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	P0139	OXYGEN SENSOR CIRCUIT SLOW RE-SPONSE (BANK 1 SENSOR 2)

DTC	P0156	OXYGEN SENSOR CIRCUIT MALFUNCTION (BANK 2 SENSOR 2)

DTC	P0157	OXYGEN SENSOR CICRCUIT LOW VOLTAGE (BANK 2 SENSOR 2)

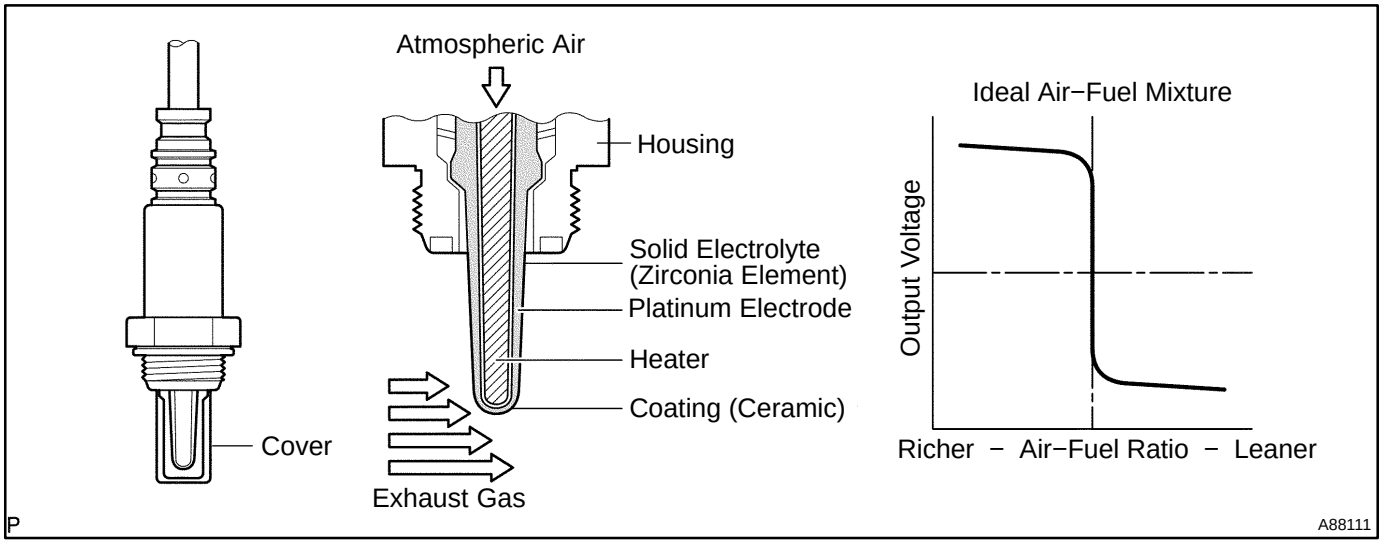
DTC	P0158	OXYGEN SENSOR CIRCUIT HIGH BOLTAGE (BANK 2 SENSOR 2)

DTC	P0159	OXYGEN SENSOR CIRCUIT SLOW RE-SPONSE (BANK 2 SENSOR 2)

CIRCUIT DESCRIPTION

The heated oxygen sensor (HO2S) is used to monitor oxygen in the exhaust gas. For optimum catalyst operation, the air fuel mixture (air−fuel ratio) must be maintained near the ideal ”stoichiometric” ratio. The HO2S 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 stoichiometirc.

The HO2S generates a voltage between 0.1 and 0.9 volts in response to oxygen in the exhaust gas. If the oxygen in the exhaust gas increases, the air−fuel ratio becomes ”Lean”. The ECM interprets Lean when the HO2S voltage is below 0.45 volts. If the oxygen in the exhaust gas decreases, the air−fuel ratio becomes ”Rich”. The ECM interprets Rich when the HO2S voltage is above 0.45 volts.



DTC No.	DTC Detection Condition	Trouble Area
P0136	• Either of the following condition set: (a) Heated oxygen sensor voltage was lower than 0.05 V for a certain period (2−trip detection logic) (b) Heated oxygen sensor did not switch for a certain period (2−trip detection logic)	• Heated oxygen sensor circuit (bank 1) • Heated oxygen sensor (bank 1) • Oxygen sensor heater (bank 1) • A/F sensor (bank 1) • A/F sensor heater (bank 1)
P0137	Heated oxygen sensor voltage was lower than 0.03 V for 90 seconds	• Heated oxygen sensor circuit (bank 1) • Heated oxygen sensor (bank 1) • Oxygen sensor heater (bank 1)
P0138	Either of the following condition set (a) Heated oxygen sensor voltage did not drop during fuel−cut (2−trip detection logic) (b) Heated oxygen sensor voltage was 1.2 V or higher for 10 seconds	• Heated oxygen sensor circuit (bank 1) • Heated oxygen sensor (bank 1) • Oxygen sensor heater (bank 1)
P0139	Signal of oxygen sensor (bank 1 sensor 2) was not switching between lean and rich	• Heated oxygen sensor circuit (bank 1) • Heated oxygen sensor (bank 1) • Oxygen sensor heater (bank 1)
P0156	• Either of the following condition set: (a) Heated oxygen sensor voltage was lower than 0.05 V for a certain period (2−trip detection logic) (b) Heated oxygen sensor did not switch for a certain period (2−trip detection logic)	• Heated oxygen sensor circuit (bank 2) • Heated oxygen sensor (bank 2) • Oxygen sensor heater (bank 2) • A/F sensor (bank 2) • A/F sensor heater (bank 2)
P0157	Heated oxygen sensor voltage was lower than 0.03 V for 90 seconds	• Heated oxygen sensor circuit (bank 2) • Heated oxygen sensor (bank 2) • Oxygen sensor heater (bank 2)
P0158	Either of the following condition set (a) Heated oxygen sensor voltage did not drop during fuel−cut (2−trip detection logic) (b) Heated oxygen sensor voltage was 1.2 V or higher for 10 seconds	• Heated oxygen sensor circuit (bank 2) • Heated oxygen sensor (bank 2) • Oxygen sensor heater (bank 2)
P0159	Signal of oxygen sensor (bank 2 sensor 2) was not switching between lean and rich	• Heated oxygen sensor circuit (bank 2) • Heated oxygen sensor (bank 2) • Oxygen sensor heater (bank 2)

HINT:

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

MONITOR DESCRIPTION

The heated oxygen sensor (HO2S) outputs 0 − 1 volt of the voltage. The voltage varies with oxygen density in the exhaust gas. The ECM measures the voltage to monitor the HO2S.

Voltage

The ECM counts the time while the HO2S voltage is lower than0.05 volts. When the time exceeds a malfunction threshold, the ECM illuminates the MIL and sets DTC P0136 or P0156 (2−trip detection logic).

Switching

The ECM counts the frequency of the HO2S switching. When the HO2S does not switch for a certain period, the ECM illuminates the MIL and sets DTC P0136 or P0156 (2−trip detection logic).

Low voltage

The ECM measures the HO2S voltage. When the voltage is lower than 0.03 volts for 90 seconds, the ECM illuminates the MIL and sets DTC P0137 or P0157.

Voltage during fuel−cut

The ECM measure the HO2S voltage during the fuel−cut. When the voltage does not reach to 0.2 volts during the fuel−cut, the ECM illuminates the MIL and sets DTC P0139 or P0159 (2−trip detection logic).

High voltage

The ECM measures the HO2S voltage. When the voltage is higher than 1.2 volts for 10 seconds, the ECM illuminates the MIL and sets DTC P0138 or P0158.

MONITOR STRATEGY

Voltage:

Related DTCs	P0136 (bank 1 sensor 2), P0156 (bank 2 sensor 2)
Required Sensors/Components (Main)	Heated oxygen sensor
Required Sensors/Components (Related)	Crankshaft position sensor, Mass air flow meter, Throttle position sensor, Vehicle speed sensor
Frequency of Operation	Once per driving cycle
Duration	160 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

Switching:

Related DTCs	P0136 (bank 1 sensor 2), P0156 (bank 2 sensor 2)
Required Sensors/Components (Main)	Heated oxygen sensor
Required Sensors/Components (Related)	Crankshaft position sensor
Frequency of Operation	Once per driving cycle
Duration	480 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

Low voltage:

Related DTCs	P0137 (bank 1 sensor 2), P0157 (bank 2 sensor 2)
Required Sensors/Components (Main)	Heated oxygen sensor
Required Sensors/Components (Related)	Mass air flow meter, Oxygen sensor heater
Frequency of Operation	Continuous
Duration	90 seconds
MIL Operation	Immediate
Sequence of Operation	None

Voltage during fuel−cut

Related DTCs	P0139 (bank 1 sensor 2), P0159 (bank 2 sensor 2)
Required Sensors/Components (Main)	Heated oxygen sensor
Required Sensors/Components (Related)	Engine coolant temperature sensor, Mass air flow meter, Oxygen sensor heater
Frequency of Operation	Once per driving cycle
Duration	6 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

High voltage:

Related DTCs	P0138 (bank 1 sensor 2), P0158 (bank 2 sensor 2)
Required Sensors/Components (Main)	Heated oxygen sensor
Required Sensors/Components (Related)	None
Frequency of Operation	Continuous
Duration	10 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	See page 05−507

Voltage:

Engine	Running
Vehicle speed	1.875 mph (3 km/h) or more
Idle	OFF
Fuel−cut	OFF
Intake air amount per revolution	7 g/sec or more (1MZ−FE) 6 g/sec or more (3MZ−FE)

Switching:

All of the following conditions are met	Condition 1, 2 and 3
1. Engine	Running
2. Cumulative time when oxygen sensor heater is opening	22 seconds or more
3. Time after engine start	0 second or more

Low voltage:

Battery voltage	11 V or more
Estimated heated oxygen sensor temperature	450°C (842°F) or more

Voltage during fuel−cut:

Engine coolant temperature	70°C (158°F) or more
Estimated catalyst temperature	500°C (932°F) or more
Fuel−cut	ON

High voltage:

Engine	Running
Battery voltage	11 V or more

TYPICAL MALFUNCTION THRESHOLDS

Voltage:

All of the following conditions are met	Conditions 1, 2, 3, 4 and 5
1. Cumulative monitor time of HO2S	160 seconds or more
2. Duration while HO2S voltage is below 0.05 V	96 seconds or more
3. Duration while HO2S voltage is higher than 0.7 V	Less than 32 seconds
4. Duration while HO2S voltage is 0.45 V to 0.7 V	Less than 48 seconds
5. Duration while HO2S voltage is 0.45 V or more	Less than 20 seconds

Switching:

Both of the following conditions are met:	Conditions 1 and 2
1. Frequency in cumulative monitor time that HO2S voltage changes between (a) and (b)	0 time
(a) Maximum voltage	0.6 V or more
(b) Minimum voltage	Less than 0.4 V (1MZ−FE) Less than 0.45 V (3MZ−FE)
2. Cumulative monitor time *1 of rear HO2S	480 seconds or more
*1: Monitor time is counted when all of the following conditions are met	Conditions (a) and (b)
(a) Fuel system status	Closed−loop
(b) Idle	OFF

Low voltage:

Duration that rear oxygen sensor is less than 0.03 V	90 seconds or more

Voltage during fuel−cut:

One of the following conditions is met	Conditions 1 or 2
1. Duration until rear HO2S voltage drops to 0.2 V during fuel−cut start	6 seconds or more
2 Duration that rear HO2S voltage drops from 0.35 to 0.2 V during fuel−cut	1 second or more

High voltage:

Duration that rear oxygen sensor is 1.2 V or more	10 seconds or more

COMPONENT OPERATING RANGE

Rear HO2S voltage	Varies between 0.1 and 0.9 V

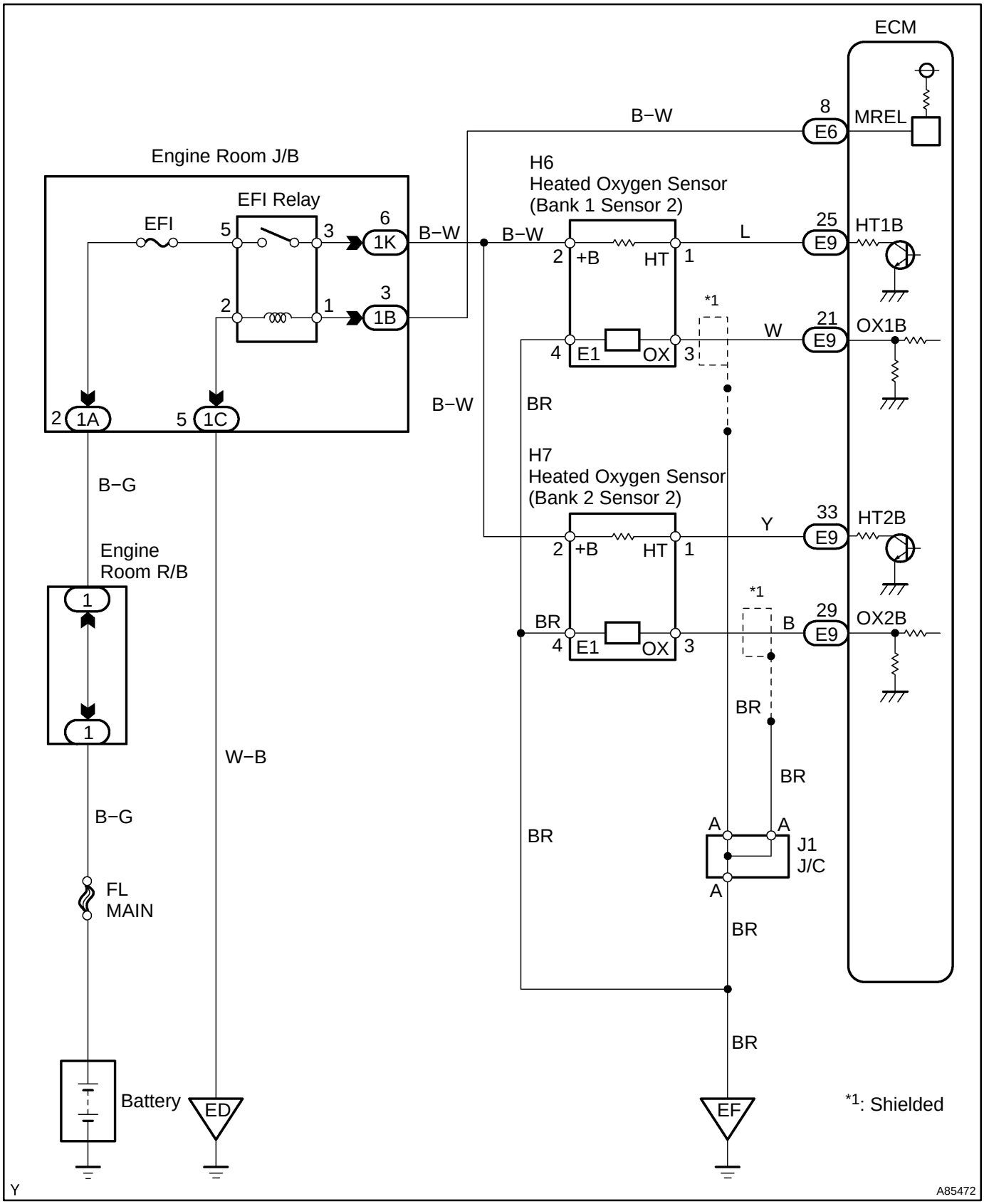
O2S TEST RESULT

Refer to page 05−514 for detailed information on O2S TEST RESULT.

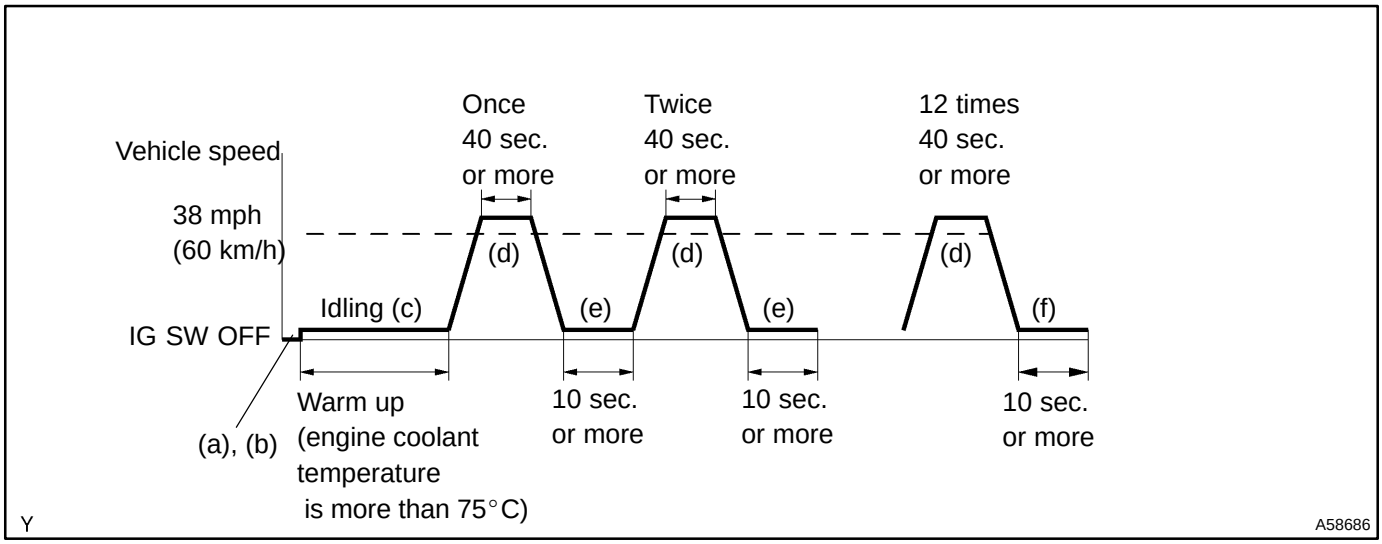
Test ID	Test Item	Description	Unit Conversion	Unit	Standard Value
$07	MIN HO2S V	Minimum HO2S voltage	Multiply by 0.005	V	Less than malfunction threshold
$08	MAX HO2S V	Maximum HO2S voltage	Multiply by 0.005	V	More than malfunction threshold
$31	Time $31	HO2S switch time from Lean to Rich	Multiply by 0.04096	second	Less than malfunction threshold
$32	Time $32	HO2S switch time from Rich to Lean	Multiply by 0.04096	second	Less than malfunction threshold
$37	Time $37	Time that HO2S voltage drops to 0.2 volts after fuel−cut begins	Multiply by 0.04096	second	Less than malfunction threshold
$81	Time $81	Percentage in monitor time when HO2S voltage is lower than 0.05 volts	Multiply by 0.3906	%	Less than malfunction threshold
$84	Time $84	Percentage in monitor time when HO2S voltage is 0.7 volts or higher	Multiply by 0.3906	%	More than malfunction threshold
$85	Time $85	Maximum time while HO2S voltage exceeded 0.45 volts continuously	Multiply by 0.2621	seconds	More than malfunction threshold
$87	Time $87	Percentage in monitor time when HO2S voltage is 0.45 volts or higher	Multiply by 0.3906	%	More than malfunction threshold

If the sensor voltage is outside the standard values, the ECM interprets this as a malfunction and sets a DTC.

WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN



(a) Connect the hand−held tester to the DLC3.
(b) Switch the hand−held tester from the normal mode to the check (test) mode (see page 05−533).
(c) Start the engine and warm up the engine until engine coolant temperature is more than 75°C.
(d) Drive the vehicle at 38 mph (60 km/h) or more for 40 seconds or more.
(e) Let the engine idle for 10 seconds or more.
(f) Perform steps (d) to (e) 12 times.

HINT:

If a malfunction exists, the MIL will illuminate during step (f).

NOTICE:

If the conditions in this test are not strictly followed, detection of a malfunction will not occur. If you do not have a hand−held tester, turn the ignition switch OFF after performing steps from (c) to (f), then perform steps from (c) to (f) again.

INSPECTION PROCEDURE

HINT:

Hand−held tester only:

It is possible the malfunctioning area can be found using 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 the ACTIVE TEST A/F CONTROL operation.

HINT:

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

(1) Connect the hand−held tester to the DLC3 on the vehicle.
(2) Turn the ignition switch ON.
(3) Warm up the engine by running the engine at 2,500 rpm for approximately 90 seconds.
(4) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(5) Perform the A/F CONTROL operation with the engine idle (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)	Mainly suspected 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, heater, A/F 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, heater, heated oxygen 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.)

The following A/F CONTROL procedure enables the technician to check and graph the voltage outputs of both the A/F sensor and the heated oxygen sensor.
For displaying the graph, enter ”ACTIVE TEST / A/F CONTROL / USER DATA”, select ”AFS B1S1 and O2S B1S2” by pressing ”YES” and push ”ENTER”. Then press ”F4”.
HINT:
Read freeze frame data using the hand−held tester or the OBD II scan tool. Freeze frame data records the engine conditions when a 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

(a) Read the DTC using the hand−held tester or the OBD II scan tool.
Result:

Display (DTC Output)	Proceed to
P0138 or P0158 is output	A
P0137 or P0157 is output	B
P0136 or P0156 is output	C

HINT:
If any other codes besides P0136, P0137, P0138, P0156, P0157 and/or P0158 are output, perform the troubleshooting for those codes first.

B → **Go to step 9**

C → **Go to step 6**

A

2 READ VALUE OF HAND−HELD TESTER OR OBD II SCAN TOOL (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

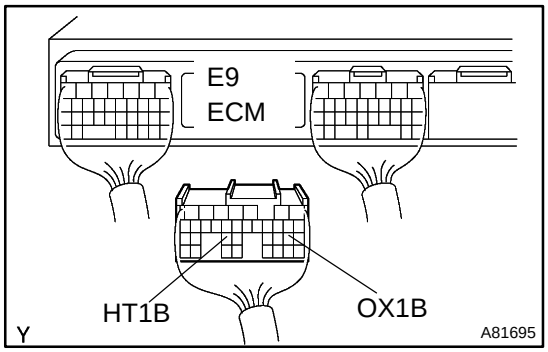
(a) Connect the hand−held tester or the OBD II scan tool to the DLC3.
(b) Turn ON the ignition switch. Push the hand−held tester or the OBD II scan tool main switch ON.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / O2S B1S2.
(d) Run the engine at idle.
(e) Read the output voltage of the heated oxygen sensor during idling.

Heated oxygen sensor output voltage	Proceed to
More than 1.2 V	A
Less than 1.0 V	B

B → **Go to step 5**

A

3 CHECK WIRE HARNESS (CHECK FOR SHORT)



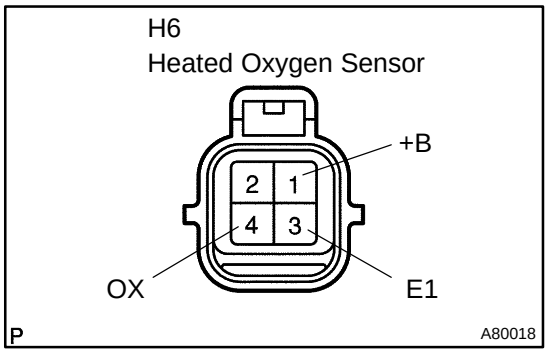
(a) Turn the ignition switch OFF and wait for 5 minutes.
(b) Disconnect the E9 ECM connector.
(c) Measure the resistance of the wire harness side connectors.
Standard:

Tester Connection	Specified Condition
E9−25 (HT1B) − E9−21 (OX1B)	No continuity

OK → **REPLACE ECM (See page 10−25)**

NG

4 INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)



(a) Disconnect the H6 heated oxygen sensor connector.
(b) Measure the resistance of the sensor side connectors.
Standard:

Tester Connection	Specified Condition
H6−1 (HT) − H6−2 (+B)	10 kΩ or higher
H6−1 (HT) − H6−4 (E1)	10 kΩ or higher

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

NG

REPLACE HEATED OXYGEN SENSOR

5 READ OUTPUT DTC (CHECK MODE)

(a) Change the ECM to check mode with the hand−held tester.
Enter the following menus: DIAGNOSIS / ENHANCED OBD II / CHECK MODE.
(b) Warm up the engine and drive the vehicle at over 25 mph (40 km/h) for an accumulated total of 10 minutes.

HINT:
The 10 minutes of driving should be driven in one instance, but it is not necessary to maintain a speed of 25 mph (40 km/h) for 10 minutes consecutively.

(c) Read the DTC.
Result:

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

B → **CHECK FOR INTERMITTENT PROBLEMS**

A

REPLACE HEATED OXYGEN SENSOR

6 READ VALUE OF HAND−HELD TESTER OR OBD II SCAN TOOL (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

(a) After warming up the engine, run the engine at 2,500 rpm for 3 minutes.
(b) Read the output voltage of the heated oxygen sensor when the engine rpm is suddenly increased.

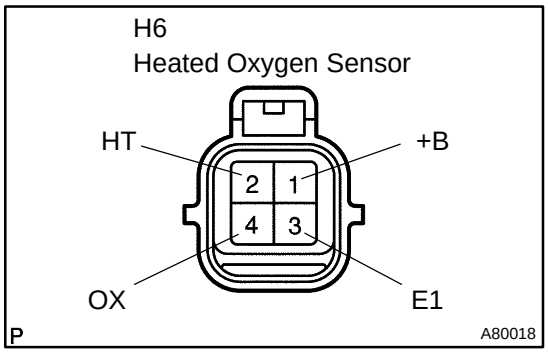
HINT:
Quickly accelerate the engine to 4,000 rpm 3 times by using the accelerator pedal.

Heated oxygen sensor output voltage: Alternates 0.4 V or less and 0.5 V or more.

OK → **Go to step 10**

NG

7 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



(a) Disconnect the H6 heated oxygen sensor connector.
(b) Measure the resistance of the heated oxygen sensor terminals.

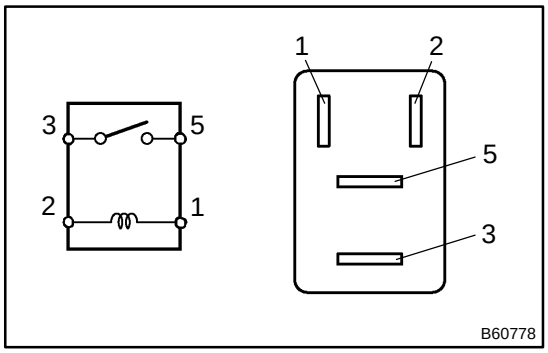
Standard:

Tester Connection	Condition	Specified Condition
H6−1 (HT) − H6−2 (+B)	20°C (68°F)	11 to 16 Ω
H6−1 (HT) − H6−2 (+B)	800°C (1,472°F)	23 to 32 Ω

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

8 INSPECT RELAY (EFI)



(a) Remove the EFI relay from the engine room J/B.
(b) Check the resistance of the EFI relay.

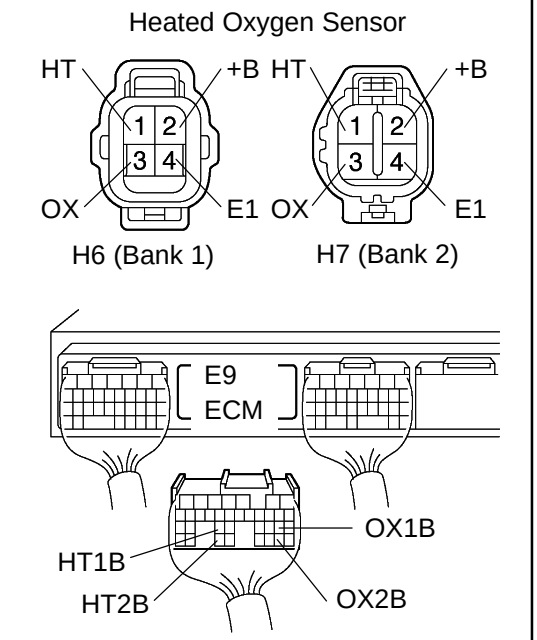
Standard:

Tester Connection	Specified Condition
3 − 5	10 kΩ or higher
3 − 5	Below 1 Ω (when battery voltage is applied to terminals 1 and 2)

NG → **REPLACE RELAY**

OK

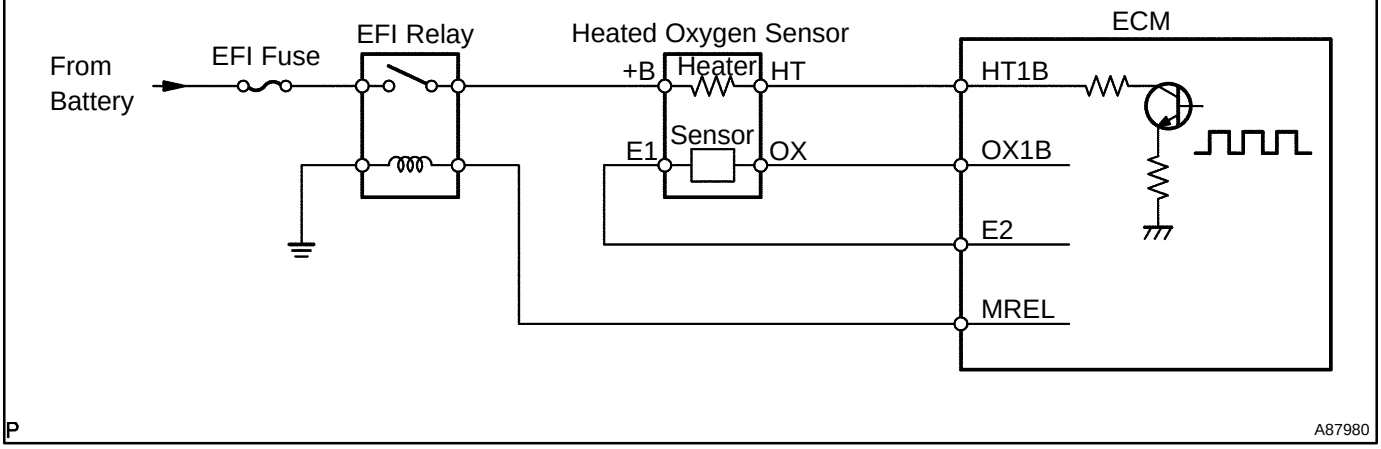
9 CHECK WIRE HARNESS



(a) Disconnect the H6 or H7 heated oxygen sensor connector.
(b) Disconnect the E9 ECM connector.
(c) Check the resistance of the wire harness side connectors.
Standard:

Tester Connection	Specified Condition
H6−3 (OX) − E9−21 (OX1B) H6−1 (HT) − E9−25 (HT1B) H7−3 (OX) − E9−29 (OX2B) H7−1 (HT) − E9−33 (HT2B)	Below 1 Ω
H6−3 (OX) or E9−21 (OX1B) − Body ground H6−1 (HT) or E9−25 (HT1B) − Body ground H7−3 (OX) or E9−29 (OX2B) − Body ground H7−1 (HT) or E9−33 (HT2B) − Body ground	10 kΩ or higher

Reference (Bank 1 Sensor 2 System Drawing)



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

OK

REPLACE HEATED OXYGEN SENSOR

10	PERFORM CONFIRMATION DRIVING PATTERN

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

NEXT

11	READ OUTPUT DTC (DTC P0136 OR P0156 IS OUTPUT AGAIN)

(a) Read the DTC using the hand−held tester or the OBD II scan tool.
Result:

Display (DTC Output)	Proceed to
P0136 or P0156 is not output again	A
P0136 or P0156 is output again	B

A → CHECK FOR INTERMITTENT PROBLEMS

B

12	REPLACE HEATED OXYGEN SENSOR

NEXT

13	PERFORM CONFIRMATION DRIVING PATTERN

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

NEXT

14	READ OUTPUT DTC (DTC P0136 OR P0156 IS OUTPUT AGAIN)

(a) Read the DTC using the hand−held tester or the OBD II scan tool.
Result:

Display (DTC Output)	Proceed to
P0136 is not output again	A
P0136 is output again	B

A → REPAIR COMPLETED

B

15	PERFORM ACTIVE TEST USING HAND−HELD TESTER

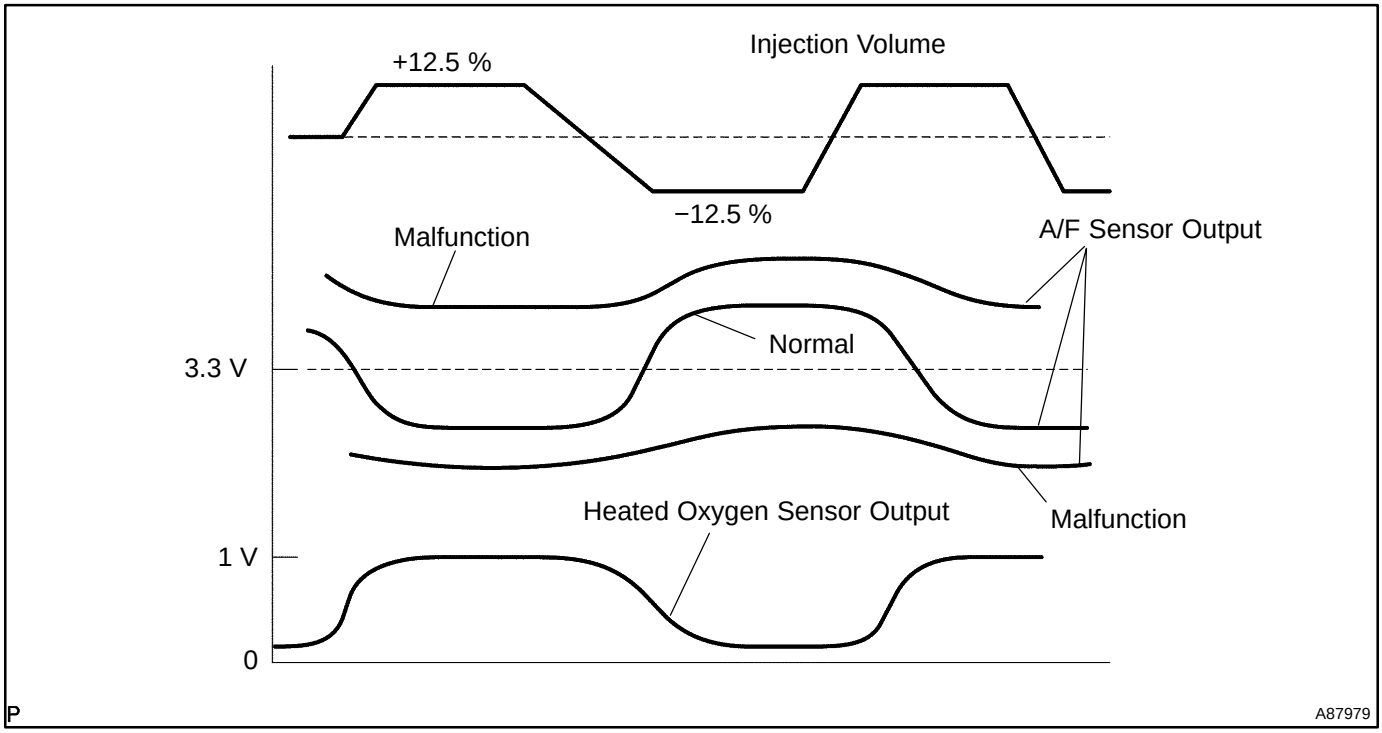
(a) Start the engine and warm it up.
(b) Connect the hand−held tester to the DLC3.
(c) Turn ON the ignition switch and the hand−held tester main switch.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INJ VOL.
(e) Using the hand−held tester, change the injection volume to check the A/F sensor output and heated oxygen sensor output values below.

HINT:

Change the injection volume from −12.5 % to +12.5 %.

Result:

A/F sensor output remains more than 3.3 V or A/F sensor output remains less than 3.3 V (Heated oxygen sensor reacts in accordance with increase and decrease of injection volume)



OK → **REPLACE AIR FUEL RATIO SENSOR**

NG

CHECK AND REPLACE EXTREMLY RICH OR LEAN ACTUAL AIR FUEL RATIO