

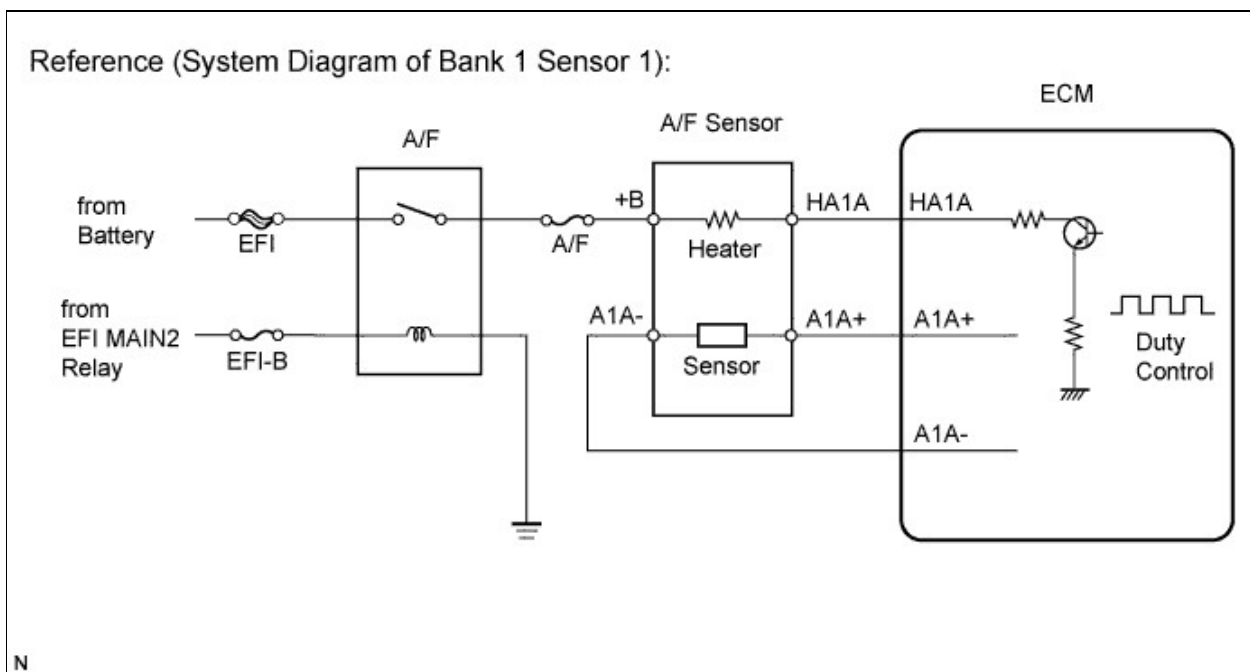
**1UR-FSE ENGINE CONTROL SYSTEM > SFI SYSTEM > P2237 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 1 Sensor 1) / P2238 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 1 Sensor 1) / P2239 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 1 Sensor 1) / P2240 Oxygen (A/F) Sensor Pumping Current Circuit / Open (Bank 2 Sensor 1) / P2241 Oxygen (A/F) Sensor Pumping Current Circuit Low (Bank 2 Sensor 1) / P2242 Oxygen (A/F) Sensor Pumping Current Circuit High (Bank 2 Sensor 1) / P2252 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 1 Sensor 1) / P2253 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 1 Sensor 1) / P2255 Oxygen (A/F) Sensor Reference Ground Circuit Low (Bank 2 Sensor 1) / P2256 Oxygen (A/F) Sensor Reference Ground Circuit High (Bank 2 Sensor 1)**

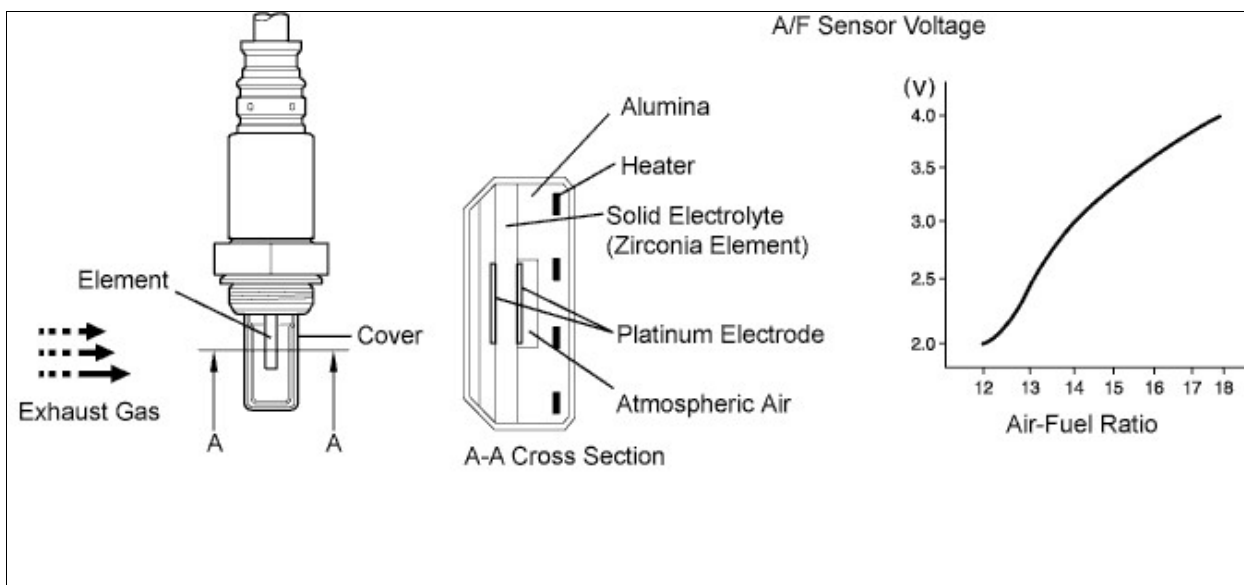
### DESCRIPTION

The A/F sensor, which is located between the exhaust manifold and catalyst, consists of alloyed metal elements and a heater.

Depending on the engine operating conditions, the heater heats the sensor elements to activate them. Battery voltage is applied to the heater, the sensor ground is controlled by the ECM using a duty ratio.

The sensor elements convert the oxygen concentration in the exhaust gas into voltage values to output. Based on the voltage, the ECM determines the air-fuel ratio and regulates the fuel injection volume depending on the air-fuel ratio and engine operating conditions. The voltage changes between 0.6 V and 4.5 V while the engine is running. If the air-fuel ratio is lean, which means the oxygen concentration in the exhaust gas is high, the voltage is high. If the air-fuel ratio is rich, which means the oxygen concentration in the exhaust gas is low, the voltage is low.





DTC No.	DTC Detection Condition	Trouble Area
P2237	Open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the AF sensor while engine is running (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 1 sensor 1) circuit</li> <li>• A/F sensor (bank 1 sensor 1)</li> <li>• A/F sensor (bank 1 sensor 1) heater</li> <li>• ECM</li> </ul>
P2238	Any of the following conditions are met (2 trip detection logic) <ul style="list-style-type: none"> <li>• AF sensor output drops while engine is running.</li> <li>• Voltage at terminal A1A+/A2A+ is 0.5 V or less.</li> <li>• Voltage difference between terminals A1A+ and A1A-/A2A+ and A2A- is 0.1 V or less.</li> </ul>	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 1 sensor 1) circuit</li> <li>• A/F sensor (bank 1 sensor 1)</li> <li>• A/F sensor (bank 1 sensor 1) heater</li> <li>• ECM</li> </ul>
P2239	A1A+/A2A+ voltage more than 4.5 V (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 1 sensor 1) circuit</li> <li>• A/F sensor (bank 1 sensor 1)</li> <li>• ECM</li> </ul>
P2240	Open in the circuit between terminals A1A+ and A1A-/A2A+ and A2A- of the AF sensor while engine is running (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 2 sensor 1) circuit</li> <li>• A/F sensor (bank 2 sensor 1)</li> <li>• A/F sensor (bank 2 sensor 1) heater</li> <li>• ECM</li> </ul>
P2241	Any of the following conditions are met (2 trip detection logic) <ul style="list-style-type: none"> <li>• AF sensor output drops while engine is running.</li> </ul>	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 2 sensor 1) circuit</li> <li>• A/F sensor (bank 2 sensor 1)</li> </ul>

	<ul style="list-style-type: none"> <li>• Voltage at terminal A1A+/A2A+ is 0.5 V or less.</li> <li>• Voltage difference between terminals A1A+ and A1A-/A2A+ and A2A- is 0.1 V or less.</li> </ul>	<ul style="list-style-type: none"> <li>• A/F sensor (bank 2 sensor 1) heater</li> <li>• ECM</li> </ul>
P2242	A1A+/A2A+ voltage more than 4.5 V (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 2 sensor 1) circuit</li> <li>• A/F sensor (bank 2 sensor 1)</li> <li>• ECM</li> </ul>
P2252	A1A-/A2A- voltage 0.5 V or less (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 1 sensor 1) circuit</li> <li>• A/F sensor (bank 1 sensor 1)</li> <li>• ECM</li> </ul>
P2253	A1A-/A2A- voltage more than 4.5 V (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 1 sensor 1) circuit</li> <li>• A/F sensor (bank 1 sensor 1)</li> <li>• ECM</li> </ul>
P2255	A1A-/A2A- voltage 0.5 V or less (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 2 sensor 1) circuit</li> <li>• A/F sensor (bank 2 sensor 1)</li> <li>• ECM</li> </ul>
P2256	A1A-/A2A- voltage more than 4.5 V (2 trip detection logic)	<ul style="list-style-type: none"> <li>• Open or short in A/F sensor (bank 2 sensor 1) circuit</li> <li>• A/F sensor (bank 2 sensor 1)</li> <li>• ECM</li> </ul>

**MONITOR DESCRIPTION**

These DTCs are output when there is an open or short in the A/F sensor circuit, or if A/F sensor output drops. To detect these problems, the voltage of the A/F sensor is monitored when turning the engine switch to the on (IG) position, and the admittance (admittance is an electrical term that indicates the ease of flow of current) is checked while driving. If the voltage of the A/F sensor is between 0.6 V and 4.5 V, it is considered normal. If the voltage is out of the specified range, or the admittance is less than the standard value, the ECM will determine that there is a malfunction in the A/F sensor. If the same malfunction is detected in next driving cycle, the MIL will be illuminated and a DTC will be stored.

**MONITOR STRATEGY**

Related DTCs	P2237: A/F sensor (bank 1) open circuit between A1A+ and A1A- P2238: A/F sensor (bank 1) short circuit between A1A+ and A1A- P2238: A/F sensor (bank 1) short circuit between A1A+ and GND P2238: A/F sensor (bank 1) low impedance P2239: A/F sensor (bank 1) short circuit between A1A+ and +B P2240: A/F sensor (bank 2) open circuit between A2A+ and A2A- P2241: A/F sensor (bank 2) short circuit between A2A+ and A2A- P2241: A/F sensor (bank 2) short circuit between A2A+ and GND P2241: A/F sensor (bank 2) low impedance P2242: A/F sensor (bank 2) short circuit between A2A+ and +B P2252: A/F sensor (bank 1) short circuit between
--------------	--

	A1A- and GND P2253: A/F sensor (bank 1) short circuit between A1A- and +B P2255: A/F sensor (bank 2) short circuit between A2A- and GND P2256: A/F sensor (bank 2) short circuit between A2A- and +B
Required Sensors/Components (Main)	A/F sensor
Required Sensors/Components (Related)	Engine Coolant Temperature (ECT) sensor, Crankshaft position sensor
Frequency of Operation	Continuous
Duration	10 seconds
MIL Operation	2 driving cycles
Sequence of Operation	None

**TYPICAL ENABLING CONDITIONS**

**P2237 and P2240 (A/F sensor open circuit between A1A+ and A1A-/A2A+ and A2A-):**

Monitor runs whenever following DTCs are not present	P0016, P0018 (VVT System - Misalignment) P0017, P0019 (Exhaust VVT System - Misalignment) P0031, P0032, P0051, P0052 (Air Fuel Ratio Sensor Heater) P0102, P0103, P010C, P010D (Mass Air Flow Sensor) P0097, P0098, P0112, P0113 (Intake Air Temperature Sensor) P0115, P0117, P0118 (Engine Coolant Temperature Sensor) P0125 (Insufficient Coolant Temperature for Closed Loop Fuel Control) P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (Throttle Position Sensor) P0128 (Thermostat) P0171, P0172, P0174, P0175 (Fuel System) P0300 - P0308 (Misfire) P0335 (Crankshaft Position Sensor) P0451, P0452, P0453 (EVAP system) P1340 (Camshaft Position Sensor) P0500 (Vehicle Speed Sensor) P0505 (IAC valve)
Estimated sensor temperature	450 to 550°C (842 to 1022°F)
Engine	Running
Battery voltage	11 V or more

**P2238 and P2241 (A/F sensor low impedance):**

	P0016, P0018 (VVT System - Misalignment) P0017, P0019 (Exhaust VVT System - Misalignment) P0031, P0032, P0051, P0052 (Air Fuel Ratio Sensor Heater) P0102, P0103, P010C, P010D (Mass Air Flow Sensor) P0097, P0098, P0112, P0113 (Intake Air Temperature Sensor)
--	--

Monitor runs whenever following DTCs are not present	P0115, P0117, P0118 (Engine Coolant Temperature Sensor) P0125 (Insufficient Coolant Temperature for Closed Loop Fuel Control) P0120, P0121, P0122, P0123, P0220, P0222, P0223, P2135 (Throttle Position Sensor) P0128 (Thermostat) P0171, P0172, P0174, P0175 (Fuel System) P0300 - P0308 (Misfire) P0335 (Crankshaft Position Sensor) P0451, P0452, P0453 (EVAP system) P1340 (Camshaft Position Sensor) P0500 (Vehicle Speed Sensor) P0505 (IAC valve)
Estimated sensor temperature	700 to 800°C (1292 to 1472°F)
Engine coolant temperature	-6°C (21.2°F) or higher
Fuel cut	No executed

**Other:**

Battery voltage	11 V or more
Engine switch	On (IG)
Time after engine switch is off to on (IG)	5 seconds or more

**TYPICAL MALFUNCTION THRESHOLDS****P2237 and P2240 (A/F sensor open circuit between A1A+ and A1A-/A2A+ and A2A-):**

A/F sensor admittance	Below 0.002 1/Ω
-----------------------	-----------------

**P2238 and P2241 (A/F sensor low impedance):**

A/F sensor admittance	Below 0.022 1/Ω
-----------------------	-----------------

**P2238 and P2241 (A/F sensor short circuit between A1A+ and GND/A2A+ and GND):**

A1A+/A2A+ terminal voltage	0.5 V or less
----------------------------	---------------

**P2239 and P2242 (A/F sensor short circuit between A1A+ and +B/A2A+ and +B):**

A1A+/A2A+ terminal voltage	More than 4.5 V
----------------------------	-----------------

**P2252 and P2255 (A/F sensor short circuit between A1A- and GND/A2A- and GND):**

A1A-/A2A- terminal voltage	0.5 V or less
----------------------------	---------------

**P2253 and P2256 (A/F sensor short circuit between A1A- and +B/A2A- and +B):**

A1A-/A2A- terminal voltage	More than 4.5 V
----------------------------	-----------------

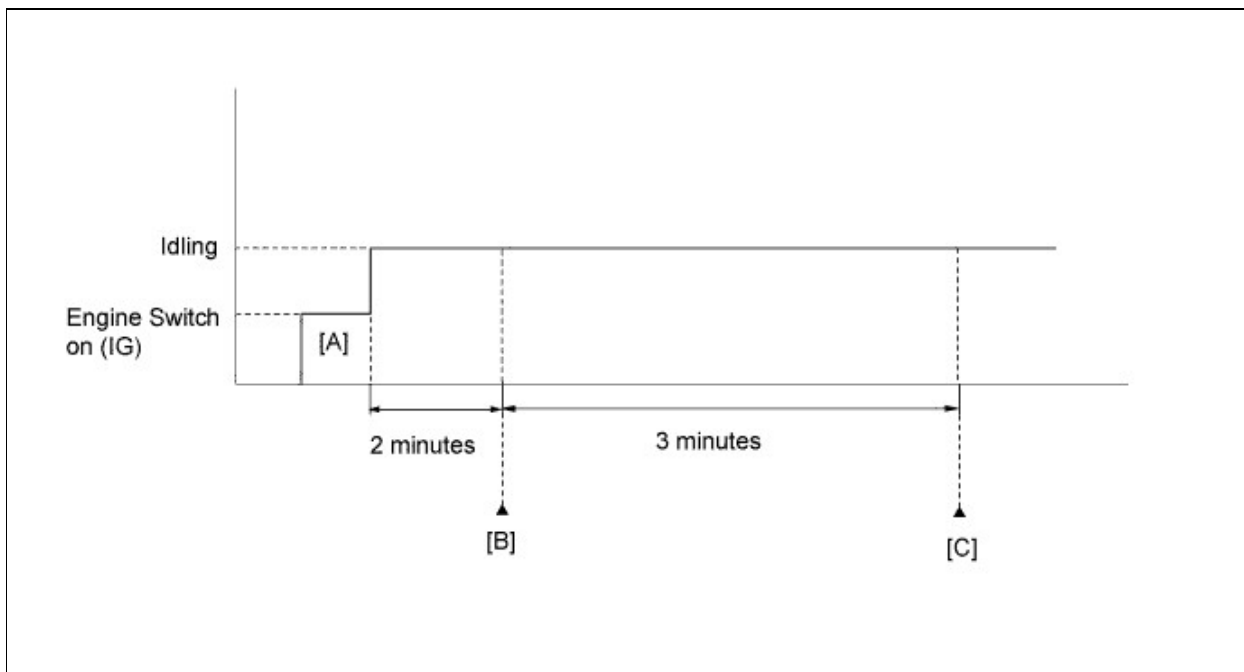
**P2238 and P2241 (A/F sensor short circuit between A1A+ and A1A-/A2A+ and A2A-):**

Difference between A1A+ terminal and A1A- terminal/A2A+ terminal and A2A- voltage	0.1 V or less
---	---------------

**COMPONENT OPERATING RANGE**

A/F sensor admittance	0.022 1/Ω or more
A1A+/A2A+ terminal voltage	0.6 to 4.5 V
A1A-/A2A- terminal voltage	0.6 to 4.5 V
Difference between A1A+ and A1A-/A2A+ and A2A- terminal voltages	0.1 to 0.8 V

**CONFIRMATION DRIVING PATTERN**



1. Connect the Techstream to the DLC3.
2. Turn the engine switch on (IG) and turn the Techstream on.
3. Clear the DTCs (even if no DTCs are stored, perform the clear DTC procedure) (Refer to 1UR-FSE ENGINE CONTROL SYSTEM > SFI SYSTEM > DTC CHECK / CLEAR(200909 - )).
4. Turn the engine switch off and wait for at least 30 seconds.
5. Turn the engine switch on (IG) and turn the Techstream on [A].
6. Start the engine and wait 2 minutes.
7. Enter the following menus: Powertrain / Engine / Trouble Codes.
8. Read the pending DTCs [B].

**HINT:**

- If a pending DTC is output, the system is malfunctioning.
- If a pending DTC is not output, perform the following procedure.

9. Enter the following menus: Powertrain / Engine / Utility / All Readiness.
10. Input the DTC: P2237, P2238, P2239, P2240, P2241, P2242, P2252, P2253, P2255 or P2256.
11. Check the DTC judgment result.

Techstream Display	Description
NORMAL	<ul style="list-style-type: none"> <li>• DTC judgment completed</li> <li>• System normal</li> </ul>
ABNORMAL	<ul style="list-style-type: none"> <li>• DTC judgment completed</li> <li>• System abnormal</li> </ul>
INCOMPLETE	<ul style="list-style-type: none"> <li>• DTC judgment not completed</li> <li>• Perform driving pattern after confirming DTC enabling conditions</li> </ul>
UNKNOWN	<ul style="list-style-type: none"> <li>• Unable to perform DTC judgment</li> <li>• Number of DTCs which do not fulfill DTC preconditions has reached ECU memory limit</li> </ul>

**HINT:**

- If the judgment result shows ABNORMAL, the system has a malfunction.
- If the judgment result shows INCOMPLETE or UNKNOWN, idle the engine for 3

minutes and check the DTC judgment result again [C].

12. If the test result is INCOMPLETE or UNKNOWN and no pending DTC is output, perform a universal trip and check for permanent DTCs (Refer to 1UR-FSE ENGINE CONTROL SYSTEM > SFI SYSTEM > DTC CHECK / CLEAR(200909 - )).

**HINT:**

- If a permanent DTC is output, the system is malfunctioning.
- If no permanent DTC is output, the system is normal.

**WIRING DIAGRAM**

Refer to DTC P2195 (Refer to 1UR-FSE ENGINE CONTROL SYSTEM > SFI SYSTEM > P2195 / P2196 / P2197 / P2198(200909 - )).