

<b>DTC</b>	<b>P1441</b>	<b>Secondary Air Injection System Switching Valve No.2 Stuck Open Bank 1</b>
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<b>DTC</b>	<b>P1444</b>	<b>Secondary Air Injection System Switching Valve No.2 Stuck Open Bank 2</b>
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<b>DTC</b>	<b>P2440</b>	<b>Secondary Air Injection System Switching Valve Stuck Open Bank 1</b>
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## CIRCUIT DESCRIPTION

Refer to DTC P0412 on page [DI-656](#).

DTC No.	DTC Detection Condition	Trouble Area
P1441	<b>Air switching valve No.2 (bank 1) stuck open:</b> The pressure sensor detects exhaust pulsation, when both of air switching valve No.2 OFF (and air switching valve ON). (2 trip detection logic)	<ul style="list-style-type: none"> <li>• VSV for air injection control circuit (Bank 1)</li> <li>• Air switching valve No.2 (Bank 1)</li> <li>• VSV for air injection system (Bank 1)</li> <li>• ECM</li> </ul>
P1444	<b>Air switching valve No.2 (bank 2) stuck open:</b> The pressure sensor detects exhaust pulsation, when both of air switching valve No.2 OFF (and air switching valve ON). (2 trip detection logic)	<ul style="list-style-type: none"> <li>• VSV for air injection control circuit (Bank 2)</li> <li>• Air switching valve No.2 (Bank 2)</li> <li>• VSV for air injection system (Bank 2)</li> <li>• ECM</li> </ul>
P2440	<b>Air switching valve stuck open:</b> The pressure sensor detects exhaust pulsation when the system is not operate (both of air switching valve No.2 OFF, and air switching valve OFF and air pump OFF). This DTC means open stuck of air switching valve and "air switching valve No.2 bank 1 or bank 2" (1 trip detection logic)	<ul style="list-style-type: none"> <li>• Electromagnetic air switching valve</li> <li>• Air switching valve No.2 (Bank 1 and/or 2)</li> <li>• VSV for air injection system (Bank 1 and/or 2)</li> <li>• Air injection driver</li> <li>• Air injection driver circuit</li> <li>• ECM</li> </ul>

## MONITOR DESCRIPTION

The ECM detects pressure change with the pressure sensor to determine malfunctioning parts in the system, and stores the DTCs. The ECM measures pressure and/or exhaust pulsation of the system at 6 points, A to F, when the air injection system is in operation or when not in operation. When the pressure is high, the ECM determines that the pump operates. When exhaust pulsation is detected, the ECM determines that the ASV is open. The ECM determines malfunction parts based on the measured value, and stores the DTCs.

Points A and B:

ECM detects pressure changes (decrease), and determines that the ASV No.2 is open.

Points C and F:

ECM detects pressure and exhaust pulsation, and determines the pressure pattern of the system.

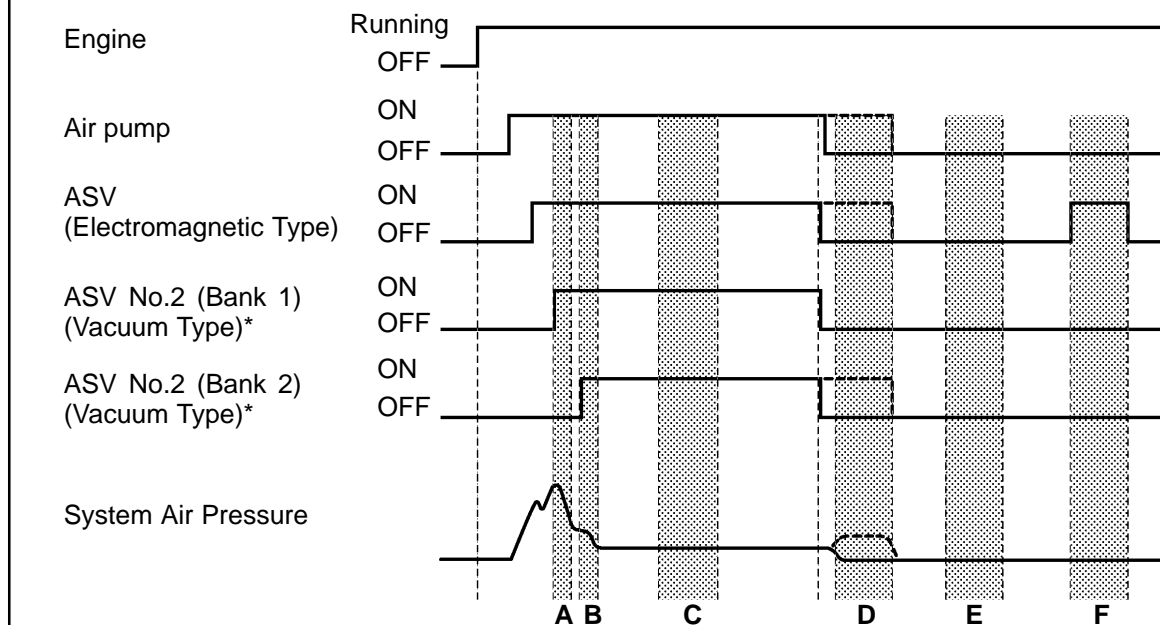
Point D:

ECM operate the system, as indicated by the dashed lines, to determine which of the ASV No.2 is malfunctioning only when pressure changes cannot be detected at point B.

Point E:

ECM detects exhaust pulsation to determine the condition of the system.

### Monitor Operation Outline



N

\*: ASV No.2 opens alternately per a trip.

B17424

### Pressure condition in Secondary Air Injection System

#### Pattern 1:

Air Pump	ON
Air Switching Valve and Air Switching Valve No.2	Open
Pressure	2.5 kPa or more
Pulsation detection	Exhaust gas pulsation detected

**Pattern 2:**

Air Pump	OFF
Air Switching Valve and Air Switching Valve No.2	Open
Pressure	Less than 2.5 kPa
Pulsation detection	Exhaust gas pulsation detected

**Pattern 3:**

Air Pump	ON
Air Switching Valve and Air Switching Valve No.2	Close
Pressure	2.5 kPa or more
Pulsation detection	Slight pulsation detected

**Pattern 4:**

Air Pump	OFF
Air Switching Valve and Air Switching Valve No.2	Close
Pressure	Less than 2.5 kPa
Pulsation detection	Not detected

**Judgement and decision of failure mode:**

Monitor						Judgement
C	F	A	B	D	E	DTCs where set
Pattern 1	Pattern 1	Pressure changed	Pressure changed	–	No pulsation detected	P2444, P1441 and P1443
Pattern 1	Pattern 1	No pressure changed	Pressure changed	–	No pulsation detected	P2444 and P1441
Pattern 1	Pattern 1	Pressure changed	No pressure changed	Pulsation detected	No pulsation detected	P2444 and P1443
Pattern 1	Pattern 1	No pressure changed	No pressure changed	Pulsation detected	No pulsation detected	P2444, P1441 and P1443
Pattern 1	Pattern 2	Pressure changed	Pressure changed	–	No pulsation detected	P1441 and P1443
Pattern 1	Pattern 2	No pressure changed	Pressure changed	–	No pulsation detected	P1441
Pattern 1	Pattern 2	Pressure changed	No pressure changed	Pulsation detected	No pulsation detected	P1443 and P1444
Pattern 1	Pattern 2	No pressure changed	No pressure changed	Pulsation detected	No pulsation detected	P1441, P1443 and P1444
Pattern 1	Pattern 3	Pressure changed	Pressure changed	–	No pulsation detected	P2444
Pattern 1	Pattern 3	No pressure changed	Pressure changed	–	No pulsation detected	P2444 and P1442
Pattern 1	Pattern 3	Pressure changed	No pressure changed	No pulsation detected	No pulsation detected	P2444 and P1442
Pattern 1	Pattern 3	No pressure changed	No pressure changed	No pulsation detected	No pulsation detected	P2444, P1442 and P1444
Pattern 1	Pattern 4	Pressure changed	Pressure changed	–	No pulsation detected	Normal
Pattern 1	Pattern 4	Pressure changed	No pressure changed	Pulsation detected	No pulsation detected	Normal
Pattern 1	Pattern 4	Pressure changed	No pressure changed	No pulsation detected	No pulsation detected	P1444
Pattern 1	Pattern 4	No pressure changed	Pressure changed	–	No pulsation detected	P1442
Pattern 1	Pattern 4	No pressure changed	No pressure changed	Pulsation detected	No pulsation detected	P1442
Pattern 1	Pattern 4	No pressure changed	No pressure changed	No pulsation detected	No pulsation detected	P1442 and P1444
Pattern 2	–	No pressure changed	No pressure changed	–	No pulsation detected	P2445
Pattern 3	Pattern 3	No pressure changed	No pressure changed	No pulsation detected	No pulsation detected	P2441, P2444, P1442 and P1444
Pattern 3	Pattern 4	No pressure changed	No pressure changed	No pulsation detected	No pulsation detected	P2441, P1442 and P1444
Pattern 4	–	No pressure changed	No pressure changed	–	–	P2445
–	–	–	–	–	Pulsation detected	P2440 and "P1441 or P1444"

## MONITOR STRATEGY

Related DTCs	P1441	AIR VSV (Bank 1) is stuck open (case 1)
	P1444	AIR VSV (Bank 2) is stuck open (case 2)
	P1441, P1444	AIR VSVs stuck open (case 3)
	P2440	AIR valve stuck open (case 4)
	P2440	AIR valve and AIR VSVs stuck open (case 5)
Required sensors/components	AIR pressure sensor, AIR valve, AIR VSV (Bank 1), AIR VSV (Bank 2)	
Frequency of operation	Once per driving cycle	
Duration	Within 60 seconds	
MIL operation	P1441, P1444: 2 driving cycles P2440: 1 driving cycle	
Sequence of operation	None	

## TYPICAL ENABLING CONDITIONS

### P1441, P1444: Air switching valve No. 2 bank 1 and/or bank 2 are stuck open

Item	Specification	
	Minimum	Maximum
The monitor will run whenever these DTCs are not present	See page <a href="#">DI-437</a>	
<b>Conditions for case 1, case 2, and case 4:</b>		
Atmospheric pressure	45 kPa (338 mmHg)	–
Battery voltage	11.5 V	–
Sequence 1 to 6 are performed to monitor AIR	–	
Sequence 1	–	
AIR	In operation	
AIR pump	ON	
AIR valve (Electric type)	ON	
Either of the following conditions is met:	Condition 1 or 2	
1. Both of the following conditions are met:	Condition (a) and (b)	
(a) AIR valve (vacuum type) bank 1	ON	
(b) AIR valve (vacuum type) bank 2	OFF	
2. Both of the following conditions are met:	Condition (c) and (d)	
(c) AIR valve (vacuum type) bank 1	OFF	
(d) AIR valve (vacuum type) bank 2	ON	
Idle	ON	
Sequence 2	–	
AIR valve (Electric type)	ON	
AIR valve (vacuum type) bank 1	ON	
AIR valve (vacuum type) bank 2	ON	
Idle	ON	
Sequence 3	–	
AIR pump	ON	
AIR valve (Electric type)	ON	
AIR valve (vacuum type) bank 1	ON	
AIR valve (vacuum type) bank 2	ON	

## DIAGNOSTICS – ENGINE (2UZ-FE)

Engine RPM	–	3750 rpm
Sequence 4 (This sequence is run when AIR pressure is no change at monitor)	–	
AIR	Not operating	
AIR pump	ON	
AIR valve (Electric type)	ON	
Either of the following conditions is met:	Condition 1 or 2	
1. Both of the following conditions are met:	Condition (a) and (b)	
(a) AIR valve (vacuum type) bank 1	ON	
(b) AIR valve (vacuum type) bank 2	OFF	
2. Both of the following conditions are met:	Condition (c) and (d)	
(c) AIR valve (vacuum type) bank 1	OFF	
(d) AIR valve (vacuum type) bank 2	ON	
Engine RPM	–	3750 rpm
Sequence 5	–	
AIR	Not operating	
AIR pump	OFF	
AIR valve (Electric type)	OFF	
AIR valve (vacuum type) bank 1	OFF	
AIR valve (vacuum type) bank 2	OFF	
Engine RPM	–	3750 rpm
Sequence 6	–	
AIR status	Not operating	
AIR pump	OFF	
AIR valve (Electric type)	ON	
AIR valve (vacuum type) bank 1	OFF	
AIR valve (vacuum type) bank 2	OFF	
Engine RPM	–	3750 rpm
<b>Conditions for case 3:</b>		
Atmospheric pressure	45 kPa (338 mmHg)	–
Battery voltage	11.5 V	–
AIR pump	OFF	
Time after engine start	10 seconds	–
AIR VSV bank 1	OFF	
AIR VSV bank 2	OFF	
AIR status	OFF	
Engine load	0 %	–
Intake air amount	40 g/sec.	–
IAT at engine start	–15°C (5°F)	–
ECT at engine start	–	5°C (41°F)
AIR valve (Electric type)	ON	
Engine RPM	–	3750 rpm
<b>Conditions for case 5:</b>		
Cumulative intake air amount	172 g/sec.	–
AIR pump	OFF	
AIR valve	OFF	

AIR VSV bank 1	OFF	
AIR VSV bank 2	OFF	
Engine RPM	–	3750 rpm
AIR pressure sensor malfunction (open circuit, out of range)	Not detected	
AIR status	OFF	

## TYPICAL MALFUNCTION THRESHOLDS

Detection Criteria	Threshold
<b>Thresholds for case 1</b>	
Both of the following conditions are met:	Condition 1 or 2
1. One of the following conditions is met:	Condition (a), (b) or (c)
(a) All of the following conditions are met:	–
AIR pressure during monitor sequence 3	1 kPa (7.5 mmHg) or more and pulse is generated
AIR pressure during monitor sequence 6	Less than 5 kPa (37.5 mmHg) and pulse is generated
(b) All of the following conditions are met:	–
AIR pressure during monitor sequence 3	1 kPa (7.5 mmHg) or more and pulse is generated
AIR pressure during monitor sequence 6	5 kPa (37.5 mmHg) or more and pulse is generated
(c) All of the following conditions are met:	–
AIR pressure during monitor sequence 3	Less than 1 kPa (7.5 mmHg) and pulse is generated
AIR pressure during monitor sequence 6	Less than 5 kPa (37.5 mmHg) and pulse is generated
2. One of the following conditions is met:	Condition (d), (e) or (f)
(d) All of the following conditions are met:	–
AIR pressure during monitor sequence 1	Change
AIR pressure during monitor sequence 2	Change
(e) AIR pressure during monitor sequence 1 (when AIR VSV bank 1 is open)	No change
(f) AIR pressure during monitor sequence 2 (when AIR VSV bank 1 is open)	No change
<b>Thresholds for case 2</b>	
Both of the following conditions are met:	Condition 1 or 2
1. One of the following conditions is met:	Condition (a), (b) or (c)
(a) All of the following conditions are met:	–
AIR pressure during monitor sequence 3	1 kPa (7.5 mmHg) or more and pulse is generated
AIR pressure during monitor sequence 6	Less than 5 kPa (37.5 mmHg) and pulse is generated
(b) All of the following conditions are met:	–
AIR pressure during monitor sequence 3	1 kPa (7.5 mmHg) or more and pulse is generated
AIR pressure during monitor sequence 6	5 kPa (37.5 mmHg) or more and pulse is generated
(c) All of the following conditions are met:	–
AIR pressure during monitor sequence 3	Less than 1 kPa (7.5 mmHg) and pulse is generated
AIR pressure during monitor sequence 6	Less than 5 kPa (37.5 mmHg) and pulse is generated
2. One of the following conditions is met:	Condition (d), (e) or (f)
(d) All of the following conditions are met:	–
AIR pressure during monitor sequence 1	Change
AIR pressure during monitor sequence 2	Change

(e) AIR pressure during monitor sequence 1 (when AIR VSV bank 2 is open)	No change
(f) AIR pressure during monitor sequence 2 (when AIR VSV bank 1 is open)	No change
<b>Thresholds for case 3</b>	
AIR pressure	Pulse is generated
<b>Thresholds for case 4</b>	
Both of the following conditions are met:	–
AIR pressure during monitor sequence 3	Less than 1 kPa (7.5 mmHg) and pulse is generated
AIR pressure during monitor sequence 5	No pulse is generated
<b>Thresholds for case 5</b>	
AIR pressure change	Pulse is generated

## MONITOR RESULT

Refer to page [DI-445](#) 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 (refer to "Confirmation Monitor").

- MID (Monitor Identification Data) is assigned to each emissions-related component.
- TID (Test Identification Data) is assigned to each test value.
- Scaling is used to calculate the test value indicated on generic tools.

### Secondary air injection (AIR) system

MID	TID	Scaling	Description of Test Value	Minimum Test Limit	Maximum Test Limit
\$71	\$E1	Multiply by 0.01 (g/s)	Test value of AIR amount insufficient	Minimum test limit	Maximum test limit
\$71	\$E2	Multiply by 0.01 (kPa)	Test value of AIR pump stuck ON	Minimum test limit	Maximum test limit
\$71	\$E3	Multiply by 0.01 (kPa)	Test value of AIR pump stuck OFF	Minimum test limit	Maximum test limit
\$71	\$E4	Multiply by 0.01 (kPa)	Test value of AIR control valve ON	Minimum test limit	Maximum test limit
\$71	\$E5	Multiply by 0.01 (kPa)	Test value of AIR control valve OFF	Minimum test limit	Maximum test limit
\$71	\$E6	Multiply by 0.01 (kPa)	Test value of AIR pressure change for AIR valve	Minimum test limit	Maximum test limit
\$71	\$E7	Multiply by 0.01 (kPa)	Test value of AIR pressure change for AIR VSV bank 1	Minimum test limit	Maximum test limit
\$71	\$E8	Multiply by 0.01 (kPa)	Test value of AIR pressure change for AIR VSV bank 2	Minimum test limit	Maximum test limit
\$71	\$E9	Multiply by 0.01 (kPa)	Test value of AIR pressure pulsation for AIR VSV when AIR pressure is low	Minimum test limit	Maximum test limit

## WIRING DIAGRAM

Refer to DTC P0412 on page [DI-656](#).

## INSPECTION PROCEDURE

1	Check any other DTCs output (In addition to secondary air injection system DTCs).
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### PREPARATION:

- (a) Connect 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.

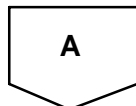
### RESULT:

Display (DTC Output)	Proceed To
"P1441 and/or P1444" and P2440	A
P1441 and/or P1444	B
"P1441 and/or P1444 and/or P2440" and other DTCs	C

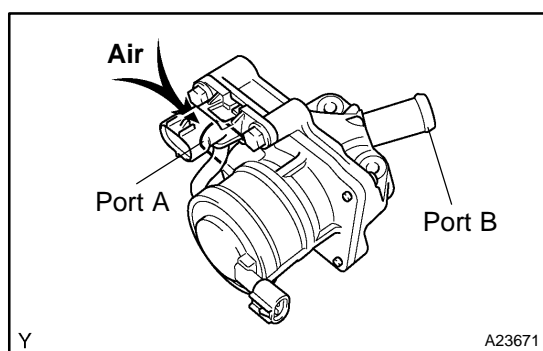
### HINT:

If any DTCs other than P1441, P1444 or P2440 are output, troubleshoot those DTCs first.

B	Go to step 7.
C	Go to DTC chart (See page <a href="#">DI-462</a> ).



2	Check air switching valve operation.
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### PREPARATION:

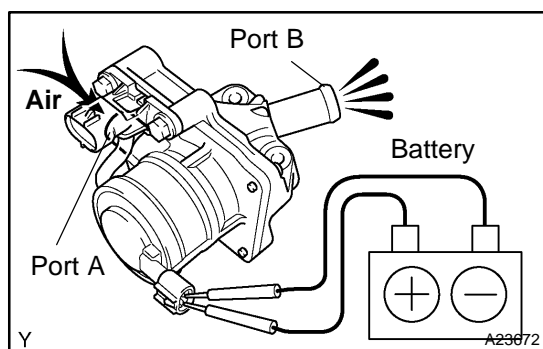
- (a) Remove the intake manifold (see page [EM-36](#)).
- (b) Remove the air switching valve.

### CHECK:

Blow air into port A and check that air is not discharged from port B.

### OK:

**Not discharged**



### CHECK:

- (a) Apply battery positive across the terminals.
- (b) Blow air into port A and check that air is discharged from port B.

### OK:

**Discharged**



NG

Replace air switching valve and go to step 7.

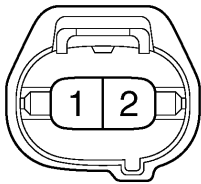
OK

3

Check voltage between terminal 1 of air switching valve and body ground.

Wire Harness Side:

A31



Air Switching Valve Connector

N

B17440

**PREPARATION:**

- (a) Remove the intake manifold (see page [EM-36](#)).
- (b) Disconnect the A31 air switching valve connector.
- (c) Turn the ignition switch ON.

**CHECK:**

Measure the voltage between terminal 1 of the air switching valve connector and body ground.

**OK:**

**Standard:**

Tester Connection	Specified Condition
A31-1 – Body ground	Below 1.0 V

NG

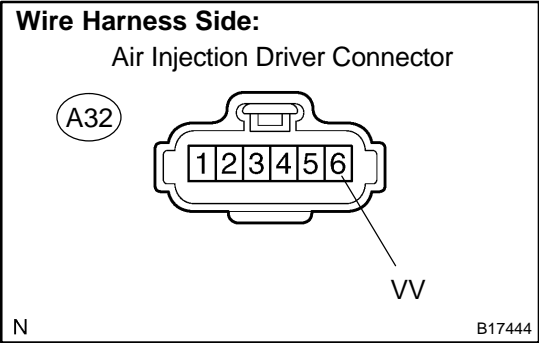
Go to step 4.

OK

Check for intermittent problems  
(See page [DI-430](#)) and go to step 7.

4

Check for open and short in harness and connector between air injection driver and air switching valve.



**PREPARATION:**

- (a) Remove the intake manifold (see page EM-36).
- (b) Disconnect the A32 air injection driver connector.
- (c) Disconnect the A31 air switching valve connector.
- (d) Disconnect the battery positive terminal cable.

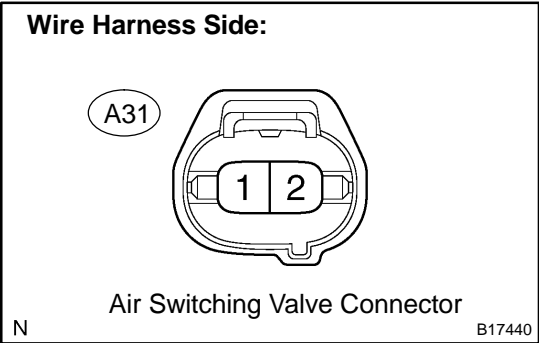
**CHECK:**

Measure the resistance between the wire harness side connectors.

**OK:**

**Standard:**

Tester Connection	Specified Condition
VV (A32-6) – A31-1	Below 1 $\Omega$
VV (A32-6) or A31-1 – Battery positive terminal cable	10 k $\Omega$ or higher



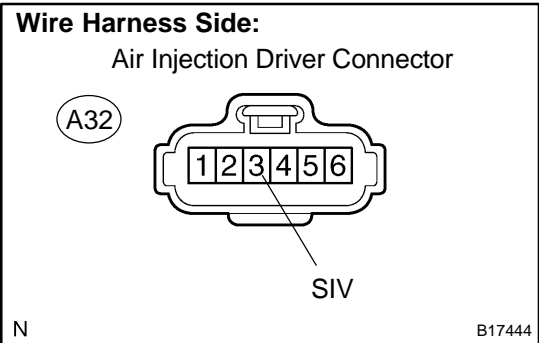
NG

Repair or replace harness or connector.

OK

5

Check voltage between SIV terminal of air injection driver and body ground.



**PREPARATION:**

- (a) Disconnect the A32 air injection driver connector.
- (b) Turn the ignition switch ON.

**CHECK:**

Measure the voltage between terminal 3 (SIV) of the air injection driver connector and body ground.

**OK:**

**Standard:**

Tester Connection	Specified Condition
3 (SIV) – Body ground	10 V or more

NG

Go to step 6.

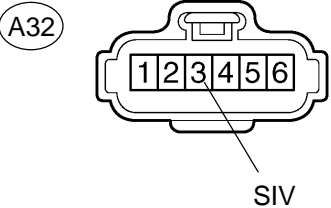
OK

Replace air injection driver.

**6** Check for open and short in harness and connector between air injection driver and ECM.

**Wire Harness Side:**

Air Injection Driver Connector



N

B17444

**PREPARATION:**

- (a) Disconnect the air injection driver connector.
- (b) Disconnect the E3 ECM connector.

**CHECK:**

Measure the resistance between the wire harness side connectors.

**OK:**

**Standard:**

Tester Connection	Specified Condition
SIV (A32-3) – AIRV (E3-4)	Below 1 $\Omega$
SIV (A32-3) or AIRV (E3-4) – Body ground	10 k $\Omega$ or higher

N

B17417

**NG**

Repair or replace harness or connector.

**OK**

Replace ECM (See page [SF-82](#)).

## 7 Check air switching valve No.2 operation.

```

AIR INJ CHECK
AIR PUMP.....ON
EASV .....OPEN
ASV1. ....OPEN
ASV2.....OPEN
A/F BANK1.....19.05
A/F BANK2.....14.5
PRESSURE.....17kPa
PULSATION.....25.39 kPa
AI STATUS.....OK
Remaining Time 05 sec.

Press [EXIT] to quit

```

A16555

**PREPARATION:**

- Start the engine and warm it up.
- Turn the ignition switch to OFF.
- Connect the hand-held tester to the DLC3.
- Start the engine and push the hand-held tester main switch ON.

**CHECK:**

- Select the following menu items: DIAGNOSIS/ENHANCED OBD II/SYSTEM CHECK/ AIR INJ CHECK/ MANUAL OPERATION/OPERATION 5 and 6

**HINT:**

OPERATION 5: AP:ON, EASV:OPEN, ASV1:OPEN, ASV2:CLOSE

OPERATION 6: AP:ON, EASV:OPEN, ASV1:CLOSE, ASV2:OPEN

**NOTICE:**

**This test only allows technicians to operate the AI system for 5 seconds. Furthermore, the test can be performed 4 times a trip. If the test is repeated, intervals of at least 30 seconds are required between tests.**

**While the AI system operation using the hand-held tester is prohibited, the tester displays the prohibition (WAIT or ERROR). If the ERROR (AI STATUS NG) is displayed on the tester, stop the engine for 10 minutes and then try again..**

- Read values of the A/F BANK1 and BANK2 on the hand-held tester.

**RESULT:**

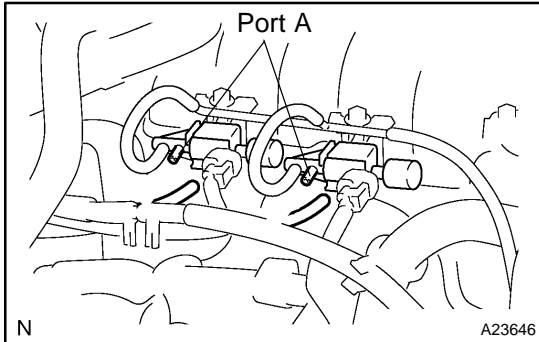
Air switching valve No.2 operation	Air-fuel ratio
Open	18 or more
Close	Approximately 14.5

**HINT:**

- When the ASV No.2 operates normally, the A/F value is 18 or more when the valve is open, and approximately 14.5 when the valve is closed.
- Perform the following procedures only on the bank of which the valve is not close.

**NEXT**

# 8 Check VSV for air injection control operation.



## PREPARATION:

- Turn the ignition switch OFF.
- Disconnect the vacuum hose from the VSV for air injection control.
- Connect the hand-held tester to the DLC3.
- Start the engine and turn the tester ON.

## CHECK:

- Select the following menu items: DIAGNOSIS/ENHANCED OBD II/SYSTEM CHECK/ AIR INJ CHECK/ MANUAL OPERATION/OPERATION 1
- At this time, check that no negative pressure generates at port A of the VSV.

## HINT:

OPERATION 1: AP: OFF, EASV:CLOSE, ASV1:CLOSE, ASV2:CLOSE

## NOTICE:

This test only allows technicians to operate the AI system for 5 seconds. Furthermore, the test can be performed 4 times a trip. If the test is repeated, intervals of at least 30 seconds are required between tests.

While the AI system operation using the hand-held tester is prohibited, the tester displays the prohibition (WAIT or ERROR). If the ERROR (AI STATUS NG) is displayed on the tester, stop the engine for 10 minutes and then try again..

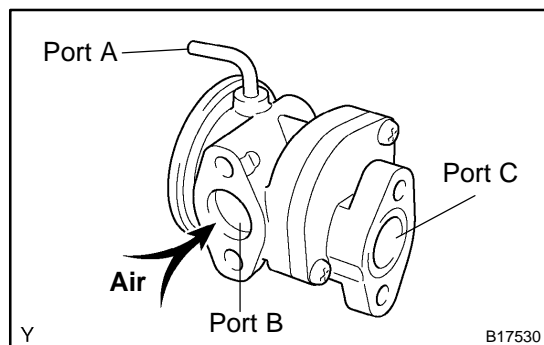
## OK:

No negative pressure is generated.

NG

Go to step 10.

OK

**9 Check air switching valve No.2 operation.****PREPARATION:**

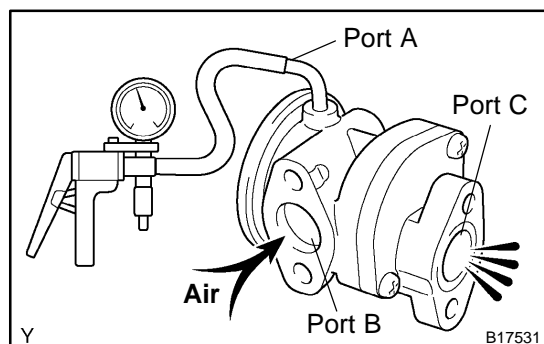
Remove the air switching valve No.2.

**CHECK:**

Blow air into port B and check that air is not discharged from port C.

**OK:**

**Not discharged from port C**

**CHECK:**

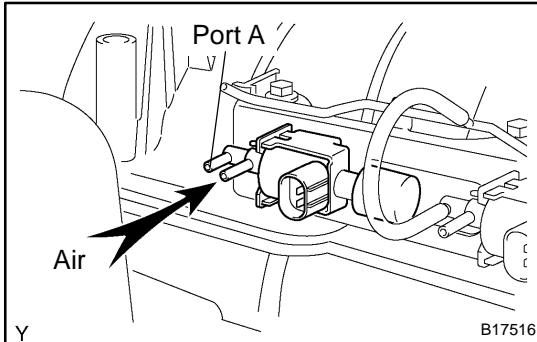
Apply vacuum 30 kPa (225 mmHg) to port A, blow air into port B and check that air is discharged from port C.

**OK:**

**Discharged from port C**

**NG****Replace air switching valve No.2.****OK**

**Check for intermittent problems  
(See page [DI-430](#)).**

**10 Check VSV for air injection control.****PREPARATION:**

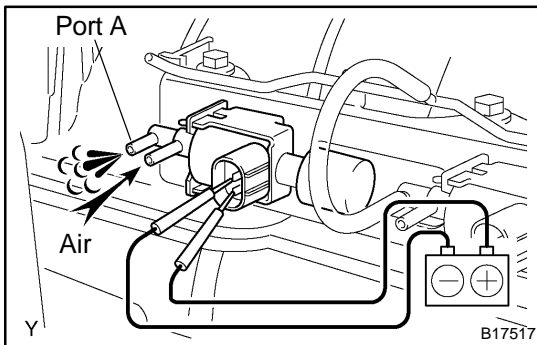
Disconnect the connector from the VSV for air injection control.

**CHECK:**

Check that air does not flow from the port as shown in the illustration.

**OK:**

**Does not flow from port A**

**CHECK:**

Apply battery positive across the terminals, check that air flows from the ports.

**OK:**

**Flows from port A**

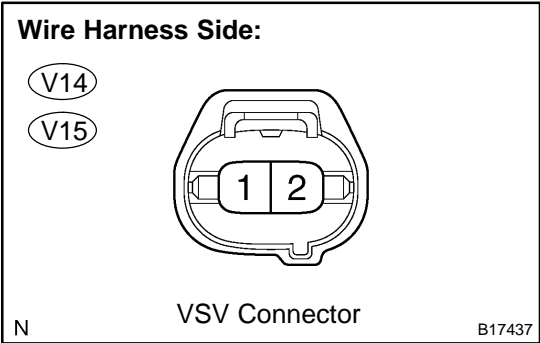
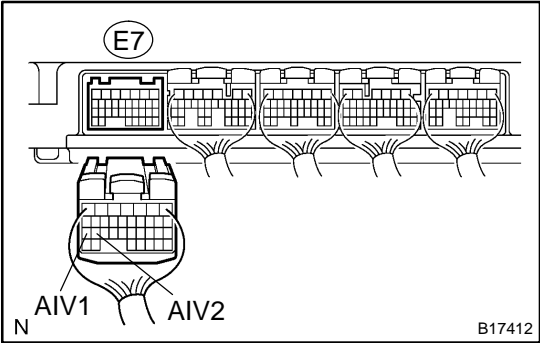
**NG**

**Replace VSV for air injection control.**

**OK**

11

Check for open and short circuit in harness and connector between ECM and VSV for air injection system control



PREPARATION:

- (a) Remove the intake manifold (see page EM-36).
- (b) Disconnect the E7 ECM connector.
- (c) Disconnect the VSV for air injection system control connector.

CHECK:

Measure the resistance between the VSV connector and ECM.

OK:

Standard:

Tester connection	Specified condition
E7-27 (AIV1) – V14-2	Below 1 Ω
E7-26 (AIV2) – V15-2	Below 1 Ω

CHECK:

Measure the resistance between the VSV connector and body ground.

OK:

Standard:

Tester connection	Specified condition
E7-27 (AIV1) or V14-2 and Body ground	10 KΩ or higher
E7-26 (AIV2) or V15-2 and Body ground	10 KΩ or higher

NG

Repair or replace harness or connector.

OK

Replace ECM (See page SF-82).