

DTC	P0031	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 1 Sensor 1)
DTC	P0032	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 1 Sensor 1)
DTC	P0051	Oxygen (A/F) Sensor Heater Control Circuit Low (Bank 2 Sensor 1)
DTC	P0052	Oxygen (A/F) Sensor Heater Control Circuit High (Bank 2 Sensor 1)

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HINT:

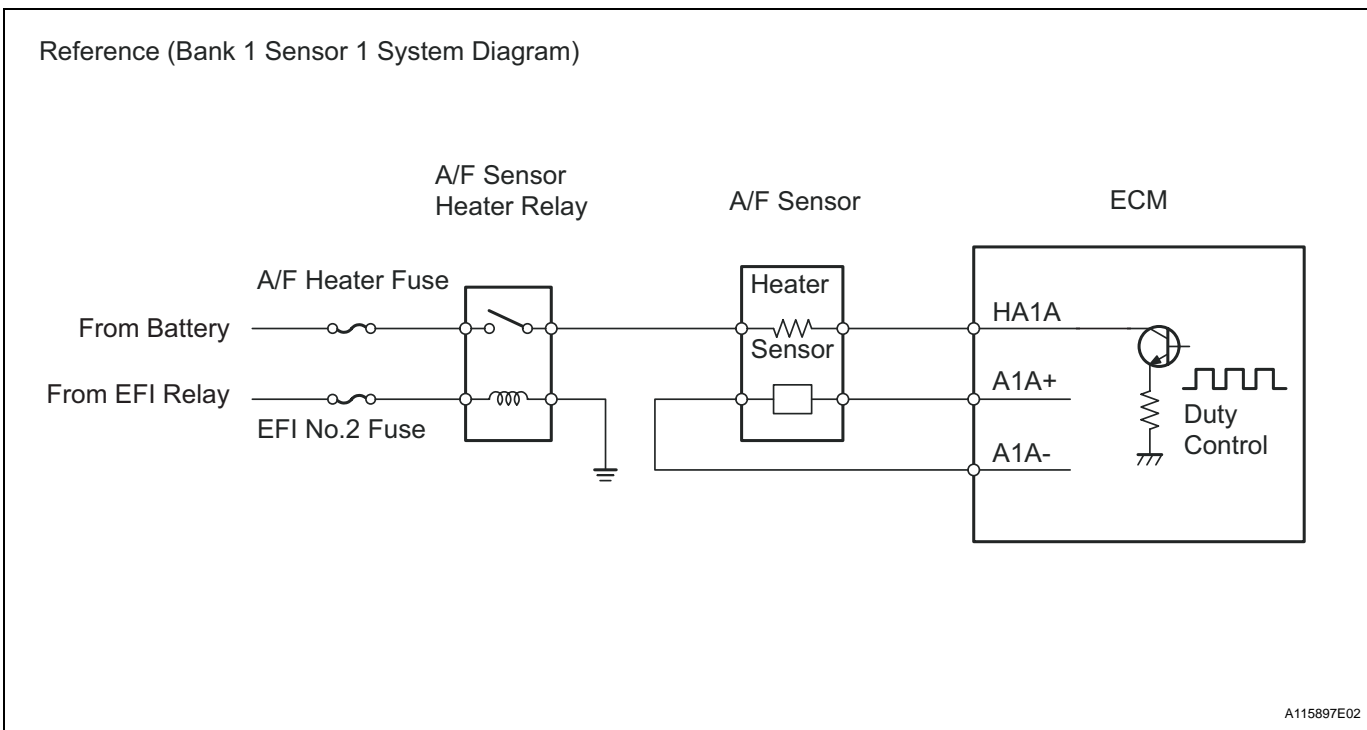
- Although the DTC titles say the oxygen sensor, these DTCs relate to the Air-Fuel Ratio (A/F) sensor.
- Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.

DESCRIPTION

Refer to DTC P2195 (See page [ES-304](#)).

HINT:

- When any of these DTCs are set, the ECM enters fail-safe mode. The ECM turns off the A/F sensor heater in fail-safe mode. Fail-safe mode continues until the ignition switch is turned OFF.
- The ECM provides a pulse width modulated control circuit to adjust the current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.



DTC No.	DTC Detection Conditions	Trouble Areas
P0031 P0051	Air-Fuel Ratio (A/F) sensor heater current less than 0.8 A (1 trip detection logic)	<ul style="list-style-type: none"> • Open in A/F sensor heater circuit • A/F sensor heater • A/F sensor heater relay • ECM

DTC No.	DTC Detection Conditions	Trouble Areas
P0032 P0052	Air-Fuel Ratio (A/F) sensor heater current more than 10 A (1 trip detection logic)	<ul style="list-style-type: none"> • Short in A/F sensor heater circuit • A/F sensor heater • A/F sensor heater relay • 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 ECM uses information from the Air-Fuel Ratio (A/F) sensor to regulate the air-fuel ratio and keep it close to the stoichiometric level. This maximizes the ability of the Three-Way Catalytic Converter (TWC) to purify the exhaust gases.

The A/F sensor detects oxygen levels in the exhaust gas and transmits the information to the ECM. The inner surface of the sensor element is exposed to the outside air. The outer surface of the sensor element is exposed to the exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element.

The zirconia element generates a small voltage when there is a large difference in the oxygen concentrations between the exhaust gas and outside air. The platinum coating amplifies this voltage generation.

The A/F sensor is more efficient when heated. When the exhaust gas temperature is low, the sensor cannot generate useful voltage signals without supplementary heating. The ECM regulates the supplementary heating using a duty-cycle approach to adjust the average current in the sensor heater element. If the heater current is outside the normal range, the signal transmitted by the A/F sensor will be inaccurate, as a result, the ECM will be unable to regulate air-fuel ratio properly.

When the current in the A/F sensor heater is outside the normal operating range, the ECM interprets this as a malfunction in the sensor heater and sets a DTC.

Example:

The ECM sets DTC P0032 or P0052 when the current in the A/F sensor heater is more than 10 A.

Conversely, when the heater current is less than 0.8 A, DTC P0031 or P0051 is set.

MONITOR STRATEGY

Related DTCs	P0031: A/F sensor heater (bank 1) open/short (Low electrical current) P0032: A/F sensor heater (bank 1) open/short (High electrical current) P0051: A/F sensor heater (bank 2) open/short (Low electrical current) P0052: A/F sensor heater (bank 2) open/short (High electrical current)
Required Sensors/Components (Main)	A/F sensor heater (bank 1 and 2)
Required Sensors/Components (Related)	-
Frequency of Operation	Continuous
Duration	10 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS**All:**

Monitor runs whenever following DTCs not present	None
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P0031 and P0051:

Battery voltage	10.5 V or more
A/F sensor heater duty-cycle ratio	50 % or more
Time after engine start	10 seconds or more

P0032 and P0052:

Time after engine start	10 seconds or more
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TYPICAL MALFUNCTION THRESHOLDS

P0031 and P0051:

A/F sensor heater current	Less than 0.8 A
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P0032 and P0052:

A/F sensor heater current	More than 10 A
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COMPONENT OPERATING RANGE

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A/F sensor heater current	1.8 to 3.4 A at 20°C (68°F)
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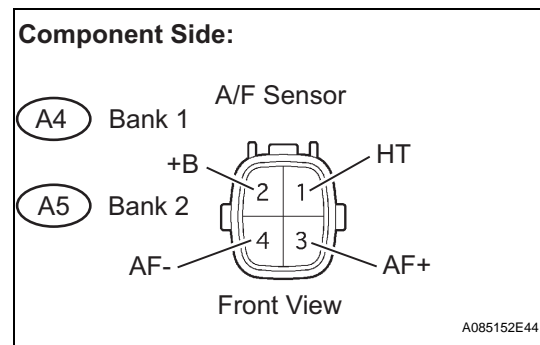
WIRING DIAGRAM

Refer to DTC P2195 (See page [ES-309](#)).

HINT:

Read freeze frame data using an intelligent tester. 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.

1 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



- (a) Disconnect the A4 or A5 A/F sensor connector.
- (b) Measure the resistance between the terminals of the A/F sensor connector.

Standard Resistance

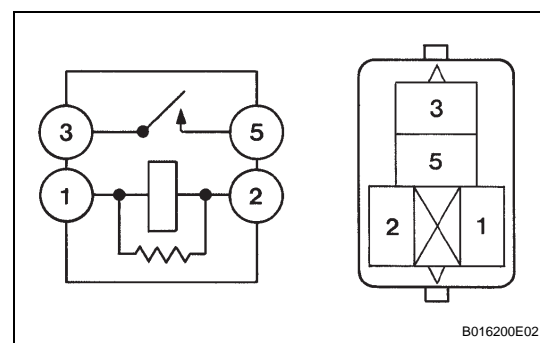
Tester Connections	Specified Conditions
HT (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HT (1) - AF- (4)	10 kΩ or higher

- (c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

2 INSPECT AIR FUEL RATIO SENSOR HEATER RELAY



- (a) Remove the A/F sensor heater relay from the engine room relay block.
- (b) Check the A/F sensor heater relay resistance.

Standard Resistance

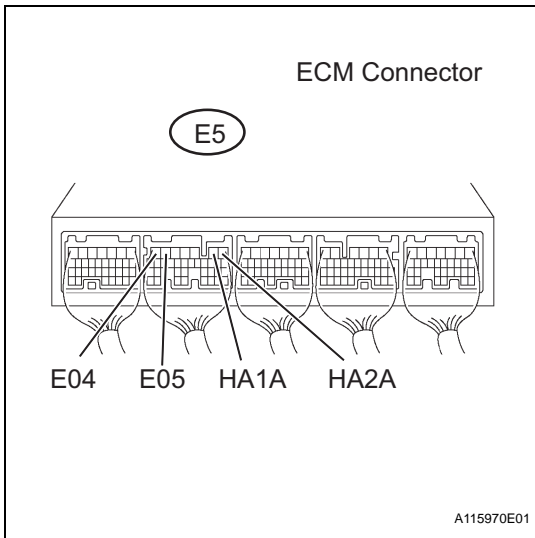
Tester Connections	Specified Conditions
3 - 5	10 kΩ or higher
3 - 5	Below 1 Ω (when battery voltage applied to terminals 1 and 2)

- (c) Reinstall the A/F sensor heater relay.

NG **REPLACE AIR FUEL RATIO SENSOR HEATER RELAY**

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3 INSPECT ECM (HA1A OR HA2A VOLTAGE)



- (a) Turn the ignition switch ON.
- (b) Measure the voltage between the terminals of the E5 ECM connector.

Standard Voltage

Tester Connections	Specified Conditions
HA1A (E5-2) - E04 (E5-7)	9 to 14 V
HA2A (E5-1) - E05 (E5-6)	

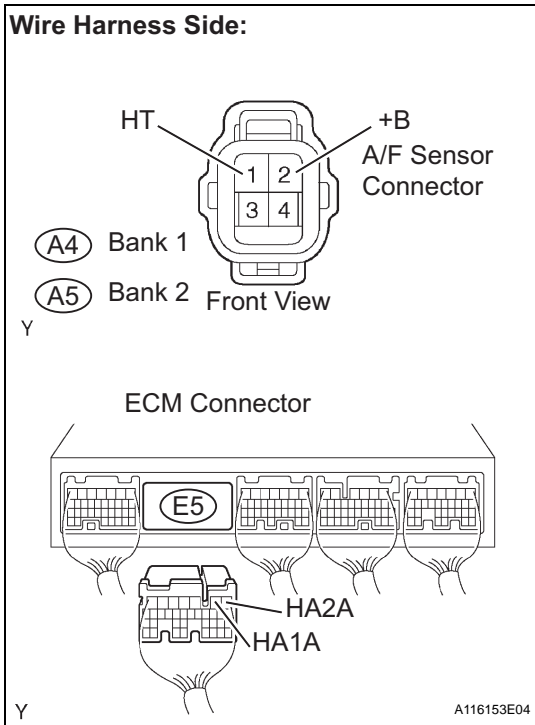
HINT:

- The HA1A means the A/F sensor bank 1 sensor 1.
- The HA2A means the A/F sensor bank 2 sensor 1.

OK **REPLACE ECM**

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4 CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM, A/F SENSOR - A/F SENSOR HEATER RELAY)



- (a) Check the harness and the connector between the ECM and the A/F sensor.
 - (1) Disconnect the A4 or A5 A/F sensor connector.
 - (2) Disconnect the E5 ECM connector.
 - (3) Check the resistance.

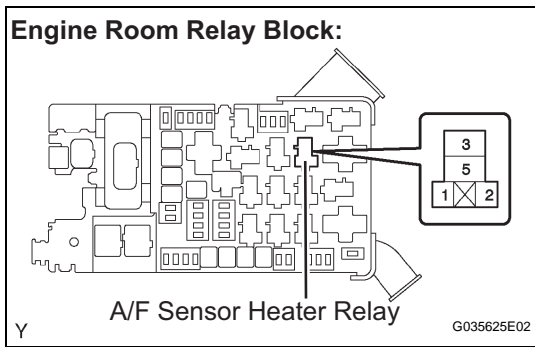
Standard Resistance (Check for open)

Tester Connections	Specified Conditions
HT (A4-1) - HA1A (E5-2)	Below 1 Ω
HT (A5-1) - HA2A (E5-1)	

Standard Resistance (Check for short)

Tester Connections	Specified Conditions
HT (A4-1) or HA1A (E5-2) - Body ground	10 kΩ or higher
HT (A5-1) or HA2A (E5-1) - Body ground	

- (4) Reconnect the A/F sensor connector.
- (5) Reconnect the ECM connector.
- (b) Check the harness and the connector between the A/F sensor and A/F sensor heater relay.
 - (1) Disconnect the A4 or A5 A/F sensor connector.
 - (2) Remove the A/F sensor heater relay from the engine room relay block.



- (3) Check the resistance.
Standard Resistance (Check for open)

Tester Connections	Specified Conditions
+B (A4-2) - A/F sensor heater relay (3)	Below 1 Ω
+B (A5-2) - A/F sensor heater relay (3)	

Standard Resistance (Check for short)

Tester Connections	Specified Conditions
+B (A4-2) or A/F sensor heater relay (3) - Body ground	10 k Ω or higher
+B (A5-2) or A/F sensor heater relay (3) - Body ground	

- (4) Reconnect the A/F sensor connector.
 (5) Reinstall the A/F sensor heater relay.

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REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM

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