

DTC	P0365	Camshaft Position Sensor "B" Circuit (Bank 1)
DTC	P0367	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)
DTC	P0368	Camshaft Position Sensor "B" Circuit High Input (Bank 1)
DTC	P0390	Camshaft Position Sensor "B" Circuit (Bank 2)
DTC	P0392	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)
DTC	P0393	Camshaft Position Sensor "B" Circuit High Input (Bank 2)

DESCRIPTION

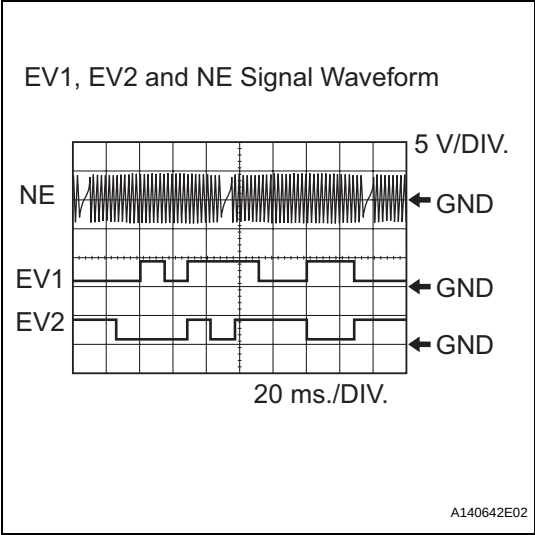
The exhaust camshaft's Variable Valve Timing (VVT) sensor consists of a magnet and MRE (Magnet Resistance Element).

The exhaust camshaft has a sensor plate with 3 teeth on its outer circumference.

When the exhaust camshaft rotates, changes occur in the air gaps between the 3 teeth and MRE, which affects the magnet. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the exhaust camshaft rotation data to pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

DTC No.	DTC Detection Condition	Trouble Area
P0365 P0390	- Input voltage to ECM remains 0.3 V or less, or 4.7 V or higher for more than 5 seconds, when 2 or more seconds have elapsed after turning engine switch on (IG) (1 trip detection logic) - No VVT sensor signal to ECM during cranking (1 trip detection logic)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM
P0367 P0392	Output voltage of VVT sensor is 0.3 V or less for 5 seconds (1 trip detection logic)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM
P0368 P0393	Output voltage of VVT sensor is 4.7 V or more for 5 seconds (1 trip detection logic)	- Open or short in VVT sensor for exhaust camshaft circuit - VVT sensor for exhaust camshaft - Exhaust camshaft - Jumped tooth of timing chain - ECM

Reference: Inspection using an oscilloscope



HINT:

- The correct waveform is as shown.
- EV1+ and EV2+ stand for the VVT sensor signal, and NE+ stands for the CKP sensor signal.

Item	Content
Terminal	NE+ - NE- EV1+ - EV1- EV2+ - EV2-
Equipment Setting	5 V/DIV. 20 ms./DIV.
Condition	Cranking or idling

MONITOR DESCRIPTION

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

MONITOR STRATEGY

Related DTCs	P0365: VVT sensor (Bank 1) open/short P0365: VVT position/Crankshaft position misalignment (Bank 1) P0367: VVT position sensor (Bank 1) range check (low voltage) P0368: VVT position sensor (Bank 1) range check (high voltage) P0390: VVT sensor (Bank 2) open/short P0390: VVT position/Crankshaft position misalignment (Bank 2) P0392: VVT position sensor (Bank 2) range check (low voltage) P0393: VVT position sensor (Bank 2) range check (high voltage)
Required Sensors/Components (Main)	VVT position sensor (Bank 1 and 2)
Required Sensors/Components (Sub)	Crankshaft position sensor
Frequency of Operation	Continuous
Duration	5 seconds
MIL Operation	2 driving cycles: P0365, P0390 (cranking) Immediate: Others
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

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

Chattering, Low voltage, High voltage:

Starter	OFF
Engine switch	ON
Time after turning engine switch off to on (IG)	2 seconds or more
Battery voltage	8 V or more

P0365, P0390 (Engine running):

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

P0365, P0390 (Cranking):

Starter	ON
Minimum battery voltage	Less than 11 V

TYPICAL MALFUNCTION THRESHOLDS**P0365, P0390 (Chattering):**

Exhaust camshaft position sensor voltage	Less than 0.3 V, or more than 4.7 V
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P0367, P0392 (Low voltage):

Exhaust camshaft position sensor voltage	Less than 0.3 V
--	-----------------

P0368, P0393 (High voltage):

Exhaust camshaft position sensor voltage	More than 4.7 V
--	-----------------

P0365, P0390 (Engine running, Cranking):

Exhaust camshaft position signal	No signal
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COMPONENT OPERATING RANGE

VVT sensor voltage	0.3 to 4.7 V
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WIRING DIAGRAM

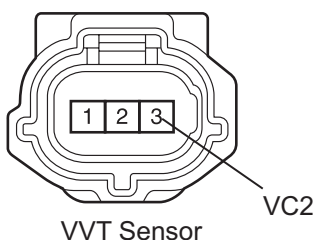
Refer to DTC P0335 (See page [ES-220](#)).

INSPECTION PROCEDURE

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 HARNESS AND CONNECTOR (SENSOR POWER SOURCE)**Wire Harness Side:**

(B43) Bank 1 (B45) Bank 2



N

A107149E28

OK

- (a) Disconnect the B43 or B45 VVT sensor connector.
 (b) Measure the voltage according to the value(s) in the table below.

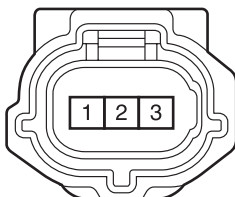
Standard voltage

Tester Connection	Specified Condition
VC2 (B43-3) - Body ground	4.5 to 5.0 V
VC2 (B45-3) - Body ground	4.5 to 5.0 V

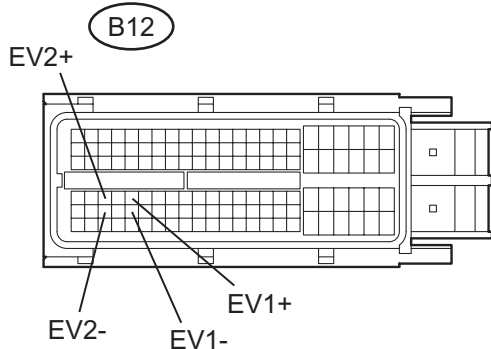
- (c) Reconnect the VVT sensor connector.

NG**REPAIR OR REPLACE HARNESS OR CONNECTOR****ES****2 CHECK HARNESS AND CONNECTOR (VVT SENSOR - ECM)****Wire Harness Side:**

VVT Sensor

(B43)
Bank 1(B45)
Bank 2

ECM Connector



A135027E06

OK

- (a) Disconnect the B43 or B45 VVT sensor 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
EX+ (B43-1) - EV1+ (B12-68)	Below 1 Ω
EX- (B43-2) - EV1- (B12-91)	Below 1 Ω
EX+ (B45-1) - EV2+ (B12-66)	Below 1 Ω
EX- (B45-2) - EV2- (B12-89)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
EX+ (B43-1) or EV1+ (B12-68) - Body ground	10 k Ω or higher
EX- (B43-2) or EV1- (B12-91) - Body ground	10 k Ω or higher
EX+ (B45-1) or EV2+ (B12-66) - Body ground	10 k Ω or higher
EX- (B45-2) or EV2- (B12-89) - Body ground	10 k Ω or higher

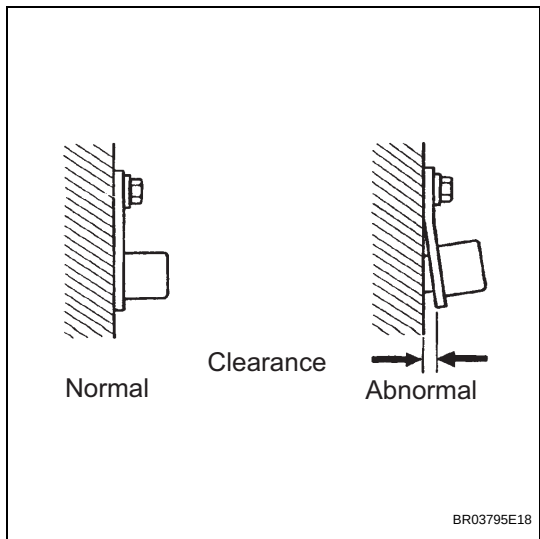
- (d) Reconnect the VVT sensor connector.
 (e) Reconnect the ECM connector.

NG**REPAIR OR REPLACE HARNESS OR CONNECTOR**

ES

3

CHECK VVT SENSOR FOR EXHAUST CAMSHAFT (SENSOR INSTALLATION)



(a) Check the VVT sensor installation condition.

OK:
Sensor is installed correctly.

NG

REPAIR OR REPLACE VVT SENSOR

OK

4

CHECK EXHAUST CAMSHAFT

(a) Check the teeth of the camshaft.

NG

REPLACE EXHAUST CAMSHAFT

OK

5

REPLACE VVT SENSOR

NEXT

6

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

Result

Display (DTC Output)	Proceed to
No output	A
P0365, P0352, P0353, P0354, P0355 or P0356	B

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

B

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

A

END

ES

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

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

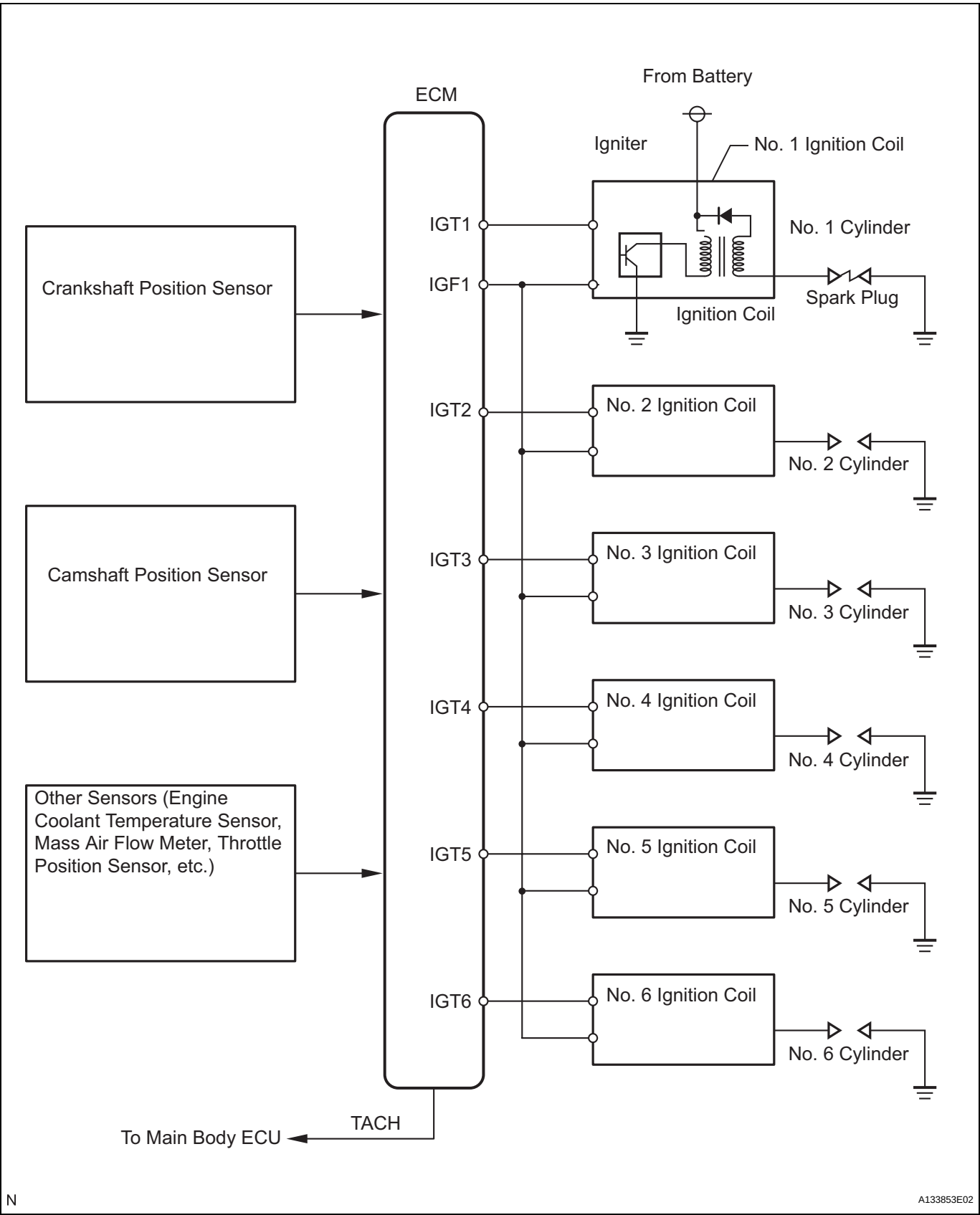
- These DTCs indicate malfunctions relating to the primary circuit.
- If DTC P0351 is set, check the No. 1 ignition coil circuit.
- If DTC P0352 is set, check the No. 2 ignition coil circuit.
- If DTC P0353 is set, check the No. 3 ignition coil circuit.
- If DTC P0354 is set, check the No. 4 ignition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

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

The DIS is a 1-cylinder ignition system in which each cylinder is ignited by one ignition coil and spark plug is connected to the end of each secondary wiring. A powerful voltage, generated in the secondary wiring, is applied directly to each spark plug. Sparks of the spark plugs pass from the center electrode to the ground electrodes.

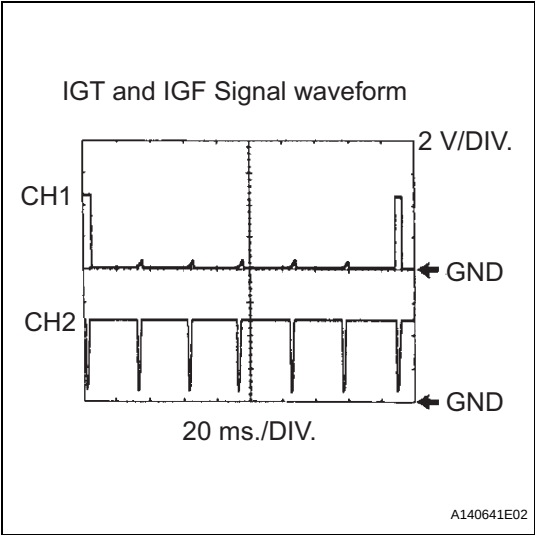
The ECM determines the ignition timing and transmits the ignition signals (IGT) to each cylinder. Using the IGT signal, the ECM turns the power transistor inside the igniter on and off. The power transistor, in turn, switches on and off the current to the primary coil. When the current to the primary coil is cut off, a powerful voltage is generated in the secondary coil. This voltage is applied to the spark plugs, causing them to spark inside the cylinders. As the ECM cuts the current to the primary coil off, the igniter sends back an ignition confirmation signal (IGF) to the ECM, for each cylinder ignition.

ES



DTC No.	DTC Detection Condition	Trouble Area
P0351 P0352 P0353 P0354 P0355 P0356	No IGF signal to ECM while engine is running (1 trip detection logic)	- Ignition system - Open or short in IGF1 or IGT circuit (1 to 6) between ignition coil and ECM - No. 1 to No. 6 ignition coils - ECM

Reference: Inspection using an oscilloscope.

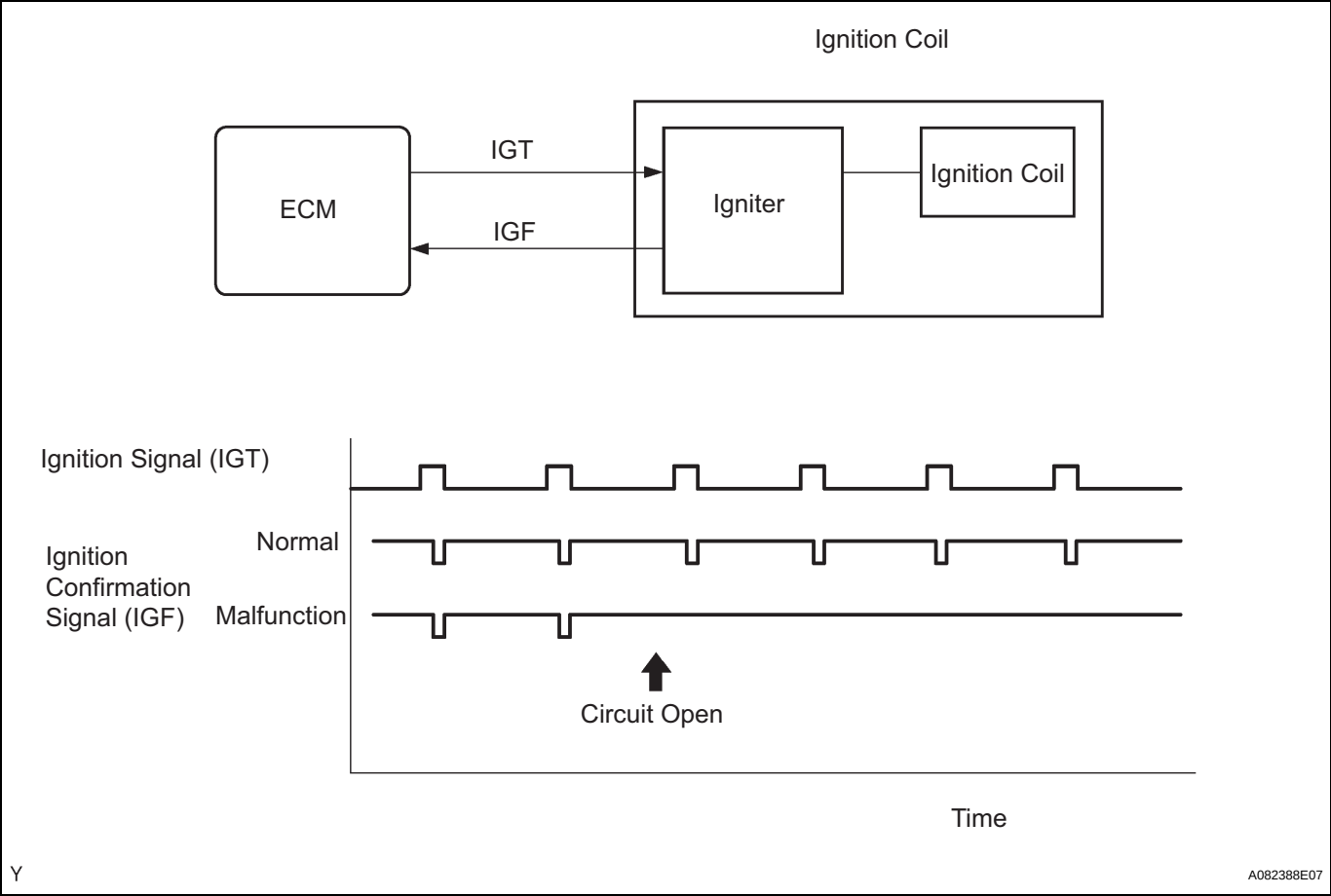


ES

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

Item	Content
Terminals	CH1: IGT1, IGT2, IGT3, IGT4, IGT5, IGT6 - E1 CH2: IGF1 - E1
Equipment Settings	2 V/DIV. 20 ms./DIV.
Conditions	Cranking or idling

MONITOR DESCRIPTION



If the ECM does not receive any IGF signals despite transmitting the IGT signal, it interprets this as a fault in the igniter and sets a DTC.

If the malfunction is not repaired successfully, a DTC is set 1 second after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0351: Igniter (cylinder 1) malfunction P0352: Igniter (cylinder 2) malfunction P0353: Igniter (cylinder 3) malfunction P0354: Igniter (cylinder 4) malfunction P0355: Igniter (cylinder 5) malfunction P0356: Igniter (cylinder 6) malfunction
Required Sensors/Components (Main)	Igniter (Cylinder 1 to 6)
Required Sensors/Components (Sub)	Crankshaft position sensor
Frequency of Operation	Continuous
Duration	0.256 seconds and 4 sparks
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever the following DTCs are not present	None
Either following condition A or B is met:	-
A. Engine RPM	1,500 rpm or less
B. Starter	OFF
Either following condition C or D is met:	-

C. Both of the following conditions are met:	-
(a) Engine speed	500 rpm or less
(b) Battery voltage	6 V or more
D. All of the following conditions are met:	-
(a) Engine speed	More than 500 rpm
(b) Battery voltage	10 V or more
(c) Number of sparks after CPU reset	5 sparks or more

TYPICAL MALFUNCTION THRESHOLDS

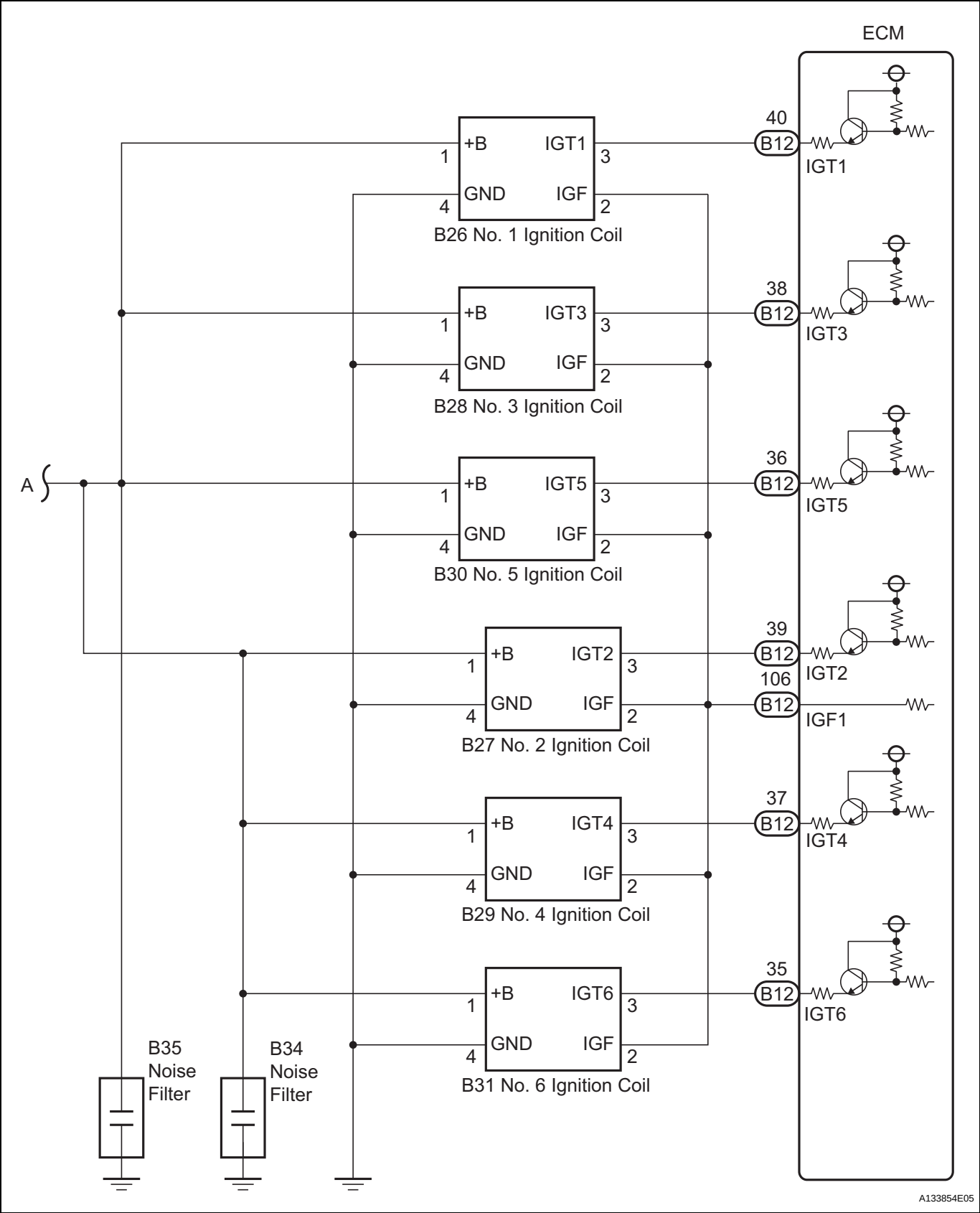
Ignition signal fail count	More than 2 times
Ignition signal fail count	No ignition confirmation signal from igniter

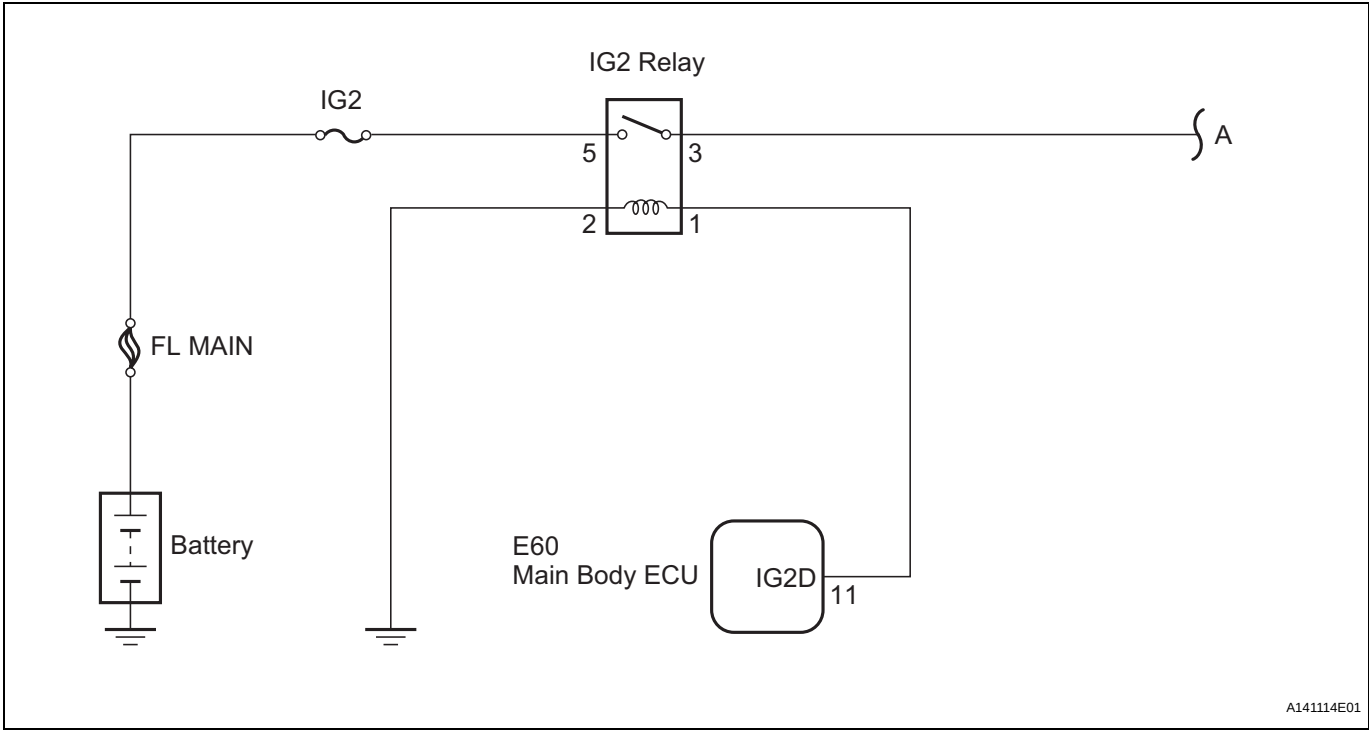
COMPONENT OPERATING RANGE

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

ES





A141114E01

INSPECTION PROCEDURE

HINT:

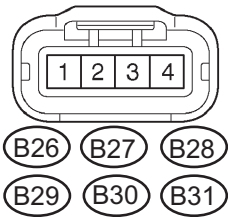
Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed 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

INSPECT IGNITION COIL ASSEMBLY (POWER SOURCE)

Wire Harness Side:

Ignition Coil Connector



Y

A054393E77

- (a) Disconnect the B26, B27, B28, B29, B30 or B31 ignition coil connector.
- (b) Turn the engine switch on (IG).
- (c) Measure the voltage according to the value(s) in the table below.

Standard voltage

Tester Connection	Specified Condition
B26-1 - Body ground	9 to 14 V
B27-1 - Body ground	9 to 14 V
B28-1 - Body ground	9 to 14 V
B29-1 - Body ground	9 to 14 V
B30-1 - Body ground	9 to 14 V
B31-1 - Body ground	9 to 14 V

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

Standard resistance

Tester Connection	Specified Condition
B26-4 - Body ground	Below 1 Ω
B27-4 - Body ground	Below 1 Ω

Tester Connection	Specified Condition
B28-4 - Body ground	Below 1 Ω
B29-4 - Body ground	Below 1 Ω
B30-4 - Body ground	Below 1 Ω
B31-4 - Body ground	Below 1 Ω

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

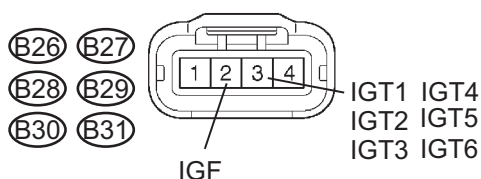
ES

2

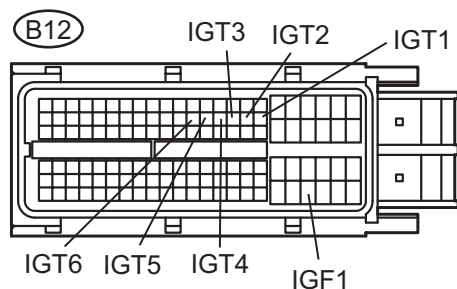
CHECK HARNESS AND CONNECTOR (IGNITION COIL ASSEMBLY - ECM (IGT SIGNAL TERMINAL))

Wire Harness Side Front View:

Ignition Coil with Igniter Connector



ECM Connector



A105983E16

- Disconnect the B26, B27, B28, B29, B30 or B31 ignition coil connector.
- Disconnect the ECM B12 connectors.
- Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
IGT1 (B26-3) - IGT1 (B12-40)	Below 1 Ω
IGT2 (B27-3) - IGT2 (B12-39)	Below 1 Ω
IGT3 (B28-3) - IGT3 (B12-38)	Below 1 Ω
IGT4 (B29-3) - IGT4 (B12-37)	Below 1 Ω
IGT5 (B30-3) - IGT5 (B12-36)	Below 1 Ω
IGT6 (B31-3) - IGT6 (B12-35)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
IGT1 (B26-3) or IGT1 (B12-40) - Body ground	10 k Ω or higher
IGT2 (B27-3) or IGT2 (B12-39) - Body ground	10 k Ω or higher
IGT3 (B28-3) or IGT3 (B12-38) - Body ground	10 k Ω or higher
IGT4 (B29-3) or IGT4 (B12-37) - Body ground	10 k Ω or higher
IGT5 (B30-3) or IGT5 (B12-36) - Body ground	10 k Ω or higher
IGT6 (B31-3) or IGT6 (B12-35) - Body ground	10 k Ω or higher

Standard resistance (Check for open)

Tester Connection	Specified Condition
IGF (B26-2) - IGF1 (B12-106)	Below 1 Ω
IGF (B27-2) - IGF1 (B12-106)	Below 1 Ω
IGF (B28-2) - IGF1 (B12-106)	Below 1 Ω
IGF (B29-2) - IGF1 (B12-106)	Below 1 Ω
IGF (B30-2) - IGF1 (B12-106)	Below 1 Ω
IGF (B31-2) - IGF1 (B12-106)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
IGF (B26-2) or IGF1 (B12-106) - Body ground	10 k Ω or higher
IGF (B27-2) or IGF1 (B12-106) - Body ground	10 k Ω or higher
IGF (B28-2) or IGF1 (B12-106) - Body ground	10 k Ω or higher
IGF (B29-2) or IGF1 (B12-106) - Body ground	10 k Ω or higher

Tester Connection	Specified Condition
IGF (B30-2) or IGF1 (B12-106) - Body ground	10 kΩ or higher
IGF (B31-2) or IGF1 (B12-106) - Body ground	10 kΩ or higher

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

3

PERFORM SIMULATION TEST

- (a) Clear the DTC(s) (See page [ES-41](#)).
- (b) Change the arrangement of the ignition coils (with igniters).
- NOTICE:**
Do not change the location of the connectors.
- (c) Perform a simulation test.

ES

Result

Display (DTC Output)	Proceed to
Same DTCs (that have been erased)	A
Other DTCs	B

B

REPLACE IGNITION COIL ASSEMBLY

A

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

DTC	P0340	Camshaft Position Sensor Circuit Malfunction
DTC	P0342	Camshaft Position Sensor "A" Circuit Low Input (Bank 1 or Single Sensor)
DTC	P0343	Camshaft Position Sensor "A" Circuit High Input (Bank 1 or Single Sensor)
DTC	P0345	Camshaft Position Sensor "A" Circuit (Bank 2)
DTC	P0347	Camshaft Position Sensor "A" Circuit Low Input (Bank 2)
DTC	P0348	Camshaft Position Sensor "A" Circuit High Input (Bank 2)

ES

DESCRIPTION

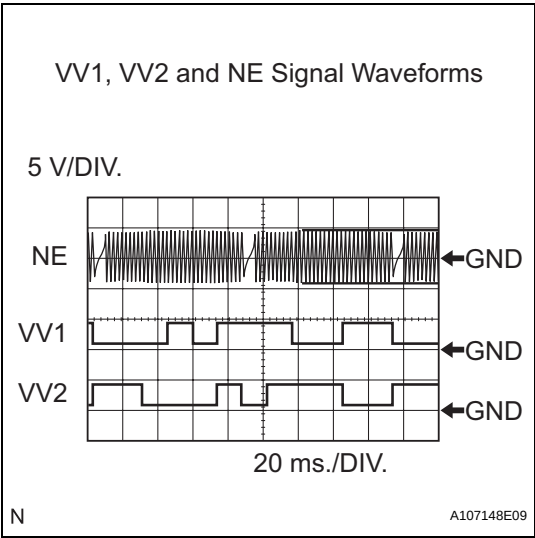
The intake camshaft's Variable Valve Timing (VVT) sensor (G signal) consists of a magnet and MRE (Magnet Resistance Element).

The VVT camshaft drive gear has a sensor plate with 3 teeth on its outer circumference. When the gear rotates, changes occur in the air gaps between the sensor plate and MRE, which affects the magnetic field. As a result, the resistance of the MRE material fluctuates. The VVT sensor converts the gear rotation data to pulse signals, uses the pulse signals to determine the camshaft angle, and sends it to the ECM.

The crankshaft angle sensor plate has 34 teeth. The pickup coil generates 34 signals for each engine revolution. Based on combination of the G signal and NE signal, the ECM detects the crankshaft angle. Then the ECM uses this data to control fuel injection time and injection timing. Also, based on the NE signal, the ECM detects the engine speed.

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

Reference: Inspection using an oscilloscope



HINT:

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

Item	Content
Terminals	NE+ - NE- VV1+ - VV1- VV2+ - VV2-
Equipment Settings	5 V/DIV. 20 ms./DIV.
Conditions	Cranking or idling

MONITOR DESCRIPTION

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

All:

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

P0340 (Engine running):

Engine speed	600 rpm or more
Starter	OFF

P0345 (Engine running):

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

P0340 (Cranking):

Starter	ON
Minimum battery voltage	Less than 11 V
CPU initial	Not initial

ES

P0345 (Cranking):

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

P0340, P0342, P0343 (Chattering, Low voltage, High voltage):

Starter	OFF
Engine switch	ON
Time after engine switch off to on	2 seconds or more

P0345, P0347, P0348 (Chattering, Low voltage, High voltage):

Starter	OFF
Engine switch	ON
Time after engine switch off to on	2 seconds or more
Battery Voltage	8 V or more

TYPICAL MALFUNCTION THRESHOLDS**P0340 (Engine running):**

Camshaft position and crankshaft position phase	Misaligned
Camshaft position signal	No signal

P0340 (Cranking):

Camshaft position signal	No signal
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P0340 (Chattering):

Camshaft position sensor voltage	Less than 0.3 V, or more than 4.7 V
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P0342 (Low voltage):

Camshaft position sensor voltage	Less than 0.3 V
----------------------------------	-----------------

P0343 (High voltage):

Camshaft position sensor voltage	More than 4.7 V
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P0345 (Engine running, cranking):

VVT sensor signal	No signal
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P0345 (Chattering):

VVT sensor voltage	Less than 0.3 V, or more than 4.7 V
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P0347 (Low voltage):

VVT sensor voltage	Less than 0.3 V
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P0348 (High voltage):

VVT sensor voltage	More than 4.7 V
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COMPONENT OPERATING RANGE

VVT sensor voltage	0.3 to 4.7 V
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WIRING DIAGRAM

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

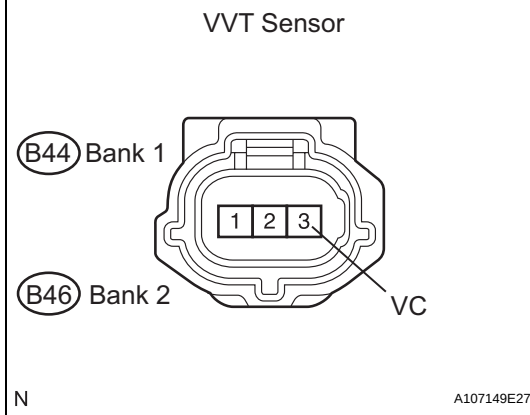
INSPECTION PROCEDURE

ES 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 HARNESS AND CONNECTOR (SENSOR POWER SOURCE)**

Wire Harness Side:



- (a) Disconnect the B44 or B46 VVT sensor connector.
- (b) Measure the voltage according to the value(s) in the table below.

Standard voltage

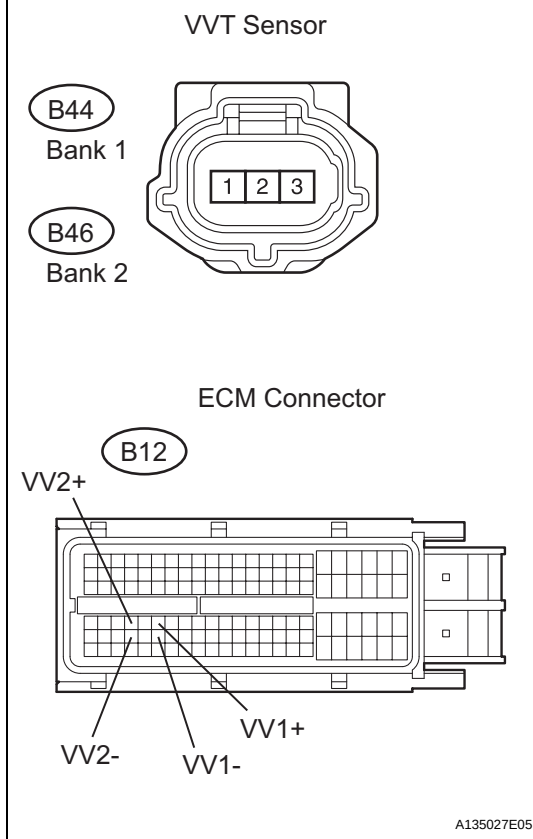
Tester Connection	Specified Condition
VC (B44-3) - Body ground	4.5 to 5.0 V
VC (B46-3) - Body ground	4.5 to 5.0 V

- (c) Reconnect the VVT sensor connector.

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

2**CHECK HARNESS AND CONNECTOR (VVT SENSOR FOR INTAKE CAMSHAFT - ECM)****Wire Harness Side:**

- Disconnect the B44 or B46 VVT sensor connector.
- Disconnect the B12 ECM connector.
- Measure the resistance according to the value(s) in the table below.

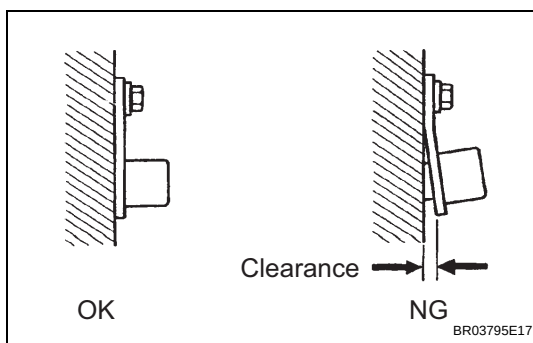
Standard resistance (Check for open)

Tester Connection	Specified Condition
VVR+ (B44-1) - VV1+ (B12-69)	Below 1 Ω
VVR- (B44-2) - VV1- (B12-92)	Below 1 Ω
VVL+ (B46-1) - VV2+ (B12-67)	Below 1 Ω
VVL- (B46-2) - VV2- (B12-90)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VVR+ (B44-1) or VV1+ (B12-69) - Body ground	10 k Ω or higher
VVR- (B44-2) or VV1- (B12-92) - Body ground	10 k Ω or higher
VVL+ (B46-1) or VV2+ (B12-67) - Body ground	10 k Ω or higher
VVL- (B46-2) or VV2- (B12-90) - Body ground	10 k Ω or higher

- Reconnect the VVT sensor connector.
- Reconnect the ECM connector.

NG**REPAIR OR REPLACE HARNESS OR CONNECTOR****OK****3****CHECK VVT SENSOR FOR INTAKE CAMSHAFT (SENSOR INSTALLATION)**

- Check the CKP sensor installation condition.

OK:**Sensor is installed correctly.****NG****REPAIR OR REPLACE VVT SENSOR****OK****4****CHECK CAMSHAFT TIMING GEAR ASSEMBLY (TEETH OF PLATE)**

- Check the teeth of the signal plate.

OK:
Sensor plate teeth do not have any cracks or deformation.

NG

REPLACE CAMSHAFT TIMING GEAR ASSEMBLY

OK

5

REPLACE VVT SENSOR

NEXT

ES

6

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

Result

Display (DTC Output)	Proceed to
No output	A
P0340, P0342, P0343, P0345, P0347 or P0348	B

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

B

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

A

END

DTC	P0335	Crankshaft Position Sensor "A" Circuit
DTC	P0339	Crankshaft Position Sensor "A" Circuit Intermittent

DESCRIPTION

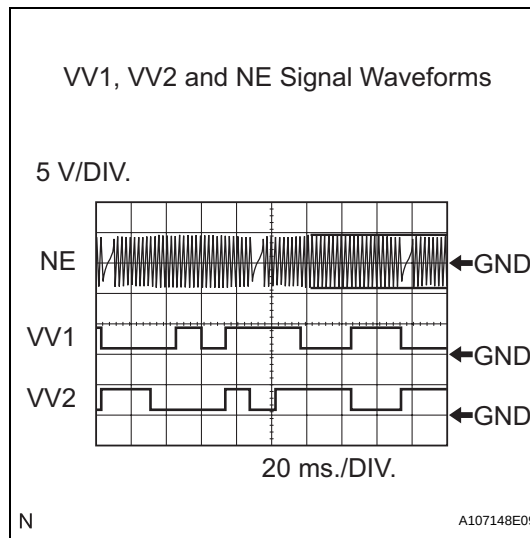
The crankshaft position (CKP) sensor system consists of a crankshaft position sensor plate and a magnetic coil.

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

ES

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

Reference: Inspection using an oscilloscope.



HINT:

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

Item	Content
Terminals	VV1+ - VV1- VV2+ - VV2- NE+ - NE-
Equipment Settings	5 V/DIV. 20 ms./DIV.
Conditions	Cranking or idling

MONITOR DESCRIPTION

If there is no signal from the crankshaft position sensor despite the engine revolving, the ECM interprets this as a malfunction of the sensor.

If the malfunction is not repaired successfully, these DTCs are set 10 seconds after the engine is next started.

MONITOR STRATEGY

Related DTCs	P0335: CKP sensor signal check when starter ON P0335: CKP sensor signal check when starter OFF P0335: Sensor pulse check
Required Sensors/Components (Main)	Crankshaft Position (CKP) sensor
Required Sensors/Components (Sub)	-
Frequency of Operation	Continuous
Duration	Within 5 seconds and 3 times
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor will run whenever these DTCs are not present	-
--	---

CKP sensor signal check when starter OFF:

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

CKP sensor pulse check:

Battery voltage	7 V or higher
Starter	ON
Number of VVT sensor signal pulse	6 times
CMP sensor circuit fail	Not detected
Engine switch	ON

TYPICAL MALFUNCTION THRESHOLDS

CKP sensor signal check when starter OFF:

Sensor signal	No signal
---------------	-----------

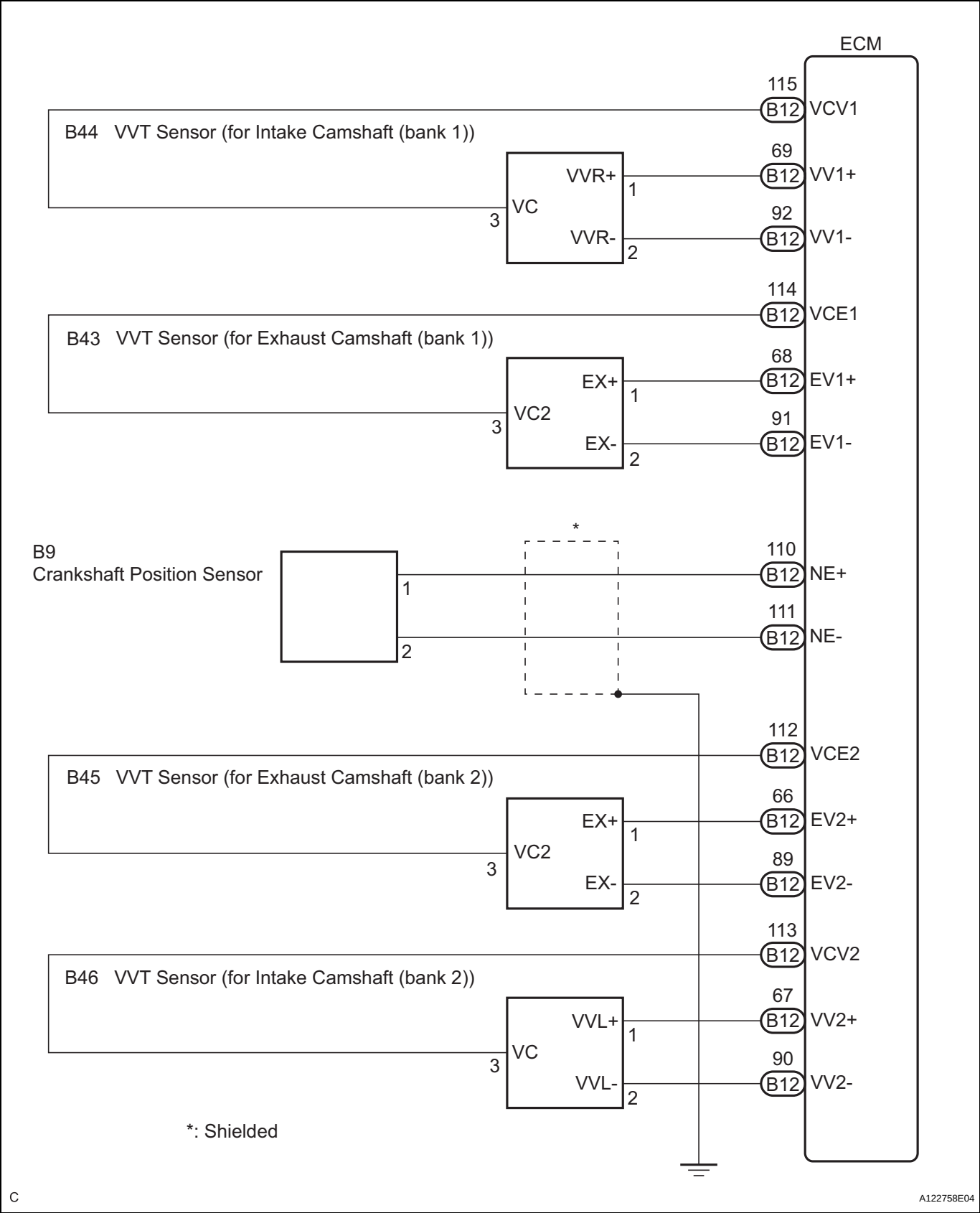
CKP sensor pulse check:

Number of sensor pulse	132 or less, or 174 or more
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COMPONENT OPERATING RANGE

CKP sensor	- CKP sensor output voltage fluctuates while crankshaft is revolving 34 CKP sensor signals per crankshaft revolution
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WIRING DIAGRAM



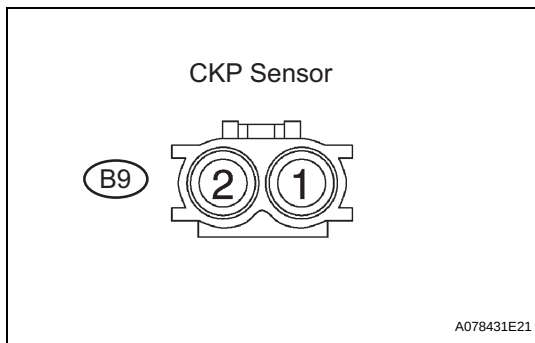
INSPECTION PROCEDURE

HINT:

- If no problem is found by this diagnostic troubleshooting procedure, troubleshoot the engine mechanical system.
- Check the engine speed. The engine speed can be checked by using the intelligent tester. To check, follow the procedure below:
 - 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 / ENGINE SPD.
 The engine speed may be indicated as zero despite the engine revolving normally. This is caused by a lack of NE signals from the crankshaft position (CKP) sensor. Alternatively, the engine speed may be indicated as lower than the actual engine speed, if the CKP sensor output voltage is insufficient.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can 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

INSPECT CRANKSHAFT POSITION SENSOR



- Disconnect the B9 crankshaft position (CKP) sensor connector.
- Measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Condition	Specified Condition
1 - 2	Cold	1,630 to 2,740 Ω
1 - 2	Hot	2,065 to 3,225 Ω

HINT:

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

- Reconnect the CKP sensor connector.

NG

REPLACE CRANKSHAFT POSITION SENSOR (See page [ES-513](#))

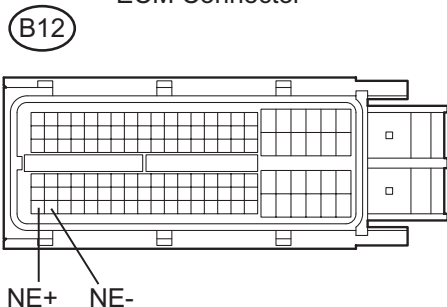
OK

2**CHECK HARNESS AND CONNECTOR (CRANKSHAFT POSITION SENSOR - ECM)****Wire Harness Side:**

Crankshaft Position Sensor



ECM Connector



A135026E03

- (a) Disconnect the B9 CKP sensor connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance according to the value(s) in the table below.

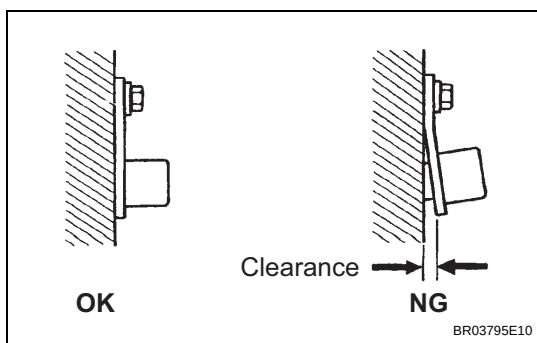
Standard resistance (Check for open)

Tester Connection	Specified Condition
B9-1 - NE+ (B12-110)	Below 1 Ω
B9-2 - NE- (B12-111)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
B9-1 or NE+ (B12-110) - Body ground	10 k Ω or higher
B9-2 or NE- (B12-111) - Body ground	10 k Ω or higher

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

NG**REPAIR OR REPLACE HARNESS OR CONNECTOR****OK****3****CHECK CRANK POSITION SENSOR (SENSOR INSTALLATION)**

- (a) Check the CKP sensor installation condition.

OK:**Sensor is installed correctly.****NG****REPAIR OR REPLACE CRANK POSITION SENSOR****OK****4****CHECK CRANKSHAFT POSITION SENSOR PLATE (TEETH OF SENSOR PLATE)**

- (a) Check the teeth of the sensor plate.

ES

OK:

Sensor plate does not have any cracks or deformation.

NG

REPLACE CRANKSHAFT POSITION
SENSOR PLATE

OK

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

DTC	P0327	Knock Sensor 1 Circuit Low Input (Bank 1 or Single Sensor)
DTC	P0328	Knock Sensor 1 Circuit High Input (Bank 1 or Single Sensor)
DTC	P0332	Knock Sensor 2 Circuit Low Input (Bank 2)
DTC	P0333	Knock Sensor 2 Circuit High Input (Bank 2)

DESCRIPTION

A flat type knock sensor (non-resonant type) has a structure that can detect vibrations over a wide band of frequencies: between approximately 6 kHz and 15 kHz.

Knock sensors are fitted onto the engine block to detect engine knocking.

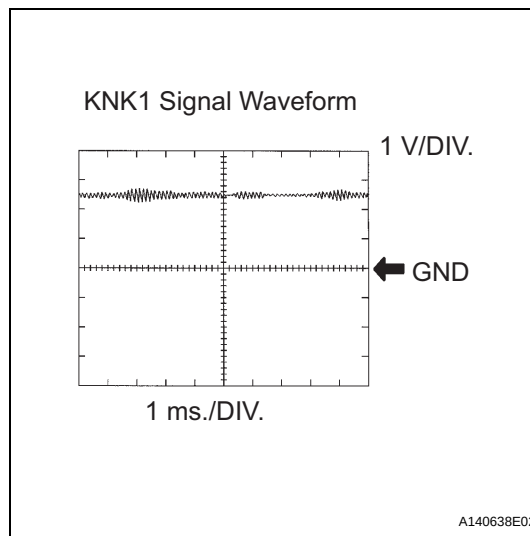
The knock sensor contains a piezoelectric element which generates a voltage when it becomes deformed. The voltage is generated when the engine block vibrates due to knocking. Any occurrence of engine knocking can be suppressed by delaying the ignition timing.

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

HINT:

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

Reference: Inspection using an oscilloscope



The correct waveform is as shown.

Item	Content
Terminals	KNK1 - EKNK or KNK2 - EKN2

Item	Content
Equipment Settings	0.01 to 10 V/DIV. 0.01 to 10 ms./DIV.
Conditions	Keep engine speed at 4,000 rpm with warm engine

MONITOR DESCRIPTION

The knock sensor, located on the cylinder block, detects spark knock. When spark knock occurs, the piezoelectric element of the sensor vibrates. When the ECM detects a voltage in this frequency range, it retards the ignition timing to suppress spark knock.

The ECM also senses background engine noise with the knock sensor and uses this noise to check for faults in the sensor. If the knock sensor signal level is too low for more than 10 seconds, or if the knock sensor output voltage is outside the normal range, the ECM interprets this as a fault in the knock sensor and sets a DTC.

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

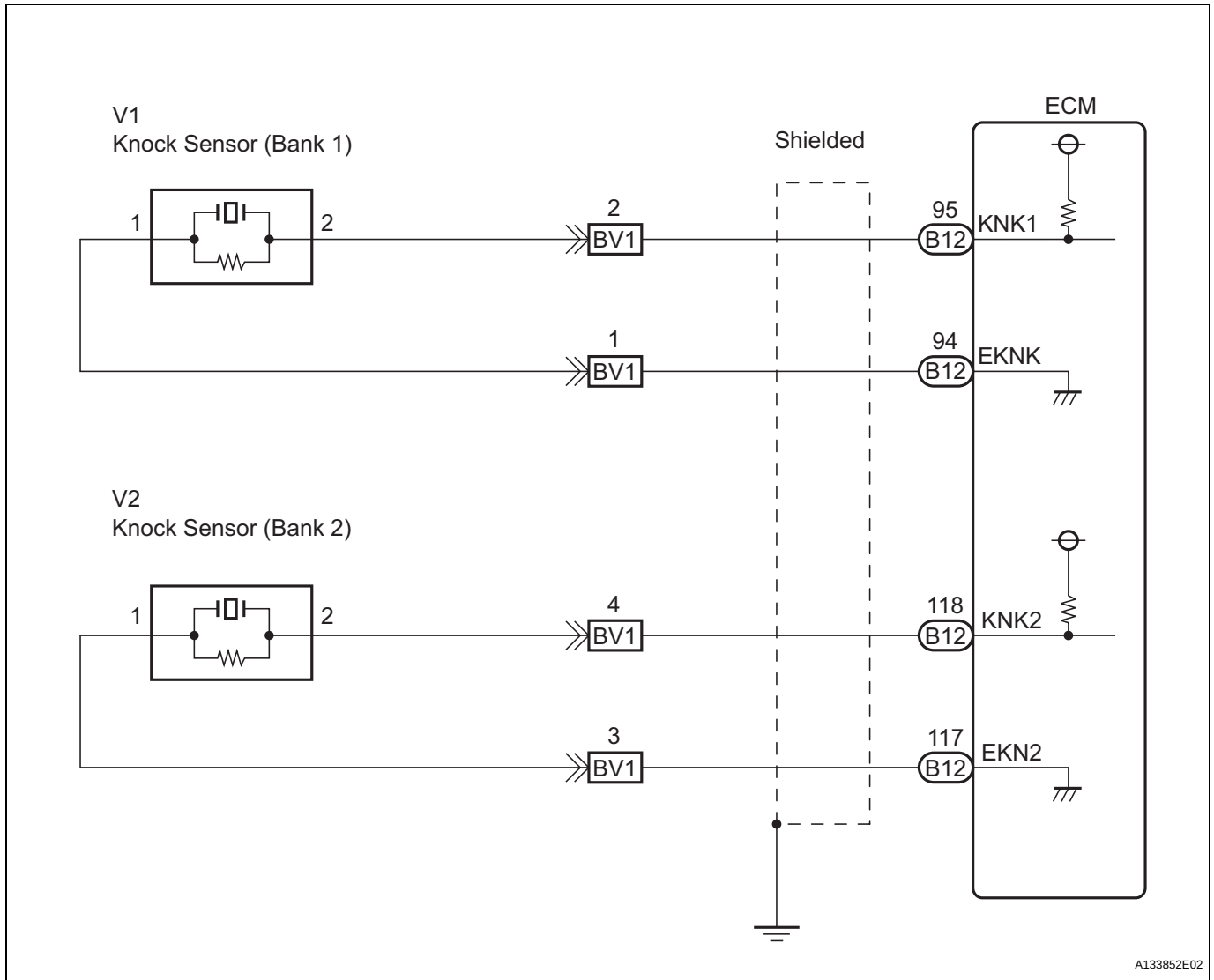
Knock Sensor Range Check (Low voltage) P0327 and P0332:

Knock sensor voltage	Less than 0.5 V
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Knock Sensor Range Check (High voltage) P0328 and P0333:

Knock sensor voltage	More than 4.5 V
----------------------	-----------------

WIRING DIAGRAM


ES

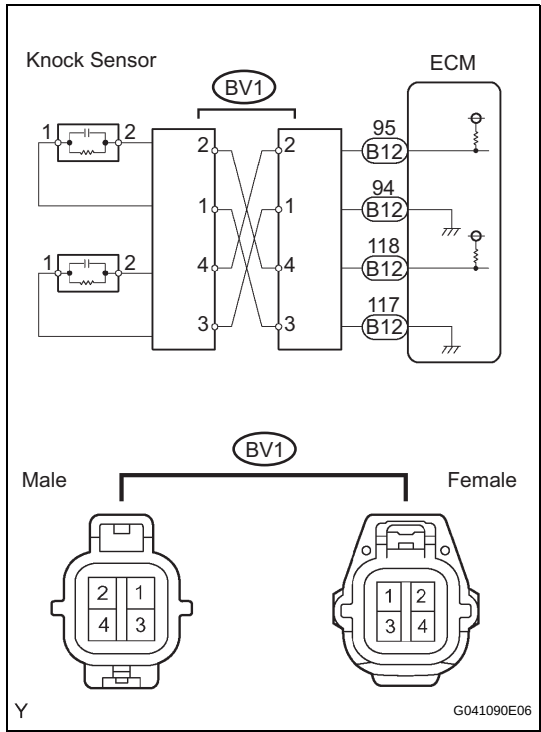
INSPECTION PROCEDURE

HINT:

- DTCs P0327 and P0328 are for the bank 1 knock sensor circuit.
- DTCs P0332 and P0333 are for the bank 2 knock sensor circuit.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

1

READ OUTPUT DTC (CHECK KNOCK SENSOR CIRCUIT)



- (a) Disconnect the BV1 connector.
(b) Using lead wires, connect the connectors as follows:

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

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

Result

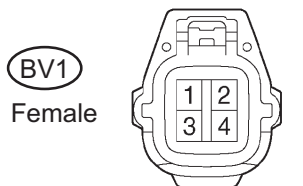
Display	Proceed to
DTCs same as when vehicle brought in: P0327, P0328 → P0327, P0328 or P0332, P0333 → P0332, P0333	A
DTCs different from when vehicle brought in: P0327, P0328 → P0332, P0333 or P0332, P0333 → P0327, P0328	B

- (i) Reconnect the BV1 connector.

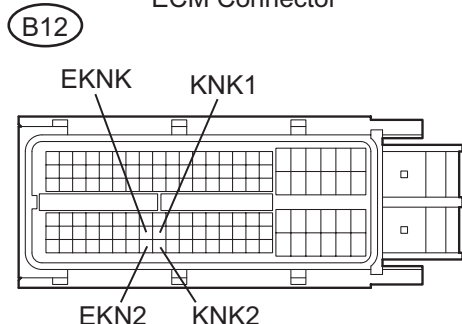
B

Go to step 4

A

2**CHECK WIRE HARNESS AND CONNECTOR (CONNECTOR - ECM)****Wire Harness Side:**BV1
Female

ECM Connector



A135193E04

- Disconnect the BV1 connector.
- Disconnect the B12 ECM connector.
- Measure the resistance according to the value(s) in the table below.

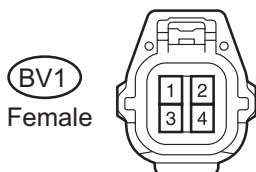
Standard resistance (Check for open)

Tester Connection	Specified Condition
BV1 female connector 2 - KNK1 (B12-95)	Below 1 Ω
BV1 female connector 1 - EKNK (B12-94)	Below 1 Ω
BV1 female connector 4 - KNK2 (B12-118)	Below 1 Ω
BV1 female connector 3 - EKN2 (B12-117)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
BV1 female connector 2 or KNK1 (B12-95) - Body ground	10 k Ω or higher
BV1 female connector 1 or EKNK (B12-94) - Body ground	10 k Ω or higher
BV1 female connector 4 or KNK2 (B12-118) - Body ground	10 k Ω or higher
BV1 female connector 3 or EKN2 (B12-117) - Body ground	10 k Ω or higher

- Reconnect the BV1 connector.
- Reconnect the ECM connector.

NG**REPAIR OR REPLACE HARNESS OR CONNECTOR****OK****3****INSPECT ECM**BV1
Female

N

A137955E02

- Disconnect the BV1 connector.
- Turn the engine switch on (IG).
- Measure the voltage according to the value(s) in the table below.

Standard voltage

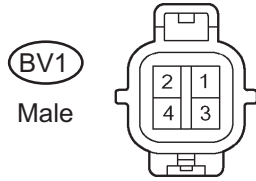
Tester Connection	Specified Condition
BV1 female connector 2 - 1	4.5 to 5.5 V
BV1 female connector 4 - 3	4.5 to 5.5 V

- Reconnect the ECM connector.

NG**REPLACE ECM (See page ES-543)****OK****CHECK FOR INTERMITTENT PROBLEMS**

4 INSPECT KNOCK SENSOR

Wire Harness Side:



G042949E06

- Disconnect the BV1 connector.
- Measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Specified Condition
BV1 male connector 1 - 2	120 to 280 k Ω
BV1 male connector 3 - 4	120 to 280 k Ω

- Reconnect the BV1 connector.

OK

CHECK FOR INTERMITTENT PROBLEMS

NG

5 CHECK HARNESS AND CONNECTOR (CONNECTOR - KNOCK SENSOR)

HINT:

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

- Disconnect the BV1 connector.
- Disconnect the V1 and V2 knock sensor connectors.
- Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open)

Tester Connection	Specified Condition
BV1 male connector 2 - V1-2	Below 1 Ω
BV1 male connector 1 - V1-1	Below 1 Ω
BV1 male connector 4 - V2-2	Below 1 Ω
BV1 male connector 3 - V2-1	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
BV1 male connector 2 or V1-2 - Body ground	10 k Ω or higher
BV1 male connector 1 or V1-1 - Body ground	10 k Ω or higher
BV1 male connector 4 or V2-2 - Body ground	10 k Ω or higher
BV1 male connector 3 or V2-1 - Body ground	10 k Ω or higher

- Reconnect the BV1 connector.
- Reconnect the knock sensor connectors.

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE KNOCK SENSOR (See page [ES-525](#))

ES

DTC	P0300	Random / Multiple Cylinder Misfire Detected
DTC	P0301	Cylinder 1 Misfire Detected
DTC	P0302	Cylinder 2 Misfire Detected
DTC	P0303	Cylinder 3 Misfire Detected
DTC	P0304	Cylinder 4 Misfire Detected
DTC	P0305	Cylinder 5 Misfire Detected
DTC	P0306	Cylinder 6 Misfire Detected

ES

DESCRIPTION

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

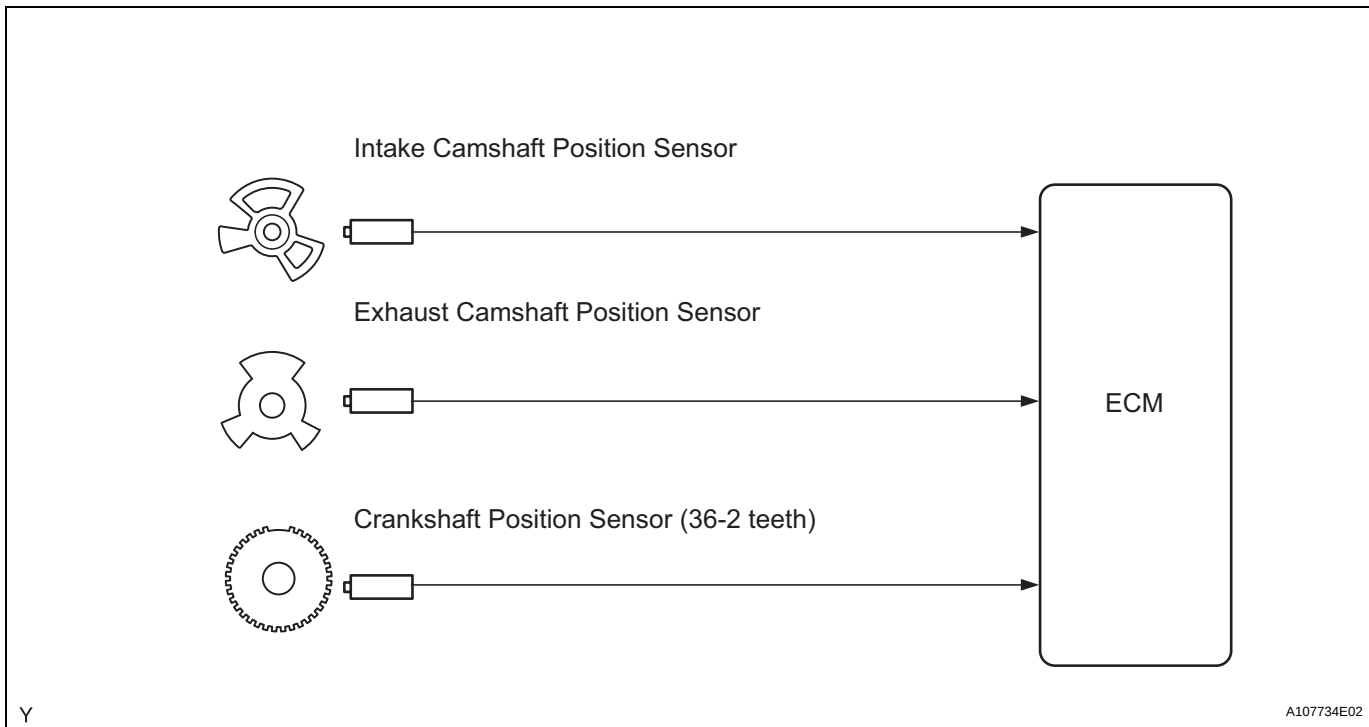
DTC No.	DTC Detection Condition	Trouble Area
P0300	Simultaneous misfiring of several cylinder detected (2 trip detection logic)	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant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

DTC No.	DTC Detection Condition	Trouble Area
P0301 P0302 P0303 P0304 P0305 P0306	Misfiring of specific cylinder detected (2 trip detection logic)	• Open or short in engine wire harness • Connector connection • Vacuum hose connections • Ignition system • Injector • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Compression pressure • Valve clearance • Valve timing • PCV valve and hose • PCV hose connections • Air induction system • ECM

ES

If DTCs that indicate misfires are set for different cylinders, but DTC P0300 is not set, it indicates that misfires have been detected in different cylinders at different times. DTC P0300 is only set when several misfiring cylinders are detected at the same time.

MONITOR DESCRIPTION



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

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

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

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

MONITOR STRATEGY

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

ES

TYPICAL ENABLING CONDITIONS

Misfire:

Monitor runs whenever following DTCs are not present	P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for Closed Loop) P0327 - P0333 (Knock sensor) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0500 (VSS)
Battery voltage	8 V or more
VVT system	Not operated by scan tool
Engine RPM	450 to 6,500 rpm
Either following condition (a) or (b) is met:	-
(a) ECT at engine start	More than -7°C (19°F)
(b) ECT	More than 20°C (68°F)
Fuel cut	OFF

Monitor period of emission-related-misfire:

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

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

All of following conditions 1, 2 and 3 are met:	Crankshaft 200 revolutions
1. Driving cycles	1st
2. Check mode	OFF
3. Engine RPM	Less than 2,500 rpm
Except above	Crankshaft 200 revolutions x 3

TYPICAL MALFUNCTION THRESHOLDS

Monitor period of emission-related-misfire:

Misfire rate	1 % or more
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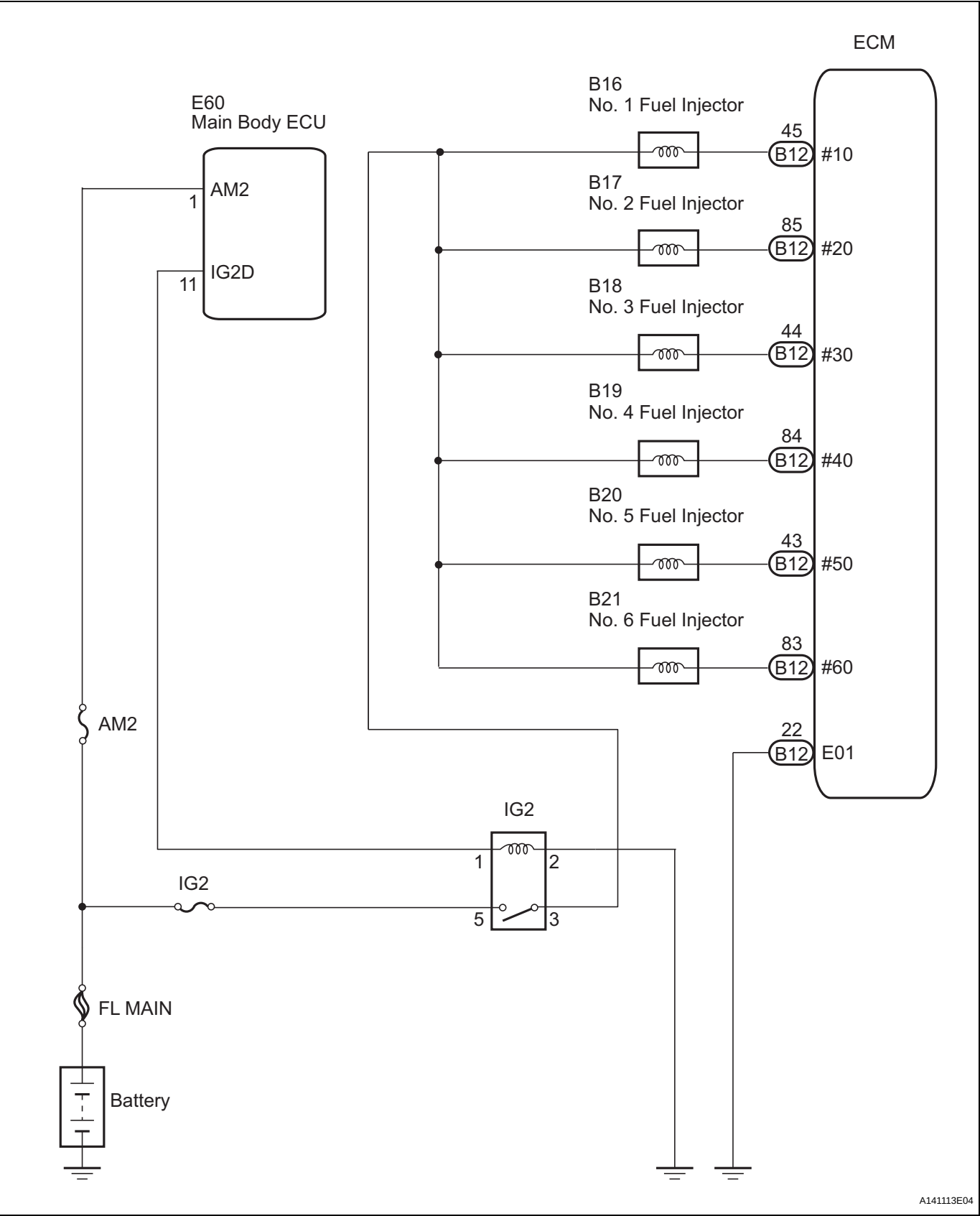
Monitor period of catalyst-damage-misfire (MIL blinks):

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

MONITOR RESULT

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

WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN

1. Connect the intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Record the DTC(s) and freeze frame data.
5. Using the tester, switch the ECM from normal mode to check mode (See page [ES-45](#)).
6. Read the misfire counts of each cylinder (CYL #10 to #60) with the engine in an idling condition. If any misfire count is displayed, skip the following confirmation driving pattern.
7. Drive the vehicle several times with the conditions, such as engine rpm and engine load, shown in MISFIRE RPM and MISFIRE LOAD in the DATA LIST.

HINT:

In order to store misfire DTCs, it is necessary to operate the vehicle for the period of time shown in the table below, using the MISFIRE RPM and MISFIRE LOAD in the DATA LIST.

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

8. Check whether misfires have occurred by checking DTCs and freeze frame data.

HINT:

Do not turn the engine switch off until the stored DTC(s) and freeze frame data have been recorded.

When the ECM returns to normal mode (default), the stored DTC(s), freeze frame data and other data will be erased.

9. Record the DTC(s), freeze frame data and misfire counts.
10. Turn the engine switch off and wait for at least 5 seconds.

INSPECTION PROCEDURE

HINT:

- If any DTCs other than misfire DTCs are output, troubleshoot those DTCs first.
- Read freeze frame data using 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](#)).
- If the misfire does not recur when the vehicle is brought to the workshop, reproduce the conditions stored in the ECM as freeze frame data.
- If the misfire still cannot be reproduced even though the conditions stored in the ECM as freeze frame data have been reproduced, one of the following factors is considered to be a possible cause of the problem:
 - (a) There was insufficient fuel in the tank.
 - (b) Improper fuel is used.
 - (c) The spark plugs have been contaminated.
 - (d) The problem requires further diagnosis.
- After finishing repairs, check the misfire counts of the cylinders (CYL #1, #2, #3, #4, #5 and #6).
- Be sure to confirm that no misfiring cylinder DTCs are set again by conducting the confirmation driving pattern after finishing repairs.
- For 6 and 8 cylinder engines, the ECM intentionally does not set the specific misfiring cylinder DTCs at a high engine RPM. If misfires occur only in high engine RPM areas, only DTC P0300 is set. In the event of DTC P0300 being present, perform the following operations:
 - (a) Clear the DTC (See page [ES-41](#)).
 - (b) Start the engine and conduct the confirmation driving pattern.
 - (c) Read the misfiring rates of each cylinder or DTC(s) using the tester.

(d) Repair the cylinder(s) that has a high misfiring rate or is indicated by the DTC.

(e) After finishing repairs, conduct the confirmation driving pattern again, in order to verify that DTC P0300 is not set.

- When one of SHORT FT #1, LONG FT #1, SHORT FT #2 or LONG FT #2 in the freeze frame data is outside the range of +20 %, the air-fuel ratio may be RICH (-20 % or less) or LEAN (+20 % or more).
- When COOLANT TEMP in the freeze frame data is less than 75°C (167°F), misfires have occurred only while warming up the engine.

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

- (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
P0300, P0301, P0302, P0303, P0304, P0305 and/or P0306	A
P0300, P0301, P0302, P0303, P0304, P0305 and/or P0306 and other DTCs	B

HINT:

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

B

GO TO DTC CHART (See page ES-59)

A

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

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG) and turn the tester on.
- (c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / MISFIRE RPM and MISFIRE LOAD.
- (d) Read and note the MISFIRE RPM and MISFIRE LOAD (engine load) values.

HINT:

The MISFIRE RPM and MISFIRE LOAD values indicate the vehicle conditions under which the misfire occurred.

NEXT

3 CHECK PCV HOSE (HOSE CONNECTIONS)

OK:

PCV hose is connected correctly and is not damaged.

NG

REPAIR OR REPLACE PCV HOSE

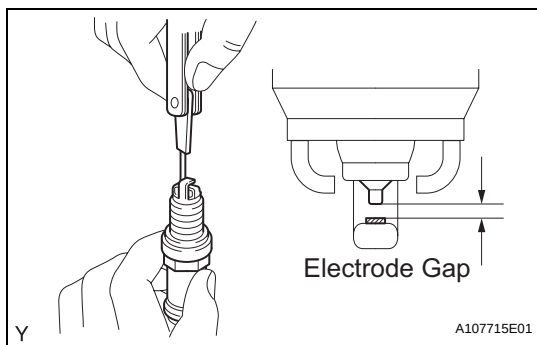
OK

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

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG).
- (c) Turn the tester on.
- (d) Clear the DTCs.
- (e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / CYL #1, #2, #3, #4, #5 and #6 (Step "A").
- (f) Allow the engine to idle (Step "B").
- (g) Read the value of CYL #1 to #6 displayed on the tester. If no misfire counts occur in any cylinders, perform the following operations (Step "C"):
 - (1) Shift the gear selector lever to the D position.
 - (2) Repeat steps "A" to "C" above.
 - (3) Check the CYL #1 to #6.
 - (4) If misfire counts are still not displayed, perform steps "D" and "E" and then check the misfire counts again.
- (h) Drive the vehicle with MISFIRE RPM and MISFIRE LOAD noted in step 2 (Step "D").
- (i) Read CYL #1 to #6 or DTCs displayed on the tester (Step "E").

Result

Misfire count	Proceed to
1 or 2 cylinders have misfire counts	A
3 cylinders or more have misfire counts	B

B**Go to step 13****A****5 CHECK SPARK PLUG**

- (a) Remove the ignition coil and the spark plug of the misfiring cylinder.
- (b) Measure the spark plug electrode gap.
Standard:
Between 1.0 mm and 1.4 mm (0.039 in. and 0.055 in.)
- (c) Check the electrode for carbon deposits.
Recommended spark plug:

Manufacturer	Product
DENSO	FK20HR11

NOTICE:

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

NG**REPLACE SPARK PLUG****ES**

OK

6 CHECK FOR SPARKS AND IGNITION

- (a) Disconnect the injector connectors, in order to prevent the engine from starting.
- (b) Install the spark plug to the ignition coil.
- (c) Attach the spark plug assembly to the cylinder head cover.
- (d) Crank the engine for less than 2 seconds and check the sparks.

OK:**Sparks jump across the electrode gap.**

- (e) Reconnect the injector connectors.

NG

Go to step 8

OK

7 CHECK CYLINDER COMPRESSION PRESSURE (MALFUNCTION CYLINDER)

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

OK

Go to step 9

NG

REPAIR OR REPLACE ENGINE TO DETERMINE CAUSE OF LOW COMPRESSION**8 CHANGE SPARK PLUG WITH NORMAL ONE AND CHECK FOR SPARKS OF MISFIRING CYLINDER**

- (a) Change the installed spark plug with a spark plug that functions normally.
- (b) Perform a spark test.

CAUTION:**Always disconnect each injector connector.****NOTICE:****Do not crank the engine for more than 2 seconds.**

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

OK:**Sparks jump across the electrode gap.**

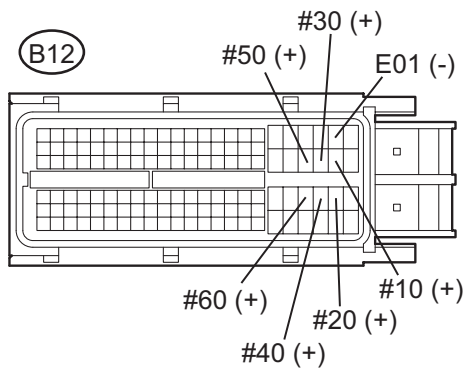
NG

REPLACE IGNITION COIL ASSEMBLY (See page IG-8)

OK

REPLACE SPARK PLUG**9****INSPECT ECM (#10, #20, #30, #40, #50 AND/OR #60 VOLTAGE))****Wire Harness Side Front View:**

ECM Connector



- Disconnect the B12 ECM connector.
- Turn the engine switch on (IG).
- Measure the voltage between the terminals.

Standard voltage

Tester Connection	Specified Condition
#10 (B12-45) - E01 (B12-22)	9 to 14 V
#20 (B12-85) - E01 (B12-22)	9 to 14 V
#30 (B12-44) - E01 (B12-22)	9 to 14 V
#40 (B12-84) - E01 (B12-22)	9 to 14 V
#50 (B12-43) - E01 (B12-22)	9 to 14 V
#60 (B12-83) - E01 (B12-22)	9 to 14 V

- Reconnect the ECM connector.

OK

Go to step 12

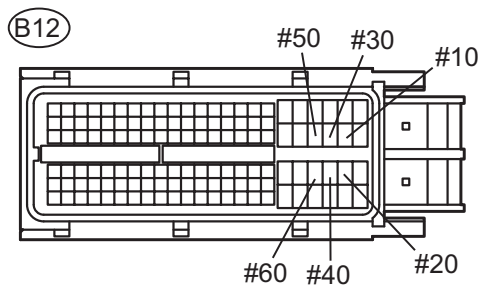
NG

10**CHECK HARNESS AND CONNECTOR (INJECTOR - ECM)****Wire Harness Side Front View:**

Injector Connector



ECM Connector



- Disconnect the injector connector (misfire cylinder).
- Disconnect the B12 ECM connector.
- Measure the resistance according to the value(s) in the table below.

Standard resistance

Tester Connection	Specified Condition
#10 (B12-45) - B16-1	Below 1 Ω
#20 (B12-85) - B17-1	Below 1 Ω
#30 (B12-44) - B18-1	Below 1 Ω
#40 (B12-84) - B19-1	Below 1 Ω
#50 (B12-43) - B20-1	Below 1 Ω
#60 (B12-83) - B21-1	Below 1 Ω
#10 (B12-45) or B16-1 - Body ground	10 k Ω or higher
#20 (B12-85) or B17-1 - Body ground	10 k Ω or higher
#30 (B12-44) or B18-1 - Body ground	10 k Ω or higher
#40 (B12-84) or B19-1 - Body ground	10 k Ω or higher
#50 (B12-43) or B20-1 - Body ground	10 k Ω or higher
#60 (B12-83) or B21-1 - Body ground	10 k Ω or higher

- Reconnect the injector connector.
- Reconnect the ECM connector.

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

ES

OK

11 CHECK FUEL INJECTOR ASSEMBLY (MISFIRING CYLINDER)

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

NG

REPLACE FUEL INJECTOR ASSEMBLY (See page [FU-12](#))

OK

ES**12 CHECK VALVE CLEARANCE (MISFIRING CYLINDER)**

NG

ADJUST VALVE CLEARANCE

OK

13 CHECK AIR INDUCTION SYSTEM

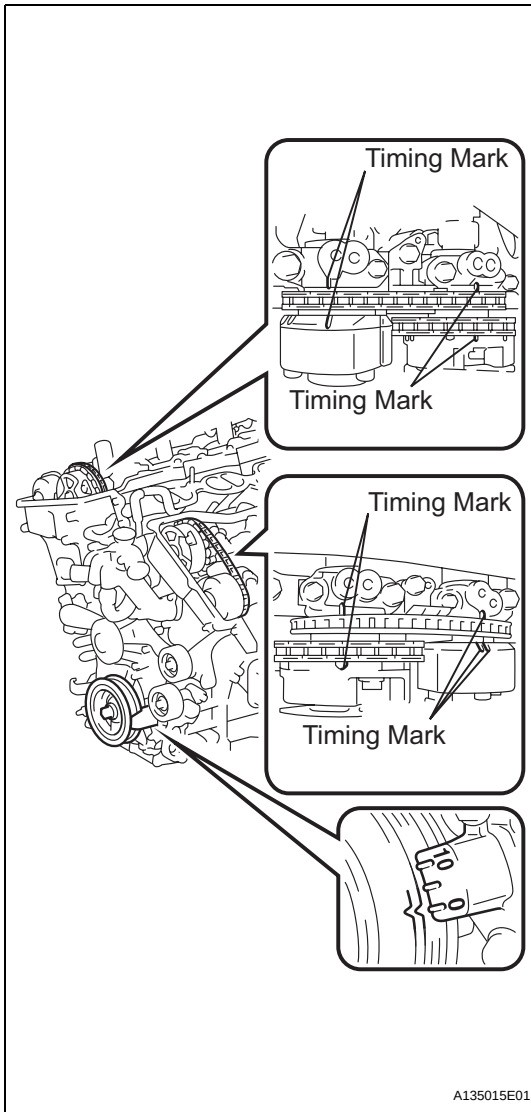
- (a) Check the air induction system for vacuum leakage.

OK:**No leakage from air induction system.**

NG

REPAIR OR REPLACE AIR INDUCTION SYSTEM

OK

14 CHECK VALVE TIMING

- Remove the cylinder head covers.
- 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°) and 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****15 CHECK FUEL PRESSURE**

- Check the fuel pressure (high or low pressure).
Standard

Item	Standard Condition
Fuel pressure	147 kPa (1.5 kgf/cm ² , 21 psi)

NG**CHECK AND REPLACE FUEL SYSTEM****OK****16 READ VALUE ON INTELLIGENT TESTER (COOLANT TEMP)**

- Connect the intelligent tester to the DLC3.

ES

- (b) Turn the engine switch on (IG).
- (c) Turn the tester on.
- (d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
- (e) Read COOLANT TEMP twice, when the engine is both cold and warmed up.

Standard:**With cold engine:****Same as ambient air temperature.****With warm engine:****Between 75°C and 95°C (167°F and 203°F).****NG****REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page [ES-516](#))****OK****17 READ VALUE OF INTELLIGENT TESTER (MAF)**

- (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 / MAF and COOLANT TEMP.
- (e) Allow the engine to idle until COOLANT TEMP reaches 75°C (167°F) or more.
- (f) Read the MAF with the engine in an idling condition and at an engine speed of 2,500 rpm.

Standard:**MAF while engine is idling:****Between 2.1 g/sec and 3.1 g/sec (shift position: N, A/C: OFF).****MAF at an engine speed of 2,500 rpm:****Between 7.8 g/sec and 11.4 g/sec (shift position: N, A/C: OFF).****NG****REPLACE MASS AIR FLOW METER (See page [ES-497](#))****OK****18 CHECK MISFIRE COUNT (CYL #1, #2, #3, #4, #5 AND #6)****HINT:**

- If the result of step 4 is "1 or 2 cylinders", proceed to A.
- If the result of step 4 is "more than 3 cylinders", proceed to B.

B**Go to step 5****A****CHECK FOR INTERMITTENT PROBLEMS**

DTC	P0171	System Too Lean (Bank 1)
DTC	P0172	System Too Rich (Bank 1)
DTC	P0174	System Too Lean (Bank 2)
DTC	P0175	System Too Rich (Bank 2)

DESCRIPTION

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

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

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

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

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

HINT:

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

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

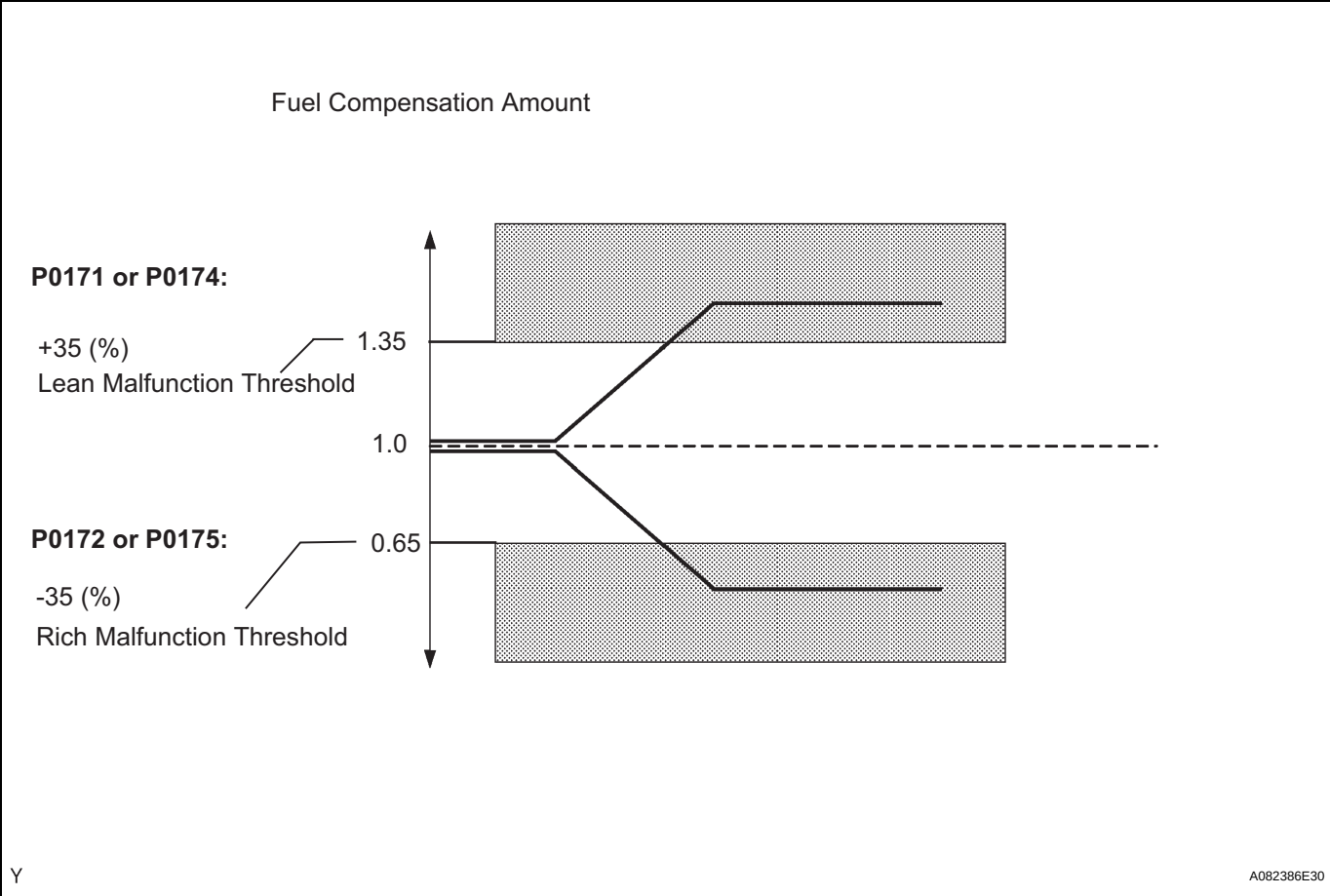
MONITOR DESCRIPTION

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

Example:

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

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MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

Fuel trim:

The monitor will run whenever these DTCs are not present	P0010, P0020 (VVT VSV1, 2), P0011, P0012 (VVT System-Advance, Retard), P0021, P0022(VVT System2-Advance, Retard), P0031, P0031, P0032, P0051, P0052 (A/F Sensor heater Sensor 1), P0100, P0101, P0102, P0103 (MAF Sensor), P0115, P0116, P0117, P0118 (ECT Sensor), P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (TP Sensor), P0125 (Insufficient ECT for Closed Loop), P0335 (CKP Sensor), P0340, P0342, P0343, P0345 (VVT Sensor 1, 2), P0351, P0352, P0353, P0354, P0356 (Ignitor), P0500 (VSS),
Fuel system status	Closed-loop
Battery voltage	11 V or more
Either following condition is met	Condition 1 or 2
1. Engine RPM	Less than 1,100 rpm
2. Intake air amount per revolution	0.22 g/rev or more

TYPICAL MALFUNCTION THRESHOLDS

Fuel trim:

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

WIRING DIAGRAM

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

INSPECTION PROCEDURE

HINT:

For use of the intelligent tester only:

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

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

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

HINT:

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

Standard voltage

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

Tester Display (Sensor)	Injection Volumes	Status	Voltages
O2S B1S2 or O2S B2S2 (HO2)	+25%	Rich	More than 0.55
O2S B1S2 or O2S B2S2 (HO2)	-12.5%	Lean	Less than 0.4

NOTICE:

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

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.55 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		- A/F sensor - A/F sensor heater - A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.55 V Less than 0.4 V		
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		- HO2 sensor - HO2 sensor heater - HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage Almost no reaction		
4	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		- Injector - Fuel pressure - Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

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

HINT:

- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.
- A low A/F sensor voltage could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.
- A high A/F sensor voltage could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.

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

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

Result

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

HINT:

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

B

GO TO DTC CHART (See page ES-59)

A

2 CHECK PCV HOSE CONNECTIONS

OK:

PCV hose is connected correctly and is not damaged.

NG

REPAIR OR REPLACE PCV HOSE

OK

3 CHECK AIR INDUCTION SYSTEM

- (a) Check the air induction system for vacuum leakage.

OK:

No leakage from the air induction system.

NG

REPAIR OR REPLACE AIR INDUCTION SYSTEM

OK

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

- (a) Connect the intelligent tester to the DLC3.
- (b) Start the engine and turn the tester on.
- (c) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
- (d) Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
- (e) Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).

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

HINT:

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

Standard voltage

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

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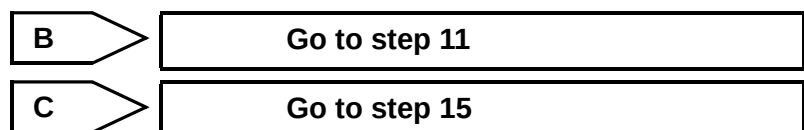
Result

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

Lean: During A/F CONTROL, the A/F sensor output voltage (AFS) is consistently more than 3.35 V, and the HO2 sensor output voltage (O2S) is consistently less than 0.4 V.

Rich: During A/F CONTROL, the AFS is consistently less than 3.0 V, and the O2S is consistently more than 0.55 V.

Lean/Rich: During A/F CONTROL of the ACTIVE TEST, the output voltage of the heated oxygen sensor alternates correctly.



A

5

READ VALUE OF INTELLIGENT TESTER (COOLANT TEMP)

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

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

NG

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page [ES-516](#))

OK

6

READ VALUE OF INTELLIGENT TESTER (MAF)

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

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

NG

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

OK

7

CHECK FUEL PRESSURE

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

NG

REPAIR OR REPLACE FUEL SYSTEM

OK**8 CHECK FOR EXHAUST GAS LEAKS**

OK:

No gas leakage.

NG**REPAIR OR REPLACE EXHAUST SYSTEM**OK**9 CHECK FOR SPARKS AND IGNITION**

- (a) Check for sparks and ignition (See page ES-214).

HINT:

If the spark plugs or ignition system malfunctions, engine misfire may occur. The misfire count can be read using the intelligent tester. Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / CYL #1 (to CYL #6).

NG**REPAIR OR REPLACE IGNITION SYSTEM**OK**10 INSPECT FUEL INJECTOR ASSEMBLY (INJECTION AND VOLUME)**

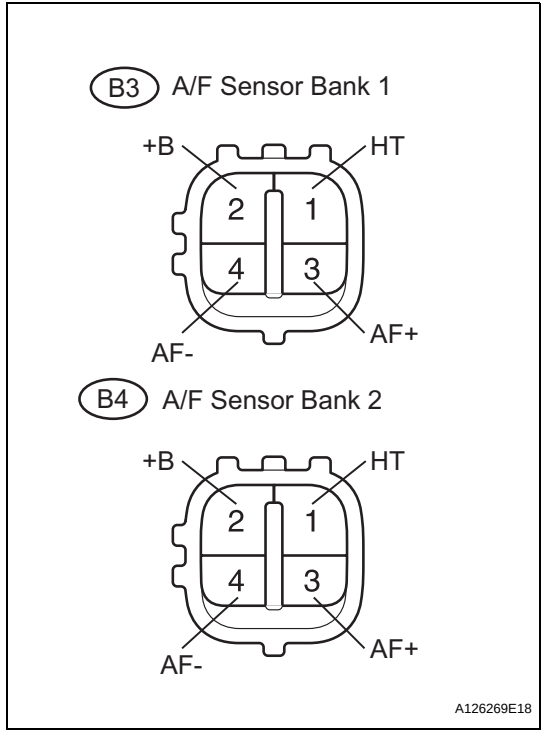
- (a) Inspect the fuel injector assembly (See page
- [FU-14](#)
-).

HINT:

If the injectors malfunction, engine misfire may occur. The misfire count can be read using the intelligent tester. Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / CYL #1 (to CYL #6).

NG**REPLACE FUEL INJECTOR ASSEMBLY (See page [FU-12](#))**OK

11INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



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

Standard resistance:

Bank 1

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

Bank 2

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

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

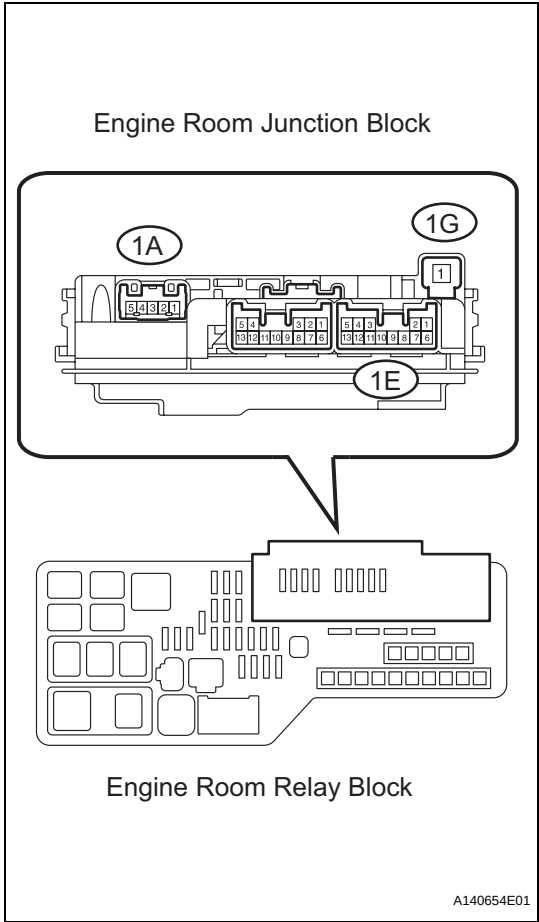
NG

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

OK

ES

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



- (a) Remove the engine room junction block from the engine room R/B.
- (b) Measure the A/F relay resistance.
- Standard resistance**

Tester Connections	Specified Conditions
1G-1 - 1A-4	10 kΩ or higher
1G-1 - 1A-4	Below 1 Ω (when battery voltage applied to terminals 1E-6 and 1E-10)

- (c) Reinstall the engine room junction block.

NG

REPLACE ENGINE ROOM JUNCTION BLOCK

OK

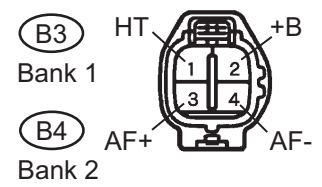
ES

13

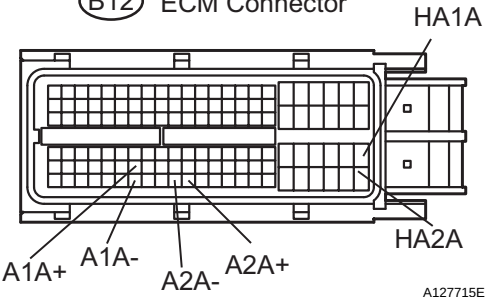
CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

Wire Harness Side:

Air Fuel Ratio Sensor Connector



(B12) ECM Connector



A127715E34

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

Standard voltage

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

- (d) Turn the engine switch off.
- (e) Disconnect the B12 ECM connector.
- (f) Measure the resistance.

Standard resistance (Check for open)

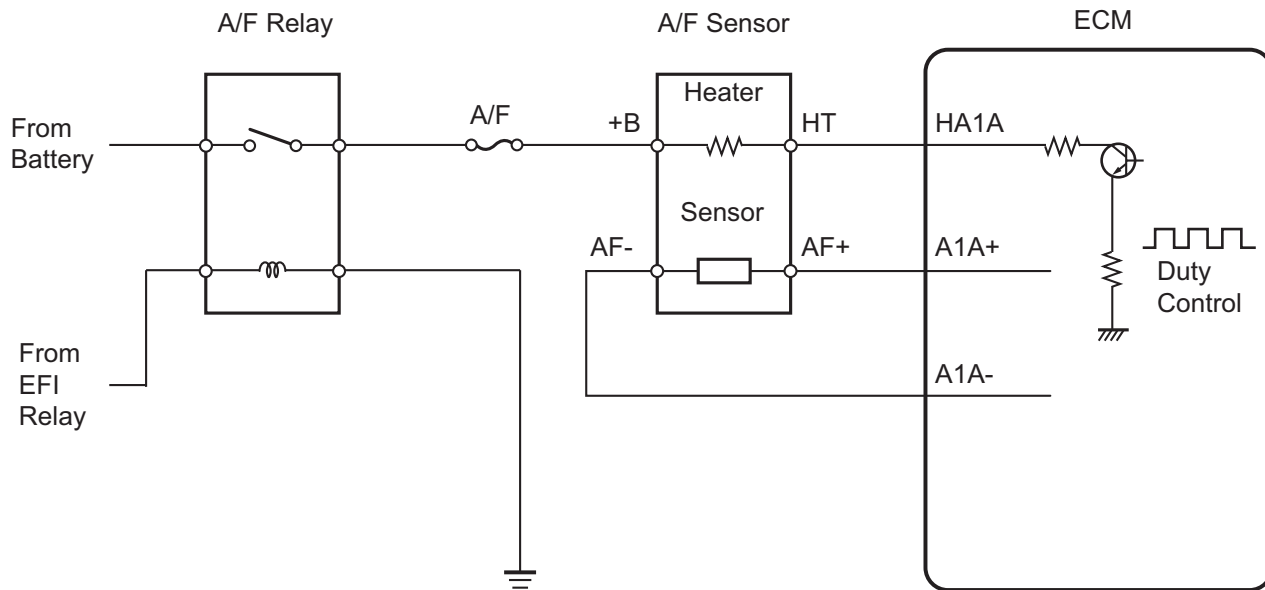
Tester Connections	Specified Conditions
HT (B3-1) - HA1A (B12-86)	Below 1 Ω
AF+ (B3-3) - A1A+ (B12-93)	Below 1 Ω
AF- (B3-4) - A1A- (B12-116)	Below 1 Ω
HT (B4-1) - HA2A (B12-109)	Below 1 Ω
AF+ (B4-3) - A2A+ (B12-120)	Below 1 Ω
AF- (B4-4) - A2A- (B12-119)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HT (B3-1) or HA1A (B12-86) - Body ground	10 kΩ or higher
AF+ (B3-3) or A1A+ (B12-93) - Body ground	10 kΩ or higher
AF- (B3-4) or A1A- (B12-116) - Body ground	10 kΩ or higher
HT (B4-1) or HA2A (B12-109) - Body ground	10 kΩ or higher
AF+ (B4-3) or A2A+ (B12-120) - Body ground	10 kΩ or higher
AF- (B4-4) or A2A- (B12-119) - Body ground	10 kΩ or higher

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

Reference (System Diagram of Bank 1 Sensor 1):



NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

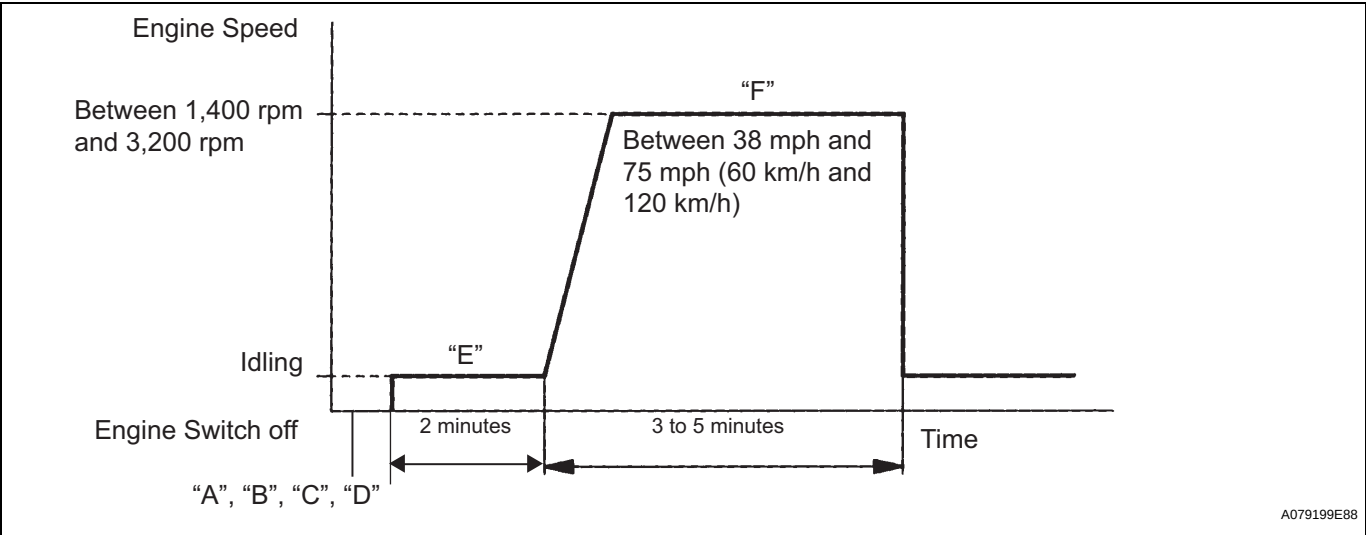
14 REPLACE AIR FUEL RATIO SENSOR

- (a) Replace the air fuel ratio sensor (See page [EC-19](#)).

NEXT

15 PERFORM CONFIRMATION DRIVING PATTERN

- Connect the intelligent tester to the DLC3 (Procedure A).
- Turn the engine switch on (IG) and turn the tester on (Procedure B).
- Clear the DTCs (See page [ES-41](#)) (Procedure C).
- Select the check mode using the tester (See page [ES-45](#)) (Procedure D).
- Start the engine and warm it up with all the accessories switched off (Procedure E).
- Drive the vehicle at between 38 mph and 75 mph (60 km/h and 120 km/h) and at an engine speed of between 1,400 rpm and 3,200 rpm for 3 to 5 minutes (Procedure F).



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

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

NEXT

16

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

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

Result

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

B

Go to step 5

A

END

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

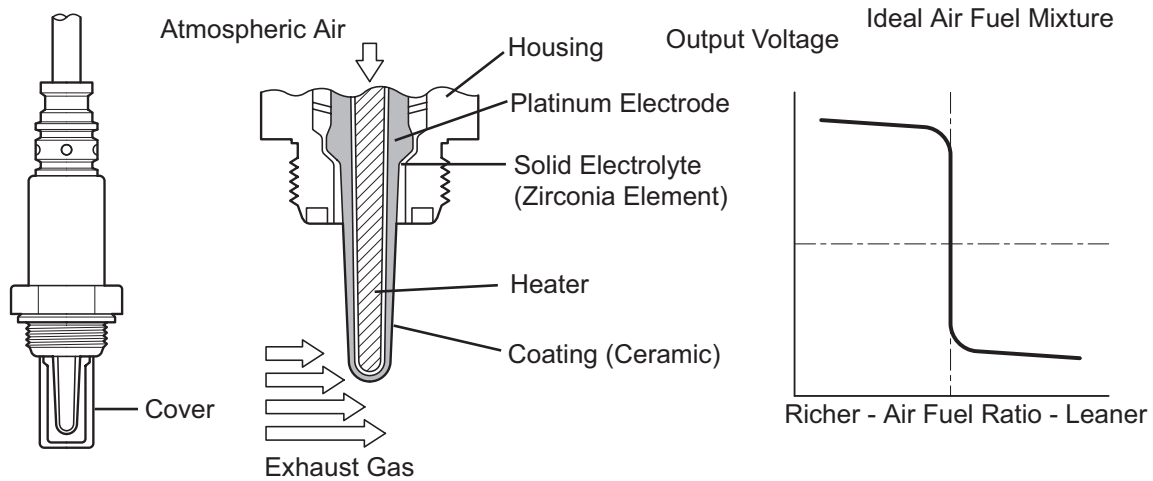
DESCRIPTION

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

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

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

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



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

MONITOR DESCRIPTION

1. Active Air-Fuel Ratio Control

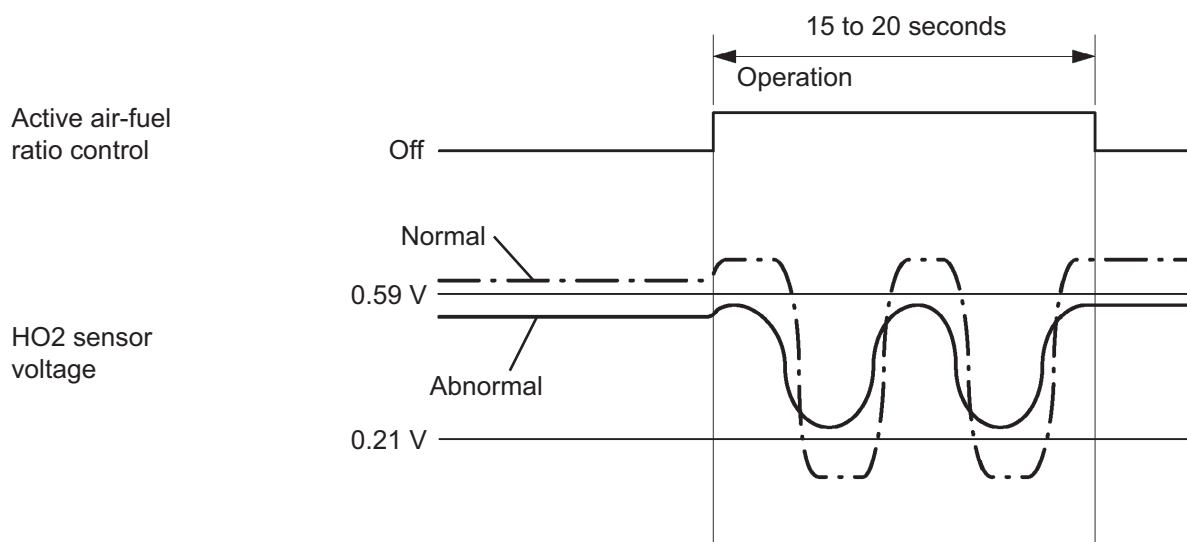
The ECM usually performs air-fuel ratio feedback control so that the Air-Fuel Ratio (A/F) sensor output indicates a near stoichiometric air-fuel level. This vehicle includes active air-fuel ratio control in addition to regular air-fuel ratio control. The ECM performs active air-fuel ratio control to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

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

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

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

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



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

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

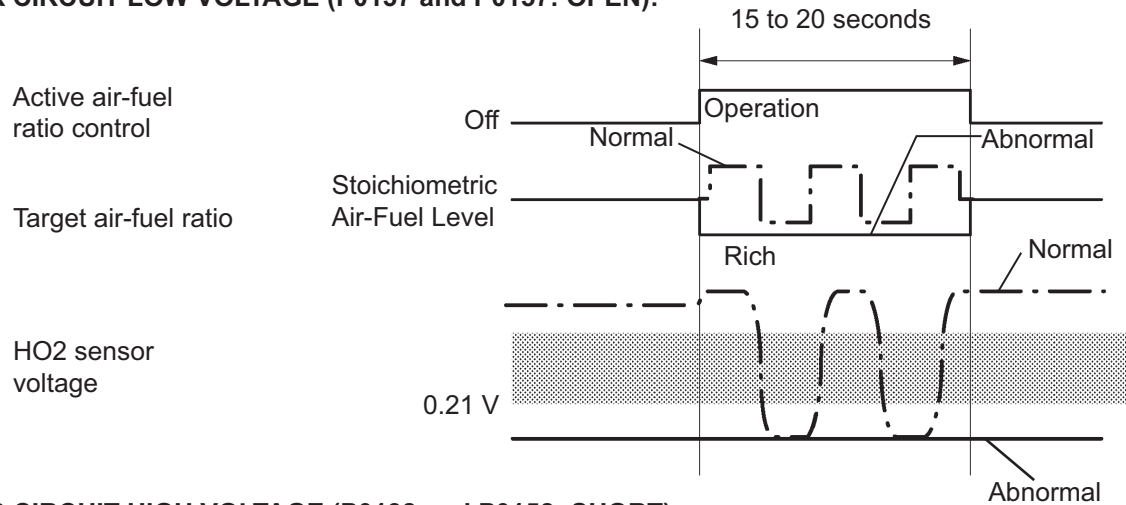
While performing active air-fuel ratio control, when the target air-fuel ratio is rich and the HO2 sensor voltage output is 0.21 V or less (lean), the ECM interprets this as an abnormally low sensor output voltage and sets DTC P0137 or P0157. When the target air-fuel ratio is lean and the voltage output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

HINT:

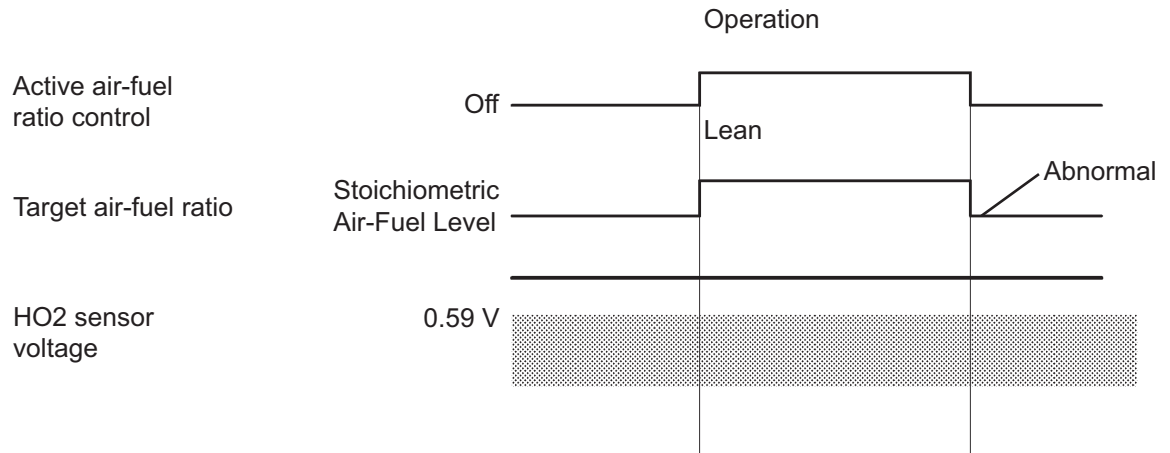
DTC P0138 or P0158 is also set if the HO2 sensor voltage output is more than 1.2 V for 30 seconds or more.

*: The TWC has the capability to store oxygen. The OSC and the emission purification capacity of the TWC are mutually related. The ECM determines whether the catalyst has deteriorated, based on the calculated OSC value (See page [ES-245](#)).

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



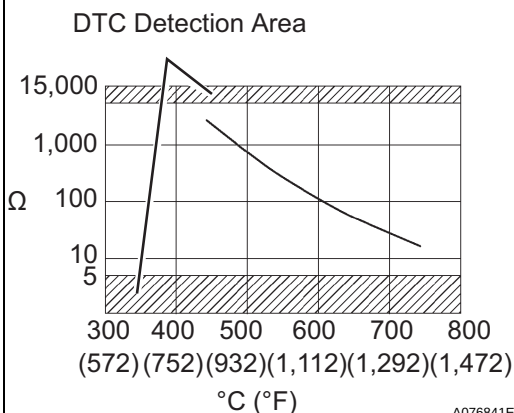
HO2 SENSOR CIRCUIT HIGH VOLTAGE (P0138 and P0158: SHORT):



Y

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Interrelation between temperature of element and impedance:



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

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

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

HINT:

- The impedance cannot be measured using an ohmmeter.

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

MONITOR STRATEGY

ES

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

TYPICAL ENABLING CONDITIONS

All:

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

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

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

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

HO2S low impedance (P0136, P0156):

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

HO2S high impedance (P0137, P0157):

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

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

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

TYPICAL MALFUNCTION THRESHOLDS**HO2S voltage (P0136, P0156):**

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

HO2S low impedance (P0136, P0156):

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

HO2S high impedance (P0137, P0157):

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

HO2S low voltage (P0137, P0157):

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

HO2S high voltage (P0138, P0158):

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

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

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

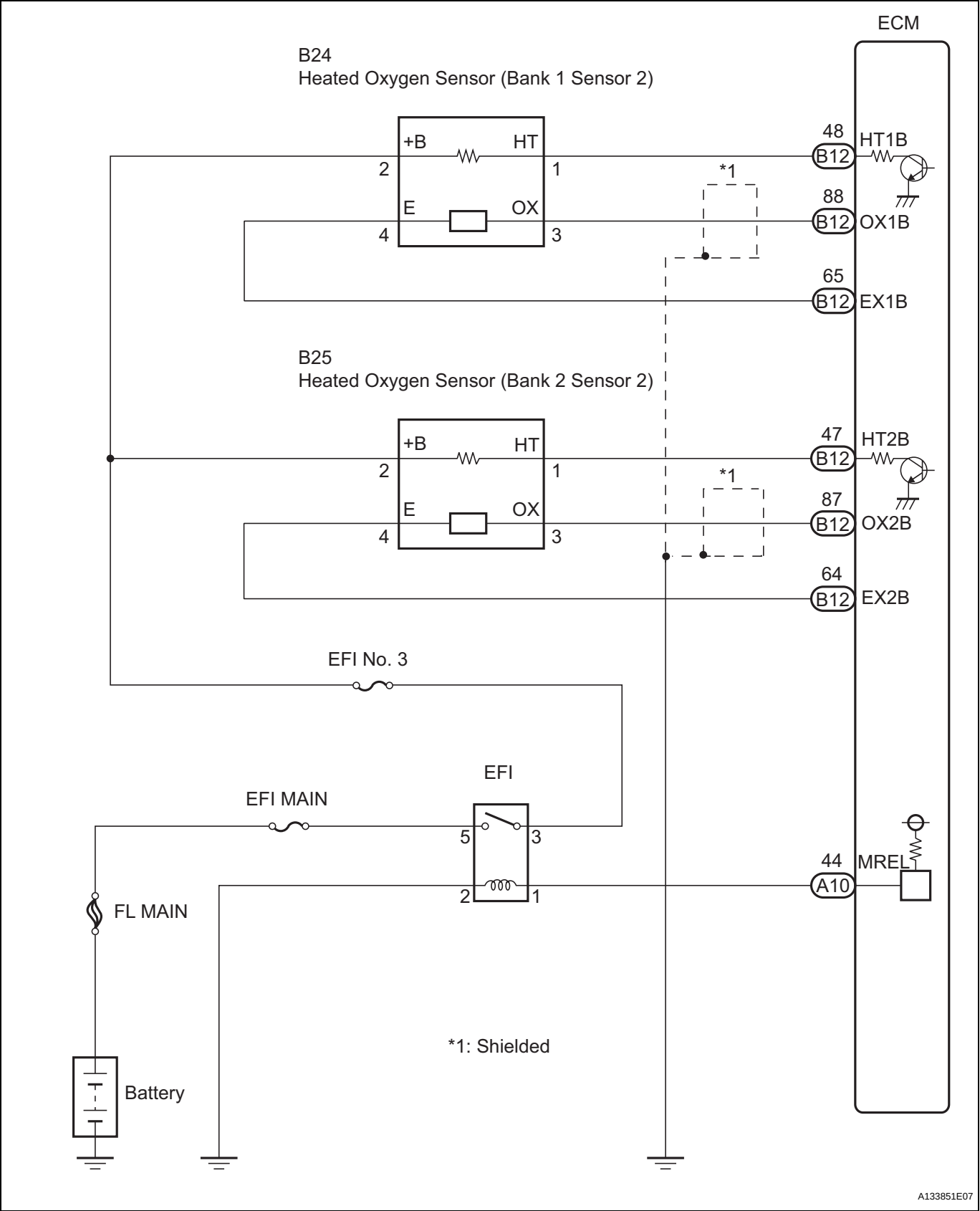
COMPONENT OPERATING RANGE

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

MONITOR RESULT

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

WIRING DIAGRAM



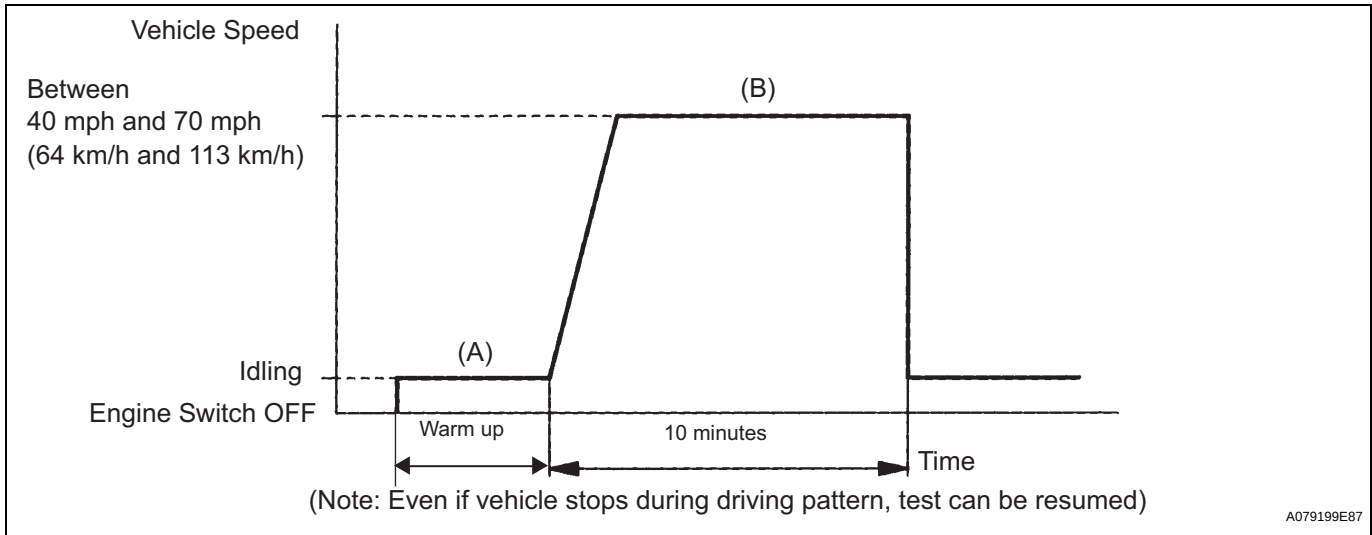
CONFIRMATION DRIVING PATTERN

HINT:

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

NOTICE:

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



READINESS TESTS	
MISFIRE MON	AVAIL
FUEL SYS MON	AVAIL
COMP MON	AVAIL
CAT EVAL	INCMPL
HTD CAT EVAL	N/A
EVAP EVAL	INCMPL
2nd AIR EVAL	N/A
A/C EVAL	N/A
O2S EVAL	INCMPL
O2S HTR EVAL	INCMPL
EGR EVAL	N/A

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1. Connect an intelligent tester to the DLC3.
2. Turn the engine switch on (IG).
3. Turn the tester on.
4. Clear the DTCs (where set) (See page [ES-41](#)).
5. Select the following menu items: DIAGNOSIS / CARB OBD II / READINESS TESTS.
6. Check that O₂S EVAL is INCMPL (incomplete).
7. Start the engine and warm it up (Procedure "A").
8. Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes (Procedure "B").
9. Note the state of the Readiness Tests items. Those items will change to COMPL (complete) as O₂S EVAL monitor operates.
10. On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES and check if any DTCs (any pending DTCs) are set.

HINT:

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

INSPECTION PROCEDURE

HINT:

Intelligent tester only:

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

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

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

HINT:

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

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

NOTICE:

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

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

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

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

HINT:

- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).
- If the OX1B wire from the ECM connector is short-circuited to the +B wire, DTC P0136 will be set.
- If the OX2B wire from the ECM connector is short-circuited to the +B wire, DTC P0156 will be set.

1 READ DTC OUTPUT

- 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
P0138 or P0158	A
P0137 or P0157	B
P0136 or P0156	C

B

Go to step 14

C

Go to step 7

A

2 READ VALUE OF OXYGEN SENSOR (OUTPUT VOLTAGE)

- Connect the intelligent tester to the DLC3.
- Turn the engine switch on (IG) and turn the tester on.

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

Result

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

B

Go to step 5

A

ES

3

CHECK HARNESS AND CONNECTOR (CHECK FOR SHORT)

Wire Harness Side:

B12

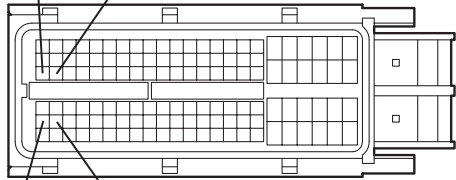
 ECM Connector

HT2B

HT1B

OX2B

OX1B



A137016E09

- (a) Turn the engine switch off and wait for 5 minutes.
- (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
HT1B (B12-48) - OX1B (B12-88)	10 kΩ or higher
HT2B (B12-47) - OX2B (B12-87)	10 kΩ or higher

- (d) Reconnect the ECM connector.

NG

Go to step 4

OK

REPLACE ECM (See page ES-543)

4

INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)

Component Side:

Heated Oxygen Sensor

B24

Bank 1

+B

2

1

HT

4

3

E

OX

B25

Bank 2

+B

2

1

HT

4

3

E

OX

A137614E12

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

Standard resistance (Bank 1 sensor 2)

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

Standard resistance (Bank 2 sensor 2)

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

NG

REPLACE HEATED OXYGEN SENSOR (See page EC-21)

OK

REPAIR OR REPLACE HARNESS OR CONNECTOR

5

PERFORM CONFIRMATION DRIVING PATTERN

NEXT

6

CHECK WHETHER DTC OUTPUT RECURS (DTC P0138 or P0158)

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

Result

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

A

B

CHECK FOR INTERMITTENT PROBLEMS

REPLACE HEATED OXYGEN SENSOR (See page EC-21)

ES

7 READ VALUE OF OXYGEN SENSOR (OUTPUT VOLTAGE)

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the engine switch on (IG) and turn the tester on.
- (c) Start the engine.
- (d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / O2S B1S2 or O2S B1S2.
- (e) After warming up the engine, run the engine at an engine speed of 2,500 rpm for 3 minutes.
- (f) Read the output voltage of the HO2 sensor when the engine rpm is suddenly increased.

HINT:

Quickly accelerate the engine to 4,000 rpm 3 times using the accelerator pedal.

Standard voltage:

Fluctuates between 0.4 V or less and 0.5 V or more.

NG

Go to step 14

OK

8 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

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

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

Result

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

B

CHECK FOR INTERMITTENT PROBLEMS

A

10 REPLACE HEATED OXYGEN SENSOR

- (a) Replace the hated oxygen sensor (See page [EC-21](#)).

NEXT

ES

11 PERFORM CONFIRMATION DRIVING PATTERN**NEXT****12 CHECK WHETHER DTC OUTPUT RECURS (DTC P0136 or P0156)**

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

ES Result

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

B**END****A****13 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (INJECTION VOLUME)**

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

HINT:

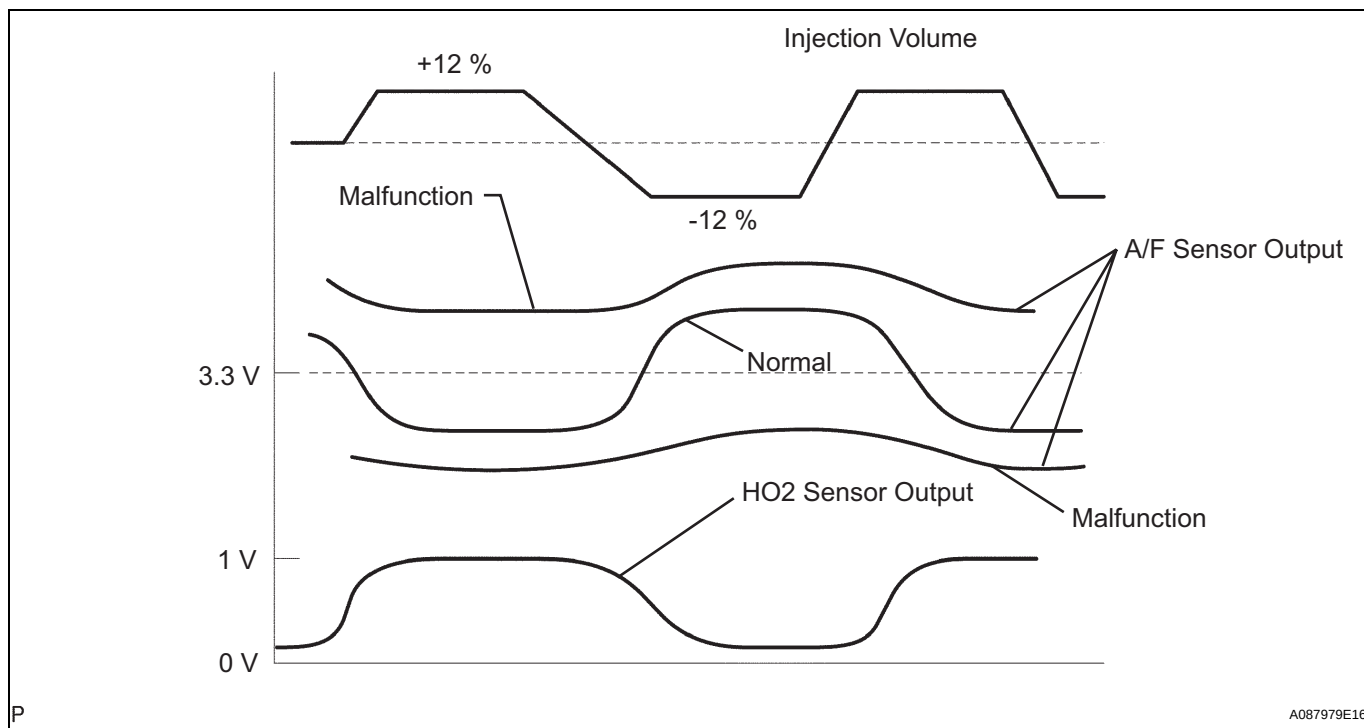
- Change the fuel injection volume within the range of -12 % and +12 %. The injection volume can be changed in 1 % graduations within the range.
- The A/F sensor is displayed as AFS B1S1 or AFS B2S1, and the HO2 sensor is displayed as O2S B1S2 or O2S B2S2, on the intelligent tester.

Result

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

HINT:

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



NG

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

OK

CHECK AND REPAIR EXTREMELY RICH OR LEAN ACTUAL AIR FUEL RATIO (INJECTOR, FUEL PRESSURE, GAS LEAKAGE FROM EXHAUST SYSTEM)**14 CHECK FOR EXHAUST GAS LEAKS****OK:**
No gas leakage.

NG

REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

ES

15INSPECT 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 oxygen sensor connector (Bank 1 Sensor 2) or B25 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

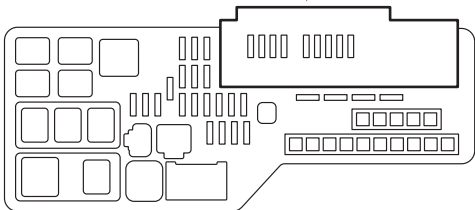
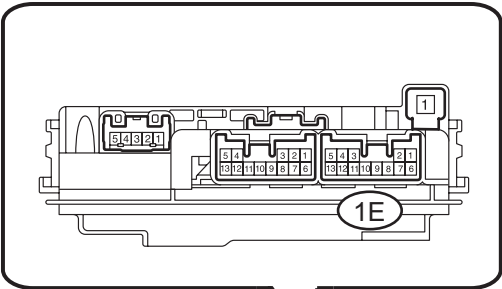
NG

REPLACE HEATED OXYGEN SENSOR (See page EC-21)

OK

16 INSPECT ENGINE ROOM JUNCTION BLOCK (EFI RELAY)

Engine Room Junction Block



Engine Room Relay Block

A140654E02

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

Standard resistance

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

- (c) Reinstall the engine room junction block.

NG

REPLACE ENGINE ROOM JUNCTION BLOCK

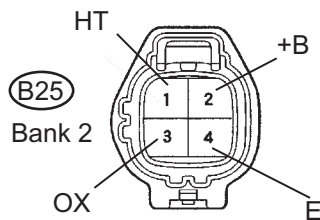
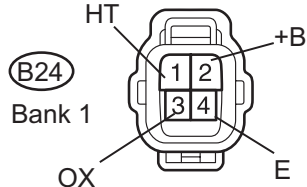
OK

ES

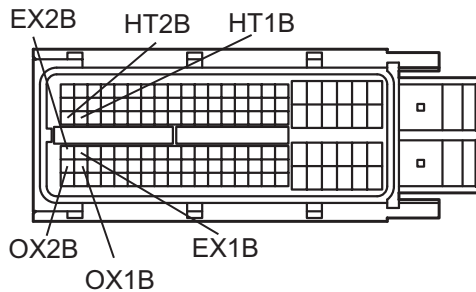
17 CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR - ECM)

Wire Harness Side:

Heated Oxygen Sensor Connector



(B12) ECM Connector



A137615E14

- (a) Disconnect the B24 oxygen sensor connector (Bank 1 Sensor 2) or B25 oxygen sensor connector (Bank 2 sensor 2).

- (b) Turn the engine switch on (IG).

- (c) 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

- (d) Turn the engine switch off.

- (e) Disconnect the B12 ECM connector.

- (f) 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

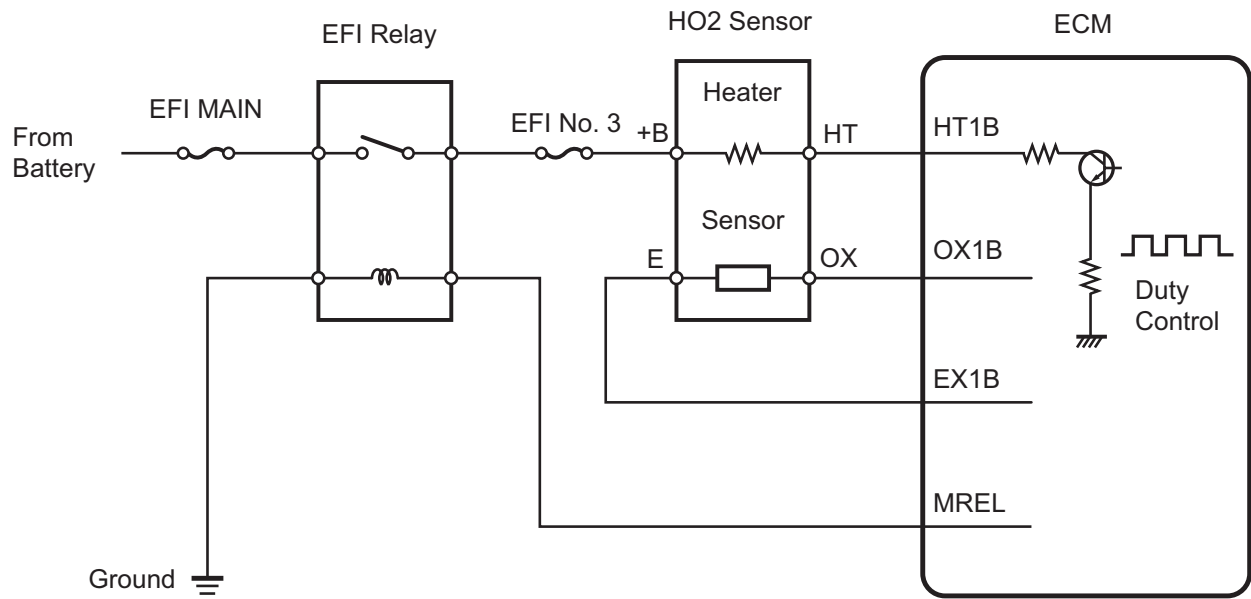
Standard resistance (Check for short)

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

- (g) Reconnect the HO2 sensor connector.

- (h) Reconnect the ECM connector.

Reference (System Diagram of Bank 1 Sensor 2):



ES

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

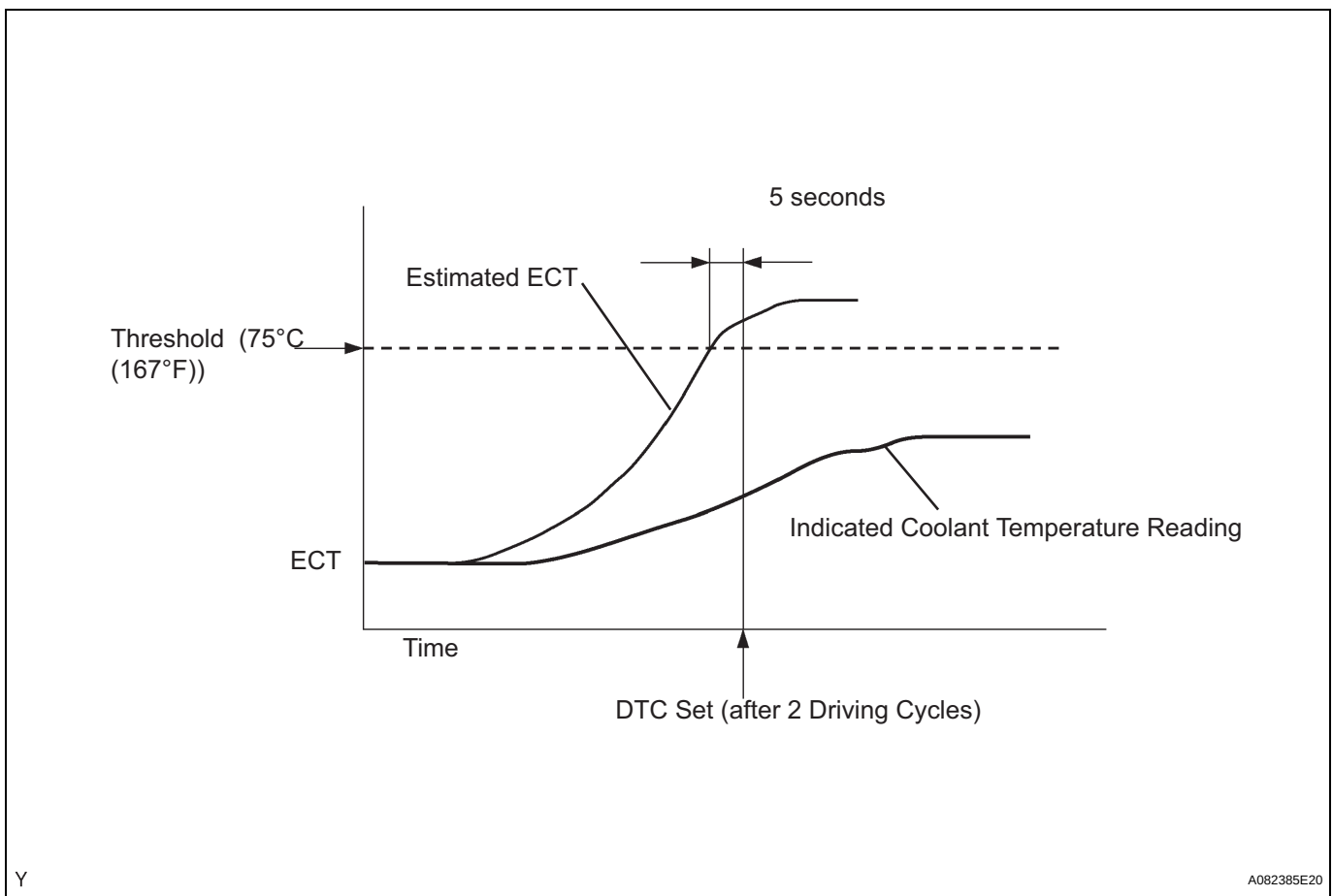
OK

REPLACE HEATED OXYGEN SENSOR (See page [EC-21](#))

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

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

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

ES**MONITOR DESCRIPTION**

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

MONITOR STRATEGY

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

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

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

INSPECTION PROCEDURE

HINT:

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

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

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

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

Result

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

HINT:

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

B**GO TO DTC CHART (See page [ES-59](#))****A****ES****2****CHECK COOLING SYSTEM**

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

NG**REPAIR OR REPLACE COOLING SYSTEM****OK****3****INSPECT THERMOSTAT**

- (a) Remove the thermostat (See page [CO-13](#)).
- (b) Check the valve opening temperature of the thermostat.

Standard:**80 to 84°C (176 to 183°F)**

HINT:

In addition to the above check, confirm that the valve is completely closed when the temperature is below the standard.

- (c) Reinstall the thermostat (See page [CO-14](#)).

NG**REPLACE THERMOSTAT (See page [CO-13](#))****OK****REPLACE ECM (See page [ES-543](#))**

DTC	P0125	Insufficient Coolant Temperature for Closed Loop Fuel Control
------------	--------------	--

DESCRIPTION

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

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

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

ES

MONITOR DESCRIPTION

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

Example:

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

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

WIRING DIAGRAM

Refer to DTC P0115 (See page [ES-142](#)).

INSPECTION PROCEDURE

HINT:

- If any of DTCs P0115, P0116, P0117 or P0118 are set simultaneously with DTC P0125, the Engine Coolant Temperature (ECT) sensor may have an open or a short circuit. Troubleshoot those DTCs first.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

ES

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

- Connect an intelligent tester to the DLC3.
- Turn the engine switch on (IG).
- 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
P0125	A
P0125 and other DTCs	B

HINT:

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

B

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

A

2 INSPECT THERMOSTAT

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

NG

REPLACE THERMOSTAT (See page [CO-13](#))

OK

3 CHECK COOLING SYSTEM

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

NG

REPAIR OR REPLACE COOLING SYSTEM

ES

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page [ES-516](#))

DTC	P0121	Throttle / Pedal Position Sensor / Switch "A" Circuit Range / Performance Problem
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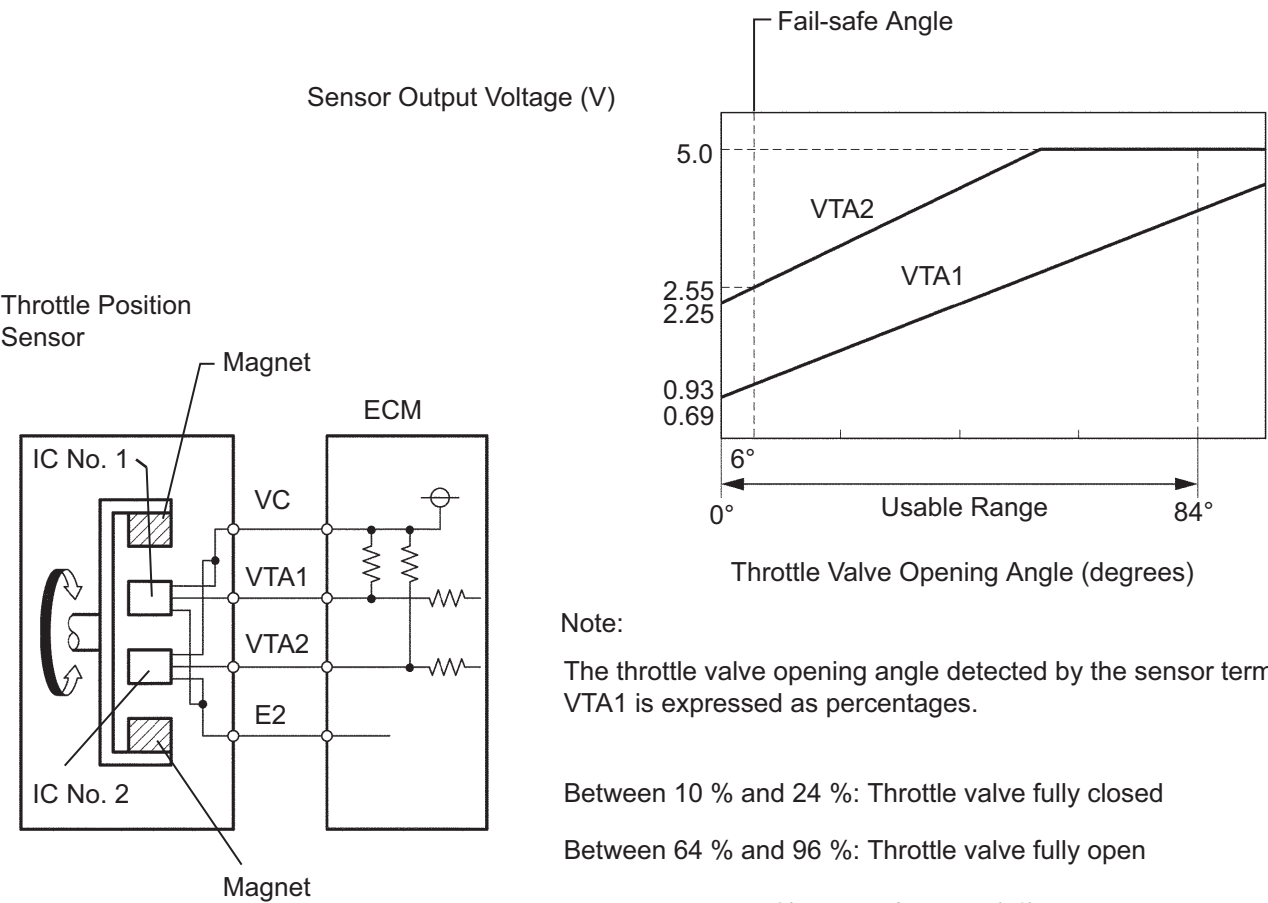
DESCRIPTION**HINT:**

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

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

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

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



Note:

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

Between 10 % and 24 %: Throttle valve fully closed

Between 64 % and 96 %: Throttle valve fully open

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

A019802E59

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

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

MONITOR DESCRIPTION

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

For each throttle opening angle, a specific voltage difference is expected between the outputs of VTA1 and VTA2. If the output voltage difference between the two signals deviates from the normal operating range, the ECM interprets this as a malfunction of the TP sensor. The ECM illuminates the MIL and sets the DTC.

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

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

FAIL-SAFE

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

Fail-safe mode continues until a pass condition is detected, and the engine switch is then turned off.

INSPECTION PROCEDURE

HINT:

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

1

CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0121)

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

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

Result

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

B

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

A

REPLACE THROTTLE BODY (See page [ES-519](#))

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

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

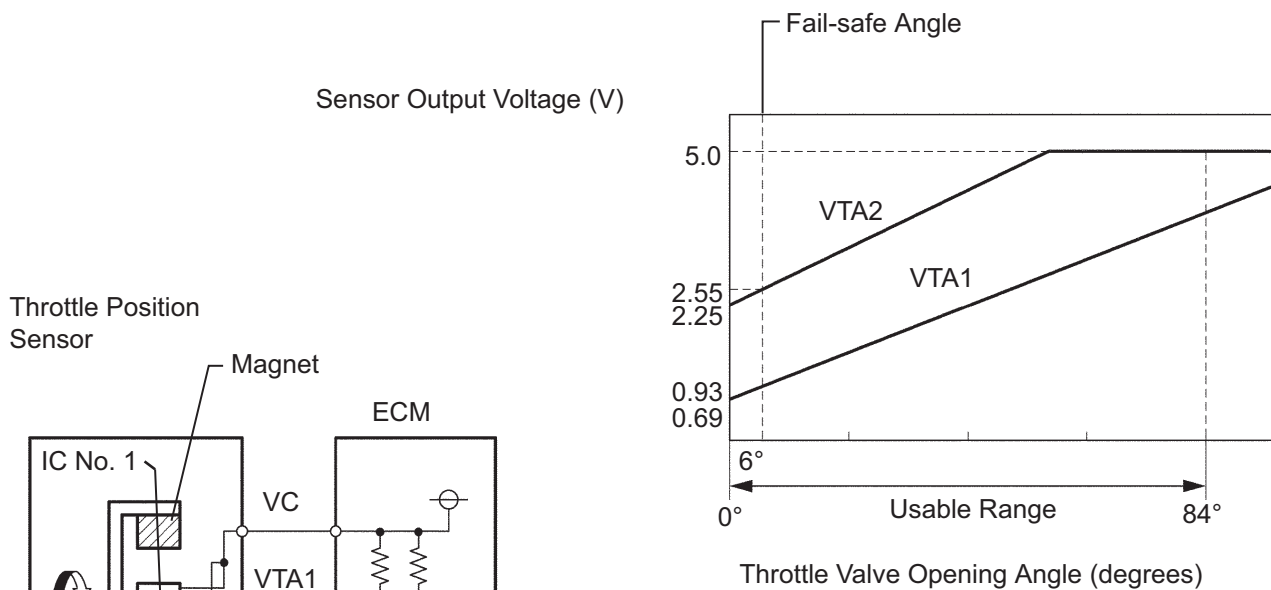
This ETCS (Electrical Throttle Control System) does not use a throttle cable.

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

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

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

ES



Note:

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

Between 10 % and 24 %: Throttle valve fully closed

Between 64 % and 96 %: Throttle valve fully open

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

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

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

HINT:

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

Reference (Normal Condition):

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

MONITOR DESCRIPTION

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

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

MONITOR STRATEGY

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

ES

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

P0120:

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

P0122:

VTA1 voltage	0.2 V or less
--------------	---------------

P0123:

VTA1 voltage	4.535 V or more
--------------	-----------------

P0220:

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

P0222:

VTA2 voltage	1.75 V or less
--------------	----------------

P0223:

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

P2135:

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

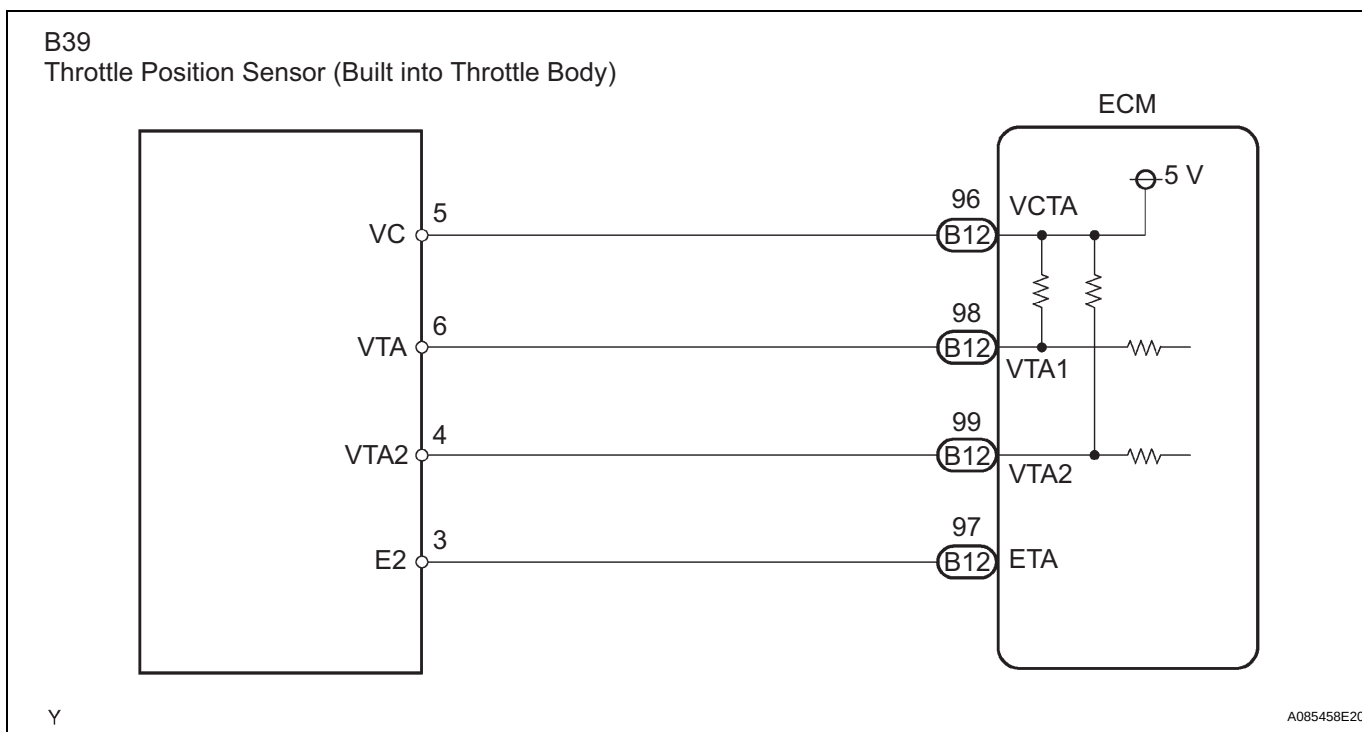
COMPONENT OPERATING RANGE

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

FAIL-SAFE

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

WIRING DIAGRAM



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 THROTTLE POSITION SENSOR (THROTTLE POS AND THROTTLE POS #2)

- Connect the intelligent tester to the DLC3.
- Turn the engine switch on (IG) and turn the intelligent tester on.

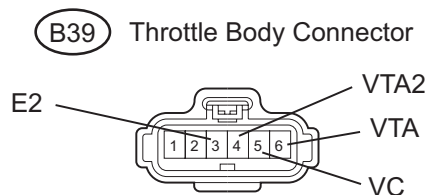
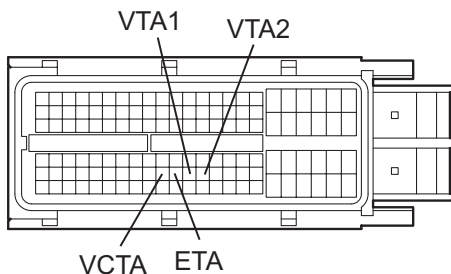
- (c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ETCS / THROTTLE POS and THROTTLE POS #2.
- (d) Check the values displayed on the tester.

Result

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

HINT:

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

B**Go to step 5****A****2****CHECK HARNESS AND CONNECTOR (THROTTLE POSITION SENSOR - ECM)****Wire Harness Side Front View:****B12** ECM Connector

A107944E13

- (a) Disconnect the B39 throttle body 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
VC (B39-5) - VCTA (B12-96)	Below 1 Ω
VTA (B39-6) - VTA1 (B12-98)	Below 1 Ω
VTA2 (B39-4) - VTA2 (B12-99)	Below 1 Ω
E2 (B39-3) - ETA (B12-97)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
VC (B39-5) or VCTA (B12-96) - Body ground	10 k Ω or higher
VTA (B39-6) or VTA1 (B12-98) - Body ground	10 k Ω or higher
VTA2 (B39-4) or VTA2 (B12-99) - Body ground	10 k Ω or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

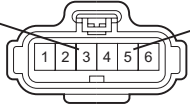
OK

3 INSPECT ECM (VC VOLTAGE)

Wire Harness Side Front View:

B39 Throttle Body Connector

E2 VC



Y A107895E13

- (a) Disconnect the B39 throttle body connector.
 - (b) Turn the engine switch on (IG).
 - (c) Measure the voltage according to the value(s) in the table below.
- Standard voltage**

Tester Connection	Specified Condition
VC (B39-5) - E2 (B39-3)	4.5 to 5.0 V

- (d) Reconnect the throttle body connector.

NG

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

OK

4 REPLACE THROTTLE BODY

- (a) Replace the throttle body assembly (See page [ES-519](#)).

NEXT

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

- (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.
- (e) Allow the engine to idle for 15 seconds or more.
- (f) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
- (g) Read the DTCs.

Result

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

B

SYSTEM IS OK

A

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

DTC	P0116	Engine Coolant Temperature Circuit Range / Performance Problem
------------	--------------	---

DESCRIPTION

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

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

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

MONITOR DESCRIPTION

The ECT sensor is used to monitor the ECT. The ECT sensor has a built-in thermistor with a resistance that varies according to the temperature of the engine coolant. When the ECT drops, the resistance of the thermistor increases. When the temperature rises, the resistance drops. These variations in the resistance are reflected in the output voltage from the ECT sensor.

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

Examples:

- (1) Upon starting the engine, the ECT is between 35°C and 60°C (95°F and 140°F). If, after driving for 250 seconds, the ECT remains within 3°C (5.4°F) of the starting temperature, the DTC is set (2 trip detection logic).
- (2) Upon starting the engine, the ECT is over 60°C (140°F). If, after driving for 250 seconds, the ECM remains within 1°C (1.8°F) of the starting temperature, the DTC is set (2 trip detection logic).

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

All:

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

ECT sensor cold start monitor:

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

ECT sensor soak monitor:

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

ES**TYPICAL MALFUNCTION THRESHOLDS****ECT sensor cold start monitor:**

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

ECT sensor soak monitor:

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

COMPONENT OPERATING RANGE

Engine coolant temperature	Varies with actual engine coolant temperature
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INSPECTION PROCEDURE**HINT:**

- If any of DTCs P0115, P0117, P0118 or P0125 are set simultaneously with DTC P0116, the ECT sensor may have an open or a short circuit. Troubleshoot those DTCs first.
- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction (See page [ES-41](#)).

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

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

Result

Display (DTC output)	Proceed to
P0116	A

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

B

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

A

2

INSPECT THERMOSTAT

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

NG

REPLACE THERMOSTAT (See page [CO-13](#))

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page [ES-516](#))

DTC	P0115	Engine Coolant Temperature Circuit Malfunction
DTC	P0117	Engine Coolant Temperature Circuit Low Input
DTC	P0118	Engine Coolant Temperature Circuit High Input

DESCRIPTION

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

ES

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

HINT:

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

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

HINT:

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

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

MONITOR DESCRIPTION

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

Example:

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

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

MONITOR STRATEGY

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

TYPICAL ENABLING CONDITIONS

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

TYPICAL MALFUNCTION THRESHOLDS

P0115:

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

P0117:

Engine coolant temperature sensor voltage	Less than 0.14 V
---	------------------

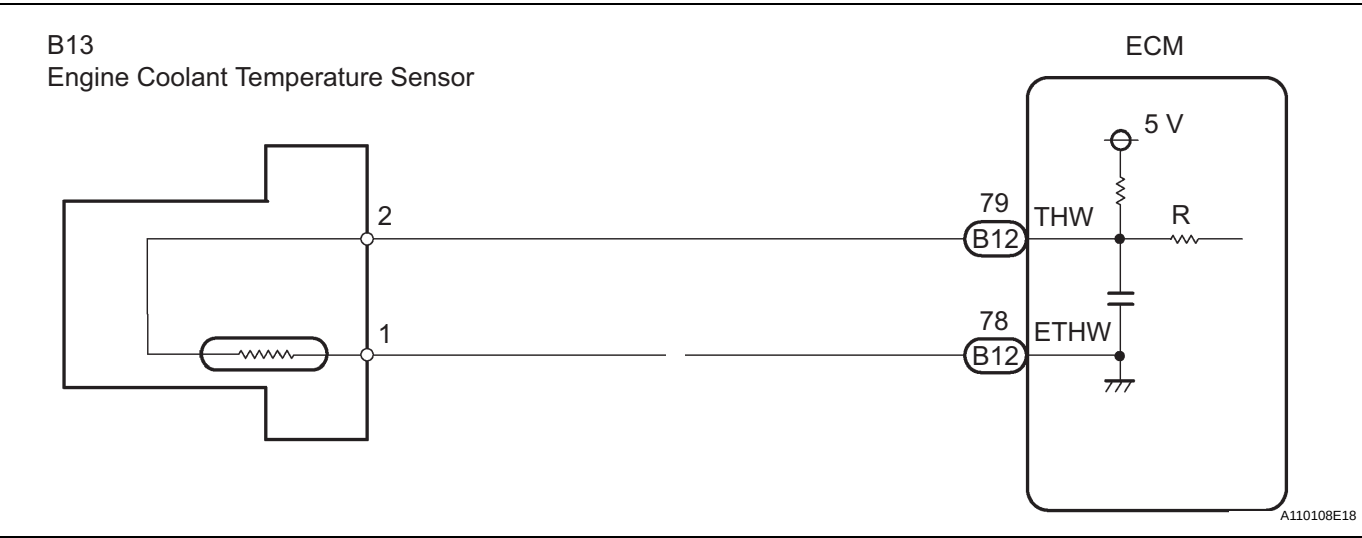
P0118:

Engine coolant temperature sensor voltage	More than 4.91 V
---	------------------

COMPONENT OPERATING RANGE

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

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

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

1 CHECK DTC OUTPUT

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

Result

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

B

Go to step 6

C

Go to step 4

A

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

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

Standard:

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

Result

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

HINT:

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

B

Go to step 5

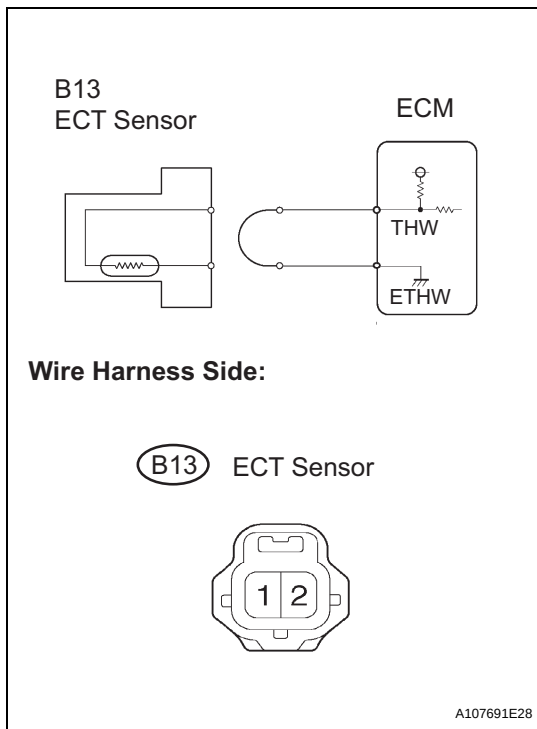
C

CHECK FOR INTERMITTENT PROBLEMS

A

3

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



- (a) Confirm good connection of the sensor.
- (b) Disconnect the B13 engine coolant temperature (ECT) sensor connector.
- (c) Connect terminals 1 and 2 of the ECT sensor connector on the wire harness side.
- (d) Connect the intelligent tester to the DLC3.
- (e) Turn the engine switch on (IG).
- (f) Turn the tester on.
- (g) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
- (h) Read the value displayed on the tester.

Standard:**140°C (284°F) or higher.**

- (i) Reconnect the ECT sensor connector.

OK

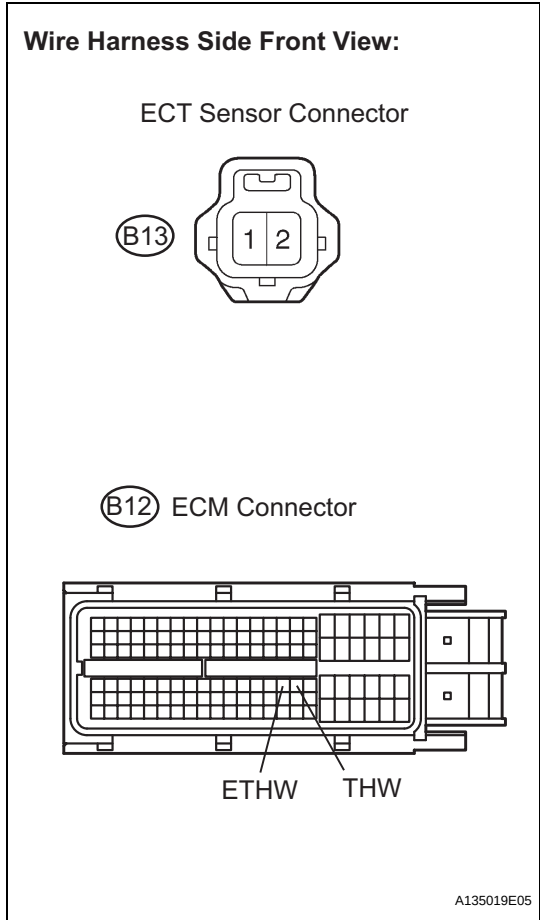
REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page [ES-516](#))

NG

ES

4

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



- (a) Disconnect the B13 ECT sensor connector.
- (b) Disconnect the B12 ECM connector.
- (c) Measure the resistance between the terminals.

Standard resistance

Tester Connection	Specified Condition
THW (B12-79) - B13-2	Below 1 Ω
ETHW (B12-78) - B13-1	Below 1 Ω

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

NG

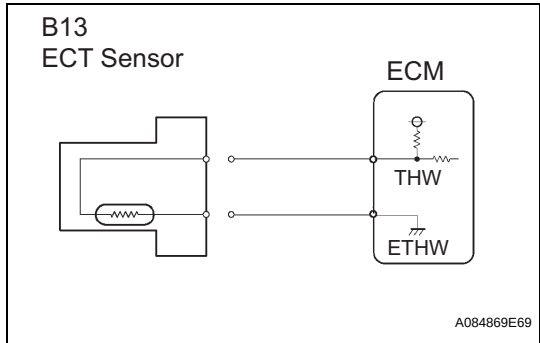
REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM (See page ES-543)

5

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



- (a) Disconnect the B13 ECT sensor 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 / COOLANT TEMP.
- (f) Read the value displayed on the tester.

Standard:

-40°C (-40°F)

- (g) Reconnect the ECT sensor connector.

OK

REPLACE ENGINE COOLANT TEMPERATURE SENSOR (See page ES-516)

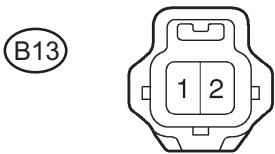
NG

6

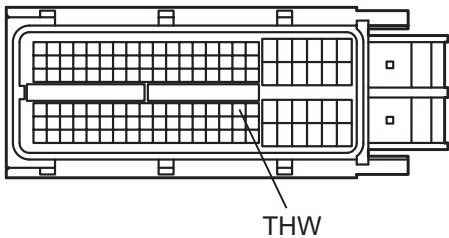
CHECK HARNESS AND CONNECTOR (ENGINE COOLANT TEMPERATURE SENSOR - ECM)

Wire Harness Side Front View:

ECT Sensor Connector



B12 ECM Connector



A135019E07

- (a) Disconnect the B13 ECT sensor 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
THW (B12-79) or B13-2 - Body ground	10 kΩ or higher

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

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

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

ES