DTC P0420 CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 1); DTC P0430 CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 2)

MONITOR DESCRIPTION

The ECM uses the two sensors, mounted in front of and behind the Three-Way Catalytic Converter (TWC), to monitor its efficiency.

The first sensor, the Air-Fuel Ratio (A/F) sensor (sensor 1), sends pre-catalyst information to the ECM.

The second sensor, the Heated Oxygen (HO2) sensor (sensor 2), sends post-catalyst information to the ECM. The ECM compares the information transmitted by these two sensors to determine the efficiency of the TWC performance and its ability to store oxygen.

When the TWC is functioning properly, the variation in the oxygen concentration in the exhaust gas, after it has passed through the TWC, is small. As a result, the voltage output of sensor 2 slowly alternates between the rich and lean signal voltages (shown in the illustration below). As the TWC performance efficiency deteriorates, its oxygen storage capacity decreases, and the variation in the oxygen concentration in the exhaust gas increases. As a result, the sensor voltage output fluctuates frequently. While the catalyst monitor is running, the ECM measures the signal length of both sensors 1 and 2, and calculates the ratio of the signal lengths to determine the extent of the TWC deterioration. If the deterioration level exceeds the preset threshold, the ECM interprets this as the TWC malfunction. The ECM then illuminates the MIL and sets the DTC.
Fig. 115: Normal TWC/Deteriorated TWC Waveform Of A/F Sensor And HO2 Sensor
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

Heated Oxygen Sensor Signal Length
**CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD**

<table>
<thead>
<tr>
<th>DTC No.</th>
<th>DTC Detection Condition</th>
<th>Trouble Area</th>
</tr>
</thead>
</table>
| P0420   | After engine and TWC warmed up, and while vehicle driven within set vehicle and engine speeds, waveform of Heated Oxygen (HO2) sensor (bank 1 sensor 2) alternates frequently between rich and lean (2 trip detection logic) | • Gas leakage from exhaust system  
• A/F sensor (bank 1 sensor 1)  
• HO2 sensor (bank 1 sensor 2)  
• Three-Way Catalytic Converter (TWC) (Exhaust manifold) |
| P0430   | After engine and catalyst are warmed up, and while vehicle is driven within set vehicle and engine speed ranges: Waveform of heated oxygen sensor (bank 2 sensor 2) alternates frequently between rich and lean (2 trip detection logic) | • Gas leakage from exhaust system  
• A/F sensor (bank 2 sensor 1)  
• HO2 sensor (bank 2 sensor 2)  
• Three-Way Catalytic Converter (TWC) (Exhaust manifold) |

**HINT:**

- Bank 1 refers to the bank that includes cylinder No. 1  
- Bank 2 refers to the bank that does not include cylinder No. 1  
- Sensor 1 refers to the sensor closest to the engine assembly.  
- Sensor 2 refers to the sensor farthest away from the engine assembly.

**MONITOR STRATEGY**

**Related DTCs**

- P0420: Catalyst (Bank 1) deterioration  
- P0430: Catalyst (Bank 2) deterioration

**Required Sensors/Components (Main)**

- A/F sensor and heated oxygen sensor

**Required Sensors/Components (Related)**

- Intake air temperature sensor, mass air flow meter, crankshaft position sensor and engine coolant temperature sensor
<table>
<thead>
<tr>
<th>Frequency of Operation</th>
<th>Once per driving cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>150 seconds or more</td>
</tr>
<tr>
<td>MIL Operation</td>
<td>2 driving cycles</td>
</tr>
<tr>
<td>Sequence of Operation</td>
<td>None</td>
</tr>
</tbody>
</table>

**TYPICAL ENABLING CONDITIONS**

Monitor will run whenever this DTC is not present:

- P0011 (VVT System 1 - Advance)
- P0012 (VVT System 1 - Retard)
- P0021 (VVT System 2 - Advance)
- P0022 (VVT System 2 - Retard)
- P0031, P0032, P0051, P0052 (A/F sensor heater - Sensor 1)
- P0037, P0038, P0057, P0058 (O2 sensor heater - Sensor 2)
- P0100 - P0103 (MAF meter)
- P0115 - P0118 (ECT sensor)
- P0120 - P0223, P2135 (TP sensor)
- P0125 (Insufficient ECT for Closed Loop)
- P0136, P0156 (O2 Sensor - Sensor 2)
- P0171 - P0175 (Fuel system)
- P0300 - P0306 (Misfire)
- P0351 - P0356 (Igniter)
- P0500 (VSS)
- P2196, P2198 (A/F sensor - rationality)
- P2A00, P2A03 (A/F sensor - slow response)

Accumulated time that all of following conditions are met:

- 30 seconds

Battery voltage:

- 11 V or more

Intake air temperature:

- -10°C (14°F) or more

Idle:

- OFF

Mass air flow rate:

- 6 to 45 g/sec.

Engine RPM:

- Less than 3,000 rpm

Engine coolant temperature sensor:

- 75°C (167°F) or more

Fuel system status:

- Closed loop

Rich experience after fuel cut:

- Yes

A/F sensor:

- Activated

Rear heated oxygen sensor:

- Activated

Estimated catalyst temperature:

- Both of following conditions 1 and 2 met
  1. Up stream catalyst temperature:
     - 500 to 800°C (932 to 1,472°F) or more
  2. Down stream catalyst temperature:
     - 500 to 800°C (932 to 1,472°F) or more
TYPICAL MALFUNCTION_THRESHOLDS

**TYPICAL MALFUNCTION_THRESHOLDS**

| Oxygen storage capacity of catalyst | 15 V or more (varies with A/F sensor locus length) |

**MONITOR RESULT**

Refer to [CHECKING MONITOR STATUS](#).

**CONDITIONING FOR SENSOR TESTING**

**HINT:**

Perform the operation with the engine speeds and time durations described below in [Fig. 117](#) prior to checking the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.

![Fig. 117: Engine Speeds And Time Durations Blinking Pattern](#)

**Fig. 117: Engine Speeds And Time Durations Blinking Pattern**

*Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.*

1. Connect the intelligent tester to the DLC3.
2. Start the engine and warm it up with all the accessories switched OFF, until the engine coolant temperature stabilizes.
3. Run the engine at engine speed of between 2,500 rpm and 3,000 rpm for at least 3 minutes.
4. While running the engine at 3,000 rpm for 2 seconds and 2,000 rpm for 2 seconds, check the waveforms of the A/F and HO2 sensors using the tester or scan tool.

**HINT:**

Intelligent tester only:
Malfunctioning areas can be identified by performing the A/F CONTROL function provided in the ACTIVE TEST. The A/F CONTROL function can help to determine whether the Air-Fuel Ratio (A/F) sensor, Heated Oxygen (HO2) sensor and other potential trouble areas are malfunctioning.

The following instructions describe how to conduct the A/F CONTROL operation using an intelligent tester.

1. Connect the intelligent tester to the DLC3.
2. Start the engine and turn the tester ON.
3. Warm up the engine at engine speed of 2,500 rpm for approximately 90 seconds.
4. On the tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
5. Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume.)
6. Monitor the output voltages of the A/F and HO2 sensors (AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2) displayed on the tester.

HINT:

- The A/F CONTROL operation lowers the fuel injection volume by 12.5 % or increases the injection volume by 25 %.
- Each sensor reacts in accordance with increases and decreases in the fuel injection volume.

Standard

TESTER DISPLAY (SENSOR)

<table>
<thead>
<tr>
<th>Tester Display (Sensor)</th>
<th>Injection Volume</th>
<th>Status</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFS B1S1 or AFS B2S1 (A/F)</td>
<td>+25 %</td>
<td>Rich</td>
<td>Less than 3.0</td>
</tr>
<tr>
<td></td>
<td>-12.5 %</td>
<td>Lean</td>
<td>More than 3.35</td>
</tr>
<tr>
<td>O2S B1S2 or O2S B2S2 (HO2)</td>
<td>+25 %</td>
<td>Rich</td>
<td>More than 0.55</td>
</tr>
<tr>
<td></td>
<td>-12.5 %</td>
<td>Lean</td>
<td>Less than 0.4</td>
</tr>
</tbody>
</table>

NOTE: The Air-Fuel Ratio (A/F) sensor has an output delay of a few seconds and the Heated Oxygen (HO2) sensor has a maximum output delay of approximately 20 seconds.

A/F SENSOR (SENSOR 1)/HO2 (SENSOR 2) OUTPUT VOLTAGE

<table>
<thead>
<tr>
<th>Case</th>
<th>A/F Sensor (Sensor 1) Output Voltage</th>
<th>HO2 Sensor (Sensor 2) Output Voltage</th>
<th>Main Suspected Trouble Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Injection Volume +25 %</td>
<td>Injection Volume +25 %</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-12.5 %</td>
<td>-12.5 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output Voltage More</td>
<td>Output Voltage More</td>
<td></td>
</tr>
<tr>
<td>Injection Volume</td>
<td>Output Voltage</td>
<td>A/F sensor • A/F sensor heater • A/F sensor circuit</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
<td>------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>+25 % -12.5 %</td>
<td>Almost no reaction</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>Less than 0.4 V</td>
<td>Less than 3.0 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injection Volume</th>
<th>Output Voltage</th>
<th>HO2 sensor • HO2 sensor heater • HO2 sensor circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25 % -12.5 %</td>
<td>More than 3.35 V</td>
<td>OK</td>
</tr>
<tr>
<td>Less than 0.4 V</td>
<td>Less than 3.0 V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injection Volume</th>
<th>Output Voltage</th>
<th>Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25 % -12.5 %</td>
<td>Almost no reaction</td>
<td>NG</td>
</tr>
</tbody>
</table>

- Following the A/F CONTROL procedure enables technicians to check and graph the output voltages of both the A/F and HO2 sensors.
- To display the graph, enter the following menus on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2, and press the YES button and then the ENTER button followed by the F4 button.

**INSPECTION PROCEDURE 📝**

**HINT:**

Read freeze frame data using the intelligent tester or OBD II scan tool. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When
troubleshooting, freeze frame data can help determine if the vehicle was running or stopped, 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 ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 AND/OR P0430)**
   a. Connect the intelligent tester to the DLC3.
   b. Turn the ignition switch ON and turn the tester ON.
   c. Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
   d. Read DTCs.

   **Result**

   **ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 AND/OR P0430)**

<table>
<thead>
<tr>
<th>Display (DTC output)</th>
<th>Proceed to</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0420 and/or P0430</td>
<td>A</td>
</tr>
<tr>
<td>P0420 and/or P0430 and other DTCs</td>
<td>B</td>
</tr>
</tbody>
</table>

   **HINT:**

   If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

   **B: GO TO [DIAGNOSTIC TROUBLE CODE CHART](#)**

   **A: GO TO NEXT STEP**

2. **PERFORM ACTIVE TEST USING INTELLIGENT TESTER (A/F CONTROL)**
   a. Connect the intelligent tester to the DLC3.
   b. Start the engine and turn the tester ON.
   c. Warm up the engine at engine speed of 2,500 rpm for approximately 90 seconds.
   d. On the tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
   e. Perform the A/F CONTROL operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume.).
   f. Monitor the output voltages of the A/F and HO2 sensors (AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2) displayed on the tester.

   **HINT:**

   - The A/F CONTROL operation lowers the fuel injection volume by 12.5 % or increases the injection volume by 25 %.
   - Each sensor reacts in accordance with increases and decreases in the fuel injection volume.

   **Standard**
### A/F CONTROL (1 OF 2)

<table>
<thead>
<tr>
<th>Tester Display (Sensor)</th>
<th>Injection Volume</th>
<th>Status</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFS B1S1 or AFS B2S1 (A/F)</td>
<td>+25 %</td>
<td>Rich</td>
<td>Less than 3.0</td>
</tr>
<tr>
<td></td>
<td>-12.5 %</td>
<td>Lean</td>
<td>More than 3.35</td>
</tr>
<tr>
<td>O2S B1S2 or O2S B2S2 (HO2)</td>
<td>+25 %</td>
<td>Rich</td>
<td>More than 0.55</td>
</tr>
<tr>
<td></td>
<td>-12.5 %</td>
<td>Lean</td>
<td>Less than 0.4</td>
</tr>
</tbody>
</table>

### Result

### A/F CONTROL (2 OF 2)

<table>
<thead>
<tr>
<th>Status AFS B1S1 or AFS B2S1</th>
<th>Status O2S B1S2 or O2S B2S2</th>
<th>A/F Condition and A/F and HO2 Sensor Conditions</th>
<th>Misfire</th>
<th>Main Suspected Trouble Areas</th>
<th>Proceed to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean/Rich</td>
<td>Lean/Rich</td>
<td>Normal</td>
<td>-</td>
<td>• Three-Way Catalytic Converter (TWC)</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Gas leakage from exhaust system</td>
<td></td>
</tr>
<tr>
<td>Lean</td>
<td>Lean/Rich</td>
<td>A/F sensor malfunction</td>
<td>-</td>
<td>• A/F sensor</td>
<td>B</td>
</tr>
<tr>
<td>Rich</td>
<td>Lean/Rich</td>
<td>A/F sensor malfunction</td>
<td>May occur</td>
<td>• A/F sensor</td>
<td>B</td>
</tr>
<tr>
<td>Lean/Rich</td>
<td>Lean</td>
<td>HO2 sensor malfunction</td>
<td>-</td>
<td>• HO2 sensor</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Gas leakage from exhaust system</td>
<td></td>
</tr>
<tr>
<td>Lean/Rich</td>
<td>Rich</td>
<td>HO2 sensor malfunction</td>
<td>-</td>
<td>• HO2 sensor</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Gas leakage from exhaust system</td>
<td></td>
</tr>
<tr>
<td>Lean</td>
<td>Lean</td>
<td>Actual air-fuel ratio lean</td>
<td>May occur</td>
<td>• Extremely rich or lean actual air-fuel ratio</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Gas leakage from exhaust system</td>
<td></td>
</tr>
<tr>
<td>Rich</td>
<td>Rich</td>
<td>Actual air-fuel ratio lean</td>
<td>-</td>
<td>• Extremely rich or lean actual air-fuel ratio</td>
<td>A</td>
</tr>
</tbody>
</table>

2/1/2012
Lean: During A/F CONTROL, the A/F sensor output voltage (AFS) is consistently more than 3.35 V, and the HO2 sensor output voltage (O2S) is consistently less than 0.4 V.
Rich: During A/F CONTROL, the AFS is consistently less than 3.0 V, and the O2S is consistently more than 0.55 V. Lean/Rich: During A/F CONTROL of the ACTIVE TEST, the output voltage of the HO2 sensor alternates correctly.

**B: CHECK AND REPLACE AIR FUEL RATIO SENSOR**

**C: CHECK AND REPLACE HEATED OXYGEN SENSOR, AND CHECK AND REPAIR EXHAUST GAS LEAKAGE**

**A: GO TO NEXT STEP**

**3. CHECK FOR EXHAUST GAS LEAKAGE**

OK: No gas leakage.

NG: REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK: REPLACE THREE-WAY CATALYTIC CONVERTER (EXHAUST MANIFOLD LH OR Rh)