DIDRN−01

| DTC | P0420 | Catalyst System Efficiency Below Threshold (Bank 1) |
|---|---|---|

| DTC | P0430 | Catalyst System Efficiency Below Threshold (Bank 2) |
|---|---|---|

## MONITOR DESCRIPTION

The ECM uses the two 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 (sensor 1), sends pre−catalyst information to the ECM. The second sensor, the Heated Oxygen (HO2) sensor (sensor 2), sends post−catalyst information to the ECM. The ECM compares the information transmitted by these two sensors to determine the efficiency of the TWC performance and its ability to store oxygen.

When the TWC is functioning properly, the variation in the oxygen concentration in the exhaust gas, after it has passed through the TWC, is small. In this condition, the voltage output of sensor 2 slowly alternates between the rich and lean signal voltages (shown in the illustration below). As the TWC performance efficiency deteriorates, its oxygen storage capacity decreases, and the variation in the oxygen concentration in the exhaust gas increases. As a result, the sensor voltage output fluctuates frequently.

While the catalyst monitor is running, the ECM measures the signal lengths of both sensors 1 and 2, and calculates the ratio of the signal lengths to determine the extent of the TWC deterioration. If the deterioration level exceeds the preset threshold, the ECM interprets this as the TWC malfunction. The ECM then illuminates the MIL and sets the DTC.

| DTC No. | DTC Detecting Condition | Trouble Area |
|---|---|---|
| P0420<br>P0430 | OSC value smaller than standard value under active air−fuel ratio control (2 trip detection logic) | • Gas leakage on exhaust system<br>• A/F sensor (Bank 1, 2 sensor 1)<br>• Heated oxygen sensor (bank 1, 2 sensor 2)<br>• Three−way catalytic converter |

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 mounted in front of the Three−Way Catalytic Converter (TWC) and located near the engine assembly.
- Sensor 2 refers to the sensor mounted behind the TWC and located far from the engine assembly.

## MONITOR STRATEGY

| | | |
|---|---|---|
| Related DTCs | P0420 | Bank 1 catalyst is deteriorated |
| | P0430 | Bank 2 catalyst is deteriorated |
| Required sensors/components | Main sensors/components | Front and rear heated oxygen sensor |
| | Related sensors/components | Mass air flow meter, Engine coolant temperature sensor, Engine speed sensor, Intake air temperature sensor |
| Frequency of operation | Once per driving cycle | |
| Duration | 30 sec. | |
| MIL operation | 2 driving cycles | |
| Sequence of operation | None | |

## TYPICAL ENABLING CONDITIONS

| Item | Specification | |
|---|---|---|
| | Minimum | Maximum |
| The monitor will run whenever these DTCs are not present | See page DI−437 | |
| Battery voltage | 11 V | − |
| Intake air temperature | −10°C (14°F) | − |
| Engine coolant temperature | 75°C (167°F) | − |
| Atmospheric pressure coefficient | 0.75 | − |
| Idle | OFF | |
| Engine RPM | − | 3,200 rpm |
| A/F sensor | 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 | 6 to 75 g/sec | |
| 2. Front catalyst temperature (estimated) | 620 to 830°C (1,148 to 1,526°F) | |
| 3. Rear catalyst temperature (estimated) | 410 to 830°C (770 to 1,526°F) | |
| Rear HO2S monitor | Completed | |
| Shift position | 4th | − |

## TYPICAL MALFUNCTION THRESHOLDS

| Detection Criteria | Threshold |
|---|---|
| Oxygen storage capacity (OSC) of catalyst | Less than 0.16 g |

## MONITOR RESULT

Refer to page DI−445 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 (refer to ”Confirmation Monitor”).

- MID (Monitor Identification Data) is assigned to each emissions−related component.
- TID (Test Identification Data) is assigned to each test value.
- Scaling is used to calculate the test value indicated on generic OBD ll scan tools.

**Catalyst bank 1 − Active A/F control method**

| MID | TID | Scaling | Description of Test Value | Minimum Test Limit | Maximum Test Limit |
|---|---|---|---|---|---|
| $21 | $A9 | Multiply by 0.0003 (no dimension) | Oxygen storage capacity of catalyst | Minimum test limit for catalyst | Maximum test limit for catalyst |

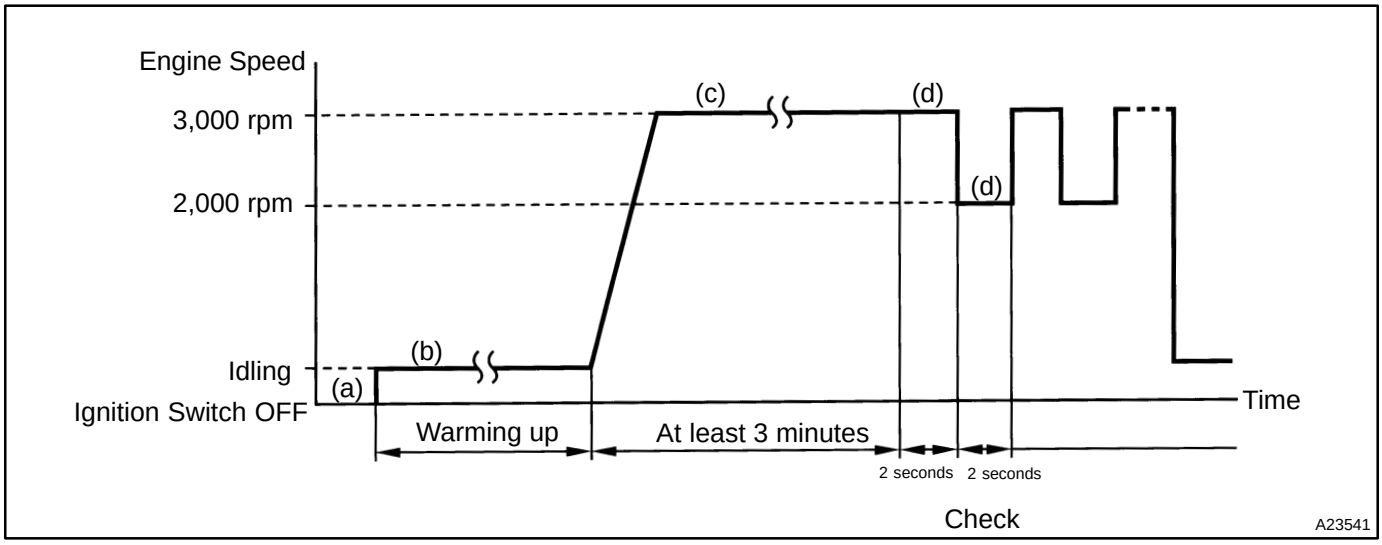
**Catalyst bank 2 − Active A/F control method**

| MID | TID | Scaling | Description of Test Value | Minimum Test Limit | Maximum Test Limit |
|---|---|---|---|---|---|
| $22 | $A9 | Multiply by 0.0003 (no dimension) | Oxygen storage capacity of catalyst | Minimum test limit for catalyst | Maximum test limit for catalyst |

## WAVEFORMS OF AIR−FUEL RATIO (A/F) AND HEATED OXYGEN (HO2) SENSORS

HINT:

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




(a) Connect the hand−held tester to the DLC3.

(b) Start the engine and warm it up with all the accessories switched OFF, until the engine coolant temperature stabilizes.

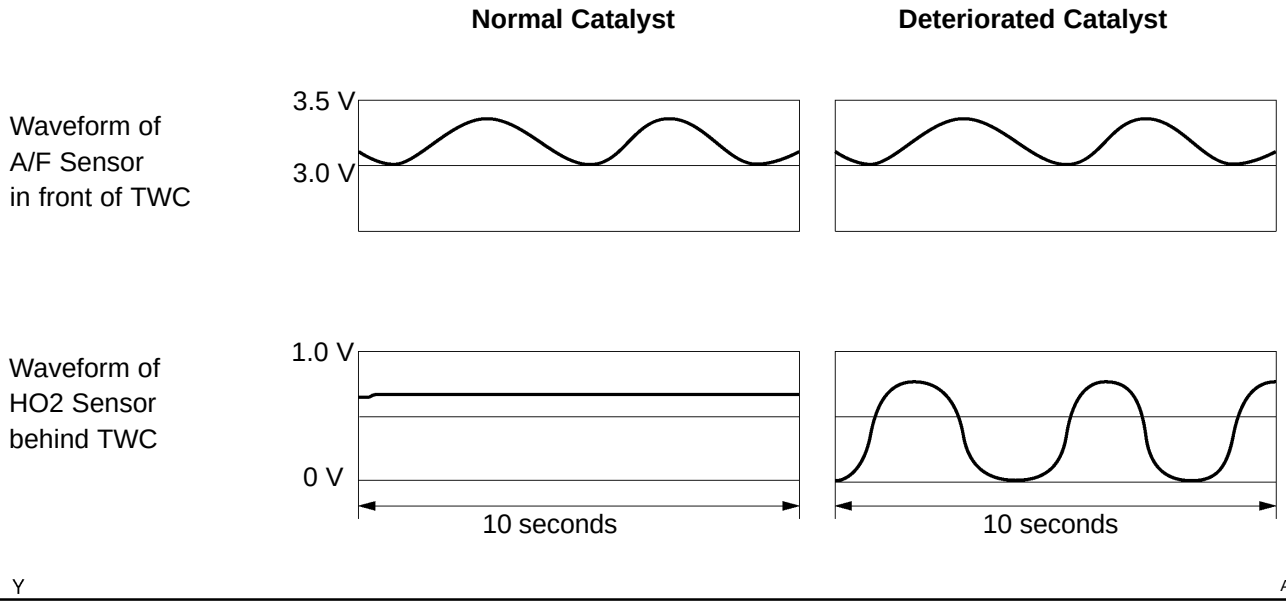
(c) Run the engine at an engine speed of between 2,500 rpm and 3,000 rpm for at least 3 minutes.

(d) After confirming that the waveform of the heated oxygen sensor (bank 1, 2 sensor 1 (OX1A, OX2A)), oscillate around 0.5 V during feedback to the ECM, check the waveform of the heated oxygen sensor (bank 1, 2 sensor 2 (OX1B, OX2B)).

HINT:

- If either of the voltage outputs of the Air−Fuel Ratio (A/F) or Heated Oxygen (HO2) sensors 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 A/F CONTROL using a hand−held tester.
- 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).

**Voltage output when active air−fuel ratio control not performed**




## A/F CONTROL

HINT:

Hand−held tester only:

Malfunctioning areas can be identified by performing the A/F CONTROL function provided in the ACTIVE TEST. The A/F CONTROL 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 A/F CONTROL operation using a hand−held tester.

(1) Connect a hand−held tester 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) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(5) Perform the A/F CONTROL 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 OS2 B1S2) displayed on the tester.

HINT:

- The A/F CONTROL 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:**

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

**NOTICE:**

**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.**

| Case | A/F Sensor (Sensor 1) Output Voltage | HO2 Sensor (Sensor 2) Output Voltage | Main Suspected Trouble Areas |
|---|---|---|---|
| 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** | — |
| 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<br>● A/F sensor heater<br>● A/F sensor circuit |
| 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** | ● HO2 sensor<br>● HO2 sensor heater<br>● 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** | ● Injector<br>● Fuel pressure<br>● Gas leakage from exhaust system<br>(Air−fuel ratio extremely lean or rich) |

- Following the A/F CONTROL 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: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL / USER DATA / AFS B1S1 and O2S B1S2, and press the YES button and then the ENTER button followed by the F4 button.

## INSPECTION PROCEDURE

HINT:

Read freeze frame data using the hand−held tester. 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, as well as other data from the time when a malfunction occurred.

| | |
|---|---|
| **1** | **Are there any other codes (besides DTC P0420 or P0430) being output?** |

**PREPARATION:**

(a) Connect the hand−held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand−held tester main switch ON.
(c) When using hand−held tester, enter the following menu: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.

**CHECK:**

Read the DTC using the hand−held tester.

**RESULT:**

| Display (DTC Output) | Proceed to |
|---|---|
| ”P0420 and/or P0430” | A |
| ”P0420 or P0430” and other DTCs | B |

HINT:

If any other codes besides ”P0420 and/or P0430” are output, perform the troubleshooting for those DTCs first.

**B** → **Go to relevant DTC chart (See page DI−477).**

**A**

| | |
|---|---|
| **2** | **Check A/F sensor (bank 1, 2 sensor 1).** |

(a) Connect the hand−held tester to the DLC3.
(b) Start the engine and turn the tester ON.
(c) Warm up the engine with the engine speed at 2,500 rpm for approximately 90 seconds.
(d) On the tester, select the following menu items: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
(e) Perform the A/F CONTROL 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) displayed on the tester.

HINT:

- The A/F CONTROL 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:**

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

**RESULT:**

| Status A/F S1 | Status O2S S2 | A/F Condition and A/F and HO2 Sensors Condition | Misfires | Main Suspected Trouble Areas | Proceed To |
|---|---|---|---|---|---|
| Lean/Rich | Lean/Rich | Normal | − | • Three−way Catalytic Converter (TWC)<br>• Gas leakage 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 | B |
| Lean/Rich | Lean | HO2 sensor malfunction | − | • HO2 sensor<br>• Gas leakage from exhaust system | C |
| Lean/Rich | Rich | HO2 sensor malfunction | − | • HO2 sensor<br>• Gas leakage from exhaust system | C |
| Lean | Lean | Actual air−fuel ratio lean | May occur | • Extremely rich or lean actual air−fuel ratio<br>• Gas leakage from exhaust system | A |
| Rich | Rich | Actual air−fuel ratio lean | − | • Extremely rich or lean actual air−fuel ratio<br>• Gas leakage from exhaust system | A |

Lean: During A/F CONTROL, 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 A/F CONTROL, the AFS is consistently less than 3.0 V, and the O2S is consistently more than 0.55 V.

**B** → **Check and replace A/F sensor.**

**C** → **Check and replace heated oxygen sensor and check and repair exhaust gas leakage.**

**A**

| | |
|---|---|
| 3 | **Check gas leakage on exhaust system.** |

**OK:**

**No exhaust gas leakage.**

**NG** → **Repair or replace exhaust gas leakage point.**

**OK**

**Replace front and rear three−way catalytic converter in the bank a malfunction is detected.**