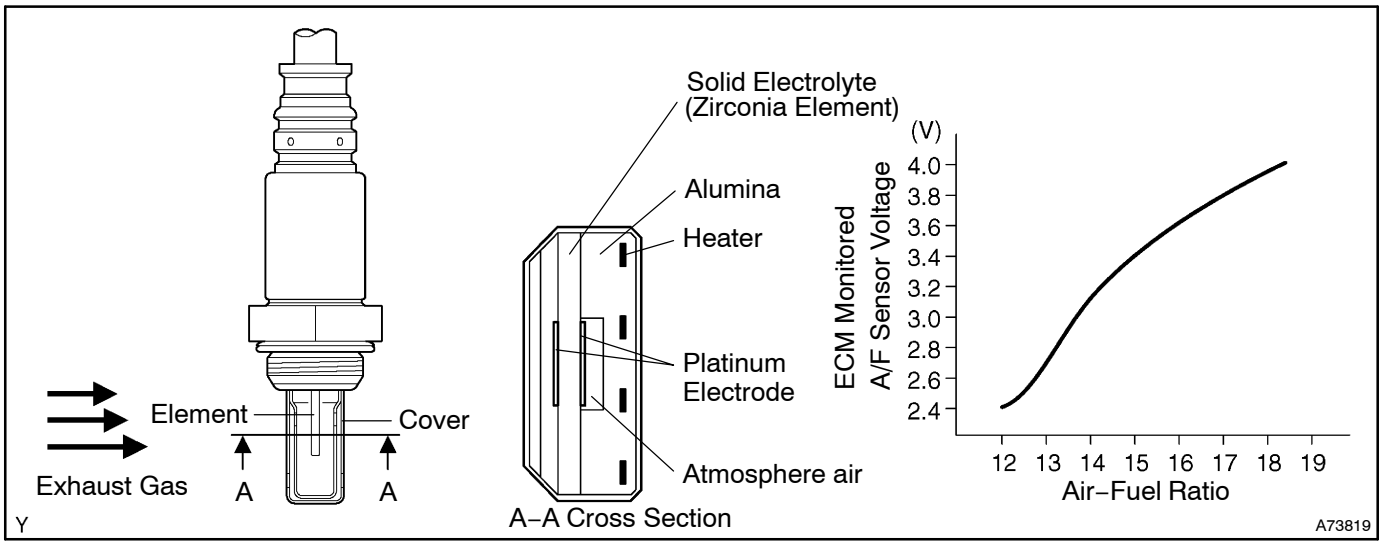
DTC	P2195	OXYGEN (A/F) SENSOR SIGNAL STUCK LEAN (BANK 1 SENSOR 1)

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

HINT:
Although each DTC title says ”oxygen sensor”, these DTCs are related to the A/F sensor.

CIRCUIT DESCRIPTION

The air–fuel ratio (A/F) sensor provides output voltage* which is almost 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 the 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 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 inside the ECM only.

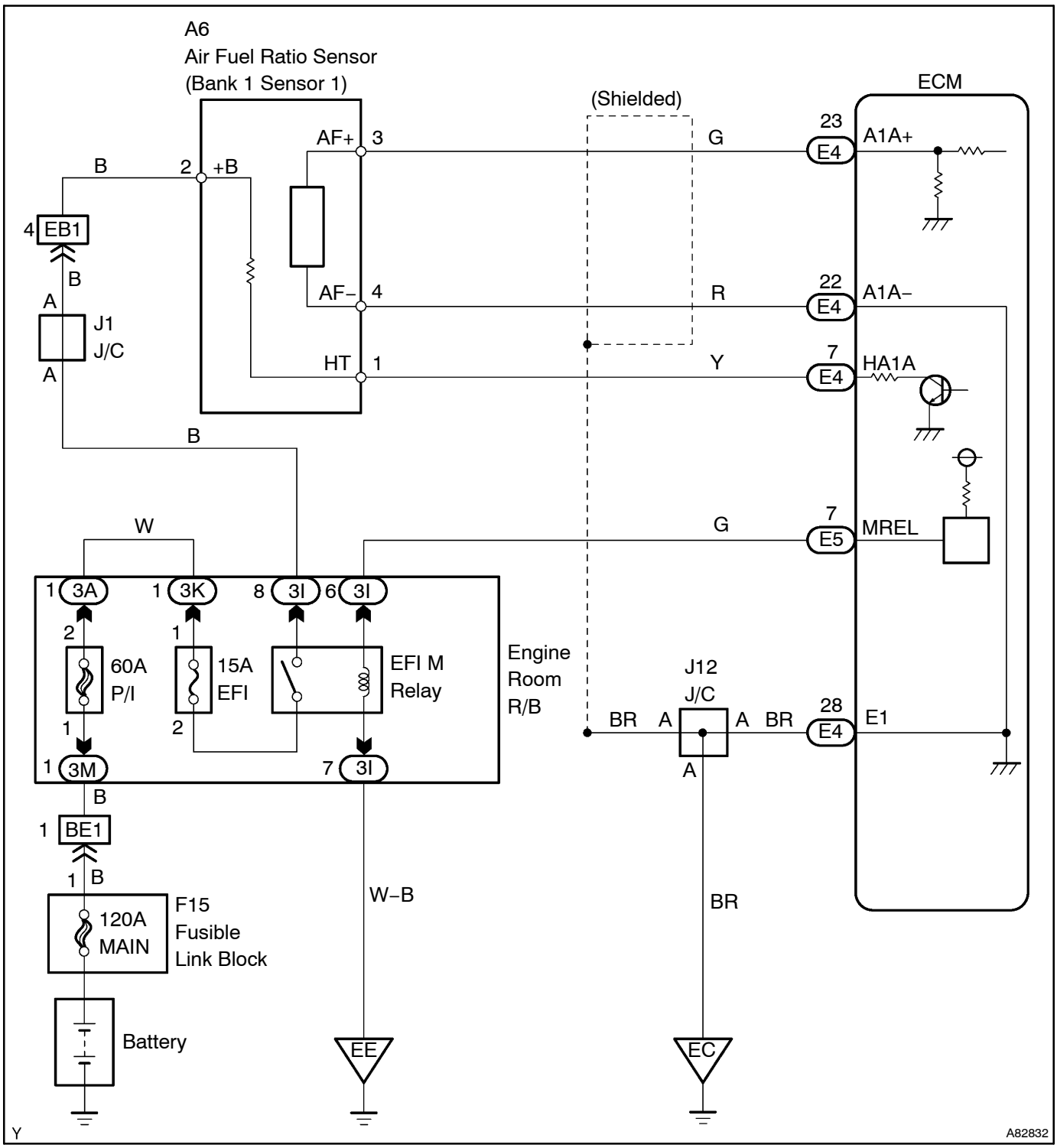


DTC No.	DTC Detection Condition	Trouble Area
P2195	Conditions (a) and (b) continue for 2 seconds or more : (a) A/F sensor voltage is more than 3.8 V (b) Heated oxygen sensor voltage is 0.15 V or more	• Open or short in A/F sensor (bank 1 sensor 1) circuit • A/F sensor (bank 1 sensor 1) • A/F sensor heater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

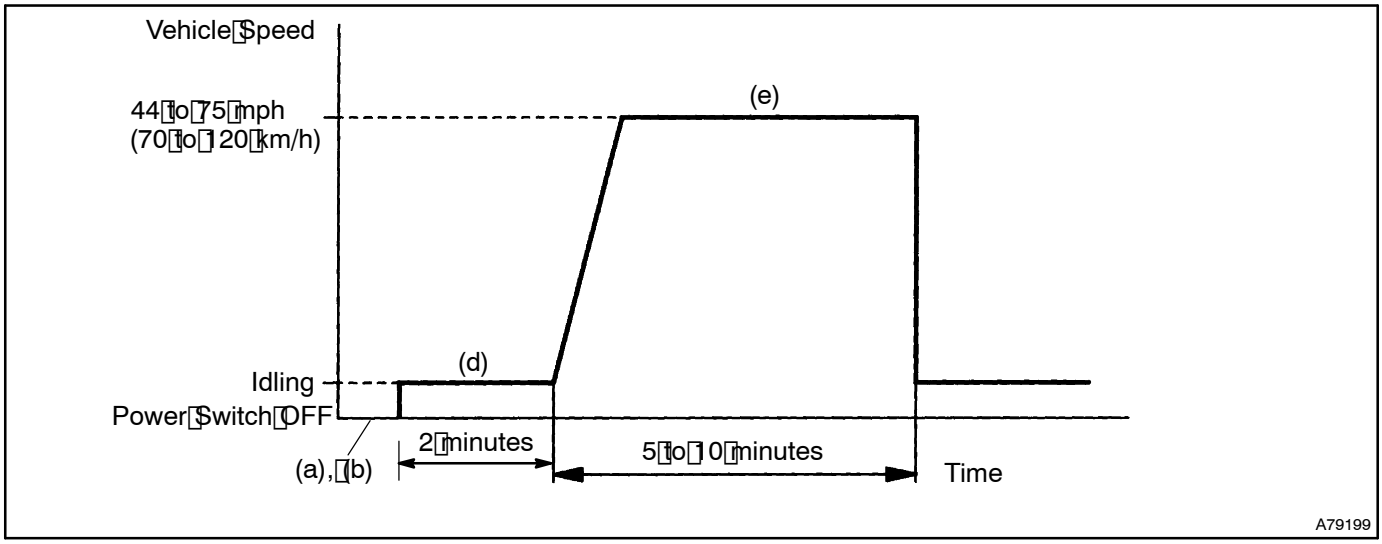
HINT:

- Sensor 1 refers to the sensor mounted before the TWC and is located near the engine assembly.
- After confirming DTC P2195 and P2196, confirm voltage output of A/F sensor (AFS B1 S1) in Powertrain / Engine and ECT / Data List using the intelligent tester II.
- The A/F sensor output voltage and the short−term fuel trim value can be read using the intelligent tester II.
- The ECM controls the voltage of the A1A+, and A1A− terminals of the ECM to a fixed voltage. Therefore, it is impossible to confirm the A/F sensor output voltage without the intelligent tester II.

WIRING DIAGRAM



CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester II to the DLC3.
(b) Switch the ECM from normal mode to check mode using the intelligent tester II (see page 05–29).
(c) Put the engine in inspection mode (see page 05–1).
(d) Start the engine and warm it up with all the accessories switched OFF.
(e) Deactivate inspection mode and drive the vehicle at 70 to 120 km/h (44 to 75 mph) for 5 to 10 minutes.

HINT:
If a malfunction exists, the CHK ENG will be illuminated during step (e).

NOTICE:

- **If the conditions in this test are not strictly followed, no malfunction will be detected. If you do not have the intelligent tester II, turn the power switch OFF after performing steps (d) and (e), then perform steps (d) and (e) again.**
- **Do not drive the vehicle without deactivating inspection mode, otherwise damaging the transaxle may result.**

INSPECTION PROCEDURE

HINT:
Malfunctioning areas can be found by performing 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 Active Test using the intelligent tester II.

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

(1) Connect the intelligent tester II to the DLC3 on the vehicle.
(2) Turn the power switch ON (IG).
(3) Put the engine in inspection mode (see page 05–1).
(4) Warm up the engine by running the engine at 2,500 rpm, depressing the accelerator pedal more than 60 % for approximately 90 seconds.
(5) Select the item: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F Sensor.
(6) Select the monitor item: AFS B1S1 and O2S B1S2.
(7) Perform the A/F CONTROL operation with the engine in an idle condition (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)	Main Suspect 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, sensor heater, 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, sensor heater, 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 output of both A/F sensor and heated oxygen sensor.

To display the graph, select the item on the tester: View / Line graph.

HINT:

- A low A/F sensor voltage could be caused by a RICH air fuel mixture. Check the conditions that would cause the engine to run with the RICH air–fuel mixture.
- A high A/F sensor voltage could be caused by a LEAN air fuel mixture. Check the conditions that would cause the engine to run with the LEAN air–fuel mixture.
- Read freeze frame data using the intelligent tester III. Freeze frame data records the engine condition when 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) Connect the intelligent tester III to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester III ON.
(d) On the intelligent tester III, select the item: Powertrain / Engine and ECT / DTC.
(e) Read DTCs.

Result:

Display	Proceed to
A/F sensor circuit DTCs	A
A/F sensor circuit DTCs and other codes	B

HINT:

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

B → GO TO RELEVANT DTC CHART (See page 05–39)

A

2	READ VALUE OF INTELLIGENT TESTER II (OUTPUT VOLTAGE OF A/F SENSOR)

(a) Connect the intelligent tester II to the DLC3.
(b) Put the engine in inspection mode (see page 05–1).
(c) Warm up the A/F sensors (bank 1 sensor 1) by running the engine at 2,500 rpm with the accelerator pedal depressed more than 60 % for approximately 90 seconds.
(d) Read A/F sensor voltage output on the intelligent tester II.
(e) On the intelligent tester II, enter the menus: Powertrain / Engine and ECT / Data List.
(f) Select the monitor item: AFS B1S2 and Engine Speed.

HINT:

If necessary, record the data using the SNAPSHOT function.

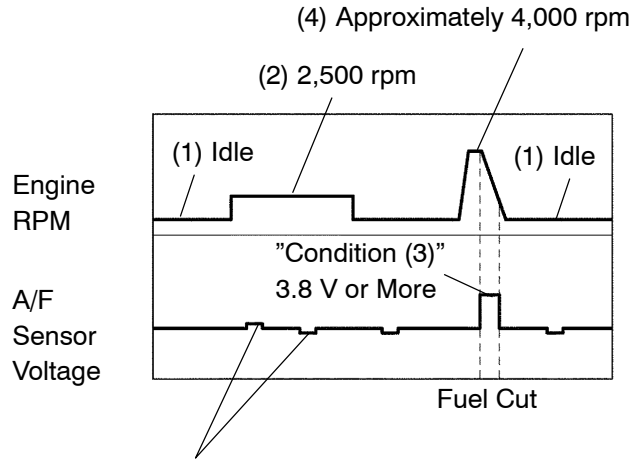
(g) Monitor the A/F sensor voltage carefully.
(h) Check the A/F sensor voltage output under the following conditions:
    (1) Put the engine in inspection mode and allow the engine to idle for 30 seconds.
    (2) Put the engine in inspection mode and running the engine at 2,500 rpm with depressing the accelerator pedal more than 60 % (where engine RPM is not suddenly changed).
    (3) Deactivate inspection mode and drive the vehicle with the shift position in B.
    (4) Accelerate the vehicle to 70 km/h (44 mph) and quickly release the accelerator pedal so that the throttle is fully closed.

CAUTION:

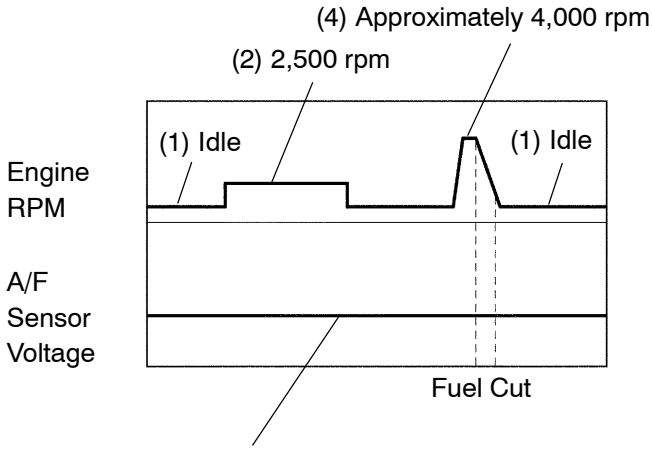
- **Strictly observe of posted speed limits, traffic laws, and road conditions when performing these drive patterns.**
- **Do not drive the vehicle without deactivating inspection mode, otherwise damaging the transaxle may result.**

Standard:
Condition (1) and (2)
Voltage changes in the vicinity of 3.3 V (between approximately 3.1 to 3.5 V) as shown in the illustration.
Condition (4)
A/F sensor voltage increases to 3.8 V or more during engine deceleration (when fuel cut) as shown in the illustration.

Normal Condition:



Malfunction Condition:



A72304

HINT:

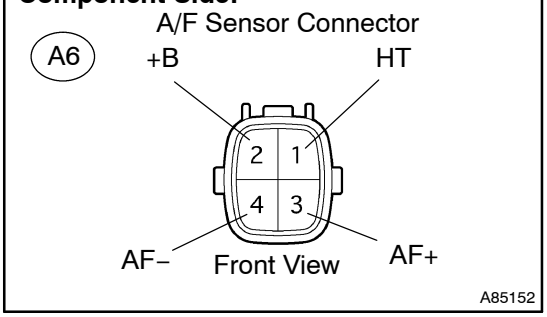
- To display the graph, select the item on the tester: View / Line graph.
- Whenever the output voltage of the A/F sensor remains at approximately 3.3 V (see diagram Malfunction Condition) under any condition as well as the above conditions, the A/F sensor may have an open–circuit. (This will happen also when the A/F sensor heater has an open–circuit.)
- Whenever the output voltage of the A/F sensor remains at a certain value of approximately 3.8 V or more, or 2.8 V or less (see diagram Malfunction Condition) 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 cut) during engine deceleration. This will cause a LEAN condition and should result in a momentary increase in A/F sensor voltage output.
- The ECM must establish a closed throttle position learned value to perform fuel cut. If the battery terminal was reconnected, the vehicle must be driven over 16 km/h (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 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.

OK → **Go to step 13**

NG

3 INSPECT AIR FUEL RATIO SENSOR(RESISTANCE OF A/F SENSOR HEATER)



(a) Disconnect the A6 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/F sensor.
Resistance:

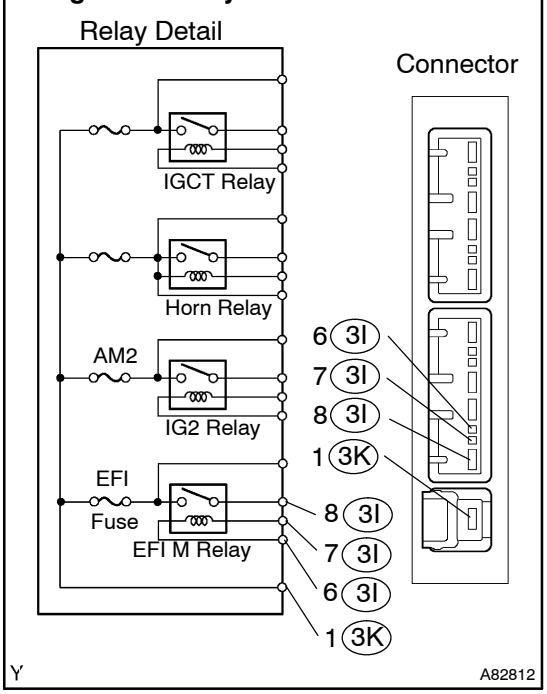
Tester Connection	Resistance
HT (1) – +B (2)	1.8 to 3.4 Ω at 20°C (68°F)

(c) Reconnect the A/F sensor connector.

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

4 INSPECT INTEGRATION RELAY(EFI M RELAY)



(a) Remove the integration relay from the engine room R/B.
(b) Inspect the EFI M relay.
Standard:

Tester Connection	Specified Condition
(3K–1) – (3I–8)	10 kΩ or higher
(3K–1) – (3I–8)	Below 1 Ω (Apply battery voltage to terminals 3I–6 and 3I–7)

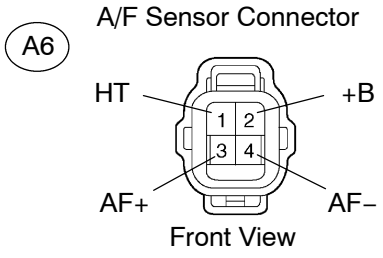
(c) Reinstall the integration relay.

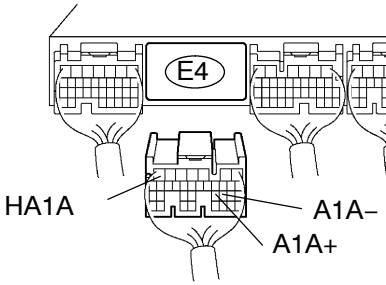
NG → **REPLACE INTEGRATION RELAY**

OK

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

Wire Harness Side:





(a) Disconnect the A6 A/F sensor connector.
(b) Disconnect the E4 ECM connector.
(c) Check the resistance between the wire harness side connectors.

Standard (Check for open):

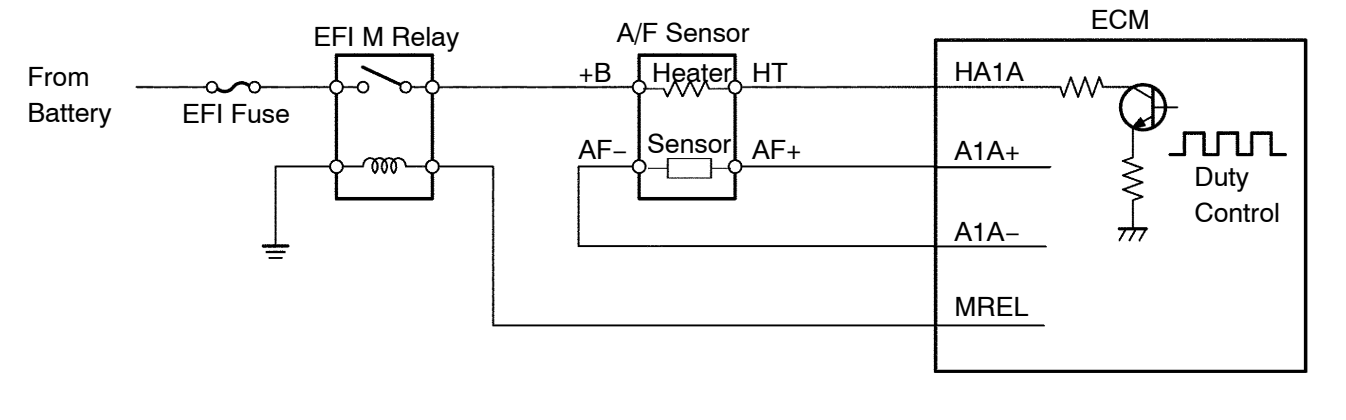
Tester Connection	Specified Condition
AF+ (A6–3) – A1A+ (E4–23)	Below 1 Ω
AF– (A6–4) – A1A– (E4–22)	Below 1 Ω
HT (A6–1) – HA1A (E4–7)	Below 1 Ω

Standard (Check for short):

Tester Connection	Specified Condition
AF+ (A6–3) or A1A+ (E4–23) – Body ground	10 kΩ or higher
AF– (A6–4) or A1A– (E4–22) – Body ground	10 kΩ or higher
HT (A6–1) or HA1A (E4–7) – Body ground	10 kΩ or higher

(d) Reconnect the A/F sensor connector.
(e) Reconnect the ECM connector.

Reference (Bank 1 Sensor 1 System Diagram):



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

OK

6	CHECK AIR INDUCTION SYSTEM

(a) Check for vacuum leaks in the air induction system.
OK: No leak in the air induction system.

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM

OK

7	CHECK FUEL PRESSURE (See page 11–7)

(a) Check fuel pressure (High or low fuel pressure).
OK:
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 11–9)

(a) Check injector injection (high or low fuel injection quantity or poor injection pattern).
OK:
Injection volume: 36 to 46 cm^3 (2.1 to 2.8 cu in.) per 15 seconds.

NG → REPLACE FUEL INJECTOR ASSY (See page 11–12)

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 DTCS(SEE IF A/F SENSOR DTCS OUTPUT AGAIN)

(a) Connect the intelligent tester II to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester II ON.
(d) On the intelligent tester II, select the item: Powertrain / Engine and ECT / DTC.
(e) Read the DTCs.

Result :

Display	Proceed to
No output	A
A/F sensor circuit DTC	B

B → **REPLACE ECM(See page 10–24) AND PERFORM CONFIRMATION DRIVING PATTERN**

A

12	CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

YES: Vehicle has run out of fuel in past.

NO → **CHECK FOR INTERMITTENT PROBLEMS (See page 05–14)**

YES

DTCS ARE 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 DTCS(SEE IF A/F SENSOR DTCS OUTPUT AGAIN)

(a) Connect the intelligent tester II to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester II ON.
(d) On the intelligent tester II , select the item: Powertrain / Engine and ECT / DTC.
(e) Read DTCs.

Result :

Display	Proceed to
A/F sensor circuit DTCs	A
No 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 DTCS(SEE IF A/F SENSOR DTCS OUTPUT AGAIN)

(a) Connect the intelligent tester II to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester II ON.
(d) On the intelligent tester II, select the item: Powertrain / Engine and ECT / DTC.
(e) Read DTCs.

Result:

Display	Proceed to
No output	A
A/F sensor circuit DTCs	B

B → **REPLACE ECM (See page 10–24) 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 05–14)**

YES

DTCS ARE CAUSED BY RUNNING OUT OF FUEL