EFI SYSTEM TIPS

Always remember to disconnect the battery before doing any wiring on your vehicle!

ELECTRICAL GROUNDS

The single leading cause of most electrical problems is poor grounds.

Ideally, the ground for the fuel injection system should connect directly to the battery at the negative post. Using the steel chassis or engine block as a ground can create excessive resistance causing the Powertrain Control Module (PCM) to function improperly.

An example of how a high ground or connection resistance can have very serious effects is as follows. This particular case applies to a 2005 Mustang GT, but can easily be extended to any electronically controlled Ford vehicle: consider the case where a PCM is reading a MAF sensor signal of 4.1 V (due to a high ground or connection resistance) when it should really be reading 4.3 V. This equates to a difference in measured air mass of 13%. That is, the MAF will be telling the PCM that there is 13% less air entering the engine than there really is. Let's say this happens at WOT, where air/fuel ratio is critical not only to performance, but also to engine durability. The result is that the actual air/fuel ratio can go from a safe 12.5:1 to a potentially damaging 14.1:1, just from a 0.2 V change in the MAF return signal!

All PCM sensors, not just the MAF, are affected in a similar fashion, so it is absolutely critical that all electrical connections are solid and that the grounds are reliable. The potential penalty for a bad ground can range from strange drivability issues that are difficult to diagnose all the way to a damaged engine, as in the above example.

All resistance tests should be done with the ignition key in the off position. Having voltage going through the system can return a false reading of excessive resistance. Additionally, it is possible to have a ground that tests OK when the engine is cold, but not when the engine is hot. Heat increases resistance, so these tests should be performed on a warm engine when possible.

To test for an adequate ground circuit in the EFI system for a 1986 to 1993 5.0L Mustang, use a Volt/Ohm meter to check the resistance of the following circuits:

- **To verify a proper ground to the PCM**, check the resistance from pin 40 and pin 60 DIRECTLY to the negative side of the battery. Resistance should be no greater than 0.2 ohms.
- **To verify a proper ground to the main PCM harness**, check the resistance from the MAF sensor at pin 'B' DIRECTLY to the negative side of the battery. Resistance should be no greater than 0.2 ohms.
- **To verify a proper ground to the engine harness**, check the resistance from the black wire at the Throttle Position Sensor (TPS) DIRECTLY to the negative side of the battery. Resistance should be no greater than 0.3 ohms.

Note that while 0.2 ohms or less is desirable, a resistance as high as 0.5 ohms is considered acceptable. Greater than 0.5 ohms is excessive and could result in drivability concerns.

A weak ground connection can also cause the PCM's internal reference voltage regulator to function incorrectly. This can be checked at the TPS by checking voltage between the black ground wire and the orange reference voltage wire. With the key on, this voltage signal should be somewhere between 4.7 V and 5.3 V.

GENERAL TIPS

- Whenever possible, the PCM should be mounted inside the vehicle to protect it from water damage. The PCM should also be mounted with the electrical connectors at the bottom to avoid trapping water. Some PCMs on newer model cars are mounted under the hood, but they are sealed against moisture and designed to operate in such an environment. When in doubt, mount the PCM inside the vehicle.

EFI SYSTEM TIPS (continued...)

- When setting the voltage at the TPS, you should check the voltage between the black and green wires (1986-1993 5.0L Mustang). This voltage should be somewhere between 0.96 V and 0.98 V. If the key is on while the engine is off, set the voltage at 0.96 V. If the engine is running, set it at 0.98 V. The TPS can be set by loosening the mounting screws and slightly rotating the sensor. If you are unable to achieve the proper setting, you may need to elongate the TPS mounting holes.

- If you ever need to lengthen any harness leads for your specific application, it is strongly advised that you lengthen only one wire at a time, which will help to avoid making mistakes.

- If you are using long tube headers, and need to lengthen the leads of the harness to reach the Heated Exhaust Gas Oxygen (HEGO, also known as O_2 or oxygen) sensors, NEVER lengthen the wires of the O_2 sensor itself. These wires are made up of a unique material and you will disrupt the signal coming from the O_2 sensor **even if they are soldered correctly!** If you must increase the length of the leads to the O_2 sensor, always lengthen the wires on the wiring harness side of the O_2 sensor. Many aftermarket companies offer HEGO sensor extensions that work quite well and are a quick and easy solution to this problem.

- When soldering two or more wires together, you should “tin” the bare ends to be soldered. This will prevent cold solder joints and make the process easier. “Crimp” style or “solder-less” connectors are not recommended. Over time, these have a tendency to loosen and permit corrosion. Additionally, these connectors can commonly allow short circuits to develop within the connection. Many of these problems within the harness can be difficult to locate. Always use weather-tight heat shrink over all soldered joints.

- If the factory coolant tubes are not used, the Engine Coolant Temperature (ECT) sensor should be installed directly into the threaded boss in the intake manifold near the thermostat, if applicable. This is a coolant passage.

- The ACT sensor should generally not be moved from the stock location. Some aftermarket companies offer ACT relocation kits while making false claims of increased horsepower by reading cooler air. While it is true that a cooler air can result in more power, this “trick” is not cooling the incoming air, but instead is merely reading the temperature from a different location. This can have a negative effect on overall engine performance and drivability because the PCM was calibrated under the assumption that the ACT sensor was in the stock design location. On a forced-induction engine, it is generally preferable to have the ACT sensor located after the power adder and after the intercooler, if applicable, which will simplify the calibration (“tuning”) process. Some of our FRPP supercharger kits leave the ACT sensor in the stock location upstream of the supercharger, but this was accounted for in the calibration and should not be changed.

- Protect the air filter element from turbulence created by the engine cooling fan. This is commonly referred to as “fan wash.” If you are using an open element air filter on the end of the MAF sensor, it is strongly advised that you use a shield to reduce the effects of the turbulence.

- It’s best if the air filter gets cold air from in front of the radiator. If the filter is located in the engine compartment, as in many street rod applications, the inlet air temperature can be up to 60 degrees hotter than ambient which can result in a 5% torque loss from the air density decrease. The PCM will also retard ignition timing for the hotter air which can result in an additional 5-10% torque loss. Colder air is always better.

- An improperly functioning charging system can cause engine running problems. Under-drive pulleys spin the accessories slower meaning that they consume less power from the engine. This results in a greater net horsepower available at the flywheel, but at a cost. Normally this is not a problem, but some systems may not perform properly if you under-drive the alternator excessively, especially if you’ve increased the electrical load on the system through the use of bigger cooling fans, high-capacity fuel pump, stereo system, etc. If the alternator does not generate enough voltage to keep the system adequately charged, it can have an adverse effect on the EFI system and result in a variety of drivability issues.

- The inside diameter of the fuel return line should be at least 75% of the size of the inside diameter of the fuel supply line.

FUEL PUMP LOCATION

A common and often overlooked problem is the location of the fuel pump or pumps. Optimally, the fuel pump should be mounted IN THE TANK to reduce the possibility of pump cavitation. Cavitation is essentially localized boiling caused by a reduction in pressure, generally occurring on the inlet side of a pump. This localized boiling results in fuel vapor bubbles which will reduce the volume of fuel the pump is capable of delivering to the engine. Any reduction in pressure or increase in temperature at the inlet side of the pump increases the chances that cavitation will occur. For this reason, it is always best to either have the pump inside the tank immersed in fuel or (in the case of an external pump) gravity fed, which will increase the pressure on the inlet side of the pump. If the fuel pump has to “pull” the fuel, this will result in a reduction in pressure at the fuel pump inlet potentially allowing cavitation and, thus, vapor bubbles to develop. These vapor bubbles are then drawn into the fuel pump and exit the high-pressure side of the fuel pump as compressed vapor. They travel the entire length of the fuel system and are expelled through the fuel injector. This can cause issues ranging from stumbles and hesitations to engine damage due to insufficient fuel delivery and lean A/F ratios. Sometimes this problem can characterize itself by only appearing when the weather gets warmer, which can confound the diagnosis of the issue. In certain cases, it may seem to only develop when driving on certain surfaces, because pavement reflects more heat than an off-road 4x4 trail. Remember, more heat and lower pressure on the inlet side of the pump means a greater chance of cavitation, which is to be avoided whenever possible.

If you are using an external mounted fuel pump, you should run a very coarse (typically around 100 micron) filter on the inlet side of the fuel pump, and a finer (typically around 10 micron) filter on the outlet side of the pump. A paper filter is NOT recommended on the inlet of the fuel pump because it can cause a restriction in fuel flow which, as mentioned previously, can lead to cavitation.