

Fuel Trims

Fuel trims are found as live data in a capable scanner and can tell us a lot about what's going on with your vehicle, particularly if you're trying to diagnose an issue. First some background:

When you first start your truck the fuel system is in open loop and you can see that status in live data on your scanner. At this point the truck is taking certain sensor values and looking up the theoretical fuel delivery requirement using a look up table that came from the factory and the ECM/PCM/VCM changes the injector pulse duty cycle to deliver the proper amount of fuel. As the O2 sensors warm up they then come online and the system transitions to closed loop fuel system operation. Now the upstream O2 sensors measure and report the exhaust composition and the computer uses that information to constantly tweak the fuel delivery with the goal of minimal emissions. That occurs when the air/fuel ration is at "stoich" or a 14:1 ratio.

The computer is still calculating the theoretical fuel delivery values without the O2 sensor data and compares that to the fuel delivery required based on the O2 sensor exhaust gas analysis and reports the difference as fuel trim data. The ideal fuel trim values are zero, no correction to the theoretical are needed. In practice you will have values other than zero which will increase over time as the engine wears and/or if you have a problem.

The computer sets a code when fuel trims go above 25% absolute value but there is usually trouble on an older truck if you're above 10% absolute value. There are 4 fuel trim values, short term (STFT) and long term (LTFT) for each of two banks. Bank 1 is the driver's side or the side with cylinder 1. Positive fuel trims indicate that the truck is adding fuel to compensate for a lean condition. Negative trims indicate that the computer is reducing fuel delivery to compensate for a rich condition. The computer takes the long term correction average and programs that amount as long term trim and always delivers that correction until the long term average slowly changes. Any instantaneous correction needed as an offset to that long term value is short term fuel trim which changes quickly as a result. The net amount of fuel trim at any given moment is the addition of long term and short term for that bank, mindful of sign. If you improve something you will see STFT change immediately and then LTFT will slowly walk toward zero with STFT changing in synch.

This is a useful diagnostic tool because it tells us if your truck is running lean or rich, how that changes under different conditions and how this changes after a targeted repair. An example:

You see that you have excessive positive fuel trims on both banks which means that the computer is adding fuel to compensate for a lean condition. The basic sensors (MAF, ECT, ...) indicate an appropriate fuel delivery amount but the O2 sensors are saying no you're too lean and we need to add fuel to get to the minimum level of emissions. This could be caused by a number of things and further testing is required to nail down the issue but you just cut your possibilities in half. Let's say that you have a vacuum leak that is causing additional unmetered air into the intake (after the MAF). Your MAF is under reporting and you're lean. At idle the vacuum leak is a significant amount of unmetered air but at 2500 RPM, your fuel trims become less positive (with a rapid change in STFT value) because the unmetered air just became a lower percentage of the total, a less significant fault. This helps to confirm a vacuum leak.

George