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Service Category: Engine/Hybrid System	**Section:** Engine Control	
Model Year: 2008	**Model:** ES350	**Doc ID:** RM000000PFA04GX
Title: 2GR-FE ENGINE CONTROL SYSTEM: SFI SYSTEM: P0037: Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2) (2008 ES350)		

DTC	**P0037**	**Oxygen Sensor Heater Control Circuit Low (Bank 1 Sensor 2)**

DTC	**P0038**	**Oxygen Sensor Heater Control Circuit High (Bank 1 Sensor 2)**

DTC	**P0057**	**Oxygen Sensor Heater Control Circuit Low (Bank 2 Sensor 2)**

DTC	**P0058**	**Oxygen Sensor Heater Control Circuit High (Bank 2 Sensor 2)**

DTC	**P0141**	**Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)**

DTC	**P0161**	**Oxygen Sensor Heater Circuit Malfunction (Bank 2 Sensor 2)**

DESCRIPTION

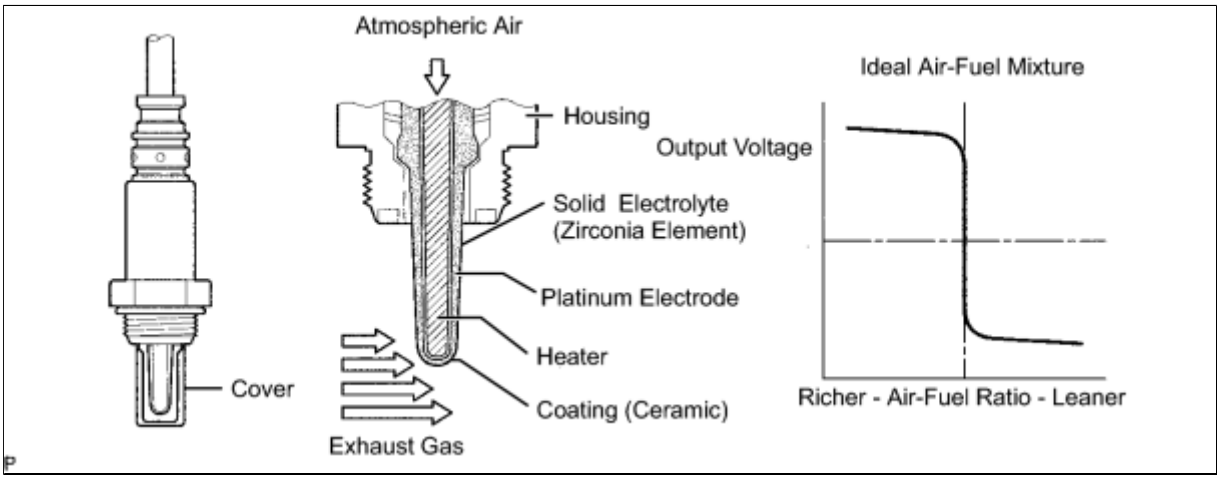
A three-way catalytic converter (TWC) is used in order to convert the carbon monoxide (CO), hydrocarbon (HC), and nitrogen oxide (NOx) into less harmful substances. To allow the TWC to function effectively, it is necessary to keep the air-fuel ratio of the engine near the stoichiometric air-fuel ratio. 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 becomes 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.

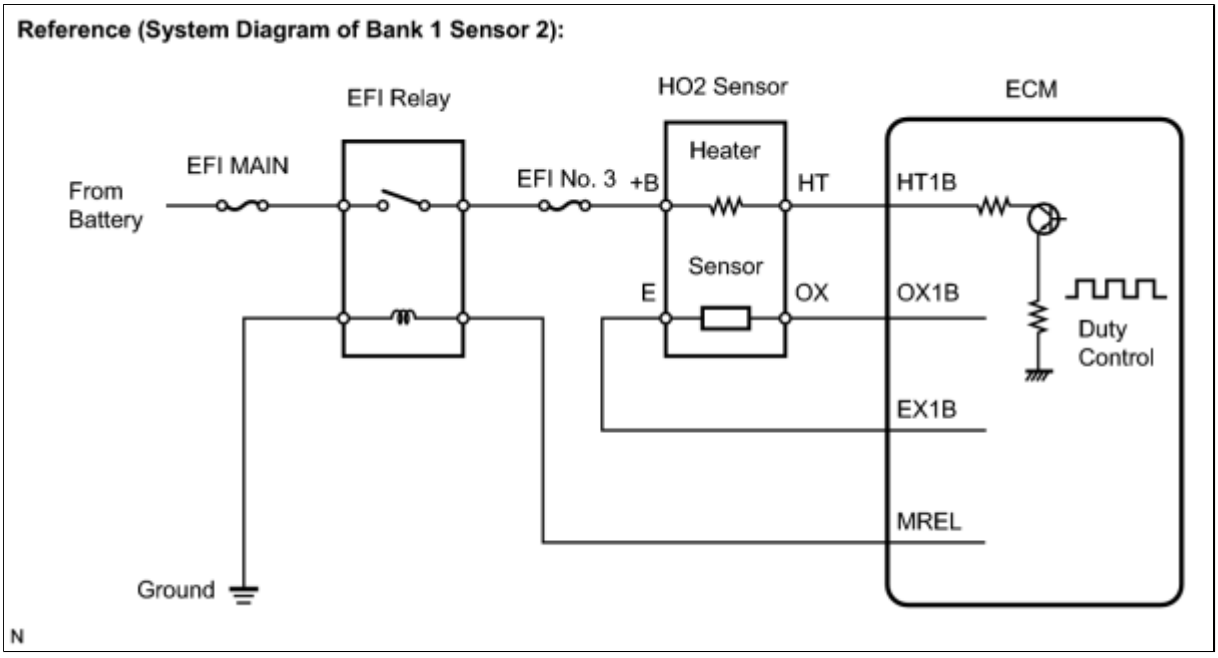
The ECM uses the supplementary information from the HO2 sensor to determine whether the air-fuel ratio after the TWC is rich or lean, and adjusts the fuel injection time accordingly. Thus, if the HO2 sensor is working improperly due to internal malfunctions, the ECM is unable to compensate for deviations in the primary air-fuel ratio control.



HINT:

- Sensor 2 refers to the sensor mounted behind the Three-Way Catalytic Converter (TWC) and located far from the engine assembly.
- When any of these DTCs are set, the ECM enters fail-safe mode. The ECM turns off the Heated Oxygen (HO2) Sensor heater in fail-safe mode. Fail-safe mode continues until the engine switch is turned off.
- The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The HO2 sensor heater circuit uses a relay on the B+ side of the circuit.

Reference (System Diagram of Bank 1 Sensor 2):



DTC NO.	DTC DETECTION CONDITION	TROUBLE AREA
P0037 P0057	Heated Oxygen (HO2) sensor heater current is less than 0.3 A (1 trip detection logic)	• Open in HO2 sensor heater circuit • HO2 sensor heater • Engine room junction block (EFI relay) • ECM
P0038	Heated Oxygen (HO2) sensor heater current is more than 3.5 A (1 trip	• Short in HO2 sensor heater circuit • HO2 sensor heater

P0058	detection logic)	• Engine room junction block (EFI relay) • ECM
P0141 P0161	Cumulative heater resistance correction value exceeds the acceptable threshold. (2 trip detection logic)	• HO2 sensor heater • ECM

HINT:

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

MONITOR DESCRIPTION

The sensing position of the Heated Oxygen (HO2) sensor has a zirconia element which is used to detect the oxygen concentration in the exhaust gas. If the zirconia element is at the appropriate temperature, and the difference between the oxygen concentrations surrounding the inside and outside surfaces of the sensor is large, the zirconia element generates voltage signals. In order to increase the oxygen concentration detecting capacity of the zirconia element, the ECM supplements the heat from the exhaust with heat from a heating element inside the sensor.

Heated oxygen sensor heater range check (P0037,P0038, P0057 and P0058):

The ECM monitors the current applied to the O2 sensor heater to check the heater for malfunctions. If the current is below the threshold value, the ECM will determine that there is an open circuit in the heater. If the current is above the threshold value, the ECM will determine that there is a short circuit in the heater.

Heated oxygen sensor heater performance (P0141 and P0161):

After the accumulated heater ON time exceeds 100 seconds, the ECM calculates the heater resistance using the battery voltage and the current applied to the heater. If the resistance is above the threshold value, the ECM will determine that there is a malfunction in the HO2S heater and set DTC P0141 and P0161.

MONITOR STRATEGY

Related DTCs	P0037: Heated oxygen sensor heater (bank 1 sensor 2) open/short (Low electrical current) P0038: Heated oxygen sensor heater (bank 1 sensor 2) open/short (High electrical current) P0057: Heated oxygen sensor heater (bank 2 sensor 2) open/short (Low electrical current) P0058: Heated oxygen sensor heater (bank 2 sensor 2) open/short (High electrical current) P0141: Heated oxygen sensor heater performance (bank 1 sensor 2) P0161: Heated oxygen sensor heater performance (bank 2 sensor 2)
Required sensors/components (Main)	Heated oxygen sensor heater (bank 1 sensor 2) Heated oxygen sensor heater (bank 2 sensor 2)
Required sensors/components (Sub)	Vehicle speed sensor

Frequency of operation	Continuous
Duration	1 second: P0037, P0038, P0057 and P0058 10 seconds: P0141 and P0161
MIL operation	Immediate: P0037, P0038, P0057 and P0058 2 driving cycles: P0141 and P0161
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs are not present	None

P0037 and P0057:

Battery voltage	10.5 to 20 V

P0038 and P0058 (Case 1):

Battery voltage	10.5 V or more
Engine	Running
Starter	OFF

P0038 and P0058 (Case 2):

Battery voltage	10.5 to 20 V

P0141 and P0161:

One of the following conditions is met:	Condition A or B
A. All of the following conditions are met:	Conditions 1, 2, 3, 4 and 5
1. Battery voltage	10.5 V or more
2. Fuel cut	OFF
3. Time after fuel cut ON to OFF	30 seconds or more
4. Accumulated heater ON time	100 seconds or more
5. Learned heater OFF current operation	Completed
B. Duration that rear heated oxygen sensor impedance is less than 15 kΩ	2 seconds or more

TYPICAL MALFUNCTION THRESHOLDS

P0037 and P0057:

Heater current	Less than 0.3 A

P0038 and P0058:

One of the following conditions is met:	Condition A or B

A. Learned heater OFF current	More than 2 A
B. Heater current	2 A or more

P0141 and P0161 (Heater performance monitor check):

Accumulated heater resistance	Varies with sensor element temperature (Example: More than 23 ohm)

COMPONENT OPERATING RANGE

Heated Oxygen (HO2) sensor heater current	0.4 to 1 A (when engine idles, HO2 sensor warmed up and battery voltage 11 to 14 V)

MONITOR RESULT

Refer to CHECKING MONITOR STATUS INFO .

WIRING DIAGRAM

Refer to DTC P0136 INFO .

INSPECTION PROCEDURE

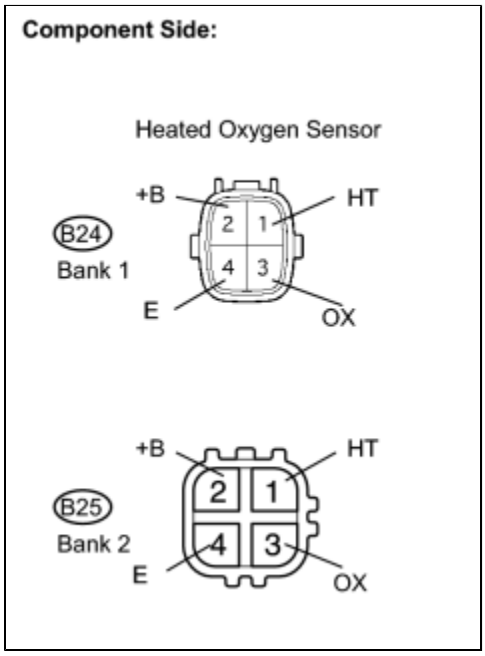
HINT:

Read freeze frame data using Techstream. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction INFO .

PROCEDURE

1.	**INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)**

(a) Disconnect the B24 heated oxygen sensor connector (Bank 1 Sensor 2) or B25 heated oxygen sensor connector (Bank 2 Sensor 2).



(b) Measure the resistance according to the value(s) in the table below.

Standard resistance (Bank 1 sensor 2):

TESTER CONNECTION	CONDITION	SPECIFIED CONDITION
HT (1) - +B (2)	20°C (68°F)	11 to 16 Ω
HT (1) - E (4)	Always	10 kΩ or higher

Standard resistance (Bank 2 sensor 2):

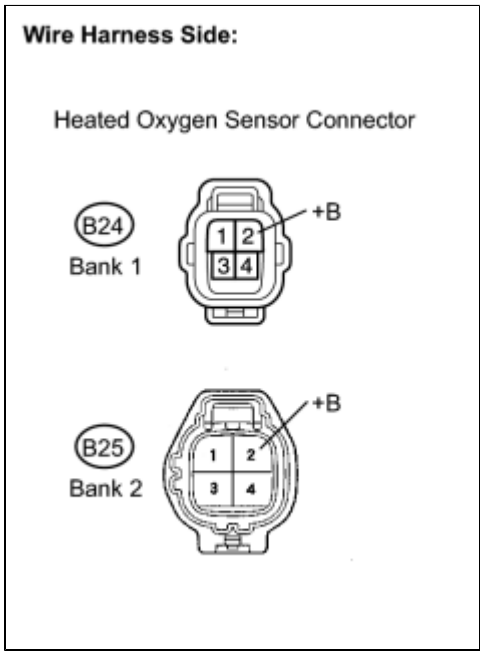
TESTER CONNECTION	CONDITION	SPECIFIED CONDITION
HT (1) - +B (2)	20°C (68°F)	11 to 16 Ω
HT (1) - E (4)	Always	10 kΩ or higher

(c) Reconnect the HO2 sensor connector.

NG ▶ **REPLACE HEATED OXYGEN SENSOR**

OK
▼

2.	**CHECK TERMINAL VOLTAGE (+B OF HO2 SENSOR)**



(a) Disconnect the B24 heated oxygen sensor connector (Bank 1 Sensor 2) or B25 heated oxygen sensor connector (Bank 2 Sensor 2).

(b) Turn the engine switch on (IG).

(c) Measure the voltage between the terminals.

Standard voltage:

TESTER CONNECTION	SPECIFIED CONDITION
+B (B24-2) - Body ground	9 to 11 V
+B (B25-2) - Body ground	9 to 11 V

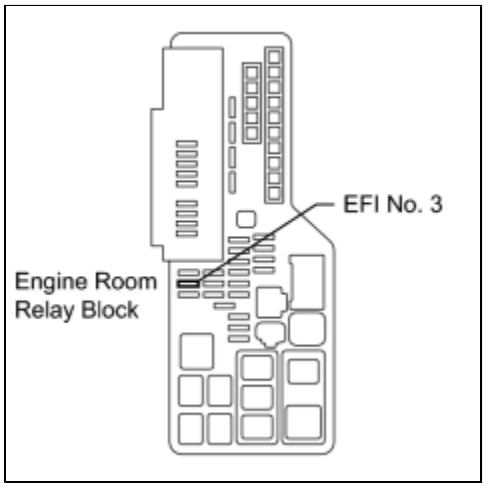
(d) Reconnect the HO2 sensor connector.

OK ▶ **CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)**

NG ▼

3.	**INSPECT FUSE (EFI NO. 3)**

(a) Remove the EFI No. 3 fuse from the engine room R/B.



(b) Measure the EFI No. 3 fuse resistance.

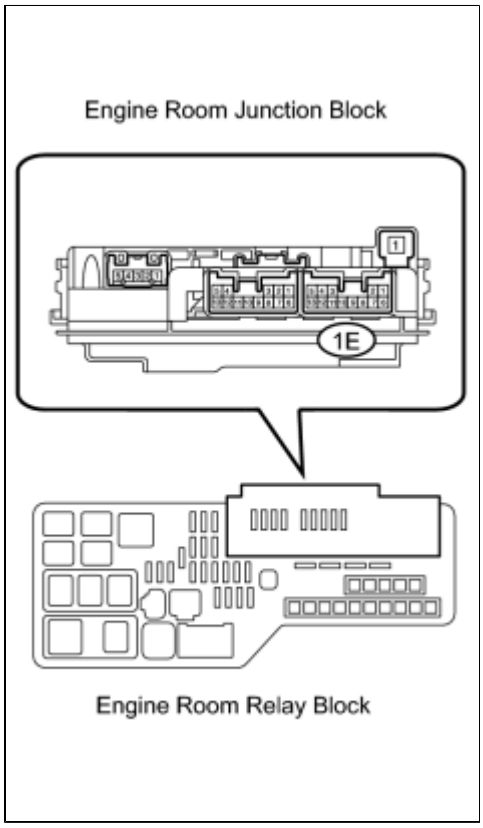
Standard resistance:
Below 1 Ω

(c) Reinstall the EFI No. 3 fuse.

NG ▶ **REPLACE EFI NO. 3 FUSE**

OK ▼

4.	INSPECT ENGINE ROOM JUNCTION BLOCK



(a) Remove the engine room junction block from the engine room R/B.

(b) Inspect the EFI relay.

(1) Measure the EFI relay resistance.

Standard resistance:

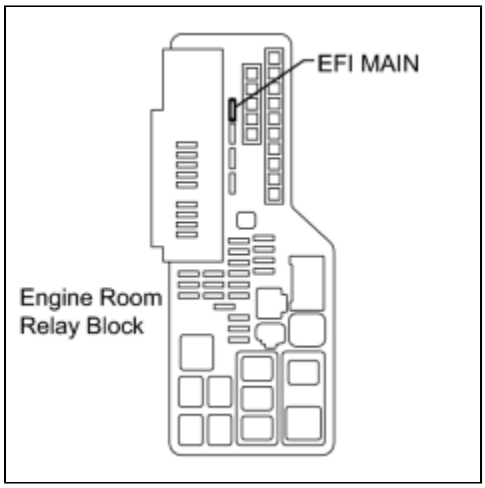
TESTER CONNECTION	SPECIFIED CONDITION
1E-12 - 1E-6	10 kΩ or higher
1E-12 - 1E-6	Below 1 Ω (Apply battery voltage between terminals 1E-9 and 1E-10)

(c) Reinstall the engine room junction block.

NG ▶ **REPLACE ENGINE ROOM JUNCTION BLOCK**

OK ▼

5.	INSPECT FUSE (EFI MAIN)



(a) Remove the EFI MAIN fuse from the engine room R/B.

(b) Measure the EFI MAIN fuse.

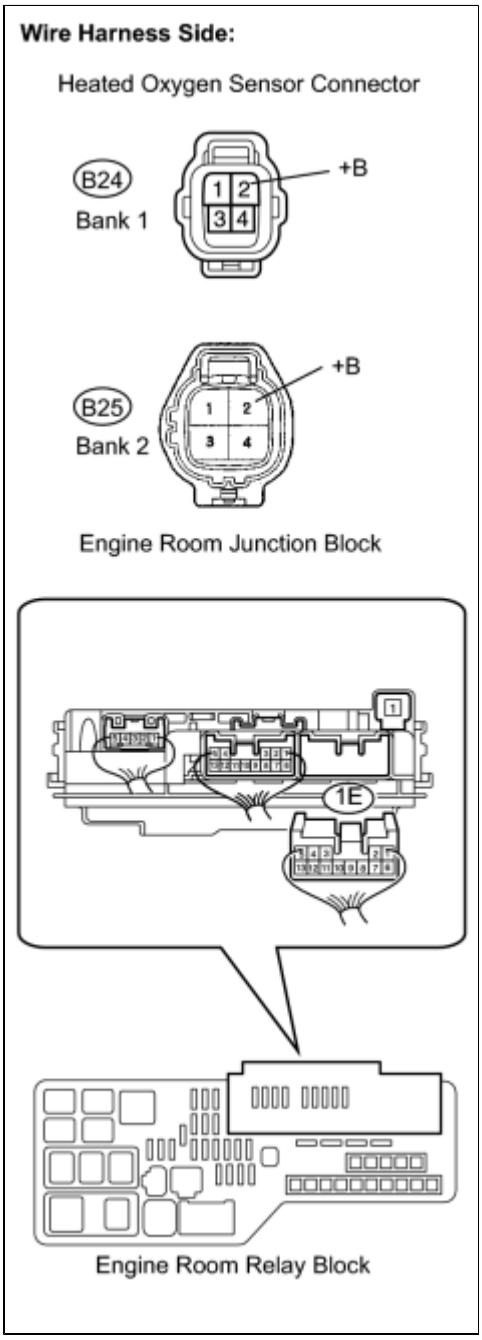
Standard resistance:
Below 1 Ω

(c) Reinstall the EFI MAIN fuse.

NG ▶ **REPLACE EFI MAIN FUSE**

OK ▼

6.	CHECK HARNESS AND CONNECTOR (HO2 SENSOR - EFI RELAY)



(a) Disconnect the B24 or B25 heated oxygen sensor connector.

(b) Remove the engine room junction block from the engine room R/B.

(c) Measure the resistance between the terminals.

Standard resistance (Check for open):

TESTER CONNECTION	SPECIFIED CONDITION
+B (B24-2) - 1E-6 (Engine room R/B)	Below 1 Ω
+B (B25-2) - 1E-6 (Engine room R/B)	Below 1 Ω

Standard resistance (Check for short):

TESTER CONNECTION	SPECIFIED CONDITION
+B (B24-2) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher

+B (B25-2) or 1E-6 (Engine room R/B) - Body ground	10 kΩ or higher

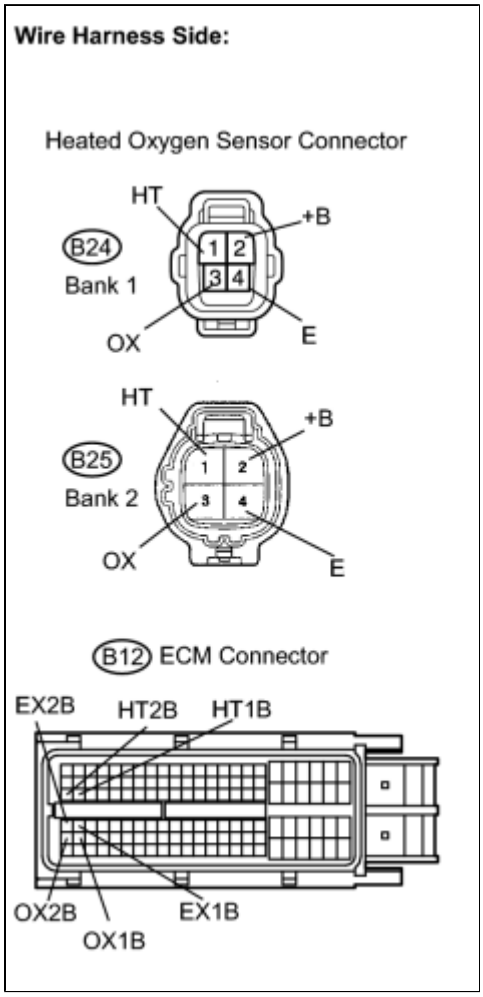
(d) Reinstall the engine room junction block.

(e) Reconnect the HO2 sensor connector.

NG ▶ **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK ▶ **CHECK ECM POWER SOURCE CIRCUIT**

8.	CHECK HARNESS AND CONNECTOR (HO2 SENSOR - ECM)



(a) Disconnect the B24 heated oxygen sensor connector (Bank 1 Sensor 2) or B25 heated oxygen sensor connector (Bank 2 Sensor 2).

(b) Turn the engine switch on (IG).

(c) Measure the voltage according to the value(s) in the table below.

Standard voltage:

TERMINAL CONNECTION	SPECIFIED CONDITION
+B (B24-2) - Body ground	9 to 14 V
+B (B25-2) - Body ground	9 to 14 V

(d) Turn the engine switch off.

(e) Disconnect the B12 ECM connector.

(f) Measure the resistance according to the value(s) in the table below.

Standard resistance (Check for open):

TERMINAL CONNECTION	SPECIFIED CONDITION
HT (B24-1) - HT1B (B12-48)	Below 1 Ω
OX (B24-3) - OX1B (B12-88)	Below 1 Ω
E (B24-4) - EX1B (B12-65)	Below 1 Ω
HT (B25-1) - HT2B (B12-47)	Below 1 Ω
OX (B25-3) - OX2B (B12-87)	Below 1 Ω
E (B25-4) - EX2B (B12-64)	Below 1 Ω

Standard resistance (Check for short):

TERMINAL CONNECTION	SPECIFIED CONDITION
HT (B24-1) or HT1B (B12-48) - Body ground	10 kΩ or higher
OX (B24-3) or OX1B (B12-88) - Body ground	10 kΩ or higher
E (B24-4) or EX1B (B12-65) - Body ground	10 kΩ or higher
HT (B25-1) or HT2B (B12-47) - Body ground	10 kΩ or higher
OX (B25-3) or OX2B (B12-87) - Body ground	10 kΩ or higher
E (B25-4) or EX2B (B12-64) - Body ground	10 kΩ or higher

(g) Reconnect the HO2 sensor connector.

(h) Reconnect the ECM connector.

NG ▶ **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK ▼

9.	CHECK WHETHER DTC OUTPUT RECURS

(a) Connect Techstream to the DLC3.

(b) Turn the engine switch on (IG).

(c) Turn Techstream on.

(d) Clear the DTCs INFO .

(e) Start the engine.

(f) Allow the engine to idle for 2 minutes.

(g) Select the following menu items: Powertrain / Engine / Trouble Code.

(h) Read the DTCs.

Result:

DISPLAY (DTC OUTPUT)	PROCEED TO
No output	A
P0037, P0038, P0057, P0058, P0141 and/or P0161	B

B ▶ **REPLACE ECM**

A ▶ **CHECK FOR INTERMITTENT PROBLEMS**