

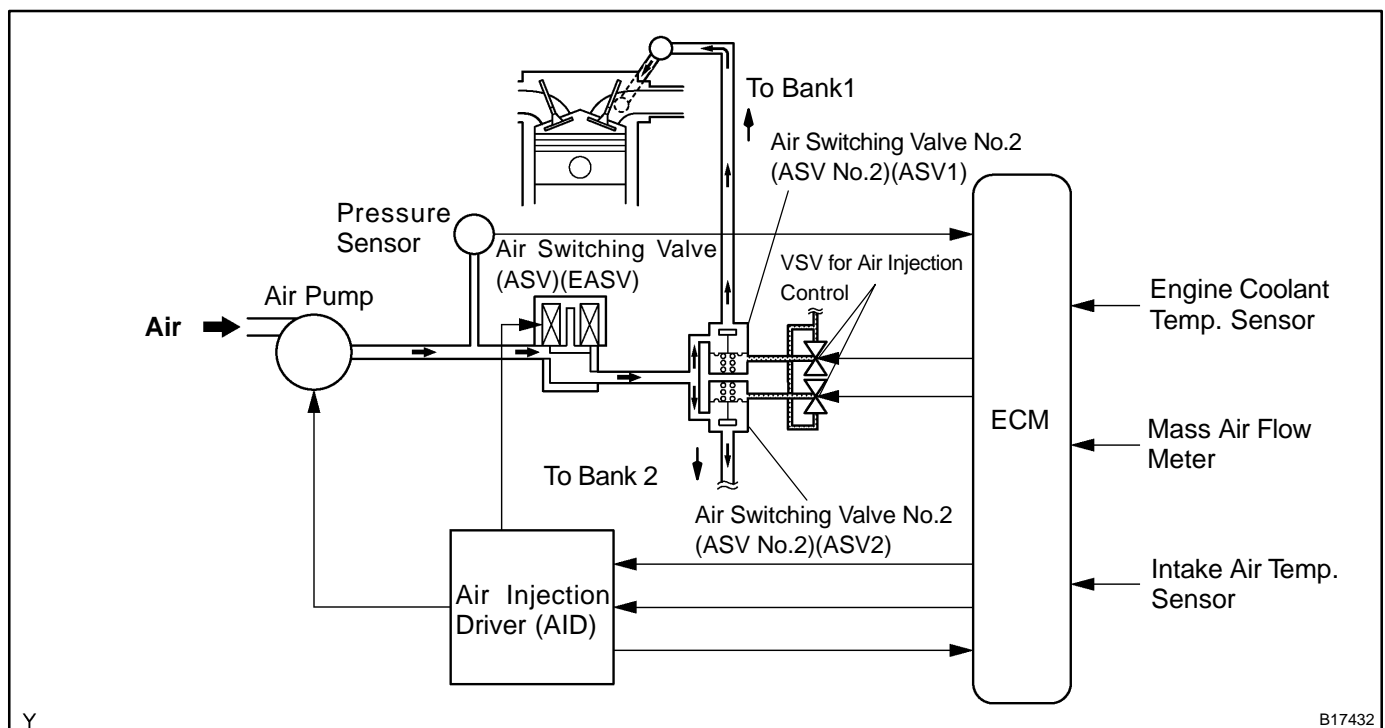
DTC	P0412	Secondary Air Injection System Air Switching Valve "A" Circuit
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CIRCUIT DESCRIPTION

The secondary air injection system pumps air to the exhaust port to accelerate the activation of the catalyst. The secondary air injection system consists of the ECM, air pump, Air Switching Valve (ASV) (EASV), Air Switching Valve No.2 (ASV No.2) (ASV1, 2), pressure sensor and air injection driver (AID). The Air Switching Valve (ASV)(EASV) is an electromagnetic type and Air Switching Valve No.2 (ASV No.2)(ASV1,2) is a vacuum type.

The secondary air injection system pumps pressurized air to the exhaust port by the air pump through the ASV and ASV No.2. The ASV assists the ASV No.2. The ASV No.2 also controls air supply.

The ECM sends signals to the AID, and then the AID operates the air pump and ASV. The pressure sensor detects pressure and exhaust pulsation in the system when the system operates and when it does not operate, and sends the data to the ECM.



DTC No.	DTC Detection Condition	Trouble Area
P0412	All of the following conditions are met when engine is idling just after cold start (1 trip detection logic): (a) Air injection system does not operate (Air pump OFF and all ASVs OFF) (b) Air injection driver diagnostic signal duty is 40%.	<ul style="list-style-type: none"> • Open in air switching valve drive circuit • Short between air switching valve circuit and +B circuit • Air injection driver • Air switching valve • ECM
P0412	All of the following conditions are met when engine is idling just after cold start (1 trip detection logic): (a) Air injection system operates (Air pump ON and all ASVs ON) (b) Air injection driver diagnostic signal duty is 40%.	<ul style="list-style-type: none"> • Short between air switching valve circuit and body ground • Air injection driver • Air switching valve • ECM

MONITOR DESCRIPTION

The air injection driver (AID) detects an open or short in the circuit according to the voltage of the air pump terminal (VP) and electromagnetic air switching valve terminal (VV), and sends a signal as diagnostic information to the ECM.

The AID outputs the air switching valve terminal malfunction signal to the ECM if: 1) VV terminal voltage is low despite the AID receiving the command signal from the ECM to drive the air switching valve terminal or 2) VV terminal voltage is high despite the AID not receiving the command signal from the ECM.

The ECM stores the DTC based on the diagnostic signal from the AID and illuminates the MIL.

MONITOR STRATEGY

Related DTCs	P0412	Air switching valve circuit malfunction (Secondary air injection system)
Required sensors/components	Air injection driver, Air switching valve	
Frequency of operation	Continuous	
Duration	3 sec.	
MIL operation	Immediate	
Sequence of operation	None	

TYPICAL ENABLING CONDITIONS

Item	Specification	
	Minimum	Maximum
The monitor will run whenever this DTC is not present	See page DI-437	
Case 1:		
Air pump	Operating	
Air switching valve	Operating	
Battery voltage	8 V	–
Ignition switch	ON	
Starter	OFF	
Case 2:		
Air pump	Not operating	
Air switching valve	Not operating	
Battery voltage	8 V	–
Ignition switch	ON	
Starter	OFF	

TYPICAL MALFUNCTION THRESHOLDS

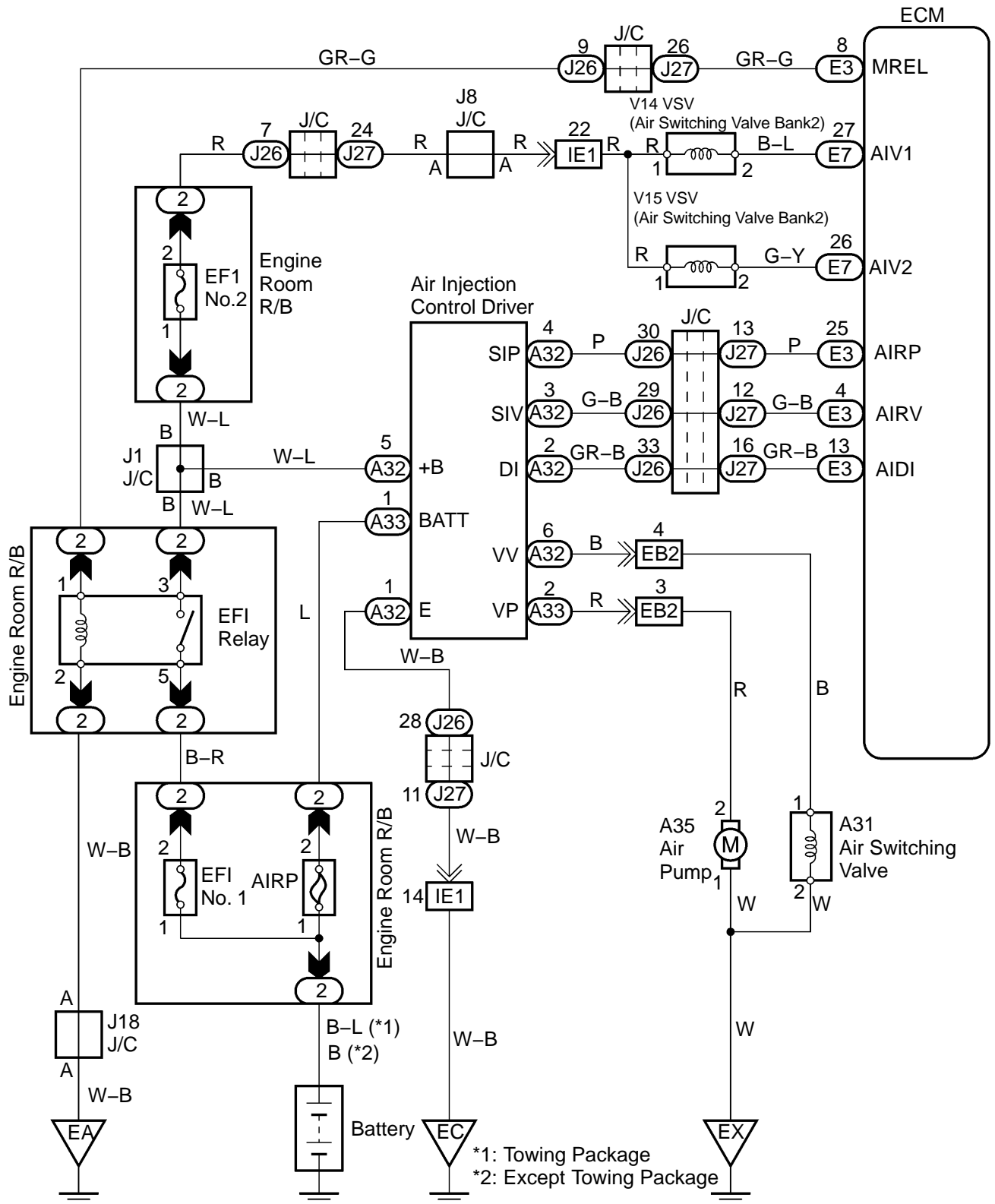
Detection Criteria	Threshold
Case 1, 2:	
Diagnostic signal duty ratio from air injection driver	31 to 48 %

COMPONENT OPERATING RANGE

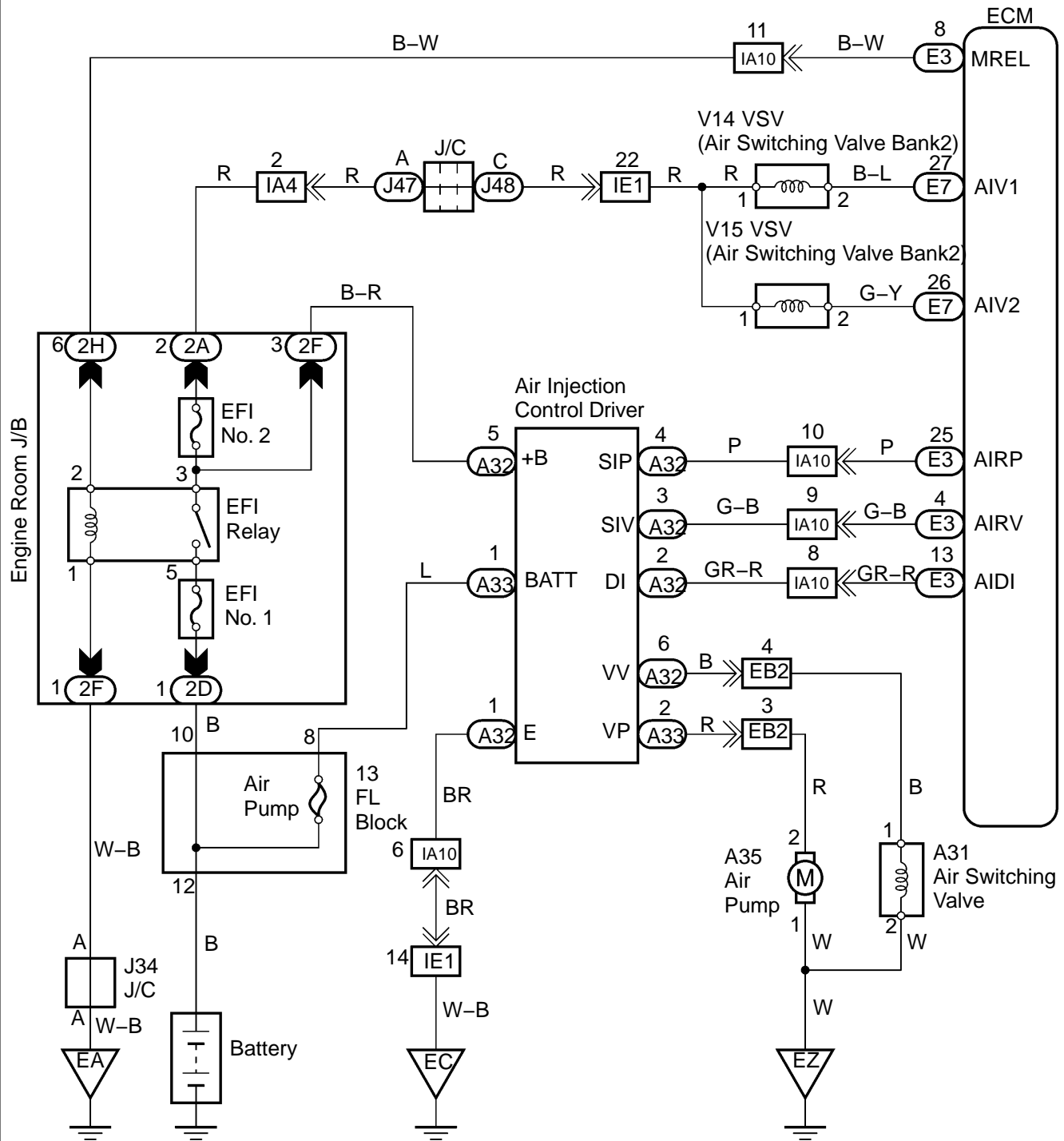
Parameter	Standard Value
Diagnostic signal duty ratio from air injection driver	70 to 90% when secondary air injection system operating and 0% when secondary air injection system not operating

WIRING DIAGRAM

Access Cab, Standard Cab:



Double Cab:



C

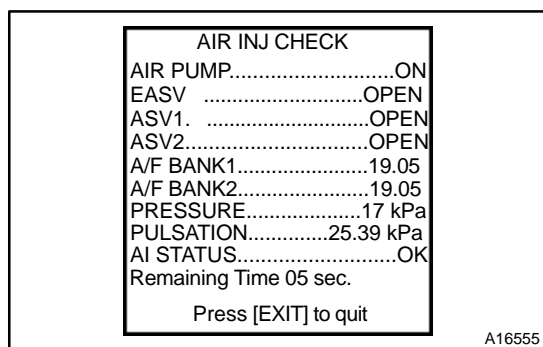
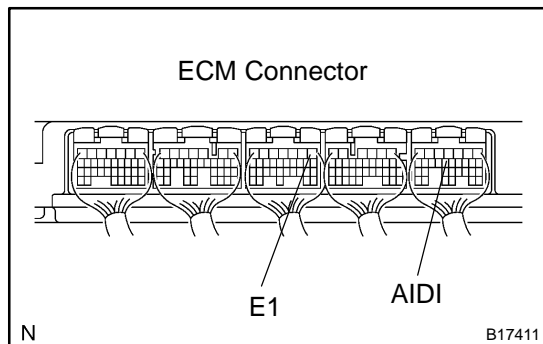
A23643

INSPECTION PROCEDURE

HINT:

The diagnostic information output from AID can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. It narrows a trouble area search to read the waveform on the oscilloscope when performing the AI system intrusive operation function provided in the SYSTEM CHECK.

- (1) Start the engine and warm it up.
- (2) Turn the ignition switch to OFF.
- (3) Connect a hand-held tester to the DLC3.
- (4) Connect an oscilloscope probe to the AIDI terminal of the ECM.
- (5) Start the engine and turn the tester ON.

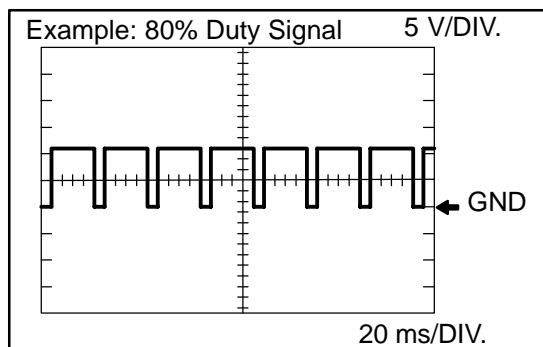


- (6) On the tester, select the following menu items:
DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / OPERATION 1 and 2.

HINT:

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

OPERATION 2: AP: ON, EASV:OPEN, ASV1:OPEN, ASV2:OPEN



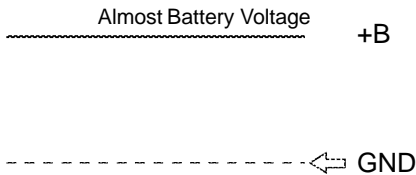
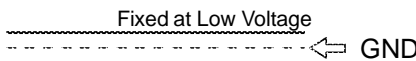
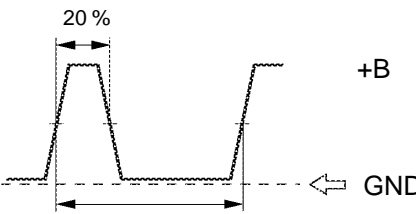
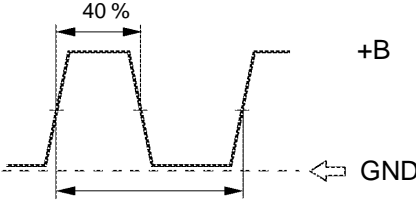
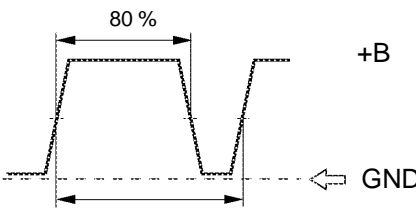
- (7) Monitor the voltage output of the AID (duty ratio signal).

Oscilloscope range:

Items	Contents
Terminals	CH1: AIDI – E1
Equipment Settings	5 V/Division, 20 to 40 ms/Division
Conditions	Idling

NOTICE:

- This AIR INJECTION CHECK only allows technicians to operate the AI system for 5 seconds. Furthermore, the check can be performed 4 times a trip. If the test is repeated, intervals of at least 30 seconds are required between checks.
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.
- Performing the AIR INJ CHECK over and over again may cause the damage in the secondary air injection system. If necessary, put an interval of several minutes between tests to prevent overheating the system.

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100 % Duty ratio 	Any Air Injection (AI) System operation	P1613	<ul style="list-style-type: none"> • Open in diagnostic signal circuit • Air Injection Control Driver (AID) • Open in AID+B circuit (AID power source) • Short between +B circuit and diagnostic signal circuit
0 % Duty ratio 	AI System: ON (Air pump ON, ASV ON)	P1613	<ul style="list-style-type: none"> • Open or short in air pump or Air Switching Valve (ASV) command signal circuit (ECM-AID) • Open in AID ground circuit • Short between diagnostic signal circuit and body ground • AID • ECM
	AI System: OFF (Air pump OFF, ASV OFF)	—	Normal
20 % Duty ratio 	Air Pump: ON	P0418	Short between air pump drive circuit and body ground <ul style="list-style-type: none"> • Harness & connector (AID-Pump) • Air Pump • AID • ECM
	Air Pump: OFF	P0418	Open in air pump drive circuit (AID-Pump), or short between air pump drive circuit and +B <ul style="list-style-type: none"> • Harness & connector (AID-Pump) • Air Pump • AID • ECM
40 % Duty ratio 	ASV: ON	P0412	Short between ASV drive circuit and body ground <ul style="list-style-type: none"> • Harness & connector (AID-ASV) • ASV • AID • ECM
	ASV: OFF	P0412	Open in ASV drive circuit (AID-ASV), or short between ASV drive circuit and +B <ul style="list-style-type: none"> • Harness & connector (AID-ASV) • AID • ASV • ECM
80 % Duty ratio 	AI System: OFF (Air pump OFF, ASV OFF)	P1613	<ul style="list-style-type: none"> • AID • ECM
	AI System: ON (Air pump ON, ASV ON)	—	Normal
Excluding above (excluding 0, 20, 40, 80, 100 % duty)	—	P1613	<ul style="list-style-type: none"> • AID • Open in AID ground circuit

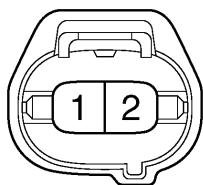
HINT:

- Using the AIR INJ CHECK operation of the SYSTEM CHECK provided in the hand-held tester function, conditions for air-fuel ratio and pressure in the secondary air injection system passage can be checked while the secondary air injection system operating. It helps technicians to troubleshoot the system when it malfunctioning.
- Read freeze frame data using a hand-held 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.

1	Check voltage between terminal 1 of air switching valve connector and body ground.
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Wire Harness Side:

A31



Air Switching Valve Connector

N

B17440

PREPARATION:

- Remove the intake manifold (see page [EM-36](#)).
- Disconnect the A31 air switching valve connector.
- Connect the hand-held tester to the DLC3.
- Turn the ignition switch ON and turn the tester ON.

CHECK:

- When the air switching valve is operated using the hand-held tester, measure voltage between terminal A31-1 of the air switching valve connector and body ground.
- Select the following menu items: DIAGNOSIS/ENHANCED OBD II/SYSTEM CHECK/ AIR INJ CHECK/ MANUAL OPERATION/OPERATION 1 and 4

HINT:

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

OPERATION 4: AP:OFF, EASV:OPEN, 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:**Standard:**

Tester operation	Tester Connection	Specified Condition
Operation 4	A31-1 – Body ground	10 V or more
Operation 1	A31-1 – Body ground	Below 1.0 V

NG

Go to step 4.

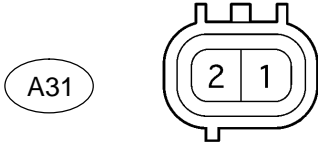
OK

2

Check air switching valve.

Component Side:

ASV Connector



Front View

A23465

PREPARATION:

- (a) Remove the intake manifold (see page [EM-36](#)).
- (b) Disconnect the ASV connector.

CHECK:

Measure the resistance of the ASV.

OK:

Standard:

Tester Connections	Specified Conditions
ASV (B13-1) – ASV (B13-2)	4.5 to 5.5 Ω

NG

Replace air switching valve.

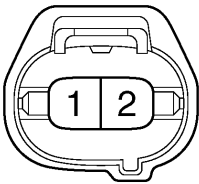
OK

3

Check for open in harness and connector between 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.

CHECK:

Check the resistance between the wire harness side connectors and body ground.

OK:

Standard:

Tester Connection	Specified Condition
A31-2 – Body ground	Below 1 Ω

NG

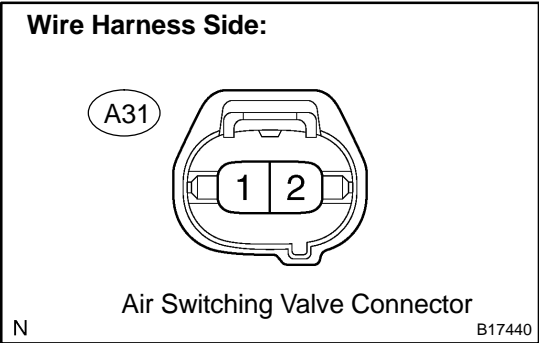
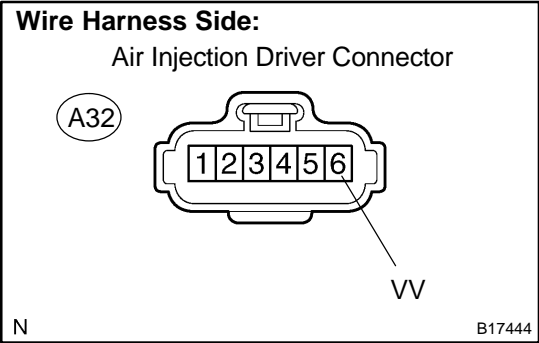
Repair or replace harness or connector.

OK

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

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.

CHECK:

Check the resistance between the wire harness side connectors.

OK:

Standard:

Tester Connection	Specified Condition
VV (A32-6) – A31-1	Below 1 Ω
VV (A32-6) or A31-1 – Body ground	10 kΩ or higher

NG

Repair or replace harness or connector.

OK

Replace air injection driver.