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)

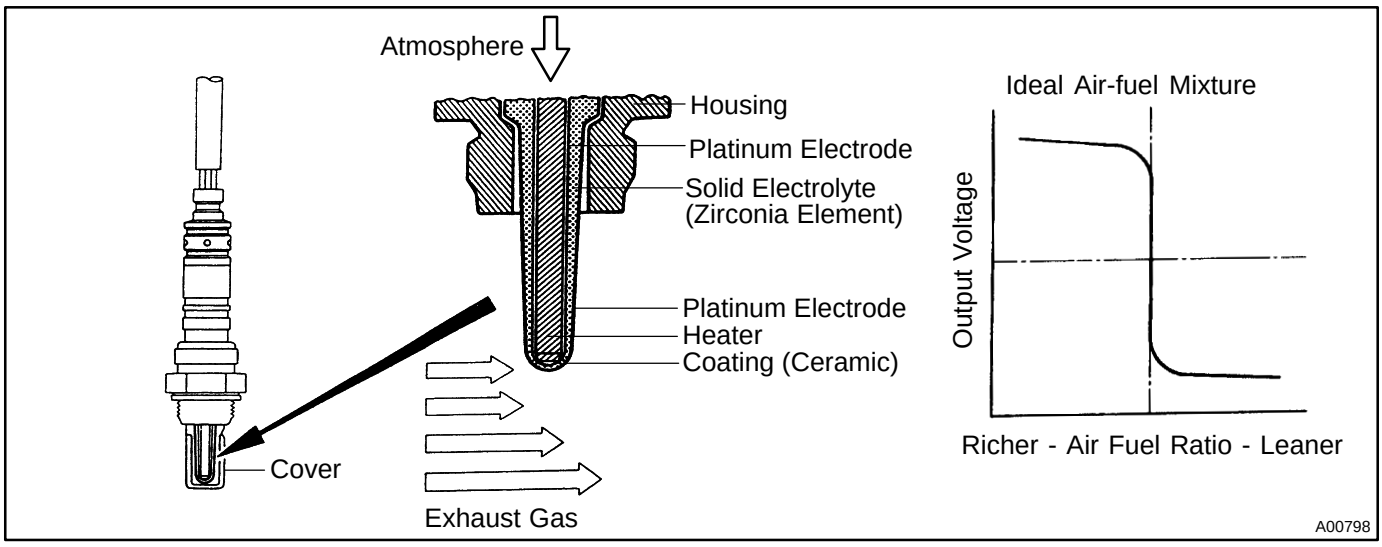
DTC	P0157	OXYGEN SENSOR CICRCUIT LOW VOLTAGE (BANK 2 SENSOR 2)

DTC	P0158	OXYGEN SENSOR CIRCUIT HIGH VOLTAGE (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 V 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 V. 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 V.



DTC No.	DTC Detection Condition	Trouble Area
P0136	• Either of the following condition is met: (a) Heated oxygen sensor voltage was less 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 less 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 is met: (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)
P0156	• Either of the following condition is met: (a) Heated oxygen sensor voltage was less 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 less 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 is met: (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)

MONITOR DESCRIPTION

The ECM monitors the rear heated oxygen sensor (HO2S) in the following 3 items:

- 1. The HO2S voltage changes between Rich (more than 0.45 V) and Lean (less than 0.45 V) while the vehicle is running (repeating acceleration and deceleration) for 8 minutes. If not, the ECM interprets this as a malfunction, illuminates the MIL, and then sets a DTC.
- 2. The HO2S voltage does not remain at less than 0.05 V for a long time while the vehicle is running (60% of the time in the 220 seconds monitor, the sensor output is less than 0.05 V). If it does, the ECM interprets this as a malfunction, illuminates the MIL, and then sets a DTC.
- 3. The sensor's voltage drops to below 0.2 V (extremely Lean status) immediately when the vehicle decelerates and the fuel cut is working for 6 seconds. If not, the ECM interprets this to mean the sensor's response feature has deteriorated, illuminates the MIL, and then sets a DTC.

MONITOR STRATEGY

Related DTCs	P0136, P0156: Heated oxygen sensor output voltage (Output voltage) P0136, P0156: Heated oxygen sensor impedance (Low impedance) P0137, P0157: Heated oxygen sensor low voltage P0138, P0158: Heated oxygen sensor high voltage P0138, P0158: Heated oxygen sensor output voltage (Extremely high)
Required sensors/components (Main)	HO2S
Required sensors/components (Related)	ECT sensor, MAF meter, VSS
Frequency of operation	Once per driving cycle
Duration	Within 480 seconds
MIL operation	Immediate: Heated oxygen sensor low/high voltage 2 driving cycles: Others
Sequence operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	See page 05-377

P0136, P0156 (Rear HO2S output voltage - case 1):

All of the following conditions are met:	Conditions 1, 2, 3 and 4
1. Malfunction determination in this driving cycle	Not detected
2. Engine	Running
3. Time after engine start	0 second or more
4. Either of the following conditions is met:	Conditions (a) or (b)
(a) Cumulative time while HO2S heater is operating	22 seconds or more
(b) HO2S voltage	Has reached to 0.2 V or more

P0136, P0156 (Rear HO2S output voltage - case 2):

Engine	Running

P0137, P0157 (Rear HO2S low voltage):

Battery voltage	11 V or more
Estimated heated oxygen sensor temperature	450°C (842°F) or more
Time after fuel-cut ended	30 seconds or more

P0138, P0158 (Rear HO2S high voltage):

Engine	Running
Battery voltage	11 V or more

P0138, P0158 (Rear HO2S output voltage during fuel-cut):

Engine coolant temperature	70°C (158°F) or more
Catalyst temperature	500°C (932°F) or more
Fuel-cut	Excuting

TYPICAL MALFUNCTION THRESHOLDS

P0136, P0156 (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	320 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, P0156 (Rear HO2S output voltage - case 2):

All of the following conditions are met:	Conditions 1, 2, 3, 4 and 5
1. Cumulative monitor time *2 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
*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	7 g/rev or more
2. Vehicle speed	3 km/h (1.875 mph) or more
3. Idle	OFF
4. Fuel-cut	OFF

P0137, P0157 (Rear HO2S low voltage):

Sensor voltage	Lower than 0.03 V

P0138, P0158 (Rear HO2S high voltage):

Sensor voltage	1.2 V or more

P0138, P0158 (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	6 seconds or more
2. Both of the following conditions are met:	Conditions (a) and (b)
(a) Rear HO2S voltage when fuel-cut starts	0.5 V or more
(b) Duration that HO2S voltage is 0.2 to 0.35 V	1 second or more

COMPONENT OPERATING RANGE

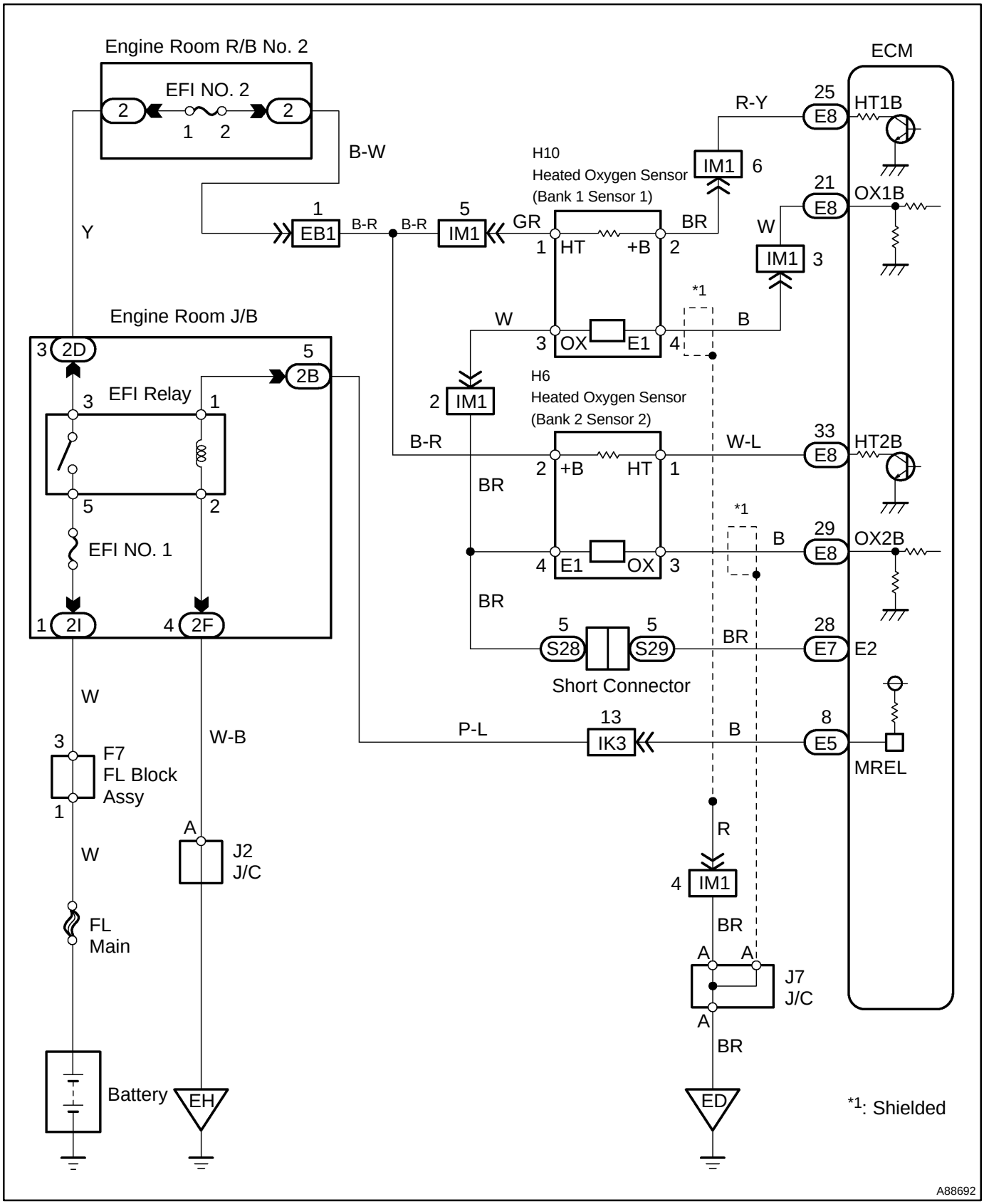
HO2S voltage	Varies between 0.1 and 0.9 V

O2S TEST RESULT (MODE 05)

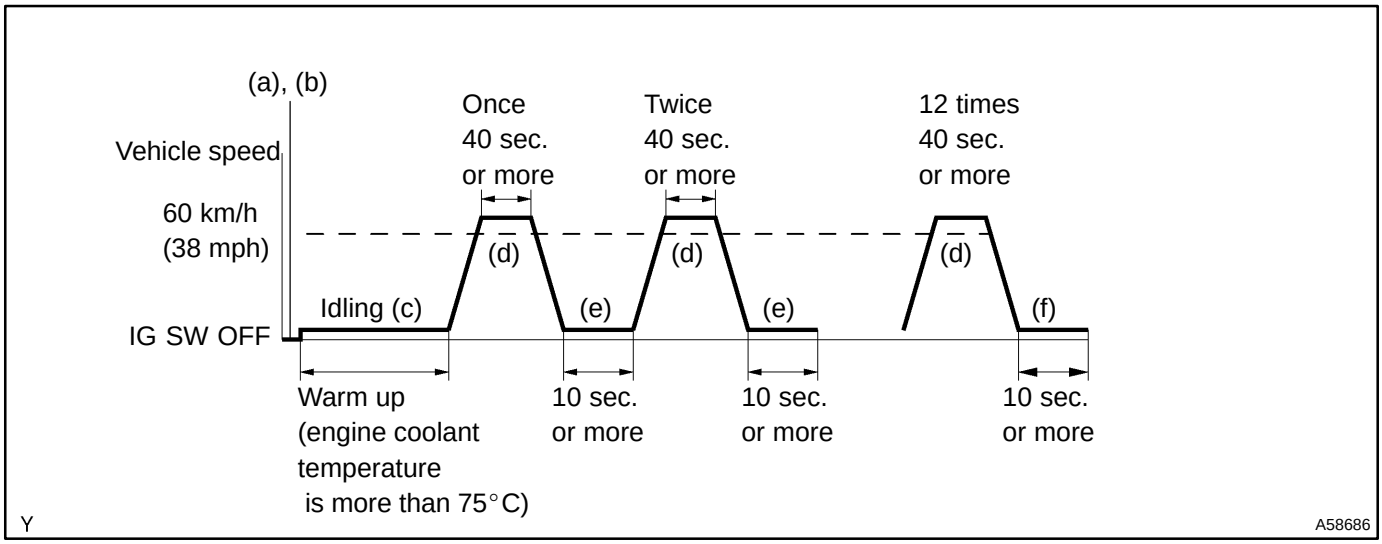
Refer to page 05-383 for detailed information.

TEST ID/COMP ID	Description of TEST VALUE	Conversion Factor	Unit	Standard Value
$07	Minimum HO2S voltage	N/A	V	Less than TEST LIMIT
$08	Maximum HO2S voltage	N/A	V	More than TEST LIMIT
$31	Average time per one-cycle of HO2S frequency that HO2S switches Rich to Lean	N/A	Second	Less than TEST LIMIT
$32	Average time per one-cycle of HO2S frequency that HO2S switches Lean to Rich	N/A	Second	Less than TEST LIMIT
$37	Time until HO2S voltage drops to 0.2 V during fuel-cut	N/A	Second	Less than TEST LIMIT
$81	Percentage in monitoring time while HO2S voltage is lower than 0.05 V	Multiply by 0.39	%	Less than TEST LIMIT
$84	Percentage in monitoring time while HO2S voltage is higher than 0.7 V	Multiply by 0.39	%	Less than TEST LIMIT
$85	Continuous time while HO2S voltage is higher than 0.45 V	Multiply by 0.262	Second	Less than TEST LIMIT
$87	Percentage in monitoring time while HO2S voltage is higher than 0.45 V	Multiply by 0.39	%	More than TEST LIMIT

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 05-402).
(c) Start the engine and warm up the engine untill engine coolant temperature is more than 75°C.
(d) Drive the vehicle at 60 km/h (38 mph) 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.

CONFIRMATION DRIVING PATTERN (P0137 and/or P0157)

Warm up the engine and run the engine at 60 km/h (38 mph) for 7 minutes.

CONFIRMATION DRIVING PATTERN (P0138 and/or P0158)

Warm up the engine and run the engine at idle for 30 seconds.

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 by 12.5 % or increases the injection volume by 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

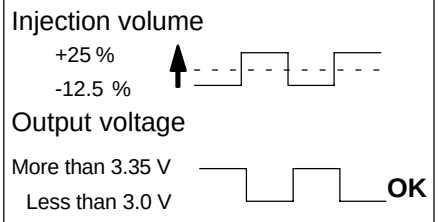
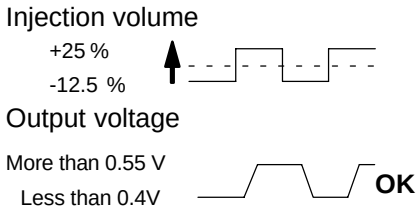
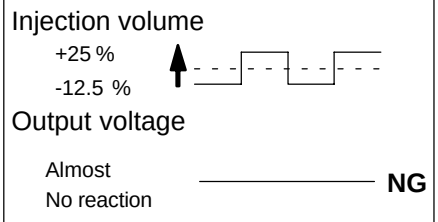
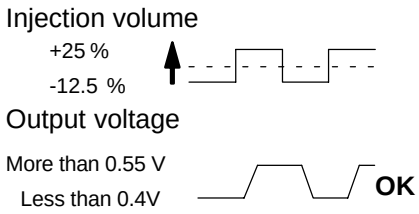
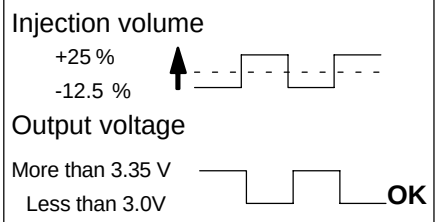
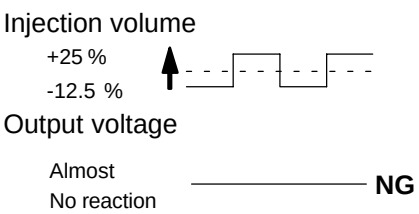
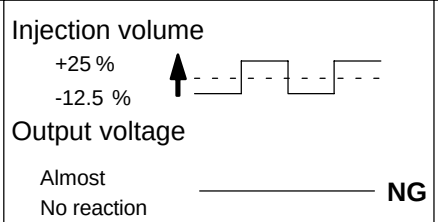
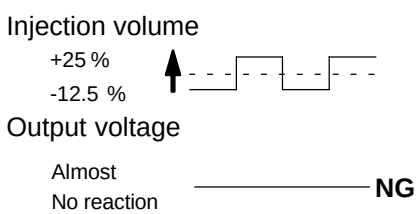
Heated oxygen sensor reacts in accordance with increase and decrease of injection volume:

+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			—
Case 2			A/F sensor (A/F sensor, heater, A/F sensor circuit)
Case 3			Heated oxygen sensor (heated oxygen sensor, heater, heated oxygen sensor circuit)
Case 4			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 the graph of the voltage output from both the A/F sensor and the heated oxygen sensor.

To display the graph, enter ”ACTIVE TEST / A/F CONTROL / USER DATA”, select ”AFS B1S1 and O2S B1S2” by pressing ”YES”, and then ”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 and/or P0158 are output	A
P0137 and/or P0157 are output	B
P0136 and/or P0156 are 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)

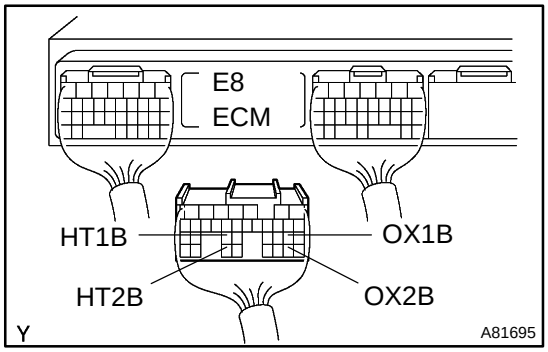
(a) Connect the hand-held tester or the OBD II scan tool to the DLC3.
(b) Turn ON the ignition switch. Push the hand-held tester or the OBD II scan tool main switch ON.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / O2S B1S2.
(d) Run the engine at idle.
(e) Read the output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



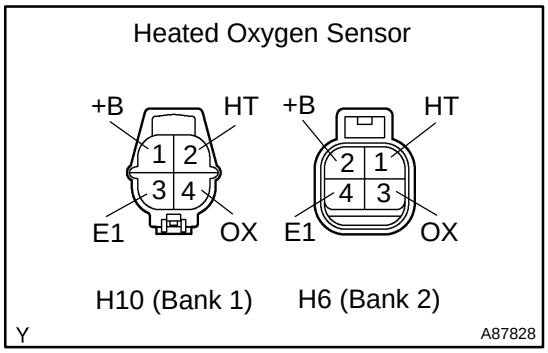
(a) Turn the ignition switch OFF and wait for 5 minutes.
(b) Disconnect the E8 ECM connector.
(c) Measure the resistance of the wire harness side connectors.
Standard:

Tester Connection	Specified Condition
E8-25 (HT1B) - E8-21 (OX1B)	10 kΩ or higher
E8-33 (HT2B) - E8-29 (OX2B)	10 kΩ or higher
E8-25 (HT1B) - Body ground	10 kΩ or higher
E8-33 (HT2B) - Body ground	10 kΩ or higher

OK → **REPLACE ECM**

NG

4 INSPECT HEATED OXYGEN SENSOR (CHECK FOR SHORT)



(a) Disconnect the H10 heated oxygen sensor connector.
(b) Measure the resistance of the sensor side connectors.
Standard:

Tester Connection	Specified Condition
H10-1 (+B) - H10-3 (E1)	10 kΩ or higher
H10-1 (+B) - H10-4 (OX)	10 kΩ or higher
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:
Driving should be continued for 10 minutes consecutively, but it is not necessary to maintain a speed of 25 mph (40 km/h) during this time.

(c) Read the DTC.
Result:

Display (DTC output)	Proceed to
P0138 and/or P0158 are output	A
No DTC	B

B → **CHECK FOR INTERMITTENT PROBLEMS (See page 05-370)**

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.

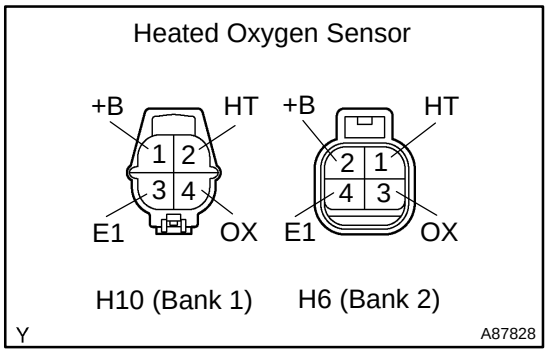
HINT:
Quickly accelerate the engine to 4,000 rpm 3 times by using the accelerator pedal.

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 RESISITANCE)



(a) Disconnect the H10 heated oxygen sensor connector.
(b) Measure the resistance of the heated oxygen sensor terminals.

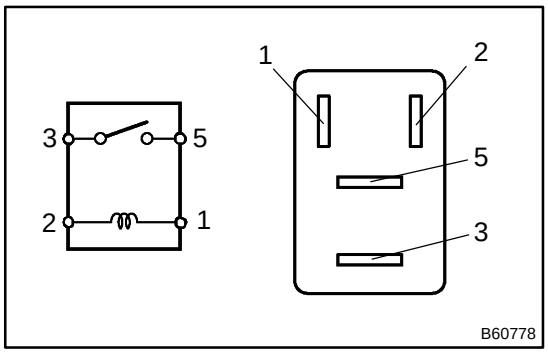
Standard:

Tester Connection	Condition	Specified Condition
H10-2 (HT) - H10-1 (+B)	20°C (68°F)	11 to 16 Ω
H6-1 (HT) - H6-2 (+B)	20°C (68°F)	11 to 16 Ω
H10-2 (HT) - H10-1 (+B)	800°C (1,472°F)	23 to 32 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) Measure the resistance of the EFI relay.

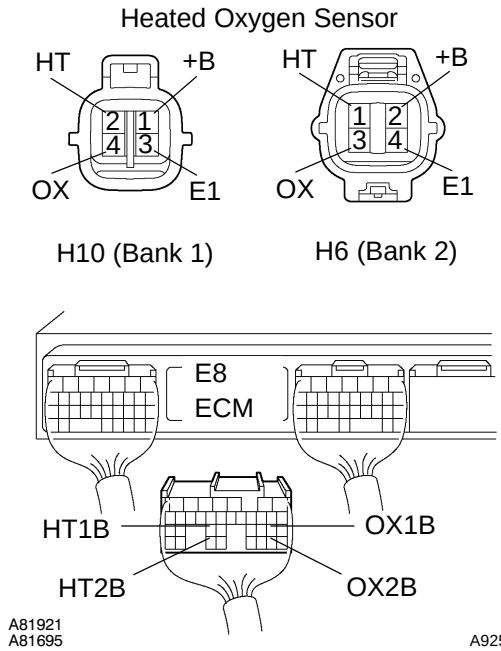
Standard:

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

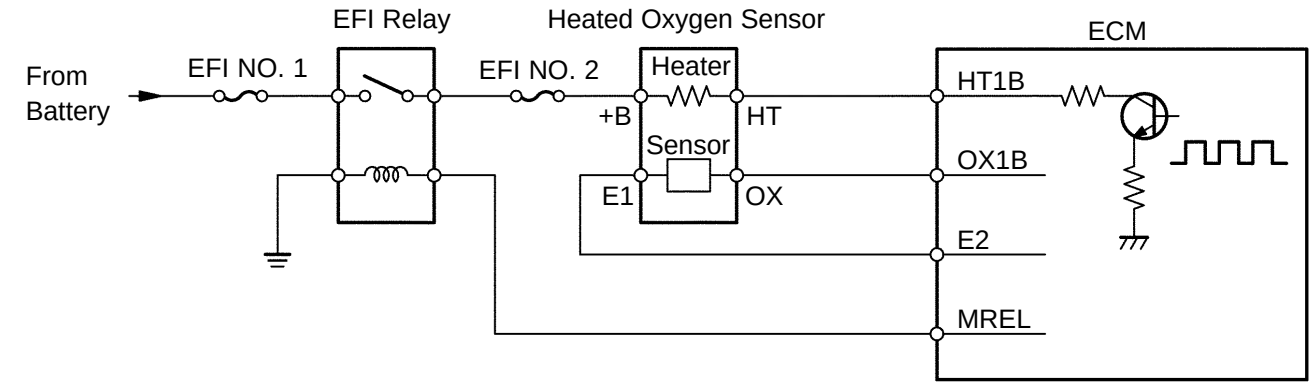


(a) Check the wire harness between the ECM and heated oxygen sensor.
  (1) Disconnect the H10 heated oxygen sensor connector.
  (2) Disconnect the E8 ECM connector.
  (3) Measure the resistance of the wire harness side connectors.

Standard:

Tester Connection	Specified Condition
H10-4 (OX) - E8-21 (OX1B)	Below 1 Ω
H10-2 (HT) - E8-25 (HT1B)	Below 1 Ω
H6-3 (OX) - E8-29 (OX2B)	Below 1 Ω
H6-1 (HT) - E8-33 (HT2B)	Below 1 Ω
H10-4 (OX) or E8-21 (OX1B) - Body ground	10 kΩ or higher
H10-2 (HT) or E8-25 (HT1B) - Body ground	10 kΩ or higher
H6-3 (OX) or E8-29 (OX2B) - Body ground	10 kΩ or higher
H6-1 (HT) or E8-33 (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.

GO

11	READ OUTPUT DTC (DTC P0136 AND/OR P0156 ARE OUTPUT AGAIN)

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

Display (DTC Output)	Proceed to
P0136 and/or P0156 are not output again	A
P0136 and/or P0156 are output again	B

A → **CHECK FOR INTERMITTENT PROBLEMS (See page 05-370)**

B

12	REPLACE HEATED OXYGEN SENSOR

GO

13	PERFORM CONFIRMATION DRIVING PATTERN

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

GO

14	READ OUTPUT DTC (DTC P0136 AND/OR P0156 ARE OUTPUT AGAIN)

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

Display (DTC Output)	Proceed to
P0136 and/or P0156 are not output again	A
P0136 and/or P0156 are output again	B

A → **REPAIR COMPLETED**

B

15	PERFORM ACTIVE TEST USING HAND-HELD TESTER

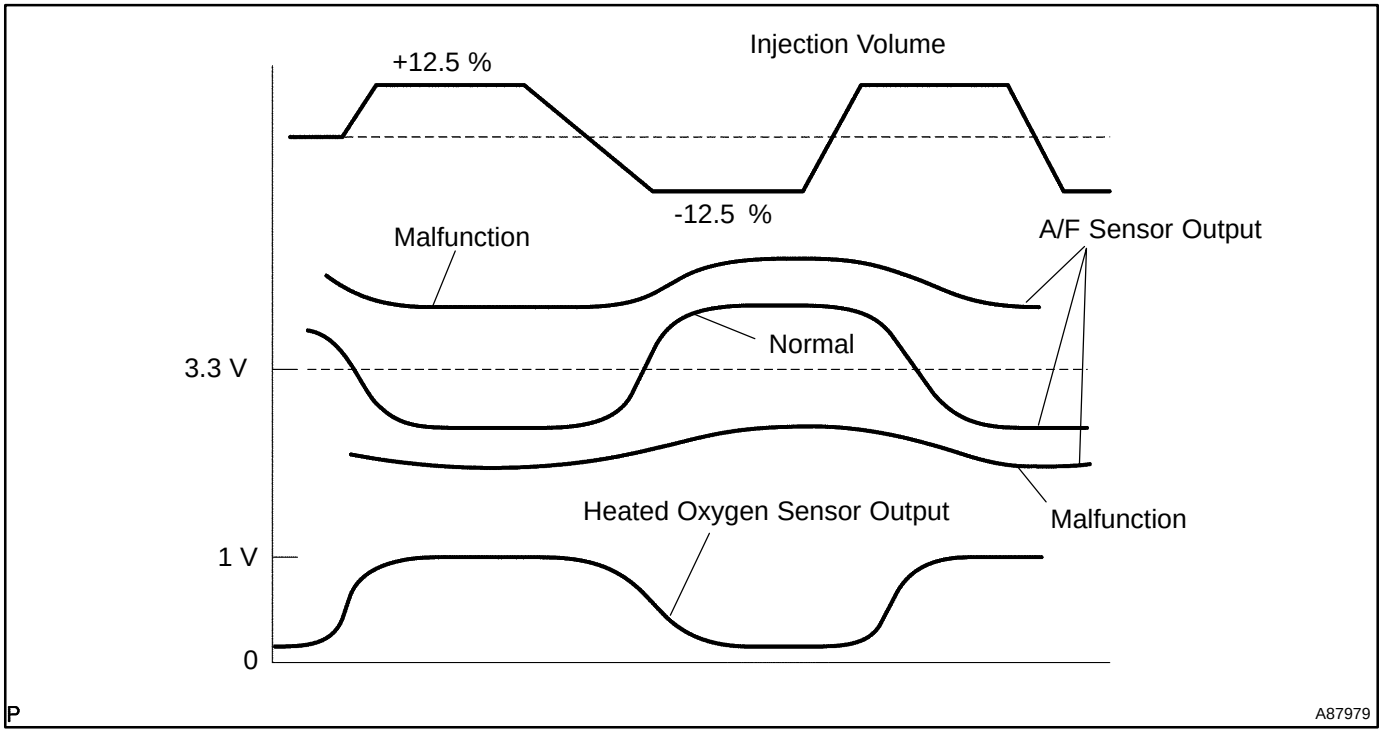
(a) Start the engine and warm it up.
(b) Connect the hand-held tester to the DLC3.
(c) Turn ON the ignition switch and the hand-held tester main switch.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / INJ VOL.
(e) Using the hand-held tester, change the injection volume to check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