DIC27–03

DTC	P0133	Oxygen Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC	P0153	Oxygen Sensor Circuit Slow Response (Bank 2 Sensor 1)

CIRCUIT DESCRIPTION

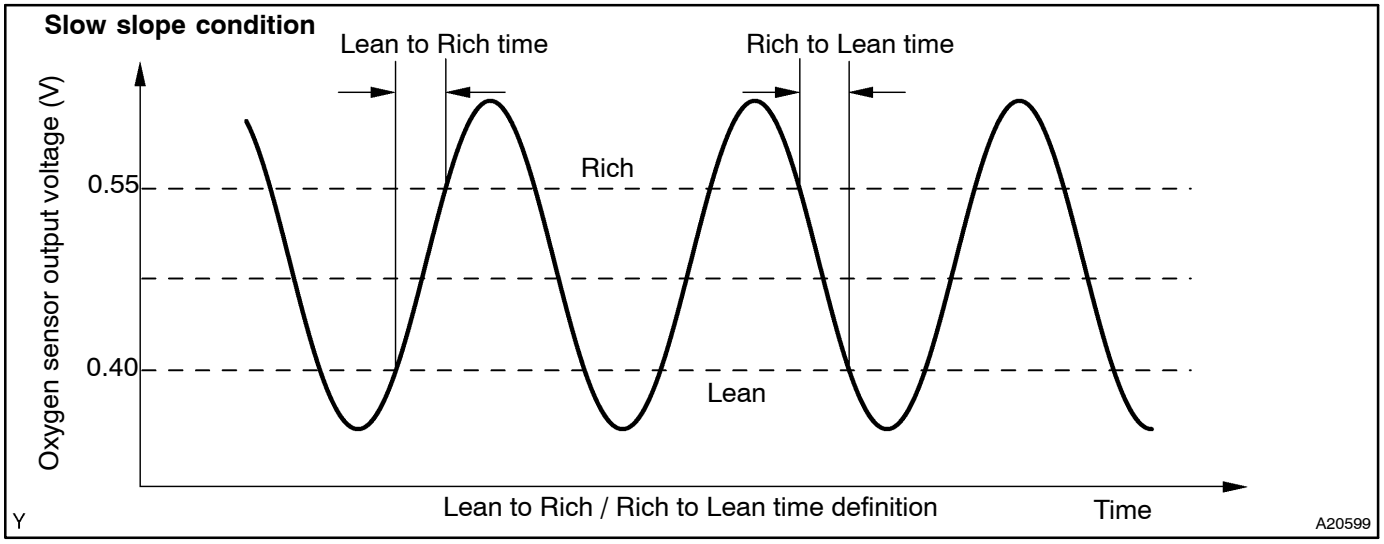
Refer to DTC P0031 on page DI–53.

DTC No.	DTC Detecting Condition	Trouble Area
P0133 P0153	After engine has been warmed up, if response time that heated oxygen sensor's output voltage reaches from RICH to LEAN, or from LEAN to RICH, is 0.6 seconds or more during idling. (2 trip detection logic)	• Open or short in heated oxygen sensor circuit • Heated oxygen sensor • Heated oxygen sensor heater • EFI or ECD relay • Air induction system • Fuel pressure • Injector • ECM
	If response time of heated oxygen sensor's output voltage in one RICH–LEAN cycle is 5.6 seconds or more during idling. (2 trip detection logic)	

HINT:

- Bank 1 refers to bank that includes cylinder No. 1.
- Bank 2 refers to bank that does not includes cylinder No. 1.
- Sensor 1 refers to the sensor closer to the engine assembly.

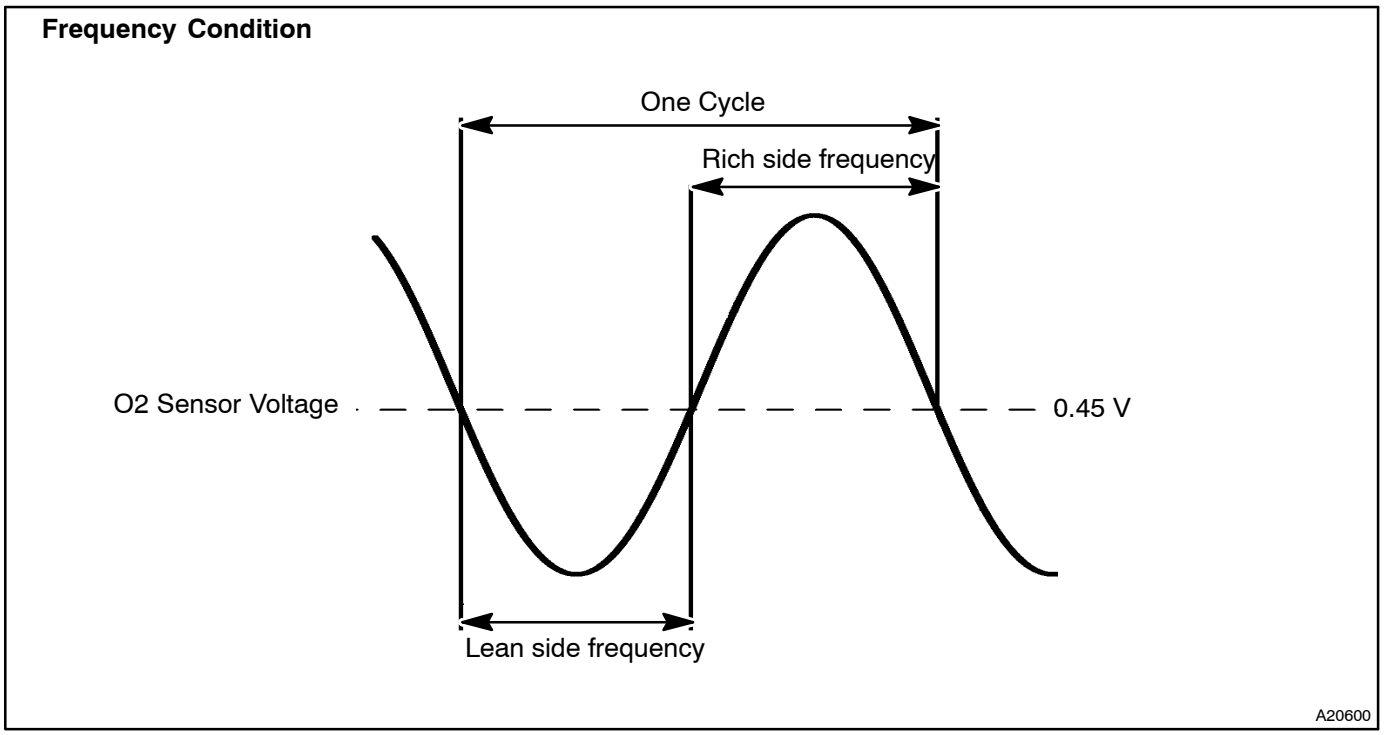
MONITOR DESCRIPTION



The ECM uses the heated oxygen sensor information to regulate the air–fuel ratio close to a stoichiometric ratio. This maximizes the catalytic converter's ability to purify the exhaust gases. The sensor detects oxygen levels in the exhaust gas and sends this signal to the ECM.

The inner surface of the sensor element is exposed to outside air. The outer surface of the sensor element is exposed to exhaust gas. The sensor element is made of platinum coated zirconia and includes an integrated heating element. The heated oxygen sensor has the characteristic whereby its output voltage changes suddenly in the vicinity of the stoichiometric air–fuel ratio. The heated oxygen sensor generates waveforms of a voltage between 0 V and 1 V in response to the oxygen concentration in exhaust gas. When the output voltage of the heated oxygen sensor is 0.55 V or more, the ECM judges that the air–fuel ratio is RICH. When it is 0.40 V or less, the ECM judges that the air–fuel ratio is LEAN.

The ECM monitors the response feature of the heated oxygen sensor. If the response time of the heated oxygen sensor output status change from RICH to LEAN or vice versa becomes longer, the ECM interprets this as a malfunction in the heated oxygen sensor and sets a DTC.



MONITOR STRATEGY

Related DTCs	P0133	Front heated oxygen sensor response monitor (Bank 1)
	P0153	Front heated oxygen sensor response monitor (Bank 2)
Required sensors/components	Main sensors/components	Front heated oxygen sensor
	Related sensors/components	Crank position sensor, Vehicle speed sensor, Mass air flow meter
Frequency of operation	Once per drive cycle	
Duration	Within 60 sec.	
MIL operation	2 driving cycles	
Sequence of operation	None	

TYPICAL ENABLING CONDITIONS

Item	Specification
Slow slope condition:	
Precondition is met if all of A through G are met	
A. Vehicle had run continuously (Vehicle speed 40 km/h (25mile/h) or more and engine speed 900 rpm more)	20 sec. or more
B. Time after engine start	120 sec. or more
C. Idle switch is ON	1 sec. or more
D. Fuel system status	Closed loop
E. Vehicle speed is continuously (1 sec. or more)	Less than 5 km/h (3 mph)
F. Engine coolant temperature	40˚C (104˚F) or more
G. Neither fail nor pass is determined yet in this frive cycle	
Rich to rean respone time is the time for the oxygen sensor voltage to switch	0.4 V to 0.55 V
Rich to roan repone time is the time for the oxygen sensor voltage to switch	0.55 V or 0.4 V
Frequency (idle):	
Frequency cllection precondition is defined as follows	
History of following condition met	ON
Continuous time while following condition met (Vehicle speed 40 km/h (25 mph) or more Engine speed 900 rpm or more	20 sec. or more
Time after engine start	More than 120 sec.
Idle	ON
Vehicle speed	Less than 5 km/h (3 mph)
Time after engine speed less than 5 km/h (3mph)	1 sec. or more
Fuel system status	Closed loop
Engine coolant temperature	75˚C (167˚F) or more
No pass/malfunction detection this driving cycle	
Frequency (cruise):	
Frequency cllection precondition is defined as follows	
History of following condition met	ON
Continuous time while following condition met (Vehicle speed 40 km/h (25 mph) or more Engine speed 900 rpm or more)	20 sec. or more
Time after engine start	More than 120 sec.
Idle	OFF
Time after engine On to OFF	1 sec. or more

Intake air amount	3 to 13 g/sec.
Fuel system status	Closed loop
Engine speed	1000 to 3500 rpm
Time after fuel cut ON to OFF	0.7 sec. or more
Engine coolant temperature	70°C (158°F) or more
No pass/malfunction detection in this driving cycle	
Secondary air system	Not operating

TYPICAL MALFUNCTION THRESHOLDS

Detection Criteria	Threshold
Slow slope:	
Following condition A or B is met	
A. Average lean to rich response time	0.9 sec. or more
B. Average rich to rean response time	0.9 sec. or more
Frequency:	
Intrusive method of cruise monitor	Fail
Intrusive method of cruise monitor is executed when both	
Of idle and cruise monitor detect fail	
Frequency (idle):	
AVG 'AVG(lean side frequency in one period))+ AVG 'AVG(rich side frequency in one period)) (Bank 1)	5.6 sec. or more
AVG 'AVG(lean side frequency in one period))+ AVG 'AVG(rich side frequency in one period)) (Bank 2)	5.6 sec. or more
Frequency (cruise):	
Sum of DETECTION (Bank 1 and 2)	0 sec. or more
DETECTION is defined as follow	
DETECTION =AVG (criterion frequency in one period) – {AVG (lean side frequency in one period) +AVG (rich side frequency in one)	
Frequency (intrusive method of cruise monitor):	
Detection Criteria	Threshold
Sum of DETECTION (BANK 1 AND 2)	0 sec.
The sampling method is same as the method of cruise monitor but sub–feedback compensation factor is set at default condition	

COMPONENT OPERATING RANGE

Parameter	Standard value
Voltage output from heated oxygen sensor	Quickly fluctuates between 0.4 and 0.55 V

O2S TEST RESULT

Refer to page DI–3 for detailed information.

Front HO2S slow slope monitor

If the HO2S sensor voltage is out of the standard value, the ECM interprets this as a malfunction.

TEST ID	Description of TEST DATA	Conversion Factor	Unit
$03	(Test constant) Low sensor voltage for response time calculation	N/A	V
$04	(Test constant) High sensor voltage for response time calculation	N/A	V

If the time required to change is out of the standard value, the ECM interprets this as a malfunction.

TEST ID	Description of TEST DATA	Conversion Factor	Unit
$31	Time to change from Lean (≦0.4 V) to Rich (≧0.55 V)	N/A	sec.
$32	Time to change from Rich (≧0.55 V) to Lean (≦0.4 V)	N/A	sec.

Front HO2S frequency monitor (idling)

If the $38 is out of the standard value, the ECM interprets this as a malfunction.

TEST ID	Description of TEST DATA	Conversion Factor	Unit
$38	Response time of heated oxygen sensor's output voltage in one RICH–LEAN cycle	N/A	sec.

Front HO2S frequency monitor (cruse)

If the $90 is out of the standard value, the ECM interprets this as a malfunction.

TEST ID	Description of TEST DATA	Conversion Factor	Unit
$90	Remained value of that average of switching frequency is subtracted from average of switching frequency threshold	Multiply by 0.04096 plus 5.2	sec.

WIRING DIAGRAM

Refer to DTC P0031 on page DI–53.

INSPECTION PROCEDURE

HINT:

Hand–held tester only:

The narrowing down the trouble area is possible by performing ACTIVE TEST of the following ”A/F CONTROL” (Heated oxygen sensor or another can be distinguished).

(a) Perform ACTIVE TEST by hand–held tester (A/F CONTROL).

HINT:

”A/F CONTROL” is the ACTIVE TEST which changes the injection volume to –12.5 % or +25 %.

(1) Connect the hand–held tester to the DLC3 on the vehicle.
(2) Turn the ignition switch ON.
(3) Warm up the engine with the engine speed at 2,500 rpm for approximately 90 seconds.
(4) Select the item ”DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL”.
(5) Perform ”A/F CONTROL” with the engine in an idle condition (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:

However, there is a few second delay in the sensor 1 (front sensor) output. And there is about 20 seconds delay in the sensor 2 (rear sensor).

	Output voltage of heated oxygen sensor (sensor 1: front sensor)	Output voltage of heated oxygen sensor (sensor 2: rear sensor)	Mainly suspect trouble area
Case 1	Injection volume +25 % –12.5 % Output voltage More than 0.5 V Less than 0.4 V **OK**	Injection volume +25 % –12.5 % Output voltage More than 0.5 V Less than 0.4 V **OK**	—
Case 2	Injection volume +25 % –12.5 % Output voltage Almost no reaction **NG**	Injection volume +25 % –12.5 % Output voltage More than 0.5 V Less than 0.4 V **OK**	Sensor 1: front sensor (sensor 1, heater, sensor 1 circuit)
Case 3	Injection volume +25 % –12.5 % Output voltage More than 0.5 V Less than 0.4 V **OK**	Injection volume +25 % –12.5 % Output voltage Almost no reaction **NG**	Sensor 2: rear sensor (sensor 2, heater, sensor 2 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 of the actual air–fuel ratio (Injector, fuel pressure, gas leakage in exhaust system, etc.)

The following A/F CONTROL procedure enables the technician to check and graph the voltage output of the heated oxygen sensors (sensor 1 and 2).
For displaying the graph indication, enter ”ACTIVE TEST / A/F CONTROL / USER DATA” then select ”O2S B1S1 and O2S B1S2” by pressing ”YES” button and push ”ENTER” button before pressing ”F4” button.

NOTICE:

If the vehicle is short of fuel, the air–fuel ratio becomes LEAN and DTCs P0133 and/or P0153 will be recorded, and the MIL then comes on.

- If different DTCs related to different systems while terminal E2 as ground terminal are output simultaneously, terminal E2 may be open.
- 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, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.
- A high heated oxygen sensor (sensor 1) voltage (0.5 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 heated oxygen 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	**Are there any other codes (besides DTC P0133 or P0153) being output?**

PREPARATION:

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

CHECK:

Read the DTC using the hand–held tester or the OBD II scan tool.

RESULT:

Display (DTC Output)	Proceed to
”P0133 and/or P0153”	A
”P0133 or P0153” and other DTCs	B

HINT:
If any other codes besides ”P0133 and/or P0153” are output, perform the troubleshooting for those DTCs first.

B → **Go to relevant DTC chart (See page DI–43).**

A

2	**Check output voltage of heated oxygen sensor during idling.**

PREPARATION:

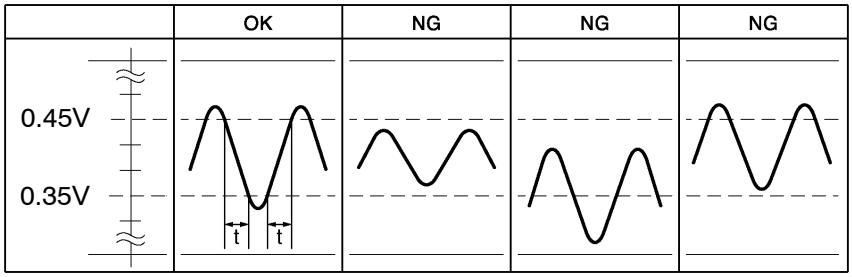
(a) Warm up the heated oxygen sensor with the engine speed at 2,500 rpm for approximately 90 seconds.
(b) Connect the hand–held tester or OBD II scan tool to the DLC3.
(c) When using hand–held tester, enter the following menu: DIAGNOSIS / ENHANCED OBD II / DATA LIST / ALL / O2S B1 S1 or B2 S1.

CHECK:

Check the output voltage of the heated oxygen sensor while idling the OBD II scan tool or hand–held tester.

OK:

Heated oxygen sensor output voltage:
Alternates between less than 0.35 V and more than 0.45 V, and period of "t" must exist less than 0.6 seconds (See the following table).



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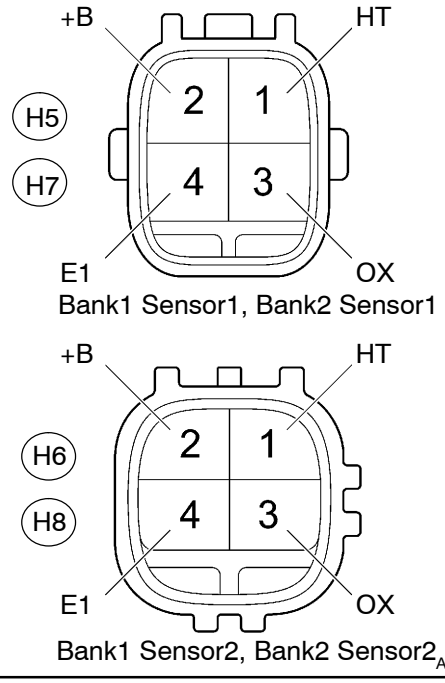
OK	**Go to step 9.**

NG

3	Check resistance of heated oxygen sensor heater.

Components Side:



PREPARATION:

Disconnect the H5, H6, H7 or H8 heated oxygen sensor connector.

CHECK:

Measure resistance between terminals of the heated oxygen sensor.

OK:

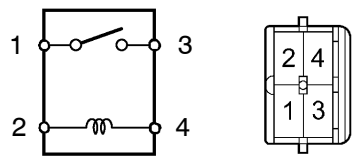
Tester Connection	Specified Condition
HT (H5–1) – +B (H5–2)	11 to 16 Ω (20°C)
HT (H6–1) – +B (H6–2)	11 to 16 Ω (20°C)
HT (H7–1) – +B (H7–2)	11 to 16 Ω (20°C)
HT (H8–1) – +B (H8–2)	11 to 16 Ω (20°C)

NG → **Replace heated oxygen sensor.**

OK

4	Check EFI or ECD relay.

EFI or ECD Relay



PREPARATION:

Remove the EFI or ECD relay from the engine room R/B.

CHECK:

Inspect the EFI or ECD relay.

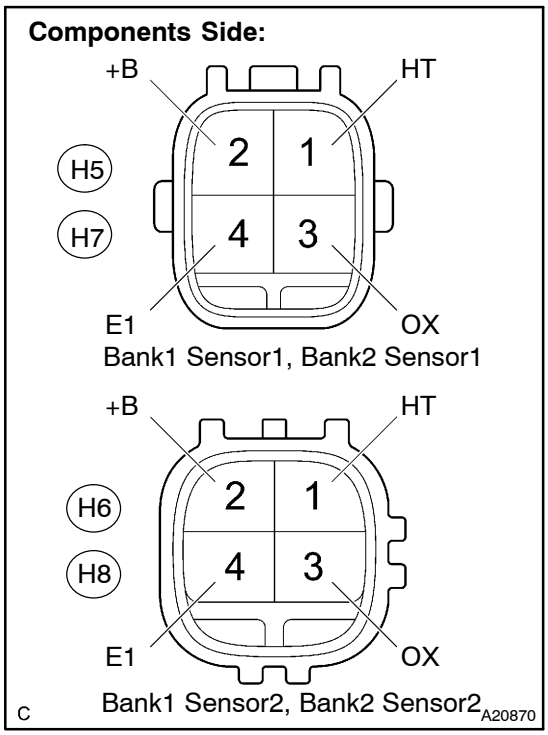
OK:

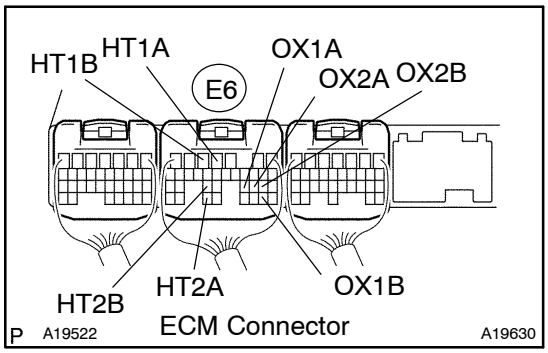
Terminal No.	Condition	Specified Condition
2 – 4	Constant	Continuity
1 – 3	Usually	No Continuity
	Apply B+ between terminals 2 and 4	Continuity

NG → **Replace EFI or ECD relay.**

OK

5	Check for open and short in harness and connector between ECM and heated oxygen sensor.





PREPARATION:

(a) Disconnect the H5, H6, H7 or H8 heated oxygen sensor connector.

(b) Disconnect the E6 ECM connector.

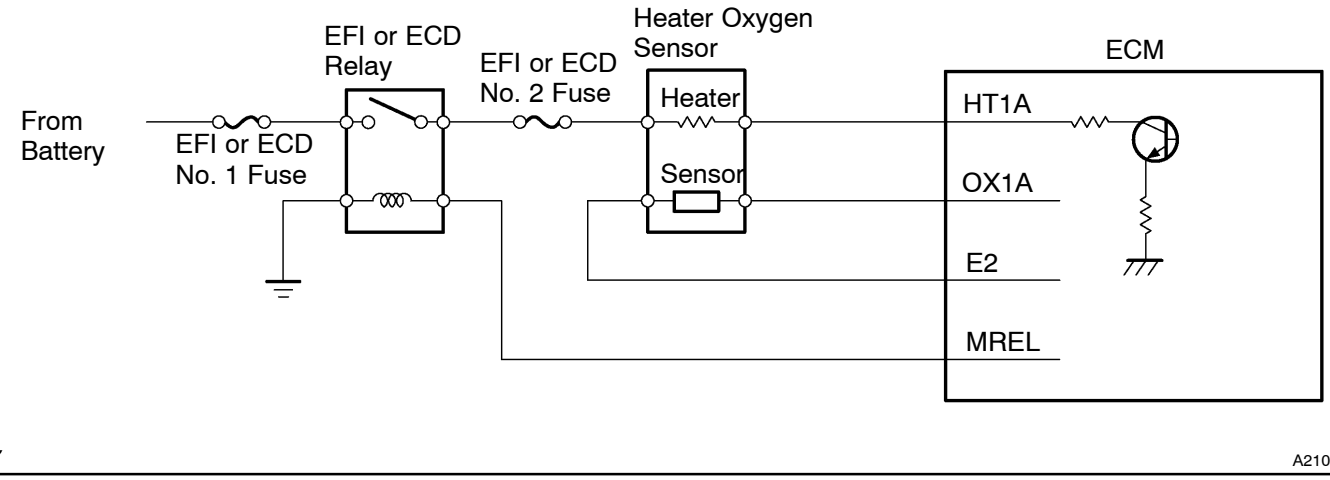
CHECK:

Measure the resistance between the wire harness side connectors.

OK:

Tester Connection	Specified Condition
OX (H5–3) – OX1A (E6–23)	Below 1 Ω
HT (H5–1) – HT1A (E6–4)	Below 1 Ω
OX (H6–3) – OX1B (E6–29)	Below 1 Ω
HT (H6–1) – HT1B (E6–5)	Below 1 Ω
OX (H7–3) – OX2A (E6–22)	Below 1 Ω
HT (H7–1) – HT2A (E6–33)	Below 1 Ω
OX (H8–3) – OX2B (E6–21)	Below 1 Ω
HT (H8–1) – HT2B (E6–25)	Below 1 Ω
OX (H5–3) or OX1A (E6–23) – Body ground	10 kΩ or higher
HT (H5–1) or HT1A (E6–4) – Body ground	10 kΩ or higher
OX (H6–3) or OX1B (E6–29) – Body ground	10 kΩ or higher
HT (H6–1) or HT1B (E6–5) – Body ground	10 kΩ or higher
OX (H7–3) or OX2A (E6–22) – Body ground	10 kΩ or higher
HT (H7–1) or HT2A (E6–33) – Body ground	10 kΩ or higher
OX (H8–3) or OX2B (E6–21) – Body ground	10 kΩ or higher
HT (H8–1) or HT2B (E6–25) – Body ground	10 kΩ or higher

Reference (Bank 1 Sensor 1 System Drawing)



NG	**Repair or replace harness or connector.**

OK

6	**Check air induction system (See page SF–1).**

CHECK:

Check the air induction system for vacuum leaks.

NG	**Repair or replace air induction system.**

OK

7	**Check fuel pressure (See page SF–7).**

CHECK:

Check the fuel pressure (high or low pressure).

NG	**Check and repair fuel pump, pressure regulator, fuel pipe line and filter (See page SF–1).**

OK

8	Check injector injection (See page SF–24).

NG → Replace injector.

OK →

Replace heated oxygen sensor.

9	Perform confirmation driving pattern (See page DI–110).

HINT:
Clear all DTCs prior to performing the confirmation driving pattern.

Go →

10	Is there DTC P0133 or P0153 being output again?

NO → Check for intermittent problems (See page DI–3).

YES →

Replace heated oxygen sensor.