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

| DTC | P2A03 | A/F Sensor Circuit Slow Response (Bank 2 Sensor 1) |
|---|---|---|

HINT:
- DTC P2A00 is a malfunction related to the bank 1 A/F sensor.
- DTC P2A03 is a malfunction related to the bank 2 A/F sensor.

## DESCRIPTION



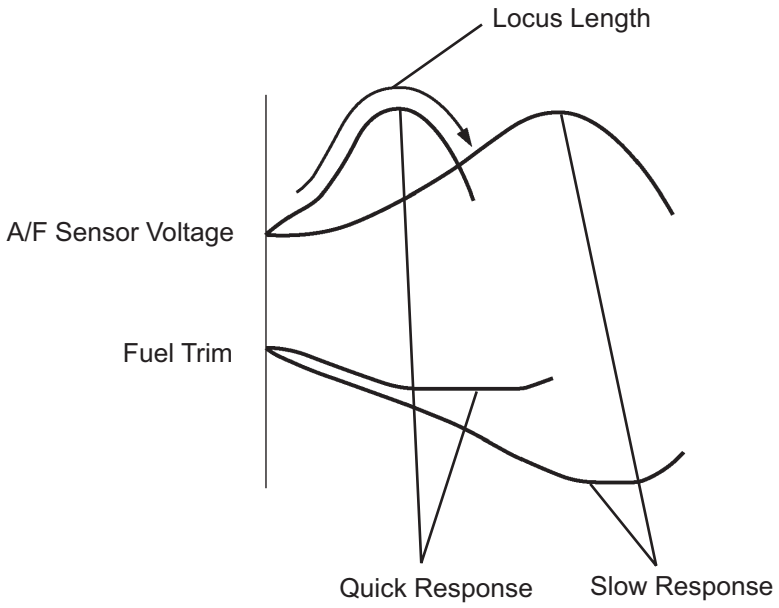
Refer to DTC P2195 (See page ES-271).

| DTC No. | DTC Detecting Condition | Trouble Area |
|---|---|---|
| P2A00<br>P2A03 | In conditions (a), (b), and (c), when A/F sensor output voltage change is below expected level compared to fuel trim change, ECM judges that A/F sensor circuit has slow response:<br>(2 trip detection logic)<br>(a) After engine is warmed up<br>(b) During vehicle driving with engine speed 1,400 rpm or more<br>(c) Vehicle speed 25 mph (40 km/h) or more | • Open or short in A/F sensor (bank 1, 2 sensor 1) circuit<br>• A/F sensor (bank 1, 2 sensor 1)<br>• A/F sensor heater<br>• A/F relay<br>• Open or short in A/F sensor heater and relay circuits<br>• Air induction system<br>• Fuel pressure<br>• Injector<br>• PCV hose connection<br>• ECM |

HINT:
- 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.

## MONITOR DESCRIPTION

The air fuel ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. Based on the output voltage, the ECM determines if the air-fuel ratio is RICH or LEAN and adjusts the stoichiometric air-fuel ratio. The ECM also checks the fuel injection volume compensation value to check if the A/F sensor is deteriorating or not. The output voltage variation, known as locus length, should be high when the air-fuel ratio fluctuates. When the A/F sensor response rate has deteriorated, the locus length should be short. The ECM concludes that there is a malfunction in the ratio of the A/F sensor when the locus length is short and the response rate has deteriorated.




## MONITOR STRATEGY

| | |
|---|---|
| Related DTCs | P2A00: A/F sensor (Bank 1) Slow Response<br>P2A03: A/F sensor (Bank 2) 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 operation | None |

## TYPICAL ENABLING CONDITIONS

| | |
|---|---|
| The monitor will run whenever these DTCs are not present | P0031, P0032, P0051, P0052 (A/F sensor heater sensor 1), P0100, P0101, P0102, P0103 (MAF sensor), P0110, P0112, P0113 (IAT sensor), P0120, P0122, P0123, P0220, P0222, P0223, P2135 (TP sensor), P0125 (Insufficient ECT for closed loop), P0171, P0172, P0174, P0175 (Fuel system), P0300, P0301, P0302, P0303, P0304, P0305, P0306 (Misfire), P0340, P0341 (CMP sensor), P0402 (EGR system (Open)), P0442, P0445, P0456 (EVAP system), P0500 (VSS), P2196, P2198 (A/F sensor (Rationality)). |
| Engine condition | Running |
| Time after engine start | 120 seconds or more |
| Fuel system status | Closed Loop |
| A/F sensor status | Activated |
| Idle | OFF |
| Time after idle OFF | 2 seconds or more |
| Engine RPM | 1,400 to 3,200 rpm |

| | |
|---|---|
| Vehicle speed | 37.5 to 75 mph (60 to 120 km/h) |
| Time after fuel cut is OFF | 2 seconds or more |
| Driving for 20 seconds or more | Vehicle speed is 25 mph (40 km/h) or more and engine speed is 900 rpm or more |

## TYPICAL MALFUNCTION THRESHOLDS

| | |
|---|---|
| Response rate deterioration level | 6.0 or more |

## MONITOR RESULT

Refer to "Checking Monitor Status" for detailed information (See page ES-14).
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 ES-16).

- 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 II scan tools.

**TID $06: A/F sensor**

| TLT | CID | Unit Conversion | Description of Test Data | Description of Test Limit |
|---|---|---|---|---|
| 0 | $01 | Multiply by 0.000244 (no dimension) | Parameter for identify A/F sensor response rate (Bank 1) | Malfunction threshold for A/F sensor deterioration |
| 0 | $11 | Multiply by 0.000244 (no dimension) | Parameter for identify A/F sensor response rate (Bank 2) | Malfunction threshold for A/F sensor deterioration |

## WIRING DIAGRAM

Refer to DTC P2195 (See page ES-275).

HINT:
Intelligent tester only:
The malfunctioning area can be found by the ACTIVE TEST A/F CONTROL operation. The A/F CONTROL operation can determine if the A/F sensor, heated oxygen sensor or other suspected areas are malfunctioning or not.

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

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

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

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

ES

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:

- DTC P2A00 or P2A03 may be also detected, 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 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 |
|---|---|
| DTC P2A00 and/or P2A03 are output. | A |
| DTC P2A00 and/or P2A03 and other DTCs are output. | B |

HINT:
If any other DTCs besides P2A00 and/or P2A03 are output, perform the troubleshooting for those DTCs first.

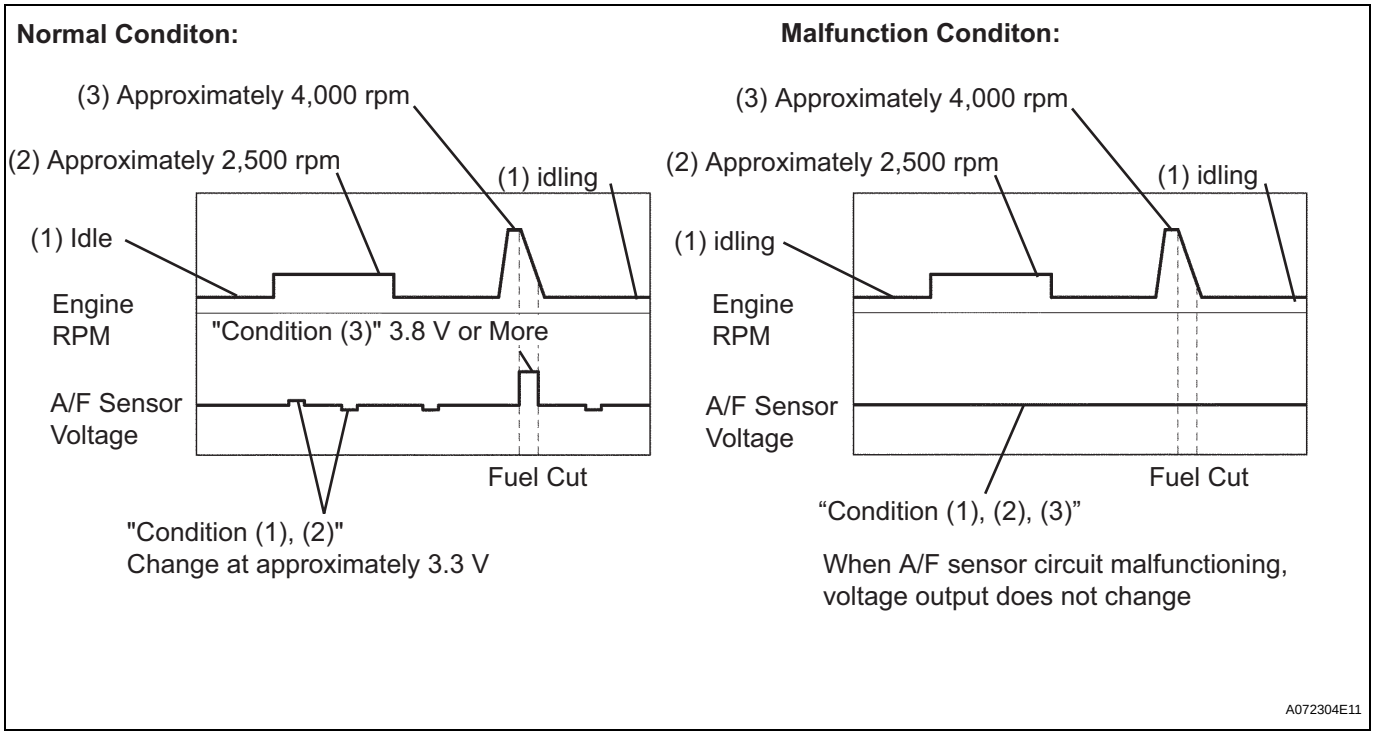
B → GO TO RELEVANT DTC CHART

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 DLC3.
(b) Warm up the A/F sensor (bank 1 sensor 1 and bank 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) Intelligent 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 speed to 4,000 rpm and quickly release the accelerator pedal so that the throttle is fully closed (3).




**Standard:**

**Conditions (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 when fuel is cut during engine deceleration 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.

- 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 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 (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.

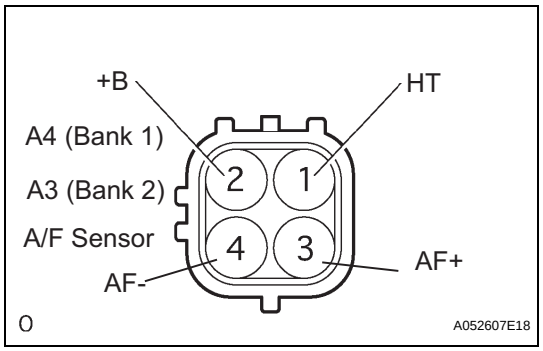
*: Voltage when using the OBD II scan tool.



OK → Go to step 14

NG

## 3 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)




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

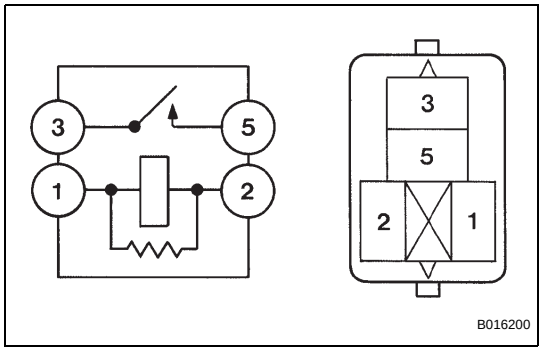
| Tester Connection | Condition | Specified Condition |
|---|---|---|
| 1 (HT) - 4 (AF-) | - | 10 kΩ or higher |
| 1 (HT) - 2 (+B) | 20°C (68°F) | 1.8 to 3.4 Ω |

(c) Reconnect the A/F sensor connector.

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**

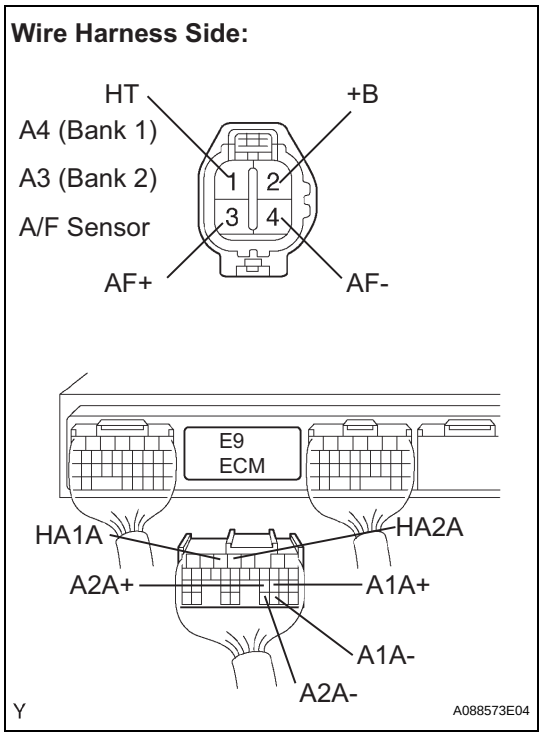
| Tester Connection | Specified Condition |
|---|---|
| 1 - 2 | Below 1 Ω |
| 3 - 5 | 10 kΩ or higher |
| 3 - 5 | Below 1 Ω (when battery voltage is applied to terminals 1 and 2) |

(c) Reinstall the A/F relay.

NG → REPLACE AIR FUEL RATIO SENSOR RELAY

OK

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

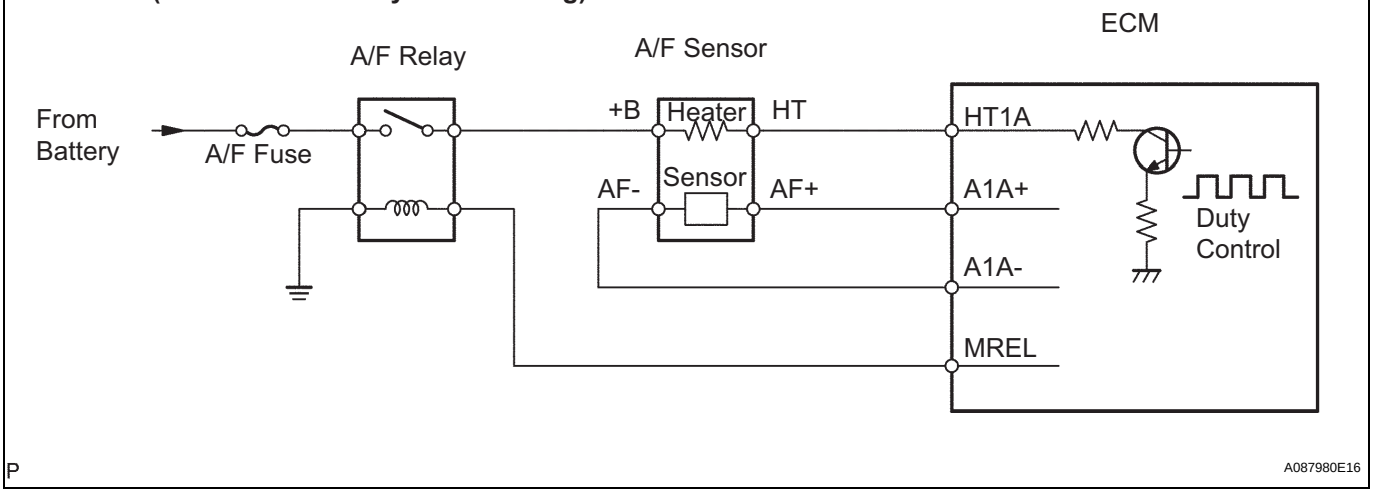



(a) Disconnect the A3 or A4 A/F sensor connector.
(b) Disconnect the E9 ECM connector.
(c) Measure the resistance of the wire harness side connectors.

**Standard resistance**

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

**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 the air induction system.

**OK:**

**There is no leak in air induction system.**

NG → REPAIR OR REPLACE AIR INDUCTION SYSTEM

OK

**7 CHECK CONNECTION OF PCV HOSE**

**OK:**
**PCV hose is connected correctly. And PCV hose has no damage.**

NG → REPAIR OR REPLACE PCV HOSE

OK

**8 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 55 psi).**

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

**9 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

**10 REPLACE AIR FUEL RATIO SENSOR**

NEXT

**11 PERFORM CONFIRMATION DRIVING PATTERN**

HINT:
Clear all DTCs prior to performing the confirmation driving pattern (See page ES-16).

NEXT

| 12 | 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 |
|---|---|
| DTC P2A00 and/or P2A03 are not output | A |
| DTC P2A00 and/or P2A03 are output again | B |

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN

A

| 13 | CONFIRM IF VEHICLE HAS RUN OUT OF FUEL IN PAST |
|---|---|

NO → CHECK FOR INTERMITTENT PROBLEMS

YES

DTC CAUSED BY RUNNING OUT OF FUEL

| 14 | PERFORM CONFIRMATION DRIVING PATTERN |
|---|---|

HINT:
Clear all DTCs prior to performing the confirmation driving pattern (See page ES-16).

NEXT

| 15 | 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 |
|---|---|
| DTC P2A00 and/or P2A03 are not output | A |
| DTC P2A00 and/or P2A03 are output | B |

B → Go to step 19

A

| 16 | REPLACE AIR FUEL RATIO SENSOR |
|---|---|

NEXT

| 17 | PERFORM CONFIRMATION DRIVING PATTERN |
|---|---|

HINT:
Clear all DTCs prior to performing the confirmation driving pattern (See page ES-16).

NEXT

| 18 | 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 |
|---|---|
| DTC P2A00 and/or P2A03 are output | A |
| DTC P2A00 and/or P2A03 are not output | B |

B → REPLACE ECM AND PERFORM CONFIRMATION DRIVING PATTERN

A

| 19 | 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