DTC	P0420	CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 1)

MONITOR DESCRIPTION

The ECM uses 2 sensors mounted before and after the three-way catalytic converter (TWC) to monitor its' efficiency. The air-fuel ratio (A/F) sensor (sensor 1) sends pre-catalyst information to the ECM. The heated oxygen (O2) sensor (sensor 2) sends post-catalyst information to the ECM.
In order to detect deterioration in the catalyst, the ECM calculates Oxygen Storage Capacity (OSC) in the catalyst based on voltage output of the sensor 2 while performing "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 being driven 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 sensor 2 is long, the OSC will become greater. The greater OSC and capability of the catalyst are mutually related. The ECM judges if the catalyst has deteriorated based on the calculated OSC value. The ECM will illuminate the MIL and a DTC will be set.

DTC No.	DTC Detection Condition	Trouble Area
P0420	OSC value is smaller than the standard value under "active air-fuel ratio control"	• Exhaust manifold with front catalyst and exhaust front pipe with rear catalyst • Gas leakage in exhaust system • A/F sensor • Heated oxygen sensor

HINT:

- Sensor 1 refers to the sensor mounted before the TWC and is located near the engine assembly.
- Sensor 2 refers to the sensor mounted after the TWC and is located far from the engine assembly.

MONITOR STRATEGY

Related DTCs	P0420: Bank 1 catalyst is deterioration
Required sensors/components	Main: A/F sensor, heated oxygen sensor Related: Mass air flow meter, engine coolant temperature sensor, engine speed sensor, intake air temperature sensor
Frequency of operation	Once per driving cycle
Duration	30 seconds
MIL operation	2 driving cycles
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever the following DTCs are not present	See page 05-20
Battery voltage	11.5 V or more
Intake air temperature	-10 °C (14°F) or more
Idle	OFF
Engine speed	Less than 3,200 rpm
Engine coolant temperature	75°C (157°F) or more
Estimated catalyst temperature conditions are met:	1 & 2
1. Upstream estimated catalyst temperature	Less than 800°C (1,508°F), and 430 °C (806 °F) or more
2. Downstream estimated catalyst temperature	Less than 675°C (1,292°F), and 290 °C (554 °F) or more
Fuel system status	Closed-loop

TYPICAL MALFUNCTION THRESHOLDS

Oxygen storage capacity	Less than 0.08 g

MONITOR RESULT

The detailed information is described in “CHECKING MONITOR STATUS” (see page 05-26).

- MID (Monitor Identification) is assigned to each component/system.
- TID (Test Identification) is assigned to each test component.
- Scaling is used to calculate the test value indicated on generic OBD scan tools.

Catalyst Bank 1

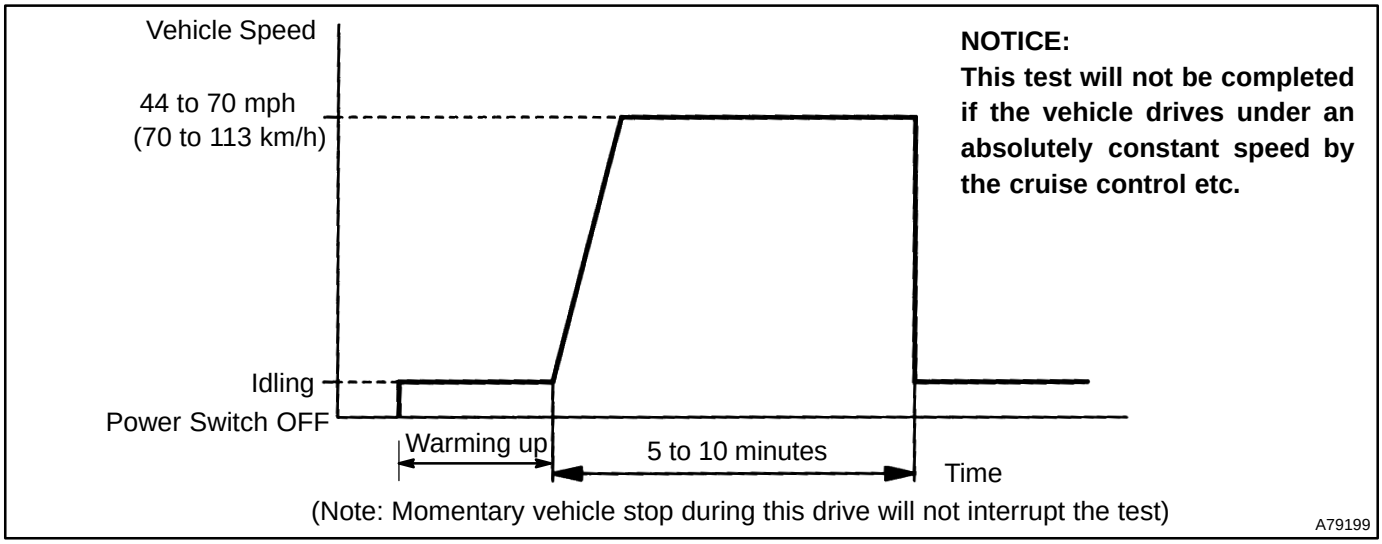
MID	TID	Scaling	Description of Test Value
$21	$A9	Multiply by 0.0003 (no dimension)	Oxygen storage capacity

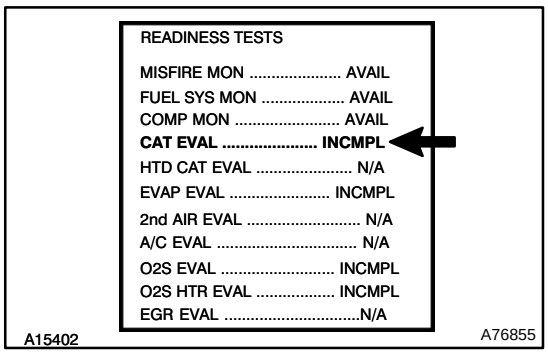
CONFIRMATION DRIVING PATTERN FOR READINESS MONITOR

PURPOSE (See page 05-27)

HINT:

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





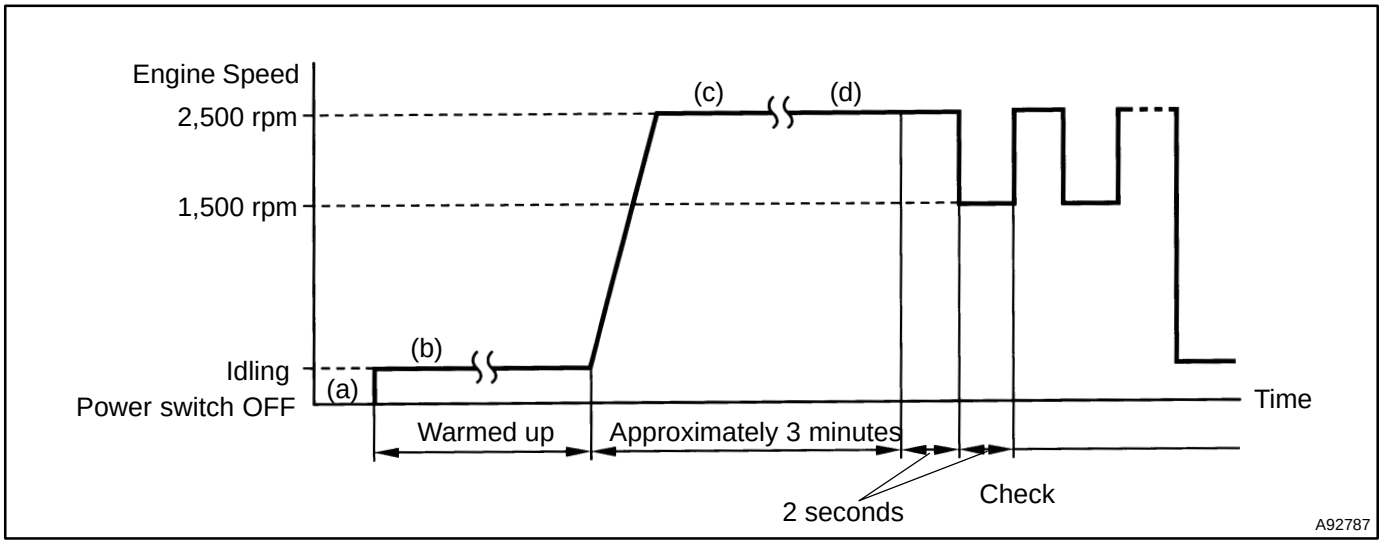
(a) Clear the DTCs.
(b) Connect the hand-held tester to the DLC3.
(c) Select the item: DIAGNOSIS / CARB OBD II / READINESS TESTS. Check that CAT EVAL is INCMPL (incomplete).
(d) Drive the vehicle according to the confirmation driving pattern. Note the state of the Readiness Tests. They will change to COMPL (complete) as the CAT evaluation monitors operate.
(e) Select the item: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES. Check if any DTC (any pending code) is set.

If the READINESS CODE of CAT EVAL was INCMPL and any DTC (includes 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 power switch upon finishing the first confirmation driving pattern.

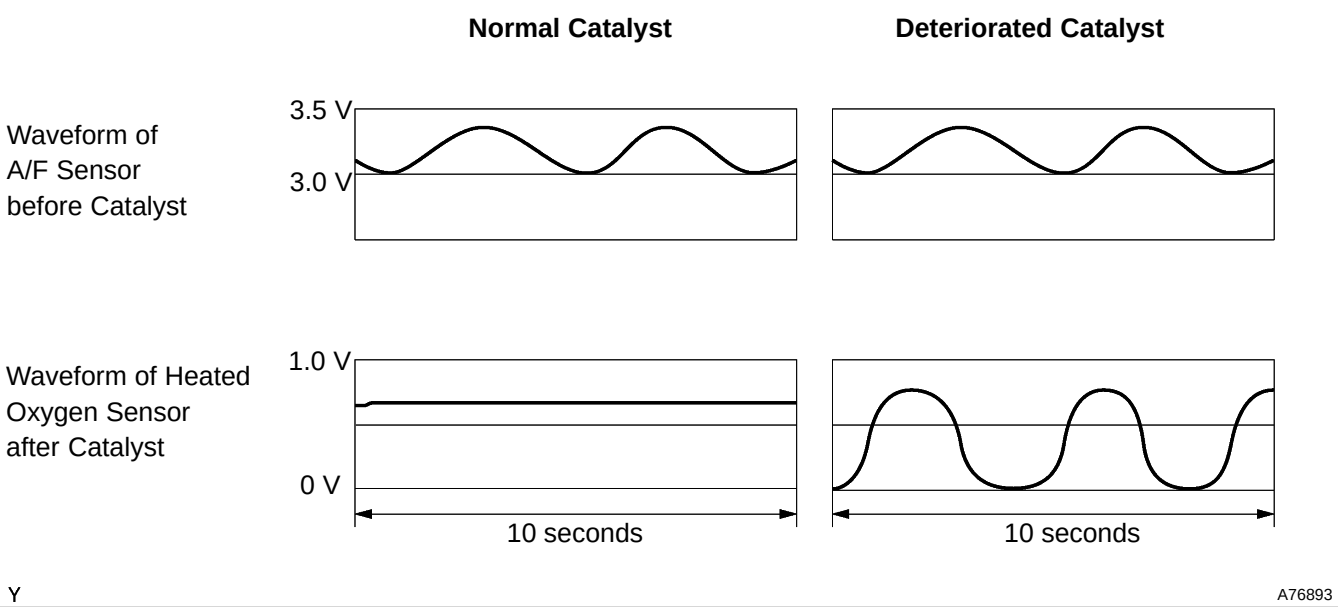
CONDITIONING THE A/F SENSOR AND HEATED OXYGEN SENSOR FOR TESTING



(a) Connect the OBD II scan tool or the hand-held tester to the DLC3.
(b) Put the engine in inspection mode (see page 05-1).
(c) Start the engine and warm it up with all the accessories switched OFF until the engine coolant temperature becomes table.
(d) Run the engine at 2,500 rpm for approximately 3 minutes.
(e) Run the engine at 2,500 rpm for 2 seconds and then 1,500 rpm for 2 seconds
(f) Check the waveform of the oxygen sensor (sensor 2).

HINT:
If output of the A/F sensor or the heated oxygen sensor does not fluctuate or has noise, the sensor may be malfunctioning.
If voltage output of both sensors remain at LEAN or RICH, the air-fuel ratio may be extremely LEAN or RICH. In such a case, perform the following A/F CONTROL operation in ACTIVE TEST using the hand-held tester.
If the catalyst has deteriorated, the voltage output of the heated oxygen sensor fluctuates up and down widely even under normal driving (”active air-fuel ratio control” is not performed).

Voltage output when ”active air-fuel ratio control” is not performed:



INSPECTION PROCEDURE

HINT:
Read freeze frame data using the hand−held tester or the OBD II scan tool. Freeze frame data records the engine condition when 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, and other data from the time the malfunction occurred.

1	CHECK OTHER DTC OUTPUT(IN ADDITION TO DTC P0420)

(a) Connect the hand-held tester or the OBD II scan tool to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the hand-held tester or the OBD II scan tool ON.
(d) On the hand-held tester, select the item: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read DTCs using the hand-held tester or the OBD II scan tool.
Result:

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

HINT:
If any other codes besides P0420 are output, perform troubleshooting for those DTCs first.

B → **GO TO RELEVANT DTC CHART (See page 05-54)**

A

2	CHECK FOR EXHAUST GAS LEAKAGE

OK: No gas leakage.

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

OK

3	INSPECT AIR FUEL RATIO SENSOR(BANK 1 SENSOR 1) (See page 05-313)

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

4	INSPECT HEATED OXYGEN SENSOR(BANK 1 SENSOR 2) (See page 05-124)

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

REPLACE THREE-WAY CATALYTIC CONVERTER (REPLACE FRONT PIPE)

HINT:
Malfunctioning areas can be found by performing the ACTIVE TEST / A/F CONTROL operation. The A/F CONTROL operation can determine if the A/F sensor, heated oxygen sensor or other potential trouble area are malfunctioning or not.
(a) Perform the ACTIVE TEST A/F CONTROL operation.

HINT:

The A/F CONTROL operation lowers the injection volume 12.5% or increases the injection volume 25%.

(1) Connect the hand-held tester to the DLC3 on the vehicle.
(2) Turn the power switch ON (IG).
(3) Put the engine in inspection mode (see page 05-1).
(4) Warm up the engine by running the engine at 2,500 rpm with the accelerator pedal depressed more than 60 % for approximately 90 seconds.
(5) Select the item: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(6) Perform the A/F CONTROL operation 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

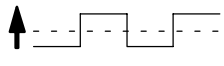
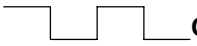
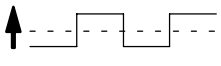
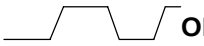
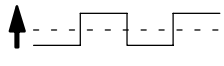
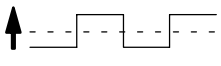
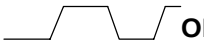
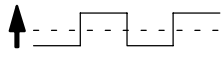
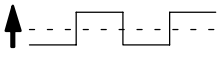
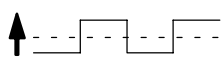
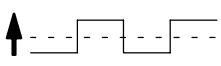
Heated oxygen sensor reacts in accordance with increase and decrease of injection volume:

+25 % → rich output: More than 0.55 V

-12.5 % → lean output: Less than 0.4 V

NOTICE:

The A/F sensor output has a few seconds of delay and the heated oxygen sensor output has about 20 seconds of delay at maximum.

	Output voltage of A/F sensor (sensor 1)	Output voltage of heated oxygen sensor (sensor 2)	Main Suspect Trouble Area
Case 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**	—
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 Less than 0.4V  **OK**	A/F sensor (A/F sensor, sensor heater, sensor circuit)
Case 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**	Heated oxygen sensor (heated oxygen sensor, sensor heater, 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 the technician to check and graph the voltage output of both A/F sensor and the heated oxygen sensor.
To display the graph, enter ACTIVE TEST/ A/F CONTROL/USER DATA, select ”AFS B1S1 and O2S B1S2” by pressing the ”YES” button followed by the ”ENTER” button and then the ”F4” button.