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|------------|--------------|--|
| DTC | P0010 | Camshaft Position "A" Actuator Circuit (Bank 1) |
| DTC | P0020 | Camshaft Position "A" Actuator Circuit (Bank 2) |

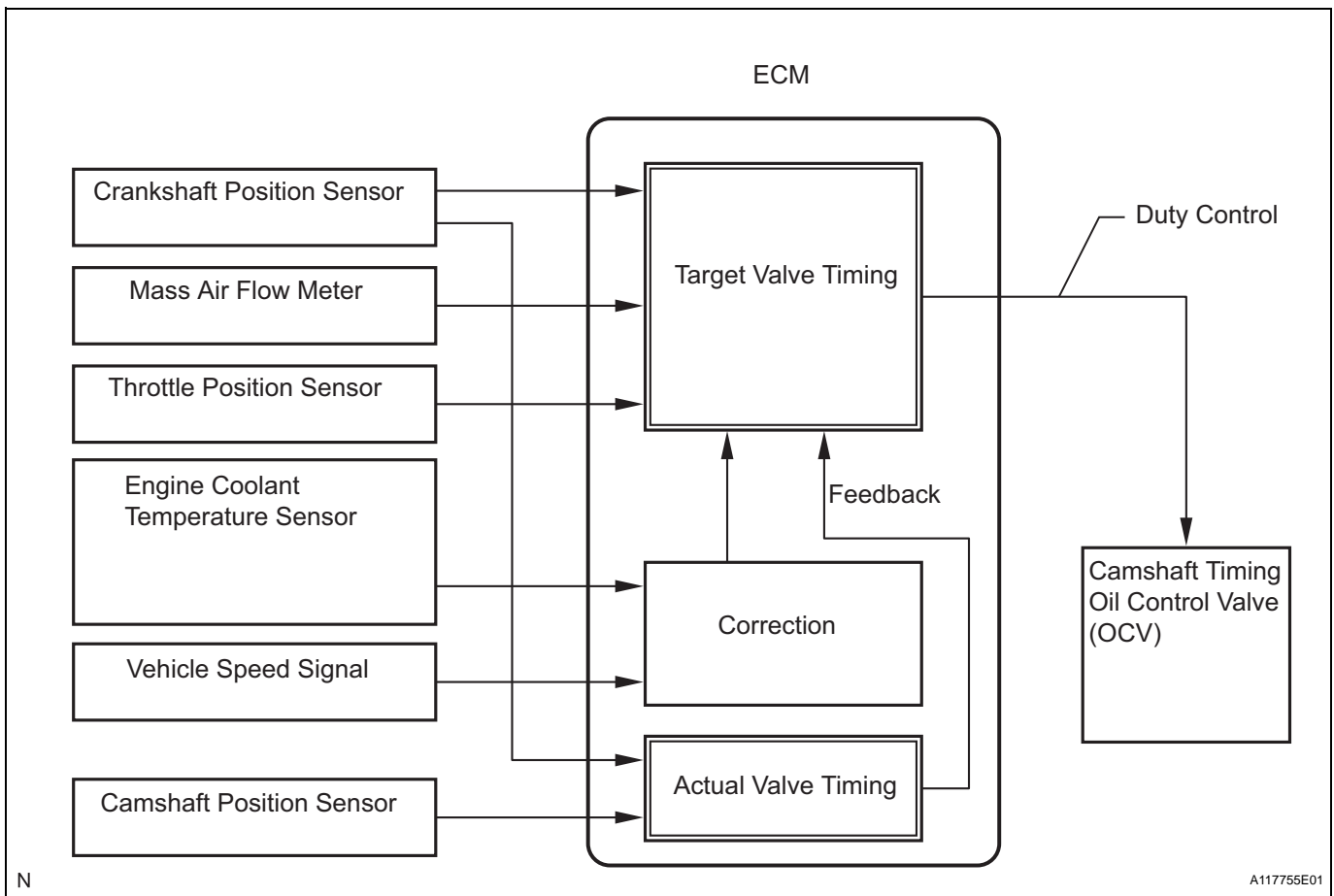
DESCRIPTION

HINT:

These DTCs relate to the Oil Control Valve (OCV).

The Variable Valve Timing (VVT) system includes the ECM, Oil Control Valve (OCV) and VVT controller. The ECM sends a target duty-cycle control signal to the OCV. This control signal regulates the oil pressure supplied to the VVT controller. Camshaft timing control is performed according to engine operating conditions such as intake air volume, throttle valve position and engine coolant temperature. The ECM controls the OCV, based on the signals transmitted by several sensors. The VVT controller regulates the intake camshaft angle using oil pressure through the OCV. As a result, the relative positions of the camshaft and crankshaft are optimized, the engine torque and fuel economy improve, and the exhaust emissions decrease under overall driving conditions. The ECM detects the actual intake valve timing using signals from the camshaft and crankshaft position sensors, and performs feedback control. This is how the target intake valve timing is verified by the ECM.

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| DTC No. | DTC Detection Condition | Trouble Area |
|---------|---|--|
| P0010 | Open or short in Oil Control Valve (OCV) (bank 1) circuit (1 trip detection logic) | <ul style="list-style-type: none"> Open or short in Oil Control Valve (OCV) (bank 1) circuit Oil Control Valve (OCV) (bank 1) ECM |

| DTC No. | DTC Detection Condition | Trouble Area |
|---------|---|--|
| P0020 | Open or short in OCV (bank 2) circuit (1 trip detection logic) | <ul style="list-style-type: none"> • Open or short in OCV (bank 2) circuit • OCV (bank 2) • ECM |

MONITOR DESCRIPTION

After the ECM sends the "target" duty-cycle signal to the OCV (Oil Control Valve), the ECM monitors the OCV current to establish an "actual" duty-cycle. When the actual duty-cycle ratio varies from the target duty-cycle, the ECM sets a DTC.

MONITOR STRATEGY

| | |
|---------------------------------------|--|
| Related DTCs | P0010: OCV (bank 1) range check P0020: OCV (bank 2) range check |
| Required Sensors/Components (Main) | VVT OCV |
| Required Sensors/Components (Related) | - |
| Frequency of Operation | Continuous |
| Duration | 1 second |
| MIL Operation | Immediate |
| Sequence of Operation | None |

TYPICAL ENABLING CONDITIONS

| | |
|--|---------------------|
| Monitor will run whenever these DTCs are not present | None |
| Starter | OFF |
| Ignition switch | ON |
| Time after ignition switch OFF to ON | 0.5 seconds or more |

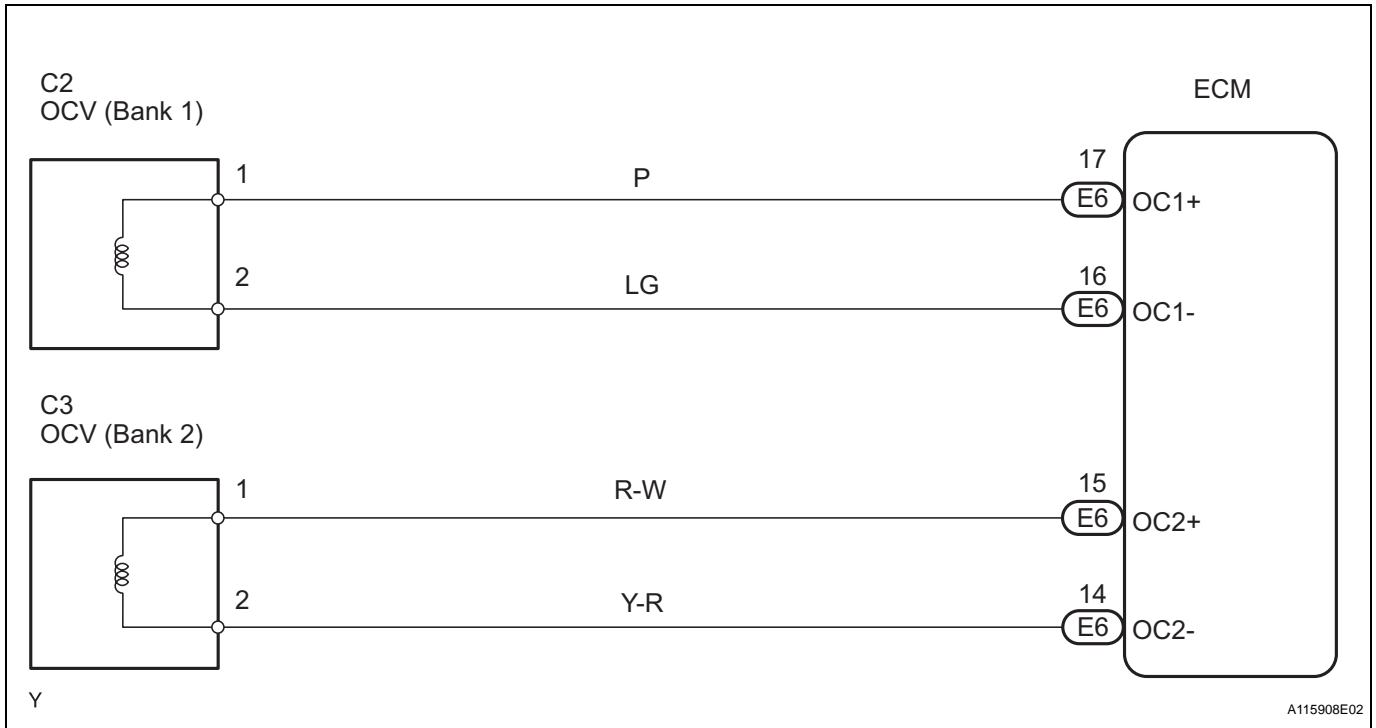
TYPICAL MALFUNCTION THRESHOLDS

| | |
|---|----------------------------------|
| One of the following conditions is met | Condition A, B or C |
| A. All of the following conditions are met | Condition (a), (b) and (c) |
| a. Battery voltage | 11 V or more, and less than 13 V |
| b. Target duty ratio | Less than 70 % |
| c. Output signal duty ratio | 100 % or more |
| B. All of the following conditions are met | Condition (a), (b) and (c) |
| a. Battery voltage | 13 V or more |
| b. Target duty ratio | Less than 80 % |
| c. Output signal duty ratio | 100 % or more |
| C. Both of the following conditions are met | Condition (a) and (b) |
| a. Current cut status | Not cut |
| b. Output signal duty ratio | 3 % or less |

COMPONENT OPERATING RANGE

| | |
|----------------------------|------------------------------------|
| Output signal duty for OCV | More than 3 %, and less than 100 % |
|----------------------------|------------------------------------|

WIRING DIAGRAM



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INSPECTION PROCEDURE

HINT:

- If DTC P0010 is displayed, check the bank 1 VVT system circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- If DTC P0020 is displayed, check the bank 2 VVT system circuit.
- Bank 2 refers to the bank that does not include cylinder No. 1.
- Read freeze frame data using an intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air/fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.

1 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (OCV OPERATION)

- (a) Connect the intelligent tester to the CAN VIM. Then connect the CAN VIM to the DLC3.
- (b) Start the engine and warm it up.
- (c) Turn the ignition switch ON and turn the tester ON.
- (d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / VVT CTRL B1 or VVT CTRL B2.
- (e) Operate the Oil Control Valve (OCV) and check the engine condition at idling.

OK

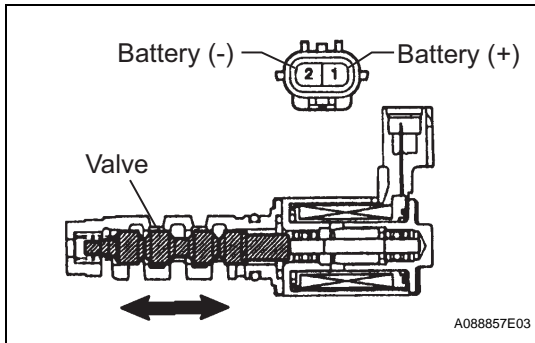
| Tester Operation | Specified Condition |
|------------------|---|
| OCV is OFF | Normal engine speed |
| OCV is ON | Engine idles roughly or stalls (soon after OCV switched from OFF to ON) |

OK

CHECK FOR INTERMITTENT PROBLEMS

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2 INSPECT CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY (OPERATION)



- (a) Disconnect the C13 or C14 OCV connectors.
- (b) Apply battery voltage to the terminals of the OCV.
- (c) Check the engine speed.

OK:

Rough idle or engine stalled.

- (d) Reconnect the OCV connectors.

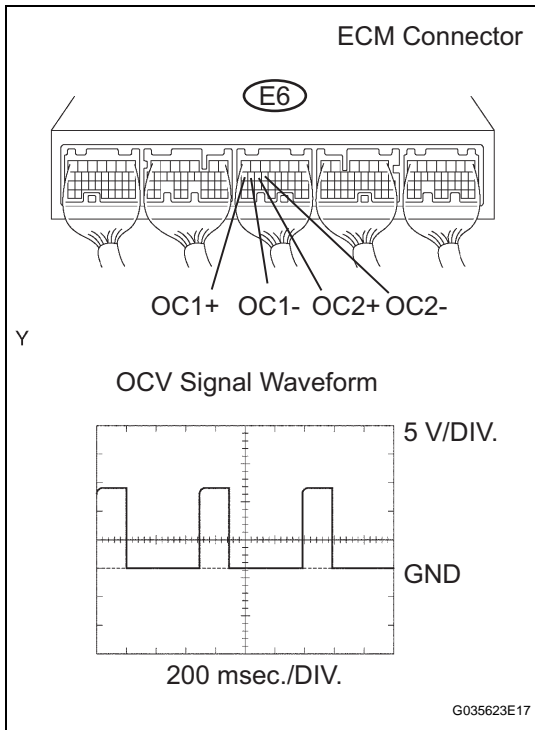
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REPLACE CAMSHAFT TIMING OIL CONTROL VALVE ASSEMBLY

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OK

3 CHECK ECM (OCV SIGNAL)



- (a) Inspect the ECM using an oscilloscope.
- (b) While idling the engine, check the waveform of the E6 ECM connector using an oscilloscope.

Standard voltage

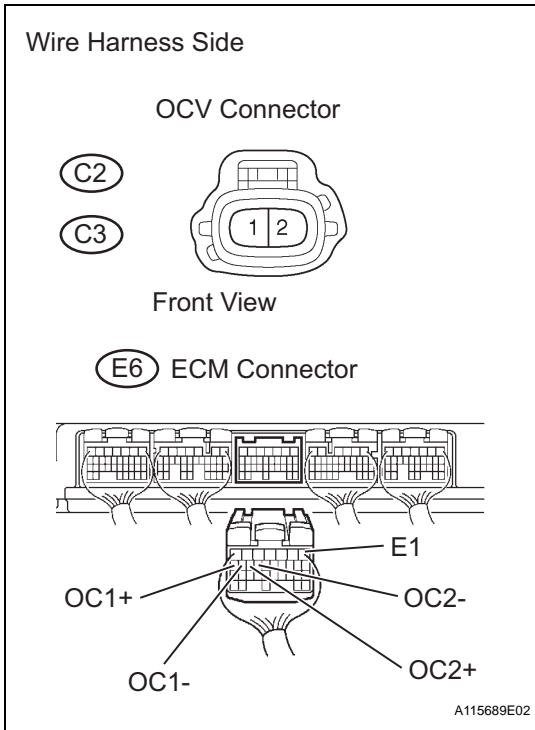
| Tester Connection | Specified Condition |
|-----------------------------|------------------------------|
| OC1+ (E6-17) - OC1- (E6-16) | Correct waveform is as shown |
| OC2+ (E6-15) - OC2- (E6-14) | |

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REPLACE ECM

OK

4 CHECK HARNESS AND CONNECTOR (OCV - ECM)



- (a) Disconnect the C2 or C3 OCV connectors.
- (b) Disconnect the E6 ECM connector.
- (c) Measure the resistance between the wire harness side connectors.

Standard resistance (Check for open)

| Tester Connection | Specified condition |
|---------------------------|---------------------|
| OCV (C2-1) - OC1+ (E6-17) | Below 1 Ω |
| OCV (C2-2) - OC1- (E6-16) | |
| OCV (C3-1) - OC2+ (E6-15) | |
| OCV (C3-2) - OC2- (E6-14) | |

Standard resistance (Check for short)

| Tester Connection | Specified condition |
|--|---------------------|
| OCV (C2-1) or OC1+ (E6-17) - Body ground | 10 kΩ or higher |
| OCV (C2-2) or OC1- (E6-16) - Body ground | |
| OCV (C3-1) or OC2+ (E6-15) - Body ground | |
| OCV (C3-2) or OC2- (E6-14) - Body ground | |

- (d) Reconnect the OCV connectors.
- (e) Reconnect the ECM connector.

NG **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

CHECK FOR INTERMITTENT PROBLEMS

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