DTC P0420 CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 1); DTC P0430 CATALYST SYSTEM EFFICIENCY BELOW THRESHOLD (BANK 2)

MONITOR DESCRIPTION

The ECM uses 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, sends pre-catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor, sends post-catalyst information to the ECM. In order to detect any deterioration in the TWC, the ECM calculates the Oxygen Storage Capacity (OSC) of the TWC. This calculation is based on the voltage output of the HO2 sensor while performing active air-fuel ratio control, rather than the conventional detecting method, which uses the locus ratio. The OSC value is an indication of the oxygen storage capacity of the TWC. When the vehicle is being driven with a warm engine, active air-fuel ratio control is performed for approximately 15 to 20 seconds. When it is performed, the ECM deliberately sets the air-fuel ratio to lean or rich levels. If a rich-lean cycle of the HO2 sensor is long, the OSC becomes greater. There is a direct correlation between the OSCs of the HO2 sensor and the TWC.

The ECM uses the OSC value to determine the state of the TWC. If any deterioration has occurred, it illuminates the MIL and sets a DTC.

DTC DETECTION CONDITIONS CHART

DTC No.	DTC Detection Conditions	Trouble Areas
P0420	OSC value smaller than standard value under active air-fuel ratio control (2 trip detection logic)	• Gas leak from exhaust system • A/F sensor(bank 1 sensor 1) • HO2 sensor (bank 1 sensor 2) • Exhaust manifold (TWC)
P0430	OSC value smaller than standard value under active air-fuel ratio control (2 trip detection logic)	• Gas leak from exhaust system • A/F sensor(bank 2 sensor 1) • HO2 sensor (bank 2 sensor 2) • Exhaust manifold (TWC)

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

MONITOR STRATEGY

Related DTCs	P0420: Catalyst Deterioration P0430: Catalyst Deterioration
Required Sensors/Components (Main)	A/F sensor and heated oxygen sensor
Required Sensors/Components (Related)	Intake air temperature sensor, mass air flow meter, crankshaft position sensor and engine coolant temperature sensor
Frequency of Operation	Once per driving cycle
Duration	About 30 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

TYPICAL ENABLING CONDITIONS CHART

Monitor runs whenever following DTCs not present	P0011 (VVT System 1 - Advance) P0012 (VVT System 1 - Retard) P0021 (VVT System 2 - Advance) P0022 (VVT System 2 - Retard) P0031, P0032, P0051, P0052 (A/F sensor heater - Sensor 1) P0037, P0038, P0057, P0058 (HO2 sensor Heater - Sensor 2) P0100 - P0103 (MAF meter) P0115-P0118(ECT sensor) P0120 - P0223, P2135 (TP sensor) P0125 (Insufficient ECT for closed loop) P0136, P0156 (HO2 Sensor - Sensor 2) P0171, P0172, P0174, P0175 (Fuel system) P0300 - P0306 (Misfire) P0335 (CKP sensor) P0340 (CMP sensor) P0351 - P0356 (Ignitor) P0500 (VSS) P2196, P2198 (A/F sensor - rationality) P2A00, P2A03 (A/F sensor - slow response)
Battery voltage	11 V or more
IAT	-10°C(14°F) or more
Engine coolant temperature sensor	75°C(167°F) or more
Atmospheric pressure coefficient	76 kPa (570 mmHg) or more
Idling	OFF
Engine RPM	Less than 3,200 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. Mass air flow rate	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 HO2 sensor monitor	Completed
Shift position	4th or higher

TYPICAL MALFUNCTION THRESHOLDS

TYPICAL MALFUNCTION THRESHOLDS

Oxygen Storage Capacity (OSC) of Three-Way Catalytic Converter (TWC)	Less than 0.04g

MONITOR RESULT

Refer to **CHECKING MONITOR STATUS** .

CONFIRMATION DRIVING PATTERN

HINT:

Performing this confirmation pattern will activate the catalyst monitor. This is very useful for verifying the completion of a repair.

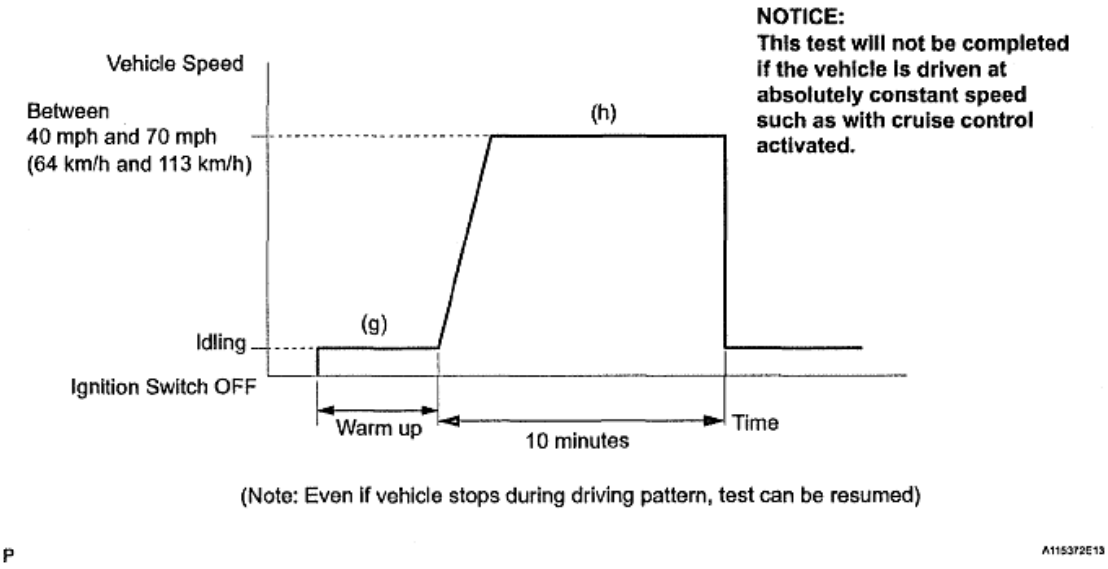


Fig. 144: Identifying Vehicle Speed - Driving Pattern
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

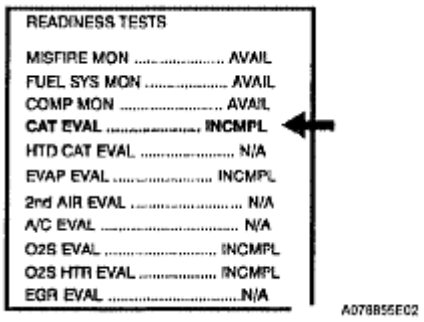


Fig. 145: Identifying Readiness Test Menu
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

a. Connect a Techstream to the DLC3.
b. Turn the ignition switch ON.
c. Turn the tester ON.
d. Clear DTCs (if set) (See **DTC CHECK/CLEAR**).
e. Select the following menu items: Powertrain / Engine and ECT / Monitor.
f. Check that Catalyst / Status 2 is Incomplete.
g. Start the engine and warm it up.
h. Drive the vehicle at between 40 mph and 70 mph (64 km/h and 113 km/h) for at least 10 minutes.
i. Note the state of the Readiness Tests items. Those items will change to Complete as Catalyst monitor operates.
j. On the tester, select the following menu items: Powertrain / Engine and ECT / Trouble Codes / Pending and check if any DTCs (any pending DTCs) are set.

   HINT:

   If Catalyst does not change to Complete, and any pending DTCs fail to set, extend the driving time.

CONDITIONING FOR SENSOR TESTING

HINT:

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

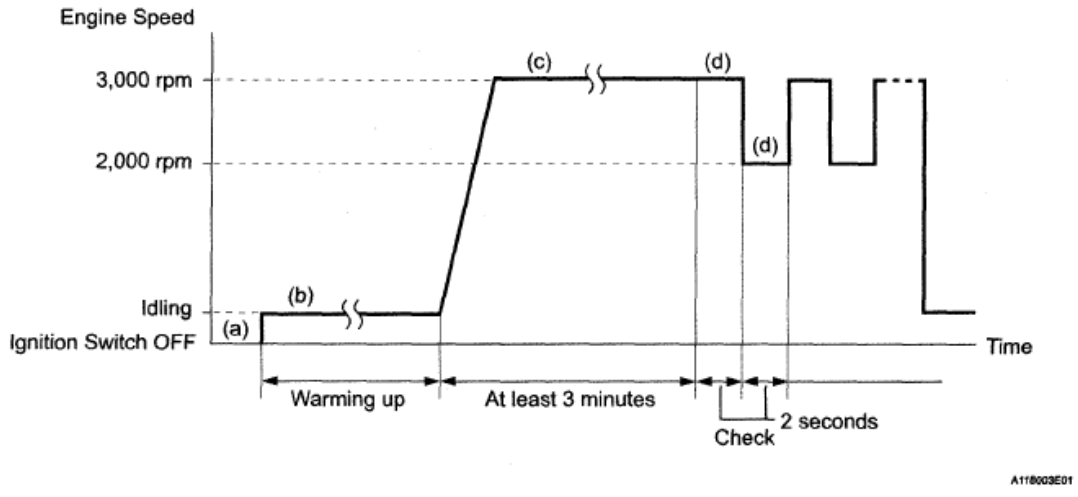


Fig. 146: Identifying Engine Speed - Driving Pattern
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

a. Connect a Techstream to the DLC3.
b. Start the engine and warm it up with all the accessories switched OFF, until the engine coolant temperature stabilizes.

c. Run the engine at an engine speed of between 2,500 rpm and 3,000 rpm for at least 3 minutes.
d. While running the engine at 3,000 rpm for 2 seconds and 2,000 rpm for 2 seconds, check the waveforms of the A/F and HO2 sensors using the tester.

HINT:

- If either of the voltage outputs of the Air Fuel Ratio (A/F) or Heated Oxygen (HO2) sensor 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 Control the Injection Volume for A/F sensor using a Techstream.
- 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).

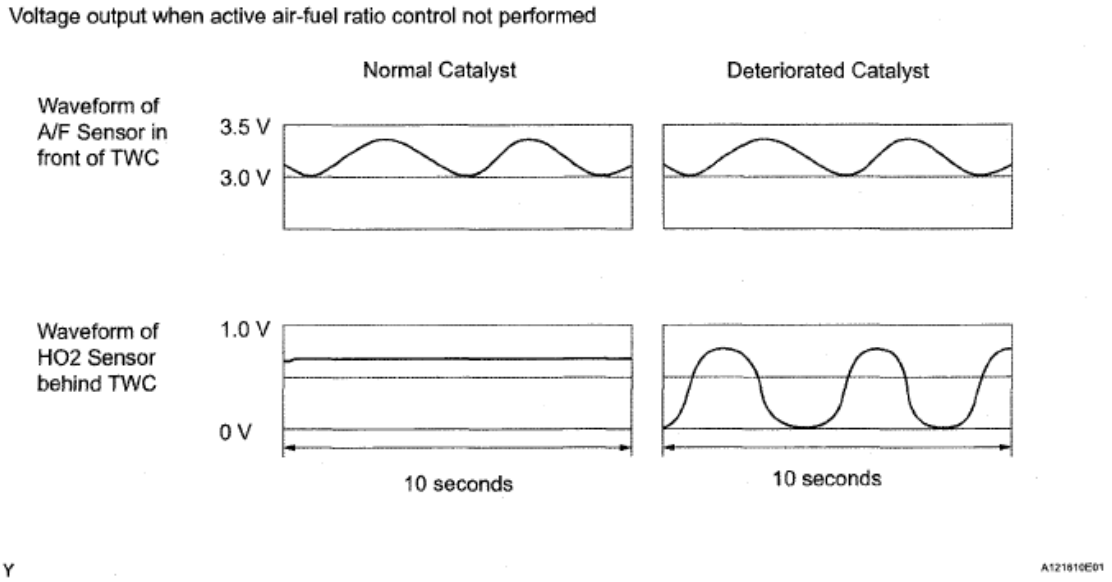


Fig. 147: Identifying Voltage Variation Graph
Courtesy of TOYOTA MOTOR SALES, U.S.A., INC.

INSPECTION PROCEDURE

HINT:

Techstream only:

Malfunctioning areas can be identified by performing the Control the Injection Volume for A/F sensor function provided in the ACTIVE TEST. The Control the Injection Volume for A/F sensor 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 Control the Injection Volume for A/F sensor operation using a Techstream.

1. Connect a Techstream 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. Select the following menu items: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
5. Perform the Control the Injection Volume for A/F sensor 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 O2S B1S2 or AFS B2S1 and O2S B2S2) displayed on the tester.

HINT:

- The Control the Injection Volume for A/F sensor 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.

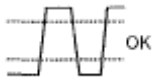
Standard

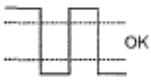
STANDARD VOLTAGE

Tester Display (Sensor)	Injection Volumes	Status	Voltages
AFS B1S1 or AFS B2S1 (A/F)	+25 %	Rich	Less than 3.0
AFS B1S1 or AFS B2S1 (A/F)	-12.5%	Lean	More than 3.35
O2S B1S2 or O2S B2S2 (HO2)	+25%	Rich	More than 0.55
O2S B1S2 or O2S B2S2 (HO2)	-12.5%	Lean	Less than 0.4

NOTE: 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.

VOLTAGE OUTPUT DELAY

Case	A/F Sensor (Sensor 1) Output Voltage		HO2 Sensor (Sensor 2) Output Voltage		Main Suspected Trouble Area
1	Injection Volume	+25% -12.5% 	Injection Volume	+25% -12.5% 	-
	Output Voltage	More than 3.35 V Less than 3.0 V 	Output Voltage	More than 0.55 V Less than 0.4 V 	
2	Injection Volume	+25% -12.5% 	Injection Volume	+25% -12.5% 	• A/F sensor • A/F sensor heater • A/F sensor circuit
	Output Voltage	Almost no reaction 	Output Voltage	More than 0.55 V Less than 0.4 V 	
	Injection	+25%	Injection	+25%	

3	Volume	-12.5%		Volume	-12.5%		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage	More than 3.35 V Less than 3.0 V		Output Voltage	Almost no reaction		
4	Injection Volume	+25% -12.5%		Injection Volume	+25% -12.5%		• Fuel Injector • Fuel pressure • Gas leak from exhaust system (Air fuel ratio extremely rich or lean)
	Output Voltage	Almost no reaction		Output Voltage	Almost no reaction		

- Following the Control the Injection Volume for A/F sensor 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: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor / A/F Control System / AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2, then press the graph button on the Data List view.

HINT:

Read freeze frame data using a Techstream. Freeze frame data record the engine condition when malfunctions are detected. When troubleshooting, freeze frame data can help determine if the vehicle was moving or stationary, 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 ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0420 AND/OR P0430)**
   a. Connect a Techstream to the DLC3.
   b. Turn the ignition switch ON and turn the tester ON.
   c. Select the following menu items: Powertrain / Engine and ECT / Trouble Codes.
   d. Read DTCs and write them down.

   Result

   RESULT REFERENCE

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

   HINT:

   If any DTCs other than P0420 or P0430 are output, troubleshoot those DTCs first.

B: GO TO DTC CHART (See **DIAGNOSTIC TROUBLE CODE CHART**)

A: Go To Next Step

2. **PERFORM ACTIVE TEST USING TECHSTREAM (A/F CONTROL)**
   a. Connect a Techstream to the DLC3.
   b. Start the engine and turn the tester ON.
   c. Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
   d. Select the following menu items: Powertrain / Engine and ECT / Active Test / Control the Injection Volume for A/F sensor.
   e. Perform the Control the Injection Volume for A/F sensor operation with the engine in an idling condition (press the RIGHT or LEFT button to change the fuel injection volume).
   f. Monitor the voltage outputs of the A/F and HO2 sensors (AFS B1S1 and O2S B1S2 or AFS B2S1 and O2S B2S2) displayed on the tester.

   HINT:

   - The Control the Injection Volume for A/F sensor 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

   STANDARD VOLTAGE

Tester Display (Sensor)	Injection Volumes	Status	Voltages
AFS B1S1 or AF SB2S1 (A/F)	+25 %	Rich	Less than 3.0
AFS B1S1 or AFS B2S1 (A/F)	-12.5%	Lean	More than 3.35
O2S B1S2 or O2S B2S2 (HO2)	+25 %	Rich	More than 0.55
O2S B1S2 or O2S B2S2 (HO2)	-12.5%	Lean	Less than 0.4

   Result

   RESULT REFERENCE

Status AFS B1S1 or AFS B2S1	Status O2S B1S2 or O2S B2S2	A/F Condition and A/F and HO2 Sensors Conditions	Misfires	Main Suspected Trouble Areas	Proceed To
Lean/Rich	Lean/Rich	Normal	-	• Three-Way Catalytic Converter (TWC) • Gas leak from exhaust system	A
Lean	Lean/Rich	A/F sensor malfunction	-	• A/F sensor	B
Rich	Lean/Rich	A/F sensor malfunction	-	• A/F sensor	
Lean/Rich	Lean	HO2 sensor	-	• HO2 sensor • Gas leak from	

		malfunction		exhaust system	
Lean/Rich	Rich	HO2 sensor malfunction	-	• HO2 sensor • Gas leak from exhaust system	C
Lean	Lean	Actual air-fuel ratio lean	May occur	• Extremely rich or lean actual air-fuel ratio • Gas leak from exhaust system	A
Rich	Rich	Actual air-fuel ratio rich	-	• Extremely rich or lean actual air-fuel ratio • Gas leak from exhaust system	
Lean: During Control the Injection Volume for A/F sensor, the A/F sensor output voltage (AFS) is consistently more than 3.35 V, and the HO2 sensor output voltage (O2S) is consistently less than 0.4 V. Rich: During Control the Injection Volume for A/F sensor, the AFS is consistently less than 3.0 V, and the O2S is consistently more than 0.55 V. Lean/Rich: During Control the Injection Volume for A/ F sensor of the ACTIVE TEST, the output voltage of the HO2 sensor alternates correctly.					

B: CHECK AND REPLACE AIR FUEL RATIO SENSOR

C: CHECK AND REPLACE HEATED OXYGEN SENSOR, AND CHECK AND REPAIR EXHAUST GAS LEAK

A: Go To Next Step

3. **CHECK FOR EXHAUST GAS LEAK**

OK: No gas leak.

NG: REPAIR OR REPLACE EXHAUST GAS LEAK POINT

OK: Go to Next Step

4. **CHECK DTC OUTPUT (DTC P0420 AND/OR P0430)**
   a. According to the DTCs output in Step 1 (CHECK ANY OTHER DTCS OUTPUT), proceed to the next step, referring to the table below.

Result

RESULT REFERENCE

Display (DTC Output)	Proceed To
P0420	A
P0430	B
P0420 and P0430	A and B

A: Go to step 5

B: Go to step 6

5. **REPLACE EXHAUST MANIFOLD SUB-ASSEMBLY RH**
   a. Replace the exhaust manifold sub-assembly RH (See **REMOVAL**).

   NEXT: REPLACE FRONT EXHAUST PIPE ASSEMBLY (See **INSTALLATION**)

6. **REPLACE EXHAUST MANIFOLD SUB-ASSEMBLY LH**
   a. Replace the exhaust manifold sub-assembly LH (See **REMOVAL**).

   NEXT: REPLACE NO. 2 FRONT EXHAUST PIPE ASSEMBLY (See **INSTALLATION**)

