



## Fuel Trim

by [Larry Carley](#) copyright 2019 AA1Car.com

Fuel Trim is the adjustment the engine computer (PCM) makes to the fuel mixture to maintain a balanced [air/fuel ratio](#). Fuel trim is usually displayed as a PERCENTAGE reading on a scan tool.

For lowest emissions, the engine computer tries to keep the fuel mixture balanced around 14.7 to 1 (14.7 parts of air to one part fuel). If the air/fuel ratio is less than 14.7 to one (say 12 to 1), the fuel mixture is RICH. A rich fuel mixture can produce more power (up to a point) but it also increases fuel consumption and emissions. Conversely, if the fuel mixture is greater than 14.7 to one (say 16 to one), it is LEAN. A lean fuel mixture reduces fuel consumption but can also increase emissions if the air/fuel mixture is so lean that it fails to ignite and causes lean misfire.

The engine computer monitors the air/fuel ratio via the oxygen sensor(s) in the exhaust manifold(s). An oxygen sensor is essentially a RICH or LEAN indicator. When the engine is running lean (too much air and not enough fuel), the O2 sensor generates a low voltage signal that tells the engine computer more fuel is needed. When the engine is running rich (too much fuel and not enough air), the O2 sensor produces a higher voltage signal that tells the engine computer the engine is getting too much fuel and to cut back the fuel delivery. On vehicles that have an Wide Ratio Air/Fuel sensor (WRAF) or A/F sensor, the sensor tells the computer the exact air fuel sensor so the computer can increase or decrease the fuel delivery as needed.

Accurate fuel trim values require an accurate feedback signal from the Oxygen sensor, otherwise the engine computer has no way of knowing whether the fuel mixture is running rich or lean.

When a cold engine is first started, it may take 10 to 30 seconds or more for the heaters inside the oxygen sensors to warm the sensors up to operating temperature. Until that point is reached and the fuel feedback control system goes into "closed loop", the fuel mixture is fixed at a predetermined value so no fuel trim adjustments are made. But once the Oxygen sensors are hot and the coolant temperature is high enough for the computer to go into closed loop, the computer starts to generate fuel trim values and make adjustments in the fuel mixture.

When the engine is shut off, the fuel trim values are retained in the computer's memory so the next time the vehicle is driven it can pick up where it left off. Erasing the computer's memory with a scan tool or by disconnecting the battery or the PCM power supply to clear codes also wipes the fuel trim values, which means the computer has to start learning the fuel adjustments all over again the next time the engine runs.

## How to Read Fuel Trim

The fuel trim value is read by plugging a scan tool into the OBD II diagnostic connector located under the instrument panel (on the driver's side near the steering column). When the key is turned on, the scan tool will initialize and start to communicate with the vehicle's onboard computer. Depending on the tool and the vehicle, it may be necessary to enter the vehicle year, make, model and engine VIN code before the scan tool can read the data.

The engine must be started and running to read the fuel trim information. Depending on the scan tool and how its menu options are set up, you choose the option that allows you to read system live data. This will display a long list of sensor outputs and other readings called PIDs (Parameter IDs). On this list will be two fuel trim values for inline four and six cylinder engines, and four fuel trim values for V6 and V8 engines (one pair for each cylinder bank).

There are two types of fuel trim values shown:

**Short Term Fuel Trim (STFT)** is what the engine computer is doing to the fuel mixture right now.

This value changes rapidly and can bounce around quite a bit depending on engine load, speed, temperature and other operating conditions). Values normally range from negative 10 percent to positive 10 percent, though the readings may jump as much as 25 percent or more in either direction.

**Long Term Fuel Trim (LTFT)** is a longer term average of what the engine computer has been doing to balance the fuel mixture over a predetermined interval of time. This value is a more accurate indicator of how the fuel mixture is being corrected to compensate for changes in the air/fuel ratio that are occurring inside the engine.

**STFT B1** is Short Term Fuel Trim engine cylinder Bank 1

**STFT B2** is Short Term Fuel Trim engine cylinder Bank 2

**LTFT B1** is Long Term Fuel Trim engine cylinder Bank 1

**LTFT B2** is Long Term Fuel Trim engine cylinder Bank 2

How do you know which cylinder bank is 1 or 2 on a V6 or V8 engine? Bank 1 will be the cylinder bank that has cylinder number one in the engine firing order. For more information on firing orders, see the following:

[Firing Orders \(Chevy\)](#)

[Firing Orders \(Chrysler\)](#)

[Firing Orders \(Ford\)](#)

## What Fuel Trim Values Mean

**POSITIVE** fuel trim values mean the engine computer is adding fuel (increasing the pulse width or on-time of the fuel injectors) to add more fuel to the engine. In other words, it is attempting to RICHEN the fuel mixture because it thinks the engine's air/fuel mixture is running too lean.

**NEGATIVE (-)** fuel trim values mean the engine computer is subtracting fuel (decreasing the pulse width or on-time of the fuel injectors) to reduce the amount of fuel injected into the engine. This is done to LEAN out the fuel mixture to compensate for what it perceives as a rich running condition.

Remember, all this is based on what the oxygen sensors are telling the engine computer. If the O2 sensors indicate LEAN, the computer adds fuel and generates a POSITIVE fuel trim value. If the O2 sensors are reading RICH, the computer compensates by subtracting fuel and generates a NEGATIVE fuel trim value.

By reading the STFT and LTFT fuel trim values on a scan tool while your engine is running, you can tell if the air/fuel mixture is running rich (negative fuel trim percentages) or lean (positive fuel trim percentages).

## What Fuel Trim Values Should Be

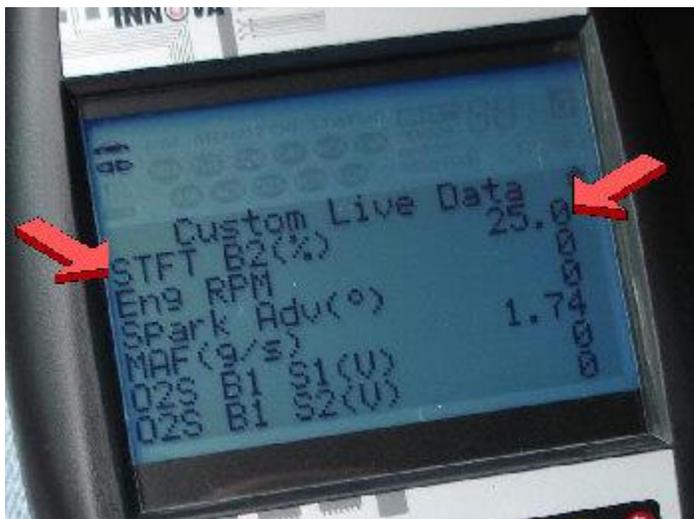
Ideally, the STFT and LTFT should be within a few percentage points of zero when the engine is idling or being held at a steady RPM. Remember, STFT can bounce around

quite a bit as when you suddenly snap open the throttle or decelerate. But LTFT can tell you if the average fuel/mixture is running rich or lean.

Good LTFT values should be as close to zero as possible, though they can range from 5 to 8 percent depending on the condition of the engine. If the LTFT is getting up around 10 percent or higher, it usually indicates a problem that needs to be diagnosed.

**LTFT values that get up around 20 to 25 percent will usually set a P0171 or P0174 lean code.**

**LTFT values that drop down to negative 20 to 25 will usually set a P0172 or P0175 rich code.**



*This scantool is displaying a STFT value of 25 percent. Normally that would indicate a problem, but in this case the engine is not running (Engine RPM is zero). As soon as the engine starts and goes into closed loop, the fuel trim readings will begin to change.*

## **How Fuel, Ignition and Engine Problems Affect Fuel Trim**

Lean fuel mixtures are a more common problem than rich fuel mixtures, though either can happen depending on the cause.

LEAN fuel mixtures will generate higher than normal POSITIVE fuel trim readings on your scan tool.

RICH fuel mixtures will generate NEGATIVE fuel trim values.

## **Some possible causes of LEAN fuel mixtures include:**

Air or vacuum leaks in the intake manifold, near the throttle body or at vacuum hose connections.

Weak fuel pump that is not generating enough pressure or volume

Fuel line restrictions (like a pinches hose or plugged filter)

A weak fuel pressure regulator that is not maintaining adequate fuel pressure

Air leaks in the PCV plumbing

Dirty MAF (Mass Airflow) sensor that is under reading airflow into the engine

Dirty or dead fuel injectors

Ignition misfire (a fouled spark plug, weak ignition coil or bad plug wire that causes a misfire allows unburned oxygen to pass into the exhaust and fool the O2 sensors)

Compression leaks (bad exhaust valve that allows unburned oxygen into exhaust and fools O2 sensors)

Exhaust manifold crack or gasket leak (allows unburned air into exhaust and fools O2 sensors)

Bad O2 sensor (signal shorted to ground so the sensor reads lean all the time)

## **Some possible causes of RICH fuel mixtures include:**

Leaky fuel injector

Excessive fuel pressure due to bad fuel pressure regulator or restricted fuel return line

Extremely dirty air filter or restrictions in air intake system

Exhaust restrictions (clogged converter, crushed exhaust pipe or plugged muffler)

Bad O2 sensor (output shorted to voltage so it reads RICH all the time)

## Using Fuel Trim to Diagnose Problems

Use Fuel Trim to Diagnose Vacuum and Fuel Delivery Leaks. With the engine idling, look at the Short Term Fuel Trim (STFT) and Long Term Fuel Trim (LTFT) values. Normal range may be high as plus or minus 8, but closer to zero is best. If the numbers are +10 or higher for STFT and LTFT, your engine is running LEAN. Rev the engine to 1500 to 2000 RPM and hold it steady for half a minute or so. If the fuel trim numbers drops back down to a more normal reading, it confirms the engine has a vacuum leak at idle. This is because vacuum leaks have less of a leaning effect on the fuel mixture as engine speed and load increase.

If the fuel trim readings do not change much, the lean fuel condition is more likely due to a fuel delivery problem (weak fuel pump, restricted fuel filter, dirty fuel injectors or a leaky fuel pressure regulator) than a vacuum leak.

LTFT fuel trim readings that are trending high might also be the result of a slight ignition misfire that is not bad enough yet to set a misfire code but is bad enough to cause a drop in fuel economy. One or more fouled spark plugs that are misfiring occasionally, or a weak ignition coil or bad plug wire that is allowing some occasional misfires could be the cause. For more information on misfire diagnose, [Click Here](#).

You can use fuel trim to identify dirty fuel injectors. If the LTFT fuel trim readings are trending up (POSITIVE), it means the fuel feedback control system is compensating for an air/fuel mixture that is becoming progressively leaner over time. The most likely cause would be dirty fuel injectors. Fuel delivery can be restricted by the accumulation of varnish deposits inside the injector nozzles. The fix here is to clean the injectors. If the fuel trim values return to normal after the injectors have been cleaned, it verifies you have solved the problem. If the fuel trim values don't change after cleaning the injectors, the lean fuel condition may be due to low fuel pressure or air/vacuum leaks.

You can use fuel trim readings to check the response of the oxygen sensors and engine computer to changes you make in the fuel mixture. While the engine is idling, temporarily disconnect a vacuum hose. You should see the STFT fuel trim readings jump immediately and go POSITIVE, and the LTFT should start to creep up in response to the artificial lean fuel mixture you have just created by disconnecting the vacuum hose.

To test a rich response, you can feed some propane vapor from a small propane tank into the throttle body or a vacuum hose connection on the intake manifold. This time, you should see a drop in fuel trim readings, with STFT going NEGATIVE, and LTFT creeping downward in response to the rich fuel mixture.

No change in fuel trim readings when you create an artificial lean or rich fuel mixture would tell you the engine computer is NOT operating in closes loop, or that the oxygen sensor(s) are not responding to changes in the fuel mixture.



## **More Fuel System Articles:**

[Air/Fuel Ratios](#)

[Fuel Trim by Wells Manufacturing](#) (PDF file).

[Ford P0171 & P0174 Lean Codes](#)

[How Fuel Injection Affects Emissions](#)

[Most Common Trouble Codes](#) (and what causes them)

[Mass Airflow Sensors](#)

[Oxygen Sensors](#)

[Wide Ratio Air Fuel \(WRAF\) Sensors](#)

[More on Check Engine Lights & Fault Code Diagnostics](#)

[Scan Tool Diagnostics](#)

[Decoding Onboard Diagnostics](#)

[TROUBLE CODES Help](#)

[OBD II Diagnostic Tips](#)

[Help with DTC P0300 Random Misfire Codes](#)

[Troubleshoot Fuel Injectors](#)

[Troubleshoot Electronic Fuel Injection & Fuel Pump Diagnosis](#)