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2023 Ford Police Interceptor Utility Service and Repair Manual

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Sensor Response With Brake Override	plate response to the APP (accelerator pedal position) sensor input is delayed as the accelerator pedal is applied. The engine returns to idle RPM (revolutions per minute) whenever the brake pedal is applied. The powertrain malfunction indicator (wrench) illuminates, but the MIL (malfunction indicator lamp) does not illuminate in this mode. An APP (accelerator pedal position) sensor related DTC (diagnostic trouble code) sets.
Time Based Driver Demand With Brake Override	This mode is caused by the loss of one BPP (brake pedal position) and one APP (accelerator pedal position) sensor input or both APP (accelerator pedal position) sensor inputs due to sensor, wiring, or PCM (powertrain control module) concerns. The system is unable to determine driver demand. There is no response when the accelerator pedal is applied. The engine returns to idle RPM (revolutions per minute) whenever the brake pedal is applied. When the brake pedal is released, the PCM (powertrain control module) slowly increases the APP (accelerator pedal position) signal to a fixed value. The powertrain malfunction indicator (wrench) illuminates, but the MIL (malfunction indicator lamp) does not illuminate in this mode. An APP (accelerator pedal position) or BPP (brake pedal position) sensor related DTC (diagnostic trouble code) sets.
RPM (revolutions per minute) Guard With Pedal Follower	In this mode, torque control is disabled due to the loss of a critical sensor or PCM (powertrain control module) concern. The throttle is controlled in pedal follower mode as a function of the APP (accelerator pedal position) sensor input only. A maximum allowed RPM (revolutions per minute) is determined based on the position of the accelerator pedal (RPM (revolutions per minute) Guard). If the actual RPM (revolutions per minute) exceeds this limit, spark and fuel are used to bring the RPM (revolutions per minute) below the limit. The powertrain malfunction indicator (wrench) and the MIL (malfunction indicator lamp) illuminate in this mode and a DTC (diagnostic trouble code) for an ETC related component sets. The EGR (exhaust gas recirculation) and VCT (variable camshaft timing) outputs are set to default values and cruise control is disabled.
RPM (revolutions per minute) Guard With Default Throttle	In this mode, the throttle plate control is disabled due to the loss of both TP (throttle position) sensor inputs, loss of throttle plate control, stuck throttle plate, significant processor concerns, or other major electronic throttle body concern. The spring returns the throttle plate to the default (limp home) position. A maximum allowed RPM (revolutions per minute) is determined based on the position of the accelerator pedal (RPM (revolutions per minute) Guard). If the actual RPM (revolutions per minute) exceeds this limit, spark and fuel are used to bring the RPM (revolutions per minute) below the limit. The powertrain malfunction indicator (wrench) and the MIL (malfunction indicator lamp) illuminate in this mode and a DTC (diagnostic trouble code) for an ETC

Do not apply battery positive (B+) voltage directly to the fuel injector electrical connector pins. Internal damage to the solenoid may occur in a matter of seconds.

The fuel injector is a solenoid operated valve that meters fuel flow to the engine. The fuel injector opens and closes a constant number of times per crankshaft revolution. The amount of fuel is controlled by the length of time the fuel injector is held open.

The fuel injector is normally closed and is operated by a 12 volt source. The ground signal is controlled by the PCM (powertrain control module) .

The fuel injector is a deposit resistant injector (DRI) type and does not have to be cleaned. Install a new fuel injector if the flow is checked and found to be out of specification.

Fuel Injectors — Direct Injection

The gasoline direct fuel injection fuel injector delivers fuel directly into the cylinder under high pressure. Each injector is controlled by 2 circuits from the PCM (powertrain control module) .

A boosted voltage supply, up to 65 volts, is generated in the PCM (powertrain control module) and used to initially open the injector. The injector driver controls three transistor switches that apply the boost voltage to open the injector and then modulates the current to hold the injector open. If boost voltage is unavailable, the correct injector opening current may not be generated in the time required.

The PCM (powertrain control module) contains a smart driver that monitors and compares high side and low side injector currents to diagnose numerous concerns. Each fuel injector high side circuit is paired inside the PCM (powertrain control module) with another fuel injector high side circuit. All injector concerns are reported with a single DTC per injector.

Fuel Rail Pressure (FRP) Sensor

The FRP (fuel rail pressure) sensor sensor is a diaphragm strain gauge device. The FRP (fuel rail pressure) sensor sensor measures the pressure difference between the fuel rail and atmospheric pressure. The FRP (fuel rail pressure) sensor sensor nominal output varies between 0.5 and 4.5 volts, with 0.5 volts corresponding to 0 MPa (0 psi) gauge and 4.5 volts corresponding to 26 MPa (3771 psi) gauge. The FRP (fuel rail pressure) sensor can read vacuum and may lower the output voltage to slightly below 0.5 volts. This condition is normal and is usually the case after several hours of cold soak.

The FRP (fuel rail pressure) sensor sensor is located on the fuel rail and provides a feedback signal to indicate the fuel rail pressure to the PCM (powertrain control module) . The PCM (powertrain control module) uses the fuel rail pressure (FRP) signal to command the correct injector timing and pulse width for correct fuel delivery at all speed and load conditions. The FRP (fuel rail pressure) sensor, along with the fuel volume regulator (part of the fuel injection pump), form a closed loop fuel pressure control system. An electrically faulted FRP (fuel rail pressure) sensor sensor results in the deactivation of the fuel injection pump. Fuel pressure to injectors is then provided only by the fuel pump (FP) assembly. When the fuel injection pump is de-energized and the injectors are active, the fuel rail pressure is approximately 70 kPa (10 psi) lower than fuel pump (FP)

The universal HO2S (heated oxygen sensor) , sometimes referred to as a wideband oxygen sensor, uses the typical HO2S (heated oxygen sensor) combined with a current controller in the PCM (powertrain control module) to infer an air to fuel ratio relative to the stoichiometric air to fuel ratio. This is accomplished by balancing the amount of oxygen ions pumped in or out of a measurement chamber within the sensor. The typical HO2S (heated oxygen sensor) within the universal HO2S (heated oxygen sensor) detects the oxygen content of the exhaust gas in the measurement chamber. The oxygen content inside the measurement chamber is maintained at the stoichiometric air to fuel ratio by pumping oxygen ions in and out of the measurement chamber. As the exhaust gasses get richer or leaner, the amount of oxygen that must be pumped in or out to maintain a stoichiometric air to fuel ratio in the measurement chamber varies in proportion to the air to fuel ratio. The amount of current required to pump the oxygen ions in or out of the measurement chamber is used to measure the air to fuel ratio. The measured air to fuel ratio is actually the output from the current controller in the PCM (powertrain control module) and not a signal that comes directly from the sensor.

The universal HO2S (heated oxygen sensor) also uses a self contained reference chamber to make sure an oxygen differential is always present. The oxygen for the reference chamber is supplied by pumping small amounts of oxygen ions from the measurement chamber into the reference chamber.

Part to part variance is compensated for by placing a resistor in the connector. This resistor trims the current measured by the current controller in the PCM (powertrain control module) .

The universal HO2S (heated oxygen sensor) heater is embedded with the sensing element allowing the engine to enter closed loop operation sooner. The heating element heats the sensor to a temperature of 780°C to 830°C (1,436°F to 1,526°F). The VPWR circuit supplies voltage to the heater. The PCM (powertrain control module) controls the heater ON and OFF by providing the ground to maintain the sensor at the correct temperature for maximum accuracy.

PCM (powertrain control module)	P0040:00	Oxygen Sensor Signals Swapped Bank 1 Sensor 1/Bank 2 Sensor 1: No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0041:00	Oxygen Sensor Signals Swapped Bank 1 Sensor 2/Bank 2 Sensor 2: No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0050:00	HO2S Heater Control Circuit (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0053:00	HO2S Heater Resistance (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0054:00	HO2S Heater Resistance (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0056:00	HO2S Heater Control Circuit (Bank 2 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0059:00	HO2S Heater Resistance (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0060:00	HO2S Heater Resistance (Bank 2 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P00D2:00	HO2S Heater Control Circuit Range/Performance (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0130:00	O2 Sensor Circuit (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0131:00	O2 Sensor Circuit Low Voltage (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ

PCM (powertrain control module)	P013E:00	O2 Sensor Delayed Response - Rich To Lean (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0140:00	O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0141:00	O2 Sensor Heater Circuit (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P014A:00	O2 Sensor Delayed Response - Rich To Lean (Bank 2 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P0150:00	O2 Sensor Circuit (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0151:00	O2 Sensor Circuit Low Voltage (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0152:00	O2 Sensor Circuit High Voltage (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0153:00	O2 Sensor Circuit Slow Response (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0154:00	O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0155:00	O2 Sensor Heater Circuit (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P0157:00	O2 Sensor Circuit Low Voltage (Bank 2 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW

PCM (powertrain control module)	P1138:00	Lack Of HO2S12 Switches - Sensor Indicates Rich: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P1157:00	Lack Of HO2S22 Switches - Sensor Indicates Lean: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P1158:00	Lack Of HO2S22 Switches - Sensor Indicates Rich: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P1646:00	Linear O2 Sensor Control Chip (Bank 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P1647:00	Linear O2 Sensor Control Chip (Bank 2): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P164A:00	O2 Sensor Positive Current Trim Circuit Performance (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P164B:00	O2 Sensor Positive Current Trim Circuit Performance (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2096:00	Post Catalyst Fuel Trim System Too Lean (Bank 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2097:00	Post Catalyst Fuel Trim System Too Rich (Bank 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2098:00	Post Catalyst Fuel Trim System Too Lean (Bank 2): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2099:00	Post Catalyst Fuel Trim System Too Rich (Bank 2): No Sub Type Information	GO to Pinpoint Test DZ

PCM (powertrain control module)	P21A1:00	Cylinder 6 Air-Fuel Ratio Imbalance: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2237:00	O2 Sensor Positive Current Control Circuit/Open (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2240:00	O2 Sensor Positive Current Control Circuit/Open (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2243:00	O2 Sensor Reference Voltage Circuit/Open (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2247:00	O2 Sensor Reference Voltage Circuit/Open (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2251:00	O2 Sensor Negative Current Control Circuit/Open (Bank 1 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2254:00	O2 Sensor Negative Current Control Circuit/Open (Bank 2 Sensor 1): No Sub Type Information	GO to Pinpoint Test DZ
PCM (powertrain control module)	P2270:00	O2 Sensor Signal Biased/Stuck Lean (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P2270:00	O2 Sensor Signal Biased/Stuck Lean (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2271:00	O2 Sensor Signal Biased/Stuck Rich (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P2271:00	O2 Sensor Signal Biased/Stuck Rich (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test H

PCM (powertrain control module)	P2A01:00	O2 Sensor Circuit Range/Performance (Bank 1 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P2A04:00	O2 Sensor Circuit Range/Performance (Bank 2 Sensor 2): No Sub Type Information	GO to Pinpoint Test DW
PCM (powertrain control module)	P2BEC:00	Fuel Control System A Too Lean Bank 1: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BED:00	Fuel Control System A Too Rich Bank 1: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BEE:00	Fuel Control System A Too Lean Bank 2: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BEF:00	Fuel Control System A Too Rich Bank 2: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BF0:00	Fuel Control System B Too Lean Bank 1: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BF1:00	Fuel Control System B Too Rich Bank 1: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BF2:00	Fuel Control System B Too Lean Bank 2: No Sub Type Information	GO to Pinpoint Test H
PCM (powertrain control module)	P2BF3:00	Fuel Control System B Too Rich Bank 2: No Sub Type Information	GO to Pinpoint Test H

Symptom Chart

Symptom	Possible Sources	Action

PCM (powertrain control module) P0038:00	HO2S Heater Control Circuit High (Bank 1, Sensor 2): No Sub Type Information	Sets when the PCM (powertrain control module) detects the sensor does not warm up to the required temperature in a calibrated amount of time. This DTC (diagnostic trouble code) also sets when the PCM (powertrain control module) is not able to maintain the required temperature after the sensor is warm. The PCM (powertrain control module) controls the HO2S (heated oxygen sensor) bank 1, sensor 2 heater ON and OFF duty cycle to maintain a calibrated temperature.
PCM (powertrain control module) P0041:00	Oxygen Sensor Signals Swapped Bank 1 Sensor 2 / Bank 2 Sensor 2: No Sub Type Information	Sets when the PCM (powertrain control module) detects there is no response from the HO2S (heated oxygen sensor) being tested. The HO2S (heated oxygen sensor) monitor determines if the HO2S (heated oxygen sensor) signal response for a fuel shift corresponds to the correct engine bank. Connect the HO2S (heated oxygen sensor) connector to the correct bank.
PCM (powertrain control module) P0054:00	HO2S Heater Resistance (Bank 1, Sensor 2): No Sub Type Information	Sets when the PCM (powertrain control module) detects the heater current requirements are too low or too high in the HTR12 circuit.
PCM (powertrain control module) P0056:00	HO2S Heater Control Circuit (Bank 2, Sensor 2): No Sub Type Information	Sets when the PCM (powertrain control module) detects the sensor does not warm up to the required temperature in a calibrated amount of time. This DTC (diagnostic trouble code) also sets when the PCM (powertrain control module) is not able to maintain the required temperature after the sensor is warm. The PCM (powertrain control module) controls the HO2S (heated oxygen sensor) bank 2, sensor 2 heater ON and OFF duty cycle to maintain a calibrated temperature.
PCM (powertrain control module) P0060:00	HO2S Heater Resistance (Bank 2, Sensor 2): No Sub Type Information	Sets when the PCM (powertrain control module) detects the heater current requirements are too low or too high in the HTR22 circuit.
PCM (powertrain control	HO2S Heater Control Circuit Range/Performance	Sets when the PCM (powertrain control module) detects the internal impedance of the heated oxygen sensor bank 1, sensor 2 exceeds the calibrated threshold.