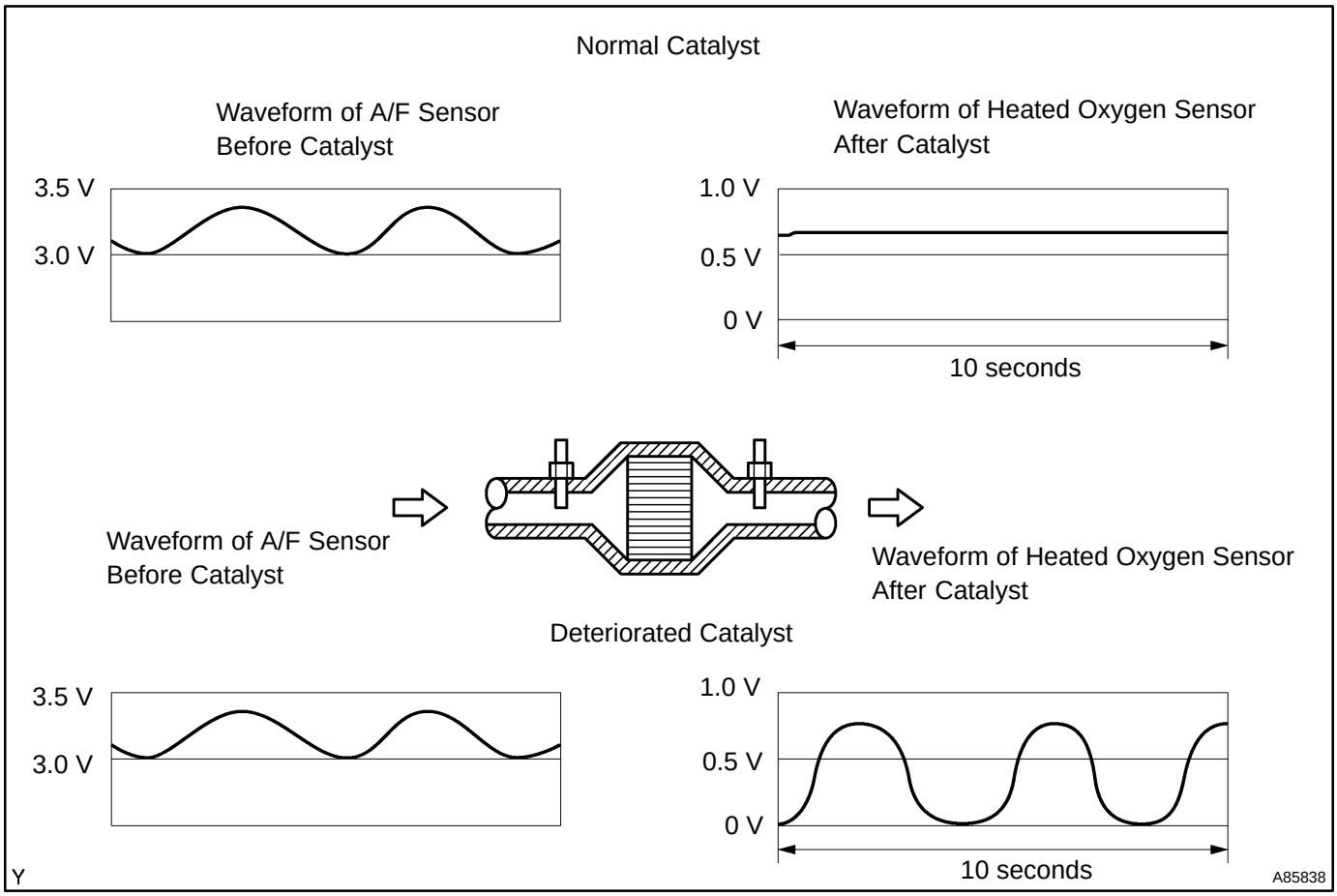
DTC	P0420	CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 1)

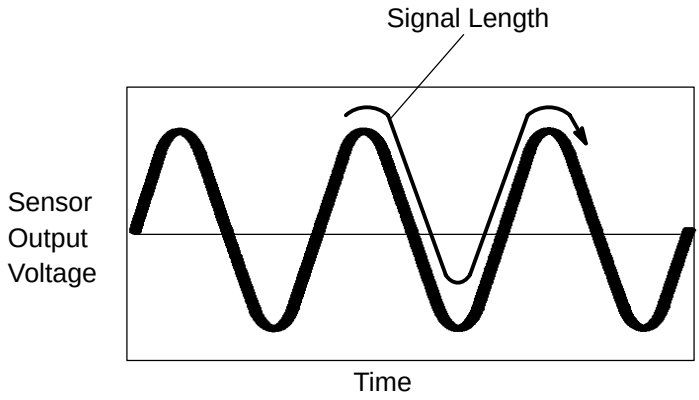
MONITOR DESCRIPTION

The ECM uses sensors mounted before and after the three-way catalyst (TWC) to monitor its efficiency. The first sensor, an Air Fuel ratio (A/F) sensor, sends pre-catalyst A/F ratio information to the ECM. The second sensor, a heated oxygen sensor (O2S), sends post-catalyst information to the ECM. The ECM compares these two signals to judge the efficiency of the catalyst and the catalyst's ability to store oxygen. During normal operation, the TWC stores and releases oxygen as needed. The capacity to store oxygen results in a low variation in the post-TWC exhaust stream as shown below.

If the catalyst is functioning normally, the waveform of the heated oxygen sensor slowly switches between RICH and LEAN. If the catalyst is deteriorated, the waveform will alternate frequently between RICH and LEAN. As the catalyst efficiency degrades, its ability to store oxygen is reduced and the catalyst output becomes more variable. When running the monitor, the ECM compares sensor 1 signals (A/F sensor) over a specific amount of time to determine catalyst efficiency. The ECM begins by calculating the signal length for both sensors (for the rear oxygen sensor, the ECM uses the output voltage signal length). If the oxygen sensor output voltage signal length is greater than the threshold (threshold is calculated based on the A/F sensor signal length), the ECM concludes that the catalyst is malfunctioning. The ECM will turn on the MIL and a DTC will be set.



Heated Oxygen Sensor Signal Length



DTC No.	DTC Detection Condition	Trouble Area
P0420	After engine and catalyst are warmed up, and while vehicle is driven within set vehicle and engine speed, waveform of heated oxygen sensor (bank 1 sensor 2) alternates frequently between RICH and LEAN (2 trip detection logic)	• Gas leakage in exhaust system • A/F sensor (bank 1 sensor 1) • Heated oxygen sensor (bank 1 sensor 2) • Three-way catalytic converter (Exhaust manifold)

HINT:

- Sensor 1 is the sensor closest to the engine assembly.
- Sensor 2 is the sensor farthest away from the engine assembly.

MONITOR STRATEGY

Related DTCs	P0420: Catalyst deterioration
Required sensors / components (Main)	Catalyst
Required sensors / components (Related)	A/F sensor, Heated oxygen sensor (HO2S), IAT sensor, MAF meter, CKP sensor, ECT sensor
Frequency of operation	Once per driving cycle
Duration	150 sec. (30 sec. x 5)
MIL operation	2 driving cycles
Sequence of operation	None

TYPICAL ENABLING CONDITIONS

The monitor will run whenever this DTC is not present	See page 05-16
Accumulated time that the following conditions are met:	30 sec.
Battery voltage	11 V or more
IAT	-10 °C (14°F) or more
Idle status	OFF
MAF	8 to 35 g/sec.
Engine RPM	Less than 4,500 rpm
ECT	75°C (167°F) or more
Rich experience after fuel cut	Yes
Fuel system status	Closed Loop
A/F sensor	Activated
Rear HO2S	Activated
Estimated catalyst temperature	Both of the following conditions 1 and 2 are met:
1. Upstream catalyst temperature	500 to 900°C (932 to 1,652°F)
2. Downstream catalyst temperature	350 to 900°C (662 to 1,652°F)

TYPICAL MALFUNCTION THRESHOLDS

Rear HO2S locus length	13 V or more (Varies with A/F sensor locus length)
Frequency of the monitor	4 times

MONITOR RESULT

Refer to page 05-24 for detailed information.

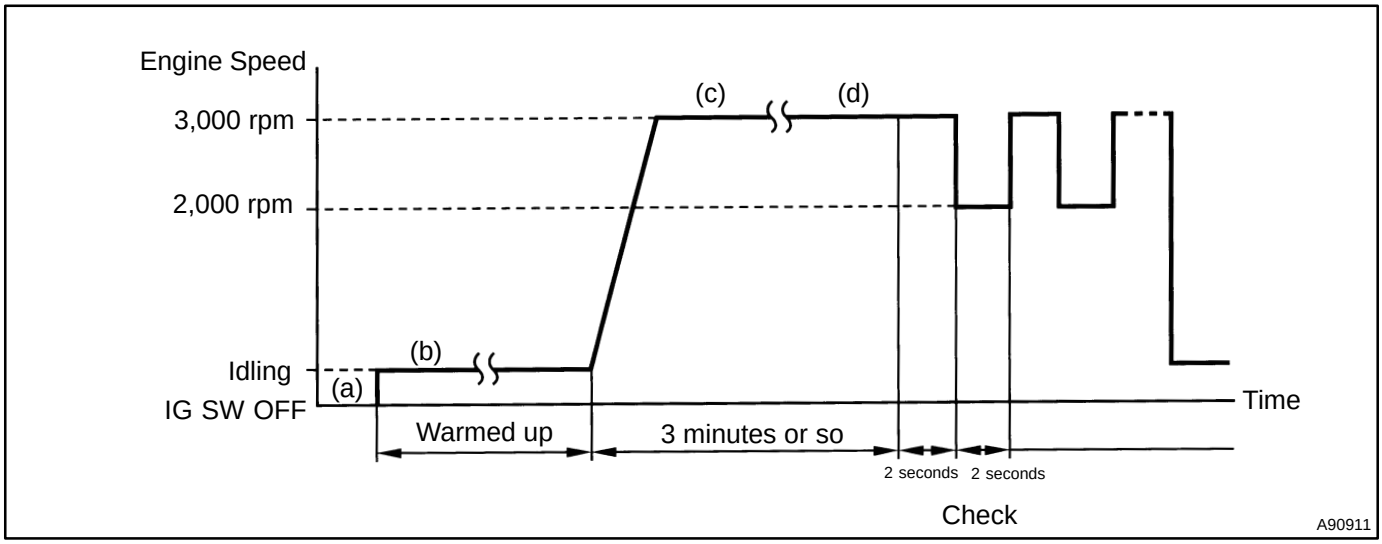
The test value and test limit information are described as shown in the following table. Check the monitor result and test values after performing the monitor drive pattern (see page 05-26).

- 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 - Sensor 1 A/F sensor, Sensor 2 HO2S

TLT	CID	Unit Conversion	Description of Test Data	Description of Test Limit
0	$01	Multiply by 0.0078 (no dimension)	Catalyst deterioration level: Determined by waveforms of A/F sensor and HO2S	Malfunction criteria for catalyst deterioration

CONDITIONING A/F SENSOR AND HEATED OXYGEN SENSOR FOR TESTING



(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 Engine Coolant Temperature (ECT) is stable.
(c) Run the engine at 2,500 to 3,000 rpm for about 3 minutes.
(d) When alternating the engine between 3,000 rpm and 2,000 rpm for 2 seconds respectively, check the waveform of the oxygen sensor (bank 1 sensor 2).

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, 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) Read the DTC using the hand-held tester or the OBD II scan tool.
Result:

Display (DTC Output)	Proceed to
Only P0420 is output	A
P0420 and other DTCs are output	B

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

B → **GO TO RELEVANT DTC CHART (See page 05-48)**

A

2	CHECK FOR EXHAUST GAS LEAKAGE

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

OK

3	INSPECT AIR FUEL RATIO SENSOR (BANK 1 SENSOR 1) (See page 12-6)

NG → **REPLACE AIR FUEL RATIO SENSOR**

OK

4	INSPECT HEATED OXYGEN SENSOR (See page 05-1 18)

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

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

REPLACE EXHAUST MANIFOLD AND FRONT EXHAUST PIPE

HINT:

Hand-held tester only:

- The following procedure enables a technician to identify a trouble area if there is a malfunction in front A/F sensor or rear heated oxygen sensors other than the catalyst converter, or the malfunction that indicates the actual air-fuel ratio extremely RICH or LEAN.

It is possible the malfunctioning area can be found using 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 areas are malfunctioning or not.

(a) Perform the ACTIVE TEST A/F CONTROL operation.

HINT:

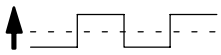
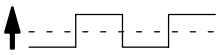
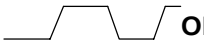
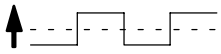
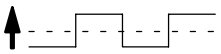
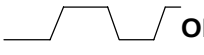
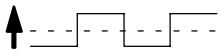
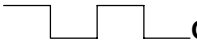
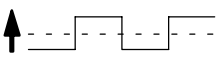
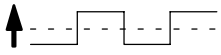
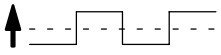
The A/F CONTROL operation lowers the injection volume 12.5 % or increases the injection volume 25 %.

(1) Connect the hand-held tester to the DLC3 on the vehicle.
(2) Turn the ignition switch ON.
(3) Warm up the engine by running the engine speed at 2,500 rpm for approximately 90 seconds.
(4) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(5) Perform the A/F CONTROL operation with the engine idle (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:
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, heater, A/F 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, 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 of A/F CONTROL procedure enables a technician to check and graph the voltage outputs of both the heated oxygen sensors.
For displaying the graph, enter ”ACTIVE TEST / A/F CONTROL / USER DATA”, select ”AFS B1S1 and O2S B1S2” by pressing ”YES” and push ”ENTER”. Then press ”F4”.