

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

- These DTCs indicate abnormal voltage output from the heated oxygen sensor 2.
- Sensor 2 is the sensor positioned in the 2nd location from the engine assembly, located after the front catalyst (see page 05-350).

CIRCUIT DESCRIPTION

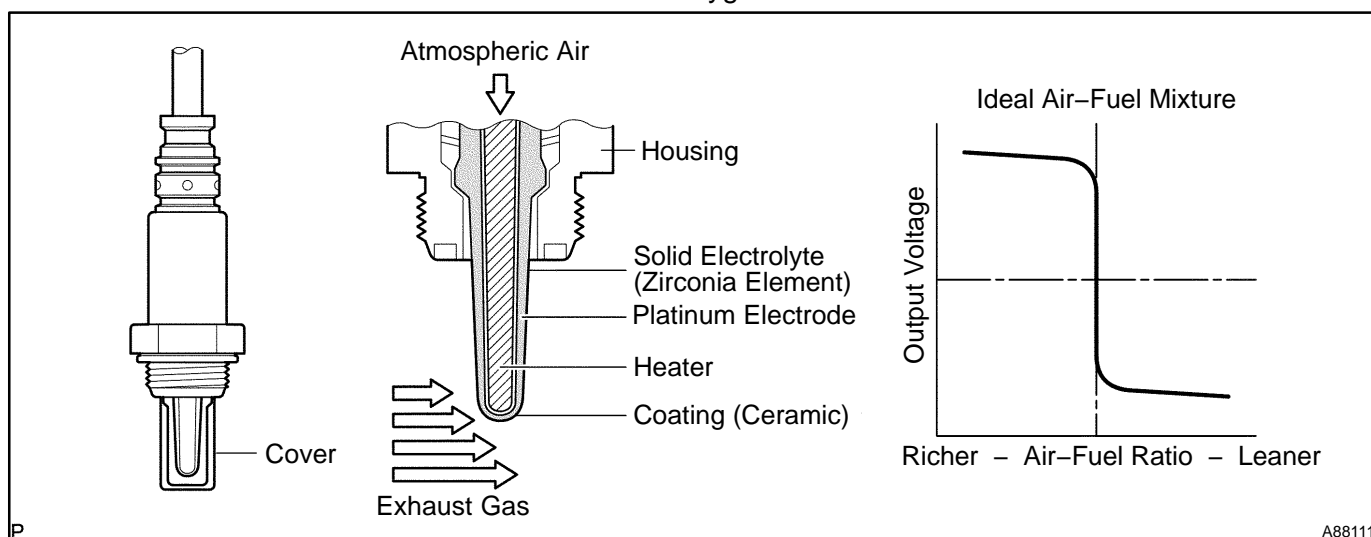
To obtain a high purification rate for the CO, HC and NO_x components of the exhaust gas, a three-way catalytic converter is used. For the most efficient use of the three-way catalytic converter, the air-fuel ratio must be precisely controlled so that it is always close to the stoichiometric air-fuel ratio.

The heated oxygen sensor has the characteristic whereby its output voltage changes suddenly in the vicinity of the stoichiometric air-fuel ratio. This is used to detect the oxygen concentration in the exhaust gas and provide the ECM with feedback control the air-fuel ratio.

When the air-fuel ratio becomes LEAN, the oxygen concentration in the exhaust gas increases. And the heated oxygen sensor informs the ECM of the LEAN condition (low voltage, i.e. less than 0.45 V).

When the air-fuel ratio is RICHER than the stoichiometric air-fuel ratio, the oxygen will be vanished from the exhaust gas. And the heated oxygen sensor informs the ECM of the RICH condition (high voltage, i.e. more than 0.45 V). The ECM judges by the voltage output from the heated oxygen sensor whether the air-fuel ratio is RICH or LEAN and controls the injection time accordingly. If the malfunction of the heated oxygen sensor causes an output of abnormal voltage, the ECM becomes unable to perform accurate air-fuel ratio control.

The heated oxygen sensor include a heater which heats the zirconia element. The heater is controlled by the ECM. When the intake air volume is low (the temperature of the exhaust gas is low), current flows to the heater in order to heat the sensor for the accurate oxygen concentration detection.



Active Air-Fuel Ratio Control

Usually the ECM performs the air-fuel ratio control so that the A/F sensor output indicates a near stoichiometric air-fuel ratio. This vehicle includes "active air-fuel ratio control" besides the regular air-fuel ratio control. The ECM performs the "active air-fuel ratio control" to detect deterioration in front catalyst and the heated oxygen sensor 2 malfunction. (refer to the diagram below)

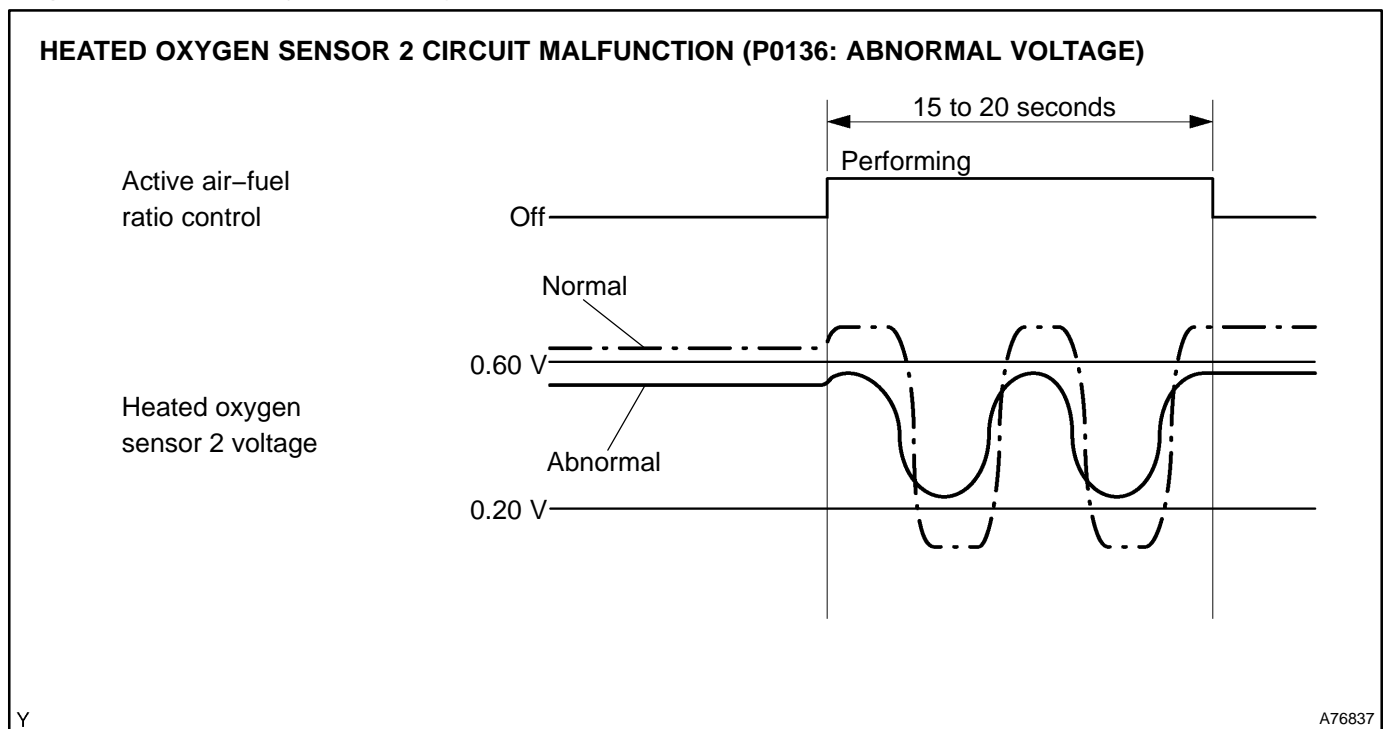
"Active air-fuel ratio control" is performed for approximately 15 to 20 seconds during a vehicle driving with a warm engine. Under "active air-fuel ratio control", the air-fuel ratio is forcibly regulated to go LEAN or RICH by the ECM.

If the ECM detects a malfunction it is recorded in the following DTCs: DTC P0136 (Abnormal voltage output), DTC P0137 (Circuit open) and P0138 (Circuit short).

Abnormal Voltage Output of Heated Oxygen Sensor 2 (DTC P0136)

As the ECM is performing the "active air-fuel ratio control", the air-fuel ratio is forcibly regulated to go RICH or LEAN. If the sensor is not functioning properly, the voltage output variation is smaller.

Under the "active air-fuel ratio control", if the maximum voltage output of the heated oxygen sensor 2 is 0.6 V or less, or the minimum voltage output is 0.2 V or more, the ECM determines that it is abnormal voltage output of the sensor (DTC P0136).



Open or Short in the Heated Oxygen Sensor 2 Circuit (P0137 or P0138)

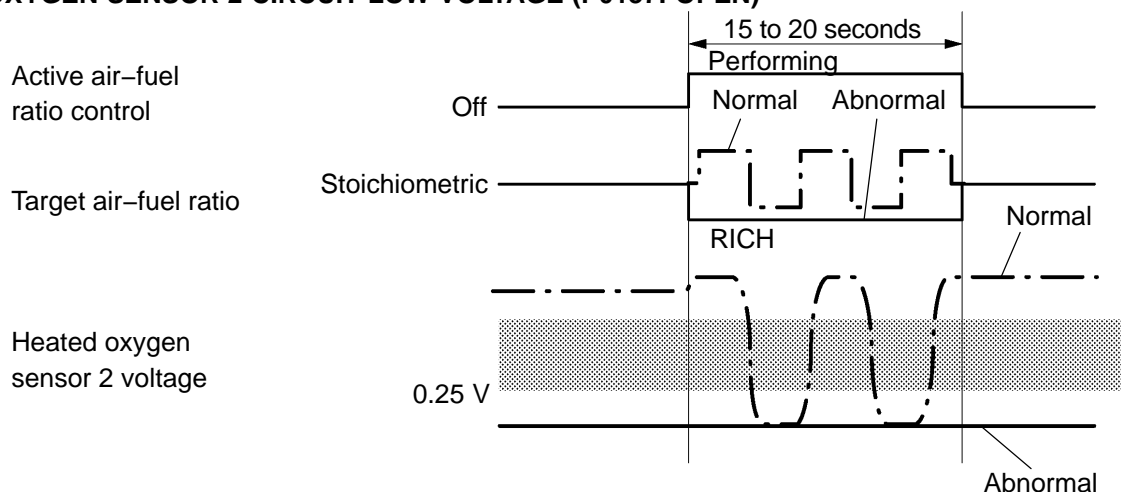
Under "active air-fuel ratio control", the ECM calculates the Oxygen Storage Capacity (OSC) * in the catalyst by forcibly regulating the air-fuel ratio to go RICH (or LEAN).

If the heated oxygen sensor 2 has an open or short, or the voltage output by the sensor noticeably decreases, the OSC will indicate extraordinary high value. Even if the ECM attempts to continue regulating the air-fuel ratio to go RICH (or LEAN), the heated oxygen sensor 2 output does not change.

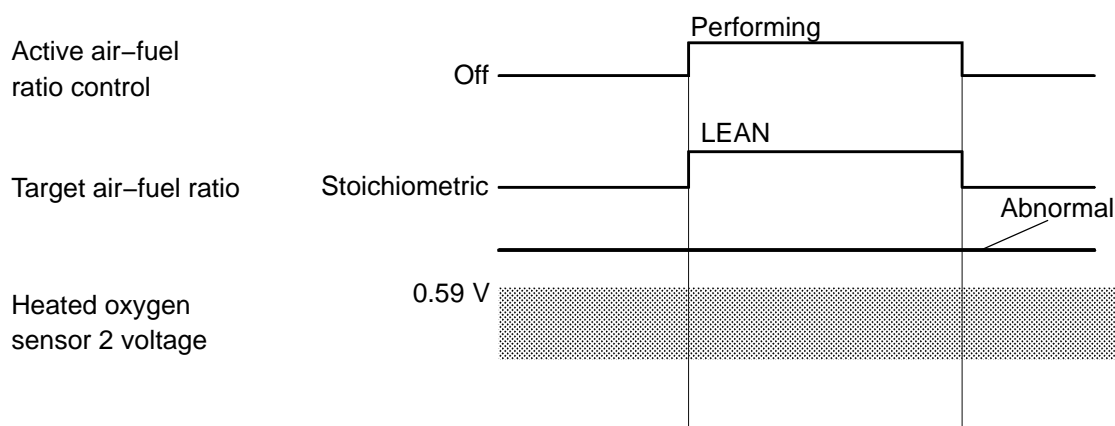
Under "active air-fuel ratio control", although the targeted air-fuel ratio is RICH but the voltage output of the heated oxygen sensor is 0.25 V or less (LEAN), the ECM determines that it is an abnormal low voltage (DTC P0137). Also, the targeted air-fuel ratio is LEAN but the voltage output is 0.59 V or more (RICH), it is determined that the voltage output of the sensor is abnormal high (DTC P0138).

*: Oxygen Storage Capacity (OSC): A catalyst has a capability for storing oxygen. The OSC and the emission purification capacity of the catalyst are mutually related. The ECM judges if the catalyst has deteriorated based on the calculated OSC value. (see page 05-426)

HEATED OXYGEN SENSOR 2 CIRCUIT LOW VOLTAGE (P0137: OPEN)



HEATED OXYGEN SENSOR 2 CIRCUIT HIGH VOLTAGE (P0138: SHORT)



DTC No.	DTC Detection Condition	Trouble Area
P0136 Abnormal voltage output	Under "Active air-fuel ratio control", voltage output of the heated oxygen sensor 2 is as follows. ((a) or (b)) (d) Heated oxygen sensor 2 output voltage remains 0.2 V or more. (e) Heated oxygen sensor 2 output voltage remain 0.6 V or less.	<ul style="list-style-type: none"> • Open or short in heated oxygen sensor 2 (bank 1 sensor 2) circuit • Heated oxygen sensor 2 (bank 1 sensor 2) • Heated oxygen sensor 2 heater (bank 1 sensor 2) • EFI relay
P0137 Low voltage (open)	Under "Active air-fuel ratio control", all of following conditions are met. (a) Heated oxygen sensor 2 output voltage is less than 0.25 V (b) "Target air-fuel ratio" is RICH	<ul style="list-style-type: none"> • Open in heated oxygen sensor 2 (bank 1 sensor 2) circuit • Heated oxygen sensor 2 (bank 1 sensor 2) • Heated oxygen sensor 2 heater (bank 1 sensor 2) • EFI relay
P0138 High voltage (short)	Under "Active air-fuel ratio control", all of following conditions are met. (a) Heated oxygen sensor 2 output voltage is 0.59 V or more (b) "Target air-fuel ratio" is LEAN	<ul style="list-style-type: none"> • Short in heated oxygen sensor 2 (bank 1 sensor 2) circuit • Heated oxygen sensor 2 (bank 1 sensor 2) • Heated oxygen sensor 2 heater (bank 1 sensor 2) • EFI relay

MONITOR STRATEGY

Related DTCs	P0136: Heated oxygen sensor output voltage (Output voltage) P0136: Heated oxygen sensor impedance (Low) P0137: Heated oxygen sensor output voltage (Low voltage) P0137: Heated oxygen sensor impedance (High) P0138: Heated oxygen sensor output voltage (High voltage) P0138: Heated oxygen sensor output voltage (Extremely high)
Required sensors / components (Main)	HO2S (Sensor 2)
Required sensors / components (Related)	Crankshaft position sensor, ECT sensor, MAF sensor, Throttle position sensor
Frequency of Operation	Once per driving cycle: Heated oxygen sensor output voltage (Extremely high) Continuous: Others
Duration	20 seconds: Heated oxygen sensor output voltage (Output voltage) Heated oxygen sensor output voltage (Low voltage) Heated oxygen sensor output voltage (High voltage) 30 seconds: Heated oxygen sensor impedance (Low) 90 seconds: Heated oxygen sensor impedance (High) 10 seconds: Heated oxygen sensor output voltage (Extremely high)
MIL Operation	2 driving cycles: Heated oxygen sensor output voltage (Output voltage) Heated oxygen sensor output voltage (Low voltage) Heated oxygen sensor output voltage (High voltage) Immediate: Others
Sequence operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	See page 05-360
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P0136, P0137, P0138 Heated Oxygen Sensor Output Voltage (Output Voltage, High Voltage and Low Voltage):

Active air-fuel ratio control	Performing
Active air-fuel ratio control begins when all of the following conditions met	–
Battery voltage	11 V or more
Engine coolant temperature	75°C (167°F) or more
Idle	OFF
Engine RPM	Less than 4,000 rpm
A/F sensor status	Activated
Fuel cut	OFF
Engine load	10 to 70 %
Shift position	3rd

P0136 Heated Oxygen Sensor Impedance (Low):

Estimated HO2S temperature	Less than 700°C (1,292°F)
Battery voltage	11.0 V or more
P0606	Not set

P0137 Heated Oxygen Sensor Impedance (High):

Estimated HO2S temperature	450°C (842°F) or more
Battery voltage	11.0 V or more
P0606	Not set

P0138 Heated Oxygen Sensor Output Voltage (Extremely High):

Battery voltage	11.0 V or more
Time after engine start	2 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P0136 Heated Oxygen Sensor Output Voltage (Output voltage):

Either of the following conditions is met:	Condition 1 or 2
1. All of the following conditions are met	Condition (a), (b) and (c)
(a) Commanded air-fuel ratio	14.3 or less
(b) Rear HO2S voltage	0.25 to 0.59 V
(c) OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more
2. All of the following conditions are met	Condition (a), (b) and (c)
(a) Commanded air-fuel ratio	14.9 or more
(b) Rear HO2S voltage	0.25 to 0.59 V
(c) OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more

P0137 Heated Oxygen Sensor Output Voltage (Low output voltage):

All of the following conditions are met	Condition 1, 2 and 3
1. Commanded air-fuel ratio	14.3 or less
2. Rear HO2S voltage	Less than 0.25 V
3. OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more

P0138 Heated Oxygen Sensor Output Voltage (High output voltage):

All of the following conditions are met	Condition 1, 2 and 3
1. Commanded air-fuel ratio	14.9 or more
2. Rear HO2S voltage	More than 0.59 V
3. OSC (Oxygen Storage Capacity of catalyst)	1.2 g or more

P0136 Heated Oxygen Sensor Impedance (Low):

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

P0137 Heated Oxygen Sensor Impedance (High):

Duration of the following condition	90 seconds or more
Rear HO2S impedance	15 k Ω or more

P0138 Heated Oxygen Sensor Output Voltage (Extremely High):

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

COMPONENT OPERATING RANGE

Heated oxygen sensor voltage	Varies between 0.1 and 0.9 V
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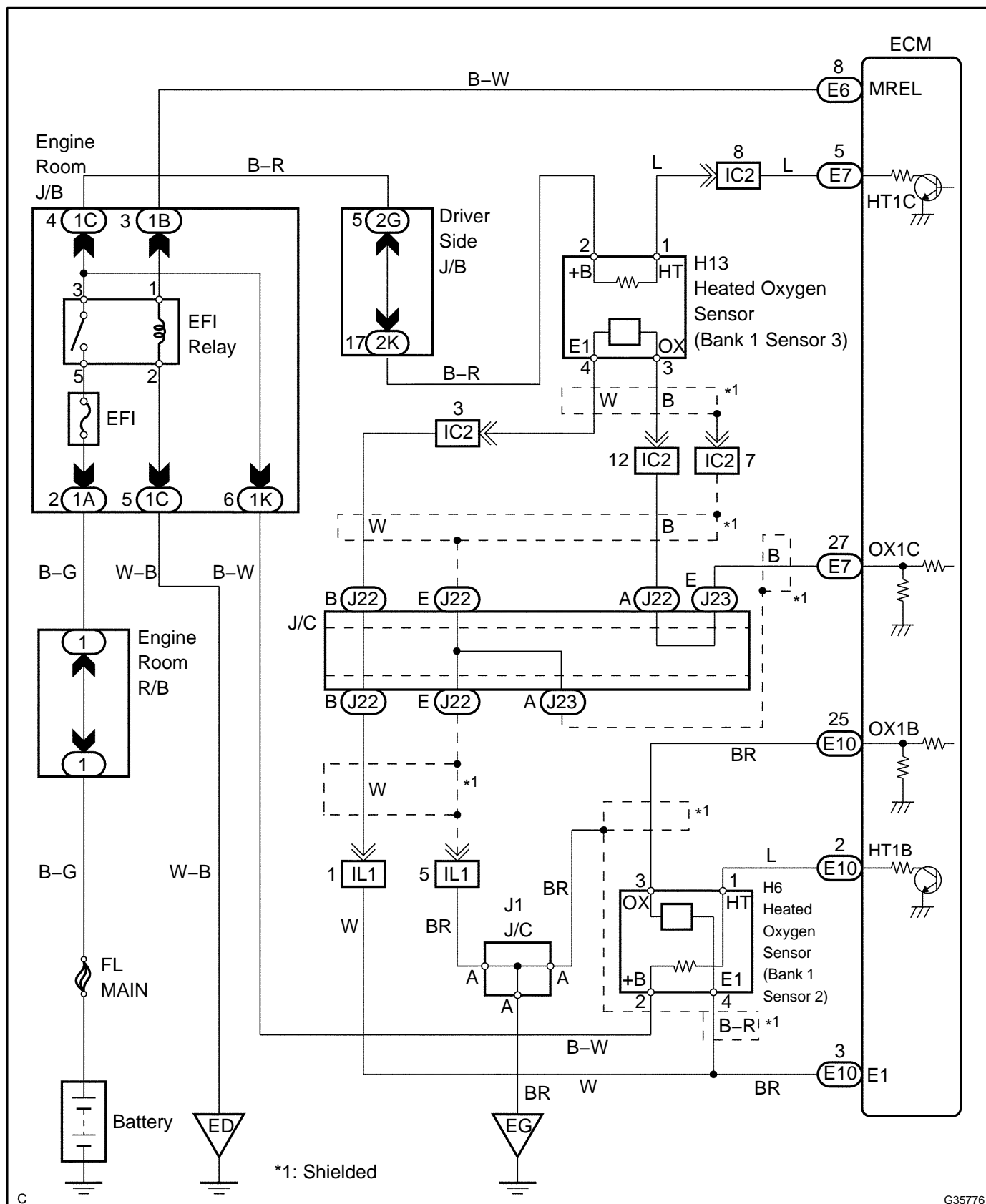
O2S TEST RESULT

Refer to page [05-369](#) 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
\$91	Time \$91	Maximum oxygen storage capacity	Multiply by 0.0156	Gram	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

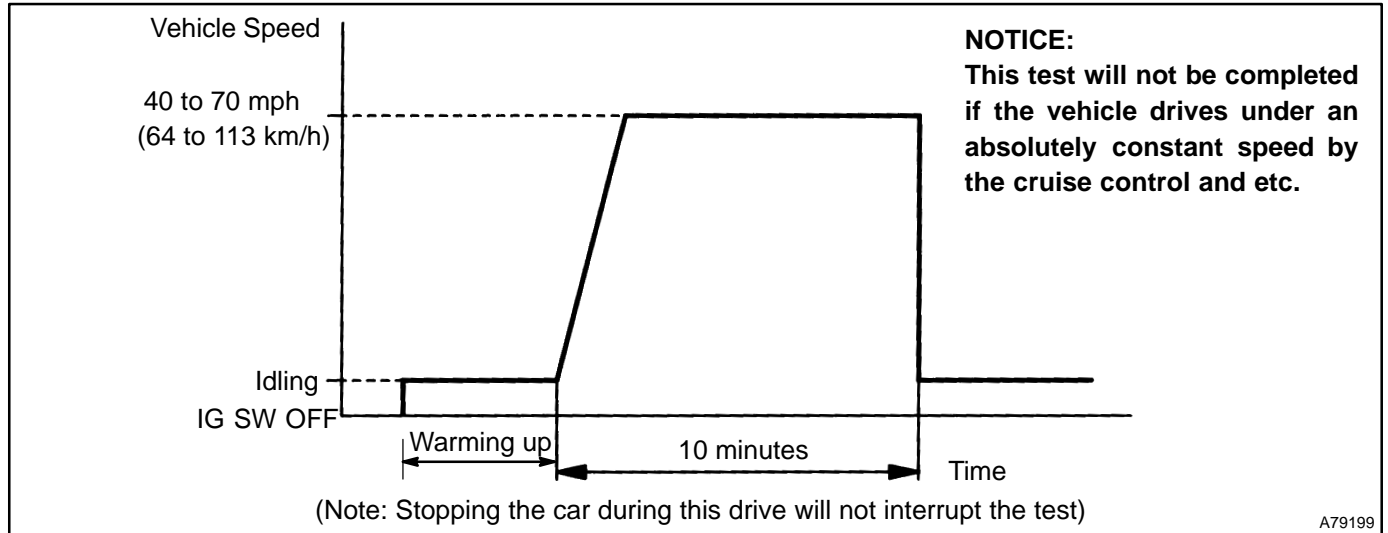


CONFIRMATION DRIVING PATTERN FOR READINESS MONITOR

PURPOSE (See page 05-371)

HINT:

Performing this confirmation pattern will activate the heated oxygen sensor 2 monitoring by the ECM. (The catalyst monitoring is performed simultaneously) This is very useful for verifying the completion of a repair.



READINESS TESTS	
MISFIRE MON	AVAIL
FUEL SYS MON	AVAIL
COMP MON	AVAIL
CAT EVAL	INCMPL
HTD CAT EVAL	N/A
EVAP EVAL	INCMPL
2nd AIR EVAL	N/A
A/C EVAL	N/A
O2S EVAL	INCMPL
O2S HTR EVAL	INCMPL
EGR EVAL	N/A

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- Clear the DTCs.
 - Disconnect the battery cable or remove the EFI and ETCS fuses for 60 seconds or more.
- Connect the hand-held tester to the DLC3.
- Enter the following menus: DIAGNOSIS / CARB OBD II / READINESS TESTS and check that O2S EVAL is INCMPL (incomplete).
- Drive the vehicle according to the confirmation driving pattern. Note the state of the READINESS TESTS. O2S EVAL will change to COMPL (complete) as O2S evaluation monitors operate.
- Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES and check if any DTC (any pending code) is set.

If the READINESS CODE of "O2S EVAL" was "INCMPL" and any DTC (include pending codes) was not set, extend the driving time.

NOTICE:

If you do not have the hand-held tester, perform again the same confirmation driving pattern after turning off the ignition switch upon finishing the first confirmation driving pattern.

INSPECTION PROCEDURE

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, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air-fuel ratio was lean or rich, etc. at the time of the malfunction.

Hand-held tester:**1 CHECK OTHER DTC OUTPUT (IN ADDITION – DTC P0136, P0137 AND/OR P0138)**

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

Result:

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

HINT:

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

B

GO TO RELEVANT DTC CHART
(See page [05-390](#))

A**2 PERFORM ACTIVE TEST BY HAND-HELD TESTER (A/F CONTROL)****HINT:**

Narrowing down the trouble area is possible by performing the "A/F CONTROL" ACTIVE TEST (A/F sensor, heated oxygen sensor 2 or other trouble areas can be distinguished).

(a) Perform ACTIVE TEST using the hand-held tester (A/F CONTROL).

HINT:

"A/F CONTROL" is an ACTIVE TEST which changes the injection volume –12.5 % or +25 %.

- (1) Connect the hand-held tester to the DLC3 on the vehicle.
- (2) Turn the ignition switch ON.
- (3) Push the "ON" button of the hand-held tester.
- (4) Warm up the engine by running the engine at 2,500 rpm for approximately 3 minutes.
- (5) For displaying the graph indication, enter "DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA", then select "AFS B1S1 and O2S B1S2" by pressing "YES" button and push "ENTER" before pressing "F4" button.
- (6) Perform "A/F CONTROL" with the engine in an idle condition (press the right or left button).

Result:

A/F sensor reacts in accordance with increase and decrease of injection volume:

+25 % → rich output: Less than 3.0 V

–12.5 % → lean output: More than 3.35 V

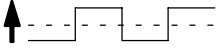
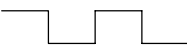
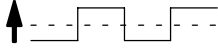
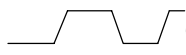
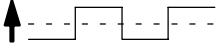

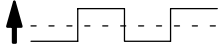
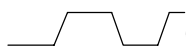
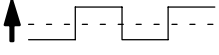
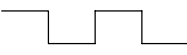
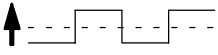
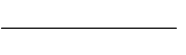
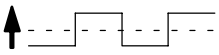
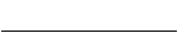
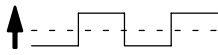
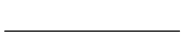
Heated oxygen sensor 2 reacts in accordance with increase and decrease of injection volume:

+25 % → rich output: More than 0.55 V

–12.5 % → lean output: Less than 0.4 V

NOTICE:

There is a few seconds delay in the A/F sensor output and there is about 20 seconds delay in the heated oxygen sensor 2 output.

	Output voltage of A/F sensor: (AFS B1S1)	Output voltage of heated oxygen sensor 2: (O2S B1S2)	Mainly suspect trouble area
Case 1	Injection volume +25 %  -12.5 % Output voltage More than 3.35 V  OK Less than 3.0 V	Injection volume +25 %  -12.5 % Output voltage More than 0.55 V  OK Less than 0.4V	—
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  OK Less than 0.4V	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  OK Less than 3.0V	Injection volume +25 %  -12.5 % Output voltage Almost No reaction  NG	Heated oxygen sensor 2 (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.)

Result:

Output voltage of A/F sensor	Output voltage of heated oxygen sensor 2	Proceed to
OK	OK	A
NG	OK	B
OK	NG	C
NG	NG	D

B**GO TO DTC P2237 (See page 05-282)****C****Go to step 5****D****GO TO DTC P0171 (See page 05-138)****A****3****PERFORM CONFIRMATION DRIVING PATTERN****HINT:**

Clear all DTCs prior to performing the confirmation driving pattern.

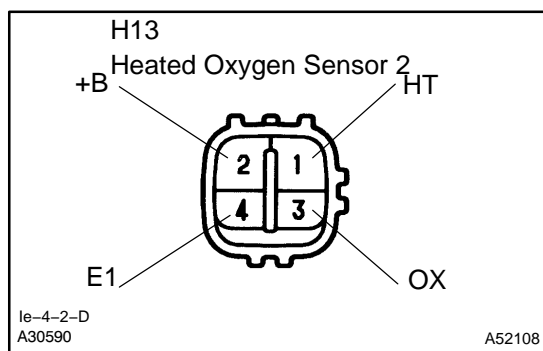
GO

4 READ OUTPUT DTC (DTC P0136, P0137 AND/OR P0138 ARE OUTPUT AGAIN)

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

Result:

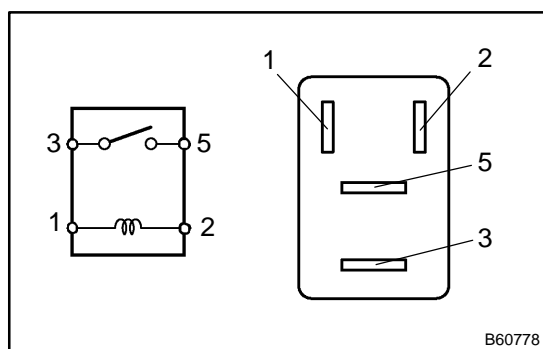
Display (DTC output)	Proceed to
P0136, P0137 and/or P0138 are not output again	A
P0136, P0137 and/or P0138 are output again	B

B**REPLACE HEATED OXYGEN SENSOR****A****CHECK FOR INTERMITTENT PROBLEMS****5 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)**

- (a) Disconnect the H13 heated oxygen sensor 2 connector.
 (b) Check the resistance of the heated oxygen sensor terminals.

Standard (Bank 1 Sensor 2):

Tester Connection	Specified Condition
1 (HT) – 2 (+B)	11 to 16 Ω
1 (HT) – 4 (E1)	10 k Ω or higher

NG**REPLACE HEATED OXYGEN SENSOR****OK****6 INSPECT RELAY (EFI)**

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

Standard:

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

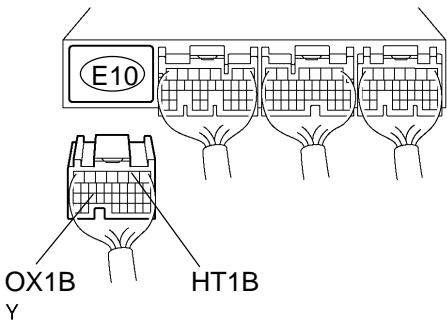
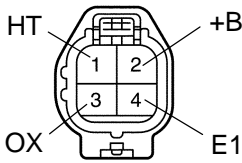
NG**REPLACE RELAY****OK**

7

CHECK WIRE HARNESS (HEATED OXYGEN SENSOR – ECM)

Wire Harness Side

H6
Heated Oxygen Sensor



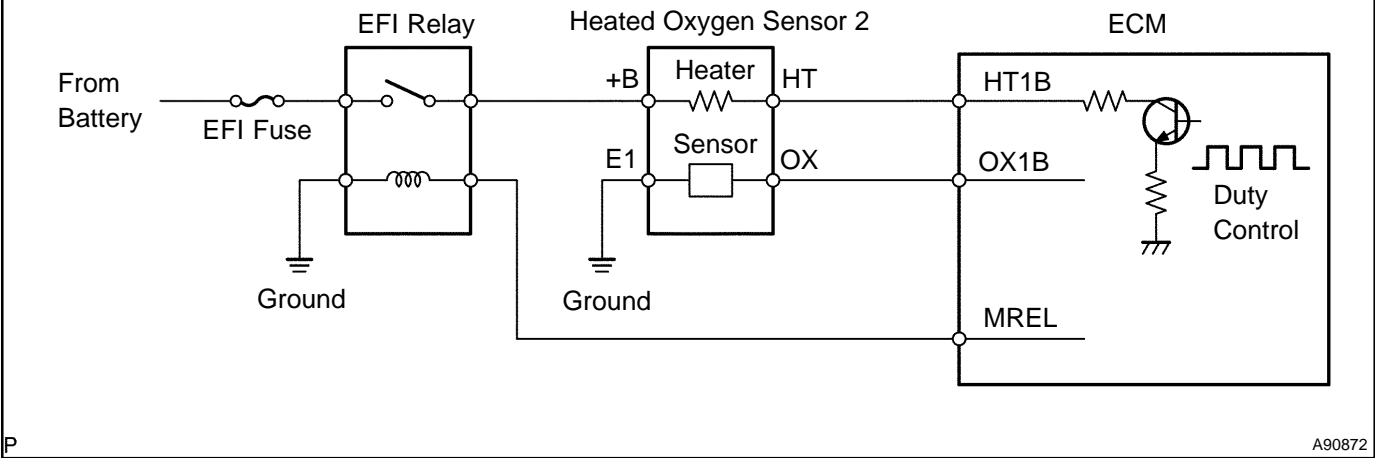
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- (a) Disconnect the H6 heated oxygen sensor 2 connector.
- (b) Disconnect the E10 ECM connector.
- (c) Check the resistance of the wire harness side connectors.

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 (Bank 1 Sensor 2 System Drawing)



NG

REPAIR OR REPLACE HARNESS AND CONNECTOR

OK

REPLACE HEATED OXYGEN SENSOR

OBD II scan tool (excluding hand-held tester):**1 CHECK OTHER DTC OUTPUT (IN ADDITION TO DTC P0136, P0137 AND/OR P0138)**

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

Result:

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

HINT:

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

B

GO TO RELEVANT DTC CHART
(See page 05-403)

A**2 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 2 when the engine rpm is suddenly increased.

HINT:

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

OK: Heated oxygen sensor 2 output voltage: Alternates 0.4 V or less and 0.5 V or more.

NG

Go to step 5

OK**3 PERFORM CONFIRMATION DRIVING PATTERN****HINT:**

Clear all DTCs prior to performing the confirmation driving pattern.

GO**4 READ OUTPUT DTC (DTC P0136, P0137 AND/OR P0138 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, P0137 and/or P0138 are not output again	A
P0136, P0137 and/or P0138 are output again	B

B

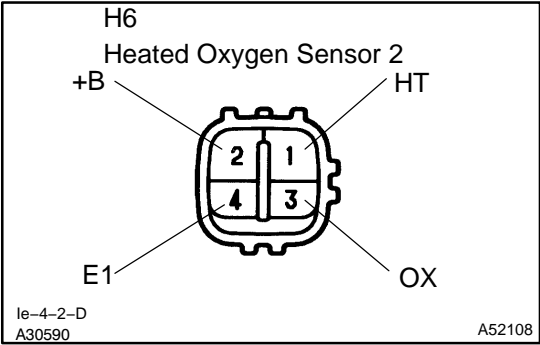
REPLACE HEATED OXYGEN SENSOR

A

CHECK FOR INTERMITTENT PROBLEMS

5

INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



- (a) Disconnect the H6 heated oxygen sensor 2 connector.
- (b) Check the resistance of the heated oxygen sensor terminals.

Standard (Bank 1 Sensor 2):

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

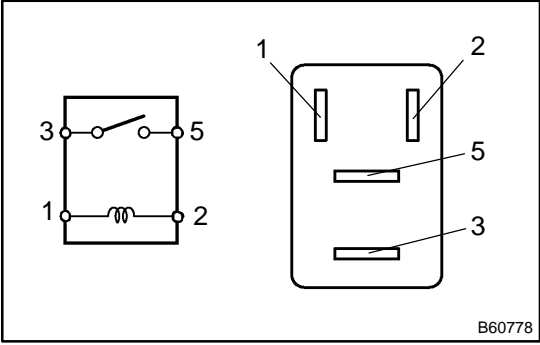
NG

REPLACE HEATED OXYGEN SENSOR

OK

6

INSPECT RELAY (EFI)



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

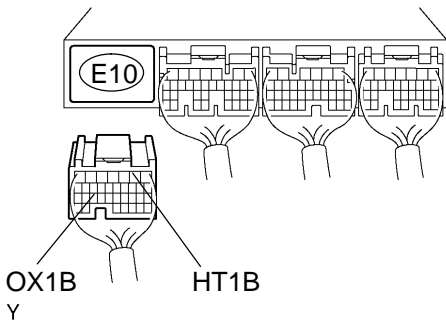
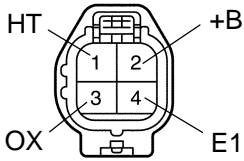
REPLACE RELAY

OK

7 CHECK WIRE HARNESS (HEATED OXYGEN SENSOR - ECM)

Wire Harness Side

H6
Heated Oxygen Sensor

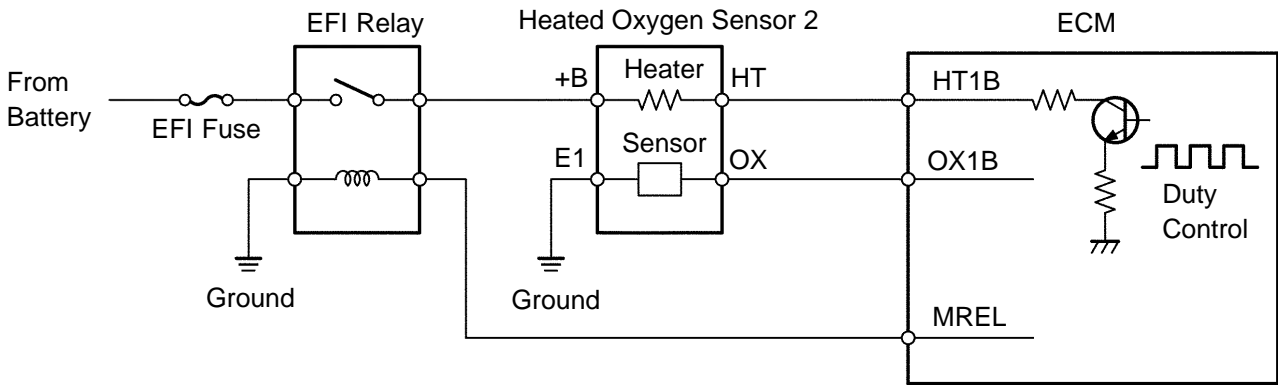


- (a) Disconnect the H6 heated oxygen sensor 2 connector.
- (b) Disconnect the E10 ECM connector.
- (c) Check the resistance of the wire harness side connectors.

Standard:

Tester Connection	Specified Condition
H6-3 (OX) - E10-25 (OX1B) H6-1 (HT) - E10-2 (HT1B) H6-4 (E1) - Body ground	Below 1 Ω
H6-3 (OX) or E10-25 (OX1B) - Body ground H6-1 (HT) or E10-2 (HT1B) - 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