

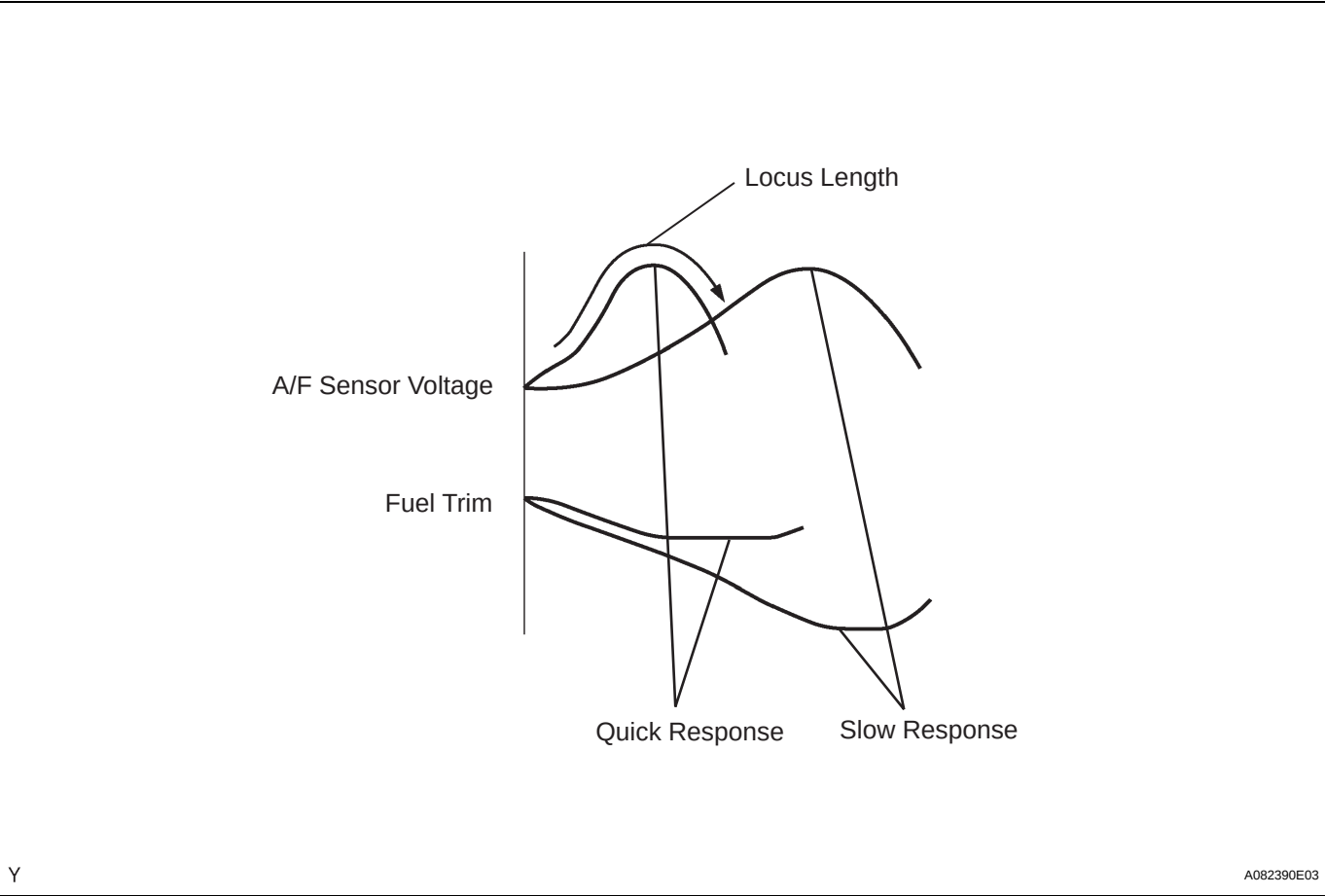
DTC	P2A00	A/F Sensor Circuit Slow Response (Bank 1 Sensor 1)
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DESCRIPTION

HINT:
Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.
Refer to DTC P2195 (See page [ES-293](#)).

DTC No.	DTC Detection Condition	Trouble Area
P2A00	Air-Fuel Ratio (A/F) sensor circuit slow response: Under conditions (a), (b) and (c), A/F sensor output voltage changing value below regular changing value in comparison with fuel trim changing value (2 trip detection logic): (a) Warm engine (b) Driving at engine speed of between 1,400 rpm and 3,200 rpm (c) Vehicle speed between 37.5 mph and 75 mph (60 km/h and 120 km/h)	• Open or short in A/F sensor (sensor 1) circuit • A/F sensor (sensor 1) • A/F sensor heater (sensor 1) • EFI relay • A/F sensor heater and EFI relay circuits • Air induction system • Fuel pressure • Injector • PCV valve and hose • PCV hose connection • ECM

MONITOR DESCRIPTION



The output voltage of the A/F sensor varies in proportion to the air-fuel ratio. Based on these voltage variations, the ECM determines whether the actual air-fuel ratio is rich or lean, and makes adjustments to bring it close to the stoichiometric level. In addition, the ECM checks the fuel injection volume compensation value to determine whether the A/F sensor response time is normal or slow. The ECM calculates the ratio of the variations in both the A/F sensor output voltage and the fuel trim value.

MONITOR STRATEGY

Related DTCs	P2A00: Air-Fuel Ratio (A/F) sensor slow response
Required Sensors/Components (Main)	A/F sensor
Required Sensors/Components (Related)	Vehicle speed sensor, Crankshaft position sensor
Frequency of Operation	Once per driving cycle
Duration	60 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever the following DTCs are not present	P0031, P0032 (A/F sensor heater sensor 1), P0100, P0102 (MAF sensor), P0110, P0112, P0113 (IAT sensor), P0115, P0117, P0118 (ECT sensor), P0120, P0122, P0123, P0220, P0222, P0223, P2135 (TP sensor), P0125 (Insufficient ECT for closed loop), P0171, P0172 (Fuel system), P0300, P0301, P0302, P0303, P0304 (Misfire), P0335 (CKP sensor), P0340, P0341 (CMP sensor), P450, P0451, P0452, P0453 (EVAP system), P0500 (VSS), P2196 (A/F sensor (Rationality))
Engine condition	Running
Time after engine start	2 minutes or more
Duration that vehicle has been driven under following conditions A and B	20 seconds or more
A. Vehicle speed	25 mph (40 km/h) or more
B. Engine RPM	900 rpm or more
Fuel system status	Closed-loop
A/F sensor status	Activated
Idling	OFF (for 2 seconds or more)
Engine RPM	1,400 to 3,200 rpm
Vehicle speed	37.5 to 75 mph (60 to 120 km/h)
Fuel-cut	OFF (for 2 seconds or more)
Malfunction determination in this driving cycle	Not yet
A/F sensor malfunction (P2195-P2198)	Not detected
A/F sensor malfunction (P2238-P2256)	Not detected

TYPICAL MALFUNCTION THRESHOLDS

Response rate deterioration level	8 or more
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MONITOR RESULT

The monitor result (mode 6) allows the OBD scan tool to display the monitor status, test value and test limit. A problem in this component can be found by comparing the test value and test limit. This procedure is described in "CHECKING MONITOR STATUS" (See page [ES-15](#)).

- TID (Test Identification) is assigned to each emission-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) is assigned to each test value.
- Unit Conversion is used to calculate the test value indicated on generic OBD scan tools.

TID \$06: A/F Sensor

TLT	CID	Unit Conversion	Description of Test Value	Description of Test Limit
0	\$01	Multiply by 0.000244 (No dimension)	Parameter for identify A/F sensor response rate (bank 1)	Malfunction criterion

WIRING DIAGRAM

Refer to DTC P2195 (See page [ES-296](#)).

INSPECTION PROCEDURE

HINT:

Intelligent 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 an intelligent tester.

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1. Connect an intelligent 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
Case 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		
Case 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		

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Areas
Case 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		
Case 4	Injection volume +25 % -12.5 %		Injection Volume +25 % -12.5 %		- Injector - Fuel pressure - Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

- 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:

- DTC P2A00 may be also set, when the air-fuel ratio is stuck rich or lean.
- 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.
- Read freeze frame data using an intelligent tester or 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 be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air-fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.

1 CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P2A00)

- Connect an intelligent tester or OBD II scan tool to the DLC3.
- Turn the ignition switch to ON.
- Turn the tester or scan tool ON.
- On the tester, select the following menu items:
DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
- If using an OBD II scan tool, refer to the instruction manual.
- Read DTCs.

Result

Display (DTC Output)	Proceed to
P2A00	A
P2A00 and other DTCs	B

HINT:

If any DTCs other than P2A00 are output, troubleshoot those DTCs first.

B

GO TO DTC CHART

A

2

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

- (a) Connect an intelligent 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) (Step (1)).
 - (2) At an engine speed of approximately 2,500 rpm (without any sudden changes in engine speed) (Step (2)).
 - (3) Raise the engine speed to 4,000 rpm and then quickly release the accelerator pedal so that the throttle valve is fully closed (Step (3)).

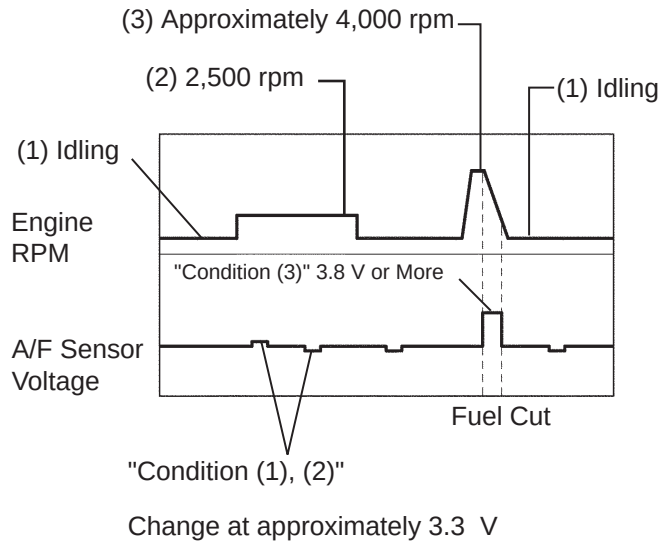
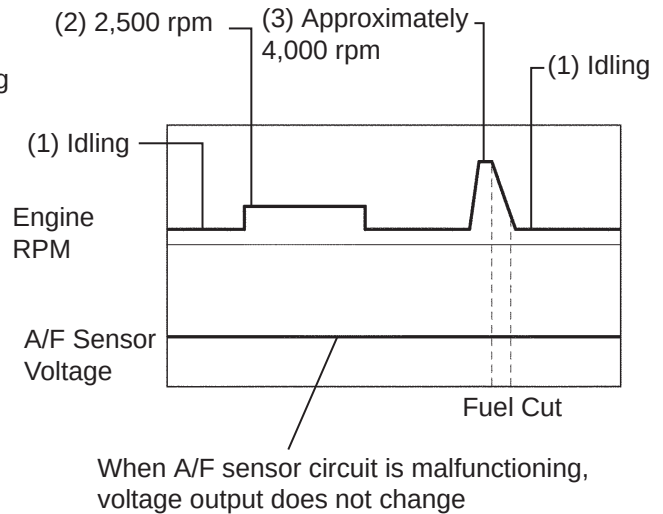
Standard voltage

Conditions	A/F Sensor Voltage Variations	Reference
Steps (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*)
Step (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.

Normal Condition:**Malfunction Condition:**

A072304E15

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 P2A00)

- (a) Read DTCs using the intelligent tester or OBD II scan tool.
- (b) If using an intelligent 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
P2A00	A
No output	B

B

Go to step 8

A

5

REPLACE AIR FUEL RATIO SENSOR

- (a) Replace the air-fuel ratio sensor.

NEXT

6

PERFORM CONFIRMATION DRIVING PATTERN

NEXT

7

CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00)

- (a) Read DTCs using the intelligent tester or OBD II scan tool.
- (b) If using an intelligent 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
P2A00	B

NOTICE:

When replacing the ECM, perform confirmation driving pattern (See page [ES-16](#)).

B

REPLACE ECM

A

8

CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO

CHECK FOR INTERMITTENT PROBLEMS

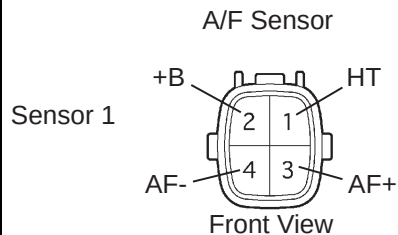
YES

DTC CAUSED BY RUNNING OUT OF FUEL

9

INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

Component Side:



A085152E58

- (a) Disconnect the A24 A/F sensor connector.
(b) Measure the resistance between the terminals of the A/F sensor connector.

Standard resistance

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.

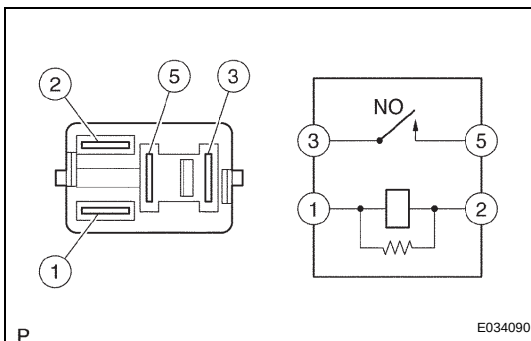
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REPLACE AIR FUEL RATIO SENSOR

OK

10

INSPECT EFI RELAY



P

E034090

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

Standard resistance

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.

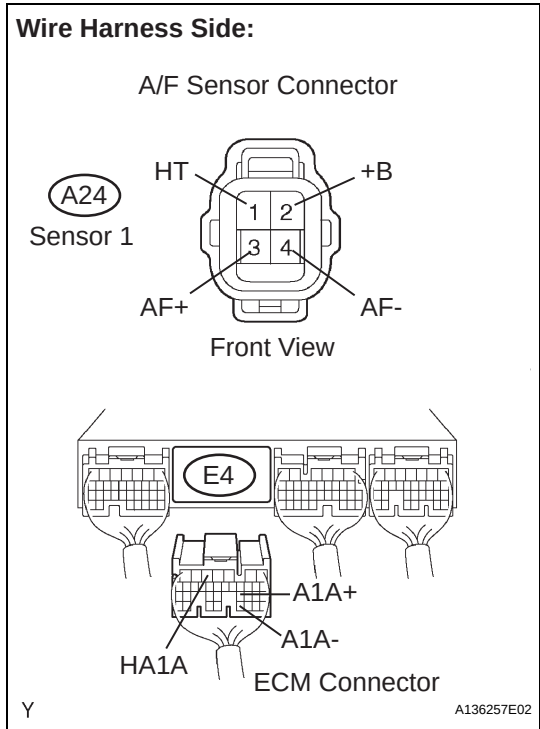
NG

REPLACE EFI RELAY

OK

11

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



- (a) Disconnect the A24 A/F sensor connector.
- (b) Turn the ignition switch to ON.
- (c) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.

Standard voltage

Tester Connections	Specified Conditions
+B (A24-2) - Body ground	Between 9 V and 14 V

- (d) Turn the ignition switch to OFF.
- (e) Disconnect the E4 ECM connector.
- (f) Check the resistance.

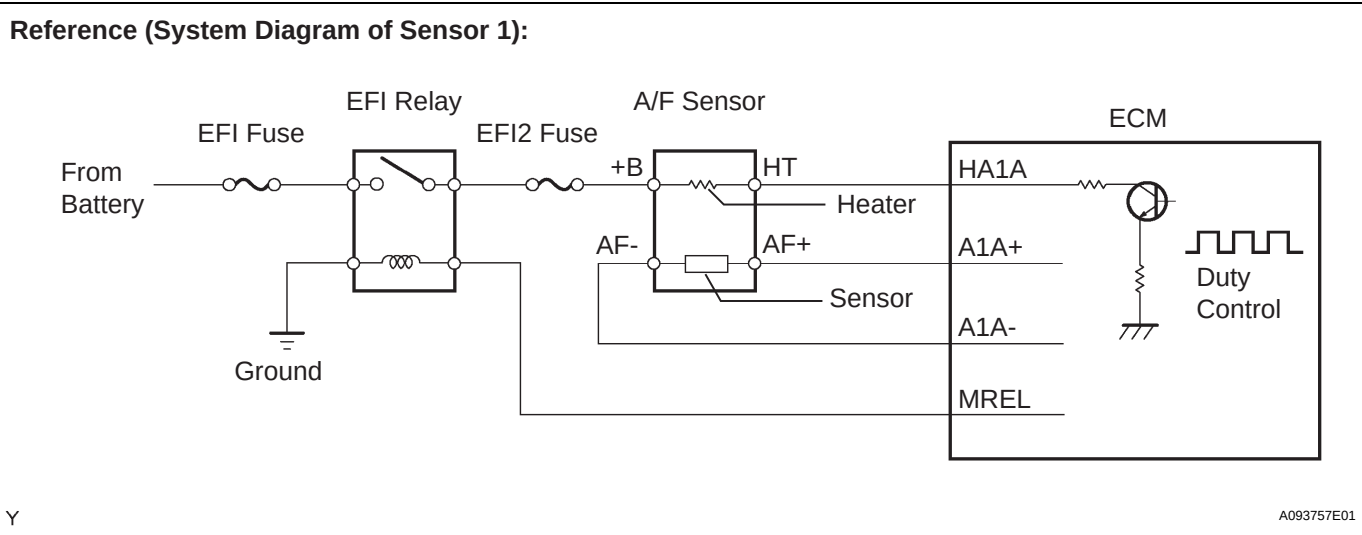
Standard resistance (Check for open)

Tester Connections	Specified Conditions
HT (A24-1) - HA1A (E4-5)	Below 1 Ω
AF+ (A24-3) - A1A+ (E4-23)	Below 1 Ω
AF- (A24-4) - A1A- (E4-31)	Below 1 Ω

Standard resistance (Check for short)

Tester Connections	Specified Conditions
HT (A24-1) or HA1A (E4-5) - Body ground	10 k Ω or higher
AF+ (A24-3) or A1A+ (E4-23) - Body ground	10 k Ω or higher
AF- (A24-4) or A1A- (E4-31) - Body ground	10 k Ω or higher

- (g) Reconnect the ECM connector.
- (h) Reconnect the A/F sensor connector.



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 PCV HOSE (CONNECTIONS)

OK:

PCV hose is connected correctly and is not damaged.

NG

REPAIR OR REPLACE PCV HOSE

OK

14 CHECK FUEL PRESSURE

- (a) Check the fuel pressure (See page [FU-8](#)).

NG

REPAIR OR REPLACE FUEL SYSTEM

OK

15 INSPECT FUEL INJECTOR ASSEMBLY

- (a) Check the injector injection (whether fuel volume is high or low, and whether injection pattern is poor) (See page [FU-13](#)).

NG

INSPECT FUEL INJECTOR ASSEMBLY

OK

16 REPLACE AIR FUEL RATIO SENSOR

- (a) Replace the air-fuel ratio sensor.

NEXT

17 PERFORM CONFIRMATION DRIVING PATTERN

NEXT

ES

18

CHECK WHETHER DTC OUTPUT RECURS (DTC P2A00)

- (a) Read DTCs using the intelligent tester or OBD II scan tool.
- (b) If using an intelligent 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
P2A00	B

NOTICE:
When replacing the ECM, perform confirmation driving pattern (See page [ES-16](#)).

B

REPLACE ECM

A

19

CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST

NO

CHECK FOR INTERMITTENT PROBLEMS

YES

DTC CAUSED BY RUNNING OUT OF FUEL