DTC	P0136	Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

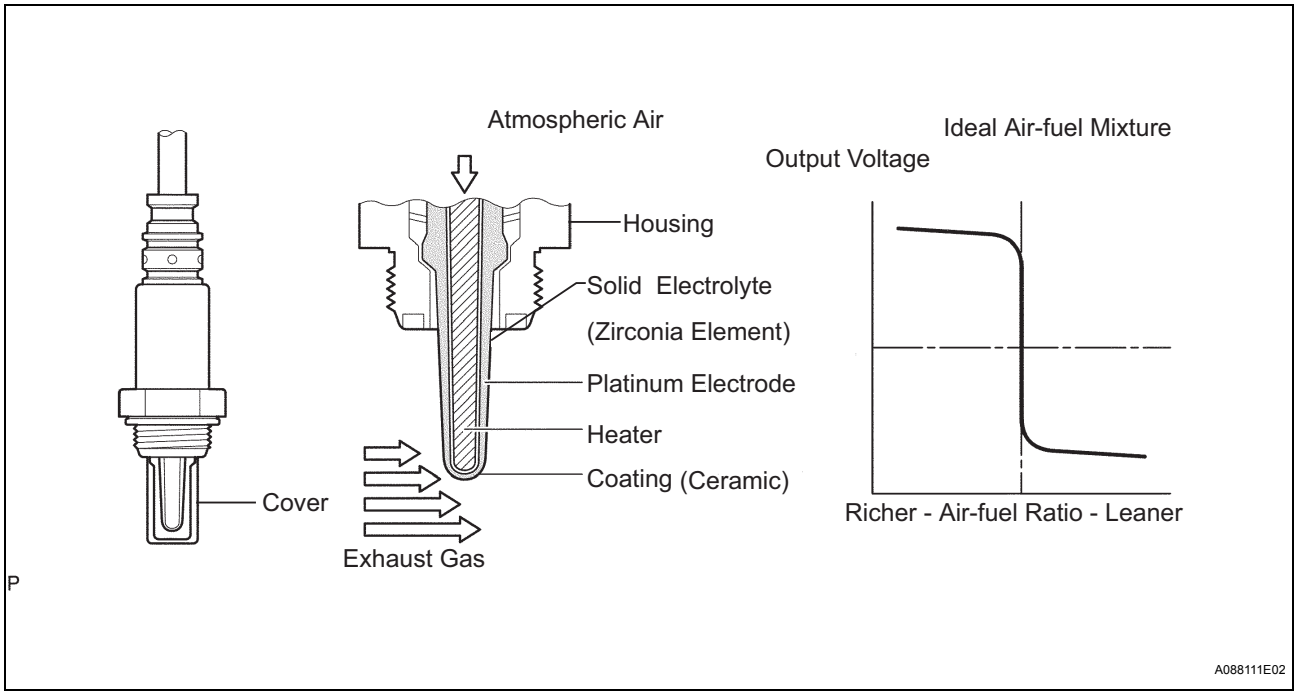
DTC	P0137	Oxygen Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC	P0138	Oxygen Sensor Circuit High Voltage (Bank 1 Sensor 2)

ES

DESCRIPTION

The heated oxygen sensor is used to monitor oxygen concentration in the exhaust gas. For optimum catalytic converter operation, the air-fuel mixture must be maintained near the ideal "stoichiometric" ratio. The oxygen sensor output voltage changes suddenly in the vicinity of the stoichiometric ratio. The ECM adjusts the fuel injection time so that the air-fuel ratio is nearly stoichiometric ratio.
When the air-fuel ratio becomes LEAN, the oxygen concentration in the exhaust gas increases. The heated oxygen sensor informs the ECM of the LEAN condition (low voltage, i.e. less than 0.45 V).
When the air-fuel ratio is RICHER than the stoichiometric air-fuel ratio, the oxygen will be vanished from the exhaust gas. The heated oxygen sensor informs the ECM of the RICH condition (high voltage, i.e. more than 0.45 V).
The heated oxygen sensor includes a heater which heats the zirconia element. The heater is controlled by the ECM. When the intake air volume is low (the temperature of the exhaust gas is low), current flows to the heater in order to heat the sensor for the accurate oxygen concentration detection.



DTC No.	DTC Detection Condition	Trouble Area
P0136	• Problem in heated oxygen sensor voltage • Heated oxygen sensor impedance is too low	• Heated oxygen sensor (bank 1 sensor 2) circuit • Heated oxygen sensor (bank 1 sensor 2) • Heated oxygen sensor heater (bank 1 sensor 2) • A/F sensor (bank 1 sensor 1) • A/F sensor heater

DTC No.	DTC Detection Condition	Trouble Area
P0137	• Heated oxygen sensor impedance is too high • Problem in heated oxygen sensor output (low voltage side)	• Heated oxygen sensor (bank 1 sensor 2) circuit • Heated oxygen sensor (bank 1 sensor 2) • Heated oxygen sensor heater (bank 1 sensor 2) • A/F sensor (bank 1 sensor 1) • A/F sensor heater
P0138	• Problem in heated oxygen sensor output (high voltage side)	• Heated oxygen sensor (bank 1 sensor 2) circuit • Heated oxygen sensor (bank 1 sensor 2) • Heated oxygen sensor heater (bank 1 sensor 2) • A/F sensor (bank 1 sensor 1) • A/F sensor heater

ES

MONITOR DESCRIPTION

Active Air-Fuel Ratio Control

Usually the ECM performs the air-fuel ratio control so that the A/F sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes "active air-fuel ratio control" besides the regular air-fuel ratio control. The ECM performs the "active air-fuel ratio control" to detect deterioration in a catalyst and the heated oxygen sensor malfunction. (Refer to the diagram below)

The "Active air-fuel ratio control" is performed for approximately 15 to 20 seconds during a vehicle driving with a warm engine. Under the "active air-fuel ratio control", the air-fuel ratio is forcibly regulated to go LEAN or RICH by the ECM.

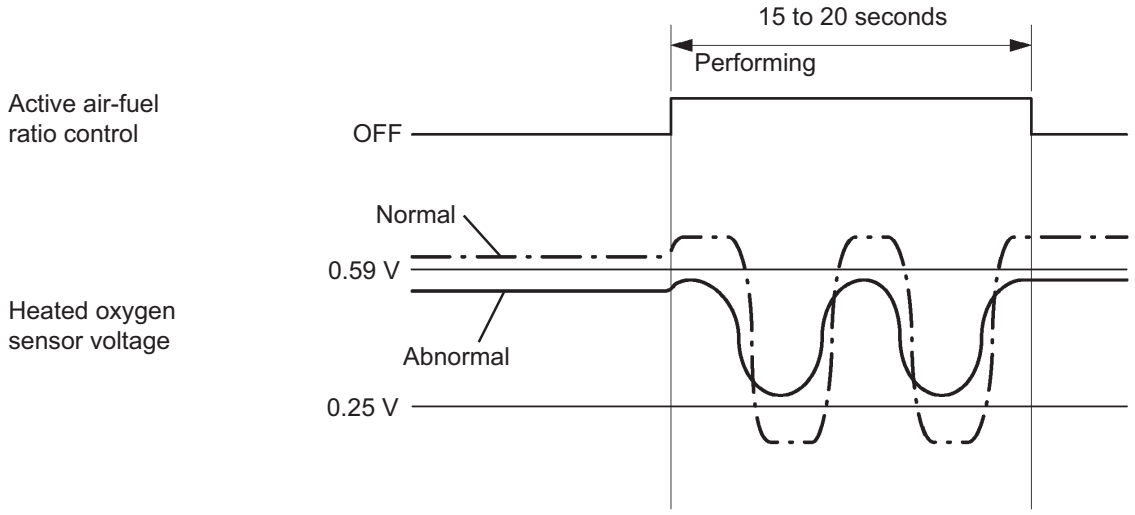
If the ECM detects malfunction, it is recorded in the following DTCs: DTC P0136 (Abnormal Voltage Output), DTC P0137 (Circuit Open) and P0138 (Circuit Short).

Abnormal Voltage Output of Heated Oxygen Sensor (DTC P0136)

As the ECM is performing the "active air-fuel ratio control", the air-fuel ratio is forcibly regulated to go RICH or LEAN. If the sensor is not functioning properly, the voltage output variation is smaller.

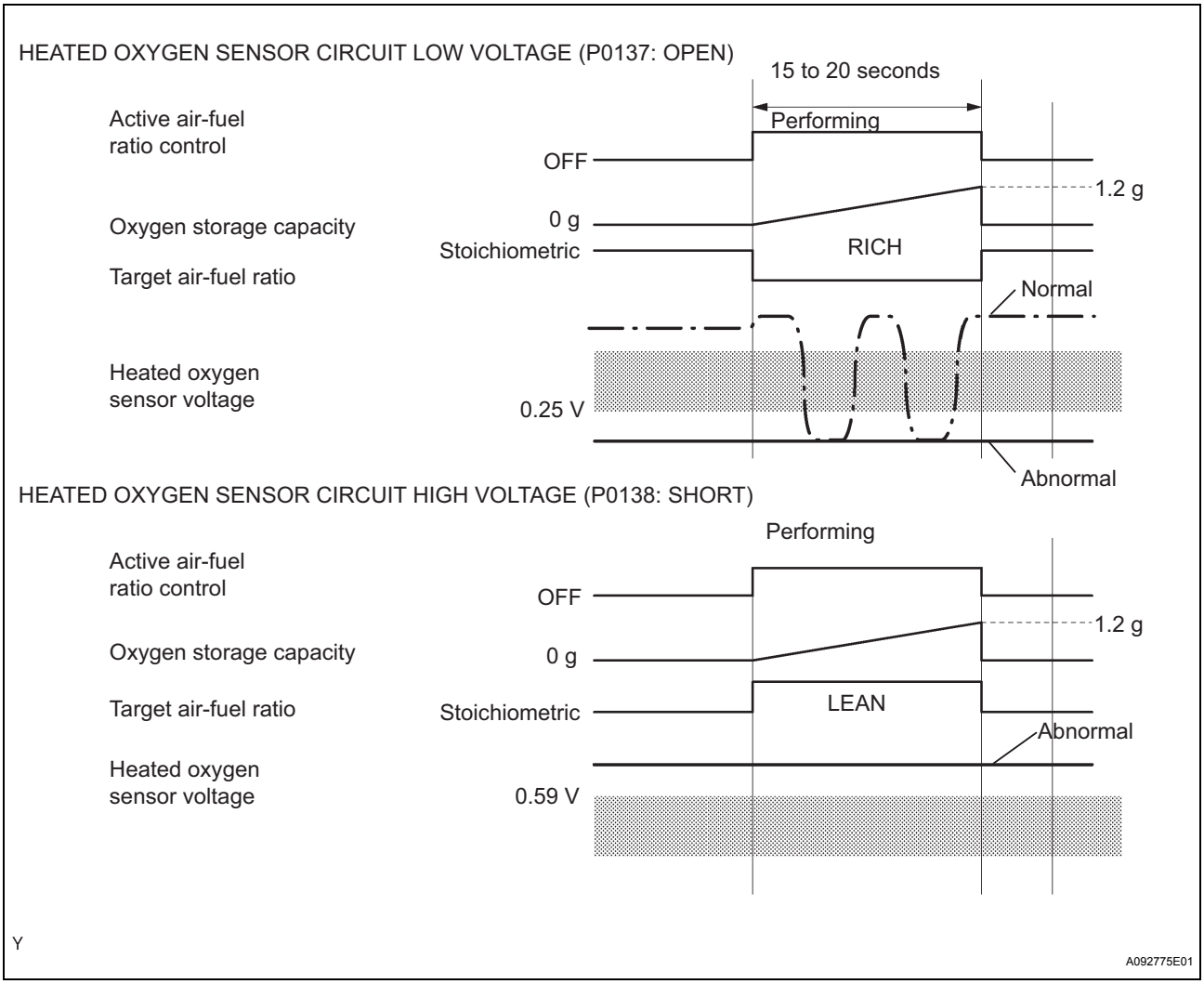
Under the "active air-fuel ratio control", if the maximum voltage output of the heated oxygen sensor is less than 0.59 V, or the minimum voltage output is 0.25 V or more, the ECM determines that it is abnormal voltage output of the sensor (DTC P0136).

HEATED OXYGEN SENSOR CIRCUIT MALFUNCTION (P0136: ABNORMAL VOLTAGE)

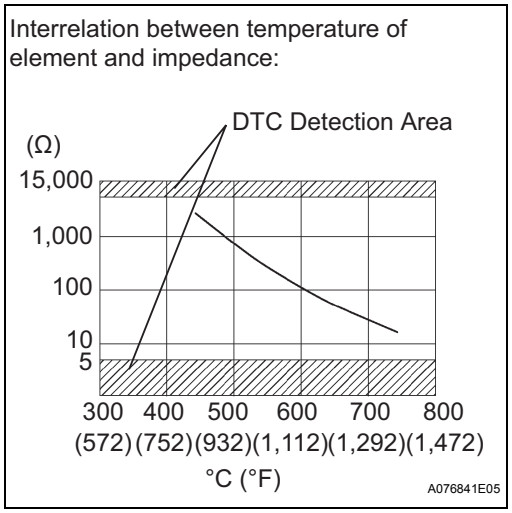


Oxygen Storage Capacity Detection in the Heated Oxygen Sensor Circuit (P0136, P0137 or P0138)

Under "active air-fuel ratio control", the ECM calculates the Oxygen Storage Capacity (OSC)* in the catalyst by forcibly regulating the air-fuel ratio to go RICH (or LEAN).
If the heated oxygen sensor has an open or short, or the voltage output by the sensor noticeably decreases, the OSC will indicate extraordinary high value. Even if the ECM attempts to continue regulating the air-fuel ratio to go RICH (or LEAN), the heated oxygen sensor output does not change.
When the value of OSC calculated by the ECM reaches 1.2 gram under the active air-fuel ratio control, although the targeted air-fuel ratio is RICH but the voltage output of the heated oxygen sensor is 0.25 V or less (LEAN), the ECM determines that it is an abnormal low voltage (DTC P0137). Also, the targeted air-fuel ratio is LEAN but the voltage output is 0.59 V or more (RICH), it is determined that the voltage output of the sensor is abnormally high (DTC P0138).
In addition to the OSC detection, if the fluctuation of the sensor voltage output is in a specific narrow range (more than 0.25 V and less than 0.59) despite the ECM ordering the air-fuel ratio to go RICH or LEAN while the OSC is above 1.2 gram, the ECM interprets this as a malfunction in the heated oxygen sensor circuit (DTC P0136).
*Oxygen Storage Capacity (OSC): A catalyst has a capability for storing oxygen. The OSC and the emission purification capacity of the catalyst are mutually related. The ECM judges if the catalyst has deteriorated based on the calculated OSC value (see page ES-177).



HINT:
DTC P0138 is also set if the voltage output from the heated oxygen sensor is more than 1.2 V for 10 seconds or more.
Heated oxygen sensor impedance



During normal feedback control of the air-fuel ratio, there are small variations in the exhaust gas oxygen concentration. In order to continuously monitor the slight variation of the signal from the oxygen sensor while the engine is running, the impedance* of the sensor is measured by the ECM. The ECM detects that there is 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 can not be measured with an ohmmeter.
- DTC P0136 indicates deterioration of the heated oxygen sensor. The ECM sets the DTC by calculating the impedance of the sensor after the typical enabling conditions are satisfied (2 driving-cycles).
- DTC P0137 indicates an open or short circuit in the heated oxygen sensor system (2 driving-cycles). The ECM sets this DTC when the impedance of the sensor exceeds the threshold 15 kΩ.

MONITOR STRATEGY

Case 1: Output voltage (Active A/F control method)

Related DTCs	P0136
Required sensors/components (main)	Heated oxygen sensor (bank 1 sensor 2)
Required sensors/components (related)	A/F sensor
Frequency of operation	Once per driving cycle
Duration	20 seconds
MIL operation	1 driving cycles
Sequence of operation	None

Case 2: Low impedance

Related DTCs	P0136
Required sensors/components (main)	Heated oxygen sensor (bank 1 sensor 2)
Required sensors/components (related)	None
Frequency of operation	Continuously
Duration	30 seconds
MIL operation	2 driving cycles
Sequence of operation	None

Case 3: High impedance

Related DTCs	P0137
Required sensors/components (main)	Heated oxygen sensor (bank 1 sensor 2)
Required sensors/components (related)	None
Frequency of operation	Continuously
Duration	155 seconds

MIL operation	2 driving cycles
Sequence of operation	None

Case 4: Low voltage (Active A/F control method)

Related DTCs	P0137
Required sensors/components (main)	Heated oxygen sensor (bank 1 sensor 2)
Required sensors/components (related)	A/F sensor
Frequency of operation	Once per driving cycle
Duration	20 seconds
MIL operation	1 driving cycles
Sequence of operation	None

Case 5: High voltage (Active A/F control method)

Related DTCs	P0138
Required sensors/components (main)	Heated oxygen sensor (bank 1 sensor 2)
Required sensors/components (related)	A/F sensor
Frequency of operation	Once per driving cycle
Duration	20 seconds
MIL operation	1 driving cycles
Sequence of operation	None

Case 6: High voltage

Related DTCs	P0138
Required sensors/components (main)	Heated oxygen sensor (bank 1 sensor 2)
Required sensors/components (related)	None
Frequency of operation	Continuously
Duration	10 seconds
MIL operation	2 driving cycles
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

Monitor will run whenever these DTCs are not present	P0031, P0032 (A/F sensor heater - Sensor 1) P0037, P0038 (O2 sensor heater - Sensor 2) P0100 - P0103 (MAF meter) P0110 - P0113 (IAT sensor) P0115 - P0118 (ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for closed loop) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0442 - P0456 (EVAP system) P0500 (VSS) P2196 (A/F sensor - Rationality) P2A00 (A/F sensor - Slow response)

Case 1: Output voltage (Active A/F control method)

Active A/F control	Executing
Active A/F control begins when the following conditions are met	-
Battery voltage	11.5 V or higher
Engine coolant temperature	75°C (167°F) or higher
Idle	OFF
Engine speed	Less than 3,200 rpm
A/F sensor status	Activated
Duration after fuel-cut: OFF	10 seconds or more

Engine load	10 to 70%

Case 2: Low impedance

Estimated sensor temperature	Lower than 750°C (1,382°F)

Case 3: High impedance

Estimated sensor temperature	450°C (842°F) or higher
Intake air amount	More than 0 g/sec.

Case 4: Low voltage (Active A/F control method)

Same as case 1

Case 5: High voltage (Active A/F control method)

Same as case 1

Case 6: High voltage

Engine	Running
Battery voltage	10.5 V or higher

TYPICAL MALFUNCTION THRESHOLDS

Case 1: Output voltage (Active A/F control method)

Either of the following conditions 1 or 2 set	-
1. All of following conditions (a), (b) and (c) set	-
(a) Commanded air-fuel ratio	14.3 or less
(b) Sensor voltage	0.25 to 0.59 V
(c) OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more
2. All of following conditions (d), (e) and (f) set	-
(d) Commanded air-fuel ratio	14.9 or more
(e) Rear HO2S voltage	0.25 to 0.59 V
(f) OSC (oxygen storage capacity of catalyst)	1.2 g or more

Case 2: Low impedance

Sensor impedance	Less than 5 Ω

Case 3: High impedance

Sensor impedance	15,000 Ω or higher

Case 4: Low voltage (Active A/F control method)

All of following conditions (a), (b) and (c) set	-
(a) Commanded air-fuel ratio	14.3 or less
(b) Sensor voltage	Less than 0.25 V
(c) OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more

Case 5: High voltage (Active A/F control method)

All of following conditions (d), (e) and (f) set	-
(d) Commanded air-fuel ratio	14.9 or more
(e) Sensor voltage	More than 0.59 V
(f) OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more

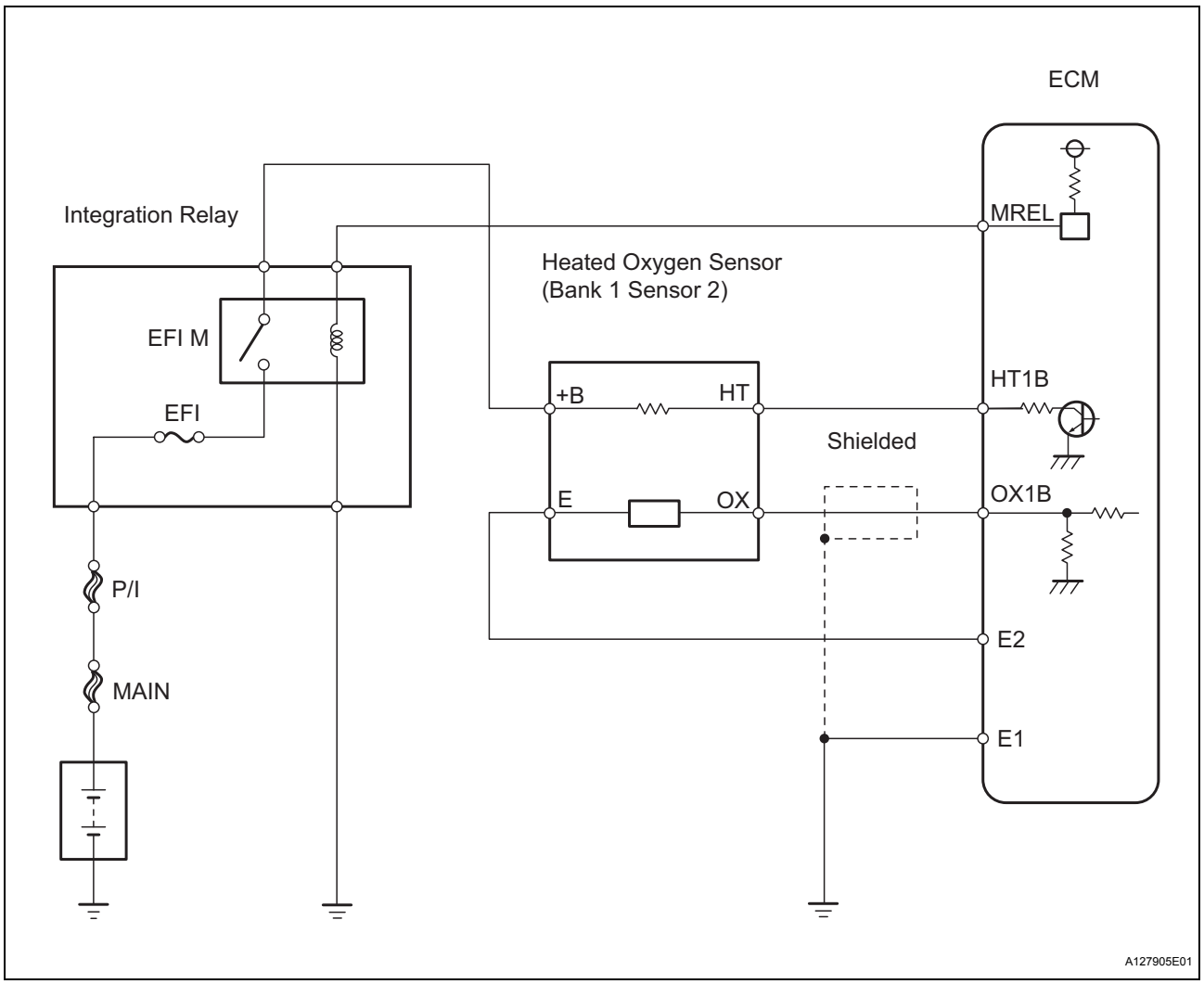
Case 6: High voltage

Sensor voltage	1.2 V or more

MONITOR RESULT

Refer to detailed information (see page ES-15).

WIRING DIAGRAM

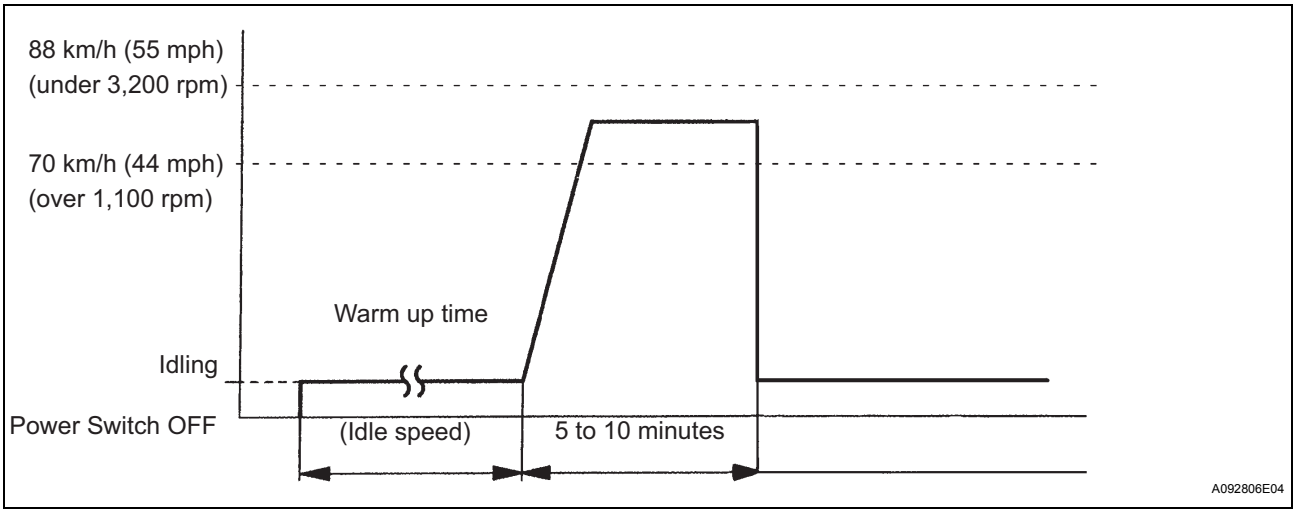


CONFIRMATION DRIVING PATTERN

1. For DTC P0136 and P0137

HINT:

Performing this confirmation pattern will activate the DTC detection (P0136) of the ECM. This is very useful for verifying the completion of a repair.



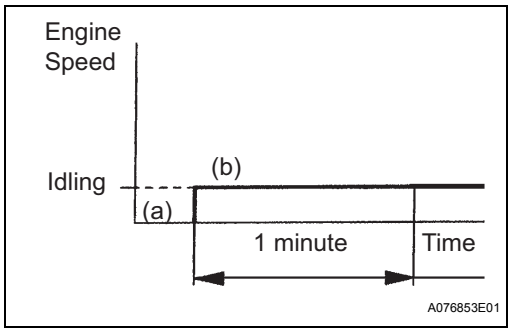
(a) Clear the DTCs (see page ES-29).
(b) Put the engine in inspection mode (see page ES-1).
(c) Start the engine and warm it up with all the accessory switches OFF.
(d) Deactivate the inspection mode and drive the vehicle at 70 to 112 km/h (44 to 70 mph) for 5 to 10 minutes.
(e) Read DTCs.

NOTICE:

- **If the conditions in this test are not strictly followed, no malfunction will be detected. If you do not have the intelligent tester, turn the power switch OFF after performing steps (c) and (e), then perform step (d) again.**
- **Do not drive the vehicle without deactivating inspection mode, otherwise damaging the transaxle may result.**

2. For DTC P0138

HINT:
Performing this confirmation pattern will activate the DTC detection (P0138) of the ECM. This is very useful for verifying the completion of a repair.



(a) Clear the DTCs (see page ES-29).
(b) Put the engine in inspection mode (see page ES-1).
(c) Start the engine and let the engine idle for 1 minute.
(e) Read DTCs.

NOTICE:

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

INSPECTION PROCEDURE

HINT:
Read freeze frame data using the intelligent tester. Freeze frame data records the engine condition when malfunction is detected. When troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, if the engine was warmed up or not, if the air-fuel ratio was lean or rich, and other data from the time the malfunction occurred.

1	CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0136, P0137 AND/OR P0138)

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

Result

Display (DTC output)	Proceed to
P0136, P0137 and/or P0138	A
P0136, P0137 and/or P0138, and other DTCs	B

HINT:
If any other codes besides P0136, P0137 and/or P0138 are output, perform troubleshooting for those DTCs first.

B → GO TO RELEVANT DTC CHART

A

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

HINT:
Malfunctioning areas can be found by performing the ACTIVE TEST / A/F CONTROL operation. The A/F CONTROL operation can determine if the A/F sensor, heated oxygen sensor or other potential trouble area are malfunctioning or not.

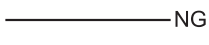
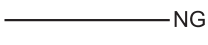
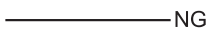
(a) Perform A/F CONTROL operation using the intelligent tester.
HINT:
The A/F CONTROL operation lowers the injection volume 12.5% or increases the injection volume 25%.
(1) Connect the intelligent tester to the DLC3.
(2) Turn the power switch ON (IG).
(3) Put the engine in inspection mode (see page ES-1).
(4) Warm up the engine by running the engine at 2,500 rpm, depressing the accelerator pedal more than 60% for approximately 90 seconds.
(5) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(6) Perform the A/F CONTROL operation with the engine in an idle condition (press the right or left button).

Result:

A/F sensor reacts in accordance with increase and decrease of injection volume:
+25% → rich output: Less than 3.0 V
-12.5% → lean output: More than 3.35 V
Heated oxygen sensor reacts in accordance with increase and decrease of injection volume:
+25% → rich output: More than 0.55 V
-12.5% → lean output: Less than 0.4 V

NOTICE:

The A/F sensor output has a few seconds of delay and the heated oxygen sensor output has about 20 seconds of delay at maximum.

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%		• Fuel Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely or lean rich)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

The following A/F CONTROL procedure enables the technician to check and graph the voltage output of both A/F sensor and heated oxygen sensor.

To display the graph, enter ACTIVE TEST/ A/F CONTROL / USER DATA, select "AFS B1S1 and O2S B1S2" by pressing the "YES" button followed by the "ENTER" button and then the "F4" button.

- A high A/F sensor voltage could be caused by a RICH air-fuel mixture. Check the conditions that would cause the engine to run with the RICH air-fuel mixture.
- A low A/F sensor voltage could be caused by a LEAN air-fuel mixture. Check the conditions that would cause the engine to run with the LEAN air-fuel mixture.

Result

Output voltage of A/F sensor	Output voltage of heated oxygen sensor	Proceed to
OK	OK	A
NG	OK	B
OK	NG	C
NG	NG	D

B → GO TO DTC P2238

C → Go to step 5

D → GO TO DTC P0171

ES

A

3 PERFORM CONFIRMATION DRIVING PATTERN

HINT:
Clear all DTCs prior to performing the confirmation driving pattern.

GO

4 READ OUTPUT DTCS (DTC P0136, P0137 AND/OR P0138 ARE OUTPUT AGAIN)

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

Result

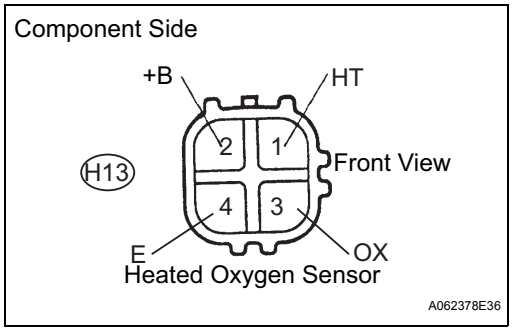
Display (DTC output)	Proceed to
P0136, P0137 and/or P0138	A
P0136, P0137 and/or P0138, and other DTCs	B

B → REPLACE HEATED OXYGEN SENSOR

A

CHECK FOR INTERMITTENT PROBLEMS

5 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



(a) Disconnect the H13 heated oxygen sensor connector.
(b) Measure the resistance between the terminals of the heated oxygen sensor connector.
Standard resistance

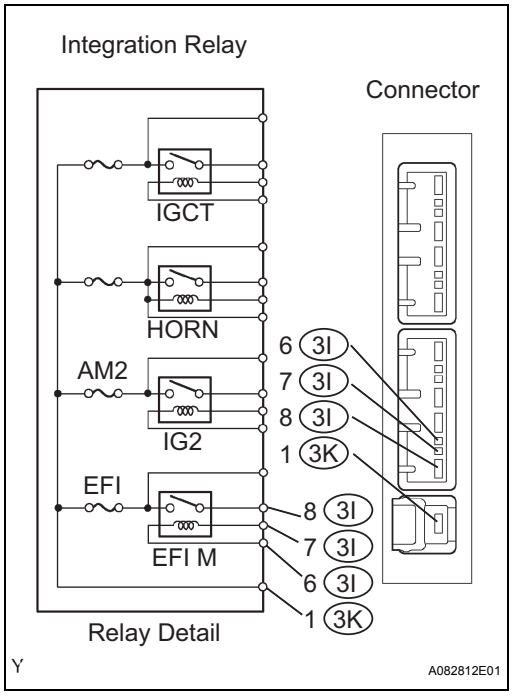
Tester Connection	Specified Condition
H13-1 (HT) - H13-2 (+B)	11 to 16 Ωat 20°C (68°F)
H13-1 (HT) - H13-4 (E)	10 kΩ or higher

(c) Reconnect the heated oxygen sensor connector.

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

6 INSPECT INTEGRATION RELAY (EFI M RELAY)



(a) Remove the integration relay from the engine room relay block.
(b) Inspect the EFI M relay.
Standard resistance

Tester Connection	Specified Condition
3K-1 - 3I-8	10 kΩ or higher
3K-1 - 3I-8	Below 1 Ω (Apply battery voltage to terminals 3I-6 and 3I-7)

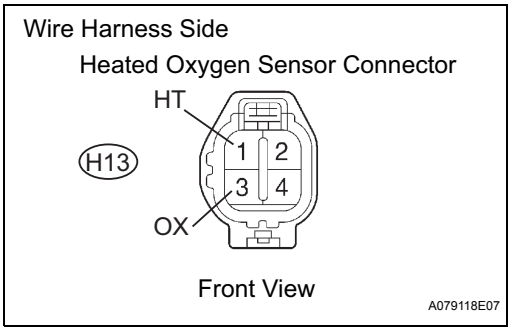
(c) Reinstall the integration relay.

NG → **REPLACE INTEGRATION RELAY**

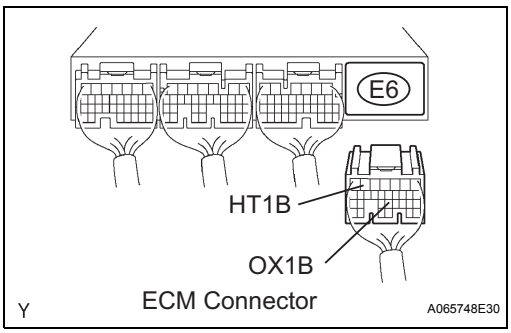
OK

ES

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



(a) Disconnect the H13 heated oxygen sensor connector.



(b) Disconnect the E6 ECM connectors.
(c) Measure the resistance between the wire harness side connectors.

Standard resistance (Check for open)

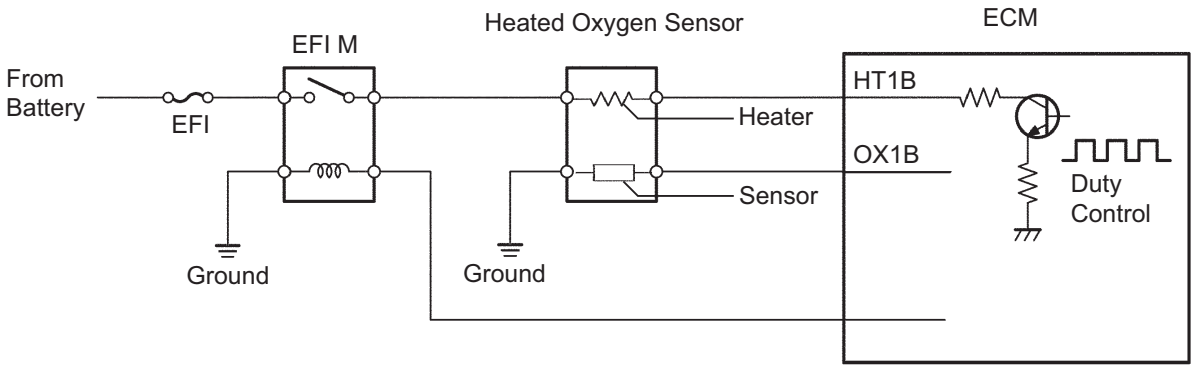
Tester Connection	Specified Condition
H13-1 (HT) - E6-6 (HT1B)	Below 1 Ω
H13-3 (OX) - E6-22 (OX1B)	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
H13-1 (HT) or E6-6 (HT1B) - Body ground	10 kΩ or higher
H13-3 (OX) or E6-22 (OX1B) - Body ground	10 kΩ or higher

(d) Reconnect the heated oxygen sensor connector.
(e) Reconnect the ECM connector.

Reference (Bank 1 Sensor 2 System Diagram)



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

OK

REPLACE HEATED OXYGEN SENSOR