DTC	P0171	System Too Lean (Bank 1)

DTC	P0172	System Too Rich (Bank 1)

DESCRIPTION

The fuel trim is related to the feedback compensation value, not to the basic injection time. The fuel trim consists of both the short-term and long-term fuel trims.

The short-term fuel trim is fuel compensation that is used to constantly maintain the air-fuel ratio at stoichiometric levels. The signal from the front Heated Oxygen (HO2) sensor indicates whether the air-fuel ratio is rich or lean compared to the stoichiometric ratio. This triggers a reduction in the fuel injection volume if the air-fuel ratio is rich and an increase in the fuel injection volume if it is lean.

Factors such as individual engine differences, wear over time and changes in operating environment cause short-term fuel trim to vary from the central value. The long-term fuel trim, which controls overall fuel compensation, compensates for long-term deviations in the fuel trim from the central value caused by the short-term fuel trim compensation.

If both the short-term and long-term fuel trims are lean or rich beyond predetermined values, it is interpreted as a malfunction, and the ECM illuminates the MIL and sets a DTC.

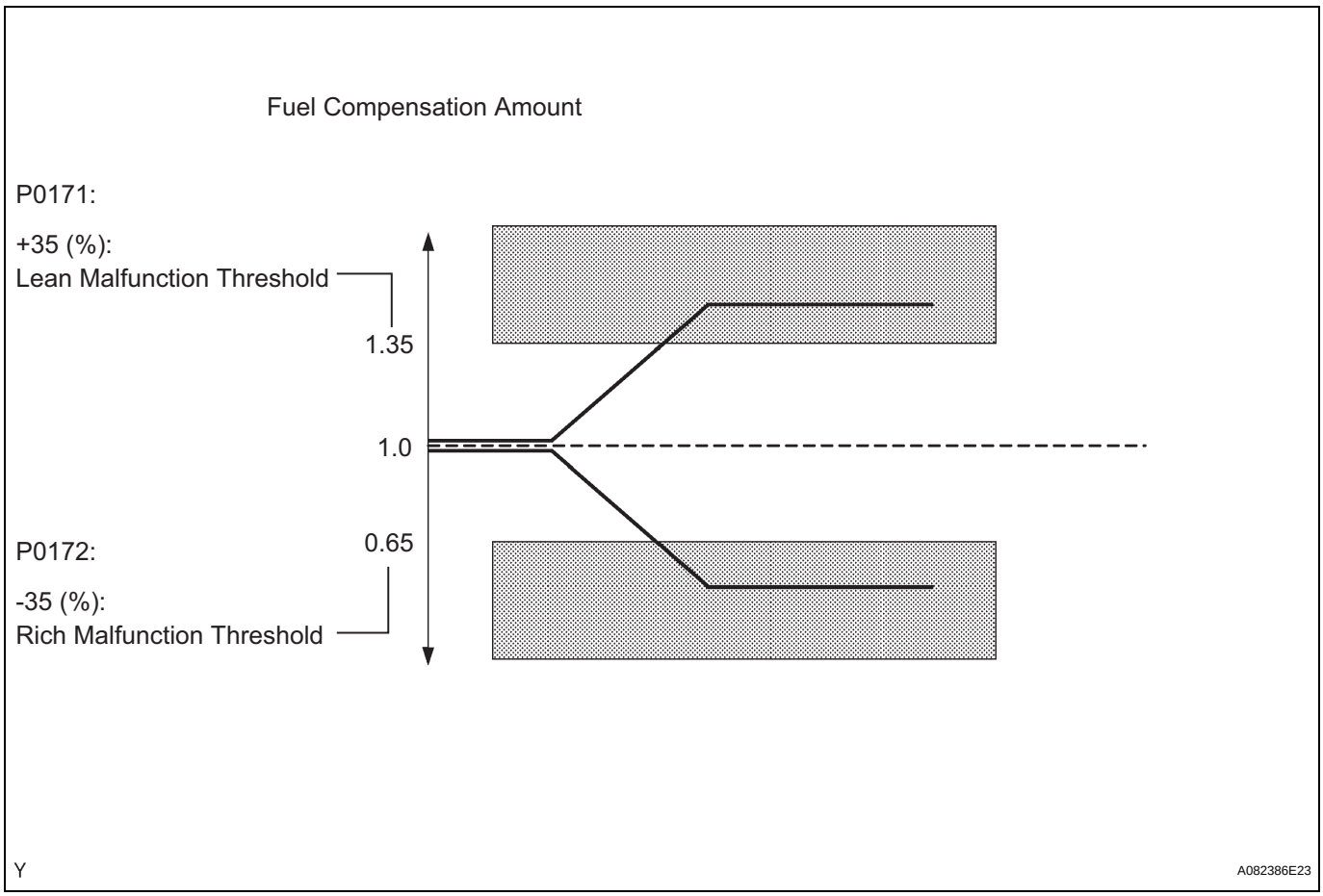
DTC No.	DTC Detection Condition	Trouble Area
P0171	With warm engine and stable air-fuel ratio feedback, fuel trim considerably in error to lean side (2 trip detection logic)	• Air induction system • Injector blockage • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor • Fuel pressure • Gas leakage from exhaust system • Open or short in Heated Oxygen (HO2) sensor (bank 1 sensor 1) circuit • HO2 sensor (bank 1 sensor 1) • HO2 sensor heater (bank 1 sensor 1) • EFI relay • Ventilation valve and hose • Ventilation hose connections • ECM
P0172	With warm engine and stable air-fuel ratio feedback, fuel trim considerably in error to rich side (2 trip detection logic)	• Injector leakage or blockage • MAF meter • ECT sensor • Ignition system • Fuel pressure • Gas leakage from exhaust system • Open or short in HO2 sensor (bank 1 sensor 1) circuit • HO2 sensor (bank 1 sensor 1) • HO2 sensor heater (bank 1 sensor 1) • EFI relay • ECM

HINT:

- When DTC P0171 is set, the actual air-fuel ratio is on the lean side. When DTC P0172 is set, the actual air-fuel ratio is on the rich side.
- If the vehicle runs out of fuel, the air-fuel ratio is lean and DTC P0171 may be set. The MIL is then illuminated.
- When the total of the short-term and long-term fuel trim values is within the malfunction threshold (and the engine coolant temperature is more than 75°C [167°F]), the system is functioning normally.

MONITOR DESCRIPTION

Under closed loop fuel control, fuel injection volumes that deviate from those estimated by the ECM cause changes in the long-term fuel trim compensation value. The long-term fuel trim is adjusted when there are persistent deviations in the short-term fuel trim values. Deviations from the ECM's estimated fuel injection volumes also affect the average fuel trim learning value, which is a combination of the average short-term fuel trim (fuel feedback compensation value) and the average long-term fuel trim (learning value of the air-fuel ratio). If the average fuel trim learning value exceeds the malfunction thresholds, the ECM interprets this as a fault in the fuel system and sets a DTC.
Example:
When the average fuel trim leaning value is more than +35% or less than -35%, the ECM interprets this as a fuel system malfunction.



MONITOR STRATEGY

Related DTCs	P0171: Fuel trim Lean (bank 1) P0172: Fuel trim Rich (bank 1)
Required Sensors/Components (Main)	Fuel system
Required Sensors/Components (Related)	Heated oxygen sensor (sensor 1), Mass air flow meter, Crankshaft position sensor
Frequency of Operation	Continuous
Duration	Within 10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS

Monitor runs whenever these DTCs not present	P0010 (VVT OCV 1) P0011 (VVT system 1 - advance) P0012 (VVT system 1 - retard) P0031, P0032 (heated oxygen sensor 1) P0100 - P0103 (MAF meter) P0115 - P0118 (ECT sensor) P0120 - P0123 (TP sensor) P0125 (insufficient ECT for closed loop) P0130 (heated oxygen sensor 1) P0134 (heated oxygen sensor 1) P0171, P0172 (fuel system) P0300 - P0304 (misfire) P0335 (crankshaft position sensor) P0441 - P0456 (EVAP system) P0500 (VSS)
Battery voltage	11 V or more
Fuel system	Closed loop (for more than 13 seconds)
Either of following conditions (a) or (b) met:	-
(a) Engine RPM	Less than 1,100 rpm
(b) Intake air amount per revolution	0.15 g/rev or more

TYPICAL MALFUNCTION THRESHOLDS

All:

EVAP purge-cut	Executing

Fuel trim Lean:

Average fuel trim learning value	35% or more (varies with engine coolant temperature [ECT])

Fuel trim Rich:

Average fuel trim learning value	-35% or less (varies with ECT)

WIRING DIAGRAM

Refer to DTC P0130 (see page ES-113).

HINT:
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 Heated Oxygen (HO2) sensors and other potential trouble areas are malfunctioning.
The following instructions describe how to conduct the A/F CONTROL operation using the intelligent tester.

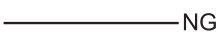
1. Connect the intelligent tester to the DLC3.
2. Start the engine and turn the tester ON.
3. Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
4. On the tester, enter the following menus: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
5. Perform the A/F CONTROL 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 HO2 sensors (O2S 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
O2S B1S1 (Front HO2 Sensor)	+25%	Rich	More than 0.55
O2S B1S1 (Front HO2 Sensor)	-12.5%	Lean	Less than 0.4
O2S B1S2 (Rear HO2 Sensor)	+25%	Rich	More than 0.5
O2S B1S2 (Rear HO2 Sensor)	-12.5%	Lean	Less than 0.4

NOTICE:
The front HO2 sensor has an output delay of a few seconds and the rear HO2 sensor has a maximum output delay of approximately 20 seconds.

ES

Case	Front HO2 Sensor (Sensor 1) Output Voltage		Rear 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 0.55 V Less than 0.4 V		Output Voltage More than 0.55 V Less than 0.4 V		
2	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• Front HO2 sensor • Front HO2 sensor heater • Front HO2 sensor circuit
	Output Voltage Almost no reaction		Output Voltage More than 0.55 V Less than 0.4 V		
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• Rear HO2 sensor • Rear HO2 sensor heater • Rear HO2 sensor circuit
	Output Voltage More than 0.55 V Less than 0.4 V		Output Voltage Almost no reaction		
4	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely rich or lean)
	Output Voltage Almost no reaction		Output Voltage Almost no reaction		

- Following the A/F CONTROL procedure enables technicians to check and graph the voltage outputs of both the front and rear HO2 sensors.
- To display the graph, enter the following menus on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST/ A/F CONTROL / USER DATA / O2S B1S1 and O2S B1S2; then press the YES button and ENTER button followed by the F4 button.
  NOTICE:
  If the vehicle is short of fuel, the air-fuel ratio becomes lean, HO2 sensor DTCs are recorded, and the ECM illuminates the MIL.

HINT:

- If other DTCs relating to different systems that have terminal E2 as the ground terminal are output simultaneously, terminal E2 may have an open circuit.

- Read freeze frame data using the intelligent tester. Freeze frame data records 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.
- A high HO2 sensor (sensor 1) voltage (0.55 V or more) could be caused by a rich air-fuel mixture. Check for conditions that would cause the engine to run rich.
- A low HO2 sensor (sensor 1) voltage (0.4 V or less) could be caused by a lean air-fuel mixture. Check for conditions that would cause the engine to run lean.

1 CHECK ANY OTHER DTCS OUTPUT (IN ADDITION TO DTC P0171 OR P0172)

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

Result

Display (DTC Output)	Proceed to
P0171 or P0172	A
P0171 or P0172 and other DTCs	B

HINT:
If any DTCs other than P0171 or P0172 are output, troubleshoot those DTCs first.

B → **GO TO DTC CHART**

A

2 CHECK VENTILATION HOSE CONNECTIONS

OK:
Ventilation hose is connected correctly, and is not damaged.

NG → **REPAIR OR REPLACE VENTILATION HOSE**

OK

3 CHECK AIR INDUCTION SYSTEM

(a) Check the air induction system for vacuum leakage.

OK:
No leakage from air induction system.

NG → **REPAIR OR REPLACE AIR INDUCTION SYSTEM**

OK

4 PERFORM ACTIVE TEST BY INTELLIGENT TESTER (A/F CONTROL)

(a) Connect the intelligent tester 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) Enter the following menus: 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 output of the Heated Oxygen (HO2) sensors (O2S 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.

ES

Standard

Tester Display (Sensor)	Injection Volumes	Status	Voltages
O2S B1S1 (Front HO2 Sensor)	+25%	Rich	More than 0.55
O2S B1S1 (Front HO2 Sensor)	-12.5%	Lean	Less than 0.4
O2S B1S2 (Rear HO2 Sensor)	+25%	Rich	More than 0.5
O2S B1S2 (Rear HO2 Sensor)	-12.5%	Lean	Less than 0.4

Result

Status O2S B1S1	Status O2S B1S2	A/F Condition and HO2 Sensor Condition	Misfires	Suspected Trouble Areas	Proceed to
Lean/Rich	Lean/Rich	Normal	-	-	C
Lean	Lean	Actual air-fuel ratio lean	May occur	• Ventilation valve and hose • Ventilation hose connections • Injector blockage • Gas leakage from exhaust system • Air induction system • Fuel pressure • Mass Air Flow (MAF) meter • Engine Coolant Temperature (ECT) sensor	A
Rich	Rich	Actual air-fuel ratio rich	-	• Injector leakage or blockage • Gas leakage from exhaust system • Ignition system • Fuel pressure • MAF meter • ECT sensor	A
Lean	Lean/Rich	HO2 sensor malfunction	-	• HO2 sensor	B

Status O2S B1S1	Status O2S B1S2	A/F Condition and HO2 Sensor Condition	Misfires	Suspected Trouble Areas	Proceed to
Rich	Lean/Rich	HO2 sensor malfunction	-	• HO2 sensor	B

Lean: During A/F CONTROL, both the front and rear HO2 sensor output voltages (O2S) are consistently less than 0.4 V.
Rich: During A/F CONTROL, both of the O2S voltages are consistently more than 0.55 V.

B → **Go to step 11**

C → **Go to step 15**

ES

A

5 READ VALUE OF INTELLIGENT TESTER (COOLANT TEMP)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / COOLANT TEMP.
(d) Read the COOLANT TEMP twice, when the engine is cold and also when warmed up.
Standard:
With cold engine: Same as ambient air temperature.
With warm engine: 75°C to 95°C (167°F to 203°F)

NG → **REPLACE ENGINE COOLANT TEMPERATURE SENSOR**

OK

6 READ VALUE OF INTELLIGENT TESTER (MAF)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / PRIMARY / MAF and COOLANT TEMP.
(d) Allow the engine to idle until the COOLANT TEMP reaches 75°C (167°F).
(e) Read the MAF with the engine in an idling condition and at an engine speed of 2,500 rpm.
Standard:
MAF while engine idling: 1.4 g/sec. to 2.3 g/sec. (A/C: OFF).
MAF at engine speed of 2,500 rpm: 5.4 g/sec. to 7.9 g/sec. (A/C: OFF).

NG → **REPLACE MASS AIR FLOW METER**

OK

7	CHECK FUEL PRESSURE

(a) Check the fuel pressure (high or low pressure) (see page FU-7).

NG → REPAIR OR REPLACE FUEL SYSTEM

OK

ES

8	CHECK FOR EXHAUST GAS LEAKAGE

OK:
No gas leakage.

NG → REPAIR OR REPLACE EXHAUST SYSTEM

OK

9	CHECK FOR SPARKS AND IGNITION

HINT:
If the spark plugs or ignition system malfunctions, engine misfire may occur. The misfire count can be read using the intelligent tester. Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / CYL #1 (to CYL #4).

NG → REPAIR OR REPLACE IGNITION SYSTEM

OK

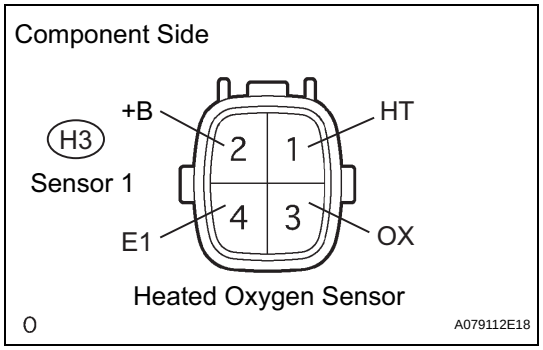
10	INSPECT FUEL INJECTOR (INJECTION AND VOLUME)

HINT:
If the injectors malfunction, engine misfire may occur. The misfire count can be read using the intelligent tester. Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DATA LIST / MISFIRE / CYL #1 (to CYL #4).

NG → REPLACE FUEL INJECTOR

OK

11 INSPECT HEATED OXYGEN SENSOR (HEATER RESISTANCE)



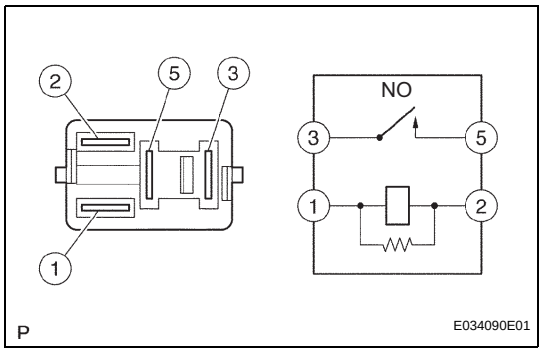
(a) Disconnect the H3 HO2 sensor connector.
(b) Measure the resistance of the HO2 sensor connector.
Standard resistance

Tester Connection	Specified Condition
HT (H3-1) - +B (H3-2)	11 to 16 Ω at 20°C (68°F)
HT (H3-1) - E1 (H3-4)	10 kΩ or higher

NG → **REPLACE HEATED OXYGEN SENSOR**

OK

12 INSPECT EFI RELAY (Marking: EFI)



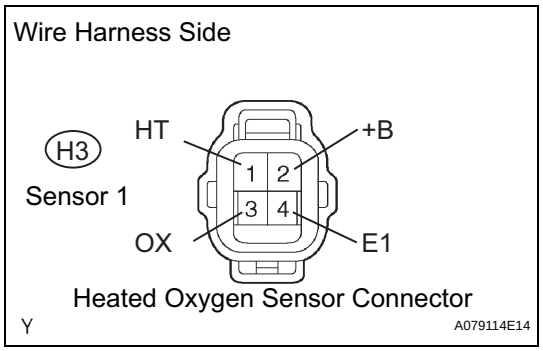
(a) Remove the EFI relay from the engine room relay block.
(b) Measure the resistance of the EFI relay.
Standard resistance

Tester Connection	Specified Condition
3 - 5	10 kΩ or higher
3 - 5	Below 1 Ω (When battery voltage is applied to terminals 1 and 2)

NG → **REPLACE EFI RELAY**

OK

13 CHECK HARNESS AND CONNECTOR (HEATED OXYGEN SENSOR (SENSOR 1) - ECM)

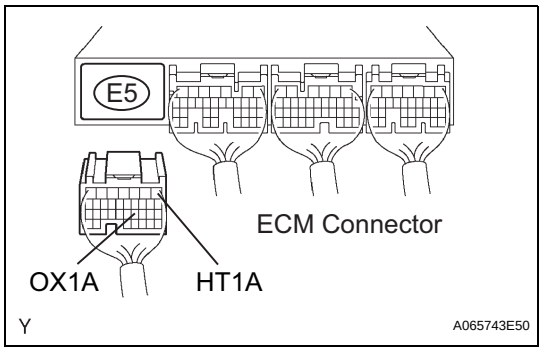


(a) Disconnect the H3 HO2 sensor connector.
(b) Turn the ignition switch ON.
(c) Measure the voltage between the +B terminal of the H3 HO2 sensor connector and body ground.
Standard voltage

Tester Connection	Specified Condition
+B (H3-2) - Body ground	9 to 14 V

(d) Turn the ignition switch OFF.

ES



(e) Disconnect the E5 ECM connector.
(f) Measure the resistance of the wire harness side connectors.

Standard resistance (Check for open)

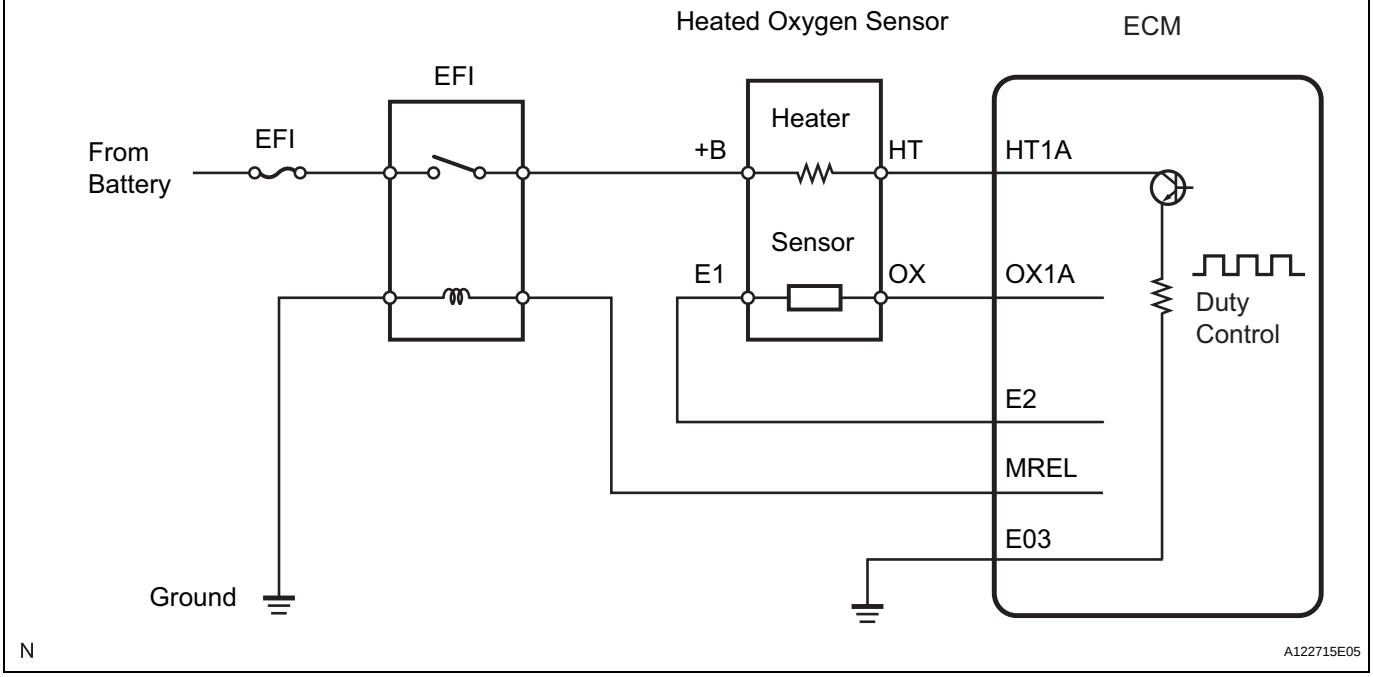
Tester Connection	Specified Condition
HT (H3-1) - HT1A (E5-1)	Below 1 Ω
OX (H3-3) - OX1A (E5-21)	Below 1 Ω
E1 (H3-4) - Body ground	Below 1 Ω

Standard resistance (Check for short)

Tester Connection	Specified Condition
HT (H3-1) or HT1A (E5-1) - Body ground	10 kΩ or higher
OX (H3-3) or OX1A (E5-21) - Body ground	10 kΩ or higher

ES

Reference (System Diagram of Bank 1 Sensor 1)



NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

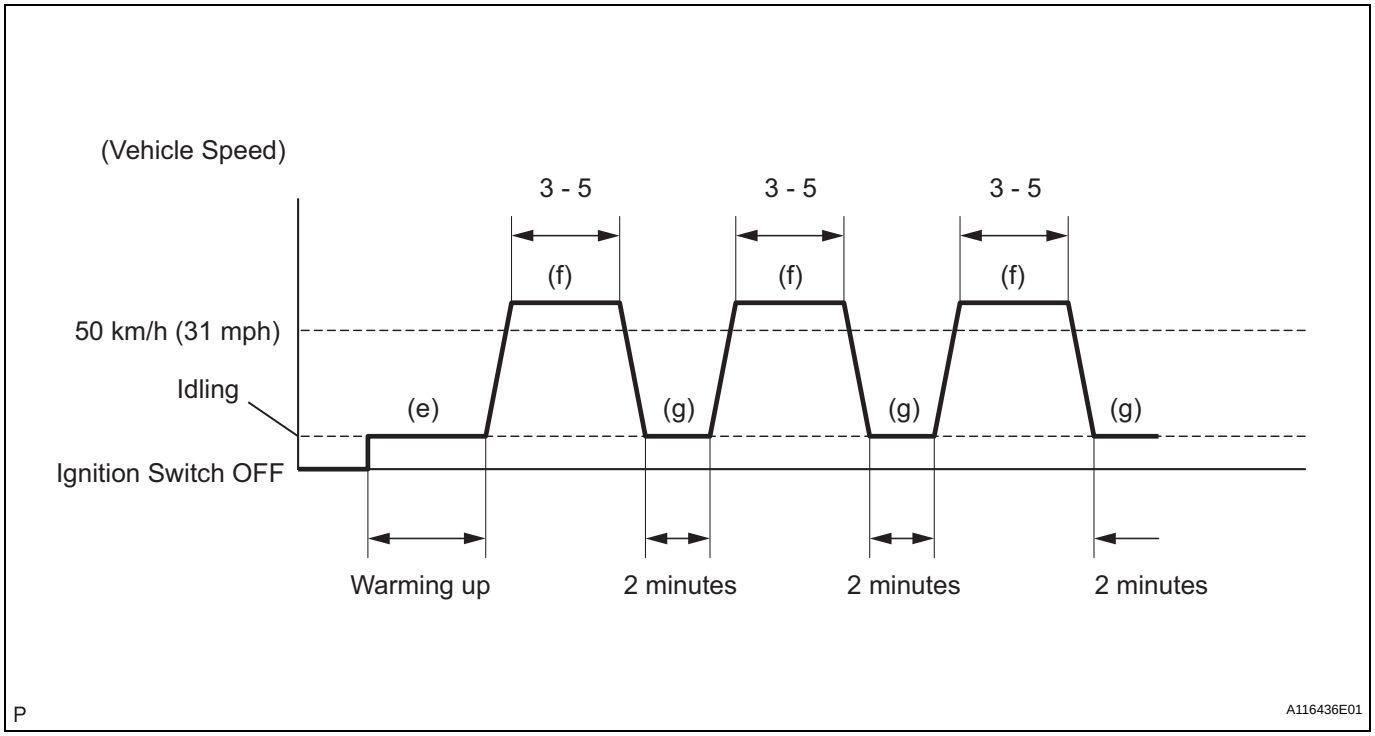
OK

14	REPLACE HEATED OXYGEN SENSOR (SENSOR 1)

(a) Replace the HO2 sensor (see page EC-20).

NEXT

15	PERFORM CONFIRMATION DRIVING PATTERN



(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Clear DTCs (see page ES-37).
(d) Switch the ECM from normal mode to check mode using the tester (see page ES-41).
(e) Start the engine and warm it up with all accessories switched OFF.
(f) Drive the vehicle at 50 km/h (31 mph) or more for 3 to 5 minutes.
(g) Allow the engine to idle for 2 minutes.
(h) Perform steps (f) and (g) at least 3 times.

NEXT

16	CHECK WHETHER DTC OUTPUT RECURS (DTC P0171 OR P0172)

(a) Connect the intelligent tester to the DLC3.
(b) Turn the ignition switch ON and turn the tester ON.
(c) Enter the following menus: DIAGNOSIS / ENHANCED OBD II / DTC INFO / CURRENT CODES.
(d) Read DTCs (see page ES-48).

Result

Display (DTC Output)	Proceed to
No output	A
P0171 or P0172	B

B → **Go to step 5**

A

END