DIDU5−01

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 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.

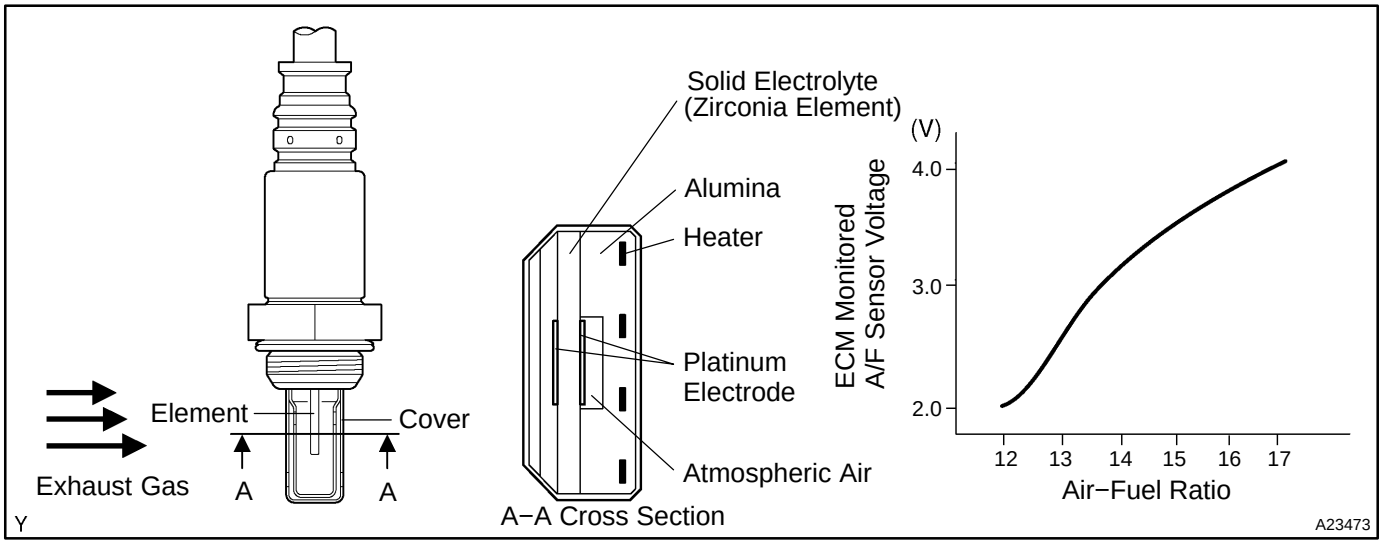
CIRCUIT DESCRIPTION

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 air−fuel ratio 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 though 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 P2197	While fuel−cut operation performing (during vehicle deceleration), air−fuel ratio sensor current is 3.6 mA or more for 3 seconds.	• A/F sensor (sensor 1) • ECM
P2196 P2198	While fuel−cut operation performing (during vehicle deceleration), air−fuel ratio sensor current is less than 1.4 mA for 3 seconds.	• A/F sensor (sensor 1) • ECM

HINT:

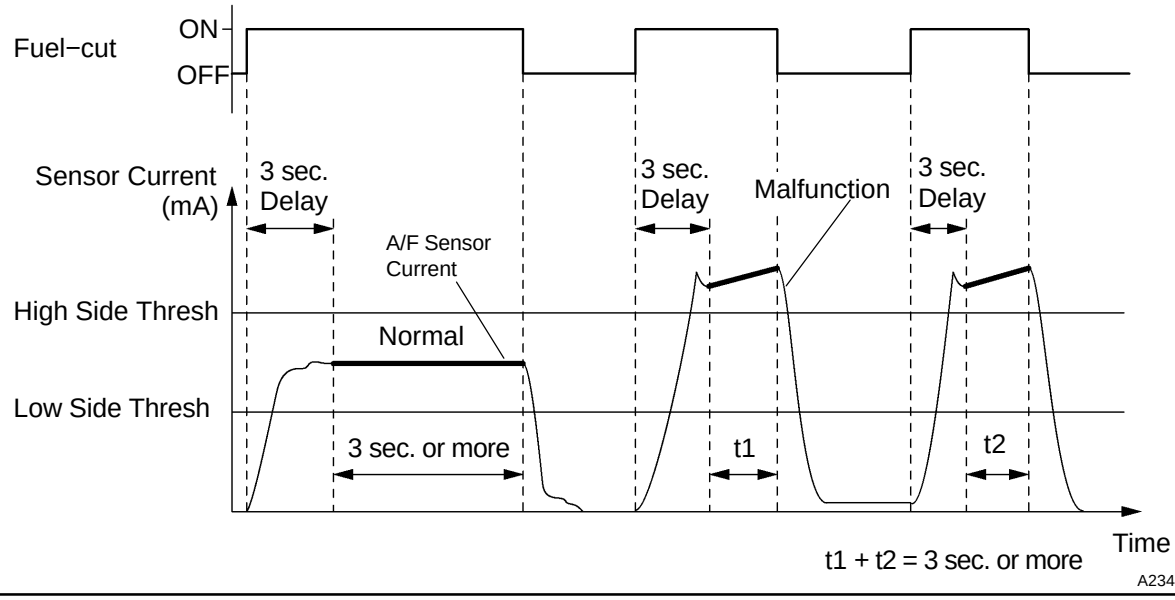
- When any of these DTCs are set, check the A/F sensor voltage output by selecting the following menu items on a hand−held tester: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / AFS B1S1.
- Short−term fuel trim values can also be read using a hand−held tester.

MONITOR DESCRIPTION

A rich air−fuel mixture causes a low air−fuel ratio sensor current, and a lean air fuel mixture causes a high air fuel ratio sensor current. Therefore, the sensor output becomes high during acceleration, and the sensor becomes low during deceleration.

The ECM monitors the air−fuel ratio sensor current during fuel−cut and detects an unusual current value. If the cumulative time the sensor output is out of range exceeds more than 3 seconds, the ECM interprets a malfunction in the air−fuel ratio sensor and sets a DTC.

Air−fuel Ratio Sensor Current Monitor:



MONITOR STRATEGY

Related DTCs	P2195	A/F sensor (Bank 1) signal stuck lean
		A/F sensor (Bank 1) current (high side)
	P2196	A/F sensor (Bank 1) signal stuck rich
		A/F sensor (Bank 1) current (low side)
	P2197	A/F sensor (Bank 2) signal stuck lean
		A/F sensor (Bank 2) current (high side)
	P2198	A/F sensor (Bank 2) signal stuck rich
		A/F sensor (Bank 2) current (low side)
Required sensors/components	A/F sensor	
Frequency of operation	Continuous	
Duration	10 sec.: A/F sensor signal stuck lean/rich 3 sec.: A/F sensor current (high/low side)	
MIL operation	2 driving cycles	
Sequence of operation	None	

TYPICAL ENABLING CONDITIONS

Item	Specification	
	Minimum	Maximum
The monitor will run whenever these DTCs are not present	See page DI−18	
P2195, P2197 (A/F sensor signal stuck lean):		
Duration while all of following conditions met	2 sec.	−
Rear HO2S voltage	0.15 V	−
Time after engine start	30 sec.	−
A/F sensor status	Activated	
Fuel system status	Closed−loop	
Engine	Running	
P2196, P2198 (A/F sensor signal stuck rich):		
Duration while all of following conditions met	2 sec.	−
Rear HO2S voltage	−	0.6 V
Time after engine start	30 sec.	−
A/F sensor status	Activated	
Fuel system status	Closed−loop	
Engine	Running	
P2195, P2197 (A/F sensor current (High side)):		
Battery voltage	11 V	−
ECT	75°C (167°F)	−
Atmospheric pressure/760 mmHg	0.75	−
A/F sensor status	Activated	
Continuous time of fuel−cut	3 to 10 sec.	
P2196, P2198 (A/F sensor current (Low side)):		
Battery voltage	11 V	−
ECT	75°C (167°F)	−
Atmospheric pressure/760 mmHg	0.75	−
A/F sensor status	Activated	
Continuous time of fuel−cut	3 to 10 sec.	

TYPICAL MALFUNCTION THRESHOLDS

Detection Criteria	Threshold
P2195, P2197 (A/F sensor signal stuck lean):	
A/F sensor voltage	More than 3.8 V
P2196, P2198 (A/F sensor signal stuck rich):	
A/F sensor voltage	Less than 2.8 V
P2195, P2197 (A/F sensor current (High side)):	
A/F sensor current	3.6 mA or more
P2196, P2198 (A/F sensor current (Low side)):	
A/F sensor current	Less than 1.57 mA

MONITOR RESULT

Refer to page DI−26 for detailed information.

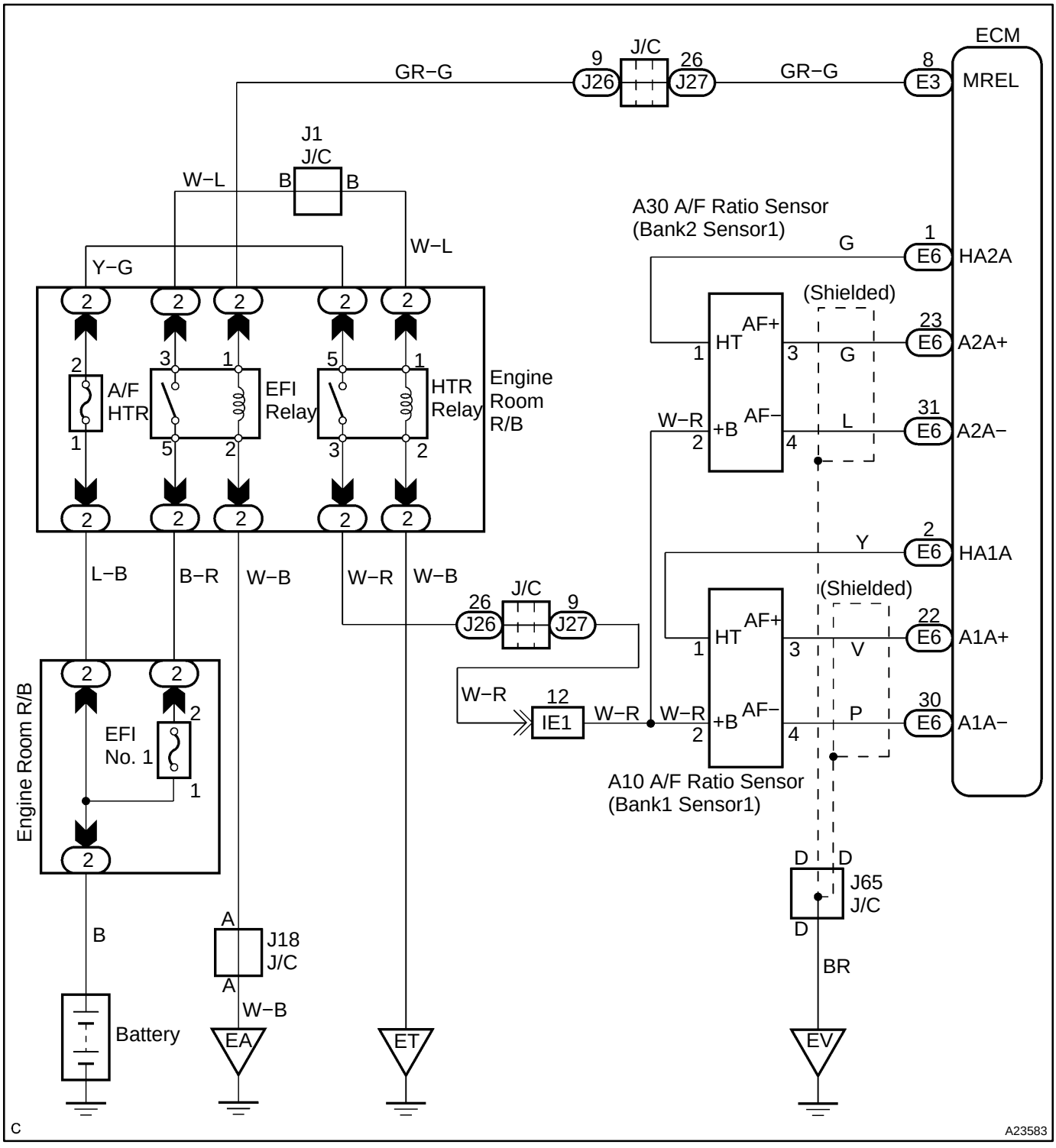
The test value and test limit information are described as shown in the following table. Check the monitor result and test values after performing the monitor drive pattern (see page DI−27).

- 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 ll scan tools.

TID $06: A/F sensor (Active A/F control method)

TLT	CID	Unit Conversion	Description of Test Data	Description of Test Limit
1	$01	Multiply by 0.0003 (V)	Cumulative A/F sensor locus length (Bank 1)	Lower malfunction criterion for A/F sensor
0	$01	Multiply by 0.0003 (V)	Cumulative A/F sensor locus length (Bank 1)	Upper malfunction criterion for A/F sensor
1	$11	Multiply by 0.0003 (V)	Cumulative A/F sensor locus length (Bank 2)	Lower malfunction criterion for A/F sensor
0	$11	Multiply by 0.0003 (V)	Cumulative A/F sensor locus length (Bank 2)	Upper malfunction criterion for A/F sensor
1	$02	Multiply by 0.000039 (A)	A/F sensor current (Bank 1)	Lower malfunction criterion for A/F sensor
0	$02	Multiply by 0.000039 (A)	A/F sensor current (Bank 1)	Upper malfunction criterion for A/F sensor
1	$12	Multiply by 0.000039 (A)	A/F sensor current (Bank 2)	Lower malfunction criterion for A/F sensor
0	$12	Multiply by 0.000039 (A)	A/F sensor current (Bank 2)	Upper malfunction criterion for A/F sensor

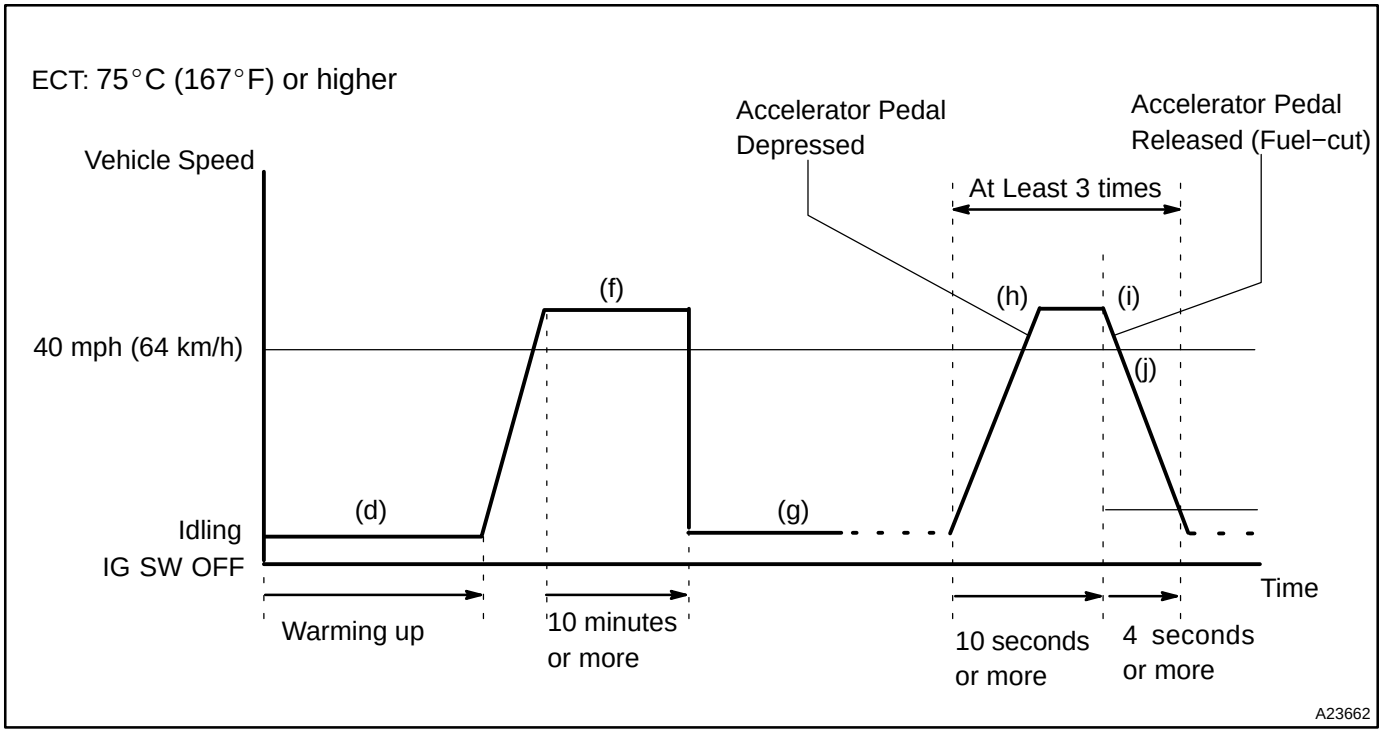
WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN

HINT:

This confirmation driving pattern is used in steps 2, 4, 7, 17 and 21 of the following diagnostic troubleshooting procedure when using a hand−held tester.



(a) Connect the hand−held tester to DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Clear DTC (See page DI−42).
(d) Start the engine, and warm it up until the ECT reaches 75°C (167°F) or higher.
(e) On the hand−held tester, select the following menu items: DIAGNOSIS/ENHANCED OBD II/DATA LIST/FC IDL.
(f) Drive the vehicle at 40 mph (64 km/h) or more for at least 10 minutes.
(g) Change the transmission to 2nd gear.
(h) Drive the vehicle at proper vehicle speed to perform fuel−cut operation.

HINT:

Fuel−cut is performed under following conditions met:

- Accelerator pedal fully released.
- Engine speed 2,500 rpm or more (fuel injection returns at 1,000 rpm).

(i) Accelerate the vehicle to 30 mph (48 km/h) or more by depressing the accelerator pedal for at least 10 seconds.
(j) Soon after performing step (8) above, release the accelerator pedal for at least 4 seconds without depressing the brake pedal, in order to execute fuel−cut control.
(k) Stop the vehicle and allow the engine to idle for 10 seconds or more.
(l) Allow the vehicle to decelerate until the vehicle speed declines to less than 6 mph (10 km/h).
(m) Repeat steps from (8) through (10) above at least 3 times in one driving cycle.

HINT:

Completing all A/F sensor monitors are required to change the value in TEST RESULT.

CAUTION:

Strictly observe of posted speed limits, traffic laws, and road conditions when performing these drive pattern.

INSPECTION PROCEDURE

HINT:

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 (AFS B2S1) and OS2 B1S2 (O2S B2S2)) 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 (AFS B2S1) (A/F)	+25 %	Rich	Less than 3.0
AFS B1S1 (AFS B2S1) (A/F)	−12.5 %	Lean	More than 3.35
O2S B1S2 (O2S B2S2) (HO2)	+25 %	Rich	More than 0.55
O2S B1S2 (O2S B2S2) (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 Less than 3.0 V **OK**	Injection volume +25 % −12.5 % Output voltage More than 0.55 V Less than 0.4V **OK**	—
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
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**	● 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**	● 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 DTC P2195, P2196, P2197 or P2198).**

PREPARATION:

(a) Connect a hand−held tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

CHECK:

(a) Read DTCs.

Result:

Display (DTC Output)	Proceed To
P2195, P2196, P2197 or P2198	A
P2195, P2196, P2197 or P2198 and other DTCs	B

HINT:
If any DTCs other than P2195, P2196, P2197 or P2198 are output, troubleshoot those DTCs first.

B → **Go to DTC chart (See page DI−57).**

A

2	**Check A/F sensor output current.**

PREPARATION:

(a) Connect a hand−held tester to the DLC3.
(b) Turn the ignition switch to ON and turn the tester ON.
(c) Clear DTC (See page DI−42).
(d) On the hand−held tester, select the following menu items: DIAGNOSIS/ENHANCED OBD II/MONITOR INFO/MONITOR STATUS.
(e) Check that the status of O2S MON is COMPL.
(f) On the hand−held tester, select the following menu items: DIAGNOSIS/ENHANCED OBD II/MONITOR INFO/TEST RESULT/RANGE BISI and B2S1.
(g) Check the test value of the air−fuel ratio sensor output current during fuel−cut.

RESULT:

Test Value	Proceed to
Out of normal range (1.4 mA or more, and less than 3.6 mA)	A
Within normal range (Less than 1.4 mA, or 3.6 mA or more)	B

B → **Go to step 20.**

A

3	Read value output voltage of A/F sensor.

PREPARATION:

(a) Connect the OBD II scan tool to the DLC3.
(b) Start the engine and turn the scan tool ON.
(c) Warm up the Air−Fuel Ratio (A/F) sensor at an engine speed of 2,500 rpm for 90 seconds.

CHECK:

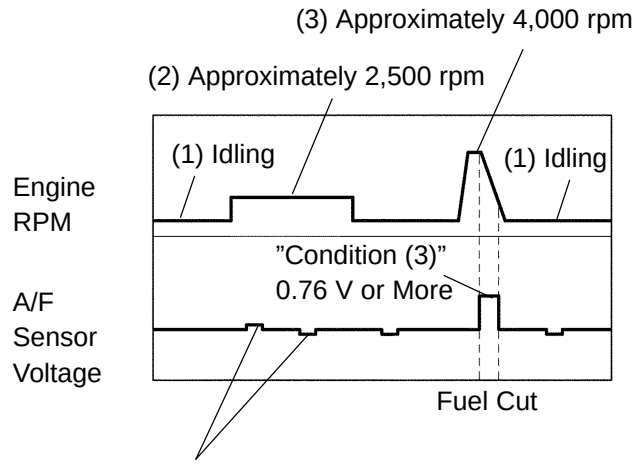
(a) Using the scan tool, check the A/F sensor voltage 3 times, once when the engine is in each of the following conditions:
  (1) While idling (check for at least 30 seconds)
  (2) At an engine speed of approximately 2,500 rpm (without any sudden changes in engine speed)
  (3) Raise the engine speed to 4,000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed.

  Standard:

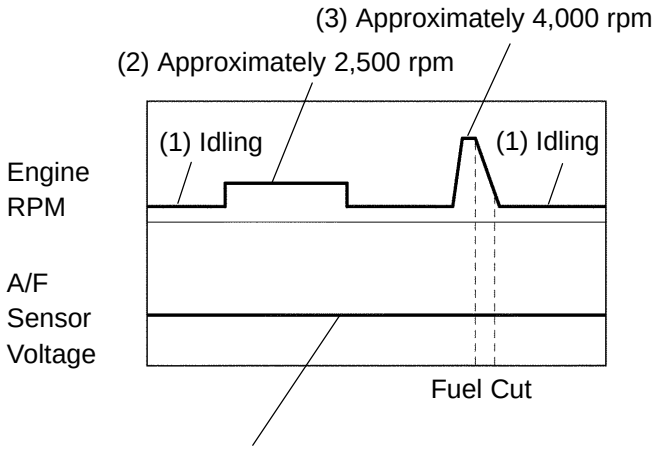
Conditions	A/F Sensor Voltage Variations	Reference
(1) and (2)	Changes at approx 0.66 V	Between 0.62 V and 0.7 V
(3)	Increases to 0.76 V or more	This occurs during engine deceleration (when fuel−cut performed)

For more information, see the diagrams below.

Normal Condition:



Malfunction Condition:



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HINT:

- If the output voltage of the A/F sensor remains at approximately 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 0.76 V or more, or 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 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.

NG → **Go to step 9.**

OK

4	**Perform confirmation driving pattern.**

NEXT

5	**Check whether DTCoutput recurs (DTC P2195, P2196, P2197 or P2198)**

CHECK:

(a) On the hand−held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

(b) Read DTCs.

RESULT:

Display (DTC Output)	Proceed To
P2195, P2196, P2197 or P2198	A
No output	B

B → **Go to step 5.**

A

6	**Replace air fuel ratio sensor.**

NEXT

7	**Perform confirmation driving pattern.**

NEXT

8	**Check whether DTCoutput recurs (DTC P2195, P2196, P2197 or P2198)**

CHECK:

(a) On the hand−held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

(b) Read DTCs.

RESULT:

Display (DTC Output)	Proceed To
P2195, P2196, P2197 or P2198	A
No output	B

B → **Go to step 5.**

A

9	**Confirm whether vehicle has run out of fuel in past.**

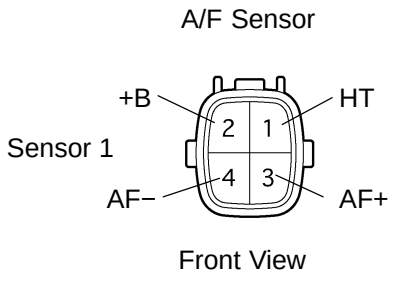
NO → **Check for intermittent problems (See page DI−11).**

YES

DTC caused by running out of fuel.

10	Check resistance of air−fuel ratio (A/F) sensor heater.

Component Side:



PREPARATION:

Disconnect the air−fuel ratio (A/F) sensor connector.

CHECK:

Measure resistance between the terminals of the A/F sensor connector.

OK:

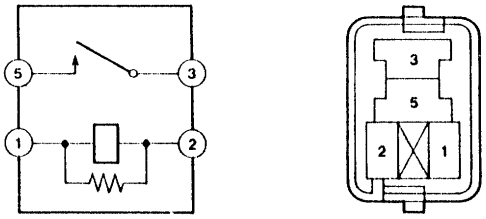
Tester Connection	Specified Condition
HT (1) − +B (2)	Between 1.8 Ω and 3.4 Ω at 20°C (68°F)
HT (1) − AF− (4)	10 kΩ or higher

NG → **Replace air−fuel ratio (A/F) sensor.**

OK

11	Check A/F relay.

A/F Relay



PREPARATION:

Remove the A/F relay from the engine room J/B.

CHECK:

Inspect the A/F relay.

OK:

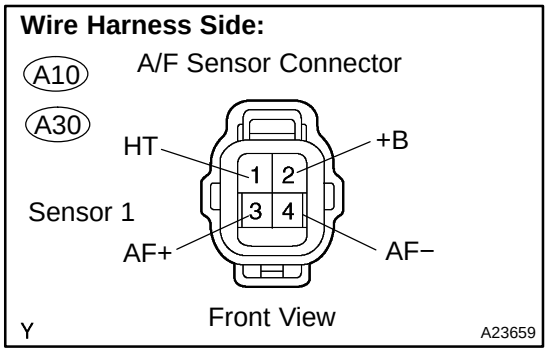
Standard:

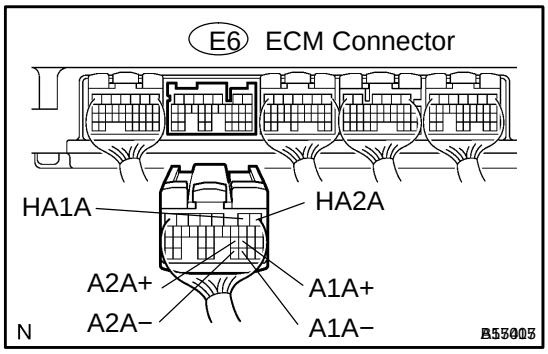
Terminal No.	Condition	Specified Condition
3 − 5	Always	10 KΩ or higher
3 − 5	Apply B+ between terminals 1 and 2	Below 1 Ω

NG → **Replace EFI relay.**

OK

12	Check for open and short in harness and connector between ECM and A/F sensor.





PREPARATION:

(a) Disconnect the A10 or A30 A/F sensor connector.

(b) Turn the ignition switch to ON.

CHECK:

(a) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.

Standard:

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

PREPARATION:

(a) Turn the ignition switch to OFF.

(b) Disconnect the E6 ECM connector.

CHECK:

(a) Check the resistance.

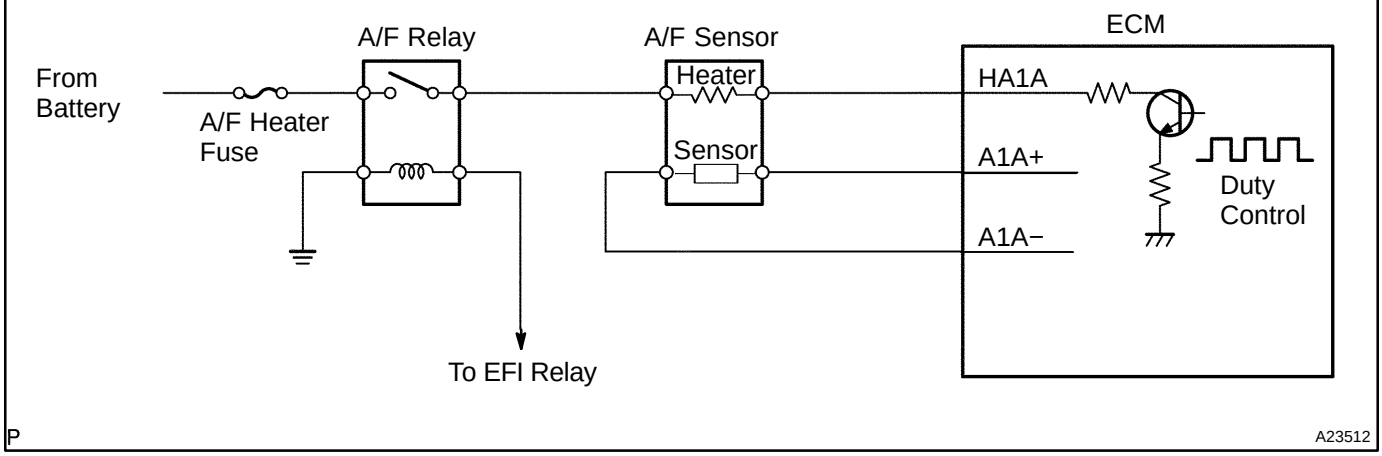
Standard (Check for open):

Tester Connections	Specified Conditions
HT (A10−1) − HA1A (E6−2) HT (A30−1) − HA2A (E6−1)	Below 1 Ω
AF+ (A10−3) − A1A+ (E6−22) AF+ (A30−3) − A2A+ (E6−23)	Below 1 Ω
AF− (A10−4) − A1A− (E6−30) AF− (A30−4) − A2A− (E6−31)	Below 1 Ω

Standard (Check for short):

Tester Connections	Specified Conditions
HT (A10−1) or HA1A (E6−2) − Body ground HT (A30−1) or HA2A (E6−1) − Body ground	10 kΩ or higher
AF+ (A10−3) or A1A+ (E6−22) − Body ground AF+ (A30−3) or A2A+ (E6−23) − Body ground	10 kΩ or higher
AF− (A10−4) or A1A− (E6−30) − Body ground AF− (A30−4) or A2A− (E6−31) − Body ground	10 kΩ or higher

Reference (Bank 1 Sensor 1 System Drawing):



NG → Replace or replace harness or connector.

OK

13	Check air induction system (See page SF−1).

CHECK:
Check the air induction system for vacuum leaks.

NG → Repair or replace air induction system.

OK

14	Check fuel pressure (See page SF−5).

CHECK:
Check the fuel pressure (high or low pressure).

NG → Check and replace fuel pump, pressure regulator, fuel pipe line and filter (See page SF−1).

OK

15	Check injector injection (See page SF−26).

NG → Replace injector.

OK

16	**Replace air fuel ratio sensor.**

NEXT

17	**Perform confirmation driving pattern.**

NEXT

18	**Check whether DTCoutput recurs (DTC P2195, P2196, P2197 or P2198)**

CHECK:

(a) On the hand−held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

(b) Read DTCs.

RESULT:

Display (DTC Output)	Proceed To
P2195, P2196, P2197 or P2198	A
No output	B

B → **Replace ECM (See page SF−66) and perform confirmation driving pattern.**

A

19	**Confirm whether vehicle has run out of fuel in past.**

NO → **Check for intermittent problems (See page DI−11).**

YES

DTC caused by running out of fuel.

20	**Replace air fuel ratio sensor.**

NEXT

21	**Perform confirmation driving pattern.**

NEXT

22	**Check whether DTC output recurs (DTC P2195, P2196, P2197 or P2198)**

CHECK:

(a) On the hand−held tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES.

(b) Read DTCs.

RESULT:

Display (DTC Output)	Proceed To
P2195, P2196, P2197 or P2198	A
No output	B

A → **Replace ECM (See page SF−66).**

B

END