

DTC	P0420	Catalyst System Efficiency Below Threshold (Bank 1)
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DTC	P0430	Catalyst System Efficiency Below Threshold (Bank 2)
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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. 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.

DTC No.	DTC Detecting Condition	Trouble Area
P0420 P0430	After engine and catalyst are warmed up, and while vehicle is driven within set vehicle and engine speed range, each waveform of heated oxygen sensors has same amplitude (2 trip detection logic)	<ul style="list-style-type: none"> • Gas leakage on exhaust system • Heated oxygen sensor (bank 1, 2 sensor 1, 2) • Three-way catalytic converter

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	Bank 1 catalyst is deteriorated
	P0430	Bank 2 catalyst is deteriorated
Required sensors/components	Main sensors/components	Front and rear heated oxygen sensor
	Related sensors/components	Mass air flow meter, Engine coolant temperature sensor, Engine speed sensor, Intake air temperature sensor
Frequency of operation	Once per driving cycle	
Duration	30 sec.	
MIL operation	2 driving cycles	
Sequence of operation	None	

TYPICAL ENABLING CONDITIONS

Item	Specification	
	Minimum	Maximum
The monitor will run whenever these DTCs are not present	See page DI-18	
Battery voltage	11 V	–
IAT	–10°C (14°F)	–
ECT	75°C (167°F)	–
Atmospheric pressure coefficient	0.75	–
Idle	OFF	
Engine RPM	–	3,200 rpm
A/F sensor	Activated	
Fuel system status	Closed loop	
Engine load	10 to 70 %	
All of the following conditions are met	Condition 1, 2 and 3	
1. MAF	5 to 70 g/sec	
2. Front catalyst temperature (estimated)	650 to 840°C (1,202 to 1,544°F)	
3. Rear catalyst temperature (estimated)	100 to 900°C (212 to 1,652°F)	
Rear HO2S monitor	Completed	
Shift position	4th	–

TYPICAL MALFUNCTION THRESHOLDS

Detection Criteria	Threshold
Oxygen storage capacity (OSC) of catalyst	Less than 0.04

MONITOR RESULT

Refer to page [DI-26](#) for detailed information.

The test value and test limit information are described as shown in the following table. Check the monitor result and test values after performing the monitor drive pattern (see page [DI-27](#)).

- TID (Test Identification Data) is assigned to each emissions-related component.
- TLT (Test Limit Type):
 - If TLT is 0, the component is malfunctioning when the test value is higher than the test limit.
 - If TLT is 1, the component is malfunctioning when the test value is lower than the test limit.
- CID (Component Identification Data) is assigned to each test value.
- Unit Conversion is used to calculate the test value indicated on generic OBD II scan tools.

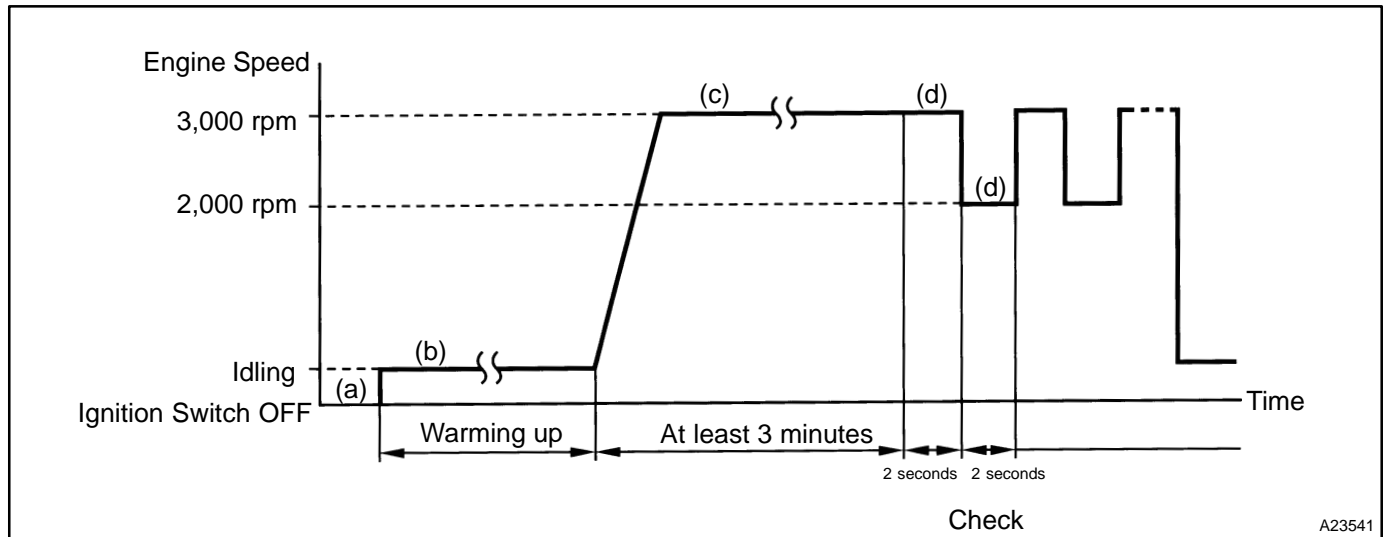
TID \$01: Catalyst (Active A/F control method)

TLT	CID	Unit Conversion	Description of Test Data	Description of Test Limit
1	\$01	Multiply by 0.0078 (no dimension)	Oxygen storage capacity (bank 1): Calculated by HO2S 2 output	Malfunction criteria for catalyst deterioration
1	\$02	Multiply by 0.0078 (no dimension)	Oxygen storage capacity (bank 2): Calculated by HO2S 2 output	Malfunction criteria for catalyst deterioration

WAVEFORMS OF AIR-FUEL RATIO (A/F) AND HEATED OXYGEN (HO2) SENSORS

HINT:

Perform the operation with the engine speeds and time durations described below prior to check the waveforms of the A/F and HO2 sensors. This is in order to activate the sensors sufficiently to obtain the appropriate inspection results.

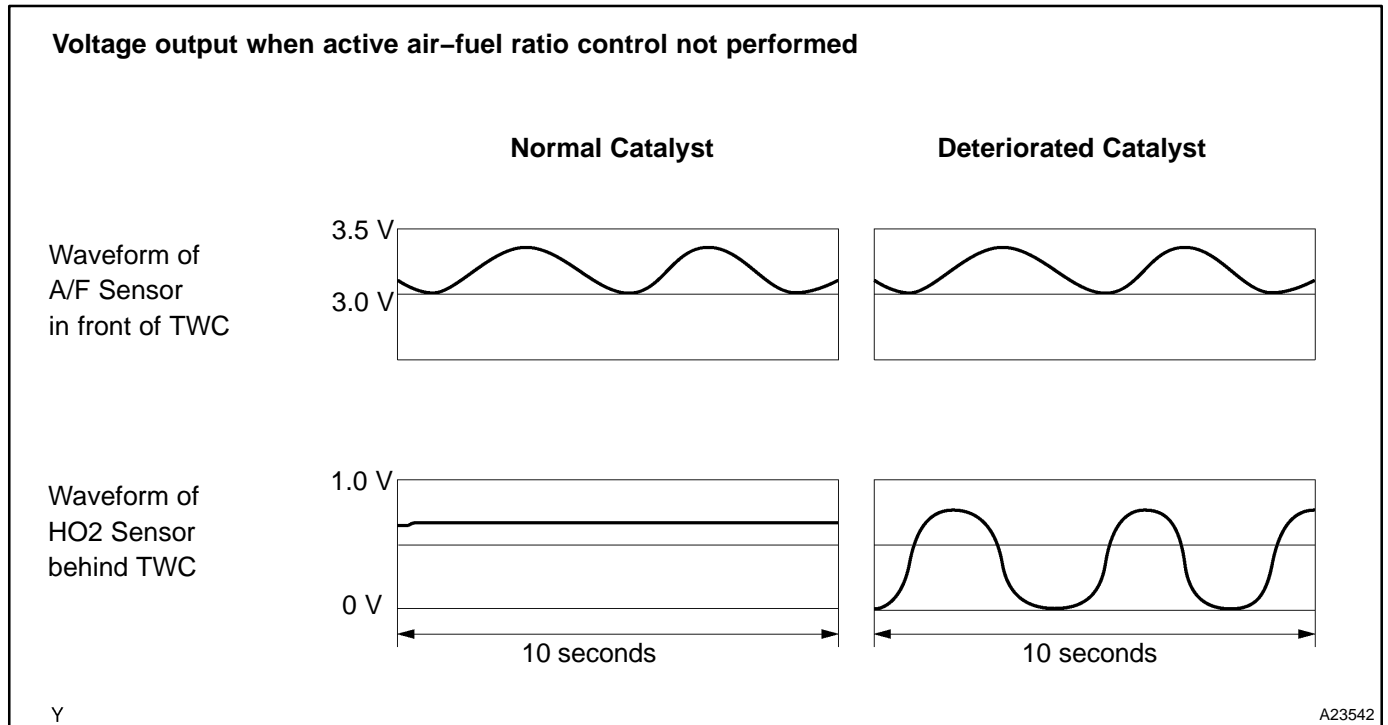


- Connect the hand-held tester to the DLC3.
- Start the engine and warm it up with all the accessories switched OFF, until the engine coolant temperature stabilizes.
- Run the engine at an engine speed of between 2,500 rpm and 3,000 rpm for at least 3 minutes.
- After confirming that the waveform of the heated oxygen sensor (bank 1, 2 sensor 1 (OX1A, OX2A)), oscillate around 0.5 V during feedback to the ECM, check the waveform of the heated oxygen sensor (bank 1, 2 sensor 2 (OX1B, OX2B)).

HINT:

- If either of the voltage outputs of the Air-Fuel Ratio (A/F) or Heated Oxygen (HO2) sensors does not fluctuate, or either of the sensors makes a noise, the sensor may be malfunctioning.
- If the voltage outputs of both the sensors remain lean or rich, the air-fuel ratio may be extremely lean or rich. In such cases, perform the following A/F CONTROL using a hand-held tester.

- If the Three-Way Catalytic Converter (TWC) has deteriorated, the HO2 sensor (located behind the TWC) voltage output fluctuates up and down frequently, even under normal driving conditions (active air-fuel ratio control is not performed).



A/F CONTROL

HINT:

Hand-held 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 a hand-held tester.

- (1) Connect a hand-held tester to the DLC3.
- (2) Start the engine and turn the tester ON.
- (3) Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
- (4) On the tester, select the following menu items: 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 voltage outputs of the A/F and HO2 sensors (AFS B1S1 and OS2 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
AFS B1S1 (A/F)	+25 %	Rich	Less than 3.0
AFS B1S1 (A/F)	-12.5 %	Lean	More than 3.35
O2S B1S2 (HO2)	+25 %	Rich	More than 0.55
O2S B1S2 (HO2)	-12.5 %	Lean	Less than 0.4

NOTICE:

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.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Areas
1	Injection volume +25 % -12.5 % Output voltage More than 3.35 V Less than 3.0 V OK	Injection volume +25 % -12.5 % Output voltage More than 0.55 V Less than 0.4V OK	—
2	Injection volume +25 % -12.5 % Output voltage Almost no reaction NG	Injection volume +25 % -12.5 % Output voltage More than 0.55 V Less than 0.4V OK	<ul style="list-style-type: none"> • A/F sensor • A/F sensor heater • A/F sensor circuit
3	Injection volume +25 % -12.5 % Output voltage More than 3.35 V Less than 3.0V OK	Injection volume +25 % -12.5 % Output voltage Almost no reaction NG	<ul style="list-style-type: none"> • HO2 sensor • HO2 sensor heater • HO2 sensor circuit
4	Injection volume +25 % -12.5 % Output voltage Almost no reaction NG	Injection volume +25 % -12.5 % Output voltage Almost no reaction NG	<ul style="list-style-type: none"> • Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)

- Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the A/F and HO2 sensors.
- To display the graph, select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2, and press the YES button and then the ENTER button followed by the F4 button.

INSPECTION PROCEDURE

HINT:

Read freeze frame data using the hand-held tester. Freeze frame data records the engine conditions when a malfunction is detected. 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, as well as other data from the time when a malfunction occurred.

1	Are there any other codes (besides DTC P0420 or P0430) being output?
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PREPARATION:

- (a) Connect the hand-held tester to the DLC3.
- (b) Turn the ignition switch to ON and push the hand-held tester main switch ON.
- (c) When using hand-held tester, enter the following menu: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

CHECK:

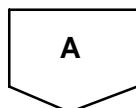
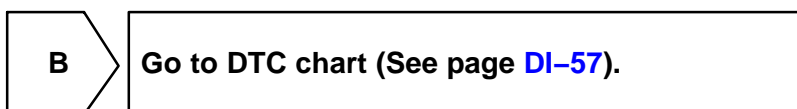
Read the DTC using the hand-held tester.

RESULT:

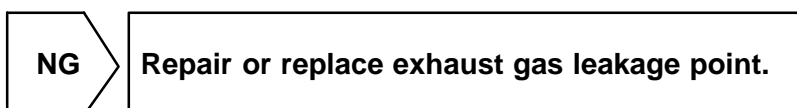
Display (DTC Output)	Proceed to
"P0420 and/or P0430"	A
"P0420 or P0430" and other DTCs	B

HINT:

If any other codes besides "P0420 and/or P0430" are output, perform the troubleshooting for those DTCs first.



2	Check gas leakage on exhaust system.
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3	Check A/F sensor (bank 1, 2 sensor 1) (See page SF-64).
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HINT:

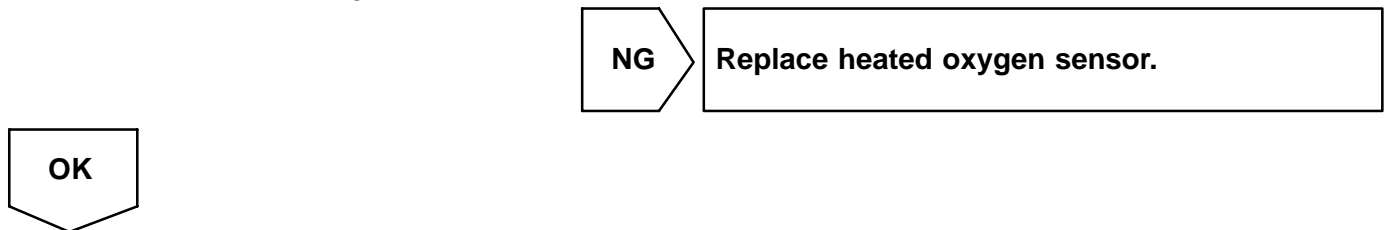
Refer to the HINT following the end of this flowchart.



4	Check heated oxygen sensor (bank 1, 2 sensor 2) (See page SF-64).
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HINT:

Refer to the HINT following the end of this flowchart.



Replace front and rear three-way catalytic converter in the bank a malfunction is detected.

HINT:

Hand-held tester only:

Narrowing down the trouble area is possible by performing ACTIVE TEST of the following "A/F CONTROL" (Heated oxygen sensor or another can be distinguished).

(a) Perform ACTIVE TEST by hand-held tester (A/F CONTROL).

HINT:

"A/F CONTROL" is the ACTIVE TEST which changes the injection volume to -12.5 % or +25 %.

- (1) Connect the hand-held tester to the DLC3 on the vehicle.
- (2) Turn the ignition switch to ON.
- (3) Warm up the engine with the engine speed at 2,500 rpm for approximately 90 seconds.
- (4) Select the menu "DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL".
- (5) Perform "A/F CONTROL" with the engine in an idle condition (press the right or left button).

RESULT:

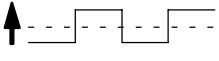


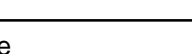
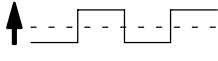


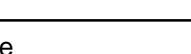
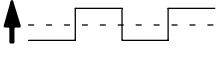

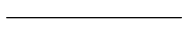
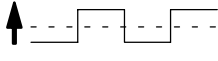


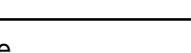
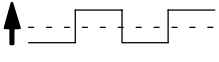


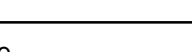
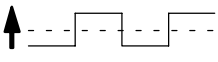


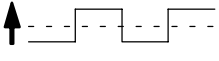

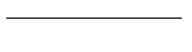
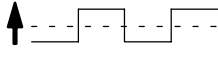

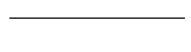
Heated oxygen sensor reacts in accordance with increase and decrease of injection volume

+25 % → rich output: More than 0.5 V

-12.5 % → lean output: Less than 0.4 V

NOTICE:

There is a few second delay in the sensor 1 (front sensor) output. And there is approximately 20 seconds delay in the sensor 2 (rear sensor).

	Output voltage of heated oxygen sensor (sensor 1: front sensor)	Output voltage of heated oxygen sensor (sensor 2: rear sensor)	Mainly suspected trouble area
Case 1	Injection volume +25 %  -12.5 %  Output voltage More than 0.5 V  Less than 0.4 V  OK	Injection volume +25 %  -12.5 %  Output voltage More than 0.5 V  Less than 0.4 V  OK	—
Case 2	Injection volume +25 %  -12.5 %  Output voltage Almost no reaction  NG	Injection volume +25 %  -12.5 %  Output voltage More than 0.5 V  Less than 0.4 V  OK	Sensor 1: front sensor (sensor 1, heater, sensor 1 circuit)
Case 3	Injection volume +25 %  -12.5 %  Output voltage More than 0.5 V  Less than 0.4 V  OK	Injection volume +25 %  -12.5 %  Output voltage Almost no reaction  NG	Sensor 2: rear sensor (sensor 2, heater, sensor 2 circuit)
Case 4	Injection volume +25 %  -12.5 %  Output voltage Almost no reaction  NG	Injection volume +25 %  -12.5 %  Output voltage Almost no reaction  NG	Extremely rich or lean actual air-fuel ratio (Injector, fuel pressure, gas leakage in exhaust system, etc.)

The following A/F CONTROL procedure enables the technician to check and graph the voltage output of the heated oxygen sensors (sensor 1 and 2).

For displaying the graph indication, enter "ACTIVE TEST / A/F CONTROL / USER DATA" then select "O2S B1S1 and O2S B1S2" by pressing "YES" button and push "ENTER" button before pressing "F4" button.

NOTICE:

If the vehicle is short of fuel, the air-fuel ratio becomes LEAN and DTCs P0133 and/or P0153 will be recorded, and the MIL then comes on.

- If different DTCs related to different systems while terminal E2 as ground terminal are output simultaneously, terminal E2 may be open.
- Read freeze frame data using the hand-held tester or the OBD II scan tool. Freeze frame data records the engine conditions when a malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air-fuel ratio was lean or rich, etc. at the time of the malfunction.
- A high heated oxygen sensor (sensor 1) voltage (0.5 V or more) could be caused by a rich air fuel mixture. Check for conditions that would cause the engine to run rich.
- A low heated oxygen sensor (sensor 1) voltage (0.4 V or less) could be caused by a lean air fuel mixture. Check for conditions that would cause the engine to run lean.