

MX: Fuel Control

 **WARNING:** Contact with exposed fuel injector wiring, if energized, may result in electric shock. Use care when working on or around energized fuel injector wiring. Fuel injector wiring supplies high voltage to operate the fuel injectors. Failure to follow this instruction may result in serious personal injury.

 **WARNING:** Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Clean all fuel residue from the engine compartment. If not removed, fuel residue may ignite when the engine is returned to operation. Failure to follow this instruction may result in serious personal injury.

Note: Regeneration may occur during normal operation. During regeneration, diagnostic procedures may display biased values. If a regeneration occurs during diagnostic procedures, allow the process to complete before continuing diagnostics.

This pinpoint test is intended to diagnose the following:

- exhaust gas recirculation (EGR) system
- exhaust system
- fuel control system
- intake air system
- turbocharger system

MX1 CHECK THE EGR VALVE POSITION VALUES

Note: DTCs P0170, P0171 or P0172 may be accompanied by other DTCs. Diagnose all other DTCs before entering this pinpoint test.

Note: For Transit Connect, GO to [MX2](#).

- Ignition ON, engine OFF.
- Access the PCM and monitor the EGRVP (VOLT) PID.
- Monitor the EGRVP PID and compare the values to the EGR valve position sensor table.
- Access the PCM and control the EGRVPDES (PER) PID.
- Increase the EGRVPDES PID to 100%.

EGR Valve Position Sensor (Approximate)

EGR Command	EGR V Minimum	EGR V Maximum
5% (F-650/750) 0% (all others)	0.4 V (F-150) 0.61 V (F-650 / F-750) 0.92 V (F-Series Super Duty) 0.71 V (Transit) 0.68 V (all others)	0.6 V (F-150) 1.14 V (F-650 / F-750) 1.07 V (F-Series Super Duty) 0.90 V (Transit) 1.14 V (all others)

EGR Command	EGR V Minimum	EGR V Maximum
60% (F-150) 65% (F-Series Super Duty) 100% (Transit) 70% (all others)	2.75 V (F-150) 1.903 V (F-650 / F-750) 3.14 V (F-Series Super Duty) 3.60 V (Transit) 2.72 V (all others)	3.05 V (F-150) 3.082 V (F-650 / F-750) 3.23 V (F-Series Super Duty) 3.82 V (Transit) 3.35 V (all others)

Does the EGR position volts value approximately match the values in the EGR Valve Position Sensor (Approximate) table?

Yes	GO to MX2 .
No	A concern is present in the EGR system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test W .

MX2 INTERMITTENT MAF SENSOR CHECK

Note: The MAF_HZ PID value fluctuates while the engine is running.

- Ignition ON, engine running.
- Access the PCM and control the EGRTP_CMD (PER) PID.
- Decrease the EGRTP_CMD PID to 0%.
- Access the PCM and control the VGTDC (PER) PID.
- Decrease the VGTDC PID to 0%.
- Access the PCM and control the EGRVPDES (PER) PID.
- Decrease the EGRVPDES PID to 0%.
- Access the PCM and monitor the MAF_HZ (FREQ) PID.
- Record the MAF_HZ PID high and low values.
- Set the scan tool MAF_HZ PID graph limits 0.2 kHz above and below the previously recorded high and low values.
- While observing the PID, lightly tap on the MAF/IAT sensor and wiggle the harness from the MAF/IAT sensor to the PCM.

Does the MAF_HZ PID value exceed the set limits range?

Yes	A concern is present in the MAF system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test J .
No	For Transit Connect, GO to MX4 . For all others, GO to MX3 .

MX3 CHECK THE MAF SYSTEM OPERATION

- Ignition ON, engine running.
- Access the PCM and control the EGRTP_CMD (PER) PID.
- Decrease the EGRTP_CMD PID to 0%.
- Access the PCM and control the VGTDC (PER) PID.
- Decrease the VGTDC PID to 0%.
- Access the PCM and control the EGRVPDES (PER) PID.
- Decrease the EGRVPDES PID to 0%.
- Access the PCM and monitor the MAF_HZ (FREQ) PID.
- Monitor the MAF_HZ PID at idle and record the value.
- Access the PCM and control the RPMDSD (RPM) PID.
- Increase the engine speed to 1,200 RPM.
- Record the MAF_HZ PID value.
- Increase the engine speed to 2,000 RPM.
- Record the MAF_HZ PID value.

Is the MAF_HZ PID value between 3.5-3.8 kHz (Transit) 3.5-3.9 kHz (all others) at idle, 4.1-4.4 kHz (Transit) 4.5-5.4

kHz (all others) at 1,200 RPM and 5.0-5.4 kHz (Transit) 5.8-6.3 kHz (all others) at 2,000 RPM?

Yes	GO to MX4 .
No	A concern is present in the MAF system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test J .

MX4 TURBOCHARGER SYSTEM PERFORMANCE

Note: Visually inspect the vehicle for aftermarket accessories and performance modifications (air filter, exhaust system, intake system, performance chip, turbocharger). Refer to Section 1, [Engine Control \(EC\) System](#), Modifications to OBD Vehicles.

- Check for modifications to the electronic engine control (EEC) system.
- Visually inspect the intake air system for the following:
 - restricted or modified air filter or housing
 - water intrusion
 - worn gaskets between the mass air flow (MAF) sensor and the air cleaner assembly
 - exhaust gas recirculation (EGR) valve gasket leak to EGR cooler
 - verify the integrity of the crankcase ventilation system
 - incorrectly seated engine oil dipstick, tube or oil fill cap
 - leaks or restrictions in the charge air cooler (CAC)
 - low CAC coolant level
 - leaks, cracks, loose connections, punctures, or any other non-factory modifications
- Visually inspect the exhaust system for the following:
 - tailpipe modifications that increase or decrease the exhaust restriction
 - leaks, cracks, loose connections, punctures, or any other non-factory modifications

Is a concern present?

Yes	REPAIR as necessary. Clear the PCM DTCs. REPEAT the self-test.
No	GO to MX5 .

MX5 CHECK THE CHARGE AIR COOLER, AIR INTAKE AND EXHAUST SYSTEMS FOR LEAKS AND RESTRICTIONS

NOTICE: Strict observance of posted speed limits and attention to driving conditions are mandatory when carrying out the road test. Failure to follow these instructions may result in personal injury.

NOTICE: Pressure above 241 kPa (35 psi) can cause damage to system components. Regulate the shop air to 137.9 kPa (20 psi) before connecting to the system.

Note: Remember to reinstall the exhaust gas temperature bank 1 sensor 1 (EGT11) and the manifold absolute pressure (MAP) sensor (Transit) or the exhaust pressure (EP) sensor and the exhaust gas recirculation temperature bank 1, sensor 2 (EGRT12) (all others) and remove the plastic bag from the air filter at the completion of this step.

- Ignition OFF.
- For Transit,
- Remove the EGT11 sensor.
- For all others,
- Remove the EP sensor.
- Use a suitable method to temporarily plug the exhaust pipe outlet.
- Connect the Rotunda Smoke Machine, Fuel Evaporative Emission System Tester 218-00001 (522) or equivalent to the exhaust system.
- Fill the exhaust system with smoke using the sensor fitting.
- Pressurize the exhaust system with 139 kPa (20 psi) regulated shop air.
- Check the exhaust system for leaks and restrictions.
- For Transit,
- Remove the MAP sensor.
- For all others,
- Remove the EGRT12 sensor.

- Place the air filter in a plastic bag to prevent air flow out the intake port and reinstall it in the vehicle.
- Connect the smoke machine to the intake air system.
- Fill the intake air system with smoke using the sensor fitting.
- Pressurize the intake air system with 137.9 kPa (20 psi) regulated shop air.
- Check the intake air system for leaks and restrictions.

Is a concern present?

Yes	REPAIR or INSTALL a new component as necessary. CLEAR the PCM DTCs. ROAD TEST the vehicle and ACCELERATE the vehicle to achieve full boost. REPEAT the self-test.
No	For Transit and Transit Connect, GO to MX6 . For all others, GO to MX9 .

MX6 CHECK FOR AN INPUT SENSOR BIAS CONCERN

- Ignition ON, engine OFF.
- Access the PCM and monitor the BARO (PRESS) and MAP (PRESS) PIDs.

Is the MAP PID value within 9.5 kPa (1.38 psi) of the BARO PID value?

Yes	GO to MX7 .
No	DIAGNOSE the sensor that is out of range. For the MAP sensor, GO to Pinpoint Test E . For the BARO sensor, Clear the PCM DTCs. REPEAT the self-test. If the concern is still present, INSTALL a new PCM. REFER to Section 2, Flash Electrically Erasable Programmable Read Only Memory (EEPROM) .

MX7 CHECK THE TURBOCHARGER OPERATION BOOST

- Ignition ON, engine running.
- Access the PCM and control the EGRVPDES (PER) PID.
- Command the EGRVPDES PID duty cycle to 0%.
- Access the PCM and control the EGRTP_CMD (PER) PID.
- Command the EGRTP_CMD PID to the minimum value.
- Access the PCM and control the RPMDSD (RPM) PID.
- Command the engine speed to 1,500 RPM.
- Access the PCM and control the VGTDC (PER) PID.
- Access the PCM and monitor the MAP (PRESS) PID.
- Command the VGTDC duty cycle to 100%.
- Command the VGTDC duty cycle to 0%.

Does the MAP pressure increase and decrease as the VGTDC PID is increased and decreased?

Yes	GO to MX8 .
No	A concern is present in the turbocharger system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test KA .

MX8 CHECK THE TURBOCHARGER BOOST PRESSURE

Note: Additional DTCs may set during the use of output state control (OSC). Clear all PCM and transmission control module (TCM) DTCs after the diagnostics have been completed. Repeat the self-test to verify all DTCs have been cleared.

- Allow the engine to idle at the normal operating temperature.
- Access the PCM and monitor the BARO (PRESS) and MAP (PRESS) PIDs.

- Access the PCM and control the EGRVPDES (PER) PID.
- Command the EGRVPDES PID to 0%.
- Access the PCM and control the EGRTP_CMD (PER) PID.
- Command the EGRTP_CMD PID to the minimum value.
- Access the PCM and control the RPMDSD (RPM) PID.
- Command the engine speed to 1,800 RPM.
- Access the PCM and control the VGTDC (PER) PID.
- Command the VGTDC PID duty cycle to 100%.
- Record the MAP PID value.
- Command the VGTDC PID duty cycle to 0%.
- Record the MAP PID value.

Is the MAP PID value within 5% of the BARO PID value at 0% VGTDC duty cycle and does the MAP PID increase by greater than 48.26 kPa (7.0 psi) at 100% VGTDC duty cycle?

Yes	GO to MX12 .
No	A concern is present in the turbocharger system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test KA .

MX9 CHECK FOR INPUT SENSOR BIAS

- Ignition ON, engine OFF.
- Access the PCM and monitor the BARO (PRESS), EBP (PRESS) and MAP (PRESS) PIDs.

Is the EBP PID value within 7.5 kPa (1.09 psi) and the MAP_A PID value within 5 kPa (0.73 psi) of the BARO PID value?

Yes	GO to MX10 .
No	DIAGNOSE the sensor that is out of range. For the EP sensor, GO to Pinpoint Test X . For the MAP sensor, GO to Pinpoint Test E . For the BARO sensor, Clear the PCM DTCs. REPEAT the self-test. If the concern is still present, GO to MX22 .

MX10 CHECK THE TURBOCHARGER OPERATION BOOST

- Ignition ON, engine running.
- Access the PCM and control the EGRVPDES (PER) PID.
- Command the EGRVPDES PID duty cycle to 0%.
- Access the PCM and control the EGRTP_CMD (PER) PID.
- Command the EGRTP_CMD PID to the minimum value.
- Access the PCM and monitor the EBP (PRESS) and MAP (PRESS) PIDs.
- Access the PCM and control the RPMDSD (RPM) PID.
- Command the engine speed to 1,500 RPM.
- Access the PCM and control the VGTDC (PER) PID.
- Command the VGTDC duty cycle to 100%.
- Command the VGTDC duty cycle to 0%.

Does the EBP and MAP pressure increase and decrease as the VGTDC PID is increased and decreased?

Yes	GO to MX11 .
No	A concern is present in the turbocharger system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test KA .

MX11 CHECK THE TURBOCHARGER BOOST PRESSURE

Note: Additional DTCs may set during the use of output state control (OSC). Clear all PCM and transmission control module (TCM) DTCs after the diagnostics have been completed. Repeat the self-test to verify all DTCs have been cleared.

Note: MAP_A PID value is an absolute value, not a gauge value.

Note: All PIDs may not be available on all vehicles.

- Access the PCM and monitor the ECT (TEMP) PID.
- Access the PCM and monitor the EOT (TEMP) PID.
- Allow the engine to idle with the engine coolant temperature (ECT) greater than 70C (158F) (F-150) or engine oil temperature (EOT) greater than 70C (158F) (all others).
- Access the PCM and monitor the BARO (PRESS) and MAP (PRESS) PIDs.
- Access the PCM and control the EGRVPDES (PER) PID.
- Command the EGRVPDES PID to 0%.
- Access the PCM and control the EGRTP_CMD (PER) PID.
- Command the EGRTP_CMD PID to the minimum value.
- Access the PCM and control the RPMDSD (RPM) PID.
- Command the engine speed to 1,500 RPM.
- Access the PCM and control the VGTDC (PER) PID.
- Command the VGTDC PID duty cycle to 100%.
- Record the MAP PID value.
- Command the VGTDC PID duty cycle to 0%.
- Record the MAP PID value.

Is the MAP PID value within 5% of the BARO PID value at 0% VGTDC duty cycle and does the MAP PID increase by greater than 36 kPa (5.20 psi) (pickup vehicles) or 48 kPa (6.96 psi) (all others) at 100% VGTDC duty cycle?

Yes	GO to MX12 .
No	A concern is present in the turbocharger system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test KA .

MX12 COMPARE O2 SENSOR READINGS

Note: All PIDs may not be available on all vehicles.

- Ignition ON, engine running.
- Access the PCM and monitor the O2S11_PCT (PER) and O2S12_PCT (PER) PIDs.
- Access the PCM and monitor the EGT12 (TEMP), EGT13 (TEMP) and EGT14 (TEMP) PIDs.
- Increase the engine speed or drive the vehicle until the EGT12, EGT13 and EGT14 are greater than 200°C (392°F) for 2 minutes.

Are the O2S11_PCT PID and the O2S12_PCT PID values within 2% of each other at idle?

Yes	GO to MX13 .
No	INSTALL a new NOx12 sensor. REFER to the Workshop Manual Section 303-14, Electronic Engine Controls. CARRY OUT the Reset And Clear The Specified Function Nitrogen Oxide Sensor 2 on the scan tool. REFER to Section 2, Clear The Continuous Diagnostic Trouble Codes (DTCs) And Reset The Emission Monitors Information In The Powertrain Control Module (PCM) .

MX13 CHECK THE LOW PRESSURE FUEL SYSTEM

Note: The fuel pump runs for 30 seconds then shuts off at ignition ON, engine OFF.

Note: On some vehicles, the FP PID may not turn off the fuel pump. Cycle the ignition from ON to OFF to command the fuel pump OFF.

- Ignition ON, engine OFF.
- For F-650 / F-750,
- Access the PCM and monitor the FLP (PRESS) PID.
- Access the PCM and control the FPL_CMD (MODE) PID.

- Command the FPL_CMD PID ON then OFF.
- For Transit,
- Access the PCM and monitor the LP_FUEL_SW (MODE) PID.
- Access the PCM and control the FP (MODE) PID.
- Command the FP PID ON then OFF.
- For all others,
- Access the PCM and monitor the FLP (PRESS) PID.
- Access the PCM and control the FP (MODE) PID.
- Command the FP PID to ON then OFF.

Does the LP_FUEL_SW PID value cycle from Low to Not Low (Transit) or is the FLP PID value greater than 379 kPa (55 psi) (all others)?

Yes	GO to MX14 .
No	A concern is present in the low pressure fuel system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test MA .

MX14 CARRY OUT THE SUFFICIENT CLEAN FUEL TEST

- Carry out the Sufficient Clean Fuel Test. Refer to Section 4, [Diagnostic Procedures](#).

Is a concern present?

Yes	REPAIR as necessary. Clear the PCM DTCs. REPEAT the self-test.
No	GO to MX15 .

MX15 RELATIVE COMPRESSION TEST

- Carry out the Relative Compression Test. Refer to the scan tool manufacturer's manual for specific information on the scan tool setup, operation, and specific cables and adapters required.

Do all cylinders pass the test?

Yes	GO to MX16 .
No	GO to Pinpoint Test M .

MX16 MONITOR ALL THE FUEL BALANCING PIDS

Note: All PIDs may not be available on all vehicles.

- Ignition ON, engine running at Idle with the gear selector in DRIVE and engine at operating temperature.
- Access the PCM and monitor the CYL_BAL_1 (MASS), CYL_BAL_2 (MASS), CYL_BAL_3 (MASS), CYL_BAL_4 (MASS), CYL_BAL_5 (MASS), CYL_BAL_6 (MASS), CYL_BAL_7 (MASS) and CYL_BAL_8 (MASS) PIDs.

Are all the fuel balance quantity PID values within 6.4 mg (0.1 gr) (Transit), 2.4 mg (0.04 gr) (Transit Connect) or 3.2 mg (0.05 gr) (all others) of each other?

Yes	GO to MX17 .
No	GO to Pinpoint Test M .

MX17 CARRY OUT THE POWER BALANCE TEST

- Access the PCM and monitor the ECT (TEMP) PID.
- Ignition ON, engine running at normal Idle (between 790 to 810 RPM for Transit, (between 770 to 790 RPM for Transit Connect or between 590 to 610 RPM for all others), in Park, and the engine at operating temperature (ECT PID at least 158°F (70°C)).

- Carry out the Power Balance Test. Refer to the scan tool manufacturer's manual for specific information on the scan tool setup, operation, and specific cables and adapters required.

Are all cylinders contributing within 10 RPM during the power balance test?

Yes	GO to MX18 .
No	GO to Pinpoint Test M .

MX18 CARRY OUT THE MANUAL INJECTOR BALANCE TEST

Note: The IDS test referenced in this step may not be available on all vehicles. Proceed to the next step if the IDS test is not available.

- Access the PCM and monitor the ECT (TEMP) PID.
- Ignition ON, engine running at normal Idle (between 790 to 810 RPM for Transit, (between 770 to 790 RPM for Transit Connect or between 590 to 610 RPM for all others), in Park, and the engine at operating temperature (ECT PID at least 158°F (70°C)).
- Carry out the Manual Injector Balance Test. Refer to the scan tool manufacturer's manual for specific information on the scan tool setup, operation, and specific cables and adapters required.

Are all cylinders contributing within 10 RPM during the manual cylinder balance test?

Yes	GO to MX19 .
No	GO to Pinpoint Test M .

MX19 CHECK FOR A BIASED FRP SENSOR

- Key OFF for a minimum of 15 seconds (10 minutes for Transit) to allow the fuel rail pressure to bleed off.
- For Transit,
- Access the PCM and monitor the FRP_A (PRESS) PID.
- For all others,
- Access the PCM and monitor the FRP (PRESS) PID.

Is the PID value between 0 kPa (0 psi) and 3447 kPa (500 psi)?

Yes	GO to MX20 .
No	A concern is present with the fuel rail pressure sensor. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test MB .

MX20 CHECK THE FUNCTIONALITY OF THE FRP SENSOR

- Ignition ON, engine running.
- Access the PCM and monitor the FRP (VOLT) PID.
- Access the PCM and control the RPMDSD (RPM) PID.
- Increase the engine speed to 1,400 RPM.
- Access the PCM and control the FRP_DSD (PRESS) PID.
- Increase the FRP_DSD PID pressure to 180 MPa (26,106 psi) and monitor the FRP voltage.
- Decrease the FRP_DSD PID pressure to 40 MPa (5,801 psi) and monitor the FRP voltage.

Does the FRP voltage increase and decrease when the FRP_DSD PID pressure is increased and decreased during each step?

Yes	GO to MX21 .
No	A concern is present in the fuel pump control system. Follow the symptoms without DTCs direction in the pinpoint test. GO to Pinpoint Test ME .

MX21 CARRY OUT THE HIGH PRESSURE FUEL SYSTEM TEST

- Carry out the High Pressure Fuel System Test. Refer to the scan tool manufacturer's manual for specific information on the scan tool setup, operation, and specific cables and adapters required.

Is a concern present?

Yes	GO to Pinpoint Test M .
No	The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector.

MX22 CHECK FOR CORRECT PCM OPERATION

- Disconnect all the PCM connectors.
- Visually inspect for:
 - pushed out pins
 - corrosion
- Connect all the PCM connectors and make sure they seat correctly.
- Carry out the PCM self-test.
- Verify the concern is still present.

Is the concern still present?

Yes	INSTALL a new PCM. REFER to Section 2, Flash Electrically Erasable Programmable Read Only Memory (EEPROM) . CLEAR the DTCs. REPEAT the self-test.
No	The system is operating correctly at this time. The concern may have been caused by a loose or corroded connector.