DTC	P0136	OXYGEN SENSOR CIRCUIT MALFUNCTION (BANK 1 SENSOR 2)

DTC	P0137	OXYGEN SENSOR CIRCUIT LOW VOLTAGE (BANK 1 SENSOR 2)

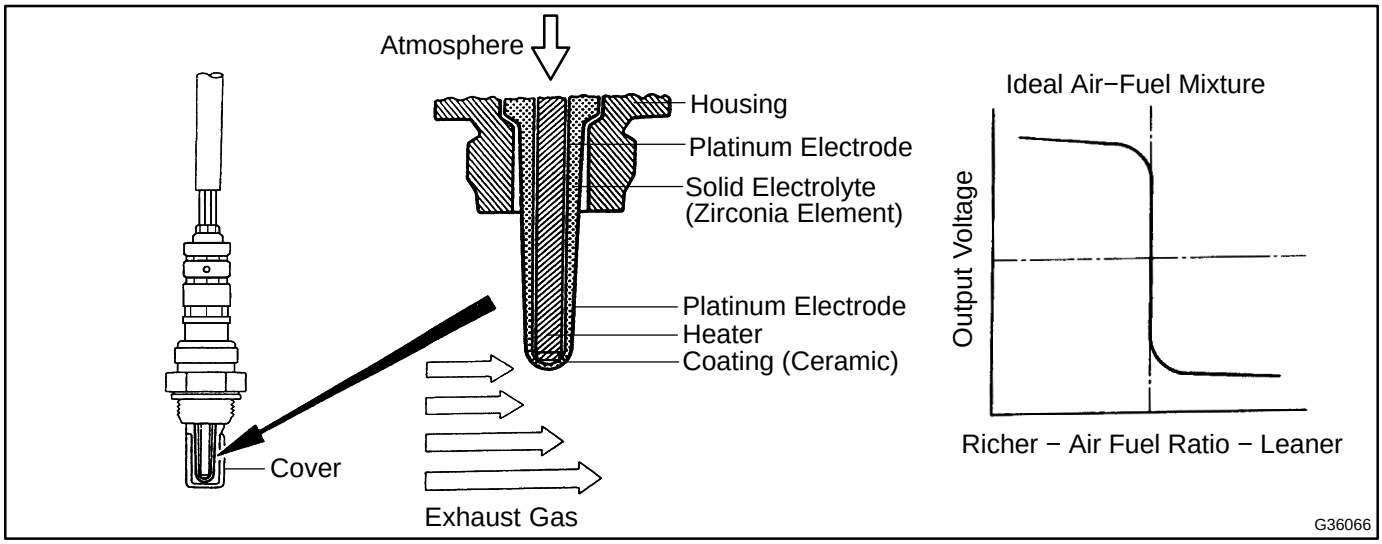
DTC	P0138	OXYGEN SENSOR CIRCUIT HIGH VOLTAGE (BANK 1 SENSOR 2)

DTC	P0139	OXYGEN SENSOR CIRCUIT SLOW RESPONSE (BANK 1 SENSOR 2)

HINT:
Sensor 2 refers to the sensor mounted behind the Three−Way Catalytic Converter (TWC) and located far from the engine assembly.

CIRCUIT DESCRIPTION

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air−fuel ratio must be precisely controlled so that it is always close to the stoichiometric air−fuel level. For the purpose of helping the ECM to deliver accurate air−fuel ratio control, a Heated Oxygen (HO2) sensor is used.
The HO2 sensor is located behind the TWC, and detects the oxygen concentration in the exhaust gas. Since the sensor is integrated with the heater that heats the sensing portion, it is possible to detect the oxygen concentration even when the intake air volume is low (the exhaust gas temperature is low).
When the air−fuel ratio becomes lean, the oxygen concentration in the exhaust gas is 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.



DTC No.	DTC Detection Conditions	Trouble Areas
P0136	• Abnormal voltage output: During active air−fuel ratio control, following conditions (a) and (b) met for certain period of time (2 trip detection logic): (a) Heated Oxygen (HO2) sensor voltage does not decrease to less than 0.45 V (b) HO2 sensor voltage does not increase to more than 0.6 V • Low impedance: Sensor impedance 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 (sensor 2) circuit • HO2 sensor (sensor 2) • HO2 sensor heater (sensor 2) • Air−Fuel Ratio (A/F) sensor (sensor 1) • EFI relay • Gas leakage from exhaust system
P0137	• High impedance: Sensor impedance 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 (sensor 2) circuit • HO2 sensor (sensor 2) • HO2 sensor heater (sensor 2) • EFI relay • Gas leakage from exhaust system
P0138	• Extremely high voltage (short): HO2 sensor voltage output exceeds 1.2 V for more than 10 seconds (2 trip detection logic)	• Short in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • ECM internal circuit malfunction
P0139	• Fuel−cut HO2 sensor voltage: Either of following conditions (1) or (2) met (2 trip detection logic): 1. Duration until HO2 sensor voltage drops to 0.2 V after fuel−cut start 7 seconds or more 2. Both following conditions (a) and (b) met: (a) Rear HO2 sensor voltage when fuel−cut start 0.5 V or more (b) Duration that HO2 sensor voltage to 0.35 to 0.2 V 1 second or more	• Short in HO2 sensor (sensor 2) circuit • HO2 sensor (sensor 2) • ECM internal circuit malfunction

MONITOR DESCRIPTION

The ECM monitors the rear Heated Oxygen (HO2) sensor to check for the following malfunctions. If any of the malfunctions are detected, the ECM illuminates the MIL and sets a DTC:

- The HO2 sensor output voltage remains above 0.45 V (rich) or below 0.45 V (lean) while the vehicle is accelerated and decelerated for 8 minutes.
- The HO2 sensor output voltage remains at below 0.05 V, for a long period of time while the vehicle is driven.
- The HO2 sensor output voltage does not decrease below 0.2 V (extremely lean condition) within 7 seconds after fuel−cut is performed while the vehicle is decelerated. The ECM interprets this as the sensor response having deteriorated.

MONITOR STRATEGY

Related DTCs	P0136: Heated oxygen sensor output voltage (Output voltage) P0136: Heated oxygen sensor impedance (Low impedance) P0137: Heated oxygen sensor output voltage (Low voltage) P0137: Heated oxygen sensor impedance (High impedance) P0138: Heated oxygen sensor output voltage (High voltage) P0139: Heated oxygen sensor output voltage (Extremely high)
Required Sensors/Components (Main)	Heated oxygen sensor
Required Sensors/Components (Related)	Crankshaft position sensor, engine coolant temperature sensor, mass air flow meter and throttle position sensor
Frequency of Operation	Once per driving cycle: Active air−fuel ratio control detection Continuous: Others
Duration	480 seconds: P0136 (Rear HO2S output voltage − case 1) 180 seconds: P0136 (Rear HO2S output voltage − case 2, A/T models) 170 seconds: P0136 (Rear HO2S output voltage − case 2, M/T models) 30 seconds: P0136 (Rear HO2S low impedance) 90 seconds: P0137 (Rear HO2S high impedance) 10 seconds: P0138 (Rear HO2S output voltage − case 3) 7 seconds: P0139 (Rear HO2S output voltage during fuel−cut)
MIL Operation	2 driving cycles: P0136 (Rear HO2S output voltage − case 1) P0136 (Rear HO2S output voltage − case 2) P0139 (Rear HO2S voltage during fuel−cut) Immediate: Others
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	See page 05−16

P0136 (Rear HO2S output voltage − case 1):

All of the following conditions are met	Conditions 1, 2 and 3
1. Engine	Running
2. Time after engine start	0 second or more
3. Either of the following conditions is met:	Conditions (a) or (b)
Cumulative time while HO2S heater is operating	22 seconds or more

P0136 (Rear HO2S output voltage − case 2):

Engine	Running

P0136 (Rear HO2S low impedance):

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

P0137 (Rear HO2S high impedance):

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

P0138 (Rear HO2S output voltage − case 3):

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

P0139 (Rear HO2S output voltage during fuel−cut):

Engine coolant temperature	70°C (158°F) or more
Catalyst temperature	400°C (752°F) or more
Fuel−cut	ON

TYPICAL MALFUNCTION THRESHOLDS

P0136 (Rear HO2S output voltage − case 1):

Both of the following conditions are met:	Conditions 1 and 2
1. Frequency that HO2S voltage changes between (a) and (b)	0 time
(a) Maximum voltage	0.6 V or more
(b) Minimum voltage	Less than 0.45 V
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

P0136 (Rear HO2S output voltage − case 2):

A/T models: All of the following conditions are met	Conditions 1, 2, 3, 4 and 5
1. Cumulative sensor monitor time *2 of HO2S	180 seconds or more
2. Cumulative time while HO2S voltage is below 0.05 V	108 seconds or more
3. Cumulative time while HO2S voltage is higher than 0.7 V	Less than 36 seconds
4. Cumulative time while HO2S voltage is 0.45 V to 0.7 V	Less than 72 seconds
5. Maximum time while HO2S voltage is 0.45 V or more	Less than 20 seconds
M/T models: All of following conditions are met	Conditions 1, 2, 3, 4 and 5
1. Cumulative sensor monitor time *2 of HO2S	170 seconds or more
2. Cumulative time while HO2S voltage is below 0.05 V	102 seconds or more
3. Cumulative time while HO2S voltage is higher than 0.7 V	Less than 34 seconds
4. Cumulative time while HO2S voltage is 0.45 V to 0.7 V	Less than 68 seconds
5. Maximum time while HO2S voltage is 0.45 V or more	Less than 20 seconds
*2: Monitor time is counted when all of the following conditions are met	Conditions 1, 2, 3 and 4
1. Intake air amount per revolution	5 g/rev or more
2. Vehicle speed	3 km/h (1.875 mph) or more
3. Idle	OFF
4. Fuel−cut	OFF

P0136 (Rear HO2S low impedance):

Duration of the following condition	30 seconds or more
Rear HO2S impedance	Less than 5 Ω

P0137 (Rear HO2S high impedance):

Duration of the following condition	90 seconds or more
Rear HO2S impedance	Less than 15 kΩ

P0138 (Rear HO2S output voltage − case 3):

Duration of the following condition	10 seconds or more
Rear HO2S voltage	1.2 V or more

P0139 (Rear HO2S output voltage during fuel−cut):

Either of the following conditions is met	Conditions 1 or 2
1. Duration until rear HO2S voltage drops to 0.2 V after fuel−cut start	7 seconds or more
2. Both of the following conditions are met	Conditions (a) and (b)
(a) Rear HO2S voltage when fuel−cut start	0.5 V or more
(b) Duration that HO2S voltage to 0.2 to 0.35 V	1 second or more

COMPONENT OPERATING RANGE

Rear HO2S voltage	Varies between 0.1 and 0.9 V

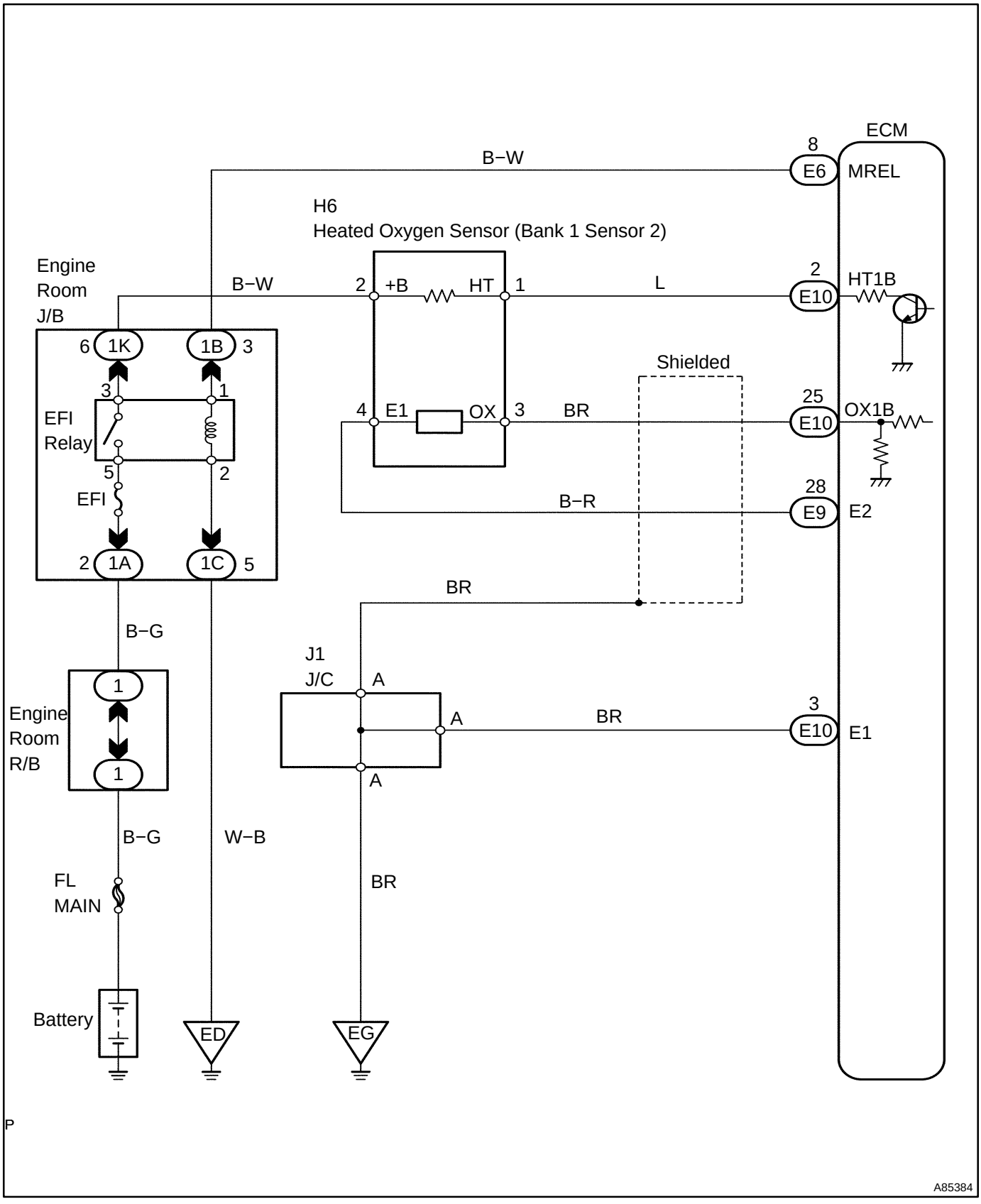
O2S TEST RESULT

Refer to page 05−23 for detailed information on O2S TEST RESULT.

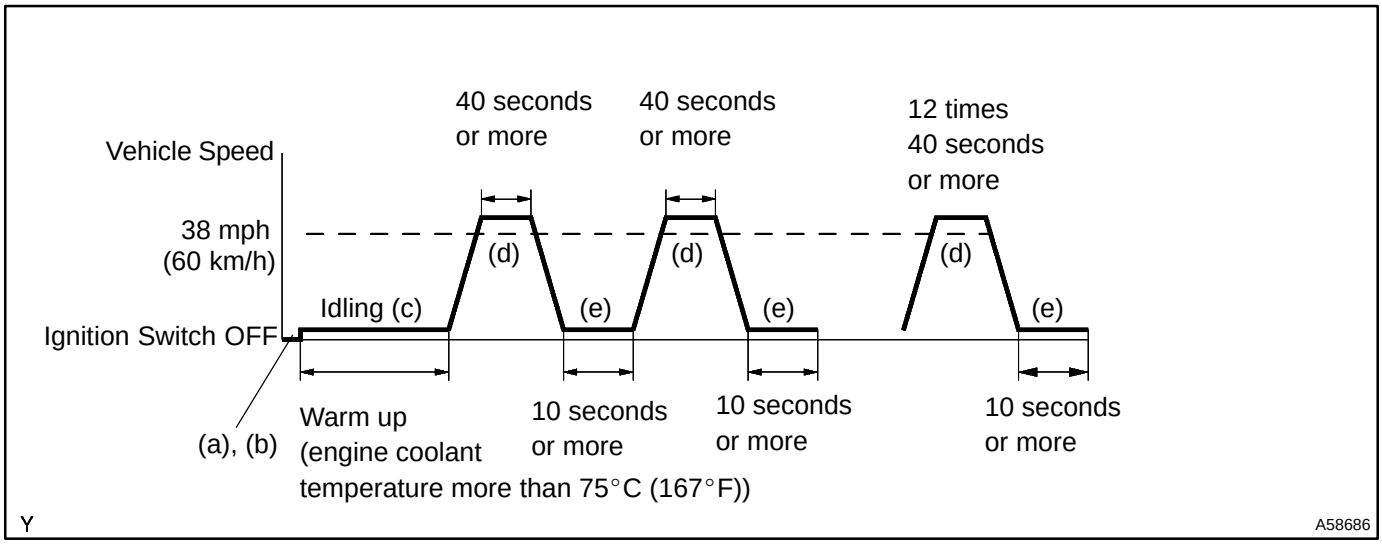
Test ID	Test Item	Description	Unit Conversion	Unit	Standard Value
$07	MIN HO2S V	Minimum HO2S voltage	Multiply by 0.005	V	Less than malfunction threshold
$08	MAX HO2S V	Maximum HO2S voltage	Multiply by 0.005	V	More than malfunction threshold
$31	Time $31	HO2S switch time from Lean to Rich	Multiply by 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 ECM from normal mode to check mode using the tester (see page 05−41).
(c) Start the engine and warm it up untill the engine coolant temperature reaches more than 75°C (167°F).
(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) and (e) 12 times.

HINT:

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

NOTICE:

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

INSPECTION PROCEDURE

HINT:

Hand−held 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 a hand−held tester.

(1) Connect a hand−held 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, select the following menu items: 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 OS2 B1S2) displayed on the tester.

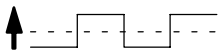
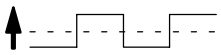
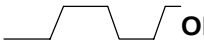
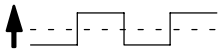
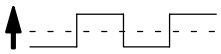
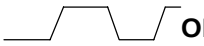
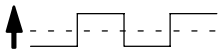
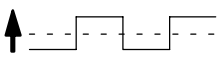
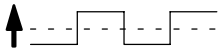
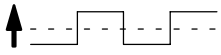
HINT:

- 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:

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

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 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, 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.)

- 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, and press the YES button and then the ENTER button followed by the F4 button.

HINT:

- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.
- Read freeze frame data using a hand−held tester or OBD II scan tool. Freeze frame data record the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, 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.
- If the OX1B wire from the ECM connector is short−circuited to the +B wire, DTC P0136 will be set.

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 is output	A
P0137 is output	B
P0136 is output	C

HINT:
If any other codes besides P0136, P0137 and/or P138 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)

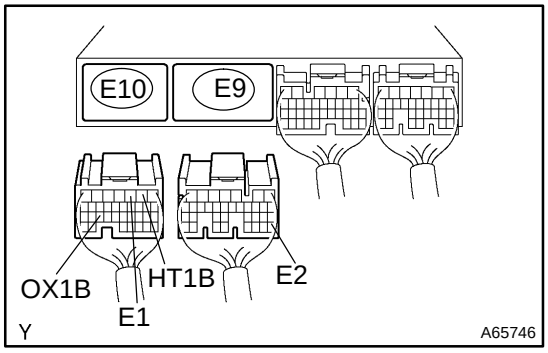
(a) Connect the hand−held tester or the OBD II scan tool to the DLC3.
(b) Turn ON the ignition switch. Push the hand−held tester or the OBD II scan tool main switch ON.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / O2S B1S2.
(d) Run the engine at idle.
(e) Read the output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



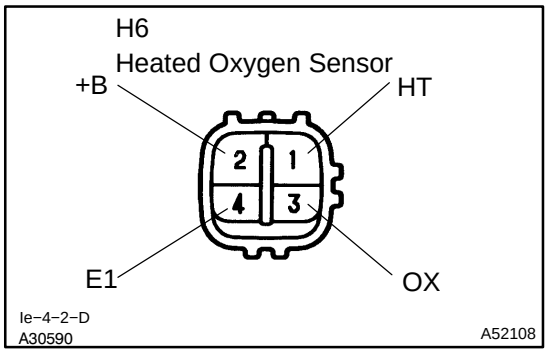
(a) Turn the ignition switch OFF and wait for 5 minutes.
(b) Disconnect the E9 and E10 ECM connector.
(c) Measure the resistance of the wire harness side connectors.
Standard:

Tester Connection	Specified Condition
E10−2 (HT1B) − E10−25 (OX1B)	No continuity
E10−2 (HT1B) − E9−28 (E2)	No continuity

OK → **REPLACE ECM**

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
H6−2 (+B) − H6−4 (E1)	10 kΩ or higher
H6−2 (+B) − H6−3 (OX)	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 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.

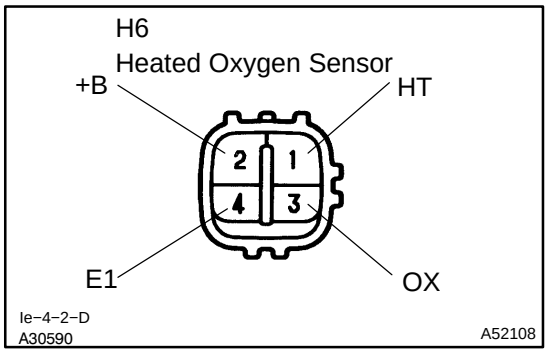
HINT:
Quickly accelerate the engine to 4,000 rpm 3 times by using the accelerator pedal.

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.

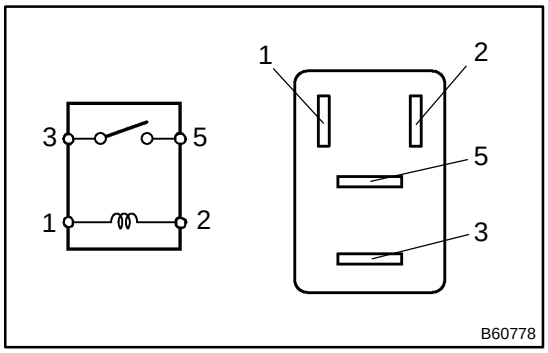
Standard:

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:

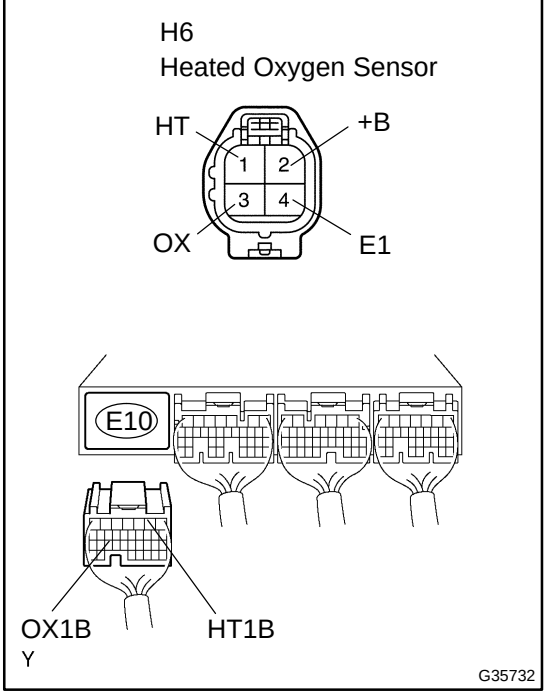
Tester Connection	Specified Condition
3 − 5	10 kΩ or higher
3 − 5	Below 1 Ω (when battery voltage is applied to terminals 1 and 2)

NG → **REPLACE RELAY**

OK

9	CHECK WIRE HARNESS

Wire Harness Side

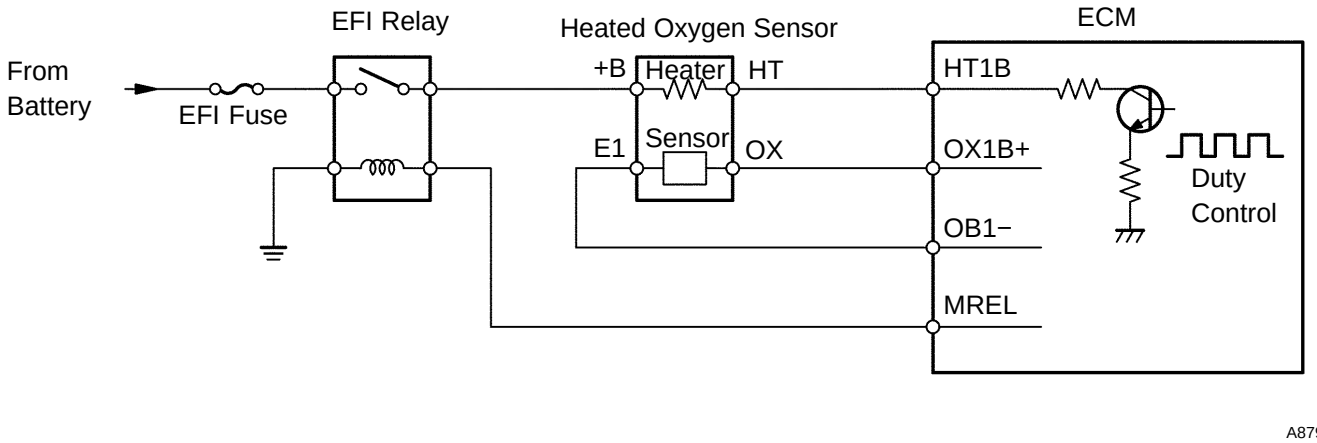


(a) Check the wire harness between the ECM and heated oxygen sensor.
  (1) Disconnect the H6 heated oxygen sensor connector.
  (2) Disconnect the E10 ECM connector.
  (3) Check the resistance of the wire harness side connectors.

Standard:

Tester Connection	Specified Condition
H6−1 (HT) − E10−2 (HT1B) H6−3 (OX) − E10−25 (OX1B)	Below 1 Ω
H6−1 (HT) or E10−2 (HT1B) − Body ground H6−3 (OX) or E10−25 (OX1B) − Body ground	10 kΩ or higher

Reference



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 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 → 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 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

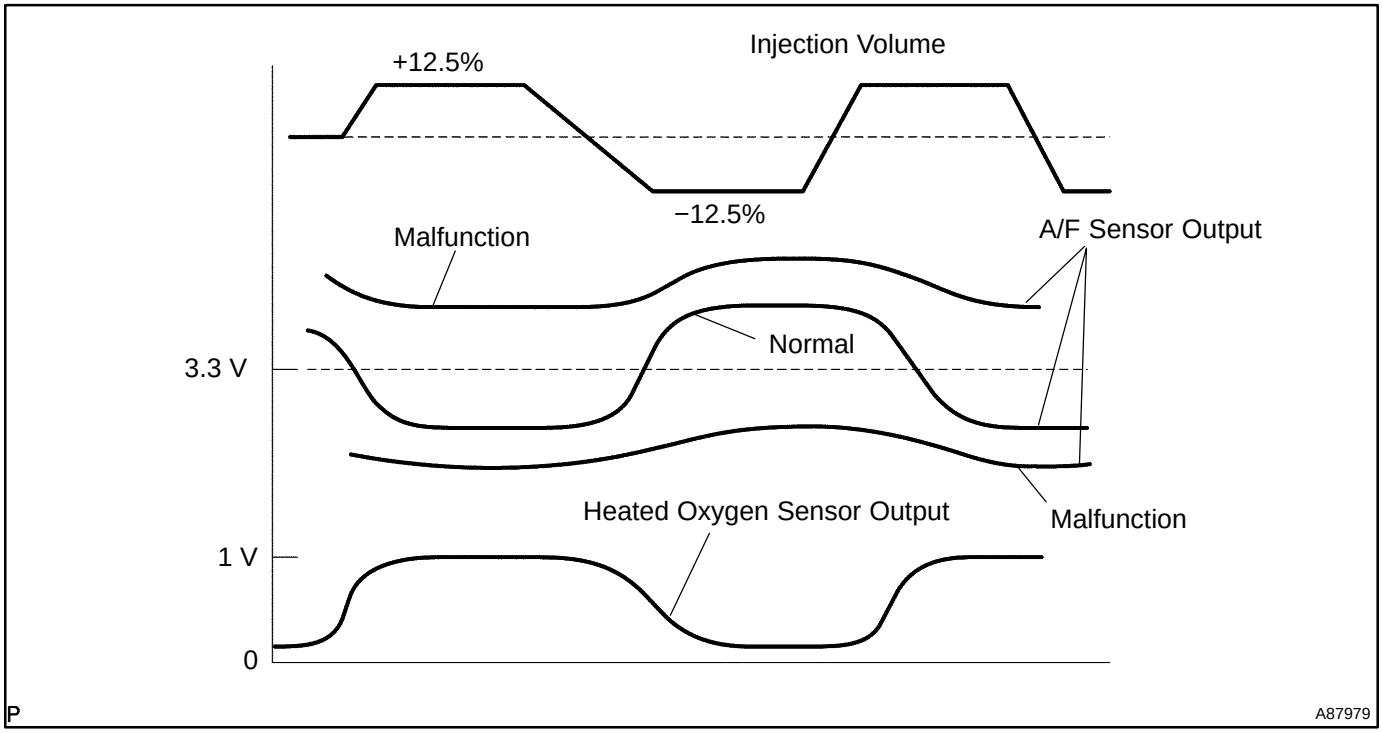
(a) Start the engine and warm it up.
(b) Connect the hand−held tester to the DLC3.
(c) Turn ON the ignition switch and the hand−held tester main switch.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INJ VOL.
(e) Using the hand−held tester, change the injection volume to check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