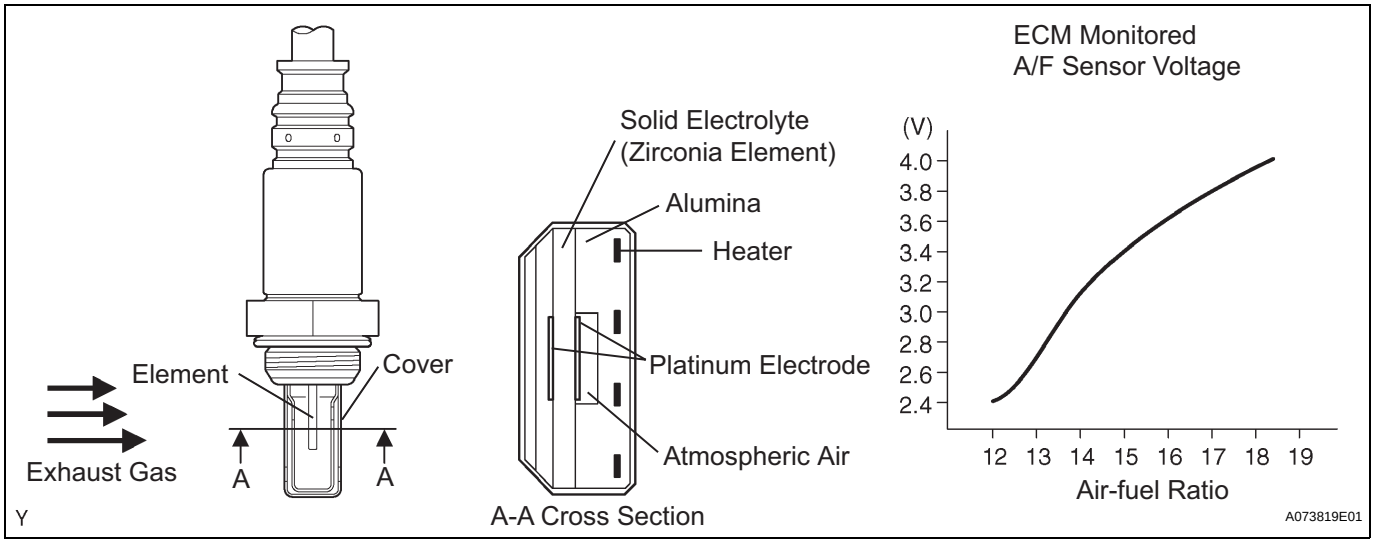
DTC	P2195	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 1 Sensor 1)
DTC	P2196	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 1 Sensor 1)
DTC	P2197	Oxygen (A/F) Sensor Signal Stuck Lean (Bank 2 Sensor 1)
DTC	P2198	Oxygen (A/F) Sensor Signal Stuck Rich (Bank 2 Sensor 1)

ES

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

DESCRIPTION

The Air-Fuel ratio 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 Detection Condition	Trouble Area
P2195 P2197	• Conditions (a) and (b) continue for 2 sec. or more (a) A/F sensor voltage is more than 3.8 V (b) Rear oxygen sensor voltage is 0.15 V or more • A/F sensor current 3.6 mA 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 relay • Open or short in A/F sensor heater and relay circuits • Air induction system • Fuel pressure • Injector • PCV hose connection • ECM
P2196 P2198	• Conditions (a) and (b) continue for 2 sec. or more: (a) A/F sensor voltage is less than 2.8 V (b) Rear oxygen sensor voltage is less than 0.85 V • A/F sensor current less than 1.57 mA	• 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 relay • Open or short in A/F sensor heater and relay circuits • Air induction system • Fuel pressure • Injector • PCV hose connection • ECM

ES

HINT:
- DTCs P2195 and P2196 indicate a malfunction related to bank 1 of the A/F sensor circuit.
- DTCs P2197 and P2198 indicate a malfunction related to bank 2 of the A/F sensor circuit.
- Bank 1 is the bank that includes cylinder No. 1.
- Bank 2 is the bank that includes cylinder No. 2.
- Sensor 1 is the sensor closest to the engine assembly.
- After confirming DTCs P2195, P2196, P2197 or P2198, use the intelligent 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 intelligent 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 intelligent tester.
- The OBD II scan tool (excluding intelligent tester) displays one fifth of the A/F sensor output voltage which is displayed on the intelligent tester.

MONITOR DESCRIPTION

Under the air-fuel ratio feedback control, if the voltage output of the A/F sensor indicates RICH or LEAN for more than a certain period of time, the ECM concludes that there is a fault in the A/F sensor system. The ECM will turn on the MIL and a DTC will be 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 0.6 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) for 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)	Rear HO2S
Frequency of operation	Continuous
Duration	10 seconds: A/F sensor voltage detection monitor (Lean/Rich side malfunction) 3 seconds: A/F sensor high/low current
MIL operation	2 driving cycles
Sequence operation	None

ES

TYPICAL ENABLING CONDITIONS

All:

The monitor will run whenever these DTCs are not present	P0031, P0032, P0051, P0052 (A/F sensor heater sensor 1), P0037, P0038, P0057, P0058 (O2 sensor heater sensor 2), P0100, P0101, P0102, P0103 (MAF sensor), P0110, P0112, P0113 (IAT sensor), P0115, P0116, P0117, P0118 (ECT sensor), P0120, P0122, P0123, P0220, P0222, P0223, P2135 (TP sensor), P0125 (Insufficient ECT for closed loop), P0136, P0156 (O2 sensor 2), P0171, P0172, P0174, P0175 (Fuel system), P0300, P0301, P0302, P0303, P0304, P0305, P0306, (Misfire), P0335 (CKP sensor), P0340, P0341 (CMP sensor), P0341 (CMP sensor), P0500 (VSS), P0511 (IAC valve), P0510 (Idle switch)

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

A/F sensor voltage	More than 3.8 V

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

A/F sensor voltage	Less than 2.8 V

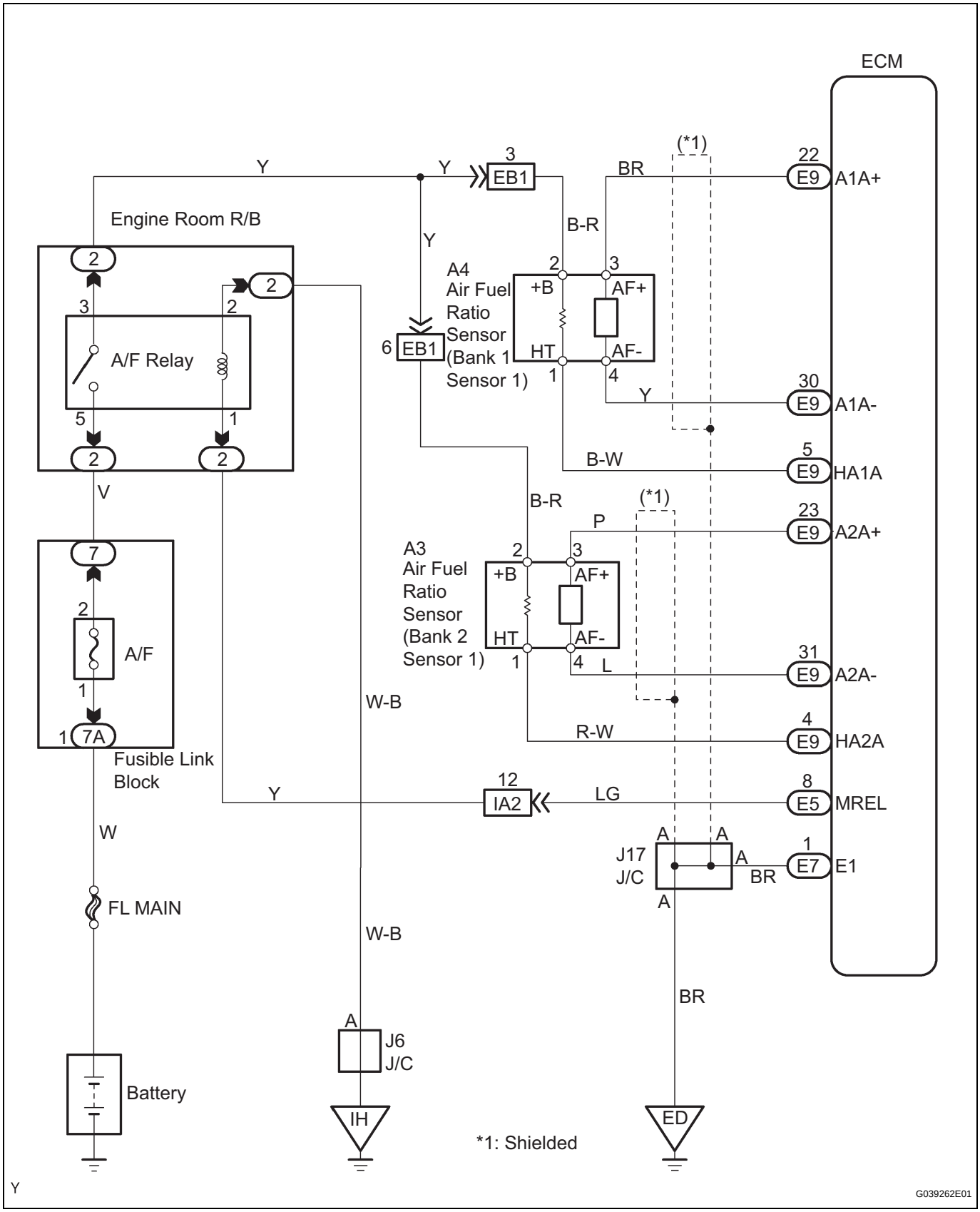
Sensor high current (P2195, P2197):

A/F sensor current	3.6 mA or more

Sensor low current (P2196, P2198):

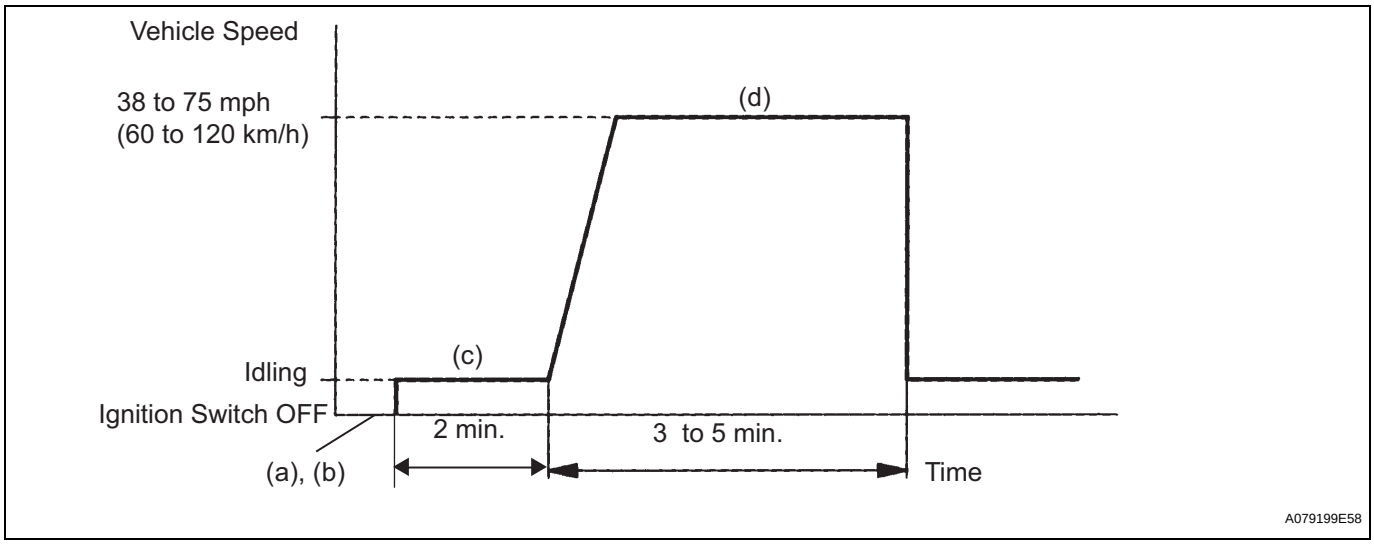
A/F sensor current	Less than 1.57 mA

WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN

(a) Connect the intelligent tester to the DLC3 Step (a).



(b) Switch the intelligent tester from the normal mode to the check mode (See page ES-29) Step (b).
(c) Start the engine and warm it up with all the accessory switches OFF Step (c).
(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 Step (d).
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 intelligent tester, turn the ignition switch OFF after performing steps (c) and (d), then perform steps (c) and (d) again.

HINT:
Intelligent 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.

1. Perform the ACTIVE TEST A/F CONTROL operation.

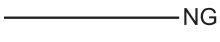
HINT:
The A/F CONTROL operation lowers the injection volume 12.5 % or increases the injection volume 25%.

(a) Connect the intelligent tester to the DLC3 on the vehicle Step (a).
(b) Turn the ignition switch ON Step (b).
(c) Warm up the engine by running the engine at 2,500 rpm for approximately 90 seconds Step (c).
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL Step (d).
(e) Perform the A/F CONTROL operation with the engine idle (press the right or left button) Step (e).

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.

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
1	Injection Volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		-
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage More than 0.55 V Less than 0.4 V		
2	Injection Volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		• A/F sensor • A/F sensor heater A/F sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.55 V Less than 0.4 V		
3	Injection Volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V		Output Voltage Almost no reaction		
4	Injection volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

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 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	CHECK OTHER DTC OUTPUT (IN ADDITION TO A/F SENSOR DTC)

(a) Read the DTC using the intelligent 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 DTCs besides A/F sensor DTC are output, perform the troubleshooting for those DTCs first.

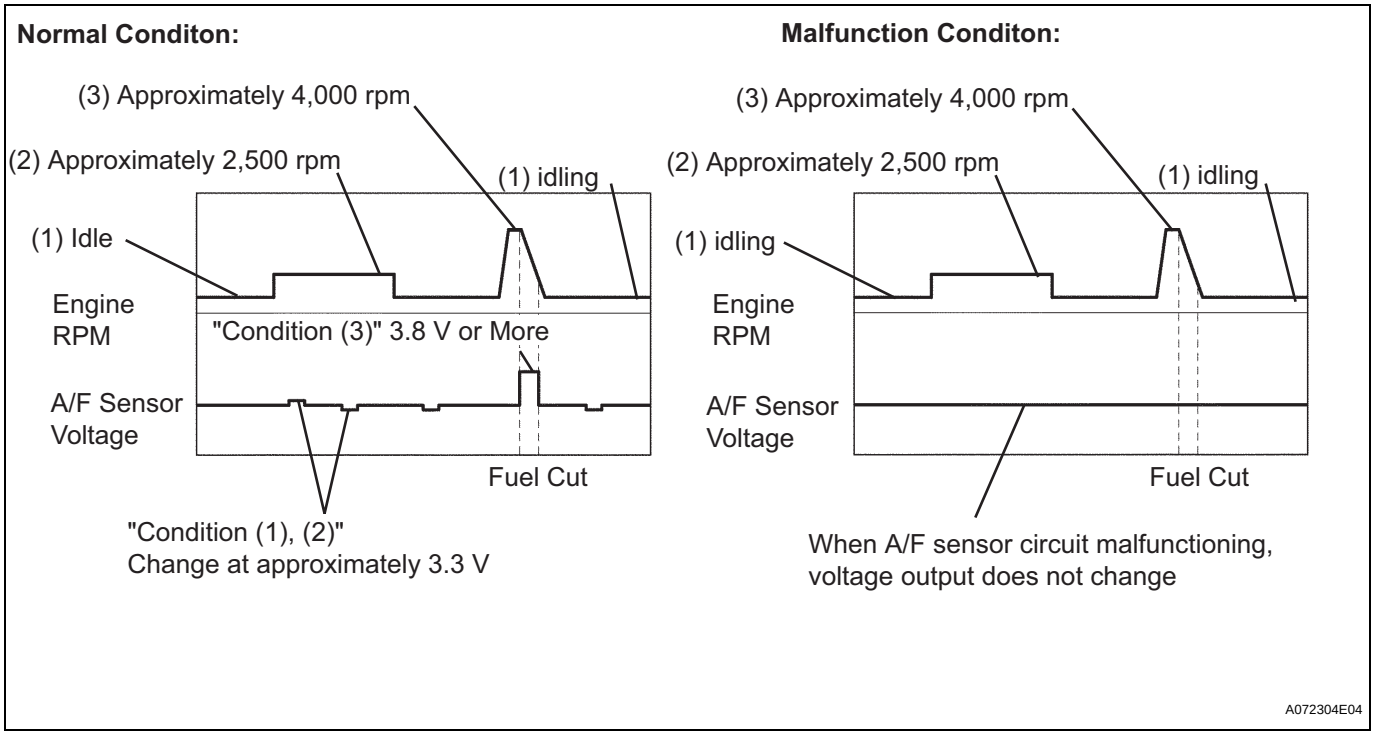
B → **GO TO RELEVANT DTC CHART**

A

ES

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

(a) Connect the intelligent tester or the OBD II scan tool to the DLC 3.
(b) Warm up the A/F sensor (bank 1, 2 sensor 1) by running the engine at 2,500 rpm for approximately 90 seconds.
(c) Read A/F sensor voltage output on the intelligent tester or the OBD II scan tool.
(d) Hand-held tester only:
On the intelligent 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 (1).
    (2) Run the engine at approximately 2,500 rpm. Do not suddenly change the rpm (2).
    (3) Raise the engine to 4,000 rpm and quickly release the accelerator pedal so that the throttle is fully closed (3).



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.

ES

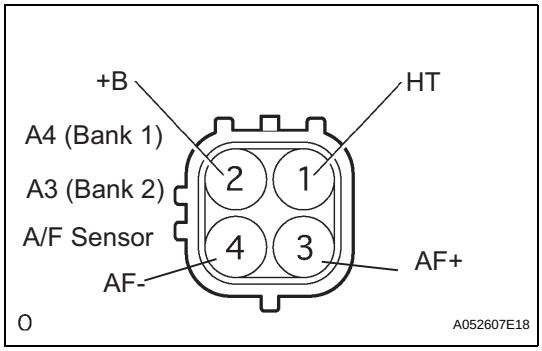
- The ECM must establish a closed throttle position learned value to perform fuel cut. If the battery terminal has been disconnected, the vehicle must be driven over 10 mph to allow the ECM to learn the closed throttle position.
- When the vehicle is driven:
  The output voltage of the A/F sensor may 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)



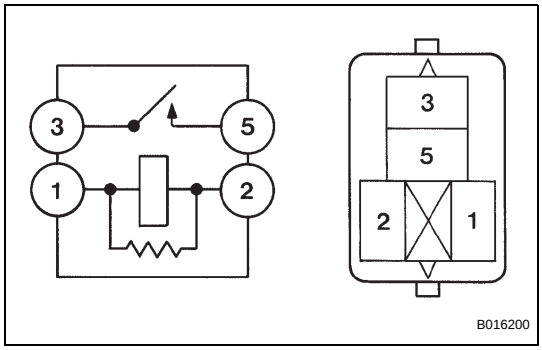
(a) Disconnect the A4 or A3 A/F sensor connector.
(b) Measure the resistance of the A/F sensor terminals.
Standard resistance

Tester Connection	Condition	Specified Condition
1 (HT) - 2 (+B)	20°C (68°F)	1.8 to 3.2 Ω
1 (HT) - 4 (AF-)	-	10 kΩ or higher

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

4 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

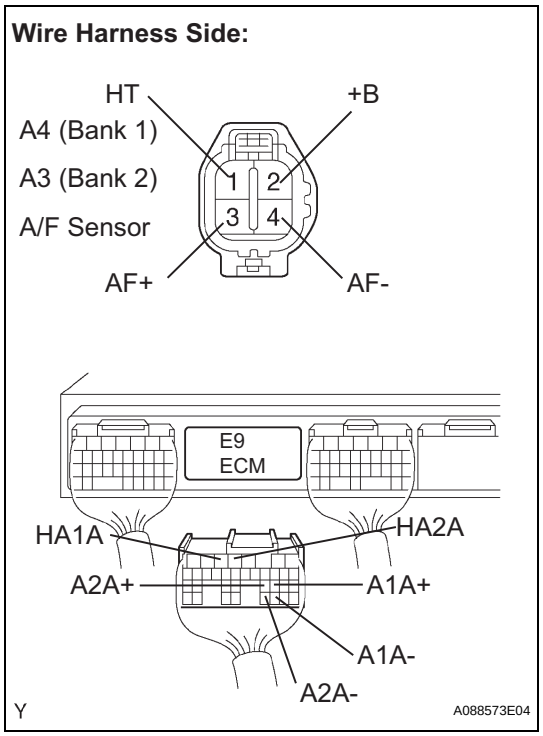
Tester Connection	Specified Condition
1 - 2	Below 1 Ω
3 - 5	10 kΩ or higher
3 - 5	Below 1 Ω (when battery voltage is applied to terminals 1 and 2)

(c) Install the A/F relay.

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

OK

5 CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)



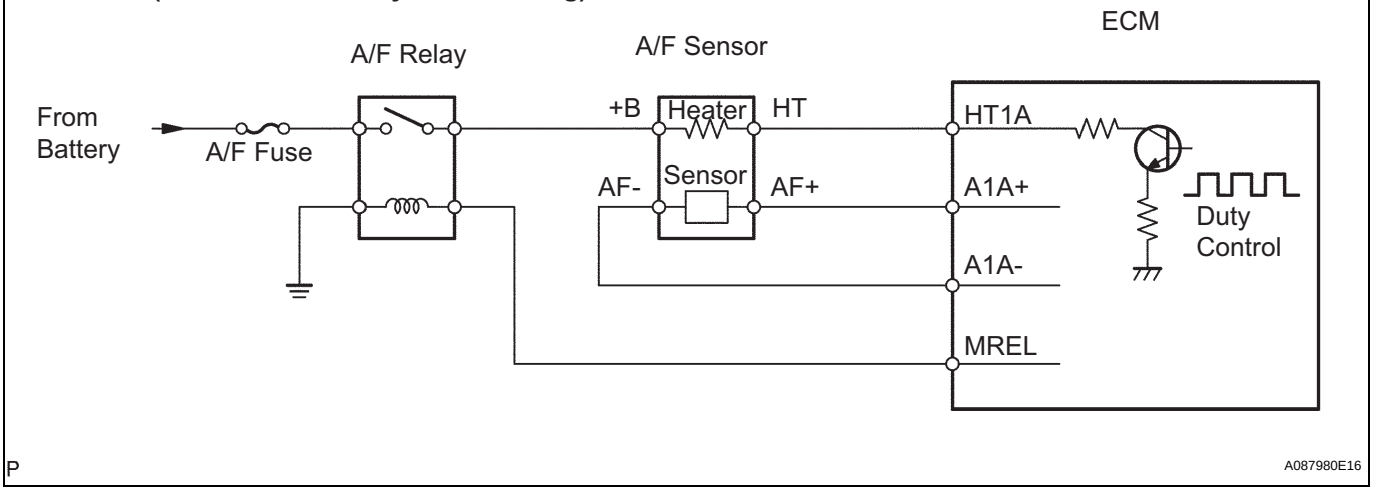
(a) Disconnect the A3 or A4 A/F sensor connector.
(b) Disconnect the E9 ECM connector.
(c) Measure the resistance of the wire harness side connectors.

Standard resistance

Tester Connection	Specified Condition
A4-3 (AF+) - E9-22 (A1A+) A4-4 (AF-) - E9-30 (A1A-) A4-1 (HT) - E9-5 (HA1A) A3-3 (AF+) - E9-23 (A2A+) A3-4 (AF-) - E9-31 (A2A-) A3-1 (HT) - E9-4 (HA2A)	Below 1 Ω
A4-3 (AF+) or E9-22 (A1A+) - Body ground A4-4 (AF-) or E9-30 (A1A-) - Body ground A4-1 (HT) or E9-5 (HA1A) - Body ground A3-3 (AF+) or E9-23 (A2A+) - Body ground A3-4 (AF-) or E9-31 (A2A-) - Body ground A3-1 (HT) or E9-4 (HA2A) - Body ground	10 kΩ or higher

ES

Reference (Bank 1 Sensor 1 System Drawing)



NG → **REPAIR OR REPLACE HARNESS OR 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

(a) Check fuel pressure (See page FU-3).
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 ASSEMBLY

(a) Check injector injection (See page FU-13).
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 ASSEMBLY

OK

9 REPLACE AIR FUEL RATIO SENSOR

NEXT

10 PERFORM CONFIRMATION DRIVING PATTERN

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

NEXT

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

(a) Read the DTC using the intelligent 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 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.

NG → CHECK FOR INTERMITTENT PROBLEMS

OK

DTC CAUSED BY RUNNING OUT OF FUEL

13 PERFORM CONFIRMATION DRIVING PATTERN

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

NEXT

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

(a) Read the DTC using the intelligent 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

NEXT

16 PERFORM CONFIRMATION DRIVING PATTERN

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

NEXT

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

(a) Read the DTC using the intelligent 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 AND PERFORM CONFIRMATION DRIVING PATTERN

ES

A

18	CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

OK:
Vehicle has run out of fuel in past.

NG → CHECK FOR INTERMITTENT PROBLEMS

OK

DTC CAUSED BY RUNNING OUT OF FUEL