

DTC	P2195	OXYGEN (A/F) SENSOR SIGNAL STUCK LEAN (BANK 1 SENSOR 1)
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DTC	P2196	OXYGEN (A/F) SENSOR SIGNAL STUCK RICH (BANK 1 SENSOR 1)
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HINT:

- Although the DTC titles say 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.

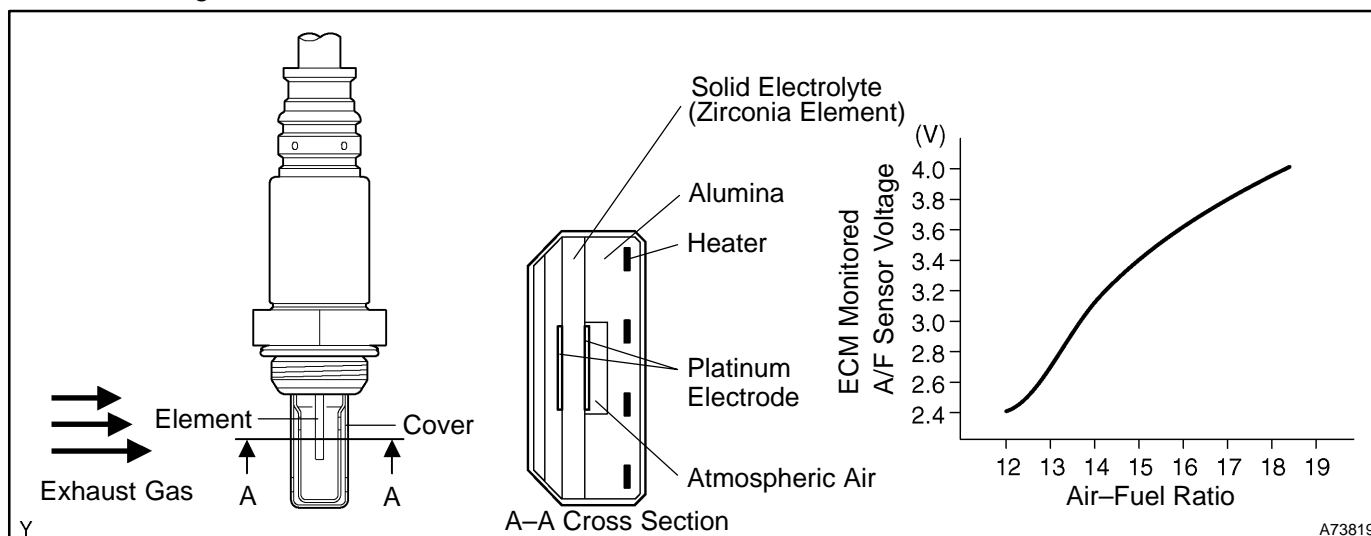
CIRCUIT DESCRIPTION

The A/F sensor generates a voltage* that corresponds to the actual air–fuel ratio. This sensor voltage is used to provide the ECM with feedback so that it can control the air–fuel ratio. The ECM determines the deviation from the stoichiometric air–fuel ratio level, and regulates the fuel injection time. If the A/F sensor malfunctions, the ECM is unable to control the air–fuel ratio accurately.

The A/F sensor is the planar type and is integrated with the heater, which heats the solid electrolyte (zirconia element). This heater is controlled by the ECM. When the intake air volume is low (the exhaust gas temperature is low), a current flows into the heater to heat the sensor, in order to facilitate accurate oxygen concentration detection. In addition, the sensor and heater portions are narrower than the conventional type. The heat generated by the heater is conducted to the solid electrolyte through the alumina, therefore the sensor activation is accelerated.

In order to obtain a high purification rate of the carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NOx) components in the exhaust gas, a TWC is used. For the most efficient use of the TWC, the air–fuel ratio must be precisely controlled so that it is always close to the stoichiometric level.

*: Value changes inside the ECM. Since the A/F sensor is the current output element, a current is converted to a voltage inside the ECM. Any measurements taken at the A/F sensor or ECM connectors will show a constant voltage.



DTC No.	DTC Detection Conditions	Trouble Areas
P2195	Conditions (a) and (b) continue for 2 seconds or more (2 trip detection logic): (a) Air–Fuel Ratio (A/F) sensor voltage more than 3.8 V (b) Heated Oxygen (HO2) sensor voltage 0.15 V or more	<ul style="list-style-type: none"> • Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor (sensor 1) heater • EFI relay • A/F sensor heater and relay circuits • Air induction system • Fuel pressure • Injector • ECM
P2196	Conditions (a) and (b) continue for 2 seconds or more (2 trip detection logic): (a) A/F sensor voltage less than 2.8 V (b) HO2 sensor voltage less than 0.85 V	<ul style="list-style-type: none"> • Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor (sensor 1) heater • EFI relay • A/F sensor heater and relay circuits • Air induction system • Fuel pressure • Injector • ECM

HINT:

- When any of these DTCs are set, check the A/F sensor voltage output by selecting the following menu items on a hand–held tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / AFS B1S1. If using an OBD II scan tool, refer to the instruction manual.
- Short–term fuel trim values can also be read using a hand–held tester or OBD II scan tool.
- The ECM regulates the voltage at the A1A+ and A1A– terminals of the ECM at a constant level. Therefore, the A/F sensor voltage output cannot be confirmed without using a hand–held tester or OBD II scan tool.
- An OBD II scan tool displays the A/F sensor voltage output at a voltage level that is 1/5 of that of a hand–held tester.

MONITOR DESCRIPTION

Under the air–fuel ratio feedback control, if the A/F sensor voltage output indicates rich or lean for a certain period of time, the ECM determines that there is a malfunction in the A/F sensor. The ECM illuminates the MIL and sets a DTC.

Example:

If the A/F sensor voltage output is less than 2.8 V (very rich condition) for 10 seconds, despite the HO2 sensor voltage output being less than 0.85 V, the ECM sets DTC P2196. Alternatively, if the A/F sensor voltage output is more than 3.8 V (very lean condition) for 10 seconds, despite the HO2 sensor voltage output being 0.15 V or more, DTC P2195 is set.

MONITOR STRATEGY

Related DTCs	P2195: A/F sensor signal stuck lean P2196: A/F sensor signal stuck rich
Required Sensors/Components (Main)	A/F sensor
Required Sensors/Components (Related)	HO2 sensor
Frequency of Operation	Continuous
Duration	10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	See page 05-19
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P2195 (Lean side malfunction):

Time while all of following conditions met	2 seconds or more
Rear HO2 sensor 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
Sub-feedback status	Executing

P2196 (Rich side malfunction):

Time while all of following conditions met	2 seconds or more
Rear HO2 sensor voltage	Below 0.85 V
Time after engine start	30 seconds or more
A/F sensor status	Activated
Fuel system status	Closed-loop
Engine	Running
Sub-feedback status	Executing

TYPICAL MALFUNCTION THRESHOLDS

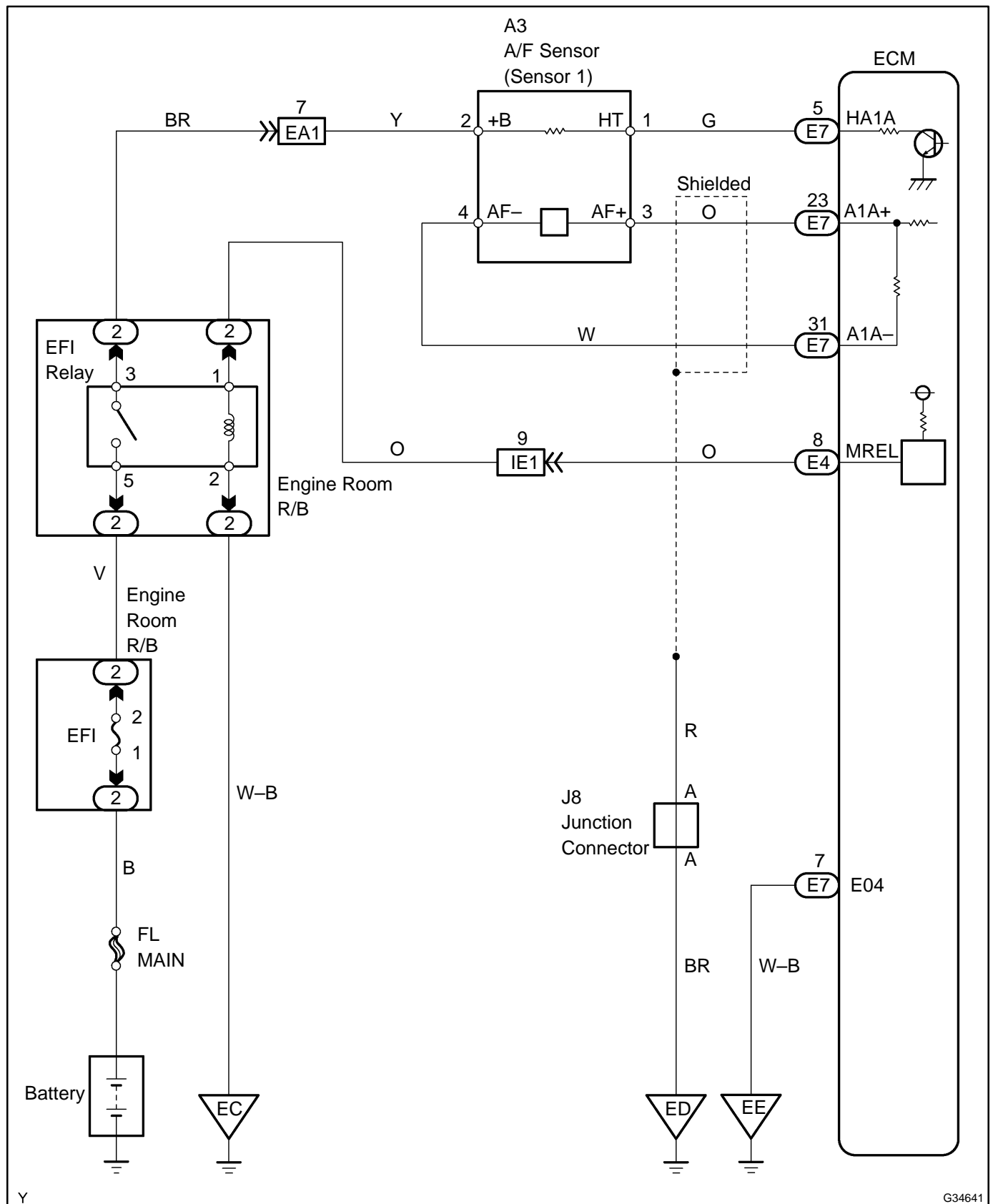
P2195 (Lean side malfunction):

A/F sensor voltage	More than 3.8 V
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P2196 (Rich side malfunction):

A/F sensor voltage	Less than 2.8 V
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WIRING DIAGRAM



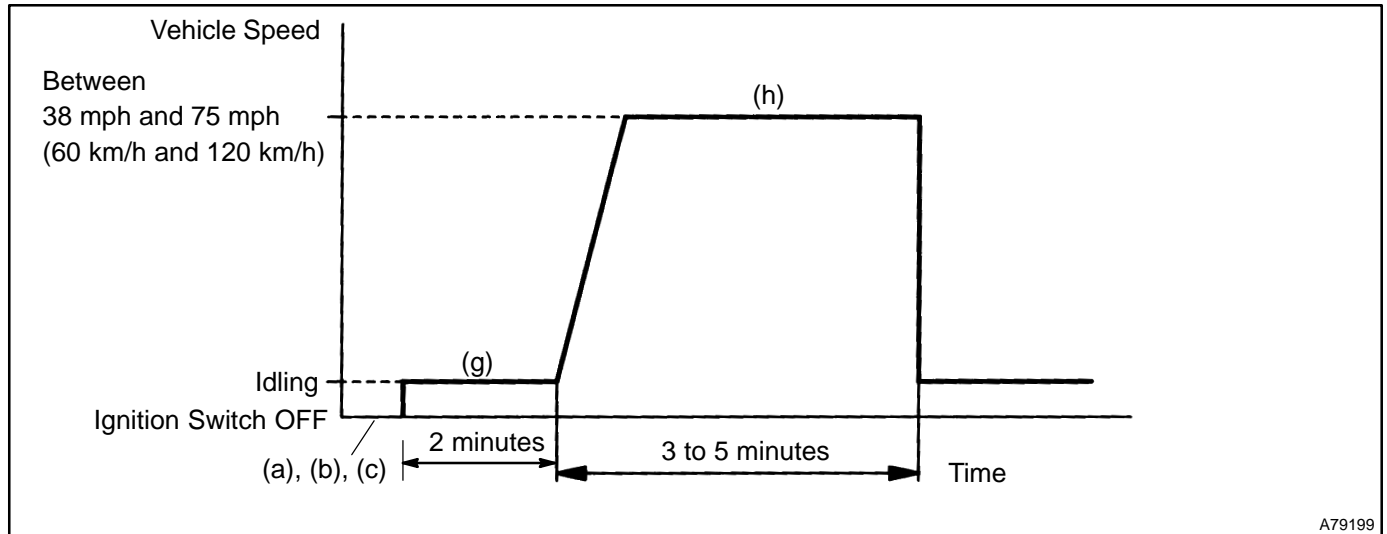
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CONFIRMATION DRIVING PATTERN

HINT:

This confirmation driving pattern is used in steps 3, 6, 8, and 16 of the following diagnostic troubleshooting procedure when using either a hand-held tester or OBD II scan tool.



- (a) Connect a hand-held tester or OBD II scan tool to the DLC3.
- (b) Turn the ignition switch to ON.
- (c) Turn the tester or scan tool ON.
- (d) Clear DTCs (see page 05-44).
- (e) If using an OBD II scan tool, go to step (g) below.
- (f) Switch the ECM from normal mode to check mode using the tester (see page 05-46)
- (g) Start the engine and warm it up for 2 minutes with all the accessories switched OFF.
- (h) Drive the vehicle at between 38 mph and 75 mph (60 km/h and 120 km/h) and at an engine speed of between 1,400 rpm and 3,200 rpm for 3 to 5 minutes.
- (i) If using an OBD II scan tool, conduct the following additional operations:
 - (1) Turn the ignition switch to OFF.
 - (2) Repeat steps (g) and (h) described above.

HINT:

- When using a hand-held tester: The MIL will be illuminated during step (h) if a malfunction still exists.
- When using an OBD II scan tool: The MIL will be illuminated during step (h) at second time if a malfunction still exists.

NOTICE:

If the conditions in this test are not strictly followed, no malfunction will be detected.

INSPECTION PROCEDURE

HINT:

Hand-held tester only:

Malfunctioning areas can be identified by performing the A/F CONTROL function provided in the ACTIVE TEST. The A/F CONTROL function can help to determine whether the Air-Fuel Ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the A/F CONTROL operation using a hand-held tester.

- (1) Connect a hand-held tester to the DLC3.
- (2) Start the engine and turn the tester ON.
- (3) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
- (4) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
- (5) Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
- (6) Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1S1 and OS2 B1S2) displayed on the tester.

HINT:







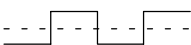




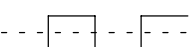



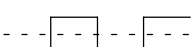




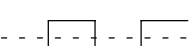

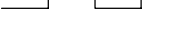


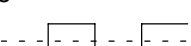



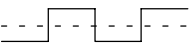



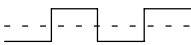


- The A/F CONTROL operation lowers the fuel injection volume by 12.5 % or increases the injection volume by 25 %.
- Each sensor reacts in accordance with increases and decreases in the fuel injection volume.

Standard:

Tester Display (Sensor)	Injection Volumes	Status	Voltages
AFS B1S1 (A/F)	+25 %	Rich	Less than 3.0
AFS B1S1 (A/F)	-12.5 %	Lean	More than 3.35
O2S B1S2 (HO2)	+25 %	Rich	More than 0.55
O2S B1S2 (HO2)	-12.5 %	Lean	Less than 0.4

NOTICE:

The Air-Fuel Ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Areas
1	Injection volume +25 %   -12.5 %  Output voltage More than 3.35 V  OK Less than 3.0 V 	Injection volume +25 %   -12.5 %  Output voltage More than 0.55 V  OK Less than 0.4V 	—
2	Injection volume +25 %   -12.5 %  Output voltage Almost no reaction  NG	Injection volume +25 %   -12.5 %  Output voltage More than 0.55 V  OK Less than 0.4V 	<ul style="list-style-type: none"> • A/F sensor • A/F sensor heater • A/F sensor circuit
3	Injection volume +25 %   -12.5 %  Output voltage More than 3.35 V  OK Less than 3.0V 	Injection volume +25 %   -12.5 %  Output voltage Almost no reaction  NG	<ul style="list-style-type: none"> • HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4	Injection volume +25 %   -12.5 %  Output voltage Almost no reaction  NG	Injection volume +25 %   -12.5 %  Output voltage Almost no reaction  NG	<ul style="list-style-type: none"> • Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)

- Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
- To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2, and press the YES button and then the ENTER button followed by the F4 button.

HINT:

- Read freeze frame data using a hand-held tester or OBD II scan tool. 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.
- 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 rich.
- 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 lean.

1	CHECK ANY OTHER DTCS OUTPUT(IN ADDITION TO P2195 OR P2196)
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- (a) Connect a hand-held tester or OBD II scan tool to the DLC3.
- (b) Turn the ignition switch to ON.
- (c) Turn the tester or scan tool ON.
- (d) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
- (e) If using an OBD II scan tool, refer to the instruction manual.
- (f) Read DTCs.

Result:

Display (DTC Output)	Proceed To
P2195 or P2196	A
P2195 or P2196 and other DTCs	B

HINT:

If any DTCs other than P2195 or P2196 are output, troubleshoot those DTCs first.

B

GO TO DTC CHART (See page 05-54)

A

2	READ VALUE USING HAND-HELD TESTER OR OBD II SCAN TOOL(OUTPUT VOLTAGE OF A/F SENSOR)
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- (a) Connect a hand-held tester or OBD II scan tool to the DLC3.
- (b) Start the engine.
- (c) Turn the tester or scan tool ON.
- (d) Warm up the Air-Fuel Ratio (A/F) sensor at an engine speed of 2,500 rpm for 90 seconds.
- (e) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / SNAPSHOT / MANUAL SNAPSHOT / USER DATA / AFS B1S1 and ENGINE SPD.
- (f) If using an OBD II scan tool, refer to the instruction manual.
- (g) Check the A/F sensor voltage three times, when the engine is in each of the following conditions:
 - (1) While idling (check for at least 30 seconds)
 - (2) At an engine speed of approximately 2,500 rpm (without any sudden changes in engine speed)
 - (3) Raise the engine speed to 4,000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

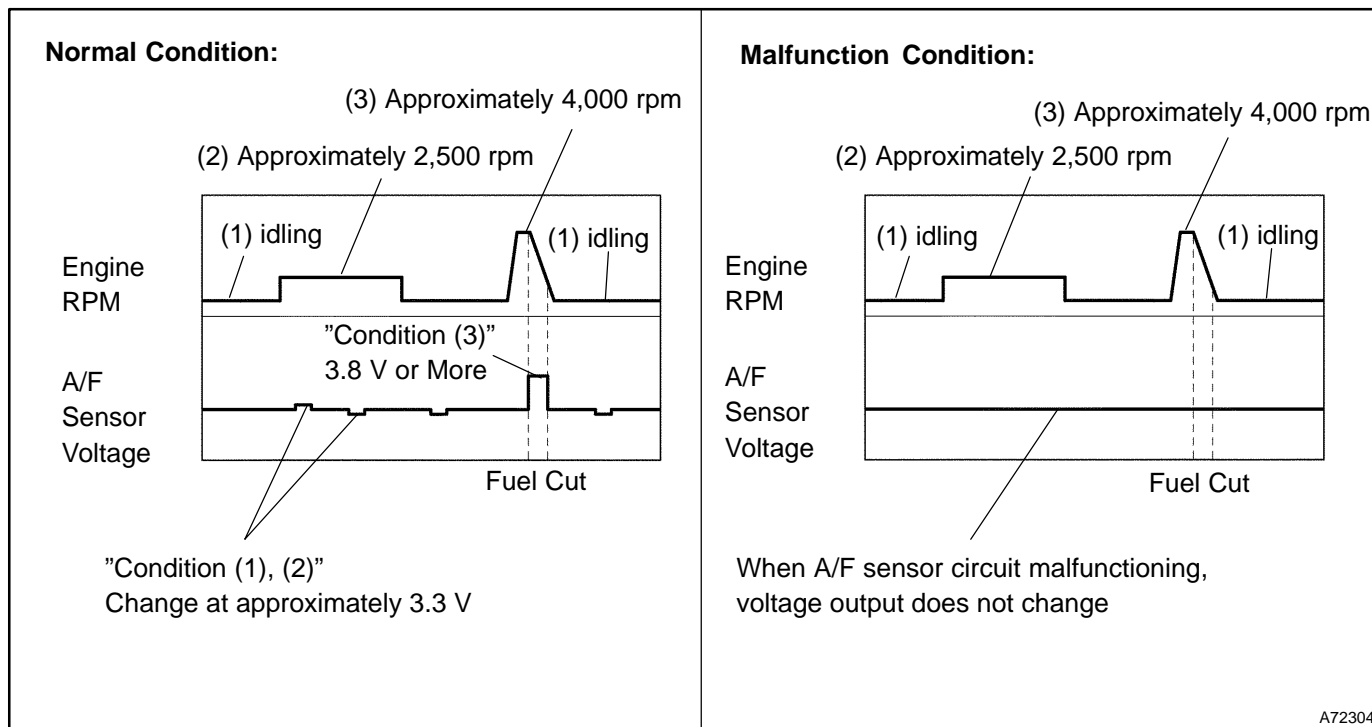
Standard:

Conditions	A/F Sensor Voltage Variations	Reference
(1) and (2)	Changes at approx 3.3 V (0.66 V*)	Between 3.1 V (0.62 V*) and 3.5 V (0.7 V*)
(3)	Increases to 3.8 V (0.76 V*) or more	This occurs during engine deceleration (when fuel-cut performed)

HINT:

*: Voltage when using the OBD II scan tool.

For more information, see the diagrams below.

**HINT:**

- If the output voltage of the A/F sensor remains at approximately 3.3 V (0.66 V*) (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have an open circuit. (This will also happen if the A/F sensor heater has an open circuit.)
- If the output voltage of the A/F sensor remains at either approximately 3.8 V (0.76 V*) or more, or 2.8 V (0.56 V*) or less (see Malfunction Condition diagram) under any conditions, including those above, the A/F sensor may have a short circuit.
- The ECM stops fuel injection (fuel cut) during engine deceleration. This causes a lean condition and results in a momentary increase in the A/F sensor output voltage.
- The ECM must establish a closed throttle valve position learning value to perform fuel cut. If the battery terminal has been reconnected, the vehicle must be driven over 10 mph (16 km/h) to allow the ECM to learn the closed throttle valve position.
- When the vehicle is driven:
The output voltage of the A/F sensor may be below 2.8 V (0.56 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; therefore, the current is converted into a voltage inside the ECM. Measuring the voltage at the connectors of the A/F sensor or ECM will show a constant voltage result.

*: Voltage when using the OBD II scan tool.

NG

Go to step 9

OK

3 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

4 CHECK WHETHER DTC OUTPUT RECURS(DTC P2195 OR P2196)

- (a) Read DTCs using the hand-held tester or OBD II scan tool.
- (b) If using a hand-held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
- (c) If using an OBD II scan tool, refer to the instruction manual.

Result:

Display (DTC Output)	Proceed To
P2195 or P2196	A
No output	B

B

Go to step 8

A

5 REPLACE AIR FUEL RATIO SENSOR

NEXT

6 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

7 CHECK WHETHER DTC OUTPUT RECURS(DTC P2195 OR P2196)

- (a) Read DTCs using the hand-held tester or OBD II scan tool.
- (b) If using a hand-held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
- (c) If using an OBD II scan tool, refer to the instruction manual.

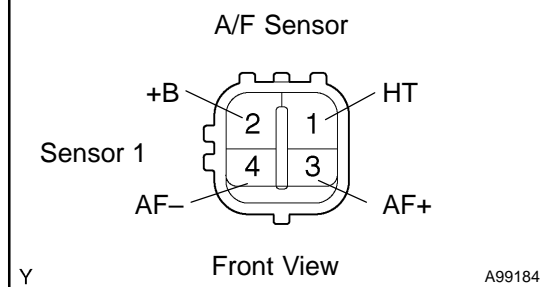
Result:

Display (DTC Output)	Proceed To
No output	A
P2195 or P2196	B

B

REPLACE ECM (See page 10-32) AND PERFORM CONFIRMATION DRIVING PATTERN

A

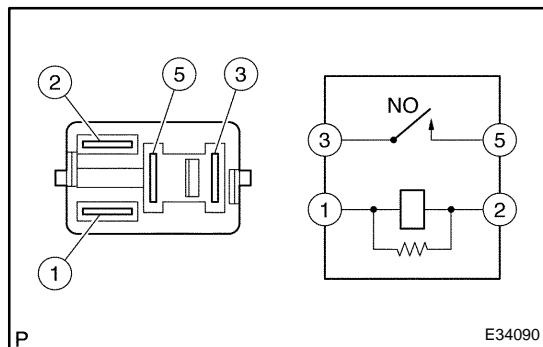
8 CONFIRM WHETHER VEHICLE HAS RUN OUT OF FUEL IN PAST**NO****CHECK FOR INTERMITTENT PROBLEMS**
(See page 05-12)**YES****DTC CAUSED BY RUNNING OUT OF FUEL****9 INSPECT AIR FUEL RATIO SENSOR(HEATER RESISTANCE)****Component Side:**

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

Standard:

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

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

NG**REPLACE AIR FUEL RATIO SENSOR****OK****10 INSPECT EFI RELAY**

- (a) Remove the EFI relay from the engine room R/B.
 (b) Check the EFI relay resistance.

Standard:

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

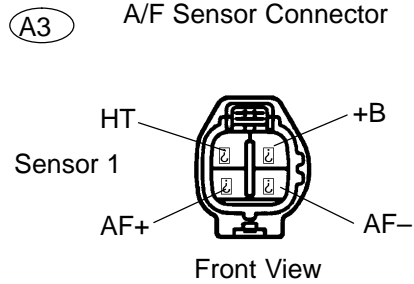
- (c) Reinstall the EFI relay.

NG**REPLACE EFI RELAY****OK**

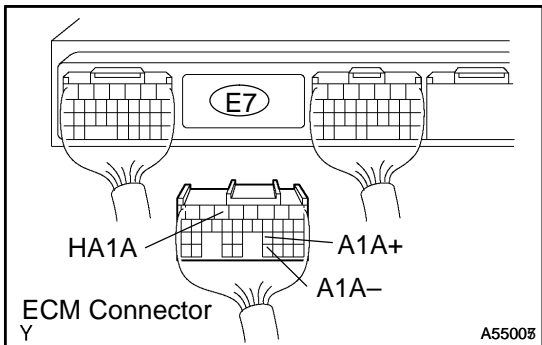
11

CHECK HARNESS AND CONNECTOR(A/F SENSOR – ECM)

Wire Harness Side:



A76787



A5500%

- Disconnect the A3 A/F sensor connector.
- Turn the ignition switch to ON.
- Measure the voltage between the +B terminal of the A/F sensor connector and body ground.

Standard:

Tester Connections	Specified Conditions
+B (A3-2) – Body ground	Between 9 V and 14 V

- Turn the ignition switch to OFF.
- Disconnect the E7 ECM connector.
- Check the resistance.

Standard (Check for open):

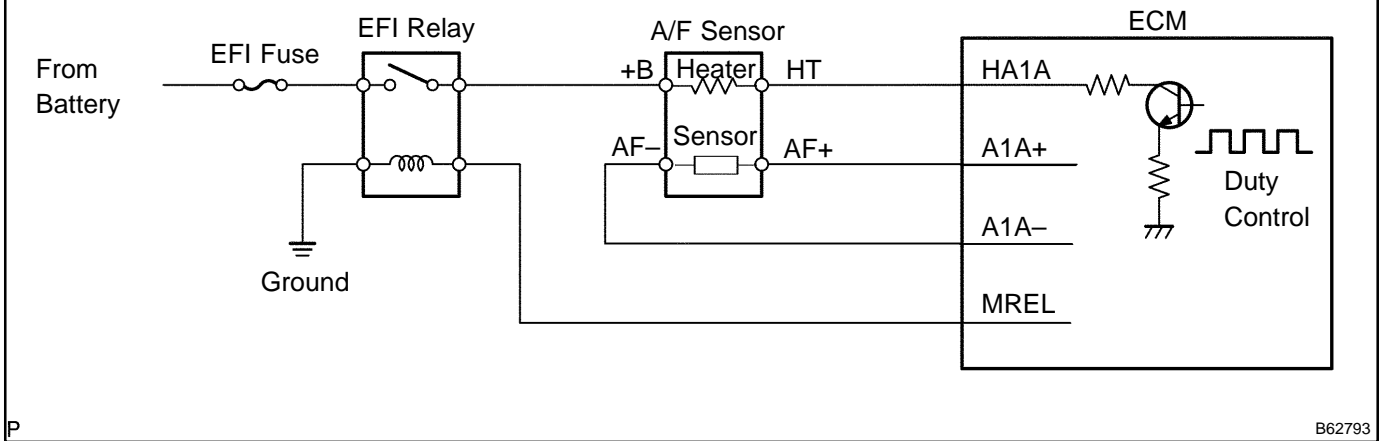
Tester Connections	Specified Conditions
HT (A3-1) – HA1A (E7-5)	Below 1 Ω
AF+ (A3-3) – A1A+ (E7-23)	Below 1 Ω
AF- (A3-4) – A1A- (E7-31)	Below 1 Ω

Standard (Check for short):

Tester Connections	Specified Conditions
HT (A3-1) or HA1A (E7-5) – Body ground	10 k Ω or higher
AF+ (A3-3) or A1A+ (E7-23) – Body ground	10 k Ω or higher
AF- (A3-4) or A1A- (E7-31) – Body ground	10 k Ω or higher

- Reconnect the ECM connector.
- Reconnect the A/F sensor connector.

Reference (System Diagram of Sensor 1):



B62793

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

12 CHECK AIR INDUCTION SYSTEM

- (a) Check the air induction system for vacuum leakage.

OK: No leakage from air induction system.

NG

REPAIR OR REPLACE AIR INDUCTION SYSTEM

OK

13 CHECK FUEL PRESSURE (See page 11-7)

- (a) Check the fuel pressure.

NG

REPAIR OR REPLACE FUEL SYSTEM

OK

14 INSPECT FUEL INJECTOR ASSY (See page 11-9)

- (a) Check the injector injection (whether fuel volume is high or low, and whether injection pattern is poor).

NG

**REPLACE FUEL INJECTOR ASSY
(See page 11-14)**

OK

15 REPLACE AIR FUEL RATIO SENSOR

NEXT

16 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

17 CHECK WHETHER DTC OUTPUT RECURS(DTC P2195 OR P2196)

- (a) Read DTCs using the hand-held tester or OBD II scan tool.
 (b) If using a hand-held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
 (c) If using an OBD II scan tool, refer to the instruction manual.

Result:

Display (DTC Output)	Proceed To
No output	A
P2195 or P2196	B

B

REPLACE ECM (See page 10-32) AND PERFORM CONFIRMATION DRIVING PATTERN

A

18	CONFIRM WHETHER VEHICLE HAS RUN OUT OF FUEL IN PAST
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NO

CHECK FOR INTERMITTENT PROBLEMS
(See page [05-12](#))

YES

DTC CAUSED BY RUNNING OUT OF FUEL