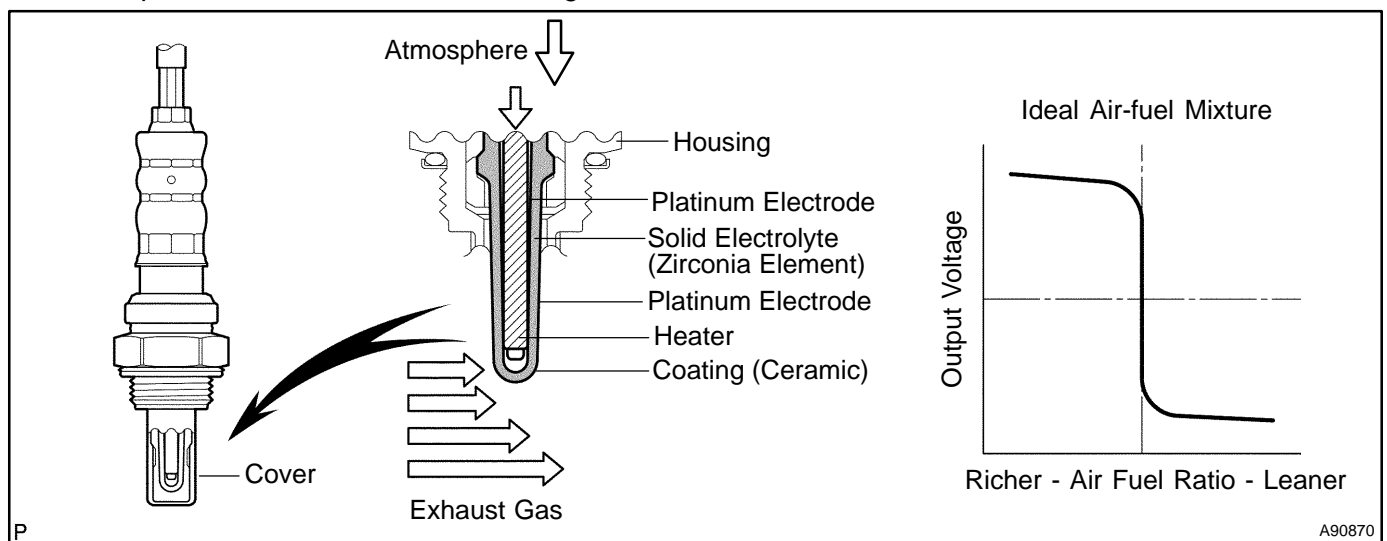


| | | |
|------------|--------------|---|
| DTC | P0136 | OXYGEN SENSOR CIRCUIT MALFUNCTION (BANK 1 SENSOR 2) |
| DTC | P0137 | OXYGEN SENSOR CIRCUIT LOW VOLTAGE (BANK 1 SENSOR 2) |
| DTC | P0138 | OXYGEN SENSOR CIRCUIT HIGH VOLTAGE (BANK 1 SENSOR 2) |

CIRCUIT DESCRIPTION

The heated oxygen sensor (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 stoichiometric.

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 | <ul style="list-style-type: none"> Following condition (a) (b) or (c) is met: (a) During driving with engine warmed up, heated oxygen sensor output does not change for 8 minutes (b) Heated oxygen sensor output is very low most of time for 220 seconds (c) The rear heated oxygen sensor voltage does not drop to below 0.2 V immediately when vehicle decelerates and fuel cut is operating Both (a) and (b) continue for more than 30 seconds: (a) Estimated rear oxygen sensor temperature is less than 800°C (b) Rear oxygen sensor impedance is less than 5Ω | <ul style="list-style-type: none"> 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) A/F sensor A/F sensor heater EFI relay |
| P0137 | Both (a) and (b) continue for more than 240 seconds: (a) Estimated rear oxygen sensor temperature is more than 450°C (b) Rear oxygen sensor impedance is more than 15kΩ | <ul style="list-style-type: none"> Open or short in heated oxygen sensor (bank 1 sensor 2) circuit (sensor to ECM) Open or short in heated oxygen sensor (bank 1 sensor 2) internal |
| P0138 | Rear oxygen sensor output voltage is over 1.2 V for more than 30 seconds | <ul style="list-style-type: none"> Short in heated oxygen sensor (bank 1 sensor 2) circuit Short in heated oxygen sensor (bank 1 sensor 2) circuit ECM internal circuit malfunction |

MONITOR DESCRIPTION

The ECM monitors the rear heated oxygen sensor (HO2S) in the following 4 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 second-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 7 seconds. If not, the ECM interprets this to mean the sensor's response feature has deteriorated, illuminates the MIL, and then sets a DTC.
4. The rear oxygen sensor impedance is 5 Ω or less, 15 kΩ or more, or output voltage is 1.2 V or more (normal voltage: 0 to 1.0 V). If so, the ECM will determine that the rear oxygen sensor or a related circuit has an open or short circuit, illuminates the MIL and sets a DTC.

Impedance is detected by the IC inside the ECM.

MONITOR STRATEGY

| | |
|---------------------------------------|---|
| Related DTCs | P0136: Heated oxygen sensor output voltage (Output voltage) P0136: Heated oxygen sensor impedance (Low impedance) P0137: Heated oxygen sensor impedance (High impedance) P0138: Heated oxygen sensor output voltage (High voltage) P0138: Heated oxygen sensor output voltage (During fuel-cut) |
| 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 | Within 480 seconds |
| MIL Operation | 2 driving cycles: P0136 (Rear HO2S output voltage - case 1) P0136 (Rear HO2S output voltage - case 2) P0138 (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, 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 (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 |
| ECM monitor | Completed |
| P0606 | Not set |

P0138 (Rear HO2S output voltage - case 3):

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

P0138 (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 | Executing |

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 | 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 (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 | 220 seconds or more |
| 2. Duration while HO2S voltage is below 0.05 V | 132 seconds or more |
| 3. Duration while HO2S voltage is higher than 0.7 V | Less than 44 seconds |
| 4. Duration while HO2S voltage is 0.45 V to 0.7 V | Less than 88 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 | 0.32 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 | 15 k Ω or more |

P0138 (Rear HO2S output voltage - case 3):

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

P0138 (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 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 |
|--------------|------------------------------|

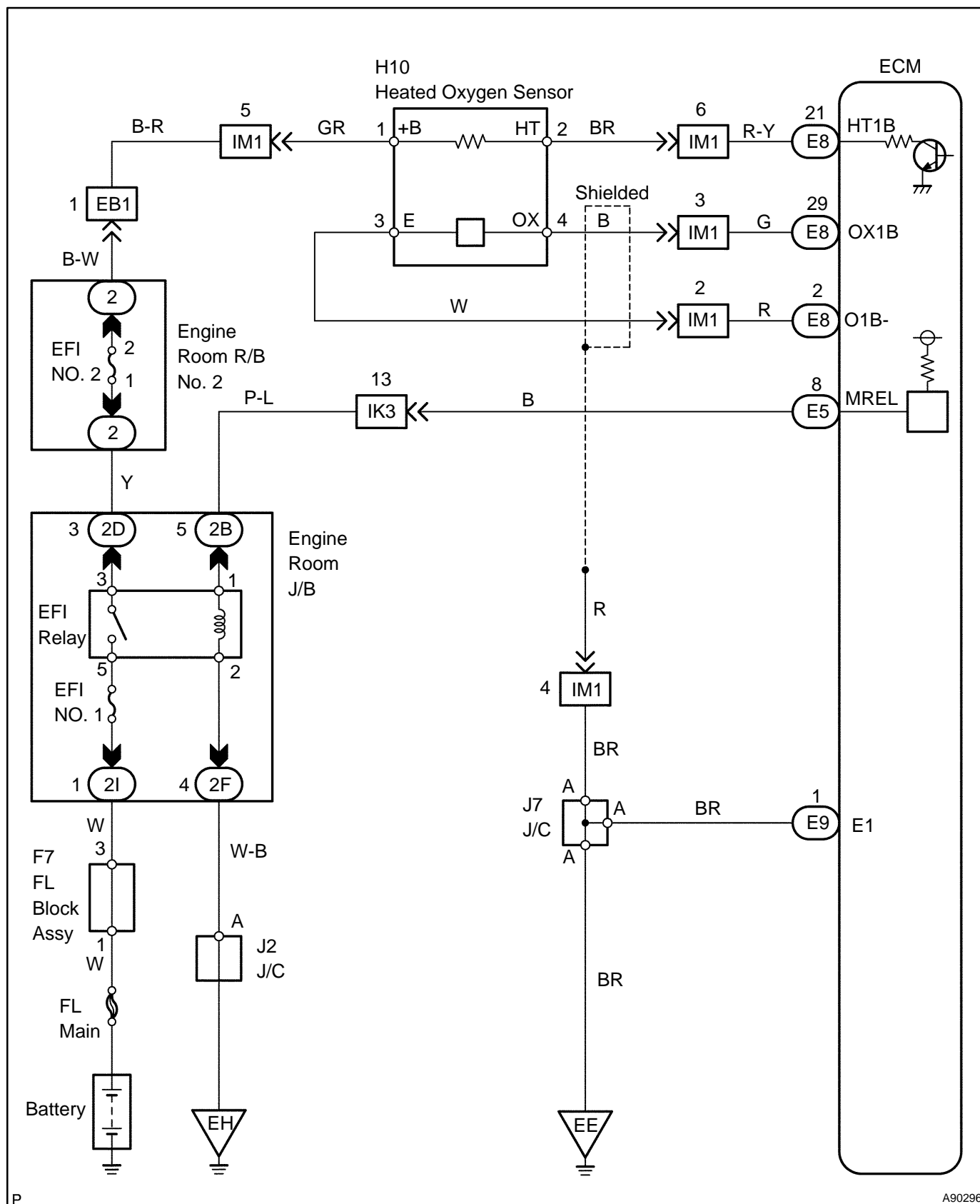
O2S TEST RESULT

Refer to page [05-22](#) for detailed information.

HO2S Output voltage (Minimum and Maximum):

| TEST ID | Description of TEST VALUE | Conversion Factor (Unit) | 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 | Minimum time per one-cycle of HO2S frequency that HO2S switches Lean to Rich | N/A | Second | Less than TEST LIMIT |
| \$32 | Minimum time per one-cycle of HO2S frequency that HO2S switches Rich to Lean | 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 0.39 | % | Less than TEST LIMIT |
| \$84 | Percentage in monitoring time while HO2S voltage is higher than 0.7 V | Multiply 0.39 | % | More than TEST LIMIT |
| \$85 | Continuous time while HO2S voltage is higher than 0.45 V | Multiply 0.262 | Second | More than TEST LIMIT |
| \$87 | Percentage in monitoring time while HO2S voltage is higher than 0.45 V | Multiply 0.39 | % | More than TEST LIMIT |

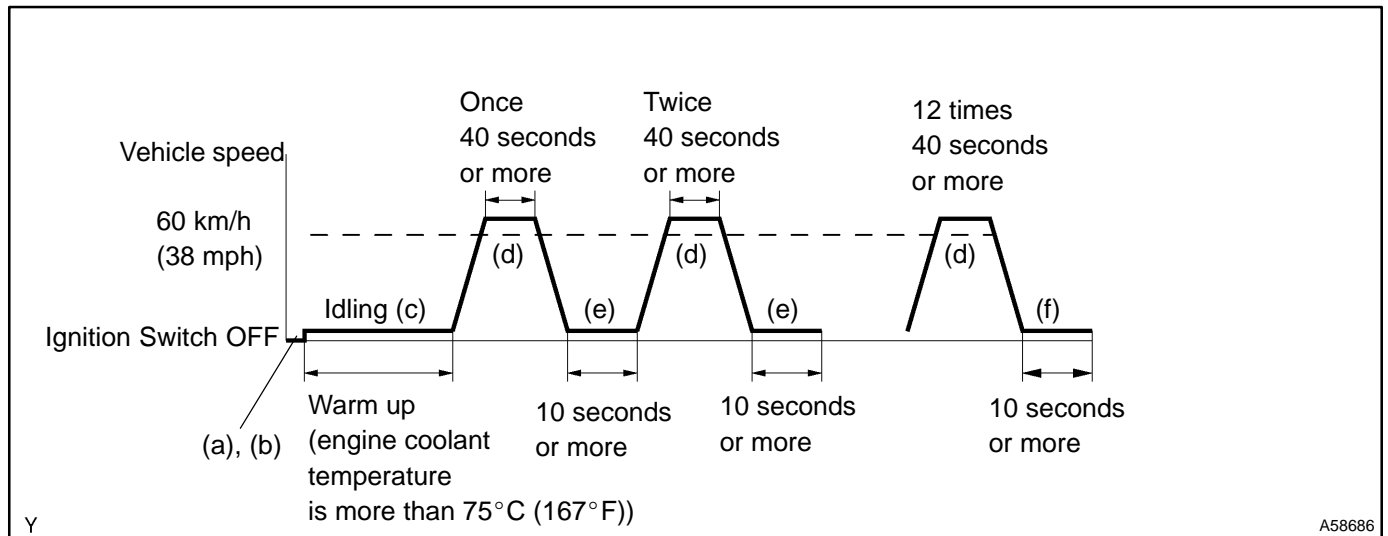
WIRING DIAGRAM



P

A90296

CONFIRMATION DRIVING PATTERN (P0136)



- (a) Connect the hand-held tester to the DLC3.
- (b) Switch the hand-held tester from normal mode to check (test) mode (see page 05-40).
- (c) Start the engine and warm it up until the engine coolant temperature becomes 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)

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

CONFIRMATION DRIVING PATTERN (P0138)

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 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

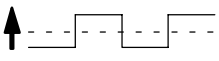



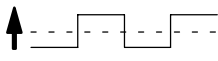

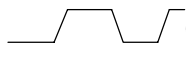

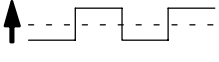


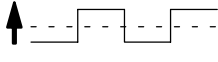

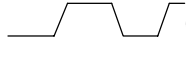

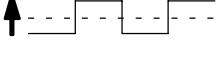

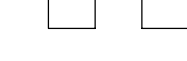

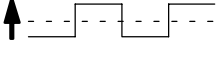


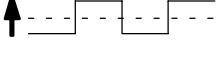


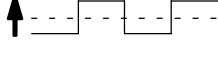


Heated oxygen sensor reacts in accordance with increase and decrease of injection volume:

+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) | 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, 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 a 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 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

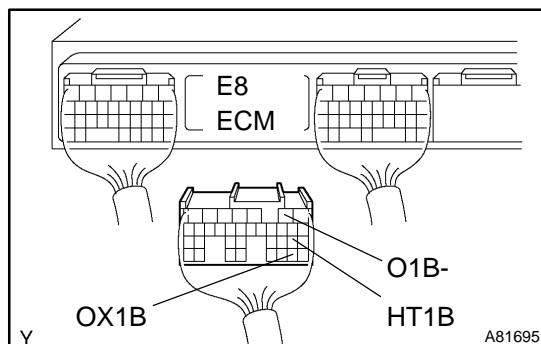
2 READ VALUE OF HAND-HELD TESTER OR OBD II SCAN TOOL (OUTPUT VOLTAGE OF HEATED OXYGEN SENSOR)

- (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 READ OUTPUT DTC

A

3 CHECK WIRE HARNESS (CHECK FOR SHORT)

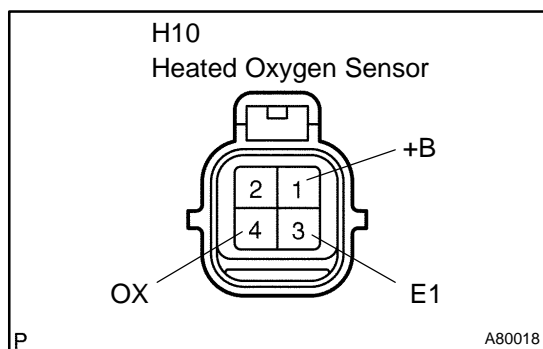
- (a) Turn the ignition switch OFF and wait for 5 minutes.
 (b) Disconnect the E8 ECM connector.
 (c) Measure the resistance of the wire harness side connectors.

Standard:

| Tester Connection | Specified Condition |
|-----------------------------|---------------------|
| E8-21 (HT1B) - E8-29 (OX1B) | 10 kΩ or higher |
| E8-21 (HT1B) - E8-2 (O1B-) | 10 kΩ or higher |

OK REPLACE ECM (See page 10-9)

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 |

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 |
|----------------------|------------|
| P0136 is output | A |
| No DTC | B |

B**CHECK FOR INTERMITTENT PROBLEMS
(See page 05-9)****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:

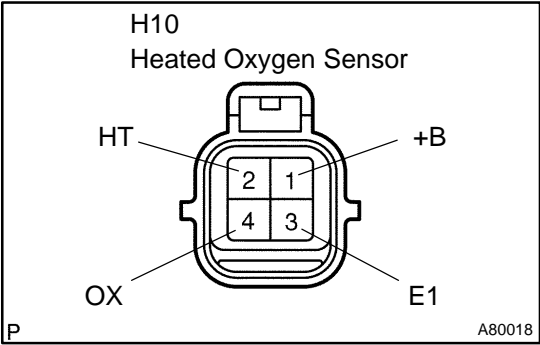
Quickly accelerate the engine to 4,000 rpm 3 times by using the accelerator pedal.

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

Standard:

| Tester Connection | Condition | Specified Condition |
|-------------------------|-----------------|---------------------|
| H10-1 (+B) - H10-2 (HT) | 20°C (68°F) | 11 to 16 Ω |
| H10-1 (+B) - H10-2 (HT) | 800°C (1,472°F) | 23 to 32 Ω |

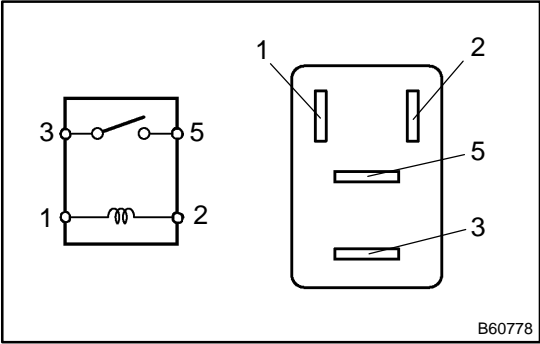
NG

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) |

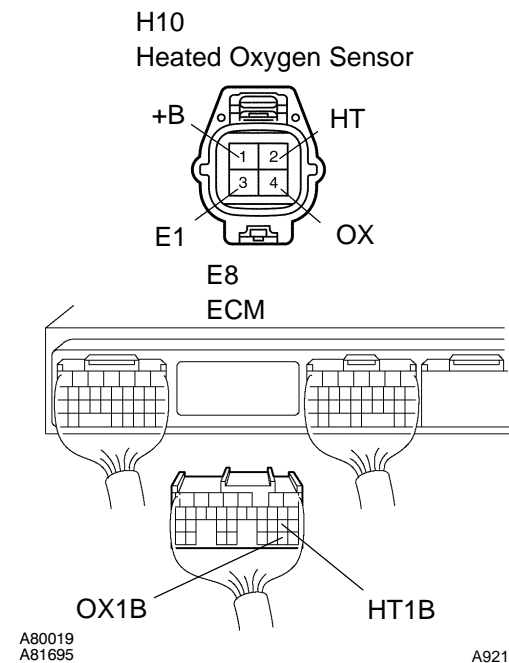
NG

REPLACE RELAY

OK

9 CHECK WIRE HARNESS

Wire Harness Side

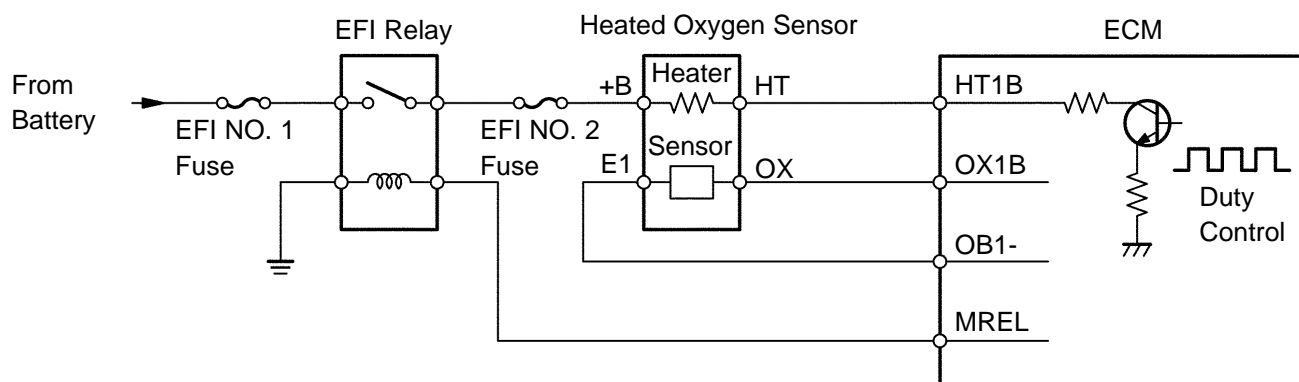


- (a) Check the wire harness between the ECM and heated oxygen sensor.
- (1) Disconnect the H10 heated oxygen sensor connector.
 - (2) Disconnect the E8 ECM connector.
 - (3) Measure the resistance of the wire harness side connectors.

Standard:

| Tester Connection | Specified Condition |
|--|-------------------------|
| H10-2 (HT) - E8-21 (HT1B) H10-4 (OX) - E8-29 (OX1B) | Below 1 Ω |
| H10-2 (HT) or E8-21 (HT1B) - Body ground H10-4 (OX) or E8-29 (OX1B) - Body ground | 10 k Ω 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 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****GO****13 PERFORM CONFIRMATION DRIVING PATTERN**

HINT:

Clear all DTCs prior to performing the confirmation driving pattern.

GO**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.

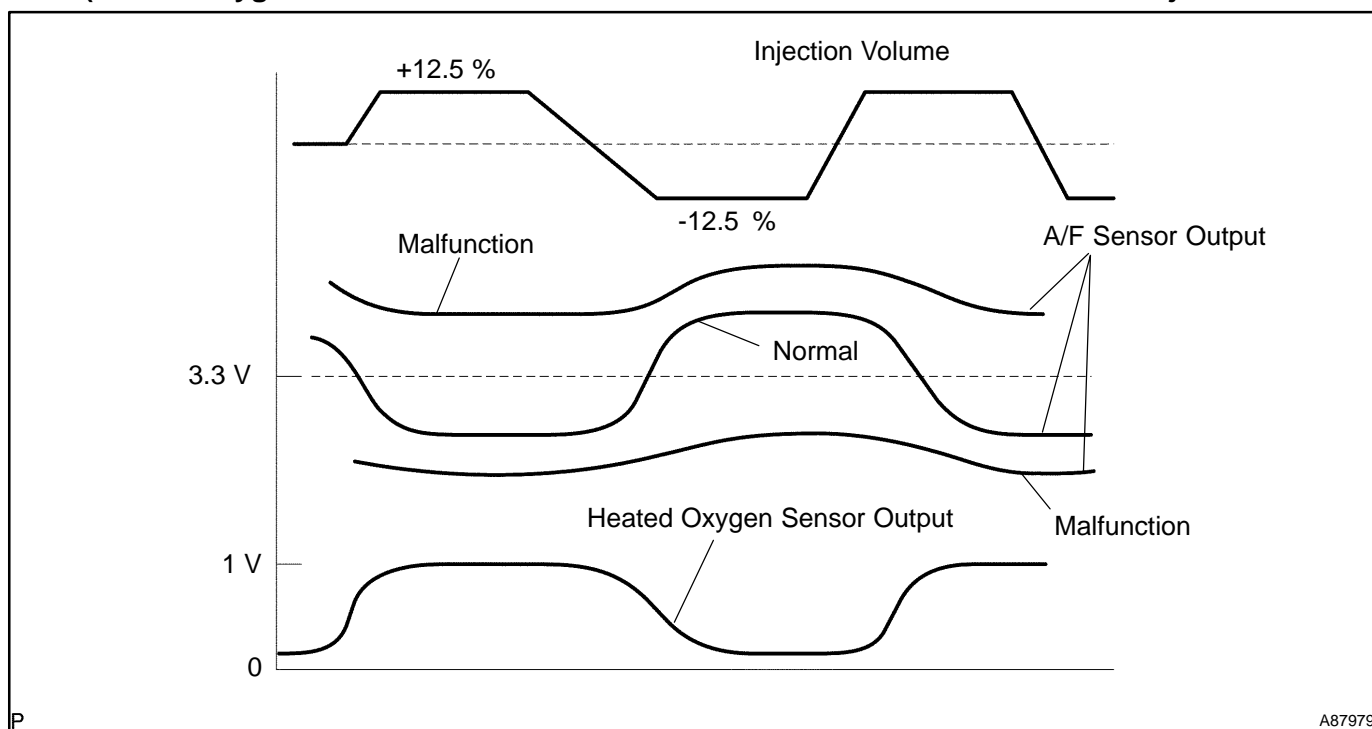
HINT:

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 EXTREMELY RICH OR LEAN ACTUAL AIR FUEL RATIO (INJECTOR, FUEL PRESSURE, GAS LEAKAGE IN EXHAUST SYSTEM, ETC.)