DTC	P2440	Secondary Air Injection System Switching Valve Stuck Open Bank1

DTC	P2441	Secondary Air Injection System Switching Valve Stuck Close Bank1

DESCRIPTION

Refer to DTC P0412 (See page ES-189).

DTC No.	DTC Detection Conditions	Trouble Areas
P2440	Pressure sensor detects pulsation of exhaust gas despite ECM commanding Air Switching Valve (ASV) to close, while engine running (2 trip detection logic)	• ASV • Open or short in ASV circuit • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM
P2441	Pressure sensor detects no pulsation of exhaust gas despite ECM commanding Air Switching Valve (ASV) to open, while engine running (2 trip detection logic)	• ASV • Open or short in ASV circuit • Vacuum hose (ASV - pressure sensor) • Air injection hose • Pressure sensor • Pressure sensor circuit • Air Injection Control Driver (AID) • ECM

HINT:
Air switching valve normal operation:
When the Air Switching Valve (ASV) is open, exhaust gas pulsation occurs in the secondary air passage.
When the ASV is closed, exhaust gas pulsation does not occur in the secondary air passage.

MONITOR DESCRIPTION

The ECM monitors the pressure in the secondary air passage using the pressure sensor connected to the ASV of the Secondary Air Injection (AIR) system.
If either of the following conditions occurs, the ECM interprets it as a malfunction of the secondary AIR system, and illuminates the MIL and sets a DTC:

- Exhaust gas pulsation is detected by the pressure sensor despite the ECM commanding the ASV to close.
- Exhaust gas pulsation is not detected by the pressure sensor despite the ECM commanding the ASV to open.

MONITOR STRATEGY

Related DTCs	P2440: Air control valve stuck open P2441: Air control valve stuck closed
Required Sensors/Components (Main)	Pressure sensor
Required Sensors/Components (Related)	-
Frequency of Operation	Once per drive cycle
Duration	7 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

All:

Monitor runs whenever following DTCs not present	• P0010 - P0022: VVT system • P0031 - P0052: Front A/F sensor heater • P0100 - P0103: MAF sensor • P0110 - P0113: IAT sensor • P0115 - P0118: ECT sensor • P0120 - P2125: TP sensor • P0125: Closed loop • P0171 - P0175: Fuel trim • P0300 - P0308: Misfire • P0325 - P0333: Knock sensor • P0335: CKP sensor • P0340 - P0346: VVT sensor • P0351 - P0358: Igniter • P0441 - P2420: EVAP system • P0500: VSS • P1340: CMP sensor • P2195 - P2A03: A/F sensor • P2430 - P2433: AIR pressure sensor
Battery voltage	11 V or more
Atmospheric pressure	45 kPa (337.5 mmHg) or more

While secondary air injection ON:

Time after secondary injection operation begins	6 seconds or more
Secondary air injection pump	ON
Secondary air injection switching valve	ON
Engine speed	Less than 3,750 rpm
Delay time after engine started	6 seconds or more
Pressure sensor malfunction	Not detected

While secondary air injection OFF:

Secondary air injection pump	OFF
Engine speed	Less than 3,750 rpm
Secondary air injection system monitor during secondary air injection ON	Completed
Pressure sensor malfunction	Not detected

TYPICAL MALFUNCTION THRESHOLDS

Condition 1:

AIR pressure during AIR ON	2.5 kPa or more and pulse is generated

Condition 2:

AIR pressure during AIR ON	Less than 2.5 kPa and pulse is generated

Condition 3:

AIR pressure during AIR ON	2.5 kPa or more and pulse is not generated

Condition 4:

AIR pressure during AIR ON	Less than 2.5 kPa and pulse is not generated

Condition 5:

AIR pressure during AIR OFF	2.5 kPa or more and pulse is generated

Condition 6:

AIR pressure during AIR OFF	Less than 2.5 kPa and pulse is generated

Condition 7:

AIR pressure during AIR OFF	2.5 kPa or more and pulse is not generated

Condition 8:

AIR pressure during AIR OFF	Less than 2.5 kPa and pulse is not generated

P2440: ASV stuck open

Any of following conditions met:	(a), (b) or (c)
(a) Conditions 1 and 6	Met
(b) Conditions 1 and 5	Met
(c) Conditions 2 and 6	Met

P2441: ASV stuck closed

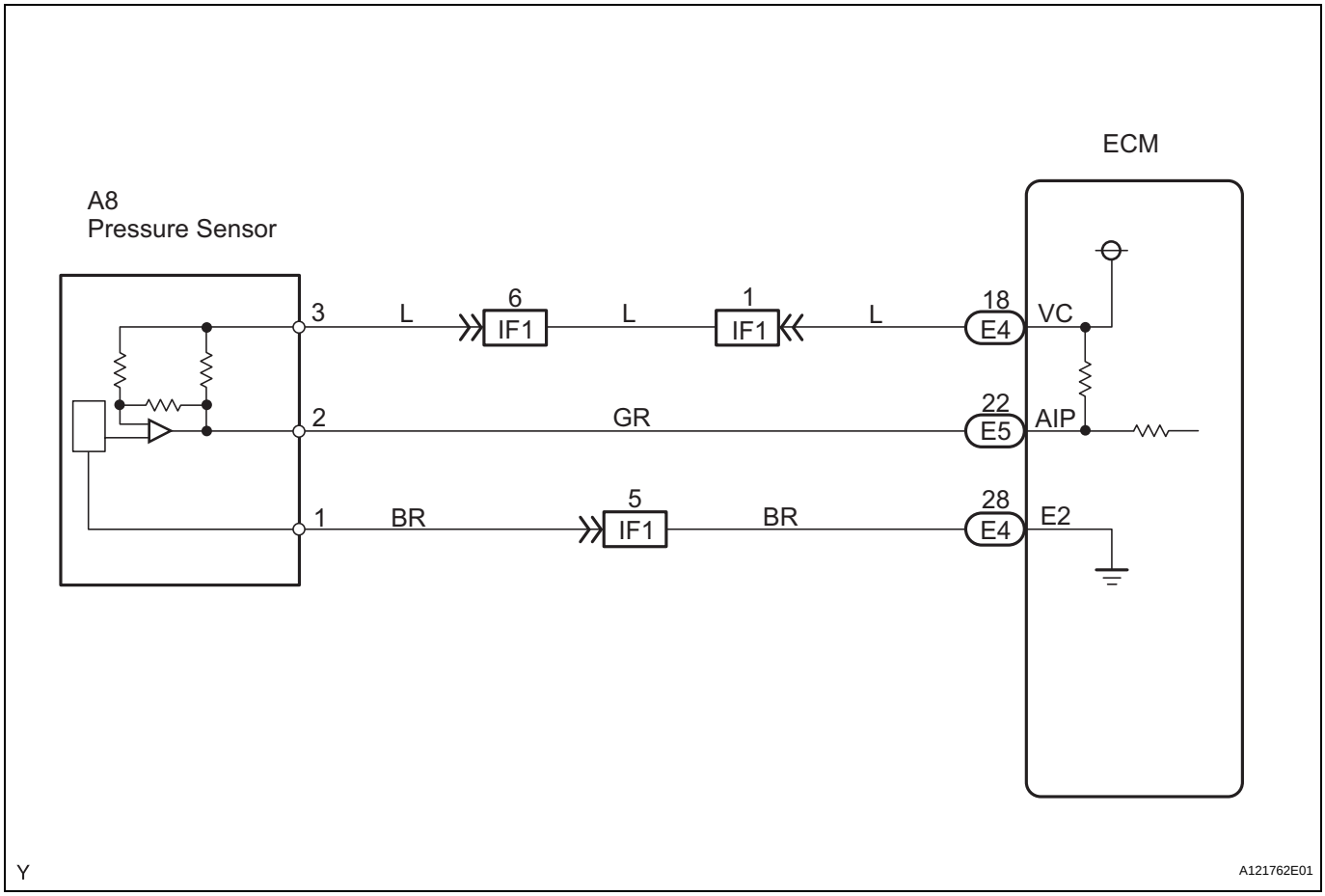
Any of following conditions met:	(a), (b) or (c)
(a) Conditions 3 and 7	Met
(b) Conditions 3 and 8	Met
(c) Conditions 4 and 8	Met

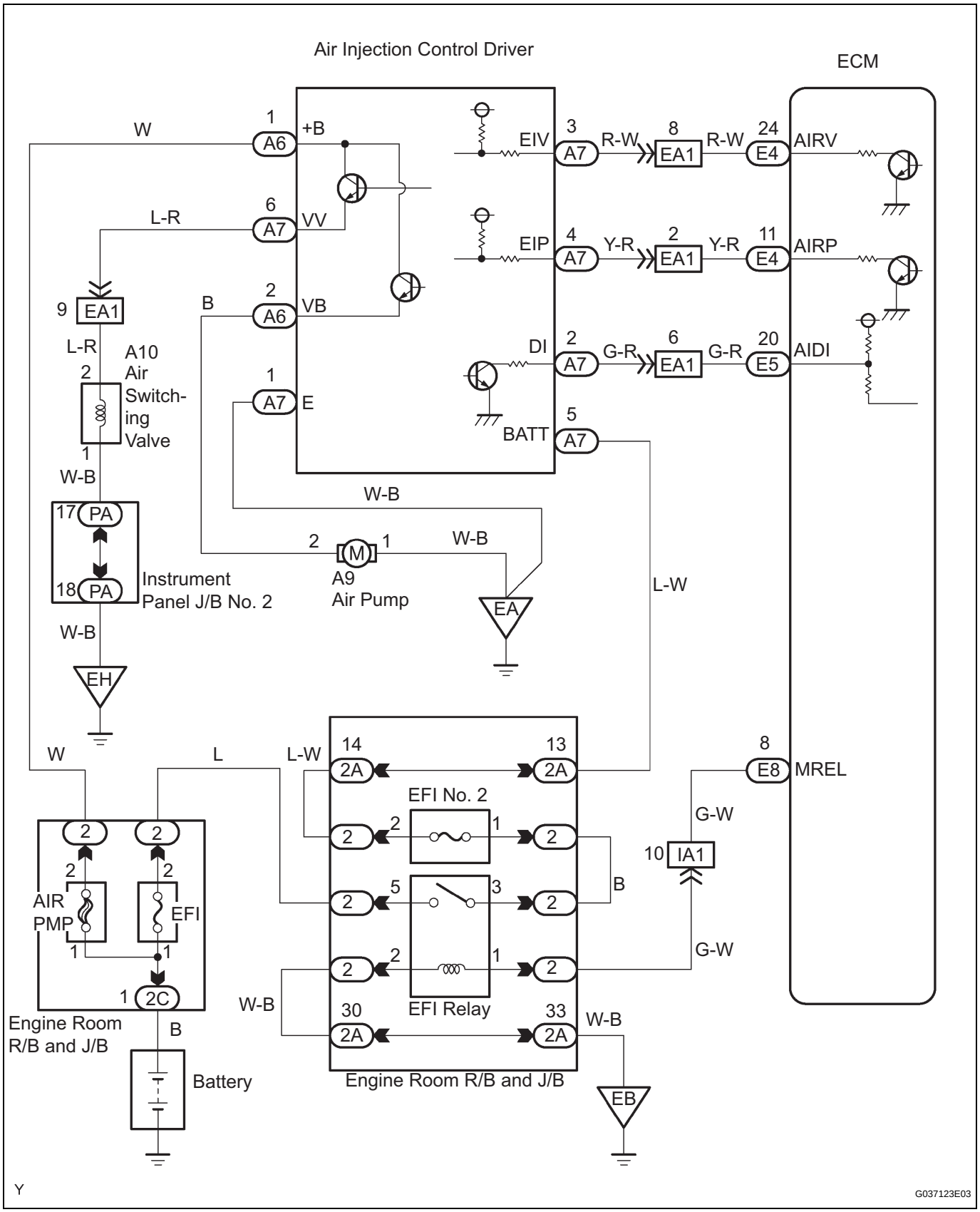
ES

MONITOR RESULT

Refer to Checking Monitor Status (See page ES-21).

WIRING DIAGRAM





HINT:
Determination by ECM monitoring:

The ECM locates malfunctions in the Secondary Air Injection (AIR) system by detecting the pressure in the AIR passage between the air pump and Air Switching Valve (ASV) and sets a DTC. Soon after cold engine starts, the monitor runs for a short time while the AIR system is both ON and OFF. The ECM detects both the pressure and the exhaust pulsation and compares them.
The following 4 patterns are AIR system pressure conditions in the AIR system passage.

Pressure condition in Secondary Air Injection System Case 1:

Air Pump	ON
Air Switching Valve	Open
Pressure	2.5 kPa or more
Pulsation Detection	Exhaust gas pulsation detected

Pressure condition in Secondary Air Injection System Case 2:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Less than 2.5 kPa
Pulsation Detection	Exhaust gas pulsation detected

ES

Pressure condition in Secondary Air Injection System Case 3:

Air Pump	ON
Air Switching Valve	Closed
Pressure	2.5 kPa or more
Pulsation Detection	Slight pulsation detected

Pressure condition in Secondary Air Injection System Case 4:

Air Pump	OFF
Air Switching Valve	Open
Pressure	Less than 2.5 kPa
Pulsation Detection	Exhaust gas pulsation detected

If the detected pressure is high, the air pump is assumed to be ON and if it alternates sharply*, the ASV is assumed to be open. The ECM locates malfunctions from the combination of pressures detected when the AIR system is ON and OFF.
*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.
HINT:

- In case 3, as the pressure sensor detects a slight pump operation pulsation, the detected value is not constant. Since the pump outlet is blocked by closing the ASV, the average pressure is higher than in case 1 (approximately 20 to 30 kPa).
- In case 1, the average pressure is approximately 9 to 11 kPa. The value of 2.5 kPa indicated in the table above is a threshold for detecting pump malfunctions.

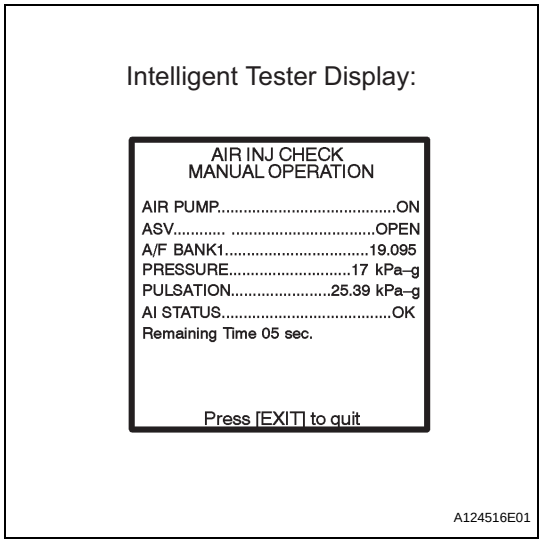
Detected Conditions while AIR operating: Air pump ON, ASV Open	Detected Conditions while AIR not operating: Air pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 1	Case 4	Normal	-
Case 1	Case 2	ASV stuck open	P2440
Case 1	Case 3	Air pump stuck ON	P2444
Case 2	Case 4	Air pump stuck OFF	P2445
Case 3	Case 4	ASV stuck closed	P2441
Case 1	Case 1	ASV stuck open and Air pump stuck ON	P2440 and P2444
Case 2	Case 2	ASV stuck open and Air pump stuck OFF	P2440 and P2445
Case 3	Case 3	ASV stuck closed and Air pump stuck ON	P2441 and P2444

Detected Conditions while AIR operating: Air pump ON, ASV Open	Detected Conditions while AIR not operating: Air pump OFF, ASV Closed	ECM Determination	DTCs Output
Case 4	Case 4	ASV stuck closed and Air pump stuck OFF	P2441 and P2445

HINT:
- If the vacuum hose between the ASV and the pressure sensor is not connected correctly, case 4 may occur.
- By using an intelligent tester to perform the AIR INJ CHECK operation in the SYSTEM CHECK, the air-fuel ratio and the pressure in the secondary air injection system passage can be checked while the secondary air injection system is operating. This helps technicians to troubleshoot the system when it malfunctions. Furthermore, PENDING CODES also can be checked by performing SYSTEM CHECK / AUTOMATIC OPERATION after the repair.
- Read freeze frame data using an intelligent tester. 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.

ES

SYSTEM CHECK:
The pressure in the secondary air passage can be checked using an intelligent tester.
(a) Start the engine and warm it up.



(b) Turn the ignition switch to OFF.
(c) Connect an intelligent tester to the DLC3.
(d) Turn the ignition switch to ON and turn the tester ON.
(e) Select the following menu items:
DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / AP: ON, ASV: OPEN and AP: OFF, ASV CLOSE.
HINT:
When MANUAL OPERATION is selected, the tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.
(f) Start the engine.
(g) Perform the AIR system intrusive operation while the engine is idling.
(h) Check that the air pump (AIR PUMP), ASV and pressure in the AIR system passage (PRESSURE) displayed on the tester, indicate the conditions shown in the table below.

Standard

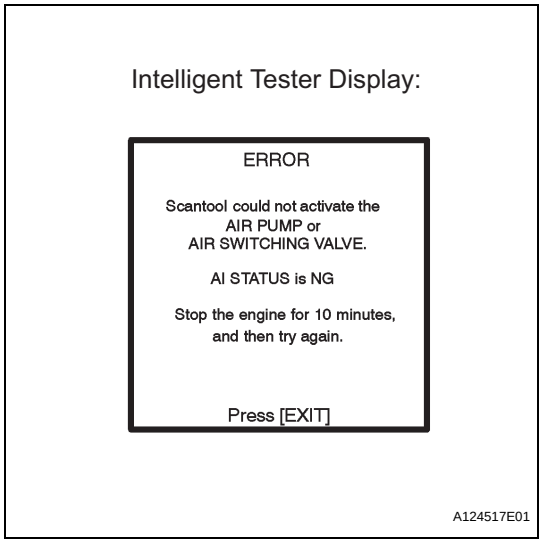
Intelligent Tester Operations	AIR PUMP	ASV	PRESSURE *1	PULSATION *2
AP: ON, ASV: OPEN	ON	OPEN	2.5 kPa or more	11.25 kPa or more

Intelligent Tester Operations	AIR PUMP	ASV	PRESSURE *1	PULSATION *2
AP: OFF, ASV: CLOSE	OFF	CLOSE	Less than 2.5 kPa	Less than 11.25 kPa

*1:
Average pumping pressure (gauge pressure). The pressure should be 2.5 kPa or more when the AIR system operates.

*2:
The cumulative exhaust pulsation calculated by the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

(i) Turn the ignition switch to OFF.



NOTICE:

- **This AIR INJECTION CHECK only allows technicians to operate the AIR system for a maximum of 5 seconds.**
  Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
  While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR as shown in the illustration is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the AIR INJ CHECK repetitively may cause damage to the AIR system. If necessary, leave an interval of several minutes between SYSTEM CHECK operations to prevent the system from overheating.**
- **When performing the AIR INJ CHECK operation after the battery cable has been reconnected, wait for 7 minutes with the ignition switch turned to ON or the engine running.**
- **Turn the ignition switch to OFF when the AIR INJ CHECK operation finishes.**

1	**CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO SECONDARY AIR INJECTION SYSTEM DTCS)**

(a) Connect an intelligent 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.
(d) Read DTCs.

Result

Display (DTC Output)	Proceed To
P2440 and/or P2441	A
P2440 and/or P2441, and P0412	B
P2440 and/or P2441, and other DTCs (except P0412)	C

If any DTCs other than P2440 and/or P2441 are output, troubleshoot those DTCs first.

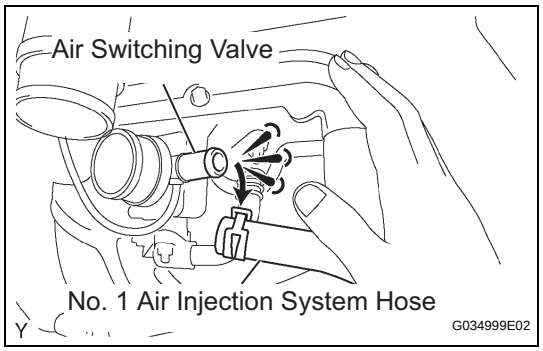
B → **GO TO AIR SWITCHING VALVE INSPECTION PROCEDURE**

C → **GO TO DTC CHART**

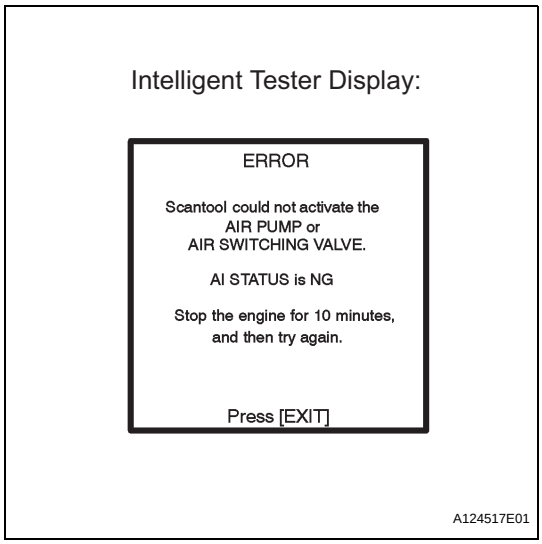
A

ES

2 PERFORM ACTIVE TEST USING INTELLIGENT TESTER



(a) Visual check
  (1) Start the engine and warm it up.
  (2) Turn the ignition switch to OFF.
  (3) Disconnect the No. 1 air injection system hose.
  (4) Connect the intelligent tester to the DLC3.
  (5) Turn the ignition switch to ON and turn the tester ON.
  (6) Select the following menu items:
  DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / AP: ON, ASV: OPEN.
  HINT:
  When MANUAL OPERATION is selected, the tester initialization (atmospheric pressure measurement) is performed automatically. The initialization takes 10 seconds. After the initialization, AP and ASV operation can be selected.
  (7) Start the engine.
  (8) Perform the AIR system intrusive operation while the engine is idling.
  (9) Place your hand near the air switching valve port and check that the exhaust gas pressure pulsates when the ASV is turned ON.
  CAUTION:
  To avoid the danger of being burned by the exhaust gas, bring your hand close to the valve port slowly.
  (10) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / AP: ON, ASV: CLOSE.
  (11) Check that the exhaust gas does not pulsate when the ASV is turned OFF.



(12) Turn the ignition switch to OFF.

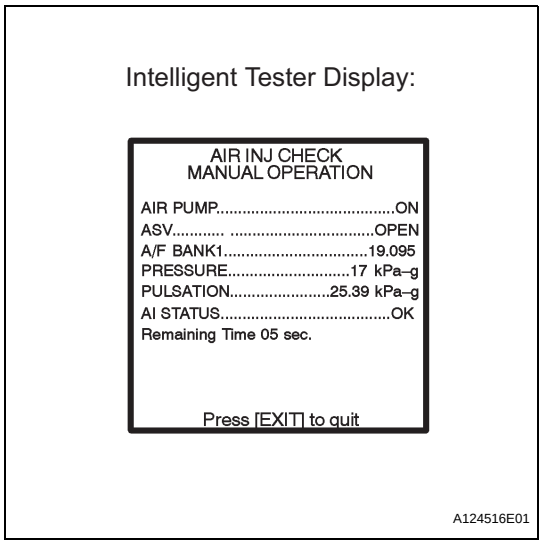
NOTICE:

- **This AIR INJECTION CHECK only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks.**
  While AIR system operation using the intelligent tester is prohibited, the tester display indicates the prohibition (WAIT or ERROR).
  If an ERROR as shown in the illustration is displayed on the tester during the test, stop the engine for 10 minutes, and then try again.
- **Performing the AIR INJ CHECK repetitively may cause damage to the AIR system. If necessary, leave an interval of several minutes between SYSTEM CHECK operations to prevent the system from overheating.**
- **When performing the AIR INJ CHECK operation after the battery cable has been reconnected, wait for 7 minutes with the ignition switch turned to ON or the engine running.**
- **Turn the ignition switch to OFF when the AIR INJ CHECK operation finishes.**

Standard

Air Pump Operations	ASV Operations	Exhaust Gas Pulsation
ON	OFF	Not detected
ON	ON	Detected

(13) Reconnect the No. 1 air injection system hose.
(14) Reconnect the air cleaner hose.



(b) Other inspection method:
The ASV operation can be confirmed by checking the cumulative pressure pulsation* provided in the SYSTEM CHECK.
Perform SYSTEM CHECK operation under MANUAL OPERATION.

*: The exhaust pulsation value is calculated in the ECM. If the calculated value exceeds a certain level, the ECM determines that the exhaust pulsation is in the AIR system.

(1) Start the engine and warm it up.
(2) Turn the ignition switch to OFF.
(3) Connect the intelligent tester to the DLC3.
(4) Turn the ignition switch to ON and turn the tester ON.
(5) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / AP: ON, ASV OPEN and AP: OFF, ASV: CLOSE.

(6) Start the engine after the tester initialization is finished.
(7) Perform the AIR system intrusive operation while the engine is idling.
(8) Check that the air-fuel ratio and pressure in the secondary air injection system passage (PULSATION) displayed on the tester, indicate the conditions shown in the table below.
(9) Turn the ignition switch to OFF.

Result

AIR System Operations	Pulsation Conditions (ECM Calculation)	Air-Fuel Ratio (Reference)
AP: ON, ASV: OPEN	11.25 kPa or more	18 or more
AP: OFF, ASV: CLOSE	Less than 11.25 kPa	Approximately 14.5 (around stoichiometric air-fuel ratio)

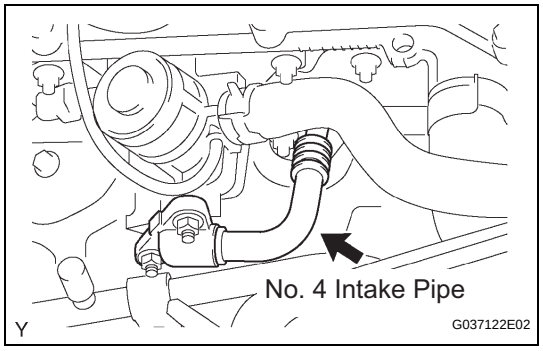
ES

REFERENCE:
If the air pump operation is confirmed as normal (See page ES-368), the air-fuel ratio detected in front of three-way catalytic converter changes in response to the secondary air pumped into the exhaust port when the air pump operates.

OK → **Go to step 9**

NG

3 INSPECT NO.4 INTAKE PIPE (BLOCKAGES AND LEAKAGES)



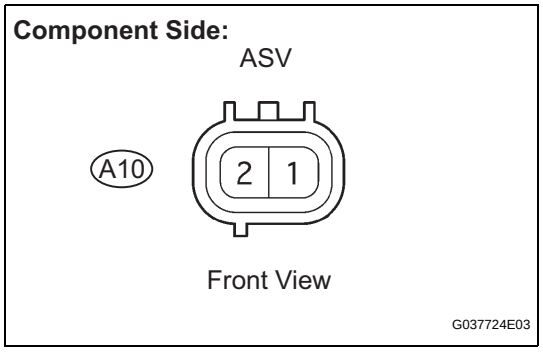
(a) Check that the No. 4 intake pipe is securely connected to both the exhaust manifold and the ASV.
(b) Inspect the No. 4 intake pipe for blockages and damage.
OK:
No blockages and damage on No. 4 intake pipe.

NG → **REPLACE NO.4 INTAKE PIPE**

OK

4 INSPECT AIR SWITCHING VALVE ASSEMBLY (AIR SWITCHING VALVE OPERATION)

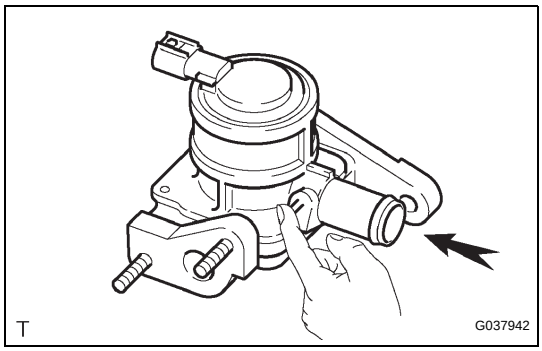
Component Side:



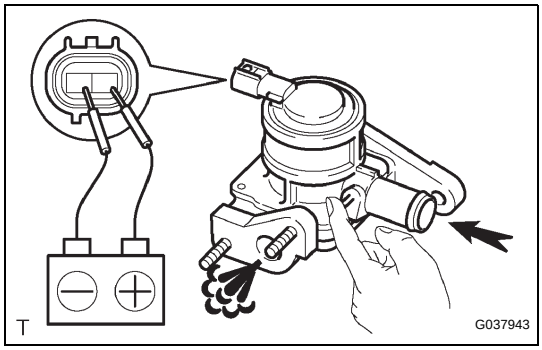
(a) Check the resistance.
(1) Using an ohmmeter, measure the resistance between the terminals.
Standard Resistance

Tester Connections	Specified Conditions
A10-1 - A10-2	3 to 10 Ω at 20°C (68°F)

If the result is not as specified, replace the ASV.



(b) Check the operation.
(1) Check that air does not flow from the ports.

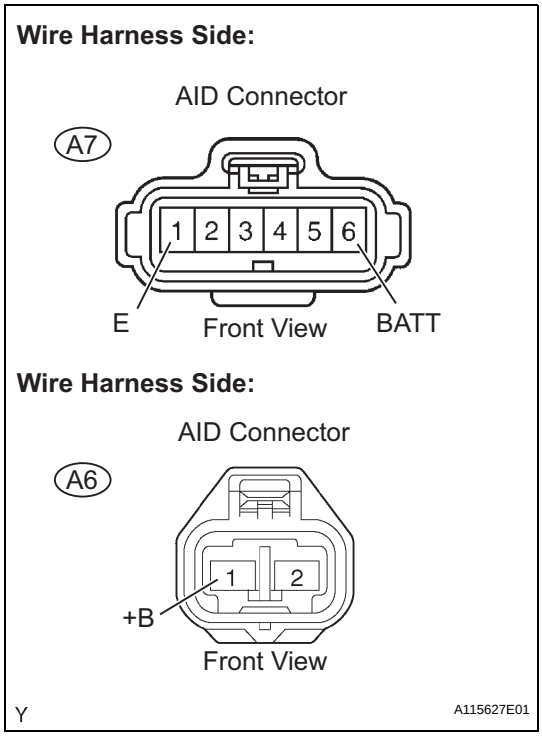


(2) Apply the battery positive voltage across the terminals.
(3) Check that air flows from the ports.
If the operation is not as specified, replace the ASV.
OK:
ASV operates correctly

NG → **REPLACE AIR SWITCHING VALVE ASSEMBLY**

OK

5	INSPECT AIR INJECTION CONTROL DRIVER (POWER SOURCE OF AIR INJECTION CONTROL DRIVER)



(a) Disconnect the A6 and A7 AID connectors.
(b) Turn the ignition switch to ON.
(c) Measure the voltage between the terminals of the AID connector.
Standard Voltage

Tester Connections	Specified Conditions
BATT (A7-5) - Body ground	9 to 14 V (near battery voltage)
+B (A6-1) - Body ground	9 to 14 V (near battery voltage)

(d) Check the resistance.
Standard Resistance (Check for open)

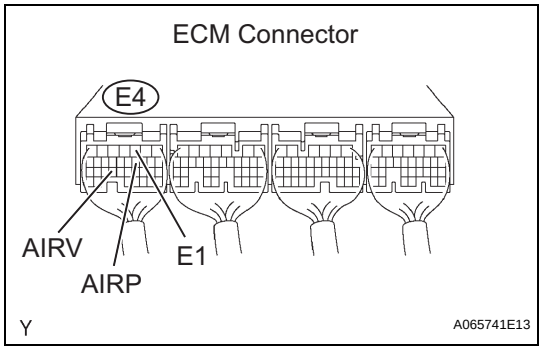
Tester Connections	Specified Conditions
E (A7-1) - Body ground	Below 1 Ω

(e) Reconnect the AID connectors.

NG → **REPAIR OR REPLACE AIR INJECTION CONTROL DRIVER POWER SOURCE CIRCUIT**

OK

6	PERFORM ACTIVE TEST USING INTELLIGENT TESTER



(a) Start the engine and warm it up.
(b) Turn the ignition switch to OFF.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch to ON and turn the tester ON.
(e) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / AP: ON, ASV: OPEN and AP: OFF, ASV: CLOSE.
(f) Start the engine after the tester initialization is finished.
(g) Operate the AIR system using the SYSTEM CHECK function and measure the voltage between the terminals of the ECM connector.
(h) Turn the ignition switch to OFF.

NOTICE:

- **Do not perform the SYSTEM CHECK operation repetitively. It may cause damage to the system. If necessary, leave an interval of several minutes between SYSTEM CHECK operations.**
- **When performing the AIR INJ CHECK operation after the battery cable has been reconnected, wait for 7 minutes with the ignition switch turned to ON or the engine running.**
- **Turn the ignition switch to OFF when the AIR INJ CHECK operation finishes.**

Standard Voltage

Intelligent Tester Operations	Voltmeter Connections	Specified Conditions
AP: ON, ASV: OPEN	AIRP (E4-11) - E1 (E4-3)	3.5 to 7.5 V
AP: OFF, ASV: CLOSE	AIRP (E4-11) - E1 (E4-3)	10 V or more
AP: ON, ASV: OPEN	AIRV (E4-24) - E1 (E4-3)	3.5 to 7.5 V
AP: OFF, ASV: CLOSE	AIRV (E4-24) - E1 (E4-3)	10 V or more

NG → Go to step 11

OK

7	REPLACE AIR INJECTION CONTROL DRIVER

NEXT

8	CHECK WHETHER DTC OUTPUT RECURS (DTC P2440 AND/OR P2441)

(a) Start the engine and warm it up.
(b) Turn the ignition switch to OFF.
(c) Connect the intelligent tester to the DLC3.
(d) Turn the ignition switch to ON and turn the tester ON.
(e) Clear DTCs (where set) (see page ES-40).
(f) Select the following menu items:

DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / AUTOMATIC OPERATION.

(g) Start the engine after the tester initialization is finished.
(h) Perform the SYSTEM CHECK operation by pressing ENTER.
(i) After operating the AIR system, press the ENTER button to confirm the AIR system pending codes.
(j) Check PENDING DTCs.
(k) Turn the ignition switch to OFF.

OK:

No pending DTC output.

NOTICE:

- **When performing the AIR INJ CHECK operation after the battery cable has been reconnected, wait for 7 minutes with the ignition switch turned to ON or the engine running.**
- **Turn the ignition switch to OFF when the AIR INJ CHECK operation finishes.**

ES

NEXT

END

9	INSPECT VACUUM HOSES (AIR SWITCHING VALVE - PRESSURE SENSOR)

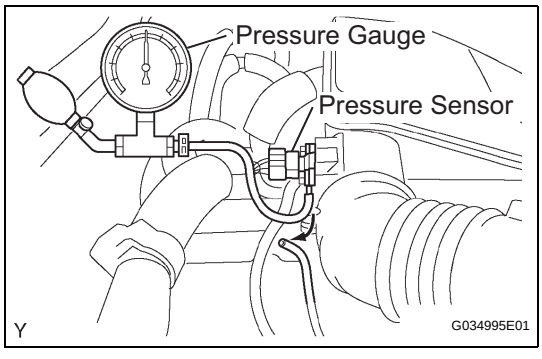
OK:

No blockage and no deformation in vacuum hose.

NG → **REPAIR OR REPLACE VACUUM HOSE**

OK

10	INSPECT ECM (AIP VOLTAGE)



(a) Connect a pressure gauge to the air pressure sensor as shown in the illustration.
(b) Connect the intelligent tester to the DLC3.
(c) Turn the ignition switch to ON and turn the tester ON.
(d) Select the following menu items: DIAGNOSIS / ENHANCED OBD ll / DATA LIST / AIR PMP PRS(A).
(e) Check that the pressure displayed on the tester fluctuates when applying pressure to the pressure sensor with the pressure gauge.

OK:

Pressure fluctuates in response to pressure applied with pressure gauge.

HINT:

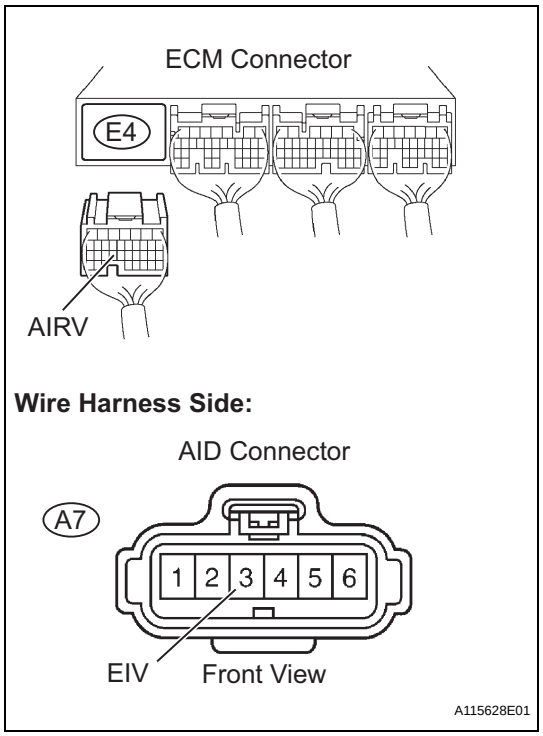
The tester displays the air pump pressure (AIR PMP PRS(A)) as absolute pressure.

NG → **REPLACE PRESSURE SENSOR (TURBO PRESSURE SENSOR)**

OK

CHECK FOR INTERMITTENT PROBLEMS

11 **CHECK HARNESS AND CONNECTOR (ECM - AIR INJECTION CONTROL DRIVER)**



(a) Disconnect the E4 ECM connector.
(b) Disconnect the A7 AID connector.
(c) Check the resistance.
Standard Resistance (Check for open)

Tester Connections	Specified Conditions
AIRV (E4-24) - EIV (A7-3)	Below 1 Ω

(d) Reconnect the ECM and AID connectors.

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

OK

REPLACE ECM

ES