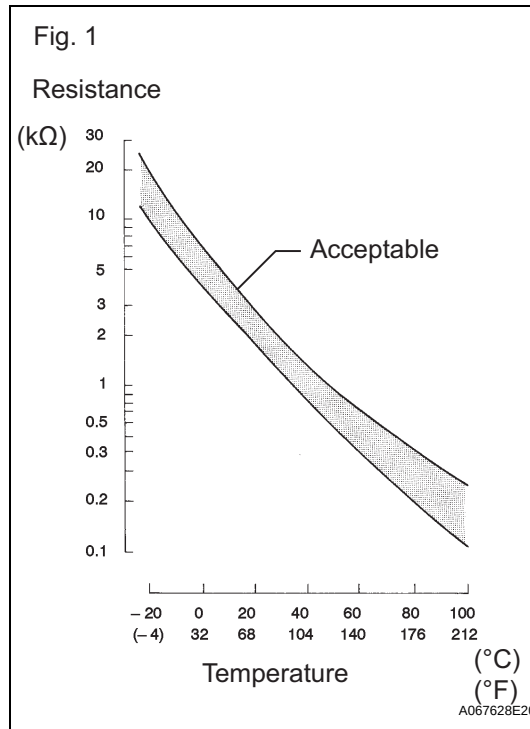


DTC**P0111****Intake Air Temperature Sensor Gradient Too High****DESCRIPTION**

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

The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R. Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

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

MONITOR DESCRIPTION

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

MONITOR STRATEGY

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

ES

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

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	None
--	------

After engine stop:

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

After cold engine start:

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

TYPICAL MALFUNCTION THRESHOLDS

After engine stop:

IAT change	Less than 1°C (2°F)
------------	---------------------

After cold engine start:

IAT change	Less than 1°C (2°F)
------------	---------------------

WIRING DIAGRAM

Refer to DTC P0110 (See page [ES-134](#)).

INSPECTION PROCEDURE

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

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

(e) Read the DTCs.

Result

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

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

B

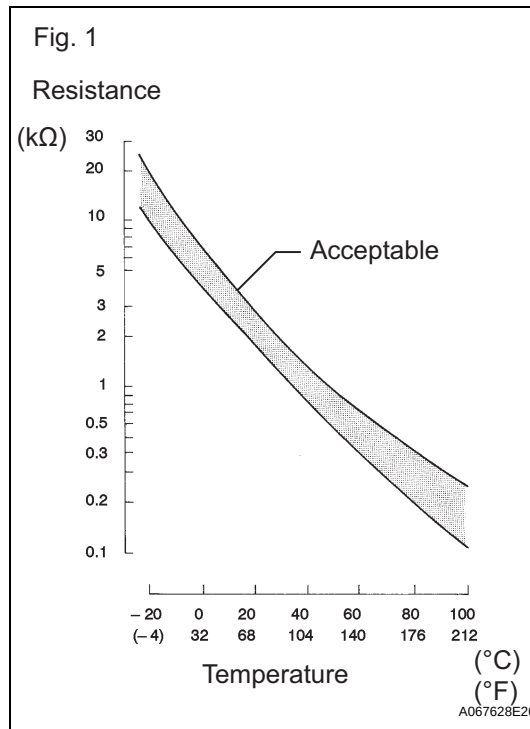
REPLACE MASS AIR FLOW METER (See page [ES-497](#))

A

GO TO DTC CHART (See page [ES-59](#))

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

DESCRIPTION



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

The IAT sensor is powered by a 5 V supply from the THA terminal of the ECM, via resistor R. Resistor R and the IAT sensor are connected in series. When the resistance value of the IAT sensor changes, according to changes in the IAT, the voltage at terminal THA also varies. Based on this signal, the ECM increases the fuel injection volume when the engine is cold to improve driveability.

HINT:

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

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

HINT:

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

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

MONITOR DESCRIPTION

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

Example:

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

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None
--	------

TYPICAL MALFUNCTION THRESHOLDS**P0110:**

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

P0112:

Intake air temperature sensor voltage	Less than 0.18 V
---------------------------------------	------------------

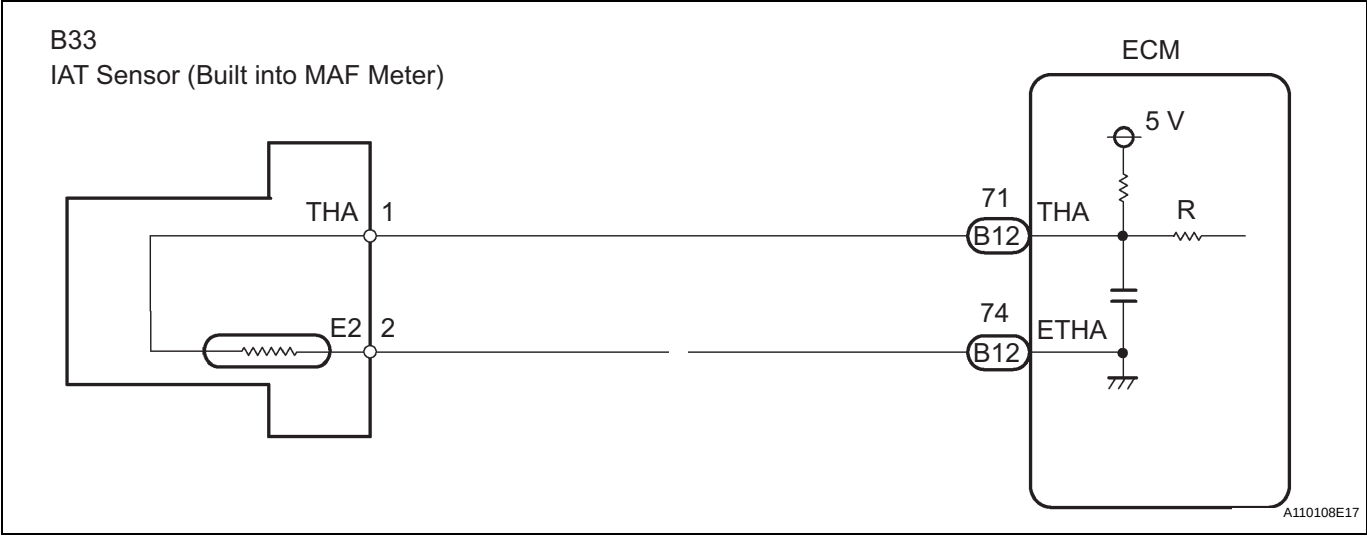
P0113:

Intake air temperature sensor voltage	More than 4.91 V
---------------------------------------	------------------

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



ES

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

1

CHECK DTC OUTPUT

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

Result

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

B

Go to step 6

C

Go to step 4

A

2

READ VALUE OF INTAKE AIR TEMPERATURE SENSOR (INTAKE AIR)

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

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

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

Result

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

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

B

Go to step 5

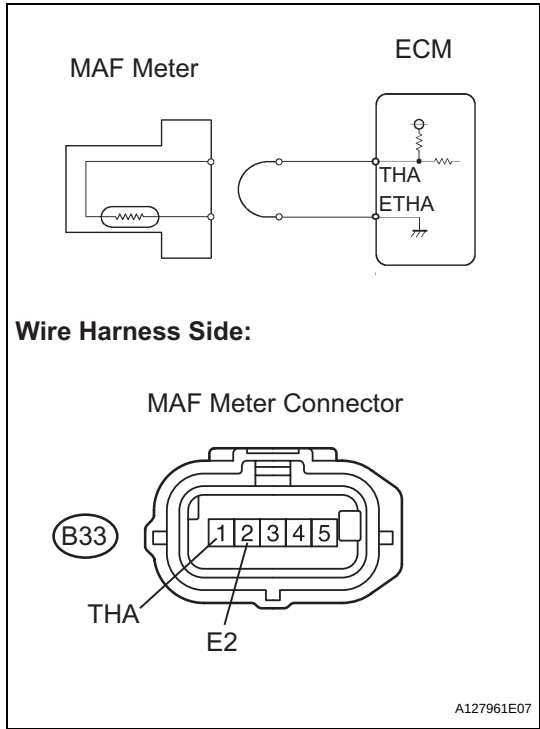
C

CHECK FOR INTERMITTENT PROBLEMS
(See page ES-28)

A

3

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



- (a) Confirm good connection of the Mass Air Flow (MAF) meter.
- (b) Disconnect the B33 MAF meter connector.
- (c) Connect terminals THA and E2 of the MAF meter wire harness side connector.
- (d) Connect the intelligent tester to the DLC3.
- (e) Turn the engine switch on (IG).
- (f) Turn the tester on.
- (g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
- (h) Read the value displayed on the tester.

Standard:
140°C (284°F) or higher

(i) Reconnect the MAF meter connector.

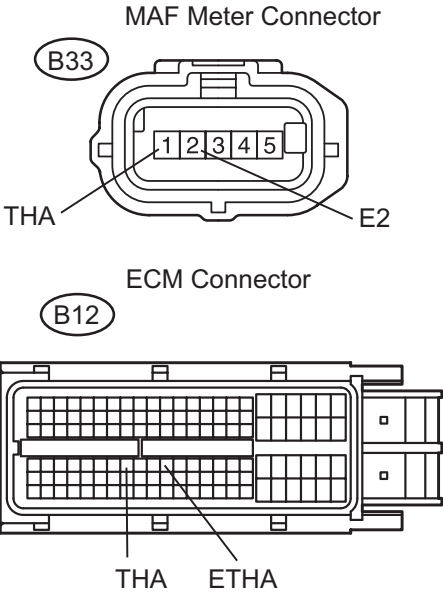
OK

REPLACE MASS AIR FLOW METER (See page ES-497)

NG

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

Wire Harness Side:



- (a) Disconnect the B33 MAF meter connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
THA (B12-71) - THA (B33-1)	Below 1 Ω
ETHA (B12-74) - E2 (B33-2)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
THA (B12-71) or THA (B33-1) - Body ground	10 kΩ or higher
ETHA (B12-74) or E2 (B33-2) - Body ground	10 kΩ or higher

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

NG

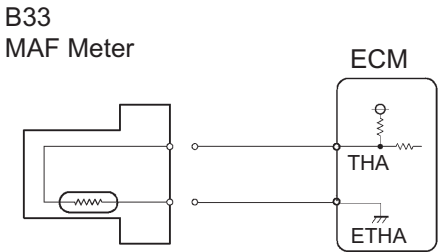
REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

ES

REPLACE ECM (See page ES-543)

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



- (a) Disconnect the B33 MAF meter connector.
- (b) Connect the intelligent tester to the DLC3.
- (c) Turn the engine switch on (IG).
- (d) Turn the tester on.
- (e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / INTAKE AIR.
- (f) Read the value displayed on the tester.

Standard:

-40°C (-40°F) or higher

- (g) Reconnect the MAF meter connector.

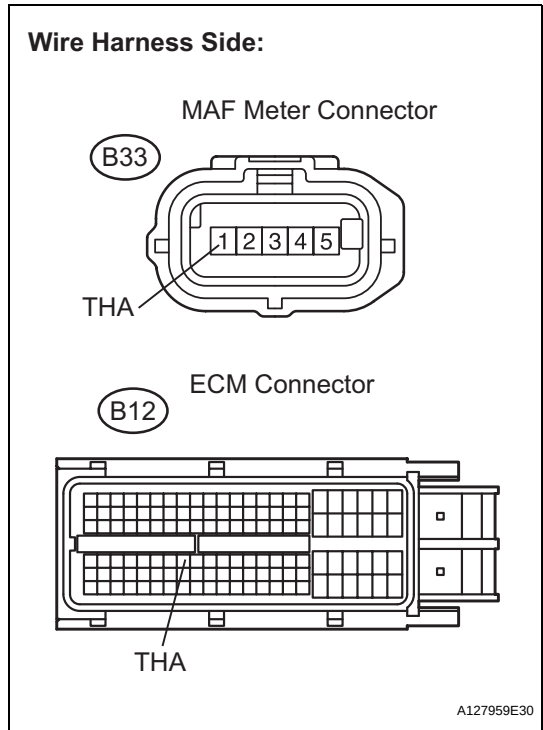
OK

REPLACE MASS AIR FLOW METER (See page ES-497)

NG

6

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



- (a) Disconnect the B33 MAF meter connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Specified Condition
THA (B12-71) or THA (B33-1) - Body ground	10 kΩ or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (See page [ES-543](#))

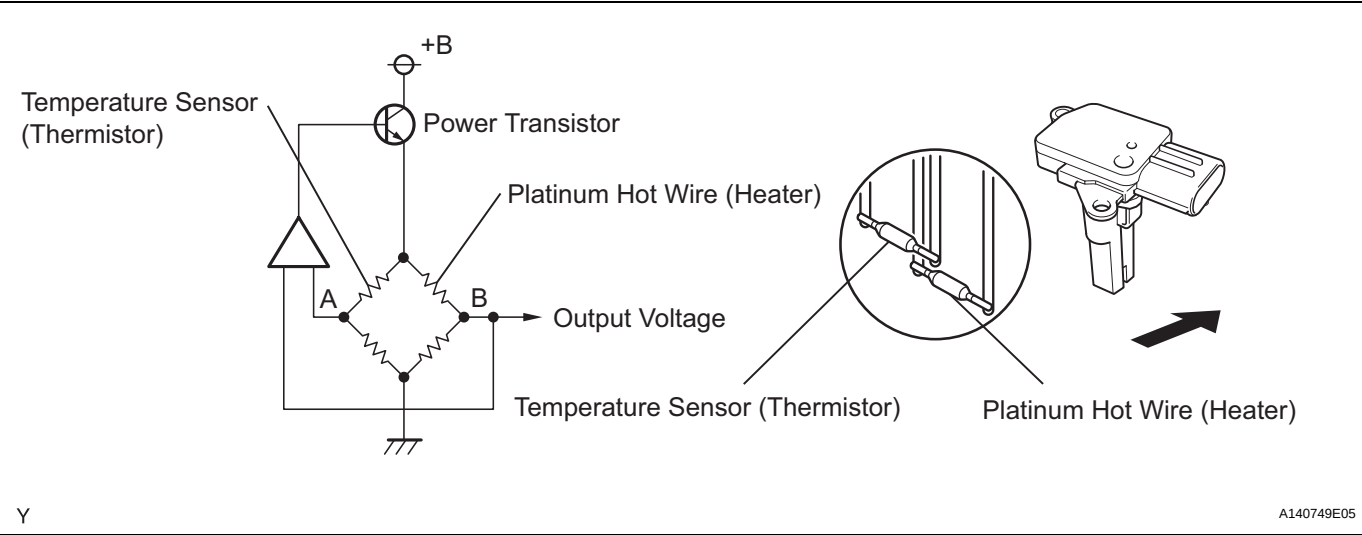
DTC	P0101	Mass Air Flow Circuit Range / Performance Problem
-----	-------	---

DESCRIPTION

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

The circuit is constructed so that the platinum hot wire and the temperature sensor provide a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.

HINT:
When any of these DTCs are set, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine RPM and throttle valve position. Fail-safe mode continues until a pass condition is detected.



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

MONITOR DESCRIPTION

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

Example:

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

ES

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

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

WIRING DIAGRAM

Refer to DTC P0100 (See page [ES-123](#)).

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

1

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

ES

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

Result

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

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



B

REPLACE MASS AIR FLOW METER (See page [ES-497](#))

GO TO DTC CHART (See page [ES-59](#))

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

DESCRIPTION

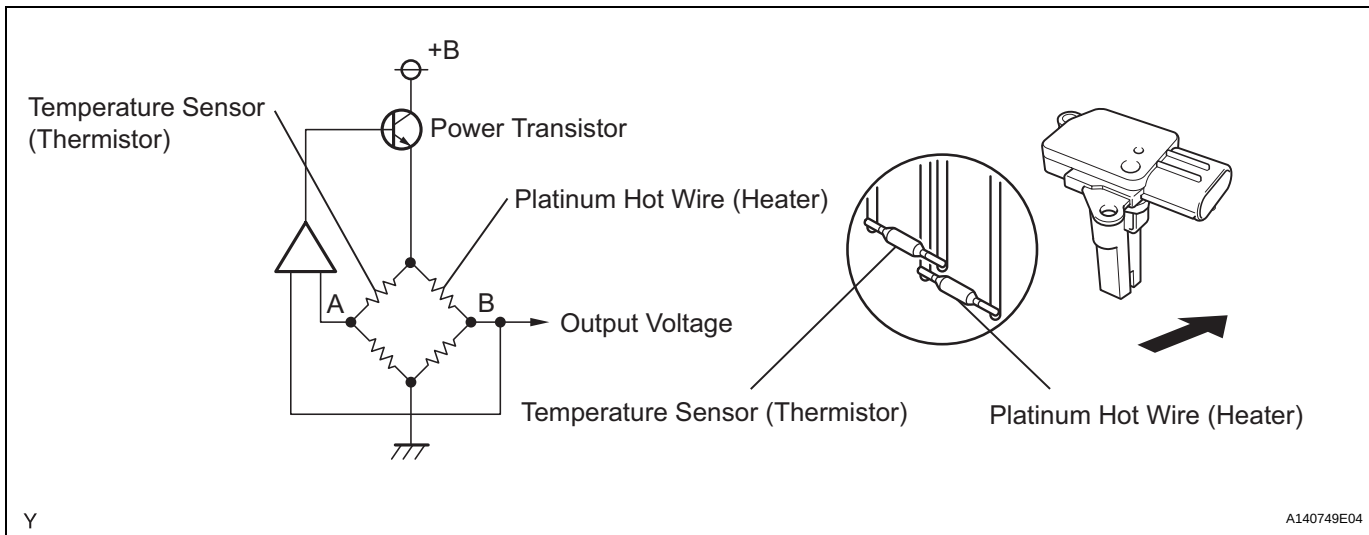
The Mass Air Flow (MAF) meter is a sensor that measures the amount of air flowing through the valve. The ECM uses this information to determine the fuel injection time and to provide appropriate air-fuel ratio. Inside the MAF meter, there is a heated platinum wire which is exposed to the flow of intake air.

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

The circuit is constructed so that the platinum hot wire and the temperature sensor provide a bridge circuit, and the power transistor is controlled so that the potentials of A and B remain equal to maintain the predetermined temperature.

HINT:

When any of these DTCs are set, the ECM enters fail-safe mode. During fail-safe mode, the ignition timing is calculated by the ECM, according to the engine RPM and throttle valve position. Fail-safe mode continues until a pass condition is detected.



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

HINT:

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

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

MONITOR DESCRIPTION

If there is a defect in the MAF meter or an open or short circuit, the voltage level deviates from the normal operating range. The ECM interprets this deviation as a malfunction in the MAF meter and sets a DTC.

Example:

When the sensor output voltage remains less than 0.2 V, or more than 4.9 V, for more than 3 seconds, the ECM sets a DTC.

If the malfunction is not repaired successfully, a DTC is set 3 seconds after the engine is next started.

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

Monitor runs whenever following DTCs are not present	None
--	------

TYPICAL MALFUNCTION THRESHOLDS**P0100:**

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

P0102:

Mass air flow meter voltage	Less than 0.2 V
-----------------------------	-----------------

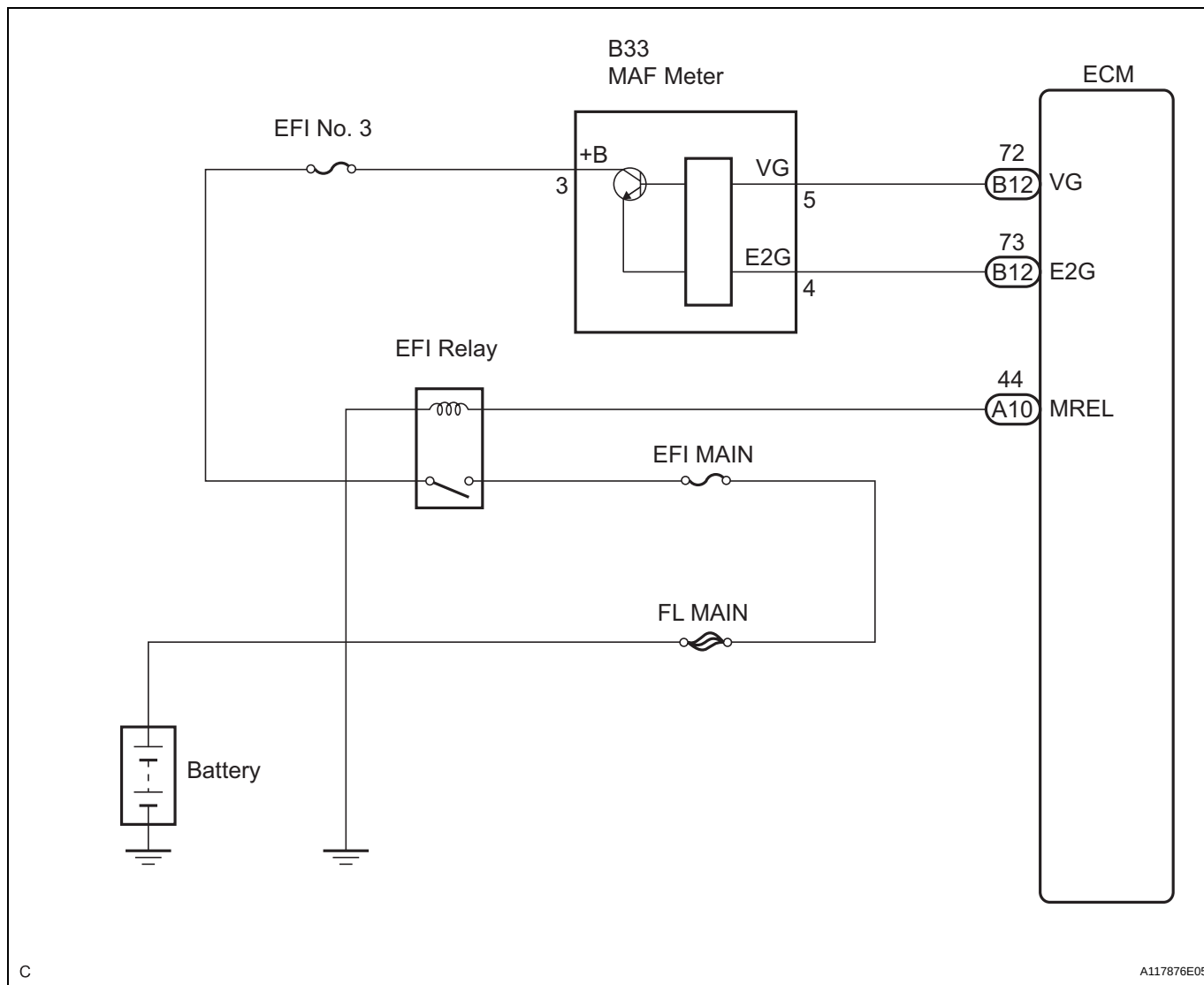
P0103:

Mass air flow meter voltage	More than 4.9 V
-----------------------------	-----------------

COMPONENT OPERATING RANGE

Mass air flow meter voltage	Between 0.4 V and 2.2 V
-----------------------------	-------------------------

WIRING DIAGRAM



C

A117876E05

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

1

READ VALUE OF MASS AIR FLOW METER (MAF)

- Connect the intelligent tester to the DLC3.
- Start the engine.
- Turn the tester on.
- Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF.
- Read the values displayed on the tester.

Result

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

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

B

Go to step 8

C

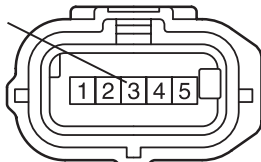
CHECK FOR INTERMITTENT PROBLEMS
(See page [ES-28](#))

A

ES

2**INSPECT MASS AIR FLOW METER (POWER SOURCE VOLTAGE)****Wire Harness Side Front View:**

+B (+)



B33 MAF Meter Connector

P

A127724E18

- Disconnect the B33 mass air flow (MAF) meter connector.
- Turn the engine switch on (IG).
- Measure the voltage according to the value(s) in the table below.

Standard voltage

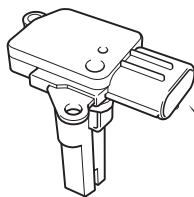
Tester Connection	Specified Condition
+B (B33-3) - Body ground	9 to 14 V

- Reconnect the MAF meter connector.

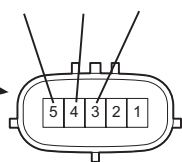
NG

Go to step 5

OK

3**INSPECT MASS AIR FLOW METER (VG VOLTAGE)****MAF Meter**

VG E2G +B



Y

A127786E02

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

Standard voltage

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

NG

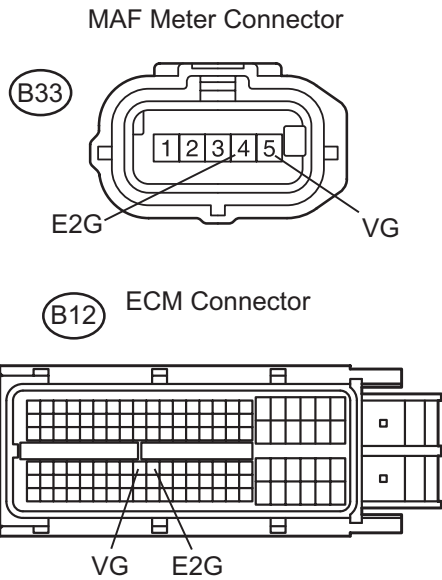
REPLACE MASS AIR FLOW METER

OK

4

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

Wire Harness Side:



- (a) Disconnect the B33 MAF meter connector.
 - (b) Disconnect the B12 ECM connector.
 - (c) Measure the resistance between the terminals.
- Standard resistance (Check for open)**

Tester Connection	Specified Condition
VG (B12-72) - VG (B33-5)	Below 1 Ω
E2G (B12-73) - E2G (B33-4)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VG (B12-72) or VG (B33-5) - Body ground	10 kΩ or higher
E2G (B12-73) or E2G (B33-4) - Body ground	10 kΩ or higher

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

NG

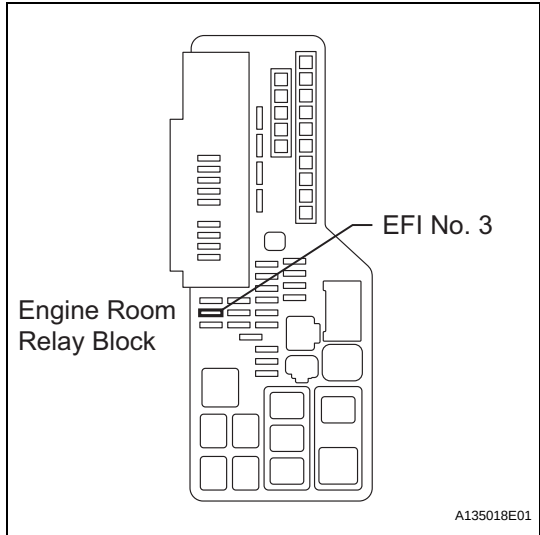
REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM

5

INSPECT FUSE (EFI NO. 3)



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

NG

REPLACE EFI NO. 3 FUSE

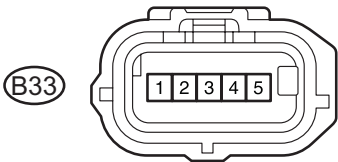
OK

6

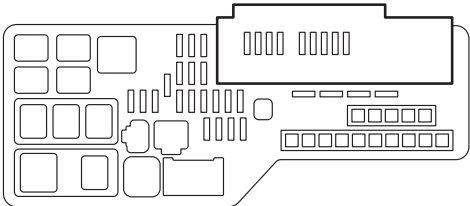
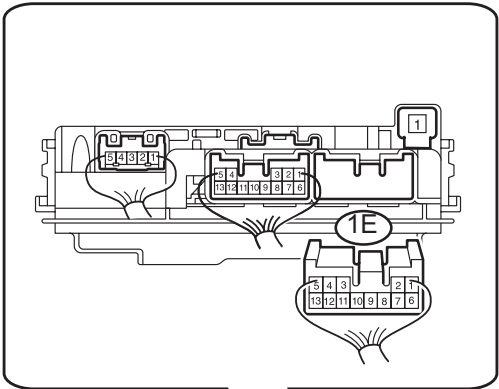
CHECK HARNESS AND CONNECTOR (MASS AIR FLOW METER - ENGINE ROOM JUNCTION BLOCK)

Wire Harness Side:

MAF Meter Connector



Engine Room Junction Block



Engine Room Relay Block

A140657E02

- (a) Disconnect the B33 MAF meter connector.
- (b) Remove the engine room junction block from the engine room R/B.
- (c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
+B (B33-3) - 1E-6 (Engine room R/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
+B (B33-3) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher

- (d) Reinstall the engine room junction block.
- (e) Reconnect the B33 MAF meter connector.

NG

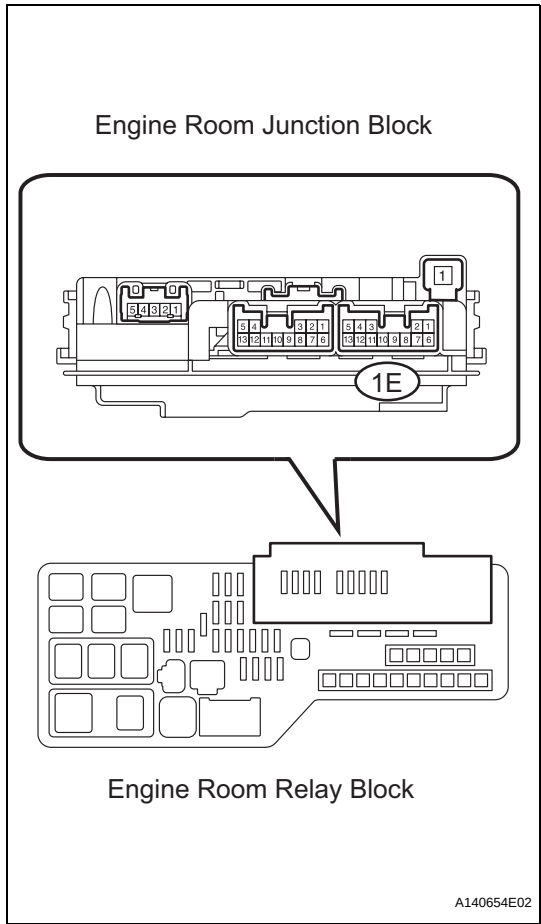
REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

ES

7

INSPECT ENGINE ROOM JUNCTION BLOCK (EFI RELAY)



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

Standard resistance

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

- (c) Reinstall the engine room junction block.

NG

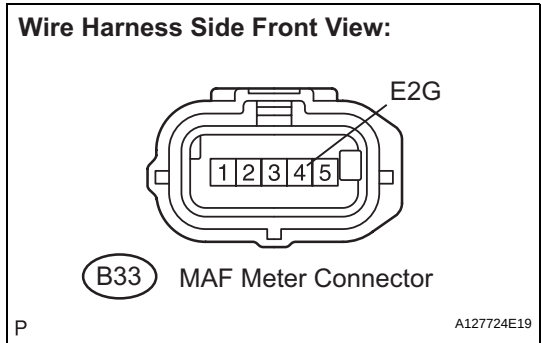
REPLACE ENGINE ROOM JUNCTION BLOCK

OK

CHECK ECM POWER SOURCE CIRCUIT (See page ES-427)

8

CHECK HARNESS AND CONNECTOR (SENSOR GROUND)



- (a) Disconnect the B33 MAF meter connector.
- (b) Measure the resistance between the terminals.

Standard resistance

Tester Connection	Specified Condition
E2G (B33-4) - Body ground	Bellow 1 Ω

- (c) Reconnect the MAF meter connector.

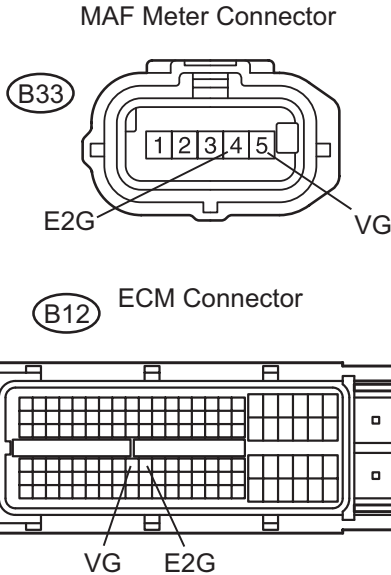
OK

REPLACE MASS AIR FLOW METER (See page ES-497)

NG

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

Wire Harness Side:



- (a) Disconnect the B33 MAF meter connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
VG (B12-72) - VG (B33-5)	Below 1 Ω
E2G (B12-73) - E2G (B33-4)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VG (B12-72) or VG (B33-5) - Body ground	10 k Ω or higher
E2G (B12-73) or E2G (B33-4) - Body ground	10 k Ω or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

ES

REPLACE ECM (See page ES-543)

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

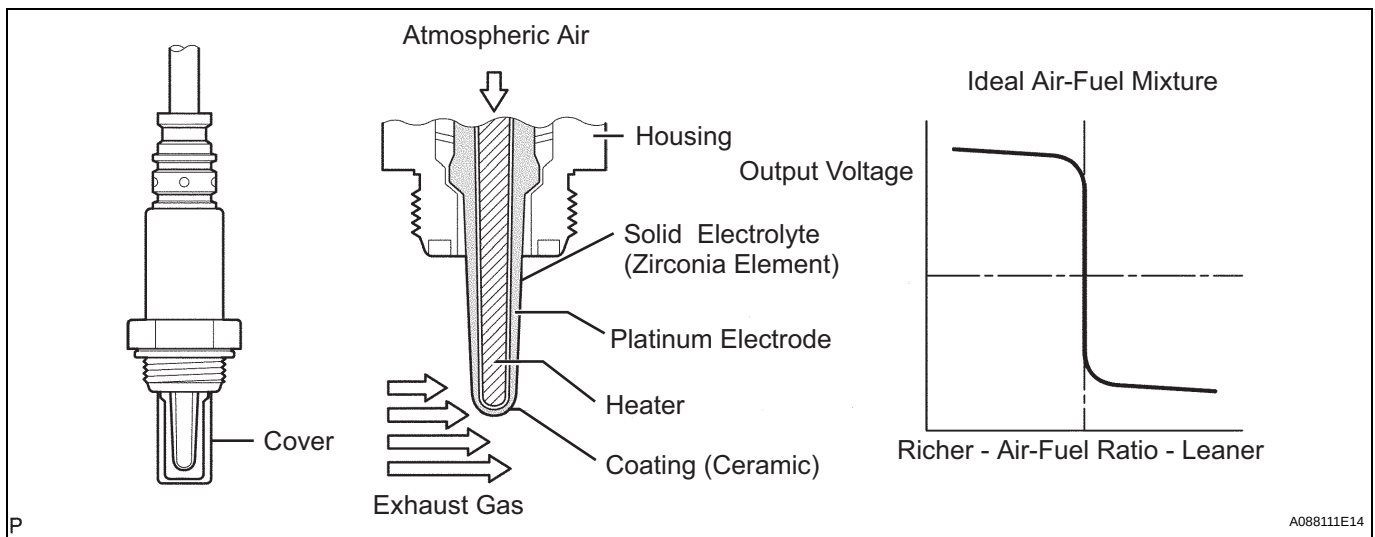
DESCRIPTION

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

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

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

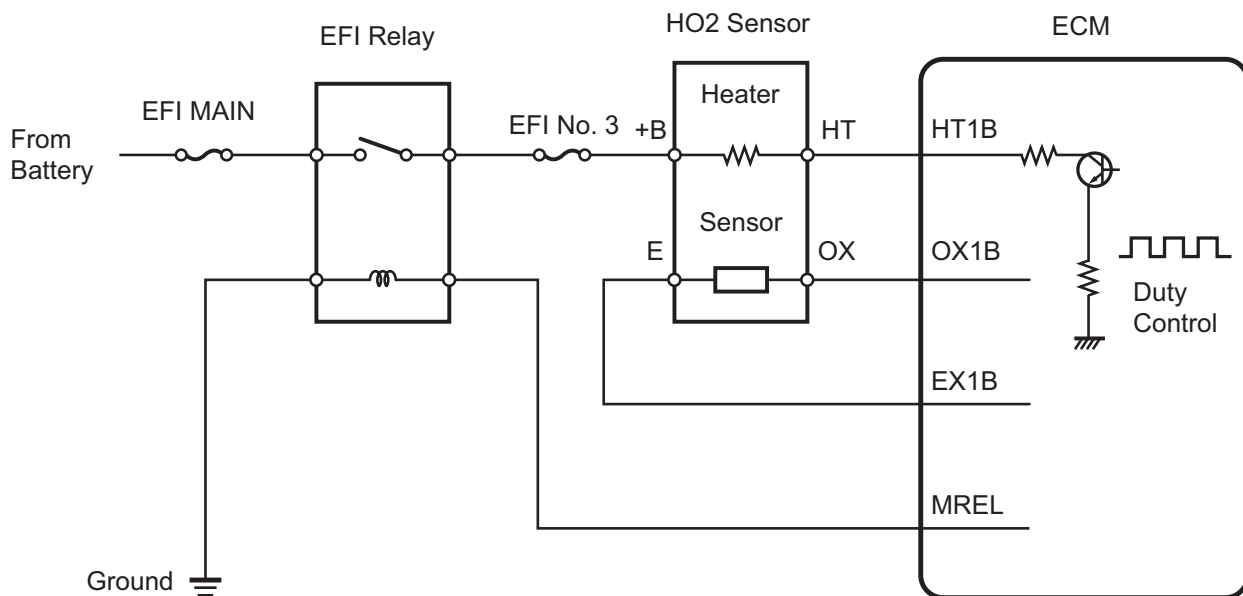
The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations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



HINT:

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

Reference (System Diagram of Bank 1 Sensor 2):



DTC No.	DTC Detection Condition	Trouble Area
P0037 P0057	Heated Oxygen (HO2) sensor heater current is less than 0.3 A (1 trip detection logic)	• Open in HO2 sensor heater circuit • HO2 sensor heater • Engine room junction block (EFI relay) • ECM
P0038 P0058	Heated Oxygen (HO2) sensor heater current is more than 3.5 A (1 trip detection logic)	• Short in HO2 sensor heater circuit • HO2 sensor heater • Engine room junction block (EFI relay) • ECM

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

HINT:

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

MONITOR DESCRIPTION

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

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

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

Example:

The ECM sets DTC P0038 or P0058 when the current in the HO2 sensor heater is more than 2 A.

Conversely, when the heater current is less than 0.3 A, DTC P0037 or P0057 is set.

Heated oxygen sensor heater performance (P0141 and P0161):

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS**All:**

Monitor runs whenever following DTCs are not present	None
--	------

P0037 and P0057:

Battery voltage	10.5 to 20 V
-----------------	--------------

P0038 and P0058 (Case 1):

Battery voltage	10.5 V or more
Engine	Running
Starter	OFF

P0038 and P0058 (Case 2):

Battery voltage	10.5 to 20 V
-----------------	--------------

P0141 and P0161:

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

ES

TYPICAL MALFUNCTION THRESHOLDS**P0037 and P0057:**

Heater current	Less than 0.3 A
----------------	-----------------

P0038 and P0058:

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

P0141 and P0161 (Heater performance monitor check):

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

COMPONENT OPERATING RANGE

Heated Oxygen (HO ₂) sensor heater current	0.4 to 1 A (when engine idles, HO ₂ sensor warmed up and battery voltage 11 to 14 V)
--	---

MONITOR RESULT

Refer to CHECKING MONITOR STATUS (See page [ES-20](#)).

WIRING DIAGRAM

Refer to DTC P0136 (See page [ES-174](#)).

INSPECTION PROCEDURE**HINT:**

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

ES

1

INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)

Component Side:

Heated Oxygen Sensor

B24

Bank 1

+B

2

1

4

3

E

HT

OX

B25

Bank 2

+B

2

1

4

3

E

HT

OX

A137614E12

- (a)
- Disconnect the B24 heated oxygen sensor connector (Bank 1 Sensor 2) or B25 heated oxygen sensor connector (Bank 2 Sensor 2).
- (b)
- Measure the resistance according to the value(s) in the table below.

Standard resistance (Bank 1 sensor 2)

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

Standard resistance (Bank 2 sensor 2)

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

- (c)
- Reconnect the HO2 sensor connector.

NG

REPLACE HEATED OXYGEN SENSOR (See page EC-21)

OK

2

CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)

Wire Harness Side:

Heated Oxygen Sensor Connector

B24

Bank 1

+B

1

2

3

4

B25

Bank 2

+B

1

2

3

4

A137619E03

- (a)
- Disconnect the B24 heated oxygen sensor connector (Bank 1 Sensor 2) or B25 heated oxygen sensor connector (Bank 2 Sensor 2).
- (b)
- Turn the engine switch on (IG).
- (c)
- Measure the voltage between the terminals.

Standard voltage

Tester Connection	Specified Condition
+B (B24-2) - Body ground	9 to 11 V
+B (B25-2) - Body ground	9 to 11 V

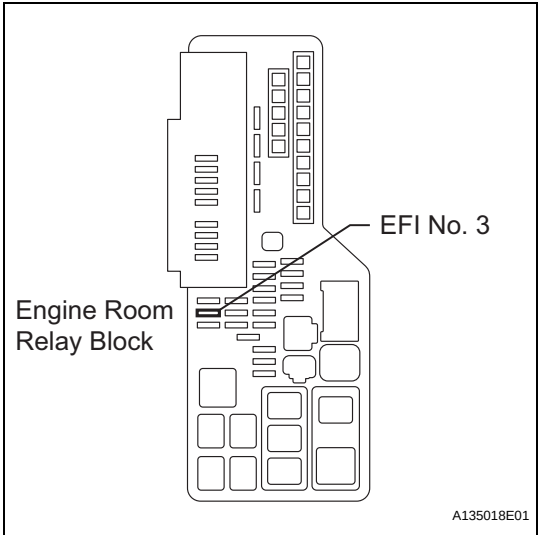
- (d)
- Reconnect the HO2 sensor connector.

OK

Go to step 7

NG

3 INSPECT FUSE (EFI NO. 3)



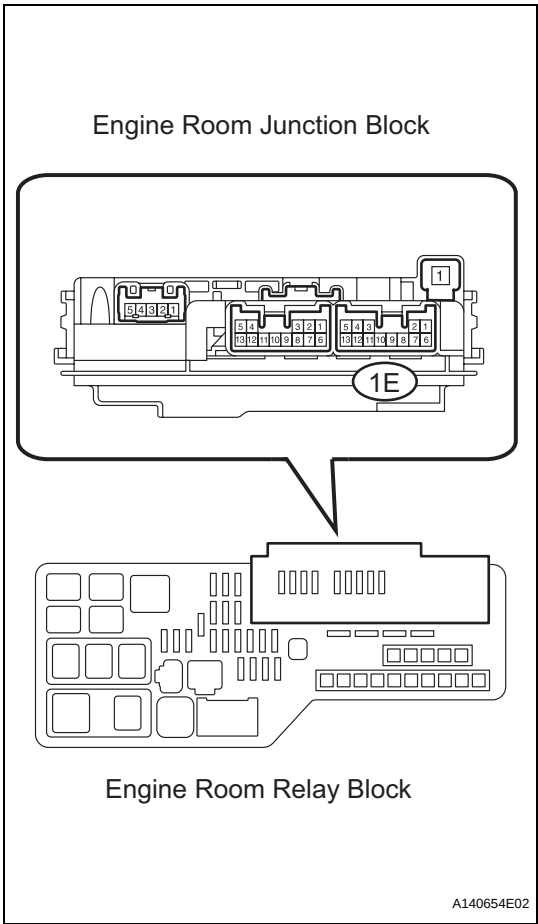
- (a) Remove the EFI No. 3 fuse from the engine room R/B.
- (b) Measure the EFI No. 3 fuse resistance.
Standard resistance:
Below 1 Ω
- (c) Reinstall the EFI No. 3 fuse.

NG

REPLACE EFI NO. 3 FUSE

OK

4 INSPECT ENGINE ROOM JUNCTION BLOCK



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

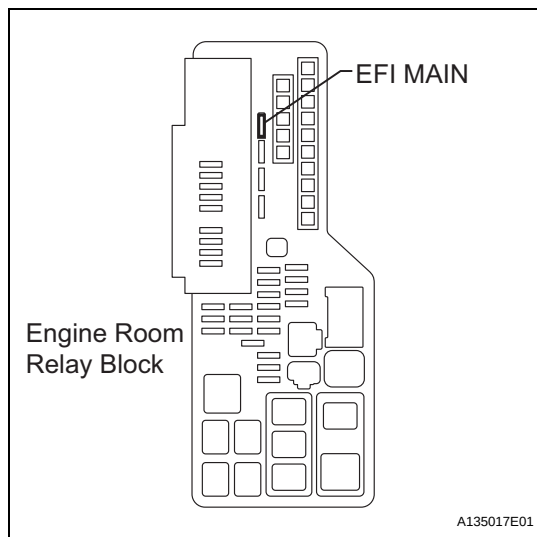
Tester Connection	Specified Condition
1E-12 - 1E-6	10 k Ω or higher
1E-12 - 1E-6	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

NG

REPLACE ENGINE ROOM JUNCTION BLOCK

OK

ES

5 INSPECT FUSE (EFI MAIN)

- (a) Remove the EFI MAIN fuse from the engine room R/B.
- (b) Measure the EFI MAIN fuse.

Standard resistance:

Below 1 Ω

- (c) Reinstall the EFI MAIN fuse.

NG

REPLACE EFI MAIN FUSE

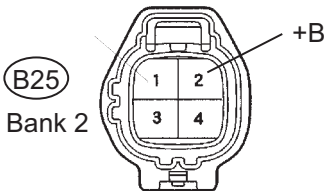
OK

ES

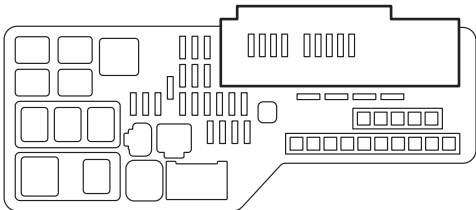
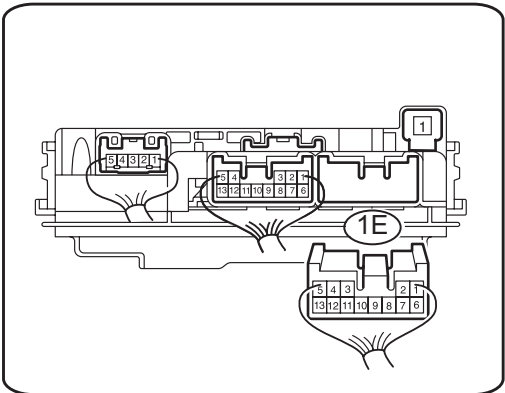
6 CHECK HARNESS AND CONNECTOR (HO2 SENSOR - EFI RELAY)

Wire Harness Side:

Heated Oxygen Sensor Connector



Engine Room Junction Block



Engine Room Relay Block

A140656E03

- (a) Disconnect the B24 or B25 HO2 sensor connector.
- (b) Remove the engine room junction block from the engine room R/B.
- (c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
+B (B24-2) - 1E-6 (Engine room R/B)	Below 1 Ω
+B (B25-2) - 1E-6 (Engine room R/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
+B (B24-2) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher
+B (B25-2) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

CHECK ECM POWER SOURCE CIRCUIT

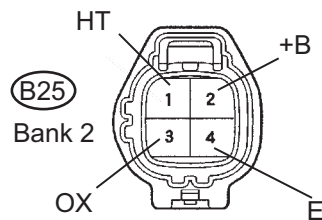
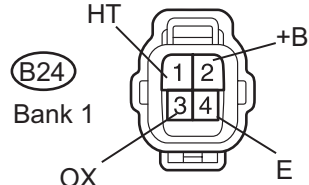
ES

7

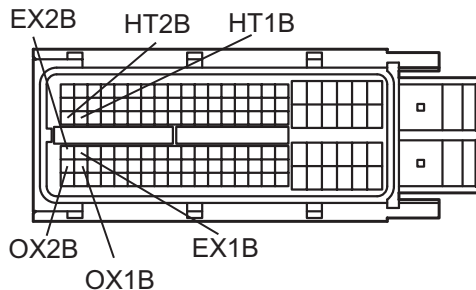
CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)

Wire Harness Side:

Heated Oxygen Sensor Connector



B12 ECM Connector



A137615E14

- Disconnect the B24 heated oxygen sensor connector (Bank 1 Sensor 2) or B25 heated oxygen sensor connector (Bank 2 Sensor 2).
- Turn the engine switch on (IG).
- Measure the voltage according to the value(s) in the table below.

Standard voltage

Terminal Connection	Specified Condition
+B (B24-2) - Body ground	9 to 14 V
+B (B25-2) - Body ground	9 to 14 V

- Turn the engine switch off.
- Disconnect the B12 ECM connector.
- Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Terminal Connection	Specified Condition
HT (B24-1) - HT1B (B12-48)	Below 1 Ω
OX (B24-3) - OX1B (B12-88)	Below 1 Ω
E (B24-4) - EX1B (B12-65)	Below 1 Ω
HT (B25-1) - HT2B (B12-47)	Below 1 Ω
OX (B25-3) - OX2B (B12-87)	Below 1 Ω
E (B25-4) - EX2B (B12-64)	Below 1 Ω

Standard resistance (Check for short)

Terminal Connection	Specified Condition
HT (B24-1) or HT1B (B12-48) - Body ground	10 k Ω or higher
OX (B24-3) or OX1B (B12-88) - Body ground	10 k Ω or higher
E (B24-4) or EX1B (B12-65) - Body ground	10 k Ω or higher
HT (B25-1) or HT2B (B12-47) - Body ground	10 k Ω or higher
OX (B25-3) or OX2B (B12-87) - Body ground	10 k Ω or higher
E (B25-4) or EX2B (B12-64) - Body ground	10 k Ω or higher

- Reconnect the HO2 sensor connector.
- Reconnect the ECM connector.

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

8

CHECK WHETHER DTC OUTPUT RECURS

- Connect the intelligent tester to the DLC3.
- Turn the engine switch on (IG).
- Turn the intelligent tester on.
- Clear the DTCs (See page ES-41).
- Start the engine.
- Allow the engine to idle for 2 minutes.

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

Result

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

B

REPLACE ECM (See page [ES-543](#))

A

CHECK FOR INTERMITTENT PROBLEMS (See page [ES-28](#))

DTC	P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)
DTC	P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)
DTC	P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)
DTC	P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

DESCRIPTION

HINT:

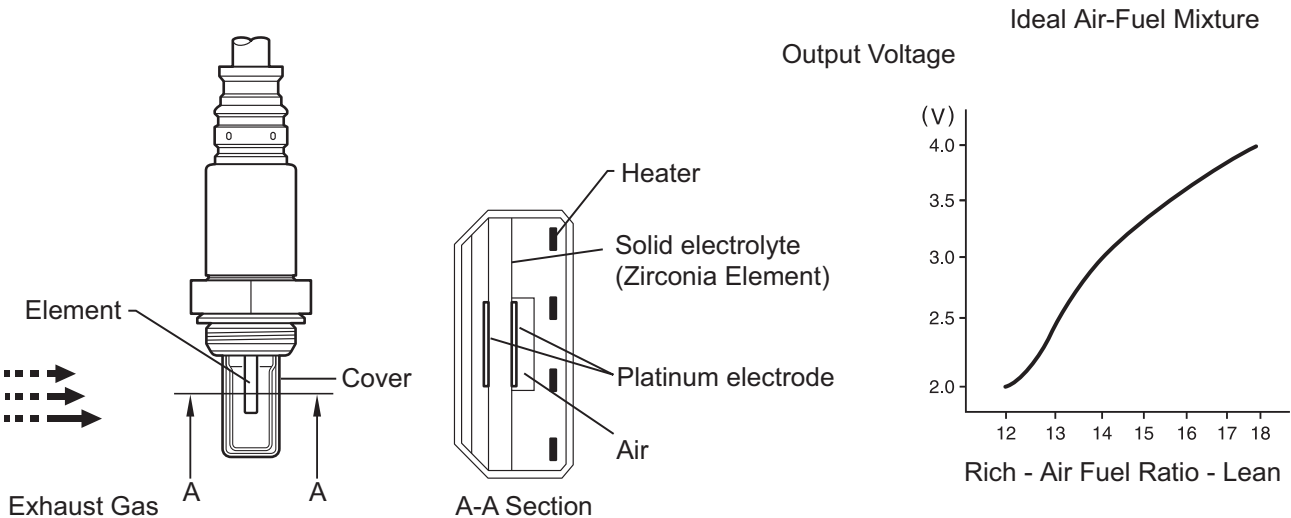
- Although the DTC titles include oxygen sensor, these DTCs relate to the Air-Fuel Ratio (A/F) sensor.
- Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.

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

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

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

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

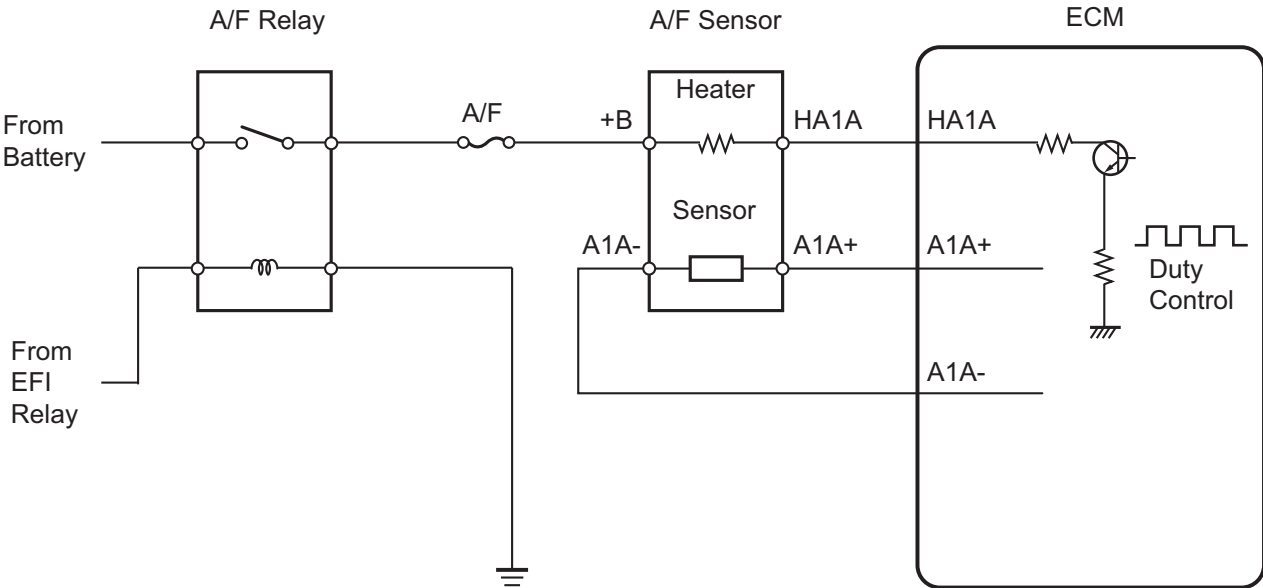


A107164E19

HINT:

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

Reference (System Diagram of Bank 1 Sensor 1):



A133850E10

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

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

HINT:

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

MONITOR DESCRIPTION**ES**

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

Example:

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS**All:**

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

P0031 and P0051:

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

Time after engine start	10 seconds or more
-------------------------	--------------------

P0032 and P0052:

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

TYPICAL MALFUNCTION THRESHOLDS**P0031 and P0051:**

A/F sensor heater current	Less than 0.8 A
---------------------------	-----------------

P0032 and P0052:

Hybrid IC high current limiter port	Fail
-------------------------------------	------

ES**COMPONENT OPERATING RANGE****P0031 and P0051:**

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

WIRING DIAGRAM

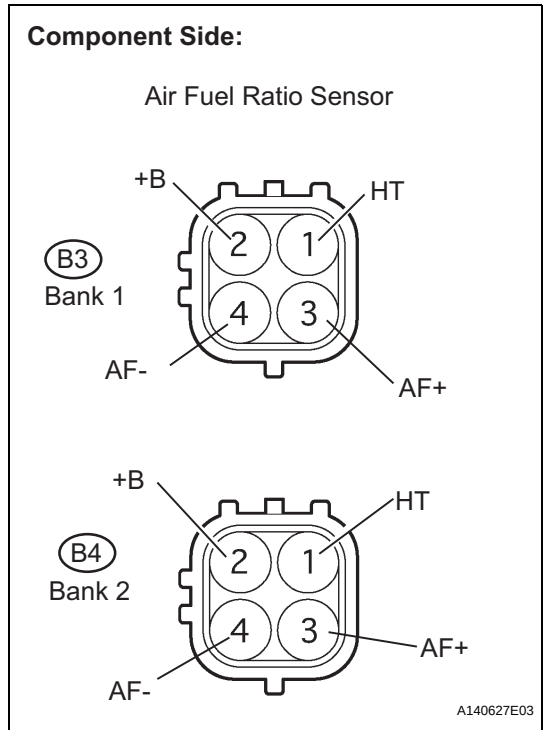
Refer to DTC P2195 (See page [ES-353](#)).

INSPECTION PROCEDURE**HINT:**

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

ES

1 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



- (a) Disconnect the B3 or B4 A/F sensor connector.
- (b) Measure the resistance according to the value(s) in the table below.

Standard resistance (Bank 1 sensor 1)

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

Standard resistance (Bank 2 sensor 1)

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

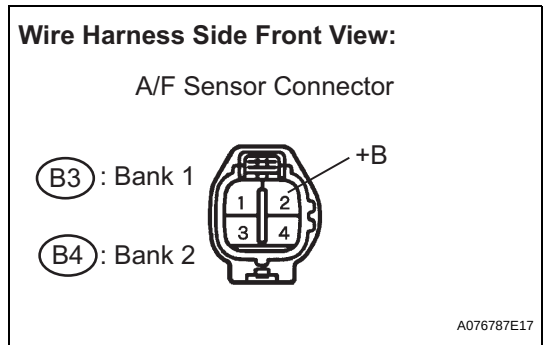
- (c) Reconnect the A/F sensor connector.

NG

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

OK

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



- (a) Disconnect the B3 or B4 A/F sensor connector.
- (b) Turn the engine switch on (IG).
- (c) Measure the voltage between the terminals of the A/F sensor connector and body ground.

Standard voltage

Tester Connection	Specified Condition
+B (B3-2) - Body ground	9 to 14 V
+B (B4-2) - Body ground	9 to 14 V

OK

Go to step 7

NG

3 INSPECT FUSE (A/F)

- (a) Remove the A/F sensor fuse from the engine room junction block.
- (b) Measure the A/F sensor fuse resistance.

Standard resistance:

Below 1 Ω

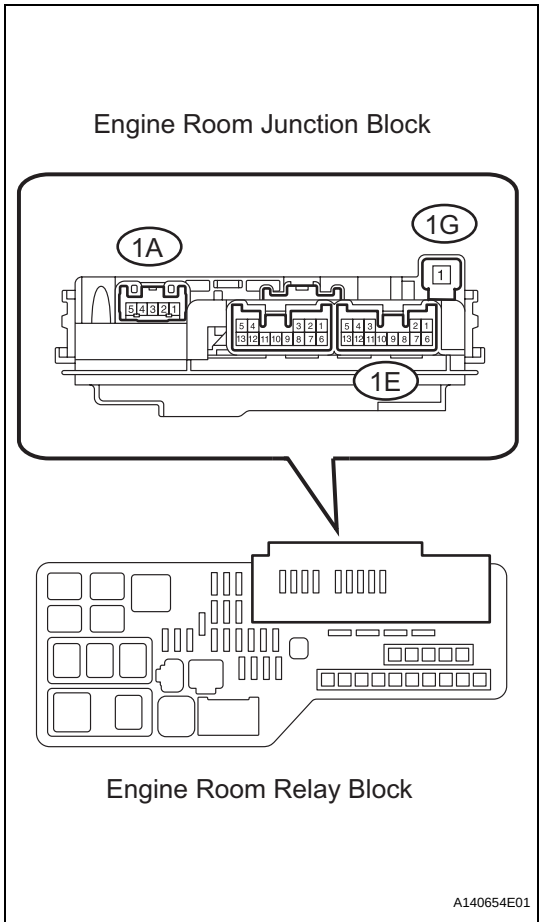
- (c) Reinstall the A/F fuse.

NG

REPLACE A/F FUSE

OK

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



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

Standard resistance

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

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

Standard resistance

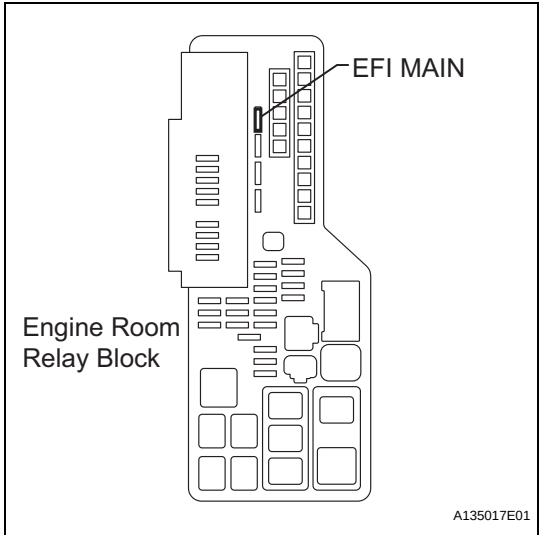
Tester Connection	Specified Condition
1G-1 - 1A-4	10 kΩ or higher
1G-1 - 1A-4	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

NG

REPLACE ENGINE ROOM JUNCTION BLOCK

OK

5 INSPECT FUSE (EFI MAIN)



- (a) Remove the EFI MAIN fuse from the engine room R/B.
- (b) Measure the EFI MAIN fuse resistance.

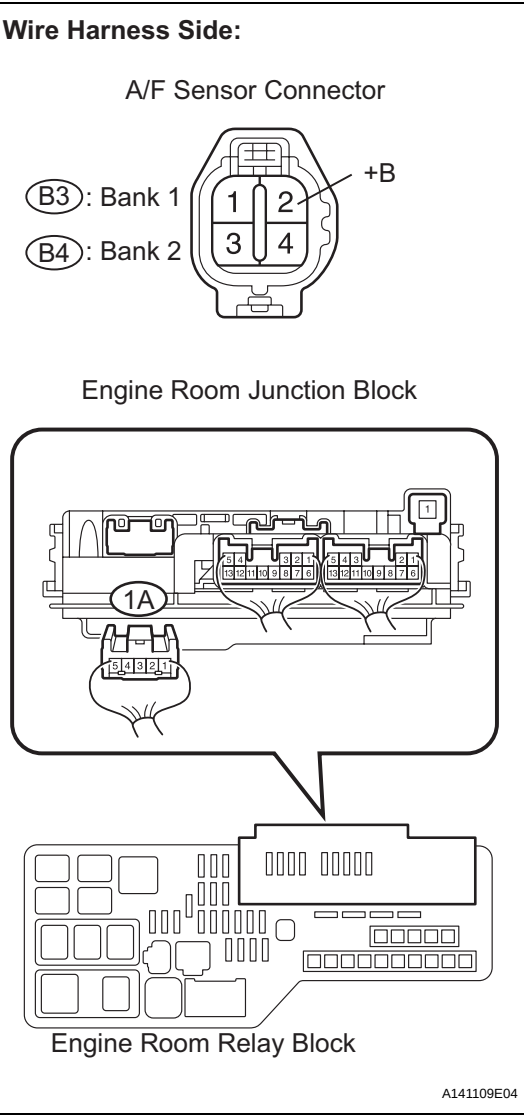
Standard resistance:
Below 1 Ω
- (c) Reinstall the EFI MAIN fuse.

NG

REPLACE EFI MAIN FUSE

OK

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



- (a) Disconnect the B3 or B4 A/F sensor connector.
 - (b) Remove the engine room junction block from the engine room R/B.
 - (c) Measure the resistance between the terminals.
- Standard resistance (Check for open)**

Tester Connection	Specified Condition
+B (B3-2) - 1A-4 (Engine room R/B)	Below 1 Ω
+B (B4-2) - 1A-4 (Engine room R/B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
+B (B3-2) or 1A-4 (Engine room R/B) - Body ground	10 kΩ or higher
+B (B4-2) or 1A-4 (Engine room R/B) - Body ground	10 kΩ or higher

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

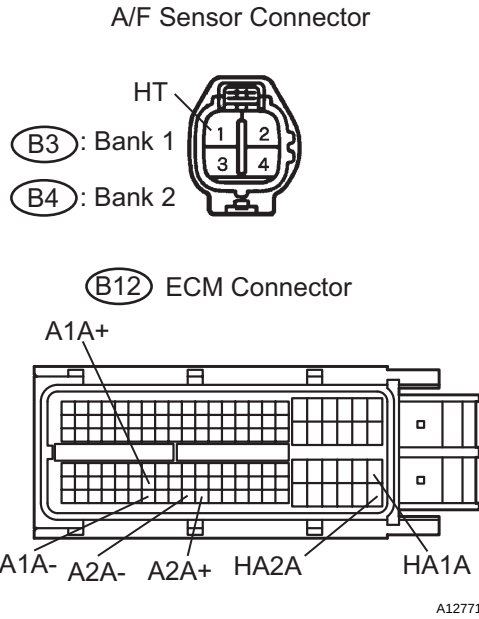
NG **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

CHECK ECM POWER SOURCE CIRCUIT (See page ES-427)

7 CHECK HARNESS AND CONNECTOR

Wire Harness Side:



- (a) Disconnect the B3 or B4 A/F sensor connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
HA1A (B12-86) - HT (B3-1)	Below 1 Ω
HA2A (B12-109) - HT (B4-1)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
HA1A (B12-86) or HT (B3-1) - Body ground	10 kΩ or higher
HA2A (B12-109) or HT (B4-1) - Body ground	10 kΩ or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

8 CHECK WHETHER DTC OUTPUT RECURS

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG).
- (c) Turn the intelligent tester on.
- (d) Clear the DTCs (See page ES-41).
- (e) Start the engine.
- (f) Allow the engine to idle for 1 minute or more.
- (g) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
- (h) Read the DTCs.

Result

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

B

REPLACE ECM (See page ES-543)

A

CHECK FOR INTERMITTENT PROBLEMS

DTC	P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)
DTC	P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)
DTC	P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)
DTC	P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)

ES**DESCRIPTION**

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

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

MONITOR DESCRIPTION

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

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

MONITOR STRATEGY

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

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

TYPICAL ENABLING CONDITIONS

All:

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

ES

Intake side:

Engine speed	500 to 1,000 rpm
--------------	------------------

Exhaust side:

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

TYPICAL MALFUNCTION THRESHOLDS

Intake side:

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

Exhaust side:

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

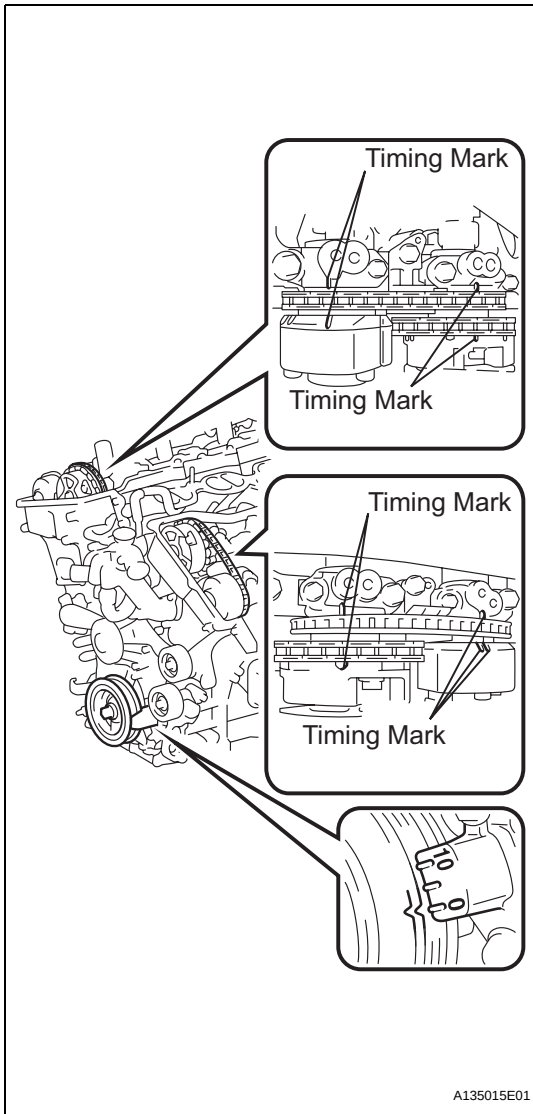
WIRING DIAGRAM

Refer to DTC P0335 (See page [ES-220](#)).

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

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

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

OK:

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

- (d) Reinstall the cylinder head covers.

NG

ADJUST VALVE TIMING (REPAIR OR REPLACE TIMING CHAIN)

OK**ES**

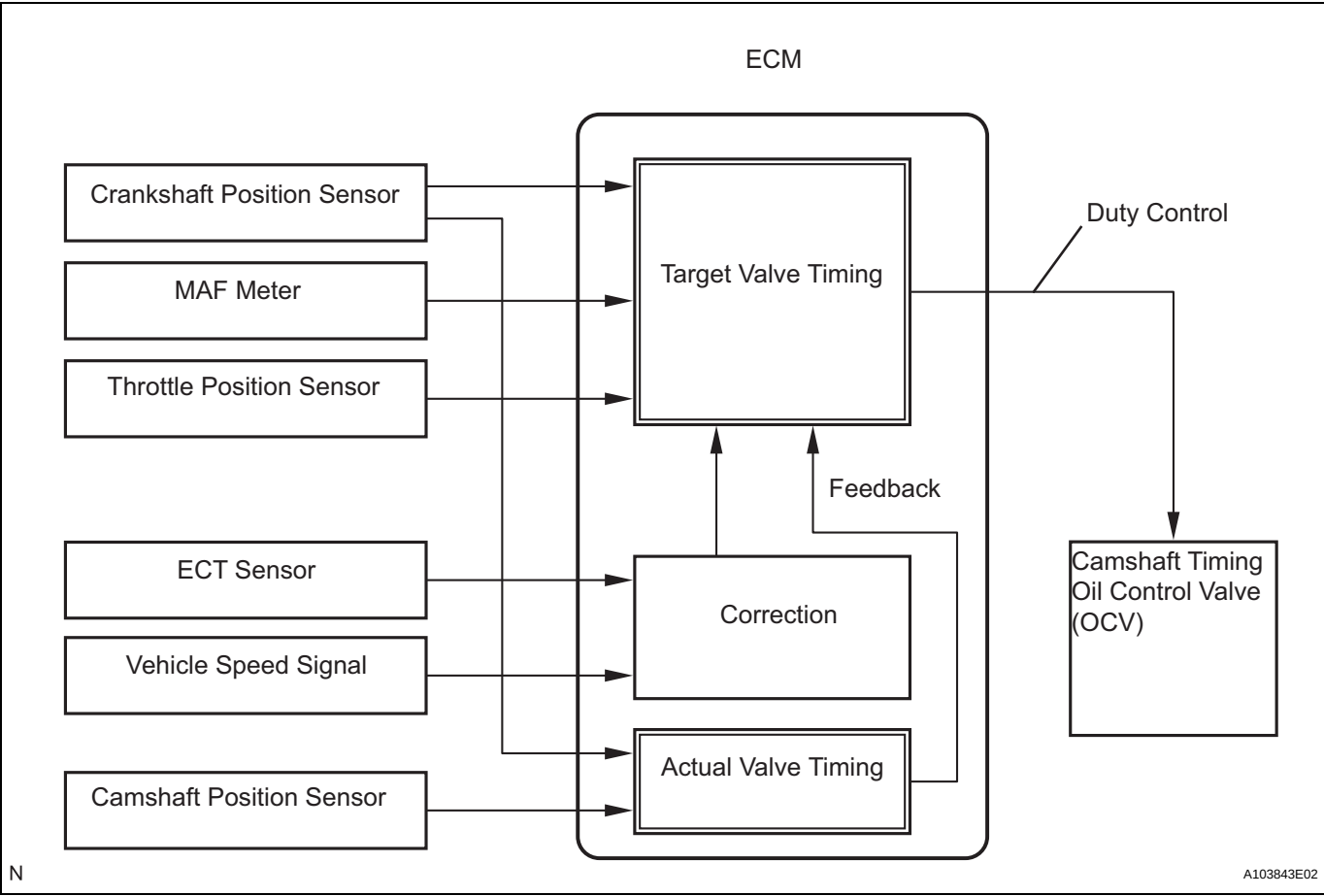
REPLACE ECM (See page [ES-543](#))

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

ES**DESCRIPTION****HINT:**

If DTC P0014, P0015, P0024 or P0025 is present, check the VVT (Variable Valve Timing) system. The Variable Valve Timing (VVT) system includes the ECM, OCV and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as the intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV, based on the signals transmitted by several sensors. The VVT controller regulates the exhaust camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual exhaust valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.

ES



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

MONITOR DESCRIPTION

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

2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.

If the difference between the target and actual exhaust valve timings is large, and changes in actual exhaust valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and sets a DTC.

Example:

A DTC is set when the following conditions A, B and C are met:

- (1) The difference between the target and actual exhaust valve timings is more than 5°C (Crankshaft Angle) and the condition continues for more than 4.5 seconds (Procedure "A").
- (2) It takes 5 seconds or more to change the valve timing by 5°C (Procedure "B").
- (3) After above procedures "A" and "B" are met, the OCV is forcibly activated 63 times or more (Procedure "C").

3. DTCs P0014 and P0024 (Advanced Cam Timing) are detected with 1 trip detection logic.

4. DTCs P0015 and P0025 (Retarded Cam Timing) are detected with 2 trip detection logic.

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

5. The monitor will not run unless the following conditions are met:

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

ES

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

Advanced camshaft timing:

Valve timing	No change
Valve timing	Advanced position

Retarded camshaft timing:

Valve timing	No change
Valve timing	Retard position

WIRING DIAGRAM

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

INSPECTION PROCEDURE

HINT:

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

- If DTC P0014 or P0015 is displayed, check the exhaust camshaft circuit for the bank 1 VVT system.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0024 or P0025 is displayed, check the exhaust camshaft circuit for the bank 2 VVT system.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

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

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

Result

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

HINT:

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

B

GO TO DTC CHART (See page [ES-59](#))

A

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

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

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

OK

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

NG

Go to step 4

OK

3

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

ES

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG) and turn the tester on.
- (c) Clear the DTCs (See page [ES-41](#)).
- (d) Start the engine and warm it up.
- (e) Switch the ECM from normal mode to check mode using the tester (See page [ES-45](#)).
- (f) Drive the vehicle for more than 10 minutes.
- (g) Read the DTCs using the tester.

OK:

No DTC output.

NG

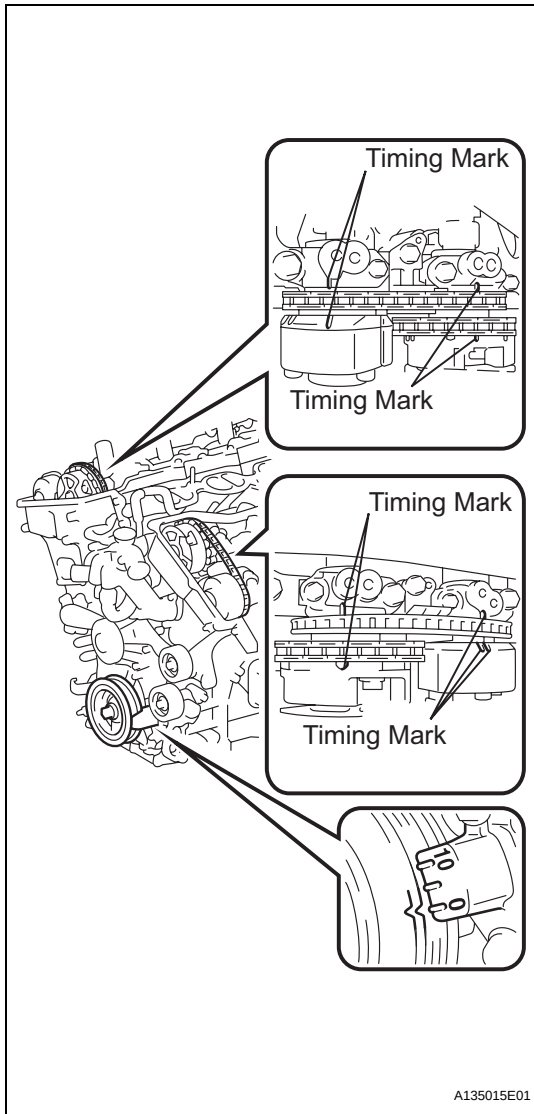
Go to step 4

OK

END

4

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



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

OK:

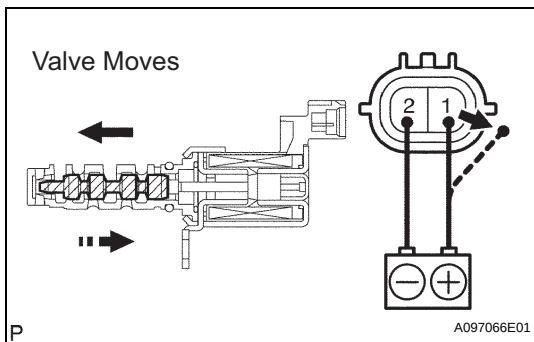
The timing marks on the crankshaft timing gears are aligned as shown in the illustration.

- (d) Reinstall the cylinder head covers.

NG**ADJUST VALVE TIMING****OK**

5

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



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

Standard resistance

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

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

OK:

Valve moves quickly.

- (d) Reinstall the OCV.

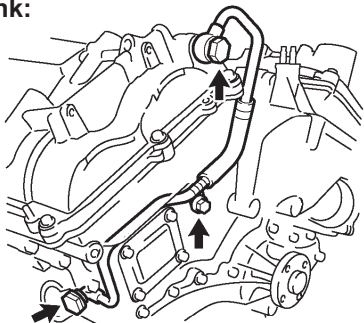
NG

**REPLACE CAMSHAFT TIMING OIL
CONTROL VALVE ASSEMBLY** (See page [ES-500](#))

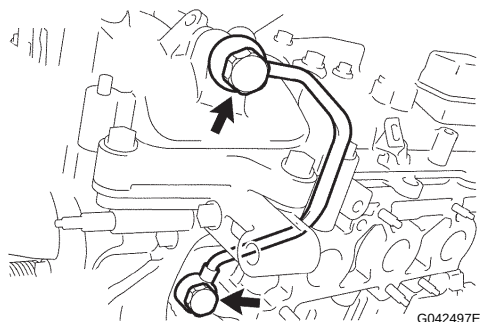
OK

6 INSPECT OIL CONTROL VALVE FILTER AND PIPE

RH Bank:



LH Bank:



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

OK:

Filter is not clogged.

NG

**CLEAN OIL CONTROL VALVE FILTER AND
PIPE**

ES

OK

7 REPLACE EXHAUST CAMSHAFT

NEXT

8 CHECK WHETHER DTC OUTPUT RECURS

- (a) Clear the DTCs.
 - (1) Operate the intelligent tester, or disconnect the EFI and ETCS fuses more than 60 seconds to erase the codes.
- (b) Start the engine and warm up the engine.
- (c) Switch the ECM from normal mode to check mode using the intelligent tester (See page [ES-45](#)).
- (d) Drive the vehicle for more than 10 minutes or more.
- (e) Read the output DTCs using the intelligent tester.

OK:

No DTC output.

HINT:

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



OK

SYSTEM IS OK



NG



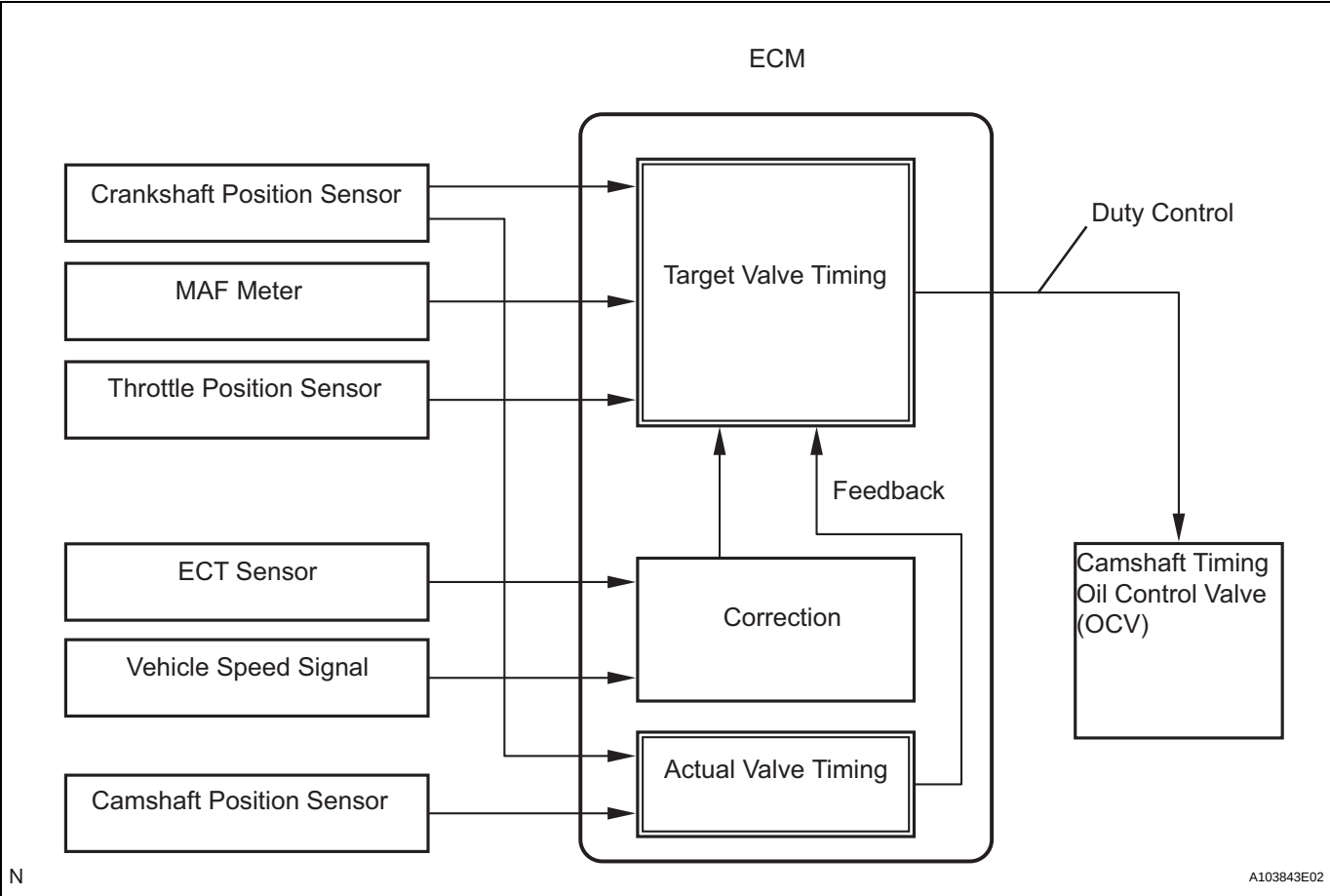
ES

REPLACE ECM (See page [ES-543](#))

DTC	P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)
DTC	P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)

DESCRIPTION

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



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

MONITOR DESCRIPTION

The ECM optimizes the valve timing using the VVT system to control the exhaust camshaft. The VVT system includes the ECM, the OCV and the VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the exhaust camshaft.

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

MONITOR STRATEGY

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

ES

TYPICAL ENABLING CONDITIONS

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

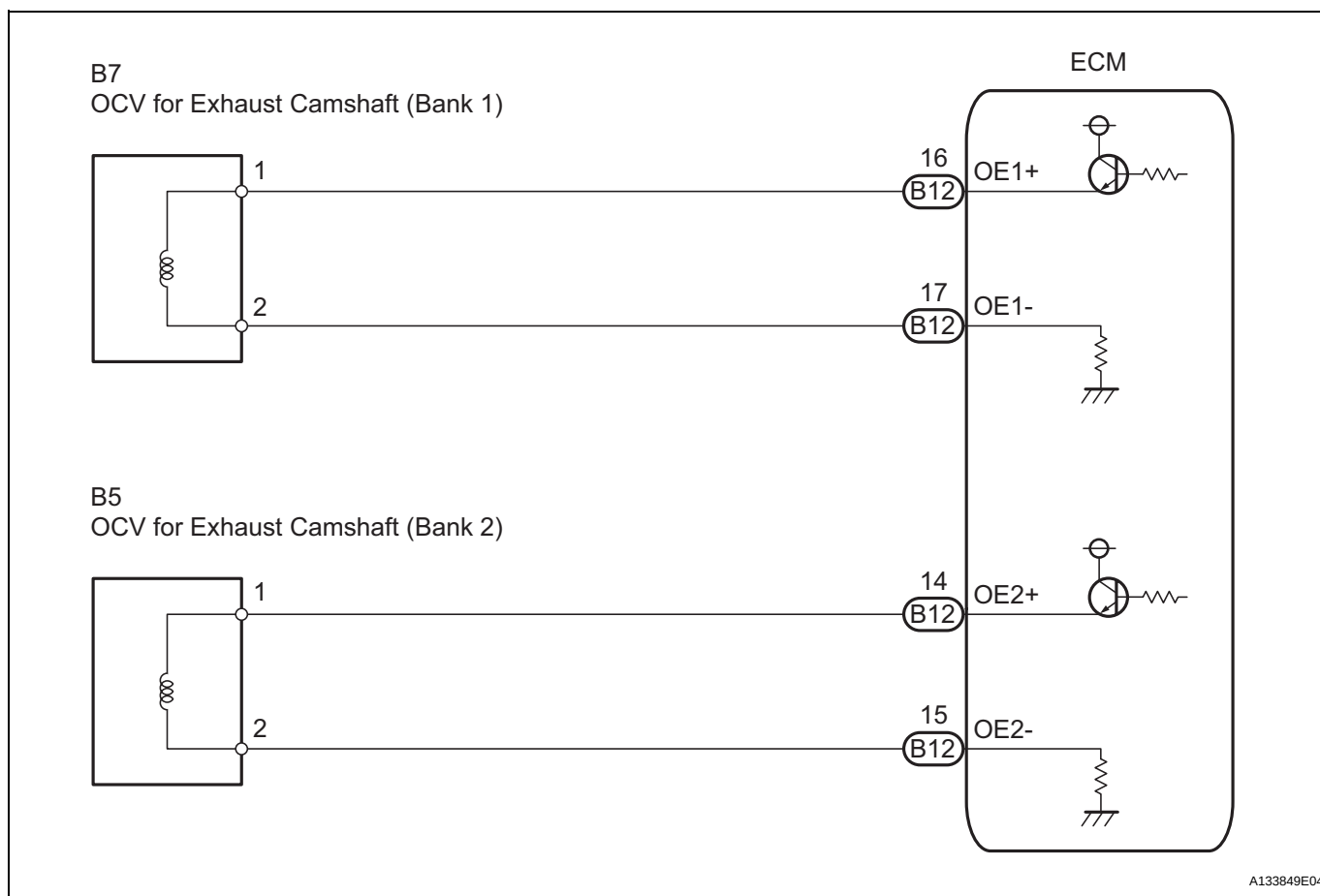
TYPICAL MALFUNCTION THRESHOLDS

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

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P0013 is displayed, check the exhaust camshaft circuit for the bank 1 VVT system.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0023 is displayed, check the exhaust camshaft circuit for the bank 2 VVT system.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using an intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

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

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

OK

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

NG

Go to step 2

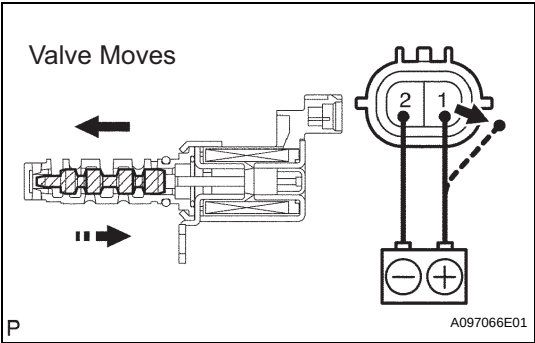
OK

CHECK FOR INTERMITTENT PROBLEMS

2

INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

ES



- (a) Disconnect the B7 or B5 OCV connector.
- (b) Measure the resistance between the terminals of the OCV.

Standard resistance

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

- (c) Reconnect the OCV connector.

NG

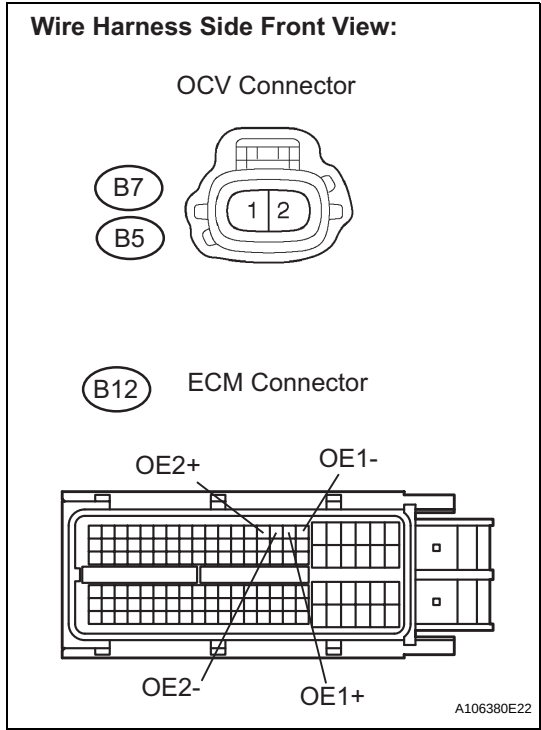
Go to step 3

OK

REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (See page ES-500)

3

CHECK HARNESS AND CONNECTOR (OCV - ECM)



- (a) Disconnect the B7 or B5 OCV connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
OE1+ (B12-16) - B7-1	Below 1 Ω
OE1- (B12-17) - B7-2	Below 1 Ω
OE2+ (B12-14) - B5-1	Below 1 Ω
OE2- (B12-15) - B5-2	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
OE1+ (B12-16) or B7-1 - Body ground	10 kΩ or higher
OE1- (B12-17) or B7-2 - Body ground	10 kΩ or higher
OE2+ (B12-14) or B5-1 - Body ground	10 kΩ or higher
OE2- (B12-15) or B5-2 - Body ground	10 kΩ or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (See page [ES-543](#))

DTC	P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)
DTC	P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)
DTC	P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)
DTC	P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)

ES**DESCRIPTION**

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

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

MONITOR DESCRIPTION

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

2. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. The VVT controller can advance or retard the intake camshaft. If the difference between the target and actual intake valve timing is large, and changes in the actual intake valve timing are small, the ECM interprets this as the VVT controller stuck malfunction and sets a DTC.

Example:

A DTC will be set when the following conditions 1), 2) and 3) are met:

- 1) The difference between the target and actual intake valve timings is more than 5°CA (Crankshaft Angle) and the condition continues for more than 4.5 seconds.
 - 2) It takes 5 seconds or more to change the valve timing by 5°CA.
 - 3) After above conditions 1) and 2) are met, the OCV is forcibly activated 63 times or more.
3. DTCs P0011 and P0021 (Advanced Cam Timing) are detected with 1 trip detection logic.
4. DTCs P0012 and P0022 (Retarded Cam Timing) are detected with 2 trip detection logic. These DTCs indicate that the VVT controller cannot operate properly due to OCV malfunctions or the presence of foreign objects in the OCV.
5. The monitor will not run unless the following conditions are met:
- (a) The engine is warm (the engine coolant temperature is 75°C (167°F) or more).
 - (b) The vehicle has been driven at more than 40 mph (64 km/h) for 3 minutes.
 - (c) The engine has idled for 3 minutes.

ES

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

Advanced camshaft timing:

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

Retard camshaft timing:

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

Valve timing

No change in retarded valve timing

WIRING DIAGRAMRefer to DTC P0010 (See page [ES-77](#)).**INSPECTION PROCEDURE**

HINT:

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

- If DTC P0011 or P0012 is displayed, check the right bank VVT system for intake camshaft circuit (bank 1).
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0021 or P0022 is displayed, check the intake camshaft circuit for the left bank VVT system (bank 2).
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using an intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

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

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

Result

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

HINT:

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

B**GO TO DTC CHART (See page [ES-59](#))****A****2****PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OPERATE OCV)**

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

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

OK

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

NG

Go to step 4

OK

ES

3

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

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG) and turn the tester on.
- (c) Clear the DTCs.
- (d) Start the engine and warm it up.
- (e) Switch the ECM from normal mode to check mode using the tester.
- (f) Drive the vehicle for more than 10 minutes.
- (g) Read the DTCs using the tester.

OK:

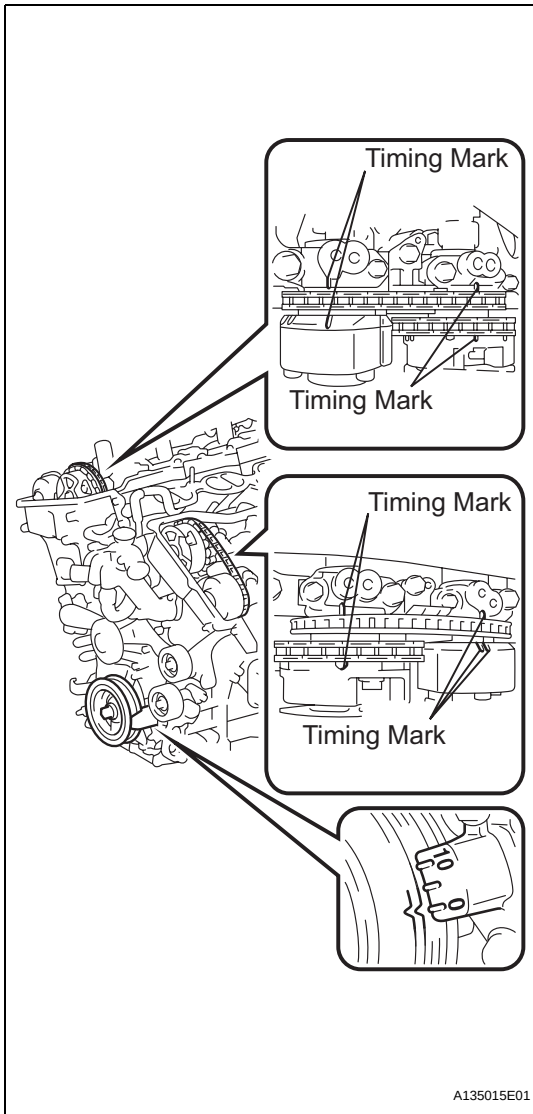
No DTC output.

NG

Go to step 4

OK

END

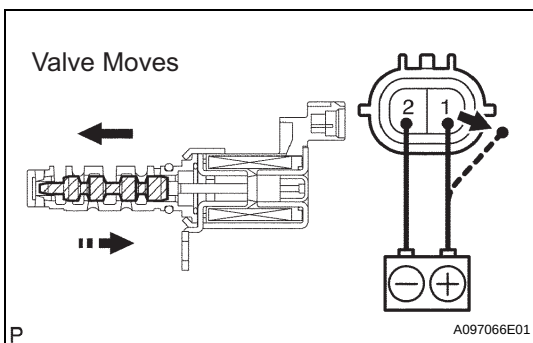
4**CHECK VALVE TIMING (CHECK FOR LOOSE AND JUMPED TEETH ON TIMING CHAIN)**

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

OK:

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

- Reinstall the cylinder head covers.

NG**ADJUST VALVE TIMING****OK****5****INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OCV)**

- Remove the OCV.
- Measure the resistance between the terminals of the OCV.

Standard resistance

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

- Apply positive battery voltage to terminal 1 and negative battery voltage to terminal 2. Check the valve operation.

OK:

Valve moves quickly.

- Reinstall the OCV.

ES

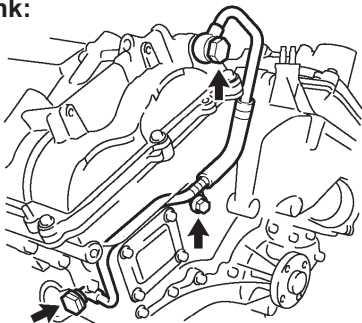
NG

**REPLACE CAMSHAFT TIMING OIL
CONTROL VALVE ASSEMBLY** (See page [ES-500](#))

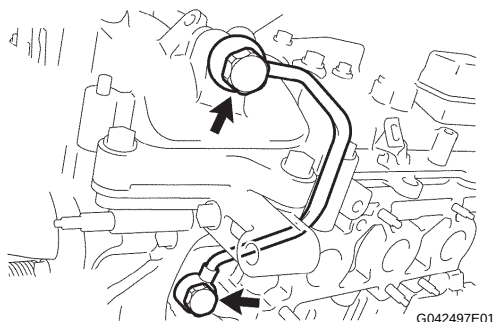
OK

6 INSPECT OIL CONTROL VALVE FILTER AND PIPE

RH Bank:



LH Bank:



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

OK:

The filter and pipe are not clogged.

NG

**CLEAN OIL CONTROL VALVE FILTER AND
PIPE**

OK

7 REPLACE CAMSHAFT TIMING GEAR ASSEMBLY

NEXT

8 CHECK WHETHER DTC OUTPUT RECURS

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG) and turn the tester on.
- (c) Clear the DTCs.
- (d) Start the engine and warm it up.
- (e) Switch the ECM from normal mode to check mode using the tester.
- (f) Drive the vehicle for more than 10 minutes.
- (g) Read the output DTCs using the intelligent tester.

OK:

No DTC output.

HINT:

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

OK

SYSTEM IS OK

NG

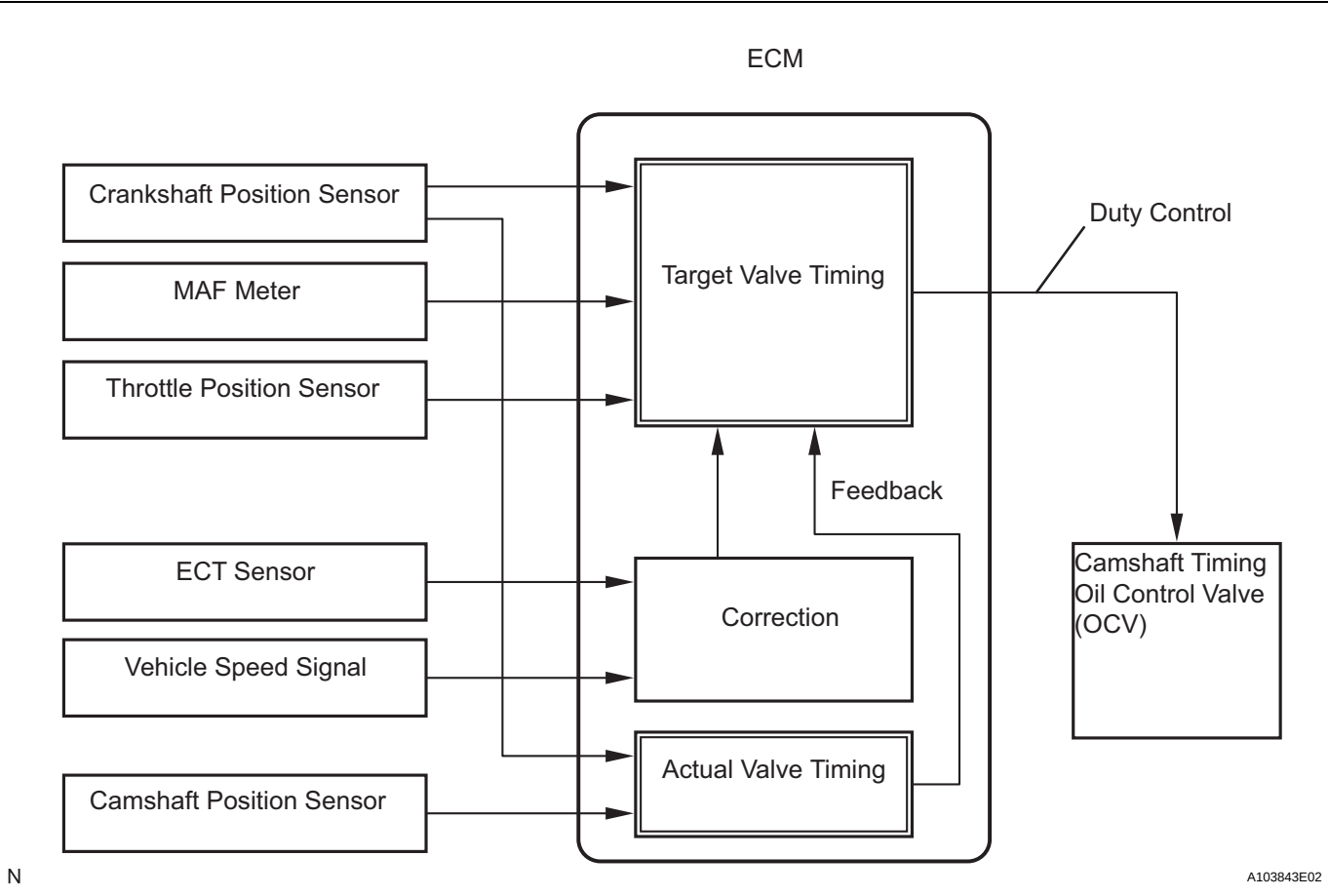
REPLACE ECM (See page [ES-543](#))

ES

DTC	P0010	Camshaft Position "A" Actuator Circuit (Bank 1)
DTC	P0020	Camshaft Position "A" Actuator Circuit (Bank 2)

DESCRIPTION

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



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

MONITOR DESCRIPTION

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

MONITOR STRATEGY

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

ES

TYPICAL ENABLING CONDITIONS

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

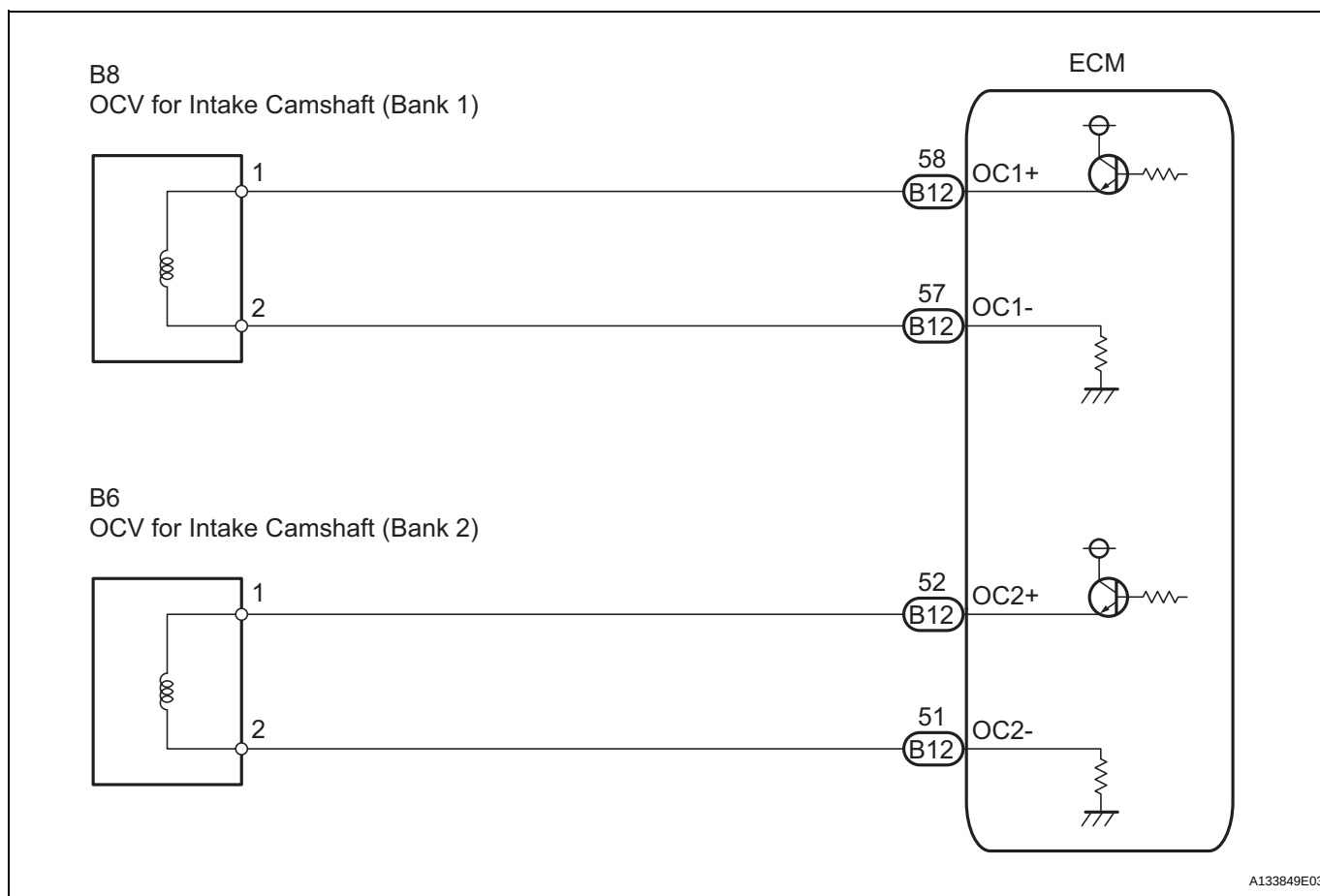
TYPICAL MALFUNCTION THRESHOLDS

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

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC P0010 is displayed, check the intake camshaft circuit for the right bank VVT system.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0020 is displayed, check the intake camshaft circuit for the left bank VVT system.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

1

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

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

OK

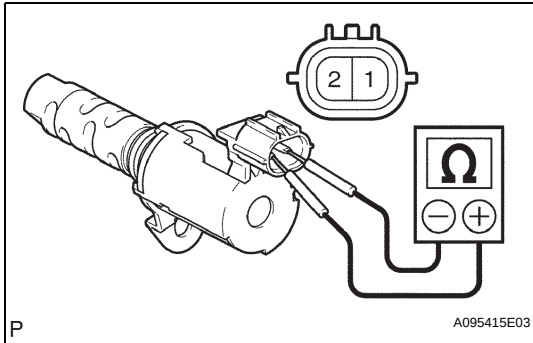
Tester Operation	Specified Condition
OCV OFF	Normal engine speed
OCV ON	Engine idles roughly or stalls (soon after OCV switched from OFF to ON)

OK

CHECK FOR INTERMITTENT PROBLEMS
(See page [ES-28](#))

NG

2 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY



- (a) Disconnect the B8 or B6 OCV connector.
(b) Measure the resistance between the terminals of the OCV.

Standard resistance

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

- (c) Reconnect the OCV connector.

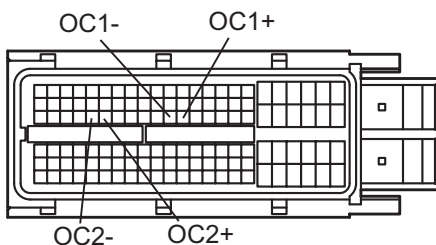
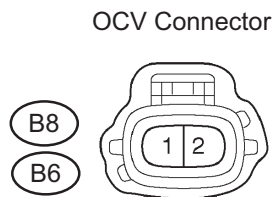
OK

REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (See page [ES-500](#))

NG

3 CHECK HARNESS AND CONNECTOR (OCV - ECM)

Wire Harness Side Front View:



A106380E21

- (a) Disconnect the B8 or B6 OCV connector.
(b) Disconnect the B12 ECM connector.
(c) Measure the resistance between the terminals.

Standard resistance (Check for open)

Tester Connection	Specified Condition
OC1+ (B12-58) - B8-1	Below 1 Ω
OC1- (B12-57) - B8-2	Below 1 Ω
OC2+ (B12-52) - B6-1	Below 1 Ω
OC2- (B12-51) - B6-2	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
OC1+ (B12-58) or B8-1 - Body ground	10 k Ω or higher
OC1- (B12-57) or B8-2 - Body ground	10 k Ω or higher
OC2+ (B12-52) or B6-1 - Body ground	10 k Ω or higher
OC2- (B12-51) or B6-2 - Body ground	10 k Ω or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

ES

A button with a black border and a downward-pointing arrow shape at the bottom, containing the text "OK".

OK

REPLACE ECM (See page [ES-543](#))

DIAGNOSTIC TROUBLE CODE CHART

HINT:

The parameters listed in the chart may not conform exactly to those read during the DTC check due to the type of instrument or other factors.

If a trouble code is displayed during the DTC check in the check mode, check the circuit for the code listed in the table below. For details of each code, refer to the "See page" column in the DTC chart.

SFI SYSTEM:

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0010	Camshaft Position "A" Actuator Circuit (Bank 1)	1. Open or short in Oil Control Valve (OCV) for intake camshaft circuit 2. OCV for intake camshaft (bank 1) 3. ECM	Comes on	DTC stored	ES-75
P0011	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 1)	1. Valve timing 2. OCV for intake camshaft 3. OCV filter 4. Intake camshaft timing gear assembly 5. ECM	Comes on	DTC stored	ES-80
P0012	Camshaft Position "A" - Timing Over-Retarded (Bank 1)	Same as DTC P0011	Comes on	DTC stored	ES-80
P0013	Camshaft Position "B" Actuator Circuit / Open (Bank 1)	1. Open or short in Oil Control Valve (OCV) for exhaust camshaft circuit 2. OCV for exhaust camshaft (bank 1) 3. ECM	Comes on	DTC stored	ES-87
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	1. Valve timing 2. OCV for exhaust camshaft 3. OCV filter 4. Exhaust camshaft 5. ECM	Comes on	DTC stored	ES-92
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	Same as DTC P0014	Comes on	DTC stored	ES-92
P0016	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor A)	1. Mechanical system (Timing chain has jumped teeth or chain is stretched) 2. ECM	Comes on	DTC stored	ES-100
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	Same as DTC P0016	Comes on	DTC stored	ES-100
P0018	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor A)	Same as DTC P0016	Comes on	DTC stored	ES-100
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	Same as DTC P0016	Comes on	DTC stored	ES-100

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0020	Camshaft Position "A" Actuator Circuit (Bank 2)	1. Open or short in Oil Control Valve (OCV) for intake camshaft circuit 2. OCV for intake camshaft (bank 2) 3. ECM	Comes on	DTC stored	ES-75
P0021	Camshaft Position "A" - Timing Over-Advanced or System Performance (Bank 2)	Same as DTC P0011	Comes on	DTC stored	ES-80
P0022	Camshaft Position "A" - Timing Over-Retarded (Bank 2)	Same as DTC P0011	Comes on	DTC stored	ES-80
P0023	Camshaft Position "B" Actuator Circuit / Open (Bank 2)	1. Open or short in Oil Control Valve (OCV) for exhaust camshaft circuit 2. OCV for exhaust camshaft (bank 2) 3. ECM	Comes on	DTC stored	ES-87
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	Same as DTC P0014	Comes on	DTC stored	ES-92
P0025	Camshaft Position "B" - Timing Over-Retarded (Bank 2)	Same as DTC P0014	Comes on	DTC stored	ES-92
P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)	1. Open in Air-Fuel Ratio (A/F) sensor heater circuit 2. A/F sensor heater (bank 1 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-103
P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)	1. Short in A/F sensor heater circuit 2. A/F sensor heater (bank 1 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-103
P0037	Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)	1. Open in Heated Oxygen (HO2) sensor heater circuit 2. HO2 sensor heater (bank 1 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-111
P0038	Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)	1. Short in HO2 sensor heater circuit 2. HO2 sensor heater (bank 1 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-111

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)	1. Open in A/F sensor heater circuit 2. A/F sensor heater (bank 2 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-103
P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)	1. Short in A/F sensor heater circuit 2. A/F sensor heater (bank 2 sensor 1) 3. A/F sensor heater relay 4. ECM	Comes on	DTC stored	ES-103
P0057	Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)	1. Open in HO2 sensor heater circuit 2. HO2 sensor heater (bank 2 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-111
P0058	Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)	1. Short in HO2 sensor heater circuit 2. HO2 sensor heater (bank 2 sensor 2) 3. Engine room junction block (EFI relay) 4. ECM	Comes on	DTC stored	ES-111
P0100	Mass or Volume Air Flow Circuit	1. Open or short in Mass Air Flow (MAF) meter circuit 2. MAF meter 3. ECM	Comes on	DTC stored	ES-121
P0101	Mass Air Flow Circuit Range / Performance Problem	MAF meter	Comes on	DTC stored	ES-129
P0102	Mass or Volume Air Flow Circuit Low Input	1. Open in MAF meter circuit 2. Short in MAF meter circuit 3. MAF meter 4. ECM	Comes on	DTC stored	ES-121
P0103	Mass or Volume Air Flow Circuit High Input	1. Short in MAF meter circuit (+B circuit) 2. MAF meter 3. ECM	Comes on	DTC stored	ES-121
P0110	Intake Air Temperature Circuit Malfunction	1. Open or short in Intake Air Temperature (IAT) sensor circuit 2. IAT sensor (built into Mass Air Flow [MAF] meter) 3. ECM	Comes on	DTC stored	ES-132
P0111	Intake Air Temperature Sensor Gradient Too High	MAF meter	Comes on	DTC stored	ES-138

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0112	Intake Air Temperature Circuit Low Input	1. Short in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. ECM	Comes on	DTC stored	ES-132
P0113	Intake Air Temperature Circuit High Input	1. Open in IAT sensor circuit 2. IAT sensor (built into MAF meter) 3. ECM	Comes on	DTC stored	ES-132
P0115	Engine Coolant Temperature Circuit Malfunction	1. Open or short in Engine Coolant Temperature (ECT) sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-141
P0116	Engine Coolant Temperature Circuit Range / Performance Problem	1. Thermostat 2. ECT sensor	Comes on	DTC stored	ES-147
P0117	Engine Coolant Temperature Circuit Low Input	1. Short in ECT sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-141
P0118	Engine Coolant Temperature Circuit High Input	1. Open in ECT sensor circuit 2. ECT sensor 3. ECM	Comes on	DTC stored	ES-141
P0120	Throttle / Pedal Position Sensor / Switch "A" Circuit Malfunction	1. Throttle Position (TP) sensor (built into throttle body) 2. ECM	Comes on	DTC stored	ES-150
P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem	TP sensor (built into throttle body)	Comes on	DTC stored	ES-157
P0122	Throttle / Pedal Position Sensor / Switch "A" Circuit Low Input	1. TP sensor (built into throttle body) 2. Short in VTA1 circuit 3. Open in VC circuit 4. ECM	Comes on	DTC stored	ES-150
P0123	Throttle / Pedal Position Sensor / Switch "A" Circuit High Input	1. TP sensor (built into throttle body) 2. Open in VTA1 circuit 3. Open in E2 circuit 4. Short between VC and VTA1 circuits 5. ECM	Comes on	DTC stored	ES-150
P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control	1. Cooling system 2. ECT sensor 3. Thermostat	Comes on	DTC stored	ES-161
P0128	Coolant Thermostat (Coolant Temperature Below Thermostat Regulating Temperature)	1. Thermostat 2. Cooling system 3. ECT sensor 4. ECM	Comes on	DTC stored	ES-164

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)	1. Open or short in HO2 sensor (bank 1 sensor 2) circuit 2. HO2 sensor (bank 1 sensor 2) 3. HO2 sensor heater (bank 1 sensor 2) 4. A/F sensor (bank 1 sensor 1) 5. Engine room junction block (EFI relay) 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-167
P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)	1. Open in HO2 sensor (bank 1 sensor 2) circuit 2. HO2 sensor (bank 1 sensor 2) 3. HO2 sensor heater (bank 1 sensor 2) 4. Engine room junction block (EFI relay) 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-167
P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)	1. Short in HO2 sensor (bank 1 sensor 2) circuit 2. HO2 sensor (bank 1 sensor 2) 3. ECM internal circuit malfunction	Comes on	DTC stored	ES-167
P0141	Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)	1. HO2 sensor 2. ECM	Comes on	DTC stored	ES-111
P0156	Oxygen Sensor Circuit Malfunction (Bank 2 Sensor 2)	1. Open or short in HO2 sensor (bank 2 sensor 2) circuit 2. HO2 sensor (bank 2 sensor 2) 3. HO2 sensor heater (bank 2 sensor 2) 4. A/F sensor (bank 2 sensor 1) 5. Engine room junction block (EFI relay) 6. Gas leakage from exhaust system	Comes on	DTC stored	ES-167
P0157	Oxygen Sensor Circuit Low Voltage (Bank 2 Sensor 2)	1. Open in HO2 sensor (bank 2 sensor 2) circuit 2. HO2 sensor (bank 2 sensor 2) 3. HO2 sensor heater (bank 2 sensor 2) 4. Engine room junction block (EFI relay) 5. Gas leakage from exhaust system	Comes on	DTC stored	ES-167

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0158	Oxygen Sensor Circuit High Voltage (Bank 2 Sensor 2)	1. Short in HO2 sensor (bank 2 sensor 2) circuit 2. HO2 sensor (bank 2 sensor 2) 3. ECM internal circuit malfunction	Comes on	DTC stored	ES-167
P0161	Oxygen Sensor Heater Circuit Malfunction (Bank 2 Sensor 2)	1. HO2 sensor 2. ECM	Comes on	DTC stored	ES-111
P0171	System Too Lean (Bank 1)	1. Air induction system 2. Injector blockage 3. MAF meter 4. ECT sensor 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 1 sensor 1) circuit 8. A/F sensor (bank 1 sensor 1) 9. A/F sensor heater (bank 1 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. PCV hose connections 13. PCV valve and hose 14. ECM	Comes on	DTC stored	ES-187
P0172	System Too Rich (Bank 1)	1. Injector leakage or blockage 2. MAF meter 3. ECT sensor 4. Ignition system 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 1 sensor 1) circuit 8. A/F sensor (bank 1 sensor 1) 9. A/F sensor heater (bank 1 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. ECM	Comes on	DTC stored	ES-187

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0174	System Too Lean (Bank 2)	1. Air induction system 2. Injector blockage 3. MAF meter 4. ECT sensor 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 2 sensor 1) circuit 8. A/F sensor (bank 2 sensor 1) 9. A/F sensor heater (bank 2 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. PCV hose connections 13. PCV valve and hose 14. ECM	Comes on	DTC stored	ES-187
P0175	System Too Rich (Bank 2)	1. Injector leakage or blockage 2. MAF meter 3. ECT sensor 4. Ignition system 5. Fuel pressure 6. Gas leakage from exhaust system 7. Open or short in A/F sensor (bank 2 sensor 1) circuit 8. A/F sensor (bank 2 sensor 1) 9. A/F sensor heater (bank 2 sensor 1) 10. A/F sensor heater relay 11. A/F sensor heater and A/F sensor heater relay circuits 12. ECM	Comes on	DTC stored	ES-187
P0220	Throttle / Pedal Position Sensor / Switch "B" Circuit	1. TP sensor (built into throttle body) 2. ECM	Comes on	DTC stored	ES-150
P0222	Throttle / Pedal Position Sensor / Switch "B" Circuit Low Input	1. TP sensor (built into throttle body) 2. Short in VTA2 circuit 3. Open in VC circuit 4. ECM	Comes on	DTC stored	ES-150
P0223	Throttle / Pedal Position Sensor / Switch "B" Circuit High Input	1. TP sensor (built into throttle body) 2. Open in VTA2 circuit 3. Open in E2 circuit 4. Short between VC and VTA2 circuits 5. ECM	Comes on	DTC stored	ES-150

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0300	Random / Multiple Cylinder Misfire Detected	1. Open or short in engine wire harness 2. Connector connections 3. Vacuum hose connection 4. Ignition system 5. Injector 6. Fuel pressure 7. Mass Air Flow (MAF) meter 8. Engine Coolant Temperature (ECT) sensor 9. Compression pressure 10. Valve clearance 11. Valve timing 12. PCV valve and hose 13. PCV hose connections 14. Air induction system 15. ECM	Comes on or flashes	DTC stored	ES-200
P0301	Cylinder 1 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-200
P0302	Cylinder 2 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-200
P0303	Cylinder 3 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-200
P0304	Cylinder 4 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-200
P0305	Cylinder 5 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-200
P0306	Cylinder 6 Misfire Detected	Same as DTC P0300	Comes on or flashes	DTC stored	ES-200
P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)	1. Short in knock sensor 1 circuit 2. Knock sensor 1 3. ECM	Comes on	DTC stored	ES-212
P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)	1. Open in knock sensor 1 circuit 2. Knock sensor 1 3. ECM	Comes on	DTC stored	ES-212
P0332	Knock Sensor 2 Circuit Low Input (Bank 2)	1. Short in knock sensor 2 circuit 2. Knock sensor 2 3. ECM	Comes on	DTC stored	ES-212
P0333	Knock Sensor 2 Circuit High Input (Bank 2)	1. Open in knock sensor 2 circuit 2. Knock sensor 2 3. ECM	Comes on	DTC stored	ES-212
P0335	Crankshaft Position Sensor "A" Circuit	1. Open or short in Crankshaft Position Sensor (CKP) circuit 2. CKP sensor 3. Sensor plate (CKP sensor plate) 4. ECM	Comes on	DTC stored	ES-218
P0339	Crankshaft Position Sensor "A" Circuit Intermittent	Same as DTC P0335	Does not come on	DTC stored	ES-218

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0340	Camshaft Position Sensor Circuit Malfunction	1. Open or short in VVT sensor for intake camshaft circuit 2. VVT sensor for intake camshaft 3. Camshaft timing gear for intake camshaft 4. Jumped tooth of timing chain for intake camshaft 5. ECM	Comes on	DTC stored	ES-224
P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)	Same as DTC P0340	Comes on	DTC stored	ES-224
P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)	Same as DTC P0340	Comes on	DTC stored	ES-224
P0345	Camshaft Position Sensor "A" Circuit (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-224
P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-224
P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)	Same as DTC P0340	Comes on	DTC stored	ES-224
P0351	Ignition Coil "A" Primary / Secondary Circuit	1. Ignition system 2. Open or short in IGF1 or IGT circuit (1 to 6) between ignition coil and ECM 3. No. 1 to No. 6 ignition coils 4. ECM	Comes on	DTC stored	ES-230
P0352	Ignition Coil "B" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-230
P0353	Ignition Coil "C" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-230
P0354	Ignition Coil "D" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-230
P0355	Ignition Coil "E" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-230
P0356	Ignition Coil "F" Primary / Secondary Circuit	Same as DTC P0351	Comes on	DTC stored	ES-230
P0365	Camshaft Position Sensor "B" Circuit (Bank 1)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-239

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-239
P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-239
P0390	Camshaft Position Sensor "B" Circuit (Bank 2)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-239
P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-239
P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)	1. Open or short in VVT sensor for exhaust camshaft circuit 2. VVT sensor for exhaust camshaft 3. Exhaust camshaft 4. Jumped tooth of timing chain 5. ECM	Comes on	DTC stored	ES-239
P0420	Catalyst System Efficiency Below Threshold (Bank 1)	1. Gas leakage from exhaust system 2. A/F sensor (bank 1 sensor 1) 3. HO2 sensor (bank 1 sensor 2) 4. Exhaust manifold (Three-Way Catalytic Converter [TWC])	Comes on	DTC stored	ES-245

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0430	Catalyst System Efficiency Below Threshold (Bank 2)	1. Gas leakage from exhaust system 2. A/F sensor (bank 2 sensor 1) 3. HO2 sensor (bank 2 sensor 2) 4. Exhaust manifold (Three-Way Catalytic Converter [TWC])	Comes on	DTC stored	ES-245
P043E	Evaporative Emission System Reference Orifice Clog Up	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-251
P043F	Evaporative Emission System Reference Orifice High Flow	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-251
P0441	Evaporative Emission Control System Incorrect Purge Flow	1. EVAP VSV 2. Connector / wire harness (EVAP VSV - ECM) 3. ECM 4. Pump module 5. Leakage from EVAP system 6. Leakage from EVAP line (EVAP VSV - Intake manifold)	Comes on	DTC stored	ES-256
P0450	Evaporative Emission Control System Pressure Sensor / Switch	1. Pump module (including pressure sensor) 2. ECM	Comes on	DTC stored	ES-263
P0451	Evaporative Emission Control System Pressure Sensor Range / Performance	1. Pump module (including pressure sensor) 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-263
P0452	Evaporative Emission Control System Pressure Sensor / Switch Low Input	1. Pump module (including pressure sensor) 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-263
P0453	Evaporative Emission Control System Pressure Sensor / Switch High Input	1. Pump module (include pressure sensor) 2. Connector / wire harness (between pump module and ECM) 3. ECM	Comes on	DTC stored	ES-263

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0455	Evaporative Emission Control System Leak Detected (Gross Leak)	1. Fuel tank cap (loose) 2. Leakage from EVAP line (Canister - Fuel tank) 3. Leakage from EVAP line (EVAP VSV - Canister) 4. Pump module 5. Leakage from fuel tank 6. Leakage from canister	Comes on	DTC stored	ES-270
P0456	Evaporative Emission Control System Leak Detected (Very Small Leak)	Same as DTC P0455	Comes on	DTC stored	ES-270
P0500	Vehicle Speed Sensor "A"	1. Vehicle speed sensor 2. Vehicle speed sensor signal circuit 3. Combination meter 4. ECM 5. Skid control ECU	Comes on	DTC stored	ES-275
P0504	Brake Switch "A" / "B" Correlation	1. Short in stop light switch signal circuit 2. Stop light switch 3. ECM	Does not come on	DTC stored	ES-280
P0505	Idle Control System Malfunction	1. ETCS (Electronic Throttle Control System) 2. Air induction system 3. PCV hose connection 4. ECM	Comes on	DTC stored	ES-284
P050A	Cold Start Idle Air Control System Performance	1. Throttle body assembly 2. MAF meter 3. Air induction system 4. PCV hose connections 5. VVT system 6. Air cleaner filter element 7. ECM	Comes on	DTC stored	ES-287
P050B	Cold Start Ignition Timing Performance	Same as DTC P050A	Comes on	DTC stored	ES-287
P0560	System Voltage	1. Open in back-up power source circuit 2. ECM	Comes on	DTC stored	ES-293
P0604	Internal Control Module Random Access Memory (RAM) Error	ECM	Comes on	DTC stored	ES-298
P0606	ECM / PCM Processor	1. Exhaust gas leak 2. Heated oxygen sensor 3. ECM	Comes on (except when there is a malfunction in the ECM internal circuit)	DTC stored	ES-300

ES

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P0607	Control Module Performance	ECM	Comes on (except when there is a malfunction in the cruise control switch circuit)	DTC stored	ES-303
P0617	Starter Relay Circuit High	1. Park/Neutral Position (PNP) switch 2. Starter relay circuit 3. Cranking holding function circuit 4. Engine switch 5. ECM	Comes on	DTC stored	ES-305
P0630	VIN not Programmed or Mismatch - ECM / PCM	ECM	Comes on	DTC stored	ES-309
P0657	Actuator Supply Voltage Circuit / Open	ECM	Comes on	DTC stored	ES-311
P0705	Transmission Range Sensor Circuit Malfunction (PRNDL Input)	1. Short in park/neutral position switch circuit 2. Park/neutral position switch 3. ECM	Comes on	DTC stored	ES-313
P0724	Brake Switch "B" Circuit High	1. Short in stop light switch signal circuit 2. Stop light switch 3. ECM	Comes on	DTC stored	ES-280
P2102	Throttle Actuator Control Motor Circuit Low	1. Open in throttle actuator circuit 2. Throttle actuator 3. ECM	Comes on	DTC stored	ES-323
P2103	Throttle Actuator Control Motor Circuit High	1. Short in throttle actuator circuit 2. Throttle actuator 3. Throttle valve 4. Throttle body assembly 5. ECM	Comes on	DTC stored	ES-323
P2111	Throttle Actuator Control System - Stuck Open	1. Throttle actuator 2. Throttle body 3. Throttle valve	Comes on	DTC stored	ES-327
P2112	Throttle Actuator Control System - Stuck Closed	Same as DTC P2111	Comes on	DTC stored	ES-327
P2118	Throttle Actuator Control Motor Current Range / Performance	1. Open in ETCS power source circuit 2. ETCS fuse 3. ECM	Comes on	DTC stored	ES-330
P2119	Throttle Actuator Control Throttle Body Range / Performance	1. ETCS 2. ECM	Comes on	DTC stored	ES-334
P2120	Throttle / Pedal Position Sensor / Switch "D" Circuit	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-337
P2121	Throttle / Pedal Position Sensor / Switch "D" Circuit Range / Performance	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-344

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2122	Throttle / Pedal Position Sensor / Switch "D" Circuit Low Input	1. Accelerator Pedal Position (APP) sensor 2. Open in VCP1 circuit 3. Open or ground short in VPA circuit 4. ECM	Comes on	DTC stored	ES-337
P2123	Throttle / Pedal Position Sensor / Switch "D" Circuit High Input	1. Accelerator Pedal Position (APP) sensor 2. Open in EPA circuit 3. ECM	Comes on	DTC stored	ES-337
P2125	Throttle / Pedal Position Sensor / Switch "E" Circuit	1. Accelerator Pedal Position (APP) sensor 2. ECM	Comes on	DTC stored	ES-337
P2127	Throttle / Pedal Position Sensor / Switch "E" Circuit Low Input	1. Accelerator Pedal Position (APP) sensor 2. Open in VCP2 circuit 3. Open or ground short in VPA2 circuit 4. ECM	Comes on	DTC stored	ES-337
P2128	Throttle / Pedal Position Sensor / Switch "E" Circuit High Input	1. Accelerator Pedal Position (APP) sensor 2. Open in EPA2 circuit 3. ECM	Comes on	DTC stored	ES-337
P2135	Throttle / Pedal Position Sensor / Switch "A" / "B" Voltage Correlation	1. Short between VTA1 and VTA2 circuits 2. TP sensor (built into throttle body) 3. ECM	Comes on	DTC stored	ES-150
P2138	Throttle / Pedal Position Sensor / Switch "D" / "E" Voltage Correlation	1. Short between VPA and VPA2 circuits 2. APP sensor 3. ECM	Comes on	DTC stored	ES-337
P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)	1. Open or short in A/F sensor (bank 1 sensor 1) circuit 2. A/F sensor (bank 1 sensor 1) 3. A/F sensor heater (bank 1 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. Air induction system 7. Fuel pressure 8. Injector 9. ECM	Comes on	DTC stored	ES-348
P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)	Same as DTC P2195	Comes on	DTC stored	ES-348

ES

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)	1. Open or short in A/F sensor (bank 2 sensor 1) circuit 2. A/F sensor (bank 2 sensor 1) 3. A/F sensor heater (bank 2 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. Air induction system 7. Fuel pressure 8. Injector 9. ECM	Comes on	DTC stored	ES-348
P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)	Same as DTC P2197	Comes on	DTC stored	ES-348
P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)	1. Open or short in A/F sensor (bank 1 sensor 1) circuit 2. A/F sensor (bank 1 sensor 1) 3. A/F sensor heater (bank 1 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. ECM	Comes on	DTC stored	ES-366
P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-366
P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)	1. Open or short in A/F sensor (bank 2 sensor 1) circuit 2. A/F sensor (bank 2 sensor 1) 3. A/F sensor heater (bank 2 sensor 1) 4. A/F sensor heater relay 5. A/F sensor heater and relay circuits 6. ECM	Comes on	DTC stored	ES-366
P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-366
P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-366
P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)	Same as DTC P2238	Comes on	DTC stored	ES-366
P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-366

DTC Code	Detection Item	Suspected Trouble Area	MIL	Memory	See page
P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)	Same as DTC P2241	Comes on	DTC stored	ES-366
P2401	Evaporative Emission System Leak Detection Pump Control Circuit Low	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-251
P2402	Evaporative Emission System Leak Detection Pump Control Circuit High	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-251
P2419	Evaporative Emission System Switching Valve Control Circuit Low	1. Pump module 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-251
P2420	Evaporative Emission System Switching Valve Control Circuit High	1. Pump module (0.02 inch orifice, vacuum pump, vent valve) 2. Connector / wire harness (Pump module - ECM) 3. ECM	Comes on	DTC stored	ES-375
P2610	ECM / PCM Internal Engine Off Timer Performance	ECM	Comes on	DTC stored	ES-379
P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)	1. Open or short in A/F sensor (bank 1 sensor 1) circuit 2. A/F sensor (bank 1 sensor 1) 3. ECM	Comes on	DTC stored	ES-382
P2A03	A/F Sensor Circuit Slow Response (Bank 2 Sensor 1)	1. Open or short in A/F sensor (bank 2 sensor 1) circuit 2. A/F sensor (bank 2 sensor 1) 3. ECM	Comes on	DTC stored	ES-382
U0101	Lost Communication with TCM	1. Open or short in TCM and ECM circuit 2. TCM 3. ECM	Comes on	DTC stored	ES-391