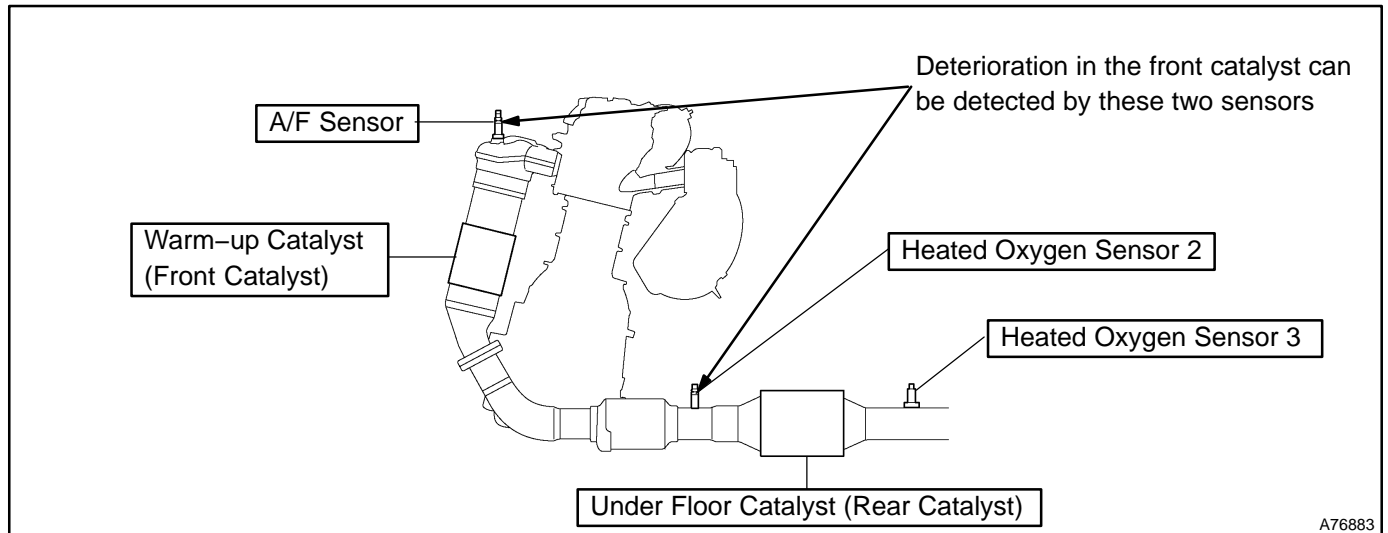


DTC	P0420	CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 1)
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CIRCUIT DESCRIPTION

The ECM uses the air-fuel ratio (A/F) sensor and the heated oxygen sensor 2 to detect deterioration in the front catalyst.



In order to detect deterioration in the front catalyst, the ECM calculates Oxygen Storage Capacity (OSC) in the catalyst based on voltage output of the heated oxygen sensor 2 while performing the "active air-fuel ratio control" instead of the conventional detecting method which uses the locus ratio.

The OSC is an indication value of the catalyst oxygen storage capacity and is used for representing how much the catalyst can store oxygen. When the vehicle is driving with a warm engine, the "active air-fuel ratio control" is performed for approximately 15 to 20 seconds. When it is performed, the air-fuel ratio is forcibly regulated to go LEAN or RICH by the ECM, and if a RICH and LEAN cycle of the heated oxygen sensor 2 is long, the OSC will become greater, and greater OSC basically capability of the catalyst are mutually related, the ECM judges if the catalyst has deteriorated based on the calculated OSC value.

DTC No.	DTC Detection Condition	Trouble Area
P0420	OSC value is smaller than the standard value under "Active air-fuel ratio control"	<ul style="list-style-type: none"> Exhaust manifold with front catalyst and exhaust front pipe with rear catalyst both Gas leakage in exhaust system A/F sensor Heated oxygen sensor 2 (bank 1 sensor 2)

MONITOR STRATEGY

Related DTCs	P0420: Catalyst Deterioration
Required sensors/ components (Main)	Catalyst
Required sensors/ components (Related)	A/F sensor, Rear HO2S, IAT sensor, MAF sensor, Crankshaft position sensor, ECT sensor
Frequency of operation	Once per driving cycles
Duration	30 seconds
MIL operation	2 driving cycles
Sequence operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever this DTC is not present	See page 05-360
Battery voltage	11 V or more
IAT	-10 °C (14 °F) or more
ECT	75 °C (167 °F) or more
Idle	OFF
Engine RPM	Less than 4,000 rpm
A/F sensor status	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	2.9 to 33 g/second
2. Front catalyst temperature (estimated)	620 to 730 °C (1,148 to 1,292 °F)
3. Rear catalyst temperature (estimated)	400 °C (752 °F)
EVAP system monitor	The monitor has not run yet or the vacuum introduction has been completed
A/F sensor monitor	Completed
Rear HO2S monitor	Completed
Shift position	3rd or higher

TYPICAL MALFUNCTION THRESHOLDS

Oxygen Storage Capacity (OSC) of catalyst	Less than 0.08 g
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MONITOR RESULT (MODE 06)

Refer to page [05-371](#) for detailed information.

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

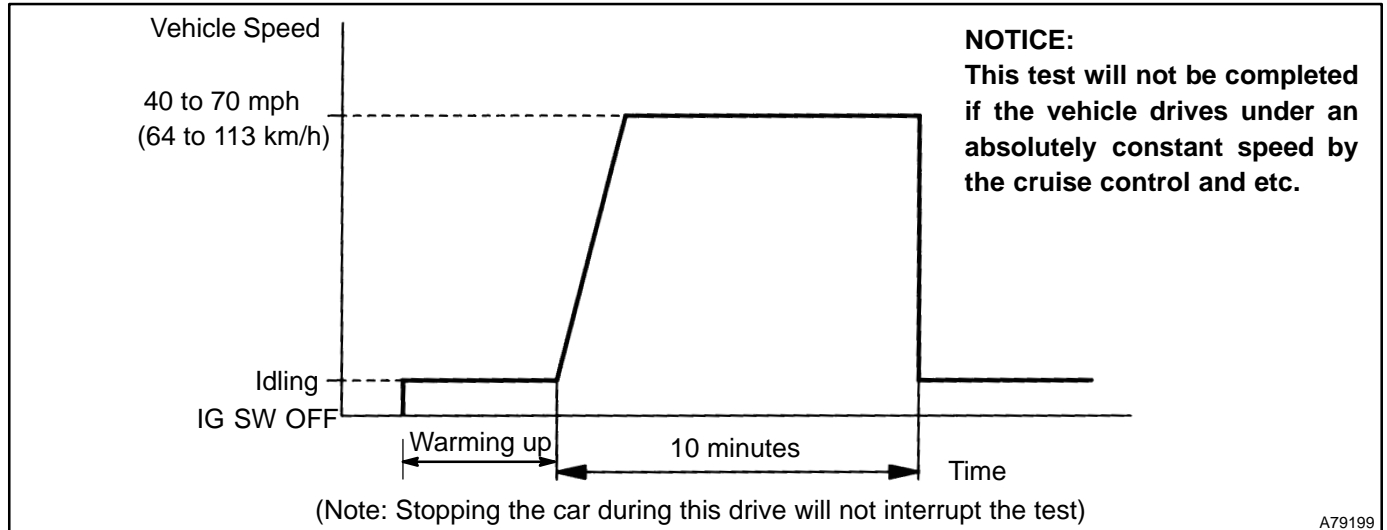
TLT	CID	Unit Conversion	Description of Test Data	Description of Test Limit
1	\$01	Multiply by 0.0078 (no dimension)	Oxygen storage capacity: Calculated by HO2S sensor 2 output	Malfunction criteria for catalyst deterioration

CONFIRMATION DRIVING PATTERN FOR READINESS MONITOR

PURPOSE (See page 05-381)

HINT:

Performing this confirmation pattern will activate the front catalyst monitoring by the ECM. This is very useful for verifying the completion of a repair.



READINESS TESTS	
MISFIRE MON	AVAIL
FUEL SYS MON	AVAIL
COMP MON	AVAIL
CAT EVAL	INCMPL
HTD CAT EVAL	N/A
EVAP EVAL	INCMPL
2nd AIR EVAL	N/A
A/C EVAL	N/A
O2S EVAL	INCMPL
O2S HTR EVAL	INCMPL
EGR EVAL	N/A

A15402

A76855

- Clear the DTCs.
 - Disconnect the battery terminal or remove the EFI and ETCS fuses for 60 seconds or more.
- Connect the hand-held tester to the DLC3.
- Enter the following menus: DIAGNOSIS / CARB OBD II / READINESS TESTS and check that CAT EVAL is INCMPL (incomplete).
- Drive the vehicle according to the confirmation driving pattern. Note the state of the Readiness Tests. They will change to COMPL (complete) as the CAT evaluation monitors operate.
- Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES and check if any DTC (any pending code) is set.

If the READINESS CODE of "CAT EVAL" was "INCMPL" and any DTC (include pending codes) was not set, extend the driving time.

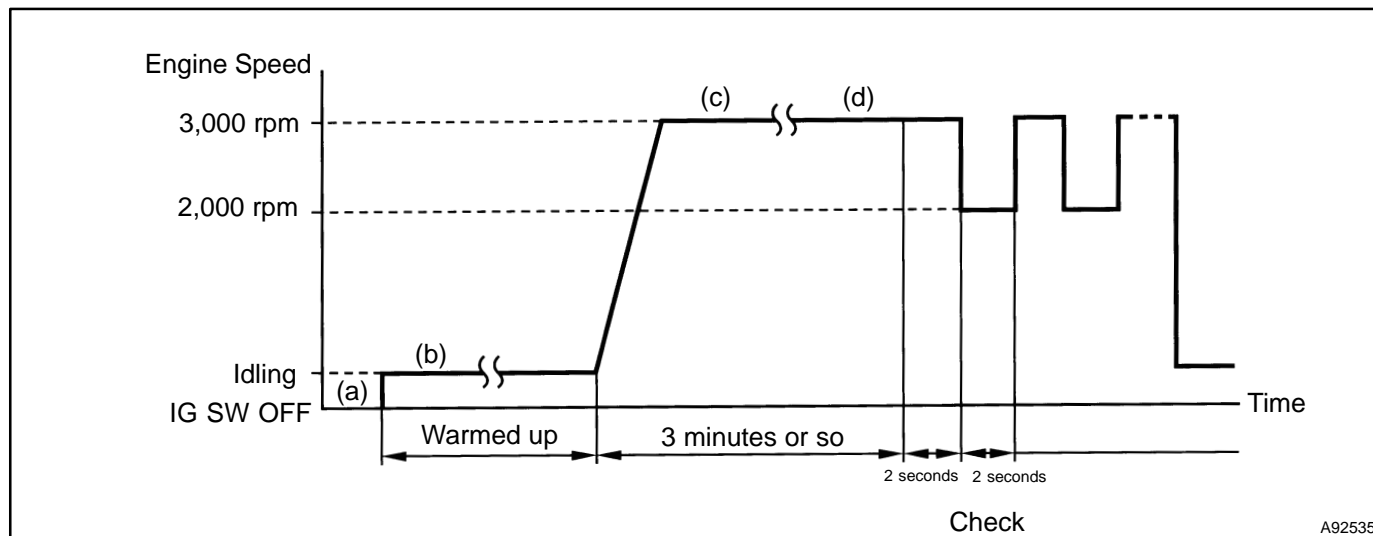
NOTICE:

If you do not have the hand-held tester, perform again the same confirmation driving pattern after turning off the ignition switch upon finishing the first confirmation driving pattern.

CONDITIONING THE A/F SENSOR AND HEATED OXYGEN SENSOR 2 FOR TESTING

HINT:

Follow this engine rpm and timing pattern to properly activate and condition these sensors prior to the observation of their output waveforms.

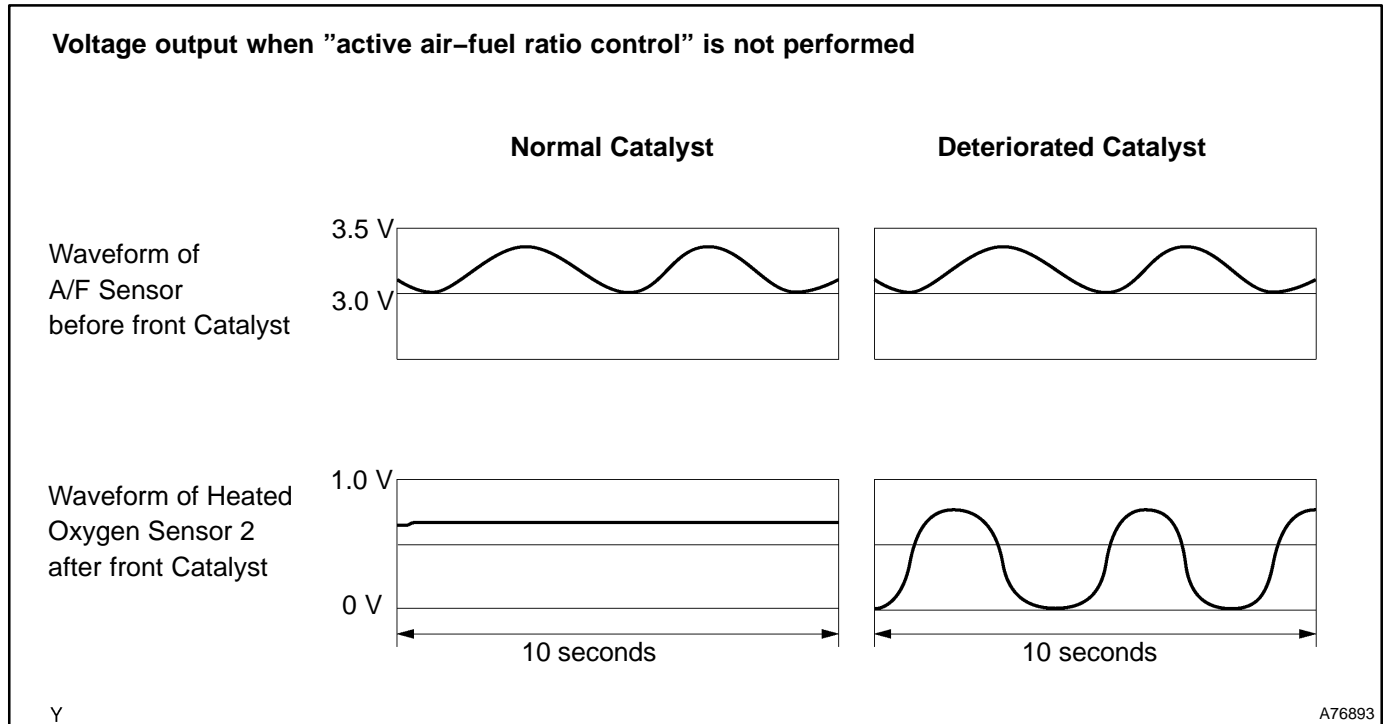


- (a) Connect the hand-held tester or the OBD II scan tool to the DLC3.
- (b) Start the engine and warm it up with all the accessories switched OFF until the coolant temperature is stable.
- (c) Run the engine at 2,500 to 3,000 rpm for about 3 minutes.
- (d) When running the engine at 3,000 rpm for 2 seconds and 2,000 rpm for 2 seconds, check the waveforms of the A/F sensor and heated oxygen sensor 2.

HINT:

If either output of the A/F sensor and the heated oxygen sensor 2 does not fluctuate or has noise, the sensor may be malfunctioning.

If voltage outputs of both the sensors remain at LEAN or RICH, the air-fuel ratio may be extremely LEAN or RICH. In such case, perform the following A/F CONTROL in ACTIVE TEST with the hand-held tester. If the catalyst has deteriorated, the voltage output of the heated oxygen sensor 2 (located after the front catalyst) fluctuates up and down extensively even under normal driving ("active air-fuel ratio control" is not performed).

**PERFORM A/F CONTROL****HINT:**

Hand-held tester only:

Narrowing down the trouble area is possible by performing the "A/F CONTROL" ACTIVE TEST (A/F sensor, heated oxygen sensor 2 or other trouble areas can be distinguished).

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

HINT:

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

- (1) Connect the hand-held tester to the DLC3 on the vehicle.
- (2) Turn the ignition switch ON.
- (3) Warm up the engine by running the engine at 2,500 rpm for approximately 90 seconds.
- (4) Enter the following menus: 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:

A/F sensor reacts in accordance with increase and decrease of injection volume:

+25 % → rich output: Less than 3.0 V

-12.5 % → lean output: More than 3.35 V






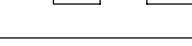

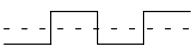


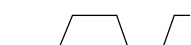


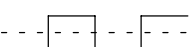

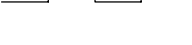
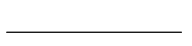

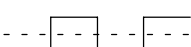

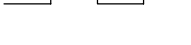



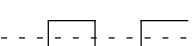

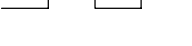

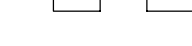

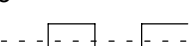




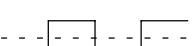

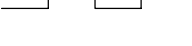


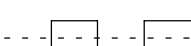

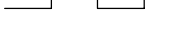

Heated oxygen sensor 2 reacts in accordance with increase and decrease of injection volume:

+25 % → rich output: More than 0.55 V

-12.5 % → lean output: Less than 0.4 V

NOTICE:

There is a few seconds delay in the A/F sensor output and there is about 20 seconds delay in the heated oxygen sensor 2 output.

	Output voltage of A/F sensor: (AFS B1S1)	Output voltage of heated oxygen sensor 2: (O2S B1S2)	Mainly suspect trouble area
Case 1	Injection volume +25 %   -12.5 %   Output voltage More than 3.35 V  OK Less than 3.0 V 	Injection volume +25 %   -12.5 %   Output voltage More than 0.55 V  OK Less than 0.4V 	Front catalyst
Case 2	Injection volume +25 %   -12.5 %   Output voltage Almost No reaction  NG	Injection volume +25 %   -12.5 %   Output voltage More than 0.55 V  OK Less than 0.4V 	A/F sensor (A/F sensor, heater, A/F sensor circuit)
Case 3	Injection volume +25 %   -12.5 %   Output voltage More than 3.35 V  OK Less than 3.0V 	Injection volume +25 %   -12.5 %   Output voltage Almost No reaction  NG	Heated oxygen sensor 2 (heated oxygen sensor, heater, heated oxygen sensor 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 to technician to check and graph the voltage outputs of both the A/F Sensor and Heated Oxygen Sensor 2.

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

INSPECTION PROCEDURE

HINT:

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.

1 READ OUTPUT DTC (IN ADDITION – P0420)

(a) Read the DTCs with the OBD II scan tool or the hand-held tester.

Result:

Display	Proceed to
Only DTC P0420 is output.	A
P0420 and other DTCs are output.	B

HINT:

If any other code besides P0420 are output, perform the troubleshooting for those DTCs first.

B

GO TO RELEVANT DTC CHART
(See page [05-426](#))

A

2 CHECK FOR EXHAUST GAS LEAKAGE

OK: No gas leakage.

NG

REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

3 CHECK AIR FUEL RATIO SENSOR (BANK 1 SENSOR 1) (See page [05-269](#))

NG

REPAIR OR REPLACE AIR FUEL RATIO SENSOR

OK

4 CHECK HEATED OXYGEN SENSOR (BANK 1 SENSOR 2) (See page [05-403](#))

OK: During air-fuel ratio feedback, the O2S's output alternates between rich and lean.

NG

REPAIR OR REPLACE HEATED OXYGEN SENSOR

OK

REPLACE THREE-WAY CATALYTIC CONVERTER (BOTH FRONT, REAR CATALYSTS)

HINT:

The ECM monitors the front catalyst to judge the degree of deterioration in both the front and rear catalysts. Therefore, both the catalysts must be replaced together when this DTC is set.