

<b>DTC</b>	<b>P0420</b>	<b>Catalyst System Efficiency Below Threshold (Bank 1)</b>
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**MONITOR DESCRIPTION**

The ECM uses the 2 Heated Oxygen (HO2) sensors, mounted in front of and behind the Three-Way Catalytic Converter (TWC), to monitor its efficiency.

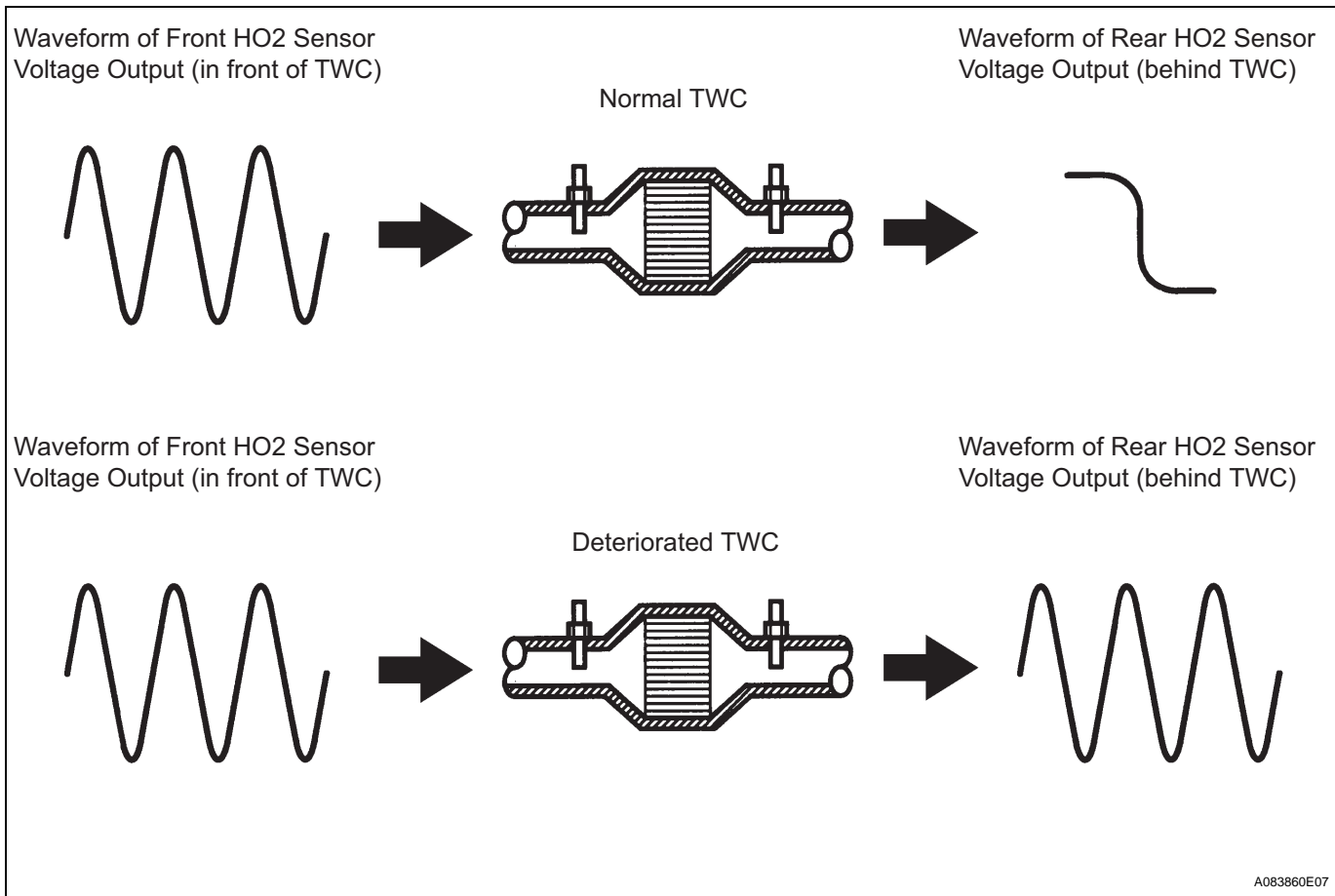
The first sensor, Sensor 1, sends pre-catalyst information to the ECM. The second sensor, Sensor 2, sends post-catalyst information to the ECM. The ECM compares the information transmitted by these 2 sensors to determine the efficiency of the TWC performance and its ability to store oxygen.

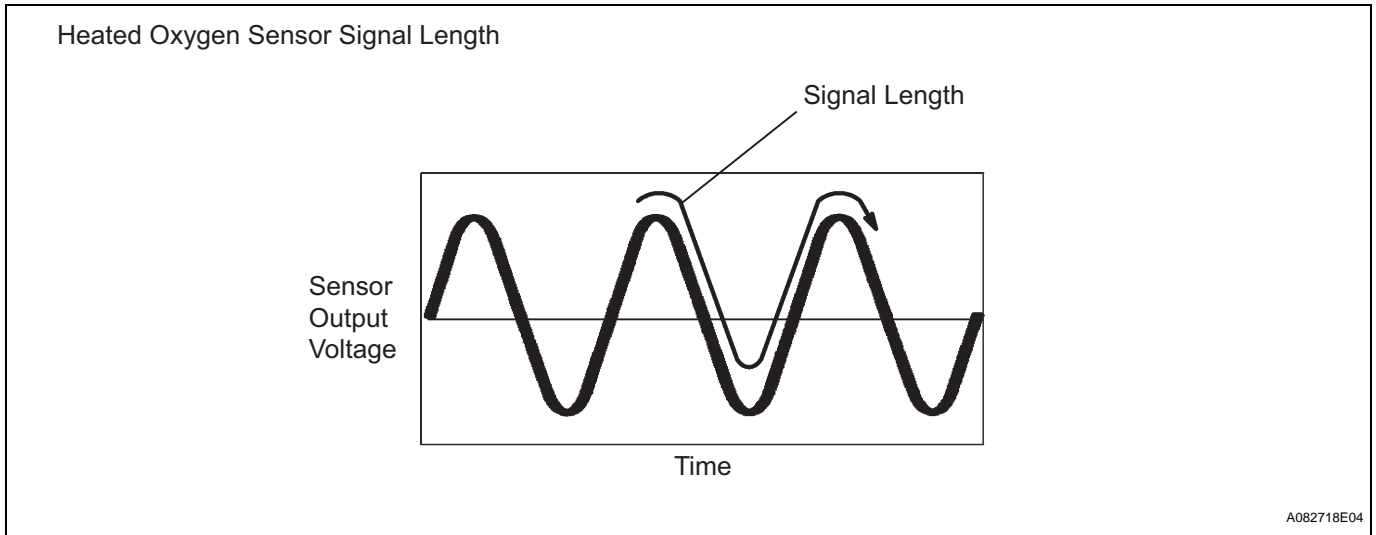
When the TWC is functioning properly, the variation in the oxygen concentration in the exhaust gas, after it has passed through the TWC, is small. In this condition, the voltage output of sensor 2 slowly alternates between the rich and lean signal voltages (shown in the illustration below). As the TWC 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 lengths 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.

This monitor begins to run when the following preconditions apply:

- The engine has warmed up (the engine coolant temperature is 75°C [167° F] or more).
- The vehicle has driven at between 60 km/h and 100 km/h (37 mph and 63 mph) for 15 minutes.

**ES**





DTC No.	DTC Detection Condition	Trouble Area
P0420	Under conditions (a) and (b), front and rear Heated Oxygen (HO2) sensor voltage output fluctuation amplitudes similar: (a) Engine and Three-Way Catalytic Converter (TWC) warmed up (b) Vehicle driven with vehicle and engine speeds within predetermined ranges	<ul style="list-style-type: none"> <li>Gas leakage from exhaust system</li> <li>Heated Oxygen (HO2) sensor (bank 1 sensors 1, 2)</li> <li>TWC</li> </ul>

### MONITOR STRATEGY

Related DTCs	P0420: Catalyst deterioration
Required Sensors/Components (Main)	TWC
Required Sensors/Components (Related)	HO2 sensor, Intake Air Temperature (IAT) sensor, Mass Air Flow (MAF) meter, Crankshaft Position (CKP) sensor, Engine Coolant Temperature (ECT) sensor
Frequency of Operation	Once per driving cycle
Duration	60 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

### TYPICAL ENABLING CONDITIONS

Monitor runs whenever these DTCs not present	P0011 (VVT system 1 - advance) P0012 (VVT system - retard) P0031, P0032 (heated oxygen sensor 1) P0037, P0038 (heated oxygen sensor 2) P0100 - P0103 (MAF meter) P0115 - P0118 (ECT sensor) P0120 - P0123 (TP sensor) P0125 (insufficient ECT for closed loop) P0130 (heated oxygen sensor 1) P0134 (heated oxygen sensor 1) P0136 (heated oxygen sensor 2) P0171, P0712 (fuel system) P0300 - P0304 (misfire) P0335 (crankshaft position sensor) P0340 (camshaft position sensor) P0351 - P0354 (igniter) P0500 (VSS)
Accumulated time that following conditions met	20 seconds
Battery voltage	11 V or more
IAT	-10°C (14°F) or more
Idle	OFF

MAF	8 to 25 g/sec.
Engine RPM	Less than 4,500 rpm
ECT	75°C (167°F) or more
Estimated TWC temperature	Up stream catalyst: 600 to 750°C (1,112 to 1,382°F) Down stream catalyst: 600 to 750°C (1,112 to 1,382°F)
Fuel system status	Closed loop

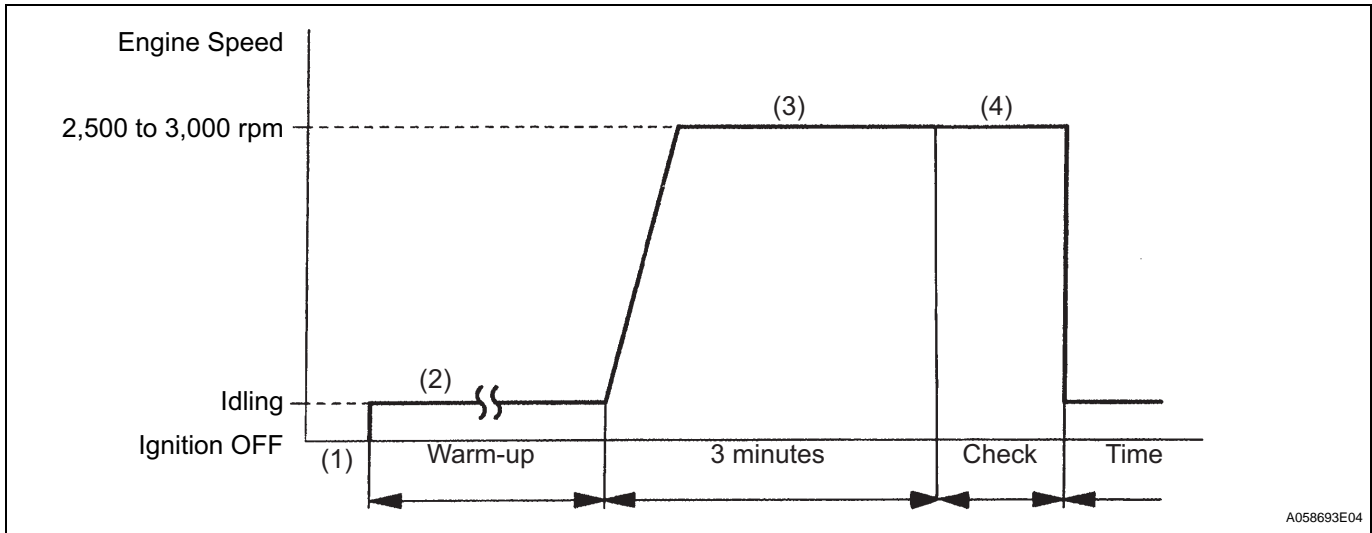
## TYPICAL MALFUNCTION THRESHOLDS

Rear HO2 sensor locus length	0.5 V or more (varies with A/F sensor locus length)
Frequency of the monitor	2 times

## ES MONITOR RESULT

Refer to CHECKING MONITOR STATUS (see page [ES-19](#)).

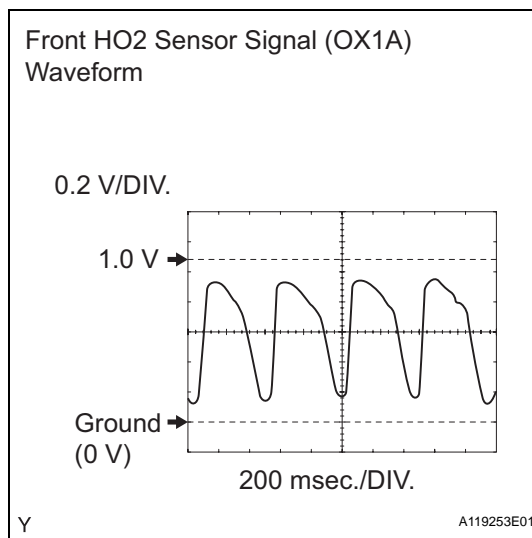
## CONFIRMATION DRIVING PATTERN



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- (1) If using the intelligent tester: Connect the intelligent tester to the DLC3.
- (2) If not using the intelligent tester: Connect oscilloscope tester probes to terminals OX1A (front Heated Oxygen [HO2] sensor: Sensor 1), OX1B (rear HO2 sensor: Sensor 2) and E1 of the ECM connector.
- (3) Start the engine.
- (4) Warm up the engine with all the accessories switched OFF until the engine coolant temperature stabilizes.
- (5) Run the engine at an engine speed between 2,500 rpm and 3,000 rpm for approximately 3 minutes.

(6) Check that the waveform of the OX1A (rear HO2 sensor) signal.



HINT:

If there is still a malfunction in the system, the waveform of OX1B may become similar to the OX1A waveform shown in the diagram above.

HINT:

Read freeze frame data using the intelligent tester. Freeze frame data records the engine conditions 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.

ES

**1 CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420)**

- (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 (see page ES-48).

**Result**

Display (DTC Output)	Proceed to
P0420	A
P0420 and other DTCs	B

HINT:

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

**B** **GO TO DTC CHART**

**A**

**2 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (A/F CONTROL)**

- (a) Connect the intelligent tester to the DLC3.
- (b) Turn the ignition switch ON and turn the tester ON.
- (c) Start the engine.

- (d) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
- (e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
- (f) 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).
- (g) Monitor the voltage outputs of the HO2 sensors (O2S B1S1 and O2S B1S2) 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)	Injection Volumes	Status	Voltages
O2S B1S1 (Front HO2 Sensor)	+25%	Rich	More than 0.55
O2S B1S1 (Front HO2 Sensor)	-12.5%	Lean	Less than 0.4
O2S B1S2 (Rear HO2 Sensor)	+25%	Rich	More than 0.5
O2S B1S2 (Rear HO2 Sensor)	-12.5%	Lean	Less than 0.4

Status O2S B1S1	Status O2S B1S2	A/F Condition and HO2 Sensors (sensors 1 and 2) Condition	Misfires	Main Suspected Trouble Areas	Proceed to
Lean / Rich	Lean / Rich	Normal	-	<ul style="list-style-type: none"> <li>• TWC</li> <li>• Gas leakage from exhaust system</li> </ul>	A
Lean	Lean / Rich	HO2 sensor (sensor 1) malfunction	-	<ul style="list-style-type: none"> <li>• HO2 sensor (sensor 1)</li> </ul>	B
Rich	Lean / Rich	HO2 sensor (sensor 1) malfunction	-	<ul style="list-style-type: none"> <li>• HO2 sensor (sensor 1)</li> </ul>	B
Lean / Rich	Lean	HO2 sensor (sensor 2) malfunction	-	<ul style="list-style-type: none"> <li>• HO2 sensor (sensor 2)</li> <li>• Gas leakage from exhaust system</li> </ul>	C
Lean / Rich	Rich	HO2 sensor (sensor 2) malfunction	-	<ul style="list-style-type: none"> <li>• HO2 sensor (sensor 2)</li> <li>• Gas leakage from exhaust system</li> </ul>	C
Lean	Lean	Actual air-fuel ratio (A/F) lean	May occur	<ul style="list-style-type: none"> <li>• Extremely rich or lean actual A/F</li> <li>• Gas leakage from exhaust system</li> </ul>	A
Rich	Rich	Actual A/F rich	-	<ul style="list-style-type: none"> <li>• Extremely rich or lean actual A/F</li> <li>• Gas leakage from exhaust system</li> </ul>	A

**Result:**

Status O2S B1S1	Status O2S B1S2	A/F Condition and HO2 Sensors (sensors 1 and 2) Condition	Misfires	Main Suspected Trouble Areas	Proceed to
Lean / Rich	Lean / Rich	Normal	-	<ul style="list-style-type: none"> <li>• TWC</li> <li>• Gas leakage from exhaust system</li> </ul>	A
Lean	Lean / Rich	HO2 sensor (sensor 1) malfunction	-	<ul style="list-style-type: none"> <li>• HO2 sensor (sensor 1)</li> </ul>	B
Rich	Lean / Rich	HO2 sensor (sensor 1) malfunction	-	<ul style="list-style-type: none"> <li>• HO2 sensor (sensor 1)</li> </ul>	B

Status O2S B1S1	Status O2S B1S2	A/F Condition and HO2 Sensors (sensors 1 and 2) Condition	Misfires	Main Suspected Trouble Areas	Proceed to
Lean / Rich	Lean	HO2 sensor (sensor 2) malfunction	-	<ul style="list-style-type: none"> <li>HO2 sensor (sensor 2)</li> <li>Gas leakage from exhaust system</li> </ul>	C
Lean / Rich	Rich	HO2 sensor (sensor 2) malfunction	-	<ul style="list-style-type: none"> <li>HO2 sensor (sensor 2)</li> <li>Gas leakage from exhaust system</li> </ul>	C
Lean	Lean	Actual air-fuel ratio (A/F) lean	May occur	<ul style="list-style-type: none"> <li>Extremely rich or lean actual A/F</li> <li>Gas leakage from exhaust system</li> </ul>	A
Rich	Rich	Actual A/F rich	-	<ul style="list-style-type: none"> <li>Extremely rich or lean actual A/F</li> <li>Gas leakage from exhaust system</li> </ul>	A

**ES**

Lean: During A/F CONTROL, the HO2 sensor (sensors 1 and 2) output voltages are consistently less than 0.4 V.  
 Rich: During A/F CONTROL, the HO2 sensor (sensors 1 and 2) output voltages are consistently more than 0.50 to 0.55 V.

**B** → **CHECK AND REPLACE OXYGEN SENSOR (SENSOR 1)**

**C** → **CHECK AND REPLACE HEATED OXYGEN SENSOR (SENSOR 2), OR CHECK AND REPAIR EXHAUST GAS LEAKAGE**

**A**

**3** | **CHECK FOR EXHAUST GAS LEAKAGE**

**OK:**  
No gas leakage.

**NG** → **REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT**

**OK**

**4** | **REPLACE THREE-WAY CATALYTIC CONVERTER (EXHAUST MANIFOLD)**

**NOTICE:**  
Replace both the front and rear catalyts (front exhaust pipe).

**NEXT**

**END**