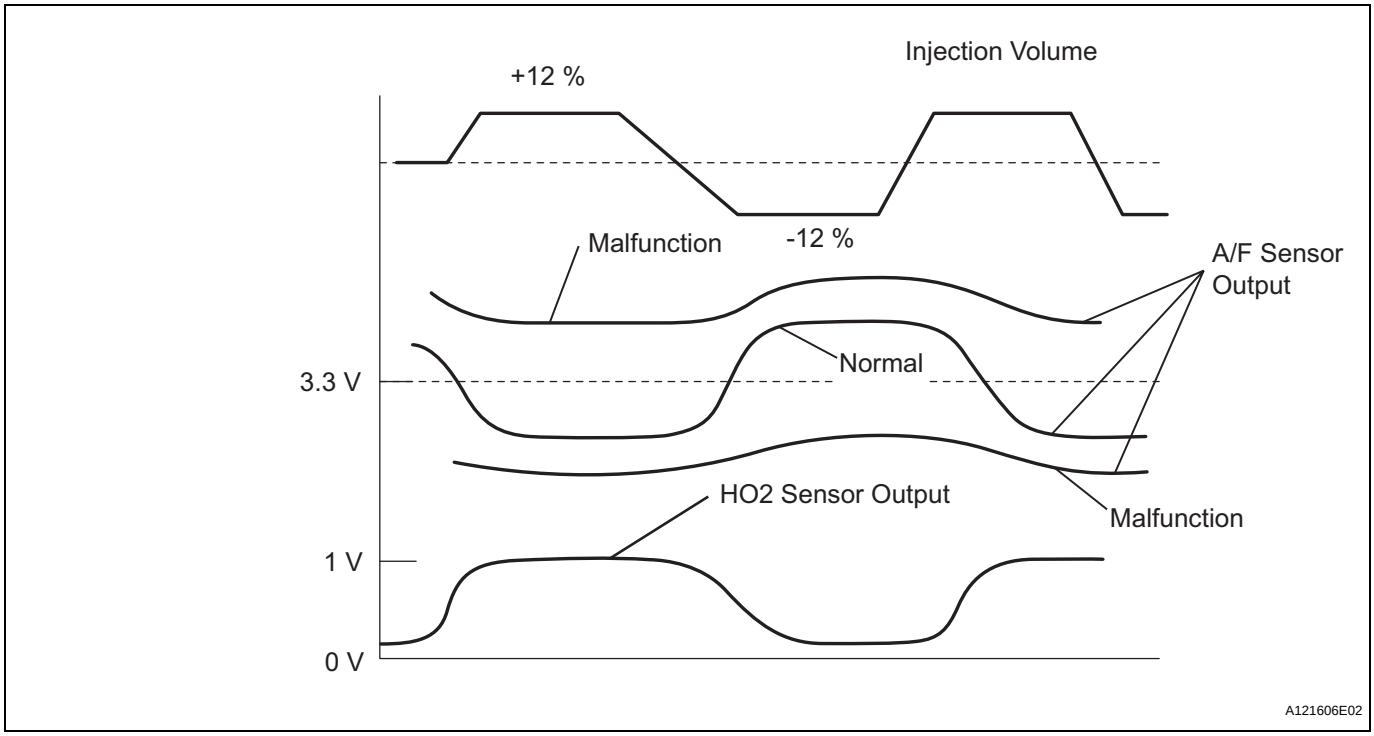
Result

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

B → REPAIR COMPLETED

A

13	PERFORM ACTIVE TEST USING INTELLIGENT TESTER (INJECTION VOLUME)



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

HINT:

- Change the fuel injection volume within the range of -12 % and +12 %. The injection volume can be changed in 1 % graduations within the range.
- The A/F sensor is displayed as AFS B1 S1, and the HO2 sensor is displayed as O2S B1 S2, on intelligent testers.

ES

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 (INJECTOR,FUEL PRESSURE,GAS LEAKAGE FROM EXHAUST SYSTEM,ETC.)

14 CHECK FOR EXHAUST GAS LEAK

OK:
No gas leakage.

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

OK ↓

15 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE) (See page ES-83)

NG → **REPLACE HEATED OXYGEN SENSOR**

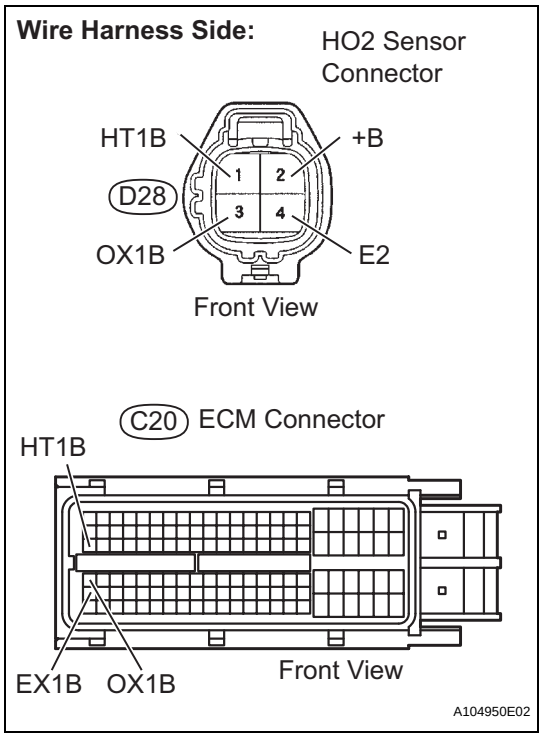
OK ↓

16	INSPECT INTEGRATION RELAY (EFI RELAY) (See page ES-78)

NG → REPLACE INTEGRATION RELAY (EFI RELAY)

OK

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



(a) Disconnect the D28 HO2 sensor connector.
(b) Turn the ignition switch to ON.
(c) Measure the voltage between the +B terminal of the HO2 sensor connector and body ground.

Standard voltage

Tester Connections	Specified Conditions
+B (D28-2) - Body ground	11 to 14 V

(d) Turn the ignition switch to OFF.
(e) Disconnect the C20 ECM connector.
(f) Check the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
HT1B (D28-1) - HT1B (C20-47)	Below 1 Ω
OX1B (D28-3) - OX1B (C20-64)	
E2 (D28-4) - EX1B (C20-87)	

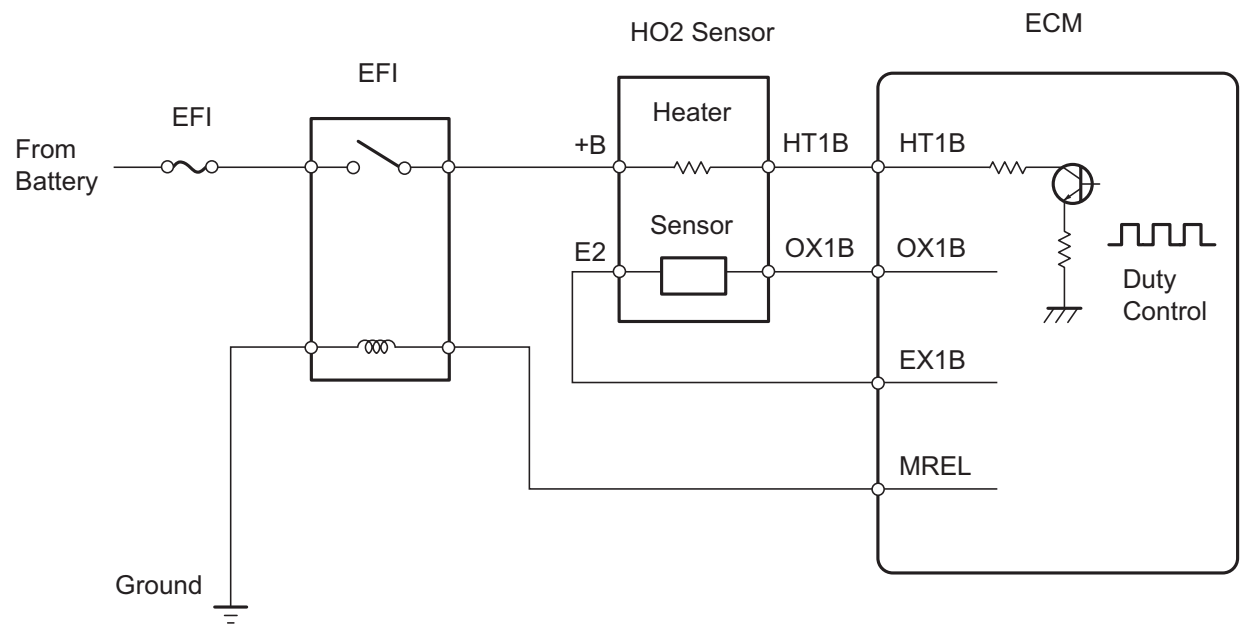
Standard resistance (Check for short)

Tester Connections	Specified Conditions
HT1B (D28-1) or HT1B (C20-47) - Body ground	10 kΩ or higher
OX1B (D28-3) or OX1B (C20-64) - Body ground	
E2 (D28-4) or EX1B (C20-87) - Body ground	

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

ES

Reference (System Diagram of 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 illuminates the MIL and sets a DTC.

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 relay) • A/F sensor heater and EFI relay circuits • PCV valve and hose • PCV hose connections • ECM
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 relay) • A/F sensor heater and EFI relay circuits • ECM

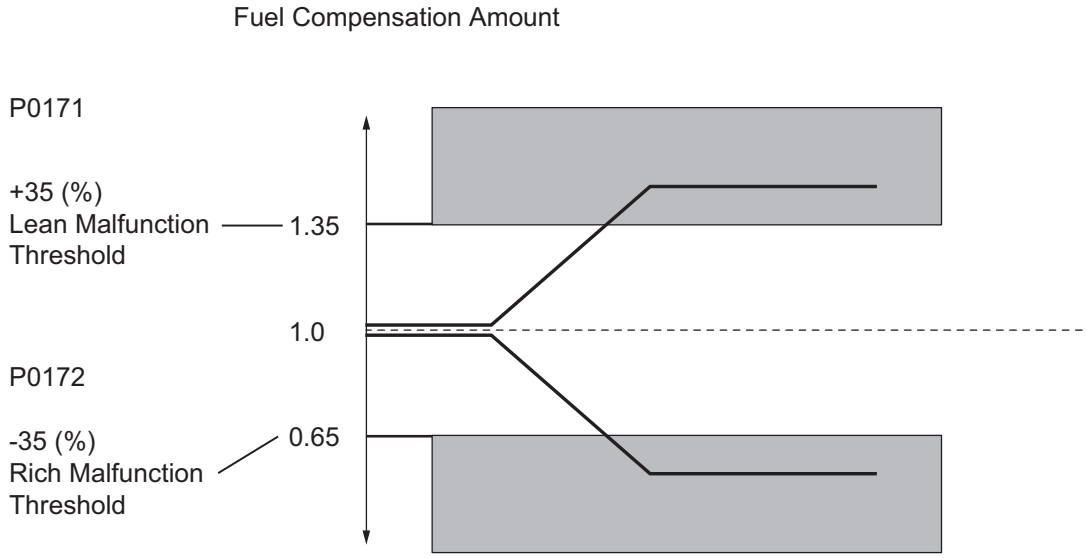
HINT:

- 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 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



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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 1,100 rpm
2. Intake air amount per revolution	0.15 g/rev or more
Catalyst monitor	Not executed

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-280).

INSPECTION PROCEDURE

HINT:

- Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read DTCs.

Result

Display (DTC Output)	Proceed To
P0171 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) Start the engine and turn the tester ON.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the outputs voltages of 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	

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, and press the YES button and then the ENTER button followed by the F4 button.

ES

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) Turn the ignition switch to ON and turn the tester ON.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF and COOLANT TEMP.
(d) Allow the engine to idle until the COOLANT TEMP reaches 75°C (167°F) or more.
(e) Read the MAF with the engine in an idling condition and at an engine speed of 2,500 rpm.
Standard:
MAF while engine idling: 1 to 3 g/sec (shift position: N, A/C: OFF).
MAF at engine speed of 2,500 rpm: 2 to 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 ignition switch to ON 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: 75°C to 100°C (167°F to 212°F).

NG → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

OK

5	CHECK PCV HOSE CONNECTIONS

(a) Check for 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 SPARKS 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-7).
Standard:
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-16).
Standard:
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-77)

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

12	INSPECT INTEGRATION RELAY (EFI RELAY) (See page ES-78)

NG → **REPLACE INTEGRATION RELAY**

OK

13	CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM) (See page ES-294)

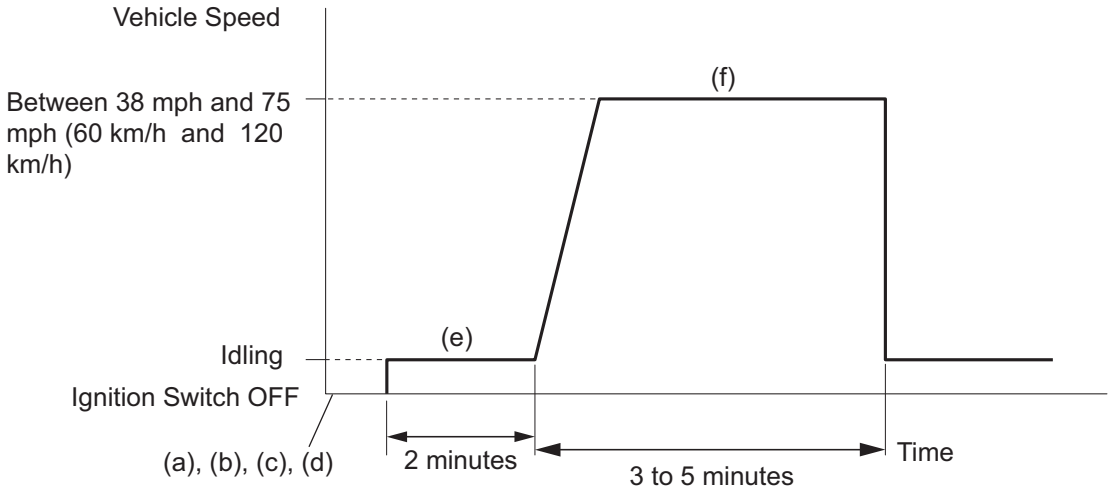
NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

14	REPLACE AIR FUEL RATIO SENSOR

NEXT

15	PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Clear DTCs (See page ES-34).
(d) Switch the ECM from normal mode to check mode using the tester (See page ES-37).
(e) Start the engine 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 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

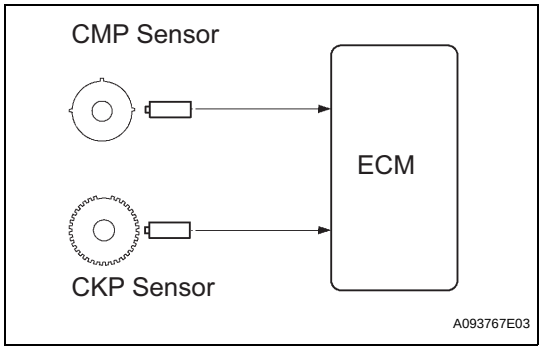
DTC	P0302	Cylinder 2 Misfire Detected

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 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 as 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 • ECM
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, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only set when several misfiring cylinders are detected at the same time.

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	450 to 6,600 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 2,800 rpm
Except above	Crankshaft 200 revolutions

TYPICAL MALFUNCTION THRESHOLDS

Monitor period of emission-related-misfire:

Misfire rate	1.63 % or more

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

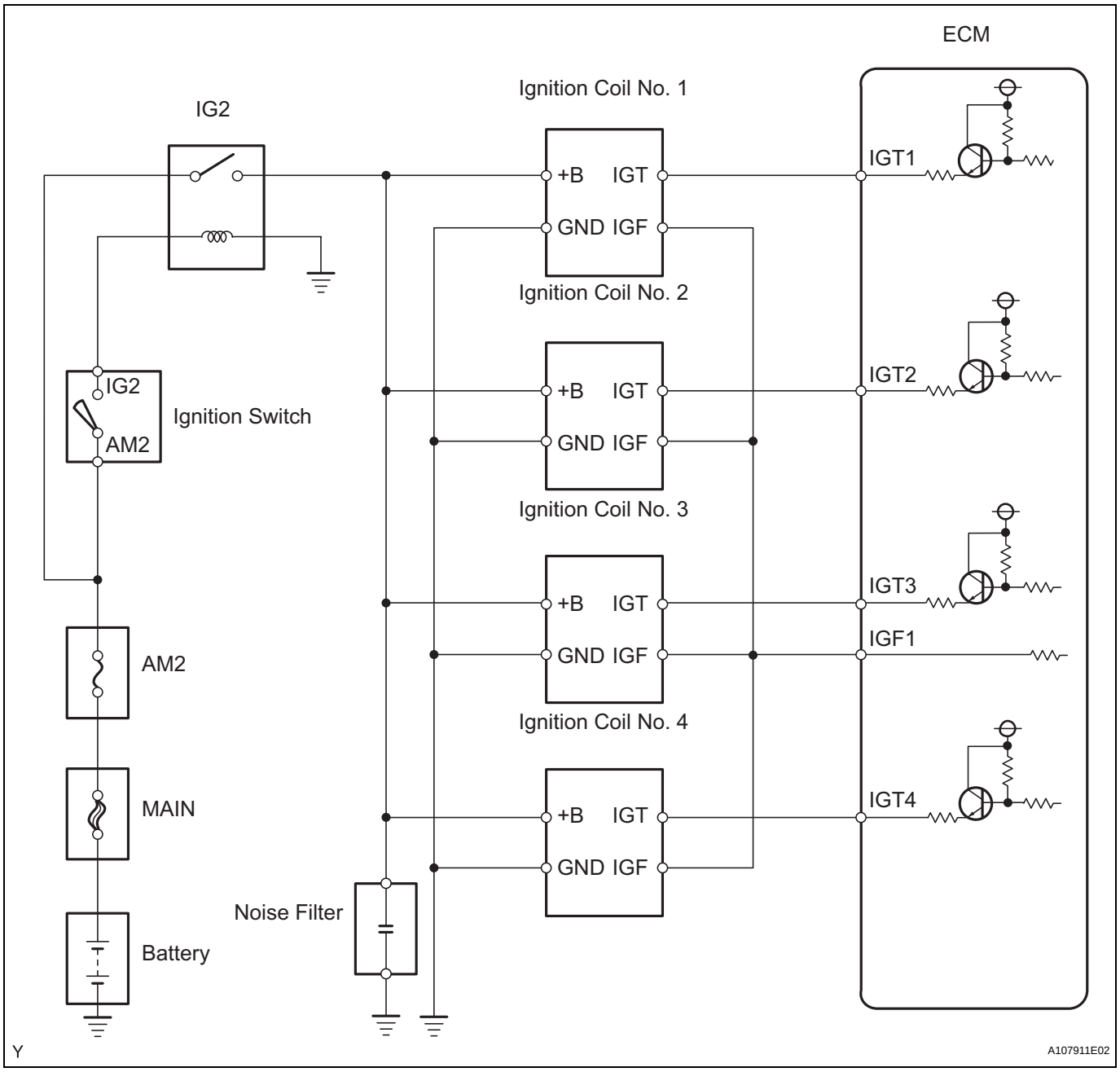
Number of misfire per 200 revolutions	101 or more (varies with intake air amount and RPM)

MONITOR RESULT

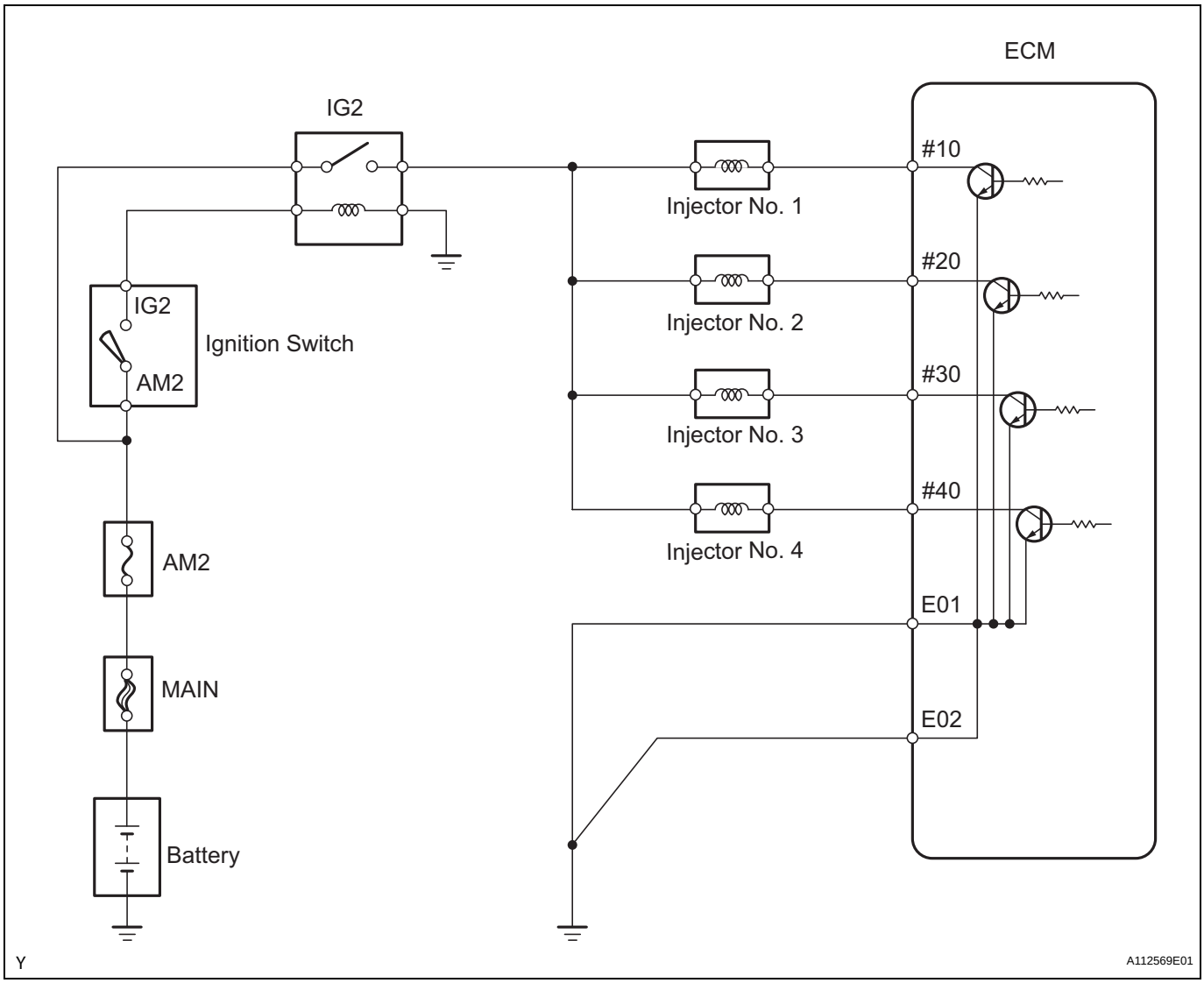
Refer to CHECKING MONITOR STATUS (See page ES-17).

WIRING DIAGRAM

Wiring diagram of the ignition system.



Wiring diagram of the injector circuit.



CONFIRMATION DRIVING PATTERN

1. Connect an intelligent tester to the DLC3.
2. Turn the ignition switch to ON.
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-37).
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 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 ignition switch to OFF until the stored DTC(s) and freeze frame data have been recorded. When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be erased.
9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the ignition switch to OFF and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.
- Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 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-34).
  (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), the misfires occurred only while warming up the engine.

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

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

Result

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

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

NEXT

3 CHECK PCV HOSE CONNECTIONS

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

NG → REPAIR OR REPLACE PCV HOSE

OK

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Clear DTCs (See page ES-34).
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / CYL #1, #2, #3 and #4.
(f) Allow the engine to idle.
(g) Read each value for CYL #1 to #4 displayed on the tester. If no misfire counts occur in any cylinders, perform the following conditions:
(1) Shift the gear selector lever to the D position.
(2) Check the 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 step 2.

(i) Read the CYL #1 to #4 or DTCs displayed on the tester.

Result

Misfire Count	Proceed To
Most misfires occur in only one or two cylinders	A
Three cylinders or more have equal misfire counts	B

HINT:

- If it is difficult to reproduce misfires for each cylinder, check the DATA LIST item called 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), the 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, the misfire may be detected immediately after the engine is started.

ES

B → **Go to step 14**

A

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

(a) Allow the engine to idle.
(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 same	A
Misfire count of cylinder before fuel cut lower than after fuel cut	B

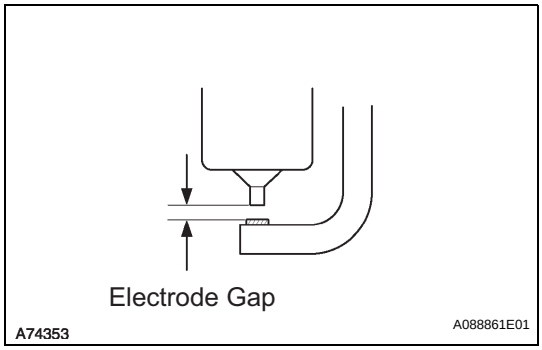
NOTICE:
This ACTIVE TEST cannot be performed while the vehicle is being driven.

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

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:
1.0 to 1.1 mm (0.039 to 0.043 in.)
(c) Check the electrode for carbon deposits.
Recommended spark plug:

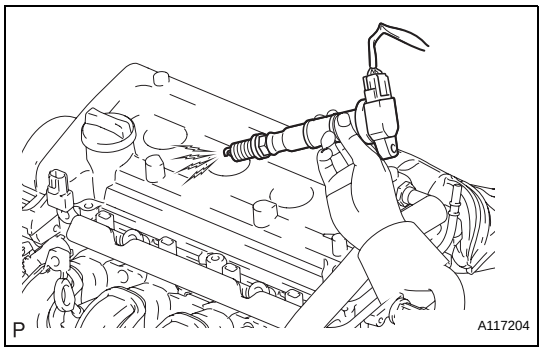
Manufactures	Products
DENSO	SK16R11
NGK	IFR5A11

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

NG → **REPLACE SPARK PLUG**

OK

7	CHECK FOR SPARKS AND IGNITION



(a) Disconnect the injector connectors, in order to prevent the engine from starting.
(b) Install the spark plug onto the ignition coil.
(c) Attach the spark plug assembly to the cylinder head.
(d) Crank the engine for less than 2 seconds and check the spark.
OK:
Sparks jump across electrode gap.
(e) Reconnect the injector connectors.

NG → **Go to step 9**

OK

8	CHECK CYLINDER COMPRESSION PRESSURE OF MISFIRING CYLINDER

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

OK → **Go to step 10**

NG

CHECK ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION

9	CHANGE NORMAL SPARK PLUG AND CHECK SPARK OF MISFIRING CYLINDER

(a) Change the installed spark plug to 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.

ES

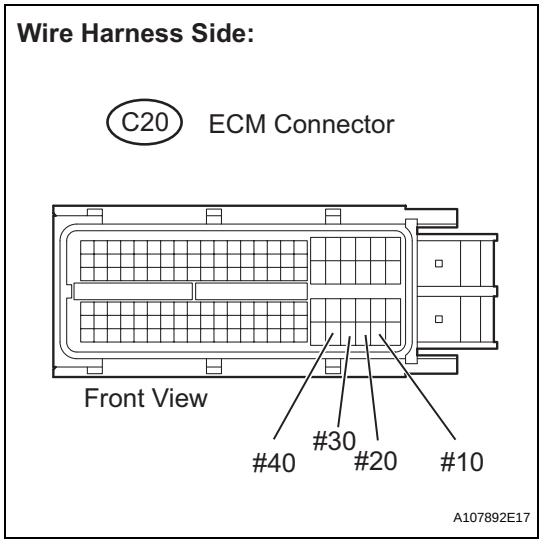
NG → **REPLACE IGNITION COIL ASSEMBLY THEN CONFIRM THAT THERE IS NO MISFIRE**

OK

REPLACE SPARK PLUG

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

Wire Harness Side:



(a) Disconnect the C20 ECM connector.
(b) Turn the ignition switch to ON.
(c) Measure the voltage between the terminals of the ECM connector.
Standard voltage

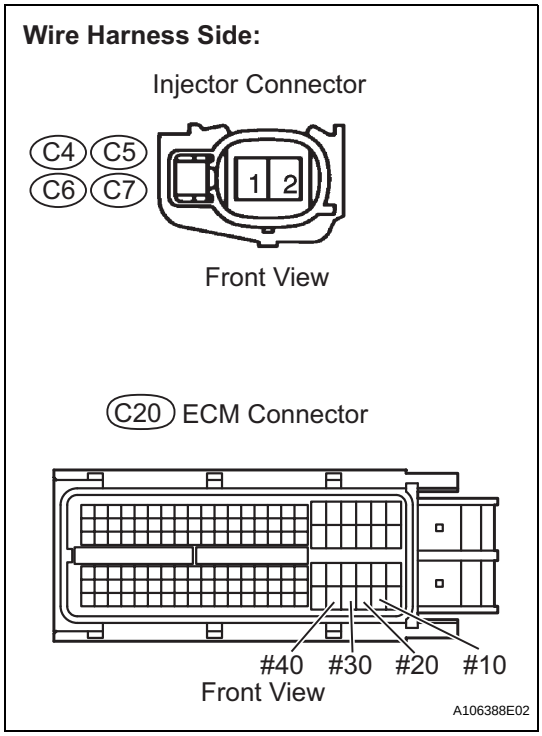
Tester Connections	Specified Conditions
#10 (C20-108) - E01 (C20-45)	11 to 14 V
#20 (C20-107) - E01 (C20-45)	
#30 (C20-106) - E01 (C20-45)	
#40 (C20-105) - E01 (C20-45)	

(d) Reconnect the ECM connector.

OK → **Go to step 12**

NG

11	CHECK HARNESS AND CONNECTOR (INJECTOR - ECM)



(a) Disconnect the injector connector (of the misfiring cylinder).
(b) Disconnect the C20 ECM connector.
(c) Turn the ignition switch to ON.
(d) Measure the resistance and voltage between the injector and the ECM connector terminals.

Standard voltage

Cylinder	Tester Connections	Specified Conditions
No. 1	C4-1 - Ground	11 to 14 V
No. 2	C5-1 - Ground	
No. 3	C6-1 - Ground	
No. 4	C7-1 - Ground	

Standard resistance

Cylinder	Tester Connections	Specified Conditions
No. 1	C4-2 - Ground	10 kΩ or higher
	C4-2 - C20-108 (#10)	Below 1 Ω
No. 2	C5-2 - Ground	10 kΩ or higher
	C5-2 - C20-107 (#20)	Below 1 Ω
No. 3	C6-2 - Ground	10 kΩ or higher
	C6-2 - C20-106 (#30)	Below 1 Ω
No. 4	C7-2 - Ground	10 kΩ or higher
	C7-2 - C20-105 (#40)	Below 1 Ω

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

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

OK ↓

12	CHECK FUEL INJECTOR OF 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 ↓

13	CHECK VALVE CLEARANCE OF 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 (See page ES-71)

NG → **ADJUST VALVE TIMING**

OK ↓

16	CHECK FUEL PRESSURE

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

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

OK ↓

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.

A knock sensor is fitted onto the engine block to detect engine knocking.

ES

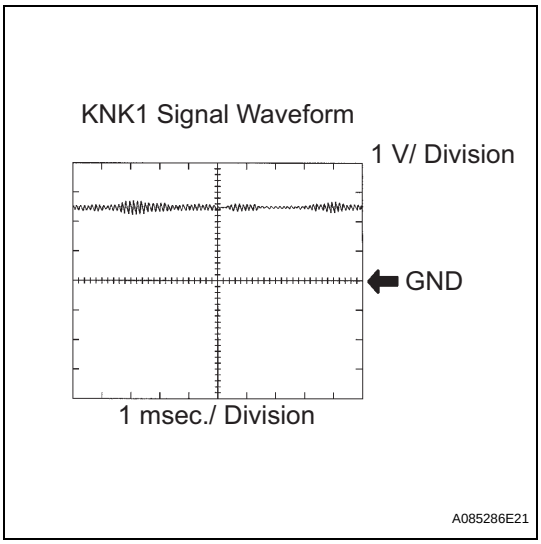
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed. The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

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

HINT:

When any of DTCs P0327 and P0328 are set, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is delayed to its maximum retardation. Fail-safe mode continues until the ignition switch is turned to OFF.

Reference: Inspection using an oscilloscope



The correct waveform is as shown.

Items	Contents
Terminals	KNK1 - EKNK
Equipment Settings	1 V/Division 1 msec./Division
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 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 not present	None
Battery voltage	10.5 V or more
Time after engine start	5 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

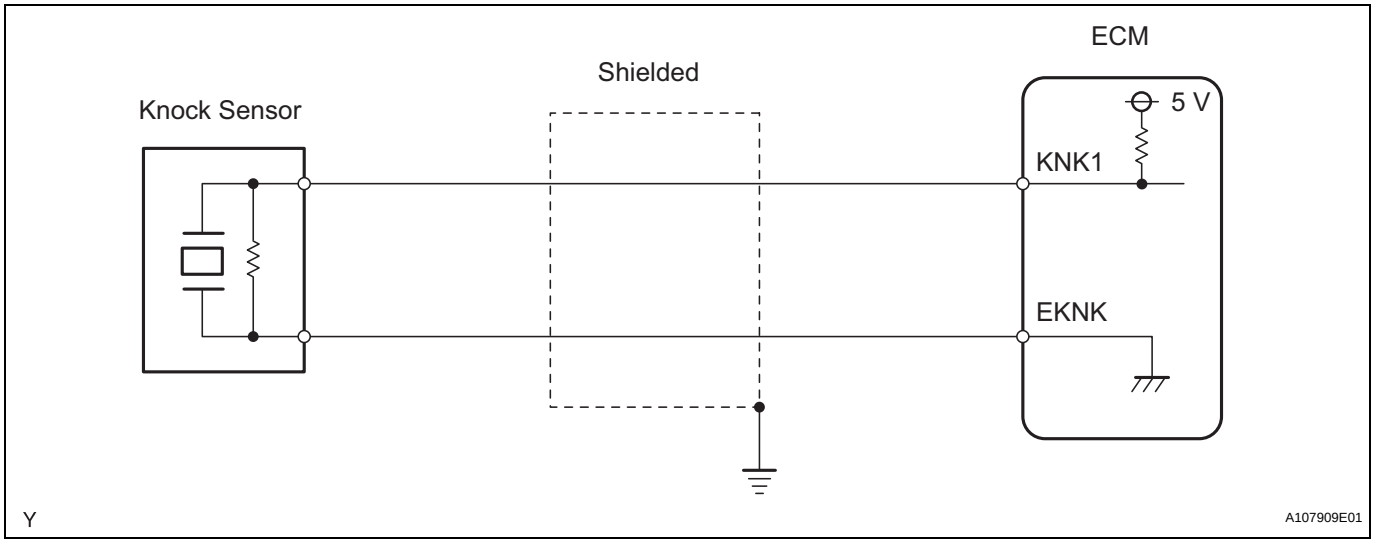
Knock Sensor Range Check (Low voltage) P0327:

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 an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Start the engine and turn the tester ON.
(c) Warm up the engine.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / USER DATA / KNOCK FB VAL.
(e) Read the values displayed on the tester while driving the vehicle.
Standard:
The values change.
HINT

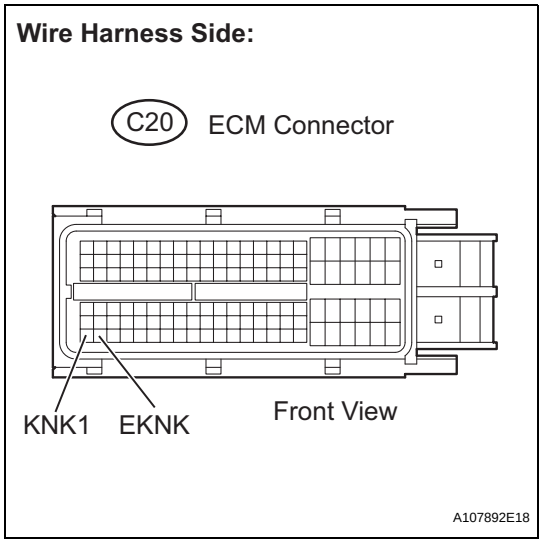
Malfunction does not occur	Knock Feedback Values change
Malfunctions occur	Knock Feedback Values do not change

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

OK → **CHECK FOR INTERMITTENT PROBLEMS**

NG

2	CHECK HARNESS AND CONNECTOR (ECM - KNOCK SENSOR)



(a) Disconnect the C20 ECM connector.
(b) Measure the resistance between the terminals.
Standard resistance

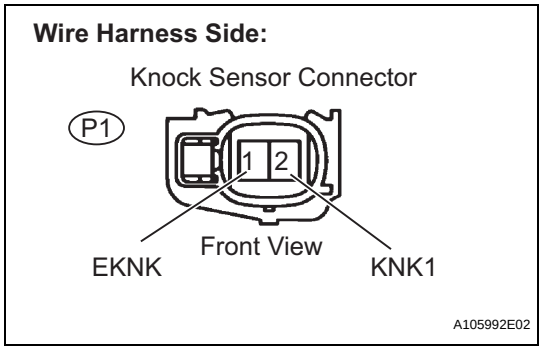
Tester Connections	Specified Conditions
KNK1 (C20-110) - EKNK (C20-111)	120 to 280 kΩ at 20°C (68°F)

(c) Reconnect the ECM connector.

NG → **Go to step 4**

OK

3 **INSPECT ECM (KNK1 VOLTAGE)**



(a) Disconnect the P1 knock sensor connector.
(b) Turn the ignition switch to ON.
(c) Measure the voltage between the knock sensor terminals.
Standard voltage

Tester Connections	Specified Conditions
KNK1 (P1-2) - EKNK (P1-1)	4.5 to 5.5 V

(d) Reconnect the knock sensor connector.

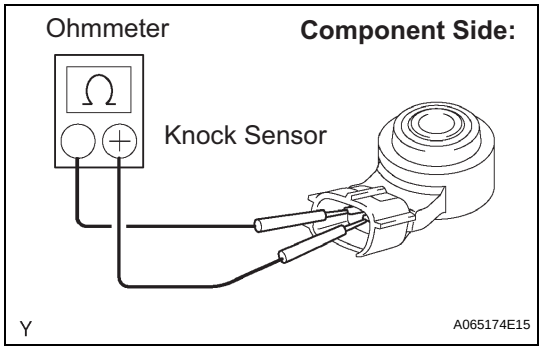
NOTICE:
Fault may be intermittent. Check the wire harness and connectors carefully and retest.

NG → **REPLACE ECM**

OK

CHECK FOR INTERMITTENT PROBLEMS

4 **INSPECT KNOCK SENSOR**



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

Tester Connections	Specified Conditions
KNK1 (2) - EKNK (1)	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

ES

DTC	P0335	Crankshaft Position Sensor "A" Circuit

DTC	P0339	Crankshaft Position Sensor "A" Circuit Intermittent

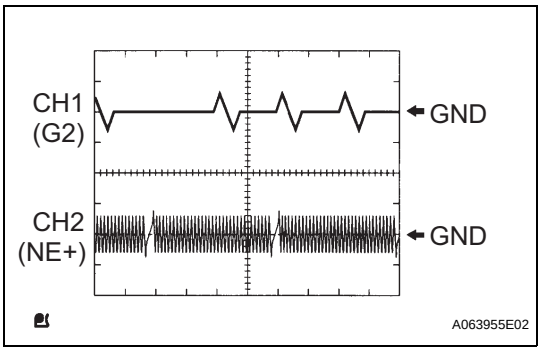
DESCRIPTION

The Crankshaft Position (CKP) sensor system consists of a CKP sensor plate and a pickup coil.
The sensor plate has 34 teeth and is installed on the crankshaft. The pickup coil is made of 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 calculates the crankshaft position and engine RPM. Using these calculations, the fuel injection time and ignition timing are controlled.

ES

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

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.
- Failure grounding of the shielded wire may causes noise in waveforms.

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

MONITOR DESCRIPTION

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

MONITOR STRATEGY

Related DTCs	P0335: 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	0.3 seconds or more
Number of CMP sensor signal pulse	6 times
Battery voltage	7 V or more
CMP sensor circuit fail	Not detected
Ignition switch	ON

Case 2:

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

TYPICAL MALFUNCTION THRESHOLDS

Case 1:

Number of CKP sensor signal pulse	132 or less, and 174 or more

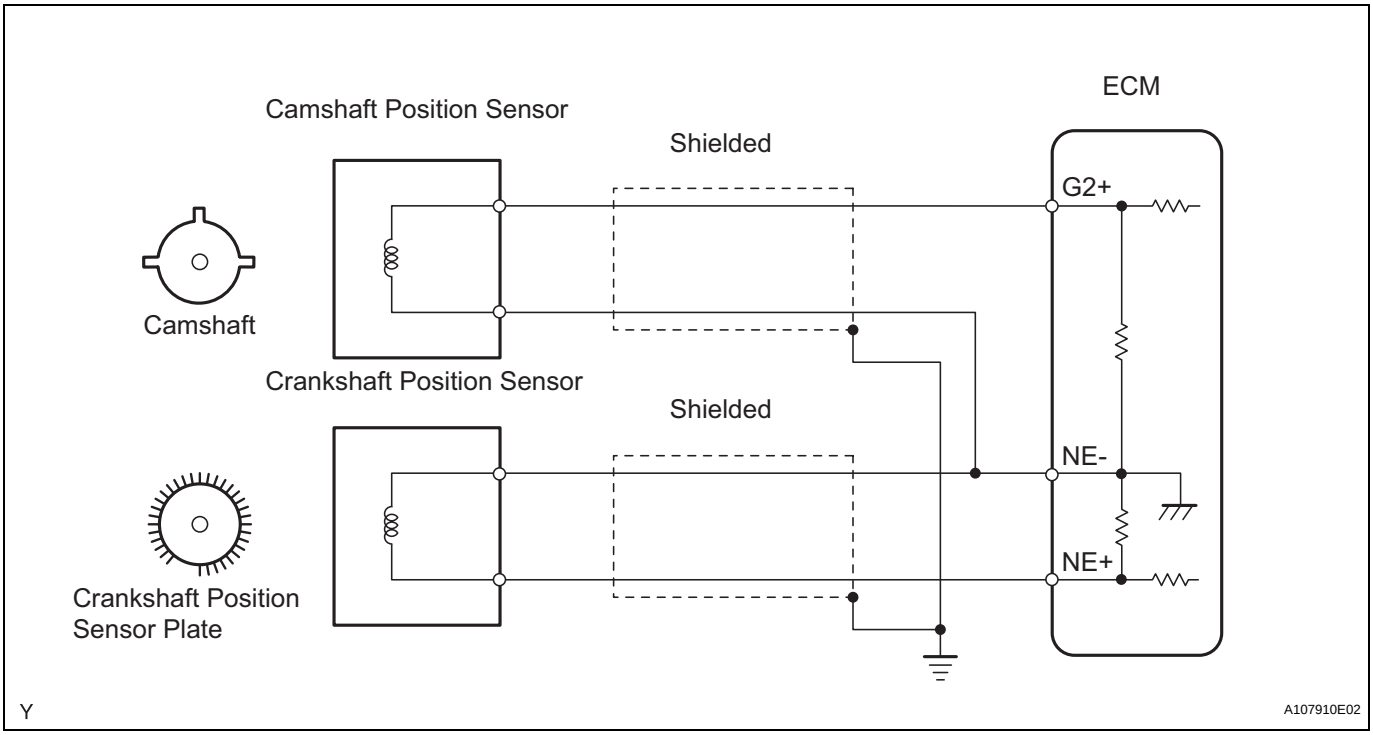
Case 2:

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



ES

INSPECTION PROCEDURE

HINT:

- If no problem is found through this diagnostic troubleshooting procedure, troubleshooting the engine mechanical systems.
- Check the engine speed. The engine speed can be checked by using an intelligent tester. To check, follow the operation below:
  (a) Connect the intelligent tester to the DLC3.
  (b) Start the engine.
  (c) Turn the tester ON
  (d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / ENGINE SPD.
  The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the Crankshaft Position (CKP) sensor. Alternatively, the engine speed may be indicated as lower than the actual engine speed, if the CKP sensor output voltage is insufficient.
- Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / ENGINE SPD.
(e) Start the engine.

(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**

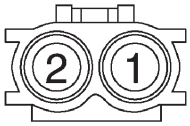
ES

NG

2 INSPECT CRANKSHAFT POSITION SENSOR (RESISTANCE)

Component Side:

CKP Sensor



Front View

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(a) Disconnect the C2 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

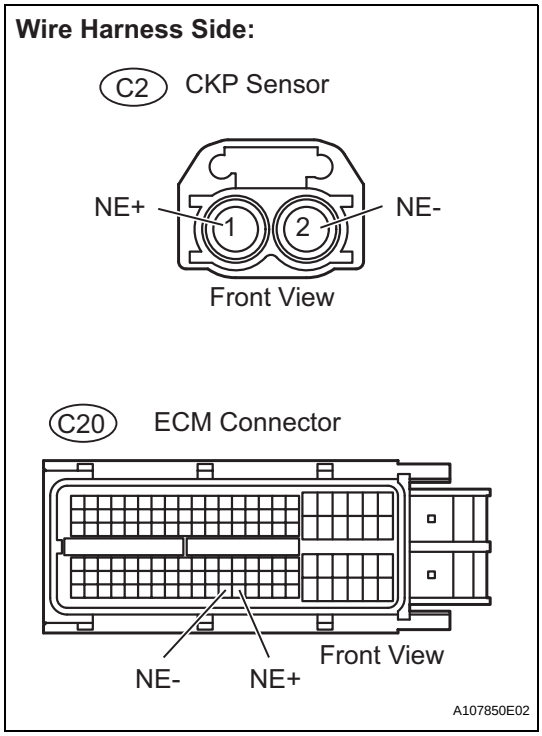
HINT:
Terms cold and hot refer to the temperature of the coils.
Cold means approximately -10 to 50°C (14 to 122°F).
Hot means approximately 50 to 100°C (122 to 212°F).

(c) Reconnect the CKP sensor connector.

NG → **REPLACE CRANKSHAFT POSITION SENSOR**

OK

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



(a) Disconnect the C2 CKP sensor connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
NE+ (C2-1) - NE+ (C20-122)	Below 1 Ω
NE- (C2-2) - NE- (C20-121)	

Standard resistance (Check for short)

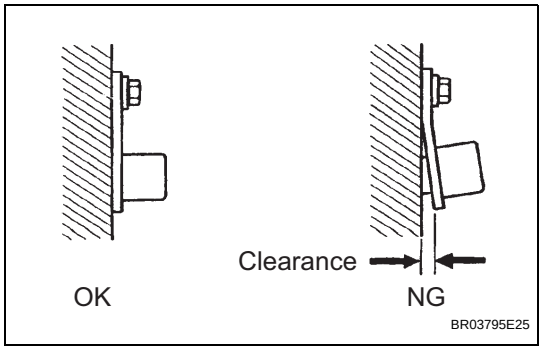
Tester Connections	Specified Conditions
NE+ (C2-1) or NE+ (C20-122) - Body ground	10 kΩor higher
NE- (C2-2) or NE- (C20-121) - Body ground	

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

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

OK

4	CHECK SENSOR INSTALLATION (CRANKSHAFT POSITION SENSOR)



(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 ignition switch to ON.
(c) Turn the tester ON.
(d) Clear DTCs (See page ES-34).
(e) Start the engine.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(g) Read DTCs.

ES

Result

Display (DTC Output)	Proceed To
No output	A
P0335 or P0339	B

HINT:
If the engine does not start, replace the ECM.

B → REPLACE ECM

A

END

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

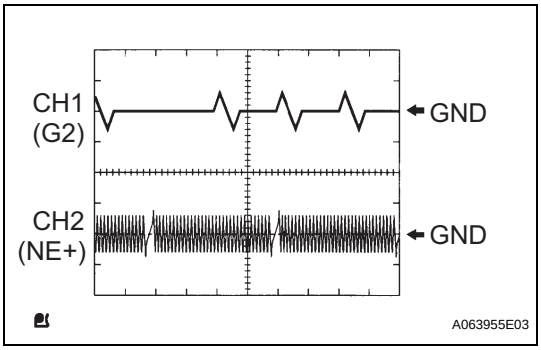
DESCRIPTION

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 to locate 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	Case 1 • No Camshaft Position (CMP) sensor signal to ECM while cranking (2 trip detection logic) Case 2 • 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 • ECM

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 - NE- CH2: NE+ - NE-
Equipment Settings	5 V/Division, 20 ms/Division
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	4 seconds: CMP sensor range check 5 seconds: Camshaft position/crankshaft position misalignment
MIL Operation	2 driving cycles: CMP sensor range check Immediate: Camshaft position/crankshaft position misalignment
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	None

Camshaft Position Sensor Range Check:

Starter	ON
Minimal battery voltage while starter ON	Less than 11 V

Camshaft Position/Crankshaft Position Misalignment:

Engine speed	600 rpm or more
Starter	OFF

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

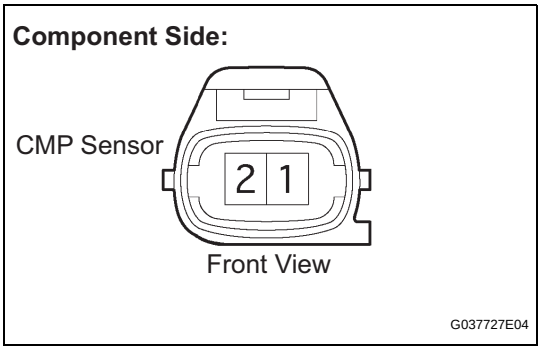
Refer to DTC P0335 (See page ES-163).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 C18 Camshaft Position (CMP) sensor connector.
(b) Measure the resistance between terminals 1 and 2.
Standard resistance

Tester Connections	Conditions	Specified Conditions
1 - 2	Cold	1,630 to 2,740 Ω
1 - 2	Hot	2,065 to 3,225 Ω

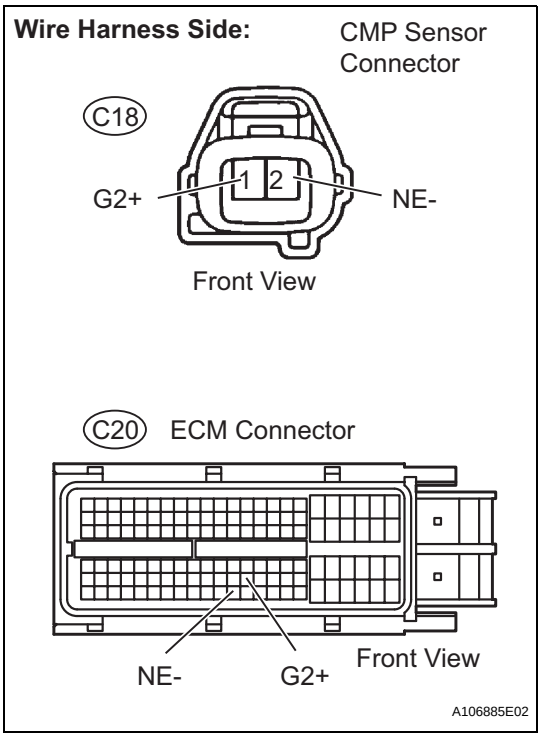
HINT:
Terms cold and hot refer to the temperature of the coils.
Cold means approximately -10° to 50°C (14 °to 122°F).
Hot means approximately 50° to 100°C (122°to 212°F).

(c) Reconnect the CMP sensor connector.

NG → **REPLACE CAMSHAFT POSITION SENSOR**

OK

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



(a) Disconnect the C18 CMP sensor connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.
Standard resistance (Check for open)

Tester Connections	Specified Conditions
G2+ (C18-1) - G2+ (C20-99)	Below 1 Ω
NE- (C18-2) - NE- (C20-121)	

Standard resistance (Check for short)

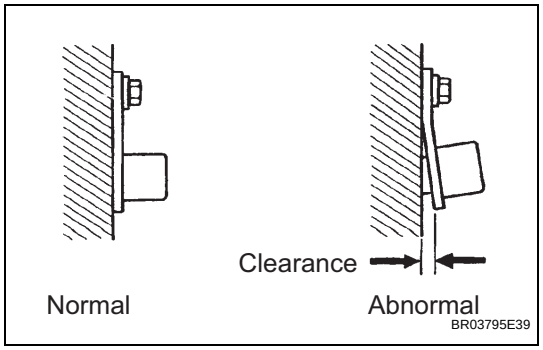
Tester Connections	Specified Conditions
G2+ (C18-1) or G2+ (C20-99) - Body ground	10 kΩ or higher
NE- (C18-2) or NE- (C20-121) - Body ground	

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

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

OK

3 CHECK SENSOR INSTALLATION (CAMSHAFT POSITION SENSOR)



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

NG → **SECURELY REINSTALL SENSOR**

OK

4 CHECK VALVE TIMING (See page ES-71)

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

6 REPLACE CAMSHAFT POSITION SENSOR

NEXT

7 CHECK WHETHER DTC OUTPUT RECURS

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Clear DTCs (See page ES-34).
(e) Start the engine.
(f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.
(g) Read DTCs.

Result

Display (DTC Output)	Proceed To
No output	A

ES

Display (DTC Output)	Proceed To
P0340	B

HINT:
If the engine does not start, replace the ECM.

B → REPLACE ECM

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

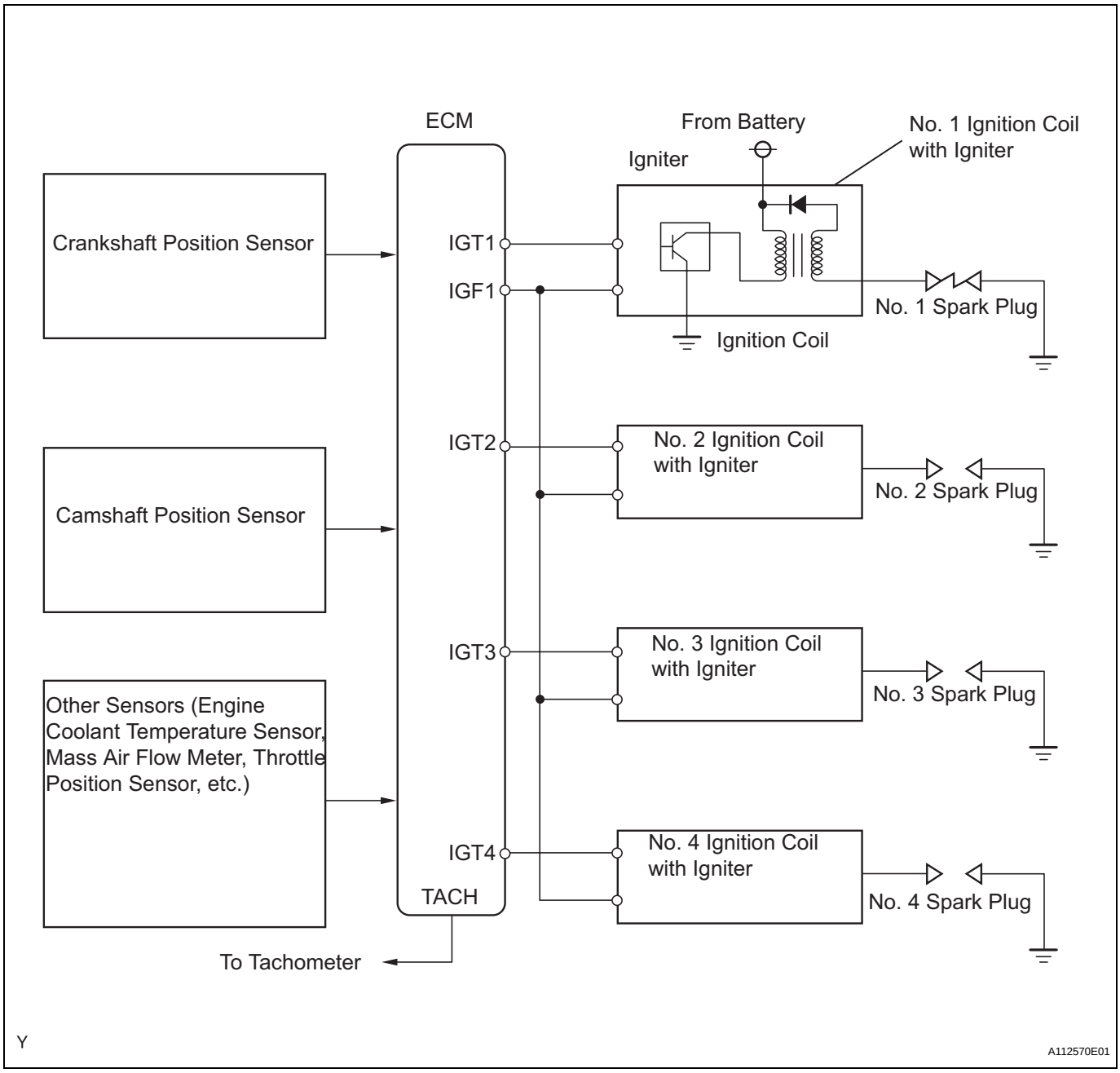
HINT:

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

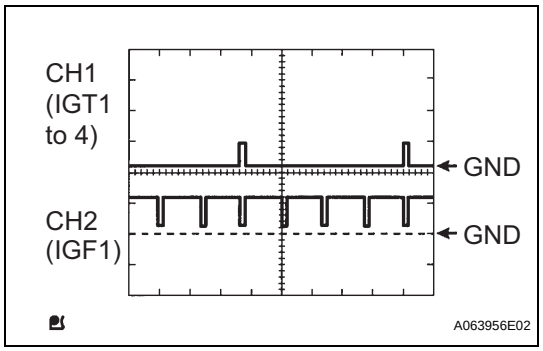
A Direct Ignition System (DIS) is used on this vehicle.

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 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.



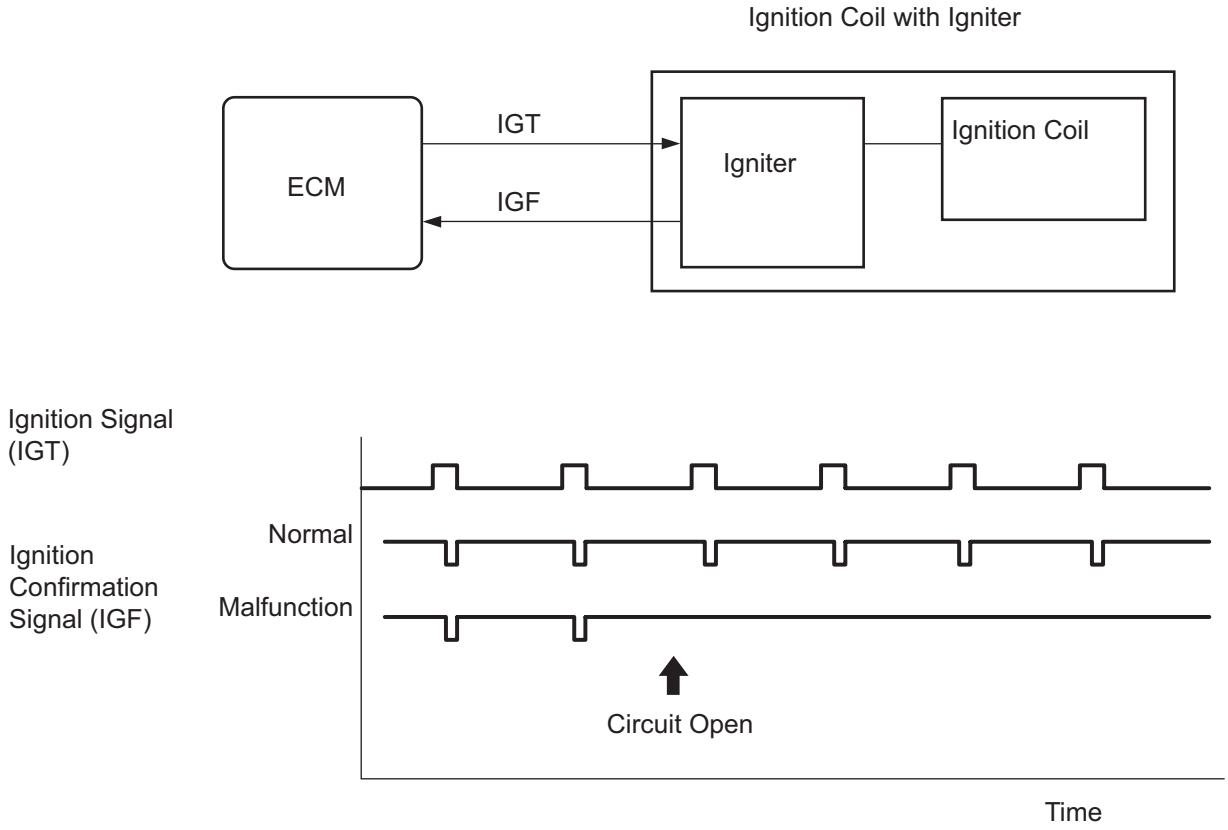
DTC No.	DTC Detection Conditions	Trouble Areas
P0351 P0352 P0353 P0354	No IGF signal to ECM while engine running (1 trip detection logic)	• Ignition system • Open or short in IGF1 or IGT circuit (1 to 4) between ignition coil with igniter and ECM • No. 1 to No. 4 ignition coils with igniters • ECM



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.

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

MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and sets a DTC.
If the malfunction is not repaired successfully, a DTC is set 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	0.256 seconds and 4 sparks
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

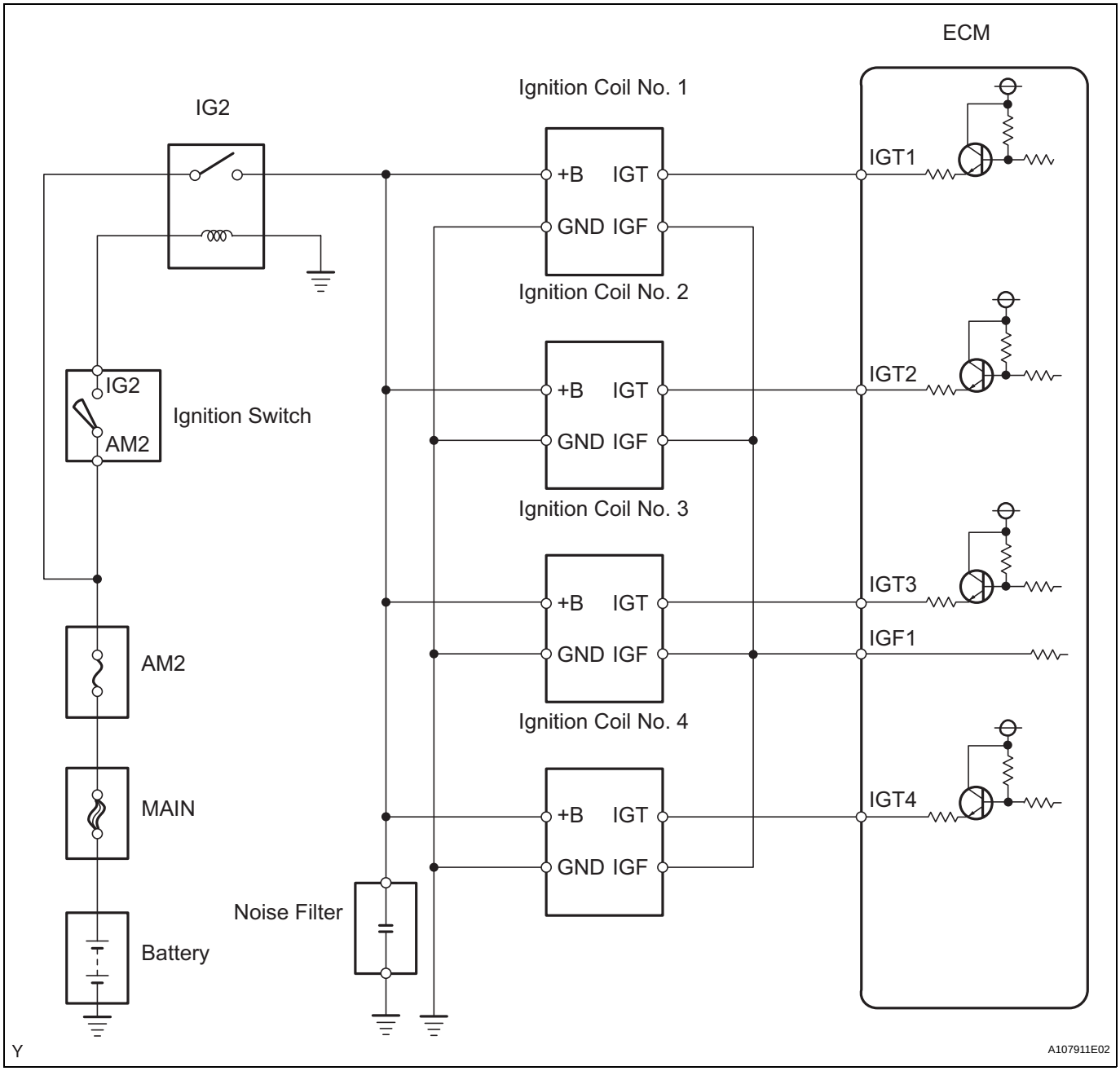
TYPICAL MALFUNCTION THRESHOLDS

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

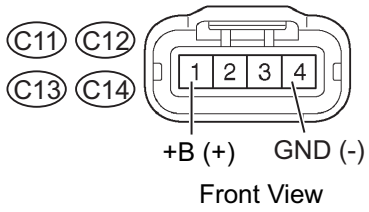
HINT:

Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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)

Wire Harness Side:

Ignition Coil with Igniter Connector



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(a) Disconnect the ignition coil with igniter connector.
(b) Check the resistance.

Standard resistance (Check for open)

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

(c) Turn the ignition switch to ON.
(d) Measure the voltage between the terminals of the wire harness side connector.

Standard voltage

Tester Connections	Specified Conditions
+B (C11-1) - GND (C11-4)	11 to 14 V
+B (C12-1) - GND (C12-4)	
+B (C13-1) - GND (C13-4)	
+B (C14-1) - GND (C14-4)	

(e) Reconnect the ignition coil with igniter connector.

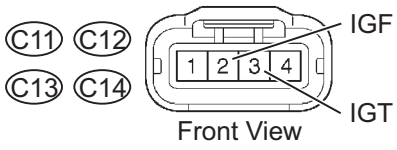
NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

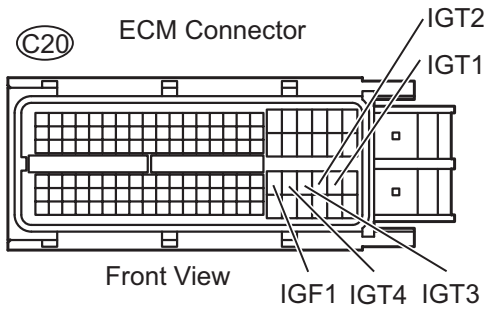
OK

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

Wire Harness Side:

Ignition Coil with Igniter Connector





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(a) Disconnect the ignition coil with connector.
(b) Disconnect the C20 ECM connector.
(c) Check the resistance.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
IGF (C11-2) - IGF1 (C20-81)	Below 1 Ω
IGF (C12-2) - IGF1 (C20-81)	
IGF (C13-2) - IGF1 (C20-81)	
IGF (C14-2) - IGF1 (C20-81)	

Standard resistance (Check for open)

Tester Connections	Specified Conditions
IGT (C11-3) - IGT1 (C20-85)	Below 1 Ω
IGT (C12-3) - IGT2 (C20-84)	
IGT (C13-3) - IGT3 (C20-83)	
IGT (C14-3) - IGT4 (C20-82)	

Standard resistance (Check for short)

Tester Connections	Specified Conditions
IGF (C11-2) or IGF1 (C20-81) - Body ground	10 kΩ or higher
IGF (C12-2) or IGF1 (C20-81) - Body ground	
IGF (C13-2) or IGF1 (C20-81) - Body ground	
IGF (C14-2) or IGF1 (C20-81) - Body ground	

Standard resistance (Check for short)

Tester Connections	Specified Conditions
IGT (C11-3) or IGT1 (C20-85) - Body ground	10 kΩ or higher
IGT (C12-3) or IGT2 (C20-84) - Body ground	
IGT (C13-3) or IGT3 (C20-83) - Body ground	
IGT (C14-3) or IGT4 (C20-82) - Body ground	

(d) Reconnect the ECM 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Clear DTCs (See page ES-34).
(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 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 ECM

DTC	P0420	Catalyst System Efficiency Below Threshold (Bank 1)

MONITOR DESCRIPTION

The ECM 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 4,000 rpm
A/F sensor status	Activated
Fuel system status	Closed loop
Engine load	10 to 80 %
All of following conditions (a), (b) and (c) met	-
(a) Mass air flow rate	2.5 to 27 g/sec
(b) Estimated front catalyst temperature	620° to 800°C (1,148° to 1,472°F)
(c) Estimated rear catalyst temperature	400° to 900°C (752° to 1,652°F)
Rear HO2 sensor heater monitor	Completed
Shift position	4th or 5th (M/T) 3rd or 4th (A/T)

ES

TYPICAL MALFUNCTION THRESHOLDS

Oxygen Storage Capacity (OSC) of Three-Way Catalytic Converter (TWC)	Less than 0.046875 g

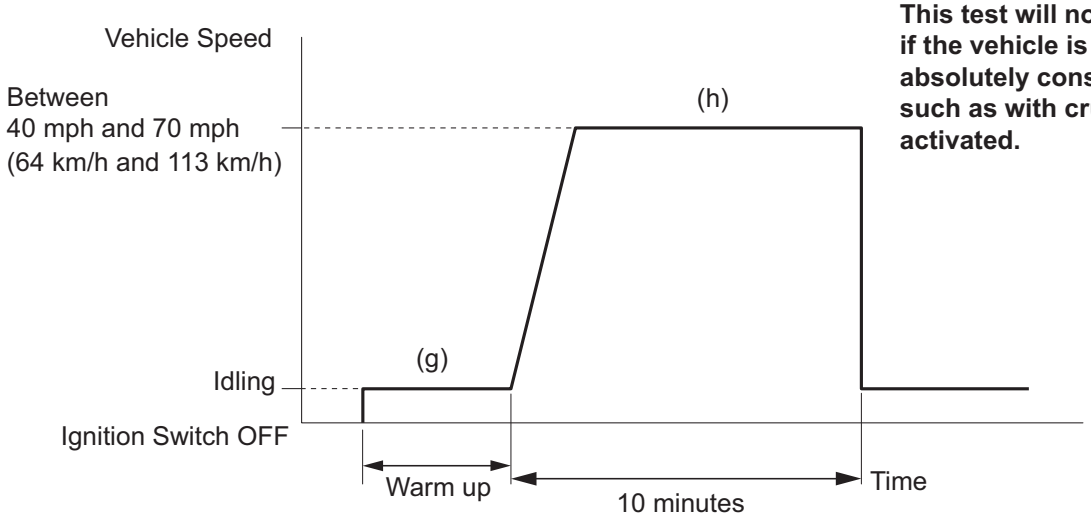
MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-17).

CONFIRMATION DRIVING PATTERN

HINT:

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



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

(Note: Even if vehicle stops during driving pattern, test can be resumed)

P

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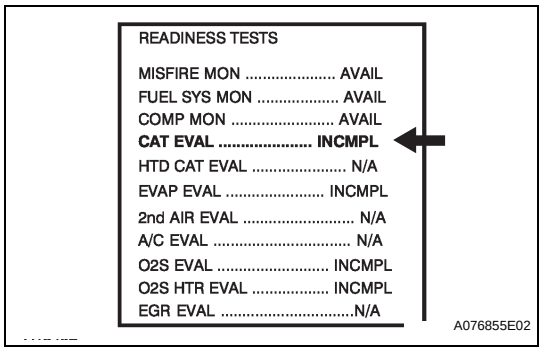
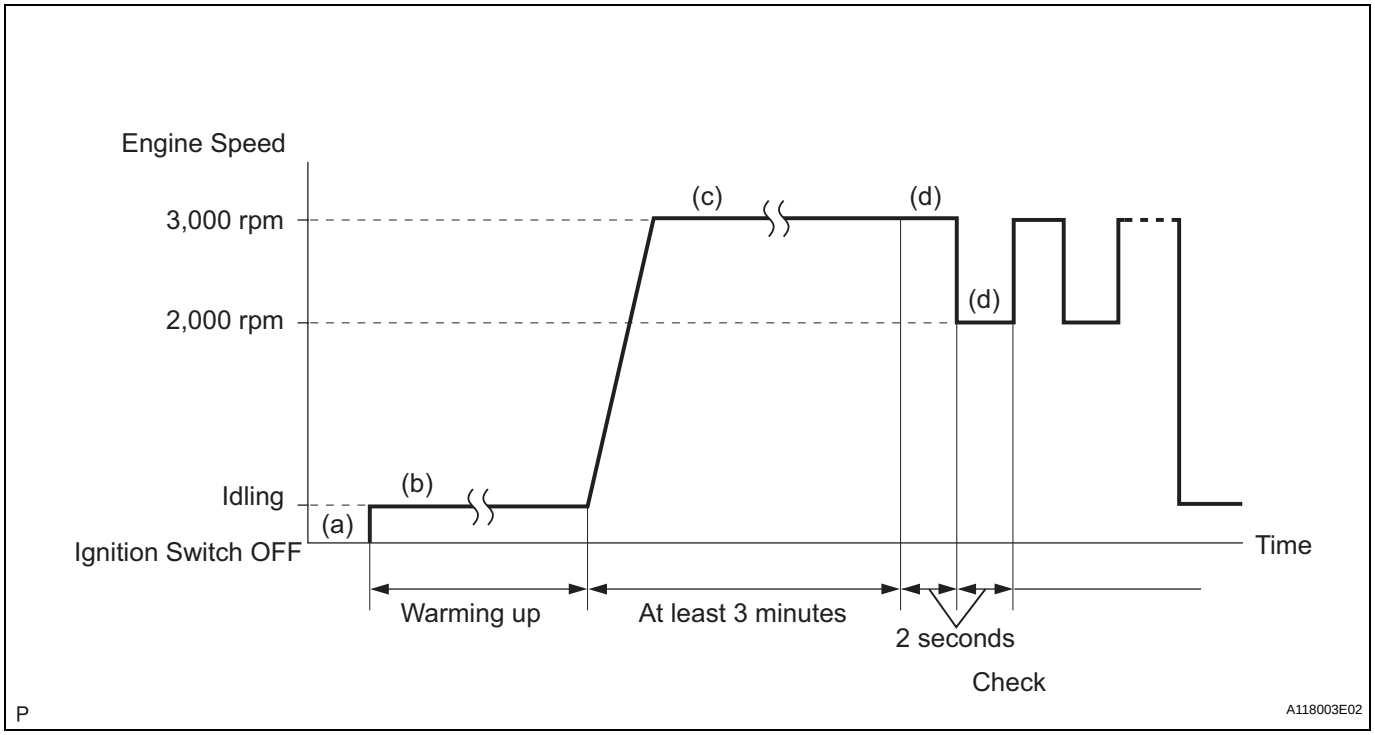


(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch to ON.
(c) Turn the tester ON.
(d) Clear DTCs (where set) (See page ES-34).
(e) Select the following menu items: DIAGNOSIS / CARB OBD II / READINESS TESTS.
(f) Check that CAT EVAL is INCMPL (incomplete).
(g) Start the engine 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 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 CAT EVAL does not change to COMPL, and any pending DTCs fail to 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.



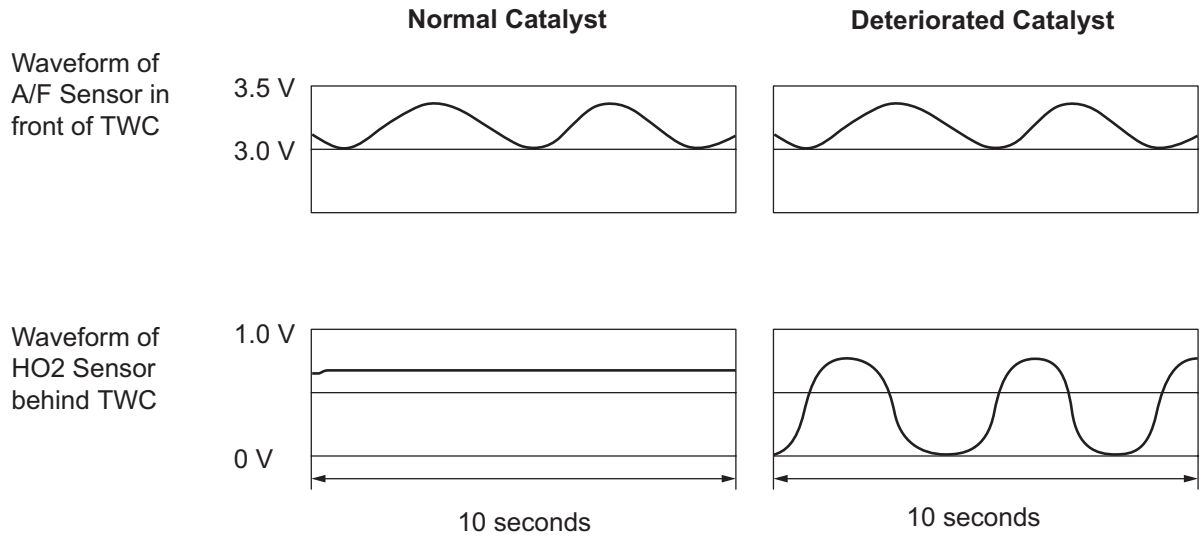
(a) Connect an intelligent tester to the DLC3.

(b) Start the engine 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 an 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:



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INSPECTION PROCEDURE

HINT:
Read freeze frame data using an intelligent tester. Freeze frame data record the engine condition when malfunctions are detected. 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 an intelligent tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read DTCs.

Result

Display (DTC Output)	Proceed To
P0420	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)

(a) Connect the intelligent tester to the DLC3.
(b) Start the engine and turn the tester ON.
(c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
(d) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
(f) Monitor the voltage outputs of the A/F and HO2 sensors (AFS 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		Output Voltage Almost no reaction		
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		Output Voltage Almost no reaction		

ES

Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
To display the graph, 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.

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 AND REPLACE EXTREMELY RICH OR LEAN ACTUAL AIR-FUEL RATIO, AND GO TO STEP 3**

A

3 CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

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

OK

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

4	CHECK FOR EXHAUST GAS LEAKAGE

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 SUMMARY

DTCs	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P043E	Reference orifice clogged	P043E, P043F, P2401, P2402 and P2419 present when one of following conditions met during key-off EVAP monitor: • EVAP pressure just after reference pressure measurement greater than -1 kPa-g (-7.5 mmHg-g) • Reference pressure less than -4.85 kPa-g (-36.4 mmHg-g) • Reference pressure greater than -1.057 kPa-g (-7.93 mmHg-g) • Reference pressure not saturated • Reference pressure difference between first and second 0.7 kPa-g (5.25 mmHg-g) or more HINT: Typical example values	• Canister pump module (Reference orifice, leak detection pump, vent valve) • Connector/wire harness (Canister pump module - ECM) • EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) • ECM	While ignition switch OFF	2 trip
P043F	Reference orifice high-flow		• Canister pump module (Reference orifice, leak detection pump, vent valve) • Connector/wire harness (Canister pump module - ECM) • EVAP system hose (pipe from air inlet port to canister pump module, canister filter, fuel tank vent hose) • ECM	While ignition switch OFF	2 trip

HINT:
The reference orifice is located inside the canister pump module.

DESCRIPTION

The description can be found in the EVAP (Evaporative Emission) System (See page ES-319).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-324).

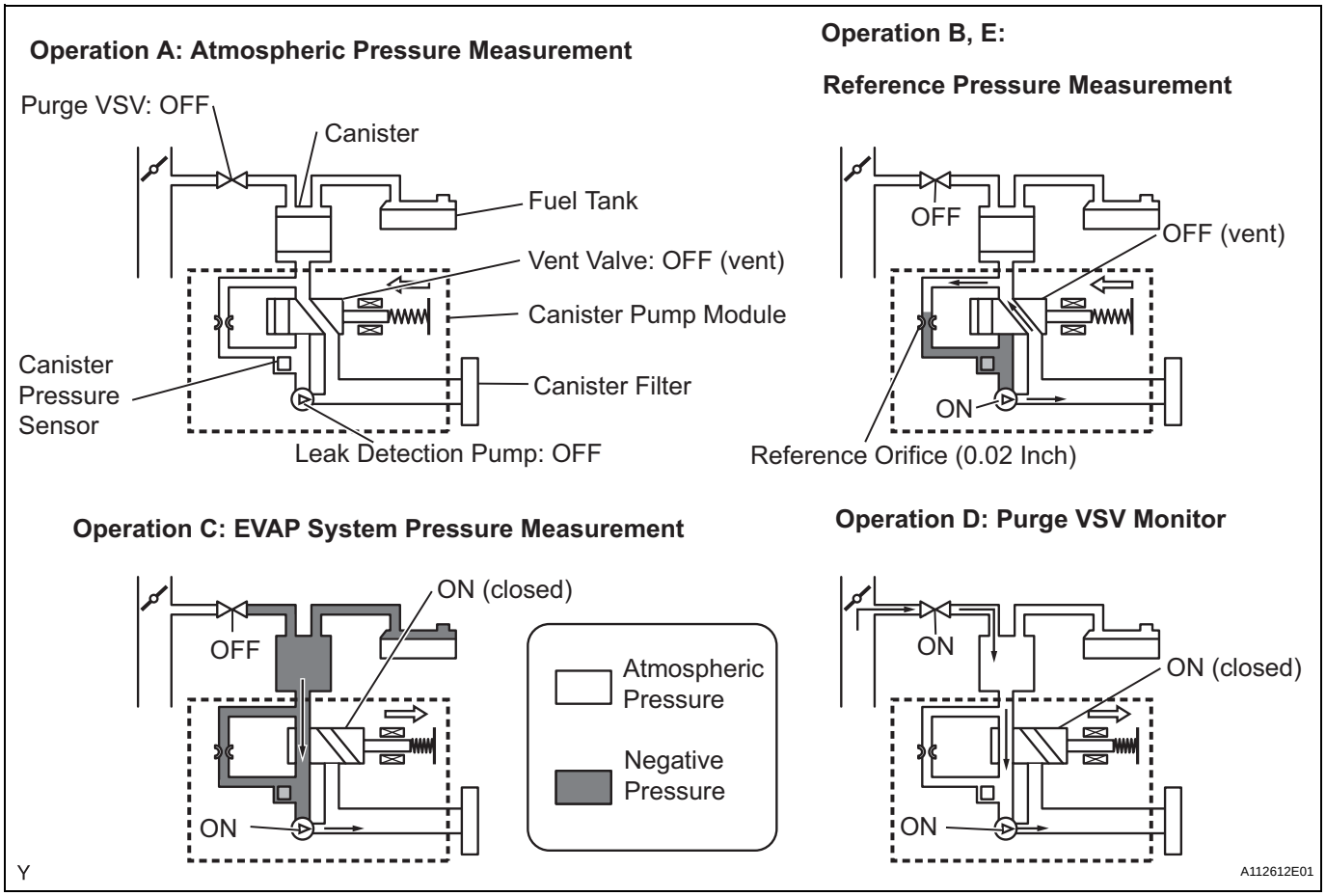
MONITOR DESCRIPTION

5 hours* after the ignition switch is turned to OFF, the leak detection pump creates negative pressure (vacuum) in the EVAP system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.
HINT:
*: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned to OFF, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned to OFF, the monitor check starts 2.5 hours later.

Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned to OFF.	-

Sequence	Operations	Descriptions	Duration
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system not between 76 kPa-a and 110 kPa-a (570 mmHg-a and 825 mmHg-a), ECM cancels EVAP system monitor.	10 seconds
B	First reference pressure measurement	In order to determine reference pressure, 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
C	EVAP system pressure measurement	Vent valve turned ON (closed) to shut EVAP system. Negative pressure (vacuum) created in EVAP system, and EVAP system pressure then measured. Write down measured value as 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 opened and then EVAP system pressure measured by ECM. Large increase indicates normality.	10 seconds
E	Second reference pressure measurement	After second reference pressure measurement, leak check performed by comparing first and second reference pressure. If stabilized system pressure higher than second reference pressure, ECM determines that EVAP system leaking.	60 seconds
F	Final check	Atmospheric pressure measured and then monitoring result recorded by ECM.	-

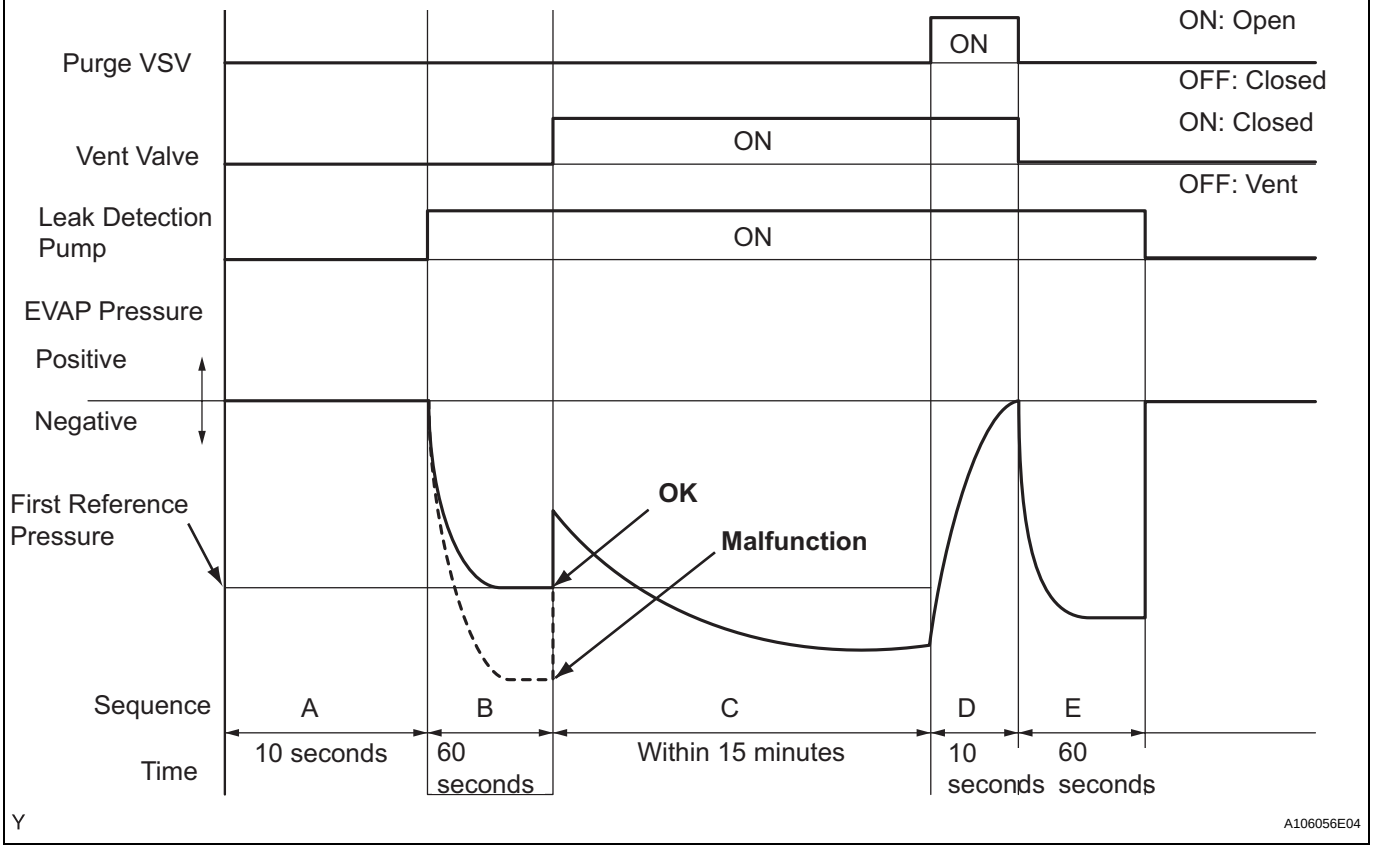
* If only a small amount of fuel is in the fuel tank, it takes longer for the EVAP pressure to stabilize.



(a) P043E: Reference orifice clogged

In operation B, 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 lower than -4.85 kPa-g (-36.4 mmHg-g), the ECM interprets this as a clog malfunction in the reference orifice, and stops the EVAP system monitor. The ECM then illuminates the MIL and sets the DTC (2 trip detection logic).

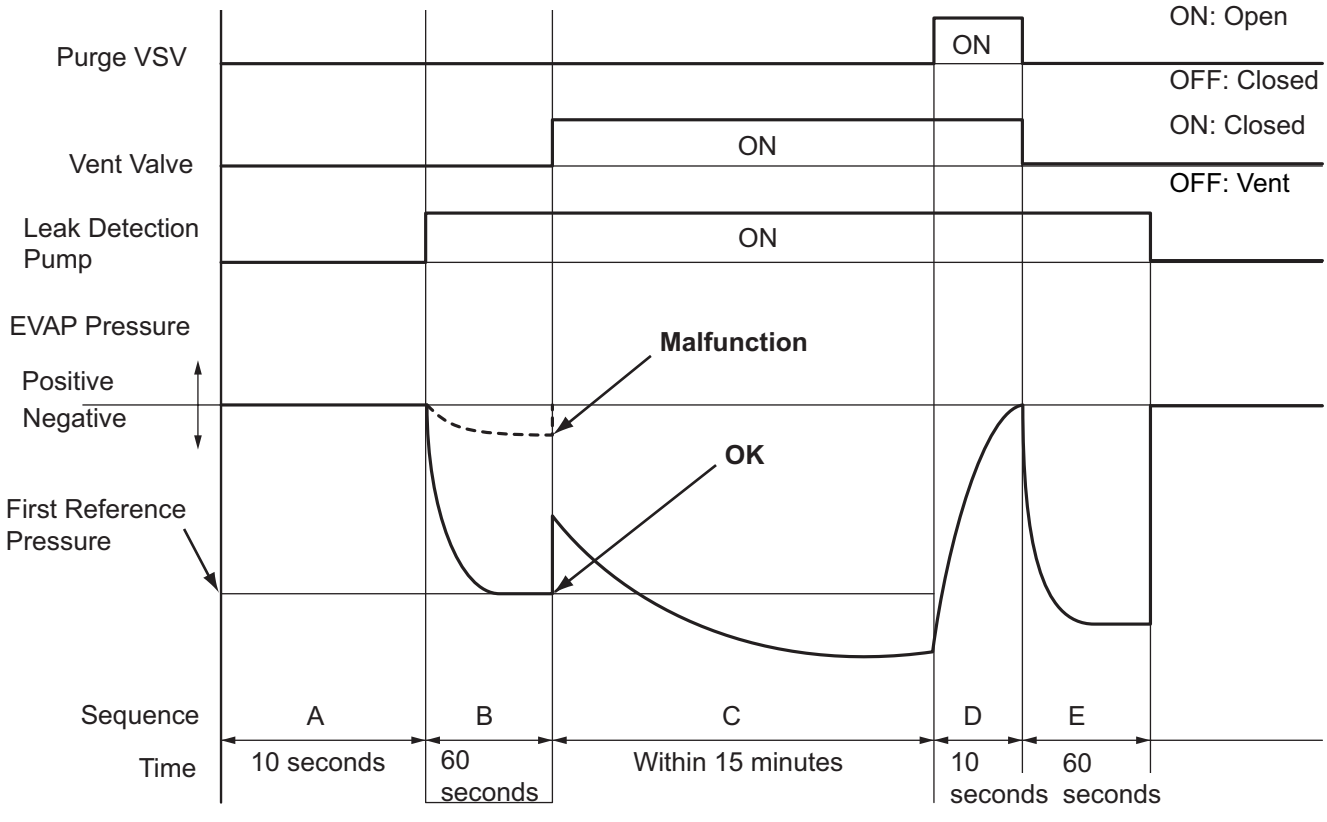
EVAP Pressure when Reference Orifice Clogged:



(b) P043F: Reference orifice high-flow

In operation B, 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 higher than -1.057 kPa-g (-7.93 mmHg-g), the ECM interprets this as a high-flow malfunction in the reference orifice, and stops the EVAP system monitor. The ECM then illuminates the MIL and sets the DTC (2 trip detection logic).

EVAP Pressure when Reference Orifice High-flow Malfunction:



MONITOR STRATEGY

Required Sensors/Components	Canister pump module
Frequency of Operation	Once per driving cycle
Duration	Within 2 minutes
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs not present	None
EVAP key-off monitor runs when all of following conditions met	-
Atmospheric pressure	76 to 110 kPa-a (570 to 825 mmHg-a)
Battery voltage	10.5 V or more
Vehicle speed	Below 2.5 mph (4 km/h)
Ignition switch	OFF
Time after key off	5 or 7 or 9.5 hours
Canister pressure 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 following conditions met before key off	Conditions 1 and 2
1. Duration that vehicle 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)

1. Key-off monitor sequence 1 to 8

1. Atmospheric pressure measurement

Next sequence run if following condition set	-
Atmospheric pressure change	Less than 0.3 kPa-g (2.25 mmHg-g) in 1 second

2. First reference pressure measurement

Next sequence run if all of following conditions set	Condition 1, 2 and 3
1. EVAP pressure just after reference pressure measurement start	-1 kPa-g (-7.5 mmHg-g) or less
2. Reference pressure	-4.85 to -1.057 kPa-g (-36.4 to -7.93 mmHg-g)
3. Reference pressure	Saturated within 60 seconds

3. Vent valve stuck closed check

Next sequence run if following condition set	-
EVAP pressure change after vent valve ON (closed)	0.3 kPa-g (2.25 mmHg-g) or more

4. Vacuum introduction

Next sequence run if following condition set	-
EVAP pressure	Saturated within 15 minutes

5. Purge VSV stuck closed check

Next sequence run if following condition set	-
EVAP pressure change after purge VSV ON (open)	0.3 kPa-g (2.25 mmHg-g) or more

6. Second reference pressure measurement

Next sequence run if all of following conditions set	Condition 1, 2, 3 and 4
1. EVAP pressure just after reference pressure	-1 kPa-g (-7.5 mmHg-g) or less
2. Reference pressure	-4.85 to -1.057 kPa-g (-36.4 to -7.93 mmHg-g)
3. Reference pressure	Saturated within 60 seconds
4. Reference pressure difference between first and second	Less than 0.7 kPa-g (5.25 mmHg-g)

7. Leak check

Next sequence run if following condition set	-
EVAP pressure when vacuum introduction complete	Second reference pressure or less

8. Atmospheric pressure measurement

EVAP monitor complete if following condition set	-
Atmospheric pressure difference between sequence 1 and 8	Within 0.3 kPa-g (2.25 mmHg-g)

TYPICAL MALFUNCTION THRESHOLDS

"Saturated" indicates that the EVAP pressure change is less than 0.286 kPa-g (2.14 mmHg-g) in 60 seconds.

One of following conditions met	-
EVAP pressure just after reference pressure measurement start	More than -1 kPa-g (-7.5 mmHg-g)
Reference pressure	Less than -4.85 kPa-g (-36.4 mmHg-g)
Reference pressure	-1.057 kPa-g (-7.93 mmHg-g) or more
Reference pressure	Not saturated within 60 seconds
Reference pressure difference between first and second	0.7 kPa-g (5.25 mmHg-g) or more

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page ES-17).

DTC	P0441	Evaporative Emission Control System Incorrect Purge Flow

DTC SUMMARY

DTC	Monitoring Items	Malfunction Detection Conditions	Trouble Areas	Detection Timings	Detection Logic
P0441	Purge VSV (Vacuum Switching Valve) stuck open	Leak detection pump creates negative pressure (vacuum) in EVAP system and EVAP system pressure measured. Reference pressure measured at start and at end of leak check. If stabilized pressure higher than [second reference pressure x 0.2], ECM determines that purge VSV stuck open	• Purge VSV • Connector/wire harness (Purge VSV - ECM) • ECM • Canister pump module • Leakage from EVAP system	While ignition switch OFF	2 trip
	Purge VSV stuck closed	After EVAP leak check performed, purge VSV turned ON (open), and atmospheric air introduced into EVAP system. Reference pressure measured at start and at end of check. If pressure does not return to near atmospheric pressure, ECM determines that purge VSV stuck closed	• Purge VSV • Connector/wire harness (Purge VSV - ECM) • ECM • Canister pump module • Leakage from EVAP system	While ignition switch OFF	2 trip
	Purge flow	While engine running, following conditions successively met: • Negative pressure not created in EVAP system when purge VSV turned ON (open) • EVAP system pressure change less than 0.5 kPa-g (3.75 mmHg-g) when vent valve turned ON (closed) • Atmospheric pressure change before and after purge flow monitor less than 0.1 kPa-g (0.75 mmHg-g)	• Purge VSV • Connector/wire harness (Purge VSV - ECM) • Leakage from EVAP line (Purge VSV - Intake manifold) • ECM	While engine running	2 trip

DESCRIPTION

The description can be found in the EVAP (Evaporative Emission) System (See page ES-319).

INSPECTION PROCEDURE

Refer to the EVAP System (See page ES-324).

MONITOR DESCRIPTION

The two monitors, Key-Off and Purge Flow, are used to detect malfunctions relating to DTC P0441. The Key-Off monitor is initiated by the ECM internal timer, known as the soak timer, 5 hours* after the ignition switch is turned to OFF. The purge flow monitor runs while the engine is running.

1. KEY-OFF MONITOR

   5 hours* after the ignition switch is turned to OFF, the leak detection pump creates negative pressure (vacuum) in the EVAP system. The ECM monitors for leaks and actuator malfunctions based on the EVAP pressure.

   HINT:

   *: If the engine coolant temperature is not below 35°C (95°F) 5 hours after the ignition switch is turned to OFF, the monitor check starts 2 hours later. If it is still not below 35°C (95°F) 7 hours after the ignition switch is turned to OFF, the monitor check starts 2.5 hours later.

Sequence	Operations	Descriptions	Duration
-	ECM activation	Activated by soak timer, 5 hours (7 or 9.5 hours) after ignition switch turned to OFF.	-

Sequence	Operations	Descriptions	Duration
A	Atmospheric pressure measurement	Vent valve turned OFF (vent) and EVAP system pressure measured by ECM in order to register atmospheric pressure. If pressure in EVAP system not between 76 kPa-a and 110 kPa-a (570 mmHg-a and 825 mmHg-a), ECM cancels EVAP system monitor.	10 seconds
B	First reference pressure measurement	In order to determine reference pressure, 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
C	EVAP system pressure measurement	Vent valve turned ON (closed) to shut EVAP system. Negative pressure (vacuum) created in EVAP system, and EVAP system pressure then measured. Write down measured value as 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 opened and then EVAP system pressure measured by ECM. Large increase indicates normality.	10 seconds
E	Second reference pressure measurement	After second reference pressure measurement, leak check performed by comparing first and second reference pressure. If stabilized system pressure higher than second reference pressure, ECM determines that EVAP system leaking.	60 seconds
F	Final check	Atmospheric pressure measured and then monitoring result recorded by ECM.	-

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* If only a small amount of fuel is in the fuel tank, it takes longer for the EVAP pressure to stabilize.