Aeromotive, Inc. Technical Bulletin #302

From: Aeromotive Technical Department

Date: **1/15/2015**

Re: **Fuel Pump Speed Controller: Troubleshooting Guide.**

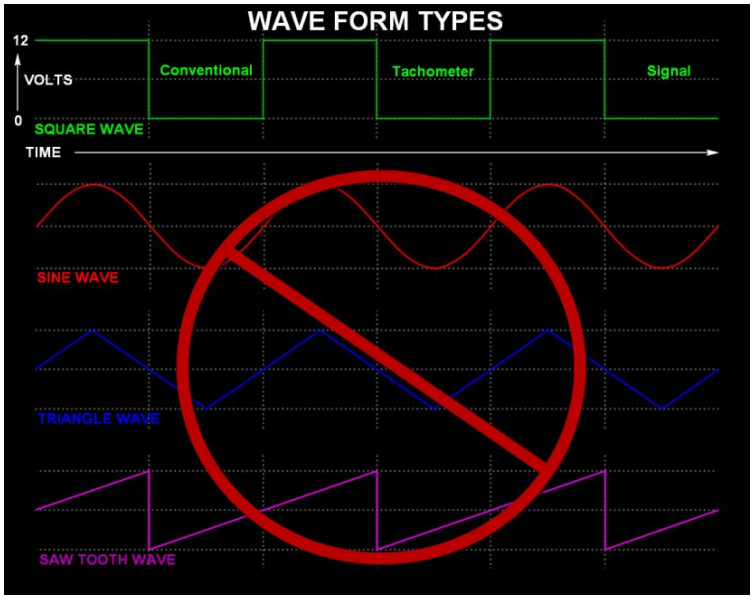
Trouble Shooting:

The Aeromotive FPSC has built-in safeguards to protect itself and the engine. The integrated processor on the circuit board is programmed to continuously monitor certain operating conditions including current draw, operating voltage and RPM input. If key operating conditions should fall outside of expected parameters, the FPSC may default into self protect mode, shutting itself and the fuel pump off. When this occurs, all LED indicator lights on the FPSC will flash in unison. ***Note: When power is removed from the IGN/PWR terminal (activation terminal) the FPSC LEDs will extinguish and the unit will reset. When power is reapplied, the FPSC will function normally until the fault condition reoccurs. If the fuel pump shuts off unexpectedly, and you wish to know whether the FPSC has entered "self protect" mode, check to see if the LED lights are flashing before turning off the ignition, or the fuel pump switch.***

Symptoms of common installation problems are outlined below, followed by detailed solutions for each. Go to the appropriate solution by clicking on the symptom, or scrolling down to the solution with the same number.

1) The correct, 12-V, square wave tach signal is not connected to the TACH terminal on the FPSC. Without the correct tach signal the FPSC can't read engine RPM, preventing it from varying the speed of the pump up and down with the engine. The Yellow "TACH" light may not flash, and/or the pump speed may not change. When the tach signal is incorrect or corrupted, the FPSC will not work, and it may shut itself and the pump off to protect the engine.

The tach reference required is described as a Square Wave, DC, 0-12V tach signal (with a dwell angle of 50ns and the ability to support current draw of 100 milliamps). This is a standard RPM signal that's been around since the early days of internal combustion engines. It's commonly used to drive aftermarket tachometers and is available at the coil-negative terminal of conventional, single-coil, 4-6-8 cylinder engines with a “points” style distributor.



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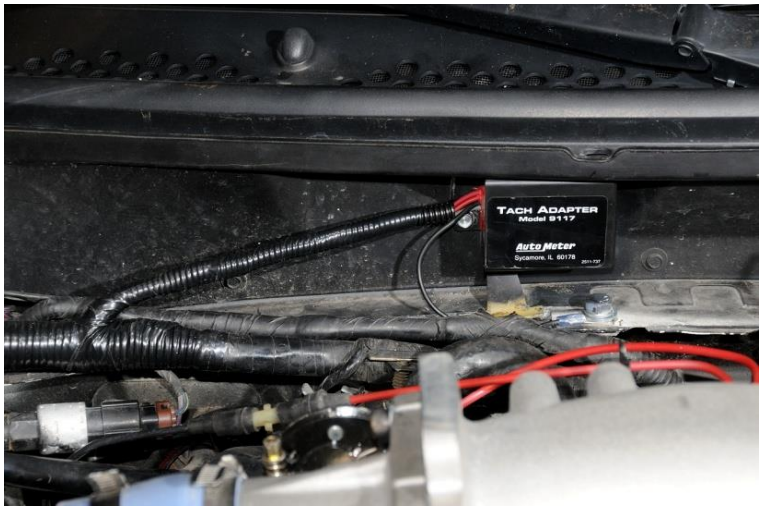


Today's multi-coil or "coil-on-plug" (COP) ignitions provide great ignition performance but are a poor source for a workable tach signal. No one, single coil can provide adequate signal frequency. For these applications a "Tach Adapter" is often used to pull the individual coil firing events together and generate the needed, 4-6 or 8 cylinder, square-wave signal. Tach adapters are available from several manufacturers:

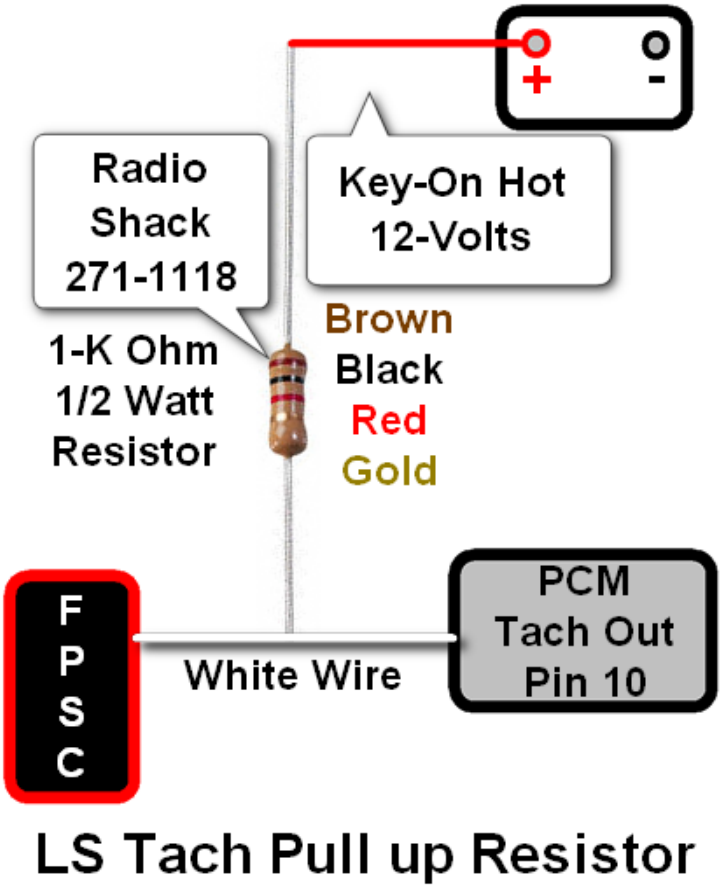
MSD P/N 8913
Autometer P/N 9117
Dakota Digital P/Ns SGI-5 and STA-1000.

Warning: Do not use the negative coil terminal for a tach signal on single coil, “multiple strike discharge” ignition like from MSD. The RPM signal is false-fast at the coil. Instead, use MSD's "tach-out" lead/terminal.

The GM LS series V-8 is one of today's most popular performance engine platforms, capable of excellent power in the OEM chassis and popular to transplant into a broad group of classic street rods and muscle cars. Retaining the OEM Powertrain Control Module (PCM) and COP ignition, a conventional, 12-Volt tach signal to run the FPSC is just not readily available.

As noted earlier, a tach adapter can work on most COP ignitions, including on the LS engine, but where the factory LS PCM is retained, it does provide a tach output signal, and it is the square wave type. However, it's a 0-5 Volt signal instead of the 0-12 Volt we need. Close, but no cigar, that is, at least not without some creative wiring to bring things "up" to speed...

Using a resistor, wired in what's called a "pull up" configuration, it's possible to raise the high-side of the OEM tach signal from 5-Volts to 12-Volts. In simple terms, we're supplying 12-Volts to the 5-Volt tach output provided by the PCM, but through a resistor, which acts to harmlessly "pull up" the signal voltage. Normally, a resistor like the one shown in the diagram at right is sufficient to raise tach voltage high enough to operate a standard tachometer and/or the Aeromotive P/N 16306 Fuel Pump Speed Controller (FPSC).



LS Tach Pull up Resistor

The resistor shown in the diagram is readily available from Radio Shack. Here is a link that will take you to their website where it can be ordered:

http://www.radioshack.com/1k-ohm-1-2w-5-carbon-film-resistor-pk-5/2711118.html#.VK9RAXuDMk4

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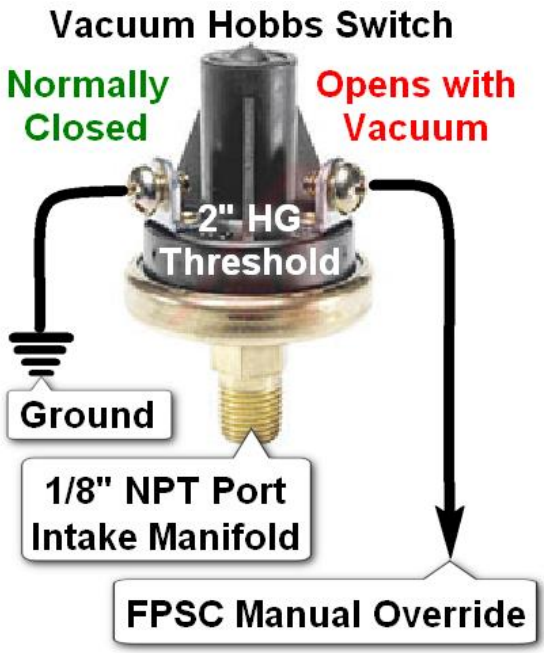
What if a good, clean tach signal just isn't available, or you don't want to control pump speed progressively with engine RPM? We can use the manual override to activate full speed, but it does turn the FPSC into a simple, two-step speed controller. Here the low-voltage stays flat and so must be set high enough to support up to medium load driving (10-11 Volts) and full pump speed is either triggered manually or by an externally switched ground signal to the manual override terminal in one step, at higher engine load.

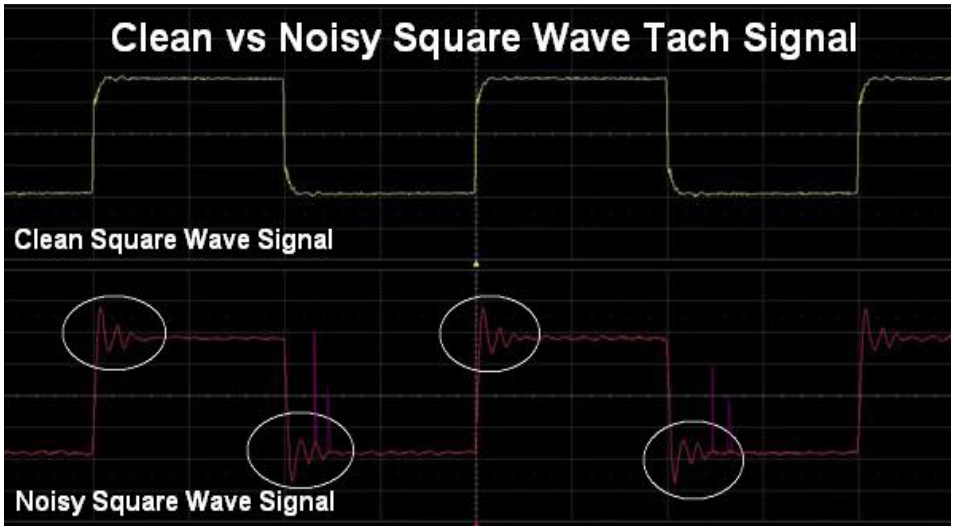


Though manual override activation is normally manually, with a little ingenuity, full pump speed may also be automated using a pressure sensing Hobbs switch, or a programmable output from an aftermarket PCM can be used. A vacuum or boost Hobbs switch can be installed in the intake manifold of any engine and is perfect for activating full pump speed with manifold pressure.

There are several pressure-sensing switch options, including a boost switch that turns on (closes) with boost, or a vacuum switch that turns off (opens) with vacuum. Between a vacuum and boost activated Hobbs switch, which is best? The vacuum switch is safer, faster and more flexible, and works equally well installed in the manifold of either a naturally aspirated or boosted engine.

The ideal Vacuum Switch will have a low threshold, between 2-3" HG, taking the pump out of high speed during light load-cruise and mild acceleration, but providing full pump speed before high engine load can develop. A vacuum switch is also safer than a boost switch, activating full speed before boost can build in the intake. Plus, if a pressure switch fails it typically fails in the "normal" position. A boost switch is "normally open", so if it fails, it fails to close and the pump stays at low speed all the time, not good. A vacuum switch is "normally closed", so if it fails, it fails to open, leaving the pump in full speed all the time, far better. Vapor lock on a hot day is inconvenient, but fuel starving the engine could be far worse.

Finding a quality vacuum switch can be tricky. Industrial suppliers are typically a good resource for things like this, but not all will sell to the general public. Digikey is an "industrial supply" class company that does sell to commercial and retail customers. Click on, or Copy and paste this link into your web browser address bar for more information, including specifications, pricing and availability, it takes you directly to the product page for the recommended vacuum switch.
Vacuum Hobbs Switch from Digikey Corp:
http://www.digikey.com/product-detail/en/77343-02.0HG-01/480-2060-ND/1162790



2.) The TACH signal is corrupted or "dirty" due to signal noise or EMI (electro-magnetic interference).
If an EMI problem, or a corrupted tach signal exists, the FPSC can't correctly identify engine RPM, causing the pump to surge randomly. If you suspect there is a signal noise issue, check to see if the "FULL" light is randomly flashing at idle. You can test for this condition by pulling the tach lead off the FPSC and driving the car easy, ***part throttle only***, but varying RPM up and down. If no default shutdown occurs with the tach wire disconnected, signal noise is the likely cause. Continue reading to learn about several solutions to this problem.

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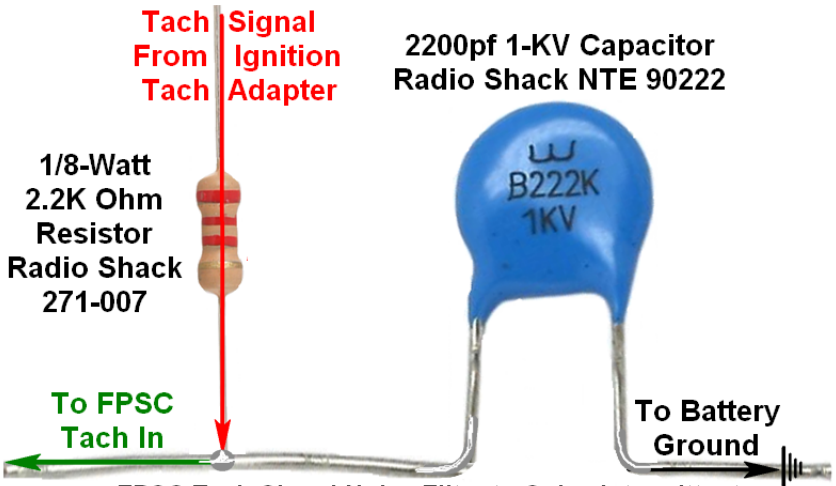
As long as we have a legitimate 12-Volt, Square Wave Tach Signal to start with, EMI noise problems may be minimized by rerouting the tach signal wire away from other components or wires in the harness. Noise can be induced from one wire into another by just being close together.

When an aftermarket tachometer is installed and shares the same tach signal as the FPSC, some tachs have been found to back-feed signal noise into the circuit. To avoid this, route the tach wire from the ignition box (or tach adapter) to the FPSC first and then from the FPSC to the tach.

If noise related problems persist, a simple EMI noise filter can be constructed using a resistor and a capacitor, as illustrated in the diagram at right. This combination has proven very effective in filtering excessive noise to a minimum, helping providing a clean tach signal the FPSC can work with.



FPSC Tach Signal Noise Filter to Solve Intermittent LED-Full Light On at Idle and Low-Speed Engine Operation

1.) Acquire resistor and capacitor per specs, Radio Shack Model #s provided.
2.) Bend Capacitor Leads and Solder Gold Band side of Resistor to one capacitor lead.
3.) Remove Tach Signal Wire from FPSC and Solder to Red Band side of Resistor.
4.) Solder New Wire to Capacitor After Resistor and Connect to FPSC Tach In Terminal.
5.) Solder New Wire to Remaining Capacitor Lead, Route and Connect to Good Ground.
6.) Insulate All Bare Leads and Connections With Shrink Tube and/or Electrical Tape.

Click the hyper-links below or copy and paste them to your browser address bar, they are direct to the product's page:
Radio Shack 2200pf 1KV Ceramic Disc Capacitor:
http://www.radioshack.com/nte-90222-cap-cer-disc-2200pf-1kv/55047614.html#.VJ8gi_8MAA

Radio Shack 1/8-Watt 2.2K Ohm Resistor:
http://www.radioshack.com/1-8-watt-2-2k-ohm-carbon-film-resistors-5-pack/2710007.html#start=13&q=resistor%2B2.2k&sz=12

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3.) Supply voltage to the FPSC terminal(s) marked IGN/PWR and/or BAT fall below 9-volts during operation.
To function correctly, the Aeromotive FPSC requires a stable, 12-Volt DC power supply to the on-board processor at all times. The FPSC monitors system voltage on the "IGN PWR" terminal (commonly referred to as the trigger terminal), and the "BAT" terminal. ***For the fuel system to prime and the engine to start and run properly, the fuel pump must run when the key is in the "run" and the "crank" positions***. The IGN terminal on most ignition switches will provide power in run and crank, however excessive components wired to the IGN terminal often result in an overload of the ignition circuit/switch. If voltage drops below 9-Volts through the switch, during crank, it can cause a default shutdown.

During engine crank-to-start, the electrical system carries the highest electrical load, during which system voltage drops to the lowest level possible. All electrical components are affected. For the engine to start reliably the pump must run while the starter is cranking. This means the battery must be fully charged, in good operating condition, and the FPSC must be wired correctly.

If you find all LED lights flashing after a failed attempt to start the engine, remove the wire connected to the IGN/PWR terminal and temporarily replace it with a test jumper routed from the "BAT" to IGN/PWR terminals. Once the jumper is connected and the pump runs, attempt to crank and start the engine. If the engine starts and runs, voltage-drop is the problem. Continue reading to learn how a relay on the IGN/PWR circuit solves the issue.

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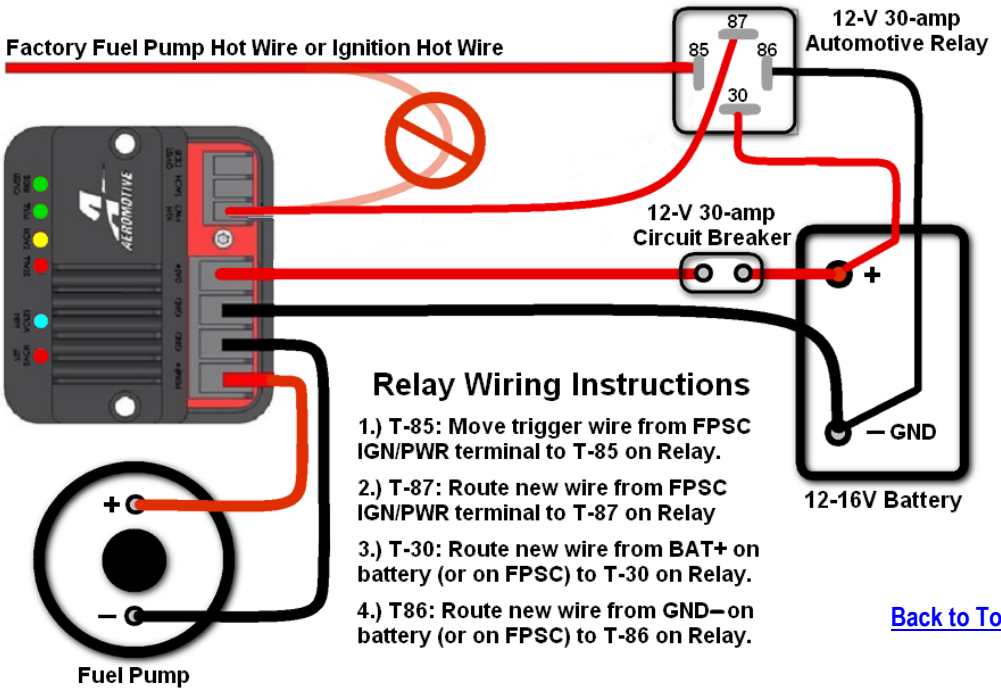
Using the schematic below, install a standard, 30-amp automotive relay (available from any auto parts store) to resolve voltage drop through the ignition switch, preventing a default shutdown while cranking. Note: the problem circuit is removed from the "IGN PWR" terminal and relocated to the relay pin 85 instead. The relay is less sensitive to voltage drop, staying on in crank and masking the voltage drop problem, preventing it from affecting the FPSC trigger circuit.

FPSC Trigger Wire with Relay to Solve Default Shutoff in Crank



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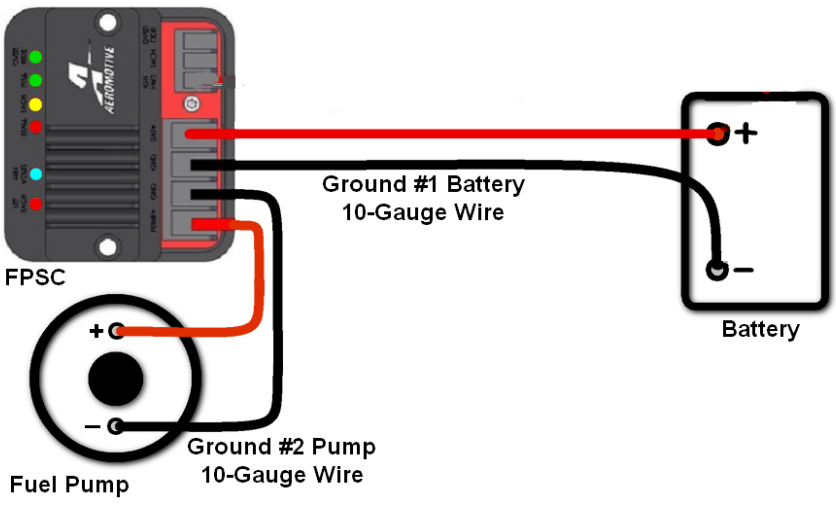
4.) Ground wiring for the FPSC is not made per instructions, or wire terminal ends and/or splices are poor or faulty. The Aeromotive FPSC ground circuit must be routed per the installation instructions. Failure to do so may result in the unit defaulting into self protect mode. The FPSC uses a frequency of on-off to drive the speed of the fuel pump. This is also referred to as PWM or "pulse width modulation" motor-drive control. The frequency of on-off is so rapid that the pump never seems to actually shut off, but the pump speed is effectively varied up and down without harming the pump.

Correct wiring of the FPSC includes particular attention to the ground circuit, including that of the fuel pump and the FPSC. The new generation Aeromotive FPSC, P/N 16306, incorporates a ground terminal for the unit itself, to battery ground, and another for pump ground.

FPSC P/N 16306
Dual Ground Wiring Schematic



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In order to ensure a proper, matching ground path for both the pump and the controller, it is necessary to route the provided 10-gauge black wire from the fuel pump ground to one of the two FPSC ground terminals. Then, route the included, 10-gauge black ground wire from the FPSC to the battery ground cable (either end of that cable, at the battery or at the chassis is an acceptable connection point). This ensures that the path to ground for both the fuel pump and the FPSC have equal (no differential) resistance, allowing the FPSC to consistently and properly control pump speed.

Properly crimped or soldered wire connections and terminal ends are critical to allow full voltage and current to be available to the pump during full speed operation. A solid, correctly crimped or soldered connection requires terminal ends match wire gauge and that suitable tools are used properly. Though soldered connections are great, crimped connections can be just as effective and durable if done right.

When crimping terminal ends a compound crimp pliers, equipped with the appropriate jaws for the type of terminal being used, providing excellent results. The recommended tools are available at many local Speed Shops or online from Summit Racing, Jeg's, Amazon, etc.

Recommended Crimping Tools
MSD Crimp Tool: P/N 35051
MSD AMP Lug Jaws: P/N 3507

Soldered connections are considered the ultimate electrical connection by many, but this is true only if soldering is done right. Use of a butane torch or soldering iron and quality, rosin core solder suitable for electrical connections is required. All soldered connections must be insulated upon completion with suitable shrink tubing and or electrical tape. Correct tools for effective soldering are available from local tool and electrical supply companies or may be purchased online from companies including Amazon, Granger, McMaster Carr, etc.

Recommended Soldering Tools
Blazer Micro Torch: P/N GB2001
Kester 44 Rosin Core Solder 60/40 .031 1 lb. Spool

Crimping Terminal-Ends Correctly
1.) Wire stripped correctly for terminal length.
2.) Proper Crimp provides tang compression.
3.) Proper Crimp provides wire strain relief.

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5.) Current draw through the FPSC has exceeded design limitations, causing the "STALL" light to illuminate.
The Aeromotive Fuel Pump Speed Controller is engineered as a heavy-duty power supply, capable of supporting modern, high flow electric fuel pumps that can draw up to 25-amps continuously. It is not suitable for a fuel pump or pumps that will exceed 30-amps continuous current draw, or for applications where peak current draw exceeds 40-amps. If the red "STALL" LED illuminates, find the cause of excess current draw before continuing use.

WARNING: ***Operating the Aeromotive P/N 16306 Fuel Pump Speed Controller in applications that illuminate the "STALL" light may result in excessive heat, poor fuel pump performance and damage to the FPSC itself.***

If the pump being run by the FPSC has not previously created excessive current draw, illuminating the "STALL" LED, check for flow restrictions after the fuel pump, including and especially any fine, post filters located downstream. A clogged post filter can create extreme fuel pump pressure and attending high current draw. Systems employing large, high flow fuel pumps, can experience enough back pressure to drive current draw above and beyond acceptable limits.

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