DTC	P2195	OXYGEN (A/F) SENSOR SIGNAL STUCK LEAN (BANK 1 SENSOR 1)

DTC	P2196	OXYGEN (A/F) SENSOR SIGNAL STUCK RICH (BANK 1 SENSOR 1)

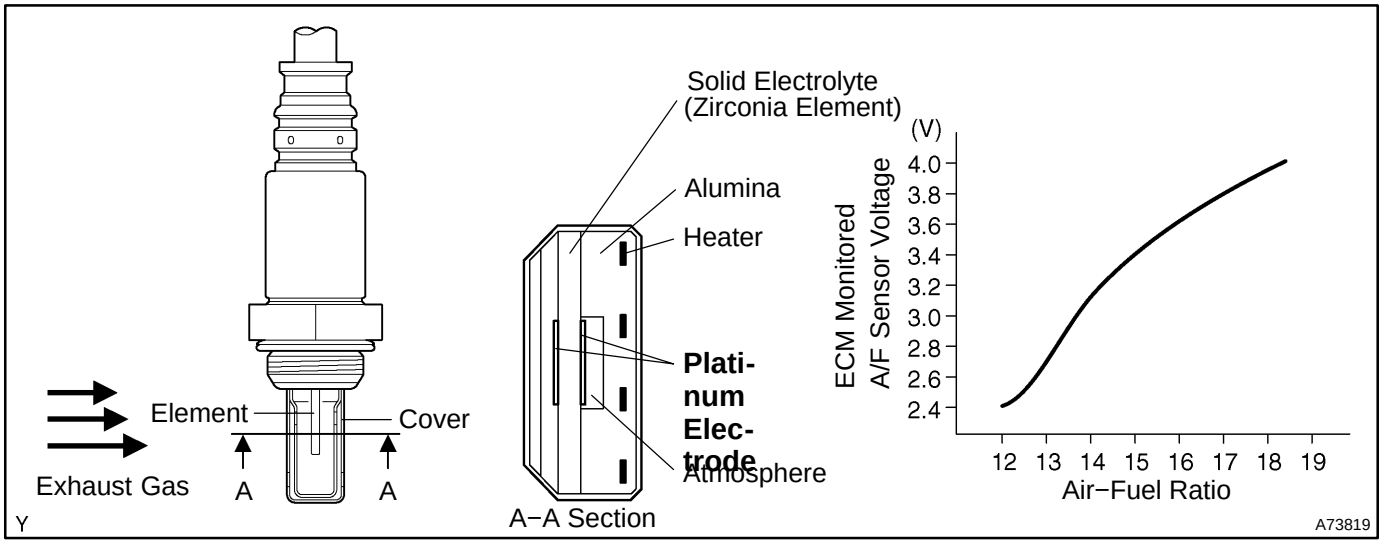
DTC	P2197	OXYGEN (A/F) SENSOR SIGNAL STUCK LEAN (BANK 2 SENSOR 1)

DTC	P2198	OXYGEN (A/F) SENSOR SIGNAL STUCK RICH (BANK 2 SENSOR 1)

HINT:
Although the title (DTC description) says ”oxygen sensor”, this DTC is related to the ”A/F sensor”.

CIRCUIT DESCRIPTION

The Air−Fuel ratio (A/F) sensor provides output voltage* approximately equal to the existing air−fuel ratio. The A/F sensor output voltage is used to provide feedback for the ECM to control the air−fuel ratio.
With the A/F sensor output, the ECM can determine deviation from the stoichiometric air−fuel ratio and control proper injection time. If the A/F sensor is malfunctioning, the ECM is unable to accurately control air−fuel ratio.
The A/F sensor is equipped with a heater which heats the zirconia element. The heater is also controlled by the ECM. When the intake air volume is low (the temperature of the exhaust gas is low), current flows to the heater to heat the sensor to facilitate detection of accurate oxygen concentration.
The A/F sensor is a planar type. Compared to a conventional type, the sensor and heater portions are narrower. Because the heat of the heater is conducted through the alumina to zirconia (of the sensor portion), sensor activation is accelerated.
To obtain a high purification rate of the CO, HC and NOx components of the exhaust gas, a three−way catalytic converter is used. The converter is most efficient when the air−fuel ratio is maintained near the stoichiometric air−fuel ratio.
*: The voltage value changes on the inside of the ECM only.



DTC No.	DTC Detecting Condition	Trouble Area
P2195 P2197	Conditions (a) and (b) continue for 2 seconds or more: (2 trip detection logic) (a) A/F sensor voltage is more than 3.8 V (b) Rear oxygen sensor voltage is 0.15 V or more	• Open or short in A/F sensor (bank 1, 2 sensor 1) circuit • A/F sensor (bank 1, 2 sensor 1) • A/F sensor heater • A/F HTR relay • A/F sensor heater and relay circuit • Air induction system • Fuel pressure • Injector • PCV hose connection • ECM
P2196 P2198	Conditions (a) and (b) continue for 2 seconds or more: (2 trip detection logic) (a) A/F sensor voltage is less than 2.8 V (b) Rear oxygen sensor voltage is less than 0.85 V	• Open or short in A/F sensor (bank 1, 2 sensor 1) circuit • A/F sensor (bank 1, 2 sensor 1) • A/F sensor heater • A/F HTR relay • A/F sensor heater and relay circuit • Air induction system • Fuel pressure • Injector • PCV hose connection • ECM

HINT:

- DTCs P2195 and P2196 indicate a malfunction related to bank 1 the A/F sensor circuit.
- DTCs P2197 and P2198 indicate a malfunction related to bank 2 the A/F sensor circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that includes cylinder No. 2.
- Sensor 1 refers to the sensor closest to the engine assembly.
- After confirming DTC P2195, P2196, P2197 or P2198, use the hand−held tester or the OBD II scan tool to confirm A/F sensor output voltage (AFS B1S1 / AFS B2S1) from the ALL menu (to reach the ALL menu: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL).
- The A/F sensor’s output voltage and the short−term fuel trim value can be read using the OBD II scan tool or the hand−held tester.
- The ECM controls the voltage of the A1A+, A2A+, A1A− and A2A− terminals of the ECM to a fixed voltage. Therefore, it is impossible to confirm the A/F sensor output voltage without the OBD II scan tool or the hand−held tester.
- The OBD II scan tool (excluding hand−held tester) displays one fifth of the A/F sensor output voltage which is displayed on the hand−held tester.

MONITOR DESCRIPTION

Under the air−fuel ratio feedback control, if the voltage output of the A/F sensor indicates RICH or LEAN for a certain period of time or more, the ECM concludes that there is a fault in the A/F sensor system. The ECM will turn on the MIL and a DTC is set.

Example:

If the A/F sensor voltage output is less than 2.8 V (very RICH) for 10 seconds even though voltage output of the heated oxygen sensor output voltage is less than 0.85 V, the ECM sets DTC P2196 or DTC P2198. If the heated oxygen sensor output voltage is 0.15 V or more but the A/F sensor voltage output is more than 3.8 V (very LEAN) 10 seconds, DTC P2195 or DTC P2197 is set.

MONITOR STRATEGY

Related DTCs	P2195: A/F Sensor (Bank 1) voltage detection monitor (lean side malfunction) P2195: A/F Sensor (Bank 1) high current P2196: A/F Sensor (Bank 1) voltage detection monitor (rich side malfunction) P2196: A/F Sensor (Bank 1) low current P2197: A/F Sensor (Bank 2) voltage detection monitor (lean side malfunction) P2197: A/F Sensor (Bank 2) high current P2198: A/F Sensor (Bank 2) voltage detection monitor (rich side malfunction) P2198: A/F Sensor (Bank 2) low current
Required sensors / components (Main)	A/F sensor
Required sensors / components (Related)	−
Frequency of operation	Continuous
Duration	10 seconds
MIL operation	2 driving cycles
Sequence operation	None

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	See page 05−507

Sensor voltage detection monitor (Lean side malfunction P2195 and P2197):

Duration while all of the following conditions are met	2 seconds or more
Rear HO2S voltage	0.15 V or more
Time after engine start	30 seconds or more
A/F sensor status	Activated
Fuel system status	Closed−loop
Engine	Running

Sensor voltage detection monitor (Rich side malfunction P2196 and P2198):

Duration while all of the following conditions are met	2 seconds or more
Rear HO2S voltage	Below 0.6 V
Time after engine start	30 seconds or more
A/F sensor status	Activated
Fuel system status	Closed−loop
Engine	Running

Sensor current high/low current (P2195, P2196, P2197 and P2198):

Battery voltage	11 V or more
Atmospheric pressure	22.5 kPa (570 mmHg) or more
A/F sensor status	Activated
Continuous time of fuel cut	3 to 10 seconds
ECT	75°C (167°F) or more

TYPICAL MALFUNCTION THRESHOLDS

Sensor voltage detection monitor (Lean side malfunction P2195 and P2197):

A/F sensor voltage	More than 3.8 V

Sensor voltage detection monitor (Rich side malfunction P2196 and P2198):

A/F sensor voltage	Less than 2.8 V

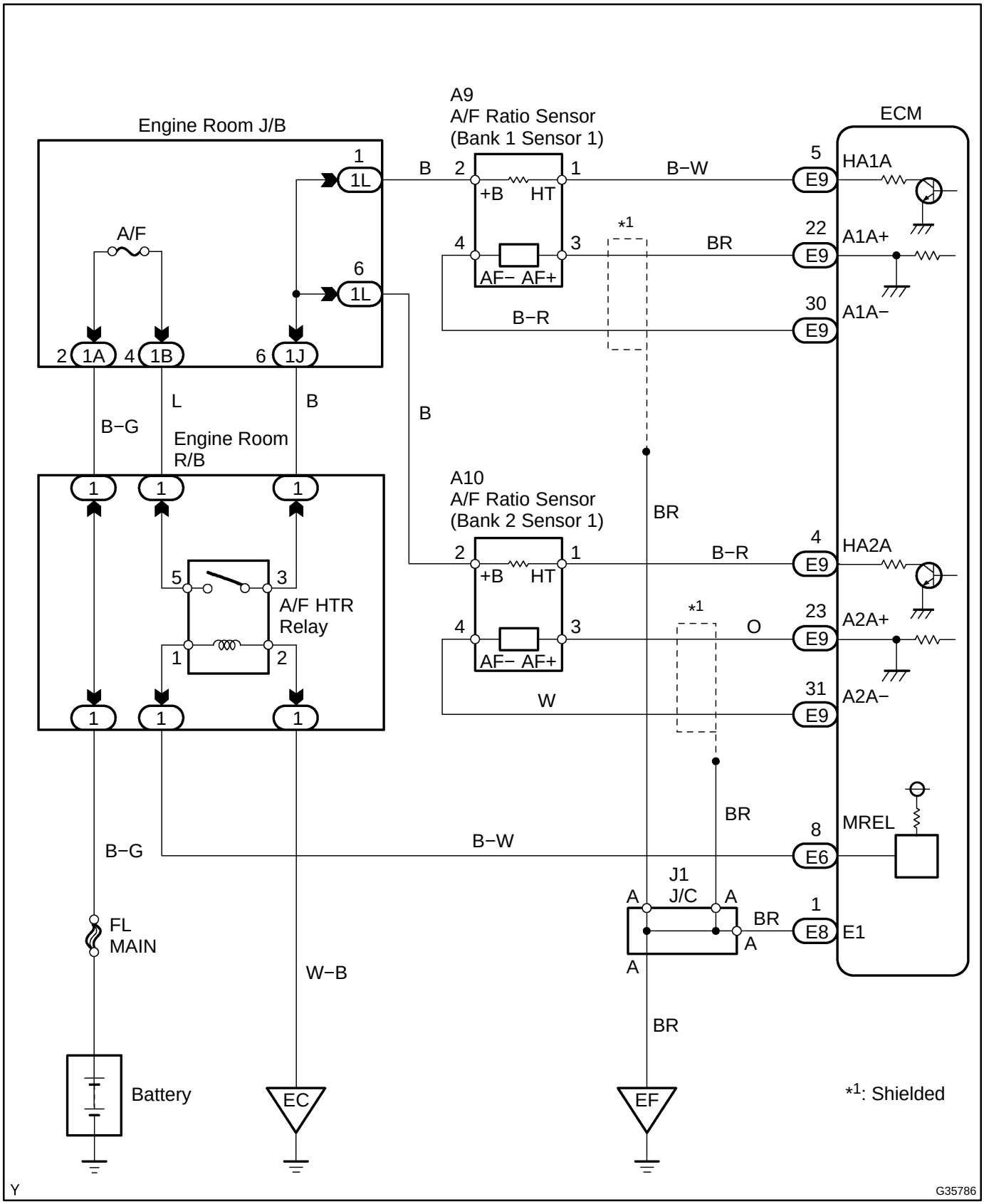
Sensor high current (P2195 and P2197):

A/F sensor current	3.6 mA or more

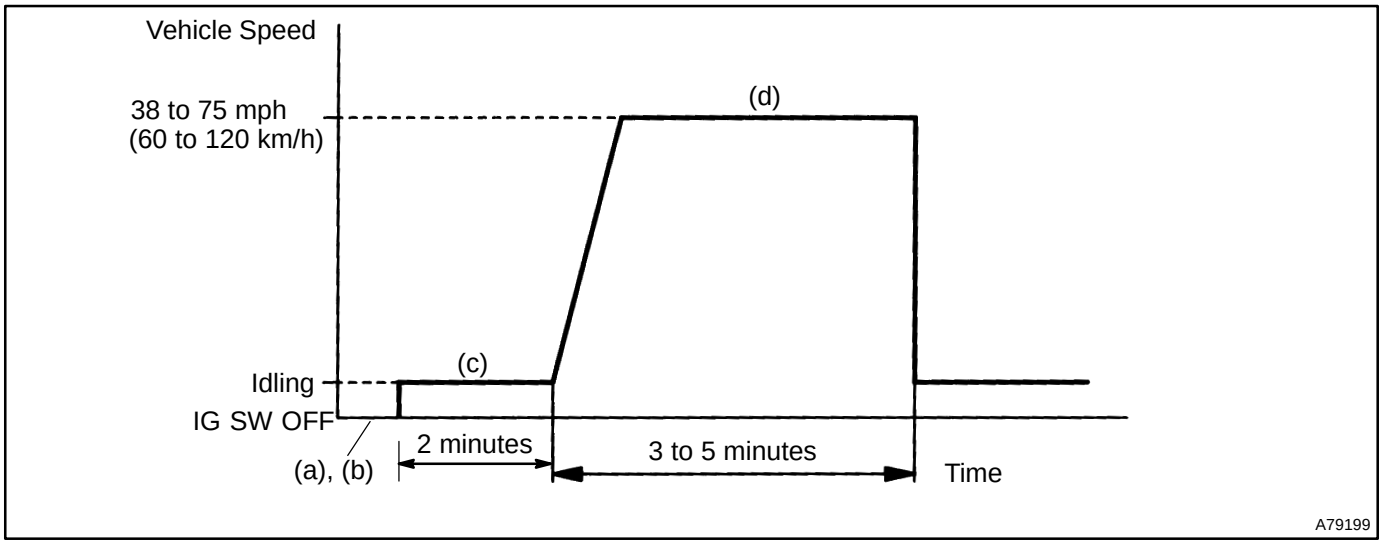
Sensor low current (P2196 and P2198):

A/F sensor current	Less than 1.57 mA

WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN



(a) Connect the hand−held tester to the DLC3.
(b) Switch the hand−held tester from the normal mode to the check mode (see page 05−531).
(c) Start the engine and warm it up with all the accessory switches OFF.
(d) Drive the vehicle at 38 to 75 mph (60 to 120 km/h) and engine speed at 1,400 to 3,200 rpm for 3 to 5 minutes.

HINT:
If a malfunction exists, the MIL will be illuminated during step (d).

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 (c) and (d), then perform steps (c) and (d) again.

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)	Mainly suspected 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 the 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:

- If DTC P2195 or P2196 is displayed, check bank 1 sensor 1 circuit.
- If DTC P2197 or P2198 is displayed, check bank 2 sensor 1 circuit.
- A low A/F sensor voltage could be caused by a RICH air−fuel mixture. Check for conditions that would cause the engine to run with a RICH air−fuel mixture.
- A high A/F sensor voltage could be caused by a LEAN air−fuel mixture. Check for conditions that would cause the engine to run with a LEAN air−fuel mixture.
- 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 (IN ADDITION TO A/F SENSOR DTC)

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

Result :

Display	Proceed to
A/F sensor circuit DTC are output	A
A/F sensor circuit DTC and other codes are output	B

HINT:

If any other codes besides A/F sensor DTC are output, perform the troubleshooting for those DTCs first.

B → **GO TO RELEVANT DTC CHART (See page 05−543)**

A

2	READ VALUE OF HAND−HELD TESTER OR OBD II SCAN TOOL (OUTPUT VOLTAGE OF A/F SENSOR)

(a) Connect the hand−held tester or the OBD II scan tool to the DLC 3.

(b) Warm up the A/F sensors (bank 1 sensor 1 and bank 2 sensor 1) by running the engine at 2,500 rpm for approximately 90 seconds.

(c) Read A/F sensor voltage output on the hand−held tester or the OBD II scan tool.

(d) Hand−held tester only:
On the hand−held tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / SNAPSHOT / MANUAL SNAPSHOT / USER DATA. Read the values.

(e) Select ”AFS B1 S1 or AFS B2 S1 / ENGINE SPD” and press YES.

(f) Monitor the A/F sensor voltage carefully.

(g) Check the A/F sensor voltage output under the following conditions:

(1) Allow the engine to idle for 30 seconds.

(2) Run the engine at approximately 2,500 rpm. Do not suddenly change the rpm.

(3) Raise the engine to 4,000 rpm and quickly release the accelerator pedal so that the throttle is fully closed.

Standard:

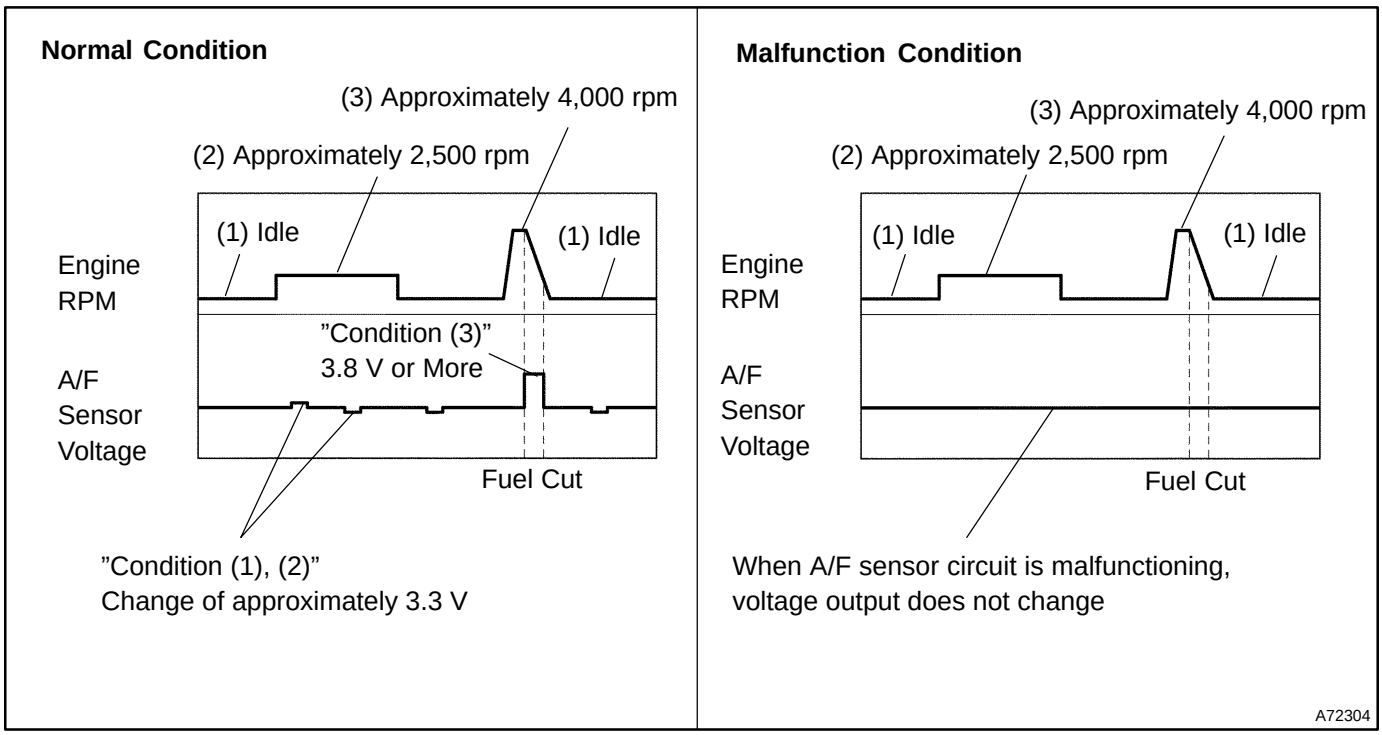
Condition (1) and (2)

Voltage change of 3.3 V (0.66 V)* (between approximately 3.1 to 3.5 V) as shown in the illustration.

Condition (3)

A/F sensor voltage increases to 3.8 V (0.76 V)* or more during engine deceleration when fuel is cut as shown in the illustration.

***: Voltage when using the OBD II scan tool.**



HINT:

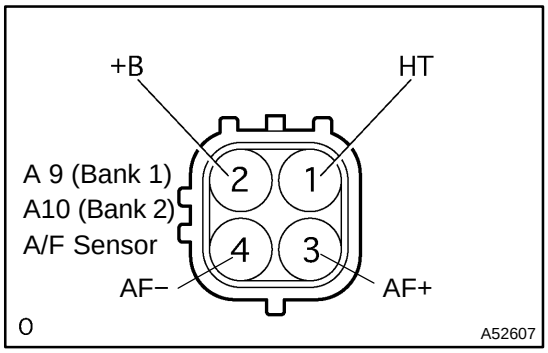
- Whenever the A/F sensor output voltage remains at approximately 3.3 V (0.660 V)* (see "Malfunction Condition" graphic) under any condition as well as the above conditions, the A/F sensor may have an open circuit. This will happen also when the A/F sensor heater has an open circuit.
- Whenever the A/F sensor output voltage remains at a certain value of approximately 3.8 V (0.76 V)* or more, or 2.8 V (0.56 V)* or less (see "Malfunction Condition" graphic) under any condition as well as the above conditions, the A/F sensor may have a short circuit.
- The ECM will stop fuel injection (fuel is cut) during engine deceleration. This will cause a LEAN condition and should result in a momentary increase in A/F sensor output voltage.
- The ECM must establish a closed throttle position learned value to perform fuel cut. If the battery terminal has been disconnected, the vehicle must be driven over 10 mph to allow the ECM to learn the closed throttle position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may be below 2.8 V (0.76 V)* during fuel enrichment. For the vehicle, this translates to a sudden increase in speed with the accelerator pedal fully depressed when trying to overtake another vehicle. The A/F sensor is functioning normally.
- The A/F sensor is a current output element, and therefore the current is converted into voltage inside the ECM. If measuring voltage at connectors of A/F sensor or ECM, you will observe a constant voltage.

*: Voltage when using the OBD II scan tool.

OK	**Go to step 13**

NG

3 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)



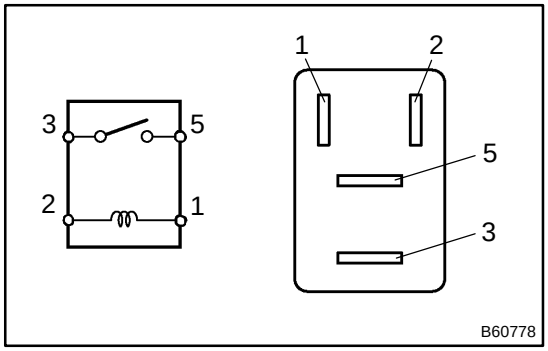
(a) Disconnect the A9 or A10 A/F sensor connector.
(b) Check the resistance of the A/F sensor terminals.
Standard:

Tester Connection	Condition	Specified Condition
1 (HT) − 2 (+B)	20°C (68°F)	0.8 to 1.4 Ω
1 (HT) − 2 (+B)	800°C (1,472°F)	1.8 to 3.4 Ω

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

4 INSPECT RELAY (A/F HTR)



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

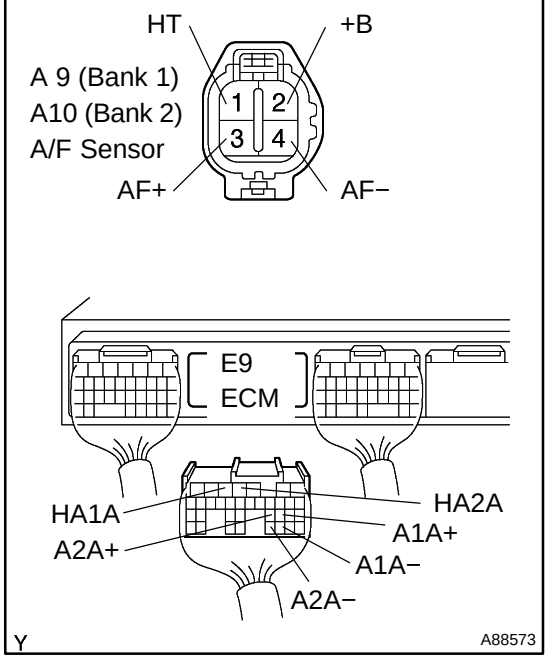
Tester Connection	Specified Condition
3 − 5	10 kΩ or higher
3 − 5	Below 1 Ω (when battery voltage is applied to terminals 1 and 2)

NG → **REPLACE RELAY**

OK

5 CHECK WIRE HARNESS (A/F SENSOR − ECM)

Wire Harness Side

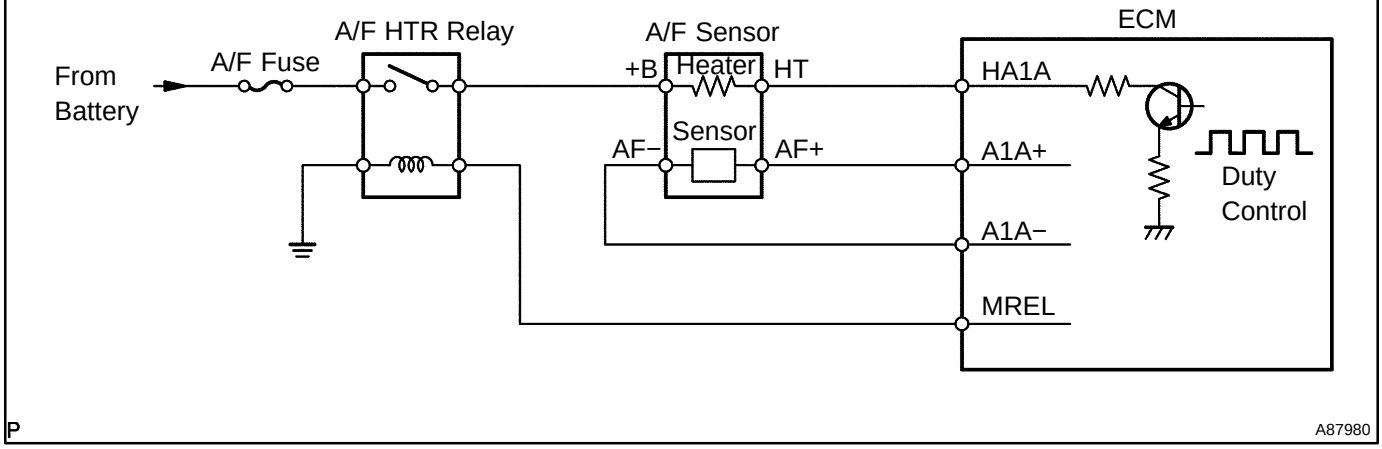


(a) Disconnect the A9 or A10 A/F sensor connector.
(b) Disconnect the E9 ECM connector.
(c) Check the resistance of the wire harness side connectors.

Standard:

Tester Connection	Specified Condition
A9−3 (AF+) − E9−22 (A1A+) A9−4 (AF−) − E9−30 (A1A−) A9−1 (HT) − E9−5 (HA1A) A10−3 (AF+) − E9−23 (A2A+) A10−4 (AF−) − E9−31 (A2A−) A10−1 (HT) − E9−4 (HA2A)	Below 1 Ω
A9−3 (AF+) or E9−22 (A1A+) − Body ground A9−4 (AF−) or E9−30 (A1A−) − Body ground A9−1 (HT) or E9−5 (HA1A) − Body ground A10−3 (AF+) or E9−23 (A2A+) − Body ground A10−4 (AF−) or E9−31 (A2A−) − Body ground A10−1 (HT) or E9−4 (HA2A) − Body ground	10 kΩ or higher

Reference (Bank 1 Sensor 1 System Drawing)



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

OK

6 CHECK AIR INDUCTION SYSTEM

(a) Check for vacuum leaks in air induction system.

OK: No leak in air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM**

OK

7	CHECK FUEL PRESSURE (See page 11−29)

(a) Check fuel pressure (high or low fuel pressure).
Standard:
Fuel pressure: 304 to 343 kPa (3.1 to 3.5 kgf/cm^2, 44 to 50 psi).

NG → **REPAIR OR REPLACE FUEL SYSTEM**

OK

8	INSPECT FUEL INJECTOR ASSY (See page 11−32)

(a) Check injector injection (high or low fuel injection quantity or poor injection pattern).
Standard:

Injection volume	Difference between each injector
60 to 73 cm^3 (3.7 to 4.5 cu in.) per 15 seconds	13 cm^3 (0.8 cu in.) or less

NG → **REPLACE FUEL INJECTOR ASSY (See page 11−38)**

OK

9	REPLACE AIR FUEL RATIO SENSOR

GO

10	PERFORM CONFIRMATION DRIVING PATTERN

HINT:
Clear all DTCs prior to performing the confirmation driving pattern.

GO

11	READ OUTPUT DTC (A/F SENSOR DTC OUTPUT AGAIN)

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

Display	Proceed to
A/F sensor circuit DTC are not output	A
A/F sensor circuit DTC are output	B

B → **REPLACE ECM (See page 10−25) AND PERFORM CONFIRMATION DRIVING PATTERN**

A

12	CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

OK: Vehicle has run out of fuel in past.

NO → **CHECK FOR INTERMITTENT PROBLEMS (See page 05−500)**

YES

DTC IS CAUSED BY RUNNING OUT OF FUEL

13	PERFORM CONFIRMATION DRIVING PATTERN

HINT:
Clear all DTCs prior to performing the confirmation driving pattern.

GO

14	READ OUTPUT DTC (A/F SENSOR DTC OUTPUT AGAIN)

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

Result :

Display	Proceed to
A/F sensor circuit DTC are output	A
A/F sensor circuit DTC are not output	B

B → **Go to step 18**

A

15	REPLACE AIR FUEL RATIO SENSOR

GO

16	PERFORM CONFIRMATION DRIVING PATTERN

HINT:
Clear all DTCs prior to performing the confirmation driving pattern.

GO

17	READ OUTPUT DTC (A/F SENSOR DTC OUTPUT AGAIN)

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

Result :

Display	Proceed to
A/F sensor circuit DTC are not output	A
A/F sensor circuit DTC are output	B

B → **REPLACE ECM (See page 10−25) AND PERFORM CONFIRMATION DRIVING PATTERN**

A

18	CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

OK: Vehicle has run out of fuel in past.

NO → **CHECK FOR INTERMITTENT PROBLEMS (See page 05−500)**

YES

DTC IS CAUSED BY RUNNING OUT OF FUEL