

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

The Secondary Air Injection (AIR) system consists of an air pump, the Air Switching Valve (ASV), a pressure sensor, the Air Injection Control Driver (AID) and the ECM. For a short time after cold engine starts, the AIR system pumps secondary air to the exhaust port of the cylinder head to purify the exhaust emissions. The secondary air is supplied by the air pump and is pumped to the exhaust port through the ASV.

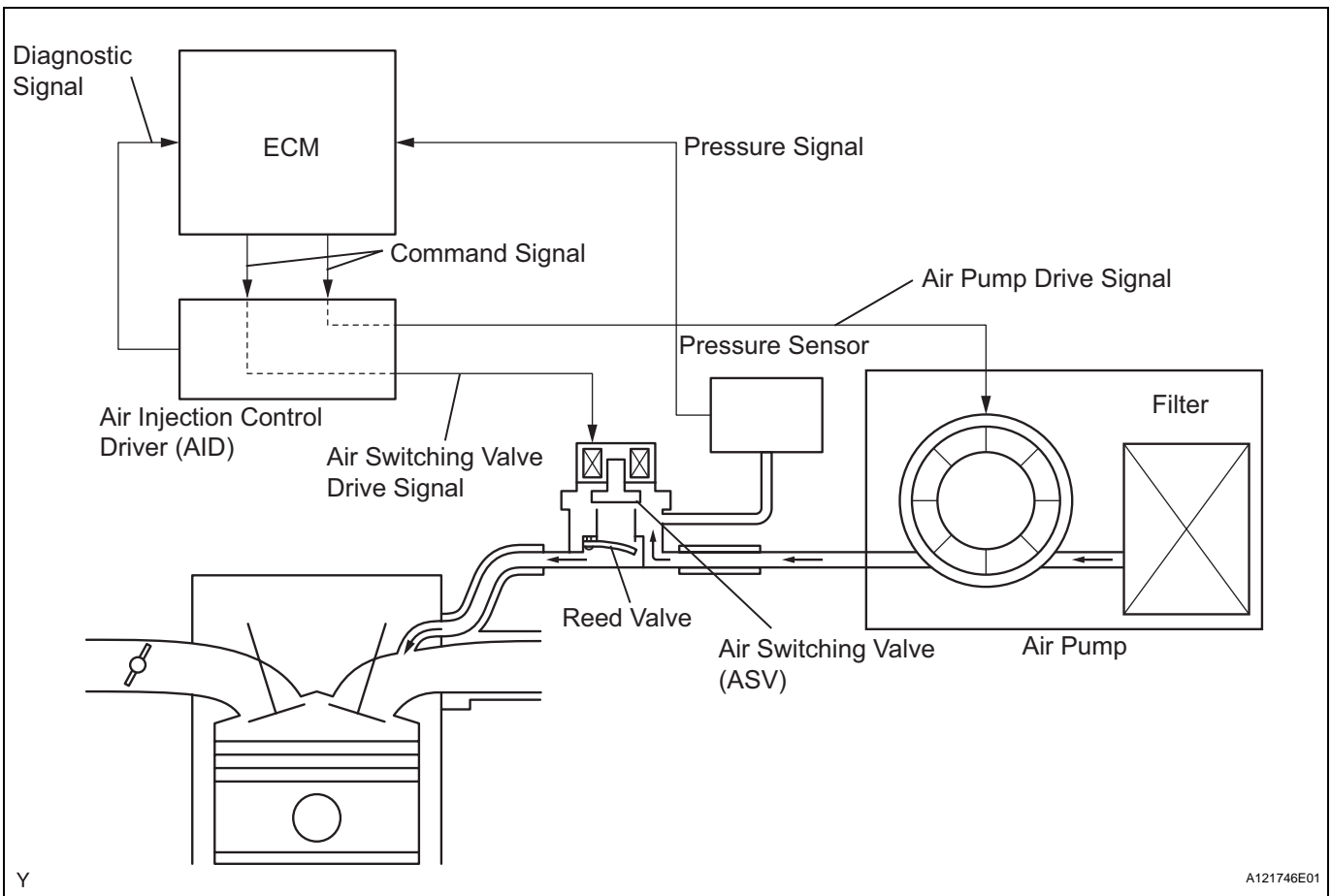
The AID drives the ASV and the air pump according to command signals transmitted by the ECM. The pressure sensor detects the pressure in the secondary air passage when the AIR system is ON and OFF, and transmits pressure signal to the ECM.

The AID is not only equipped to drive the pump and valve, but also with a diagnosis function to detect malfunctions in the AIR system circuit.

HINT:

As a large current is required to drive the air pump and ASV, an AID has been added to the previous system.

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DTC No.	DTC Detection Conditions	Trouble Areas
P0412	After cold engine starts, all of following conditions met (1 trip detection logic): (a) Air Injection (AIR) system not operating (air pump OFF, Air Switching Valve [ASV] OFF) (b) Diagnostic signal from Air Injection Control Driver (AID) 40 % (c) Battery voltage 8 V or more	<ul style="list-style-type: none"> • Open in ASV drive circuit • Short between ASV drive and +B circuits • AID • ASV • ECM

DTC No.	DTC Detection Conditions	Trouble Areas
P0412	After cold engine starts, all of following conditions met (1 trip detection logic): (a) Air Injection (AIR) system operating (air pump ON, Air Switching Valve [ASV] ON) (b) Diagnostic signal from Air Injection Control Driver (AID) 40 % (c) Battery voltage 8 V or more	<ul style="list-style-type: none"> • Short between ASV drive circuit and body ground • AID • ASV • ECM

MONITOR DESCRIPTION

The Air Injection Control Driver (AID) detects open and short circuits according to the voltages of the air pump terminal (VB) and the Air Switching Valve (ASV) terminal (VV), and transmits diagnostic information as a signal to the ECM.

For a short time after cold engine starts, the ECM transmits command signals to the AID to drive the air pump and ASV.

The AID transmits an ASV malfunction signal to the ECM if either of the following conditions is met:

- The voltage at the AID terminal relating to the ASV is low despite the AID receiving command signals from the ECM to drive the ASV.
- The voltage at the AID terminal relating to the ASV is high despite the AID receiving no command signals from the ECM to drive the ASV.

The ECM sets the DTC based on diagnostic signals from the AID.

MONITOR STRATEGY

Related DTCs	P0412: Secondary air injection system air switching valve circuit range check
Required Sensors/Components (Main)	Air injection control driver
Required Sensors/Components (Related)	Air switching valve
Frequency of Operation	Once per drive cycle
Duration	3 seconds
MIL Operation	Immediate
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Case 1:

Monitor runs whenever following DTCs not present	-
Secondary air injection system	Operating
Battery voltage	8 V or more
Ignition switch	ON
Time after ignition switch OFF to ON	0.5 seconds or more
Starter	OFF
Time after starter turned from ON to OFF	0.5 seconds or more

Case 2:

Monitor runs whenever following DTCs not present	-
Secondary air injection system	Not operating
Battery voltage	8 V or more
Ignition switch	ON
Time after ignition switch OFF to ON	0.5 seconds or more
Starter	OFF
Time after starter turned from ON to OFF	0.5 seconds or more

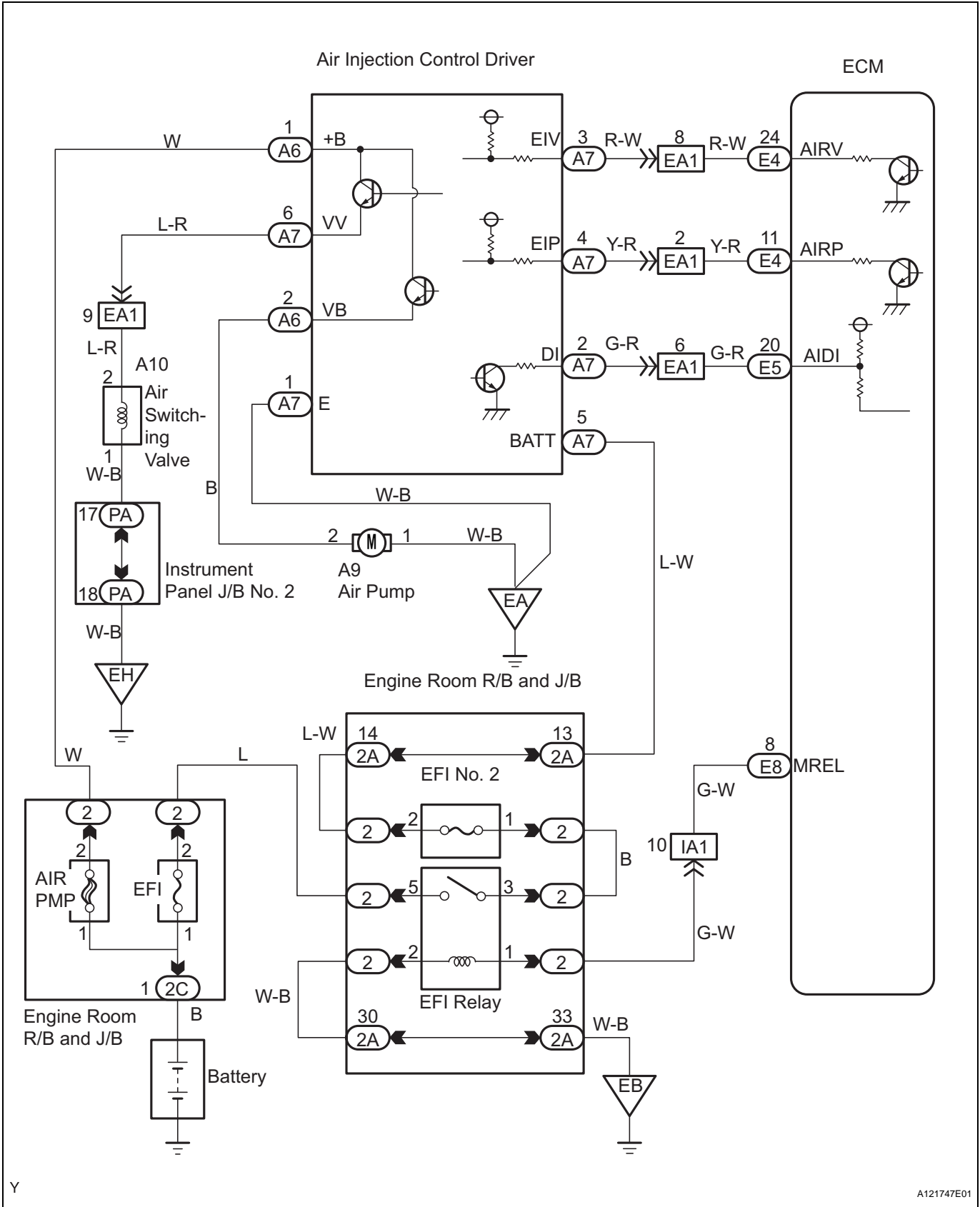
TYPICAL MALFUNCTION THRESHOLDS

Diagnostic signal duty ratio from air injection control driver	31 % or more, and 48 % or less
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COMPONENT OPERATING RANGE

Diagnostic signal duty ratio from air injection control driver	70 % or more, and 90 % or less when secondary air injection system operating. 0 % when secondary air injection system not operating.
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WIRING DIAGRAM



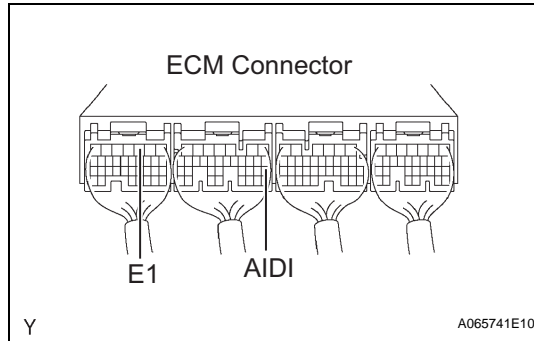
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HINT:

Diagnostic information output by the AID can be confirmed by connecting an oscilloscope to the diagnostic information terminal of the AID. Reading the waveform while performing the AIR system intrusive operation provided in the SYSTEM CHECK function, allows the possible trouble areas to be narrowed down.

- (a) Start the engine and warm it up.
- (b) Turn the ignition switch to OFF.
- (c) Connect an intelligent tester to the DLC3.
- (d) Connect oscilloscope probes to the AIDI and E1 terminals of the ECM.

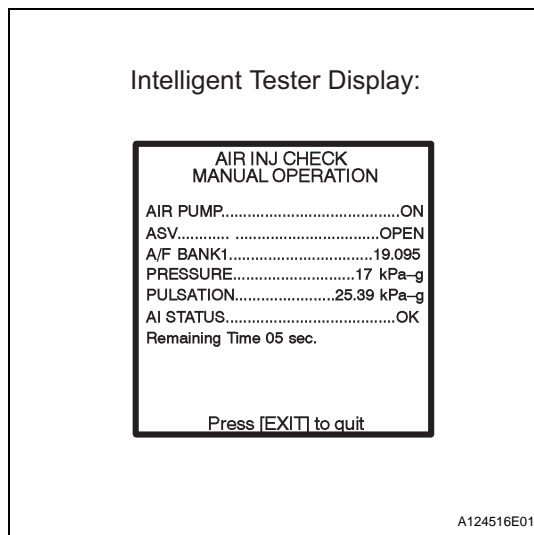


- (e) Turn the ignition switch to ON and turn the tester ON.
- (f) Select the following menu items: DIAGNOSIS / ENHANCED OBD II / SYSTEM CHECK / AIR INJ CHECK / MANUAL OPERATION / AP: ON, ASV: OPEN and AP: OFF, ASV CLOSE.

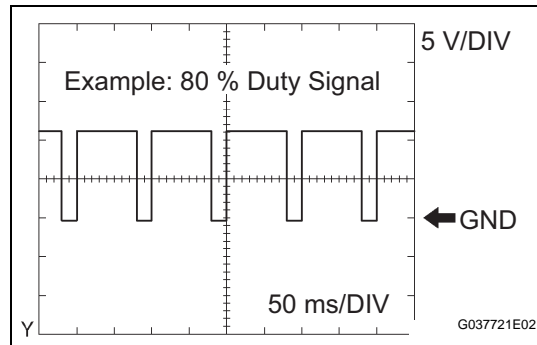
HINT:

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.

- (g) Start the engine.
- (h) Perform the AIR system intrusive operation while the engine is idling.



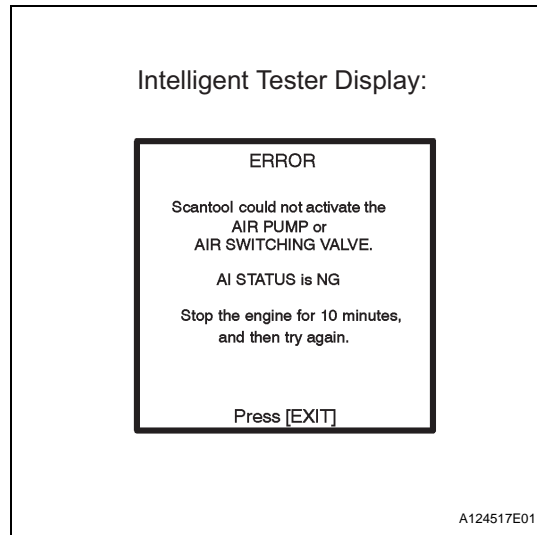
(i) Monitor the AID voltage output (duty ratio signal).



Oscilloscope range

Items	Contents
Terminals	CH1: AIDI - E1
Equipment Settings	5 V/Division, 20 to 50 ms/Division
Conditions	Idling

(j) Turn the ignition switch to OFF.

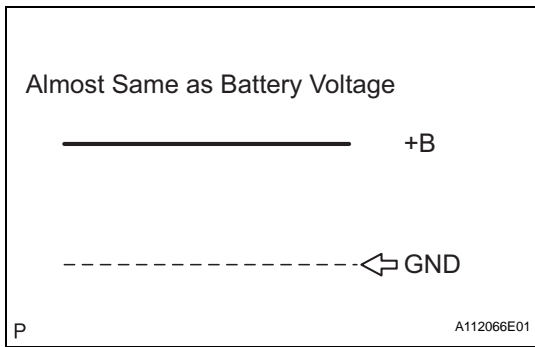


NOTICE:

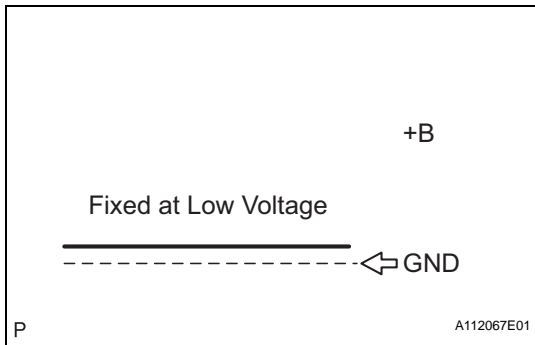
- This AIR INJECTION CHECK only allows technicians to operate the AIR system for a maximum of 5 seconds. Furthermore, the check can only be performed up to 4 times per trip. If the test is repeated, intervals of at least 30 seconds are required between checks. While AIR system operation using the intelligent 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.

AID Diagnostic Signal Waveforms	ECM Commands	DTCs (ECM Output)	Suspected Trouble Areas
100 % Duty Ratio See waveform 1	Any Air Injection (AIR) 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 and diagnostic signal circuits
0 % Duty Ratio See waveform 2	AIR 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
	AIR System: OFF (Air pump OFF, ASV OFF)	-	Normal
20 % Duty Ratio See waveform 3	Air Pump: ON	P0418	<ul style="list-style-type: none"> Short between air pump drive circuit and body ground Harness and connector (AID-Pump) Air pump AID ECM
	Air Pump: OFF	P0418	<ul style="list-style-type: none"> Open in air pump drive circuit (AID-Pump), or short between air pump drive circuit and +B Harness and connector (AID-Pump) Air pump AID ECM
40 % Duty Ratio See waveform 4	ASV: ON	P0412	<ul style="list-style-type: none"> Short between ASV drive circuit and body ground Harness and connector (AID-ASV) ASV AID ECM
	ASV: OFF	P0412	<ul style="list-style-type: none"> Open in ASV drive circuit (AID-ASV), or short between ASV drive circuit and +B Harness and connector (AID-ASV) AID ASV ECM
80 % Duty Ratio See waveform 5	AIR System: OFF (Air pump OFF, ASV OFF)	P1613	<ul style="list-style-type: none"> AID ECM
	AIR System: ON (Air pump ON, ASV ON)	-	Normal
Other than above (other than 0, 20, 40, 80 and 100 % duty)	-	P1613	<ul style="list-style-type: none"> AID Open in AID ground circuit

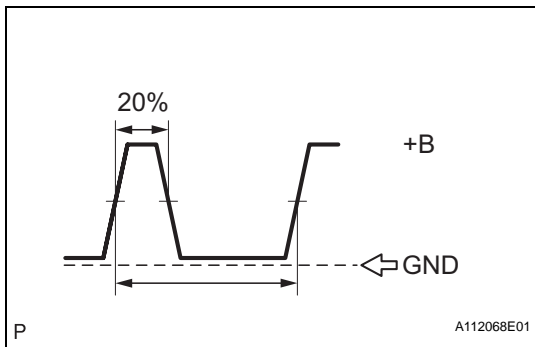
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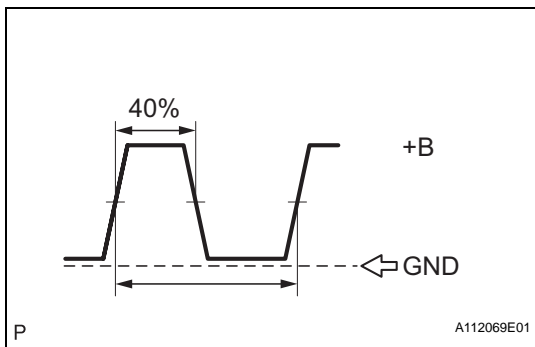
1. **Waveform 1**
100 % Duty Ratio



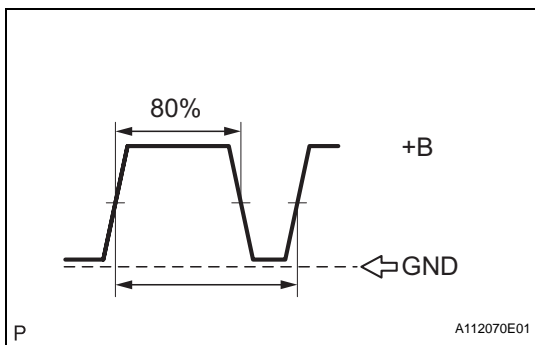
2. **Waveform 2**
0 % Duty Ratio



3. **Waveform 3**
20 % Duty Ratio



4. **Waveform 4**
40 % Duty Ratio



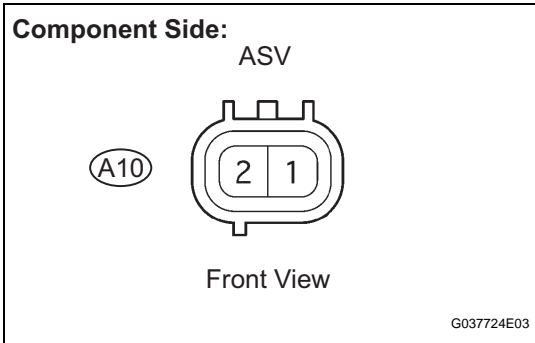
5. **Waveform 5**
80 % Duty Ratio

HINT:

- 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.
- 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.

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1 INSPECT AIR SWITCHING VALVE ASSEMBLY



- (a) Disconnect the A10 ASV connector.
 (b) Measure the ASV resistance.

Standard Resistance

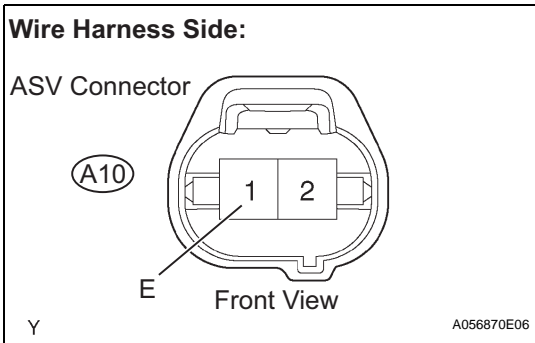
Tester Connections	Specified Conditions
ASV (A10-1) - ASV (A10-2)	3 to 10 Ω at 20°C (68°F)

- (c) Reconnect the ASV connector.

NG → **REPLACE AIR SWITCHING VALVE ASSEMBLY**

OK

2 CHECK HARNESS AND CONNECTOR (AIR SWITCHING VALVE - BODY GROUND)



- (a) Disconnect the A10 ASV connector.
 (b) Check the resistance.

Standard Resistance

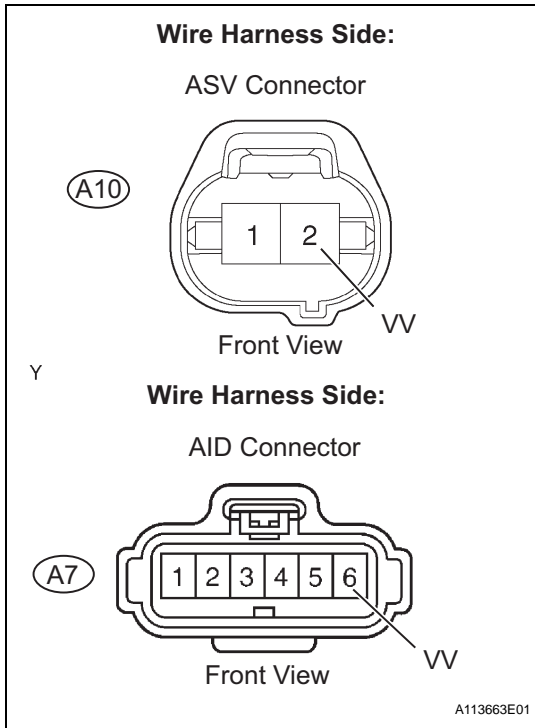
Tester Connections	Specified Conditions
ASV (A10-1) - Body ground	Below 1 Ω

- (c) Reconnect the ASV connector.

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

OK

3 CHECK HARNESS AND CONNECTOR (AIR SWITCHING VALVE - AIR INJECTION CONTROL DRIVER)



- (a) Disconnect the A10 ASV connector.
- (b) Disconnect the A7 AID connector.
- (c) Check the resistance.

Standard Resistance

Tester Connections	Specified Conditions
ASV (A10-2) - AID (A7-6)	Below 1 Ω

- (d) Reconnect the ASV connector.
- (e) Reconnect the AID connector.

NG REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE AIR INJECTION CONTROL DRIVER

ES