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)

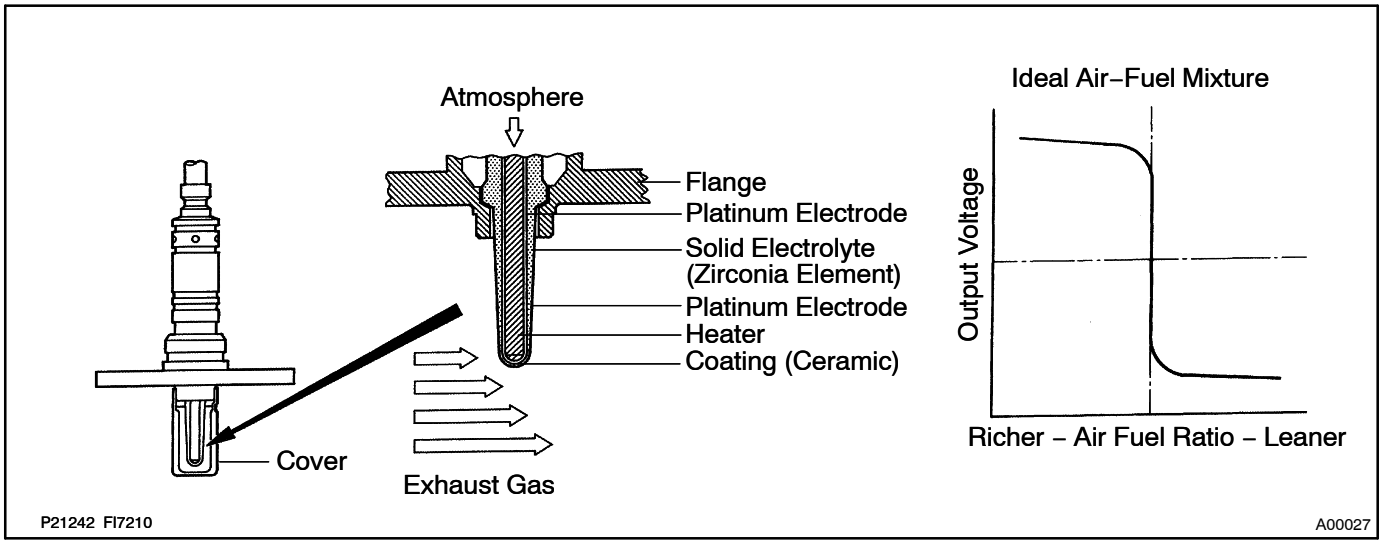
CIRCUIT DESCRIPTION

The heated oxygen sensor is used to monitor oxygen concentration in the exhaust. 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.



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 (sensor 2) 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.

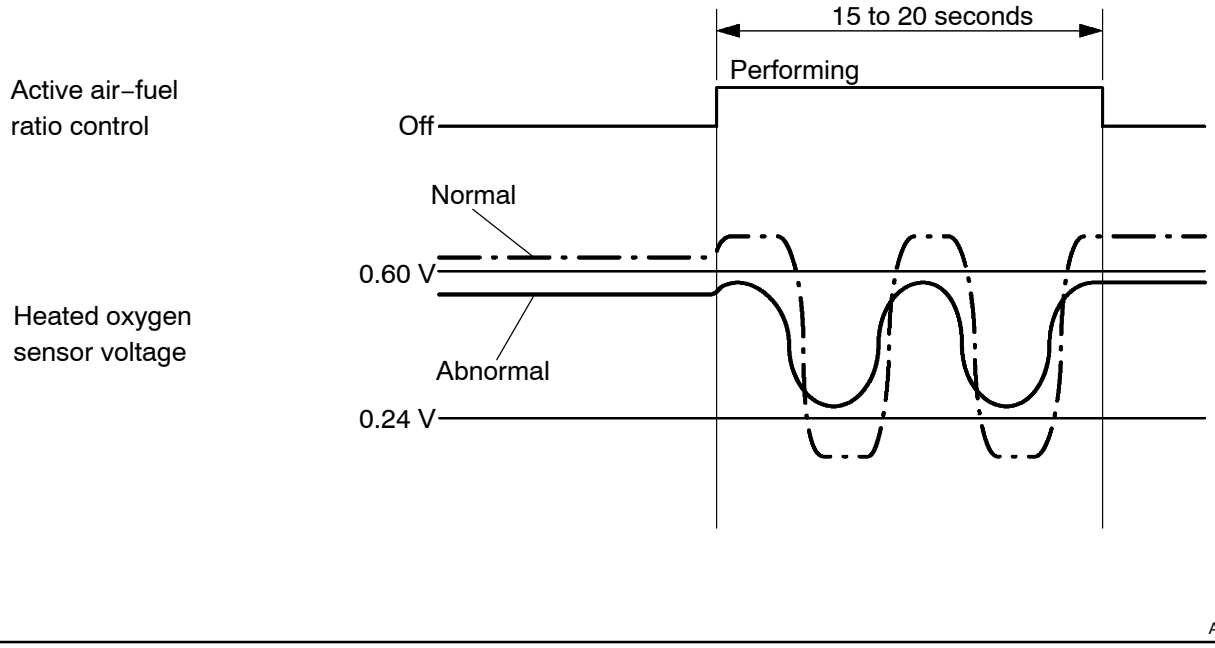
If the ECM detects malfunction, it is recorded in the following DTCs: DTC P0136 (Abnormal Voltage Output), DTC P0137 (Circuit open) and P0138 (Circuit Short).

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 0.6 V, or the minimum voltage output is 0.24 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).

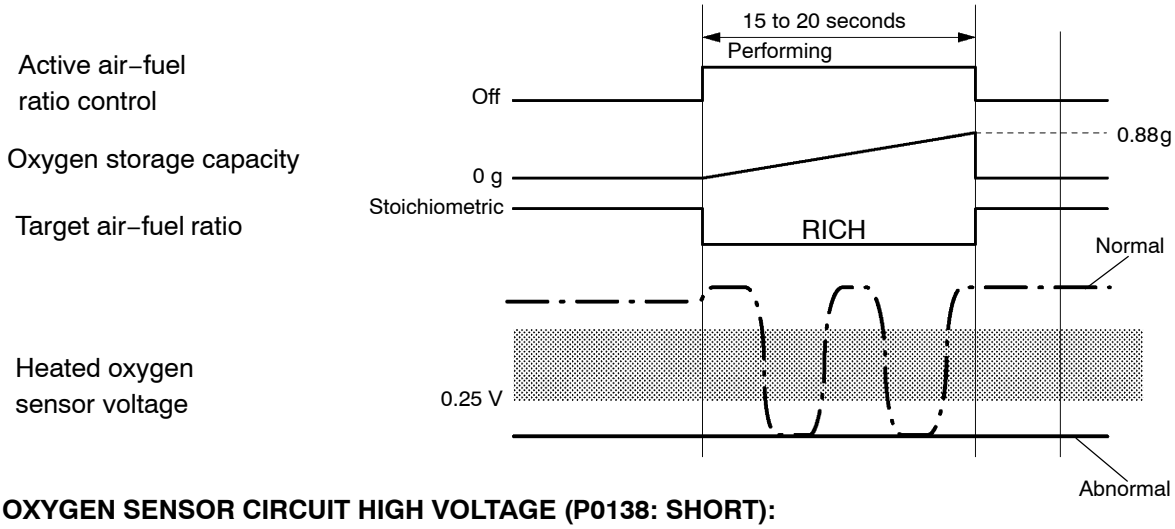
If the heated oxygen sensor has an open or short, or the voltage output by the sensor noticeably decreases, the OSC will indicate extraordinary high value. Even if the ECM attempts to continue regulating the air–fuel ratio to go RICH (or LEAN), the heated oxygen sensor output does not change.

When the value of OSC calculated by the ECM reaches 0.88 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).

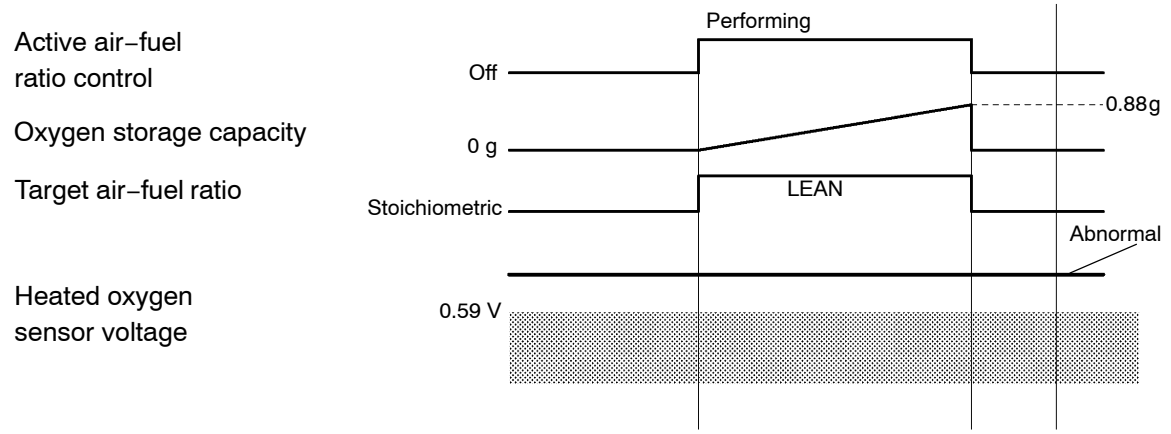
In addition to the OSC detection, if the fluctuation of the sensor voltage output is in a specific narrow range (more than 0.25 V and less than 0.59) despite the ECM ordering the air–fuel ratio to go RICH or LEAN while the OSC is above 0.88 gram, the ECM interprets this as a malfunction in the heated 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.

HEATED OXYGEN SENSOR CIRCUIT LOW VOLTAGE (P0137: OPEN):



HEATED OXYGEN SENSOR CIRCUIT HIGH VOLTAGE (P0138: SHORT):



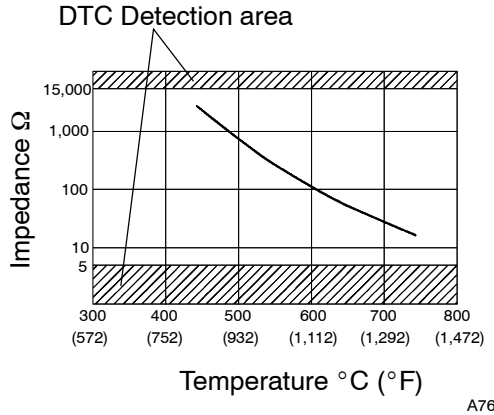
Y A92775

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

Interrelation between temperature of the element and 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:

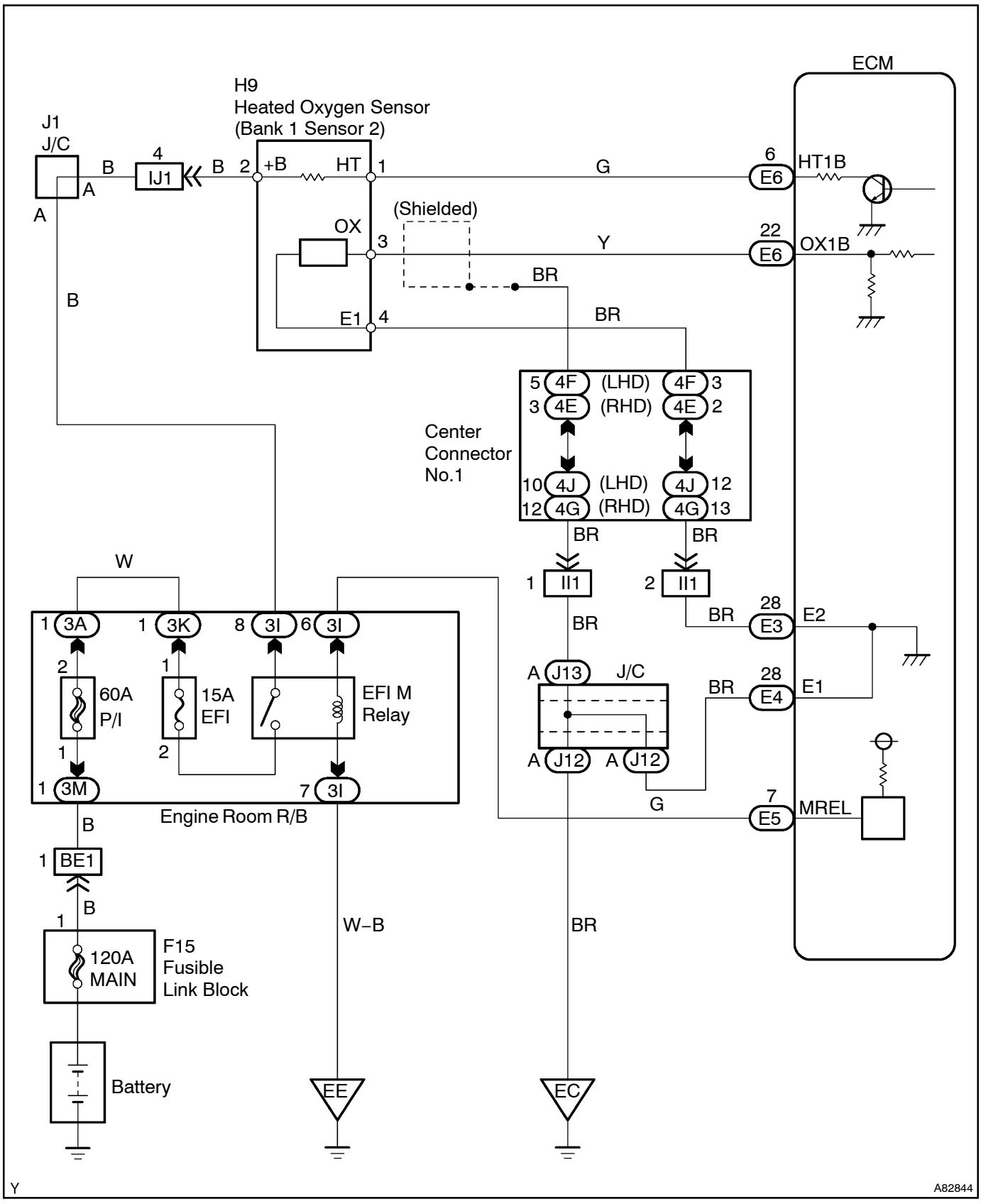
The impedance can not be measured with an ohmmeter.

HINT:

- 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 (1 driving–cycle).
- DTC P0137 indicates an open or short circuit in the heated oxygen sensor system (1 driving–cycle). The ECM sets this DTC when the impedance of the sensor exceeds the threshold 15 kΩ.

DTC No.	DTC Detection Condition	Trouble Area
P0136	One of the following conditions is met: • Sensor impedance is less than 5 Ω when ECM presumes the sensor warmed–up as well as operated normally • Under active air–fuel ratio control, either of (a) and (b) is met: (a) Sensor output voltage is 0.2 V or more (b) Sensor output voltage is 0.6 V or less • Under active air–fuel ratio control, either of (a) and (b) is met: (a) Sensor output voltage is 0.25 V or more when OSC is 0.88 g or more and target air–fuel ratio is RICH (b) Sensor output voltage is 0.59 V or less when OSC is 0.88 g or more and target air–fuel ratio is LEAN	• Open or short in heated oxygen sensor (bank 1 sensor 2) circuit • Heated oxygen sensor (bank 1 sensor 2) • Heated oxygen sensor heater (bank 1 sensor 2) • EFI M relay
P0137	Either of the following conditions is met: • Sensor impedance is more than 15 kΩ for more than 55 seconds when ECM presumes the sensor warmed–up as well as operated normally • Under active air–fuel ratio control, all of the following conditions are met: (a) Sensor output voltage is less than 0.25 V (b) Target air–fuel ratio is RICH (c) OSC is 0.88 g or more	• Open in heated oxygen sensor (bank 1 sensor 2) circuit • EFI M relay • Heated oxygen sensor (bank 1 sensor 2) • Heated oxygen sensor heater (bank 1 sensor 2)
P0138	One of the following conditions is met: • Sensor short is detected even if sensor output voltage is 1.2 V or more for 30 seconds • Under active air–fuel ratio control, all of the following conditions are met: (a) Sensor output voltage is 0.59 V or more (b) Target air–fuel ratio is LEAN (c) OSC is 0.88 g or more • Sensor output voltage is more than 1.2 V for 10 seconds	• Short in heated oxygen sensor (bank 1 sensor 2) circuit • Heated oxygen sensor (bank 1 sensor 2) • Heated oxygen sensor heater (bank 1 sensor 2) • EFI M relay

WIRING DIAGRAM

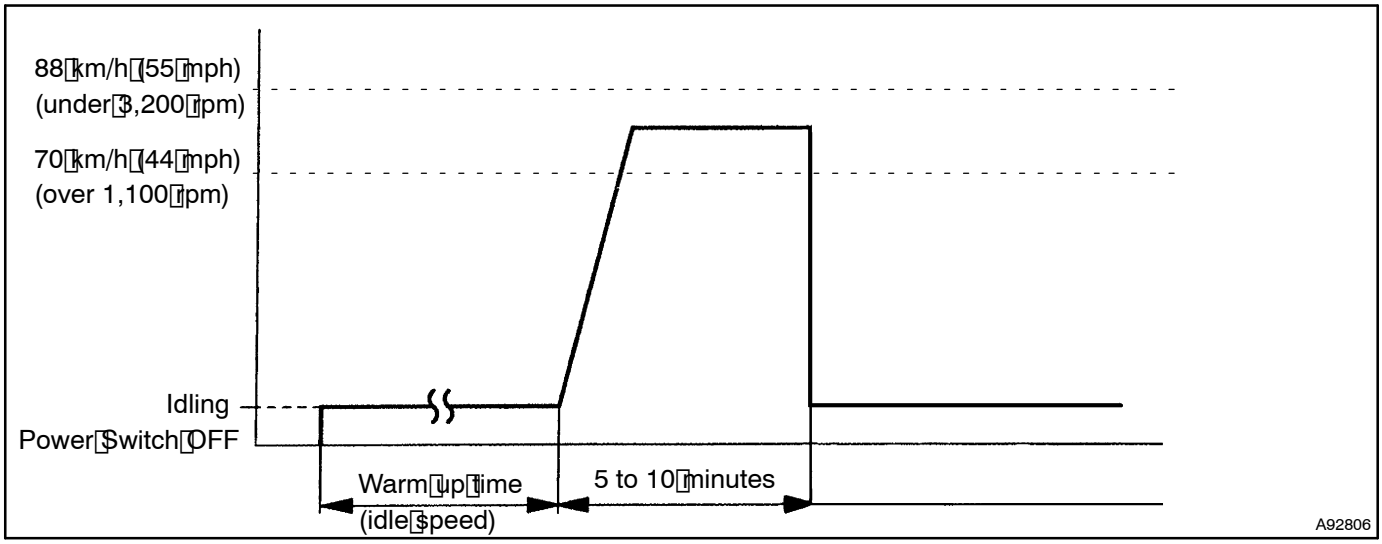


CONFIRMATION DRIVING for DTC P0136 and P0137

PURPOSE

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.



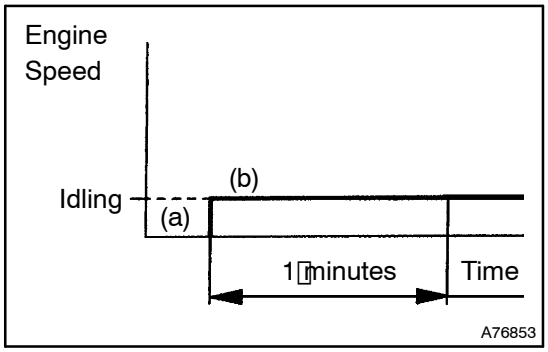
(a) Clear the DTCs (see page 05–25).
(b) Put the engine in inspection mode (see page 05–1).
(c) Start the engine and warm it up with all the accessory switches OFF.
(d) Deactivate the inspection mode and drive the vehicle at 70 to 120 km/h (44 to 70 mph) for 5 to 10 minutes.
(e) Read DTCs.

NOTICE:

- **If the conditions in this test are not strictly followed, no malfunction will be detected.**
- **Do not drive the vehicle without deactivating inspection mode. Otherwise damaging the transaxle may result.**

CONFIRMATION DRIVING PATTERN for DTC P0138

PURPOSE



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 05–25).
(b) Put the engine in inspection mode (see page 05–1).
(c) Start the engine and let the engine idle for 1 minute.
(d) Read DTCs.

NOTICE:

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

INSPECTION PROCEDURE

Read freeze frame data using the intelligent tester II. 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 II to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester II ON.
(d) On the intelligent tester II, select the item: Powertrain / Engine and ECT / DTC.
(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 the troubleshooting for those DTCs first.

B → **REPLACE GO TO RELEVANT DTC CHART (See page 05–39)**

A

2	**PERFORM ACTIVE TEST ON INTELLIGENT TESTER II (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 areas are malfunctioning or not.

(a) Perform Active Test using the intelligent tester II.

HINT:
The A/F CONTROL operation lowers the injection volume 12.5% or increases the injection volume 25%.

(1) Connect the intelligent tester II to the DLC3 on the vehicle.
(2) Turn the power switch ON (IG).
(3) Put the engine in inspection mode (see page 05–1).
(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) Select the item: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(6) Select the monitor item: AFS B1S1 and O2S B1S2.
(7) 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

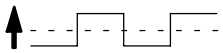
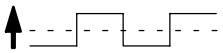
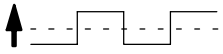
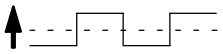
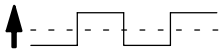
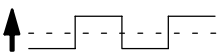
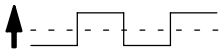
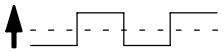
Heated oxygen sensor reacts in accordance with increase and decrease of injection volume:

+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.

	Output voltage of A/F sensor (sensor 1)	Output voltage of heated oxygen sensor (sensor 2)	Main Suspect Trouble Area
Case 1	Injection volume +25 % –12.5 %  Output voltage More than 3.35 V Less than 3.0 V  **OK**	Injection volume +25 % –12.5 %  Output voltage More than 0.55 V Less than 0.4V  **OK**	—
Case 2	Injection volume +25 % –12.5 %  Output voltage Almost no reaction **NG**	Injection volume +25 % –12.5 %  Output voltage More than 0.55 V Less than 0.4V  **OK**	A/F sensor (A/F sensor, sensor heater, sensor circuit)
Case 3	Injection volume +25 % –12.5 %  Output voltage More than 3.35 V Less than 3.0V  **OK**	Injection volume +25 % –12.5 %  Output voltage Almost no reaction **NG**	Heated oxygen sensor (heated oxygen sensor, sensor heater, sensor circuit)
Case 4	Injection volume +25 % –12.5 %  Output voltage Almost no reaction **NG**	Injection volume +25 % –12.5 %  Output voltage Almost no reaction **NG**	Extremely RICH or LEAN actual air–fuel ratio (Injector, fuel pressure, gas leakage in exhaust system, etc.)

To display the graph, select the item on the tester: View / Line graph.

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

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 II to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester II ON.
(d) On the intelligent tester II, select the item: Powertrain / Engine and ECT / DTC.
(e) Read DTCs.

Result:

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

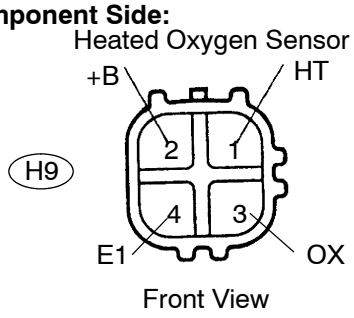
B	REPLACE HEATED OXYGEN SENSOR

A

CHECK FOR INTERMITTENT PROBLEMS

5 INSPECT HEATED OXYGEN SENSOR(HEATER RESISTANCE)

Component Side:



(a) Disconnect the H9 heated oxygen sensor connector.
(b) Measure the resistance between the terminals of the heated oxygen sensor connector.

Standard:

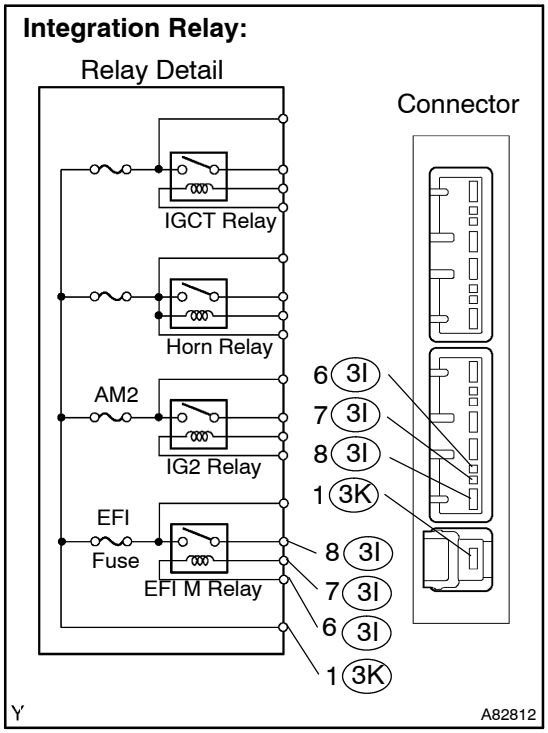
Tester Connection	Specified Condition
HT (H9–1) – +B (H9–2)	11 to 16 Ω at 20 °C (68 °F)
HT (H9–1) – E1 (H9–4)	10 kΩ or higher

(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 R/B.

(b) Inspect the EFI M relay.

Standard:

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)

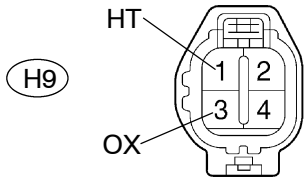
(c) Reinstall the integration relay.

NG → **REPLACE INTEGRATION RELAY**

OK

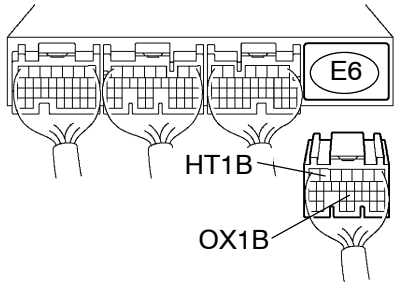
7 CHECK HARNESS AND CONNECTOR(HEATED OXYGEN SENSOR – ECM)

Wire Harness Side:
Heated Oxygen Sensor Connector



Front View

A79118



Y ECM Connector A65748

(a) Disconnect the H9 heated oxygen sensor connector.
(b) Disconnect the E6 ECM connectors.
(c) Check the resistance between the wire harness side connectors.

Standard (Check for open):

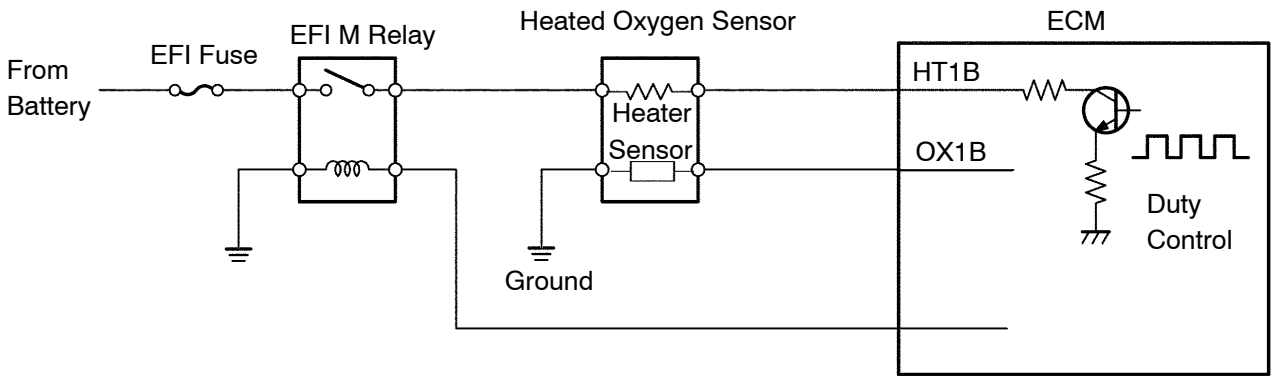
Tester Connection	Specified Condition
HT (H9–1) – HT1B (E6–6)	Below 1 Ω
OX (H9–3) – OX1B (E6–22)	Below 1 Ω

Standard (Check for short):

Tester Connection	Specified Condition
HT (H9–1) or HT1B (E6–6) – Body ground	10 kΩ or higher
OX (H9–3) or OX1B (E6–22) – 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):



P A73886

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

OK →

REPLACE HEATED OXYGEN SENSOR