

DTC	P2238	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1)
DTC	P2239	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1)
DTC	P2241	Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1)
DTC	P2242	Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1)
DTC	P2252	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1)
DTC	P2253	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1)
DTC	P2255	Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1)
DTC	P2256	Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)

HINT:

- Although the DTC titles say oxygen sensor, these DTCs relate to the Air-Fuel Ratio (A/F) sensor.
- Sensor 1 refers to the sensor mounted in front of the Three-Way Catalytic Converter (TWC) and located near the engine assembly.

DESCRIPTION

Refer to DTC P2195 (See page [ES-290](#)).

DTC No.	DTC Detection Conditions	Trouble Areas
P2238 P2241	- Case 1: Condition (a) or (b) continues for 5.0 seconds or more (1 trip detection logic): (a) AF+ voltage is 0.5 V or less (b) (AF+) - (AF-) = 0.1 V or less - Case 2: A/F sensor admittance: Less than 0.022 1/Ω (2 trip detection logic)	- Open or short in A/F sensor (bank 1, 2 sensor 1) circuit - A/F sensor (bank 1, 2 sensor 1) - A/F sensor heater - A/F sensor heater relay - A/F sensor heater and relay circuits - ECM
P2239 P2242	AF+ voltage is more than 4.5 V for 5.0 seconds or more (2 trip detection logic)	- Open or short in A/F sensor (bank 1, 2 sensor 1) circuit - A/F sensor - A/F sensor heater - A/F sensor heater relay - A/F sensor heater and relay circuits - ECM

DTC No.	DTC Detection Conditions	Trouble Areas
P2252 P2255	AF- voltage is 0.5 V or less for 5.0 seconds or more (2 trip detection logic)	- Open or short in A/F sensor (bank 1, 2 sensor 1) circuit - A/F sensor (bank 1, 2 sensor 1) - A/F sensor heater - A/F sensor heater relay - A/F sensor heater and relay circuits - ECM
P2253 P2256	AF- voltage is more than 4.5 V for 5.0 seconds or more (1 trip detection logic)	- Open or short in A/F sensor (bank 1, 2 sensor 1) circuit - A/F sensor (bank 1, 2 sensor 1) - A/F sensor heater - A/F sensor heater relay - A/F sensor heater and relay circuits - ECM

HINT:

- DTC P2238, P2239, P2252 and P2253 means malfunction related to the bank 1 A/F sensor circuit.
- DTC P2241, P2242, P2255 and P2256 means malfunction related to the bank 2 A/F sensor circuit.
- Bank 1 refers to the bank that includes cylinder No. 1.
- Bank 2 refers to the bank that includes cylinder No. 2.

MONITOR DESCRIPTION

The Air-Fuel Ratio (A/F) sensor varies its output voltage in proportion to the air-fuel ratio. If the A/F sensor impedance (alternating current resistance) or voltage output deviates greatly from the standard range, the ECM determines that there is an open or short malfunction in the A/F sensor circuit.

MONITOR STRATEGY

Related DTCs	P2238: A/F sensor (Bank 1) open circuit between AF+ and AF- P2238: A/F sensor (Bank 1) short circuit between AF+ and AF- P2238: A/F sensor (Bank 1) short circuit between AF+ and GND P2239: A/F sensor (Bank 1) short circuit between AF+ and +B P2241: A/F sensor (Bank 2) open circuit between AF+ and AF- P2241: A/F sensor (Bank 2) short circuit between AF+ and AF- P2241: A/F sensor (Bank 2) short circuit between AF+ and GND P2242: A/F sensor (Bank 2) short circuit between AF+ and +B P2252: A/F sensor (Bank 1) short circuit between AF- and GND P2253: A/F sensor (Bank 1) short circuit between AF- and +B P2255: A/F sensor (Bank 2) short circuit between AF- and GND P2256: A/F sensor (Bank 2) short circuit between AF- and +B
Required Sensors / Components (Main)	A/F sensor
Required Sensors / Components (Related)	ECT sensor, Crankshaft position sensor
Frequency of Operation	Once per driving cycle
Duration	10 seconds: A/F sensor open circuit between AF+ and AF- 5 seconds: Others
MIL Operation	2 driving cycles
Sequence of Operation	None

TYPICAL ENABLING CONDITIONS**All:**

The monitor will run whenever these DTCs are not present	None
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P2238 and P2241 (open circuit between AF+ and AF-):

AF+ terminal voltage	0.5 to 4.5 V
AF- terminal voltage	0.5 to 4.5 V
Difference between AF+ terminal and AF- terminal voltages	0.1 to 0.8 V
ECT	5°C (41°F) or more

Engine	Running
Fuel-cut	OFF
Time after A/F sensor heating	0% or more
A/F sensor heater duty ratio	20 seconds or more
Battery voltage	11 V or more
Ignition switch	ON
Time after ignition switch is OFF to ON	5 seconds or more

Others:

Battery voltage	11 V or more
Ignition switch	ON
Time after ignition switch is OFF to ON	5 seconds or more

ES**TYPICAL MALFUNCTION THRESHOLDS****P2238, P2241 (Open circuit between AF+ and AF-):**

A/F sensor admittance	Below 0.022 1/Ω
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P2238, P2241 (Short circuit between AF+ and GND):

AF+ terminal voltage	0.5 V or less
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P2238, P2241 (Short circuit between AF+ and AF-):

Difference between AF+ and AF- terminal voltages	0.1 V or less
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P2239, P2242 (Short circuit between AF+ and +B):

AF+ terminal voltage	More than 4.5 V
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P2252, P2255 (Short circuit between AF- and GND):

AF- terminal voltage	0.5 V or less
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P2253, P2256 (Short circuit between AF- and +B):

AF- terminal voltage	More than 4.5 V
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WIRING DIAGRAM

Refer to DTC P2195 (See page [ES-295](#)).

INSPECTION PROCEDURE**HINT:**

For use the intelligent 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 the intelligent tester.

- Connect the intelligent tester to the DLC3.
- Start the engine and turn the tester on.
- Warm up the engine at an engine speed of 2,500 rpm for approximately 90 seconds.
- Select the following menu items on the tester: DIAGNOSIS / ENHANCED OBD II / ACTIVE TEST / A/F CONTROL.
- 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 or AFS B2S1 and O2S B2S2) 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 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

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 Area
1	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		-
	Output Voltage More than 3.35 V Less than 3.0 V	 OK	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
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	 NG	Output Voltage More than 0.55 V Less than 0.4 V	 OK	
3	Injection Volume +25% -12.5%		Injection Volume +25% -12.5%		• HO2 sensor • HO2 sensor heater • HO2 sensor circuit
	Output Voltage More than 3.35 V Less than 3.0 V	 OK	Output Voltage Almost no reaction	 NG	
4	Injection volume +25% -12.5%		Injection Volume +25% -12.5%		• Injector • Fuel pressure • Gas leakage from exhaust system (Air-fuel ratio extremely lean or rich)
	Output Voltage Almost no reaction	 NG	Output Voltage Almost no reaction	 NG	

- Following the A/F CONTROL procedure enables technicians to check the graph of 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 or AFS B2S1 and O2S B2S2, and press the YES button and then the ENTER button followed by the F4 button.

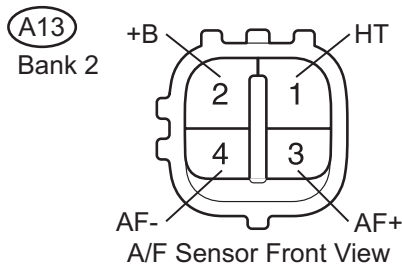
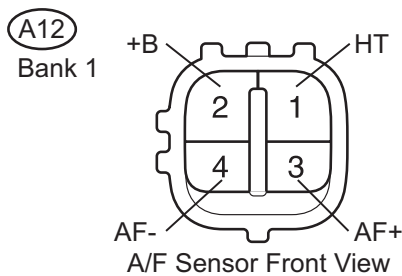
HINT:

- Read freeze frame data using the intelligent tester. The ECM records vehicle and driving condition information as freeze frame data the moment a DTC is stored. When troubleshooting, freeze frame data can be helpful in determining whether the vehicle was running or stopped, whether the engine was warmed up or not, whether the air/fuel ratio was lean or rich, as well as other data recorded at the time of a malfunction.

1 INSPECT AIR FUEL RATIO SENSOR (HEATER RESISTANCE)

ES

Component Side:



A126269E08

- Disconnect the A12 or A13 A/F sensor connector.
- Measure the resistance between the terminals of the A/F sensor connector.

Standard resistance:

Bank 1

Tester Connections	Specified Conditions
HT (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HT(1) - AF- (4)	10 k Ω or higher

Bank 2

Tester Connections	Specified Conditions
HT (1) - +B (2)	1.8 to 3.4 Ω at 20°C (68°F)
HT (1) - AF- (4)	10 k Ω or higher

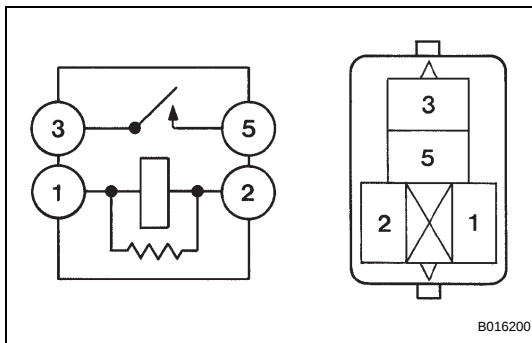
- Reconnect the A/F sensor connector.

NG

REPLACE AIR FUEL RATIO SENSOR

OK

2 INSPECT AIR FUEL RATIO SENSOR HEATER RELAY



- Remove the A/F sensor heater relay from the engine room R/B.
- Check the A/F sensor heater relay resistance.

Standard resistance

Tester Connections	Specified Conditions
3 - 5	10 k Ω or higher
3 - 5	Below 1 Ω (when battery voltage applied to terminals 1 and 2)

- Reinstall the A/F sensor heater relay.

NG

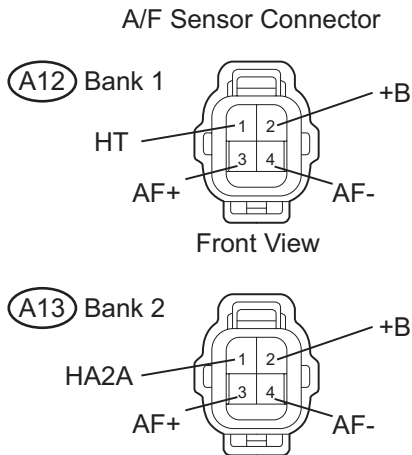
REPLACE AIR FUEL RATIO SENSOR HEATER RELAY

OK

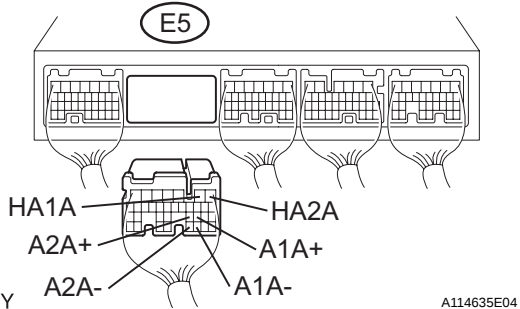
3

CHECK HARNESS AND CONNECTOR (A/F SENSOR - ECM)

Wire Harness Side:



ECM:



- (a) Disconnect the A12 or A13 A/F sensor connector.
- (b) Turn the ignition switch on.
- (c) Measure the voltage between the +B terminal of the A/F sensor connector and body ground.

Standard voltage

Tester Connections	Specified Conditions
+B (A12-2) - Body ground	9 to 14 V
+B (A13-2) - Body ground	9 to 14 V

- (d) Turn the ignition switch off.
- (e) Disconnect the B46 ECM connector.
- (f) Measure the resistance between the terminals of A/F sensor connector and ECM connector.

Standard resistance (Check for open)

Tester Connections	Specified Conditions
HA1A (A12-1) - HA1A (E5-2)	Below 1 Ω
A1A+ (A12-3) - A1A+ (E5-22)	Below 1 Ω
A1A- (A12-4) - A1A- (E5-30)	Below 1 Ω
HA2A (A13-1) - HA2A (E5-1)	Below 1 Ω
A2A+ (A13-3) - A2A+ (E5-23)	Below 1 Ω
A2A- (A13-4) - A2A- (E5-31)	Below 1 Ω

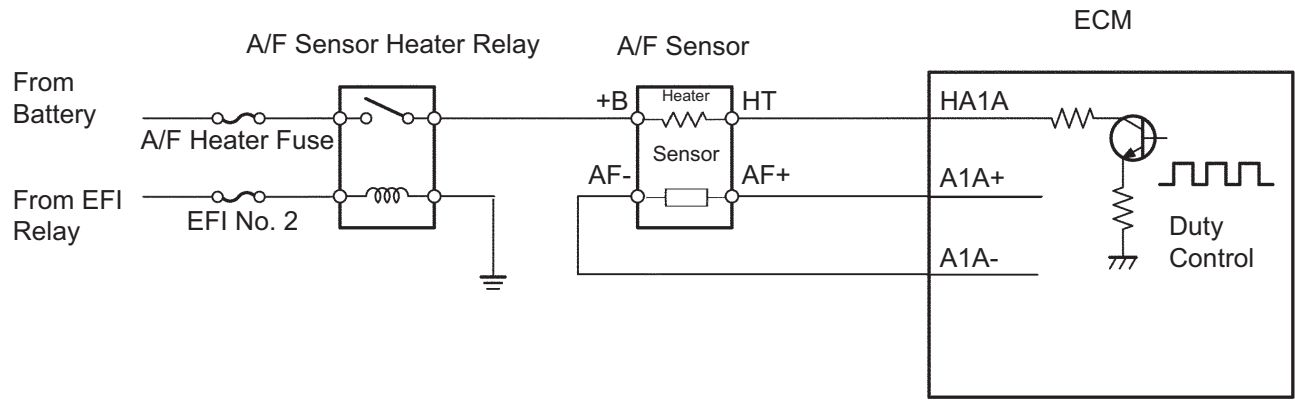
Standard resistance (Check for short)

Tester Connections	Specified Conditions
HA1A (A12-1) or HA1A (E5-2) - Body ground	10 kΩ or higher
A1A+ (A12-3) or A1A+ (E5-22) - Body ground	10 kΩ or higher
A1A- (A12-4) or A1A- (E5-30) - Body ground	10 kΩ or higher
HA2A (A13-1) or HA2A (E5-1) - Body ground	10 kΩ or higher
A2A+ (A13-3) or A2A+ (E5-23) - Body ground	10 kΩ or higher
A2A- (A13-4) or A2A- (E5-31) - Body ground	10 kΩ or higher

- (g) Reconnect the ECM connector.
- (h) Reconnect the A/F sensor connector.

ES

Reference (System Diagram of Bank 1 Sensor 1):



G035624E02

NG

REPAIR OR REPLACE HARNESS OR CONNECTOR

OK

REPLACE ECM