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2023 Ford Ranger Service and Repair Manual

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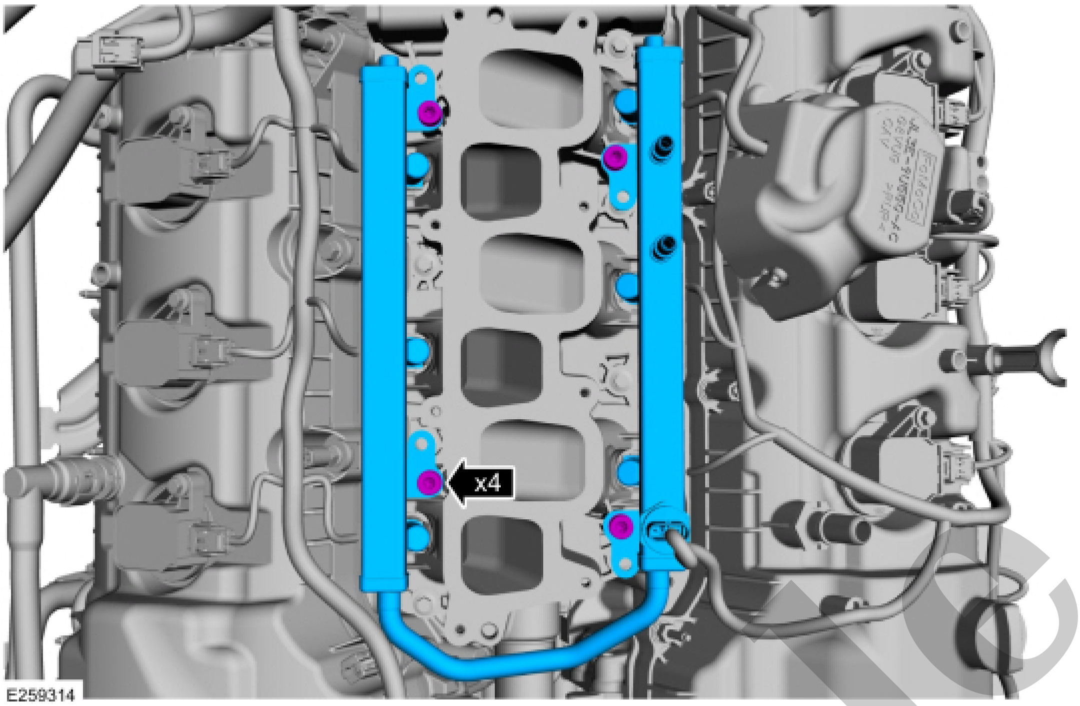
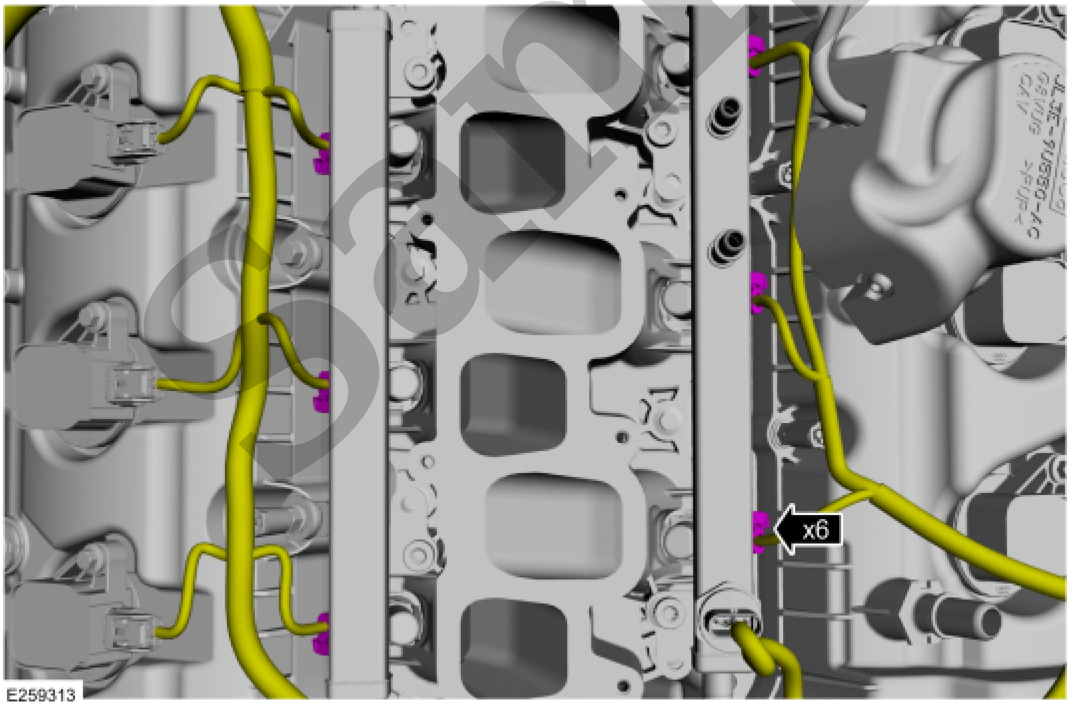


[Click here to learn about symbols, color coding, and icons used in this manual.]

4. Connect the fuel injector electrical connectors.



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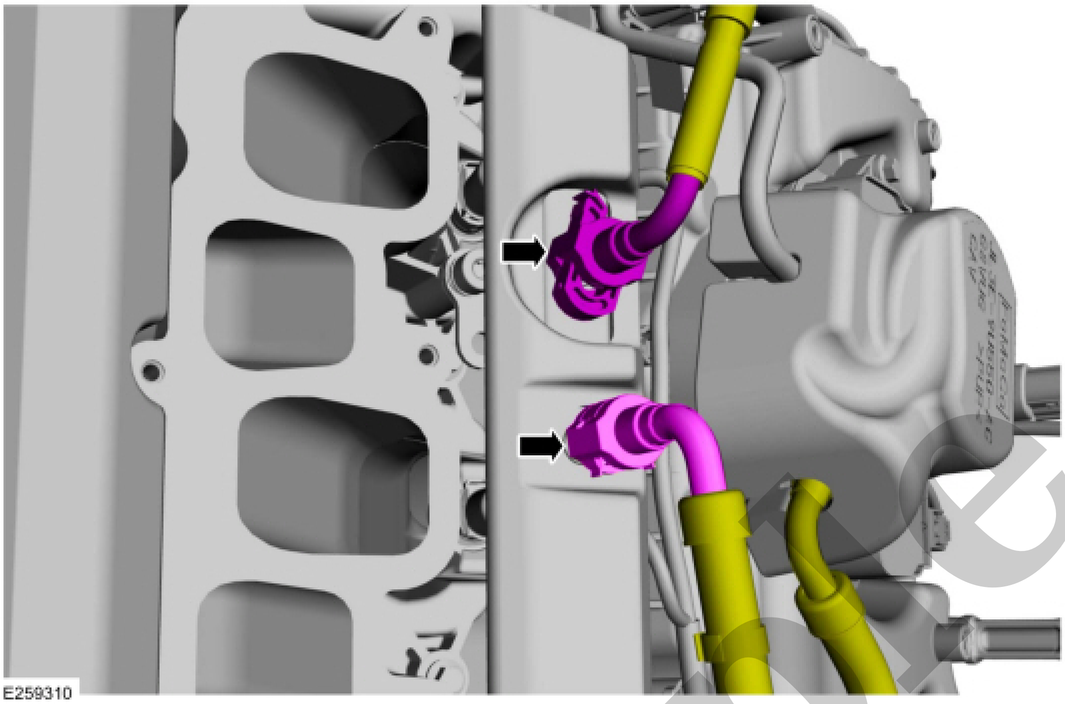
5. If equipped, install the right and left fuel rail insulators.

Refer to: Quick Release Coupling(310-00B Fuel System - General Information - 3.3L Duratec-V6, General Procedures).



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8. Install the upper intake manifold.

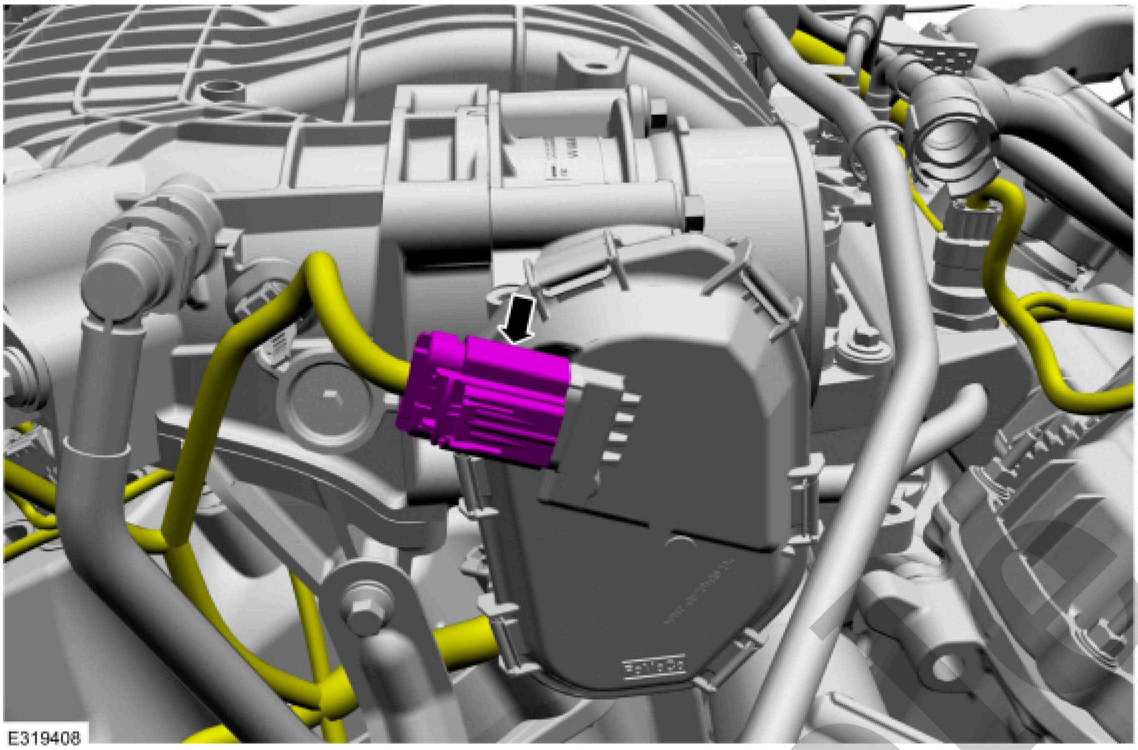
   Refer to: Upper Intake Manifold(303-01B Engine - 3.3L Duratec-V6, Removal and Installation).

9. Connect the battery negative cable.

   Refer to: Battery Disconnect and Connect(414-01 Battery, Mounting and Cables, General Procedures).

10. Pressurize the fuel system.

    Refer to: Fuel System Pressure Release(310-00B Fuel System - General Information - 3.3L Duratec-V6, General Procedures).



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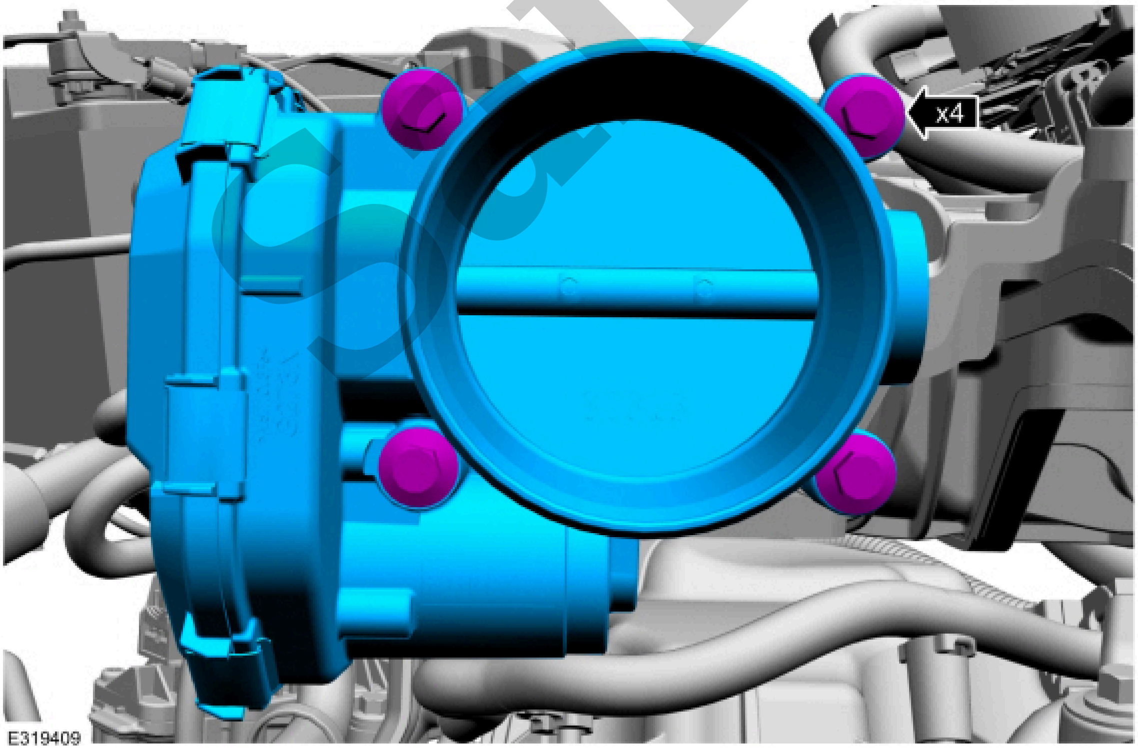
3. Remove the throttle body bolts, then remove the throttle body. Make sure that the mating faces are clean and free of foreign material.



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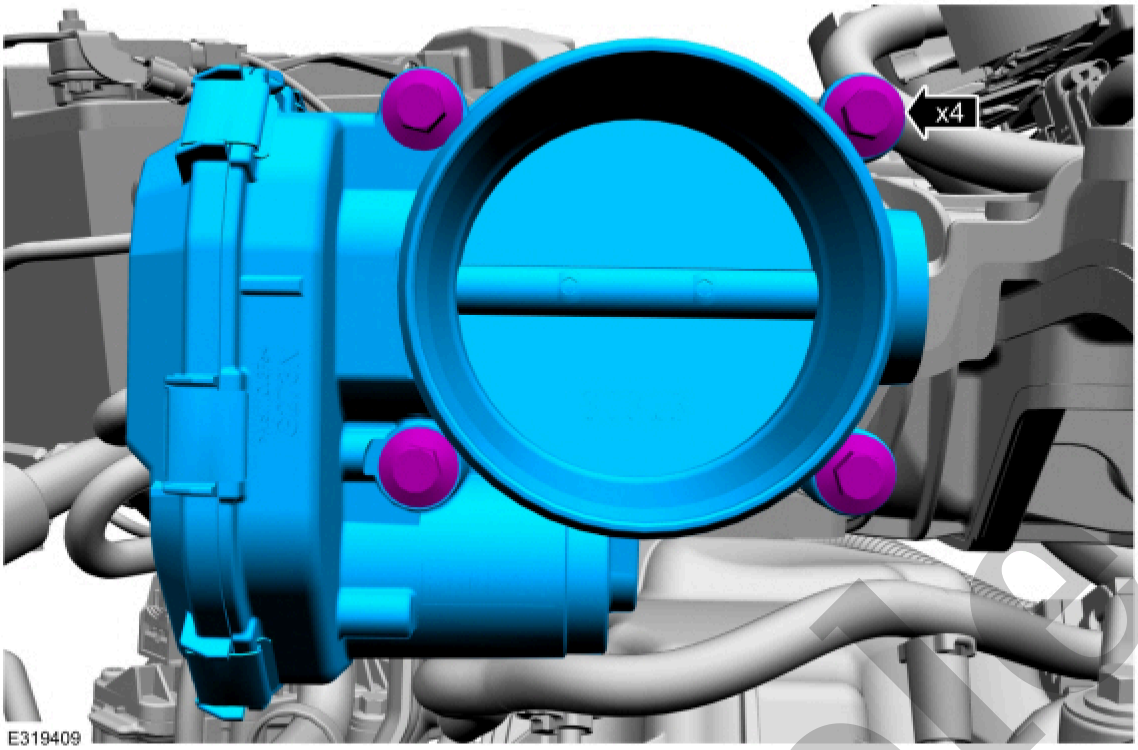


Click here to learn about symbols, color coding, and icons used in this manual.

3. **NOTE**

   When connecting the throttle body electrical connector engage the red connector locking tab after fully installing the throttle body electrical connector. The red tab will not slide forward unless the throttle body electrical connector is fully installed.

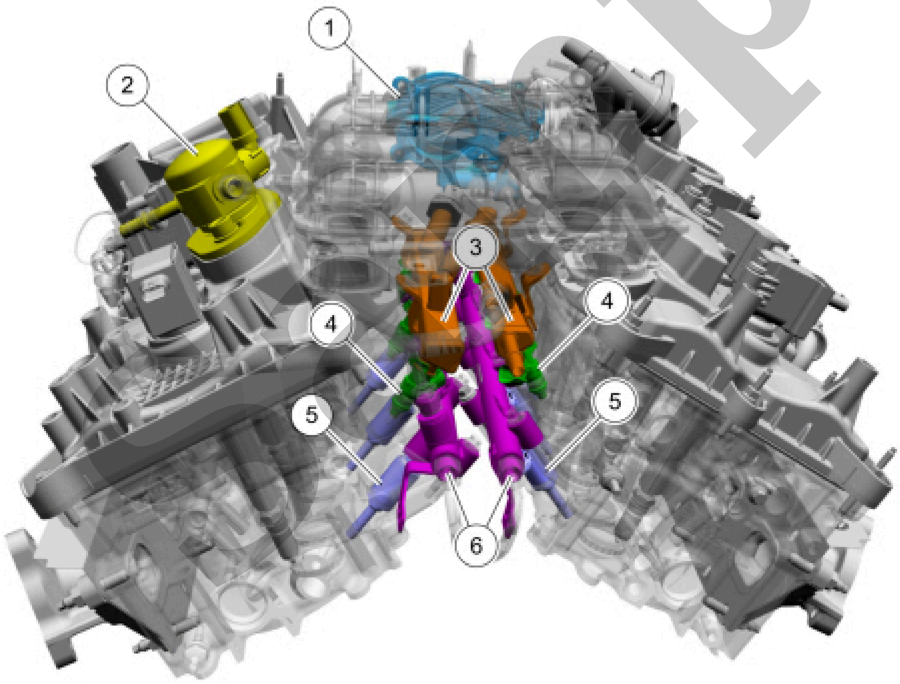
   Connect the throttle body electrical connector.

Fuel Charging and Controls - Component Location

303-04C Fuel Charging and Controls - 3.5L EcoBoost (BM)	***2022 F-150***
Description and Operation	***Procedure revision date: 09/16/2020***

Fuel Charging and Controls - Component Location

3.5L EcoBoost/PowerBoost



Item	Description
1	Throttle body
2	High-pressure fuel pump

Fuel Charging and Controls - System Operation and Component Description

303-04C Fuel Charging and Controls - 3.5L EcoBoost (BM)	*2022 F-150*
Description and Operation	***Procedure revision date: 10/13/2021***

Fuel Charging and Controls - System Operation and Component Description

System Operation

Air Fuel Ratio Imbalance Monitor

The air fuel ratio imbalance monitor is an on board diagnostic strategy designed to monitor the air fuel ratio.

Air Fuel Ratio Imbalance Monitor — Heated Oxygen Sensor (HO2S) Monitor

The air fuel ratio imbalance monitor estimates the cylinder to cylinder air fuel ratio difference using the universal HO2S (heated oxygen sensor) high frequency signal. The high frequency signal is updated at least once per engine combustion event to determine the amount the universal HO2S (heated oxygen sensor) signal is affected by individual cylinders. The result is a measurement of individual cylinder effect on the universal HO2S (heated oxygen sensor) . If the measurement exceeds a calibrated threshold, it is added to a differential signal accumulation window. An accumulation window is at least 50 engine revolutions. The differential signal accumulation is then compared to a calibrated signal threshold. A counter is incremented if the threshold is exceeded. This process is repeated for a calibrated number of total windows. After completing the calibrated number of windows the air fuel ratio imbalance index is calculated. The air fuel ratio imbalance index is a ratio of failed RPM (revolutions per minute) windows over total RPM (revolutions per minute) windows required to complete the monitor. If the air fuel ratio imbalance index exceeds the threshold value the test fails.

The MIL (malfunction indicator lamp) is activated after a concern is detected on 2 consecutive drive cycles.

Air Fuel Ratio Imbalance Monitor — Torque Monitor

The air fuel ratio imbalance torque monitor is supplemented by the air fuel ratio imbalance monitor HO2S (heated oxygen sensor) monitor. The air fuel ratio imbalance monitor torque monitor is used to detect small

- A cold start with alcohol blended fuel may be more difficult than with gasoline, due to the lower volatility of alcohol blended fuel.
- Ethanol requires more fuel flow than gasoline, and flex fuel vehicles require a higher flow injector.
- Vehicles with flex fuel capability have the fuel type identified on the fuel filler pipe.

Fuel Injection Systems

There are 2 types of fuel injection systems, direct fuel injection and port fuel injection. The direct fuel injection system delivers fuel directly into the engine cylinder. The port fuel injection system delivers fuel into the intake manifold ports where the fuel is mixed with air and enters the engine cylinder through the intake valve.

On engines with dual fuel injection systems, both the direct fuel injection system and the port fuel injection system are used to deliver fuel to the engine. During heavy acceleration, or higher engine loads, the direct fuel injection system is used to deliver fuel to the engine. During idle, or low engine load conditions, the port fuel injection system is used to deliver fuel to the engine. Both fuel injection systems may not be active at the same time. The PCM (powertrain control module) will ignore any related fuel system sensor inputs, if either fuel injection system is inactive. Related fuel injector DTCs can only be set while the direct fuel injection system or the port fuel injection system is active. A scan tool may be used to activate either system to assist in isolating the fuel injector concerns.

Fuel System Monitor

The fuel system monitor is an on board strategy designed to monitor the fuel control system. The fuel control system uses fuel trim tables stored in the PCM (powertrain control module) KAM (keep alive memory) to compensate for the variability that occurs in fuel system components due to normal wear and aging. Fuel trim tables are based on air mass. During closed loop fuel control, the fuel trim strategy learns the corrections needed to correct a biased rich or lean fuel system. The correction is stored in the fuel trim tables. The fuel trim has 2 means of adapting: long term fuel trim and a short term fuel trim. Long term fuel trim relies on the fuel trim tables and short term fuel trim refers to the desired air to fuel ratio parameter called LAMBSE. LAMBSE is calculated by the PCM (powertrain control module) from the universal HO2S (heated oxygen sensor) inputs and helps maintain a 14.7 to 1 (9 to 1 E100) air to fuel ratio during closed loop operation. Short term fuel trim and long term fuel trim work together. If the universal HO2S (heated oxygen sensor) indicates the engine is running rich, the PCM (powertrain control module) corrects the rich condition by moving the short term fuel trim into the negative range, less fuel to correct for a rich combustion. If after a certain amount of time the short term fuel trim is still compensating for a rich condition, the PCM (powertrain control module) learns this and moves the long term fuel trim into the negative range to compensate and allow the short term fuel trim to return to a value near 0%. Inputs from the CHT (cylinder head temperature) sensor or the ECT (engine coolant temperature) sensor, the IAT (intake air temperature) sensor and the MAF (mass air flow) sensor (if equipped) are required to activate the fuel trim system, which in turn activates the fuel system monitor. Once activated, the fuel system monitor looks for the fuel trim tables to reach the adaptive clip fuel trim (SHRTFT1 and SHRTFT2) where stoichiometric is represented by 0%. Richer (more fuel) is represented by a positive number and leaner (less fuel) is represented by a negative number. Normal operating range for short term fuel trim is between -25% and 25%. Some calibrations have time between switches and short term fuel trim excursions that are not equal. These unequal excursions run the system slightly lean or rich of stoichiometric. This practice is referred to as using bias. For example, the fuel system can be biased slightly rich during closed loop fuel to help reduce nitrogen oxides (NO_x).

Values for SHRTFT1 and SHRTFT2 may change significantly on a scan tool as the engine is operated at different RPM (revolutions per minute) and load points. This is because SHRTFT1 and SHRTFT2 react to fuel delivery variability that changes as a function of engine RPM (revolutions per minute) and load. Short term fuel trim values are not retained after the engine is turned OFF.

Long Term Fuel Trim

While the engine is operating in closed loop fuel control, the short term fuel trim corrections are learned by the PCM (powertrain control module) as long term fuel trim (LONGFT1 and LONGFT2) corrections. These corrections are stored in the KAM (keep alive memory) fuel trim tables. Fuel trim tables are based on engine speed and load and by bank for engines with 2 HO2S (heated oxygen sensor) forward of the catalyst. Learning the corrections in KAM (keep alive memory) improves both open loop and closed loop air fuel ratio control. Advantages include:

- Short term fuel trim does not have to generate new corrections each time the engine goes into closed loop.
- Long term fuel trim corrections can be used while in open loop and closed loop modes.

Long term fuel trim is represented as a percentage, similar to the short term fuel trim, however it is not a single parameter. A separate long term fuel trim value is used for each RPM (revolutions per minute) and load point of engine operation. Long term fuel trim corrections may change depending on the operating conditions of the engine (RPM (revolutions per minute) and load), ambient air temperature, and fuel quality (% alcohol, oxygenates). When viewing the LONGFT1 and LONGFT2 PIDs, the values may change a great deal as the engine is operated at different RPM (revolutions per minute) and load points. The LONGFT1 and LONGFT2 PID display the long term fuel trim correction currently being used at that RPM (revolutions per minute) and load point.

High Pressure Fuel System

The high pressure fuel system receives low pressure fuel from the fuel pump assembly and delivers fuel at high pressure to the direct injection fuel injectors.

The high pressure fuel system consists of the fuel injection pump, the fuel volume regulator, the FRP (fuel rail pressure) sensor, the fuel supply line, the fuel rail, and the fuel injectors.

The fuel injection pump receives fuel from the fuel pump assembly, increases the fuel pressure from approximately 448 kPa (65 psi) to a PCM (powertrain control module) determined pressure up to as high as 15 MPa (2175 psi), and delivers it to the fuel rails.

A functional test of the rear HO2S (heated oxygen sensor) is done during normal vehicle operation. The peak rich and lean voltages are continuously monitored. Voltages that exceed the calibrated rich and lean thresholds indicate a functional sensor. If the voltages have not exceeded the thresholds after a long period of vehicle operation, the air to fuel ratio may be forced rich or lean in an attempt to get the rear sensor to switch. This situation normally occurs only with a green, less than 804.7 km (500 miles), catalyst. If the sensor does not exceed the rich and lean peak thresholds, a concern is indicated. Also, a deceleration fuel shut off (DFSO) rear HO2S (heated oxygen sensor) response test is done during a deceleration fuel shut off (DFSO) event. Carrying out the HO2S (heated oxygen sensor) response test during a DFSO event helps to isolate a sensor concern from a catalyst concern. The response test monitors how quickly the sensor switches from a rich to lean voltage. It also monitors if there is a delay in the response to the rich or lean condition. If the sensor responds very slowly to the rich to lean voltage switch or is never greater than a rich voltage threshold or less than a lean voltage threshold, a concern is indicated.

The MIL (malfunction indicator lamp) is activated after a concern is detected on 2 consecutive drive cycles.

Idle Air Trim

Idle air trim is designed to adjust the idle air control calibration to correct for wear and aging of components. When the engine conditions meet the learning requirement, the strategy monitors the engine and determines the values required for ideal idle calibration. The idle air trim values are stored in a table for reference. This table is used by the PCM (powertrain control module) as a correction factor when controlling the idle speed. The table is stored in the KAM (keep alive memory) and retains the learned values even after the engine is shut OFF. A DTC (diagnostic trouble code) is set if the idle air trim has reached its learning limits.

Whenever an idle air control component is replaced, or a repair affecting idle is carried out, it is recommended the KAM (keep alive memory) be reset. This is necessary so the idle strategy does not use the previously learned idle air trim values. It is important to note that erasing DTCs with a scan tool does not reset the idle air trim table.

Once the KAM (keep alive memory) has been reset, the engine must idle for 15 minutes (actual time varies between strategies) to learn new idle air trim values. Idle quality improves as the strategy adapts. Adaptation occurs in 4 separate modes as shown in the following table.

Idle Air Trim Learning Modes

NEUTRAL	A/C ON
NEUTRAL	A/C OFF
DRIVE	A/C ON
DRIVE	A/C OFF