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 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 be LEAN or RICH by the ECM, and if a RICH and LEAN cycle of 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.

ES

DTC No.	DTC Detection Condition	Trouble Area
P0420	OSC value is smaller than the standard value under "active air-fuel ratio control"	• Gas leakage in exhaust system • A/F sensor • Heated oxygen sensor • 3-way catalytic converter

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 deteriorated
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	P0011 (VVT system 1 - Advance) P0012 (VVT system 1 - Retard) P0031, P0032 (A/F sensor heater - Sensor 1) P0037, P0038 (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 (O2 sensor - Sensor 2) P0171, P0172 (Fuel system) P0300 - P0304 (Misfire) P0335 (CKP sensor) P0340, P0341 (CMP sensor) P0351-P0354 (Igniter) P0442 - P0456 (EVAP system) P0500 (VSS) P2196 (A/F sensor - Rationality) P2A00 (A/F sensor - Slow response)
Battery voltage	11.0 V or more
Atomospheric pressure	75.981 kPa (570 mmHg) or more
Intake air temperature	-10 °C (14°F) or more
Idle	OFF
Engine speed	Less than 3,200 rpm
A/F sensor	Activate
Engine load	10 to 70 %
Engine coolant temperature	70°C (158°F) or more
All of the following condition are met:	1.2 & 3
1. MAF	5 to 30 glsec.
2. Front catalyst temperature (estimated)	420 to 800°C (788 to 1472°F)
3. Rear catalyst temperature (estimated)	Less than 290°C (554°F)
Fuel system status	Closed-loop
A/F sensor	Completed
Rear HO2S monitor	Completed

TYPICAL MALFUNCTION THRESHOLDS

Oxygen storage capacity	Less than 0.03 g

MONITOR RESULT

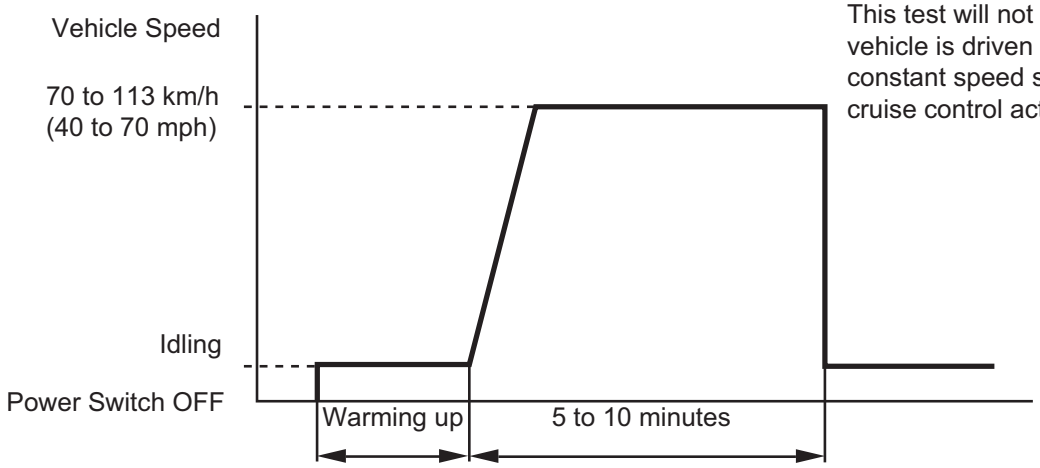
Refer to detailed information (see page ES-16).

CONFIRMATION DRIVING PATTERN

PURPOSE (see page ES-18)

HINT:

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



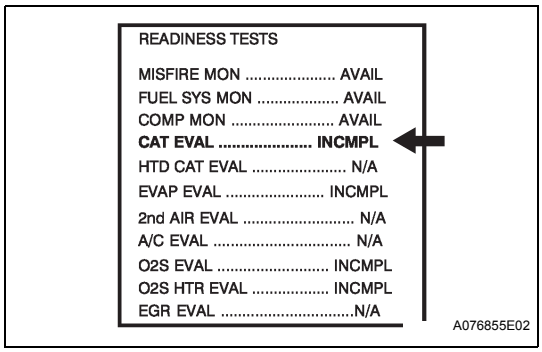
NOTICE:

This test will not be completed if the vehicle is driven at an absolutely constant speed such as with the cruise control activated.

(Note: Even if vehicle stops during driving pattern, test can be resumed.)

A154404E01

(a) Clear the DTCs.
(b) Connect the intelligent tester to the DLC3.
(c) Enter the following menus: DIAGNOSIS / CARB OBD II / READINESS TESTS. Check that CAT EVAL is INCMPL (incomplete).

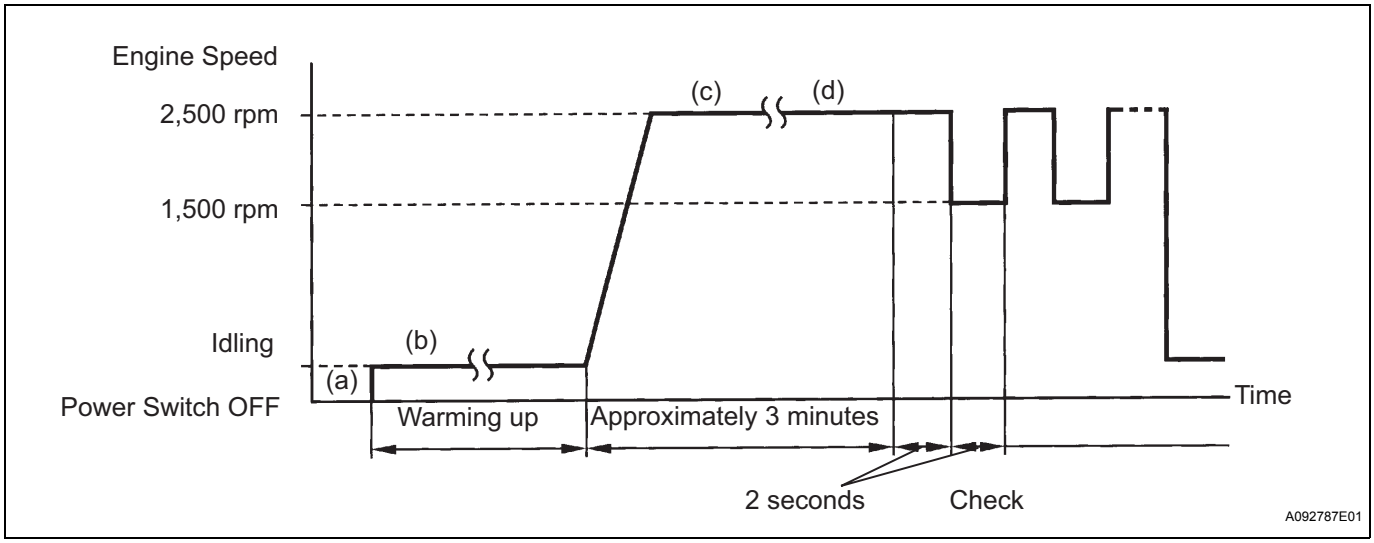


(d) Drive the vehicle according to the confirmation driving pattern. Note the state of the Readiness Tests. They will change to COMPL (complete) as the CAT evaluation monitors operate.
(e) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / PENDING CODES. Check if any DTC (any pending 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:

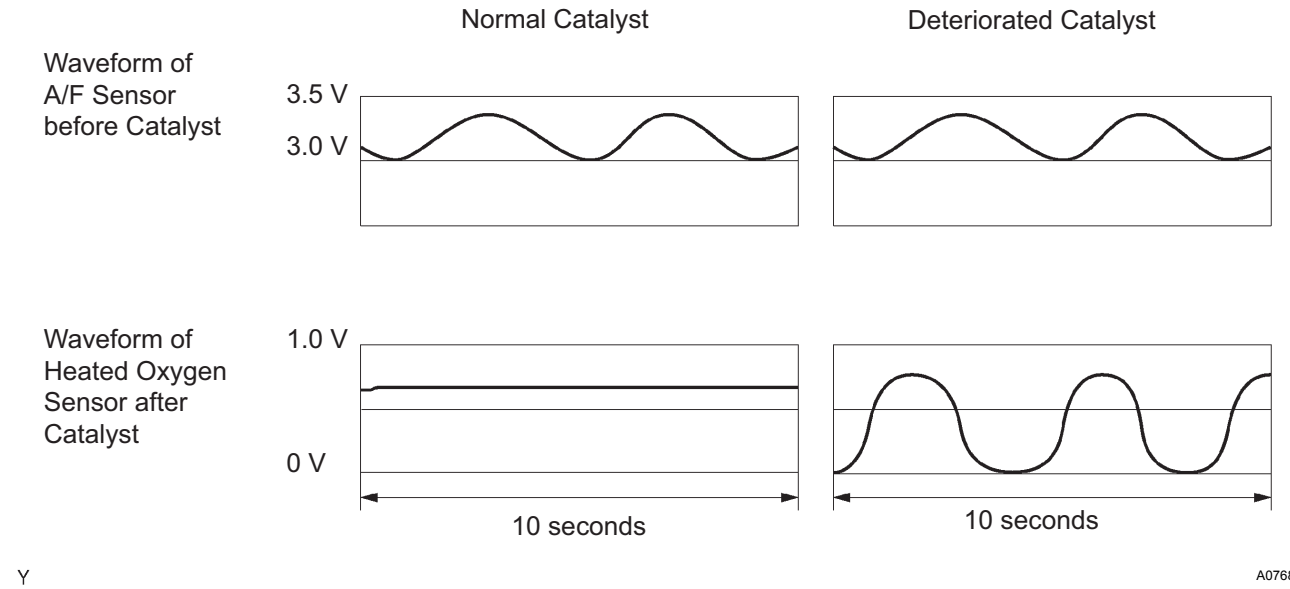
If you do not have the intelligent tester, perform again the same confirmation driving pattern after turning OFF the power switch upon finishing the first confirmation driving pattern.

CONDITIONING FOR SENSOR TESTING



(a) Connect the intelligent tester to the DLC3.
(b) Put the engine in inspection mode (see page ES-1).
(c) Start the engine and warm it up with all the accessories switched OFF until the engine coolant temperature becomes stable.
(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 intelligent 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 not performed



INSPECTION PROCEDURE

HINT:

- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air/fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.
- 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.
- The A/F CONTROL operation lowers the injection volume 12.5% or increases the injection volume 25%.

ES

(1) Connect the intelligent tester to the DLC3.
(2) Turn the power switch ON (IG).
(3) Put the engine in inspection mode (See page ES-1).
(4) Warm up the engine by running the engine at 2,500 rpm, depressing the accelerator pedal more than 60% for approximately 90 seconds.
(5) Enter the following menus: 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.

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
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 0.4 V  OK	-

Case	A/F Sensor (Sensor 1) Output Voltage	HO2 Sensor (Sensor 2) Output Voltage	Main Suspected Trouble Area
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 0.4 V  OK	• 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 3.0 V  OK	**Injection Volume:** +25 % -12.5 %  **Output Voltage:** Almost no reaction ——— NG	• 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	• Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)

The following A/F CONTROL procedure enables the technician to check and graph the voltage output of both A/F sensor and 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 press the "F4" button.

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

(a) Connect the intelligent tester to the DLC3.
(b) Turn the power switch ON (IG).
(c) Turn the intelligent tester ON.
(d) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(e) Read the DTCs.

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 DTC CHART

A

ES

2	INSPECT FOR EXHAUST GAS LEAK

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST GAS LEAKAGE POINT

OK

3	INSPECT AIR FUEL RATIO SENSOR (BANK 1 SENSOR 1)

NG → REPLACE AIR FUEL RATIO SENSOR

OK

4	INSPECT HEATED OXYGEN SENSOR (BANK 1 SENSOR 2)

NG → REPLACE HEATED OXYGEN SENSOR

OK

REPLACE THREE-WAY CATALYTIC CONVERTER (REPLACE FRONT PIPE)