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)

ES

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

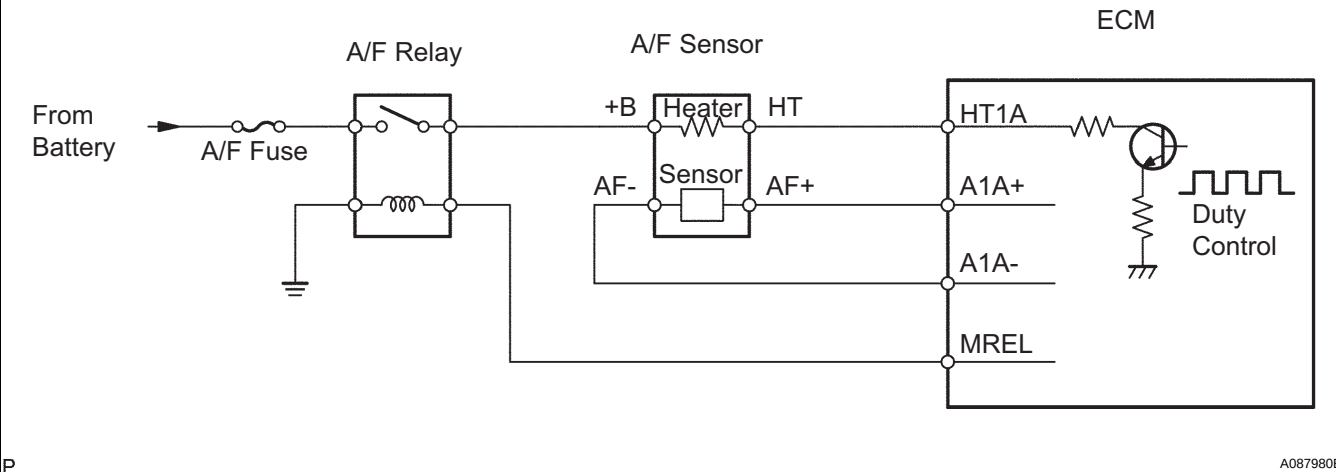
DESCRIPTION

HINT:

- Although the caption of each detection item (DTC description) says "oxygen sensor", this DTC is related to the "air fuel ratio sensor (A/F sensor)".
- The ECM provides a pulse width modulated control circuit to adjust current through the heater. The A/F sensor heater circuit uses a relay on the +B side of the circuit.

Refer to DTC P2195 (See page ES-271)

Reference (Bank 1 Sensor 1 System Drawing)



DTC No.	DTC Detection Condition	Trouble Area
P0031 P0051	Heater current is 0.8 A or less when heater operates (1 trip detection logic)	• Open or short in heater circuit of A/F sensor • A/F sensor heater • A/F relay • ECM
P0032 P0052	Heater current exceeds 19.7 A when heater operates (1 trip detection logic)	• Open or short in heater circuit of A/F sensor • A/F sensor heater • A/F relay • ECM

HINT:

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

MONITOR DESCRIPTION

The ECM uses the Air-Fuel Ratio sensor (A/F sensor) information to regulate the air-fuel ratio close to the stoichiometric ratio. This maximizes the catalytic converter's ability to purify exhaust gas. The sensor detects oxygen levels in the exhaust gas and sends this signal to the ECM.
The inner surface of the sensor element is exposed to outside air. The outer surface of the sensor element is exposed to exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element. The zirconia element generates small voltage when there is a large difference in the oxygen concentrations of the exhaust and the outside air. The platinum coating amplifies the voltage generation. When heated, the sensor becomes very efficient. If the temperature of the exhaust is low, the sensor will not generate useful voltage signals without supplemental heating. The ECM regulates the supplemental heating using a duty-cycle approach to regulate the average current in the heater element. If the heater current is out of the normal range, the sensor's output signals will be inaccurate and the ECM cannot regulate the air-fuel ratio properly.
When the heater current is out of the normal operating range, the ECM interprets this as a malfunction and sets a DTC.

MONITOR STRATEGY

Related DTCs	P0031: A/F Sensor Heater (Bank 1) Range Check (Low current) P0032: A/F Sensor Heater (Bank 1) Range Check (High current) P0051: A/F Sensor Heater (Bank 2) Range Check (Low current) P0052: A/F Sensor Heater (Bank 2) Range Check (High current)
Required sensors / components (Main)	A/F sensor heater
Required sensors / components (Related)	-
Frequency of operation	Continuous
Duration	10 seconds
MIL operation	Immediate
Sequence operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	None
Time after engine start	10 seconds or more

P0031 and P0051:

A/F sensor heater duty ratio	50 % or more
Battery voltage	10.5 V or more

TYPICAL MALFUNCTION THRESHOLDS

P0031 and P0051:

A/F sensor heater current	Less than 0.8 A

P0032 and P0052:

Hybirid IC high current limiter port	Fail

COMPONENT OPERATING RANGE

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

MONITOR RESULT

Refer to "Checking Monitor Status" for detailed information (See page ES-14).
The test value and test limit information are described as shown in the following table. Check the monitor result and test values after performing the monitor drive pattern (See page ES-16).

- TID (Test Identification Data) is assigned to each emissions-related component.
- TLT (Test Limit Type) :
  If TLT is 0, the component is malfunctioning when the test value is higher than the test limit.
  If TLT is 1, the component is malfunctioning when the test value is lower than the test limit.
- CID (Component, Identification Data) is assigned to each test value.
- Unit Conversion is used to calculate the test value indicated on generic OBD II scan tools.

TID $07: A/F sensor heater

TLT	CID	Unit Conversion	Description of Test Data	Description of Test Limit
1	$01	Multiply by 0.00017 (A)	Maximum A/F sensor heater current (Bank 1 Sensor 1)	Malfunction threshold for A/F sensor heater
1	$10	Multiply by 0.00017 (A)	Maximum A/F sensor heater current (Bank 2 Sensor 1)	Malfunction threshold for A/F sensor heater

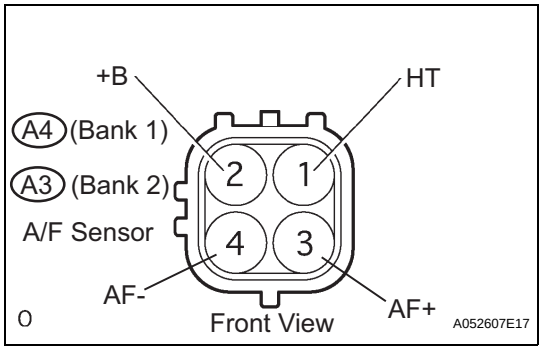
ES

WIRING DIAGRAM

Refer to DTC P2195 (See page ES-275).

HINT:
Read freeze frame data using the intelligent tester or the OBD II scan tool. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. 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 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



(a) Disconnect the A3 or A4 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/F sensor.
Standard resistance

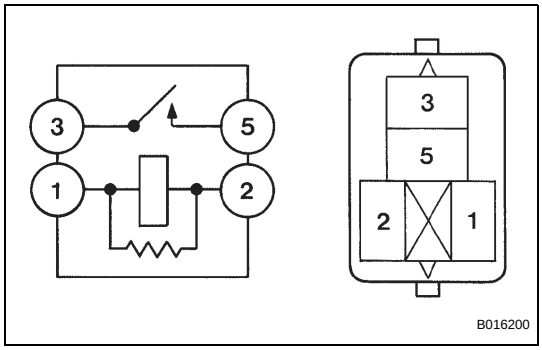
Tester Connection	Condition	Specified Condition
1 (HT) - 2 (+B)	20°C (68°F)	1.8 to 3.4 Ω
1 (HT) - 4 (AF-)	-	10 kΩ or higher

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

2 INSPECT AIR FUEL RATIO SENSOR RELAY



(a) Remove the A/F relay from the engine room R/B.
(b) Measure the resistance of the A/F relay.
Standard resistance

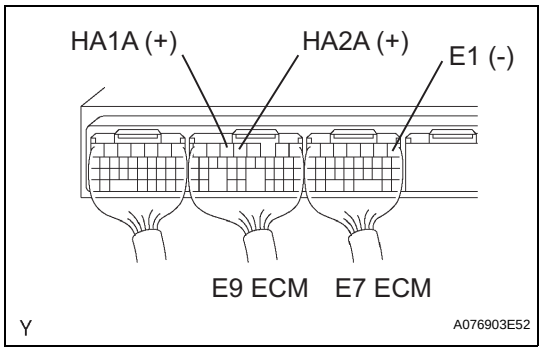
Tester Connection	Specified Condition
1 - 2	Below 1Ω
3 - 5	10 kΩ or higher
3 - 5	Below 1Ω (Apply battery voltage terminals 1 and 2)

(c) Reinstall the A/F relay.

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

OK

3	INSPECT ECM (HA1A AND HA2A VOLTAGE)



(a) Turn the ignition switch ON.
(b) Measure the voltage of the ECM connectors.
Standard voltage

Tester Connection	Specified Condition
E9-5 (HA1A) - E7-1 (E1) E9-4 (HA2A) - E7-1 (E1)	9 to 14 V

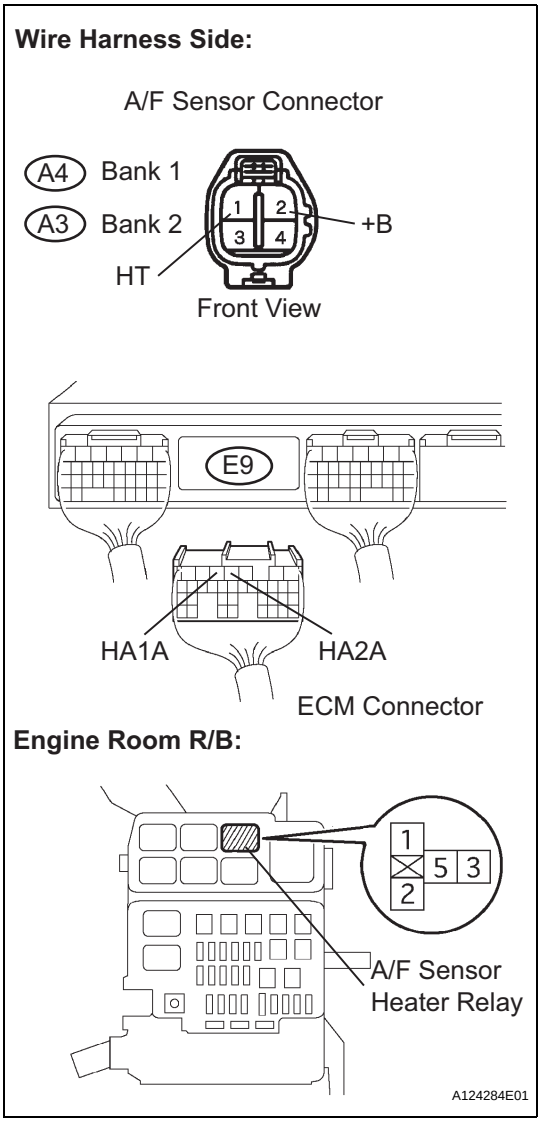
HINT:
- The HA1A stands for the A/F sensor bank 1 sensor 1.
- The HA2A stands for the A/F sensor bank 2 sensor 1.

ES

OK → **REPLACE ECM**

NG

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



(a) Check the wire harness between the ECM and A/F sensors.
  (1) Disconnect the E9 ECM connector.
  (2) Disconnect the A4 or A3 A/F sensor connector.
  (3) Measure the resistance of the wire harness side connectors.

Standard resistance

Tester Connection	Specified Condition
A4-1 (HT) - E9-5 (HA1A) A3-1 (HT) - E9-4 (HA2A)	Below 1 Ω
A4-1 (HT) or E9-5 (HA1A) - Body ground A3-1 (HT) or E9-4 (HA2A) - Body ground	10 kΩ or higher

(b) Check the wire harness between the A/F sensor and A/F relay.
  (1) Disconnect the A3 or A4 A/F sensor connector.
  (2) Remove the A/F relay from the engine room R/B.
  (3) Measure the resistance of the wire harness side connectors.

Standard resistance

Tester Connection	Specified Condition
A4-2 (+B) - A/F relay terminal 3 A3-2 (+B) - A/F relay terminal 3	Below 1 Ω
A4-2 (+B) or A/F relay terminal 3 - Body ground A3-2 (+B) or A/F relay terminal 3 - Body ground	10 kΩ or higher

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

REPLACE ECM